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 #84125

Prepared for Bonneville Power Administration and Northwest Power and Conservation Council

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FY 2019 Annual Report

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For work completed January 2020-December 2020

Contents

Table of Contents

Background and Context for FY2020 Annual Report

The Bonneville Power Administration (BPA) has supported fisheries research and management conducted by the Burns Paiute Tribe (BPT) Natural Resources Department in the Burns Paiute ancestral homeland since 1997. This report summarizes work completed by the BPT Fisheries Program in 2020. Field work conducted, data collected, objectives accomplished, and management activities fulfilled were approved by the Northwest Power and Conservation Council during the 2011-12 Categorical Review of Resident Fish Projects.

The primary focus of BPT Fisheries in 2020 was to continue mechanical efforts to suppress invasive brook trout. 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 recovery. Until regulatory processes can be completed to allow progress toward brook trout eradication via chemical treatment, mechanical suppression will be conducted by BPT Fisheries. In 2020, BPT Fisheries electroshocked the same locations (high-density sites in lower Lake Creek) as 2019, electroshocked the entire reach of upper Lake Creek, and set gillnets in High Lake.

BPT Fisheries continued monitoring the ten-annual temperature sites on the BPT Logan Valley Mitigation Property. 2020 resulted in the loss of three of the hobos (Logan Valley Annual Site #6, Murray Campground, and Meadow Fork). BPT also continued monitoring efforts at locations in the Upper Malheur and over in the North Fork of the Malheur. 2020 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 of the Malheur temperature sites are consistently cooler compared to the Upper Malheur sites.

The BPT Fisheries program continued to pair eDNA sampling with backpack electrofishing to investigate the suspected presence of invasive brook trout in the Little Malheur. In 2018 and 2019, BPT Fisheries combined environmental DNA (eDNA) samples with electroshocking in the Little Malheur River. Six 2019 sites were positive for brook trout eDNA presence, however none were caught via electrofishing efforts. In 2020, BPT eDNA sampling revealed a single positive hit for brook trout DNA, although (similar to previous efforts) no brook trout were caught with electrofishing or in minnow traps.

BPT assisted the US Forest Service on collecting baseline data for a future restoration project on Summit Creek, in the Upper Malheur. BPT sampled fish populations in Summit Creek using electrofishing and collected macroinvertebrate samples.

BPT Fisheries continued to maintain a website www.helpnativefish.com to educate public on local fisheries management and Eastern Oregon native fish species. BPT assisted ODFW with 1) North Fork Malheur bull trout spawning surveys and 2) monitoring a weir on Crane Creek. The 2020 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 and Brandon Haslick
BPT Natural Resource Department, Fisheries Program

Table of Contents

Chapter 1:

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

Rebecca J. Fritz and Brandon D. Haslick
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1.1 Introduction

Malheur River Bull Trout (*Salvelinus confluentus)* were listed as threatened under the Endangered Species Act in 1998 (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. 2020 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.

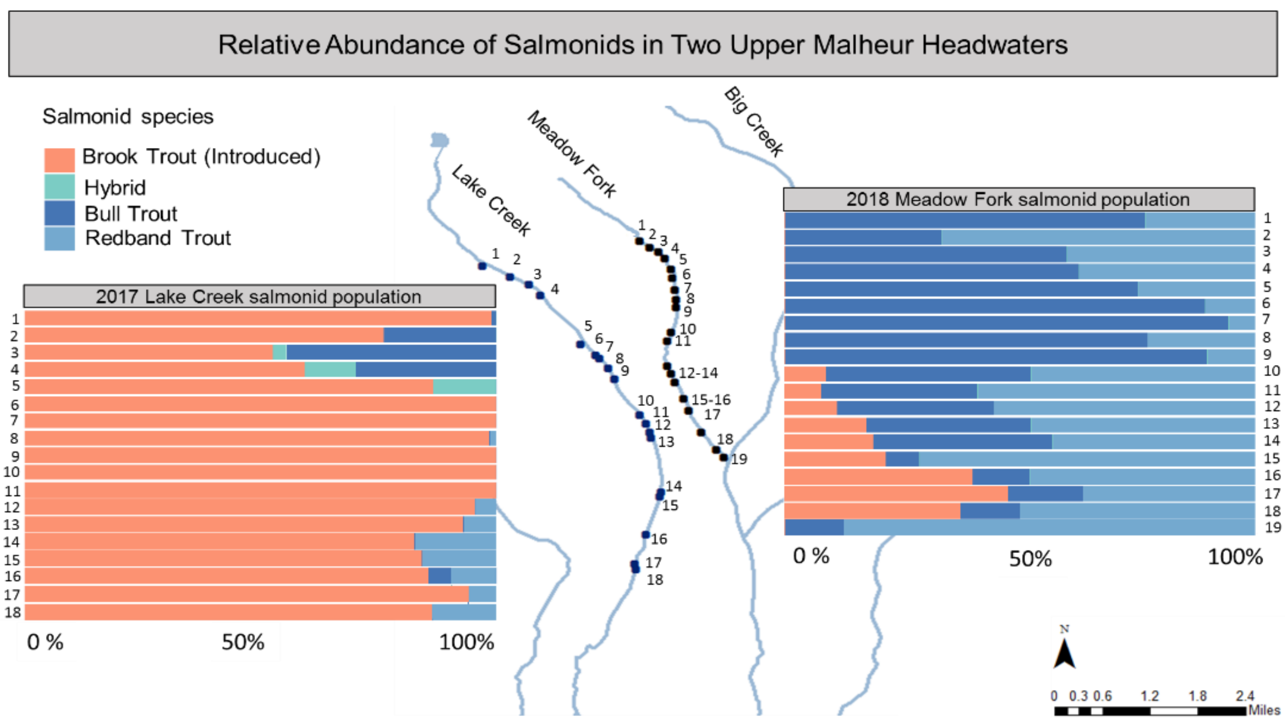


Figure 1.1 Relative abundance of 2017 and 2018 BPT population estimates**.**

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. The overarching focus of 2020 BPT field work was to continue brook trout suppression efforts in Lake Creek. Brook trout were removed using mechanical methods from multiple sites in the lower reach of Lake Creek and from the entire reach of upper Lake Creek to provide relief to the native salmonids.

1.2 Methods

The 2020 BPT Fisheries Program focused efforts on continuing the mechanical removal of brook trout from Lake Creek and High Lake. Mechanical methods included: backpack electrofishing efforts in Lake Creek, gill-netting 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 create 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) (Figure 1.2 (A)). The selected sites had been surveyed in previous years and were considered high-density brook trout sites. Lower Lake Creek electrofishing took place beginning the 29th of June and continued through the 8th 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 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.

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. Captured (brook x bull) hybrids (referred to hereafter as, hybrids) were measured and euthanized. Unless otherwise specified, data on the five individual hybrids removed during sampling season were combined with brook trout data.

Electrofishing upper Lake Creek

Upper Lake Creek was treated as a single site. A crew of two people began upstream of Lake Creek Falls and electroshocked the entire reach until High Lake. Shocking this section involved multiple efforts (a total of five) which took place from mid-July until the end of August. The final section was shocked coinciding with a gill netting effort in High Lake. All captured brook trout fry were counted and euthanized from upper Lake Creek.

Gill-netting and angling in High Lake

2020 suppression efforts ended with a final removal event in High Lake using two ¾ inch gill nets. BPT Fisheries spent a week in August 2020, setting gill-nets and angling. Two gill nets were set in High Lake and left to soak for 24 hours. Brook trout were pulled from nets and euthanized. All trout captured were measured (fork length in mm) and a subset of weights was taken (~100 randomly selected fish). Nets were cleaned are deployed again in a different section of High Lake. While nets were soaking BPT crew members angled for brook trout in High Lake and finished electrofishing in Upper Lake Creek.

Data Analysis

All 2020 data were analyzed using R studio (R version 4.0.2) and maps were created in ArcMap 10.5. Condition factor (K) was calculated for every brook trout that was both measured and weighed (100 individuals) in lower Lake Creek. The mean (K) 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 1997-01900. Data from the hybrids captured were incorporated in with brook trout analysis unless specified otherwise.

1.3 Results

In total, 1,467 brook trout were removed from Lake Creek and High Lake using various mechanical methods (Table 1). Five hybrids were also removed from Lower Lake Creek (1,472 total salmonids removed).

Table 1 Total brook trout removed in 2020 using mechanical methods

	Electrofishing	*Gill-netting*	*Angling*
Lower Lake Creek	708	—	—
Upper Lake Creek	242	—	—
High Lake	—	517	5
# Removed / Method	950	517	5
Total # Brook Trout Removed	**1,467**		

Lower Lake Creek electroshocking

Stream temperatures ranged from (4-11 °C) throughout lower Lake Creek shocking sites. Four fish species (brook trout (Table 1), bull trout (18 individuals captured), redband trout (6 individuals captured), sculpin (*Cottus spp*), and unidentified 'trout fry' (defined as salmonid fry < 50 mm) were encountered during lower Lake Creek electrofishing surveys. No bull trout or redband trout mortalities resulted from the year's sampling effort.

Brook trout (and hybrids) made up the greatest proportion (~ 93%) of the overall population captured in the 2020 lower Lake Creek Sites (Figure 1.2 (B)). Lengths ranged from ~60-250 mm (Figure 1.2 (C)) however the size distributions differed from 2019 (Appendix Figure 1.3). Combing the length data with collected weights resulted in the average condition factor for (100) fish sampled was K= 1.196 (or, 1.2, n =134). This value places the physical body condition of lower Lake Creek brook trout as being considered relatively fair (Appendix Figure 1.4) (Barnham & Baxter, 1998).

Upper Lake Creek and High Lake

Brook trout are the only fish species to occur above Lake Creek Falls and in High Lake. 242 brook trout were removed from upper Lake Creek by electroshocking the entire reach from Lake Creek Falls to High Lake (Figure 1.2 (A)). The final portion of upper Lake Creek was shocked concurrently with the High Lake gill-netting. A total of 522 brook trout were removed from High Lake with two ¾ inch gill nets and angling. High Lake had a lower mean condition factor (K= 1.13, n = 164).

1.4 Discussion

Mechanical methods unable to effectively eradicate Lake Creek brook trout

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 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 2019 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 2020 condition factor followed this trend (Appendix 1.4). **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.

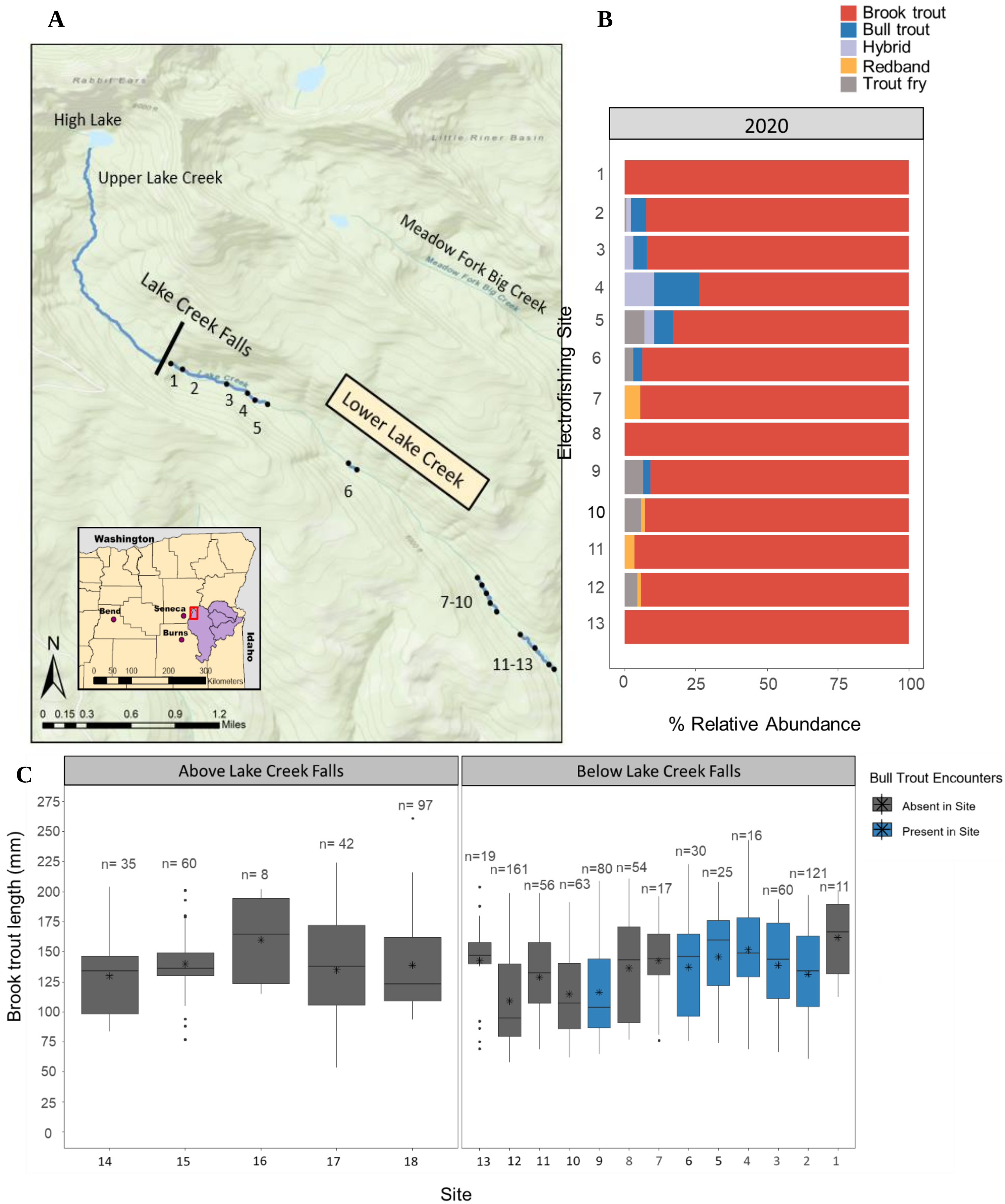


Figure 1.2 (A) Map of Lake Creek 2019 / 2020 electrofishing sites (B) 2020 relative abundance of salmonids at each electrofishing site in lower Lake Creek (C) Lengths (fork length) of lower Lake Creek brook trout and the five hybrids**.** N= 713. (*) denotes the mean for the site

Continuing the trend, 2020 brook trout dominated the lower Lake Creek salmonid relative abundance (Figure 1.2 B). **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). 2020 removal totals were lower than previous years (Fig. Appendix 1.5). Regarding High Lake, one of the gill nets was largely ineffective for two of the days it was deployed due to being snagged on an underwater log. In total, 2020 mechanical suppression efforts removed over 900 brook trout from Lake Creek, and ~700 of which were directly removed from habitat shared by native salmonids.

