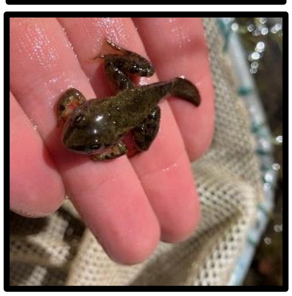
Evaluate the Life History of Salmonids in the Malheur Subbasin

Burns Paiute Tribe Natural Resources Department, Fisheries Program

Burns, Oregon

Project 1997-019-00

Contract #89448



Prepared for Bonneville Power Administration and Northwest Power and Conservation Council

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FY 2022 Annual Report

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For work completed January 2022-December 2022

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Background and Context for FY2022 Annual Report

The Bonneville Power Administration (BPA) has supported fisheries research and management conducted by the Burns Paiute Tribe (BPT or, Tribe) Natural Resources Department in the Burns Paiute ancestral homeland since 1997. This report summarizes work completed by the BPT Fisheries Program in 2022. Field work conducted, data collected, objectives accomplished, and management activities fulfilled were approved by the Northwest Power and Conservation Council during the 2019-2020 Categorical Review of Resident Fish and Sturgeon Projects.

Chapter 1: Brook Trout (Salvelinus fontinalis) suppression

Concurrent with BPT efforts to finalize the regulatory processes necessary for Brook Trout eradication via a chemical treatment, mechanical suppression occurred in lower Lake Creek and High Lake during the 2022 filed season. Brook Trout (native to eastern United States) were introduced into the Upper Malheur around the 1930's, and Brook Trout remain the primary limiting factor, as identified by U.S. Fish and Wildlife Service Endangered Species Act recovery plans, to Bull Trout *(Salvelinus confluentus)* recovery. When compared to previous years, 2022 mechanical removal efforts were scaled-back to focus on collecting the baseline habitat data needed for the proposed chemical treatment. BPT largely electroshocked the same locations (high-density Brook Trout sites in lower Lake Creek) as 2019-2021. BPT electroshocked to remove Brook Trout from high density reaches in lower Lake Creek (critical Bull Trout habitat) but did not shock the complete reach of upper Lake Creek (as Fisheries has done in previous years). This year BPT combined High Lake gill netting removal with the Oregon Natural Desert Association (ONDA) Northwest Youth Corps Tribal Stewards (Tribal Stewards) volunteer group. The Tribal Stewards participated in using gill nets and angling to remove Brook Trout from High Lake. This was an effort to incorporate more outreach and education regarding BPT's fisheries management.

Chapter 2: Baseline Data collection for the Upper Malheur Bull Trout Conservation Strategy

BPT spent a portion of the summer field season conducting surveys to collect the baseline hydrological and habitat data. These data are required to inform the TAC[1]'s proposed chemical treatment planned for High Lake and upper Lake Creek. Data collected included obtaining updated depth data for High Lake, timing flows in upper and lower Lake Creek, measuring stream discharge, and monitoring temperatures in key locations of upper Lake Creek. Preliminary results from the sampling efforts were presented at the fall TAC meeting on November 9, 2022. These data allowed for the TAC to finalize proposed methods for the chemical treatment as well as deepen the understanding of the location to allow the TAC to begin to determine specific project logistics.

Chapter 3: Stream temperature monitoring

BPT Fisheries continued monitoring the ten-annual temperature sites on the BPT Logan Valley Wildlife Mitigation Property (LVWMP). 2022 data are missing for the two sites on the LVWMP (both of which experience annual dewatering) because the loggers will need to be sent to Onset, Inc for data retrieval. BPT

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[1] The Malheur River Bull Trout Technical Advisory Committee (TAC) consists of : the BPT, Oregon department of Fish and Wildlife (ODFW), The US Forest Service (FS), The US Fish and Wildlife Service (USFWS), and the US Bureau of Reclamation (BOT)

also continued monitoring efforts at locations in the Upper Malheur and over in the North Fork of the Malheur. 2022 temperature results support past trends. 1) Lake Creek in Logan Valley continues to have high temperatures which can act as thermal barriers to Bull Trout. 2) The North Fork Malheur temperature sites and the Upper Malheur sites are consistently cooler than the sites in the LVWMP.

Chapter 4: Electrofishing surveys in Summit Creek

BPT fisheries surveyed the same sites on Summit Creek as the previous years' 2020/21 efforts to obtain baseline fish population data. The data are shared with the US Forest Service. BPT electrofished ten, 100-meter sites. Length and weight data were collected on any trout or sucker species caught and other species were counted. All fish were revived and returned to the stream after each survey.

2022 Awarded Funding

BPT Fisheries was awarded $83, 609.02 through the Bureau of Indian Affairs (BIA) Invasive Species (IS) Program. The funding is for the implementation of the TAC proposed chemical treatment in High Lake and Upper Lake Creek. The Project Name, "Eradicating the 'Seed Source' Population of Invasive Brook Trout to Protect ESA-listed Bull Trout in the Culturally Significant Upper Malheur River", has the project timeline of January 2022-December 2023. In the first round of grant reporting in Fall 2022, BPT was able to accomplish multiple project objectives. The project objectives accomplished in 2022 included: 1) submitting a Biological Assessment (BA) to the USFWS, 2) hosting TAC meetings to organize project logistics, 3) Hiring a seasonal technician prioritizing Tribal Members, 4) Outreach and education opportunities for Tribal Youth, and 5) conducting pre-treatment data collection. BPT is actively working on the remaining project objectives which will ultimately result in the implementation of the proposed chemical treatment.

Outreach

BPT Fisheries continued to maintain a website www.helpnativefish.com to educate public on local fisheries management and Eastern Oregon native fish species. BPT hosted a 'Help Native Fish' booth at the 2022 Harney County Fair. The 2022 BPT Fisheries Staff included: Brandon D. Haslick (Fish Project Manager), Rebecca Fritz (Fish Biologist), and a seasonal technician.

Chapter 1: Selective Removal of Brook Trout (*Salvelinus fontinalis)* in Lake Creek, Upper Malheur River, Oregon

Rebecca J. Fritz
BPT Natural Resource Department, Fisheries Program

Chapter 1:

Selective Removal of Brook Trout (*Salvelinus fontinalis)* in Lake Creek, Upper Malheur River, Oregon

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1.1 Introduction

Malheur River Bull Trout (*Salvelinus confluentus)* were listed as threatened under the Endangered Species Act in 1999 (USFWS 2015). The Bull Trout Recovery Plan (USFWS 2015) identifies the key threats to Bull Trout within geographically broad Recovery Units and their associated local Core Areas.

BPT Fisheries management for Bull Trout recovery falls within the Upper Snake River Recovery Unit and the Upper Malheur River Core Area. Specifically, this year's management actions were implemented in Lake Creek focusing on the removal of invasive Brook Trout (*Salvelinus fontinalis).* Brook Trout have been determined the primary threat to Upper Malheur Bull Trout recovery (USFWS 2002, 2015).

Invasive Brook Trout in the Upper Malheur

Brook Trout occur in abundance in the Upper Malheur Subbasin because of authorized and unauthorized stockings. Around the 1930's Brook Trout were stocked in Lake Creek's source, High Lake (Bowers et al. 1993). Invasive Brook Trout in the Upper Malheur Subbasin outcompete (Gunckel et al. 2002) and hybridize with threatened Bull Trout (Dehaan et al. 2009). The growing competition for resources, along with hybridization, has been directly contributing to Bull Trout population decline in the Upper Malheur.

The two major tributaries which form the Upper Malheur and are the focus of the BPT's management are Lake Creek and Big Creek. A tributary of Big Creek, Meadow Fork Big Creek, is dominated by native trout species despite the presence of Brook Trout (Crowley 2018). Neighboring Lake Creek has the opposite trend as Brook Trout significantly outnumber Bull Trout (Crowley 2017) (Figure 1.1). Due to a natural fish barrier, the uppermost ~three km of Lake Creek and High Lake contain only invasive Brook Trout. This allows them to reproduce without competition for resources- thus providing a 'seed source' population to invade downstream Bull Trout Critical Habitat. Therefore, High Lake and upper Lake Creek are of immediate management concern.

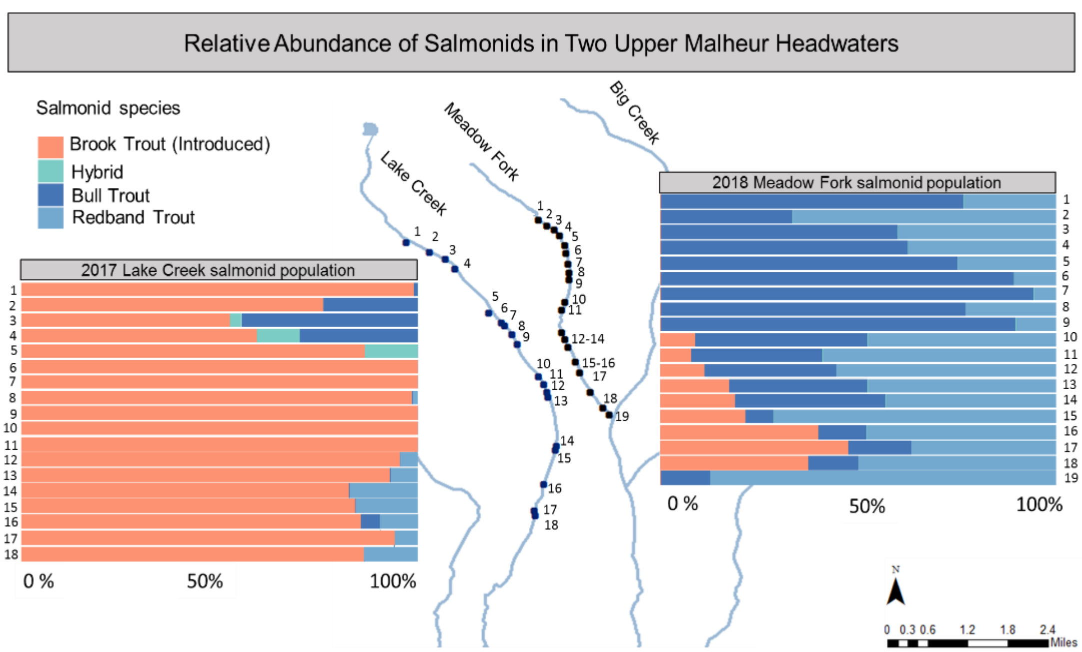

Figure 1.1 Relative abundance of 2017 and 2018 BPT population estimates

2022 BPT Brook Trout suppression efforts were conducted in Lake Creek and High Lake. Brook Trout were removed using backpack electrofishing from multiple sites in lower Lake Creek and from High Lake. There were no extensive removal efforts in upper Lake Creek in 2022.

1.2 Methods

The 2022 BPT Fisheries Program focused efforts on continuing the mechanical removal of Brook Trout from lower Lake Creek and High Lake (Figure 1.2). Mechanical methods included: backpack electrofishing efforts in Lake Creek, gillnetting efforts in High Lake, and angling in High Lake. Lake Creek Falls separates upper Lake Creek (inhabited only by Brook Trout) from lower Lake Creek (habitat to multiple salmonid species: Brook Trout, Bull Trout and Redband Trout (*Oncorhynchus mykiss gairdneri*). The falls creates a division in the Lake Creek fishery as well as in the following Brook Trout suppression methods.

Electrofishing lower Lake Creek

Fisheries used a LR24 Smith-Root backpack electrofisher to mechanically remove Brook Trout from Lake Creek. Brook Trout removal occurred at specific sites below Lake Creek Falls (lower Lake Creek). The selected sites were a subset of sites that had been surveyed in previous years and were considered high-density Brook Trout sites (Figure 1.4). Lower Lake Creek electrofishing took place beginning the 12th of July and continued through the 20th of July. At the start of each site a crew of two people performed a single pass survey working upstream. Electrofisher settings were maintained at the lowest possible settings at which fish could be caught (largely, 400 volts, 40 Hz, and at a 40% duty cycle). Brook Trout captured were measured for length (fork length) and euthanized. Subsets of Brook Trout were weighed throughout sampling until weight data had been collected from ~100 individuals. Trout fry (salmonid fry < 50 mm) were not directly targeted for capture in lower Lake Creek.

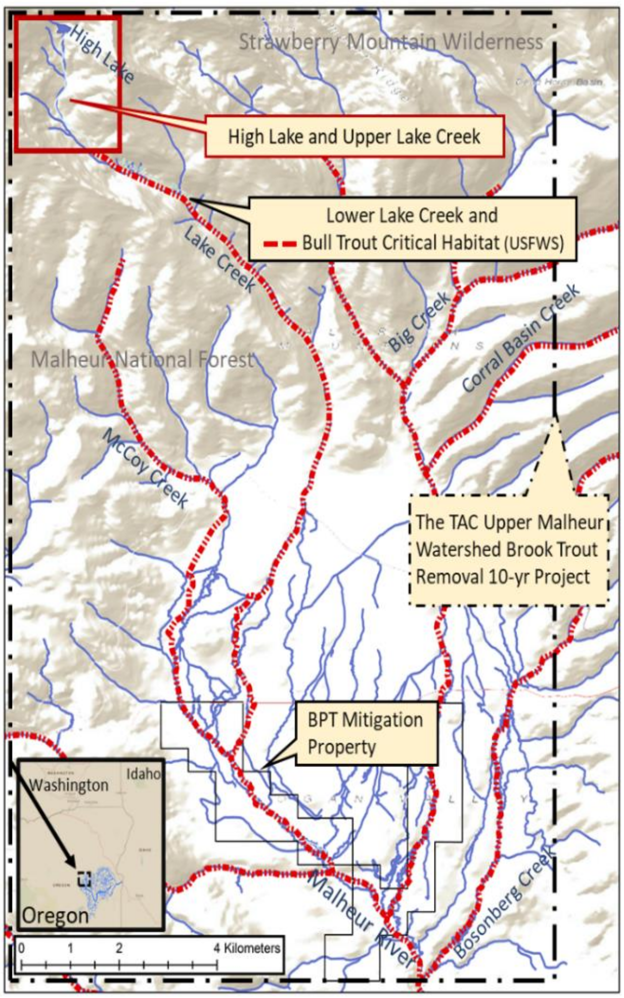

Figure 1.2 The 2022 Brook Trout removal efforts took place in High Lake/Upper Lake Creek and in Lower Lake Creek with is Critical Bull Trout Habitat (USFWS 2010).

Non-target species were encountered at sites in lower Lake Creek. Any non-target species captured were taken downstream and revived. These captures were counted but no other data were taken.

Electrofishing upper Lake Creek

In previous years, upper Lake Creek was treated as a single site and electrofished in entirety. This year involved a smaller effort as BPT fisheries only electrofished a portion of upper Lake Creek upstream of Lake Creek Falls. A crew of three people electrofished above the falls while also mapping hydrological features for a single day (July 18th). The following week, a crew of two electrofished further upstream for a day (July 25th). Upper Lake Creek was not completely electrofished due to a shifted focus on habitat surveys for the final portion of the field season. A total of 33 Brook Trout were removed from this reach. All captured Brook Trout were counted and euthanized from upper Lake Creek.

Gillnetting and angling in High Lake

A key aspect of BPT field work is the annual removal of Brook Trout from High Lake using gillnets. This year BPT combined the gillnetting removal effort with the week a group of volunteers though the Oregon Natural Desert Association (ONDA) Northwest Youth Corps Tribal Stewards (Tribal Stewards) Program would be available to help (Figure 1.3). BPT Natural Resource staff packed the nets and research equipment down to the lake while BPT Fisheries organized with the volunteers at the High Lake Trailhead.

