Effectiveness & Validation Monitoring of the Scott River Beaver Dam Analogues

Final Report 2023

Prepared for the California Department of Fish and Wildlife –
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SCOTT RIVER
WATERSHED COUNCIL

Cover Photos

Upper left: Spawning Coho Salmon - Miners Creek, January 7, 2021

Upper right: School of juvenile Coho Salmon - Sugar Creek BDA 1 Pond, September 15, 2022

Middle left: Spawner Coho Salmon over Miners BDA, January 4, 2021

Middle right: Juvenile Coho Salmon captured in Mid French Side Channel BDA Pond 2, April 26, 2021
Bottom left: Carcass of a female Coho Salmon in French Creek on December 31, 2019
Bottom right: Scott River Watershed Council's Monitoring Supervisor, Erich Yokel and Monica Tonty, current graduate student for CalPoly Humboldt sampling juvenile Coho Salmon in Sugar Creek on January 4, 2021

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Acknowledgements

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Executive Summary

The Scott River Beaver Dam Analogue (BDA) Project started in 2014 and continues to the present. The Project's BDAs were the first to be installed in California and have served as a study site to understand the effects of the structures on fish, specifically Coho Salmon (*O. kisutch*), a CESA listed salmonid that lives in the watershed, as well as a broad range of other ecological impacts. Lessons have been learned over the past nine years about BDA structure placement, construction, and management. In addition to these physical parameters, the Project has served as a testing ground for permitting process-based, as compared to form-based restoration, and understanding how to implement and manage this type of restoration in a human dominated landscape, often described as a "working landscape" (Beechie et al. 2010).

The SRWC team has embraced academic research and the Project has generated two published peer-reviewed articles, with an additional one in preparation, three masters student theses (see *Project Resulting Publications*), and numerous field and project reports (Appendix A). In addition, the Project has been presented at numerous professional conferences (Appendix B). This report is an effort to summarize and synthesize the scientific research that has taken place, but it is more than that. There is a growing body of researchers that identify a rich collection of case studies and observations to inform adaptive management actions at a project site, and identify patterns that can help target future research, monitoring, and restoration efforts as a legitimate and useful approach (Nash et al. 2021). We offer this report in that spirit.

Overview

Salmonids that spawn in the Scott River watershed are steelhead (*Oncorhynchus mykiss*), Chinook salmon (*O. tshawytscha*), and the Interior Klamath Diversity Stratum of the Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit population of Coho Salmon (*O. kisutch*). As stated by the National Marines Fisheries Services (NMFS), Coho Salmon functionally independent population is at moderate risk of extinction (NMFS 2014). The SONCC Coho, an evolutionarily significant unit, was listed as threatened under the federal Endangered Species Act (ESA) in 1997, and in 2005 this decision was reaffirmed (NMFS 2014). In 2002, Coho Salmon were listed as threatened in California from the Oregon border to Punta Gorda in northern California under the California Endangered Species Act and included in the California Department of Fish and Wildlife's Recovery strategies for California Coho Salmon report (CDFW 2004). The most recent assessment of SONCC Coho Salmon population trends (NMFS 2014) concludes that it is likely to become endangered. The decline of the population throughout its range is attributed to a combination of fishing, fish hatcheries, hydropower development, and habitat alteration resulting from a variety of land use and management activities (NMFS 2014). The Scott River basin was historically important for native Coho Salmon (NMFS 2014), and today the Scott River is the most important SONCC Coho Salmon spawning and rearing stream in the Klamath Basin (Van Kirk and Naman 2008). Juveniles spend an entire year rearing in freshwater streams, including summer, when water quantity and quality are limiting (Van Kirk and Naman 2008). Since the late 1980s, concerns over declining SONCC Coho Salmon populations have spurred efforts toward fish recovery through instream and riparian habitat improvement in the Scott River watershed.

The Scott Valley, called Beaver Valley by the first European fur trappers, once had an abundance of beaver and as a result much of the valley floor was described as "all one swamp" (Wells 1881). In the 19th century, beginning in the 1830s, trappers removed thousands of beaver from the Valley. As a result, the "swamp" characteristics such as ponds and wetlands have largely disappeared. Today slow water rearing habitat, such as that formed by beaver dams, is limited to a few isolated locations in the Scott Valley and this likely reduces Coho Salmon production potential. When these types of habitats exist, they are used throughout the year for rearing juvenile Coho Salmon, and as deep holding pools for returning adults. Studies have shown juvenile salmonids had improved survival, smolt production and growth in beaver ponds and other slow water habitat rich in cover (Roni et al. 2006, Rosenfeld et al. 2008, Bouwes et al. 2015).

Currently, the number of beaver within the Scott River system is not fully understood but it is estimated that the numbers are not near their historic levels. The Scott River Beaver Dam Analogue Restoration Project is a series of restoration projects that have been implemented since 2014 and are designed to enhance Coho Salmon populations by mimicking the actions of beaver through the use of beaver dam analogues (BDAs) to create cool, slow-water habitat (Pollock et al. 2015). To determine the effectiveness of BDAs as a restoration tool for the recovery of Coho Salmon within the Scott River watershed, SRWC has been performing a variety of monitoring activities to help answer key research questions:

1. Do BDAs support rearing juvenile Coho Salmon at higher abundance than similar sites with no BDA and at similar or higher abundance than other existing seasonal refuge sites (sites with low winter velocity or low summer temperatures)?
2. Do Coho Salmon rearing in BDAs have seasonal survival and growth similar to those to or higher than other existing seasonal refuge sites?
3. Are BDAs an impediment to movement of juvenile Coho Salmon?
    a. Are juvenile PIT tagged Coho Salmon moving upstream through or around the BDAs, particularly during times when there are decreases in streamflow?
    b. And how does that frequency of movement change with decreases in flow?
    c. How does the frequency of movement through and around the BDAs vary by size and by species and by direction (upstream versus downstream)?
    d. How does movement of juvenile salmonids through or around the BDAs vary by structure and type of passage provided at each structure?
4. How do habitat characteristics at BDA sites differ from similar sites with no BDAs and other sites where juvenile Coho Salmon seek seasonal refuge?
5. Do BDAs affect surface and groundwater storage and water quality at BDA restoration sites in ways that might mitigate future climate change effects on habitats?
6. Additionally, the patterns of movement and occupation will be correlated to physical instream habitat conditions, by measuring the physical parameters.

History of BDAs in California and the Scott River BDA Project

Since the late 1980s, concerns over declining SONCC Coho Salmon populations have spurred efforts toward fish recovery through instream and riparian habitat improvement in the Scott River watershed. Initially such efforts consisted of actions such as riparian fencing and planting, streambank stabilization with rock revetment and/or biostabilization techniques, and sediment input reduction efforts. In 2014, the Scott River Watershed Council (SRWC), initiated the use of beaver dam analogues (BDAs) to mimic the effects of beaver dams that had been historically present in the Scott Watershed. The Scott Valley was the first place in California to use BDAs as a watershed restoration tool and the project was initiated as a research experiment. As such, there was limited understanding of how to effectively design, install and manage BDAs in California and intensive interest from regulatory and research entities in the effects of BDAs.

BDAs are typically constructed in a series along streams and consist of wooden post structures pounded into a stream channel bottom that are then woven with vegetation and sediment (i.e., rocks, gravel, silt, clay) (Pollock et al. 2017). BDAs are semiporous and span all or part of a stream channel. By mimicking the effects of beaver dams, BDAs have the potential to trigger watershed restoration processes that support natural colonization by beaver, and new beaver dam complexes (Pollock et al. 2017). Increasing beaver abundance is one of the highest priority recovery actions identified for the Scott River basin in the SONCC Coho Salmon recovery plan (NMFS 2014). This "nature-based solution" to promote salmon recovery, which seeks to restore natural processes, seemed fitting in a place once known as Beaver Valley.

In 2011, the SRWC became intrigued with the potential ecological benefits of supporting beaver in the landscape and contacted Dr. Michael M Pollock, a scientist at the National Oceanic and Atmospheric Administration (NOAA) in Seattle, after hearing about his work pertaining to beaver-related restoration. Prior to his involvement in the Scott River watershed, Dr. Pollock had been conducting research on how to restore freshwater habitat for salmon recovery using beaver and BDAs at Bridge Creek in central Oregon. Dr. Pollock subsequently came to the Scott Valley and gave a talk about how beaver could be used to restore freshwater stream systems to benefit both fish and water resources.

While beaver were known to reside in the watershed, their ability to build dams was limited by the extent of anthropogenic changes to the river and stream channel and floodplain. Based on the work done in Bridge Creek, in 2012, SRWC and Dr. Pollock began to explore the idea of using BDAs in the Scott River watershed for their direct benefits and to evaluate the extent to which they would allow an expansion of beaver dam building. In 2014, California's first permitted BDAs were installed. While BDAs and other low-tech process-based restoration techniques have become increasingly recognized and utilized since 2014, at the time of implementation this project was on the forefront of restoration innovation, and therefore had no clear regulatory guidance or permitting pathways in California.

The Scott River BDA project's goals were to improve instream habitat for threatened SONCC Coho Salmon, improve instream water flows, raise groundwater levels, reduce stream channel incision by reconnecting streams to their floodplains, and demonstrate the value of BDAs as a watershed restoration tool in California. However, there was no ability to perform necessary maintenance (see *History of Project Permitting)* built into the original set of project permits.

The SRWC originally proposed installing BDAs at six sites in the Scott River watershed, with six structures per site, for a total of 36 BDAs, in alignment with the understanding that beaver build dams in series which create structural integrity and extend habitat benefits. However, they only received California state permits to install BDAs at three sites, with two structures per site. The three sites were located on streams running through private lands and were chosen based on restoration needs as well as landowner willingness to participate. Structures were built at these three sites in the summer and fall of 2014. Two sites were located on the main stem of the Scott River, and one on a Scott River tributary called Sugar Creek, which was known as a key Coho spawning and rearing tributary and had a history of beaver occupation (Figure 1). The mainstem Scott River sites were selected to enhance connectivity of two other important Coho rearing tributaries, Etna, and French Creeks, as well as supporting habitat in the Scott River itself.