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 also 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 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. In the past five years (since 2016) BPT has removed over 10,000 brook trout from the Lake Creek Drainage (Figure Appendix 1.5). In 2020, BPT had continued collaboration with the Malheur River Bull Trout Technical Advisory Committee (TAC) which formed and 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.

References

Barnham, C. & A. Baxter. 1998. Condition Factor, K, for salmonid fish. Fisheries Notes. State of Victoria, Department of Primary Industries. FN0005.

Bowers, W.L., P.A. Dupree, M.L. Hanson, R.R. Perkins. 1993. Bull Trout Population Summary Malheur River Basin. Oregon Department of Fish and Wildlife. Hines, OR. Unpublished report.

Buktenica, M.W., D.K. Hering, S.F. Girdner. 2013. Eradication of nonnative brook trout with electrofishing and Antimycin-A and the response of a remnant bull trout population. North American Journal of Fisheries Management. 33: 117-129.

Crowley, K. 2015. Population Estimates of Brook Trout from High Lake- A Population Seed Source for the Upper Malheur River, Oregon. "Evaluate the Life History of Native Salmonids in the Malheur Subbasin." FY 2014 Annual Report. Project No. 1997-01900. (BPA Report BOE/BP-00006313-5).

Crowley, K. 2017. Population Estimates of Brook Trout from High Lake- A Population Seed Source for the Upper Malheur River, Oregon. "Evaluate the Life History of Native Salmonids in the Malheur Subbasin." FY 2016 Annual Report. Project No. 1997-01900.

Crowley, K. 2018. Population Estimates for Three Salmonids in Meadow Fork Big Creek, Upper Malheur River, Oregon. "Evaluate the Life History of Native Salmonids in the Malheur Subbasin." FY 2017 Annual Report. Project No. 1997-01900.

DeHaan, P.W., Schwabe, L. T., & Ardren, W. R. 2009. Spatial patterns of hybridization between bull trout, Salvelinus confluentus, and brook trout, Salvelinus fontinalis in an Oregon stream network. Conservation Genetics, 11(3), 935-949.

Fulton, T. 1902. Rate of growth of seas fishes. Sci Invest Fish Div Scot Rept. 20.

Gunckel, S.L. 2001. Feeding Behavior and Diet of Native Bull Trout Salvelinus confluentus and Introduced Brook Trout Salvelinus fontinalis in two Eastern Oregon Streams. Master's Thesis. Oregon State University, Corvallis.

Harper, D. 2012. Selective Removal of Brook Trout Salvelinus fontinalis in Lake Creek, Upper Malheur River, Oregon. "Evaluate the Life History of Native Salmonids in the Malheur Subbasin." FY 2012 Annual Report. Project No. 1997-01900. (BPA Report BOE/BP-00006313-5).

Meyer, K.A, Lamansky, J.A., & Schill, D.J. 2006. Evaluation of an Unsuccessful Brook Trout Electrofishing Removal Project in a Small Rocky Mountain Stream. North American Journal of Fisheries Management. 26: 849-860.

Poole, A. and D. Harper. 2011. 2010 High Lake Brook Trout Suppression. "Evaluate the Life History of Native Salmonids in the Malheur Subbasin." FY 2010 Annual Report. Project No. 1997-01900. (BPA Report BOE/BP-00006313-5).

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin of the Fisheries Research Board of Canada. Ottowa.

R version 3.6.0 (2019-04-26) -- "Planting of a Tree." Copyright (C) 2019. The R Foundation for Statistical Computing. Platform: x86_64-w64-mingw32/x64 (64-bit)

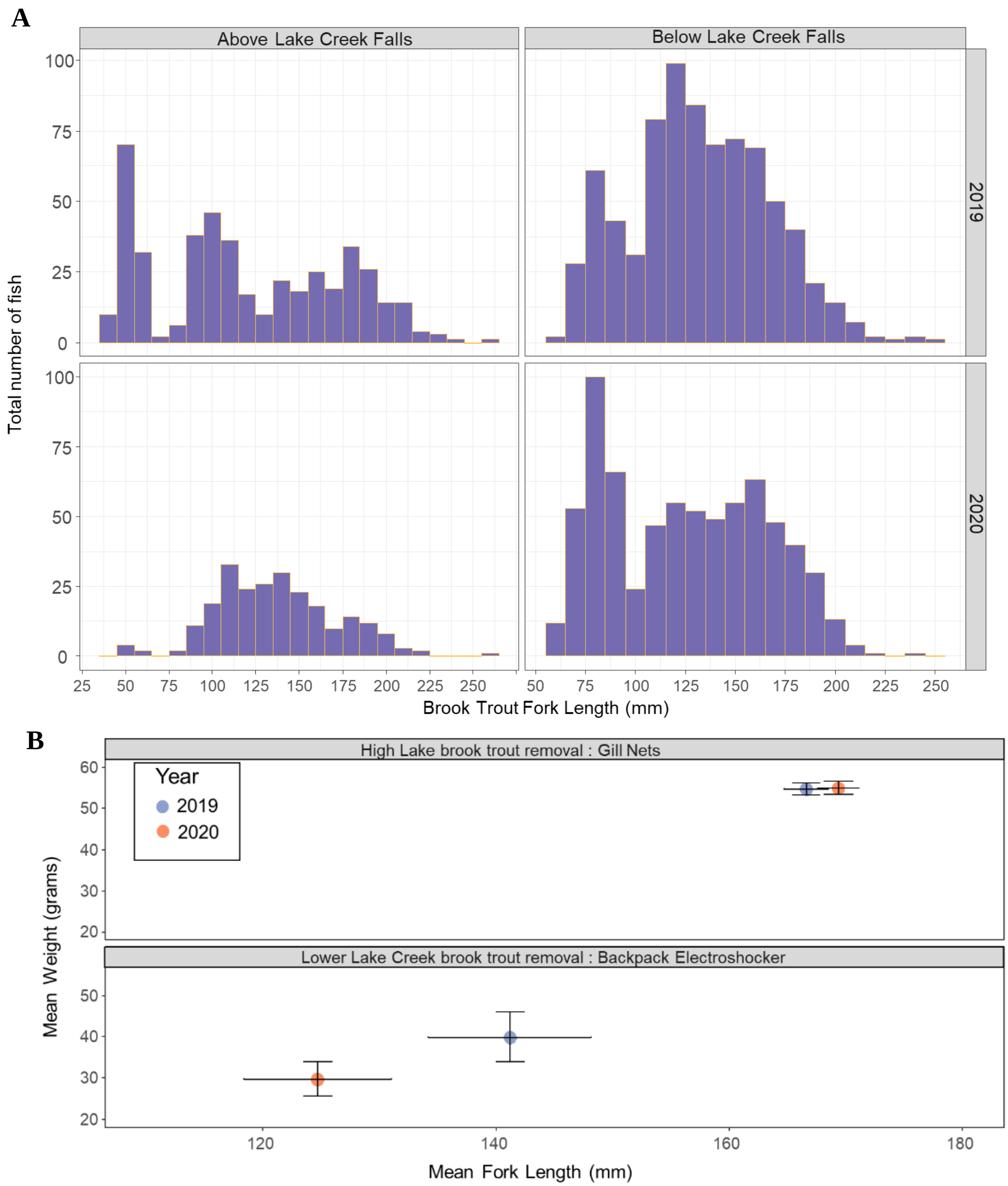
(TAC) Malheur River Bull Trout Technical Advisory Committee: Burns Paiute Tribe, Oregon Dept. of Fish and Wildlife, US Fish and Wildlife Service, US Forest Service, US Bureau of Reclamation and QW Consulting. 2017. Upper Malheur River Bull Trout Conservation Strategy. FY 2017 Annual Report. Project No.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

Thompson, P.D. & F.J. Rahel. 1996. Evaluation of depletion-removal electrofishing of brook trout in small Rocky Mountain Streams. North American Journal of Fisheries Management. 16: 332-339.

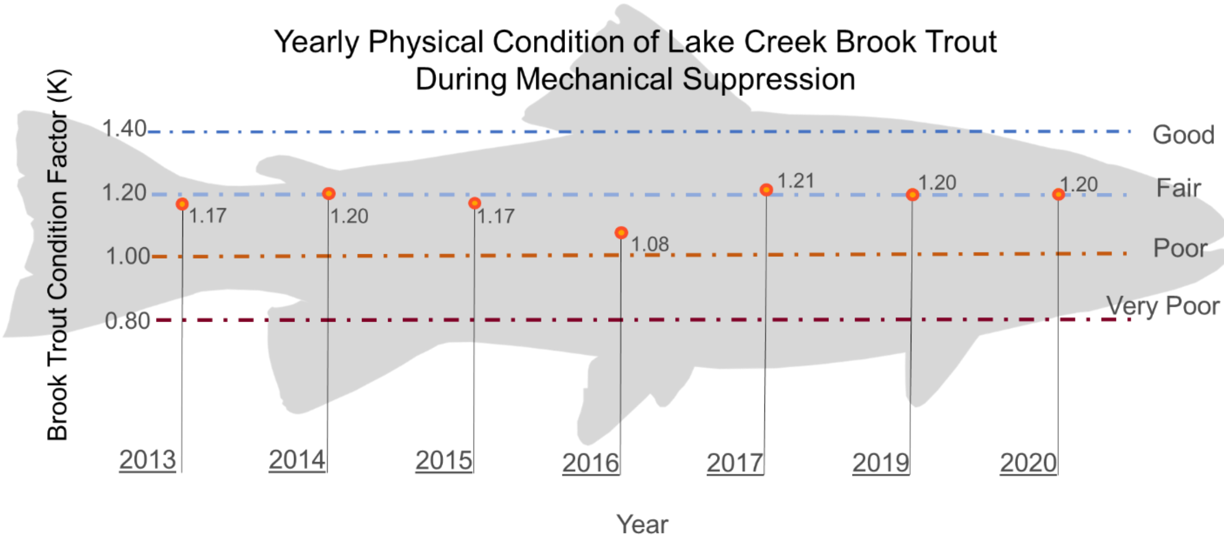
U.S. Fish and Wildlife Service. 2002. Chapter 14: Malheur Recovery Unit, Oregon. Pages 1-71 *in*: U.S. Fish and Wildlife Service. 2002. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of Bull Trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