Two ¾ inch gillnets were hiked down and set in High Lake. Nets soaked for ~24 hours after which all brook trout were pulled from nets and euthanized. The next morning, a couple of inflatable rafts were used to go and pull (often dead) trout out of the nets (Figure 1.3). One individual paddled a third boat as the 'safety boat' assisting the other two boats as needed. Once all the captured trout were collected from the nets, the nets were set in new locations by BPT staff. Fish were measured and weighed on shore and any living fish were euthanized. BPT trained volunteers in how to record the data, and measure fork length (mm) and weigh (g) the fish pulled from the nets. All Tribal Stewards shared roles in working up gillnets, measuring and weighing

Figure 1.3 **(A)** BPT and the Tribal Steward volunteers worked at High Lake in the Strawberry Mountain Wilderness July 5- 8th, 2022 **(B)** Volunteers learned to remove trout caught in gillnets **(C)** BPT and volunteers camped at High Lake **(D)** Two boats (total 4 people) worked the gillnets while one crew member paddled the safety boat **(E)** BPT Technician, Thomas Proctor, holds up Brook Trout captured in the gillnets **(F)** Volunteers worked with BPT to record length and weight data on all Brook Trout captured **(G)** Volunteers fried up the invasive trout at camp for dinner **(H)** Gillnetting removed 446 invasive Brook Trout from High Lake

fish, recording data, taking photos. To ensure public safety and awareness, temporary signs were put up on the High Lake Trailhead as well as around the lake. BPT staff talked with all recreators that were encountered during this effort and answered any questions regarding the project.

BPT packed down a total of four flyfishing rods to allow volunteers to remove Brook Trout by angling. Volunteers took turns during the morning and evening to flyfish. Volunteers recorded their time spent fishing and (#) of fish that they had caught. Captured fish were measured (fork length) and weighed (g) and then euthanized.

Data Analysis

All 2022 data were analyzed using R studio (R version 4.1.2) and maps were created in ArcMap 10.8. Condition factor (K) was calculated for every Brook Trout that was both measured and weighed in lower Lake Creek. The mean (K) (for 100 individuals randomly selected using R) is reported and was calculated in R studio where W = weight in grams and L= length in mm. $K = \frac{10^5(W)}{(L)^3}$ (Ricker 1975). Reports can be found on www.cbfish.org under project number 1997-019-00 and contact rebecca.fritz@burnspaiute-nsn.gov with any data requests.

1.3 Results

In total, 710 Brook Trout were removed from Lake Creek and High Lake using various mechanical methods (Table 1.1). Fewer Brook Trout were removed in 2022 compared to previous sampling years (Appendix Figure 1.6).

Table 1.1 *Total Brook Trout removed in 2022 using mechanical methods*

	Electrofishing	*Gillnetting*	*Angling*
Lower Lake Creek	217	—	—
Upper Lake Creek	33	—	—
High Lake	—	446	14
# Removed / Method	250	446	14
Total # Brook Trout Removed	**710**		

Lower Lake Creek electroshocking

Stream temperatures ranged from 9.0 - 14.5 °C throughout lower Lake Creek shocking sites. Three fish species (Brook Trout, Redband Trout (six individuals), and sculpin *Cottus spp* (135 individuals)) were encountered. Unidentified 'trout fry' (defined as salmonid fry < 50 mm) were counted and released during lower Lake Creek electrofishing surveys. Zero Bull Trout or Redband Trout mortalities resulted from the year's sampling effort.

Brook Trout made up the greatest proportion of the overall salmonid population captured in the lower Lake Creek sites (Figure 1.4 (C)). 2022 lower Lake Creek fork lengths ranged from 69-262 mm and averaged 123.6 mm. (Figure 1.4 (A)). Combing the length and weight data for (100 randomly selected sampled Brook Trout) resulted in the average condition factor K= 1.23. This value places the physical body condition of lower Lake Creek Brook Trout as being considered fair (Appendix Figure 1.5) (Barnham & Baxter, 1998).

Upper Lake Creek and High Lake results

Brook Trout are the only fish species to occur above Lake Creek Falls and in High Lake. Only 33 Brook Trout were removed from the downstream portion of upper Lake Creek by electrofishing. A total of 460 Brook Trout were removed from High Lake with two ¾ inch gillnets and angling. High Lake had a lower mean condition factor (K= 1.12), and the average length and weight of the High Lake 2021 and 2022 trout were smaller when compared to previous years despite the same mesh size (Figure 1.4 (A)).

1.4 Discussion

The focus of the BPT fishery program is to protect, restore, and enhance native fish assemblages in the Malheur River with an emphasis on ESA-listed Bull Trout. The unobstructed recruitment of Brook Trout in upper Lake Creek and High Lake which then populate lower Lake Creek (Critical Bull Trout Habitat) has driven almost a decade of BPT Brook Trout suppression efforts using mechanical methods (Poole and Harper 2011). BPT Fisheries established a baseline population estimate for Lake Creek Brook Trout in 2012 and compared it with the estimate resulting from a replicated study conducted in 2017. The intention of this research was to examine the effectiveness of five years of Brook Trout suppression efforts using mechanical methods (Harper 2013; Crowley 2017) addressing multiple questions. What impact did removal have physically on the Brook Trout population? Do mechanical removal efforts effectively remove a significant proportion of Brook Trout? Were there lasting impacts?

The five-year BPT study looked at the effectiveness of mechanical suppression and resulted in three main conclusions which were further supported by the 2022 data. **1)** Mechanical suppression efforts have not resulted in a significant change in Brook Trout body size or condition. After 2012, BPT saw a higher frequency of captures shifting to a slightly smaller size class but, when combined with a similar condition factor throughout the study, changes were considered minimal (Crowley 2017). The 2022 condition factor followed this trend (Appendix Figure 1.5). **2)** Although by the end of the Lake Creek study BPT reduced the Brook Trout population by ~30%, there was no increase in native salmonid populations (Crowley 2017) and Brook Trout still made up the majority of the salmonid population.

Continuing the trend, 2022 Brook Trout dominated the lower Lake Creek salmonid relative abundance (Figure 1.4 (C)). **3)** The Lake Creek Brook Trout population is resilient and rebounds despite the removal efforts. The Lake Creek Brook Trout population can almost completely recover to pre-suppression numbers within a year. Wildfires in 2013 and 2015 prevented High Lake removal efforts and the Lake Creek population strongly rebounded (Crowley 2015). BPT has invested considerable time and effort in working to suppress Brook Trout from even just the upper Lake Creek and High Lake seed source (Table 1.2). 2022 removal totals were lower than previous years (Figure Appendix 1.6). Regarding High Lake, the gillnets had a lower catch-per-unit-effort than previous years. Net sets were all in locations of previously believed high Brook Trout densities. However, after the second and third sets resulted in lower numbers of fish, BPT will consider alternating net mesh sizes or different net setting methods to widen the range of size selectivity and deter fish avoidance. In total, 2022 mechanical suppression efforts removed over 710 Brook Trout from the Lake Creek/High Lake, and ~217 of which were directly removed from habitat shared by native salmonids.

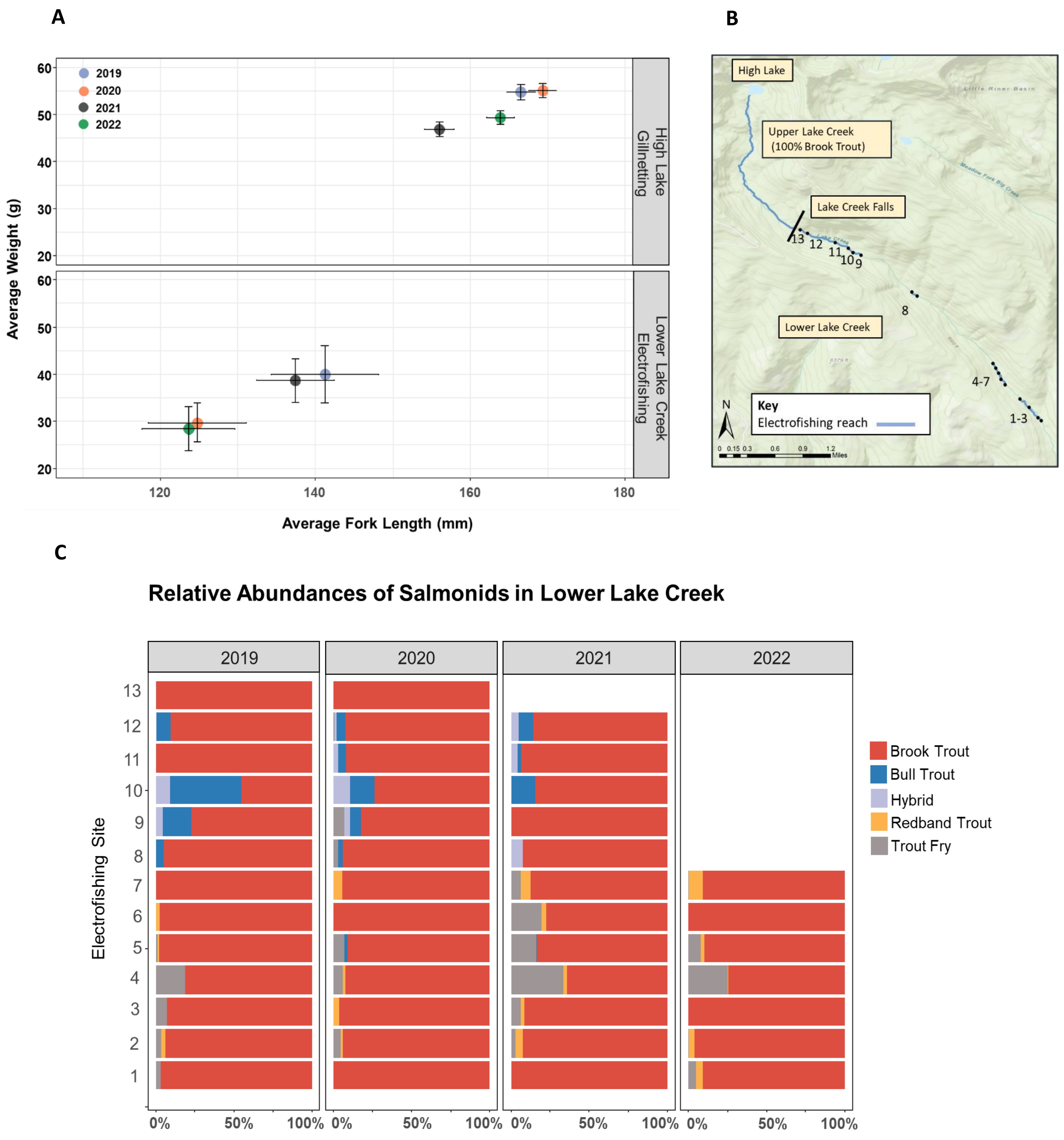

Figure 1.4 (A) Mean (±95% CI) length and weight of (~100+) Brook Trout sampled with High Lake gillnetting methods and lower Lake Creek backpack electroshocking (B) Map of Lake Creek 2019-2022 electrofishing sites (only sites downstream of wilderness boundary sampled in 2022) (C) Relative abundance of salmonids at each electrofishing site in lower Lake Creek 2019-2022.

Table 1.2. Estimated Upper Lake Creek and High Lake mechanical removal effort to suppress Brook Trout (2010-2022) and the Burns Paiute Tribe's investment to execute the projects

Location	Target Species	Treatment	Years	Investment
High Lake	Brook Trout	Gillnetting	2011-2022	2,352 staff hours
High Lake	Brook Trout	Angling	2011-2022	29 angling events
Upper Lake Creek	Brook Trout	Backpack Electrofishing	2010-2022	990 staff hours

*Estimates of BPT sampling effort (BPT, internal files)

The lack of success in eradication efforts using mechanical methods has been demonstrated outside of the BPT's efforts in Lake Creek. Various studies in multiple streams have scrutinized the inability of backpack electrofishing to fully eradicate invasive trout (Thompson & Rahel 1996; Meyer et al. 2006) as well as its higher cost in effort and resources when compared to a piscicide treatment (Buktenica et al. 2013). A collaborative management effort using electrofishing to target Brook Trout in Idaho streams ended with several conclusions mirroring BPT's own findings. The conclusions: electrofishing removal efforts failed to eradicate 100% of the population, saw a large increase in age-0 abundance after removal efforts, and did not result in a significant increase in native fish populations (Meyer et al. 2006).

Further limitations with using electrofishing to eradicate Brook Trout are emphasized by outside studies and experienced by BPT. For instance, 1) electrofishing is size selective (Reynolds 1996). A common pattern among projects is the inability to effectively capture all fry (Thompson & Rahel 1996; Meyer et al. 2006). This problem is compounded in the BPT efforts in lower Lake Creek. Due to the desire to protect struggling populations of native salmonids, BPT does not target, capture, or remove unidentified fry in lower Lake Creek. 2) Complete eradication using mechanical methods may be an effective option for small streams and/or simple habitat. Habitat complexity (log jams, pools, beaver dams) limits the ability to completely capture all targeted trout during electrofishing. Lake Creek has complex habitat throughout the entire reach. Log jams, pools, subterranean flow, marshes, side springs, pools are all examples of locations where BPT removal efforts likely fail to remove all Brook Trout. The ineffectiveness of mechanical methods to completely eradicate Brook Trout is supported by outside studies, and further restricted by Lake Creek's complex habitat as well as a limited field season.

1.5 Recommendations

Throughout removal efforts, BPT has formulated a plan to fully eradicate Brook Trout from Lake Creek using rotenone. While BPT works with agency partners to implement such a treatment, suppression efforts aim to continue in Lake Creek and High Lake to provide relief to native salmonids. Since 2015, BPT has removed more than 12,000 Brook Trout from the Lake Creek Drainage (Figure Appendix 1.6). In 2022, BPT continued collaboration with the TAC which created the Upper Malheur Watershed Bull Trout Conservation Strategy in 2017 (TAC 2017). BPT will continue mechanical suppression in Lake Creek until the implementation of an anticipated, large scale, interagency rotenone treatment in the Upper Malheur.

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(TAC) Malheur River Bull Trout Technical Advisory Committee: Burns Paiute Tribe, Oregon Dept. of Fish and Wildlife, US Fish and Wildlife Service, US Forest Service, US Bureau of Reclamation and QW Consulting. 2017. Upper Malheur River Bull Trout Conservation Strategy. FY 2017 Annual Report. Project No. 1997-01900: Appendix: 87-171.