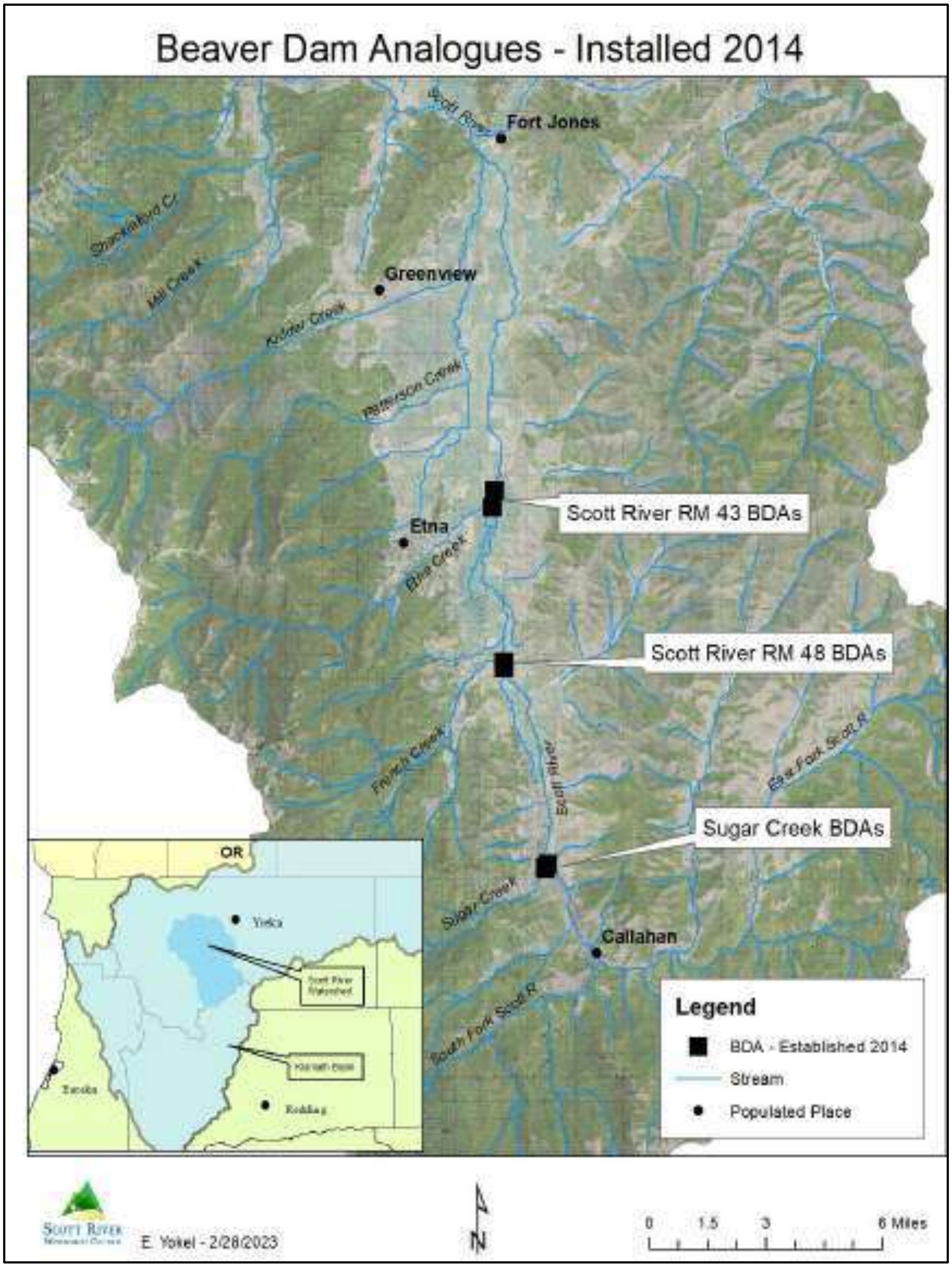

Figure 1. Location of Beaver Dam Analogues established in 2014.

Throughout most of 2014, the Scott River watershed experienced an extreme/exceptional drought however on February 7, 2015, a significant flood event of 14,600 CFS at the Scott River USGS gauge at Fort Jones occurred (National Drought Mitigation Center 2022). This flood resulted from runoff due to heavy precipitation in the Scott Mountains (the headwaters of the Scott River) and caused significant channel alteration in the Scott River resulting in considerable damage to all the main stem Scott River BDAs, totally obliterating two and significantly damaging the two others.

One factor that contributed to one of the Scott River BDAs failures, was a catastrophic and complete avulsion of the Scott River in the Tailings, through the Moore's Gravel plant which redirected the entire flow from river channel to the west side of the Valley floor. The water traveled approximately 4.6 miles before the majority of the flow returned to the Scott River channel just upstream of a BDA structure that was located just upstream of the confluence of French Creek (Photo 1).

Photo 1. Photo taken of the Scott River flows on the westside of Valley, from S. Hwy. 3, downstream of the avulsion point and upstream of Faye Lane Road. February 7, 2015.

Due to the constraints of the initial permitting as a scientific study, SRWC was unable to immediately initiate repairs of the damaged BDAs. Ultimately, due to the dynamic nature of the mainstem Scott River, as experienced in 2015 and the higher flows, SRWC decided to focus on installing additional BDAs in Scott River tributaries: Sugar Creek and those subsequently permitted to be constructed in French Creek and Miners Creek. The detailed history of each of the tributary site BDAs is below.

An important component of the BDA project has been monitoring to assess the impact of BDAs on water, fish, aquatic species passage, riparian areas, and birds. SRWC has been responsible for the bulk of the monitoring work, with some support from the CDFW and the NOAA. Monitoring includes fish movement and passage using PIT (passive integrated transponder) tags, numbers of fish above and below the BDAs, habitat rearing capacity for SONCC Coho Salmon, stream water temperature, surface water elevation, and groundwater levels and recharge. In 2016, SRWC published a technical note covering the monitoring activities in 2015 (Yokel et al. 2016) and in 2018 SRWC published Scott River Beaver Dam Analogue Coho Salmon Habitat Restoration Program 2017 Monitoring Report (Yokel et al. 2018).

While the 2018 report generated considerable interest and offered insights into BDA effects, there were still unanswered questions. As a result, SRWC received funding from the Fisheries Restoration Grant Program (FRGP) to continue to monitor the BDAs and expand the understanding of their use and effects. The funding supported SRWC and a series of graduate students. SRWC has continued its relationship with Dr. Pollock, and the FRGP funded data collection has informed his peer reviewed work both published and in preparation. Additional funding and collaborative relationships supported associated research and analysis. This current report is the result of the combined efforts and extended the data collection analysis and interpretation to the period of 2018-2022. It attempts to provide a high-level synthesis of the totality of the scientific work related to the Scott River BDA restoration sites.

History of Project Permitting

As the first permitted BDAs and an early application of a process-based restoration type project in California, the project has been an important testing ground for how to manage and permit this type of restoration. Along with the scientific questions that the project has undertaken to answer, it has served to explore these important questions. SRWC has worked with the State regulatory agencies, the North Coast Regional Water Quality Control Board (Regional Waterboard) and CDFW, as the scientific and regulatory understanding of BDAs and nature-based solutions to ecological impairments has expanded in order to find pathways to allow for the type of implementation techniques and flexible adaptive management required to achieve the best ecological outcomes.

The initial 6 BDAs were issued a Class 6 CEQA Categorical Exemption for Information gathering, with a Lake and Streambed Alteration Agreement and Clean Water Act coverage under the State Water Resources Control Board General 401 Water Quality Certification Order for Small Habitat Restoration Projects, however, as the need for on-going adaptive management of the structures became apparent, the restrictive nature of permits became problematic. Fortunately, the Habitat Restoration and Enhancement Act (HREA) was passed in 2014 by the California legislature. The act established a permitting process with CDFW to implement small-scale, voluntary habitat restoration projects throughout California, as long as they were less than 5 acres and 500 linear feet of streambank impact. All BDAs in the Scott Watershed, after the initial 6 installed in 2014, have been permitted via this pathway. SRWC advocated for the ability to develop annual work-plans in each of the 5 years of a HREA permit to allow for on-going management, as long as permit defined techniques and discharge quantities are adhered to. Discharges are materials used to construct the BDAs and remain in the system after construction such as posts, willow, straw, rock etc. Due to the active participation in site visits and dialog, CDFW and the Regional Water Board agreed to this necessity and each SRWC BDA permit contained such provisions. This permitting innovation has now become standard practice for process-based restoration.

The issue of particular concern for CDFW in regards to BDAs was Fish and Game Code 5937, which states that no structure (dam) shall impede or tend to impede the passage of fish at any life stage. CDFW's original conception of a BDA was of a very porous structure that allowed "visible fish passage"- essentially portals several inches in diameter to allow fish to swim through the structure. However, maintaining these "passageways" prevented adequate retention of water behind the structures, essentially negating the intended ecological effects of creating pool habitat and storing water. This tension led to an intense focus on understanding the impact BDAs may have on fish passage, especially listed Coho Salmon. Permit conditions for the BDAs involved on-going fish passage monitoring. We will discuss the results of that monitoring in the *Discussion-Key Takeaways* section of this report.

BDA Restoration Sites

The monitoring activities and primary focus of this project were the BDAs sites on Sugar Creek, French Creek, and Miners Creek. These sites were selected due to the ability for SRWC to perform annual maintenance if required and were all known to be Coho Salmon tributaries of the Scott River watershed. Two reference sites (or control sites) were identified both on Sugar Creek and French Creek (Figure 2).

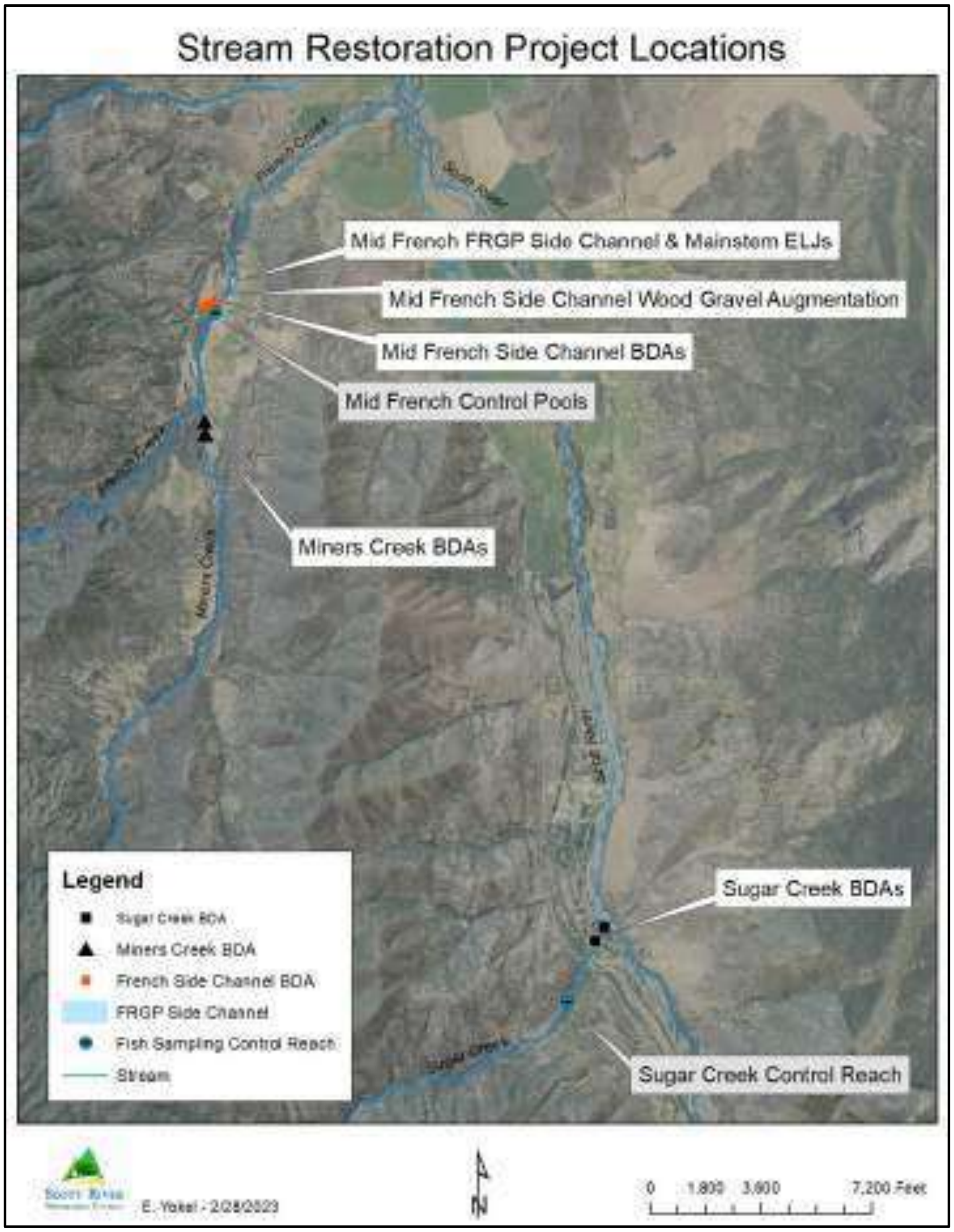

Figure 2. Locations of SRWC stream restoration projects.