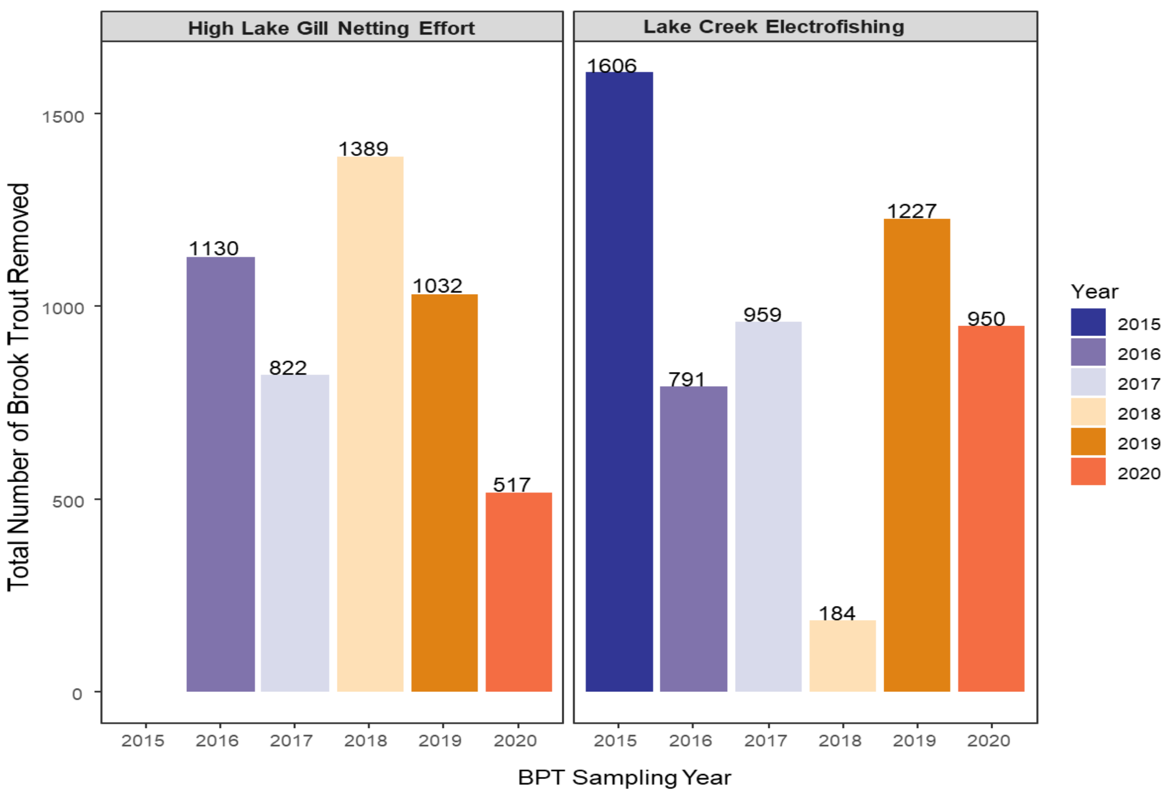
Appendices



Appendix Figure 1.3 (A) 2020 and 2019 electrofishing results: length frequency histogram detailing brook trout fork lengths (mm), bins = 25 **(B) The 2019/2020 mean values with 95% CI for length (mm) and weight (g) of a subset of brook trout removed (~100 fish) via High Lake gill nets or electrofishing removal in Lower Lake Creek**



Appendix Figure 1.4 Mean condition factor (K) calculated for the lower Lake Creek brook trout throughout BPT suppression efforts



Appendix Figure 1.5 Total brook trout removed from the Lake Creek drainage by BPT within the last five years

Chapter 2: 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

Table of Contents

Chapter 2

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

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2.1 Introduction

Stream temperature directly impacts 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 Upper Malheur River (also referred to as the Middle Fork of the Malheur). A series of ten stream temperature sites have been monitored annually to track the effects of habitat improvement projects on the property (Figure 2.1 A). Since the establishment of the annual sites, BPT's stream temperature monitoring has expanded to include various sites in the Upper Malheur as well as in 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.

2.2 Methods

Study Area

The Burns Paiute Tribe Fisheries Program monitors temperatures in the Malheur River Watershed in Eastern Oregon. The sites selected for temperature monitoring fall into two subbasins: Upper Malheur and North Fork of the Malheur. 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 the major Upper Malheur tributaries.

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 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 2.1) (Namitz 2000; Schwabe 2001, 2002, 2003, 2004, 2007; Fenton and Schwabe 2005, 2007; Fenton 2006; Abel 2008, 2009; Brown 2010, 2011, 2012; Haslick 2014, 2015, 2016, 2017, 2018, Haslick and Fritz 2019).

Table 2.1 Burns Paiute Tribe ten annual temperature sites on the Logan Valley Wildlife Mitigation Property**.** (*) denotes the loggers exposed to air temperature during the 2020 monitoring period

Site #	Location	Year Initiated	2020 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	No	Schwabe 2007
7	McCoy Creek above Lake Creek	2007	Yes	Schwabe 2007
8	Lake Creek at Cabin Bridge	2008	Yes *	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

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, and McCoy Creek (seven sites to date in 2020) (Figure Appendix 2.5).

North Fork of the Malheur River

BPT has also expanded the temperature monitoring effort to include tributaries in the neighboring North Fork Subbasin. This involves nine monitoring sites on the North Fork of the Malheur and its tributaries (Figure Appendix 2.5). These locations are on streams in USFS managed forests. In total, for the 2020 field year BPT fisheries was actively monitoring stream temperatures in both Grant and Baker County- Eastern Oregon.

Field Techniques

Pre/Post Deployment:

All stream temperatures were monitored using Tidbit v2 Temperature Loggers (hereafter 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.

Field Deployment:

All temperature loggers at the Logan Valley Mitigation Property were set in the field by the middle of May. Most Upper Malheur loggers and North Fork loggers were also set within this time frame. The 2020 upper McCoy Creek logger (#15) (Figure Appendix Figure 2.5) was moved ~100 meters upstream. 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 within October. Once gathered from the field, loggers were required to pass post-deployment accuracy tests.

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 final 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). Evidence for the two dewatered sites (Logan Valley annual sites #6 and #8) in which, the loggers were exposed to air, is provided (Appendix Figure 2.7). The point of air exposure is identified, and further temperature data are excluded. 2020 data were analyzed using R Studio (R Studio 2020) and maps of were created using ArcMap 10.5. Raw data can be obtained by contacting Brandon Haslick (brandon.haslick@burnspaiute-nsn.gov).

2.3 Results

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 thru August 15th (Perkins 1999). Peak high stream temperatures occur within or near this critical period (Figure 2.2 A) 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, 2003, 2004, 2007; Fenton and Schwabe 2005, 2007; Fenton 2006; Abel 2008, 2009; Brown 2010, 2011, 2012; Haslick 2013, 2014, 2015, 2016, 2018; Haslick and Fritz 2019).

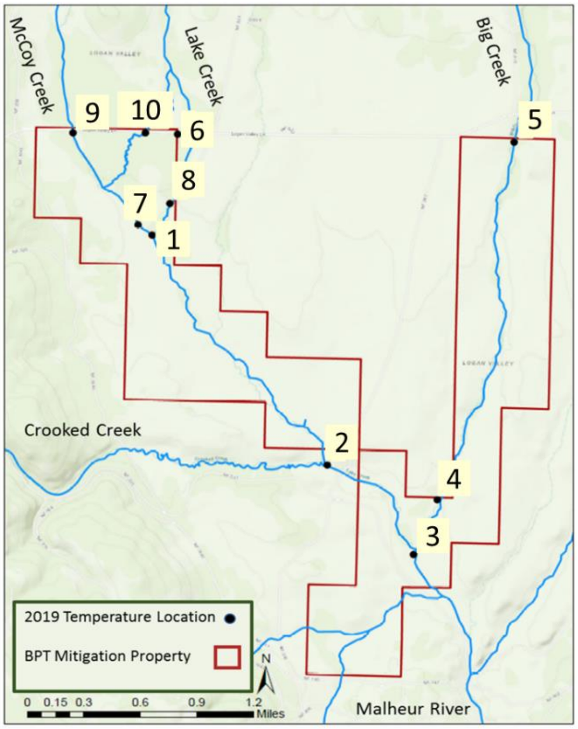
Logan Valley Mitigation Property ten annual sites

The 2020 BPT Logan Valley temperature sites (Figure 2.1 **A**) all had MWMT temperatures peak within the critical period (Figure 2.1 **B**). When comparing only the complete datasets, all but the two sites on Big Creek had an MWMT that exceeded the ILT threshold for bull trout (20.9 C) (Selong et al. 2001) (Table 2.2), 2020 had warmer peak temperatures than past years (Figure 2.2 B), and McCoy Creek has repeatedly had the warmest temperatures on the LVWMP (Figure 2.2. B). The logger for site LVWMP site #6 not recovered (neither anchor nor logger located) though the location was dewatered. The logger was exposed to air during peak summer at site 1 on Lake Creek so data is reported (2.1 B) but will not be analyzed. All logger passed post deployment checks.

Table 2.2 The total number of days (and %) for the last two seasons in which MWMT exceeded specified temperature benchmarks at the LVWMP. Sites 1 and 8 excluded due to air exposure. Site 6 was not recovered.

	DEQ: Bull Trout Days >12 °C		**DEQ: Salmonids Trout Days >16 °C**		**ILT: Bull Trout Days >20.9 °C**	
Site #	2019	2020	2019	2020	2019	2020
2	120 days 98%	122 days 100%	95 days 78%	95 days 78%	44 days 36%	50 days 41%
3	112 days 91%	122 days 100%	75 days 61%	81 days 66%	0	8 days 7%
4	111 days 91%	122 days 100%	67 days 55%	77 days 63%	0	0
5	89 days 73%	87 days 71%	14 days 11%	32 days 26%	0	0
7	No data	122 days 100%	No data	89 days 73%	No data	37 days 30%
9	122 days 100%	122 days 100%	104 days 85%	108 days 89%	54 days 44%	60 days 49%
10	105 days 86 %	114 days 93%	68 days 56%	77 days 63%	4 days 3%	22 days 18%

A



B

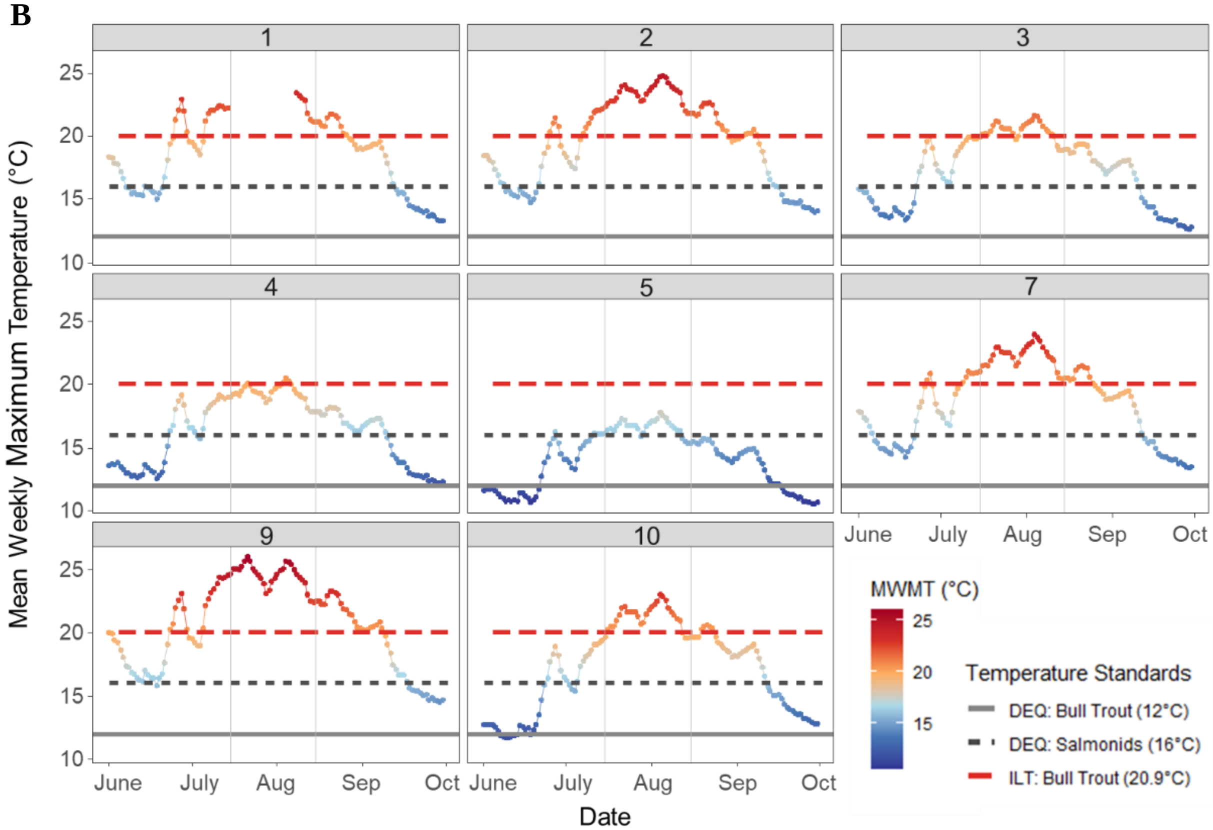


Figure 2.1 (A) BPT ten annual temperatures sites on the LVWMP **(B)** BPT 2020 MWMT (°C) values for 8 of the ten 2020 annual sites. Vertical lines denote the 'critical time period' for bull trout. Site 6 and 8 had an incomplete dataset due to air exposure and were not included.