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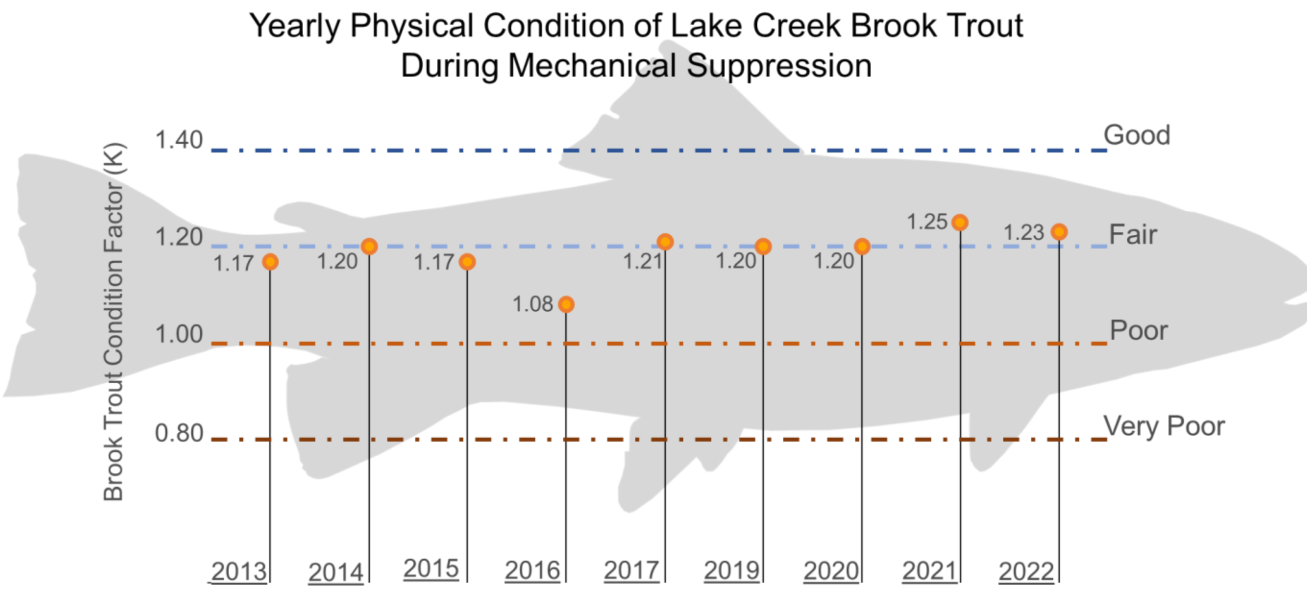
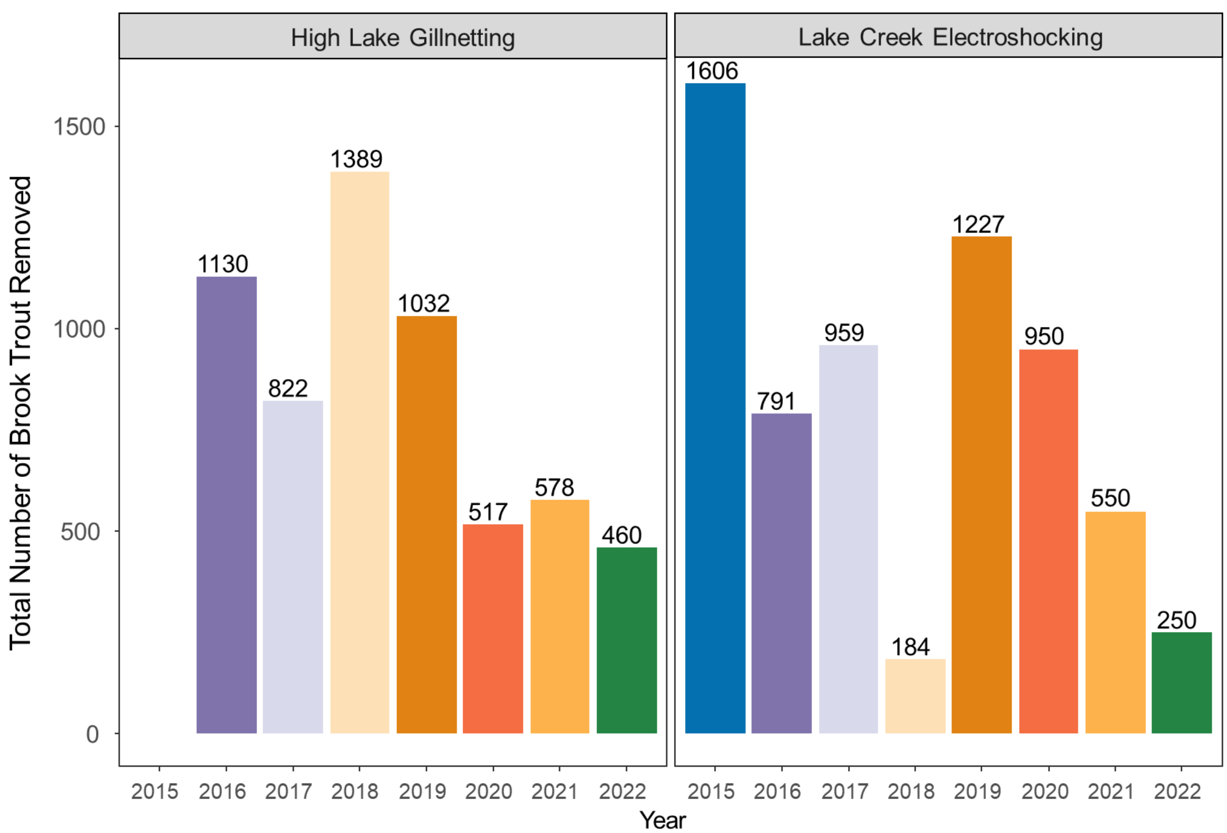
Appendices



Appendix Figure 1.5 Mean condition factor (K) calculated for the lower Lake Creek Brook Trout throughout BPT suppression efforts.



Appendix Figure 1.6 The total number of Brook Trout removed from High Lake and Lake Creek in the past eight sampling years.

Chapter 2: Baseline Data Collection for the Upper Malheur Bull Trout Conservation Strategy

Burns Paiute Tribe Natural Resources Department, Burns OR 97720

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Rebecca J. Fritz

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2.1 Introduction

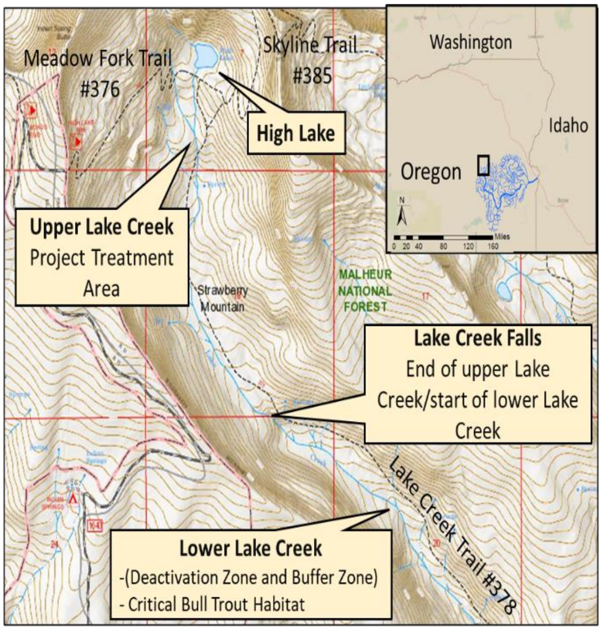

Figure 2.1. The Project Treatment Area (High Lake outflow downstream to Lake Creek Falls (natural barrier to fish movement)) and the Lower Lake Creek Action Area begins below the Falls and includes 1) The Deactivation Zone and 2) The Buffer Zone. High Lake, upper and lower Lake Creek make up the Project Action Area in the Upper Malheur River Watershed

BPT Fisheries used the 2022 field season to obtain updated habitat data on the section of Lake Creek (including High Lake) that is the focus of a proposed 2023 Brook Trout eradication pilot project. The project is outlined in, The High Lake and Upper Lake Creek, Upper Malheur Subbasin Rotenone Treatment Plan (BPT, internal files). This treatment plan describes the implementation of a chemical (rotenone) treatment, which will eradicate non-native Brook Trout to protect ESA - listed Threatened Bull Trout.

The proposed project will contribute to the delisting criteria of restoring genetically pure populations of Bull Trout to watersheds within their historic range as specified in the 2015 Recovery Plan (USFWS 2015). The removal of Brook Trout from High Lake and upper Lake Creek will contribute to USFWS Bull Trout recovery goals.

The Oregon Department of Fish and Wildlife (ODFW) will serve as lead in treatment implementation. Aspects of this project will occur at High Lake, upper Lake Creek, and in a portion of lower Lake Creek located in the Malheur Watershed. This action is recommended by The Malheur River Bull Trout Technical Advisory Committee (TAC) for High Lake and upper Lake Creek, Eastern Oregon. The TAC consists of the ODFW, the Burns Paiute Tribe (BPT, Tribe), the Malheur National Forest (USFS), the United States Fish and Wildlife Service (USFWS), and the United States Bureau of Reclamation (BOR).

2022 Pre- treatment data collection: High Lake and Lake Creek Stream Habitat Monitoring

The Project Treatment Area (as defined in Figure 2.1) will involve upper Lake Creek and its source High Lake. The Deactivation Zone and the Buffer Zone will occur in lower Lake Creek. These locations were the focus of the 2022 habitat surveys. Project success relies on a robust pre-treatment dataset regarding 1) hydrological characteristics of High Lake and 2) the hydrological / habitat characteristics of upper Lake Creek and a portion of lower Lake Creek.

High Lake

High Lake is a shallow, 5.8-acre lake located in the Strawberry Mountain Wilderness. A perennial stream as well as some seasonal seeps and tributaries flow into the lake. The outlet (forming upper Lake Creek) is located at the southern end of the lake. High Lake water temperatures at the time of treatment are expected to be ≥ 20° C based on data obtained for a BPT temperature logger placed annually at the lake's outlet (BPT Internal Files, Figure 2.5).

Upper Lake Creek

Upper Lake Creek is defined as the portion of Lake Creek flowing from High Lake until Lake Creek Falls (~1.5 mi) (Figure 2.1). Upper Lake Creek has channel widths between 3.2-6.6 feet and moderate gradients (2-5%). There are sections characterized by intermittent steep reaches (15-20%) which are believed to prevent upstream fish movement. Two streams along with springs and seeps flow into upper Lake Creek adding water volume and decreasing stream temperature.

Lower Lake Creek

Lower Lake Creek, which is the segment that flows from Lake Creek Falls downstream to its confluence with Big Creek (~11.0 miles), is characterized by moderate gradients (2-5%) and channel widths of 6-16 feet. Multiple seeps and springs occur below Lake Creek Falls. This project will focus on the reach of lower Lake Creek within the Strawberry Mountain Wilderness.

2.2 Methods

High Lake Depths

BPT took two, full sets of High Lake depth measurements during the summer 2022 field season. The first set of locations (Set 1) were replicates from depths taken for a BPT High Lake eDNA study in 2011 study (Figure 2.2) (Blakenship et al. 2012). This would allow for a comparison between different years. The second set of 2022 locations (Set 2) were the points at the intersections when a grid was drawn between the 2011 points.

To measure the lake depth, two people used a GPS to row out an established location (for example, a location in Set 1 (Figure 2.2)). While one person kept the boat on top of the location, another person measured the depth using a weighted survey-tape. A weighted tape can give a higher depth estimate because the weight can sink into organic debris (Blakenship et al. 2012,2013). BPT staff worked to minimize this by watching for the tape to hit the bottom/using the lightest weight possible to sink the survey tape. Set 1 depths were taken at the middle of August and the second set (Set 2) were taken at early in September.

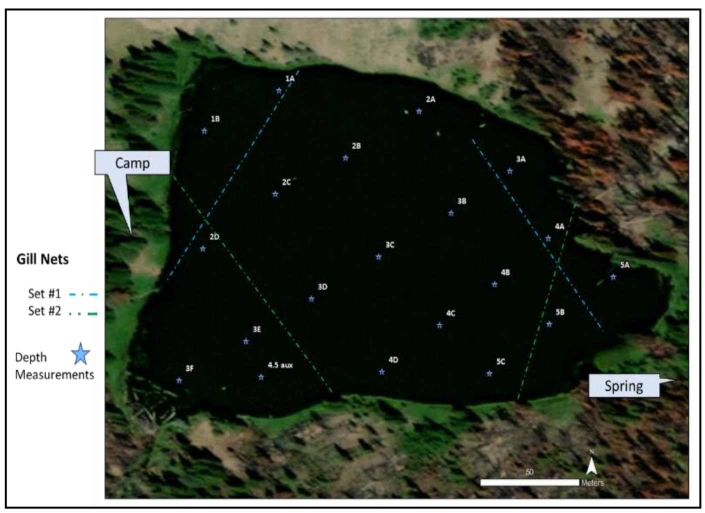

Figure 2.2 Set 1 of High Lake (2011/2022) depth sampling locations. Also show are the locations of the 2022 BPT gill net locations for Brook Trout removal.

Mapping Hydrological Features in Lake Creek

In August, BPT Fisheries surveyed multiple stream ‘points of interest’ (POI) in upper Lake Creek. Upper Lake Creek POIs included the locations of seep/spring inputs, natural fish barriers, and subterranean flow (Figure 2.3). One or two people walked upstream taking GPS waypoints at any notable locations. The 2022 mapping data was compiled with 2015 and 2019 upper Lake Creek ground-truthing efforts.

Figure 2.3. BPT Fisheries mapped out ‘points of interest’ in upper Lake Creek such as locations where the active channel goes subterranean (**A)**, locations of spring input (**B**), locations with barriers to fish movement **(C, E)** and locations of seeps (**D**).

Stream Temperature Monitoring in Lake Creek

On June 15th BPT placed some temperature loggers (Onset Tidbit V2 Loggers) in Lake Creek downstream from High Lake (Figure 2.5). Each logger was attached to a rebar stake and set in the thalweg of the stream. Loggers were collected by BPT Biologist on October 4th.

Stream Discharge Monitoring in Lake Creek

BPT measured stream discharge at multiple locations in upper Lake Creek and at a location in Lower Lake Creek using a Swoffer Model 3000 flowmeter. BPT chose discharge sites at locations both above and below major spring input. The sites also were selected based on the degree of laminar flow, avoidance of upstream features that would alter the discharge (large rocks, side channels, etc.). Discharge (Q) was calculated using the Swoffer Model 3000 and checked for accuracy in Microsoft excel (Q =Velocity * Area) in which (Area =D*W).

BPT also used biodegradable and non-toxic green tracer-dye (Bluewater Chemgroup) to understand flow and stream travel times from the outlet of High Lake to Lake Creek Falls. The dye was applied a single time upstream of a specified reach and a time was recorded when it had reached its destination. Dye dissipated completely and was not noticeable from the system within ~40 minutes. BPT also used dye test to understand the stream location in which water had travelled a half hour, hour, and two hours downstream from Lake Creek Falls. These tests were conducted during low flow conditions.

2.3 Results and Discussion

BPT Fisheries made a large effort to collect habitat data that would inform a proposed 2023 rotenone project in High Lake and upper Lake Creek. 2022 pre-treatment data included: lake depths, mapping stream features, monitoring stream temperatures, and collecting stream discharge data would allow the TAC to plan an effective rotenone treatment for eradicating the High Lake/ upper Lake Creek Brook Trout population. The 2022 data reported allows for a baseline understanding of the Treatment Area's habitat conditions, however BPT will repeat this effort in Summer 2023 to obtain data at time of treatment.