Sugar Creek

***Chronology of Restoration Activities*:** Two BDAs were installed in Sugar Creek in the first wave of BDA implementation in 2014 in the most downstream portion of the stream. This stream reach lies in the Callahan Yuba Dredge Tailings, a highly disturbed 5-mile long portion of the Scott Valley consisting of piles of cobbles. The downstream structure, "BDA 1", was placed 200 ft. upstream of the Sugar Creek-Scott River confluence at the top of the riffle descending to the confluence pool. BDA 1 was located at the location of a historic beaver dam, which had not been actively occupied by beaver in many years. The "BDA 2" was located 400 ft above BDA 1 in a highly confined canyon of tailing piles. The stream reach dewatered during construction due to the 2014 drought year conditions. The subsequent winter high flow event in early February 2015 caused approximately one third of BDA 2 to fail on river left and about 20% of BDA 1 to fail on river right. Authorization to repair the structures was obtained, however only BDA 1 was repaired due to beaver starting to build on BDA 2 (see *Beaver Utilization*).

In fall 2017, SRWC was permitted to undertake some additional construction work at the Sugar Creek BDA site under new HREA permitting and did so. This work consisted of building two step-down structures below the lower BDA to help fortify it, reduce streambed scour, and enhance fish passage; and connecting the lower BDA with an ancillary structure next to it in a side channel to help maintain high winter water flows. These three improvements to the lower BDA took place in fall 2017. In spring 2018, SRWC received a permit to maintain the existing structures and build up to 15 additional BDAs in the future in Sugar Creek if needed for adaptive management as stream conditions change.

This adaptability was utilized in 2021 when one of the original BDAs (BDA 1) was entirely reconstructed and 4 new BDAs constructed. The stream reach had been subject to dewatering in the 2018, 2020, and 2021 drought years. When BDAs dry, the weave material becomes desiccated and brittle and materials such as clay and mud used to pack the structure initial spaces becomes dry and tends to crumble away, leaving the BDA with multiple voids. Posts are also less structurally sound, resulting in the potential for structure failure in high flows. Given this, SRWC felt that a rebuild of BDA 1 would provide longevity to the project. The 4 new BDAs were placed between BDA 1 and BDA 2, with the intention of creating structural redundancy, and the ability to lower and raise the weave height to manage pool volume and fish passage opportunities in response to drought related low flow conditions.

French Creek

***Chronology of Restoration Activities*:** In late 2016, the SRWC received a new permit to install four BDAs at a side-channel site off French Creek, another Scott River tributary. Of these four, three are single BDAs and one consists of a triple structure - one primary and two step-down BDAs. The naturally occurring side channel receives flowing water from upstream during high flow events and remains wet in summer with groundwater inputs without surface flow. Monitoring prior to BDA installation had shown water of suitable quality for salmonids, but no use by adults or juveniles. During this period of early California BDA implementation, there remained concern from CDFW regarding BDAs potentially adversely affecting Coho by obstructing fish passage, and therefore a reluctance to allow placement of additional BDAs in an active stream channel. However, the lack of baseline utilization of the side channel by fish offered the opportunity to expand the study of BDA effects without concern about fish passage. The BDAs were constructed in the summer of 2017 and have been monitored since. The two most upstream structures were placed in branches of the side channel in reaches that historically dried every summer with the intention of capturing sediment being transported at high flows and to disperse high flow energy. One of the two BDAs "flanked" with lateral erosion in the winter of 2018, causing the water to erode the bank in a location that was outside the BDA's weave. After careful consideration, SRWC decided to allow the structure to continue to evolve without maintenance and it has remained essentially stable since. The two downstream BDAs (including the triple configuration) have been very stable and required no ongoing maintenance.

Miners Creek

***Chronology of Restoration Activities*:** Miners Creek is a tributary to French Creek. It is a comparatively small watershed of 7.9 square miles with basin headwaters that are at a significantly lower elevation than either French Creek or Sugar Creek. The project reach lies in a low gradient (approximately 1%) alluvial valley and with documented extensive Coho spawning utilization. There is agricultural water extraction upstream of the BDA site affecting baseflow.

In summer 2015, SRWC was permitted to install two structures in Miners Creek on private land. In spite of the spring 2015 flood event, 2015 was classified as a drought year and the reach was dry at the time of BDA installation. Due to the loss of the mainstem Scott River BDAs, this site was added as an amendment to the original scientific study BDA permitting. The specific restoration goals for the site were to enhance Coho spawning habitat, create winter slow water rearing habitat and potentially create and maintain summer pool rearing habitat. In addition, it was noted that the extensive native vegetation at the site was showing signs of drought stress with many dead and desiccated stems, and it was hoped that the BDAs would enhance the vegetation's vitality which would, in turn, support beaver to colonize the site.

In the winter of 2016-2017, a series of high flow events mobilized large amounts of decomposed granite from the upper watershed, which filled the BDA pools with up to 3 ft. of fine sediment. The event also caused the lower BDA structure to deform, losing its structural integrity and ability to hold water. In 2017, SRWC repaired the main structure by replacing a portion of the post line and replacing weave and packing materials. However, it was felt that the repaired lower BDA structure could be a fish passage barrier to spawner returns and a decision was made to partially decommission it. In 2018 SRWC built 3 new structures to replace the pool habitat lost to the decomposed granite accumulations (Photo 2). In 2018, SRWC worked with the Regional Waterboard and the California Department of Fish and Wildlife to utilize the newly available restoration permitting pathway of the Habitat Restoration and Enhancement Act (HREA) to achieve a site-specific permit to carry out these actions, as well as to allow for future adaptive management.

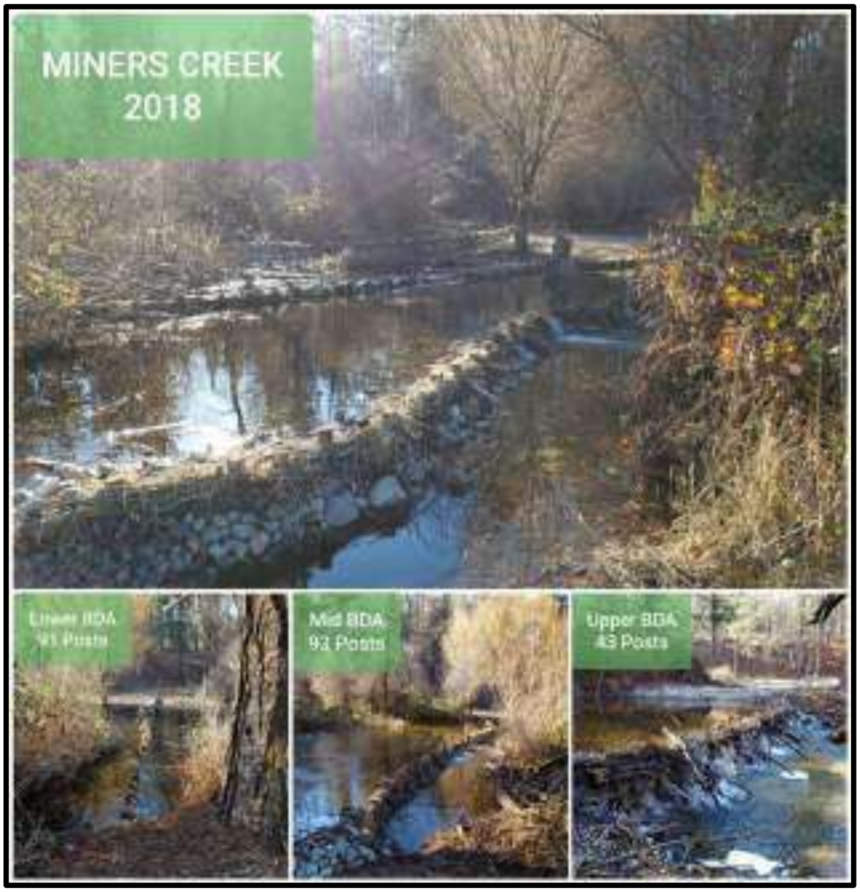

Photo 2. Miners Creek beaver dam analogues constructed in 2018.

Prior to initiating restoration at the site, SRWC underappreciated the extent that it was vulnerable to drought and climate change and to impacts from water extraction due to its small watershed size, low unimpaired flow volumes and limited snow related water storage. As drought conditions persisted through the study period of 2018-2022, with associated regulatory pressures, social conditions also evolved in a way that SRWC did not predict. At this site, the landowner became increasingly concerned about the level of regulatory contact that active restoration and monitoring incurred and intermittently disallowed monitoring, ultimately requesting termination of all monitoring in 2022. Similarly, ongoing adaptive management was not allowed after the major reconstruction in 2018, which greatly limited the ability of the BDAs to function as intended and designed, especially since beaver never occupied the site and took on BDA maintenance as was hoped prior to construction.

Reference Sites (Control Sites)

To answer the primary project question- How do habitat characteristics at BDA sites differ from similar sites with no BDAs- the basic study design entailed comparisons between BDAs and two categories of reference sites: (1) Existing seasonal refuge reference sites with no restoration, (2) sites with non-BDA restoration. This approach allowed for a set of critical comparisons. However, it was recognized from the project onset that juvenile Coho Salmon might not be present at potential BDA reference sites because habitat conditions at these sites might be unsuitable (e.g., water may be absent), so an effort was made to select non-restoration reference sites with sufficient habitat quality and quality to support salmonids. The flaw in this approach became evident after several years of sampling when it was realized that the site selection methodology had inadvertently introduced a bias. The primary reference habitats on French Creek were amongst the best unrestored habitats in the Scott stream system, rather than more typical unrestored conditions. An effort to remediate this bias was undertaken in 2022 with the addition of new sampling units in stream reaches slated to be restored in the future that were more typical of Scott River tributary stream conditions than the original reference pools.

Non-treatment (Sugar Creek, French Creek control pools, less desirable habitats sampled in 2022)

The original untreated reference sites consisted of: (1) a series of 4 pools in the mainstem French Creek running parallel to the side channel in which BDAs were constructed and (2) a reach of Sugar Creek upstream of the BDA restoration reach and upstream of a large natural beaver dam complex.

French Creek control pools encompassed four small to medium sized pools in a 360 ft long riffle-pool reach. Pool 1, the most downstream of the four, is the largest and most complex of the four, however it became increasingly difficult to sample as it was bifurcated by a naturally occurring channel spanning logjam, which was initially small, but grew in size over the study period (though it blew out in the winter of 2022-23 just after the conclusion of the 2022 monitoring season). The increased size and complexity of the jam made seining challenging and made year over year comparisons difficult as the ability to sample changed. Pool 2, next upstream, was very small and consisted of a small scour pool under a single clump of vegetation. Pool 3, again upstream, was deeper and had some complex cover. The configuration, size, cover, and complexity elements of this pool remained relatively stable over the study period. Pool 4, the most upstream, was comparatively shallow, but had some overhanging roots and undercut banks. The French Creek reference pools were consistently sampled for juvenile salmon with PIT Tag passive and mark/recapture efforts throughout the study period, generally in the same time periods as the BDA and non-BDA treatment reaches. The pools remained wetted through the entire study period and maintained water of sufficient quality to support salmonids during every baseflow period. Water temperature, water surface elevation (WSE) and stream discharge were monitored in the French Control reach since 2017.

The Sugar Creek reference site consisted of a 250 ft long reach of Sugar Creek in which a large flatwater habitat and two pool habitats were sampled. This site was sampled much less consistently than the French Creek reference site. Sampling was skipped when visual surveys demonstrated no juvenile fish and/or early season sampling efforts yielded few to no juvenile Coho. This resulted in PIT Tag efforts during the base flow period of 2019 and 2021 and not at other times. Physical parameter monitoring at the site was limited to sampled habitat area measurements. Continuous water temperature was monitored in the Sugar Control reach for the life of the project and a stream discharge station was established in May 2021.

