ANNUAL REPORT
CTUIR GRANDE RONDE WATERSHED RESTORATION PROJECT
A Columbia River Basin Fish Habitat Project

Northwest Power Planning Council Project # 1996-083-00

Report covers work performed under BPA Contract 73982 REL 161
May 1, 2022 to April 30, 2023

Prepared By:
Allen Childs, Project Leader/Fish Habitat Biologist
Jake Kimbro, Assistant Fish Habitat Biologist
Travis Dixon, Fish Habitat Biologist
Dave Mack, Fish Habitat Technician

Confederated Tribes Umatilla Indian Reservation
Department Natural Resources Fish &Wildlife Program
Pendleton, Oregon
Report Created: April, 2023

"This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA."

CONFEDERATED TRIBES UMATILLA INDIAN RESERVATION

BONNEVILLE POWER ADMINISTRATION

TABLE OF CONTENTS

TABLE OF FIGURES

List of Tables

Introduction

From time immemorial, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) culture and traditions have been interconnected to natural resources. The CTUIR retains aboriginal and treaty-reserved rights for fishing, hunting, pasturing of livestock, and gathering plant food and medicine throughout its Aboriginal Use Areas. Traditional access and use of available resources continue to be threatened by land and water development, watershed degradation, and climate change.

Efforts under this project provides support towards the overall Fisheries Habitat Program goal to protect, enhance, and restore functional floodplain, channel and watershed processes to provide sustainable and healthy habitat for aquatic First Food species (http://fisherieshabitat.ctuir.org/). Our Fisheries Habitat Program's hierarchical approach to restoration strategic planning, project development, and implementation and monitoring is guided by the CTUIR Department of Natural Resources (DNR) "First Foods" Mission and Policy (Quaempts et al 2018), which identifies physical and ecological processes ("key touchstones") of a highly functional and dynamic watershed important for providing water quality and fish habitat that supports First Foods integral for Tribal ceremonies and traditions (Umatilla River Vision, Jones et al. 2008; Upland Vision, Endress et al. 2019).

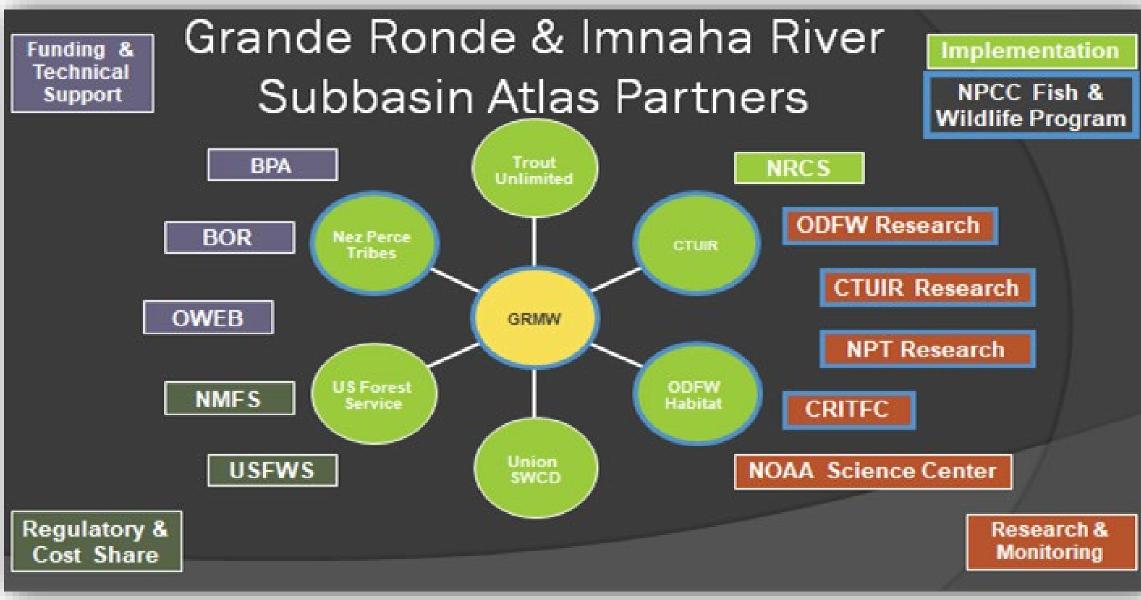
The CTUIR manages and implements multiple programs in the Grande Ronde, Umatilla, John Day, Walla Walla, and Tucannon River Basins under the Northwest Power Conservation Council (NPCC), Bonneville Power Administration (BPA) Fish and Wildlife Programs and the Columbia Basin Fish Accords and Extensions (2008, 2018) to restore habitat that supports fishery resources including Threatened Snake River spring-summer Chinook salmon (*Oncorhynchus tshawytscha*), summer steelhead (*Oncorhynchus mykiss*), and bull trout (*Salvelinus confluentus*).

Background

The CTUIR Grande Ronde Watershed Restoration Project (1996-08-300) was initiated in 1996 under the NPCC-BPA Early Action Project process to fund the CTUIR to engage the CTUIR in basin conservation planning and fish habitat restoration. The CTUIR is a core partner with

Grande Ronde Model Watershed (GRMW) Project (1992-026-01), Oregon Watershed Enhancement Board (OWEB), Focused Investment Program (FIP), and multiple basin resource managers. The CTUIR is represented on the GRMW Board of Directors, OWEB Core Partner Committee, and multiple technical teams and committees involved in basin planning and project prioritization through the GRMW Atlas.

Annual operating budgets have ranged from $61,000 in 1996 to $1,139,545 in 2022 under the CTUIR-BPA Accord which has provided resources for project implementation, administration, planning, and project development. 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 been successful in the development and implementation of several large-scale 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, 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.

During the 24-year project history, the CTUIR has contributed to the development multiple fish habitat enhancement projects along 50+ river miles in the Grande Ronde Basin. In recent years the Project has developed, administered, and implemented six large-scale fish habitat and floodplain enhancement projects pursuant to the overall CTUIR Fisheries Habitat Program goal: "*Protect, enhance, and restore functional floodplain, channel and watershed processes to provide sustainable and healthy habitat for aquatic species of the First Food order.*" Guidance from the CTUIR's River Vision has facilitated the shift towards larger, contiguous stream reaches, and broader scale projects that focus on restoring floodplains and physical and hydrological process to form and maintain complex and diverse habitats using the Atlas project prioritization approach. See links below for additional information.

Annual Reports and Project Data

Grande Ronde River Basin

Project Area Description

The Grande Ronde River originates in northeastern Oregon's Blue Mountains and flows northerly 212 miles to its confluence with the Snake River in southeastern Washington at river mile 169 (NPCC, 2004). Historically, the Snake River and its tributaries were likely the Columbia River basin's most productive drainage for salmon and steelhead, supporting more than 40 percent of all Columbia River spring and summer Chinook salmon and 55 percent of summer steelhead (NOAA, 2017). By the late 1800's, fish populations in the Grande Ronde were declining with sockeye and Coho being extirpated in the early 1900's.

Declines in Chinook, steelhead, and other native fish resulted in Tribal governments and State agencies eliminating or significantly reducing subsistence and sport fisheries by the mid-1970's (NPCC 2004). Further decline in salmon and steelhead returns led to Federal Endangered Species Act (ESA) Threatened listings of Snake River Spring-Summer Chinook and Summer Steelhead in 1992 and 1994 respectively (NOAA, 2017), and Columbia Basin Bull Trout in 1999 (USFWS, 2014). The Grande Ronde River and tributaries provide critical habitat for Snake River Chinook salmon, steelhead, and bull trout.

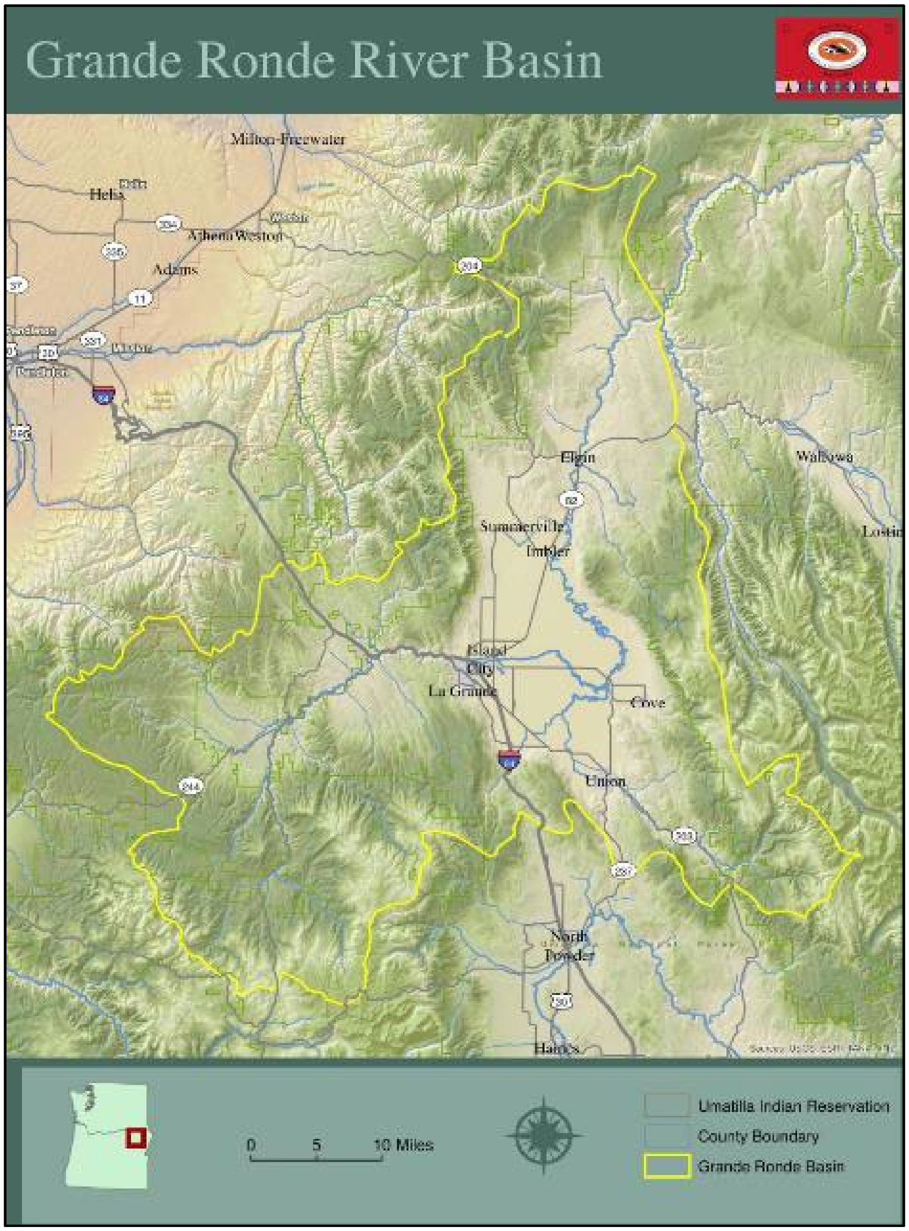


FIGURE 1 UPPER GRANDE RONDE SUBBASIN VICINITY

Degradation of instream and riparian habitat in the Grande Ronde Basin has been the dominant in-Basin cause of salmon and steelhead decline (NPCC 2004). Land use activities since the early 1800s include beaver trapping, logging, splash damming, grazing, mining, channelization, water withdrawals, road and railroad construction, and urban development. Past activities have degraded aquatic habitat conditions with extensive channel simplification (White et al. 2017, pg. 212-213), loss of large pool habitat (McIntosh 1994), significant thermal loading, and loss of cold-water refuge (Justice et al. 2017, Ebersole et al. 2003).

The Oregon Department of Environmental Quality (ODEQ) listed over 60 stream reaches in the basin on Oregon's list of water quality limited water body's 303 (d), 24 of which are listed for habitat modification, 27 for sediment, and 49 for temperature (NPCC 2004). Human-caused CO2 emissions have contributed to a summer warming trend of Pacific Northwest streams of approximately 0.14–0.27°C per decade between 1976 and 2015 (Isaak et al. 2017, 2018). Regional climate changes and forecasted warming trends are going to contribute to salmonid range contraction and decreased habitat capacity and suitability in the basin (Justice et al. 2017). Climate change is also expected to negatively influence hydrology and availability of water resources (Clifton et al. 2018), as well as increase pathways for invasive species (Rahel and Olden 2008).

Extensive evaluation of historic habitat degradation, current habitat condition, fish life histories, and habitat limiting factors have been the focus of ESA recovery planning, Biological Opinion (BiOp) Expert Panel, NPCC Fish and Wildlife Program as amended, basin planning (NPCC 2004), research and evaluation, and recent multi-disciplinary/agency strategic planning efforts. BPA and GRMW facilitated these efforts in the development of the Grande Ronde and Catherine Creek Atlas (Atlas) and Atlas User Guide (BPA et al. 2015 and 2017). The purpose of Atlas is to focus Basin partner efforts towards the most important restoration priorities in the right locations, right order, and focused on a process-based, landscape approach (BPA 2017). The core elements of Atlas are the integration of monitoring and research findings associated with focal fish limiting factors, habitat suitability, and life history requirements and the facilitation of much needed communication and collaboration between basin partners in the evaluation, prioritization, and development of restoration actions.

Additionally, the Atlas delineated biologically significant reaches (BSR) and associated life history use/timing, habitat limiting factors, prioritized habitat actions, and habitat objectives, providing a central location of data and a strategic approach that facilitates consistent project planning, development, and coordination within the basin partnership. The Atlas is an iterative and adaptive set of procedures adjusted to incorporate new empirical data, published research evidence, results from projects, and evolving local knowledge. The Atlases have been instrumental in promoting partner collaboration, and building a consistent framework for identifying, selecting, funding, and implementing restoration efforts in core Chinook salmon and steelhead habitats. In summary, the Atlas identifies the following critical life stages and limiting factors:

Catherine Creek Atlas

- Juvenile outmigration - high mortality rate
- Adult Chinook holding/spawning - high pre-spawn mortality rate
- Juvenile Chinook and steelhead summer/winter rearing - habitat capacity
- Adult Chinook immigration - thermal barriers

Upper Grande Ronde Atlas

- Juvenile outmigration - high mortality rate
- Adult Chinook holding/spawning - high pre-spawn mortality rate
- Juvenile Chinook and steelhead summer/winter rearing - habitat capacity
- Adult Chinook immigration - thermal barriers
- Adult steelhead spawning - lack of pools

Wallowa/Imnaha Atlas

- Adult Chinook holding/spawning - lack of pools, sediment, regulated flows
- Juvenile Chinook and steelhead summer/winter rearing - habitat capacity, regulated flows
- Adult Chinook immigration - anthropogenic barriers, reduced flows

The importance of restoring salmon, steelhead, resident fish, and other natural resources is central to the CTUIR's culture and traditions. Our Fisheries Habitat Program's hierarchical approach to restoration strategic planning, project development and implementation, and monitoring is guided by the "First Foods" DNR Mission and Policy (Quaempts et al. 2018) and River and Upland Visions (Jones et al. 2008; Endress et al. 2019). The CTUIR First Foods concept of "reciprocity" comes from a creation belief that acknowledges a moral and practical obligation that humans and the natural biota have to care for and sustain one another. This belief arises from the human gratitude and reverences for the contributions these First Foods make to sustain human kind. The River Vision identifies physical and ecological processes ("key touchstones") of a highly functional watershed and dynamic river system important for providing water quality.

The CTUIR's habitat objectives and Atlas objectives were developed and linked to target species life histories and limiting factors with habitat action types specified and assigned for specific habitat uplift. (CTUIR Fisheries Habitat Program)

CTUIR habitat programs tier to the NPCC Fish and Wildlife Program (NPPC 2014 and 2020 Amendments) with consistent goals and objectives associated with rebuilding Columbia and Snake River native fisheries. CTUIR programs focus on conserving and protecting the best remaining habitat (particularly cold-water refuges), reconnecting habitat and corridors, prioritizing near term resources in core areas, and building out to interconnect habitats and life stages. Floodplain restoration, hydrologic and geomorphic processes, groundwater and hyporheic functions, and habitat diversity and complexity are core features of ecological diversity and resilience.

The vision for the 2014 NPCC Fish and Wildlife Program is "a Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife, supported by mitigation across the basin for the adverse effects to fish and wildlife caused by the development and operation of the hydrosystem. This envisioned ecosystem provides abundant opportunities for tribal trust and treaty-right harvest, non-tribal harvest, and the conditions that allow for restoration of the fish and wildlife affected by the construction and operation of the hydrosystem" (NPCC 2020).

Project Goals and Objectives

The goal of CTUIR's tributary habitat programs is to protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic First Food species. Objectives are a means of achieving stated goals and include 1. Habitat protection and conservation, 2. Floodplain connectivity, 3. Channel morphology, 4. Instream structure and complexity, 5. Riparian restoration, 6. Water Quality, and 7. Fish passage.

TABLE 1 - PHYSICAL HABITAT OBJECTIVES

Physical Objectives	Description	Measureable Criteria	Monitoring Technique	Effectiveness Criteria	Notes
1. Habitat protection and conservation	• Fee title acquisition • Term conservation easement	• Protected acreage	• Bi-weekly livestock trespass monitoring • Fence/water gap inspection • Boundary inspection	• Increased acreage protected	1. Livestock exclusion, direct benefit for riparian protection. 2. Habitat program directly involved with planning/management of acquisition/easements,
2. Floodplain reconnection	• Restore connectivity to promote hydrologic and physical processes that maintain complex and resilient habitats that hydrate/store, attenuate floods, and buffer water temperature.	• Inundation @ annual 1.25 flood flow • Summer base flow • Acreage inundated • Ground water elevations • Beaver habitat suitability (# acres)(**see notes**)	• UAV Imagery (remote sensing) • Groundwater wells • Stage recorders • Piezometer	• Inundated acreage (annual) • Groundwater elevation in relation to ground surface • Summer base flow discharge • Increase acre-foot (af) storage	1. Valley form and stakeholder/landowner buy-in are limiting factors for max potential of floodplain connectivity. 2. Increase floodplain connectivity as discharges increase without increasing flood damage to nearby infrastructure (if present). 3. Beaver habitat suitability will correlate with floodplain acreage.
3. Channel morphology restoration	• Increase stream length and channel complexity	• Lengths of main channel and side channels (miles) • Number of pools (**see notes**) • Sinuosity • Node density • Maintain side-channel activation	• Longitudinal profile • UAV (remote sensing) • River complexity index (RCI)	• Increase main and side channel lengths • Increase sinuosity (geomorphic template) • Increase pools (4'depth)/mi • Higher RCI than pre-project conditions • Side-channel and peripheral habitat persistence	1. RCI will follow standard protocol of Brown 2002. 2. Deriving a target value of pool frequency will be consistent with McIntosh et al. 2000 coupled with Rosgen morphology and BOR Tributary Assessment. 3. Sinuosity is contingent on geomorphic template of project reach.
4. Instream habitat structure and complexity	• Increase large wood (LW) in project reach	• Wood loading (pieces/mile) commensurate with reference condition wood loading (**see notes**)	• Survey prior to project start • UAV(remote sensing)	• Increase pieces/mile in relation to design based on reference	1. It is expected wood loadings will vary due to recruitment and dismissal of LW. 2. Large wood frequencies within the bankfull channel will be correlated to quantities associated with reference conditions (AQI 2005, CHaMP 2013-2015, Mcintosh et al. 1994). 3. Bioclimatic region, drainage area, and channel width are dominant predictors of instream wood load (Wohl et al. 2017).
5. Riparian restoration and management	• Restore riparian and floodplain vegetation	• Percent vegetation cover	• UAV imagery (remote sensing) • Stock/stem survival • Photo points	• Year 5: >80% fully vegetated (herbaceous cover, including sedges and rushes/herbaceous) • Year 5: 20% riparian and forest shrub tree cover • Year 25: >50% riparian and forest shrub tree cover	1. Riparian vegetation will be assessed through a combination of remotely sensed imagery and on-the-ground surveys. 2. Monitoring of vegetation can extend out to 15 years post-project completion.
6. Water quality	• Improve summer and winter altered thermal regime	• Stream temperature	• Forward looking infrared (FLIR) • Thermographs • Maximum Weekly Maximum Temperature (MWMT) • Diurnal fluctuation range	• Reduce # days under 25°C (lethal limit) • Increase #days within 10°C and 18°C (core cold temps for salmonids)	1. Contingent on funding availability, hyporheic exchange would be monitored.
7. Fish passage	• Improve fish passage for all life stages of targeted species (steelhead, chinook salmon, bull trout, and Pacific lamprey)	• Overflow capacity for floodplain connection • Native fish species present • Life history stages that require fish passage	• ODFW Fish Passage Criteria (635-412-0035)(**See notes**)	• Miles of restored or improved passage for targeted species	1. ODFW Chapter 635: Division 412 Fish Passage – 635-412-0035

Biological Objectives

Fish response to habitat actions for the Project are conducted by the CTUIR Grande Ronde RM&E Project (#2009-014-00). Biological objectives related to our habitat project are described in the RM&E proposal and were developed to assess the biological response to habitat actions. Physical habitat objectives were developed based on fish life histories, limiting factors and actions described in detail in the Atlas.

Biological Objectives	Measureable Criteria	Monitoring Technique	Effectiveness/Statistical Criteria	Notes
1. Salmon/steelhead abundance	• Adult abundance by species • Juvenile abundance	• Electrofishing (**see notes**) • Snorkel Surveys • Minnow traps	• t-test for pre vs. post project mean, alpha = 0.05 • 25% Increase over baseline with data	• Adult abundance monitoring contingent on permit
2. Salmon/steelhead productivity	• Pre-spawn survival • Trib survival of seasonal parr • Smolt-to-adult return (SAR)	• Adult weir (**see notes**)	• t-test for pre vs. post project mean, alpha = 0.05 • 25% Increase over baseline with data	• Only implemented on Lookingglass Creek • ODFW collects adult data within Grande Ronde basin.
3. Holding/spawning/ incubation/emerge nce	• Redd density by species (**see notes**) • Spatial arrangement of redds	• Spawning surveys (**see notes**)	• t-test for pre vs. post project mean, alpha = 0.05 • 25% Increase over baseline with data	• Gallagher et al. 2007

TABLE 2 BIOLOGICAL OBJECTIVES AIM TO ASSESS RESTORATION PROJECT EFFECTIVENESS FOR THE CTUIR RM&E: BPA PROJECT 2007-083-00

Habitat Protection and Conservation

The Project actively pursues properties for fee title acquisition, conservation easements, and water conservation.

Floodplain Reconnection

Historic anthropogenic activities have severely altered floodplains, channel morphology and thermal regime contributing to habitat loss, degradation, and productivity of cold water fishery habitat. Our floodplain objective is to restore the connection of rivers to their floodplain, recognizing the "River is the Floodplain." Floodplains perform diverse physical and ecological functions, including attenuation of water, sediment and organic matter, storage, and organic matter (Wohl 2020). Floodplains are a repository of water, wood, sediment and nutrients, are resilient, and have high intrinsic value for ecological services, productivity, and resilience. The floodplain objective is to reconnect rivers to the historic floodplain and promote processes and function that creates and maintains habitat.

Channel Morphology Restoration

Main channel, side channels, pools, and off-channel areas provide rearing habitat for salmonid and other fish species, during all life stages. The Project aims to directly increase stream length and channel complexity to meet the needs of native fish species. Project restoration actions aim to restore or enhance main channel, side channel, and off-channel habitat, which include reconnecting or constructing perennial side channels, secondary channels, high-flow channels, floodplain ponds, wetlands, alcoves, and groundwater-fed off-channel habitat. The Project works with partners to evaluate the geomorphic template of the valley floor and hydraulics of given project reaches to determine the appropriate construction methods and utilizes comprehensive geomorphic assessment methods coupled with Rosgen morphology, BOR Tributary Assessments, and the River Complexity Index (RCI) to support desired project conditions.

Instream Habitat Structure and Complexity

Objective is to restore large wood density to increase complexity, cover, and complexity, consistent with reference conditions in the area (Wilderness areas, Minam basin) (McIntosh et al. 1994, White et al. 2017, Wohl et al. 2017).

Riparian Restoration and Management

Floodplain and river connection objectives are directly related to riparian objectives. Restoring floodplains promotes hydrologic and disturbance regimes that support moist soil conditions and hydrophilic vegetation. Encouraging development of conditions that generate natural recolonization of native sedges/rushes, shrubs, and trees and a variety of seral stages is preferred to artificial planting efforts. However, planting and seeding plans are implemented to facilitate riparian vegetation establishment. Riparian objective is to enhance or re-establish riparian vegetation communities along stream reaches to increase riparian habitat diversity, restore canopy cover to increase shading, improve beaver habitat and facilitate beaver recolonization, and increase the likelihood of large wood recruitment over time.

Water Quality

Thermal restoration is dependent on restoring floodplain hydrology and channel morphology that promotes water storage, hyporheic functions, and restoration of riparian and wetland vegetation. Floodplain attenuation contributes to hyporheic lag, providing cold water refuge during summer and warm water refuge during winter. See methods section for additional detail and references. Water quality improvement is a large task in a severely degraded thermal regime and broad actions are required to address these core limiting factors. In addition to floodplain, morphology, and riparian restoration, partners are active in water transactions, water purchases, coordinating with local farm bill programs to establish greenbelts, conservation easements and riparian restoration, and water conservation programs associated with irrigation.

Fish Passage

Reviews of the effectiveness of habitat improvement have consistently reported removal of barriers or installation of fish passage as one of the most effective at increasing fish numbers and highest priority habitat improvement measures for salmon, steelhead, and other stream fishes (Roni et al. 2002, Roni et al. 2008). The Project aims to improve fish passage in the Basin and works with The Umatilla Tribe Ceded Area Juvenile and Adult Passage Improvement Project (Project # 2009-026-00) and the US Forest Service to identify potential fish impediments (typically culverts), and restore longitudinal connectivity to impacted streams.

Recent Notable Watershed Restoration Efforts

Restoration actions during the period 2014 to 2022 have resulted in reconnecting 455 acres of floodplain habitat, protection of 1,083 acres of floodplains, uplands, and riparian areas through permanent and term conservation easements, 157 acres of floodplain and riparian habitat planted with over 47,000 native trees and shrubs, 13.5 miles of main channels restored or enhanced, 8 miles of side channels constructed, 147 large main channel pools created or enhanced, 74 side channel pools created or enhanced, and 589 large wood structures installed.

Notable CTUIR efforts in the Grande Ronde Basin include: fee title land acquisitions in the Catherine, Meadow Creek/Dark Canyon, and Lookingglass watersheds and implementation of large projects along Catherine Creek (CC44 Southern Cross), and the Grande Ronde River (Rock Creek, Bird Track Springs, Middle Upper Grande Ronde, and Longley Meadows). Since 2014, the project has sponsored six watershed projects in cooperation with partners, including the GRMW, OWEB, BPA, Bureau of Reclamation (BOR), Wallowa-Whitman National Forest (WWNF) and private landowners, encompassing over 4,135 acres of permanent habitat conservation (fee title acquisitions and permanent easements), 606 acres of term conservation easements, 348 acres of floodplain reconnection, 14 river miles of habitat restoration/ enhancement, creation/enhancement of 248 large and small pools, and over 400 miles of fish passage improvement (See CTUIR Umatilla Tribe Ceded Area Juvenile and Adult Passage Improvement Project # 2009-026-00).

Future project efforts include continuation with technical assistance on partner-sponsor projects (ODFW Catherine Creek Hall Ranch, WWNF Grande Ronde River Vey Meadows), and design and implementation of the following projects: 1) Middle Upper Grande Ronde River Phase 2 & 3 (2023), 2) Catherine Creek RM42 Fish Passage Project (2023), 3). McCoy Meadows Enhancements (2024-2025), 4) Lookingglass Restoration (2025). Additional project opportunities for conservation/protection, restoration, and passage will be ongoing and adjust to priorities and schedules with coordination through the GRMW partnership.

Noteworthy Accomplishments, FY2022

- Administered BPA contract for Grande Ronde Watershed Project. Highlights include personnel, purchasing, subcontracting for services, basin coordination, planning and design, and environmental compliance planning.
- Maintained and monitored conservation easements on the Grande Ronde River, Catherine Creek, Rock Creek, Meadow Creek, McCoy Creek, and Dark Canyon Creek (Figure 2*)*.
- Initiated planning, field surveys, and design on projects planned for construction through 2022 including:
    - Completed Middle Upper Grande Ronde River (MUGRR) Project Phase 2 and 3 construction drawings, issued construction contracts for material acquisition and helicopter construction, and stockpiled project wood and boulder materials during winter period to minimize disturbance. Construction planned for July 2023.
    - Continued planning and design and on Catherine Creek Hall Ranch as partner, Lookingglass Conservation Property, McCoy Meadows Conservation Property and the Catherine Creek RM 42.5 Passage and Habitat. Provided technical assistance to USFS for Grande Ronde River Vey Meadow Project Design and initiated planning for gravel augmentation to MUGR project reach.
- Project Leader participated on the Grande Ronde Model Watershed Board of Directors and Technical Team.
- Project Leader and Assistant Biologist participated in the Technical Implementation Team as part of the GRMW Step Wise and Atlas Strategic Planning and Project Development Process.
- Staff conducted monitoring and evaluation activities on project areas, including expanded water temperature and groundwater monitoring efforts at restoration sites, photo point documentation, and UAV drone flight coordination.
- Assisted fish salvage operations conducted by CTUIR John Day Watershed Restoration, ODFW Grande Ronde Fish Habitat, and Union County Soil and Water Conservation District at several locations along Catherine Creek and Hidaway Creek.
- Assisted CTUIR Grande Ronde M&E in conducting Chinook salmon redds surveys on Lookingglass Creek.

- CTUIR habitat staff supported other research and monitoring efforts at project sites including AEM and CTUIR physical habitat monitoring program such as juvenile salmonid population estimation and adult redds distribution surveys, large pool topographic data collection.
- Project Leader and Biologists presented at meetings and information sessions including GRMW State of Science, GRMW Technical Team, and LaGrande Rotary Club.
- Staff led multiple project tours, including GRMW Board of Directors, USFS Regional staff, local placed-based planning group, and Columbia Basin Tributary Habitat Team.
- Pursued future restoration opportunities by continuing discussions with federal land managers and private landowners about restoration opportunities along Catherine Creek, Grande Ronde River, Meadow Creek, McCoy Creek, and Rock Creek.
- Project staff coordinated with landowners, NRCS, and USWCD to provide technical assistance for restoration project enrollment in EQIP, CREP, and OWEB small grants on Rock Creek (For the Girls LLC) and Jordan Creek Ranch.

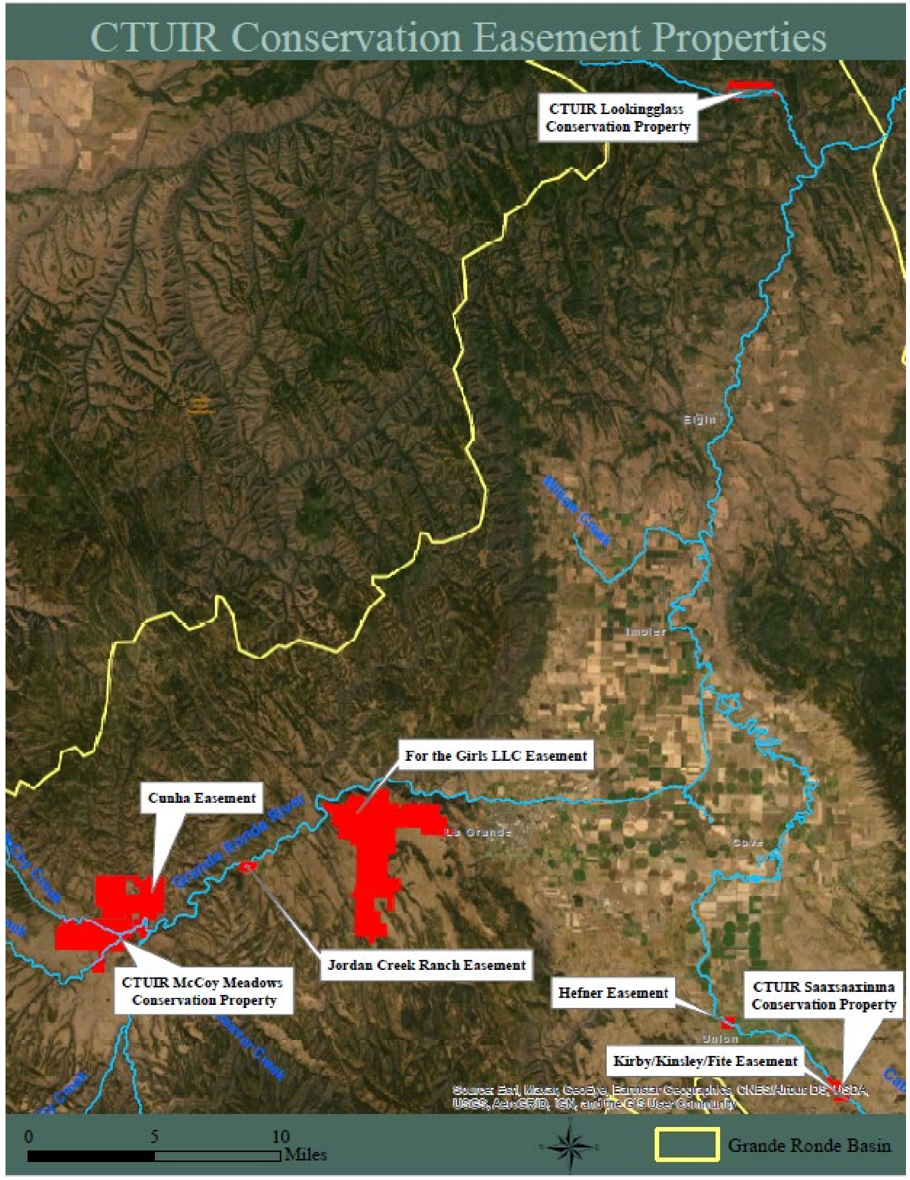


FIGURE 2 CTUIR CONSERVATION EASEMENT PROPERTIES MAP

FY 2022 Project Assessment

Bird Track Springs

In 2016, the CTUIR Grande Ronde Watershed Restoration Project partnered with BPA, BOR, U.S. Forest Service (USFS), and Cardno consultants to plan, design, and implement the Bird Track Springs Fish Habitat Enhancement project. The overall goal of the project was to improve habitat for ESA-listed Threatened Snake River Spring Chinook salmon, Summer Steelhead, and Bull Trout, and other species including resident trout, Pacific lamprey, neo-tropical migratory birds, and beaver. The project area encompasses 1.2 miles of river on the Wallowa-Whitman National Forest (WWNF) and 0.7 miles on privately-owned lands beginning at river mile 146.1 and ending downstream at river mile 144.2 (Figure 1). The project is located within the Atlas BSR UGR11. Funding for the project included grants through the Grande Ronde Model Watershed (BPA funding) and the Oregon Watershed Enhancement Board (OWEB) Focused Investment Program Funding (FIP). Restoration objectives included promoting instream structural diversity and complexity by reconnecting historic floodplain and side channel networks, promoting natural channel function and form, installation of large wood complexes that increase roughness, scour, sorting and storage of sediment, and development of riffle, pool, glide, side channel, and alcove habitats. Additional objectives included increasing beaver habitat suitability and recolonization that complement restoration activities and improve natural habitat forming processes that create floodplain wetlands, pools, and diverse riparian wetland plant communities. Project actions included main and side channel construction, boulder placement, large wood additions, and floodplain plantings. Project response has been encouraging with annual activation of island- braided morphology, restoration of large pool habitat morphological complexity, increased groundwater elevations and water storage, and riparian vegetation establishment.

Project construction was completed in November 2019 and experienced 2 consecutive ~50 year flood events in 2020 (6000+ CFS) and a ~10 year flood event in 2022 (4000+ CFS) which completely inundated the project area floodplain. Additional project response detail is documented in the following link. Bird Track Springs. Construction was implemented in two phases, beginning in the middle of August 2018 with completion in December 2019. Construction was implemented using GPS-controlled equipment which greatly contributed to effective project construction and accurate inspection.

The Project has been successful in improving channel/floodplain processes and function by reconnecting the historic floodplain, restoring morphological complexity (sinuosity, node/complexity), increasing habitat capacity and suitability (large pool habitat, wetted habitat, velocity refuge, diverse substrate/gravel, and cover), and restoring hydrologic function critical to hydrophytic plant communities that support fish and wildlife.

Metrics					
Floodplain reconnection (acreage inundated) (Existing/Restored)		Channel morphology (Existing/Post)		Instream habitat structure and complexity LWM: *key members	Riparian restoration (plants installed)
60 acres	135 acres	Main channel: 1.5 mi Side channel: NA # of pools: 1 Sinuosity: 1.2 RCI: 4.8	Main channel: 2.75 mi Side channel: 3 mi # of pools: 63 Sinuosity: 1.4 RCI: 18.2	439 pieces/mile	15,000

FIGURE 1: BIRD TRACK SPRINGS FISH HABITAT ENHANCEMENT PROJECT METRICS

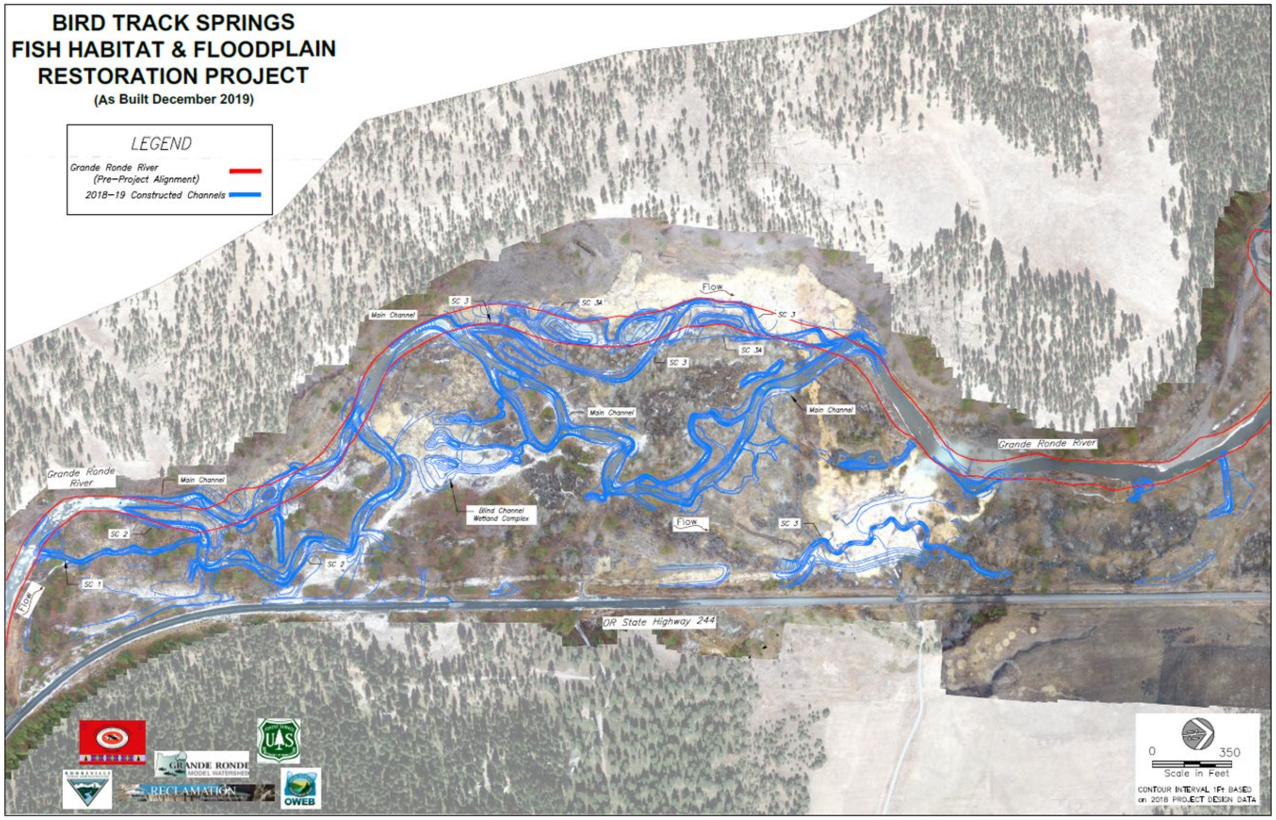


FIGURE 2: BIRD TRACK SPRINGS PROJECT OVERVIEW MAP

Project Objectives

The long-term rehabilitation vision (CTUIR's River Vision) for the Bird Track Springs reach of the Grande Ronde River is to improve physical and ecological processes by rehabilitating and restoring the project area to achieve immediate and long-term benefits to chinook, steelhead, and bull trout at all life stages. Benefits to salmonids will be achieved through restoration and rehabilitation of the whole floodplain ecosystem (Figure 2).

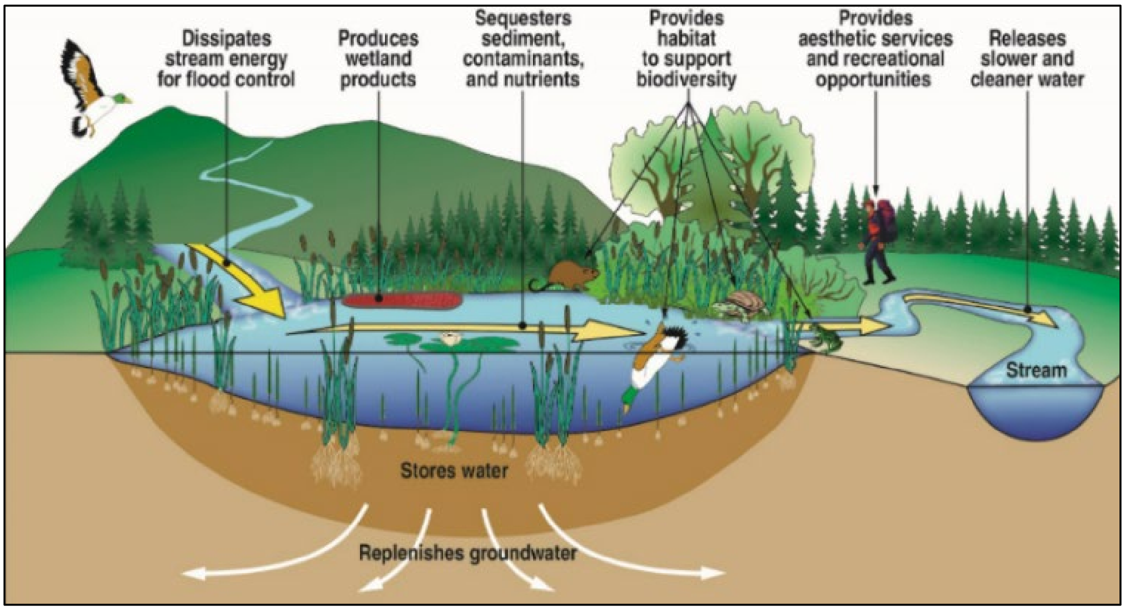


FIGURE 2: FLOODPLAIN RESTORATION BENEFITS

Objective 1 - Address Limiting Factor: Riparian Condition/Large Wood Recruitment

Facilitate development of a diversity of native plant communities and seral stages that contribute to floodplain process and function. In conjunction with natural channel and floodplain objectives, a combination of riparian/wetland habitat protection, planting and seeding, and natural recruitment will result in increased tree, shrub, and herbaceous plant communities that are resilient and self-sustaining, contributing to shade, structure, terrestrial food web, streambank stability, and future large wood recruitment.