High Lake Depths

BPT compared the data collected from the two sets of High Lake depths collected in the 2022 field season with a weighted measuring tape to the depths collected during an eDNA study in 2011 and 2012 (Blakenship et al. 2013, 2013). The first set of 2022 depths (Set 1, n = 20) were approximate replicates of the locations in the 2011 (Blakenship et al) study. In early July BPT Fisheries had the Tribal Steward volunteers use a measuring tape to measure the wetted perimeter of High Lake. At that time the distance around was ~ 610 meters or (2,003 ft). Overall, High Lake is a relatively shallow lake with an average depth of ~ 9ft and maximum depths of 11-13ft. BPT applied the average depths to calculate Acre Feet (Table 2.1). This would inform the TAC on how much rotenone would be needed to reach the desired concentration.

While the results between the two studies are similar, multiple factors need to be considered when comparing the depths between the different years. 1)It is important to note that the 2011,2012 depths were calculated to the nearest 1/10th foot using a Hawkeye H22PX Handheld Digital Sonar and the locations were created using a systematic sample grid (though, a near shore auxiliary site was added). The sonar allowed for depths to be calculated with greater precision (the weighted tape depths may be higher due to the weight sinking into organic substrate). Comparisons between the Hawkeye Sonar and a weighted tape can be reviewed in the Blankenship et al. 2011 study.

2) BPT attempted to replicate the 2011 study by taking a depth at the same GPS location. The 2011 study used either an eTrex Legend GPS and likely did not have sub-meter precision (~3 meters range) from a point. 2022 crews used a Garmin Inreach/ iPad 10 (Avenza Maps) to navigate to the earlier studies locations. Although 2022 crews made great effort to replicate the locations for each measurement there is likely error associated with each site.

3) The 2022 studies have errors associated with using the weighted tape. At least 2 person crews worked to take each depth to make sure the tape was vertical during the time of the reading. However, there may be inaccuracies due to wind drift during the time of measurement.

Table 2.1 High Lake depths

	2011[1]	2012[2]	2022[3]: Set 1	2022: Set 2
Max Depth (ft)	13.3	11.2	11.9	11.6
Average Depth (ft)	9.1	8.8	9.08	9.25
Overall Average Depth (ft)	**9.2**			
Volume (ft³)	2,358,712	2,262,172	2,344,510	2,388,405
Overall Average Volume (ft³)	**2,338,449.8**			
Volume (gal)	17,644,391	16,922,219	17,538,158	17,866,515
Overall Average Volume (gal)	**17,492,821**			
Acre Feet	54.1	51.9	53.8	54.8
Overall Average Acre Feet	**53.7**			

1- 2011 depths were taken with sonar during 2011 sampling effort (Blakenship et al. 2011-2012)

2- 2012 depths were taken during July 2012 eDNA sampling (Blakenship et al. 2011).

3- 2022: Set 1 depths were approximately taken at the same sites as 2011 depths.

Hydrological Features in Lake Creek

BPT mapped an extensive list of Hydrologic Features in upper Lake Creek (Figure 2.4). Features included locations that would be barriers to fish upstream movement (barriers), seeps, springs, tributaries, dry/wet side channels, and locations with subterraneous flow. BPT then combined the GPS locations of the features with a similar BPT effort conducted in 2015 (Figure 2.4). These locations will inform the TAC on how to plan an effective 2023 piscicide treatment. Hydrologic feature data will inform the locations of the chemical drip stations, seeps and springs which would need to be treated manually, barriers, locations for block nets, and features which will require extra effort to ensure eradication. BPT also worked to map locations of all springs and note on the potential for the springs to serve as refugia for Brook Trout to avoid the chemical treatment. These locations will likely require extra attention and treatment application by ground crews.

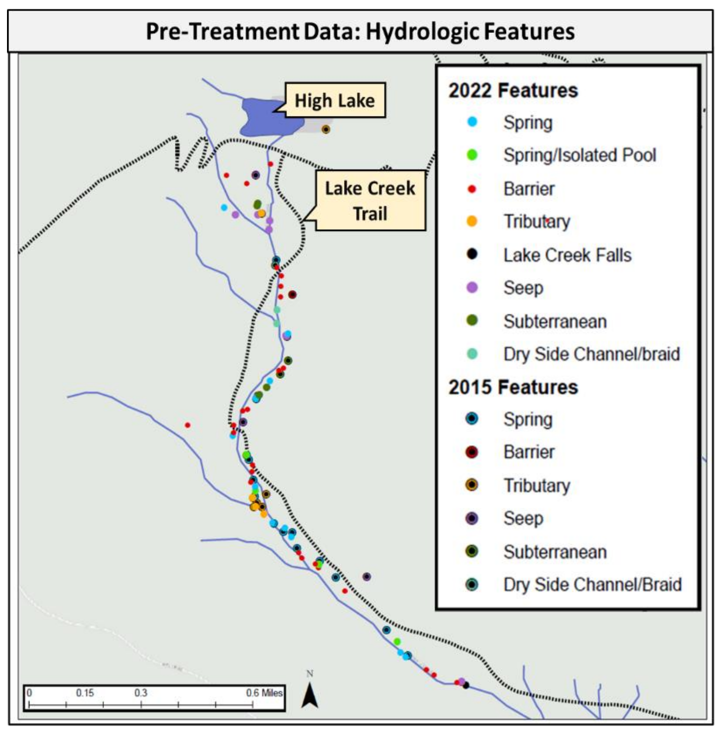

Figure 2.4 Locations of hydrologic features of interest mapped in 2022 and 2015 data (published in Haslick and Crowley 2018).

Stream Temperature Monitoring in Lake Creek

Summer temperature checks during surveys found upper Lake Creek temperatures can be around 20°C near the outlet of High Lake and from 5 to 12 °C between the outlet and Lake Creek Falls (Fig 2.5; BPT, internal files). Initial (MWMT) results for temperature loggers #2,3, and 4 (Figure 2.5) support the importance of cold-water spring input in mitigating the higher temperatures flowing from High Lake.

Stream Discharge Monitoring in Lake Creek

August field efforts included multiple efforts to measure stream discharge in upper Lake Creek (with a focus on locations with spring input). A crew of two or three worked to measure discharge using a Swoffer Flowmeter at multiple locations. Of note, 1) one of the first tributaries in the meadow downstream from High Lake doubles the flow. 2) There is substantial spring input into Lower Lake Creek downstream of Lake Creek Falls (Figure 2.6 C). 3) Comparing 2022 low flow, summer discharge results with past BPT discharge data allows for a bigger picture on the importance of treatment timing (low flow) (Figure 2.6 A). Results suggest that it would take dye/liquid ~6 hours to flow from the High outlet to Lake Creek Falls in the late summer.

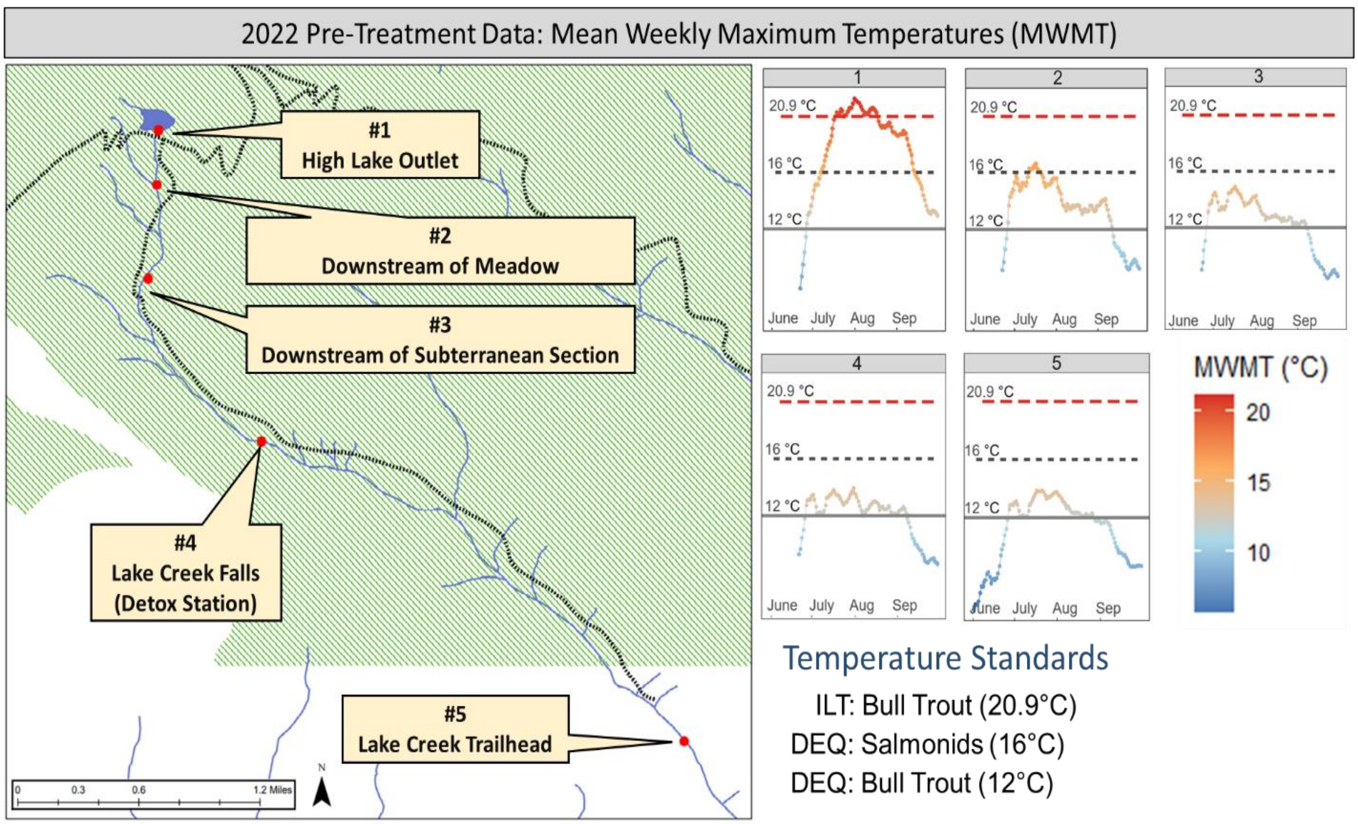

Figure 2.5 2022 stream temperature data (MWMT) collected by BPT Fisheries. Four of the loggers were in the Strawberry Wilderness (area shaded in green).

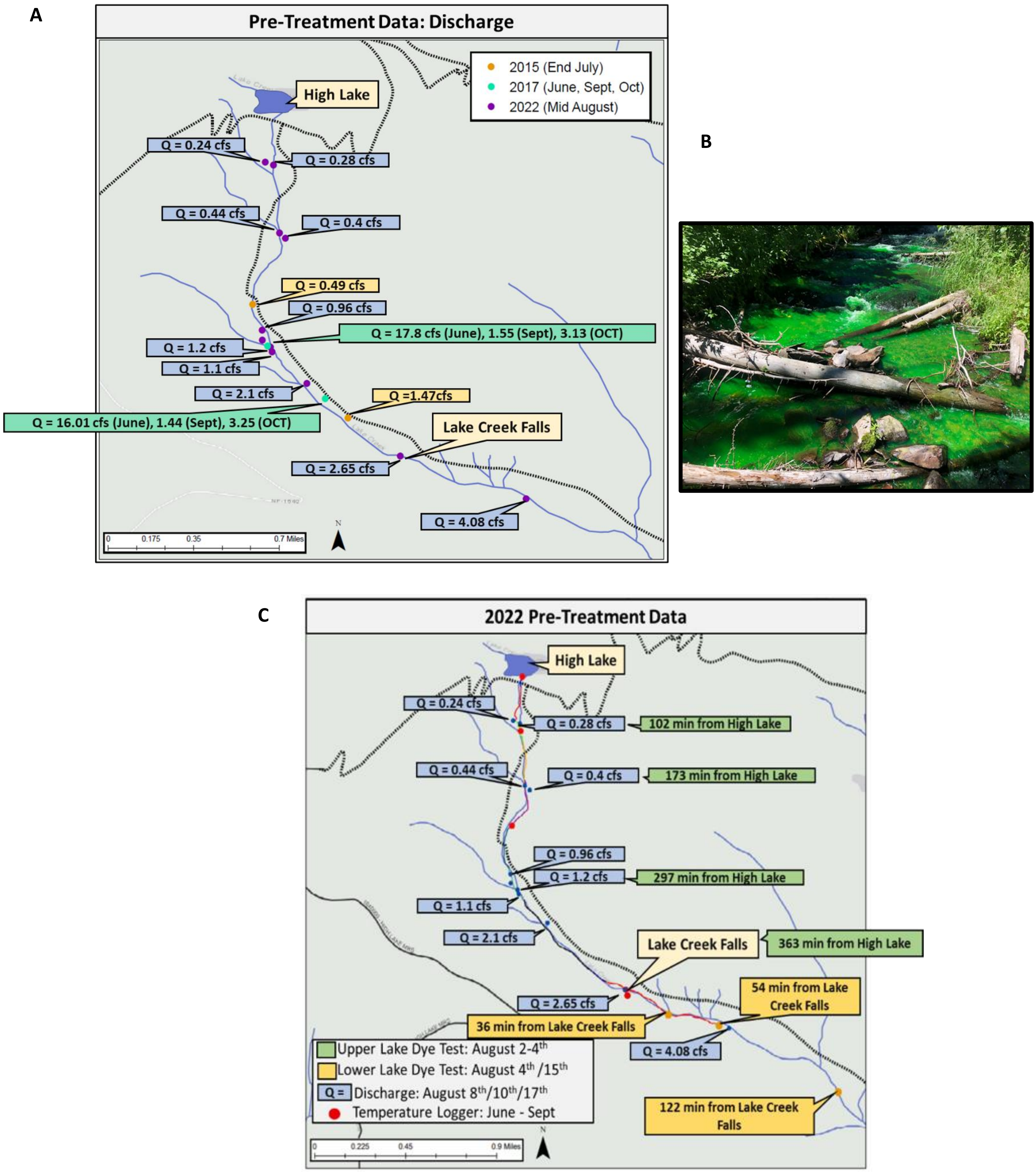

Figure 2.6 (**A**) 2015, 2017, 2022 Summary of all BPT Discharge Data (BPT, internal reports). and **(B)** a photo of the florescent biodegradable tracer-dye in upper Lake Creek (photo credit: B. Haslick) **(C)** 2022 Discharge data and estimated flow timing from summer dye tests.

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Chapter 3: Stream Temperature Monitoring in the Upper Malheur Subbasin, the *Logan Valley Wildlife Mitigation Property,* and the North Fork of the Malheur Subbasin

Burns Paiute Tribe Natural Resources Department, Burns OR 97720

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Chapter 3: Stream Temperature Monitoring in the Upper Malheur, the Logan Valley Wildlife Mitigation Property, and in the North Fork of the Malheur

Rebecca J. Fritz and Brandon D. Haslick
Burns Paiute Tribe Natural Resources Department, Burns OR 97720

3.1 Introduction

Stream temperatures directly impact native fish populations. Three of the native Malheur River Salmonids (Bull Trout, Redband Trout, and (reintroduced for a put-and-take fishery) Chinook Salmon (*Oncorhynchus tshawytscha)*) are considered vulnerable to climate change (Halofsky and Peterson 2017). Of these three, Bull Trout are a current management focus for the BPT Fisheries Program and are considered the most sensitive to high stream temperatures (Buchanan and Gregory 1997; Haas 2001; Selong et al. 2001; Dunham et al. 2003). Stream temperatures are an important component in understanding habitat quality and fish distribution, particularly in respect to Bull Trout populations. High stream temperatures create thermal barriers, threaten spawning success/early-stage survival, and decrease resiliency to wildfire or environmental disturbances (Rieman et al. 2007; Halofsky and Peterson 2017).