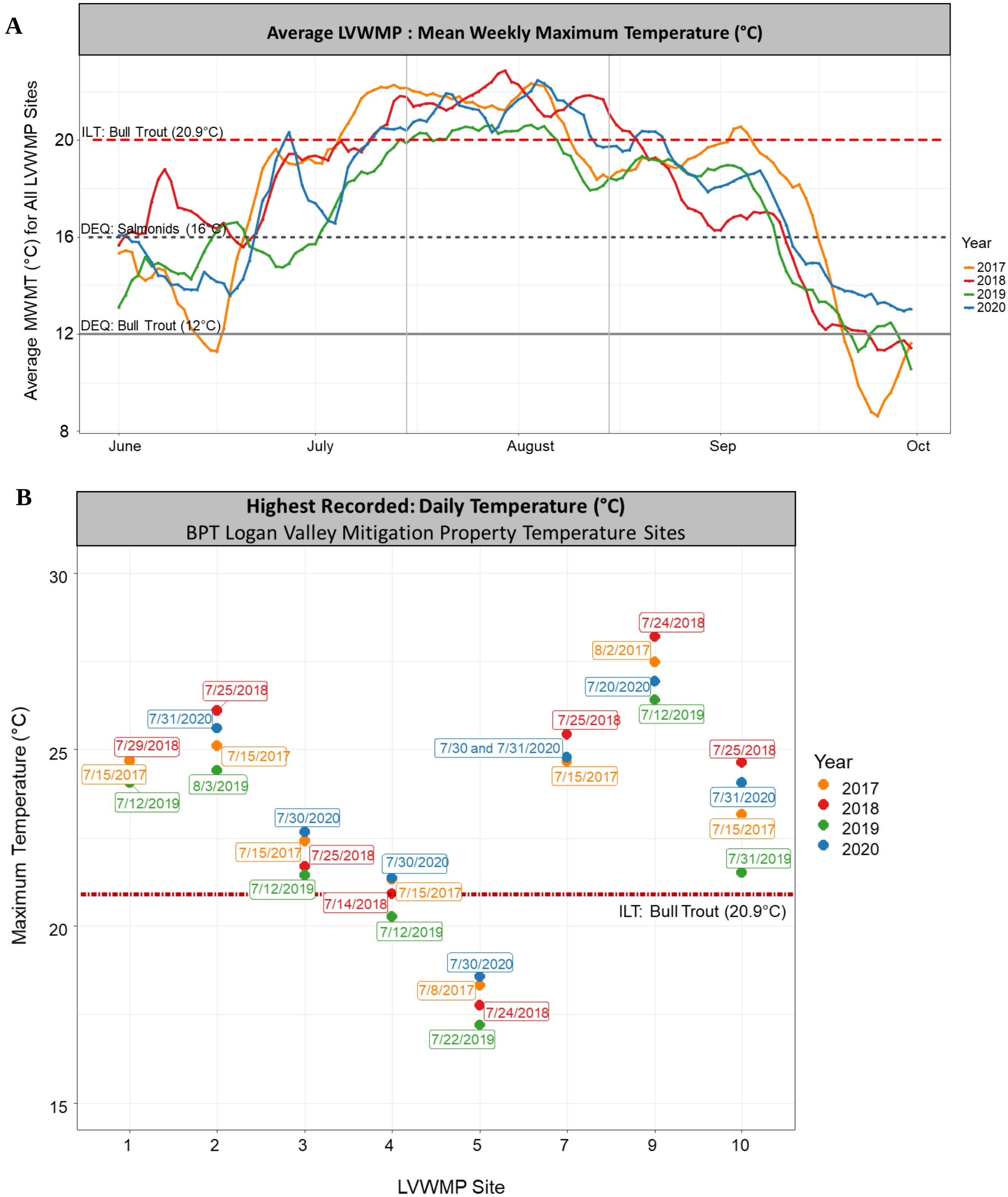


Figure 2.2 (A) Average MWMT (°C) for the BPT LVWMP ten annual temperature sites. Temperatures are recorded for the BPT monitoring period: June 1st- September 30th. Vertical lines denote the 'critical time period' for bull trout. **(B)** The highest temperatures recorded for each site (excluding sites 1, 6 and 8) for the BPT LVWMP (data found in **Appendix Table 2.3**)

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. 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 2.3). Of the BPT monitoring locations, the ten annual sites (sites 1-10) in Logan Valley result in consistent thermal barriers to bull trout migration (Figure 2.3, 2.4).

2.4 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

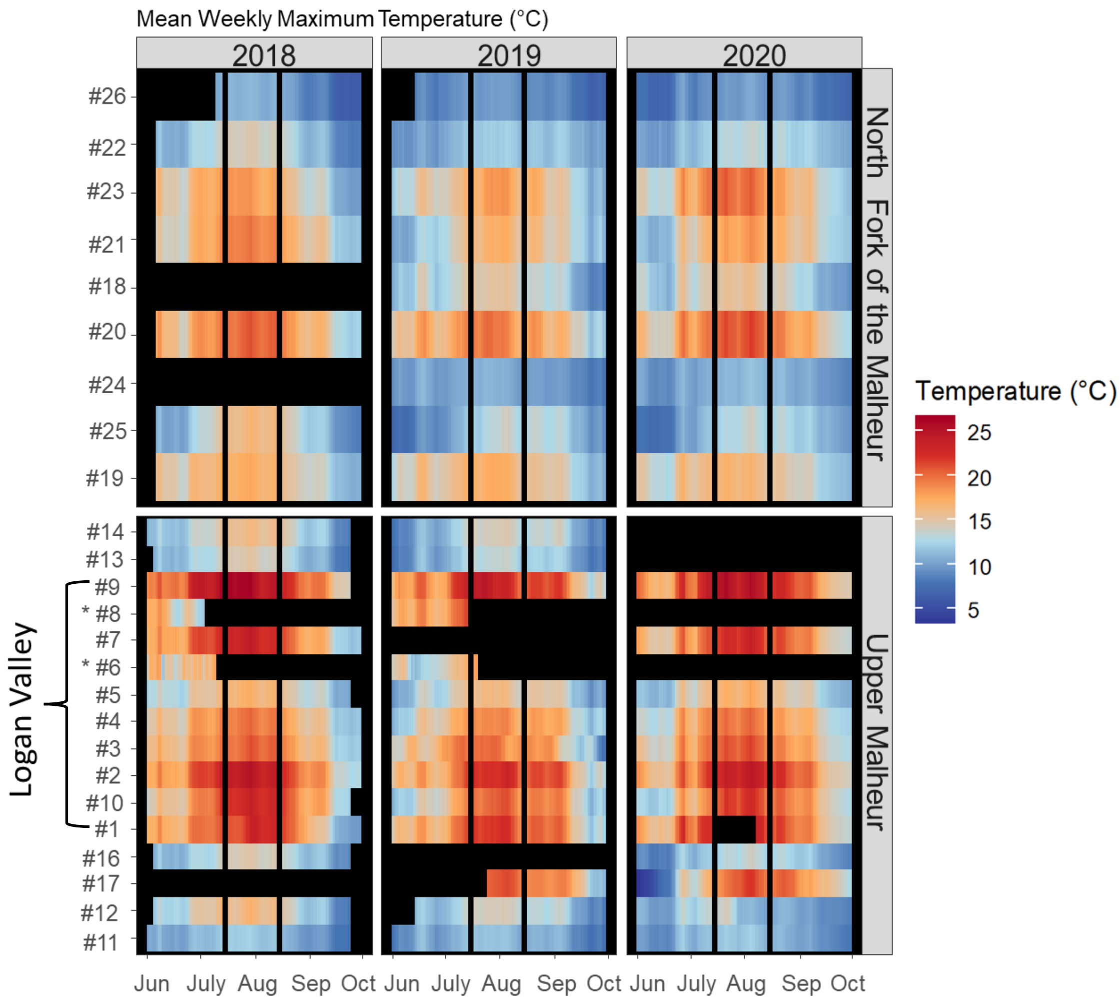


Figure 2.3 The past three years MWMT (°C) for North Fork and Upper Malheur BPT temperature logger locations**.** Sites 1-10 are the LVWMP ten annual sites. Vertical lines denote the critical period for bull trout (July 15th - August 15th). Sites (y-axis) correspond to the map: ***Appendix Figure 2.5***

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 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. The temperatures of these tributaries rise as they enter Logan Valley becoming restrictive to bull trout at most sites throughout the summer months (Figure 2.4). Several trends have been observed over time regarding temperatures on the LVWMP. 1) Big Creek lowers the temperature of the Malheur River (site 3). 2) McCoy Creek (sites 7 and 9) is a driver of the hot stream temperatures in Lake Creek. 3) Finally, lack of continuous flow throughout the summer (sites 6 and 8)

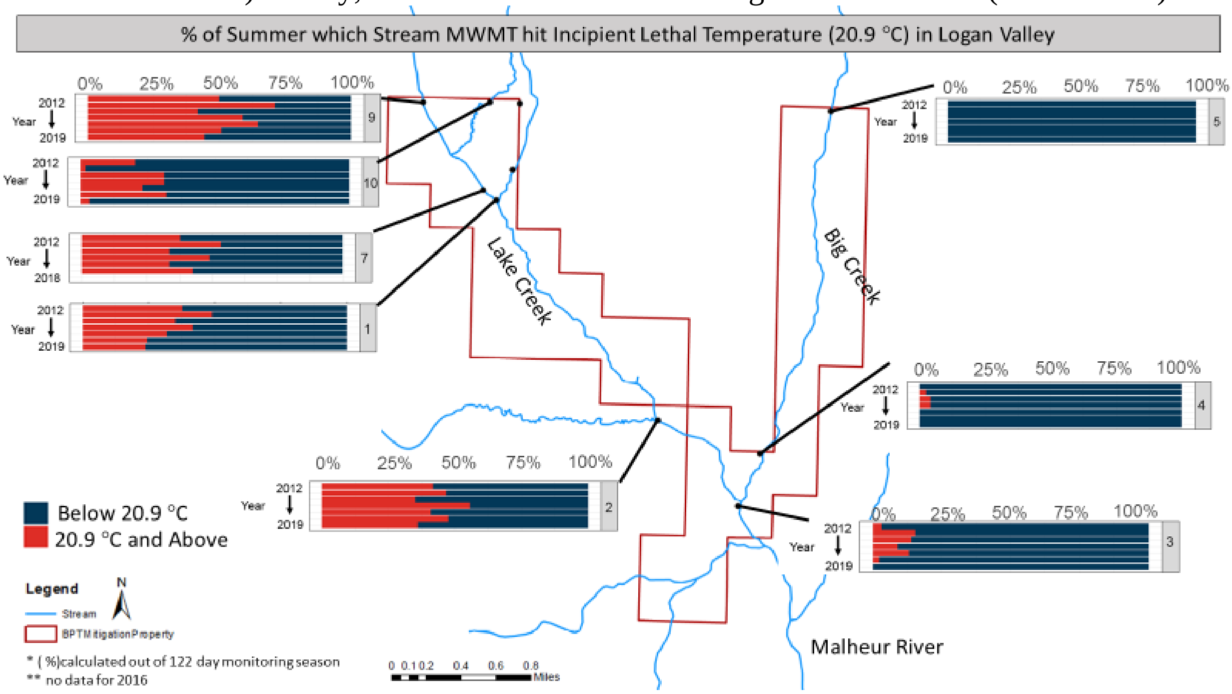


Figure 2.4 Percent of the days during the summer monitoring season (June 1st- October 1st) in which temperatures reach or exceed ILT at ten annual sites. (%) calculated out of a 122-day monitoring season. No data available for 2016 or for sites 6 and 8 (dewatered annually)

presents barriers to migrating fish and could potentially lead to entrainment (Figure 2.3, Appendix Figure 2.7) (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. The ten LVWMP loggers will provide valuable information regarding status of present and future restoration efforts.

BPT monitors temperatures upstream of the LVWMP on the Upper Malheur headwaters to inform current and future bull trout recovery efforts. Loggers located on Lake Creek provide temperature data in habitat where bull trout populations are facing competition and hybridization from invasive brook trout. Invasive brook trout are identified as the primary threat to Upper Malheur bull trout recovery, and monitoring stream temperatures in the headwater streams informs future management actions. Tracking temperature trends will provide important habitat information for planned brook trout eradication efforts. For instance, Lake Creek, particularly upper Lake Creek and High Lake, are the first locations for proposed rotenone efforts.

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 cooler as compared to Upper Malheur (Figure 2.3). North Fork logger locations are in 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 will continue future collaboration with partner agencies to collect important temperature data throughout the Upper Malheur and the North Fork Malheur.

2019 challenges and changes

2020 temperature monitoring experienced some challenges. One of the Logan Valley annual temperature loggers was not collected. The logger was not attached to the anchor upon fall retrieval. Two of the Upper Malheur loggers (Murry Campground and Meadow Fork Creek) could not be located during the fall collection event.

References

Abel, C. 2008. Synopsis of 2000-2008 Stream Temperature Monitoring with Implications for Bull Trout Recovery in the Upper Malheur. Burns Paiute Tribe 2008 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 2-1: 2-24. BPT Natural Resources Dept. Fisheries Division. Burns, Oregon.

Abel, C. 2009. 2009 Stream Temperature Monitoring with Implications for Bull Trout Recovery in the Upper Malheur. Burns Paiute Tribe 2009 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 2-1: 2-20. BPT Natural Resources Dept. Fisheries Division. Burns, Oregon.

Brown, D. 2010. 2010 Stream Temperature Monitoring in the Upper Malheur. Burns Paiute Tribe 2010 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 2-1: 2-22. BPT Natural Resources Dept. Fisheries Division. Burns, Oregon.

Brown, D. 2011. 2011 Stream Temperature Monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2011 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 5-1: 5-22. BPT Natural Resources Dept. Fisheries Division. Burns, Oregon.

Brown, D. 2012. 2012 Stream Temperature Monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2012 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 3-1: 3-24. BPT Natural Resources Dept. Fisheries Program. Burns, Oregon.

Buchanan, D.V., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 119-126 *in* Brewin, M.K., W.C. Mackay, and M. Monita. 1997. Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force, c/o Trout Unlimited Canada. Calgary, Alberta.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's Bull Trout. Oregon Department of Fish and Wildlife. Portland, Oregon.

Dehaan, P.W., L.T. Schwab, and W.R. Ardren. 2009. Spatial patterns of hybridization between bull trout, *Salvelinus confluentus*, and brook trout, *Salvelinus fontinalis* in an Oregon stream network. Conservation Genetics 11, Issue 3: 935-949.