Objective 2 -Address Limiting Factor: Peripheral and Transitional Habitats-Side Channel, Wetland, and Floodplain Conditions

Increase activation of historic flood prone areas by restoring channel morphology. A functioning floodplain recognizes that the river is the floodplain. Floodplain ecosystems contain morphologic and hydraulic diversity that support ecological processes in the creation and maintenance of diverse habitats and floral/faunal communities. Floodplain connectivity and diversity is the foundation for supporting aquatic food-webs, improving thermal diversity through hyporheic exchange, and the development of suitable conditions to restore a keystone species, the American Beaver.

Objective 3 - Address Limiting Factor: Channel Structure and Form - Bed and Channel Form/Instream Structural Complexity

Enhance in-stream structural diversity and complexity by reconnecting historic floodplain and side channel networks. Promote natural channel function and form by increasing instream and floodplain structural diversity through large wood complex additions that promote roughness, scour, sorting, and storage of sediment, and develop of a diverse assemblage of riffle, run, pool, glide, side channel, and alcove habitats.

Objective 4 - Address Limiting Factor: Water Quality-Temperature

Increase diversity and function of hydrodynamics that decrease summer maximum water temperatures, increase winter water temperatures, and moderate and buffer diurnal water temperature fluctuations during both summer and winter rearing periods. Apply restoration techniques that maximize the interaction and function of small and large scale hyporheic and groundwater exchange, reduce channel width-to-depth ratios, and decrease solar input to reduce temperature loading within the reach.

Monitoring

An intensive monitoring and evaluation effort is underway on the Bird Track Springs Project and downstream Longley Meadows Project areas to evaluate physical and biological response to large scale floodplain and riverine habitat restoration (Figure 4). Monitoring includes remote sensing for geomorphic and vegetation response, flow, groundwater elevations, groundwater and surface water temperature, development/restoration of hyporheic response, and biological monitoring (spawning and juvenile snorkel surveys during summer and fall/winter periods).

Fish response to habitat actions for the Bird Track Springs Project are monitored by the CTUIR Grande Ronde RM&E Project (#2009-014-00). Biological objectives related to Grande Ronde Watershed habitat projects were developed to assess the biological response to habitat actions. Physical habitat objectives were developed based on fish life histories, limiting factors, and actions (Figure 3).

Biological Objectives	Measureable Criteria	Monitoring Technique	Effectiveness/Statistical Criteria	Notes
1. Salmon/steelhead abundance	• Adult abundance by species • Juvenile abundance	• Electrofishing (**see notes**) • Snorkel Surveys • Minnow traps	• t-test for pre vs. post project mean, alpha = 0.05 • 25% Increase over baseline with data	• Adult abundance monitoring contingent on permit
2. Salmon/steelhead productivity	• Pre-spawn survival • Trib survival of seasonal parr • Smolt-to-adult return (SAR)	• Adult weir (**see notes**)	• t-test for pre vs. post project mean, alpha = 0.05 • 25% Increase over baseline with data	• Only implemented on Lookingglass Creek • ODFW collects adult data within Grande Ronde basin.
3. Holding/spawning/ incubation/emergence	• Redd density by species (**see notes**) • Spatial arrangement of redds	• Spawning surveys (**see notes**)	• t-test for pre vs. post project mean, alpha = 0.05 • 25% Increase over baseline with data	• Gallagher et al. 2007

FIGURE 3: BIOLOGICAL OBJECTIVES AIM TO ASSESS RESTORATION PROJECT EFFECTIVENESS

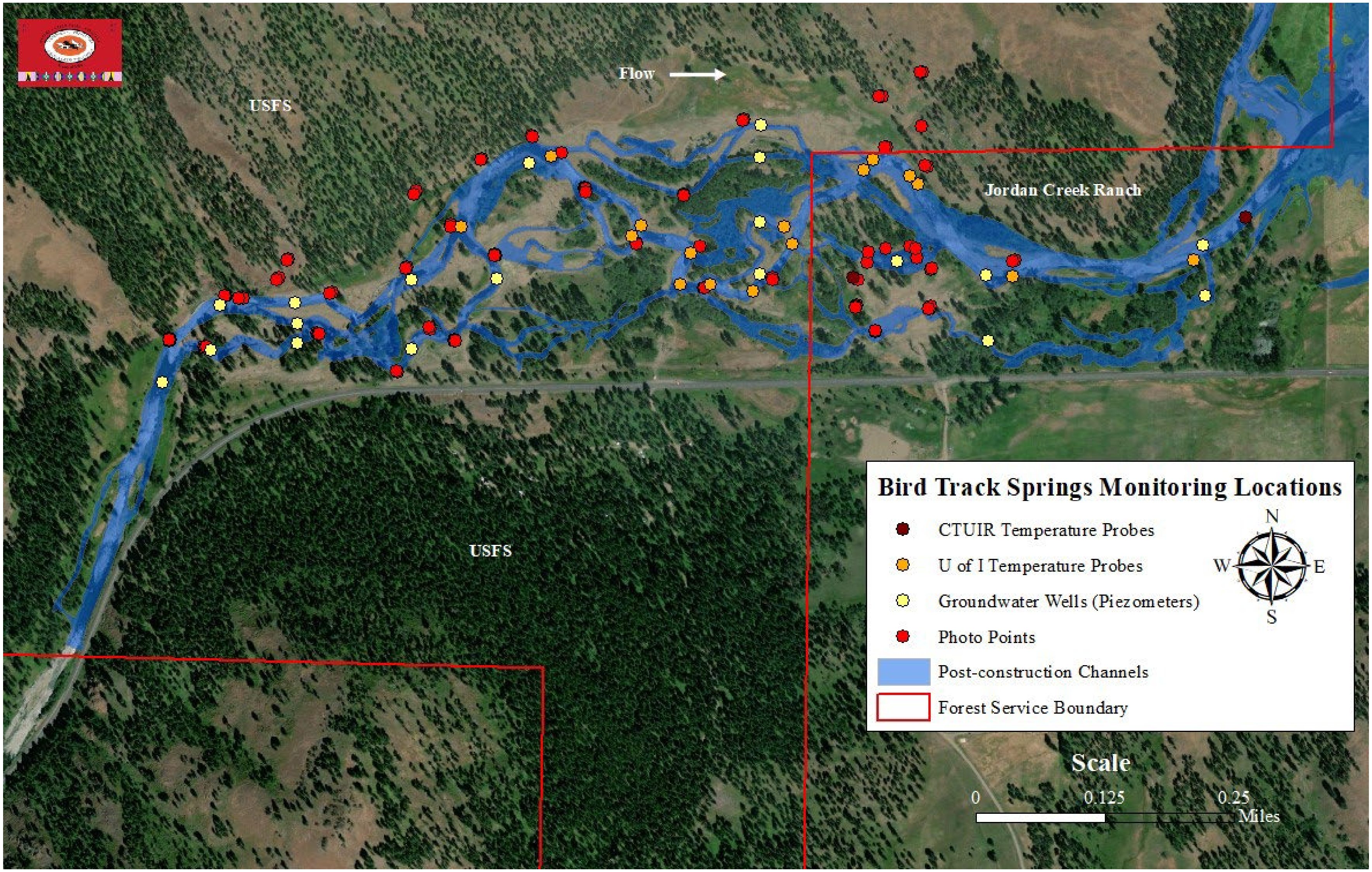


FIGURE 4: BIRD TRACK SPRINGS MONITORING LOCATIONS

Snorkel Surveys

Standardized snorkel surveys are conducted annually in July and September to quantify salmonid abundance and distribution on the Bird Track Springs Project (Figure 5). Recorded habitat metrics include channel type (main channel or side channel), habitat type, mean depth, maximum depth, length, ambient temperature, and coldest temperature. General observations post-project completion include:

- Increasing beaver colonization (dam and lodge construction), including beaver den construction within installed large wood structures.
- Resident trout colonization and significant numbers of large (12"+) Rainbow trout being caught by fishermen.
- Low abundance of juvenile Chinook and summer Steelhead summer rearing, but adult Chinook holding in pools in July.
- Annual floodplain engagement, significant off-channel/side channel rearing habitat restored.
- Cold water refuge developing, deep pools maintaining cooler summer water temperatures compared to main channel.
- Groundwater elevations increased from pre-project condition in local groundwater monitoring wells.
- Sediment routing and storage, including fine sediment that supports suitable colonization sites for sedge/rushes and riparian tree and shrub communities.
- Significant big game browsing on riparian shrubs and trees.
- Grande Ronde River Bird Track Springs mean minimum pool temperatures in September were 11.5 ℃ compared to 18.9 ℃ on the pre-project Longley Meadows reach downstream (a 38% difference).

FIGURE 5: SNORKEL SURVEYING A LARGE WOOD STRUCTURE AT BIRD TRACK SPRINGS - JULY 7, 2020

Groundwater Monitoring

Groundwater wells (piezometers) were installed on Forest Service and private property in November 2017 in the Bird Track Springs area following direction from BOR geologists. The objective was to install permanent, small-diameter groundwater monitoring wells that can be used to conduct hydrologic analysis, and record temperature measurements of groundwater and hyporheic exchange. A total of 10 piezometers were installed within the Bird Track Springs Project area.

Understanding groundwater data is complicated by variables including geology and hydrology, and often monitoring wells may be inadequate in number or location. However, groundwater wells can provide measurable outcomes for how stream restoration projects influence groundwater elevation and temperature. Increasing the amplitude and duration of cold water elevations and the subsequent buffering of surface water temperatures through hyporheic flow is a desired outcome for 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.

Temperature Monitoring

Water quality at the Bird Track Spring Project has been monitored by installing temperature loggers upstream and downstream of the Project reach. The purpose is to determine if there are noticeable differences in river temperatures between where water enters the Project reach (GR1) compared to temperatures as water leaves the Project reach (BTS1). In addition, temperature data from before and after project construction is analyzed and plotted to detect changes in temperatures possibly related to restoration activities and to see if the thermal regime is improving for fish populations. Furthermore, researchers with the University of Idaho have been monitoring 11 large pool and side channel confluences as part of a groundwater/floodplain interaction study.

In 2022, Figure 6 below shows average daily maximum temperature data from one main channel logger (Green) compared to four additional loggers located in nearby side channels.
The main channel logger recorded temperatures at or above the lethal limit (25°C) during much of the July-August window. In comparison, side channel loggers during this same time recorded temperatures that never exceeded the lethal limit and remained significantly below main channel temperatures throughout summer months.

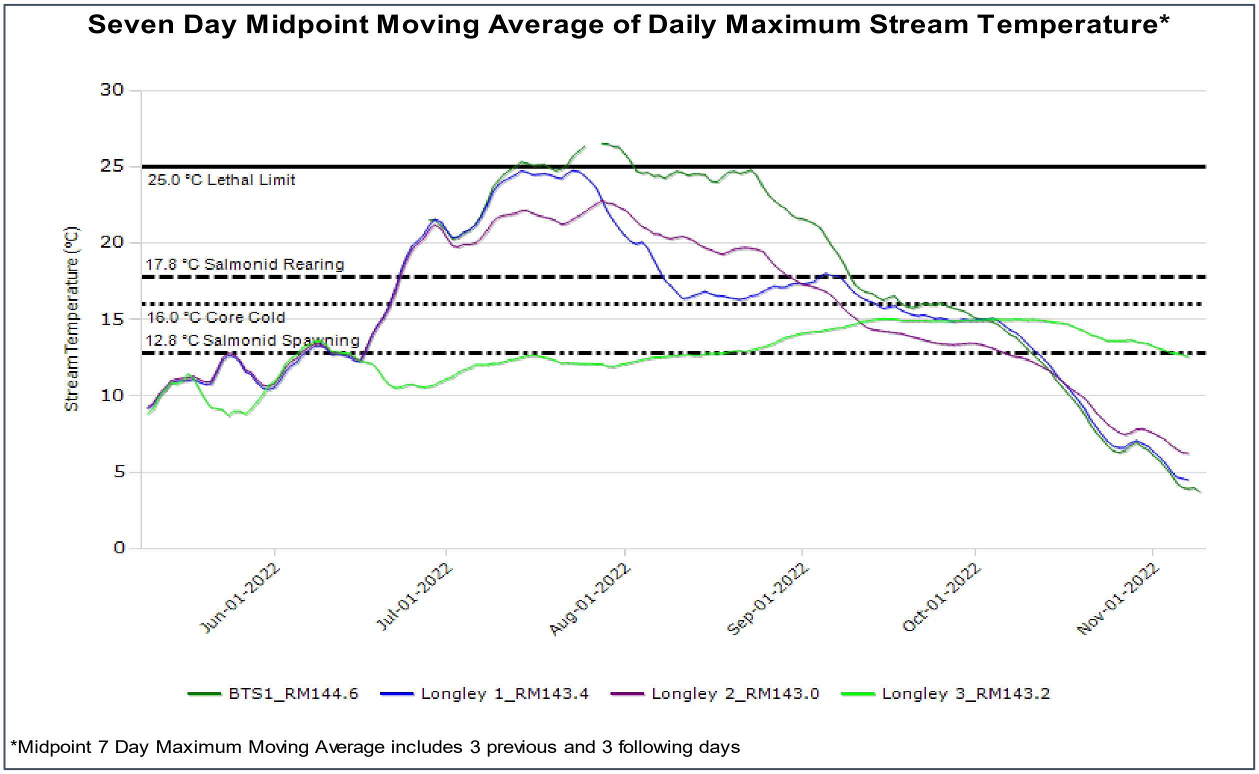


FIGURE 6: 2022 7DADM FOR GRANDE RONDE RIVER MAIN CHANNEL VS. SIDE CHANNEL PROBES

Between 2018 through 2022 surface water temperatures were monitored at two main channel locations that bracket the Bird Track Springs project area. The below data in Figure 7 show temperatures recorded in 2018 pre-project at the upstream site (GR1) in blue, and downstream site (BTS1) in green. For much of the year it is difficult to distinguish between the two locations' data trends as their respective temperature readings are almost identical. Daily maximum temperatures at both sites exceed the lethal limit for much of the July-August window, and it appears the downstream logger location recorded slightly warmer temperatures than the upstream logger location from approximatly mid-July through October.

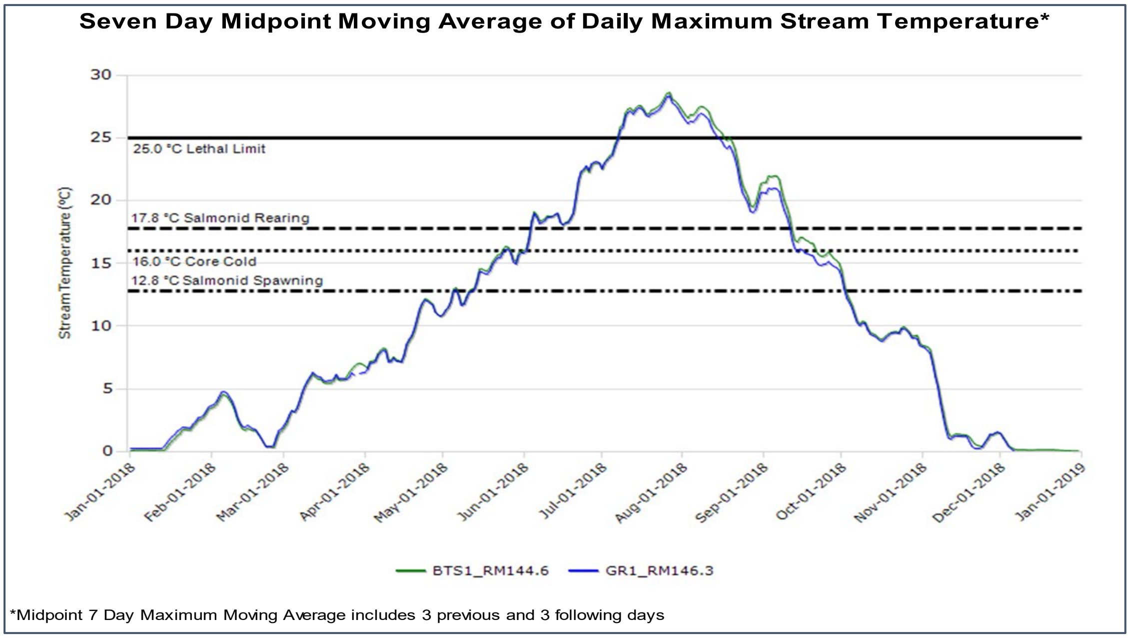


FIGURE 7: 2018 PRE-PROJECT 7DADM FOR PROBES BRACKETING BIRD TRACK SPRINGS PROJECT AREA

In 2019, while project construction activities were occurring, the same logger locations were monitored with their respective data shown below in Figure 8. During the July-August window temperatures at the downstream monitoring location recorded slightly cooler average daily maximums compared to the upstream monitoring site. The number of hourly temperature records exceeding the lethal limit threshold at both of these sites were significantly fewer in 2019 compared to 2018.

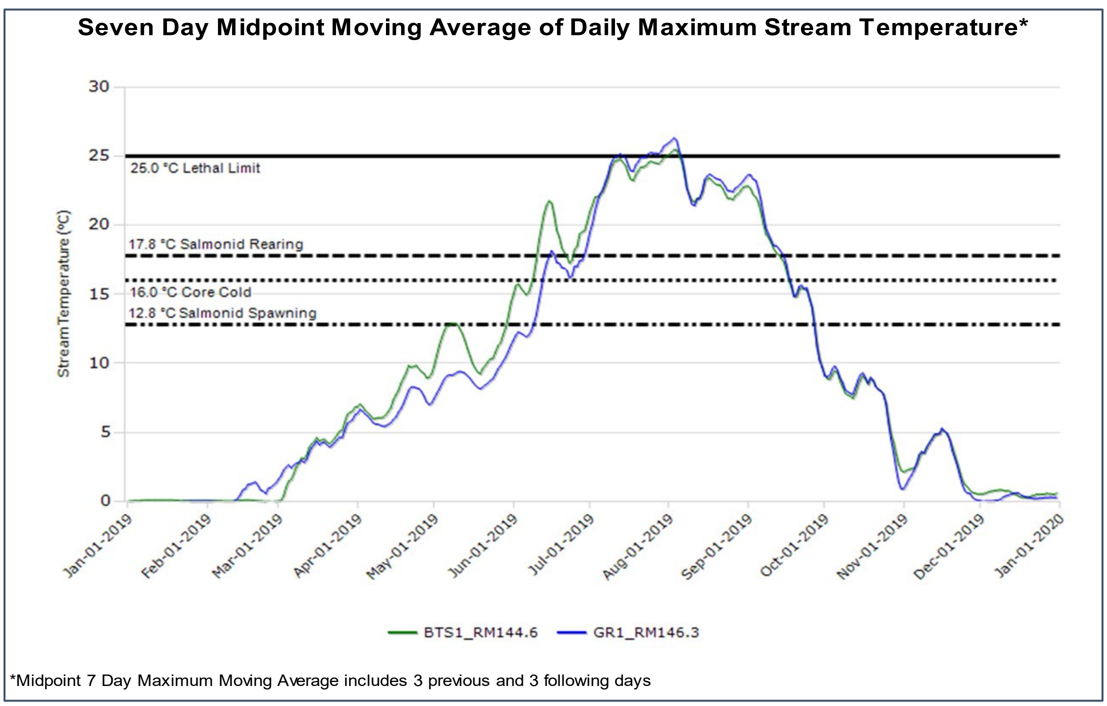


FIGURE 8: 2019 PRE-PROJECT 7DADM FOR PROBES BRACKETING BIRD TRACK SPRINGS PROJECT AREA

Temperature records from years 2020-2022 represent post-project data collected from the two loggers that bracket the BTS project area (Figures 9-12). The consistent pattern observed during the three year post-project monitoring window is that during the warmest months July-September the lower BTS1 temperature logger recorded cooler temperatures compared to its upstream GR1 counterpart. It appears water leaving the project reach is cooler than when it enters.

Strategic project design elements attempt to address high summer temperatures by increasing the volume and frequency with which water interacts with and absorbs into the floodplain, then later re-enters main channel surface flows as hyporheic cold seeps.

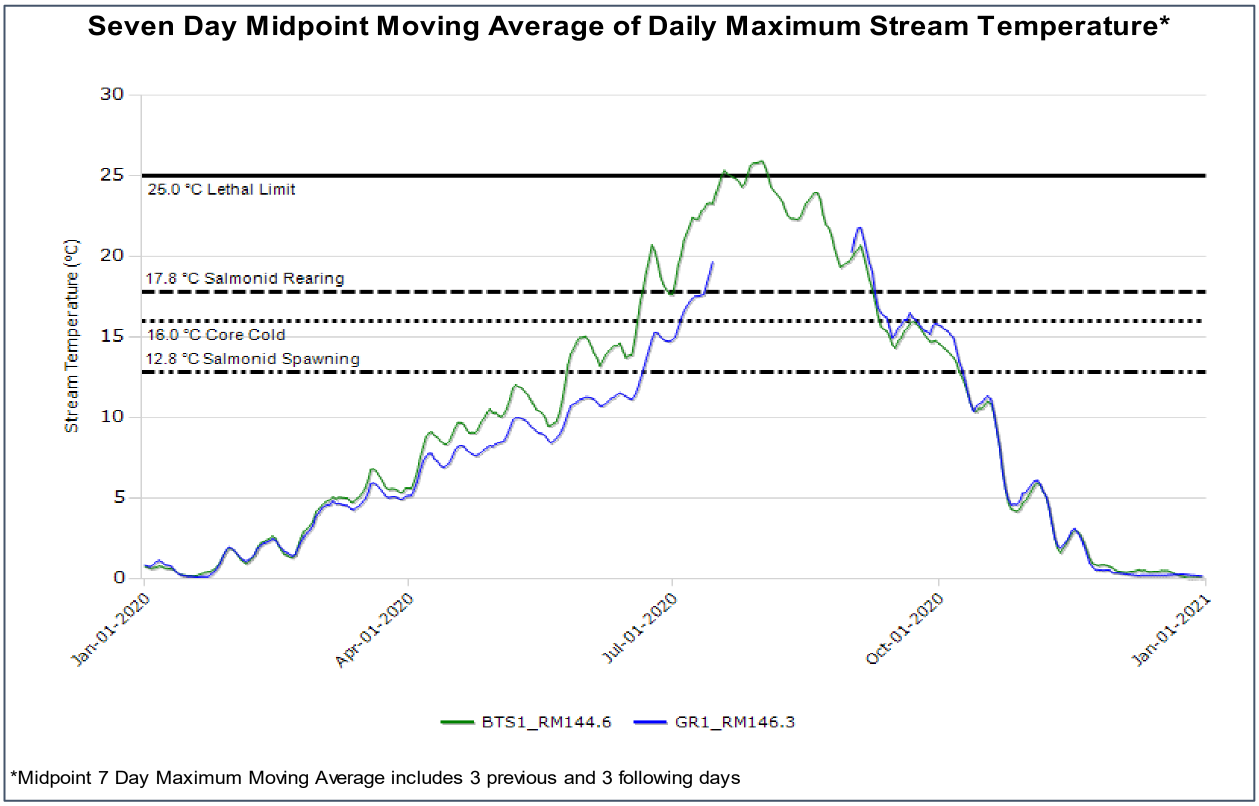


FIGURE 9: 2020 POST-PROJECT 7DADM FOR PROBES BRACKETING BIRD TRACK SPRINGS PROJECT AREA

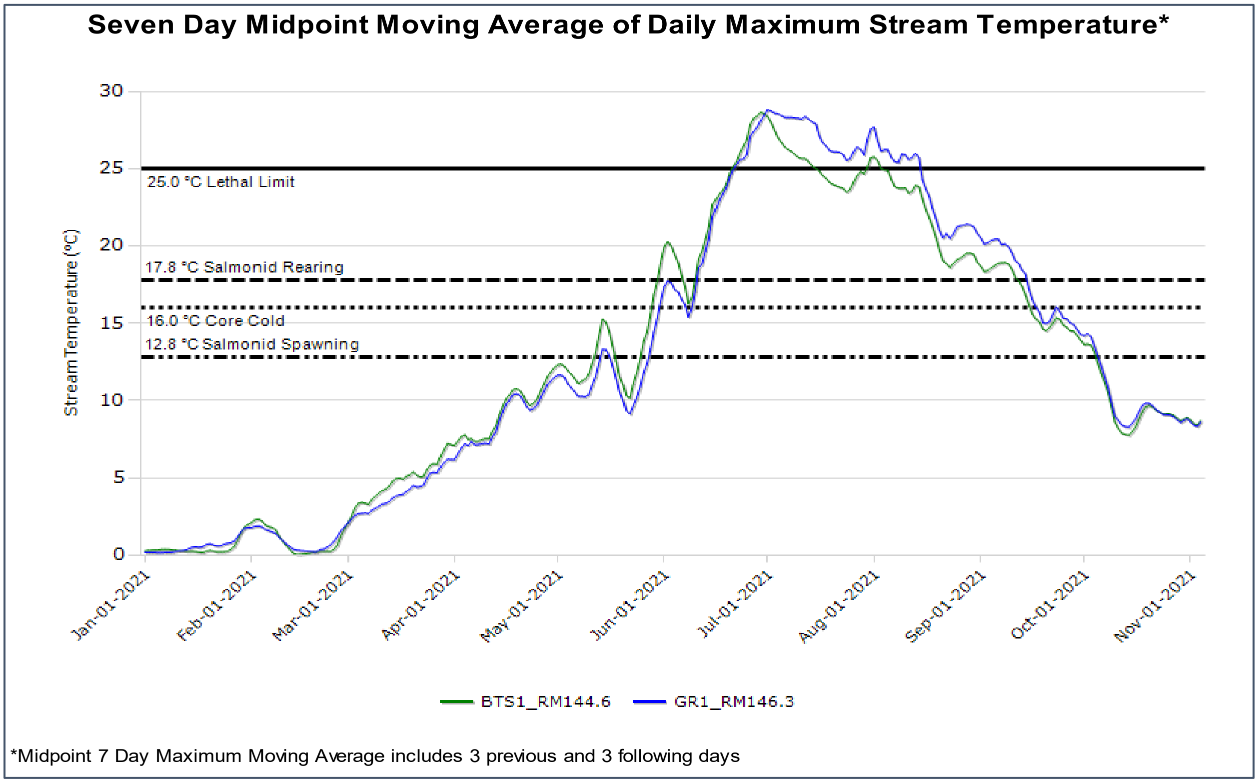


FIGURE 10: 2021 POST-PROJECT 7DADM FOR PROBES BRACKETING BIRD TRACK SPRINGS PROJECT AREA

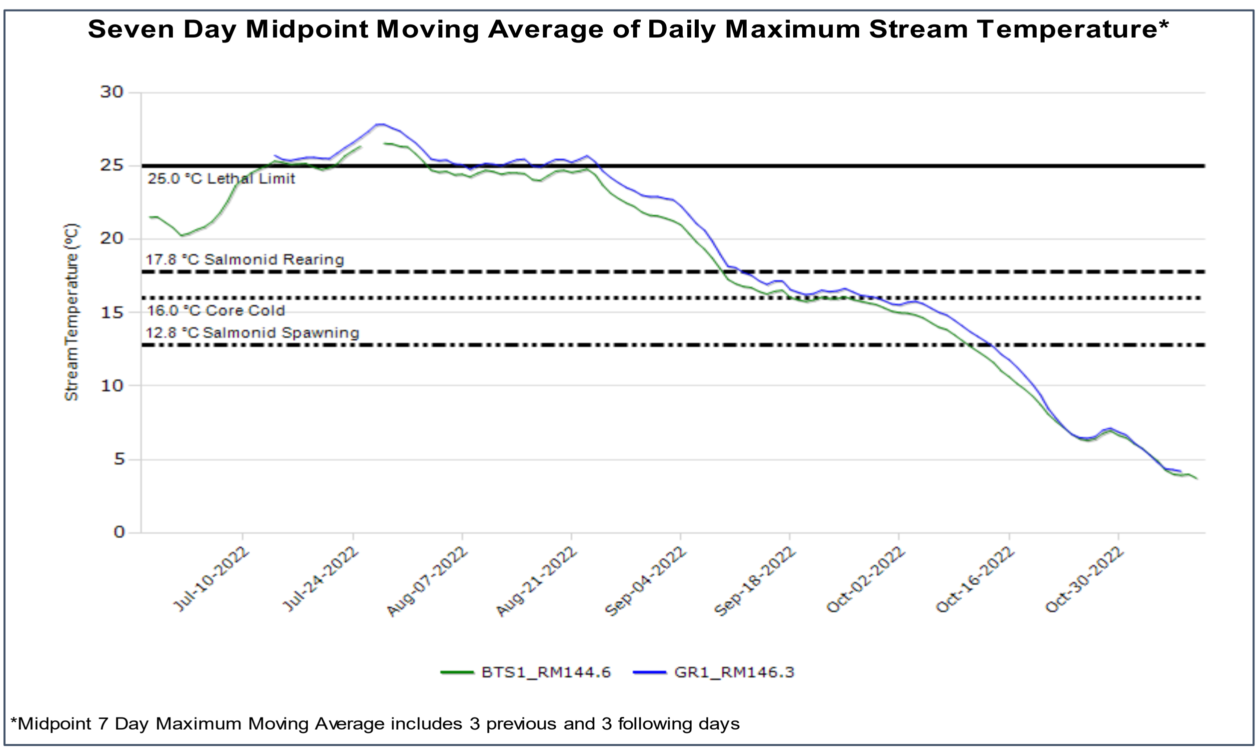


FIGURE 11: 2022 POST-PROJECT 7DADM FOR PROBES BRACKETING BIRD TRACK SPRINGS PROJECT AREA

As mentioned above, researchers with the University of Idaho have been monitoring 11 large pool and side channel confluences as part of a groundwater/floodplain interaction study. 2022 data from one pair of probes (UI 11 and UI 12) are shown below. UI 11 is located on main channel Grande Ronde River within the BTS project reach. UI 12 is located in a nearby side channel just upstream of where is enters the main channel. Temperature data recorded at these two sites during summer months show that the logger in the side channel (blue) experiences slightly cooler overall temperatures compared to its main channel counterpart (green). This might occur due to the side channel becoming disconnected from warm surface water inputs from the main channel and instead being influence by cooler groundwater seeps.

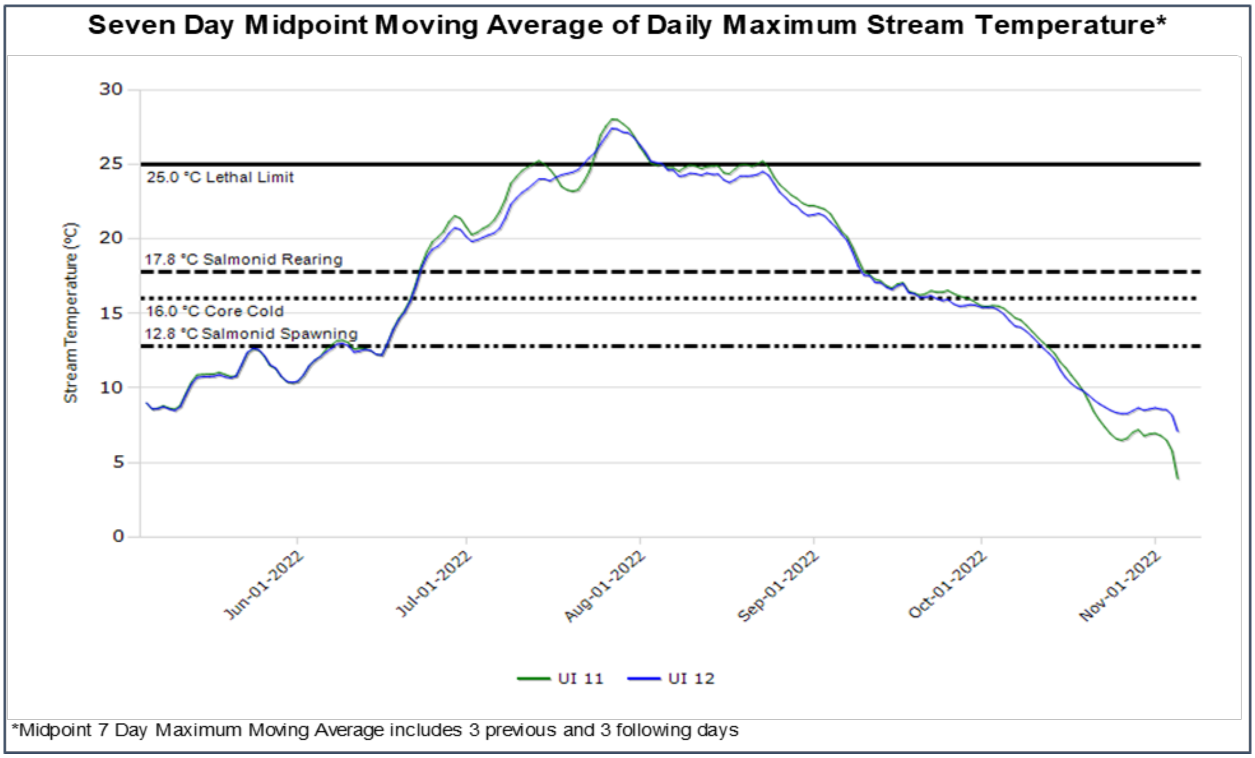


FIGURE 12: 2022 POST-PROJECT 7DADM FOR ONE MAIN CHANNEL PROBE VS. ONE NEAR-BY SIDE CHANNEL PROBE

Photo Point Monitoring

Representative photos were taken at intervals throughout the Bird Track Springs project (Figures 13 & 14), and a master photo point notebook is used to align each subsequent year's photo with the image taken the previous year (Figures 15-17). 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 and jpeg images are saved into a master photo point file. Aerial photos and videos are also taken at varying intervals along several project locations using a UAV operated by the Grande Ronde Model Watershed. A summary of photo point highlights can be viewed by following the link:

GR Habitat Photo Point Album

FIGURE 13: BIRD TRACK SPRINGS AERIAL PHOTO POINT 6 - 5/15/2018

FIGURE 14: BIRD TRACK SPRINGS AERIAL PHOTO POINT 6 – 6/14/2022

GROUND PHOTO POINTS – BEFORE (LEFT) AND AFTER CONSTRUCTION (RIGHT)

FIGURE 15: SIDE CHANNEL 1, LOOKING DOWNSTREAM

FIGURE 16: MAIN CHANNEL, LOOKING DOWNSTREAM

FIGURE 17: SIDE CHANNEL 2, LOOKING UPSTREAM

Spring 2022 Flood

On June 13th, 2022, the yearly high-flow event occurred on the Project (4000+ CFS), inundating large areas of the floodplain and activating side channels and swales (Figure 18). CTUIR staff conducted a walk-through observation to assess potential areas of erosion, deposition, and structure mobilization. The relative stability of structures, channels, and bank treatments during the large flow events in 2020 appeared to be continuing during this flow event. Subsequent walk-throughs of the project area in the summer confirmed that most structures, channels, and bank treatments were still intact and did not require adaptive management/maintenance in 2022.

FIGURE 18: SIDE CHANNEL 3 ACTIVATION, JUNE 13TH, 2022

Lessons Learned-Monitoring

- Snorkel surveys provide a snapshot of temperature within the restoration projects and have shown decreases post-restoration. However, these data are only ‘snapshots’ and are not continuous measurements of temperature so lack the resolution to determine diurnal fluctuations in water temperature or seasonal variations.
- Data can be used as a validation for other temperature data being collected as it is measured within all habitats we snorkel and therefore covers a larger sampling area than a stationary probe, (especially beneficial in low flow streams where a thermal refuge may not extend much beyond the habitat unit or can be lost when mixing with a larger volume of warmer water).
- Fish numbers can be undercounted when utilizing snorkel surveys due to poor visibility in deep, complex pools.
- It is surprisingly cold within large wood structures.
- Lamprey spawn within the project area but none have been released there (closest release site is upstream approx. 5.5 miles at Meadow Creek or 10 miles at Spool Cart on the Grande Ronde River).
- Adaptive management actions should be considered and implemented if possible following major flood events, if deemed beneficial to overall project success.

Lessons Learned-Project Development

Hydrology

The Project has been successful in reconnecting the historic floodplain, promoting an island-braided channel network, significantly increasing large pool habitat, and improving habitat complexity and diversity (Figure 19). Floodplain inundation occurs annually compared to pre-project conditions (Figure 20). Pre-project, the floodplain would activate only at higher discharges associated with larger flows (i.e. >2 year flow). Constructed channels have improved floodplain soil moisture retention, floodplain and riparian vegetative growth, water table elevations, and wetland development over pre-project conditions to some degree, although not as much as anticipated. For example, due to the short duration of floodplain inundation, containerized trees and shrubs planted on the floodplain have shown <60% survival in many locations. However, there has also been an extensive increase in hydrophytic herbaceous cover. Groundwater wells (piezometers) installed pre-project indicated significant increase in the water table at a majority of the wells installed throughout the floodplain, although groundwater elevations appear to have stabilized (Figure 21). Constructed wetland ponds remain inundated through summer, and now provide habitat for numerous waterfowl species.

Metrics					
Floodplain reconnection (acreage inundated) (Existing/Restored)		Channel morphology (Existing/Post)		Instream habitat structure and complexity LWM: *key members	Riparian restoration (plants installed)
60 acres	135 acres	Main channel: 1.5 mi Side channel: NA # of pools: 1 Sinuosity: 1.2 RCI: 4.8	Main channel: 2.75 mi Side channel: 3 mi # of pools: 63 Sinuosity: 1.4 RCI: 18.2	439 pieces/mile	15,000

FIGURE 19: BIRD TRACK SPRINGS FISH HABITAT ENHANCEMENT PROJECT METRICS

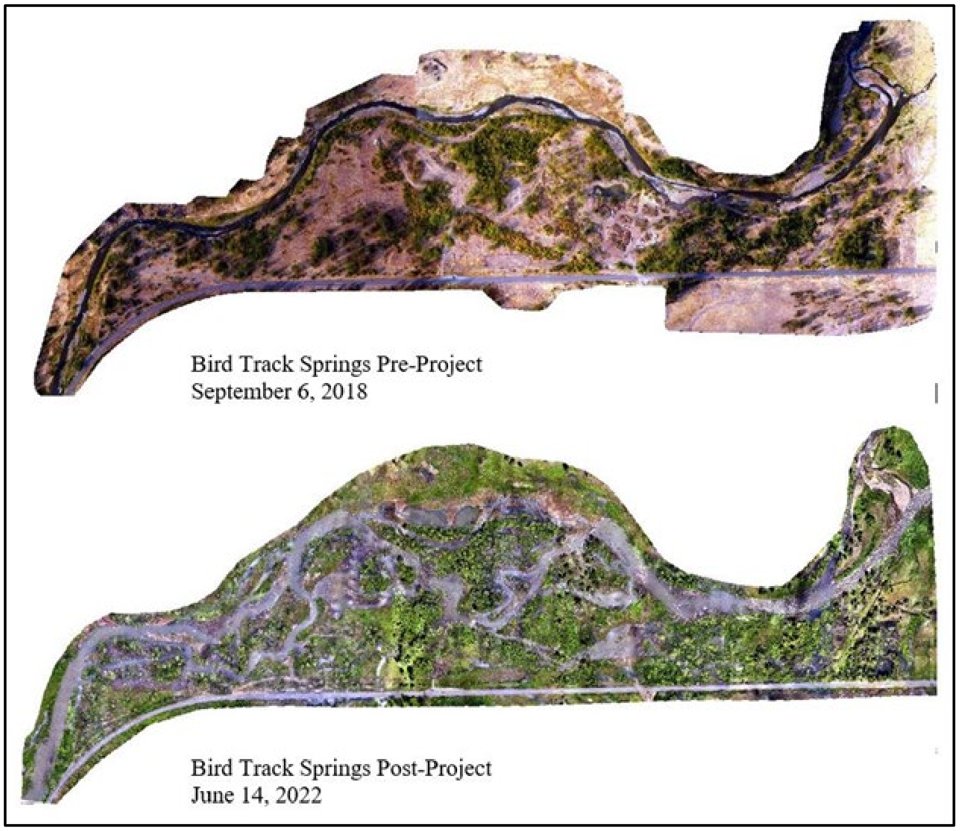


FIGURE 20 PRE AND POST PROJECT FLOODPLAIN

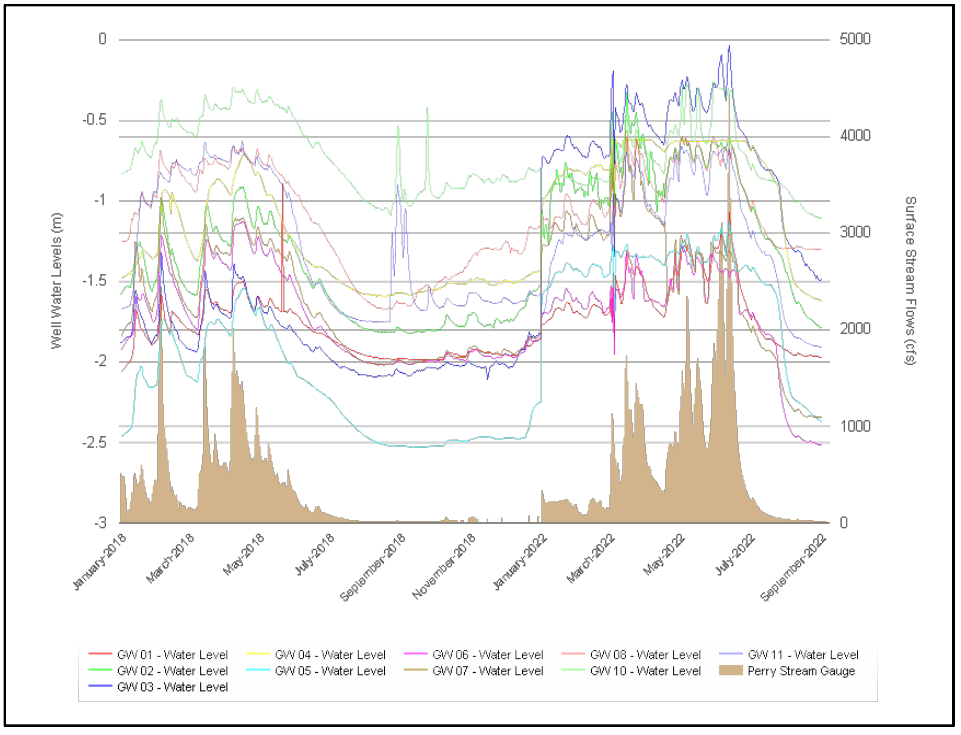


FIGURE 31 GROUNDWATER WELL ELEVATIONS PRE-PROJECT (2018) AND POST-PROJECT (2022)

Morphology
The construction of main channel, side channels, and alcoves was successful in reconnecting 135 acres of historic floodplain and increasing large pool habitat, sinuosity, the River Complexity Index (RCI), instream habitat structure and complexity, bedform diversity, and sediment routing/storage. (Figure 22). The Project is experiencing ongoing dynamics with sediment deposition and scour, wood loading, and changes in channel morphology, as expected. For example, Side channel 2, which was designed to accommodate ~40% of the Grande Ronde River total flow, now disconnects during summer baseflow Future adaptive management actions to address morphology could include side channel entrance re-grading and/or relic swale channel activation.

FIGURE 22 MAIN CHANNEL RIFFLE AND SIDE CHANNEL ENTRANCE CONSTRUCTION

Structure
Bio-engineered streambanks using live willow whips and small wood material for structural stability have generally performed well from a streambank stabilization standpoint. However, several of the structures have experienced poor willow survival due to insufficient construction techniques. Additionally, these bank treatments were over-built to withstand heavy ice flows and maintain bank lines. Unfortunately, these structures are also limiting channel processes and dynamics. Locations where bio-engineering treatments were installed properly with the willow cuttings installed at proper depth and in soil/gravel fill are observed to be performing well with higher survival rates. Large wood structures are stable and have remained relatively intact throughout multiple high-flow events (Figure 23).