The Burns Paiute Tribe began monitoring stream temperatures in the Upper Malheur Subbasin after the purchase of the Logan Valley Wildlife Mitigation Property (LVWMP) in the spring of 2000. This property includes the confluence of the headwater tributaries which form the Middle Fork Malheur. A series of ten stream temperature sites have been monitored annually to track the effects of habitat improvement projects on the property (Figure 3.1 A). Since the establishment of the annual sites, BPT's stream temperature monitoring has expanded to include various sites in the Upper Malheur, and the North Fork of the Malheur.

The BPT temperature monitoring program has grown since it started in 2000, and currently incorporates multiple objectives. 1) BPT continues to monitor thermal barriers to Bull Trout on the LVWMP. 2) BPT monitors the temperatures of the Upper Malheur headwaters to inform future Bull Trout management efforts. 3) BPT monitors temperatures throughout Bull Trout habitat in the North Fork of the Malheur and 4) collaborates with partner agencies to place loggers in locations which will contribute to the interagency monitoring effort as well as potentially provide temperature data for significant temperature modeling efforts.

3.2 Methods

Study Area

The Burns Paiute Tribe Fisheries Program monitors temperatures in the Malheur River Watershed in Eastern Oregon. BPT temperature sites in the Upper Malheur are further grouped by 1) the ten annual sites located on the BPT Logan Valley Mitigation Property and 2) sites on major Upper Malheur tributaries.

Table 3.1 Burns Paiute Tribe ten annual temperature sites on the Logan Valley Wildlife Mitigation Property. (*) Denotes the loggers exposed to air temperature during the 2022 monitoring period. Site #6 logger and #8 loggers were collected however were unable to readout and will be sent to Onset for data retrieval.

Site #	Location	Year Initiated	2022 Hobo Retrieved	Year Initiated Reference
1	Lake Creek below McCoy Creek	2000	Yes	Namitz 2000
2	Lake Creek below Crooked Creek	2000	Yes	Namitz 2000
3	Malheur River below Big/Lake Creek	2000	Yes	Namitz 2000
4	Big Creek 1-mile south FS-16 Road	2000	Yes	Namitz 2000
5	Big Creek below FS-16 Road	2000	Yes	Namitz 2000
6	Lake Creek below FS-16 Road	2007	(*)	Schwabe 2007
7	McCoy Creek above Lake Creek	2007	Yes	Schwabe 2007
8	Lake Creek at Cabin Bridge	2008	(*)	Abel 2008
9	McCoy Creek below FS-16 Road	2009	Yes	Abel 2009
10	Lake Creek Ditch below FS-16 Road	2009	Yes	Abel 2009

Logan Valley Mitigation Property

The Logan Valley Wildlife Mitigation Property is located south of the Strawberry Mountains, located in the Strawberry Mountain Wilderness in eastern Oregon. This property spans 1,760 acres and includes the confluence of McCoy Creek, Lake Creek, and Big Creek which form the Malheur River (or Middle Fork of the Malheur). These headwater tributaries come together approximately 200 river miles upstream from where the Malheur River joins the Snake River. In 2000, the Tribe began collecting seasonal (spring-fall) data on stream temperatures at five sites of the LVWMP. These sites have been maintained in the same locations and five more have been added within the property boundaries over time (Table 3.1) (Namitz 2000; Schwabe 2001, 2002-2007; Fenton and Schwabe 2005, 2007; Fenton 2006; Abel 2008, 2009; Brown 2010- 2012; Haslick 2014-2018, Fritz and Haslick 2019-2021).

Upper Malheur River

The ten annual stream temperature sites in Logan Valley are the overarching focus of the BPT monitoring effort. However, the tribe has expanded the program to include loggers upstream (North) of the LVMP. These sites are on Lake Creek (including the High Lake outlet), Big Creek, Meadow Fork of Big Creek, and McCoy Creek (seven sites to date in 2022) (Figure 3.3). BPT also monitored stream temperatures in upper Lake Creek at three additional locations in 2022, however these results are reported in Chapter 2 of this report.

North Fork of the Malheur River

BPT's temperature monitoring effort includes tributaries in the neighboring North Fork Subbasin. This involves nine monitoring sites on the North Fork of the Malheur and its tributaries (Figure 3.3). These locations are on streams in USFS managed forests. Oregon Department of Fish and Game (ODFW) and the USFS Prairie City District also monitor temperatures in the North Fork to better understand habitat quality for Bull Trout.

Field Techniques

Pre/Post Deployment:

All stream temperatures were monitored using Tidbit v2 Temperature Loggers (referred to as, loggers) which are a product of the Onset Computer Corporation. Prior to stream deployment, the battery life and memory storage were checked, and all loggers were set to take a temperature reading at the start of every hour. Once collected from the field, all loggers must pass a post-deployment test to check each logger for accuracy.

Field Deployment:

All temperature loggers at the Logan Valley Mitigation Property were set in the field by the middle of May/end of May. Most Upper Malheur loggers and North Fork loggers were also set within this time frame. At the stream site, each logger was directly attached to an eight-pound anchor and placed in the thalweg of the stream. Anchors were secured by cable and tied off on a tree or staked into the bank. Loggers were collected in October.

Data Analysis

The BPT monitors temperatures starting in late spring through late fall. Due to the yearly differences in logger deployment, BPT reports temperatures from June 1st – September 30th. This establishes a standard 122-day monitoring period for most loggers (road access and snow level can alter individual deployment dates).

Data are analyzed using the same methodology as previous years summarizing temperature data using mean weekly maximum temperature (MWMT) in °C (as summarized in Haslick 2018). MWMT (the average of a rolling 7-day temperature maximum) is used due to its accuracy as a biological parameter describing stream temperatures. Specific temperature benchmarks are recognized as standard parameters and used in this report. The first two Stream Temperature Standards established through the Department of Environmental Quality (DEQ) are 12 °C MWMT (optimal temperature for rearing juvenile Bull Trout and considered the maximum temperature for Bull Trout migration) and 16 °C is the ideal temperature for core salmonid rearing areas (OAR 340-04102004). The temperature standard highlighted in this report is the Incipient Lethal Temperature (ILT) in which stream temperatures ≥ 20.9 °C are harmful to ESA listed Bull Trout (Selong et al. 2001). For 2022 data, BPT also included a fourth temperature standard of 18°C in which the beneficial use is categorized as Salmon and trout rearing and migration. 2022 data were analyzed using R Studio and maps of were created using ArcMap 10.8. Raw data can be obtained by contacting Rebecca Fritz rebecca.fritz@burnspaiute-nsn.gov.

Oregon Department of Fish and Wildlife (ODFW) defines the critical period for high stream temperatures in the Malheur watershed as, the summer timeframe which falls within the dates, July 15th through August 15th (Perkins 1999). Peak high stream temperatures occur within or near this critical period and the critical periods has been used as a base index for comparing yearly stream temperatures in the Upper Malheur (Namitz 2000; Schwabe 2001, 2002-2007; Fenton and Schwabe 2005, 2007; Fenton 2006; Abel 2008, 2009; Brown 2010- 2012; Haslick 2014-2018, Fritz and Haslick 2019-2021).

3.3 Results

Logan Valley Mitigation Property ten annual sites

The 2022 BPT Logan Valley temperature sites (Figure 3.1 A) had MWMT temperatures peaked in the end of July/first week of August (Figure 3.1 B) in the middle of the defined critical period (July 15-Aug 15). When comparing the datasets, all but one of the sites on Big Creek had an MWMT that exceeded the ILT threshold for Bull Trout (20.9 °C) (Selong et al. 2001) (Table 3.2). McCoy Creek (site #9 in Figure 3.1) has repeatedly had the warmest temperatures on the LVWMP and there was not time during the 2022 sampling period when McCoy Creek (site #9) and the confluence of Crooked Creek (site #2) had temperatures less than 12 °C, as 50% of the sampling period consisted of temperatures at, or greater than, the ILT for Bull Trout (Figure 3.4). Of the BPT monitoring locations, the ten annual sites (sites 1-10) in Logan Valley result in consistent thermal barriers to Bull Trout (Figure 3.2). The loggers for site LVWMP site #6 and #8 not reported as they require being sent into Onset for data extraction. All 2022 loggers passed post deployment checks.

BPT Logan Valley Mitigation Property Site	*DEQ: Bull Trout MWMT > 12 °C*			*DEQ: Salmonids Trout MWMT >16 °C*			*ILT: Bull Trout MWMT >20.9 °C*		
	2020	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**
1	*	*	120 (98%)	*	*	86 (70%)	*	*	60 (49%)
2	122 days (100%)	122 days (100%)	122 (100%)	95 days (78%)	109 days (89%)	89 (73%)	50 days (41%)	65 days (53%)	71 (58%)
3	122 days (100%)	122 days (100%)	117 (96%)	81 days (66%)	92 days (75%)	80 (66%)	8 days (7%)	30 days (25%)	28 (23%)
4	122 days (100%)	119 days (97.5%)	106 (87%)	77 days (63%)	86 days (70%)	78 (64%)	0	13 days (11%)	13 (11%)
5	87 days (71%)	109 days (89%)	86 (70%)	32 days (26%)	61 days (50%)	47 (38%)	0	0	0 (0%)
7	122 days (100%)	122 days (100%)	120 (98%)	89 days (73%)	108 days (89%)	86 (70%)	37 days (30%)	63 days (52%)	64 (52%)
9	122 days (100%)	122 days (100%)	122 (100%)	108 days (89%)	110 days (90%)	106 (87%)	60 days (49%)	73 days (60%)	76 (62%)
10	114 days (93%)	122 days (100%)	103 (84%)	77 days (63%)	93 days (76%)	80 (65%)	22 days (18%)	57 days (47%)	45 (37%)

Table 3.2 The total number of days (and % of the sampling season) for the last three seasons in which MWMT exceeded specified temperature benchmarks at the LVWMP. Sites 6 and 8 excluded due to air

A

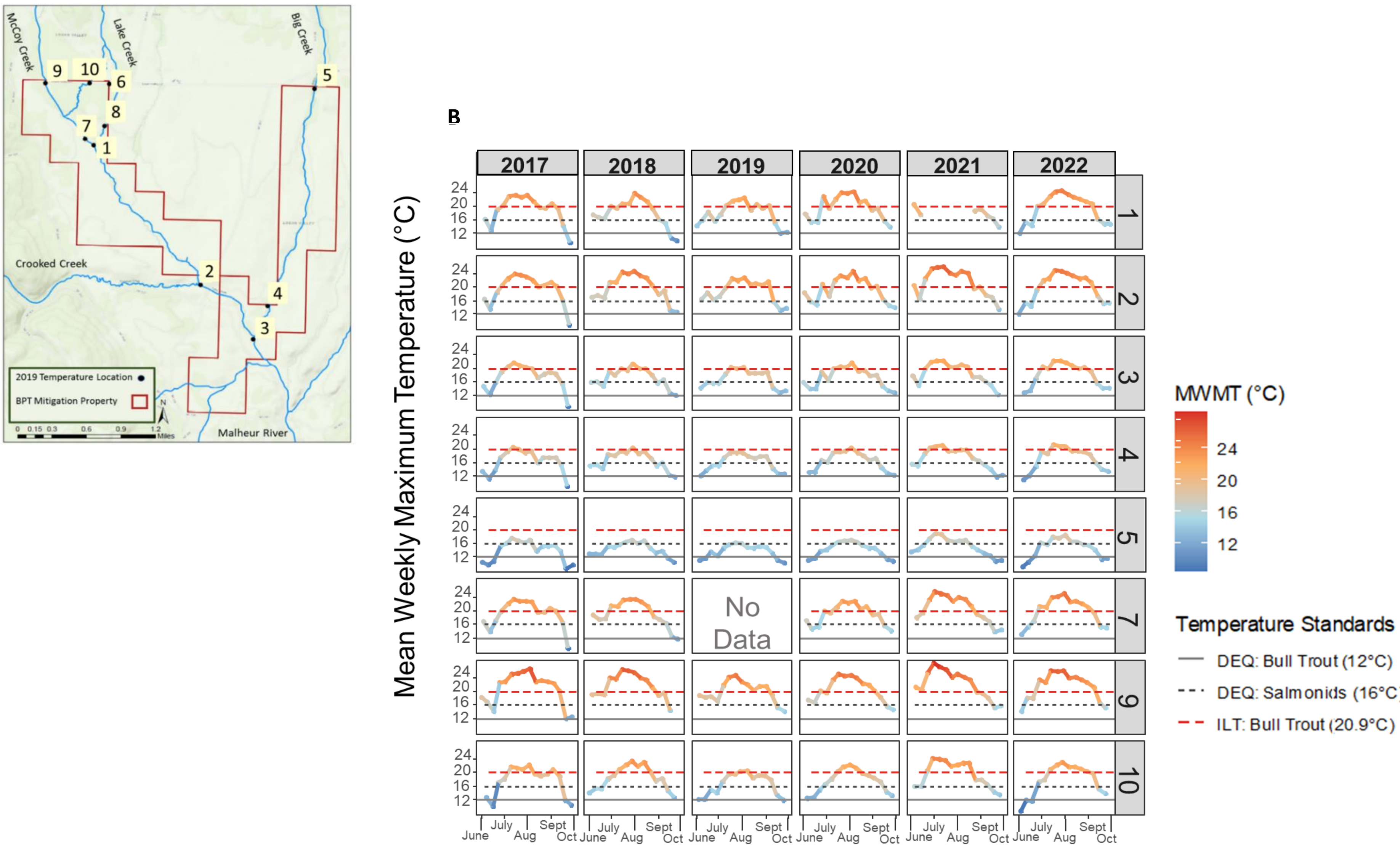

Figure 3.1 (A) BPT ten annual temperatures sites on the LVWMP (B) Six years of MWMT (°C) values for 8 of the ten LVWMP annual monitoring sites. July 15th-Aug 15th is the ‘critical time’ for Bull Trout. Sites 6 and 8 are not included due to the annual dewatering at those sites. Site 1 in 2021 has an incomplete dataset due to air exposure.

Upper Malheur and North Fork Locations

BPT temperature monitoring has expanded to encompass multiple locations upstream of the LVWMP in the Upper Malheur tributaries as well as throughout the neighboring North Fork Malheur (Figure 2.3). The North Fork Malheur provides valuable habitat to a distinct population of Bull Trout (MW Council 2004). Comparatively, North Fork tributaries have temperatures which remain cooler throughout the summer critical period for Bull Trout (Figure 3.3). One location in upper Swamp Creek (Swamp Creek RM3) resulted in the coldest temperatures when compared among the other sites as temperatures did not even meet 12 °C during the sampling period (Figure 3.4).