Dunham, J.B., and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9, Issue 2: 642-655.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894-904. American Fisheries Society.

Fenton, J., and L. Schwabe. 2001. Use of Radio Telemetry to Document Movements of Bull Trout in the Upper Malheur River, Oregon. Burns Paiute Tribe 2001 Annual Report: Evaluation of the Life History of Native Salmonids in the Malheur River Basin (Cooperative Bull Trout/Redband Trout Research Project). BPA Report DOE/BP-00006313-3. Pages 37-66. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Fenton, J., and L. Schwabe. 2005. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property, 2005. Burns Paiute Tribe 2005 Annual Report: Evaluation of the Life History of Native Salmonids in the Malheur River Basin. BPA Report DOE/BP-00006313-6. Pages 7-1: 7-21. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Fenton, J. 2006. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property, 2006. Burns Paiute Tribe 2006 Annual Report. Pages 5-1: 5-27. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Haas, G.R. 2001. The mediated associations and preferences of native bull trout and rainbow trout with respect to maximum water temperature, its measurement standards, and habitat. Pages 23-26 *in* Brewin, M.K., M. Monita, and A.J. Paul, editors. Bull Trout II Conference Proceedings. Trout Unlimited Canada. Calgary, Alberta.

Halofsky, J.E., D.L. Peterson., eds. 2017. Climate change vulnerability and adaptation in the Blue Mountains. Gen. Tech. Rep. PNW-GTR-939. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 331 p.

Haslick, B.D. 2014. 2013 Stream Temperature Monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2013 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Pages 4-1: 4-31. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Haslick, B.D. 2015. 2014 Stream Temperature Monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2014 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Pages 3-1: 3-27. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Haslick, B.D. 2016. 2015 Stream Temperature Monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2015 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Pages 2-1: 2-27. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Haslick, B.D. 2018. 2017 Stream Temperature Monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2017 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Pages 2-1: 2-28. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Haslick, B.D and R. Fritz. 20**19**. Stream Temperature Monitoring in the Upper Malheur Subbasin, the Logan Valley Wildlife Mitigation Property, and in the North Fork of the Malheur Subbasin. Burns Paiute Tribe 2019 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Pages 2-1: 2-28. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Heinrick, K.A. 2014. Informational meeting. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

Heinrick, K.A., and E.M. Maltz. 2013. Informational meeting. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.

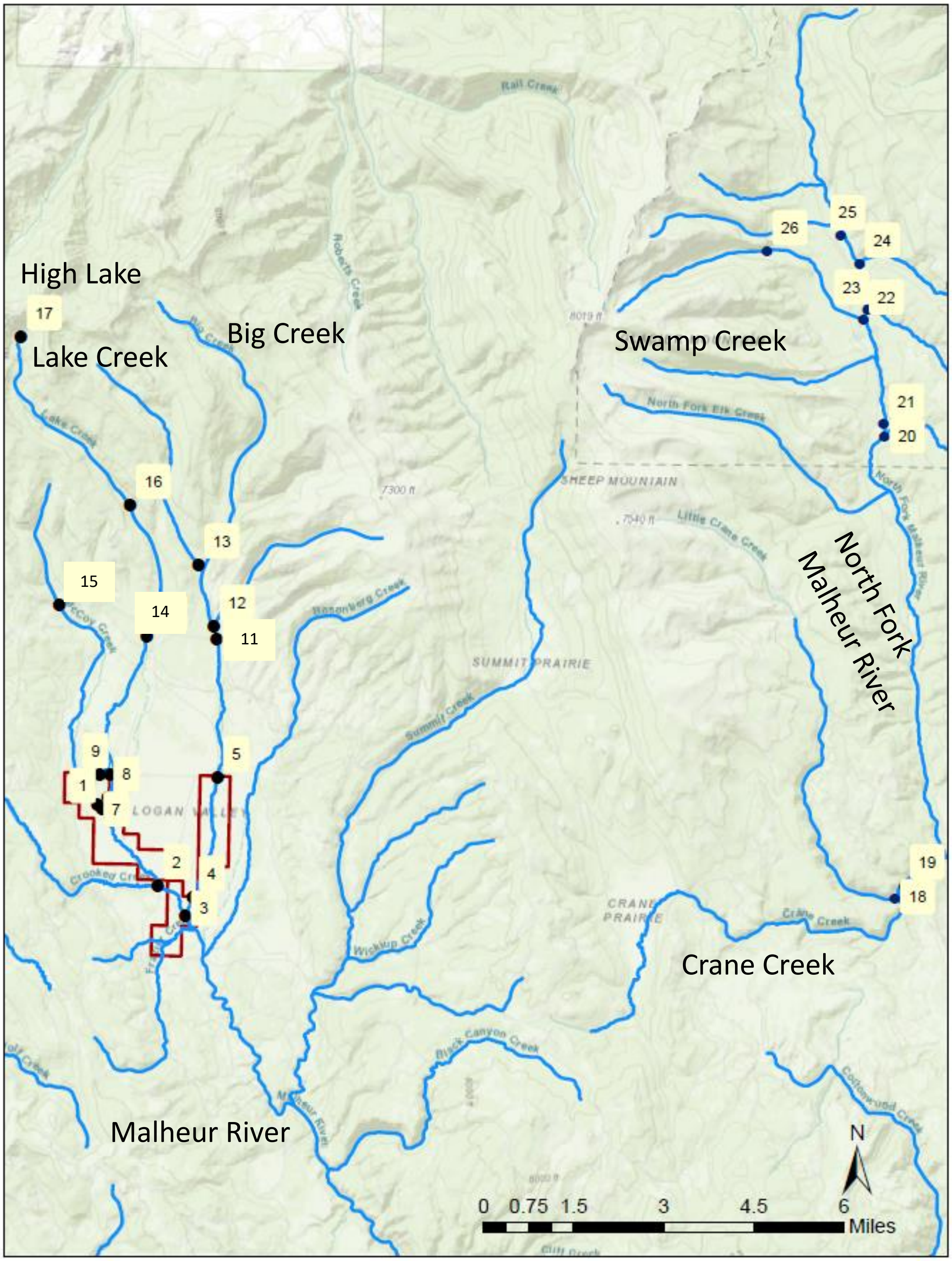
(MW Council) Malheur Watershed Council and Burns Paiute Tribe. 2004. Malheur River Subbasin Assessment and Management Plan for Fish and Wildlife Mitigation Appendix A, Part 2- Aquatic Assessment. Prepared with assistance of: Watershed Professionals Network, LLC. 1-168.

Oregon Plan for Salmon and Watersheds, Version 2.0. 2001. Water Quality Monitoring Technical Guidebook.
Oregon Administrative Rule (OAR) 340-041-0028. 2004. Oregon Secretary of State. Department of Environmental Quality. Salem, Oregon.
Namitz, S. 2000. Upper Malheur River Water Quality and Bull Trout. Burns Paiute Tribe 2000 Annual Report: Evaluation of the Life History of Native Salmonids in the Malheur River Basin (Cooperative Bull Trout/Redband Trout Research Project). BPA Report DOE/BP-00006313-2. Pages 96-119. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Perkins, R. 1999. Malheur River Bull Trout Population Status Special Report. Oregon Department of Fish and Wildlife. Southeast Fisheries District.
Rieman, B.E.; D. Isaak,S. Adams, D. Horan,D. Nagel, C. Luce,D. Myers. 2007. Anticipated Climate Warming Effects of Bull Trout Habitats and Populations Across the Interior Columbia River Basin. *Transactions of the American Fisheries Society.* 136: 1552-1565.
Schwabe, L. 2000. Use of Radio Telemetry to Document Movements of Bull Trout in the Upper Malheur River, Oregon. Burns Paiute Tribe 2000 Annual Report: Evaluation of the Life History of Native Salmonids in the Malheur River Basin (Cooperative Bull Trout/Redband Trout Research Project). BPA Report DOE/BP-00006313-2. Pages 11-32. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Schwabe, L. 2001. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property. Burns Paiute Tribe 2001 Annual Report: Evaluation of the Life History of Native Salmonids in the Malheur River Basin (Cooperative Bull Trout/Redband Trout Research Project). BPA Report DOE/BP-00006313-3. Pages 105-132. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Schwabe, L. 2002. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property, 2002. Burns Paiute Tribe 2002 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 71-82. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Schwabe, L. 2003. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property, 2003. Burns Paiute Tribe 2003 Annual Report: Evaluation of the Life History of Native Salmonids in the Malheur River Basin (Cooperative Bull Trout/Redband Trout Research Project). BPA Report DOE/BP-00006313-5. Pages 5-1: 5-20. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Schwabe, L. 2004. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property, 2004. Burns Paiute Tribe 2004 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 7-1: 7-9. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Schwabe, L. 2007. Stream Temperature Monitoring on Streams Flowing through the Logan Valley Wildlife Mitigation Property, 2007. Burns Paiute Tribe 2007 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur Subbasin. Pages 1-1: 1-27. BPT Natural Resources Dept. of Fish and Wildlife. Burns, Oregon.
Selong, J.H., T.E. McMahon, A.V. Zale, and F.T. Barrows. 2001. Effect of temperature on growth and survival of bull trout, with application of an improved method for

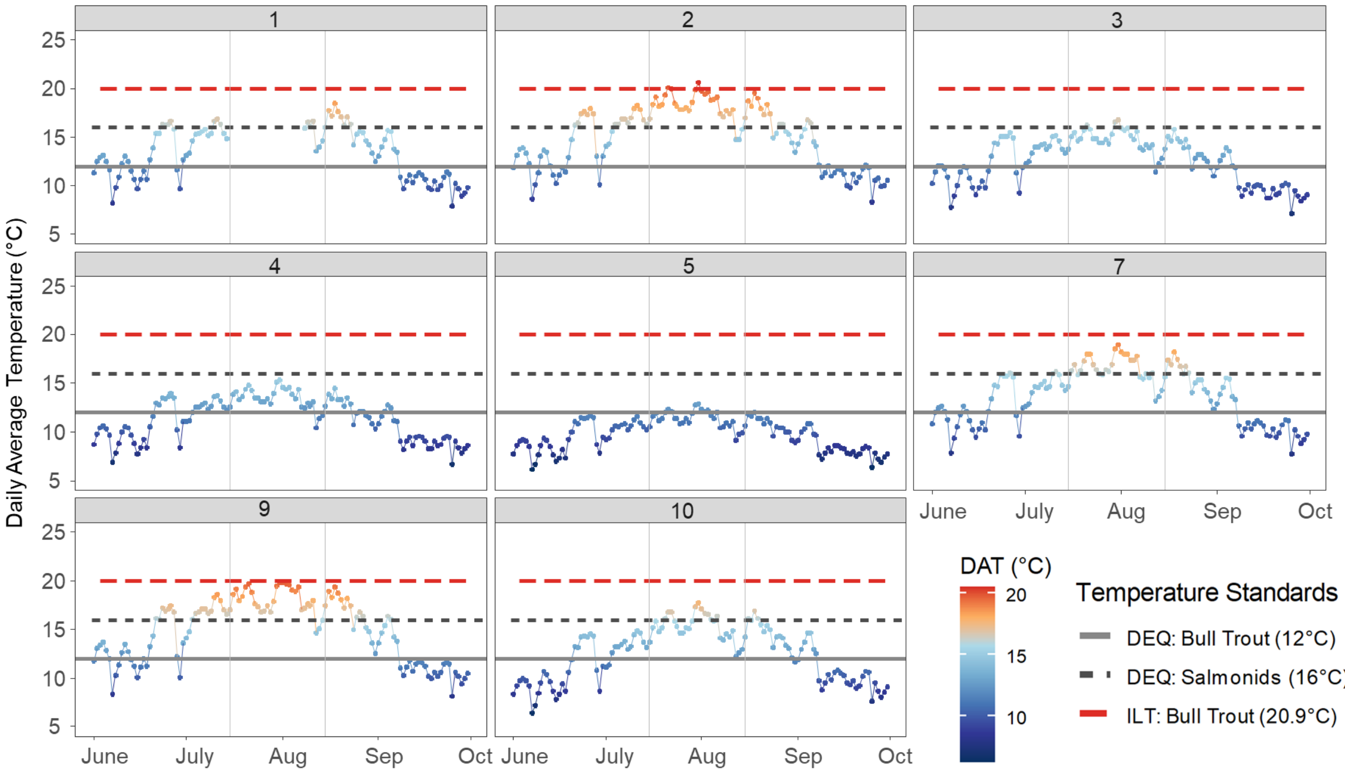
determining thermal tolerance for fishes. Transactions of the American Fisheries Society 130: 1026-1037.