FIGURE 23 LARGE WOOD STRUCTURE AND PLANTED WILLOW DURING HIGH FLOW EVENT, FEBRUARY 2020

Vegetation

Although plant mortality is high in some upland locations, herbaceous vegetation is improving along riparian areas, point bars, and side channels. Black cottonwood seedlings have established in large quantities on several point bars. Elk and deer herbivory is present and noticeable in some areas, but appears relatively minor overall. Beavers have removed several medium sized cottonwood trees in some locations, but generally have not done extensive damage. Planted floodplain areas that are inundated during spring runoff but are dry during the summer have shown high mortality, while riparian and wetland areas have shown good plant survival (mostly willows and cottonwoods). Weeds have been a problem in some disturbed areas following project construction. U.S. Forest Service and Tri-County Cooperative Weed Management Area (CWMA) crews have been chemically treating the project area since 2019, with good results. Some weeds may have been spread through the use of straw mulch used on disturbed areas immediately following construction. Future vegetation adaptive management actions could include replanting some areas with more drought-tolerant tree and shrub species.

Beaver Colonization

Beaver activity has increased dramatically post-project construction throughout the re-activated floodplain. Several side channels/alcoves contain active beaver lodges, and beaver sign (recently felled trees, chewed willow branches, tracks, etc.) is observable throughout the project area (Figure 24). Some bio-engineered bank structures have active "bank lodges" built within the structures, with evidence of beaver use throughout the year.

FIGURE 24: RECENTLY FELLED COTTONWOOD TREE, AUGUST 2022

Public Awareness and Education

The U.S. Forest Service La Grande Ranger District is currently developing a trail network and interpretive signs throughout the project area (Figure 25). Trails and signs are scheduled for completion by summer, 2023. Project tours and presentations conducted during 2022 include:

- U.S. Forest Service working group
- Grande Ronde Model Watershed Outdoor School science lessons
- Local school groups (University, High School, and Middle School)
- Newspaper articles (La Grande Observer, East Oregonian, and Confederated Umatilla Journal).

FIGURE 25: DRAFT OF FOREST SERVICE INTERPRETIVE SIGN

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 statement of work and 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 participating in project planning and design, administering/inspecting habitat enhancement activities.

Administrative work completed during 2022 included: Subcontracted for design services for Catherine Creek RM 42.5 fish passage and habitat design, Lookingglass Fish Habitat planning and design, and Middle Upper Grande Ronde River Phase 2 and 3 ground support for wood and boulder material acquisition and stockpiling for summer 2023 helicopter construction. Additionally, CTUIR coordinated with GRMW and ODFW to develop a helicopter contract solicitation for the Middle Grande and Grande Ronde Bowman project sponsored by ODFW. Work included solicitation development, review of bid proposals, selection of contractor and development and issuance of contracts for specified work.

The Project Leader supervised 4 full-time and 1 nine-month permanent employees to accomplish fish salvage, riparian planting, and easement maintenance duties.

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. Completed HIPIV 15% review for CC42.5 passage and habitat project and Lookingglass habitat restoration projects.

Additionally, CTUIR staff continued EC compliance on in cooperation with USFS on Middle Upper Grande Ronde River Project Phase 2 and 3. Activities included participation in NEPA, ESA/ARBO, Section 106, and USCOE/ODSL fill removal permit processes.

Fish Salvage 2022

Fish salvage efforts were accomplished by project staff assisting ODFW Grande Ronde Habitat, CTUIR John Day Watershed Restoration, and USWCD on several fish habitat restoration projects. Project staff assisted ODFW with fish salvage efforts on the Catherine Creek State Park Project, USWCD on the Catherine Creek RM 38 Project, and CTUIR John Day Watershed Restoration on the Hidaway Creek Project. Fish salvage efforts were made whenever a section of live water was to be diverted away from construction sites, or after work site isolation when bypass channels were to be reclaimed and live water turned back into the main channel.

FIGURE 4 ELECTRO-FISHING CATHERINE CREEK, ODFW STATE PARK PROJECT

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 FY2022 included participation on the Grande Ronde Model Watershed Board of Directors, Executive Committee, and Grande Ronde Basin Technical 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 including project tours at the Bird Track Springs, Longley Meadows Projects, Middle Upper Grande Ronde, and Catherine Creek Projects with BOR staff, BPA staff, and USFS staff.

The US Forest Service has installed signs in the vicinity of several local river restoration projects, including Bird Track Springs and Longley Meadows, to help educate public land visitors about the beneficial role beaver play in supporting and maintaining intact wetland, riparian, and floodplain ecology.

In spring 2023 participants from the Tributary Habitat Steering Committee (THSC) toured several project locations in the Grande Ronde River Subbasin to discuss recently constructed and upcoming river restoration projects. The group stopped at Longley Meadows on the Grande Ronde River and Catherine Creek River Mile 44 and project sponsors presented about key project elements and ongoing efforts to monitor salmonid population trends.

The Grande Ronde Qapqápnim Wéele Community Science Project, with support from GRMW and partnering with University of Idaho's IDAH20 Master Water Stewards, is involved with collecting water quality and riparian health data from monitoring sites in the vicinity of Bird Track Springs project area. Multiple times per year educators bring students from local schools out to collect biological and physical habitat data that relates to water quality, macroinvertebrates, and riparian vegetation. The Community Science Project's goals include empowering communities in the region, especially underserved youth, to see themselves as scientists and lifelong stewards of their environment, to be guided by and amplify our Indigenous neighbor's voices, and increase our community's knowledge of natural resource issues.

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.

Following completion of each construction phase on the Longley Meadows Project, all disturbed areas were treated with native grass seed and covered with straw mulch. Cleared native vegetation, including sedge mats and willow clumps were salvaged and replanted, or used in the construction of wood structures. Native grass seed was distributed over approximately 10 acres of disturbed ground. Straw mulch was used on seeded and planted areas to retain moisture for better grass seed establishment and to suppress competitive weeds.

FIGURE 5 REPLANTING SALVAGED WILLOW CLUMPS, LONGLEY MEADOWS PROJECT

In fall 2022, the USFS completed revegetation efforts on disturbed areas on the Longley Meadows Project (approximately 20 acres). Species planted consisted of native conifer and deciduous seedlings. There were a total of 25,000 seedlings planted in the Project area.

Planting will occur on all disturbed areas within the project. There will be 10,000 deciduous gallon potted seedlings, 10,000 conifer plug seedlings and 5,000 deciduous plug seedlings planted within these areas. All species planted will be native. Species planted will consist of willow (misc. species) (6,000), cottonwood (3,000), aspen (1,000), alder (1,000), hawthorn (1,000), red osier dogwood (1,000), golden current (500), serviceberry (1,000), choke cherry (500) and ponderosa pine (10,000).

The gallon potted seedlings will have the holes predrilled with augers. The gallon-potted seedlings will be planted by contract crews, and plugs will be hand planted by USFS crews. Seedlings will be planted at appropriate locations within the project. Species that require wetter or drier conditions will be planted according to the plant's ecological needs and water availability.

Upland areas, access roads, and disturbed areas will be planted with locally-adapted grass species which include Idaho fescue, bluebunch wheatgrass, basin wildrye, and tufted hairgrass. Swale complexes and side channels will be planted with sedges which include Nebraska sedge and Beaked sedge. Areas within swale and channel excavation limits were grubbed to salvage sedge mats and quality topsoil for use during planting activities.

With restored floodplain activation, increased groundwater elevations, and sediment sorting and routing expected from the project, native hydric plant communities are expected to flourish over time, supporting floodplain and channel resilience, future shade, food web processes, and beaver recolonization.

Operation and Maintenance of Habitat & Structures/Field Crew Projects and Ongoing Work Elements

Grande Ronde Fish Habitat Project technical staff work to support program biologists furthering the goals and objectives of the CTUIR DNR Fisheries program. With direction from the program lead and biologists, the technical staff participate in planning, scheduling, and implementation of field operations and maintenance tasks. Much of the workload is comprised of regularly scheduled maintenance and monitoring operations. However, technicians are called upon on a regular basis to assist program biologists and project partners with a variety of ancillary activities. For the 2022 field season the technical crew consisted of one full time Fisheries Technician III, and one 9-month Fisheries Technician I.

Technical support is carried out within the Catherine Creek, Upper Grande Ronde River, and Lookingglass Creek sub-basins on both CTUIR lands and private properties. Regularly scheduled responsibilities include conservation easement fencing and riparian enclosure repair and maintenance; seasonal livestock watering access site construction and deconstruction; water temperature, groundwater, vegetation, streamflow, and icing monitoring; and project equipment repair, maintenance and purchasing. Other, less regular, responsibilities include but are not limited to: assisting project lead with technician staffing; assisting biologists with fish salvage operations; cultural resource stakeouts; wood and willow acquisition; riparian fence and beaver dam analog construction; and assisting project partners with general technical support.

Conservation Easements

The CTUIR operates and maintains nine conservation easements within the Grande Ronde River watershed (Figure 2) totaling 1218 acres and enclosed by 23 miles of fencing. As such, a major component of regular duties is the repair and maintenance of easement fences. The technical crew is responsible for communicating with landowners for scheduling purposes, surveying, maintaining and repairing easement fences. Site visits take place monthly, though larger parcels with heavier livestock pressure are visited on a bi-monthly schedule. Easement fences are visually inspected from ATVs where practical, and on foot when necessary. Maintenance and repairs including clip and staple replacement, wire stretching and splicing, tree removal, brushing, stay replacement, and water access maintenance are conducted as needed. When fences have been breached, cows are removed from within the easements, and the breaches found and repaired. Water access sites and water gaps are installed in the spring or early summer (as soon as river conditions allow), and taken down after cows have been removed in the fall. For efficiency, fence checks are often combined with other objectives such as data downloads from temperature and groundwater probes, collection of photo points, and/or retrieval of photo monitoring images. The technical crew is also responsible for repair and maintenance of a number of ranch panel and single plant enclosures located on McCoy/Meadow Creeks, and Catherine Creek (Southern Cross/CC37). Conservation easement repair and maintenance represents the bulk of the technical crew's work load.

Monitoring

The Grande Ronde Fish Habitat Project monitors conditions within and adjacent to CTUIR fish habitat restoration projects in the Upper Grande Ronde, Catherine Creek, and Lookingglass sub-basins. The types of data collected include stream temperature, groundwater elevations, pre-construction and as-built surveys (longitudinal profiles and channel cross sections), riparian conditions (photo points), and time lapse images concerned with capturing ice, and high water events. GRH currently monitors water temperature at 14 sites on Catherine Creek, 24 sites on the Upper Grande Ronde River and tributaries, and 3 sites on Lookingglass Creek. 15 groundwater monitoring probes are deployed in the Upper Grande Ronde River; 10 on the Bird Track Springs Project, and 5 on the Longley Meadows Project. Each field season photo points are taken across the project areas. GRH currently has 8 time lapse cameras deployed; 3 on Catherine Creek (Southern Cross) and 5 on the Upper Grande Ronde River (Longley Meadows). Habitat technicians assist with deployment, downloads, status checks, and retrieval of temperature and groundwater probes and data; taking and cataloging photo points; and managing time lapse camera placement, setup, maintenance and downloads. Monitoring occupies a substantial portion of the technical crew's efforts. See Monitoring & Evaluation section for additional detail.

Project Equipment Maintenance

Technical staff are responsible for maintenance and repair of equipment used to accomplish program goals and objectives. Project equipment includes ATVs and UTVs, trailers, power tools (i.e. chainsaws, gas powered post drivers, earth augers, pumps etc.), and hand tools. Basic preventative maintenance tasks (oil, air filter, fluids) are carried out on ATVs/UTVs, and gas powered tools as per manufacturers' schedule. Power and hand tools are maintained (cleaning, sharpening, tuning etc.) as needed based on conditions of use. Professional services are solicited when specific repair or maintenance needs exceed the knowledge and/or capabilities of the technical staff. In these cases, technical staff take the lead in procuring the necessary services. Equipment maintenance and repair require a smaller proportion of the technical staffs' time in relation to easement repair and maintenance, and monitoring.

Purchasing

The technical crew assists program biologists with identifying purchasing needs, researching equipment, gathering price quotes, submitting requests, and purchasing equipment. Purchasing support is carried out with guidance from biologists, and following CTUIR purchasing protocols. Budgeting for capital equipment is discussed with the Project Lead as the next fiscal year budget is being assembled. For non-capital equipment, price quotes are requested and submitted along with purchase requisitions to the CTUIR Department of Natural Resources (DNR) office. Typically these activities are carried out by the lead technician with input from the technical crew. Effort expended on purchasing activities varies by year based upon program needs.

2022 Miscellaneous Program and Project Partner Support Activities

Miscellaneous program support activities vary by year and are largely dictated by project implementation schedules. Miscellaneous tasks undertaken during the 2022 field included: partner agency monitoring support; fish salvage operations; Chinook spawning, snorkel, and anecdotal beaver activity/trapping surveys;

- Technicians assisted University of Idaho (UI) researchers with monitoring and data collection efforts associated with the Bird Track Springs project. GRH technicians deployed and downloaded data from 15 UI temperature probes.
- Technicians assisted biologists with MUGR phase 2/3 logging operations monitoring
- Technicians and biologists assisted the North Fork John Day Habitat Program with fish salvage for the Hidaway Creek project.
- Technicians and biologists assisted Union County Soil and Water Conservation District (USWCD) with fish salvage operations for the CC38 project reach.
- Technicians removed remaining individual riparian plant enclosures at Southern Cross project site.
- Technicians and biologists assisted CTUIR Grande Ronde Monitoring and Evaluation Program (GR M&E) with snorkel surveys at the Bird Track Springs project site, Chinook spawning surveys on Lookingglass and Catherine Creeks, and fire prevention mowing on the Lookingglass property.
- Technicians conducted surveys to detect beaver activity/trapping in the Bird Track Springs, Longley Meadows and MUGR project areas.
- Technicians and biologists assisted US Bureau of Reclamation (BOR) with pre-project data collection in the Meadow/McCoy Creek project area.
- Technicians assisted project biologists with materials/equipment purchasing.

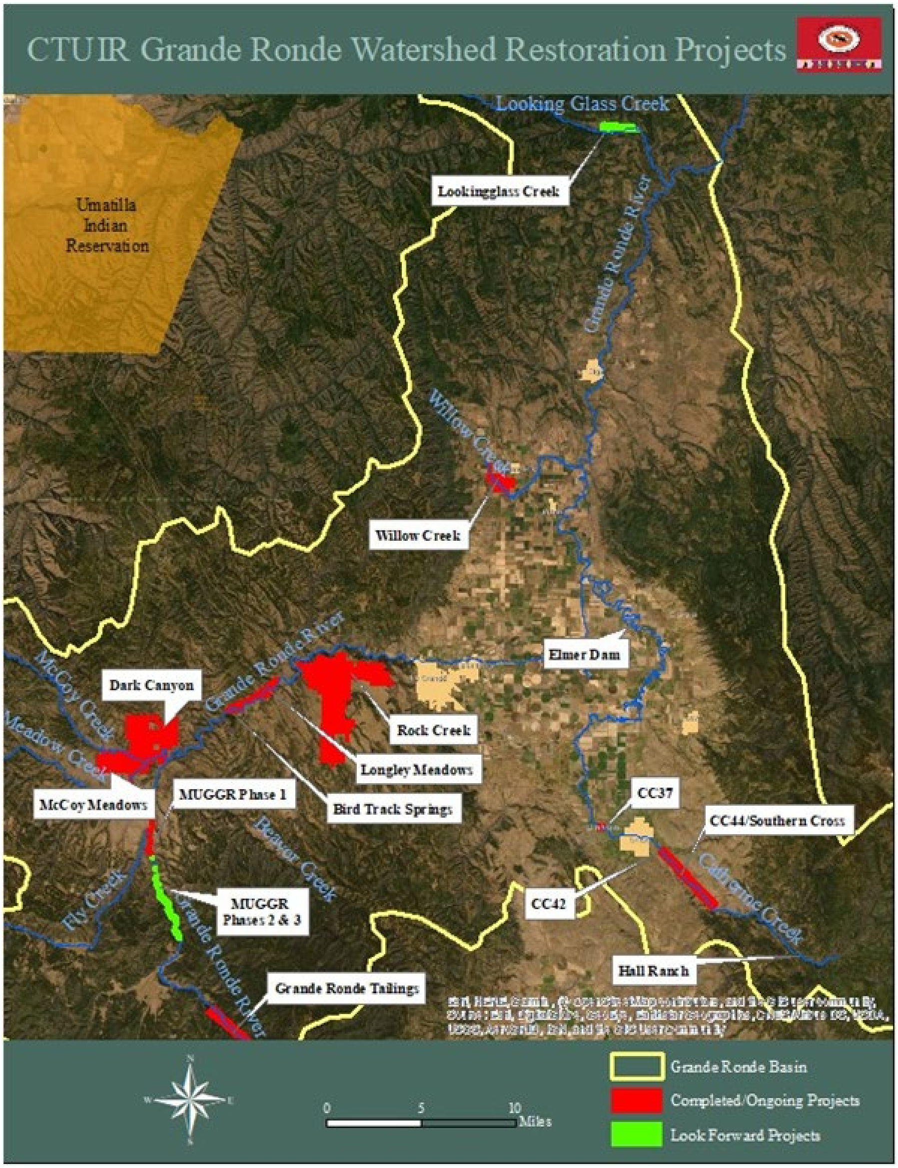


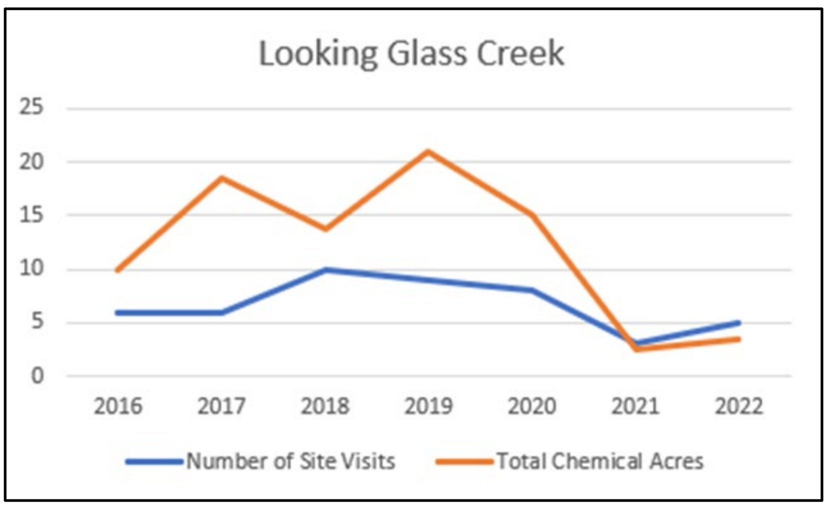
FIGURE 6 CTUIR GRANDE RONDE WATERSHED RESTORATION PROJECTS OVERVIEW MAP.

FY22 Noxious Weed Treatment

The CTUIR maintains an ongoing Cooperative Agreement with the Tri-County Cooperative Weed Management Area (CWMA) to chemically treat weeds, provide riparian vegetative enhancements (riparian plants and seeding), and administer weed treatment contracts on approximately 160 acres of CTUIR-owned and CTUIR sponsored fish habitat enhancement projects. Project areas include approximately 10 acres within the Catherine Creek CC 37 Fish Habitat Enhancement Project easement boundary, approximately 20 acres of pastures and upland terraces within the CC 44 Southern Cross Ranch Fish Habitat Enhancement Project boundary and Fite easement boundary, approximately 10 acres within the Rock Creek Fish Habitat Enhancement Project, approximately 20 acres within the Lookingglass Conservation Property, approximately 10 acres within the Bird Track Springs Fish Habitat Enhancement Project, approximately 10 acres on the Longley Meadows Fish Habitat Enhancement Project, and approximately 80 acres on the McCoy Meadows Fish Habitat Enhancement Project. 2021 weed treatment activities include:

Lookingglass Creek

Looking Glass Creek has been treated for meadow hawkweed and other noxious weeds since 2016. Treatment was completed by a licensed contractor from 2016-2020, but in 2021 and 2022 Tri-County Staff completed the work. Each year, meadow hawkweed is reduced in known populated areas which allows Tri-County to expand inventory further outside the riparian area. In 2022 upland hillsides were inventoried which expanded the inventory/treatment area farther upstream. A total of 3.44 acres were treated with herbicide, a slight increase from 2.5-acres treated in 2021. It's likely the increase in meadow hawkweed can be attributed to increased precipitation levels, as well as increased inventory acreage. Meadow hawkweed is a relatively easy plant to kill; however, difficult to find if in small quantities. When left untreated it will spread and quickly take over meadows and forest understory. Meadow hawkweed is an "A" listed species in Union County meaning that it is under mandatory control. This project also incorporates infestations upstream on The Umatilla National Forest and an adjacent private parcel funded by Oregon State Weed Board. Downstream areas on Lookingglass Creek and the Grande Ronde River are monitored and treated by Tri-County and partners for meadow hawkweed and other EDRR species to the confluence of the Snake River.

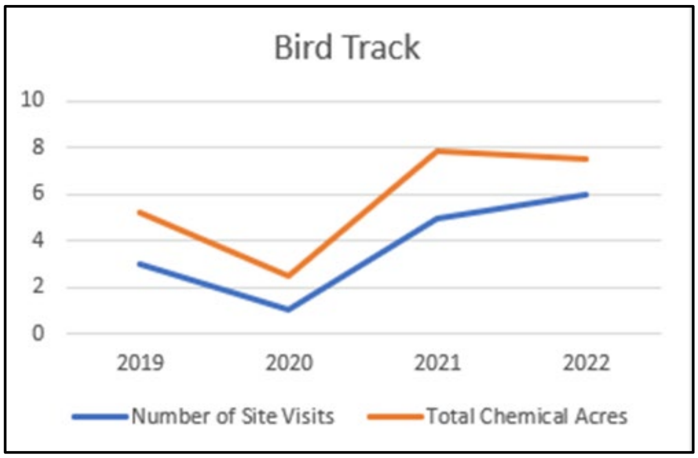


McCoy Meadows

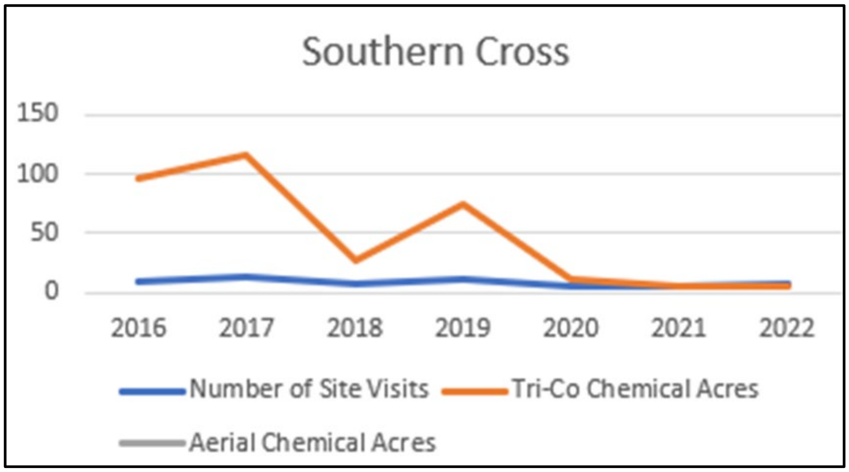
Roughly 15 acres of Leafy Spurge were treated on the McCoy Meadows property in 2022. Albee Road Spray Service spent several days backpack spraying riparian areas, and operated a UTV to spray the uplands for Leafy spurge on McCoy Meadows. In comparison to 2021, the 2022 spray season allowed for better treatment timing which increased net treatment acres significantly. OWEB has consistently funded the treatment of leafy spurge with the help of landowners along the upper Grande Ronde and tributaries. Leafy Spurge is an "A" listed Species in Union County and all leafy spurge sites in the county are treated annually.

Birdtrack Springs

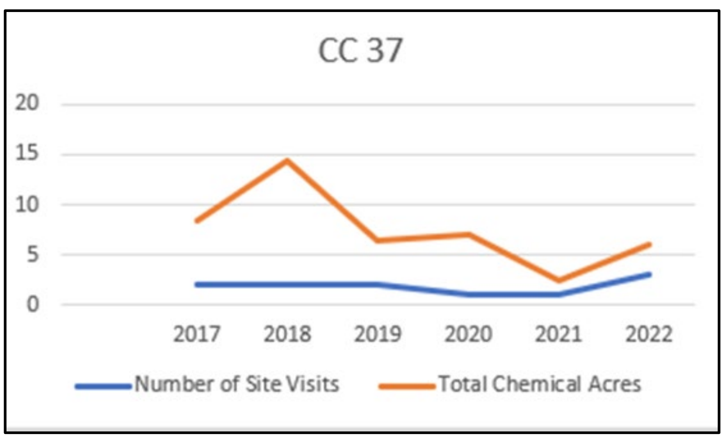
1.5 acres on Jordan Creek Ranch were treated for Leafy Spurge, Scotch thistle, Canadian thistle, hounds tongue, mullein, stinking chamomile, and knapweeds. A large amount of time was spent treating weeds that are not necessarily noxious but are "eye sores". These weeds include annual mustards, stinking chamomile, mullein, etc. All spraying was done with a backpack in order to precisely treat the desired weed species present. The high priority weeds at Bird Track Springs are leafy spurge and knapweeds, but both are only found in small quantities. Treatment acres have increased slightly in years past, but as expected, the amount of herbicide used declined in 2022 and this trend is expected to continue in the future. Coordination occurs with Forest Service crews treating the adjacent forest lands to ensure there is no overlap and that similar results occur.



Southern Cross
5.97 net acres were treated by ground for Russian thistle, Scotch thistle, Canadian thistle, Whitetop, and Annual Mustards. The site has improved significantly over the last six years. When weed treatment began, the focus was to address weeds in disturbed areas. It has now changed to maintenance of county-listed species such as whitetop, Scotch thistles, and starthistle. These weeds have been reduced, but there is a large seed source from historic overgrazing of the property. In 2021, the 10-acre Starthistle patch was sprayed aerially and in 2022, the patch had reduced in size. This past summer, Tri-County enlisted a contractor to inventory Meadow hawkweed along Catherine Creek. No Meadow Hawkweed was found on neighboring properties, and Tri-County staff has yet to find it on Southern Cross; however, it will continue to be closely monitored. Due to increased precipitation levels, and the flooding of Catherine Creek, a small increase in thistle populations was found and both Russian and Scotch thistle patches were treated extensively. This allowed for a slight increase in net acres treated when compared to 2021. Overall, the project site continues to show success with herbicide application.



CC37
6 net acres were treated for annual mustards, Canadian thistle, bull thistle, scotch thistle, and catchweed bedstraw in 2022. This site has very noxious weeds, however there have been problems with annual mustards and bedstraw climbing the riparian easement fences. To maintain a positive relationship with the landowner, the property is treated every year. With an increase in precipitation longevity, an increase of thistles and mustard species were observed in comparison to past years. At this point the main seed source is coming from surrounding agricultural fields adjacent to the riparian easement.



Rock Creek
1.5 acres were treated for whitetop, thistles, and knapweed in 2022. In 2017, at the beginning of this project, treatment was focused on the uplands with some riparian areas treated as well. Currently, the treatment area consists of the lower Rock Creek riparian easement. There are three known whitetop sites in upland areas that Tri-County monitors and treats annually. Due to a significant increase in flooding and rainfall in the spring of 2022, Tri-County staff entered the property for treatment in mid-June.

Longley Meadows

This site had known leafy spurge, Spotted Knapweed, and Oxeye daisy infestations from treatments in 2020 and years prior. No treatments were completed in 2022 due to Longley Meadows Project revegetation efforts.

Identify and Select Projects

The Project has scheduled six sponsor projects for the next five year period illustrated in the table below. See the following link for improved viewing: <Look Forward Project Table>. Project planning and design of individual projects are in various stages of development and completion schedules are estimates. See notes for current project status. Atlas prospectuses have been completed and approved for the Middle Upper Grande Ronde River, Meadow Creek McCoy Meadows, Lookingglass Creek and Catherine Creek RM 42 projects and are in development for the Meadow Creek Dark Canyon project. Specific project objectives and outcomes will be formalized during the project development process and tiered to the Atlas and project specific scope, site condition, and constraints.

TABLE 3 LOOK FORWARD PROJECT LIST FOR THE NEXT FIVE YEAR PERIOD (FY 2023 TO 2027)

CTUIR GRANDE RONDE WATERSHED RESTORATION PROJECT SCHEDULE 2023 TO 2027						
Project Title	**Description**	**Limiting Habitat Condition**	**Prioritized Actions**	**Status**	**Construction (Fiscal Year)**	**Notes**
Catherine Creek RM 42 Passage Improvement/Facility Improvement (CTUIR Adult Collection Facility) (45.1127.49/-117.4947.21)	Project is located along Catherine Creek at River mile 42 and includes CTUIR adult weir collection facility and ODFW screw trap. Year round fish passage for all life stages of concern regarding metal picket weir on Catherine Creek utilized to force adult fish into ladder and collection facility.	Fish passage	Fish Passage	Prospectus development, scoping, and development of engineering assistance subcontract solicitation	2023	Site visit and report completed. Preliminary hydraulic modeling completed. Draft engineering assistant subcontract solicitation drafted. Need to develop and submit Atlas Prospectus for review.
Grande Ronde River Middle Upper Habitat Enhancement Phase 2 (45.1209.89/-118.2253.94)	Phase 2 and 3 are part of an 8 mile planning reach that ranges from confined to semi confined with inset floodplain that are disconnected due to channel incision. Large wood structure additions to aggrade channel, engage floodplain, sort and store sediment, and enhance/create structure complexity and pool habitat. Difficult ground based equipment access. Helicopter wood and boulder placement to minimize damage. Phase 2 and 3 may be combined to improve efficiencies for permitting and helicopter construction costs.	Floodplain, Instream structural complexity, sediment, temperature	Large wood and boulder. Future gravel augmentation evaluation	60% Design Drawings completed. Cultural surveys and reporting underway.	2023-24	Update hydraulic modeling with 2020 LIDAR data. Project reach construction may be combined into single season per USFS.
Grande Ronde River Middle Upper Habitat Enhancement Phase 3 (45.0919.78/-118.2233.45)				30% Design Drawings completed. Cultural surveys and reporting underway.	2024	Update hydraulic modeling with 2020 LIDAR data. Project reach construction may be combined into single season per USFS.
Meadow Creek Dark Canyon Wood Additions (45.639.81/-118.2253.94)	Project protected under permanent CTUIR/BPA conservation easement. Approx. 2.5 miles of Dark Canyon and 0.5 miles of lower Meadow Creek.	instream structural complexity, riparian condition	Large wood, pool development, riparian	Prepare and submit Atlas project prospectus. Initiated project planning and design.	2024-2025	Design project and schedule with other helicopter projects for efficiency and decreased project costs.
Meadow Creek McCoy Meadows Floodplain Restoration (45.1548.72/-118.2352.58)	Approximate 350 floodplain in lower Meadow Creek watershed with over 3.5 miles of Meadow, McCoy, and McIntrye Creek. Permanent conservation easement under CTUIR ownership. Previous projects (1997 and 2010) initiated uplift from channelized condition but short of achieving objectives. Stage 0/Hybrid approach to restore floodplain hydrology.	Floodplain, channel form, side channel, structural complexity, sediment, Instream structural complexity, temperature, riparian/wetland condition	Stage 0 Channel Fill, Addition of large wood, floodplain reconnection, side channel and wetland connection, riparian enhancement	Project Atlas Prospectus complete and approved. Ongoing data collection, review, concept planning, groundwater well monitoring, stage data collection, remote sensing data capture to calibrate hydraulic model.	2025-2026	Update hydraulic modeling with 2020 LIDAR data. Project reach construction may be combined into single season per USFS.
Lookingglass Conservation Property Floodplain Restoration (45.4452.58/-117.5428.13)	Project areas is located on conservation property acquired under CTUIR/BPA Accord. Project includes 3 miles of mainstem Lookingglass Creek which completely channelized and entrenched. Lookingglass watershed is a cold water refuge supporting reintroduced spring Chinook (Catherine Cr stock), ESA summer steelhead and bull trout. Conceptual restoration is a Stage 0 approach	Floodplain, channel form, side channel, structural complexity, sediment, Instream structural complexity, temperature, riparain/wetland condition	Stage 0 Channel Fill, Addition of large wood, floodplain reconnection, side channel and wetland connection, riparian enhancement	Project Atlas Prospectus complete and approved. Schedule data collection, surface development using 2020 LIDAR data, hydraulic modeling and concept development.	2026-2027	Develop working surface from 2020 LIDAR data.

Catherine Creek RM 42.5 Passage Improvement & Facility Improvement (CTUIR Adult Collection Facility) – 2023-2024

The project is located along Catherine Creek at River mile 42 and includes CTUIR adult weir collection facility and ODFW screw trap. Project will provide year-round fish passage for all life stages of concern regarding metal picket weir on Catherine Creek utilized to direct adult fish into ladder and collection facility.

The existing weir and collection facility is effective for adult fish capture, enumeration, and support for the Chinook supplementation program. However, the weir and fish ladder do not meet current NMFS passage criteria. The Denali ladder exceeds velocity criteria and mortality (rates not available) which occurs frequently at high flows when fish enter the main weir and are impinged on the upstream side of the pickets. Upstream juvenile passage is adversely affected by the velocities through the weir and uncertain through the ladder. Juvenile fish rearing in valley reaches may be negatively affected is not able to migrate upstream to find cold water refuge during summer periods.

Specific objectives for the facility include:

- Meet State and NMFS fish passage criteria.
- Minimize passage delay and injury.
- Ability to operate in icy conditions.
- Non-obtrusive passage during non-trapping (August – February).
- From March 1 – May 1, passively enumerate adult summer steelhead with efficiency >95%.
- From May 1 – July 31, trap, handle, and enumerate adult Chinook and steelhead with efficiency >98%.
- Ability to handle adult Chinook from May 1 – July 31 to:
    - Collect data: length, sex, record marks, and natural or hatchery origin determination.
    - Collect hatchery brood stock.
    - Mark adult Chinook.
    - Collect genetic samples.
    - Remove surplus hatchery origin adult Chinook.
- Ability to handle adult Chinook under electro-anesthesia with minimal stress on fish and personnel.
- Ability to hold fish for 24 hours.
- Incorporate antenna equipment in fish way to detect and interrogate PIT tags on adult and juvenile Chinook and steelhead.
- Incorporate equipment for safe and efficient loading of adult Chinook into transportation vehicles in-water as much as possible.

Project planning and design was initiated in August 2022 following selection and contract award of River Sturcture, Inc for engineering services.Work included field survey (topographic data, wetlands evaluation, facility condition), hydraulic modeling, scoping with project team to refinement of objectives, development of 15% alternatives and HIPIV review, and synthesis and refinement of alternatives. Planning efforts included development of alternatives for fish passage and habitat. During winter/spring 2023, ongoing planning and design focused on refining alternatives to focus anlayses to move towards selected preferred alternative. Design contract will complete a 60% design with accompanying construction drawings and Basis of Design Report. Pending completion of 60% design, CTUIR will determine next steps to complete design. CTUIR secured additional for funding to support the design process through NOAA Fisheries. Scheduel for final design will be determined, but anticipate a 2024 completion date.

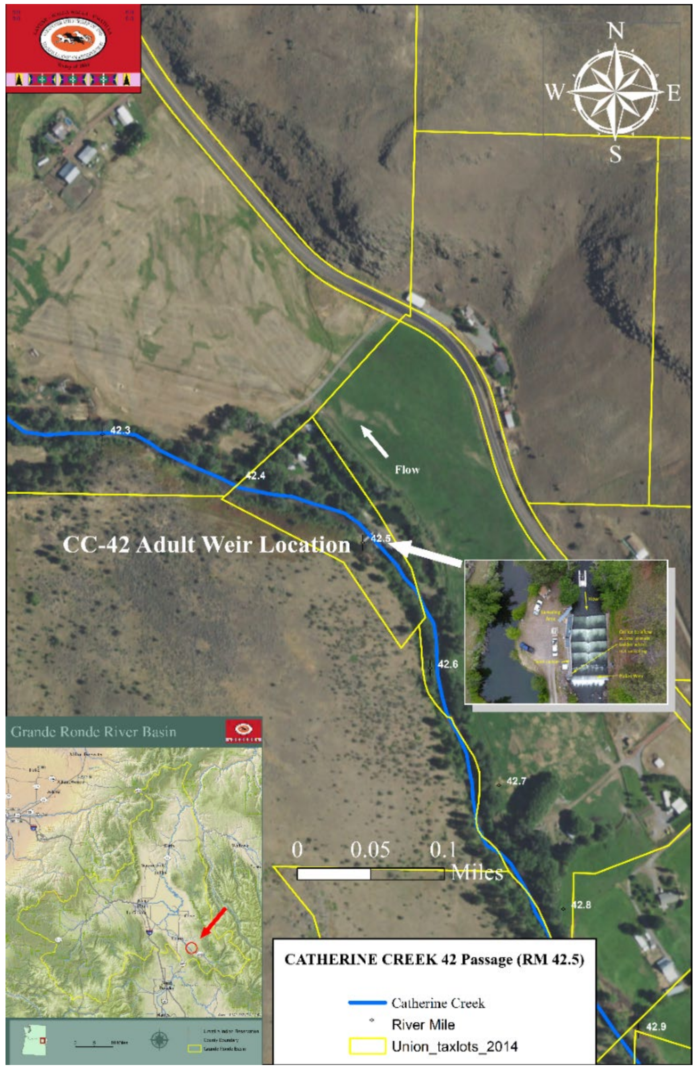


FIGURE 7 CATHERINE CREEK RM 42 PASSAGE IMPROVEMENT & FACILITY IMPROVEMENT VICINITY MAP

Grande Ronde River Middle Upper Habitat Enhancement Phases 2 and 3, July 2023.

Actions scheduled for implementation for Phases 2-3 include the continued installation of large wood structures by helicopter throughout the project reach to mimic natural historic conditions. Large wood features will be designed to force pools and maintain the multi-channel planform. Engineered Log Jam Structures (ELJS) will be constructed using the US Bureau of Reclamation's Pacific Northwest Region Resource & Technical Services Large Woody Material

Risk Based Design Guidelines, 2014. Structures are designed to be passable to fish, and are consistent with the adult and juvenile fish passage criteria provided in NOAA's Anadromous Salmonid Passage Facility Guidelines (2004) and consistent with the Aquatic Resources Biological Opinion for restoration actions on federal lands in Oregon and Washington.

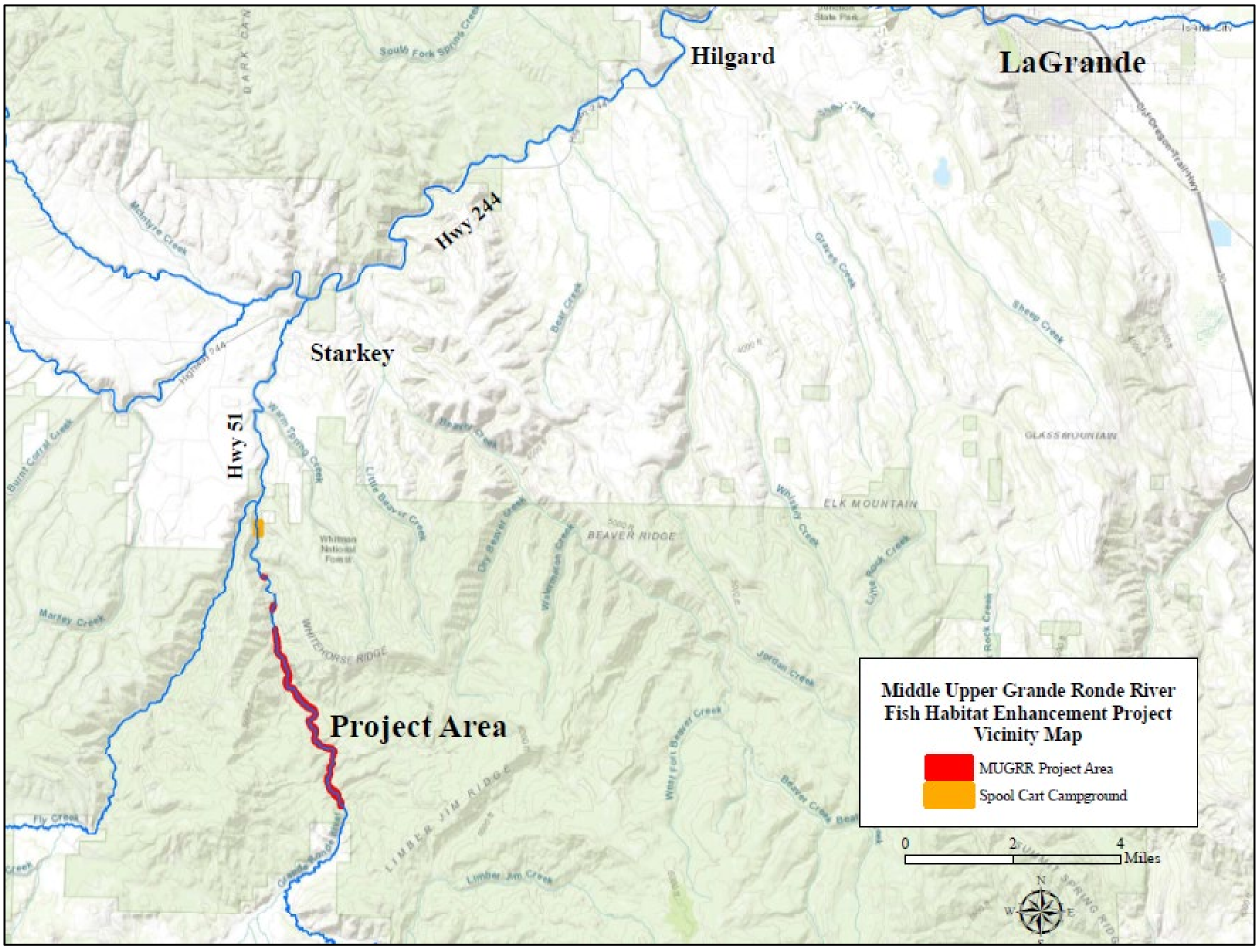


FIGURE 8 MUGRR PROJECT OVERVIEW MAP

Meadow Creek Dark Canyon Wood Additions – TBD

The Meadow Creek Dark Canyon project is located within the Cunha Ranch permanent conservation easement near the confluence of the Grande Ronde River and encompasses approximately 2.5 miles of Dark Canyon Creek and approximately 0.5 miles of Meadow Creek. Initial construction occurred in 2010 and included the installation of instream log jams and boulders along sections of Meadow Creek and Dark Canyon Creek and the removal of an old railroad grade disconnecting the floodplain along Meadow Creek. Future planned actions include installation of additional large wood structures to increase habitat complexity and promote floodplain.

McCoy Meadows Floodplain Restoration – TBD

The McCoy Meadows Conservation Property owned by the CTUIR is located in Union County about 20 miles southwest of La Grande, Oregon, near the confluence of Meadow Creek with the upper Grande Ronde River. The property encompasses about 450 acres of historic wet meadow habitat with nearly 2.9 miles of lower Meadow Creek, 3.3 miles of McCoy Creek, and 0.5 miles of McIntyre Creek. The Project area has had several prior phases implemented. Phase 1 (upper McCoy meadow) in 1997, Phase 2 (lower McCoy meadow) in 2000-2002, Meadow Creek wetland enhancement in 2006, and McCoy Creek enhancements in 2010.