3.4 Discussion

The Burns Paiute Tribe Fisheries Program entered a cooperative effort with the USDA Forest Service and ODFW to document stream temperature trends in the Upper Malheur (Namitz 2000). The BPT has been actively monitoring some temperatures in Logan Valley for nearly two decades (Namitz 2000) and this effort has grown to include over twenty locations in two different subbasins of the Malheur Watershed (the Upper Malheur and the North Fork of the Malheur) which flow into the Malheur River (Haslick 2018). The purpose of collecting temperature data is to monitor stream habitat suitability for ESA listed Bull Trout. Bull Trout are stenothermal, requiring a narrow range of cold-water temperature conditions to rear and reproduce (Buchanan and Gregory 1997). In western North America, the Bull Trout is believed to be the most thermally

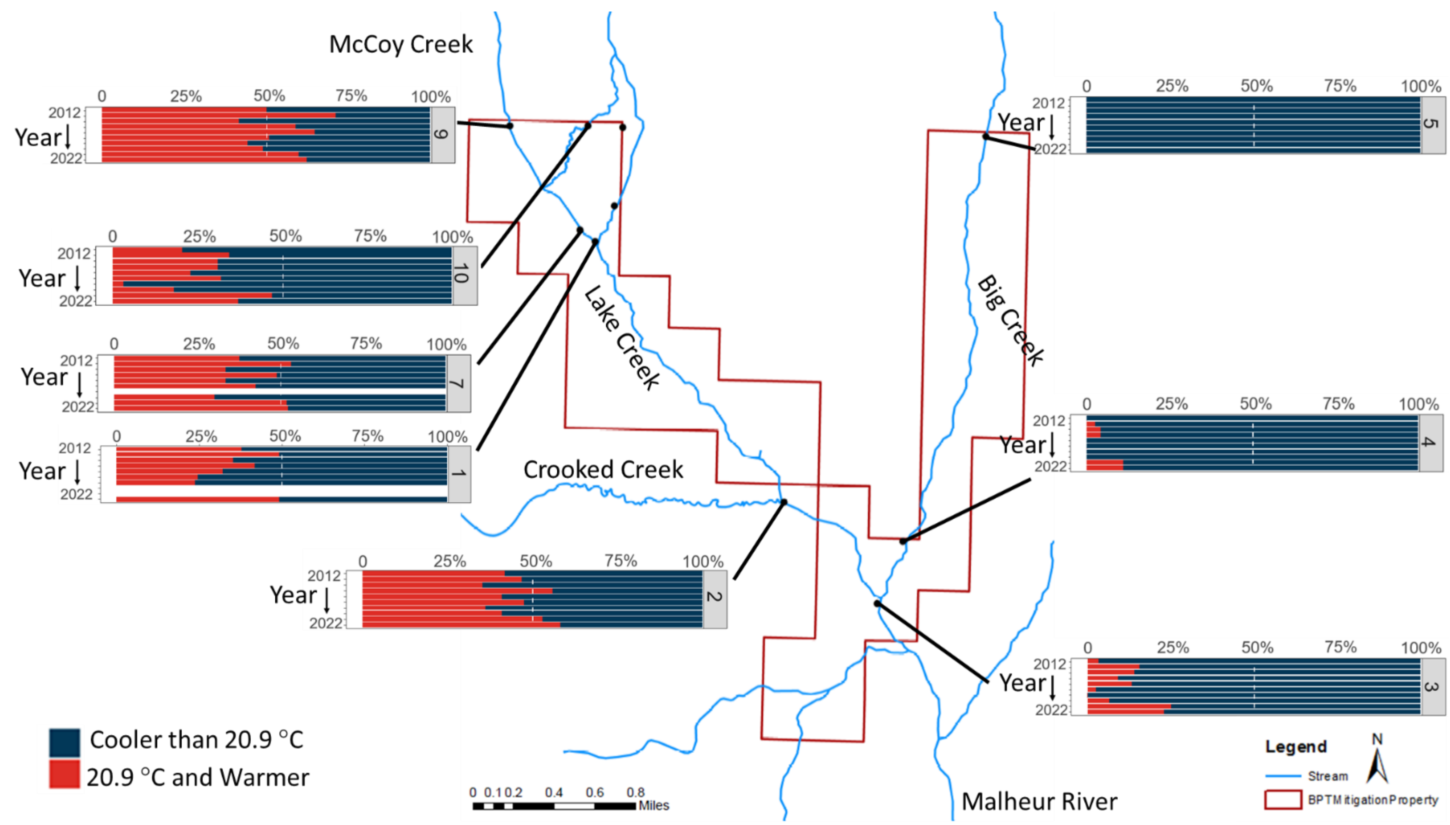

Figure 3.2 Percent of the days (2012-2022) during the summer monitoring season (June 1st- September 30th) in which temperatures reach or exceed ILT at ten annual sites. (%) calculated out of a 122-day monitoring season. No data available for 2016 or sites 6 and 8 (dewatered annually).

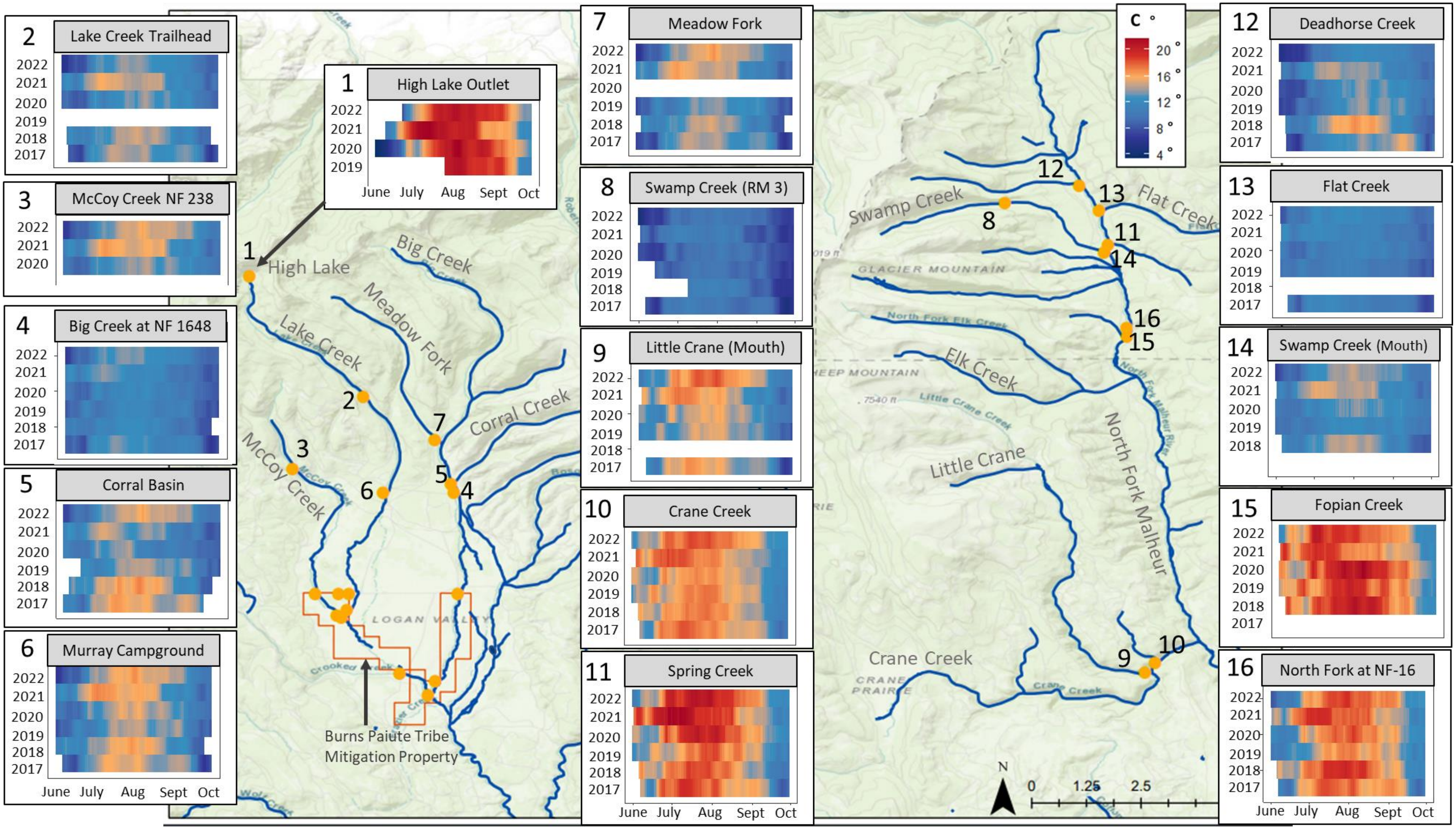

Figure 3.3. Heatmaps displaying the Mean Weekly Maximum Temperature (MWMT) for monitored locations in the Upper Malheur and the North Fork Malheur.

sensitive fish species; requiring cold water habitats (Buchanan and Gregory 1997; Haas 2001; Selong et al. 2001; Dunham et al. 2003), and maximum temperature has consistently been suggested as likely the most critical variable determining Bull Trout presence (Haas 2001; Dunham et al. 2003). The ten annual monitoring sites in Logan Valley occur in U.S. Fish and Wildlife Service designated Bull Trout Critical Habitat (75 FR 63897 2010).

Logan Valley Mitigation Property sites consistently reveal thermal barriers to Bull Trout

Upstream of the BPT Logan Valley property, the tributaries forming the Upper Malheur run through forested National Forest and designated wilderness. Groundwater inputs create cool water temperatures in these headwaters, making them valuable Bull Trout habitat (Figure 3.3). The daily average temperatures of these tributaries rise as they enter Logan Valley becoming restrictive to Bull Trout throughout the summer months (Figure Appendix 3.5). Several trends have been observed over time regarding temperatures on the LVWMP. 1) Big Creek lowers the temperature of the Malheur River (site #3) (Figure 3.2). 2) McCoy (sites #7 and #9) and Crooked Creek (site #2) drive the high stream temperatures in Lake Creek (Figure 3.2). 3) Finally, lack of continuous flow throughout the summer (sites #6 and #8, 2022 data not shown) presents barriers to fish movement and could potentially lead to entrainment (Haslick 2018). Continual monitoring of the LVWMP annual temperature sites has provided, and will continue to provide, important information regarding land use practices thought Logan Valley and inform future restoration efforts and fish management goals.

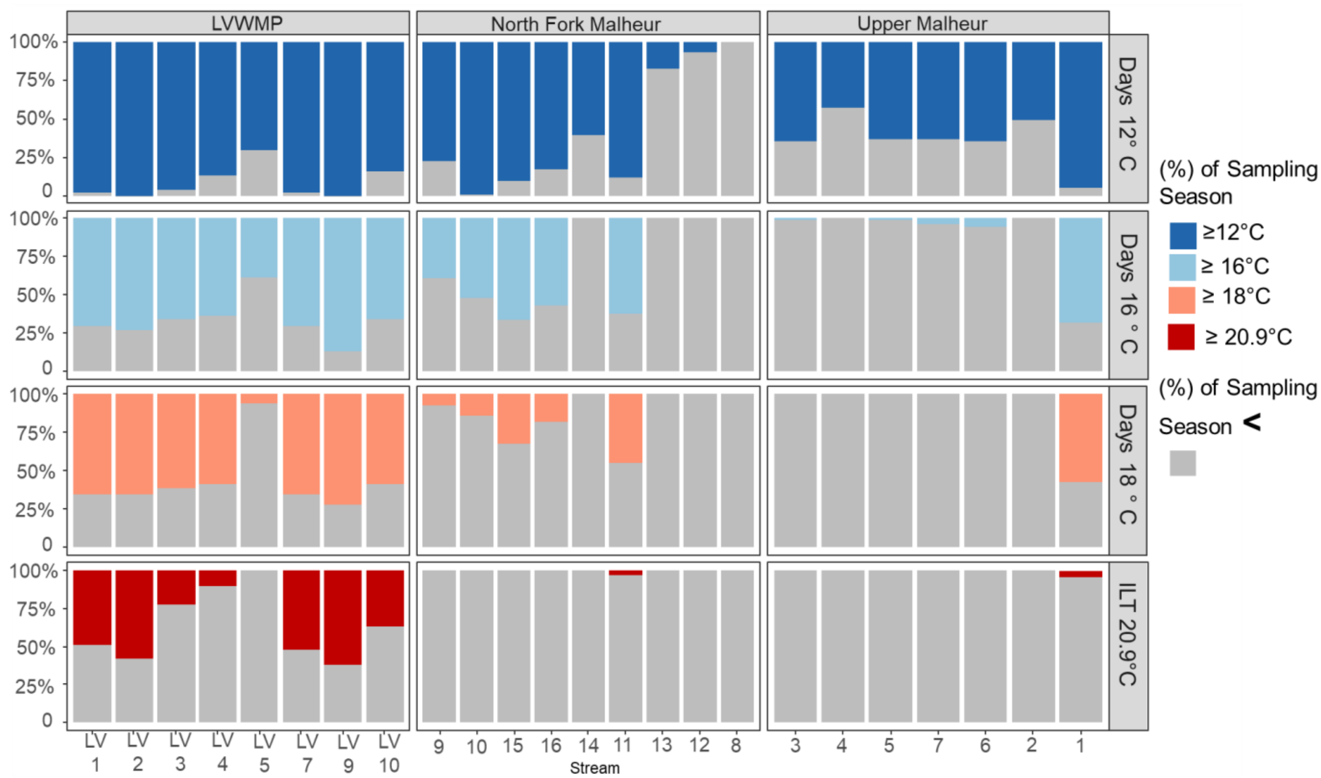

Figure 3.4. Percent of the days during the summer monitoring season (June 1st- September 30th) in which MWMT temperatures reach or exceed DEQ defined Temperature Standards. (%) calculated out of a 122-day monitoring season. LVWMP stream locations can be referenced in Figure 3.1 (A) and North Fork and Upper Malheur stream locations can be referenced on Figure 3.3.

Upper Malheur Tributaries provide core cold water habitat for native salmonids

BPT monitors temperatures upstream of the LVWMP on the Upper Malheur headwaters to inform current and future Bull Trout recovery efforts. The monitored tributaries upstream of Logan Valley (LVWMP) provide core, cold water habitat for native salmonids most sites had zero/a small percentage of the sampling period in which temperatures were at or exceeded MWMT 16.0 °C (not including High Lake) (Figure 3.4). Excluding High Lake, the tributaries maintain MWMT temperatures less than 12° C (Bull Trout spawning and rearing) for (35-57%) of the sampling season (Figure 3.4).

The loggers located on Lake Creek are of particular interest as they provide temperature data in habitat where Bull Trout populations are facing competition and hybridization from invasive Brook Trout. Monitoring stream temperatures in the headwater streams informs future management actions.

When compared to the Upper Malheur sites (namely, LVWMP), the upper North Fork Malheur has experienced fewer lasting effects of anthropogenic pressures (logging and livestock grazing) (Haslick 2016). North Fork stream temperatures maintain a pattern of being relatively cooler when compared to Upper Malheur Logan Valley Temperatures (Figure Appendix 3.5). North Fork logger locations are within reaches with active Bull Trout spawning, rearing, and migration (Perkins 2009, Haslick 2016) and therefore are providing data on valuable Bull Trout habitat. BPT collaborates with agency partners on logger locations and data are made available to provide a large picture of temperatures in the North Fork system.

BPT Fisheries will continue monitoring temperatures in the locations reported for the foreseeable future. Stream temperature data collected in the Upper Malheur and the North Fork Malheur by the BPT helps guide understanding regarding future climate impacts on Bull Trout. Using temperature data from watersheds throughout the Columbia Basin, scientists are effectively modeling future climate change scenarios. These models provide guidance for habitat restoration, Bull Trout recovery, and focused management efforts. BPT collaborates with USFS and the U.S. Geological Survey NorWeST to provide stream temperature data which can further develop and fine tune models (Haslick, 2018). BPT, ODFW, and USFS partnered to place temperature loggers and form a detailed temperature array in the North Fork Malheur in 2021. BPT will continue future collaboration with partner agencies to collect important temperature data throughout the Upper Malheur and the North Fork Malheur.