In response to the identified limitations of the reference sites discussed above, SRWC performed limited efforts to capture juvenile Coho Salmon at multiple sites in French and Sugar Creek in the 2022 summer-fall monitoring season. This included two sites on French Creek that have planned future restoration. The downstream of the two sites consisted of an approximately 200 ft long shallow flatwater and riffle reach with no defined pools. Of note, the morphology of this reach is similar to the pre-treatment condition of the downstream French Creek reach in which the Engineered Log Jams were constructed (see below). The upstream reach was 150 ft long and consisted of two pools of similar size and quality to Pool 4 of the long-term French Creek reference reach.

The 2022 Sugar Creek reference site addition was a pool lying upstream of a riffle that is immediately upstream of the Sugar Creek BDA natural beaver dam pond.

Non - BDA (Sugar Creek OCP, French Creek Side Channel, ELJs, Wood & Gravel)

The original non-BDA restoration reference sites were an off-channel pond at Sugar Creek and a constructed side channel with mainstem Engineered Log Jams (ELJs) in French Creek. An additional restoration site was constructed in French Creek (French Creek Wood-Gravel) in 2019 and monitoring was undertaken, the results of which are included in the overall Project analysis.

The Sugar Creek Off Channel Pond (Sugar OCP) was an existing isolated cold-water pond resulting from historic mining that was isolated from, but adjacent to, Sugar Creek. In October 2015, the Siskiyou Resource Conservation District constructed connecting channels to Sugar Creek and to a wetland that lies adjacent to Sugar Creek. The connections were constructed after the Sugar Creek BDAs were installed and the excavation depths for the connecting channels were set to the water surface elevations created by the BDAs. The Sugar OCP is a 0.5-acre steep walled excavated pit with water depths up to 13 ft. Water quality monitoring prior to connection and during the study period documented water quality (dissolved oxygen and temperature) suitable for rearing salmonids. Fish sampling proved difficult at the site. Seining was not possible due to the lack of any benched areas along the margins, and minnow traps generally yielded a low number of captures. Snorkel surveys by other entities reported large numbers of salmonids utilizing the pond at summer base flow, but these were never confirmed with more quantitative methods. There were paired PIT Tag antennas maintained on the outlet connection channel throughout the study period. While the Sugar OCP maintained water at all times, the connection channels dewatered and connectivity to Sugar Creek and the wetland area was lost during baseflow of 2018, 2020, 2021, and 2022.

The French Creek Fisheries Restoration Grant Program (FRGP) funded restoration that was implemented in French Creek in the summer of 2018 (SRWC 2021). The restoration consisted of several interconnected features- a constructed large complex side channel (FRGP SC), three Engineered Log Jams in the mainstem (French ELJs), and spawning gravel augmentation in the mainstem. The FRGP SC consisted of a 0.5 acre excavated channel with both an inlet and outlet. The flow through design was a FRGP program requirement. The FRGP SC was excavated with areas of variable water depth with original water depths of 7 ft in the deepest parts, however high flows deposited significant amounts of sediment within the side channel in the first winter after construction. Several iterations of adaptive management were undertaken to address the transport to and storage of sediment within the FRGP SC, including placing additional wood structure in the inlet and outlet and ultimately re-excavating a portion of the upstream side channel to the original depths in 2020.

Throughout the life of this project, beaver have significantly interacted with the site (see *Natural Beaver Ponds and Beaver Utilization*).

The French Creek Wood Gravel Side Channel project was the augmentation of large wood structures in association with spawning gravel in a 250 ft reach of a naturally occurring side channel downstream of the French Creek BDAs. In 2019, 12 large logs were placed into the channel, and approximately 60 tons of gravel suitable for spawning was placed in conjunction with the large wood structures. The side channel has remained wetted since construction, though flows are very low during the baseflow period. The side channel connects to French Creek at the downstream end and at two high flow channels between the Side Channel and French Creek towards the top of the Wood-Gravel project, but downstream of the BDAs. No adaptive management activities have been undertaken since construction. Monitoring of this project consisted of juvenile sampling and spawning surveys.

Natural Beaver Ponds (Sugar Creek & French Creek)

Beaver consistently interacted with French Creek and Sugar Creek during the study period to the extent of creating significant habitat quantities and offering the opportunity to add natural beaver ponds to the study plan as additional reference sites.

The Sugar Creek beaver dam was constructed in 2018 shortly before the stream below the new dam dewatered. Realizing that the beaver pond was potentially operating as a drought refugia, juvenile sampling was conducted in the beaver dam pond during baseflow in 2018 and continued during subsequent monitoring efforts.

The French Creek beaver have constructed a series of dams that have interacted with FRGP SC and ELJs. Beaver historically constructed a beaver dam on an instream grade control boulder vortex weir lying downstream of the FRGP SC outlet prior to the SC construction, however in 2019 evidence of beaver in mid-French Creek disappeared for a period of approximately 12 months. In 2020, beaver once again was noticed in the reach and started constructing a dam on the boulder vortex weir. The dam reached a sufficient height to back water up into the FRGP side channel and raise the water surface elevation. The beaver reconstructed the dam after winter blowouts in 2021 and 2022. Each of these dams reached a sufficient height to influence the FRGP SC WSE. In 2021, the beaver constructed an additional dam on a riffle crest downstream of the boulder weir. This new dam increased the water surface elevation, impounded a significant quantity of water and created deep slow water habitat in over 400 linear feet of French Creek. The dam survived the winter of 2021-22 essentially undamaged. In 2022 the beaver further extended their area of influence by constructing a new dam just upstream of the French ELJs and downstream of the FRGP SC inlet. All three of the beaver dams were hydrologically connected with the WSE of each extending to the upstream dam. An extensive network of surface water and groundwater elevation monitoring wells upstream of the beaver dams were installed prior to the initiation of significant beaver activity, which offered the serendipitous opportunity to capture water surface elevations in the channel and adjacent groundwater pre and post beaver activity. Juvenile Coho sampling was undertaken in the various beaver habitats, as well as adult spawning ground surveys.

Environmental Conditions/Water Type

The Scott River watershed has three long term environmental water supply data collection efforts: accumulated precipitation at the USFS Ranger Station in Fort Jones (1938 to present), stream discharge at the USGS Scott River Mile 21 (WY1941 to present) and snowpack surveys (1946 to present).

Precipitation - USFS Fort Jones Ranger Station

Accumulated precipitation at the US Forest Service Ranger Station in Fort Jones, CA was calculated from monthly accumulated precipitation for three time periods (October 1 – March 30, October 1 – June 30 and October 1 – September 30) over the period of record (www.cdec.water.ca.gov). For each calculated period of accumulated precipitation, a dry rank (1 equals the driest year on record) was calculated for each water year. The April 1st Snowpack Water Equivalent Percentage of Average from the USFS snow surveys is reported for each water year (Table 1). Accumulated annual precipitation during four of the five water years from WY2018 to WY2022 have ranked in the top ten driest water years over the period of record with WY2020 ranking as the third driest water year. The accumulated precipitation in WY2019 was slightly less than the average over the period of record.

Table 1. Accumulated precipitation (inches) at USFS Fort Jones Ranger Station and percent Snowpack Water Equivalence on April 1.

Water Year	Acc. Prec. (in) Oct. 1 - April 1	Dry Rank	Acc. Prec. (in) Oct. 1 - July 1	Dry Rank	Acc. Prec. (in) Oct. 1 - Sept.30	Dry Rank	April 1 Snowpack Water Equivalence % Average
WY13	15.7	38	19.2	45	21.4	47	40%
WY14	8.5	7	9.8	5	12.1	7	9%
WY15	16.6	43	18.7	43	19.6	39	<1%
WY16	21.3	66	23.5	58	23.6	56	97%
WY17	29.3	83	32.3	81	33.5	82	100%
WY18	8.1	5	12.2	9	12.2	8	36%
WY19	16.6	44	19.2	44	20.8	44	134%
WY20	7.0	4	9.5	4	10.1	3	44%
WY21	9.7	14	10.2	6	11.3	6	71%
WY22	8.9	9	12.8	13	13.2	9	18%
Average (85 Years)	17.0	--	19.8	--	21.1	--	--

Analysis of the cumulative departure of the accumulated precipitation from October 1 – March 30 compared to the mean precipitation from WY1938 – WY2000 shows a significant negative cumulative departure starting in 2006. A cumulative deficit of greater than 60 inches of precipitation compared to the WY1938 – WY2000 mean was recorded in Fort Jones from WY2006 to WY2022 (Figure 3). The cumulative deficit illustrates the magnitude and length of the current dry period in the Scott River.

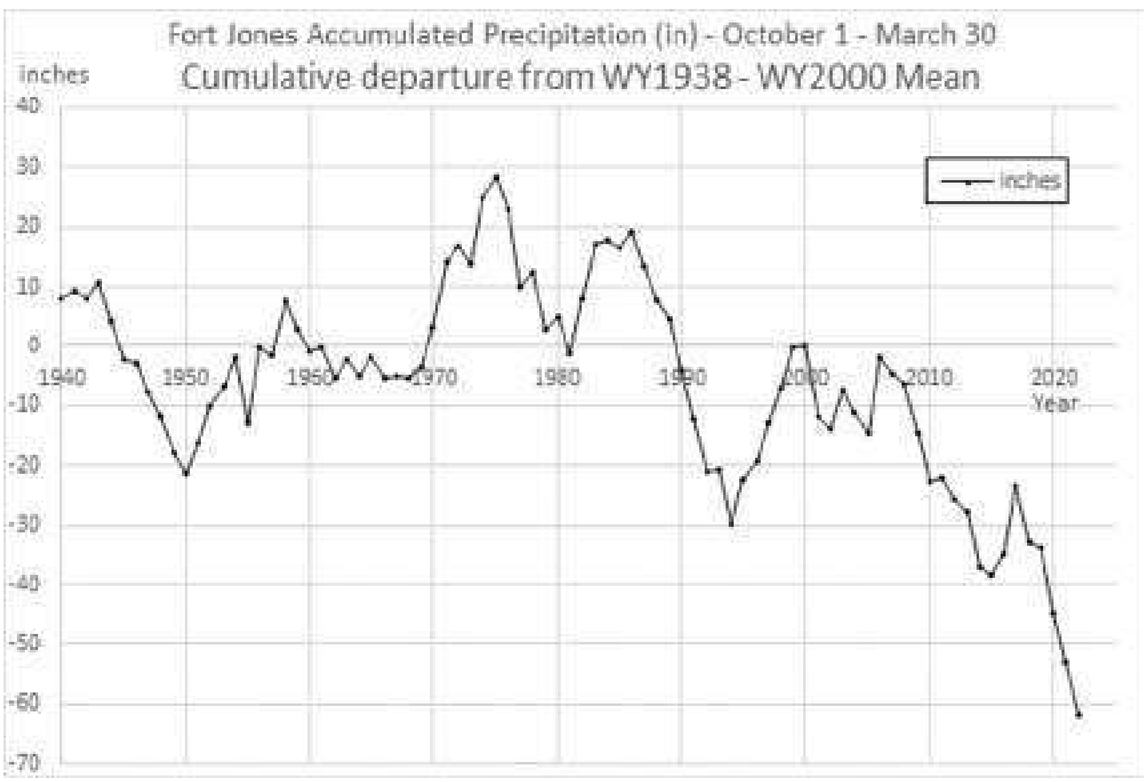

Figure 3. Cumulative departure of accumulated precipitation (October 1 - March 30) from WY1938 - WY2000 mean.