Design Approach – Combination of Valley Reset, Beaver Dam Analogs, Big Game Exclusion

One design approach being considered for future implementation is to target a process-based *Stage 0* restoration methodology consisting of an anastomosing network of channels and wetlands that frequently flood (Cluer and Thorne, 2013). This approach would create more complex, dynamic, and self-sustaining habitat and improve fluvial processes and function such as floodplain connectivity, retention of fine sediment and spawning gravels, increased pool depths, and diversified habitat. Stage 0 Habitat and Ecosystem Benefits include:

- Habitat - Multiple channels, islands and broad floodplain provide access to rich palette of diverse habitats in close proximity and refugia across a wide range of flood events. High water table, deep pools, and continuous hyporheic flow provide drought refugia in the multiple channels. Channel margins evolve semi-continuously to expose tree roots.

- Biota - Multiple, complex, dynamic channels that are connected to an extensive floodplain and which interact with groundwater support large numbers of different species. This provides for the highest possible biodiversity (species richness and trophic diversity), proportion of native species, and 1st and 2nd order productivity (Thorp, et al., 2010).

- Resilience and Persistence - Physical and vegetative attributes and functions stemming from their complexity, connectivity, and diversity act to attenuate floods and sediment pulses, making habitat and biota persistent and highly resistant to natural and anthropogenic disturbances including flood, drought, and wild fire.

- Water Quality - High capacity of multi-channel network to store sediment and cycle nutrients and other suspended solids produces exceptional water clarity. Dense, diverse proximal vegetation provides abundant shade which, together with efficient hyporheic flow, is highly effective in ameliorating temperatures.

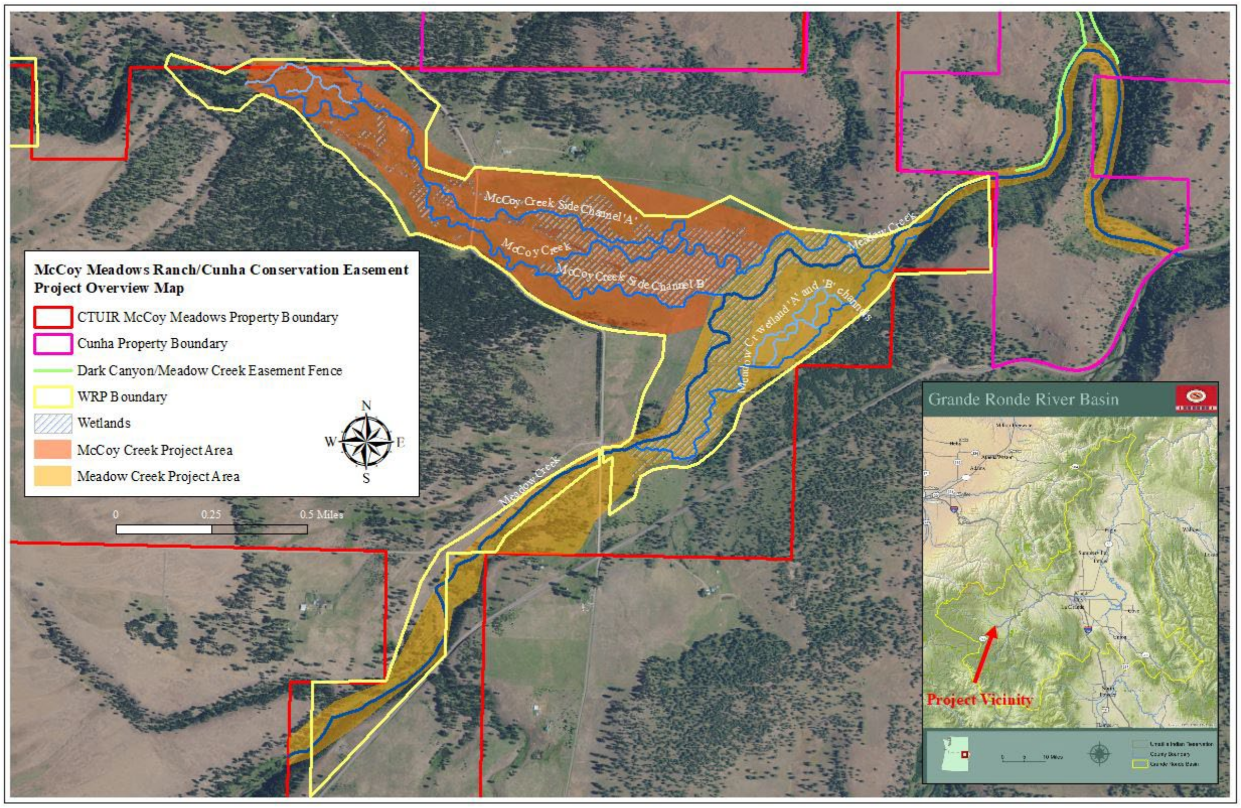


FIGURE 9 MCCOY MEADOWS RANCH/CUNHA CONSERVATION EASEMENT PROJECT OVERVIEW MAP

Lookingglass Conservation Property Floodplain Restoration – 2024-2025

The Lookingglass Creek Fish Habitat Enhancement Project is located in Atlas BSR UGR1 in the Grande Ronde River Basin along Lookingglass Creek between river miles 4 to 6 and is bordered by Umatilla National Forest System Lands along the western boundary. The CTUIR acquired the property in fee title through the CTUIR-BPA Accord land acquisition program in 2018. The project reach sits at an elevation of approximately 2,800 feet with contributing watershed area of 95 mi2, which is predominantly spring-fed and snowmelt driven. Most of the basin is forested (over 90 percent) and has very little development (less than 0.1 percent estimated impervious area) (USGS 2014). The property and resource values are protected by a permanent Bonneville Power Administration conservation easement.

The long-term rehabilitation vision (CTUIR's River Vision) for the Lookingglass Creek Fish Habitat Enhancement Project is to remove risks to native fishery resources associated with non-native fish in constructed ponds, restore the historic floodplain and morphological, ecological processes that support suitable spawning and rearing habitat for spring Chinook salmon, summer steelhead, Pacific lamprey, and bull trout. Fish habitat suitability and capacity uplift potential is significant. Juvenile salmonid rearing habitat, adult spawning habitat, and riparian-wetland habitat would benefit from restoration and enhancement (wood placement, channel and side channel reconstruction, wetland and riparian restoration, and floodplain reconnection). Activating the floodplain and utilizing the previously constructed floodplain ponds would significantly improve juvenile rearing habitat for summer and winter. CTUIR Chinook redd surveys document extensive spawning use of the of the project area despite habitat limiting factors (degraded habitat quantity and diversity, lack of large complex pools, large substrate, lack of large wood, and backwater habitat) excess fine sediment, lower summer flows, predation, alterations of the hydrologic function, and the channel being disengaged from the floodplain and elevated water temperatures (Huntington, 1993; NPCCa, 2004, GRMW 1995, WWNF 2004). A *Stage 0* design approach is also being considered.

Wolfe Water Resources was subcontracted by CTUIR to provide engineering design services in September 2022. Design work accomplished during reporting period including topographic and field surveys, development of hydraulic model, concepts, and alternatives, refinement of objectives, 15% HIPIV presentation, and development of draft Basis of Design Report, Construction drawings and specifications, refined Area of Potential Effect (APE), and bridge inspection. Design team is finalizing 30% design in preparation for additional HIPIV review and initiated coordination with CTUIR Cultural Resource Program to prepare for summer 2023 survey. Preferred restoration alternative is a valley reset approach in artificially confined reaches and a enhancements to reaches that are naturally evolving into an anastomosing channel network. Design subcontract was extended with design completion expected in April 2024.

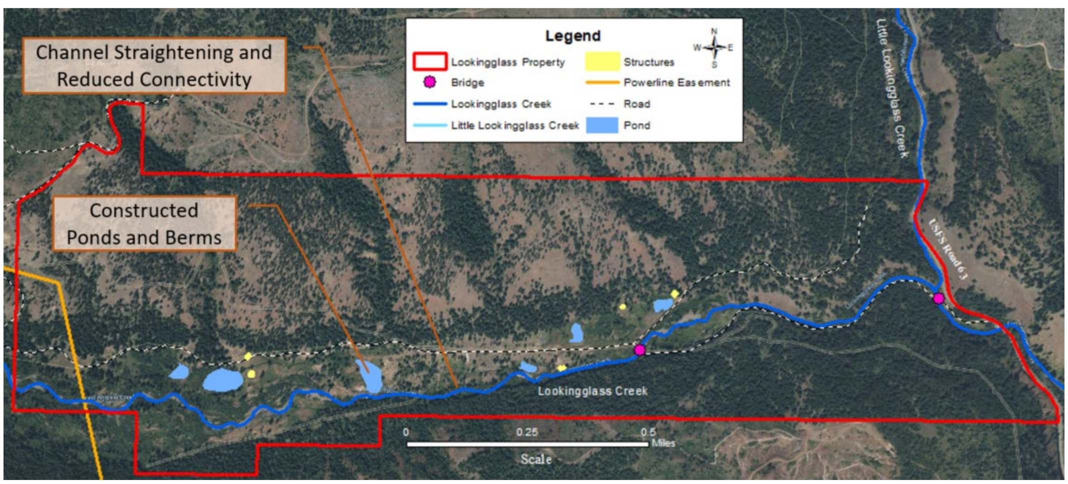


FIGURE 10 LOOKINGGLASS CREEK FISH HABITAT PROJECT EXISTING CONDITION

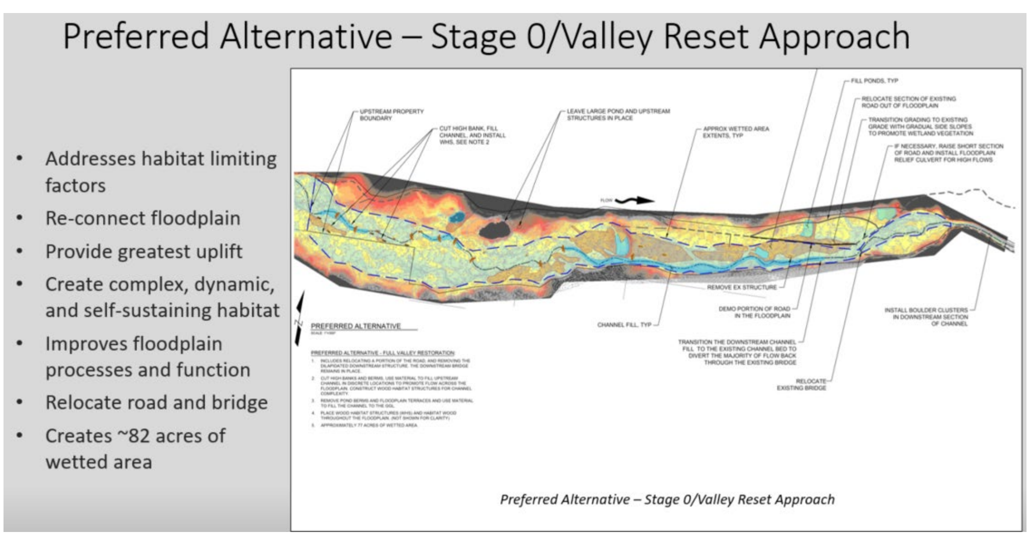


FIGURE 11 LOOKINGGLASS CREEK FISH HABITAT PROJECT PROPOSED CONDITION

Grande Ronde Sub basin 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 2020 Annual Progress Report (project #2009-014-00; BPA contract #71934) depending on the project.

M&E efforts include annual drone imagery collected by the GRMW including aerial video and Digital Terrain Model/Ortho imagery, annual photo-points, time lapse cameras at select locations, installation and maintenance 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.

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

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 27 & 28), 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, 17 level loggers were installed along channel margins in the Bird Track Springs Project to monitor surface water discharge/stage in order to evaluate changes to the hydrology and temperatures associated with fish habitat enhancement activities.

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.

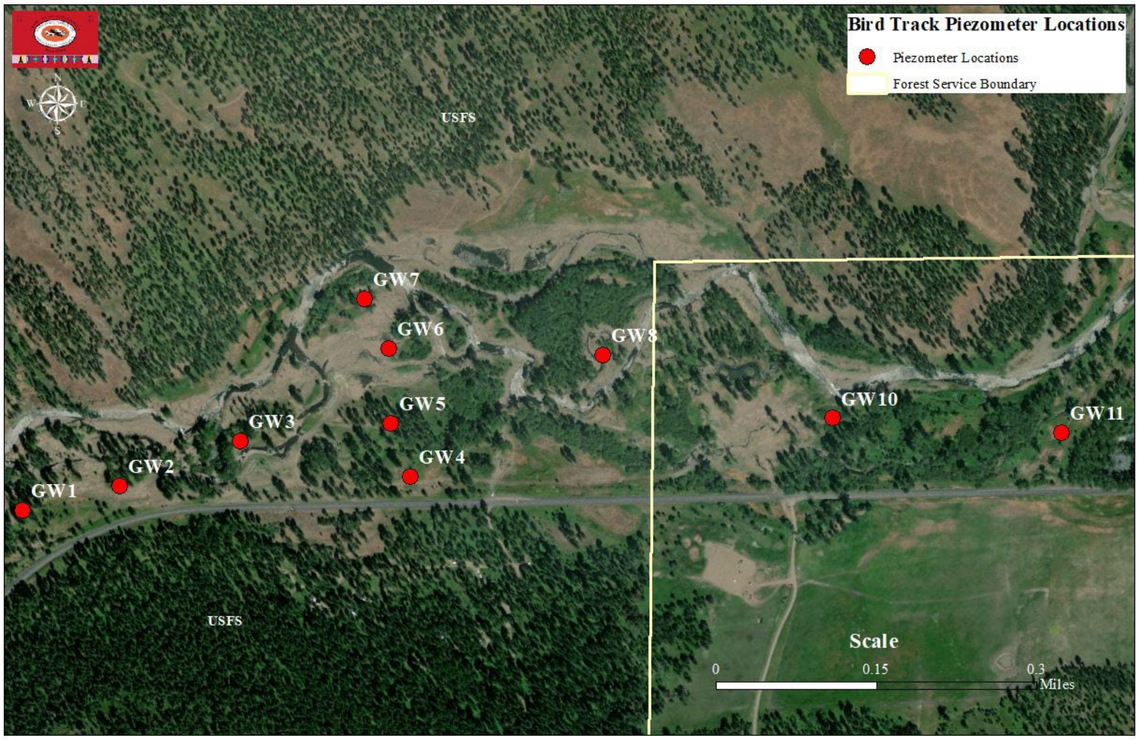


FIGURE 12 PIEZOMETER LOCATIONS IN THE BIRD TRACK SPRINGS PROJECT AREA

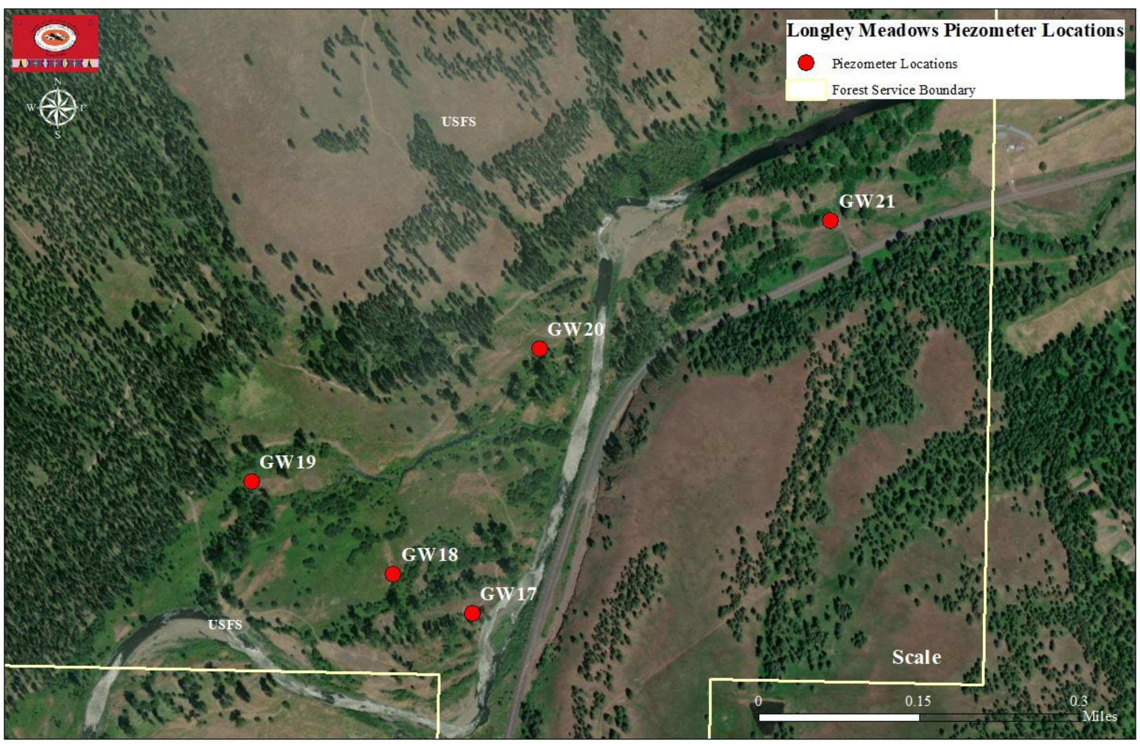


FIGURE 13 PIEZOMETER LOCATIONS IN THE LONGLEY MEADOWS PROJECT AREA

Monitoring Goals & Objectives

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 and 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 effort.

Fish salvage efforts during the two phases of the Bird Track Springs project have demonstrated the presence of juvenile rainbow trout/steelhead (*Oncorhynchus mykiss*), Pacific Lamprey (*Entosphenus tridentatus*) and Western Pearl shell 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 CTUIR.

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 for the period between January-2018 to November-2022. 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 area, although it should be noted there may be many ways to interpret the following data, which will be available through the Central Data Management System (CDMS) website operated by the CTUIR.

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 coolest temperatures occuring during the highest water elevations and the warmest water temperatures occuring in the lowest water elevations.

It is important to mention that groundwater data collected from Bird Track Springs wells 1-11 between 2018-2019 may exhibit anomolies influenced by certain project construction activities. Year 2 construction began in early May 2019 and ended in November. In-water activities such as bypass channel activation, channel de-watering and reclaimation, or pumping water out onto the floodplain could account for some wells exhibiting noticable fluctuations in groundwater elevation otherwise unassociated with any natural surface flow events. In addition, Longley Meadows wells 17-21 between 2020-2021 were similarly affected by nearby project construction activities. In the following data plots the two far left grey columns that occur in 2018 and 2019 represent the in-water work windows during BTS project construction that potentially influenced groundwater levels in wells 1-11. The remaining two far right grey columns that occur in 2020 and 2021 depict the in-water work windows during Longley Meadows project construction, and may have some influence on groundwater elevations in wells 17-21.

The first three wells (GW 1-3) are in the upper portion of the Bird Track Springs project area in the vicinity of side channel 1 & 2 (Figure 27). GW 3 (blue) has the lowest groundwater elevation of this group during 2018 and most of 2019, but quickly rises to the ground surface beginning late summer 2019 where it remains the highest groundwater elevation well in this group to present. The sudden increase and persistance in elevation coorelates to GW 3 proximity to side channel 2, which was not fully activated during 2018-2019 construction until September 2019, precisely when we see a near-vertical 0.5 meter uptick towards ground surface elevation. Other vertical increases in the data can most likely be atributed to initial spring ice melt and subsequent high flow events. Groundwater elevation at GW 1 remains the furthest from ground surface (deepest) and exhibits the shortest vertical amplitude range between lowest summer and highest spring groundwater elevations compared to othehr wells in this group. A possible explanation is that GW 1 is situated upstream of the upper-most project construction boundary. Constructed entrances to Side-channel 1 and 2 are downstream of GW 1 location and would have minimal expected influence on elevating groundwater levels within the existing floodplain upstream of these locations. Groundwater elevations at GW 1 could be useful as a “control” against “treated” well locations within project-activated floodplain and side channel networks.

The greatest range in seasonal max-min temperature was observed at GW 2 (18°C in Aug-19 down to 2°C in Feb-20 (Figure 30). Proximity to side channel 2 may explain the extreme temperature range due to a shorter sub-surface distance between the well and seasonally-influenced surface water. Additionally, groundwater at GW 2 seasonally rises and falls earlier than the two other wells in this group. This trend is likely also explained by GW 2’s closer proximity to side channel 2. The two remaining wells (GW 1 and 3) are further from main channel or side channels and exhibit more muted temperature extremes and delayed onset of seasonal rises and dips, possibly due to a greater buffering distance of sub-surface substrate between these two wells and surface water. The Grande Ronde River near Perry, OR reached just over 8000 cfs (226 cms) on February 7, 2020 and then topped out again at 9000 cfs (255 cms) on May 21, 2020. The groundwater elevations for these three wells show an almost instantaneous increase response to the river’s peak flows. As the river receded following peak flows in May so did the groundwater elevations at these three well locations. Following the first surge in 2020 there were multiple small increases in main channel surface discharge leading up to the second high water event that correspond with subtle increases in groundwater elevations. Furthermore, as main channel flows drop to summer base flow levels, groundwater elevations at these three locations seem to hold steady throught the remainder of the year. The Grande Ronde River 2021 hydrograph was much less explosive than the previous year, topping out at only 1800 cfs (51 cms) in early April-2021. Given the difference in main channel surface flow amplitude between

2020-2021 groundwater data for wells 1-3 between Jan-21 and Nov-21 appears to mirror the 2020 groundwater trends, albiet with slightly lower peaks and lower baseflow elevations.

GW wells 4-7 represent a north-south transect with the new main channel alignment directing flows north of GW 7 (Figure 27). Additionally, GW 6-7 exist within a lowland swale network that is charged with groundwater through a blind channel diversion from the right bank of side channel 2 just upstream from where it rejoins the main channel. This may be a good area to direct attention for a more intensive thermal refugia study proposed by BOR given the potential to alter the groundwater table and how the new channel alignment and off channel swale networks may influence the transect. GW 4 has the highest water elevation between 2018-present despite it being farther away from the existing channel (Figures 31 & 32). It is possible that a significant portion of groundwater at GW 4 location originates from a small draw that drains the north face of a tall ridge within Bird Track Springs Campground, south of highway 244. Compared to GW 5-7, GW 4 does not seem to respond to April-May seasonal peak discharges with similar high amplitude increase in groundwater elevation; it appears to top out at 0.5 m below ground surface. Another interesting observation, when comparing neighboring GW 4 with GW 5 after peak flows decline into May, is the large difference in groundwater elevations (approximately 1.25 m difference) when geographically these wells are the closest to each other among all BTS wells. Similarly to the observed increase in groundwater elevation at GW 3 following side channel 2 activation, GW 6 also exhibits a sharp increase in groundwater elevation corresponding to the Oct-19 activation of the blind channel swale network that envelops this well location. July 2021 experienced an extreme heatwave and subsequent low flow surface water in the Grande Ronde River. Each well in this grouping displays a sudden decrease in groundwater elevation occurring at the same time as the onset of the July-2021 sustained high air temperatures and decrease in river flow. Interestingly, GW 6 within the blind channel swale network recorded the lowest groundwater elevations during 2021 summer low flow time period, compared to GW 4 (furthest from any surface water) recorded the highest groundwater elevations during the same time period, relative to this four-well grouping.

GW 6 had the greatest range in temperature beginning with Aug-19 maximum, decreasing 14°C into Feb-20, then climbing again to the same average max temperature in Aug-20 (2.2-16.1°C-Figure 32). And again in 2021 GW 6 temperatures decreased significantly more than the other three wells going into winter, then rising significantly higher going into summer compared to the other three wells on this transect. Similarly to GW 3, the seasonal temperature swings may be due to increased interaction with surface water from side channel 2 that is diverted into the blind channel swale complex.

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 33). Each of these three wells exhibited instantaneous increases in groundwater elevation during peak surface flow events. GW 10 groundwater elevations have remained above those at GW 8 and 11 since wells were installed in 2017. Its location lies just behind the main channel bank at a sharp 90 degree meander bend in line with thalweg trajectory. The relatively high groundwater elevations recorded at GW 10 may be the result of main channel surface water encountering the sudden change in river direction and continuing on straight into the sub-surface substrate of the bank. Comparing 2020-2021 data for these wells shows that overall in 2021 these wells recorded lower groundwater elevations, possibly resulting from less extreme spring melt flows and lower than average main channel flows in summer 2021. The most downstream well, GW 11, lies adjacent to side channel 10 and appears to be trending lower in groundwater elevation with a record low elevation of 2 m below ground surface in summer 2021. In 2020, a large ponderosa tree fell across the entrance to side channel 10. The tree itself does not seem to impede flows into the side channel but may have slowed water resulting in sediment deposition occurring at the entrance which may be decreasing summer low flows in side channel 10.

Average temperature min-max range is the greatest at GW 10 (2.5-17°C Feb-20 to Aug-20, and again Feb-21 to Aug-21) suggesting that groundwater in this location may originate from nearby hyporheic exchange with seasonally-influenced main channel surface water. Conversely, GW 11 is located furthest from the main channel compared to the other two wells in this group and exhibits the most buffered temperature trends; no extreme cold dips in the winter and a relatively low summer high temperature, only fluctuating between 6-12°C annually. Construction activities such as dewatering, channel reclamation, bypass channel construction, and pumping water onto floodplain associated with construction in the summer and fall of 2019 appears to have affected some readings at GW 8 & 11 (Figure 34). However, GW 10 exists in close proximity to a 2018 completed project reach and therefore exhibits a relatively stable and predictable groundwater fluctuation regime while 2019 construction activities were happening elsewhere.

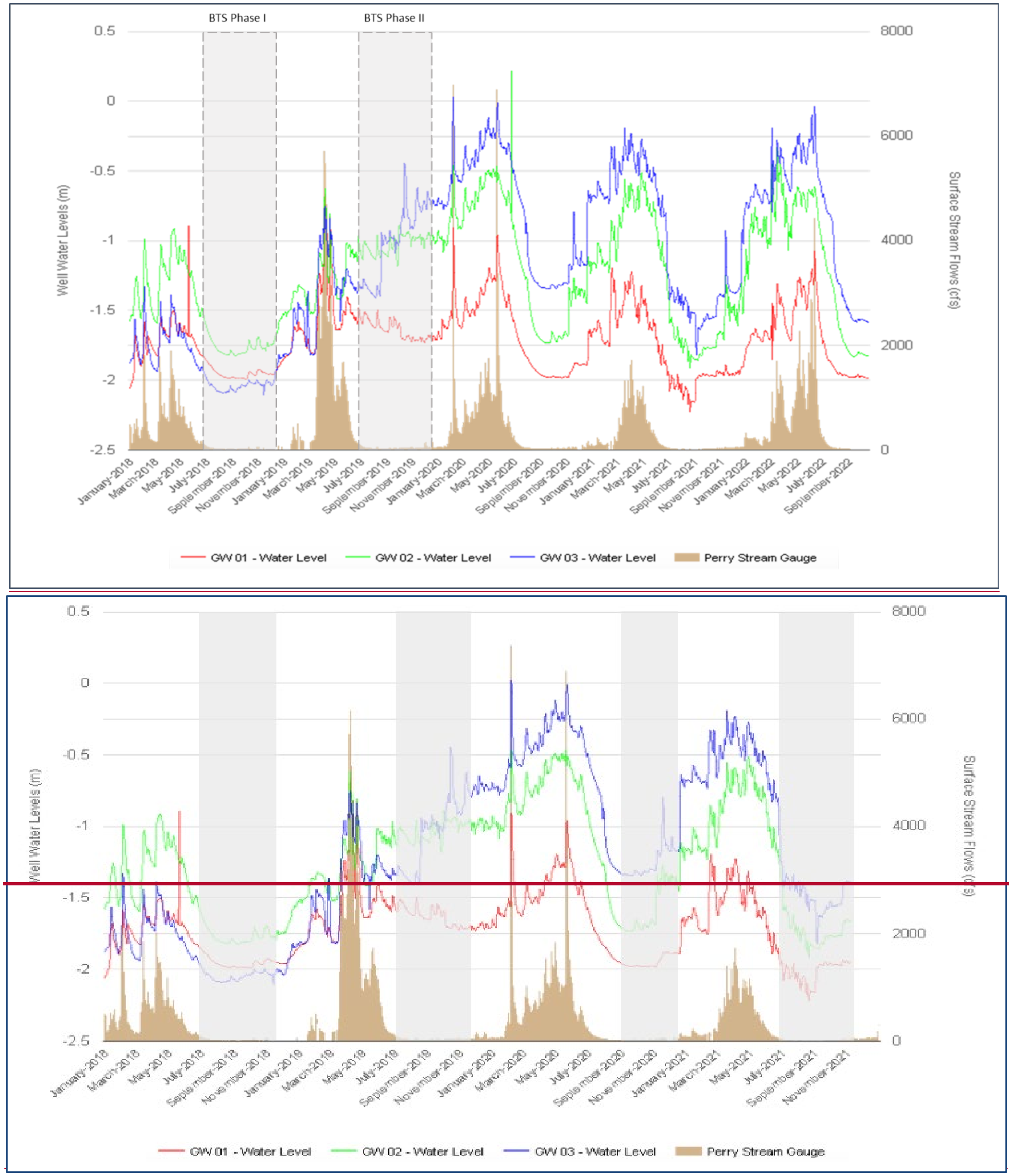


FIGURE 14 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 1-3 AT BIRD TRACK SPRINGS AND DISCHARGE AT THE PERRY GAUGE, JANUARY, 2018 TO NOVEMBER, 2022~~1~~

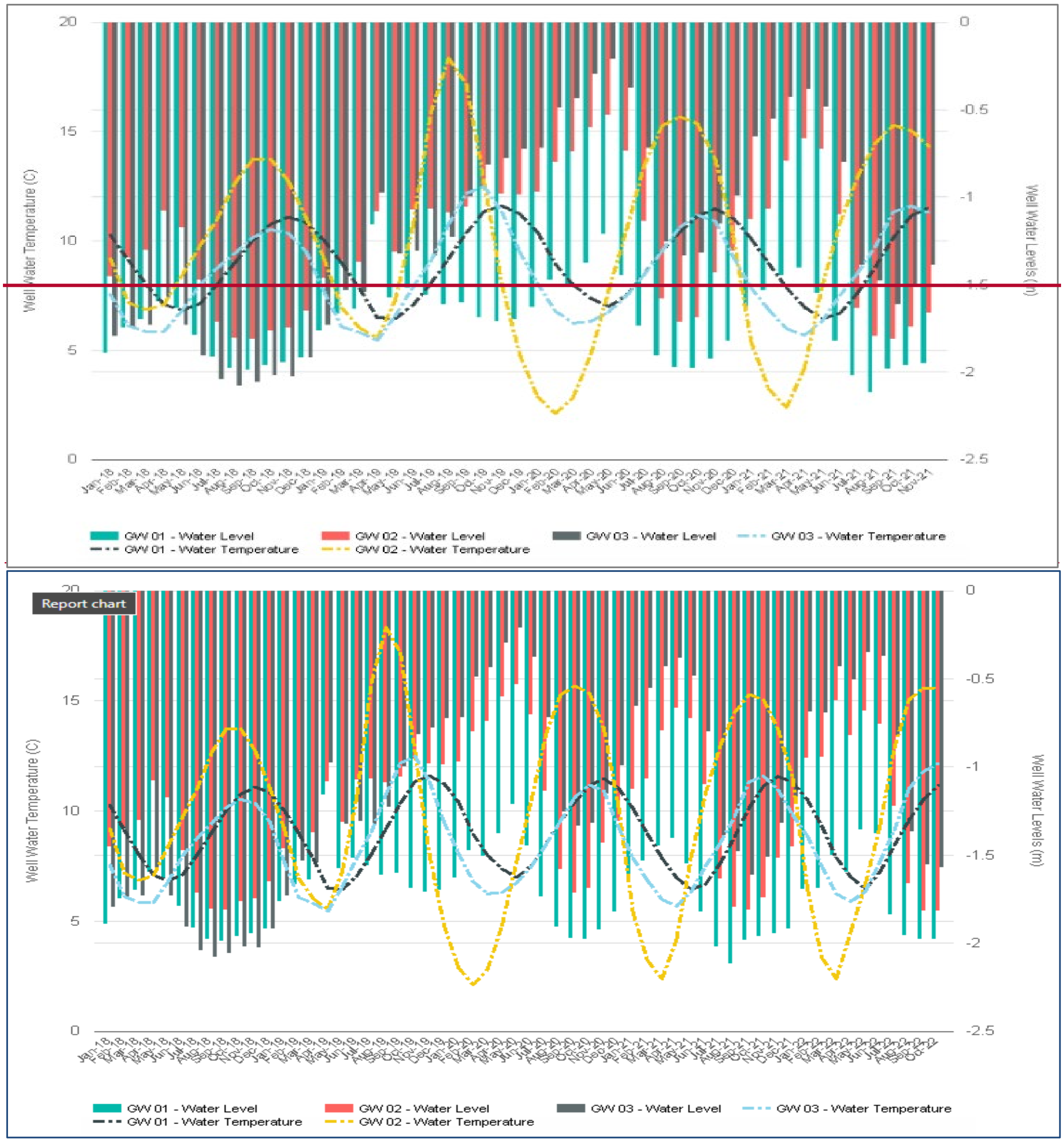
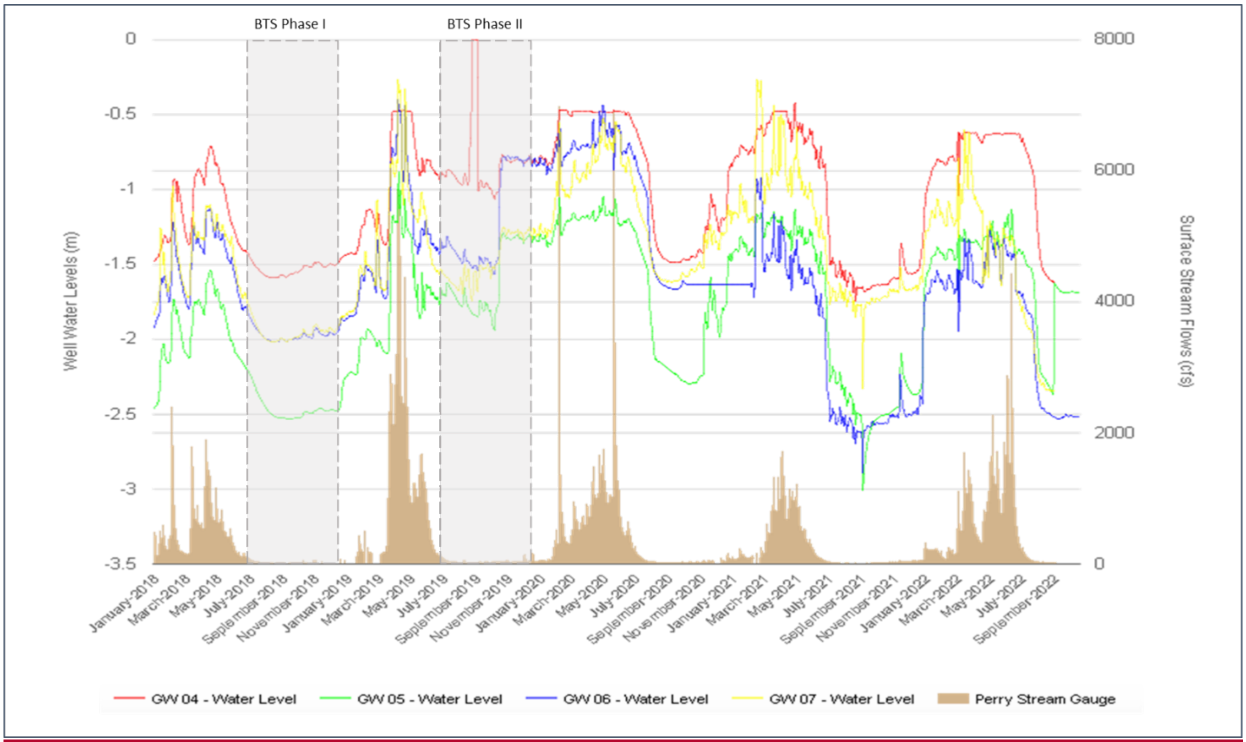


FIGURE 15 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 1-3 AT BIRD TRACK SPRINGS AND CORRESPONDING GROUNDWATER TEMPERATURES, JANUARY, 2018 TO NOVEMBER, 2022~~1~~.



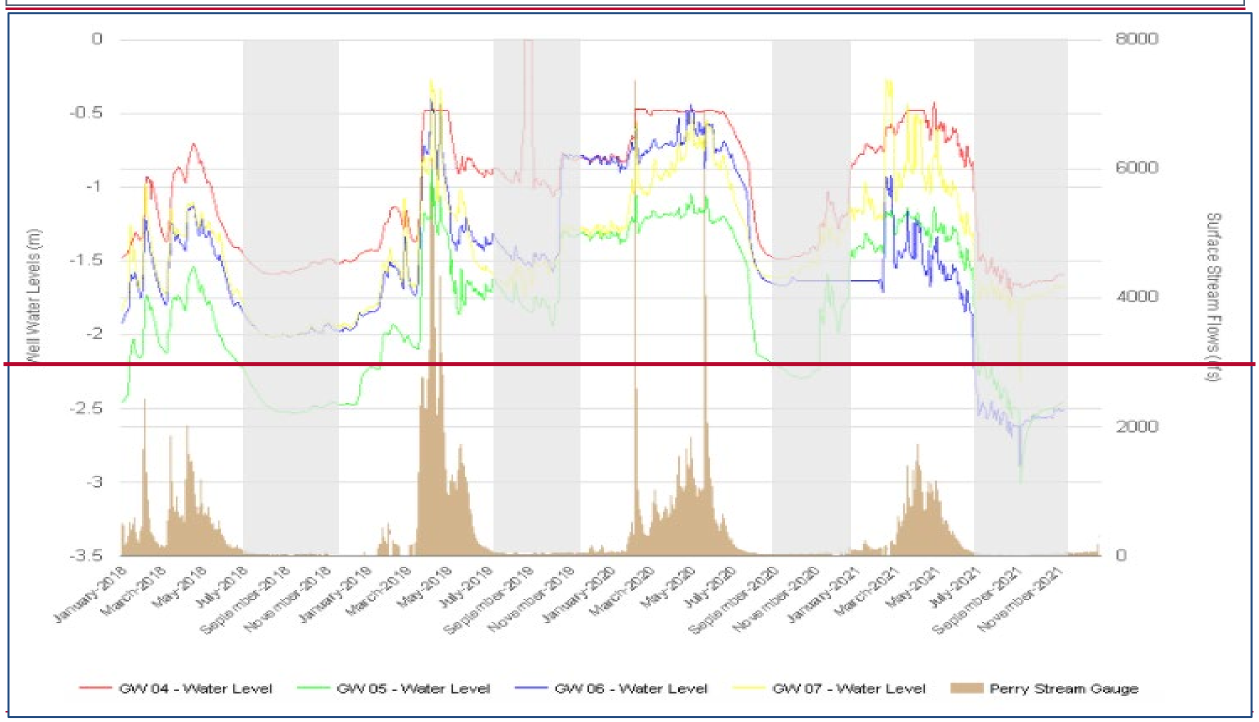
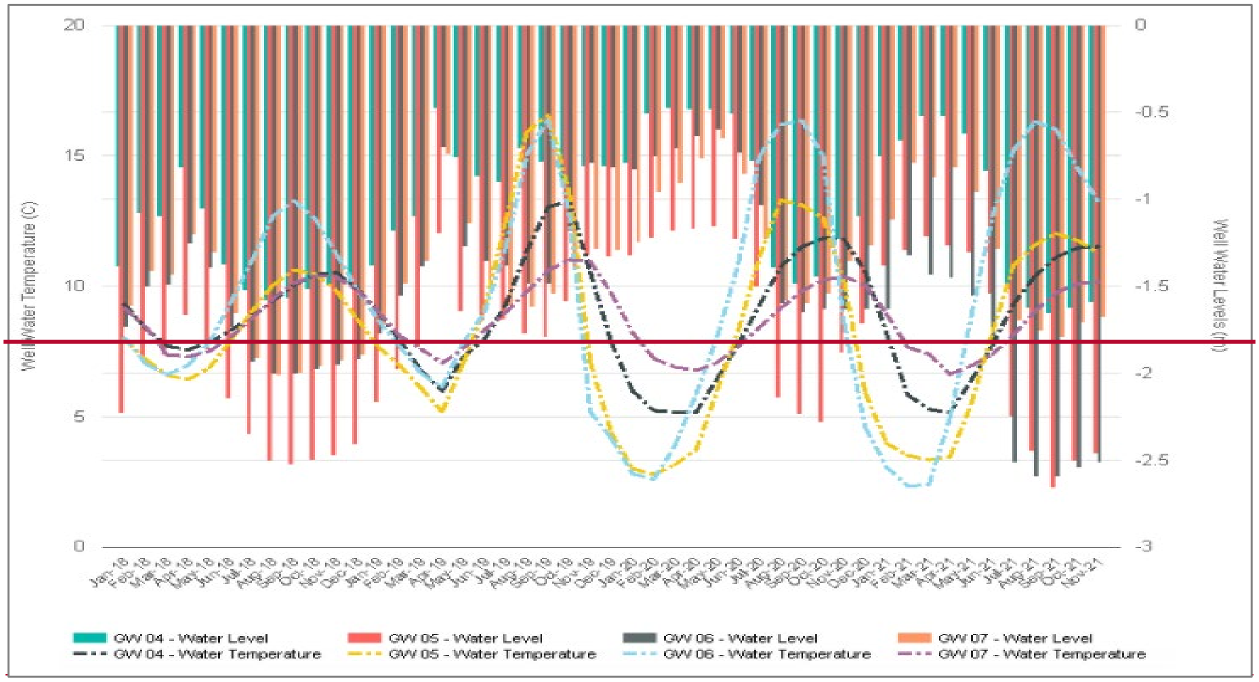


FIGURE 16 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 4-7 AT BIRD TRACK SPRINGS AND DISCHARGE AT THE PERRY GAUGE, JANUARY, 2018 TO NOVEMBER, 20221.