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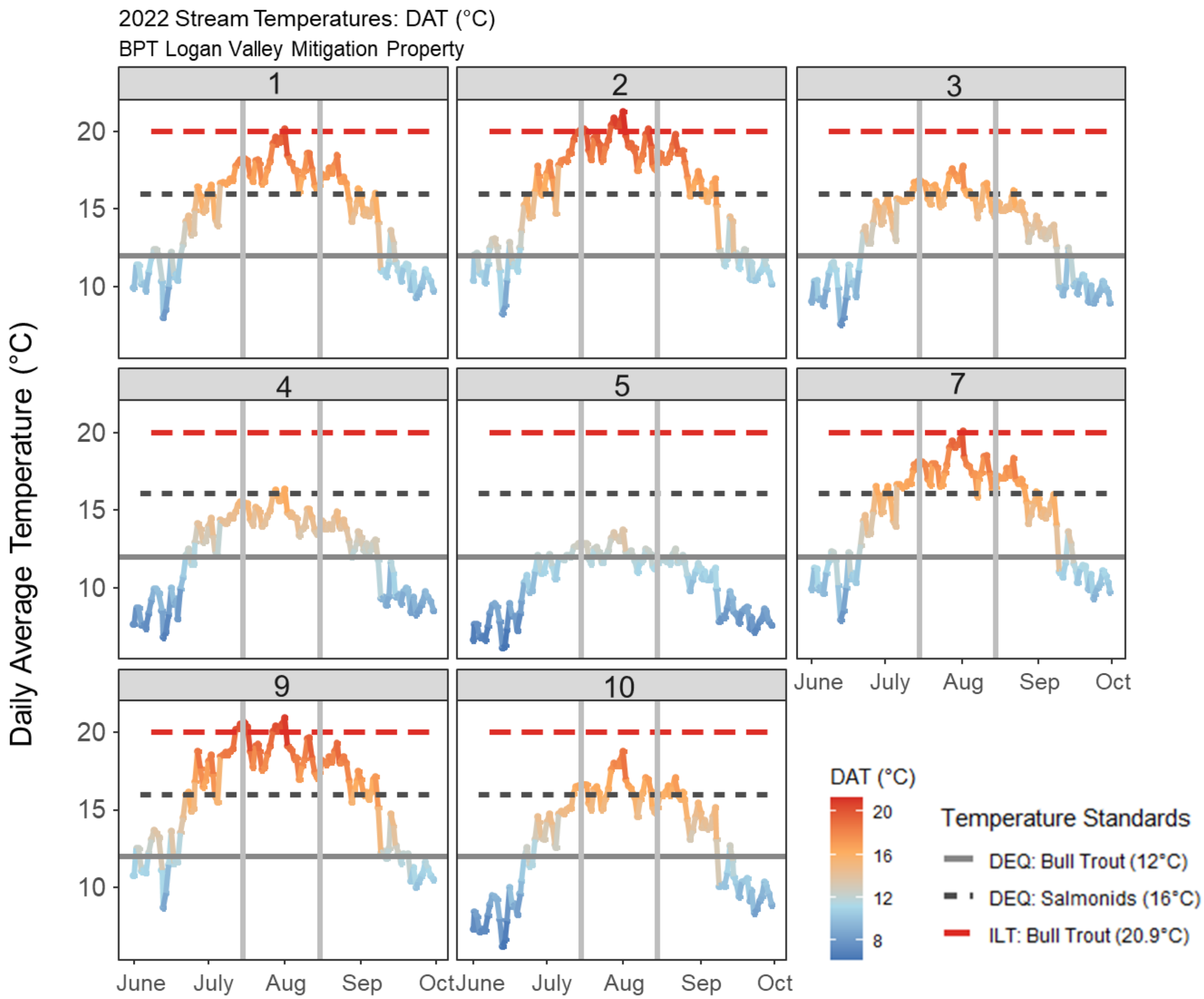
Appendices



Appendix Figure 3.5 2022 Daily Average Temperature (DAT) for eight of the ten annual Logan Valley Wildlife Mitigation sites.

Appendix Table 3.3: Summary of Temperature Maximums at annual Logan Valley Wildlife Mitigation Property BPT Temperature Sites. Dewatered sites (6 & 8) not included. Temperature Monitoring Period: June 1st- September 30th					
Site	**Year**	**Highest MWMT (°C)**	**MWMT Date**	**Absolute Maximum(°C)**	**Maximum Date**
1	2018	23.84	8/1/2018	24.68	7/29/2018
	2019	22.72	8/5/2019	24.07	7/12/2019
	2020	*No data- logger was exposed to air during this time.			
	2021	*No data- logger was exposed to air during this time.			
	2022	25.06	7/31/22	25.82	7/28/22
2	2019	23.5	8/5/2019	24.41	8/3/2019
	2020	24.76	8/5/2020	25.6	7/31/2020
	2021	26.7	7/2/2021	28.44	6/29/2021
	2022	25.35	8/1/22	26.30	7/28/22
3	2019	20.52	7/30/2019	21.44	7/12/2019
	2020	21.65	8/4/2020	22.66	7/30/2020
	2021	22.88	6/29/2021	24.22	6/29/2021
	2022	22.55	7/30/22	23.50	7/28/22
4	2019	19.24	8/5/2019	20.27	7/12/2019
	2020	20.49	8/4/2020	21.37	7/30/2020
	2021	21.64	6/29/2021	23.06	6/29/2021
	2022	21.42	7/30/22	22.37	7/28/22
5	2019	16.32	8/2/2019	17.2	7/22/2019
	2020	17.8	8/4/2020	18.58	7/30/2020
	2021	18.93	7/2/2021	20.46	6/29/2021
	2022	18.36	7/30,7/31/22	19.25	7/28/2022
7	2020	23.94	8/4/2020	24.77	7/30,7/31/2020
	2021	25.3	6/29/2021	27.35	6/29/2021
	2022	25.15	7/30/22	25.84	7/28/22
9	2019	24.95	7/23/2019	26.4	7/12/2019
	2020	25.99	8/1/2020	26.92	7/20/2020
	2021	26.89	6/27/2021	30.42	6/27/2021
	2022	27.44	7/17/22	28.17	7/14/2022
10	2019	21.16	8/5/2019	21.51	7/31/2019
	2020	23.0	8/4/2020	24.05	7/31/2020
	2021	23.96	6/29/2021	25.93	6/29/2021
	2022	23.67	8/1/2022	24.29	7/28/2022

Chapter 4: Investigating Fish Populations in Summit Creek and Crooked Creek; Two Upper Malheur Tributaries

Rebecca J. Fritz
BPT Natural Resource Department, Fisheries Program

Contents

Chapter 4: Investigating Fish Populations in Summit Creek; An Upper Malheur Tributary

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4.1 Introduction

BPT fisheries conducted electrofishing surveys in Summit Creek, an Upper Malheur tributary, for the third consecutive year in 2022. Summit Creek (Figure 4.1) is classified by the USFWS as Historic Critical Habitat for ESA Threatened Bull Trout (*Salvelinus confluentus*) (USFWS 2010). However, the information regarding Bull Trout presence and current native/non-native fish population data at this location is dated.

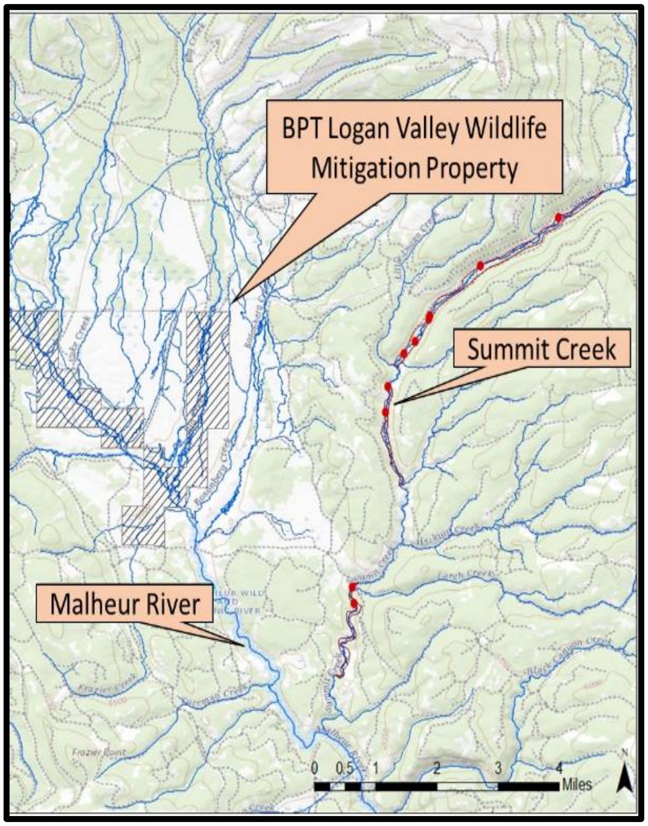


Figure 4.1 Map showing location of Summit Creek electrofishing sites in the Upper Malheur Subbasin.

The Malheur River Bull Trout Technical Advisory Committee (TAC) is an interagency organization in which the partners[2] collaborate to effectively manage the Upper Malheur Subbasin and benefit native fish species, with a focus on bull trout. The TAC provides an avenue for agencies like BPT and USFS to collaborate on riparian restoration activities, like the USFS led Stage-0 restoration plan for Summit Creek. In 2020, the BPT began gathering baseline biological data on Summit Creek to assist USFS in the restoration planning.

Summit Creek: Summit Creek is considered to once have supported Bull Trout populations however, Bull Trout have not been observed since 2000 (USFWS 2010) despite multiple BPT electrofishing surveys (BPT internal files). Restoration on Summit Creek may allow for the eventual Bull Trout expansion into the habitat (USFWS 2010). The US Forest Service is currently planning a large scale, future Stage-0 restoration. A Stage-0 treatment is proposed for the segments, hereafter referred to as upper Summit and lower Summit (Figure 4.2 A). The study reach, middle Summit, will serve as a control reach as no restoration activities are planned for this segment (Figure 4.2 A). 2022 BPT electrofishing survey sites and methods on Summit Creek are intended to replicate surveys conducted the previous year.

4.2 Methods

Study Area

Summit Creek is a 23 km long Upper Malheur River tributary which joins the Malheur River upstream of Malheur Ford Campground. This tributary largely flows through the Malheur National Forest as well as some privately-owned land. (Figure 4.1).

[2] Partner agencies in the TAC: Oregon Department of Fish and Wildlife (ODFW), United States Forest Service (USFS), United States Fish and Wildlife Service (USFWS), Burns Paiute Tribe (BPT), and Bureau of Reclamation (BOR)

Fish Sampling: Summit Creek

Fisheries electroshocked the same ten sites that were established in 2020 on Summit Creek (Figure 4.2) using a single-pass, upstream survey. Ten, 100-meter long, sites were randomly selected in 2020 among the lower, middle, and upper Summit treatment reaches. Two sites were sampled in lower Summit, two sites in middle Summit, and six sites were sampled in upper Summit Creek. Site lengths were 100-meters (established in 2020).

Fisheries used a LR24 Smith-Root backpack electrofisher to survey the fish at each site. Electrofisher settings were maintained as the lowest levels as which fish could be caught and no electrofishing was conducted if stream temperatures had exceeded 18° C. Trout fry (salmonid/unidentified fry < 50 mm) were counted and released during the survey. Redside Shiner (*Richardsonius balteatus batlteatus)* and dace spp. were also counted and immediately released to avoid mortalities. Other species, salmonids (Redband Trout (*Oncorhynchus mykiss gairdnerii)* and Brook Trout (*Salvelinus fontinalis*) and suckers (*Catostomus columbianus*) were collected in an aerated bucket, identified to species, measured (fork length), weighed, and released back into stream. 2022 methods differed from 2020 in that dace were identified to species as either: Speckled Dace *(Rhinichthys osculus)* or Long-nosed Dace *(Rhinichthys cataractae)*. Freshwater mussel/crayfish/and amphibian presence were all recorded.

2022 methods differed from previous years as BPT Fisheries surveyed several sites earlier in the field season than previous years. Upper Summit sites (except for site 40) were sampled the week of June 28th and the remaining sites (lower, middle, and upper Summit site 40) were sampled in the first two weeks of August.

Data Analysis

All 2022 data were analyzed using R studio (R version 4.1.2) and maps were created in ArcMap 10.5. Reports can be found on www.cbfish.org under project number 1997-01900. Data requests can be filled by contacting BPT Fisheries Biologist- Rebecca Fritz rebecca.fritz@burnspaiute-nsn.gov.

4.3 Results and Discussion

Summit Creek Fish

BPT fisheries encountered a total of six fish species in Summit Creek. Five of the species, Speckled Dace, Long-nose Dace, Redside Shiner, Bridgelip Sucker*,* and Redband Trout are native to the Malheur River. Brook Trout, invasive to the Malheur, were also present (Figure 4.3). In total, over 800 fish were captured (Table 4.1). This total count is much smaller than the previous two years. 2022 was a low water year and electrofishing efforts were adjusted to ensure fish health. Surveys did not use block nets, and fish were unintentionally chased upstream, out of the site during sampling.

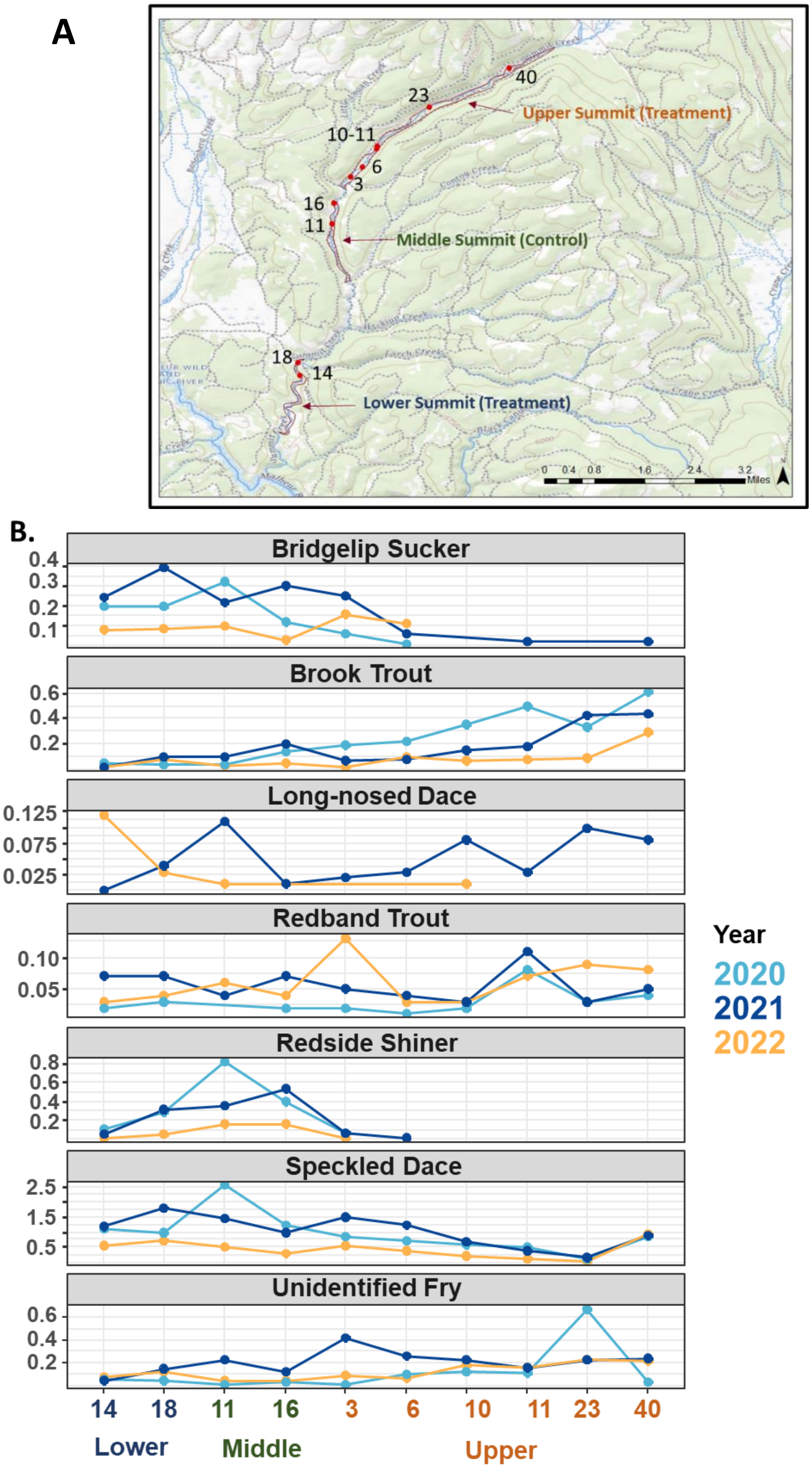


Figure 4. 2 **(A)** Map displaying the 2020-2022 Summit Creek electrofish survey sites (100-meters in length) within the USFS restoration project. **(B)** Calculated Summit Creek fish density (#fish/meter) for each electrofishing reach.