Accumulated Discharge - USGS Scott River RM 21

Monthly accumulated discharge data (acre – feet) at the Scott River RM 21 USGS Gage (11519500) was retrieved from CDEC (cdec.water.ca.gov). The accumulated discharge data covered the period of WY1942 through WY2022. The accumulated discharge for time periods that capture environmental periods and temporal periods that capture biologically significant periods were calculated and analyzed (Table 3). The accumulated discharge at Scott River RM21 was calculated for the entire water year and the base flow period of August 1 through September 30 (Figure 4 and Figure 5). There is a declining trend in the accumulated discharge for the entire water year and base flow period over the period of record. Four of the ten years with the least accumulated discharge over the entire water year have occurred in the last nine years (WY2021, WY2020, WY2014 and WY2022).

Table 2. Accumulated discharge (Thousand Acre-ft) and Dry Rank at Scott River USGS discharge station.

	October 1 - September 30		October 1 - March 31		April 1 - September 30		August 1 - September 30	
	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank
WY2013	233	20	143	28	90	15	1.35	14
WY2014	122	7	92	12	31	3	0.88	6
WY2015	295	28	269	52	26	2	0.91	7
WY2016	508	51	324	54	184	43	1.94	21
WY2017	864	76	570	74	294	68	6.27	44
WY2018	191	12	99	14	92	17	0.85	5
WY2019	411	44	163	34	249	64	3.57	29
WY2020	120	5	63	5	57	7	0.99	11
WY2021	110	3	61	4	49	5	1.19	12
WY2022	139	8	75	10	65	9	0.94	10
Average (n = 81)	435		252		184		6.02	

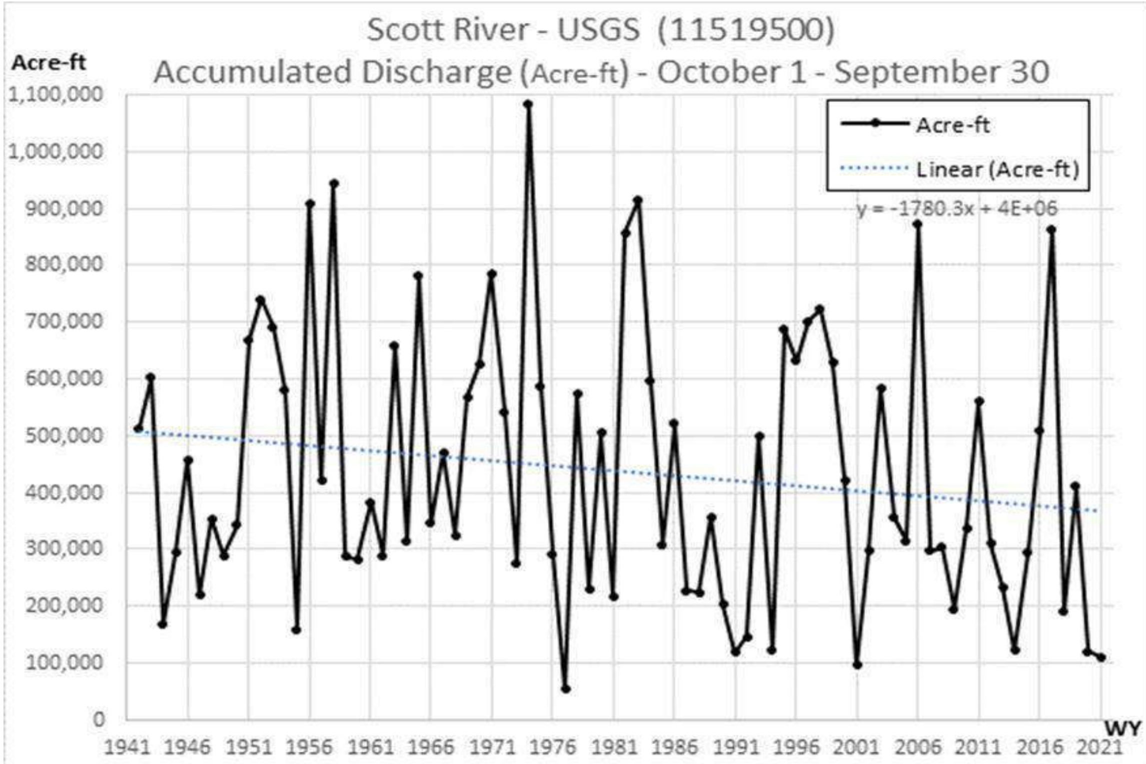

Figure 4. Accumulated discharge (af) – October 1 - September 30.

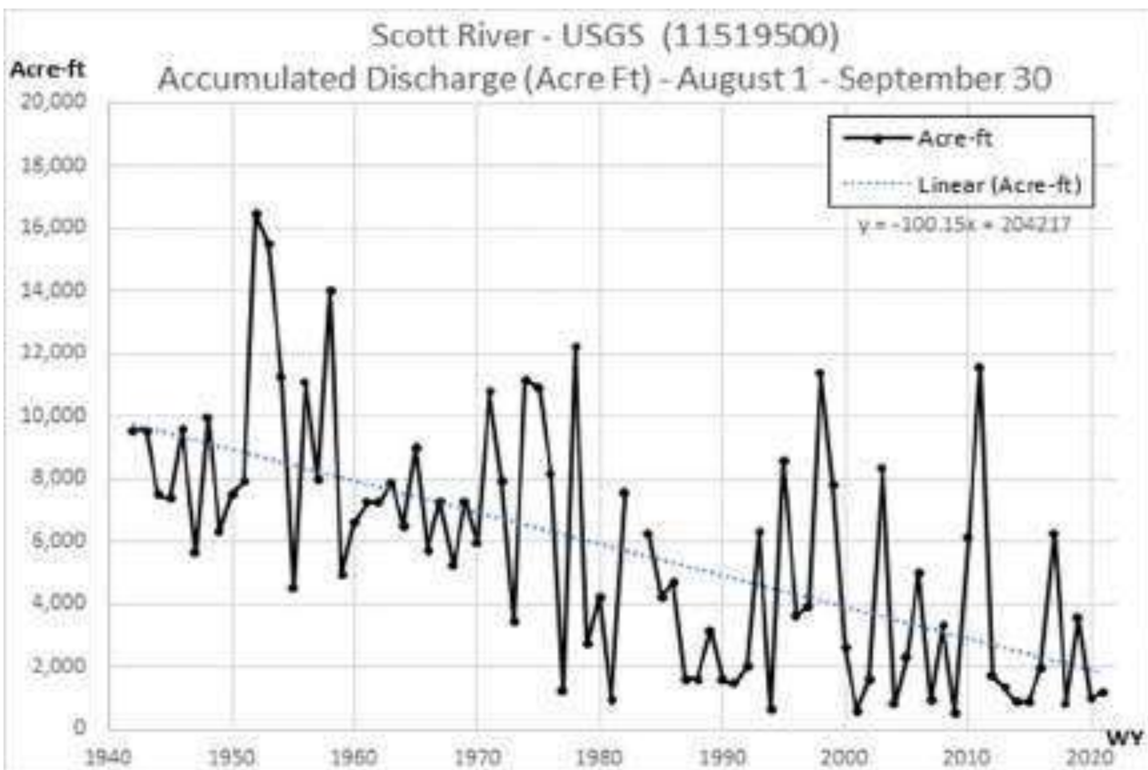

Figure 5. Accumulated discharge (af) – August 1st through September 30th.

Scott River Snowpack

Snowpack surveys have been performed at the Middle Boulder 1 site since 1946. Snow water equivalent (inches) measurements on April 1st indicate a decline in water availability on April 1st over the period of record (Figure 6).

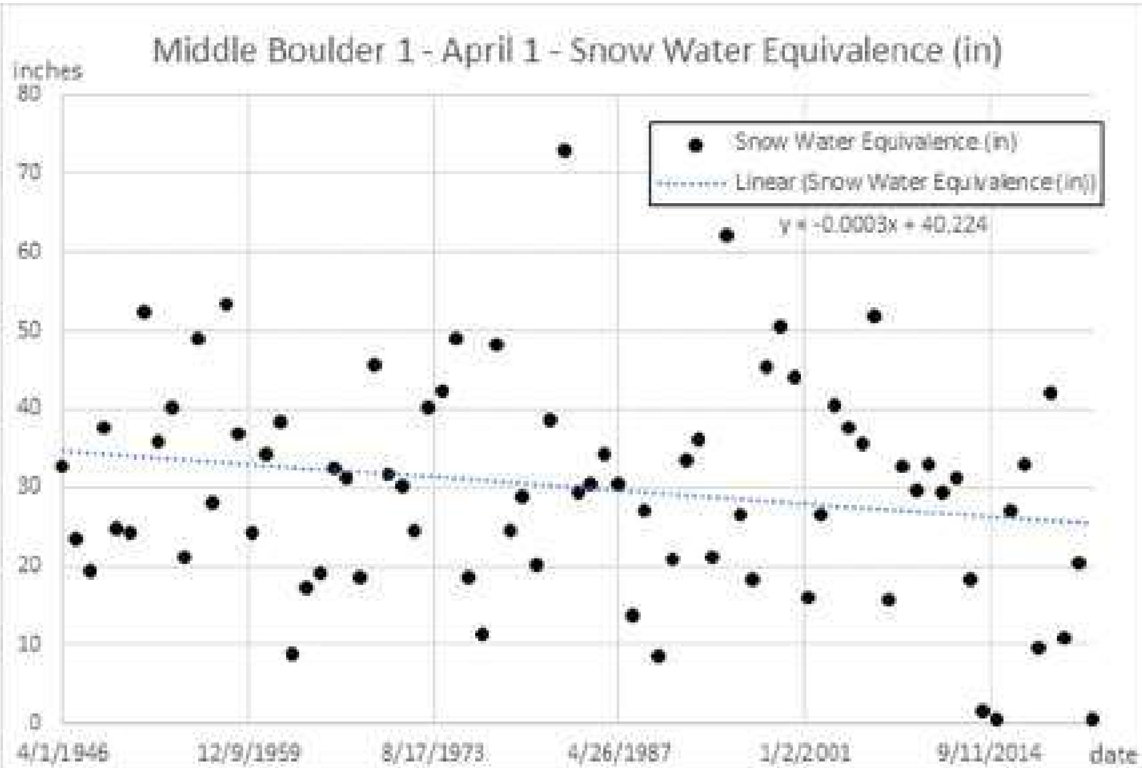

Figure 6. Snow water equivalent (inches) on April 1 - Middle Boulder 1 (Elev. = 6,600').

The three indices of water supply (accumulated precipitation in Fort Jones, accumulated discharge at Scott River RM 21 and April 1 Snow Water Equivalent) all indicate a decrease in water supply inputs and outputs. In addition to this long-term declining trend in water supply indices, four of the last five years (2018, 2020 - 2022) have been critically dry in the Scott Watershed significantly affecting the available water supply.

Agricultural Water Extraction

At all BDA sites, the adjudicated water rights to extract water for agricultural purposes above the restoration and reference reaches were exercised during the period of this project. In 2022, curtailments were in effect for the Scott River watershed, however the adherence to those curtailments is unknown. French Creek also has a point of diversion below the FRGP SC which is above the most downstream natural beaver dam. Throughout the study period, all sites had changes in flow, groundwater and surface water elevations that could not be correlated with environmental conditions and were almost certain to have been influenced by water management actions. Actual water extraction rates are difficult or impossible to obtain, and we did not attempt to do so, therefore the impact of this effect is not quantified.

Methods

Ground and Surface Water Temperatures

Continuous surface water and groundwater temperatures in the BDA affected reaches and control reaches were documented with Onset Computer Corporation loggers. Water temperature loggers (Onset ProV2 and Tidbit) in protective casings were installed in representative surface water locations on the bottom of the channel and temperature was documented at a 15-minute interval. Water temperature in groundwater and surface water locations were documented by the pressure transducers (Onset U20 and U20L) at the water surface elevation monitoring stations.

Continuous water temperature (°C) is converted to daily average, minimum and maximum temperatures and seven day moving average temperatures.