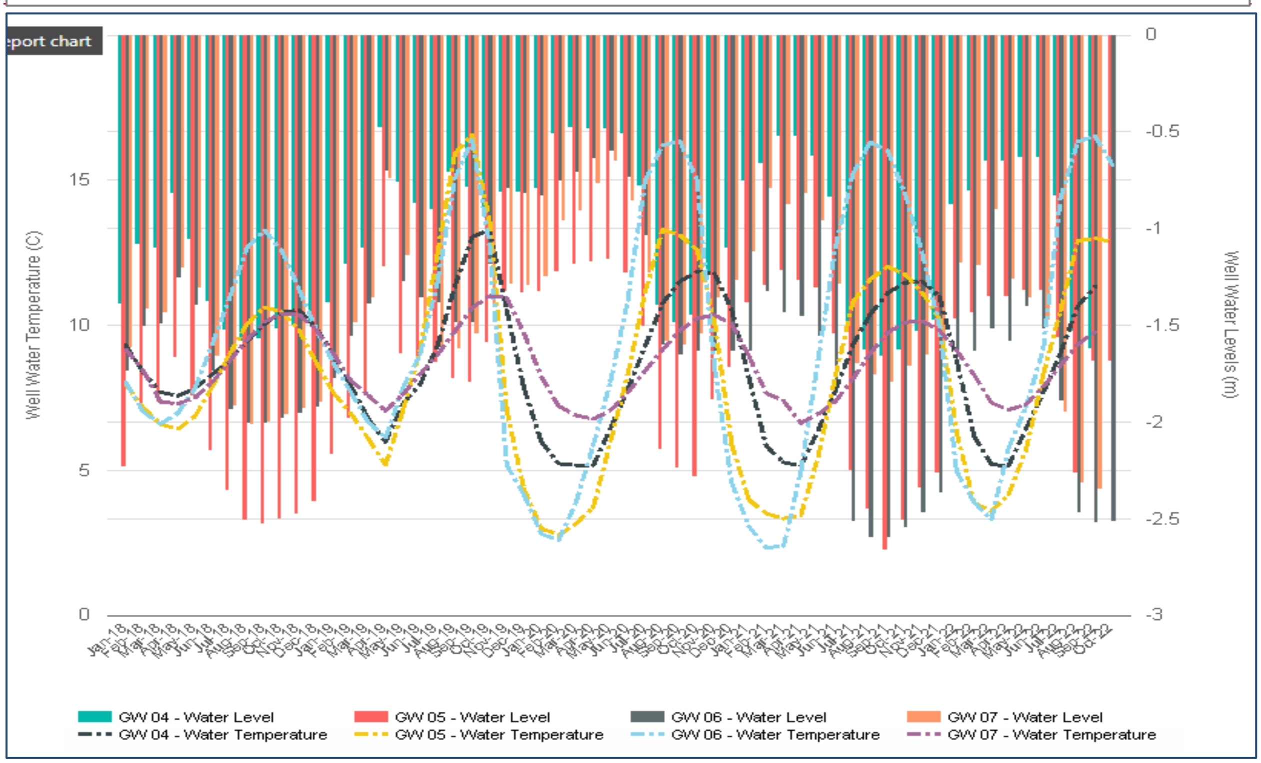
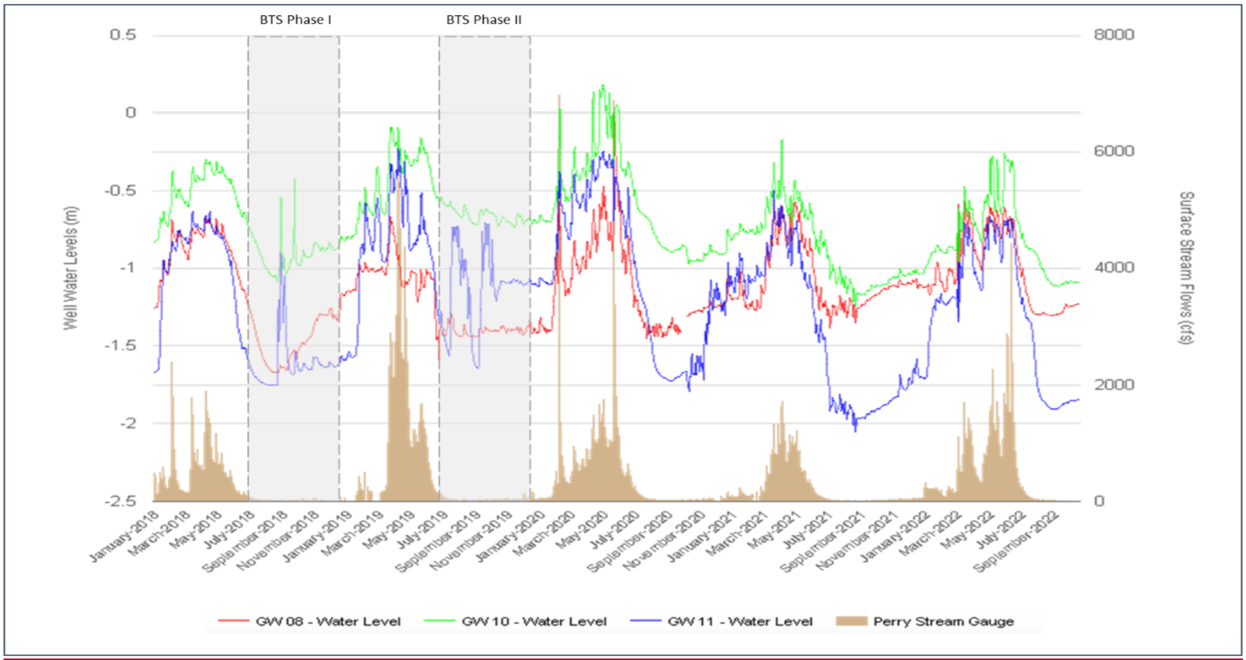


FIGURE 17 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 4-7 AT BIRD TRACK SPRINGS AND CORRESPONDING GROUNDWATER TEMPERATURES, JANUARY, 2018 TO NOVEMBER, 2022~~1~~



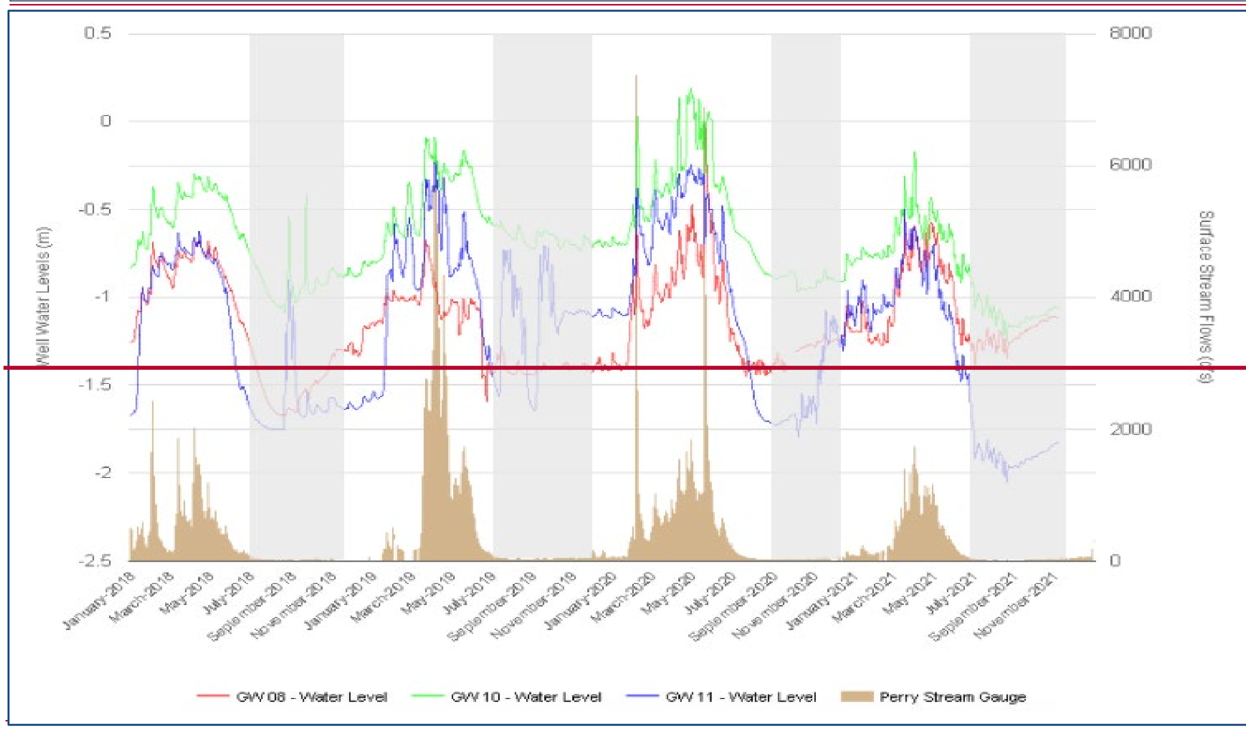


FIGURE 18 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 8-11 AT BIRD TRACK SPRINGS AND DISCHARGE AT THE PERRY GAUGE, JANUARY, 2018 TO NOVEMBER, 2022.

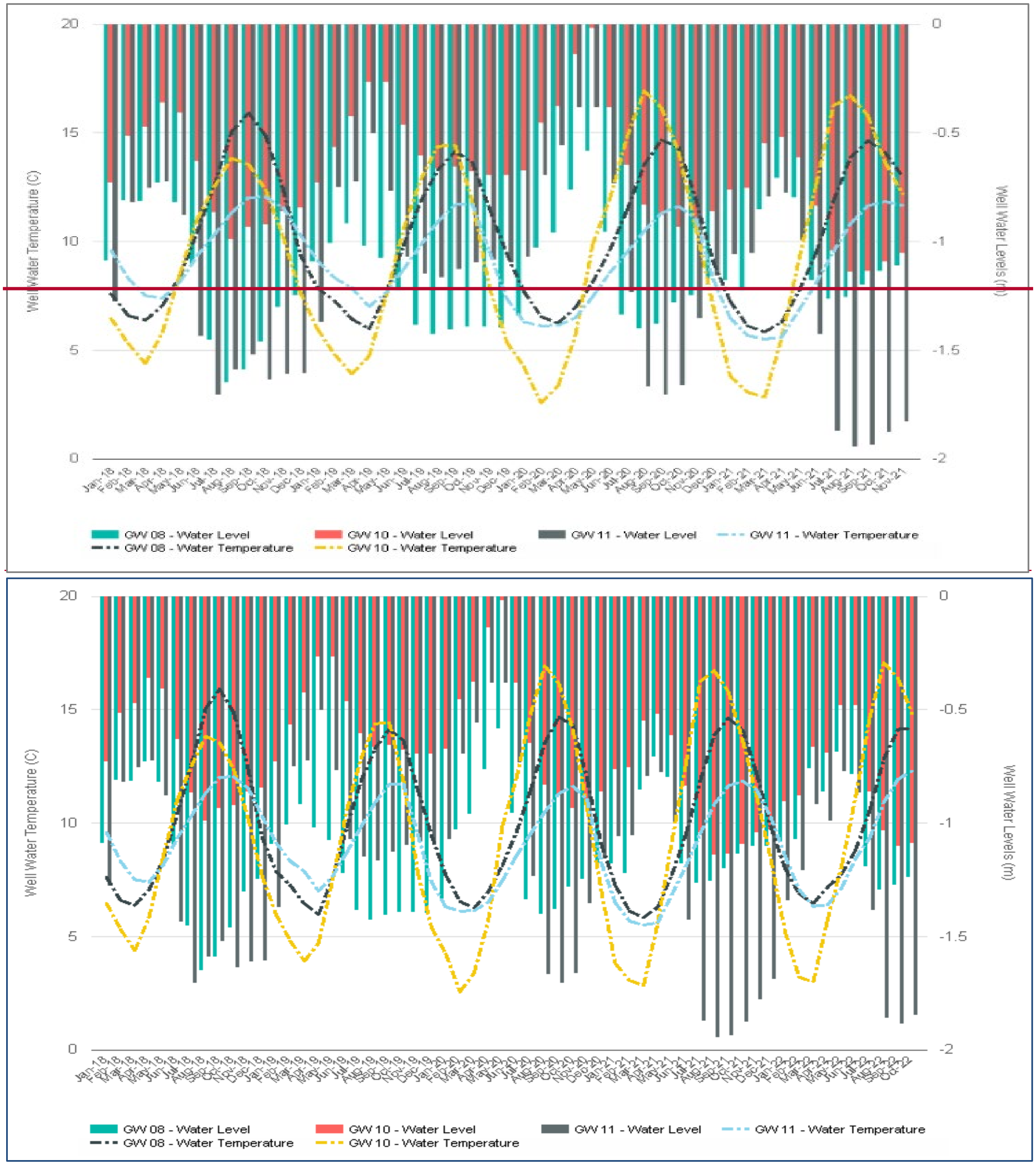


FIGURE 19 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 8-11 AT BIRD TRACK SPRINGS AND CORRESPONDING GROUNDWATER TEMPERATURES, JANUARY, 2018 TO NOVEMBER, 20221.

Longley Meadows

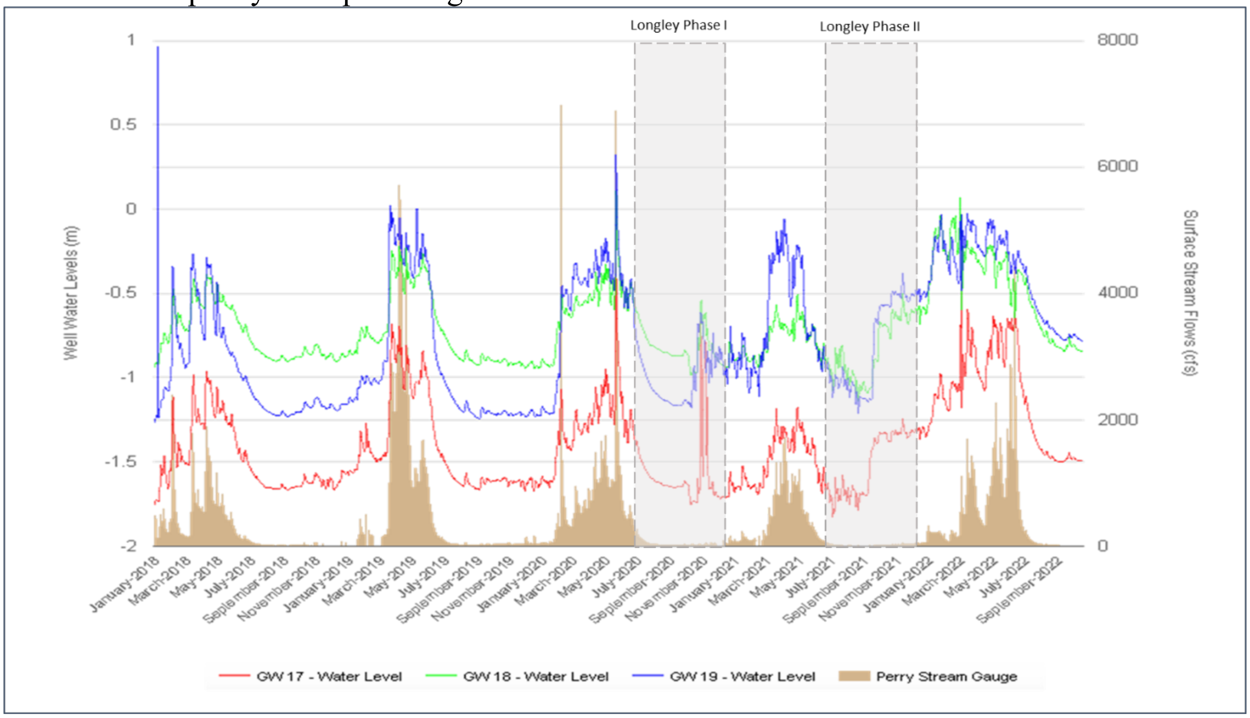
Wells 17-18 represent the upstream portion of Longley Meadows Fish Habitat Enhancement Project, orientated in a northwest transect (Figure 28). Interestingly, the closest well to the river (GW 17) exhibits the lowest water elevation, and the well furthest from the river (GW 18) recorded the highest groundwater elevation (Figure 35). In fact, GW 18 water elevation leading up to peak flows in spring 2018 and 2019 was the same distance below the meadow surface as GW 17 reached at its peak. Groundwater data collected from these three wells in fall of 2020 appears to have been influenced by Longley Meadows Fish Habitat Enhancement Project - Phase I construction activities. Prior to installation of main channel large wood bank structures a large volume of water was pumped out of deep main channel pools and onto the floodplain in the vicinity of GW 17 and 19. Records from GW 17 during this time exhibit an upward surge of approximately 1.5 m groundwater elevation, whereas groundwater elevation increased about 1 m at GW 19 during the fall 2020 construction window. In 2018 and 2019 GW 18 maintained a fairly steady groundwater elevation around -0.8 m in relation to meadow surface, whereas groundwater elevation at GW 19 hovered around -1.25 m below meadow surface, about 0.5 m lower than water level at GW 18. Interestingly, the amplitude of groundwater elevation increase during spring peak flows is greater for GW 19 in relation to GW18 and exhibits a higher maximum peak elevation at or slightly above (overland flow) the meadow surface. Overall, these three wells exhibit fairly similar average monthly seasonal temperature ranges, with GW 18 having experienced a slightly greater range of temperature between winter lows and summer highs (approximately 4.0-14.0°C) (Figure 36).

The downstream portion of Longley meadows has two wells (GW 20-21; Figure 28). Groundwater at GW 20 during spring-summer-fall months maintains a fairly steady elevation around -2.0 m relative to meadow surface, whereas groundwater elevation at GW 21 was perched slightly higher around -1.65 m during the same time span. Figure 37 below shows that when the Grande Ronde River experiences peak spring flows groundwater elevation at GW 20 exhibits a higher corresponding amplitude surge and maximum elevation (-2 m to 0 m) compared to GW 21 (-1.65 m to -0.25 m). Groundwater temperature measured at GW 21 consistently ranges from a seasonal low of around 5°C in February up to a summertime high around 12°C in August for years 2018-2020 (Figure 38). Spring-summer groundwater temperatures at GW 20 are consistently about 1-2°C cooler compared to GW 21. During fall-winter months groundwater temperatures at these two wells are about the same. Seasonal max-min temperatures at GW 21 exhibit a slight lag of about 2 weeks relative to summertime highs and winter low temperatures at GW 20.

Discussion

Some GW data recorded during 2018-2019 from the Bird Track Springs project area was influenced by two seasons of nearby construction activity, including dewatering, channel reclamation, bypass channel construction, and pumping water out of work areas onto the floodplain. Groundwater records collected during 2020 represent the first entire year of uninterrupted data since project completion. Conversely, GW data recorded from the Longley Meadows project area was unaltered by BTS construction activities 2018-2019 but show signs of construction influence during Phase I activities which began in summer 2020.

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 for 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 for 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.



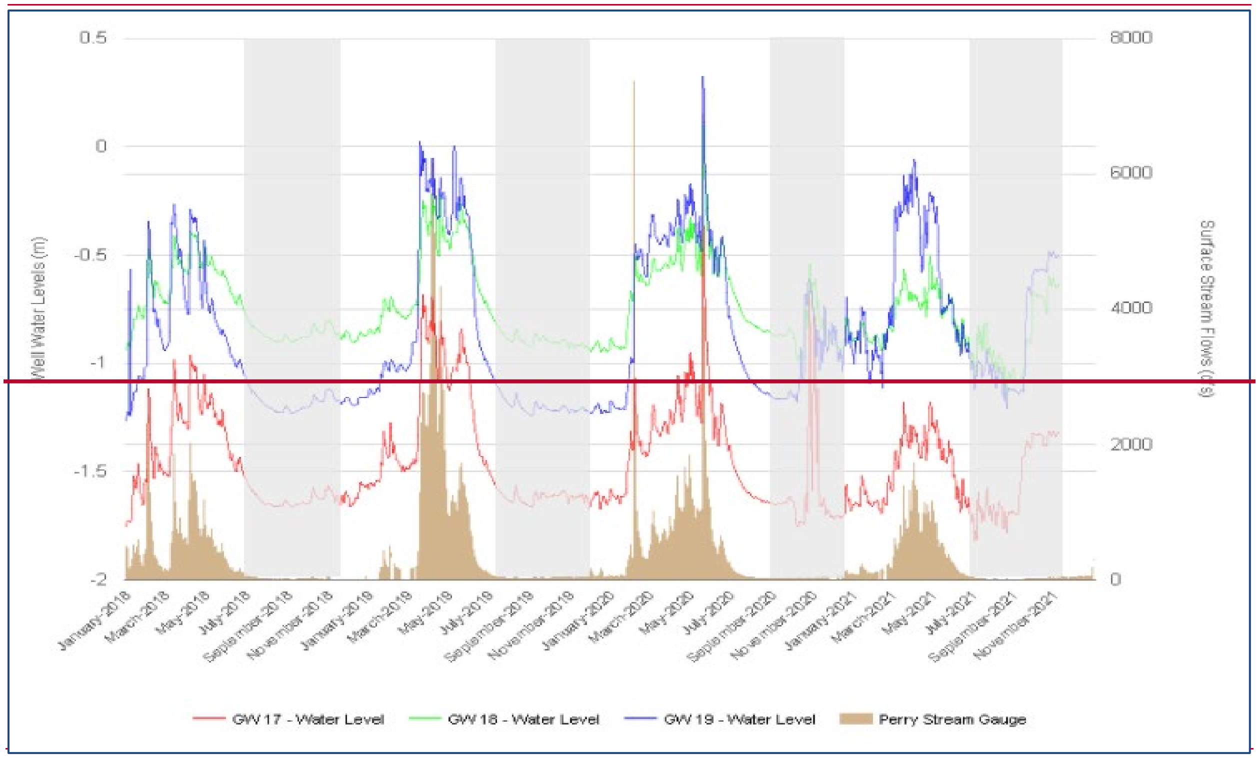
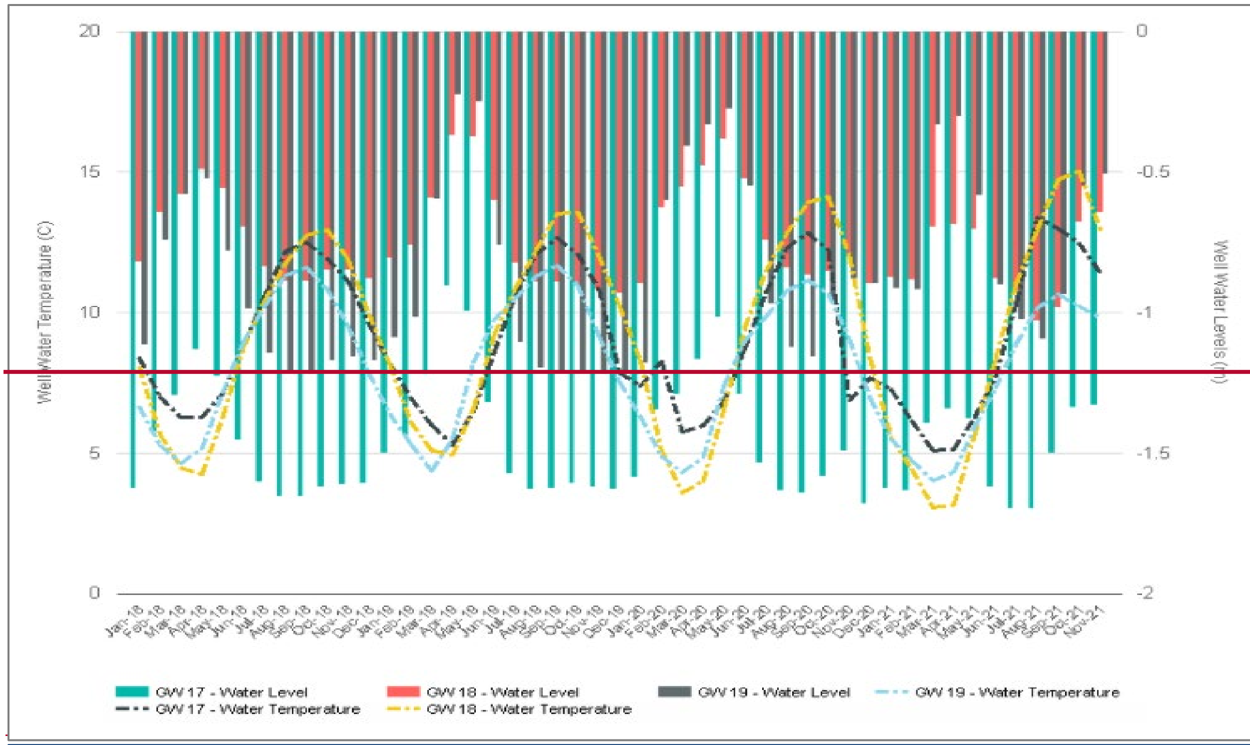


FIGURE 20 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 17-19 AT LONGLEY MEADOWS AND DISCHARGE AT THE PERRY GAUGE, JANUARY, 2018 TO NOVEMBER, 2022~~1~~.



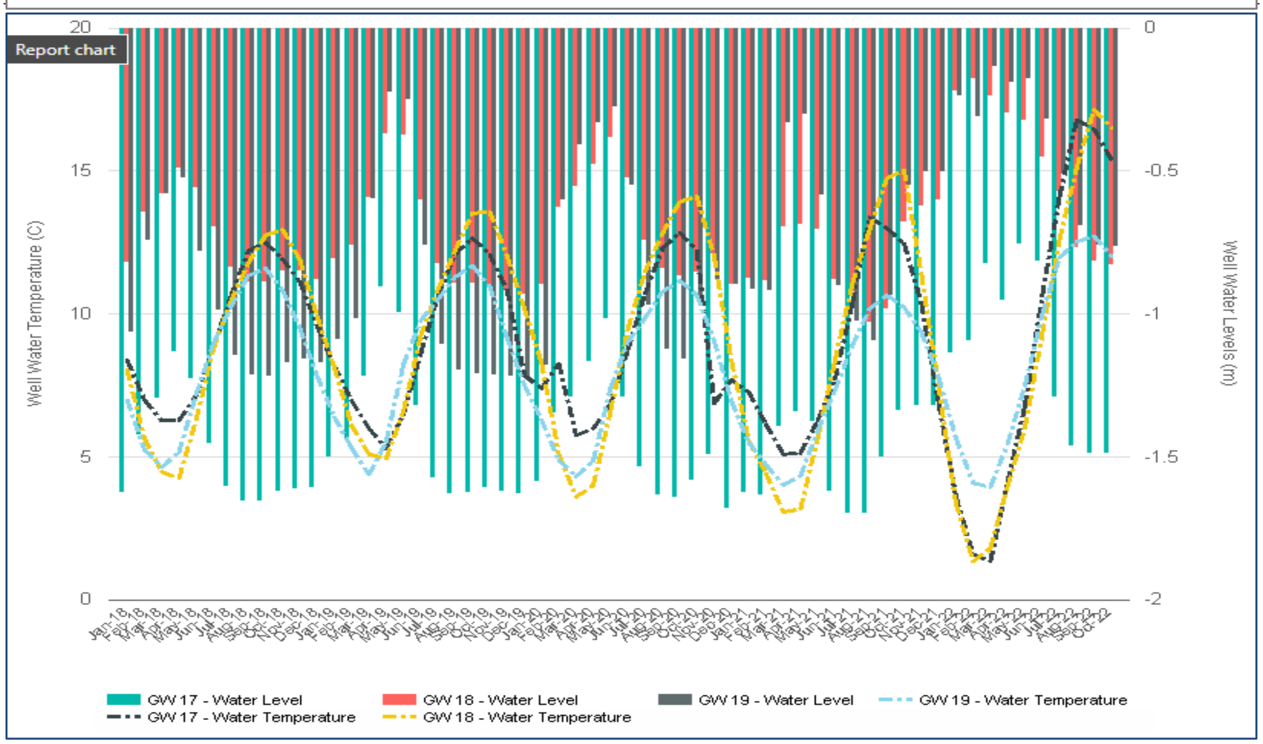


FIGURE 21 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 17-19 AT LONGLEY MEADOWS AND CORRESPONDING GROUNDWATER TEMPERATURES, JANUARY, 2018 TO NOVEMBER, 2022~~1~~.

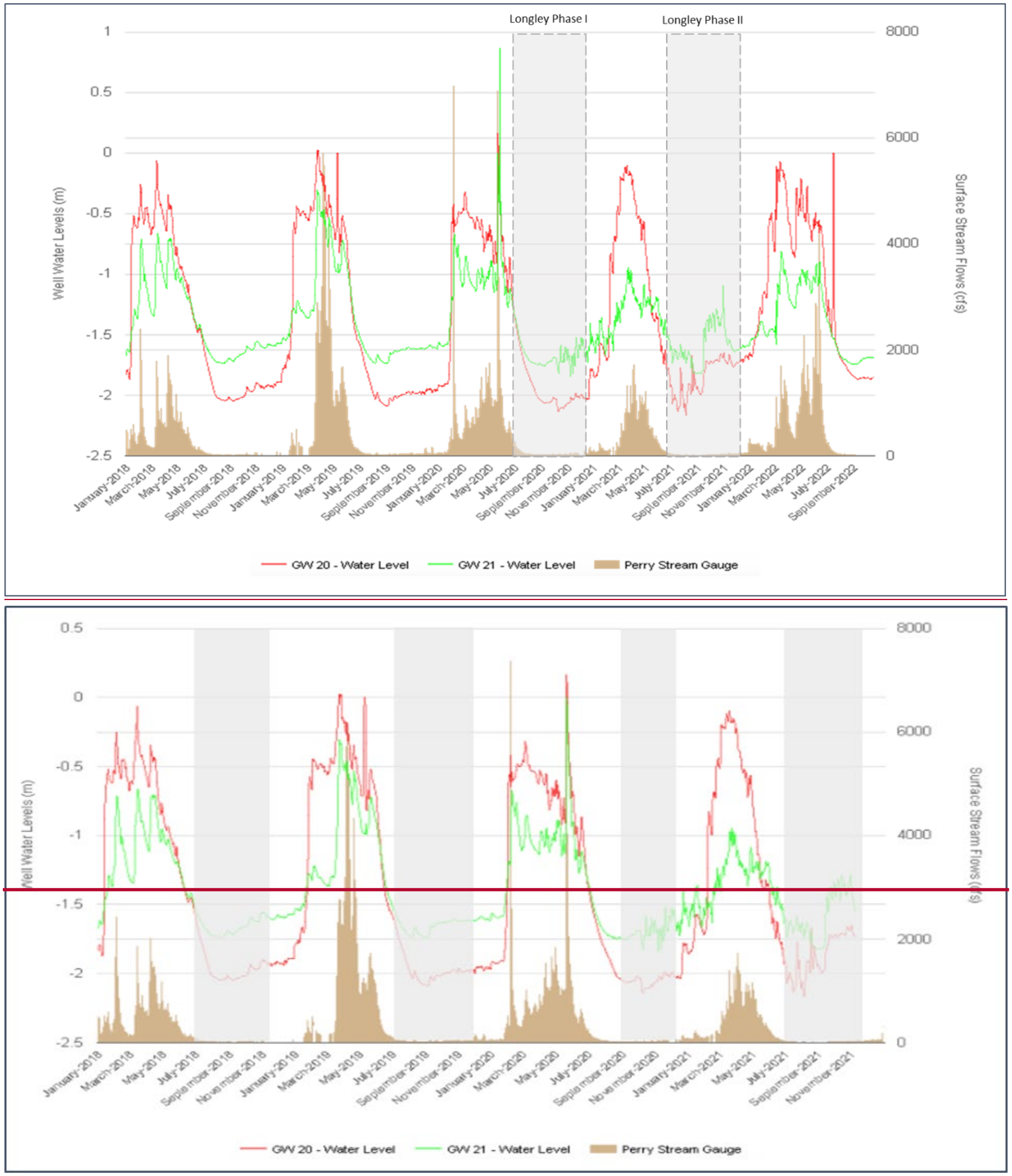


FIGURE 22 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 20-21 AT LONGLEY MEADOWS AND DISCHARGE AT THE PERRY GAUGE, JANUARY-18 TO NOVEMBER-221.

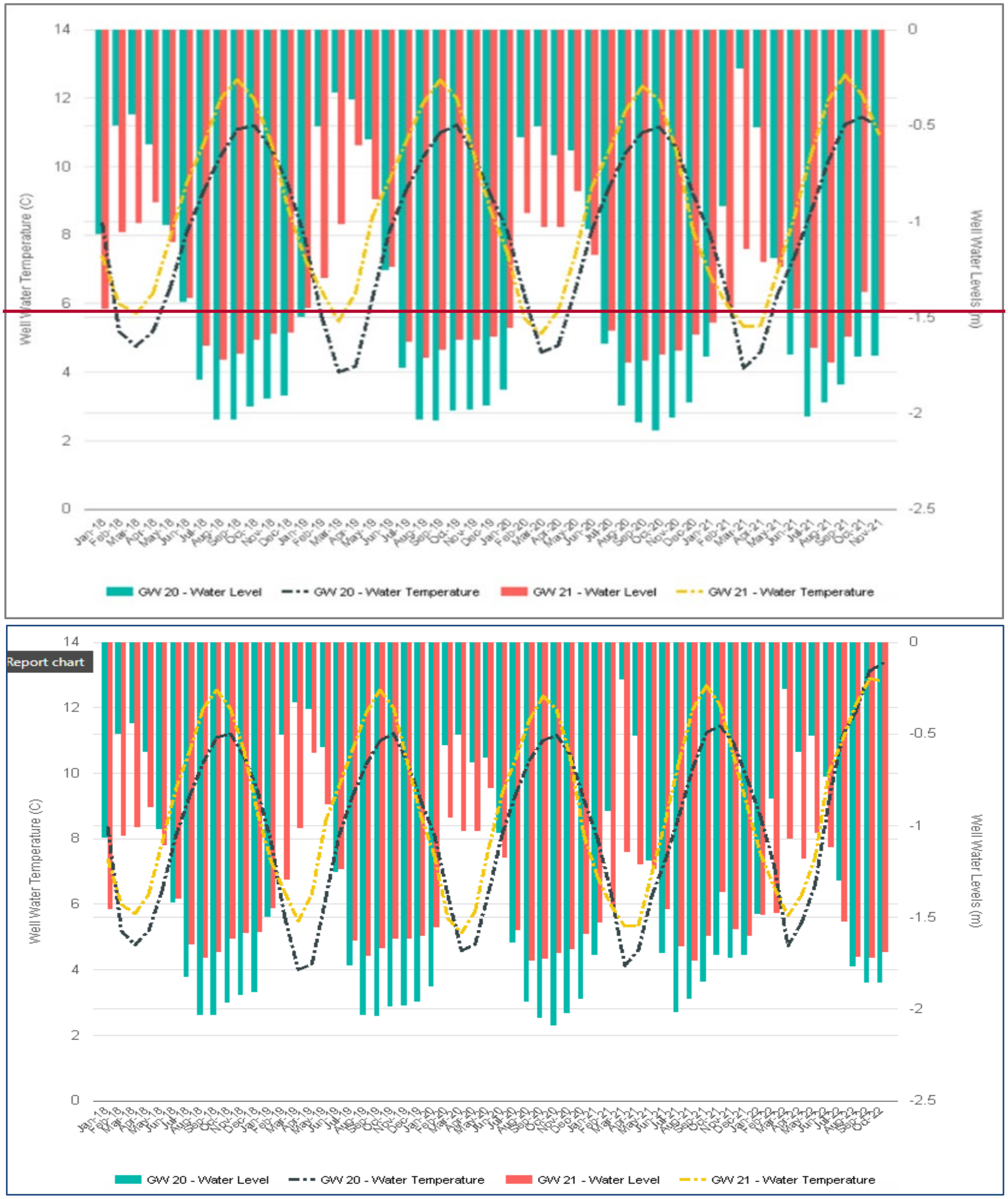


FIGURE 23 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 20-21 AT LONGLEY MEADOWS AND CORRESPONDING GROUNDWATER TEMPERATURES, JANUARY-18 TO NOVEMBER-22~~1~~.

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 (Figure 39). 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 and jpeg images are saved into a master photo point file. Aerial photos and videos are also taken at varying intervals along several project locations using a UAV operated by the Grande Ronde Model Watershed. A summary of photo point highlights can be viewed by following the link:
GR Habitat Photo Point Album

During 2022 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 wildlife ungulate enclosures.

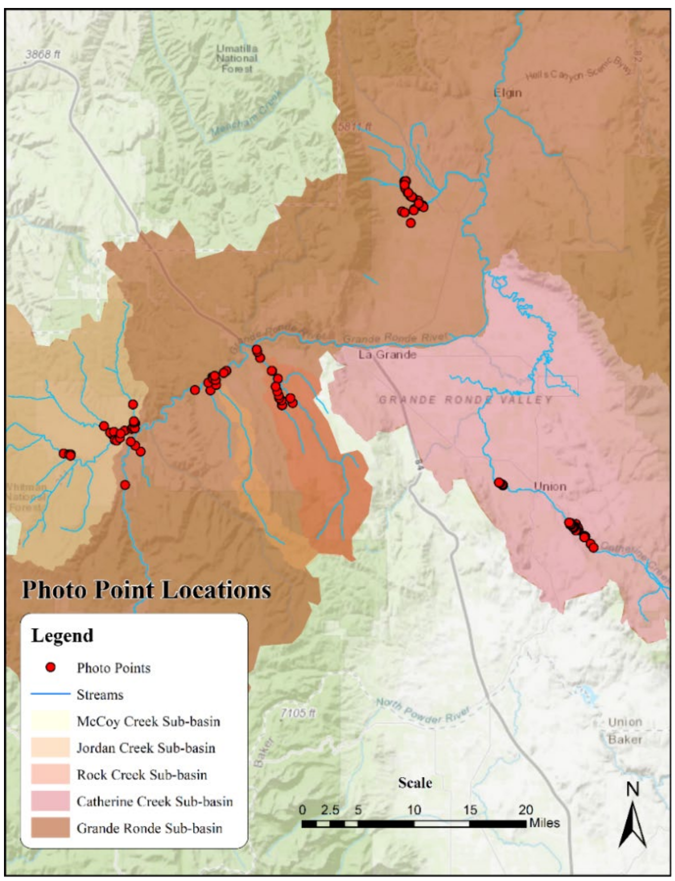


FIGURE 24 GRANDE RONDE WATERSHED PHOTO POINT MAP

Before-After Project Aerial Project Imagery

FIGURE 25 ROCK CREEK PHASE 3 AERIAL PHOTO POINT 8 – 4/24/2018

FIGURE 26 ROCK CREEK PHASE 3 AERIAL PHOTO POINT 8 – 4/9/2019

FIGURE 27 BIRD TRACK SPRINGS AERIAL PHOTO POINT 6 - 5/15/2018

FIGURE 28 BIRD TRACK SPRINGS AERIAL PHOTO POINT 6 - 5/21/20

FIGURE 29 LONGLEY MEADOWS UPPER PROJECT AREA FLOODPLAIN AND CHANNELS, VIEWING DOWNSTREAM

FIGURE 30 LONGLEY MEADOWS MID-PROJECT AREA FLOODPLAIN AND CHANNELS, VIEWING DOWNSTREAM

FIGURE 31 LONGLEY MEADOWS MID-PROJECT AREA FLOODPLAIN AND CHANNELS, VIEWING DOWNSTREAM

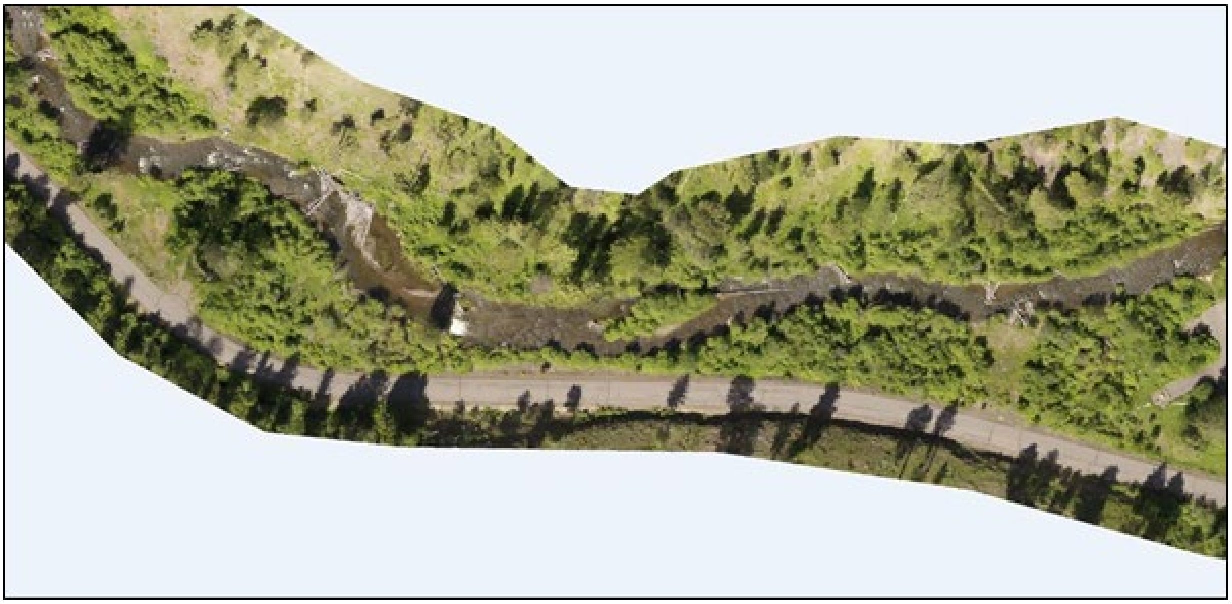


FIGURE 32 MIDDLE UPPER GRANDE RONDE RIVER PHOTO POINT 2 – 6/14/2017

FIGURE 33 MIDDLE UPPER GRANDE RONDE RIVER PHOTO POINT 2 – 7/16/2019

2022 Water Temperature Monitoring

Introduction

Thermal regimes in river and stream ecosystems are vital for fish and other aquatic organisms because most are ectotherms with physiologic processes controlled by temperatures of the ambient environment (Neuheimer and Taggart 2007). Temperature dictates the distribution and abundance of individual species across many spatial and temporal scales. Temperature also affects the limnological process, specifically, the rate of decomposition of organic material and the saturation concentration of dissolved oxygen (DO). Unfortunately, as anthropogenic climate change advances and temperatures warm, aquatic communities in rivers and streams will be altered and forced to find thermally suitable habitat. Linear networks such as streams and rivers are often fragmented by anthropogenic perturbations, which greatly impacts aquatic communities (Isaak et al. 2012). Thus, the need for floodplain and stream restoration, especially thermal regime restoration (Johnson 2004). Thermal restoration is dependent on restoring floodplain hydrology and channel morphology that promotes water storage, hyporheic functions, and restoration of riparian and wetland vegetation. Floodplain attenuation contributes to hyporheic lag, providing cold water refuge during summer and warm water refuge during winter.

It is important for fisheries managers to have a better understanding of thermal regimes in river and stream networks. Understanding the temperature variability in river streams will allow managers to evaluate changes in water temperature on aquatic habitat restoration projects. The CTUIR efforts include thermal dynamics associated with floodplain reconnection, restoration of natural channel morphology, and riparian and wetland communities. The goal of the temperature monitoring effort is obtain data and to assess whether restoration actions are improving the summer and winter altered thermal regime.

Methods

38 Tidbit Waterproof Data Loggers temperature were deployed within the Grande Ronde Basin and its tributaries (Rock Creek: 4 probes, Grand Ronde: 17 probes, Dark Canyon: 2 probes, Meadow Creek: 1 probe, and Catherine Creek: 14 probes). See Figure 49 for an overview of monitoring locations. 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.

Data loggers are programmed to record at one-hour intervals with a ± 0.2°C over 0°C to 50°C (±0.36°F over 32°F to 122°F) level of accuracy, and are deployed early summer depending on flows and are left within their monitoring location until early winter. The CTUIR focuses on having a consistent monitoring period from early June to the end of October. This monitoring period records crucial summer temperatures and early winter temperatures and provides the CTUIR data to assess if restoration efforts are improving the summer and winter thermal regime.

Temperature data is transferred to the CDMS, which gives the CTUIR natural resources staff a single place to house various data types. Within CDMS, temperature data is QA/QC'd and then exported to .csv files for data analysis.

We conducted basic exploratory data analysis to look at the distribution of data, mean, min, and max for each monitoring probe. Summary statistics were calculated for each probe that include number of days deployed, max temperature, hours of exceedance of the Oregon Department of Environmental Quality's (DEQ) lethal limit of 25°C, and the preferred salmonid core cold temperature range of 10°C to 15.6°C, which is also the preferred temperature range for juvenile Chinook salmon. In the subsequent tables, cells are highlighted with red color to show time spent in the lethal limit temperature range, orange to show time spent above 17.8°C or a decrease in core-cold temperatures from 2020 to 2021, and a green color to show increased time spent in the optimal salmonid core cold temperature range.

Diurnal fluctuations in water temperature were also plotted to show the variability in temperatures. We plotted the seven day average maximum (7DADM) for selected probes that bracket stream restoration project areas. We also can determine restoration effectiveness by assessing if there is a reduction of the number of hours at or above 25°C (lethal limit), and increasing number of hours within the 10°C and 15.6°C (core cold temperatures for salmonids).