U.S. Fish and Wildlife Service. 2002. Chapter 14: Malheur Recovery Unit, Oregon. Pages 1-71 *in*: U.S. Fish and Wildlife Service. 2002. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

Appendices



Appendix Figure 2.5: Map of all 2020 BPT temperature loggers



Appendix Figure 2.6 2020 Daily Average Temperature (DAT) for the Ten Annual Logan Valley Wildlife Mitigation sites. Vertical lines at July 15th-August 15th are the Critical Period for bull trout. *Site 1 incomplete dataset due to air exposure

Appendix Table 2.3: 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	2017	23.96	8/3/2017	24.68	7/15/2017
	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.			
2	2017	23.88	7/15/2017	25.11	7/15/2017
	2018	25.3	7/30/2018	26.11	7/25/2018
	2019	23.5	8/5/2019	24.41	8/3/2019
	2020	24.76	8/5/2020	25.6	7/31/2020
3	2017	21.65	7/13/2017	22.42	7/15/2017
	2018	21.24	7/30/2018	21.7	7/25/2018
	2019	20.52	7/30/2019	21.44	7/12/2019
	2020	21.65	8/4/2020	22.66	7/30/2020
4	2017	20.56	7/13/2017	21.32	7/15/2017
	2018	20.33	7/30/2018	20.91	7/14/2018
	2019	19.24	8/5/2019	20.27	7/12/2019
	2020	20.49	8/4/2020	21.37	7/30/2020
5	2017	17.77	7/13/2017	18.34	7/8/2017
	2018	17.31	7/29/2018	17.75	7/24/2018
	2019	16.32	8/2/2019	17.2	7/22/2019
	2020	17.8	8/4/2020	18.58	7/30/2020
7	2017	24.06	8/3/2017	24.65	7/15/2017
	2018	24.53	7/30/2018	25.43	7/25/2018
	2020	23.94	8/4/2020	24.77	7/30,7/31/2020
9	2017	26.69	8/2/2017	27.48	8/2/2017
	2018	26.64	7/29/2018	28.2	7/24/2018
	2019	24.95	7/23/2019	26.4	7/12/2019
	2020	25.99	8/1/2020	26.92	7/20/2020
10	2017	22.18	8/3/2017	23.16	7/15/2017
	2018	24.01	7/30/2018	24.63	7/25/2018
	2019	21.16	8/5/2019	21.51	7/31/2019
	2020	23.0	8/4/2020	24.05	7/31/2020

Chapter 3: Applying eDNA Methods to Elucidate the Suspected Presence of Invasive Brook Trout in the Little Malheur River

Rebecca Fritz and Brandon D. Haslick
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Table of Contents

Chapter 3

Applying eDNA Methods to Elucidate the Suspected Presence of Invasive Brook Trout in the Little Malheur River

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3.1 Introduction

Environmental DNA (eDNA) has become a powerful tool in fisheries management (Teletchea 2009; Jerde et al. 2011). Sampling for eDNA is a less invasive method when compared to other fishery sampling methods (gill netting or electroshocking) which is important when working in habitat used by endangered or threatened species. Environmental DNA has been successfully applied to survey fish species distribution (Penaluna et al. 2021), species composition (Minamoto et al. 2012), detect invasive fish species (Tahahara et al. 2013; Keskin 2014), and determine the completeness of eradication efforts (Carim et al. 2020). Although, the presence an organism’s DNA reveals that the species exists in the sampled environment, DNA does not provide accurate data regarding the health, age, population, or even if the organism was alive at the time the sample was collected. Despite these limitations, using eDNA to detect the presence of a rare/cryptic species is an exciting application in fisheries management, as current survey methods are largely unable to sample all individual fish inhabiting a site.

The Burns Paiute Tribe (BPT) Fisheries Program have established an eDNA protocol to determine the presence of invasive brook trout in streams (Crowley 2017). The protocol has been developed in partnership with Cramer Fishery Sciences and involved multiple experiments over a period of years to test different field methods for collecting brook trout DNA from various freshwater environments. The initial intention of the protocol is to apply eDNA as a monitoring method to assess the effectiveness of complete brook trout eradication post planned future rotenone treatments in the Upper Malheur (Schumer et al. 2019).

The BPT expanded the role of eDNA in the Fishery Program after 2018 when a small eDNA sampling event was paired with a large electrofishing effort to investigate the potential illegal introduction of brook trout in the Little Malheur River. When the 2018 and 2019 eDNA results (positive for brook trout DNA) contradicted electrofishing efforts (no brook trout captured), BPT continued pairing eDNA with electrofishing efforts in the Little Malheur for 2019 and 2020.

Problem: A potential brook trout introduction in the Little Malheur River

The North Fork of the Malheur has been historically blocked from the growing invasion of brook trout in the Malheur River Watershed. The Agency Valley Dam on the North Fork Malheur is impassible, as it prevents upstream fish migration effectively separating the North Fork drainage from the Upper Malheur (Figure 3.1). Brook trout have heavily populated the

Middle Fork but are not known to presently occur in the North Fork drainage (Buckman et al. 1992).

The belief of a 'brook trout free' North Fork Subbasin was upended when in 2018, partner agencies in the Malheur River Bull Trout Technical Advisory Committee (TAC), a bull trout recovery working group, had concerns regarding a potential illegal brook trout introduction into the Little Malheur River (a tributary of the North Fork Malheur River). Despite zero brook trout encountered during the concurrent electrofishing efforts, the extensive 2019 eDNA sampling effort returned positive results for brook trout DNA at multiple locations (Figure 3.2 A). However, management decisions could not effectively be made to address a potential brook trout invasion largely due to the contradicting (electrofishing vs. eDNA) results.

2020 objective- combine eDNA with an expanded electrofishing/trapping effort

The overall objective of the 2020 efforts in the Little Malheur was to use eDNA, electroshocking, and minnow traps to determine the extent of invasive brook trout presence in the main stem Little Malheur River and its tributaries. BPT aimed to confirm (fish-in-hand) and locate brook trout presence to provide information for a fast, interagency response.

3.2 Methods

Study Area: The Little Malheur River and tributaries

The Little Malheur River is a tributary to the North Fork Malheur River in Eastern Oregon (Figure 3.1). The core sampling area for 2020 sampling efforts originated at the

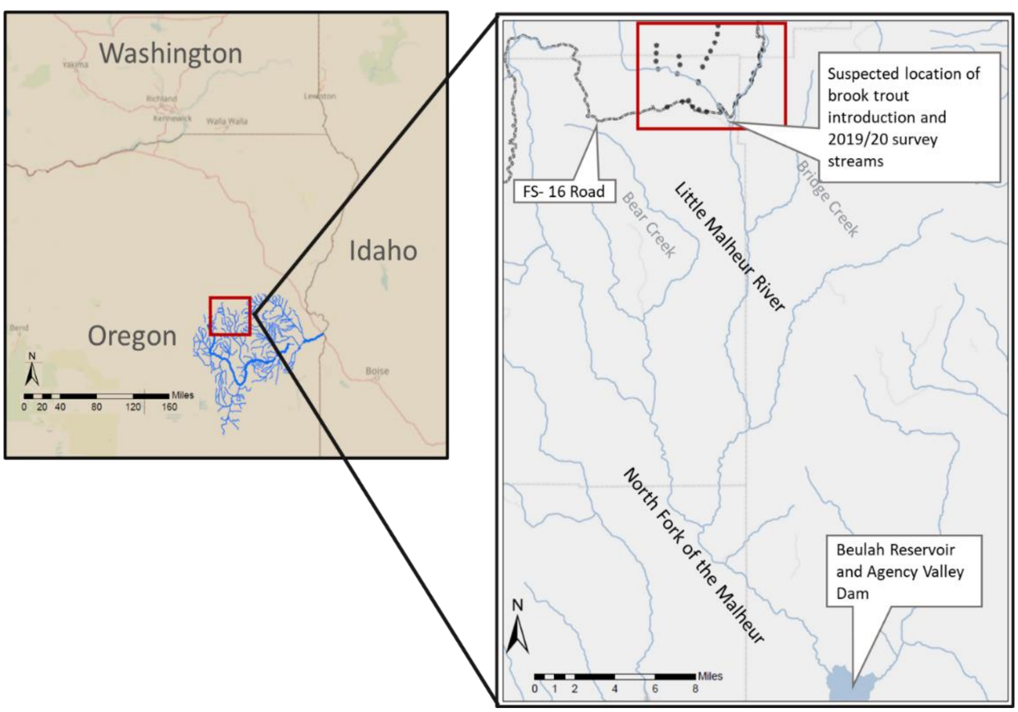

Figure 3.1 Map of Malheur Watershed with the Little Malheur River 2019/2020 sampling streams and eDNA sites (represented by grey circles)

intersection of the FS-16 Road and the Little Malheur River. This location was hypothesized to have the highest likelihood of illegal brook trout introductions. Several tributaries flow into the Little Malheur near that location: Larch Creek, Canteen Creek, Camp Creek, Unnamed Creek (dry), Anderson Creek, and Squaw Creek. 2020 efforts focused on the tributaries: Camp Creek, Squaw Creek, and Anderson Creek (the streams that were positive for brook trout DNA in 2019) (Figure 3.2 A).

Field Methods

BPT spent a two separate field stints (the end of July and the middle of August 2020) over in the Little Malheur actively electrofishing, setting minnow traps, and taking eDNA samples to attempt to understand the presence/ distribution of brook trout.

Electrofishing

BPT Fisheries conducted upstream, single-pass electrofishing without block nets using a LR24 Smith-Root backpack electrofisher. Electrofisher settings were set to the lowest levels at which fish could be caught. BPT electrofished the Little Malheur River (around the FS-16 Road crossing) and in Camp Creek. BPT shocked a continuous 2,000-meter stretch of Camp Creek starting at the mouth. BPT also shocked over 600 meters of the Little Malheur River at the USFS 16 road crossing and 100 meters before the confluence with Camp Creek. All available fish habitat was sampled. All native captured fish were counted and quickly released downstream after being fully revived. If captured, brook trout were to be photographed, measured (fork length), georeferenced, and removed from the stream (euthanized).

Minnow trapping

BPT set traps in the Little Malheur, Camp Creek, and Squaw Creek. Following any needed eDNA sampling, traps were set in reaches and left overnight (no trap was left for longer than 24 hours). Traps were placed in habitat favored by salmonids- undercuts, pools, and under woody debris. Temperatures were monitored and any fish caught in traps were put in an instream live-well until they were identified, counted, and quickly released downstream.

eDNA sampling

BPT took eDNA samples at nine different sites (Table 3.1). BPT took eDNA samples at three sites in upper Camp Creek, two sites on lower Squaw Creek, in the upper Little Malheur (the confluences of Larch and Canteen Creek), and lower in the Little Malheur at Lockhart Crossing. BPT eDNA sampling occurred the day prior to electrofishing to avoid potential site contamination. Wading gear was decontaminated with a bleach dilution before eDNA sampling efforts began and between each different location. Field equipment, methods, and protocol for eDNA samples are as described in the 2017 BPT Annual Report (Crowley, 2017). Briefly, each water sample was a single liter in volume. Samplers remained downstream of the thalweg when taking the water sample(s) from the top ~3 inches of the water column. Samples were pumped through sterile silicone tubing using a handheld, battery powered drill into a Sterivex filter (Millipore ®). All Sterivex filters were labeled, placed in new, individual Ziplock bags, and immediately put on ice and hiked out after which eDNA samples were stored in a dry ice cooler at camp until they could be placed in a -20 °C freezer. Samples were processed by Cramer Fish Sciences.

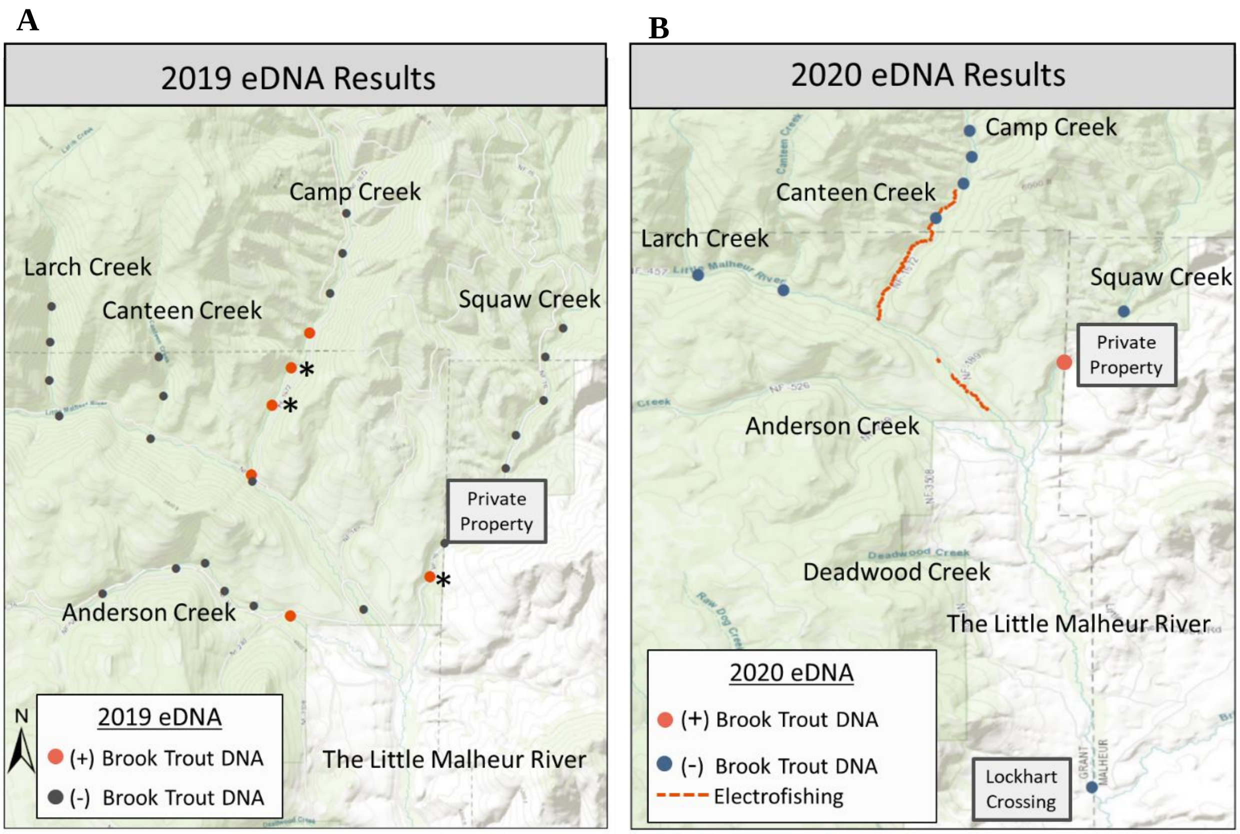

Figure 3.2 Grey = locations which tested negative for brook trout DNA. Orange = locations which tested positive for brook trout DNA. Sites denoted with (*) had 100% detection among three qPCR replicates. **(A)** 2019 eDNA results. **(B)** 2020 eDNA sample sites and extent of 2020 electrofishing efforts. Note: maps are at different scales

Lab Methods

2020 BPT samples were mailed overnight on dry ice to Cramer Fish Sciences. DNA was extracted from the filters (extraction protocol reviewed in Bergman et al. 2016) and quantified. Samples were prepped for qPCR. Quantitative real-time PCR (qPCR assay) was run in triplicate for all samples to detect presence of brook trout (mitochondrial DNA barcodes).