Ground and Surface Water Elevations

Groundwater and surface water elevations were documented using Onset Computer Corporation pressure transducers (U20 and U20L) placed in vented steel casings driven into the ground (groundwater stations) or vented PVC stilling wells (surface water stations).

A RTK GNSS survey system was utilized to document the elevation of the reference point on each water surface elevation station. The reference point elevation surveys were post processed using the National Geodetic Survey Online Positioning User Service (NGS OPUS) resulting in reference point elevations above mean sea level in the NAVD88 vertical datum.

Periodic measurements of the distance of the water surface elevation from the reference point are performed during station download and maintenance.

Continuous water depth at the sensor location was calculated in the Onset HoboWare Pro software package and mean sea level water surface elevation was calculated using the reference point elevation, the periodic measured water surface elevation, and the continuous depth measurements. Daily average, minimum and maximum water surface elevation was calculated for each station.

Habitat Capacity

Topographic surveys were performed with a RTK GNSS survey system in Sugar Creek and French Creek to document the elevation of the stream's longitudinal profile and cross sections. The stream bed elevations in conjunction with water surface elevation measurements were used to calculate the wetted volume of habitat.

Juvenile Salmonids

Usage of BDA habitats by juvenile salmonids was monitored over the course of the grant period. Data collected from in-person sampling efforts as well as from remote stations allowed for metrics such as growth, movement between habitat units and migration timing to be tracked across seasons and years.

When environmental conditions (water temperature, dissolved oxygen concentration, habitat volume, etc.) allowed, sampling efforts were carried out. Using seines and minnow traps, distinct habitat units were sampled for aquatic species. Captured fish were removed from the stream and placed into aerated water next to a processing station. All juvenile salmonids meeting condition requirements were anesthetized (either in an Alka-Seltzer or carbon dioxide bath), weighed (in grams) and measured (in millimeters). Non-salmonids that were captured were immediately returned to the stream without being anesthetized. Coho Salmon were scanned for PIT tags using a Biomark HPR Plus Handheld PIT Tag Reader. If no tag was detected, Coho with a forklength greater than 65 mm were eligible to be tagged. 12.5 mm PIT tags were implanted into the abdominal cavity using an MK25 Implanter. After being anesthetized and processed, fish were again placed into aerated water and allowed to fully recover before being returned to the stream.

Returning to sample the same units after a certain amount of time had passed allowed for growth rates to be calculated for individual fish. Previously tagged fish were recognized using the handheld PIT reader and forklengths and weights were compared to prior events. In general, sampling events took place at least six weeks apart.

In addition to in-person sampling, PIT arrays were installed at various locations throughout the watershed. These stations include antennas, reader boards and solar power stations and they allow for tagged fish to be detected as they are moving between habitats. Arrays have been operated at 28 unique locations throughout French Creek, Sugar Creek, Miners Creek and the mainstem Scott River over the course of the grant period (Table 4). Sites were selected to monitor metrics such as habitat use, residence time, and timing of outmigration (Figures 7 and Figure 8).

Table 3. PIT arrays operated for all or part of the grant period.

PIT Array Network	
01-09	SUGAR CREEK (Confluence at Scott River RKM 87.6)
1A	- Sugar Below (BP1) BDA1 RKM 0.05 - US
1B	- Sugar Below (BP1) BDA1 RKM 0.05 - DS
1C	- Sugar Below BDA1 - Side Channel
2A	- Sugar (BP1) Above BDA1 - US RKM 0.1
2B	- Sugar (BP1) Above BDA1 - DS RKM 0.1
2C	- Sugar (BP2) Above BDA2 - US RKM 0.18
2D	- Sugar (BP2) Above BDA2 - DS RKM 0.18
2E	- Sugar RKM 0.09
3A	- Sugar OCP Channel - US
3B	- Sugar OCP Channel - DS
04	- Sugar (BP2) Above BDA2 RKM 0.3
10-19	FRENCH CREEK (Confluence at Scott River RKM 77.6)
F1	- French Below Natural Beaver Dam RKM 2.85 - US
F2	French Below Natural Beaver Dam RKM 2.85 - DS
10	- Mid French Mainstem RKM 2.9 - US
11	- Mid French Mainstem RKM 2.9 - DS
12	- French FRGP SC Outlet - US RKM 3.1
15	- French FRGP SC Outlet - DS RKM 3.1
13	- Mid French SC Inlet - RKM 3.2
14	- French SC BDA Pond 1
16	- Mid French Mainstem RKM 3.5
17	- Mid French Mainstem RKM 3.1
18	- Mid French Creek RKM 4.5 - Below Miners
20-29	Miners Creek (Confluence at French RKM 4.6)
20	- Lower Miners Creek RKM 0.05
30-39	Scott River (Oasis)
30	- Scott River - Alexander Pond RKM 85.7
31	- Scott River - Oasis Alcove Inlet RKM 85.4
32	- Scott River - Oasis Below Alcove Inlet RKM 85.3
90-99	Remote Sites
90	- Round Antenna (portable)
93	- Scott River RKM 29.0 - CDFW Weir
94	- Scott River RKM 29.2 - 80ft Antenna
99	- Shasta River RKM 0.2 - CDFW Weir

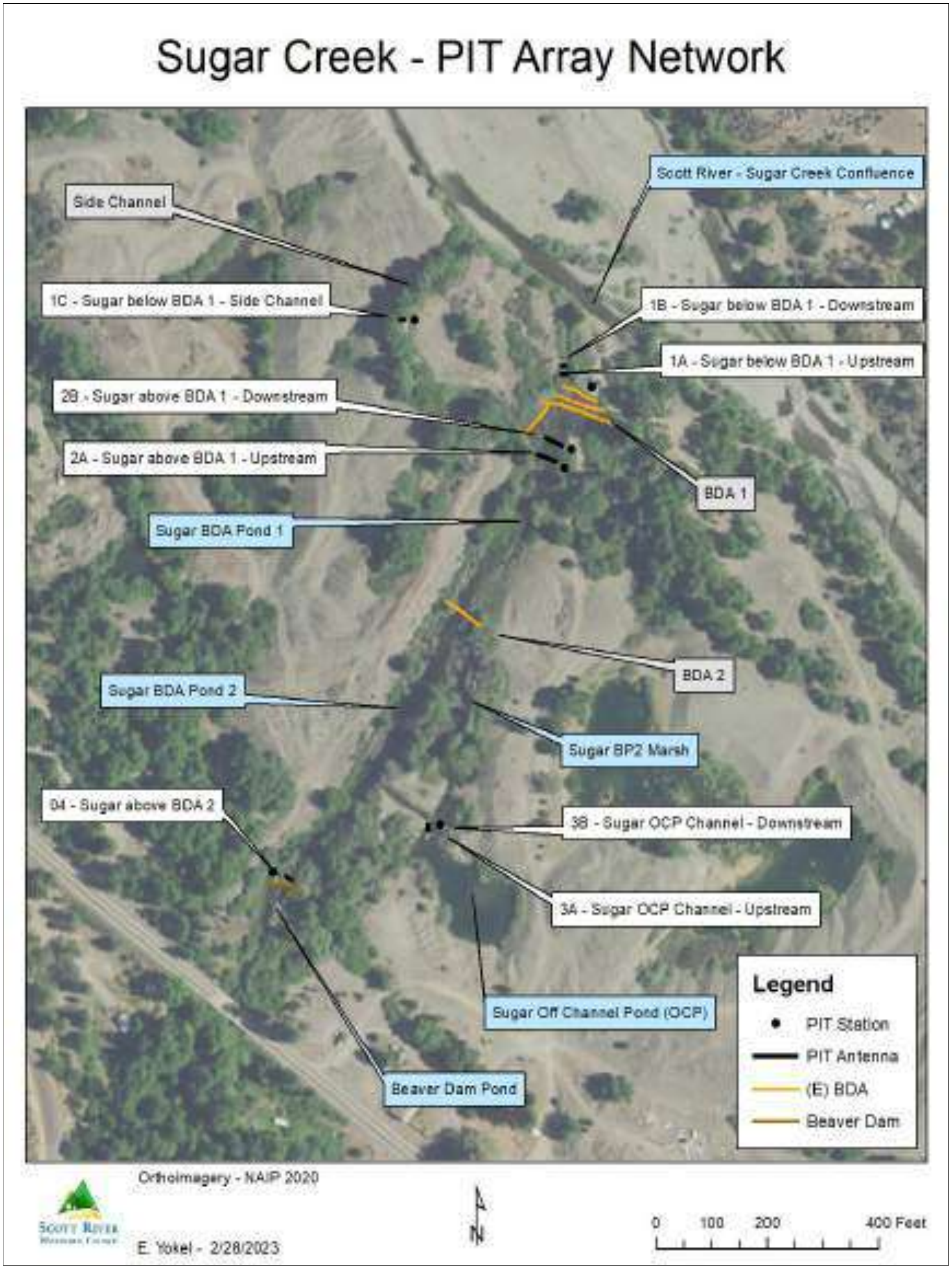

Figure 7. Map of Sugar Creek PIT array station.

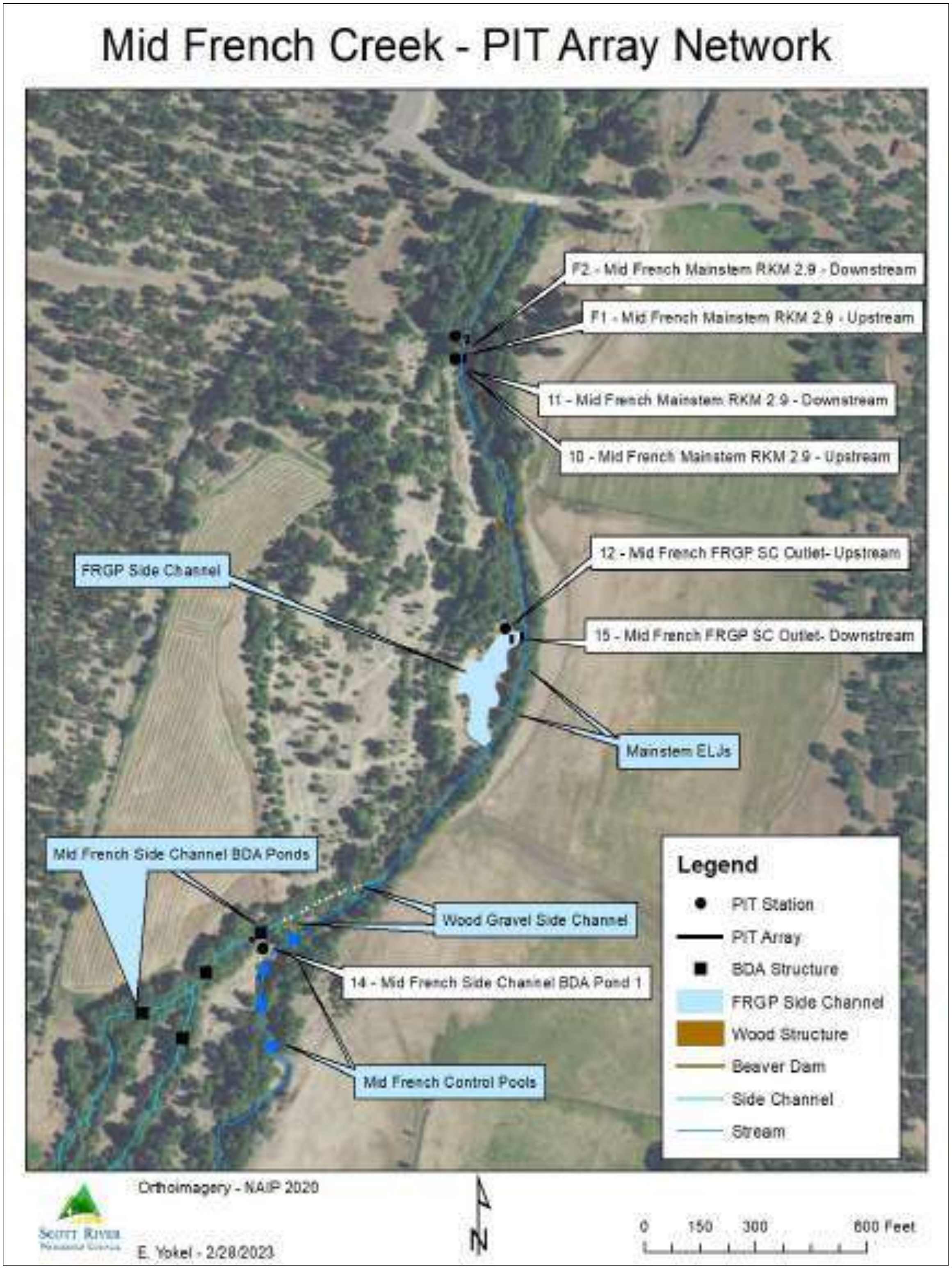

Figure 8. Map of French Creek PIT array network.