Temperature Monitoring Map

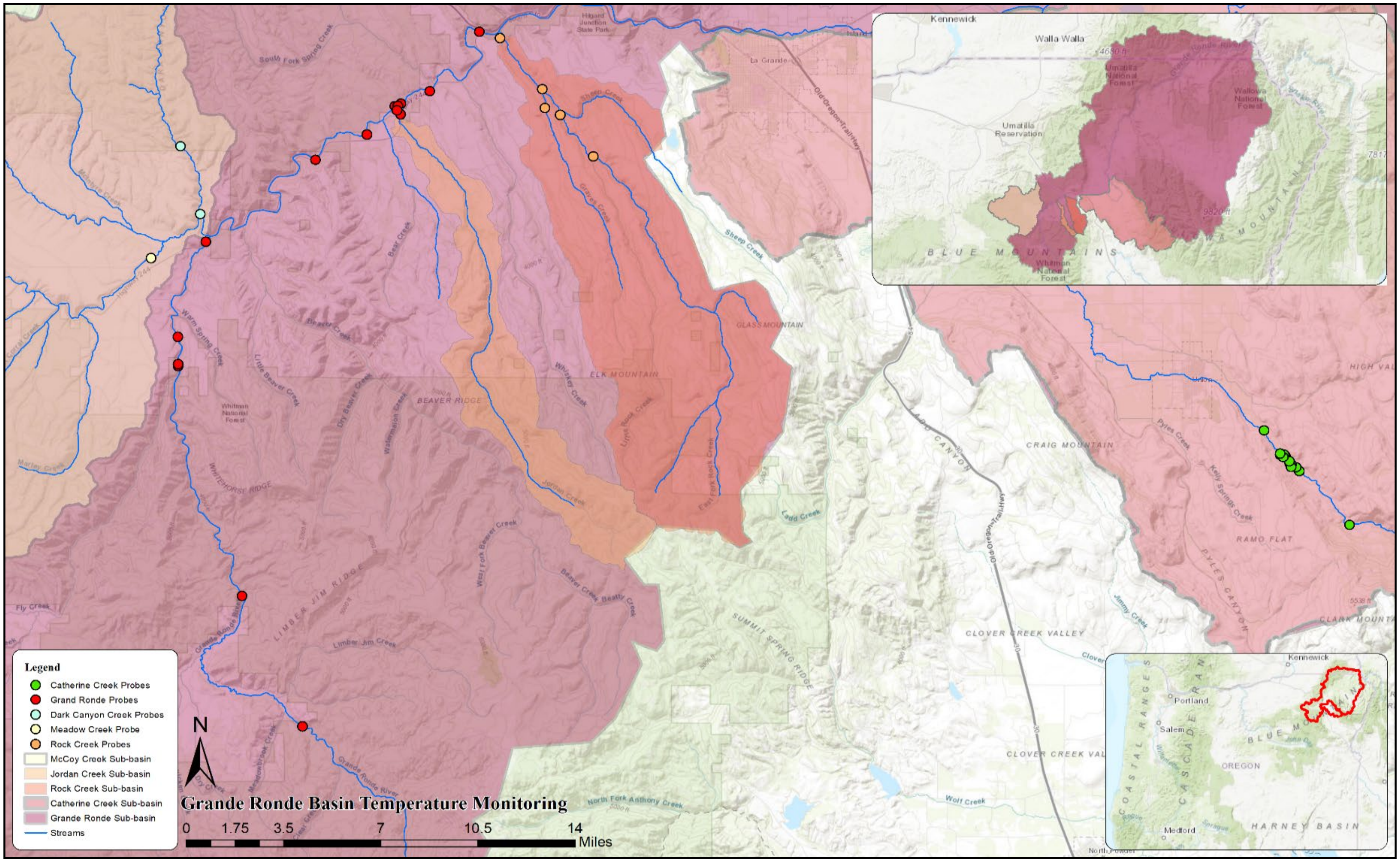


FIGURE 34 OVERVIEW MAP OF THE TEMPERATURE PROBES IN THE GRANDE RONDE BASIN

Results

Exploratory Data Analysis
Data was QA/QC'd within CDMS, checked for normality, and outliers were removed from CDMS analysis. Outliers that were removed were those that recorded temperatures while out of water during low flows, temperature recordings that were erroneous due to technological error, or washed away during high flows. There was no need to transform the time-series data since the data when plotted met the assumption of normality and transformations did not improve data distributions.

Monitoring
Recently, we have used alternative methods to detect change and support project design and project locations. This has been done through a combination of, 1) using existing temperature probes in the Grande Ronde basin that bracket project areas, 2) documenting cold water habitat in the Grande Ronde basin and off-channel habitats with additional temperature probes, 3) geospatial longitudinal temperature profile figures, and 4) deployment of novel loggers following completion of a restoration project.

Grande Ronde
The CTUIR and Grande Ronde Basin partners implemented fish habitat improvements along the Grande Ronde River (Bird Track Springs and Longley Meadows) on private and public land river mile (RM) 142-146. One of the primary objectives of fish habitat enhancement projects is to restore thermal heterogeneity to stream temperatures within project reaches, resulting in an improved altered summer and winter thermal regime. 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 and to see if the thermal regime is improving for fish populations. In addition to monitoring main channel temperature flows above and below a project, temperature loggers are also deployed within adjacent off-channel water features in order to monitor groundwater influenced habitats. Temperature records comparing mainstem locations to groundwater influenced habitats have indicated the importance of identifying existing pockets of cold water inputs, expanding them, and/or mimicking the processes that cause them and applying those actions elsewhere within the project to create thermal refugia for fish to wait out lethal mainstem summer temperatures, as well as maintain open water habitat free of anchor ice during winter low temperatures.

We plotted the 7DADM for two probes that bracket the Bird Track Springs fish habitat improvements. From the upstream probe (GR1_RM146.3) to the downstream probe (BTS1_RM152.9) there are 6.9 RMs between the two. Comparing 2022 data from GR1 to BTS1 we can see that BTS1 probe located below the project recorded noticeably cooler summer temperatures than upstream probe GR1.

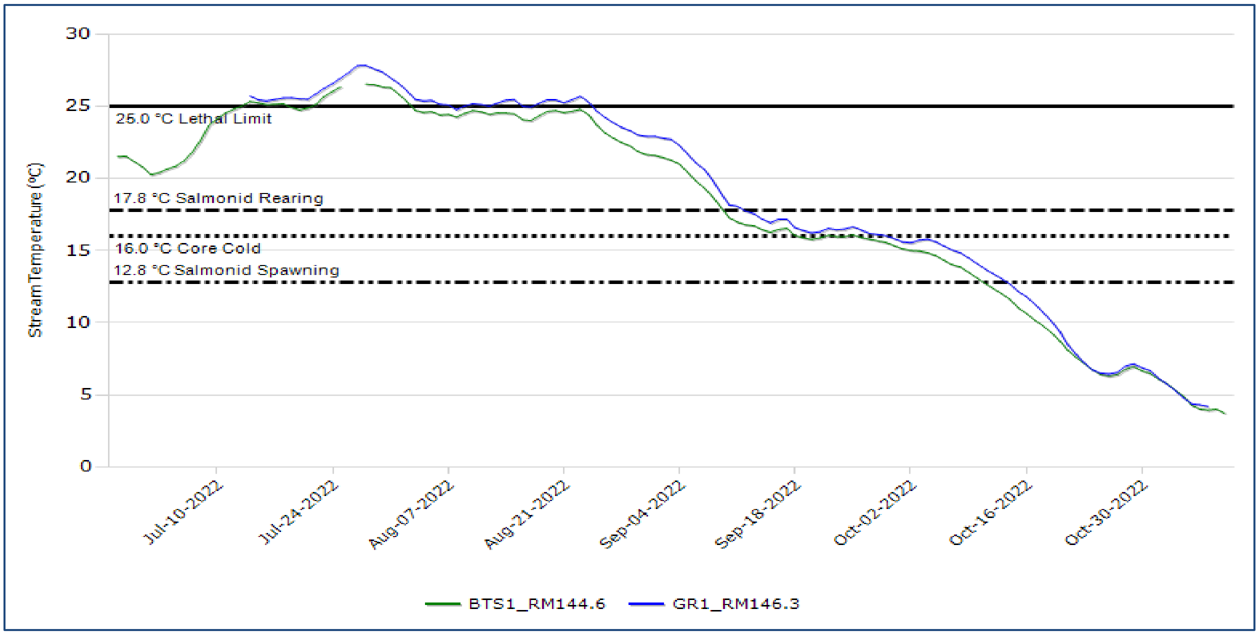


FIGURE 35 7DADM FOR GRANDE RONDE RIVER WITH PROBES BRACKETING THE BIRD TRACK SPRINGS RESTORATION PROJECT, JANUARY-NOVEMBER, 2022

Between 2018 and 2020 7DADM summer temperatures at these two locations indicate a cooling trend as well as a decrease in the amount of time spent above the 25°C lethal limit (Figure 51 below). However, temperature data recorded at these probe locations in 2021 show an upward departure from the previous years' downward trend. Beginning in June 2021 the Pacific Northwest experienced a severe heatwave lasting into July. Surface water temperature data indicate that the entire Grande Ronde Subbasin water temperature and flows were affected by the prolonged extreme air temperatures, with many probes deployed in the mainstem Grande Ronde River and some tributaries recording maximum high temperatures approaching and exceeding 30°C, and flows measured at the Grande Ronde River Perry gauge dropping below 10 cfs in August and 2 cfs measured at the Meadow Creek gauge located below the confluence with Dark Canyon Creek.

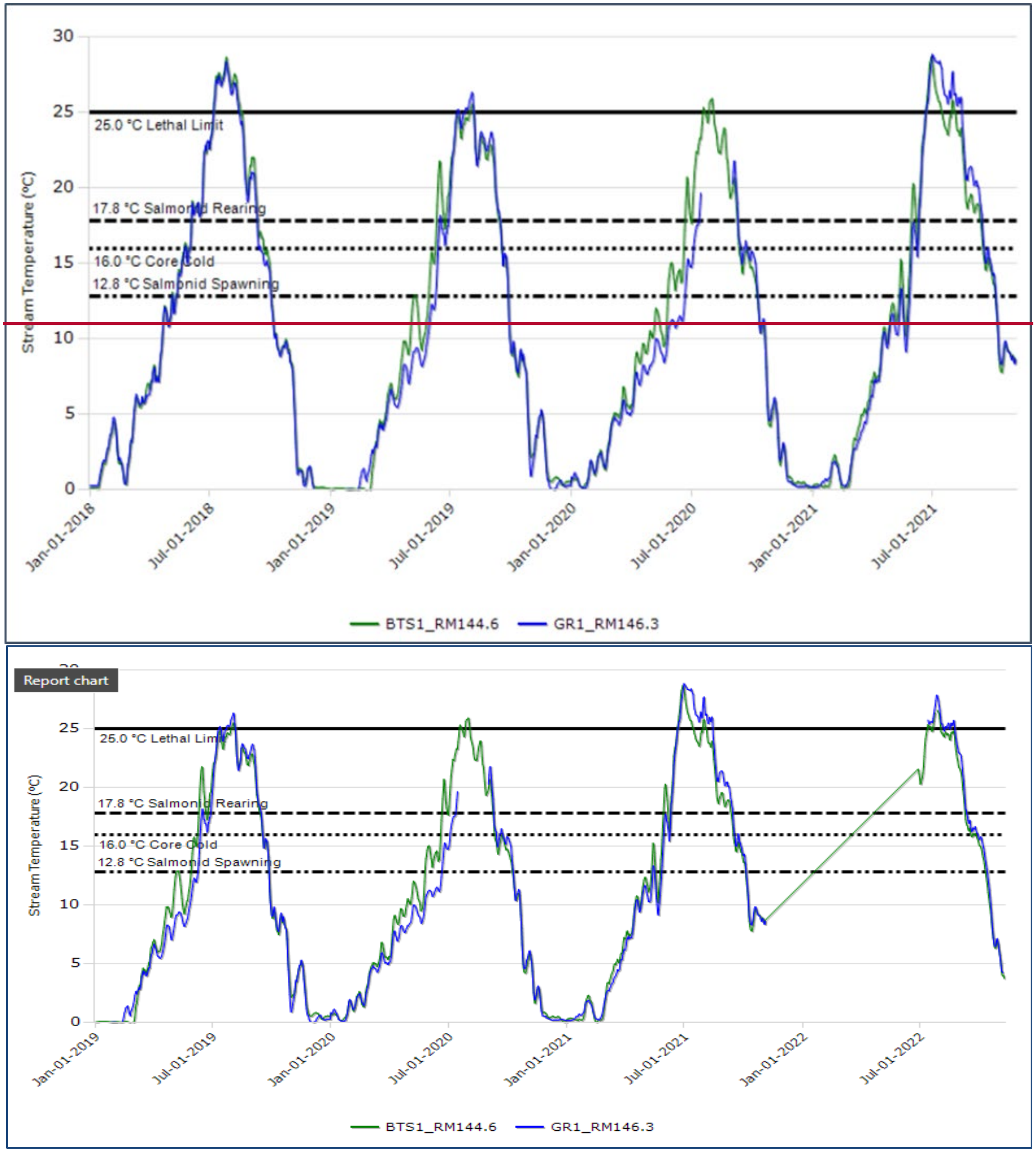


FIGURE 36 7DADM FOR GRANDE RONDE RIVER (BIRD TRACK SPRINGS) BRACKETED RESTORATION PROJECT, JANUARY-JULY, 2022

Figures 52 and 53 below show diurnal fluctuations and average daily temperatures for one mainstem Grande Ronde River probe (dark green) and three additional probes located in off-channel areas nearby. Neither of the off-channel probes recorded temperatures at or above the lethal limit, and exhibited much more muted diurnal fluctuations than the corresponding main channel BTS1 probe. The importance of these off-channel areas are vital because they provide thermal refuge for heat-sensitive salmonids rearing, migrating, and spawning within the basin, as well as cold water inputs to warmer main channel habitats.

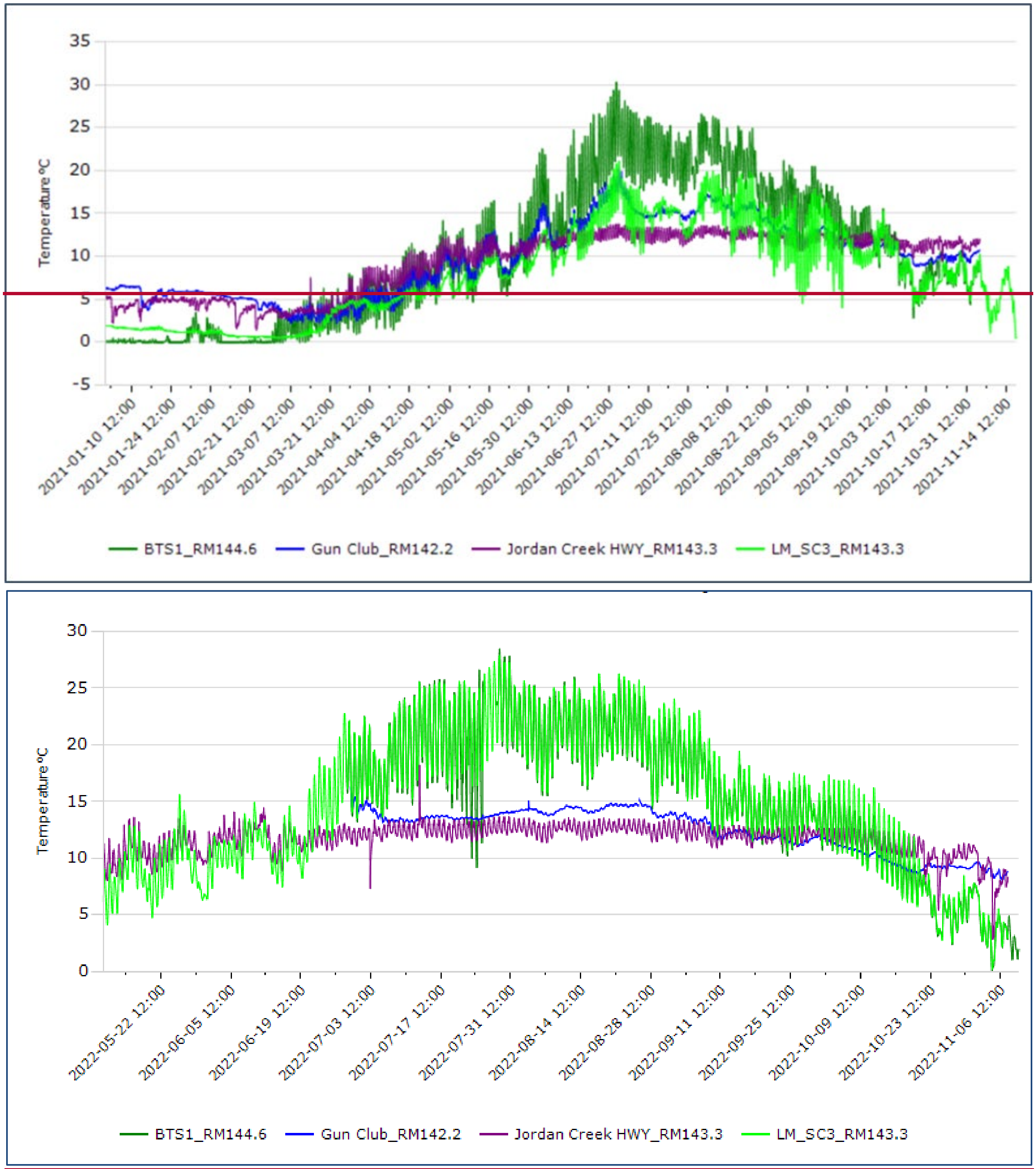


FIGURE 37 DIURNAL FLUCTUATIONS AT PROBES IN THE VICINITY OF THE BIRD TRACK SPRINGS AND LONGLEY MEADOWS PROJECTS, JANUARY-NOVEMBER, 2022

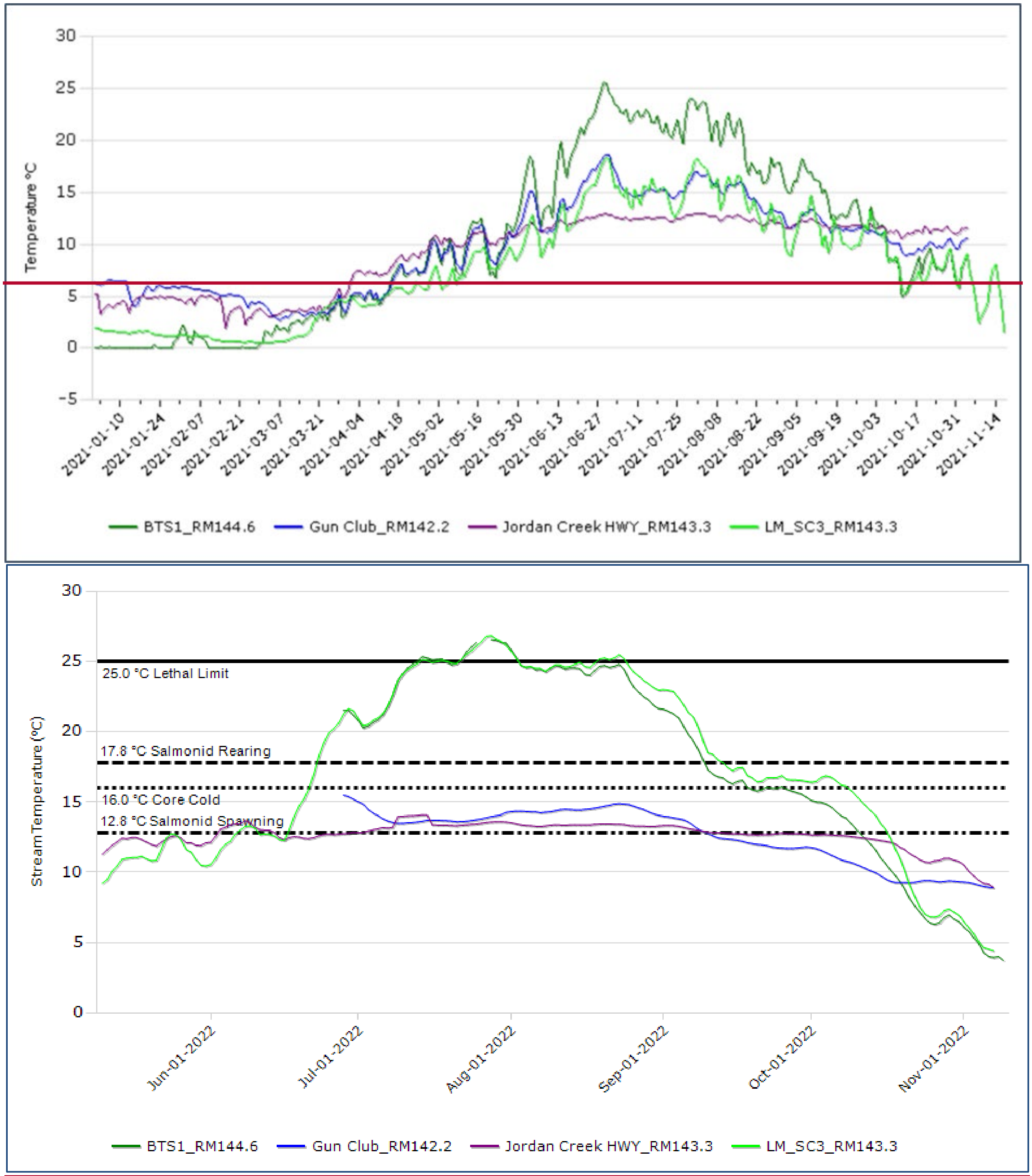
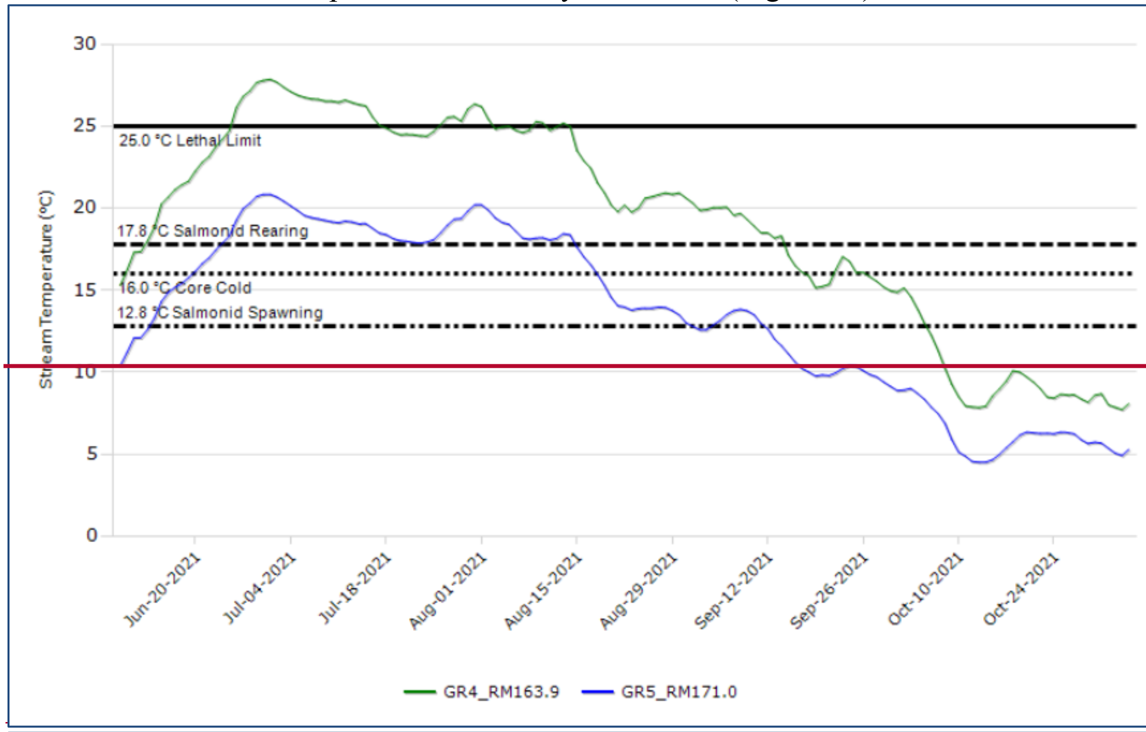


FIGURE 38 AVERAGE DAILY WATER TEMPERATURE AT PROBES IN THE VICINITY OF THE BIRD TRACK SPRINGS AND LONGLEY MEADOWS PROJECTS, JANUARY-NOVEMBER, 2022

A large, privately owned mountain meadow complex in the headwater reaches of the Grande Ronde River was bracketed with temperature probes above (GR5) and below (GR4). This cattle-grazed meadow system, mostly void of riparian vegetation and shade, is a key chinook spawning reach for salmon returning to the upper subbasin. Temperature loggers at these two locations on US Forest Service Property were deployed in June 2022 and recorded summer-fall stream temperatures into early November (Figure 52).



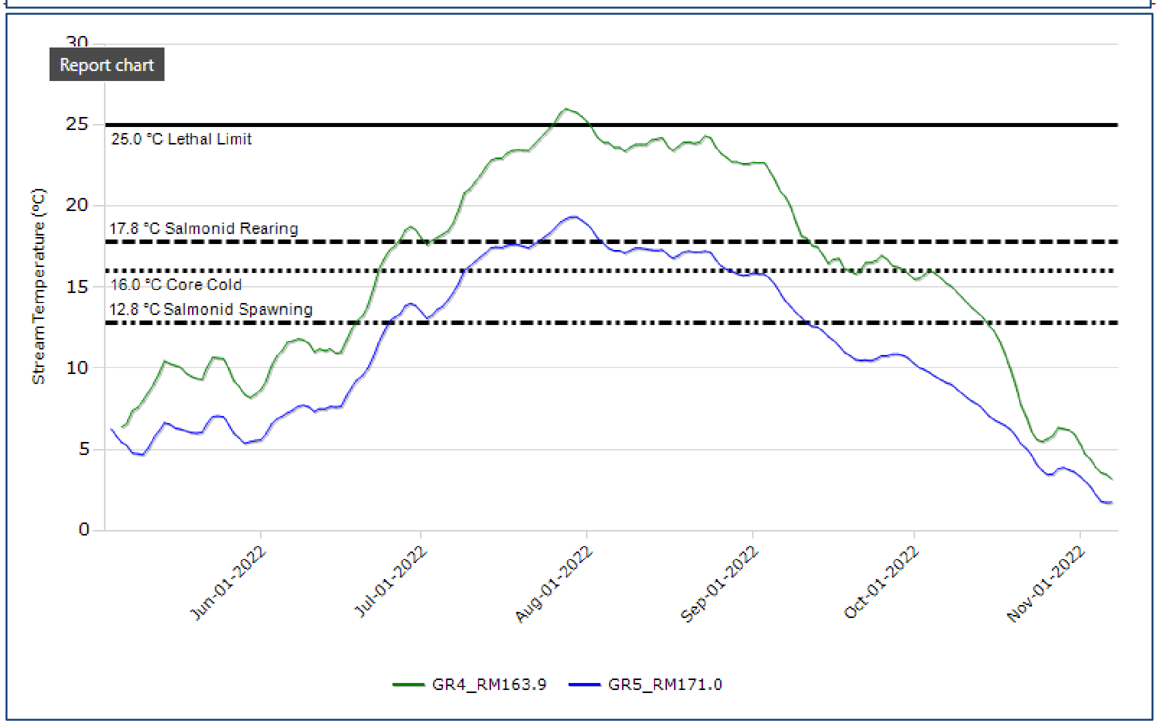
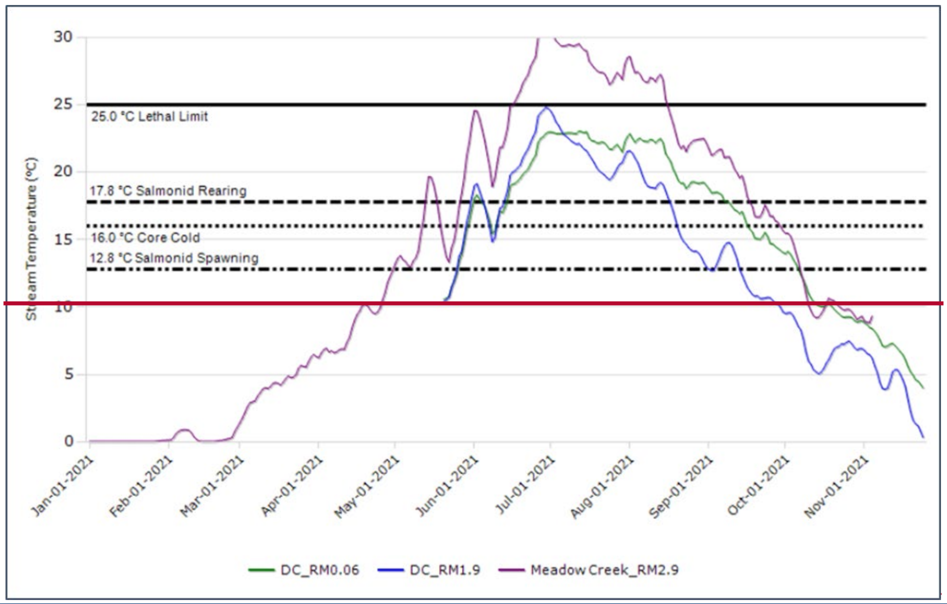


FIGURE 39 7DADM FOR GRANDE RONDE RIVER ABOVE AND BELOW VEY MEADOWS, JUNE-OCTOBER, 2022.

Meadow Creek and Dark Canyon

The Dark Canyon Creek project area, located in the Meadow Creek watershed, is bracketed by an upstream temperature probe on the USFS boundary at RM 1.9 and a downstream probe 0.06 mi. upstream from the confluence with Meadow Creek. In 2022 both probes recorded productive temperatures for salmonids (aside from the time that one of the DC probes appears to have been out of the water in July). This indicates that Dark Canyon likely plays an important role as a thermal refuge for salmonids during summer months when mainstem Meadow Creek temperatures exceed lethal limits.



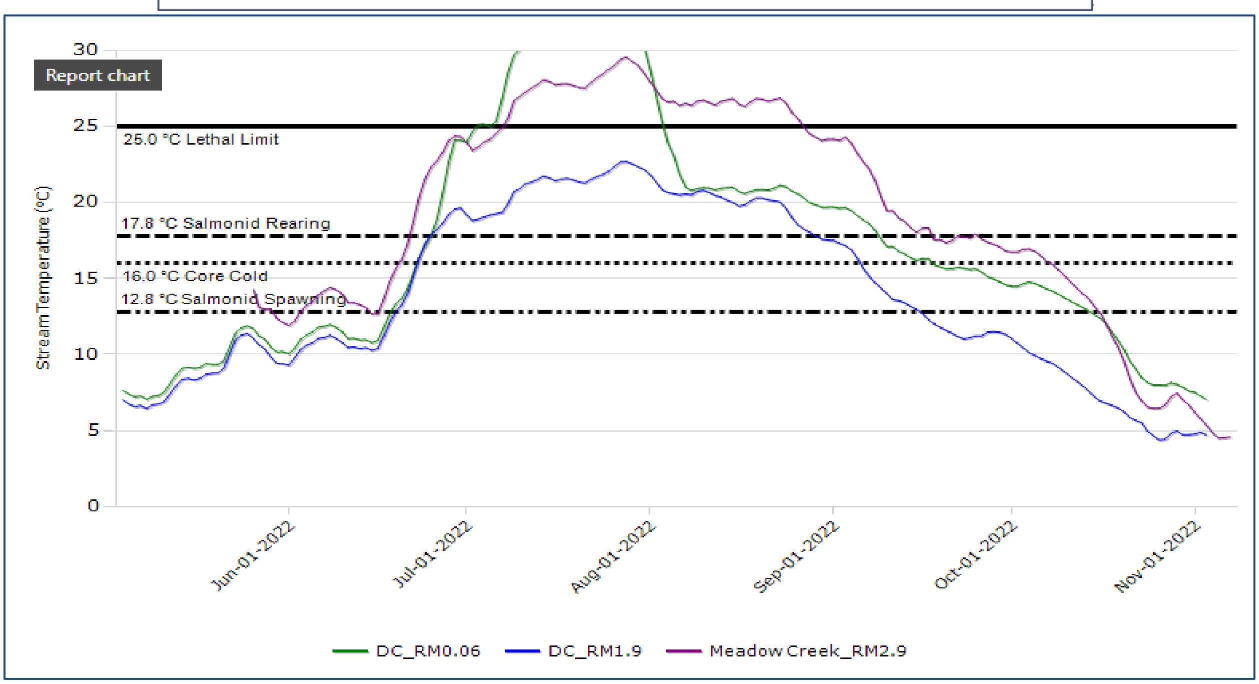


FIGURE 40 7DADM FOR DARK CANYON AND MEADOW CREEK PROBES, JANUARY-NOVEMBER, 2022.1

Rock Creek

In the figure below, 2022 surface water temperatures at the most downstream Rock Creek probe (blue) are plotted against the probe located on its tributary, Graves Creek (green). Both locations recorded almost identical temperatures in May, but in early June Graves Creek temperatures departed from Rock Creek's upward warming trajectory and steadily decreased through the rest of Summer-Fall months. A predictable annual pattern has been observed where in early summer Graves Creek pools become disconnected as surface flows dry up. The pool where Graves Creek probe is located, when disconnected, is maintained by cool groundwater seepage, as indicated in the figure below. The probe location on mainstem Rock Creek remains connected to warmer surface flows for the duration of the summer. Further monitoring is needed to measure dissolved oxygen levels in pools that remain disconnected for prolong periods, and whether those DO levels are sufficient for salmonids using the pools for summer thermal refuge.

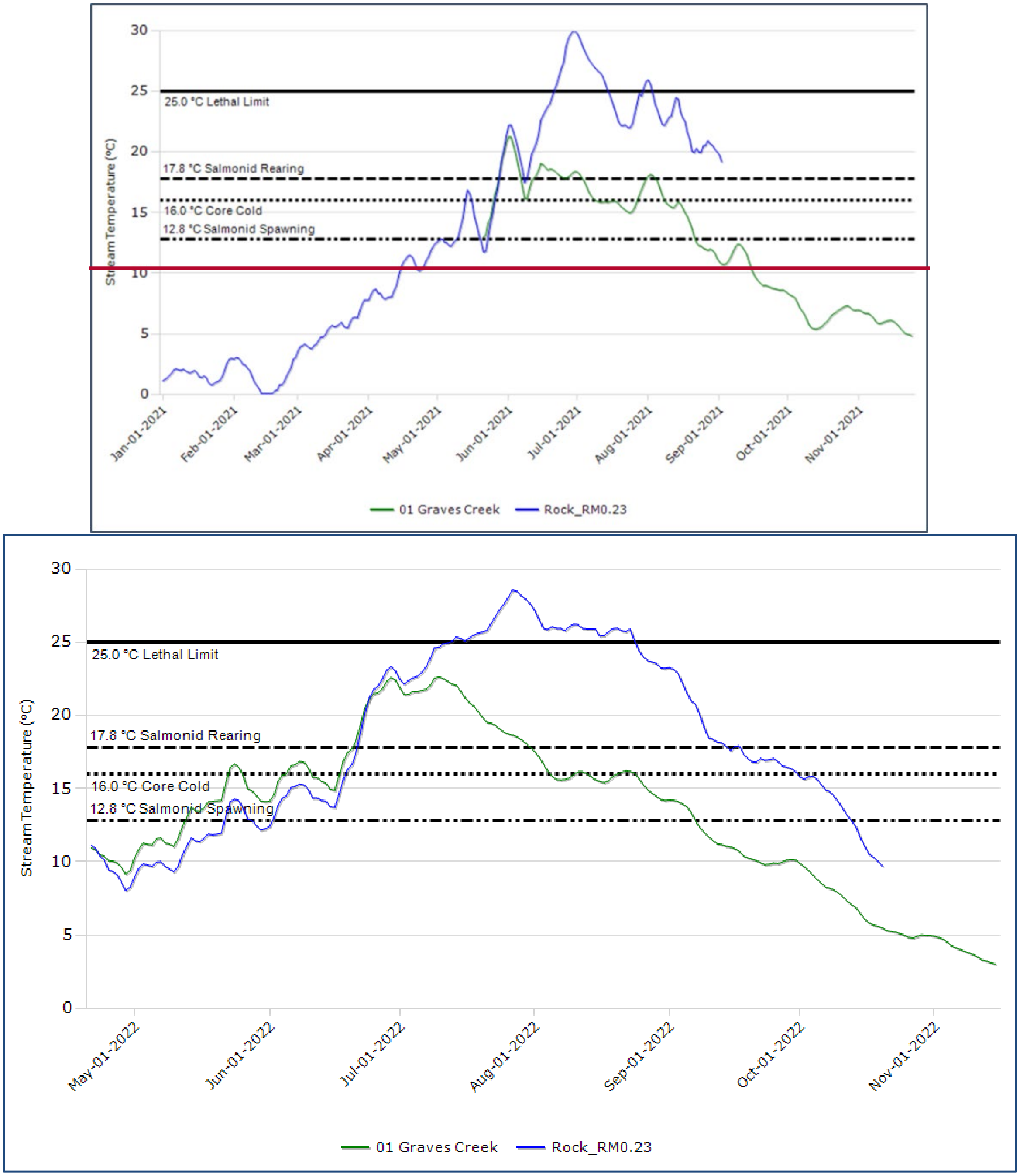
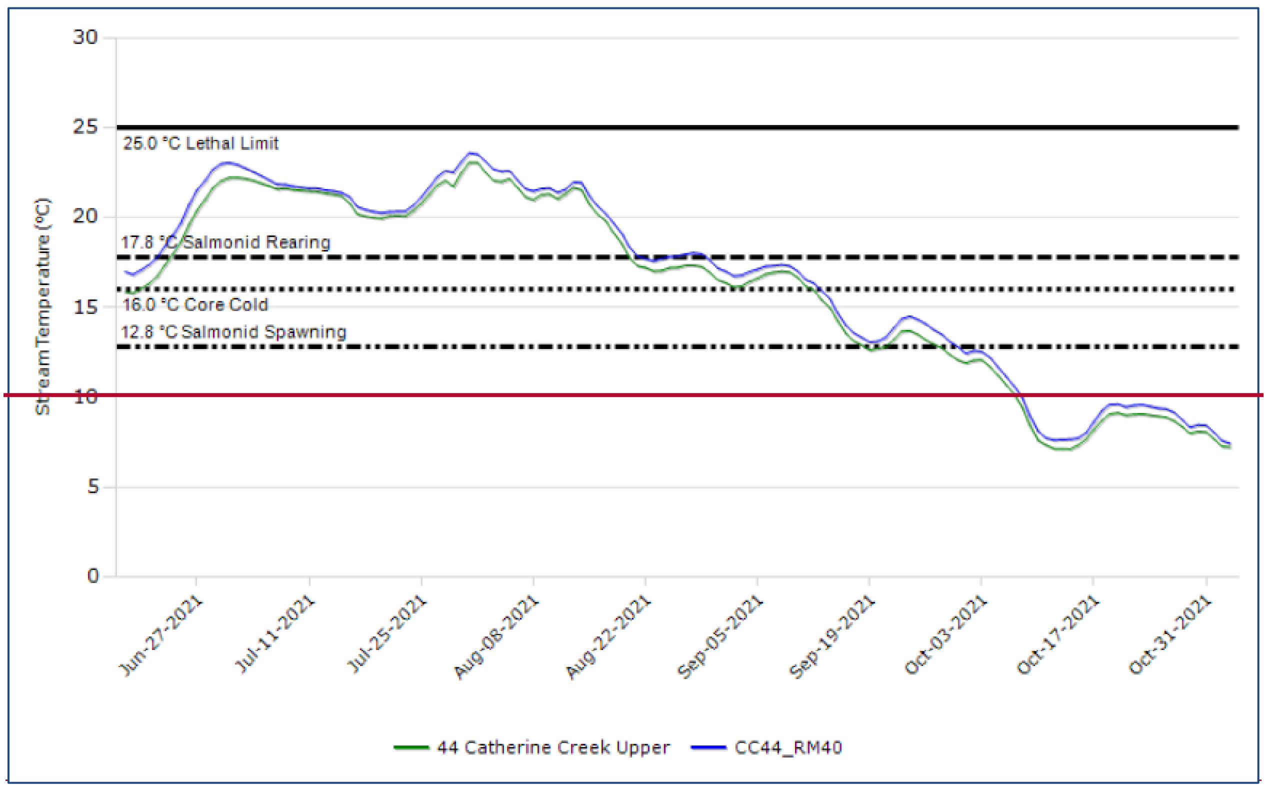


FIGURE 41 7DADM COMPARING ROCK CREEK AND GRAVES CREEK PROBES, JANUARY-NOVEMBER, 2022

Catherine Creek

Stream temperature monitoring efforts on Catherine Creek consist of 14 temperature probes at mainstem and off-channel locations between RM 41.5 and RM 45.4 that bracket the CC44 Fish Habitat Enhancement complex. One probe was deployed at the most upstream extent of the

CC44 reach (CC44Upper) to monitor water temperature as it enters the project area, and another probe was deployed at the downstream extent of the project reach (CC44Lower). Comparing records from 2012-2022 for these two locations show that temperatures do not greatly differ between the upstream and downstream sites. CC44Upper, however, consistently records slightly cooler stream temperatures compared to CC44Lower that brackets the most downstream project extent. There are approximately four miles between the upper and lower-most probes, which might explain the temperature difference; it’s possible that stream temperatures increase slightly moving downstream into lower elevations and further from its cold snowpack source. Also, there are channelized stretches of Catherine Creek upstream of the lowest probe with poor riparian conditions that allow larger solar inputs that may contribute to the warmer temperature records.



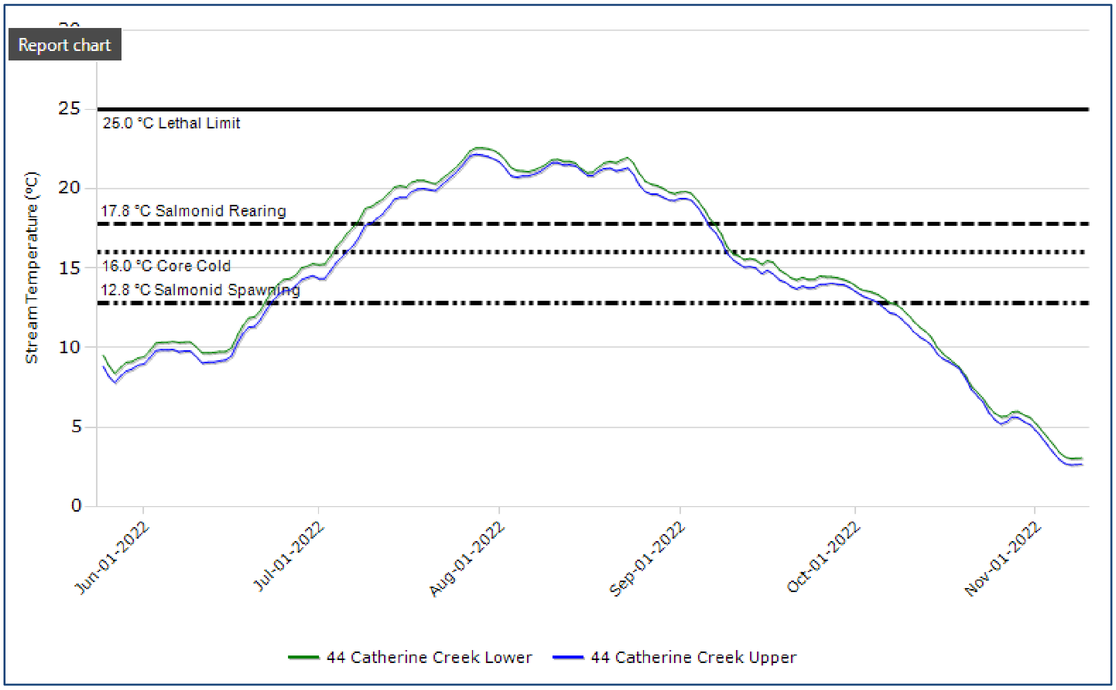


FIGURE 42 7DADM MOST UPSTREAM AND DOWNSTREAM PROBES – CATHERINE CREEK, JUNE-OCTOBER, 2022

The majority of stream temperature monitoring on Catherine Creek occurs within the Southern Cross project area where in 2022 there were 12 probes deployed. Of these, five were deployed into the main channel, one in a side channel, and the remaining six in off-channel floodplain swales and pools, and a backwater alcove. In the figure below one main channel probe (blue) is plotted against two probes located in off-channel habitats (purple and green) during the 2022 deployment period.