3.3 Results

Electrofishing

The BPT electrofished the Little Malheur River and Camp Creek. Six fish species were encountered: bridgelip sucker (*Catostomus columbianus*), northern pikeminnow *(Ptychocheilus oregonensis)*, redband trout (*Oncorhynchus mykiss gairdneri)*, redside shiner (*Richardsonius* *balteatus)*, sculpin (*Cottoidea spp.)*, and speckled dace *(Rhinichthys osculus)* (speckled and longnose dace *Rhinichthys cataractae* were lumped together as dace spp.) (Figure 3.3 A). Four locations surveyed also had 'unidentified' trout fry (trout fry less than 50 mm). The Little Malheur sites had the highest species composition as compared to Camp Creek. BPT electrofished the Little Malheur River (around the USFS 16 Road crossing) and upstream near the Camp Creek Confluence, as well as Camp Creek (Figure 3.2 B). Despite electrofishing all available habitat- no brook trout were encountered. Anderson Creek was not electrofished due to intermittent, shallow reaches and Squaw Creek was not electrofished due to electrofisher error and high temperatures. Electrofishing surveys resulted in only encountering species native to the North Fork Malheur.

Minnow traps

Minnow traps did not capture any brook trout. All traps had a low catch-per-unit effort (many traps capturing zero fish). Species in Camp and Squaw Creek included: dace, redband, and sculpin. Traps in the Little Malheur had captured all species encountered during electrofishing surveys. All fish were released downstream with no mortalities.

eDNA

BPT had a total of nine eDNA samples analyzed through Cramer Fish Sciences. One site on lower Squaw Creek resulted in a positive detection (low) for brook trout DNA (Figure 3.2 B). The site (Squaw Creek) was located at the boundary of where a private property meets forest service. The reach resulting in the positive hit runs through the private property and can be viewed from the road. BPT verified that this stretch had continuous flow for over 500-meters. The positive detection for brook trout DNA occurred in only one of three qPCR replicates and the amount of DNA detected in this sample was very low (almost 'non-detectible'). Unfortunately, BPT was unable to electroshock on Squaw Creek this year. In 2019, the site ~500 meters below 2020's positive result on Squaw Creek also tested positive for brook trout DNA thought no brook trout were found in 2019 electrofishing surveys on those reaches.

Table 3.1. 2020 Little Malheur eDNA Results

Stream	UTM	Brook Trout eDNA (# qPCR replicates + for DNA / 3)	Level of Detection (Cq value)
Camp Creek	11T 0399957 4901425	0/3	None
Camp Creek	11T 0400314 4902028	0/3	None
Camp Creek	11T 0400427 4902493	0/3	None
Camp Creek	11T 0400403 4904947	0/3	None
Squaw Creek	11T 0401543 4898876	1/3	Low
Squaw Creek	11T 0402291 4899762	0/3	None
Little Malheur	11T 0401767 4891473	0/3	None
Little Malheur	11T 0396959 4900486	0/3	None
Little Malheur	11T 0398026 4900195	0/3	None

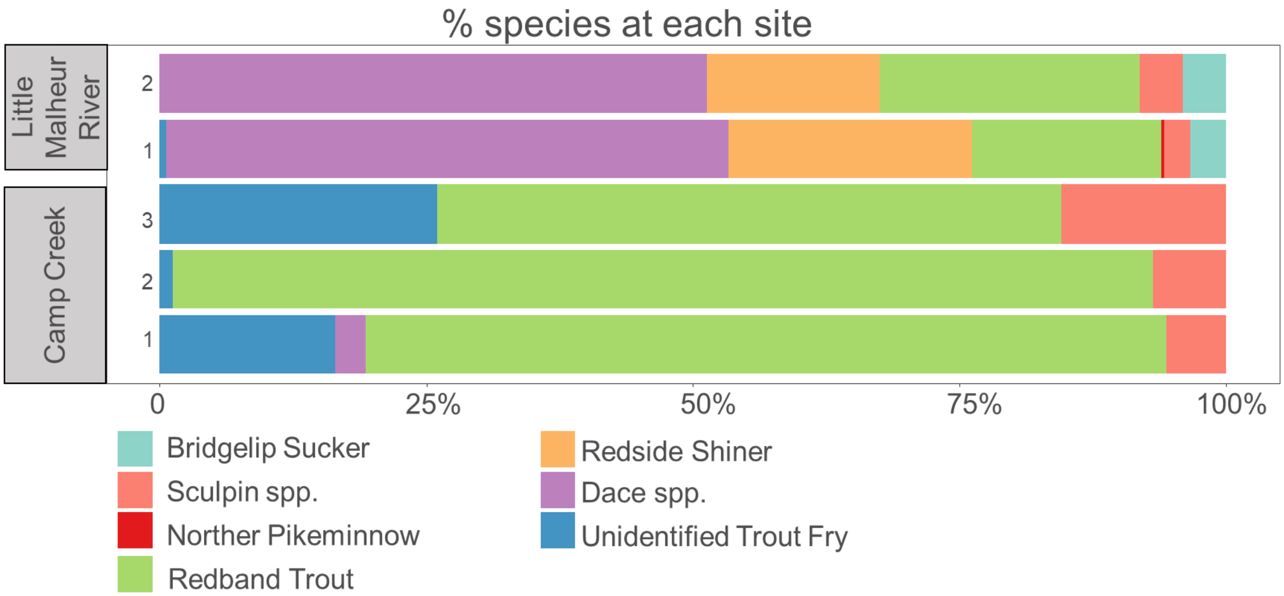

Figure 3.3. 2020 electroshocking results: the % species found at each site (2) sites on the Little Malheur and (3) sites on Camp Creek (reach length varied among sites).

3.4 Discussion

Invasive brook trout threaten a North Fork of the Malheur tributary

Although the 2020 study location in the Little Malheur River is not known to support bull trout, it drains into the North Fork of the Malheur (critical bull trout habitat). The results of the 2020 BPT eDNA sampling effort revealed brook trout presence (through a single eDNA detection result) in the Little Malheur which may have future, negative impacts on North Fork bull trout habitat. BPT eDNA samplings have successfully captured brook trout presence at a finer scale than conventional sampling methods. Three years of intensive electrofishing efforts in 2018 (BPT 2018), 2019 (Fritz and Haslick 2019), and 2020 have not resulted in conclusive brook trout presence. However, eDNA sampling is demonstrating to have greater sensitivity in species detection and be more cost-effective method in fisheries management (Wicox et al. 2016).

The ability to effectively survey for brook trout in the Little Malheur was made difficult in several locations throughout the different tributaries for different reasons. It is worth noting that these sites contained, ‘unidentified trout fry.’ The majority of all fry captured during electrofishing surveys were identified as redband trout. However, many salmonid fry, smaller than 50 mm, were counted and not speciated due to desire to avoid excessive stress and release all captured fry quickly.

Many of the method limitations that come with electrofishing were alleviated by eDNA sampling. The eDNA sampling was not as limited by temperature, deep/vegetated pools, or habitat complexity. Benefits of using eDNA include the ability to speciate brook trout from redband trout fry, less time/crew needed for sampling efforts, and the ability to cover a greater reach length. Regardless of these benefits, some of the problems experienced with electrofishing also impacted eDNA sampling. For example, the discontinuity of Anderson Creek (largely dry) affected the ability to get a 2020 sample. Also, Squaw Creek samples were taken further than 500 meters apart (allowing for a portion of the stream to be unsampled) due to private property. Despite the limitations in the eDNA sampling during the 2020 field season, eDNA confirmed what electrofishing was unable to capture: brook trout are likely present in the Little Malheur system.

The costs of managing invasive species are high

Brook trout are the primary threat to the neighboring bull trout population in the Upper Malheur River. A 10-year, interagency, large-scale eradication effort has been planned to tackle the issue using the piscicide rotenone (TAC 2017, BPT 2018-09). Though determined less costly and more effective that continuing to suppress brook trout using mechanical methods (Crowley 2017), the planned eradication efforts detailed in the Upper Malheur River Bull Trout Conservation Strategy will require immense funding and resources. These efforts involve the time and collaboration of multiple agencies, pre and post treatment data collection, applying and adhering to multiple regulatory criteria, and treatment cost. The Upper Malheur has been deemed worth the effort due to its status as it is critical bull trout habitat (USFWS 2002, 2015). The high cost associated with effectively managing invasive brook trout being experienced in the Upper Malheur, provides the need to address the smallest possibility of brook trout presence quickly and accurately in the neighboring North Fork Subbasin.

Future Recommendations

Although the higher stream temperatures in the Little Malheur may be acting as a thermal barrier deterring downstream migration to the North Fork, continued monitoring will provide a greater understanding into the extent of the invasion. Since the Little Malheur tested positive for brook trout DNA (at multiple sites in 2019 and at a single site in 2020), BPT will work with partner agencies to quickly form a management plan and monitor the suspected invasion. The issue of brook trout in the North Fork basin is of grave concern to the BPT and partner TAC agencies.

Acknowledgements

BPT is very grateful for the support and guidance of the TAC (Oregon Department of Fish and Wildlife, U.S. Bureau of Reclamation, U.S. Forest Service, and U.S. Fish and Wildlife Service). BPT has been collaborating closely with the TAC and values the insight and partnerships regarding brook trout presence in the Little Malheur as well as future issues challenging Malheur River Bull Trout Recovery. BPT Fisheries also thanks Cramer Fish Sciences for the fast turnover time on the eDNA samples.

References

Bergman, P.S., G. Schumer, S. Blankenship, E. Campbell. 2016. Detection of Adult Green Sturgeon Using Environmental DNA Analysis. PLOS ONE. 20: 114: e0153500

(BPT) The Burns Paiute Tribe. 2018. Resolution 2018-09. Upper Malheur River bull trout conservation policy. Approved by a quorum vote of the Burns Paiute Tribal Council on March 14, 2018.

BPT 2018. Agreement number 12-PA-11060400-016. Final Report Prepared by the Burns Paiute Tribe for the Malheur National Forest's Collaborative Forest Landscape Restoration Plan (CFLR). Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. 1-7.

Buckman, R.C., W.E. Hosford, P.A. Dupee. 1992. Malheur River Bull Trout Investigations. Proceedings of the Gearhart Mountain Bull Trout Workshop Oregon Chapter of the American Fisheries Society: 45-57.

Carim, K.J., N.J. Bean, J.M. Connnor, W.P. Baker, M. Jaeger, M.P. Ruggles, K.S. McKelevy, T.W. Franklin, M.K. Young, M.K. Schwartz. 2020. Environmental DNA sampling informs fish eradication efforts: case studies and lessons learned. North American Journal of Fisheries Management. 40: 488-508.

Crookes, S. 2019. Environmental DNA Analysis Report. Precision Biomonitoring, Inc. A report prepared for the Burns Paiute Tribe.

Crowley, K. 2017. Refining the use of environmental DNA for aquatic species detection. Burns Paiute Tribe 2017 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Chapter 5: 1-9.

Fritz, R. and B.D. Haslick. 2019. Chapter 3: Applying eDNA Methods to Elucidate the Suspected Presence of Invasive Brook Trout in the Little Malheur River. Burns Paiute Tribe 2019 Annual Report: Evaluate the Life History of Native Salmonids in the Malheur River Basin. BPA Project #199701900. Chapter 3: 35-46.

Jerde, C.Cl., A.R. Mahon, W.L. Chadderton, and D. M. Lodge. 2011. "Sight-unseen" detection of rare aquatic species using environmental DNA. Conservation Letters 00(2011). 1-8.

Keskin, E. 2014. Detection of invasive freshwater fish species using environmental DNA survey. Biochemical Systematics and Ecology. 56:68-74.