Direct observation surveys were employed less frequently and generally were used as a means of evaluating whether BDA structures were acting as fish passage barriers. SRWC staff used traditional equipment of masks and snorkels to verify the presence of juvenile salmonids in certain habitat units.

Fish Relocation Efforts

When faced with adverse environmental conditions, SRWC, in coordination with both NOAA and CDFW completed fish relocation efforts in 2018, 2021, and 2022. In late summer and in this extreme drought conditions meant that the habitat volume of certain BDA ponds shrank to levels low enough to be considered perilous for the fish. Staff used seine nets to remove fish from the shrinking habitats and place them into aerated buckets. A subsample of Coho Salmon were anesthetized, weighed, measured and PIT tagged to estimate the impact of relocation on survival. All other fish were identified by species and counted before being returned to recovery buckets. After a recovery period, tagged and untagged fish were then relocated to the nearest habitats with deeper, cooler water sufficient to survive the drought period before being able to volitionally return to their original habitat units when conditions improved. The relocation habitats were surveyed prior to the release of the fish to ensure that there were no, or limited numbers, of fish residing in them to avoid creating density related problems in the relocation habitats.

In July 2021, a significant relocation effort occurred in Sugar Creek in which a total of 1,368 Coho Salmon were relocated from the drying Sugar BDA Pond 1 habitat to the adjacent Sugar OCP and natural beaver dam habitats. A subsample of the relocated fish were marked with PIT tags in order to monitor the survival of the relocated fish and the success of the effort. 104 PIT marked Coho were relocated to the Sugar OCP and 62 PIT marked Coho were relocated to the natural beaver dam. Detection on the PIT array stations were utilized to document survival through the base flow period and survival to outmigration (Table 5 and Table 6). Seventy-five percent (75%) of the marked Coho relocated to the Sugar OCP were detected on a stationary PIT array after the reach reconnected and 56% of the marked fish relocated to the Sugar OCP were detected on the paired outmigrant PIT arrays. 42% of the marked Coho relocated to the natural beaver dam were detected on the outmigrant PIT arrays.

Table 4. Number of marked relocated Coho Salmon detected on Sugar Creek PIT array.

Sample date	Sample Habitat	# Marks	Comment	Number Detected	Percent Detected
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	37	70%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	31	50%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	41	80%
Total		166		109	66%

Table 5. Number of marked relocated Coho Salmon detected on paired outmigrant PIT arrays.

Sample Date	Sample Habitat	# Marks	Comment	Outmigrants Detected	Percent Detected
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	26	49%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	26	42%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	32	63%
Total		166		84	51%

Adult Returns

Spawning ground surveys were the primary method of monitoring adult salmonids in the study area. During late fall and winter of each year of the grant period, pairs of SRWC staff walked all accessible reaches of French Creek, Sugar Creek, Miners Creek, and small sections of the mainstem Scott River looking for evidence of adults returning to the watershed. In general, surveys of specific reaches were repeated weekly during the spawning period. Crews collected data on live fish, carcasses and redds. Live fish were only identified and counted, without being handled. Scale, tissue, otolith and occasionally eye samples were taken from carcasses and delivered to partners for analysis, generally the California Department of Fish and Wildlife or a research university. Redd length, width and depth were measured. Geospatial data for all three of these types of observations were recorded in Garmin GPS units, and flagging was left on streambanks perpendicular to where redds were observed.

Adult returns were also monitored using the PIT array network. Each fall the California Department of Fish and Wildlife constructs a video weir on the mainstem Scott River at river mile 18.1 to count adult salmonids as they swim upstream. Scott River Watershed Council has worked in partnership with CDFW to install and maintain an array on the weir as a means of detecting PIT-tagged adults returning to their natal streams. After CDFW operation of the weir ceased for the season, SRWC installed a channel-spanning antenna to continue detecting fish returning later in the season. Combining the data from these two arrays allowed for PIT-tagged adult Coho Salmon returning to the Scott River to be identified. Arrays placed at the downstream end of the study reaches of French and Miners Creeks provided tributary-specific data on where these adult Coho were returning to spawn. Adult tags detected on the arrays could be located in the juvenile tagging database that SRWC maintains, illustrating the habitats in which these returning fish had reared.

Beaver Utilization

Beaver activity was qualitatively monitored through repeated presence-absence surveys that looked for evidence of beaver activity such as scent mounds, cut trees, chew sticks, dam-building or BDA modifications, lodges, caches, and canals. Additionally, game cameras were used to determine the number of animals at a given site and possible familial structure.

All sites were documented to have beaver presence but only at one site, Sugar Creek, did the beaver consistently interact with the BDAs. As a result of the storm event in winter of 2015, a portion of the upstream BDA (BDA 2) structure had tipped downstream into a scour hole that had formed at the base of the structure, compromising its integrity and the BDA's ability to hold water. As SRWC attempted to negotiate an adaptive management plan in the summer of 2015, there were observations that beaver had moved into the site and began to reconstruct the damaged portion of the BDA, strengthening its integrity beyond the original structure. Since that time, SRWC has photo trapped a pair of beaver who made a bank den/lodge just upstream of the BDA/beaver dam structure. It is believed that several sets of kit(s) have been reared here since that time.

In 2018, observations of newly constructed beaver dam, 550 feet upstream of the upper BDA/beaver dam in Sugar Creek, was made on August 2, 2018, during a juvenile sampling event. At that time, the stream through the project reach to the confluence with the Scott River was fully connected. Approximately two weeks later, large portions of the mainstem Sugar Creek channel disconnected and dried from the confluence to just below the newly constructed beaver dam. It is believed that the same family of beaver moved to the pond above the newly constructed dam site until the stream flows increased later in the year. This pattern of use has been observed in the subsequent dry years of 2020, 2021, and 2022. The location of the new dam maintains ponded water, even when the flow coming into the reach decreases to less than 0.1 cfs and the stream dries downstream of the dam.

At the Miners Creek BDAs, there were very ephemeral signs of beaver exploration of the site, consisting of a few scattered chew sticks. These signs were identified in the spring of the first year or two after initial construction when pool habitat was maximal. However, beaver have not occupied the site on any consistent basis and have not contributed to maintaining the structures. The Miners Creek site has a rich abundance of willow species that beaver prefer, but has become dry every summer (except 2017, the first year after BDA construction) since the site started to be monitored.

At French Creek, beaver created a bank den, which they appeared to occupy during high flow events for a few winters, in the side channel above the French Creek BDAs, however no utilization of this site was noted after 2020. Historically, the primary focus for beaver activity in French Creek was downstream of the BDA site, and this remained true through the study period. beaver explored the FRGP SC within a week of construction as evidenced by new browsing on vegetation adjacent to the channel, and game cameras have provided evidence of ongoing beaver activity in French Creek and the FRGP side channel for all but 12 months of the study period. beaver have consistently managed French Creek downstream of the FRGP side channel, constructing a dam in 2020 on an instream boulder vortex weir placed as grade control for diversion infrastructure. They have maintained this structure, rebuilding after high flow events, to the extent that it has significant effects on water surface elevation and water quality in the FRGP SC. In 2021, beaver added to their complex by constructing a substantial dam downstream of the boulder weir structure. In 2022, beaver extended their influence on the site by constructing a small dam just downstream of the FRGP SC inlet and upstream of the FRGP ELJs in the main stem French Creek. The beaver has also extensively browsed on the willow planted in association with the French Creek SC.

Results

Temperature Monitoring – Sugar Creek

Documentation of the continuous water temperature in the mainstem Sugar Creek at RKM 0.4 illustrates the warm water temperatures during the summer base flow period, the cold-water temperatures during the winter and a large daily fluctuation in temperatures characteristic of surface water (Figure 9). Analysis of the maximum temperatures during the summer base flow period illustrates the cooler temperatures during

WY2019 (an average water year type) compared to the base flow temperatures in the drought years of WY2020 through WY2022.

Analysis of the water temperature regime at the Sugar Creek OCP - Bottom station, a location with a significant groundwater input, illustrates the cooler summer and warmer winter temperatures and small daily fluctuation in temperature characteristic of groundwater (Figure 10).

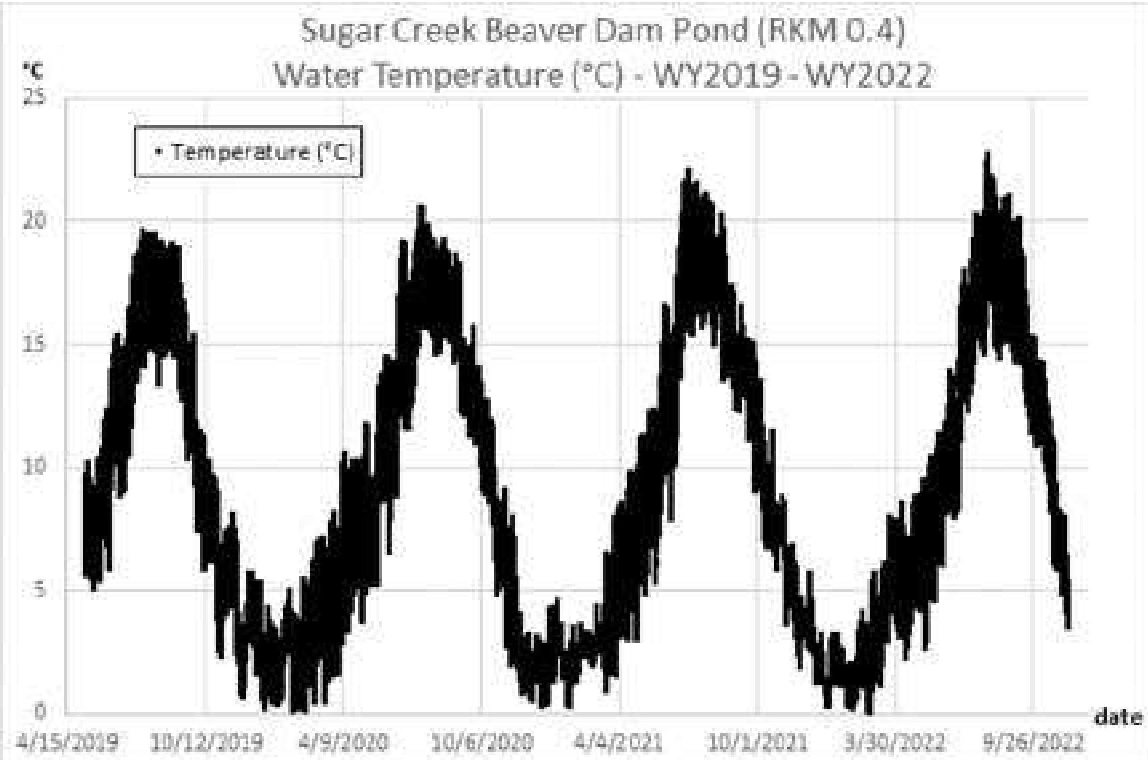

Figure 9. Continuous water temperature (°C) - Sugar Creek Beaver Dam Pond - RKM 0.4.