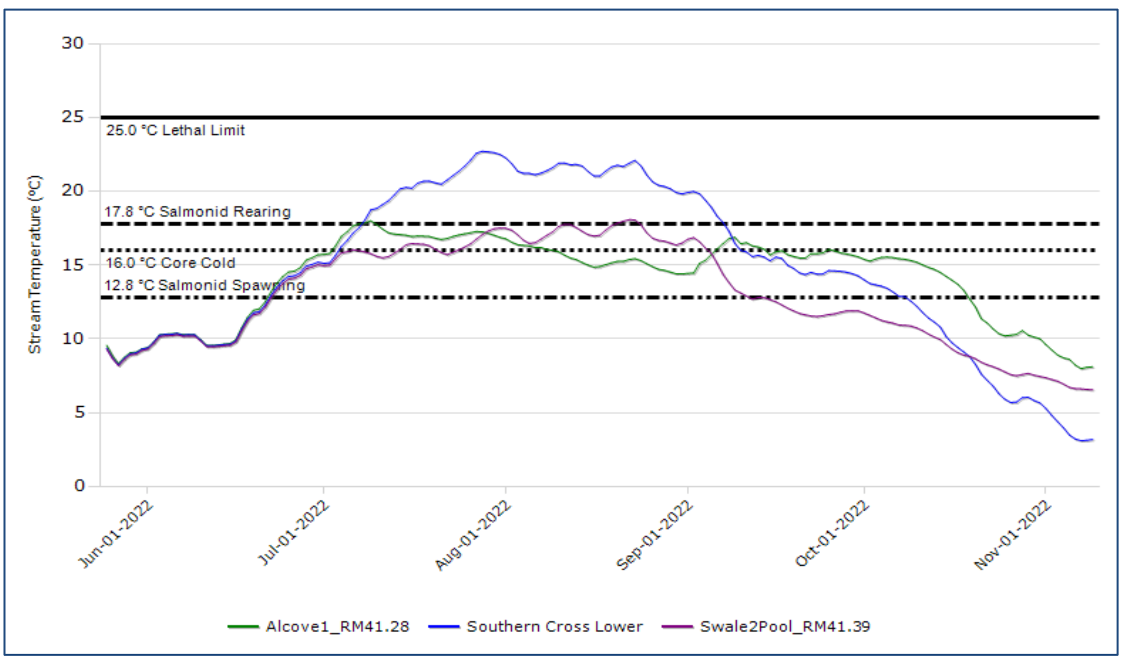


FIGURE 43 7DADM FOR THREE PROBES WITHIN SOUTHERN CROSS PROJECT AREA, JUNE-OCTOBER, 2022

In 2018 main channel SouthernCrossLower probe and off-channel Alcove1 probe were left deployed over winter (Figure 59). In addition to recording significantly cooler summertime temperatures, Alcove1 location shows that when overwinter temperatures are lowest and the main channel freezes at 0°C that off-channel groundwater remains above 5°C, preventing anchor ice from forming and expanding open water habitats for fish and their macroinvertebrate food sources. Hyporheic exchange of groundwater with surface water at this alcove location expands areas of thermal refuge in the summer with the input of cooler water, and during extreme cold in the winter provides relatively warm water to maintain open water habitats.

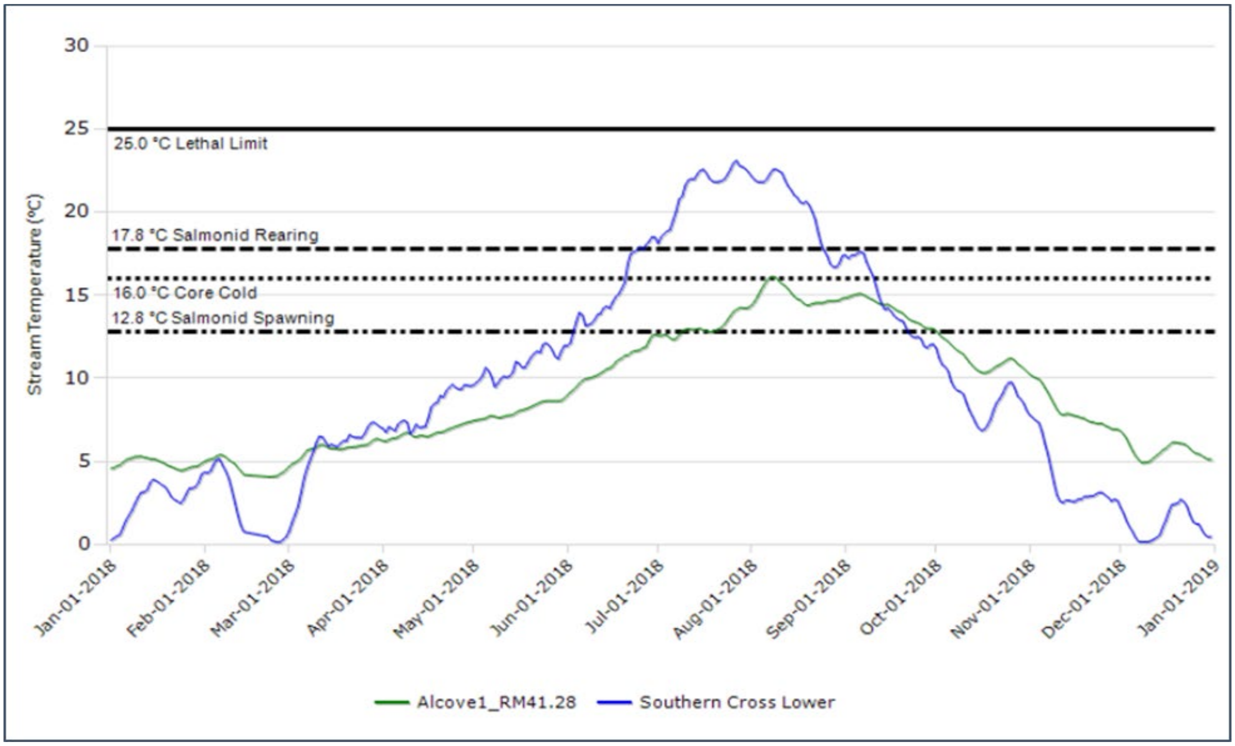


FIGURE 44 7DADM FOR OVERWINTERING MAIN CHANNEL AND ALCOVE LOCATIONS, JANUARY, 2018-JANUARY, 2019

Discussion

Grande Ronde River

There were 16 temperature probes deployed either along mainstem Grande Ronde River or in adjacent off-channel habitats in the year 2022. Mainstem probes GR3_RM143.3 (located within the Longley Meadows project area just below the confluence with Jordan Creek) and GR5_RM171.0 (located at the acclimation facility above Vey Meadows) recorded an increase in hours during core-cold temperatures of 10°C and 15.6°C.

As was previously discussed in the data analysis above, when off-channel temperature records were plotted against the mainstem records we see the importance of preserving and expanding off-channel habitats because of the buffered thermal refugia they provide for salmonids when mainstem temperatures reach lethal limits in the summer, and risk freezing solid (anchor ice) in the winter.

Meadow Creek and Dark Canyon

Three probes were deployed within the Meadow Creek and Dark Canyon basins in 2022. Meadow Creek and both the upper and lower Dark Canyon probes recorded decreased hours within the optimal core-cold temperatures for salmonids. Meadow Creek and the upper Dark Canyon probe also recorded increased hours spent at or above lethal limits, compared to the previous year. However, the lower Dark Canyon probe near the confluence with Meadow Creek recorded no amount of time at or above lethal limits

Since August 2009, the CTUIR has monitored water temperature at two locations within Dark Canyon Creek – an upper probe site (DC2) at river mile 1.9 and a lower probe site (DC1) at river mile 0.06. Dark Canyon has consistently been a thermal refuge for fish because of inputs from cold-water seeps, a shallow ground water elevation, and increasing hyporheic exchange with the river water column. Because of this, it is and has been heavily used by juvenile salmonids because of its cooler temperatures than mainstem Meadow Creek, particularly within the summer months.

Rock Creek

The lower 3 miles of Rock Creek was historically channelized by draw bottom road construction, installation of levees and utilities (power lines, gas pipelines, fiber optics), and agriculture. Alternations have contributed to floodplain confinement, channel entrenchment, increased slope, coarsened streambed sediment and loss of spawning habitat, streambank erosion, loss of wetland and riparian plant communities, poor thermal diversity, high water temperatures and homogenized and degraded fish habitat.

Restoration work was completed in 2018 along Rock Creek that aimed to remedy the impacts mentioned above. Restoration work included enhancing in-stream structural diversity, complexity, and geomorphic stability by installing large wood and riffle-boulder complexes to provide roughness, overhead cover, and attenuate velocities. Water quality was addressed by increasing channel and floodplain interactions to diversify hyporheic exchange, by facilitating preferential flow from hillside cold water spring seeps into alcoves, side channels, and the main channel, promoting vegetative cover and shade, and decreasing channel width-to-depth ratios to lower summer stream temperatures and increase winter temperatures.

In 2022, there were four probes that record temperature data within the Rock Creek basin. The three mainstem Rock Creek probes within the watershed saw a decrease in core cold water temperatures. Graves01 probe located on Graves Creek, a tributary to Rock Creek, has provided interesting insight for the CTUIR. At this probe location, flows go sub-surface and you can see a dramatic decline in water temperatures during summer months. In 2022 water temperatures at Graves01 location saw a slight increase in the percentage of time deployed within optimal salmonid core-cold temperature range, and did not record any hours at or above lethal limits. Although, not valuable for buffering surface water temperatures, this occurrence shows the importance of facilitating hyporheic interactions to buffer summer and winter stream temperatures.

Catherine Creek
There were 14 temperature probes deployed along the mainstem and off-channel habitats of Catherine Creek in the year 2022. Two main channel probes were deployed at the most upstream and downstream extents of the CC44 multi-project complex, bracketing approximately 4 miles of river. The remaining 12 probes were deployed within the Southern Cross project area, at approximately RM 43, in both main channel and off-channel habitats (Swale6channel probe excluded from 2022 analysis due to location running dry). Catherine Creek is a colder water basin compared to the upper Grande Ronde with a higher elevation headwater source leading to later seasonal runoff peaks in the hydrograph.

No Catherine Creek probes recorded temperatures at or above lethal limits, and all probes spent between 34-88% of their deployment period in water within optimal salmonid core-cold temperature range. Off-channel probe locations recorded cooler maximum seasonal temperatures and spent higher percentages of their deployment period in core-cold temperature range compared to their main channel counterparts, as was similarly observed throughout the greater Grande Ronde Subbasin. And similar to the Grande Ronde, when plotting the mainstem probes against off-channel probes, it demonstrates the importance of access to off-channel habitats because of the thermal refugia they provide for salmonids.

Temperature Monitoring Summary

Restoration actions since 2014 in the Grande Ronde basin has resulted in reconnecting 455 acres of floodplain habitat, protection of 1,083 acres of floodplains, uplands, and riparian areas through permanent and term conservation easements, 157 acres of floodplain and riparian habitat planted with over 47,000 native trees and shrubs, 13.5 miles of main channels restored or enhanced, eight miles of side channels constructed, 147 large main channel pools created or enhanced, 74 side channel pools created or enhanced, and 589 large wood structures installed. Overall, restoration practitioners are putting forth a great amount of effort to restore natural processes in the basin, however, from the temperature results above suggests that there are confounding factors that are not captured with data that was plotted or analyzed.

The relationship between stream and air temperatures is a key variable that would facilitate more in depth statistical analyses. With the increasing air temperature that is being seen across watersheds, if timed appropriately with the increasing stream temperatures such as increasing nighttime lows more than daytime highs, aquatic species, especially salmonids will be greatly impacted.

Results suggest that further restoration work within the Grande Ronde basin is still needed to facilitate temperatures optimal for salmonid productivity and to improve the summer and winter altered thermal regime. Furthermore, our findings have several limitations that hinder a robust analysis to draw stronger conclusions from and will be addressed in future monitoring efforts. Limitations are; 1) inconsistent probe deployment and removal, 2) varying probe locations, and 3) single water quality parameter collection.

We will work internally to improve deployment of probes and will install them in locations that are able to provide more detail on thermal loadings in the basin, specifically within deep pools of restoration projects, and will look for funding to potentially deploy other monitoring probes to collect other parameters such as ambient air, dissolved oxygen (DO), and/or potential of hydrogen (pH).

Long-term Analysis and Looking Forward

Oregon Department of Fish and Wildlife's Aquatic Inventory (AQI) and the Columbia Habitat Monitoring Program (CHaMP) developed a temperature/habitat ranking for steelhead and Chinook for various life stages and Watershed Sciences developed a median temperature profile of 266 river miles of the Grande Ronde River using a FLIR camera. Overlaid on each other gives insight to suitable salmonid temperatures within the basin. As seen in Figure 65, there is rapid heating from the headwaters of the Grande Ronde River as it flows through and downstream of Vey Meadows. There is increased thermal loading associated with decreases in elevation and subsequent increased in ambient air temperature, and the direct exposure to the sun as surface water flows through Vey Meadows, which has roughly 12% - 28% riparian shading (Figure 64). Downstream from Vey Meadows through the canyon there is a reduction in water temperature, and this is where most of the CTUIR is focusing current restoration actions.

The CTUIR developed a multiple year 7DADM to assess thermal regimes within the basin and determine if temperatures are improving with the restoration efforts being employed. CTUIR plotted 7DADM for the most recent restoration projects displaying the results of before and after restoration. The multiple year 7DADM focuses on the summer month period because during these times is when the most pronounced changes in stream temperatures are observed and when salmonids are heavily stressed with temperature fluxes. The multiple year 7DADM report was developed within the CDMS and provides the CTUIR a useful tool to analyze longer term datasets and draw conclusions from to assess restoration project effectiveness.

Figure 61 shows a five year 7DADM for probe BTS1_RM144.6. This probe is located at downstream end of the Bird Track Springs restoration project that concluded in 2018. Temperature data from 2016, the year before floodplain enhancement activities began, was plotted against data from the four consecutive years after restoration work ended (2019-2022).

2016 pre-project data, depicted in dark green, shows several elevated spikes in temperature through summer months. 2019 and 2020 post-project temperature data, shown in blue and purple, appear muted in comparison, with less extreme warming events and cooler summer temperatures overall. 2021 post-project data, in lime green, shows a large June-July temperature increase that corresponds to the significant heatwave the region experienced. Following this temperature anomaly the remainder of the data show a noticeable cooling trend below pre-project temperature records. Before-After project data illustrates the importance of floodplain restoration and the effect it has on stream metabolism, especially the buffering of water temperature extremes. Data from 2022 (pink) show a cooler summer trend compared to pre-project conditions (dark green).

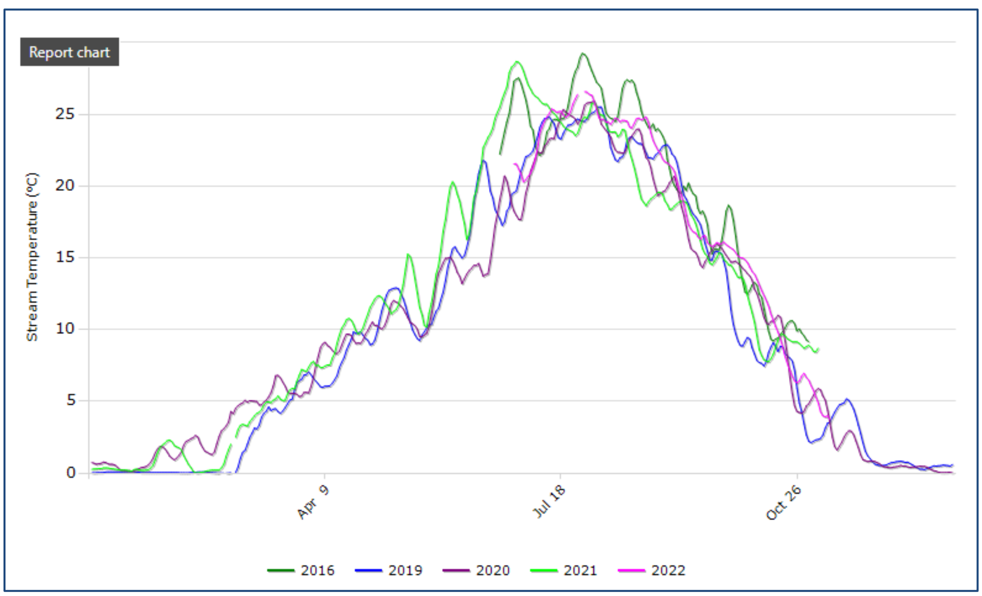


FIGURE 45 MULTI YEAR MIDPOINT 7DADM FOR GRANDE RONDE RIVER PROBE BTS1_RM144.6, BELOW RESTORATION

The following data plots show temperature records observed at three additional project areas before restoration actions began compared to 8-10 years post-restoration. The probe located at the most downstream extent of each project was chosen in order to gain insight into how restoration actions may be affecting stream temperature as water passes through and exits the project area.

Figure 62 depicts stream temperature below the Dark Canyon Fish Habitat Enhancement Project. In 2010 restoration actions were taken to reconnect Dark Canyon Creek to its floodplain with the addition of large wood complexes and cattle exclusion through riparian easement fences.

Figure 63 depicts stream temperature below the Rock Creek Fish Habitat Enhancement Project. Beginning in 2013 multiple phases of restoration activities were implemented within the Rock Creek project area including tributaries Little Rock Creek, Sheep Creek, and Graves Creek. Actions included historic channel reconnections, new channel alignment and excavation of deep pools, large wood additions, riffle construction, and fencing to exclude cattle from riparian vegetation.

Figure 64 depicts stream temperature below the Catherine Creek RM44 Fish Habitat Enhancement Project Complex. Beginning in 2013 the first of several phases was constructed within the CC44 complex with most recent actions completed in 2018. Project elements included the addition of large wood jams, riffle construction, new main channel and side channel realignments, creation of off-channel swale, alcove, and pool habitats, and riparian fencing to exclude cattle grazing impacts to vegetation.

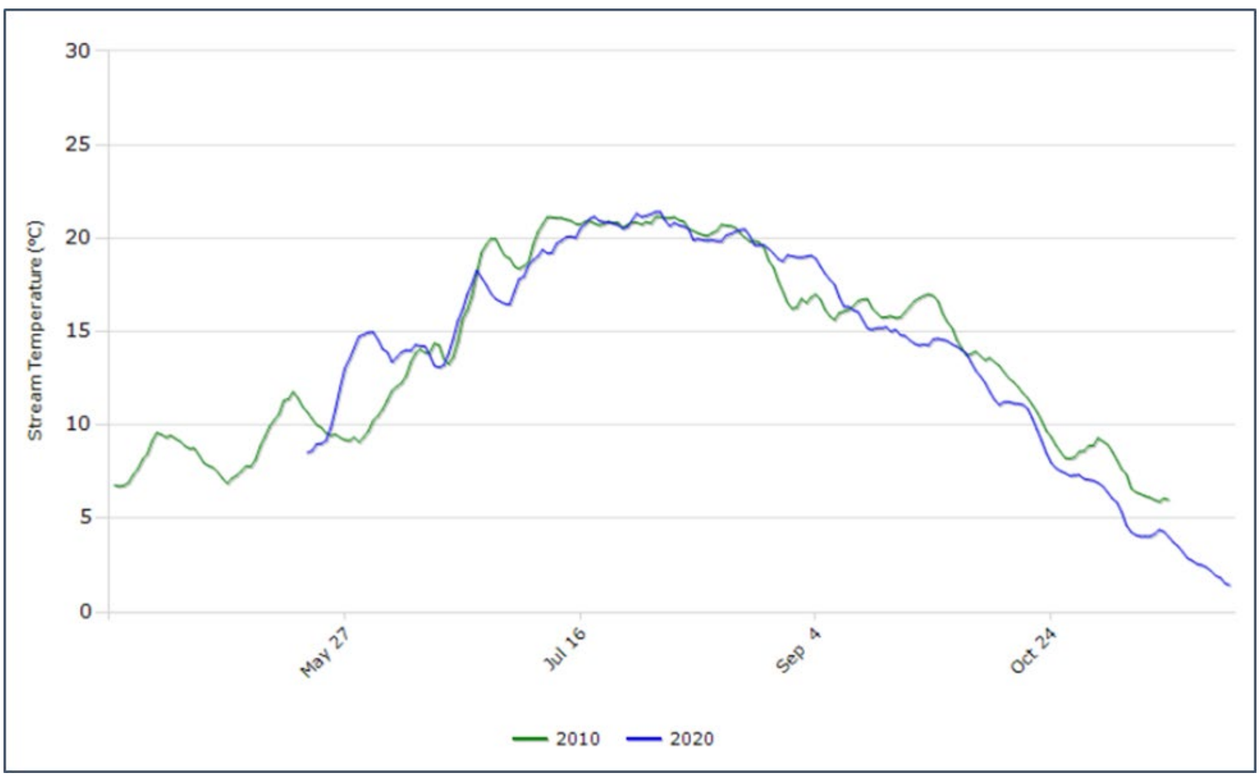


FIGURE 46 MIDPOINT MOVING AVERAGE DAILY MAXIMUM BELOW DARK CANYON PROJECT, PRE-PROJECT AND 10 YEARS LATER

FIGURE 47 MIDPOINT MOVING AVERAGE DAILY MAXIMUM BELOW ROCK CREEK PROJECT, PRE-PROJECT AND 8 YEARS LATER

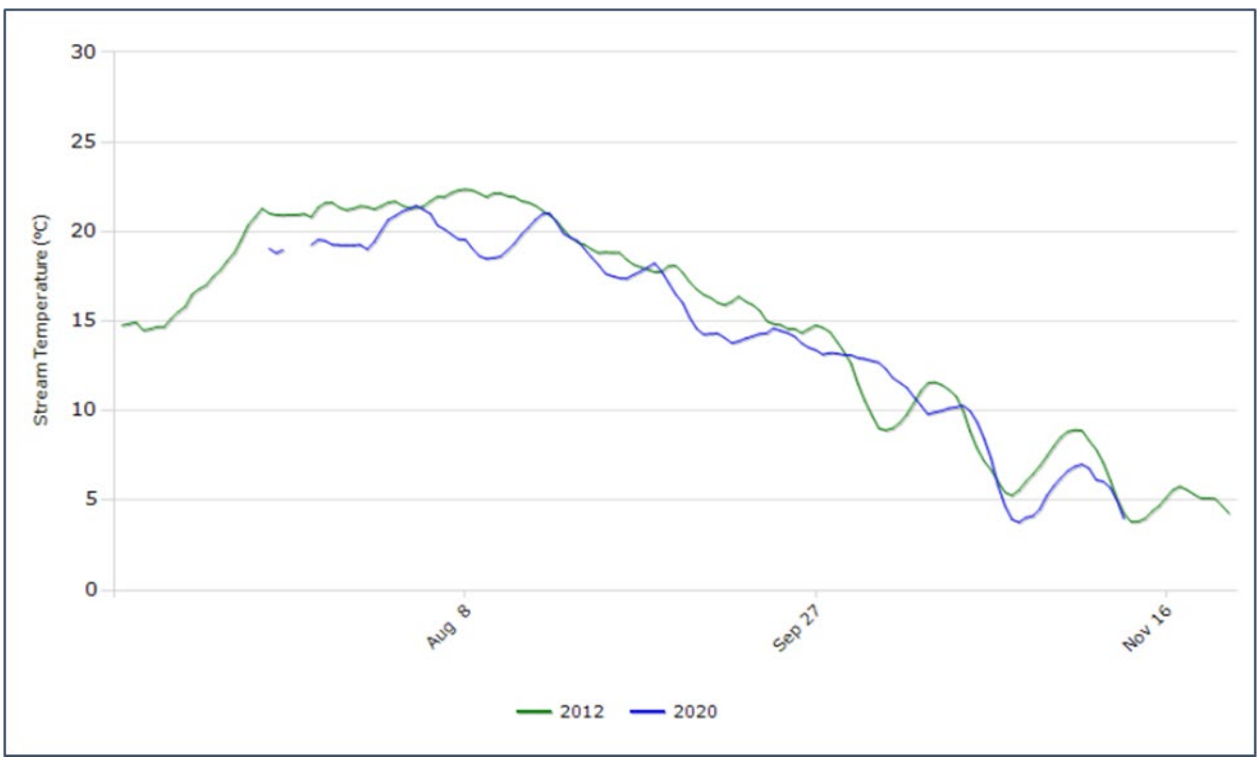


FIGURE 48 MIDPOINT MOVING AVERAGE DAILY MAXIMUM BELOW CATHERINE CREEK 44 PROJECT COMPLEX, PRE-PROJECT AND 8 YEARS LATER

Although there are multiple variables that influence stream temperature, floodplain restoration is a key tool to improve overall ecosystem function because of the increased groundwater or hyporheic exchange that leads to reduced water temperatures. Increased hyporheic flow exchange has been shown to increase thermal complexity through the emergence of upwelling cool patches, especially during summer months (July to September). Implementation of large wood (LW) facilitates cooling as well because as water flows around the LW instream structures, hydraulic forces drives water into the benthic substrate increasing hyporheic exchange and promoting thermal heterogeneity (Clark et al. 2021). The CTUIR will continue to work with partners and will meticulously design and place structures at the best configuration so that optimal hyporheic exchange is achieved and that stream temperatures are buffered. The CTUIR is continuing to monitor water temperatures within this site and have provided permission to the University of Idaho to study the thermal dynamics of this this project as well.

Across the west, climate change models indicate that stream temperatures within the Columbia Basin will increase significantly in the next 50-years, specifically eastern Oregon and within the Grande Ronde basin. As water moves down the basin temperature trends increase due to global climate change and anthropogenic perturbations including, water abstraction, and reduction in stream side vegetation, resulting temperatures will be inhospitable for salmonid fishes (Clark et al. 2021). Restoration will need to persist to remedy the impacts on streams and will need to be implemented methodically through the GRMW project place-based prioritization atlas to ensure vital areas are restored first. The CTUIR will continue to put forth their efforts to restore the Grande Ronde basin to warrant the continuance of the CTUIR's First Foods and River Vision.

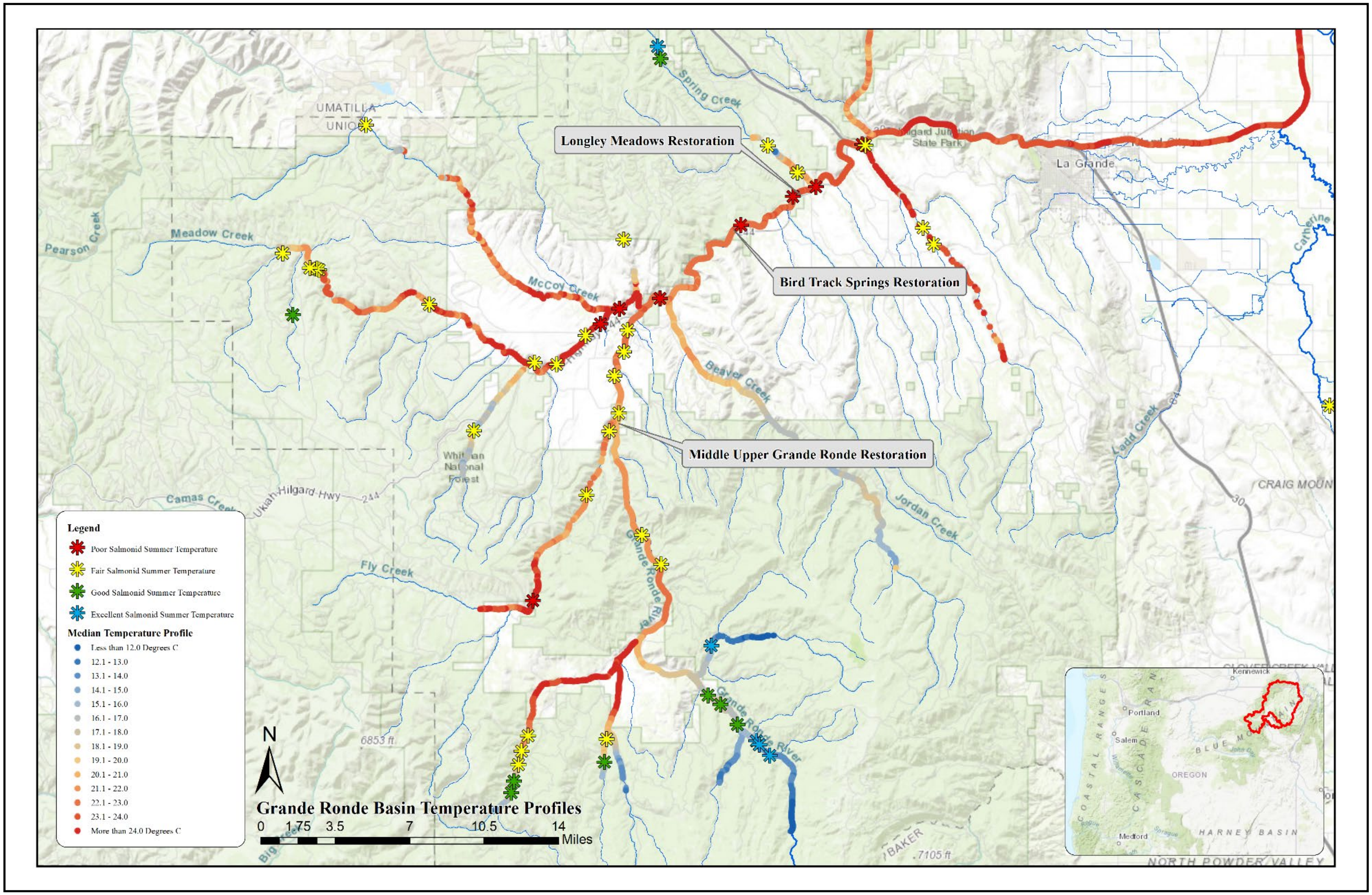


FIGURE 49 MEDIAN TEMPERATURE PROFILE MAP AND SUMMER SALMONID SUITABLE TEMPERATURE ASSESSMENT

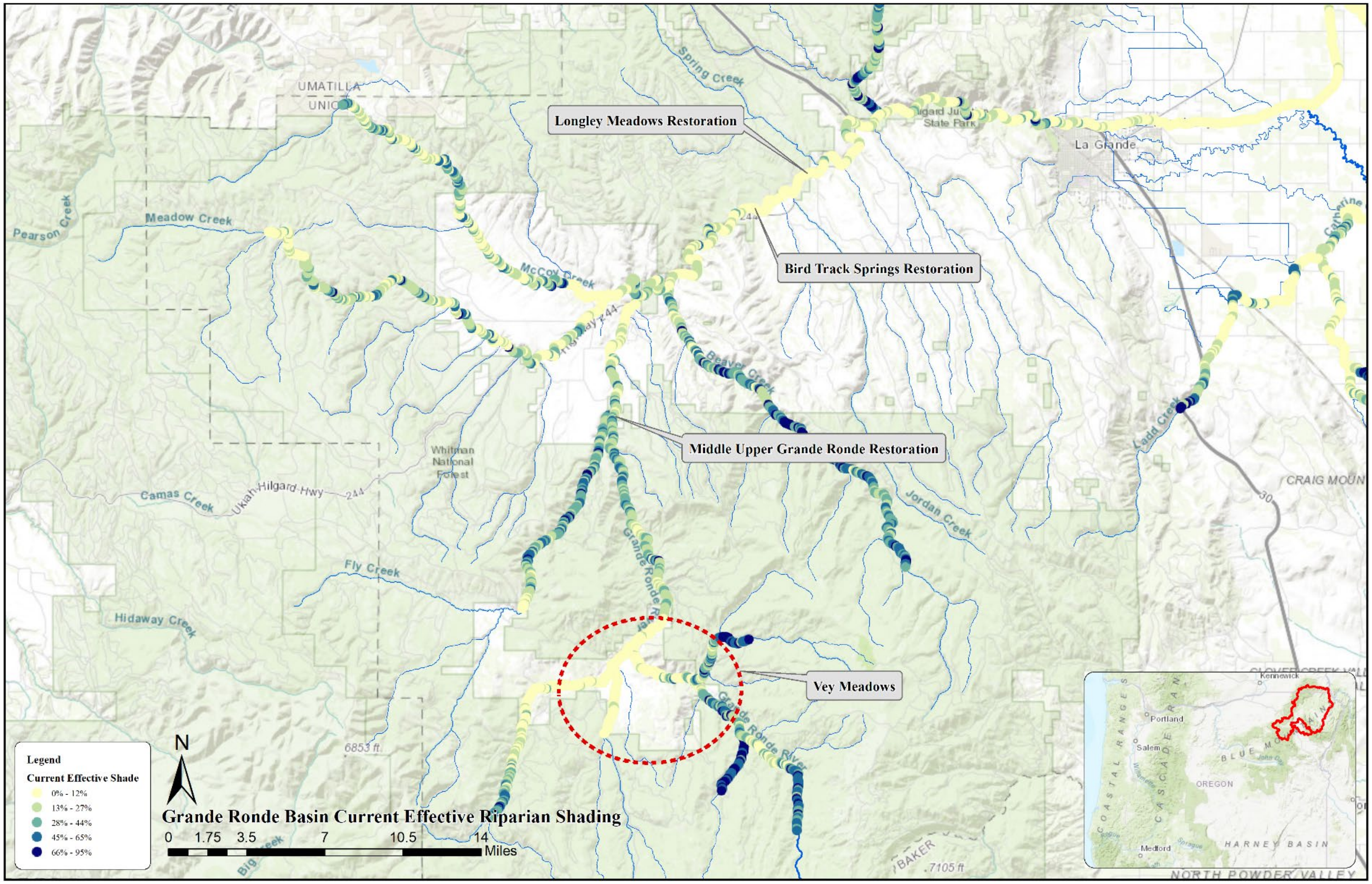


FIGURE 50 CURRENT EFFECTIVE SHADING ALONG THE GRANDE RONDE RIVER

Biological Monitoring

The CTUIR Grande Ronde RM&E Project (#2009-014-00) monitors fish response to habitat actions within the Grande Ronde Basin. The focus of the Grande Ronde RM&E Project is to monitor Grande Ronde Restoration projects at a scale larger than that used by the CHaMP and AEM programs (Naylor, et al., 2019). This monitoring effort follows the guidelines laid out in the Physical Habitat Monitoring Strategy - PHaMS (Jones, et al., 2015) and by the monitoring plan prepared by Stillwater Sciences for CTUIR (Stillwater Sciences, 2012). The overall habitat monitoring goal of the Grande Ronde RM&E Project is to provide empirical data to restoration managers on fish responses/use of restoration structures and new channels, and on changes in morphological (habitat) features as a function of the restoration actions. Monitoring objectives include: 1) provide restoration managers with information about fish response/use of different types of habitat structure or constructed channel segments; 2) provide empirical data on changes in thermal refugia associated with the restoration project, and 3) provide empirical data on morphological changes within shorter (200 m) sites nested within the larger restoration area.

Responses are measured by:

- Determining whether juvenile and adult fish responses are positively affected within the project area, post-restoration compared to pre-restoration levels (such as increased juvenile densities, relative abundance and increased spatial distribution of juveniles and redds).
- Determine fish use of restoration structures, such as large wood sites, constructed pools, side channels, alcoves, floodplains etc.
- Mapping thermal refugia within the project area pre- and post-restoration.
- Recording existing or pre-project physical habitat attributes and compare them with post-restoration attributes.

Monitoring activities provide information to restoration managers on existing fish use and response within project areas and these data will be utilized when designing habitat-enhancing projects in the future. Data will also be used as a baseline for comparison with post-restoration surveys when evaluating the effectiveness of projects in meeting their objectives. Habitat and morphology surveys follow protocols detailed in the Columbia Habitat Monitoring Protocol (CHaMP) methodology (CHaMP, 2015) using biomonitoring protocol #1955 (www.monitoringmethods.org) and are reported separately by the CTUIR Biomonitoring Project (BPA Project # 2009-014-00.

Methods

Evaluating the effectiveness of these habitat enhancement efforts is done by physical and biological sampling using regionally standardized habitat and biotic monitoring protocols and methods (Gallagher, et al., 2007; Nelle & Moberg, 2009; White, et al., 2011; Stillwater Sciences, 2012; CHaMP, 2015; Justice, et al., 2015; Bonneville Power Administration, 2016). Data collected by the CTUIR Biomonitoring Project and Grande Ronde RM&E are now stored on the CTUIR Central Database Management System (CDMS).

Spawning surveys

Steelhead - (Nelle & Moberg, 2009) Steelhead spawning surveys are conducted from March to June and are typically carried out 4 to 5 days per week, with repeat surveys for each restoration project occurring every 10 to 14 days until the spawning season is complete. Metrics collected include:

- Site ID (name of the reach surveyed)
- Stream name
- Survey date
- GPS number
- Start/End time
- Crew
- Survey direction (up or downstream)
- Air temperature at start
- Water temperature at start and end
- Lower end point coordinates
- Upper end point coordinates
- Weather conditions
- Water clarity
- Flow estimate (dry/low/moderate/high/flood)

Coordinates of all redds are recorded on a hand held GPS unit and flagged with the date, redd number, and surveyors initials on the flagging.

Chinook - (Gallagher, et al., 2007) Chinook spawning surveys are carried out late August to mid-September. A detailed description of the survey method for Lookingglass Creek that includes scale sample protocol, carcass metrics collected, and genetic sample protocol is given in (Crump & Van Sickle, 2016) published on Monitoringresources.org as Protocol #1843.

Snorkel surveys

Snorkel surveys follow the protocols outlined by White et al 2011, and the BPA Action Effectiveness Monitoring Program (White, et al., 2011; Bonneville Power Administration, 2016) and are typically undertaken in daylight hours. Surveys are conducted during daytime hours for logistical and safety reasons after comparing day and night survey results in 2016 on the Catherine Creek Southern Cross Restoration Project (Costi, et al., 2016). Surveys use a one pass, open population (no block nets) sampling design in order to not inhibit movement of ESA species between habitats.

In addition to recording observed fish species and their size, habitat data for each channel unit snorkeled is collected including:

- GPS point for downstream end of snorkeled channel unit
- Channel unit type (riffle, pool, side channel, etc.)
- Length in meters
- Mean width in meters (measurements taken at 25%, 50%, and 75% of channel unit)
- Mean depth in meters (measurements taken at 25%, 50%, and 75% of channel unit)

- Maximum depth in meters
- Ambient and minimum temperature in degrees centigrade (Justice, et al., 2015).

Radio Tracking

The Upper Grande Ronde stock of spring Chinook salmon migrate into the upper reaches of the Grande Ronde River beginning in early May and continue to move into the spawning grounds through August (McLean, et al., 2016). There is a weir and trap located at river mile 153.5 (Figure 67) operated by the CTUIR. The weir is designed to capture broodstock and enumerate upstream migrating salmon and has been in operation since 1997 (McLean, et al., 2016). The migration of Grande Ronde adults in the lower Columbia River system has been well documented (Keefer, et al., 2004; Keefer, et al., 2008). The movement and habitat use of adult Chinook in other basins has also been studied (Conder, et al., 2008), including within the Grande Ronde Basin on the Lostine River (Harbeck, et al., 2014). However, the migration patterns and stream reach use prior to spawning of the Upper Grande Ronde stock is unknown once returning adults are captured and released above the weir. In most years, the habitat in the Upper Grande Ronde River is plagued by low stream flows and high stream temperatures throughout the summer (Nowack, 2004; Justice, et al., 2017).

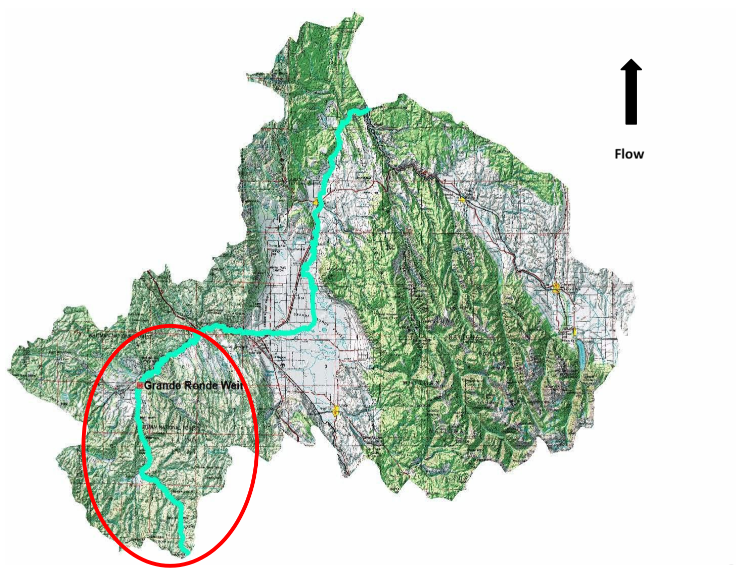


FIGURE 51 UPPER GRANDE RONDE WEIR LOCATION

Discovering where the salmon hold and how long they choose to stay in those areas may help in understanding which stream reaches and habitat types need to be protected or enhanced. Radio telemetry is a common technique that has been used to document the movement of fish and other animals within their habitat (Contor, C.R., 2010, 2014; Harbeck, et al., 2014) and we are able to handle a percentage of the run at the weir each year. There is also a large portion of the upper river (Vey Meadows, 6.5 river miles) that is under private ownership and currently access has not been granted. By using radio telemetry methods and staying within the boundaries of the National Forest it is possible document when fish enter and leave the area without having to enter the property.

Historically, when access was regularly granted to the meadow area (1986 to 1993), an average of 43% of the total redds for the Upper Grande Ronde River were counted there, with an average of 49% of redds counted in the section above the meadow to the top of the spawning area (4.2 river miles) (Tranquilli, et al., 2001). Current redd distribution information is unknown for this reach and understanding usage of this historical spawning area before/after habitat restoration actions upstream and downstream is important for understanding the population dynamics of this ESA species. During recent years there has been high pre-spawning mortality observed in the Upper Grande Ronde, but with the majority of carcasses only being recovered upstream of the private land (Joseph Feldhaus, ODFW unpublished data 2018), it is still unclear how much the section of stream within private land or downstream of the meadow is being used.

In 2019 a three year pilot study was initiated by the CTUIR to radio tag adults after broodstock needs were met to better understand where the salmon might be holding and what habitat types are important for survival prior to spawning. Information gained from this study could help guide future pre-spawning mortality surveys, understand habitat needs of adults during holding and spawning in this critical area, and identify areas of use that may influence in-stream habitat work in the future. Details of the sampling design for the monitoring proposal are uploaded to Pisces as "Migration Patterns and Stream Reach Usage of Adult Spring Chinook salmon in the Upper Grande Ronde River" under BPA contract # 73928 REL 87 (Naylor, et al., 2018).