Minamoto, T., H. Yamanaka, T. Takahara, M.N. Honjo, Z. Kawabata. 2012. Surveillance of fish species composition using environmental DNA. Limnology. 13: 193-197. doi.org/10.1007/s10201-011-0362-4

Penaluna, B. E., J. M. Allen, I. Arismendi, T. Levi, T. S. Garcia, and J. K. Walter. 2021. Better boundaries: identifying the upper extent of fish distributions in forested streams using eDNA and electrofishing. Ecosphere. 12(1): e03332. 10.1002/ecs2.3332

Schumer, G., K. Crowley, E. Maltz, M. Johnston, P. Anders, S. Blakenship. 2019. Utilizing environmental DNA for fish eradication effectiveness monitoring in streams. Biol. Invasions. 21: 3415-3426.

(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.

Takahara, T., T. Minamoto, H. Doi. 2013. Using environmental DNA to estimate the distribution of an invasive efish species in ponds. PLoS One. 8(2): e56584. doi: 10.1371/journal.pone.0056584

Teletchea, F. 2009. Molecular identification methods of fish species: reassessment and possible applications. Rev Fish Biol Fisheries 19 (3): 265-293

U.S. Fish and Wildlife Service. 2002. Chapter 14: Malheur Recovery Unit, Oregon. Pages 1-71 *in*: U.S. Fish and Wildlife Service. 2002. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

(USFWS) U. S. Fish and Wildlife Service. 2015. Recovery Plane for the coterminous United States population of Bull Trout (*Salvelinus confluentus)*. Portland, Oregon. xii+179 pages.

Wilcox, T.M., K.S. McKlevey, M.K. Young, A.J. Sepulveda, B.B. Shepard, S.F. Jane, A.R. Whiteley, W.H. Lowe, M.K. Schwartz. 2016. Understanding environmental DNA detection probabilities: A case study using a stream-dwelling char *Salvelinus fontinalis.* Biological Conservation. 194: 209-216.

Supplement: Evaluate the Life History of Salmonids in the Malheur Subbasin 2020
Summit Creek Baseline Data Collection and Help Native Fish Outreach

The 2020 Burns Paiute Tribe Fisheries Program also worked on 1) baseline fish population and macroinvertebrate community sampling on an Upper Malheur tributary and 2) the "Help Native Fish" outreach developed for BPT and the TAC by Samara Group.

Baseline Data Collection in an Upper Malheur Tributary: Summit Creek

Introduction

The BPT Fishery Program gathered baseline biological data on Summit Creek for a proposed future stream restoration by the USFS. Using electrofishing, BPT sampled the Summit Creek fish populations for one week in July 2020. BPT then returned the following week to collect macroinvertebrate samples from the same sites. Preliminary fish data are presented however, macroinvertebrate sampling results are not yet analyzed.

Methods

Study Area

Summit Creek is an Upper Malheur River tributary which joins the Malheur River upstream of Malheur Ford. Fisheries electroshocked ten, randomly selected, sites on Summit Creek in July 2020. Sites, all 100-meters in length, were electroshocked the first week and benthic macroinvertebrate samples (Figure S.2) were collected from those same sites the following week. Freshwater mussel/crayfish/and amphibian presence were recorded.

Fish sampling

Ten, 100-meter, sites were randomly selected for surveys 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. Once at the site location, BPT measured 100-meters using a tape.

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 fry < 50 mm) were counted and released during the survey. Redside shiner and dace spp. were also counted and released to avoid mortalities. Other species, salmonids (redband and brook) and suckers (bridgelip) were collected in an aerated bucket, identified to species, measured (fork length), weighed, and released back into stream. Upstream and downstream photos were taken of each site start and end (ex. Figure S.2 D).

Macroinvertebrate Sampling

BPT protocol for collecting macroinvertebrate samples was adapted from the Pacific Northwest Aquatic Monitoring Partnership (PNAP) (Hayslip 2007). BPT mapped out all riffle habitat in each electrofishing survey site and then measured the length from a GPS datapoint at the taken at the top and bottom of each riffle. Each sample (a total of eight per site) was collected using a 1 ft^2 Surber Sampler and net (500 µm). The Surber Sampler was placed on the substrate and the substrate was agitated for 60 seconds. The sample was collected in a bottle with 99% isopropyl. Individual samples were taken from each randomly selected riffle using the grid method. Due to few (< 8 riffles) at many of the sites, eight samples were taken evenly divided among the number of riffles at each site. If samples could not be evenly divided among the number of given riffles, any riffles resampled were randomly selected. Also, one (or more) of the eight 'quadrants' on the sampling grid were randomly assigned to each riffle using the microsecond setting on a stopwatch. Each site would have a total of 8 macroinvertebrate samples collected and then combined into a single site sample.

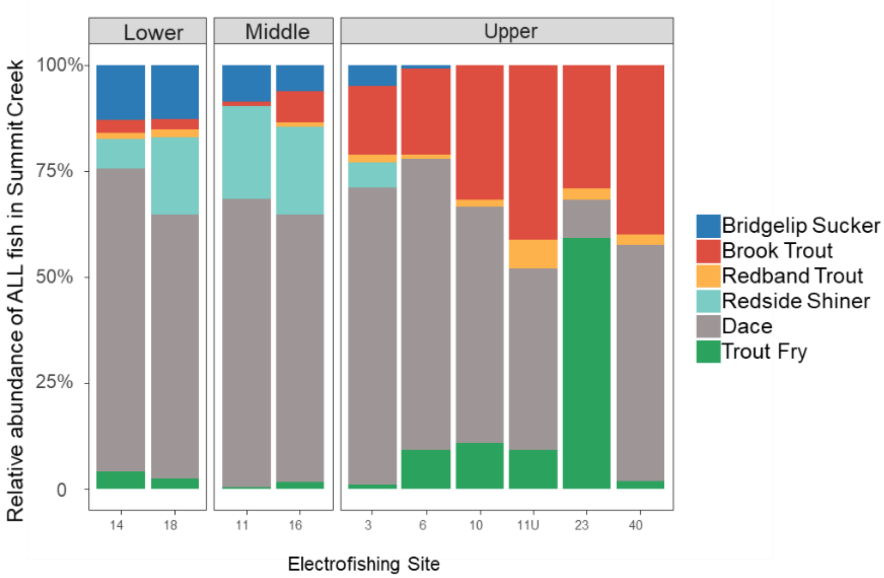

Figure S.1. Relative abundance of all fish species encountered during electrofishing surveys in Lower Summit, Middle Summit, and Upper Summit.

Results and Discussion

Summit Creek Fish Distributions

Electrofishing sites were dominated by dace species (largely, speckled dace and a few longnose dace) (Table S.1) however, the upper Summit Creek sites show an increase in the presence of invasive brook trout. This trend is even more evident when comparing the relative abundance brook trout compared to only redband trout and bridgelip suckers (Figure S.2 B). Bridgelip suckers were found in abundance in the lower reaches of Summit Creek. Condition factor was calculated for bridgelip, redband, and trout using the method commonly used for salmonids (Figure S.2 C). Bridgelip K values were much higher than the trout and further analysis will examine how to compare the different fish species/types. There was no significant difference in the overall condition of the two salmonids.

Table S.1 (%) abundance of the total electrofishing surveys

Species	Total # Fish Captured	% Abundance
Dace spp.	951	59.3 %
Brook Trout	247	15.4 %
Redside Shiner	169	10.5 %
Trout Fry	118	7.3 %
Bridgelip Sucker	91	5.6 %
Redband Trout	27	1.7 %
Total fish captured	**1603**	

The preliminary data presented here are to provide baseline information on the biota in Summit Creek for a proposed restoration project led by the USFS. The benthic macroinvertebrate samples have not been analyzed as of spring 2021. BPT also recorded presence of Signal Crayfish *Pacifastacus leniusculus* and took a GPS point at locations where there were freshwater Western Pearlshell Mussels *Margaritifera falcata.* Results will be shared with the US Forest Service.

References

Hayslip, Gretchen, editor. 2007. Methods for the collection and analysis of benthic macroinvertebrate assemblages in wadeable streams of the Pacific Northwest. Pacific Northwest Aquatic Monitoring Partnership, Cook, Washington. 31 p.

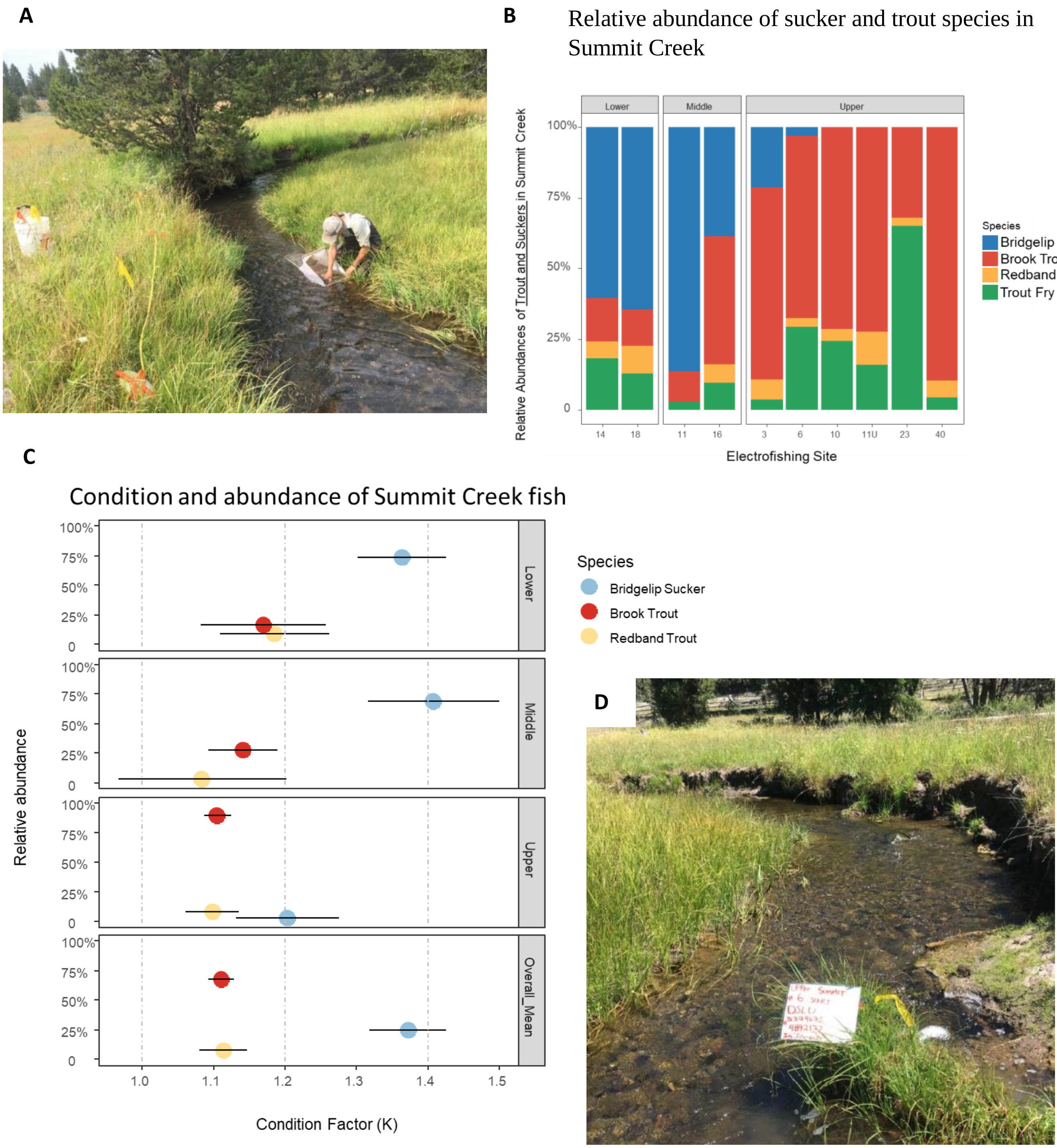

Figure S.2. (**A**) Taking a macroinvertebrate sample in riffle habitat (**B**) Relative abundance of sucker and trout species (larger fish species) encountered during 2020 electrofishing surveys. (**C**) The mean condition factor (K) with 95% CI for brook trout, redband trout, and bridgelip suckers compared to each species relative abundance. (**D**) The start of electrofishing site #6 in upper Summit Creek

2020 Help Native Fish Outreach

The 2020 BPT Fisheries Program **Help Native Fish** public outreach efforts were scaled back due to the Covid-19 pandemic. In 2018, BPT hired the outside consulting group (Samara Group) to develop an outreach/education plan for this project (Figure S.2 (A)). Help Native Fish includes a website www.helpnativefish.org, posters, and informative brochures. Posters were placed on busy trailheads in 2019 and 2020. An un-staffed Help Native Fish booth (Figure S.2 (B)) was at the 2020 Harney County Fair(Figure S.2 (C)). To (virtually) provide current management information, BPT actively maintained the Help Native Fish website up to date with recent research findings and updates.

Figure S.2: (A) Help Native Fish was developed for BPT by Samara Group resulting in this recognizable logo currently used for outreach **(B)** The Covid-19 2020 pandemic meant for challenges at the 2020 fair **(C)** BPT un-staffed fair booth with information printed off of the www.helpnativefish.org website