Table 4.1 (%) abundance of the total electrofishing survey

Species	Total # Fish Captured	% Relative Abundance
Dace spp.	446	55 %
Brook Trout	83	10%
Redside Shiner	42	5%
Unidentified Fry	123	15%
Bridgelip Sucker	57	7%
Redband Trout	60	8%
Total fish captured	**811**	**100%**

Although the overall survey size was relatively small (10 electrofishing sites), data show that 1) Summit Creek provides habitat for multiple species of native fish, 2) electrofishing sites were dominated by dace species (largely, Speckled Dace) (Table 4.1), and 3) excluding the unidentified fry, native fish made up 75% of the overall Summit Creek 2020 fish surveyed. Speckled Dace are present in all ten survey sites, and largely the

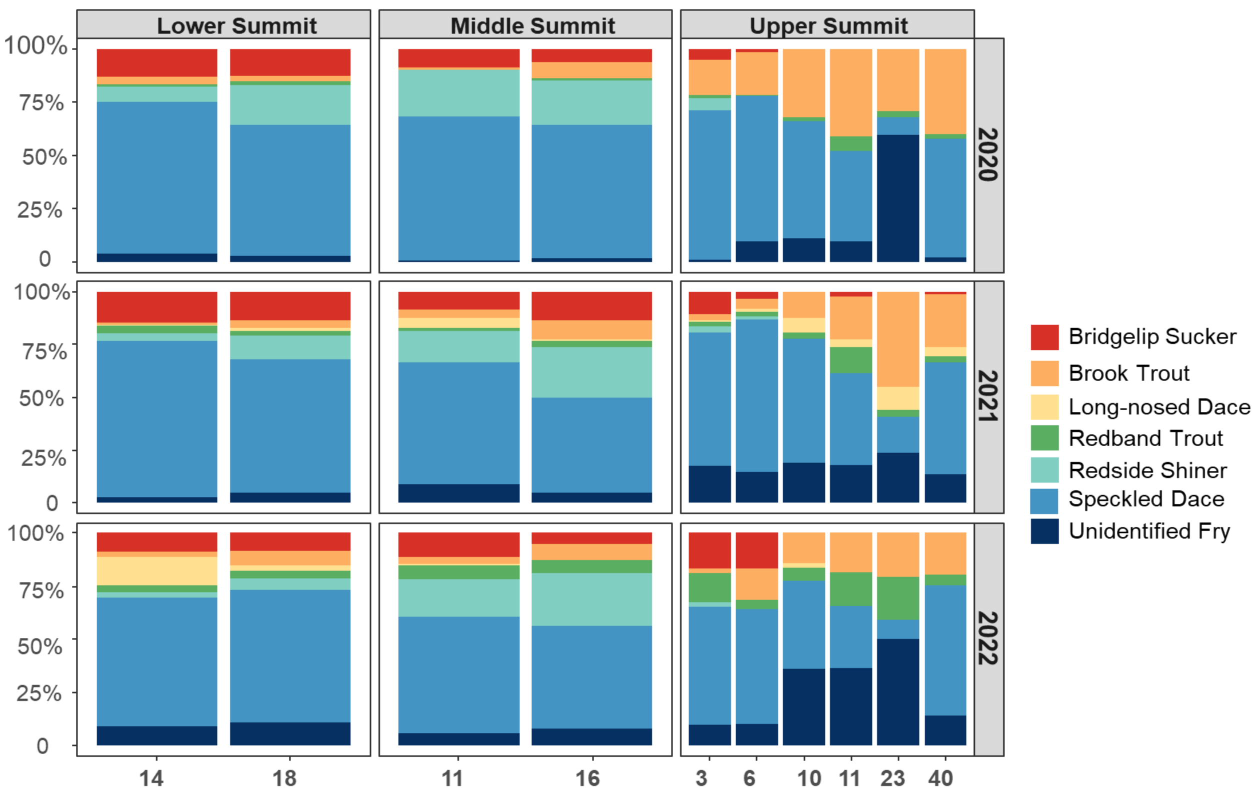


Figure 4.3. Three years of baseline sampling reveal fish species composition found in the ten electrofishing surveys distributed along the USFS restoration project. *Upper Summit 2022 sites (3,6,10,11,23) were surveyed a few weeks earlier than previous years

most abundant fish in each survey (Figure 4.3). Reflecting the previous years' results, 2020, Brook Trout become more abundant (Figure 4.3) and increase in density in the Upper Summit locations (Figure 4.2 B).

Though Brook Trout increased in abundance in Upper Summit Creek, some native fish species decreased in relative abundance at these upstream locations (Figure 4.3). Redside Shiner were not encountered in the uppermost upstream sites (Figure 4.2 B). These differences in species composition among lower and upper Summit Creek may be due to differences in habitat or due to the increase of a nonnative predator (Brook Trout). It may be a future management concern that Brook Trout occur at great densities than the native salmonid, Redband Trout. The increasing numbers of Brook Trout will be monitored by the TAC as future restoration efforts for Bull Trout and native fish recovery are implemented. The 2022 Summit Creek fish distribution or relative abundance may show differences than the previous survey years, however robust conclusions cannot be made as BPT surveyed multiple sites earlier in the season.

Occurrence of Non- Target Species

BPT Fiseries did not formally survey for freshwater mussels during any of the sampling years (2020-2022). Despite the lack of directed effort, freshwater mussel encounteres during electrofishing surveys (Table 4.2) and macroinvertebrate surveys (2020) were noted. Freshwater mussles were identified as Western Pearlshell (*Margaritfera falcata*) (Figure 4.4 C), a species known to specialize using salmonids as hosts[3]. Western Pearlshell were encountered in 2020 macroinvertebrate sampling and measured (Figure 4.4) before released. Sizes ranged from 24 mm (evidence that the mussels are reproducing) – 86mm. Western Pearlshell have been encountered in all three study reaches (low, mid, upper Summit) (Table 4.2). BPT has also spotted beds from the stream bank (Figure 4.4 B). Increasing effort to map freshwater mussles will likely be helpful

Table 4.2*.* Location of annual BPT electrofishing site with presence of non-target species

Location	**Site ID**	**UTM (Start of 100-m Survey Site)**	***Margaritfera falcata*** Present (Y) Absent (-)	***Pacifastacus leniusculus*** Present (Y) Absent (X)
Lower Summit **Treatment**	14	11T 0373503 4886768	Y	-
	18	11T 0373389 4887080	Y	-
Middle Summit **Control**	11	11T 0374115 4890753	Y	Y
	16	11T 0374197 4891215	Y	Y
Upper Summit **Treatment**	3	11T 0374462 4891899	Y	Y
	6	11T 0374672 4892176	-	Y
	10	11T 0374945 4892604	Y	Y
	11	11T 0374989 4892738	Y	Y
	23	11T 0375934 4893684	Y	Y
	40	11T 0377462 4894725	-	Y

** The majority of mussel and crayfish data were recorded in 2020
** Non-Target species Absence (X) results from no observations during electrofishing surveys

[3] Nedeau, Ethan; Smith, Allen K.; Stone, Jen; and Jepsen, Sarina. 2009. Freshwater Mussels of the Pacific Northwest. The Xerces Society. 2nd edition. 53 pages.

prior to restoration action. BPT also recorded presence of Signal Crayfish *Pacifastacus leniusculus* when encountered during electrofishing.

Future Field Objectives

BPT collected macroinvertebrate samples in 2020 (BPT Fisheries Annual Report FY 2020) but the samples still have not been sent out for processing due to limited funding. Each year BPT crews keep an eye out for evidence of the invasive Rusty Crayfish (*Orconectues rusticus)* which have been found to occur in a gravel pond near upper Summit Creek. Though there has been no formal sampling effort done by BPT, Rusty Crayfish have not been encountered during the Summit Creek surveys. BPT will partner with the USFS to determine 2023 sampling goals for the 2023 field season. 2023 will likely continue the BPT/USFS early summer surveys for amphibians and the annual electrofishing surveys.

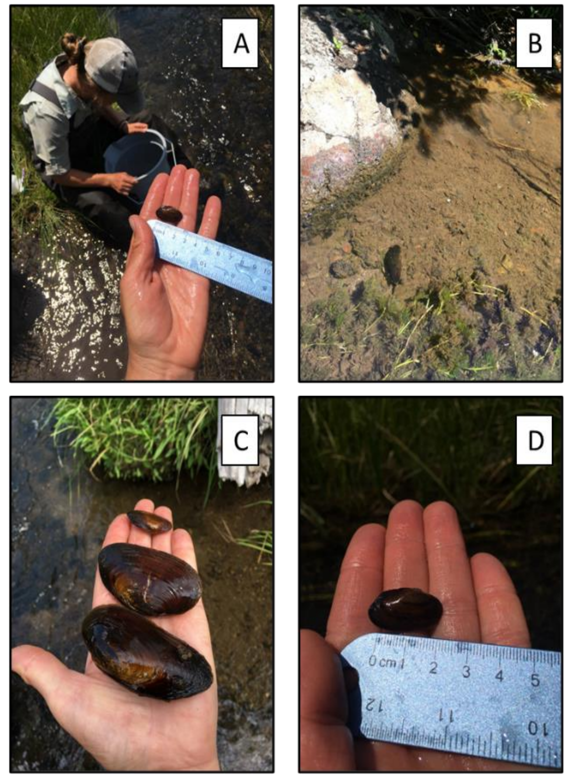
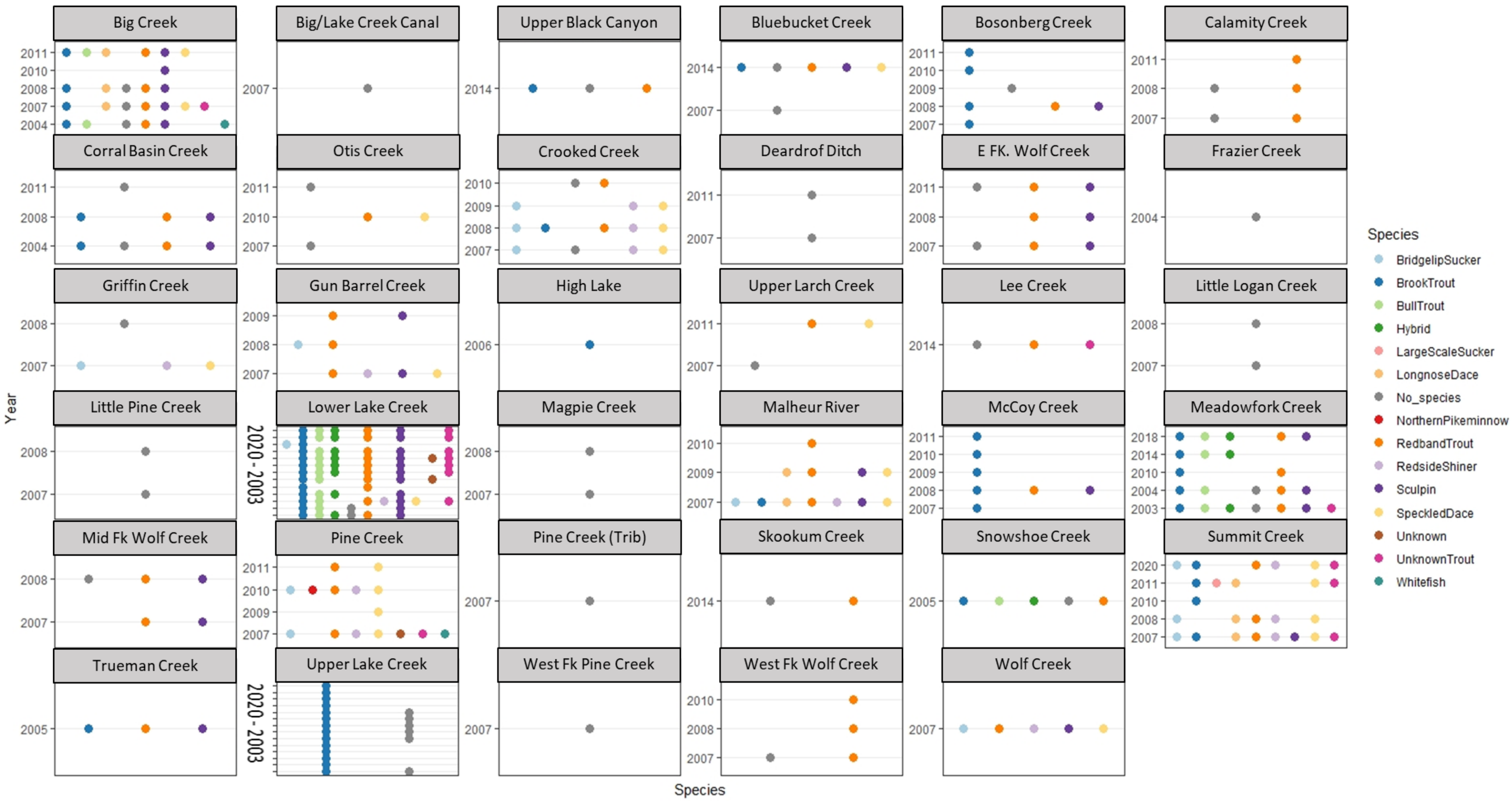


Figure 4.4 – (A) Freshwater mussels were encountered in Summit Creek during 2020 macroinvertebrate sampling or (B) spotted while electrofishing. (C) BPT noticed multiple size classes (D) including mussels ≤ 2inches.

Appendices



Appendix Figure 4.5 Archived BPT electrofishing survey data since 2003 reveals effort at Upper Malheur Streams and species encountered by staff Biologists. (Obtained from BPT Access database)