Catherine Creek – Floodplain Restoration Monitoring

During steelhead spawning surveys in spring 2017, project biologists noted large groups of juvenile Chinook within the floodplain swales, alcoves, and blind channels (perennial spring fed channels connected to the main channel at the downstream end but only connected at the upstream end in high flows). The first observations saw very few fish in late April when the main channel was running at an estimated 350 cfs (9.9 m/s) – based on the Oregon Water Resources flow gauge near Union, approximately 2.6 miles (4.1 km) downstream of the site (station # 13320000). However, as the hydrograph increased so did the observations of juvenile Chinook, and underwater videos as the hydrograph peaked at 900 cfs (25.4 m/s) provided qualitative evidence of the floodplain utilization by young-of-the-year Chinook (Naylor, et al., 2017).

The approach taken to restoring floodplain connectivity at the Southern Cross site is providing ephemeral and perennial off-channel habitat for juvenile salmonids that had not previously been available within the simplified channel. We know from the literature that floodplain access can have significant growth benefits for juvenile Chinook, but questions remain about the effectiveness of the Southern Cross project because currently we do not possess quantitative data of Chinook and O. mykiss abundance, density, or growth at this site. Nor are we able to provide information to the restoration implementers on what habitats within the floodplain are being used by these juveniles so that they can mimic them at their next floodplain projects.

This monitoring project is designed to quantify salmonid use of the newly restored floodplain habitat within the Catherine Creek – Southern Cross – restoration project so that restoration implementers can re-create the preferred floodplain habitat in future projects. To do this the CTUIR proposed to document habitat characteristics and estimate juvenile salmonid abundance and densities within these floodplain habitats and compare these with marginal (edge) habitat within the main channel at different flow events. For this annual report we will provide an overview of the work undertaken in 2019. A detailed report will be uploaded to Pieces after the completion of the monitoring period in 2022.

Discussion

Dark Canyon Creek has seen a decline in the number of juvenile Chinook and O. mykiss over the past 5 years that may be confounded by low adult returns throughout the Basin rather than indicative of poor habitat quality within the restoration project as a whole. The pool habitat between the two survey reaches were similar in area and depth for within year comparisons, but between-year comparisons showed that the lower reach had shallower and longer pools in 2019 compared to 2018. Whether this is a shift in the channel morphology in this section will be remain unclear until these habitat variables are measured for several more years. The abundance of O. mykiss was similar in both reaches in 2019, however, adding a survey of 670 meters between these two reaches showed a larger number of fish using this section.

For McCoy Creek it appears that overall the pool habitat in the most downstream reach has not changed significantly in area over the 8 year period of monitoring, has been greater in length in some years compared to the upstream reaches, but has been similar in mean pool area compared to the other reaches, it has not varied in max depth each year of survey, has been cooler than the other reaches in most years, has dissolved oxygen levels tolerable for salmonid species and similar to the upstream reach, has the most steelhead redds, but has had the lowest abundance of juvenile salmonids in most years. It appears that even though spawning occurs within this reach, when adult returns are higher, O. mykiss are not rearing here. Similar to Dark Canyon Creek the declining numbers of salmonid species may be reflective of Basin wide trends. The habitat variables we measured indicate that our hypothesis was incorrect and pool rearing habitat does not appear to be highly variable within the restoration area.

On Rock Creek, the availability of late summer habitat has been demonstrated to be an important factor in salmonid rearing (Polivka, et al., 2015) and is likely still a limiting factor. While this habitat appears to be persistent within the lower section of Rock Creek (Reach 1) each year post construction there is up to 800 meters of channel upstream of this reach which is not. These two section had very different habitat restoration work implemented due to infrastructure concerns on the upper reach. These limitations on Reach 2 may have been enough to render this reach unsuccessful in maintaining late season rearing habitat. It should be pointed out that while this may be true for late summer rearing it is not for early summer rearing as Reach 2 does provide a large section of stream habitat at this time. Fish salvage operations before the 2014 restoration work have shown that this reach can have a large abundance of O. mykiss with 2,185 juveniles captured that year in just 24 sites covering approximately 818 m2. As with other restoration project monitoring it appears that the habitat is available but the poor adult return numbers and lack of redds is leading to a shift in juvenile age structure away from being dominated by young-of-the-year to older juveniles and a reduction in the overall abundance of salmonids.

Action Effectiveness Monitoring (AEM)

The following reporting of Action Effectiveness Monitoring (AEM) efforts within the Grande Ronde River and Catherine Creek watersheds comes from Cramer Fish Sciences 2019 annual report to Bonneville Power Administration (Roni et al. 2020).

The Bonneville Power Administration (BPA) and its partners have funded thousands of riverine restoration actions across the Columbia River Basin to improve habitat for anadromous fish as part of the Northwest Power and Conservation Council's Fish and Wildlife Program. The Action Effectiveness Monitoring (AEM) Program was developed to address the pressing need for a programmatic approach to project-level effectiveness monitoring in the Columbia River Basin. The goals of the AEM Program are to quantify improvements in localized habitat and fish abundance as a function of restoration actions implemented in the Columbia River Basin and to help guide future restoration and improvement efforts to ensure the BPA is investing in effective restoration techniques. Specifically, AEM is designed to programmatically evaluate projects across the interior Columbia River Basin to determine the effect of different action categories on juvenile Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* and habitat at the reach scale, why some projects within an action type are more effective than others, and whether there are differences in project effectiveness among regions (salmon evolutionary significant units or ESUs).

The AEM Program was designed in 2013 and implemented in 2014 to provide both short-term and long-term results for previously completed (prior to 2015) and newer salmon and steelhead habitat restoration and improvement projects. A multiple before-after control-impact (MBACI) design is used to evaluate a subset of new actions and an extensive post-treatment (EPT) design for previously completed actions. The MBACI design includes collection of data in paired treatment and control reaches two years before and in years 1, 3, and 5 after restoration project implementation. In contrast, the EPT design requires the collection of data only post-treatment at paired treatment and control reaches.

At its inception, the AEM Program was split into two separate contracts with the EPT design implemented by Cramer Fish Sciences and the MBACI design being implemented by a different contractor. Cramer Fish Sciences took over the entire AEM Program in 2018 and conducted a systematic and detailed review of all MBACI data collection, monitoring methods, site selection, and data management and met with project sponsors.

Riparian Vegetation Monitoring – Extensive Post-Treatment (EPT) study design

Active restoration and enhancement of riparian areas is one of the most widespread habitat improvement techniques in the Columbia River Basin and throughout the United States for the benefit of listed Pacific salmon *Oncorhynchus* spp. and steelhead *O. mykiss* (Pollock et al. 2005; Kondolf et al. 2007; Hillman et al. 2016).

Short-term monitoring (e.g., two to five years post implementation) of riparian planting and other riparian restoration projects has found promising results, including high plant survival and improved vegetation structure and cover, as well as reduced instream temperatures and sediment loads, reduced bankfull width to depth ratios, and improved water quality (Feld et al. 2011; Conley and Lindley 2012; González et al. 2015; Hall et al. 2015). Results from riparian restoration actions vary and appear to depend upon whether underlying processes, such as hydrologic connectivity, predation, and competition, were addressed during restoration (Emmingham et al. 2000; Hall et al. 2011; Lennox et al. 2011; González et al. 2015). Moreover, the responses to restoration differ by ecoregion and there have been relatively few studies that have been conducted within the Columbia River Basin (Roni et al. 2014a; Hillman et al. 2016). Additionally, many studies have focused on monitoring the short-term (<5 years) response to riparian restoration (Roni et al. 2008; Kettering and Adams 2011; Lennox et al. 2011; González et al. 2015). Long-term monitoring of these riparian projects provides valuable insight into riparian habitat response to various restoration strategies which can inform future riparian restoration projects. It is important to continue to monitor key restoration metrics (e.g., species diversity, structure, and shade) for extended periods post-implementation (5-25 years) to better understand what factors influence long-term success of riparian plantings (González et al. 2015; Hillman et al. 2016; Roni et al. 2019).

The primary goal of the AEM Program monitoring effort for riparian projects is to determine their effectiveness at improving riparian conditions. A secondary goal is to determine if there are characteristics of the project design (e.g., type of planting, use of tree shelters) or project location (e.g., evolutionary significant unit [ESUs], ecoregion, elevation) that influence project success. Specifically, we address the following questions:

1. Did treatment (planting and invasive vegetation removal) lead to increases in native species abundance and diversity?
2. Did treatment lead to increased cover of native woody plant species?
3. Did treatment lead to increased riparian condition (e.g. structure, shade)?
4. Has riparian vegetation structure changed?

Reach lengths were determined by 20 times bankfull width, with a minimum length of 150 m and a maximum of 600 m, as measured at the thalweg (Roni et al. 2014b). Average bankfull width was taken from five equally spaced measurements across the reach. If restoration plots exceeded our site length (20 times bankfull width), a treatment reach was delineated within the project boundary that was representative of the project as a whole, as opposed to the area with the highest density of plantings. If all other minimum survey requirements were met, due to the limited number of sites that qualified to be included in the monitoring program, sites were surveyed as long as they were 150 m in length, regardless of their bankfull width calculated site length.

Surveys were conducted using two-meter wide belt transects equally spaced across reaches and oriented perpendicular to the active channel (Gregory et al. 1991; Parkyn et al. 2003; Harris 2005; Lennox et al. 2011; Merritt et al. 2017). Site layout at control reaches mimicked the layout of their paired treatment reach. Twenty percent of the reach length was used to determine the number of two-meter wide belt transects to be surveyed (Lennox et al. 2011; Gornish et al. 2017). For example, for a site length of 150 m, 30 m (20%) would be sampled, which is 15 equally spaced two-meter wide transects (i.e., 15 transects at 2 m wide equals 30 m total). Therefore, given our site length requirements, a minimum of 15 and a maximum of 60 transects were surveyed (Kaufmann 1999). Transects were delineated by running a meter tape from the active channel boundary to the outer boundary of the riparian planting (Merritt et al. 2017). The tape denoted the middle of the belt transect and surveys extended one meter on both sides of the tape. Transect lengths were determined by the extent of the planting but were a minimum of 5 m and a maximum of 20 m (Kaufmann 1999; Harris 2005).

Species composition, vegetation cover, and canopy cover were measured within each belt transect. All woody plants were identified to species except for willows, which were identified to genus *Salix* spp., woods and Nootka rose, which were grouped as Rosa *spp.* and sagebrush species, which were identified as *Artemisia* spp. For each species, the height and location (meter tape distance) were recorded. Species were classified based on height as herbaceous (<1 m), shrub (1–5 m), or tree (>5 m). Bud browse, beaver damage, living or deceased condition, and evidence of planting (tubes, markers, mulch, or cages) were recorded for each woody species. The Shannon-Weiner diversity index (*H*) and the Simpson diversity index (1-*D; D* = Simpson's diversity) were calculated for native woody species using richness and abundance data.

Riparian surveys were conducted on six restoration projects within the Grande Ronde and Catherine Creek watersheds. The following describes the project areas by their monitoring type, reach length, number of transects, transect length, and number of years since project implementation that the site was last surveyed. The CTUIR sponsored or contributed to the implementation of all but one (Meadow Creek) of the six projects listed below.

CC-37 (Upper Catherine Creek HUC-10 basin)
Riparian vegetation monitoring - EPT design
6 years since project (visited 2018)
Site length – 220 m
Transects – 22
Transect length – 15 m

End Creek (Willow Creek HUC-10 basin)
Riparian vegetation monitoring - EPT design
13 years since project (visited 2019)
Site length – 150 m
Transects – 15
Transect length – 6.3 m

McCoy Creek (Meadow Creek HUC-10 basin)
Riparian vegetation monitoring - EPT design
8 years since project (visited 2018)
Site length – 150 m.
Transects – 15
Transect length – 9.3 m

Meadow Creek (Meadow Creek HUC-10 basin)
Riparian vegetation monitoring - EPT design
5 years since project (visited 2019)
Site length – 150 m
Transects – 15
Transect length – 17.7 m

Oregon Ag Foundation (Willow Cr HUCK-10 basin)
Riparian vegetation monitoring - EPT design
11 years since project (visited 2018)
Site length – 150 m
Transects – 15
Transect length – 5 m

Southern Cross (Upper Catherine Cr HUC-10 basin)
Riparian vegetation monitoring – EPT
Physical habitat & biological monitoring – MBACI
2 years since project (visited 2018)
Site length – 272 m
Transects – 27
Transect length – 14.8 m

TABLE 4 SPECIES ABUNDANCE, DETERMINED BY THE NUMBER OF INDIVIDUAL TARGET PLANT SPECIES WITHIN TREATMENT (T) AND CONTROL (C) REACHES.

Year surveyed	Site name	Black cottonwood		Black hawthorn		Common snowberry		Red alder		Red-osier dogwood		Rose spp.		Willow spp.	
		T	C	T	C	T	C	T	C	T	C	T	C	T	C
2018	CC37	-	147	8	-	-	1	-	-	2	3	-	6	85	63
2019	End Cr	-	-	1	-	-	-	1	-	1	-	6	-	35	-
2018	McCoy	-	-	-	-	-	138	4	19	-	-	-	-	16	6
2019	Meadow Cr	-	-	3	-	-	7	-	-	-	-	-	-	259	574
2018	OAF	-	-	-	-	-	-	-	-	-	-	-	78	73	20
2018	Southern Cross	26	89	8	11	-	-	21	-	33	1	42	1	108	16
Total idividuals **T**	Total individuals **C**	26	236	20	11	0	146	26	19	36	4	48	85	576	679
732	1180														

Overall abundances for target planting species show that there were significantly more plants observed within the control reaches compared to their treatment counterpart. However, the species Black hawthorn, Red alder, and Red-osier dogwood counted in treatment reaches outnumbered those found in control reaches. No snowberry individuals were observed in treatment reaches in any of the six monitored restoration projects, compared to 146 plants counted in control reaches, with all but one found within the McCoy and Meadow Creek project areas. Willows were found at every treatment and control site except within the End Creek control reach. Willows also represent the majority of counted individual plants overall (65.6%), and were approximately evenly dispersed between treatment and control reaches.

TABLE 5 SPECIES RICHNESS AND ABUNDANCE. HERBACEOUS (WOODY SPECIES <1 M), SHRUBS (WOODY SPECIES 1-5 M), TREES (WOODY SPECIES> 5 M). STEM COUNT REFERS TO OVERALL WOODY PLANT ABUNDANCE OF ALL THREE HEIGHT CLASSES COMBINED. SHANNON INDEX (H) AND SIMPSON INDEX OF DIVERSITY (1-*D; D*= SIMPSON'S DIVERSITY).

Year surveyed	Site name	Richness		Stem count		Herb		Shrub		Tree		*H*		1-*D*	
		T	C	T	C	T	C	T	C	T	C	T	C	T	C
2018	CC37	3	6	95	222	41	88	54	43	0	91	0.4	0.9	0.2	0.5
2019	End Cr	5	0	44	0	32	0	12	0	0	0	0.7	0.0	0.3	0.0
2018	McCoy	3	4	23	164	6	163	17	1	0	0	0.8	0.5	0.5	0.3
2019	Meadow Cr	6	5	290	616	280	604	5	8	5	4	0.5	0.3	0.2	0.1
2018	OAF	2	3	76	134	68	117	8	17	0	0	0.2	1.0	0.1	0.6
2018	Southern Cross	9	8	266	145	179	67	87	51	0	27	1.7	1.2	0.8	0.6
	Averages	4.7	4.3	132.3	213.5	101.0	173.2	30.5	20.0	0.8	20.3	0.7	0.7	0.4	0.4

Overall species richness was slightly higher at treatment versus control reaches among the six monitored sites in the Grande Ronde Subbasin during 2018 and 2019 site visits, with an average of 4.7 species observed at treatment reaches and 4.3 species observed at control reaches. The Southern Cross project supported nearly twice the species richness in both treatment and control sites (9 and 8, respectively) compared to overall Subbasin average. There was significantly higher overall woody plant abundance (all three height classes combined) in control versus treatment reaches. Overall average herbaceous and tree abundance was also significantly higher in control reaches compared to treatment reaches, with shrubs found within treatment sites outnumbering those found in their control counterparts. Using the two diversity indices (Shannon's *H* and Simpson's *D*) we are shown that average species diversity is equal between overall treatment and control reaches, however overall species diversity was higher in treatment reaches within End Creek, McCoy Creek, Meadow Creek, and Southern Cross project areas. Southern Cross project also exhibited the highest species diversity in both treatment and control sites compared to the other five study areas monitored within the Subbasin.

Riparian planting projects sometimes include other restoration actions that may influence recovery of riparian conditions. Floodplain restoration projects often involve a large amount of riparian disturbance prior to restoration planting and therefore take longer for riparian areas to return to pre-restoration conditions even with substantial planting efforts (Morley et al. 2005). Control reaches were selected to match treatment reaches pre-restoration implementation condition, and therefore control reaches for floodplain enhancement projects sometimes contained more riparian vegetation than their paired restored treatment reach, likely confounding results. Therefore, given the level of riparian disturbance and the time needed for the riparian area to match pre-restoration conditions for floodplain enhancement projects, these projects should be evaluated separately when examining the success of riparian planting efforts in future monitoring programs. In addition, positive responses in cover and shading were not detected likely due to lack of elapsed time since project completion, and interactions with predation, watering, and terrace height.

Physical Habitat Tables

TABLE 6 BANKFULL WIDTH TO DEPTH RATIO, SINUOSITY, TOTAL COUNT OF BANKFULL SIDE-CHANNEL JUNCTIONS, AND SIDE-CHANNEL RATIO FOR SOUTHERN CROSS PROJECT.

Site name	Year collected	Year code	BF W/D ratio		Sinuosity		BF side-channel junctions (#)		Side-channel ratio	
			T	C	T	C	T	C	T	C
Southern Cross	2014	Yr -2	20.1	30.2	1.06	1.11	0	0	0	0
	2015	Yr -1	18.8	30.4	1.04	1.09	0	0	0	0
	2017	Yr +1	21.3	33.4	1.23	1.11	6	0	2.16	0
	2019	Yr +3	18.0	29.1	1.27	1.08	11	0	3.43	0

Pre-project bankfull width to depth ratio ranged from 18.8 to 20.1 in the treatment reach, and 30.2 to 30.4 in the control reach. One year after project completion the treatment width to depth ratio increased to 21.3 but then decreased to 18.0 when surveyed again three years post-project. Width to depth ratio in the control reach increased to 33.4 one year after project completion, but decreased to 29.1 when measured again three years post-project.

Average pre-project sinuosity was 1.05 in the treatment reach and 1.10 in the control. Measurements form the +1 and +3 year surveys post-project give us an average sinuosity of 1.25 at the treatment site (0.2 increase) and remained essentially the same in the control reach at 1.09. Bankfull side-channel junctions and side-channel ratios were null during the two years surveyed pre-project due to no side channels existing within the Southern Cross project area before restoration actions occurred in 2016. The number of bankfull side-channel junctions ranged from 6-11 in the treatment reach during the three years after project completion. During this same time period post-project side-channel ratios ranged from 2.16-2.43 in the treatment reach. In the control reach bankfull side-channel junctions and side-channel ratios did not exist post-project.

TABLE 7 POOL TO RIFFLE RATIO, PERCENT SLOW WATER, AND RESIDUAL POOL DEPTH (M) AT SOUTHERN CROSS PROJECT.

Site name	Year collected	Year code	Pool/riffle ratio		Slow water (%)		Residual pool depth (m)		Habitat Diversity (H)		RCI		LWD (volume / 100 m)	
			T	C	T	C	T	C	T	C	T	C	T	C
Southern Cross	2014	Yr -2	0.33	2.00	28	25	0.40	0.22	1.00	1.17	0.40	0.36	4.5	12.8
	2015	Yr -1	0.40	2.00	48	52	0.29	0.22	1.03	1.36	0.40	0.35	0.7	21.7
	2017	Yr +1	1.25	2.33	60	31	0.55	0.27	1.16	1.20	0.40	0.36	133.2	17.0
	2019	Yr +3	1.00	0.80	72	51	0.62	0.22	1.10	1.33	0.40	0.35	110.9	31.6

Pool/riffle ratio was 2.00 in the control reach during each of the two surveys conducted the two years prior to project implementation. The pool/riffle ratio ranged from 0.33-0.40 in the treatment reach during the same two surveys. During post-project surveys pool/riffle ratio in control reach ranged between 0.80 and 2.33. Pool/riffle ratio in the treatment reach increased to between 1.00 and 1.25 post-project.

The post-project treatment reach consisted of between 60-72% slow water, up from 28-48% during pre-project measurements. The control reach remained nearly unchanged with 25-52% slow water pre-project compared to 31-51% post-project.

Residual pool depth within the treatment reach increased in depth from 0.29-0.40 m pre-project to 0.55-0.62 m post-project. The control reach pool depth remained nearly unchanged at approximately 0.22 m before and after project implementation.

Habitat diversity increased slightly in the treatment reach from an average of 1.015 pre-project up to 1.13 post-project. Within the control reach average habitat diversity remained unchanged pre/post-project at 1.27.

A significant increase in post-project LWD/100 m. was observed in the treatment reach of the Southern Cross restoration project, averaging 2.6 LWD volume/100 m. pre-project compared to 122.1 post-project. The pre-project control reach contained an average of 17.25 LWD volume/100 m. compared to 24.3 averaged between the two post-project surveys.

TABLE 8 THE D_{50} AND D_{84} BY SIZE RANGE (MM) AND POOL TAIL FINES (%) FOR SUBSTRATE COLLECTED AT SOUTHERN CROSS PROJECT.

Site name	Year collected	Year code	D_{50} (mm)		D_{84} (mm)		Pool tail fines (%)	
			T	C	T	C	T	C
Southern Cross	2014	Yr -2	64 - 90	45 - 64	128 - 180	90 - 128	9	13
	2015	Yr -1	45 - 64	32 - 45	128 - 180	64 - 90	7	6
	2017	Yr +1	45 - 64	45 - 64	128 - 180	64 - 90	10	8
	2019	Yr +3	45 - 64	32 - 45	90 - 128	90 - 128	10	15

D_{50} substrate size surveyed in the treatment reach pre-project ranged between Gravel-Very Coarse 2 (45-64 mm) to Cobble-Small 1 (64-90 mm) but remained in the 45-64 mm category when surveyed one and three years after project completion. The control reach contained D_{50} substrate sizes that ranged from Gravel-Very Coarse 1 (32-45 mm) to Gravel-Very Coarse 2 (45-64 mm) both before and after project area restoration.

D_{84} substrate size in the treatment reach fell within the Cobble-Large 1 (128-180 mm) category pre-project, and ranged between 90-180 mm post-project. The control site averaged D_{84} substrate within the range of 64-128 both pre and post-project.

The average percent of pool tail fines observed in the treatment reach pre-project was 8% and increased to 10% in the years surveyed after project completion. In the control reach an average of 9.5% pool tail fines were observed, compared to 11.5% post-post project.

The table below contains snorkel survey total count of juvenile Chinook and steelhead, water temperature, and discharge from Southern Cross project.

TABLE 9 SNORKEL COUNT OF JUVENILE CHINOOK AND STEELHEAD, WATER TEMPERATURE, AND DISCHARGE FROM SOUTHERN CROSS PROJECT.

Site name	Year collected	Year code	Chinook		Steelhead		Temperature (C)		Discharge (cfs)	
			T	C	T	C	T	C	T	C
Southern Cross	2014	Yr -2	26	235	49	275	13.7	18.7	29.5	28.8
	2015	Yr -1	169	357	189	205	20.2	14.2	24.0	16.0
	2017	Yr +1	90	504	62	166	17.3	17.0	24.0	23.9
	2019	Yr +3	138	99	4	163	17.6	16.3	24.2	44.1

Juvenile Chinook and steelhead snorkel surveys were conducted before and after Southern Cross restoration project implementation. Two years prior to project construction the treatment reach contained 26 juvenile Chinook and 49 steelhead, while the control reach contained 235 chinook and 275 steelhead. Surveyed again one year pre-project snorkelers observed 169 juvenile chinook in the treatment reach and 189 steelhead. During this time the control reach contained 357 Chinook and 205 steelhead juveniles. One year following project construction activities the treatment reach contained 90 juvenile Chinook and 62 steelhead while the control reach contained 504 Chinook and 166 steelhead. The paired treatment-control reaches were surveyed again three years post-project. At this time the treatment reach contained 138 Chinook and 4 steelhead juveniles while snorkelers counted 99 Chinook and 163 steelhead in the control reach.

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 coarse 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 and geomorphic potential to stratify individual watershed 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.

Adaptive management and project adjustment derived from evaluation of older in-basin projects, regional project tours and reviews, and collaboration with regional and local habitat biologists and researchers continues to be an important part in the progression and evolution of floodplain and habitat restoration techniques and design features, including:

1. Hydro geomorphology and hyporheic processes and functions to promote summer and winter refuge. The CTUIR Hyporheic Flow Assessment in Columbia River Tributaries project (#2009-014-00) provides valuable insight into floodplain design and restoration of groundwater and hyporheic process and function. Examples include promoting floodplain inundation, increasing the River Complexity Index (RCI), promoting multi-thread/anastomosing channel networks, restoring sinuosity, and forcing hydrologic head through meanders to create and restore diverse flow paths.

2. Habitat suitability and juvenile life stage habitat selection (Favrot and Jonasson 2018): Local Basin research informs importance and prioritization of zero velocity and forced pool habitats. Locally derived suitability indices for depth and velocity inform habitat suitability modeling which is used in channel and floodplain design. Achieving velocity requirements during spring and early summer flows shown to be difficult to achieve without diverse floodplain and off channel habitat (low gradient swales, side channels and alcoves). Forced pool habitat design requires short radius and support complex “catcher mitt” large wood structure design with overhead cover, mimicking natural pool logjams.

3. Beaver habitat and restoration. Floodplain projects and the associated disturbance regime provide multiple ecological benefits, including restored hydrology, erosion and deposition, and support of riparian and wetland vegetation colonization. Beaver benefit from restored hydrology and the associated vegetation response that improve beaver habitat suitability indices, including a yearlong food supply, and dam and lodging materials. Degraded floodplains exhibit simplified and xeric conditions with poor riparian condition that limit habitat suitability for multiple resources. Floodplain process restoration includes hydrology and a disturbance regime that supports wetland and riparian vegetation establishment and habitat suitability for both aquatic and terrestrial fish and wildlife.

Additionally, at the request of the NPCC, ISRP, and others regarding the need to address evaluation and adaptive management, BPA developed and initiated the Action Effectiveness Monitoring (AEM) Program as a cost-effective approach to evaluate reach-scale physical and biological effectiveness of a subset of habitat improvement (restoration) actions implemented and funded under the Council's F&W Program (NPCC 2012; Roni et al. 2015). The AEM Program has been evaluating a subset of barrier removal, wood placement, riparian planting, and floodplain restoration projects using two monitoring designs (before-after control impact for new projects and extensive post-treatment for previously completed projects). The Project has closely coordinated with the AEM Program to assist with identification of potential projects to monitor, provide critical information on project design, coordinate with landowners, and contribute data collection efforts on individual monitoring sites. Results to date from the AEM Program have demonstrated positive physical and biological success of large wood placement, barrier removal, and riparian planting projects. While only a portion of the restoration projects evaluated by AEM are in our ESU or project area (watershed), results to date have shown little differences in response among ESUs. Reports from the AEM project have provided project design guidance for habitat complexity (large wood), barrier removal, and riparian planting projects both within and across ESUs, including:

Large wood placement
- Ensure the amount of "in-channel wood" is closer to historical targets
- Increase the amount of functional large wood (i.e., creating pools)
- Place more large wood in the thalweg or spanning channel, not on margins

Barrier removal
- Prioritize for target species as many remaining barriers are in small streams
- Document Chinook and steelhead use in order to assist with prioritization

Riparian
- More emphasis on design for site conditions (climate, channel incision, browse protection, watering/maintenance)
- Prioritize projects so they are less opportunistic

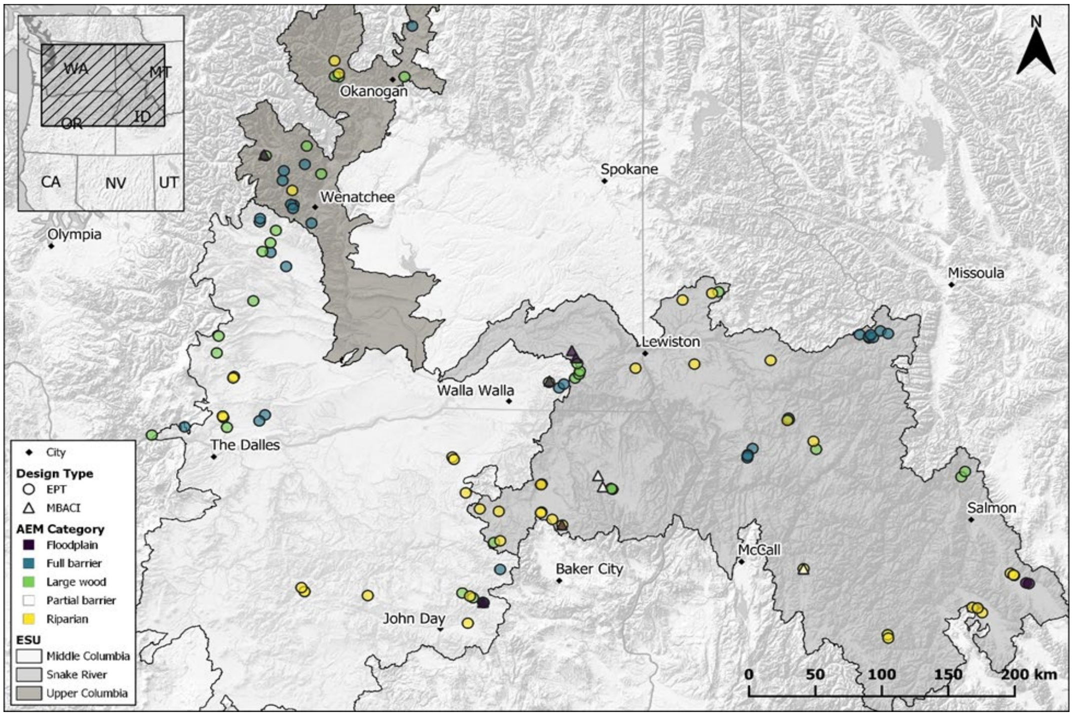


FIGURE 52 MAP OF 118 AEM PROJECTS SAMPLED (2014 TO 2021). IN 2021 AND 2022, ADDITIONAL FLOODPLAIN PROJECTS NOT SHOWN WILL BE SAMPLED USING AN EPT DESIGN. EPT = EXTENSIVE POST-TREATMENT, MBACI = MULTIPLE BEFORE-AFTER CONTROL-IMPACT.

These results and recommendations from AEM are relatively recent (Roni et al. 2020, 2021), but we are using them to adaptively manage our project selection and restoration design process to improve success of current and future habitat projects. As additional results from AEM for floodplain projects become available, we will incorporate those into our restoration approaches and designs. In addition to objective-specific monitoring, project inspections including photo documentation are conducted annually. Pre and post-project monitoring is performed by various agencies including CTUIR, Reclamation, ODFW, USFS, GRMW, the Columbia River Intertribal Fish Commission (CRITFC), and independent contractors.

Literature Cited

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

Bjornn, T.C. and Reiser, D.W. (1991) Habitat Requirements of Salmonids in Streams. In: Meehan, W.R., Ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, American Fisheries Society Special Publication, 19, 83-138.

Bonneville Power Administration Action Effectiveness Monitoring Program - protocol for monitoring the effectiveness of off-channel habitat/floodplain enhancement projects [Report]. - Portland, Oregon: Bonneville Power Administration, 2016.

Brown, et al. Effects of high river flows on errors in modeled annual average Delta water temperatures. Davis, California, 2011.

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.

Clark, C., Krall, M., Roni, P., & Ceder, K. 2021 Reach scale stream temperature response to large wood placement. *Restoration Ecology*.

Cluer, B., Thorne, C. A Stream Evolution Integrating Habitat and Ecosystem Benefits. River Research and Applications, 2013.

Conder, T., Hand, D., Olsen, D. & Lovtang, J., 2008. Distribution and Survival of Adult Hatchery Spring Chinook Salmon Radio-tagged and Released Upstream of Warm Springs National Fish Hatchery in 2008, Vancouver, WA: U.S. Fish and Wildlife Service.

Conley, W., and D. Lindley. 2012. Klickitat watershed enhancement project. Report to the Bonneville Power Administration, Project No. 1997-056-00, contract No. 35988. Yakama Nation Fisheries Resource Management Program, Toppenish, Washington.

Contor, C.R., 2010. Umatilla Basin Natural Production Monitoring and Evaluation, 2009 Annual Progress Report, Portland, OR: Bonneville Power Administration.

Contor, C. R., 2014. Umatilla Basin Natural Production Monitoring and Evaluation, 2014 Annual Progress Report, Pendleton, Oregon: Confederated Tribes of the Umatilla Indian Reservation.

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.

Crump, C., Naylor, L. M., Van Sickle, A. & Startzel-Holt, B., 2018. Evaluation of Reestablishing Natural Production of Spring Chinook Salmon in Lookingglass Creek, Oregon FY 2018 Annual Report, Boise, Idaho: U.S. Fish and Wildlife Service Lower Snake River Compensation Plan.

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/

Emmingham, W. H., S. S. Chan, D. Mikowski, P. Owston, and B. Bishaw. 2000. Silviculture practices for riparian forests in the Oregon coast range. Research Contribution 24, Forest Research Laboratory, Oregon State University, Corvallis.

Favrot, S. D. & Jonasson, B. C., 2016. Identification of Grande Ronde River Fall Migrant Juvenile Spring Chinook Salmon Overwinter Rearing Reaches, La Grande, Oregon: Oregon Department of Fish and Wildlife.

Feld, C., S. Birk, D. Bradley, D. Hering, J. Kail, A. Marzin, A. Melcher, D. Nemitz, M. Pedersen, F. Pletterbauer, D. Pont, P Verdonschot, and N. Friberg. 2011. From natural to degraded rivers and back again: a test of restoration ecology theory and practice. Advances in Ecological Research 44:119-209.

Gallagher S P, Hahn P K and Johnson D H Redd Counts [Journal] // American Fisheries Society. - 2007. - pp. 197-234.

González, E., A. A. Sher, E. Tabacchi, A. Masip, and M. Poulin. 2015. Restoration of riparian vegetation: a global review of implementation and evaluation approaches in the international, peer-reviewed literature. Journal of Environmental Management 158:85-94.

Gornish E. S., M. S. Lennox, D. Lewis, K. W. Tate, and R. D. Jackson. 2017. Comparing herbaceous plant communities in active and passive riparian restoration. PLoS ONE 12:e0176338.

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

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41:540-551.

Hall, A., & Selker, J. S. 2021. High-resolution temperature modeling of stream reconstruction alternatives. *River Research and Applications*.

Hall, J., M. Pollock, and S. Hoh. 2011. Methods for successful establishment of cottonwood and willow along an incised stream in semiarid eastern Oregon, USA. Ecological Restoration 29:261-269.

Hall, J. E., M. M. Pollock, S. Hoh, C. Volk, J. Goldsmith, and C. E. Jordan. 2015. Evaluation of dryland riparian restoration with cottonwood and willow using deep-planting and herbivore protection. Ecosphere 6:1-12.

Harbeck, J. R., Wilson, I. P. & Maxwell, A., 2014. Migratory assessment of spring Chinook salmon in the Lostine River using radio-telemetry techniques. 2010 – 2012 Progress Report, s.l.: Oregon Watershed Enhancement Board.

Harris, R. R. 2005. Monitoring the effectiveness of riparian vegetation restoration. Report to the California Department of Fish and Game. College for Forestry, University of California, Berkeley Agreement No. 09219566. Berkeley.

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.

Hillman, T., P. Roni, and J. O'Neal. 2016. Effectiveness of tributary habitat enhancement projects. Report to the Bonneville Power Administration, Portland, Oregon.

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.

Isaak, 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.

Jakober et al. Role of Stream Ice on Fall and Winter Movements and Habitat Use by Bull Trout and Cutthroat Trout in Montana Headwater Streams American Fisheries Society, 1998. Biology Department, Fish and Wildlife Program. Montana State University, Bozeman, Montana.

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

Johnson, S. L. (2004). Factors influencing stream temperatures in small streams: substrate effects and a shading experiment. *Canadian Journal of Fisheries and Aquatic Sciences*, *61*(6), 913-923

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.

Justice, C. et al. Protocol for Field Measurements of Cold-water Refuges [Report]. - Portland, Oregon: Columbia Inter Tribal Fish Commission, 2015.

Justice, C. et al., 2017. Can stream and riparian restoration offset climate change impacts to salmon populations? Journal of Environmental Management, pp. 212-227.

Kaufmann, P. R., P. Levine, E. G. Robison, C. Seeliger, and D. V. Peck. 1999. Quantifying physical habitat in wadeable streams. EPA/620/R-99/003. U.S. Environmental Protection Agency, Washington, D.C.

Keefer, M. L., Caudill, C. C., Peery, C. A. & Boggs, C. T., 2008. Non-direct homing behaviours by adult Chinook salmon in a large, multi-stock river system. Journal of Fish Biology, Issue 72, pp. 27-44.

Keefer, M. L. et al., 2004. Stock-specific migration timing of adult spring-summer Chinook salmon in the Columbia River Basin. North American Journal of Fisheries Management, Issue 24, pp. 1145-1162.

Kettering, K. M., and C. R. Adams. 2011. Lessons learned from invasive plant control experiments: a systematic review and meta-analysis. Journal of Applied Ecology 48:970-979.

Knutson, M. and Fealko, J. Reclamation, September 2014. Pacific Northwest Region Resource & Technical Services Large Woody Material – Risk Based Design Guidelines. U.S. Department of the Interior, Bureau of Reclamation. Pacific Northwest Region, Boise, Idaho.

Kondolf, G. M., S. Anderson, R. Lave, L. Pagano, A. Merenlender, and E. S. Bernhardt. 2007. Two decades of river restoration in California: what can we learn? Restoration Ecology 15:516-523.

Lennox, M. S., D. J. Lewis, R. D. Jackson, J. Harper, S. Larson, and K. W. Tate. 2011. Development of vegetation and aquatic habitat in restored riparian sites of California's north coast rangelands. Restoration Ecology 19:225-233.

Lofy, P. T. & McLean, M. L., 1995. Lower Snake River Compensation Plan Confederated Tribes of the Umatilla Indian Reservation Evaluation Studies Annual Progress Report. 1 January-31 December 1994. Report to U.S. Fish and Wildlife Service, Boise, Idaho. Contract #14-48-0001-94517, s.l.: s.n.

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

Merritt, D. M., M. E. Manning, and N. Hough-Snee, editors. 2017. The national riparian core protocol: a riparian vegetation monitoring protocol for wadeable streams of the conterminous United States. General Technical Report RMRS-GTR-367. U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

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.

McLean, M. L., Seeger, R. L. & Helwick, T., 2016. Grande Ronde Satellite Facility O&M Annual Report for 1 January-
31 December 2015, Portland, OR: Bonneville Power Administration.

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

Morley, S. A., P. S. Garcia, T. R. Bennett, and P. Roni. 2005. Juvenile salmonid (*Oncorhynchus* spp.) use of constructed and natural side channels in Pacific Northwest Rivers. Canadian Journal of Fisheries and Aquatic Sciences 62:2811-2821.

Naylor, L. M. et al. Monitoring and Evaluation of Supplemented Spring Chinook Salmon and Life Histories of Wild Summer Steelhead in the Grande Ronde Basin 2019 Annual Progress Report: Annual Report. - Portland Oregon: Bonneville Power Administration, 2019.

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.

Nelle R D and Moberg J A Field Guide of Scientific Protocols for Steelhead Redd Surveys within the Upper Columbia Monitoring Strategy [Report]. - Wauconda, Washington: Terraqua, Inc., 2009.

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 sequences. 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.

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.

NOAA Fisheries. 2017. ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon (Oncorhynchus tshawytscha) & Snake River Basin Steelhead (Oncorhynchus mykiss).

Nowack, M. C., 2004. Grande Ronde Subbasin Plan, s.l.: Northwest Power Planning Council.

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

NPCC (Northwest Power and Conservation Council). 2012. Review of research, monitoring and evaluation and artificial production projects: recommendations of the Council, June 2011 (with July 2011 addition of completed Part 4). Available at URL: https://www.nwcouncil.org/sites/default/files/2011_06decision.pdf.

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 Department: https://apps.wrd.state.or.us/apps/sw/hydro_near_real_time/display_hydro_graph.aspx?station_nbr=13318960

Parkyn, S. M., R. J. Davies-Colley, N. J. Halliday, K. J. Costley, and G. F. Croker. 2003. Planted riparian buffer zones in New Zealand: do they live up to expectations? Restoration Ecology 11:436- 447.

Polivka, K. M., Steel, A. E. & Novak, J. L., 2015. Juvenile salmon and steelhead occupancy of stream pools treated and not treated with restoration structures, Entiat River, Washington. Canadian Journal of Fisheries and Aquatic Science, Volume 72, pp. 166-174.

Pollock, M. M., T. J. Beechie, S. S. Chan, and R. Bigley. 2005. Monitoring restoration of riparian forests. Pages 67-96 in P. Roni, editor. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, Maryland.

Quaempts, E.J., Jones, K.L., O'Daniel, S.J., Beechie, T.J., and Poole, G.C. 2018. Aligning environmental management with ecosystem resilience: a First Foods example from the Confederated Tribes of the Umatilla Indian Reservation, Oregon, USA. Ecology and Society 23(2):29. https://doi.org/10.5751/ES-10080-230229

Roni, P., C. Clark, M. Krall, S. Burgess, and K. Ross. 2020. Bonneville Power Administration Action Effectiveness Monitoring Program – 2019 Annual Report. Report to Bonneville Power Administration, Project Number 2016-001-00, Portland, Oregon.

Roni, et al. 2002. A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds Northwest Fisheries Science Center, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, Washington 98112.

Roni, P., Hanson, K. and Beechie, T.J. 2008. Global review of the physical and biological effectiveness of stream habitat rehabilitation techniques. North American Journal of Fisheries Management 28, 856 – 890.

Roni, P. et al. Fish-habitat relationships and the effectiveness of habitat restoration [Report]: Technical Memorandum / U.S. Department of Commerce. - [s.l.]: NOAA, 2014. - NMFS-NWFSC-127.

Roni, P., T. Beechie, G. Pess and K. Hanson. 2014a. Fish-habitat relationships and effectiveness of habitat restoration. NOAA Technical Memorandum NMFS-NWFSC-127. Seattle, Washington.

Roni, P., J. O'Neal, and R. Scranton. 2014b. Study plan for programmatic approach to monitoring riparian actions. Prepared for the Bonneville Power Administration, Portland, Oregon.

Roni, P., M. Krall, C. Clark, and K. Ross. 2019. Salmon Recovery Funding Board reach-scale project effectiveness monitoring program: 2018 Final Report. Report to the Washington State Salmon Recovery Funding Board, Recreation and Conservation Office, Olympia.

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

Rosgen, D. 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.

Tranquilli, J. V., Keefe, M. L. & Carmichael, R. W., 2001. A compendium of Grande Ronde and Imnaha River basin spring chinook salmon spawning ground surveys conducted from 1948 through 1998, La Grande, OR: Oregon Department of Fish and Wildlife.

Tree World Plant Care Products Inc. 2018. Buy Plantskydd Deer Rabbit Vole Repellent. January 9. https://www.plantskydd.com/.

Upper Grande Ronde River Tributary Assessment, Grande Ronde River Basin Tributary Habitat Program, Oregon. U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region. January, 2014.

U.S. Fish and Wildlife Service. 2014. Revised draft recovery plan for the coterminous United States population of bull trout (*Salvelinus Confluentus*). Portland, Oregon. Xiii + 151 pp.

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

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.

Wohl, E. 2021. An integrative conceptualization of floodplain storage. Reviews of Geophysics, 59, e2020RG000724. https://doi. org/10.1029/2020RG000724