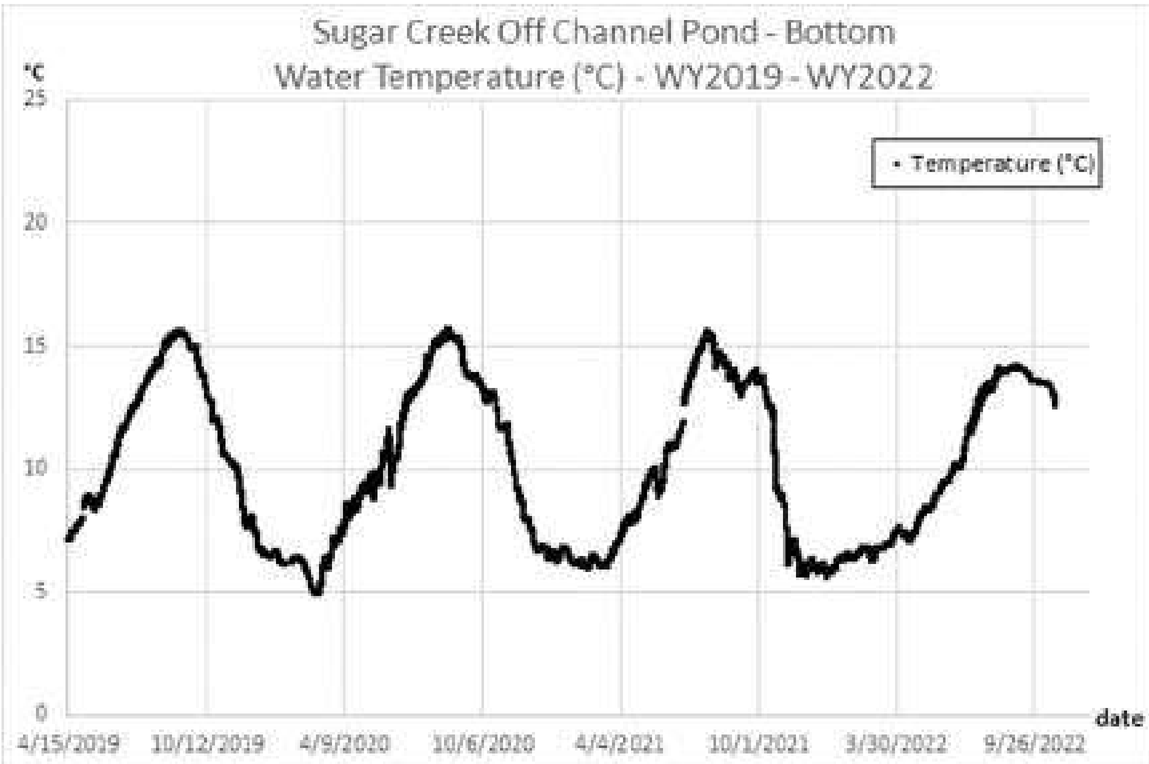

Figure 10. Continuous water temperature (°C) - Sugar Creek Off Channel Pond - Bottom.

Water temperature monitoring in the Sugar Creek BDA Reach has documented localized differences in temperature attributed to the groundwater inputs coming from the south during both the base flow period of summer and the runoff period of winter (Figure 11). Analysis of the maximum moving weekly average temperature (MWAT) during the base flow period of WY2019 (average water year type) demonstrates the significantly cooler water temperatures in the Sugar OCP (maximum MWAT - 15.6 °C) compared to the Sugar BDA Pond 1 (maximum MWAT - 17.6 °C). Additionally, thermal heterogeneity is observed throughout the mainstem sites in the Sugar Creek BDA Reach with areas of cooling - Sugar Creek RKM 0.4 to Sugar BDA 2 stations - and areas of warming - Sugar BP1 GW Input to Sugar BDA Pond 1. Thermal heterogeneity is also observed in the natural (Sugar Creek - Marsh and Sugar Creek - RL Alcove) and constructed (Sugar OCP - Outlet Channel).

Initial observations of the utilization and condition of Coho Salmon in the Sugar Creek BDA Reach during base flow documented higher densities of juvenile fish utilizing the areas of groundwater input (e.g., downstream of the Sugar Creek BP1 - GW Input station).

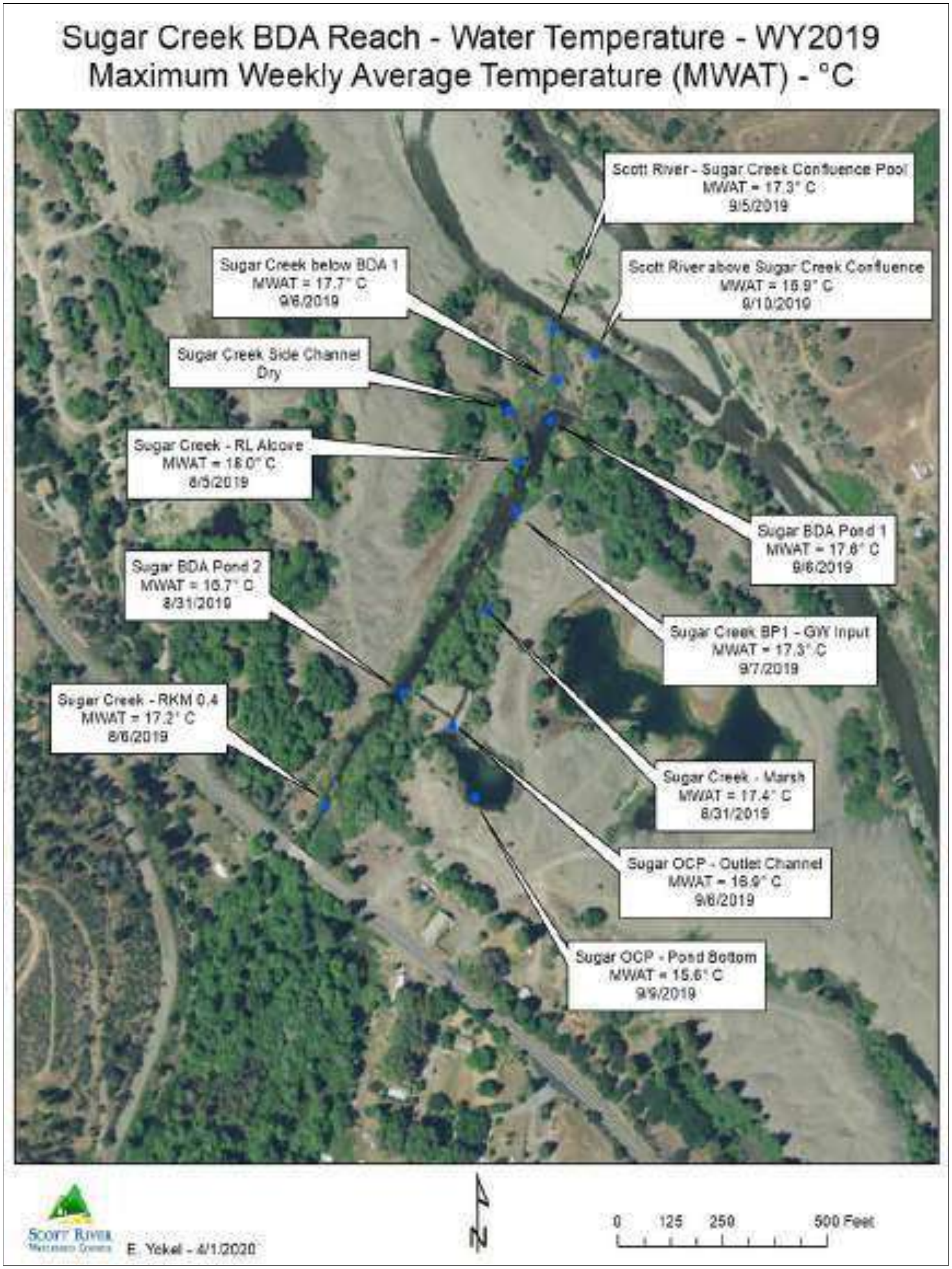

Figure 11. Maximum MWAT (°C) and date of occurrence during base flow - WY2019.

Comparison of the maximum MWAT (°C) at the mainstem Sugar Creek RKM 0.4 station and the Sugar Creek OCP - Bottom station illustrates the significantly cooler water temperatures in the groundwater fed deep pond during the summer base flow period (Table 7 and Table 8). The maximum MWAT at the mainstem site fluctuates from a minimum of 17.2° C during WY2019 and 19.4° C during WY2022 while the maximum MWAT at the Sugar Creek OCP - Bottom fluctuates from 14.2° C to 15.7° C.

Table 6. Maximum MWAT (°C) and date of occurrence - Sugar Creek - RKM 0.4.

Sugar Creek - RKM 0.4
Maximum MWAT (°C)

WY	Maximum MWAT (°C)	Date
WY2015	18.6	7/7/2015
WY2016	18.0	8/2/2016
WY2017	18.0	8/6/2017
WY2018	ND	ND
WY2019	17.2	8/6/2019
WY2020	18.3	7/23/2020
WY2021	19.2	7/4/2021
WY2022	19.4	8/2/2022

Table 7. Maximum MWAT (°C) and date of occurrence - Sugar OCP Bottom.

Sugar Creek OCP - Bottom
Maximum MWAT (°C)

WY	Maximum MWAT (°C)	Date
WY2016	15.7	9/4/2016
WY2017	14.9	9/17/2017
WY2018	15.7	9/7/2018
WY2019	15.6	9/9/2019
WY2020	15.6	8/25/2020
WY2021	15.5	7/30/2021
WY2022	14.2	9/5/2022

The minimum MWAT (°C) during winter for each water year at the mainstem Sugar Creek RKM 0.4 station illustrates the very cold-water temperatures in the tributaries of the Scott River during the period of winter base flow (Table 9). The minimum MWAT (°C) during winter at the bottom of the groundwater fed Sugar OCP illustrates the significantly warmer temperatures during winter base flow in the groundwater dominated habitat (Table 10).

Table 8. Minimum MWAT (°C) and date of occurrence - Sugar Creek - RKM 0.4.

Sugar Creek - RKM 0.4
Minimum MWAT (°C)

WY	Minimum MWAT (°C)	Date
WY2016	0.7	1/4/2016
WY2017	0.3	1/8/2017
WY2018	0.8	2/25/2018
WY2019	ND	ND
WY2020	1.4	12/29/2019
WY2021	1.0	1/30/2021
WY2022	0.7	1/3/2022

Table 9. Minimum MWAT (°C) and date of occurrence - Sugar OCP Bottom.

Sugar Creek OCP - Bottom
Minimum MWAT (°C)

WY	Minimum MWAT (°C)	Date
WY2016	5.9	1/11/2016
WY2017	5.4	1/9/2017
WY2018	3.9	12/7/2017
WY2019	5.7	2/24/2019
WY2020	5.0	3/6/2020
WY2021	6.1	2/21/2021
WY2022	5.8	1/2/2022

In conjunction with the water temperature monitoring, year-round dissolved oxygen monitoring in a variety of habitats utilized by Coho Salmon in the Sugar Creek BDA Reach has been monitored. Analysis of the temperature (°C) and dissolved oxygen (mg/L) in the beaver dam pond at Sugar Creek RKM 0.4 during the summer base flow period of the critically dry WY2020 illustrates the minimum dissolved oxygen concentration occurs during the period of maximum temperatures as is to be expected (Figure 12). A significant daily increase in dissolved oxygen concentrations is observed during the base flow period. These increases are attributed to photosynthesis releasing oxygen during the light cycle.

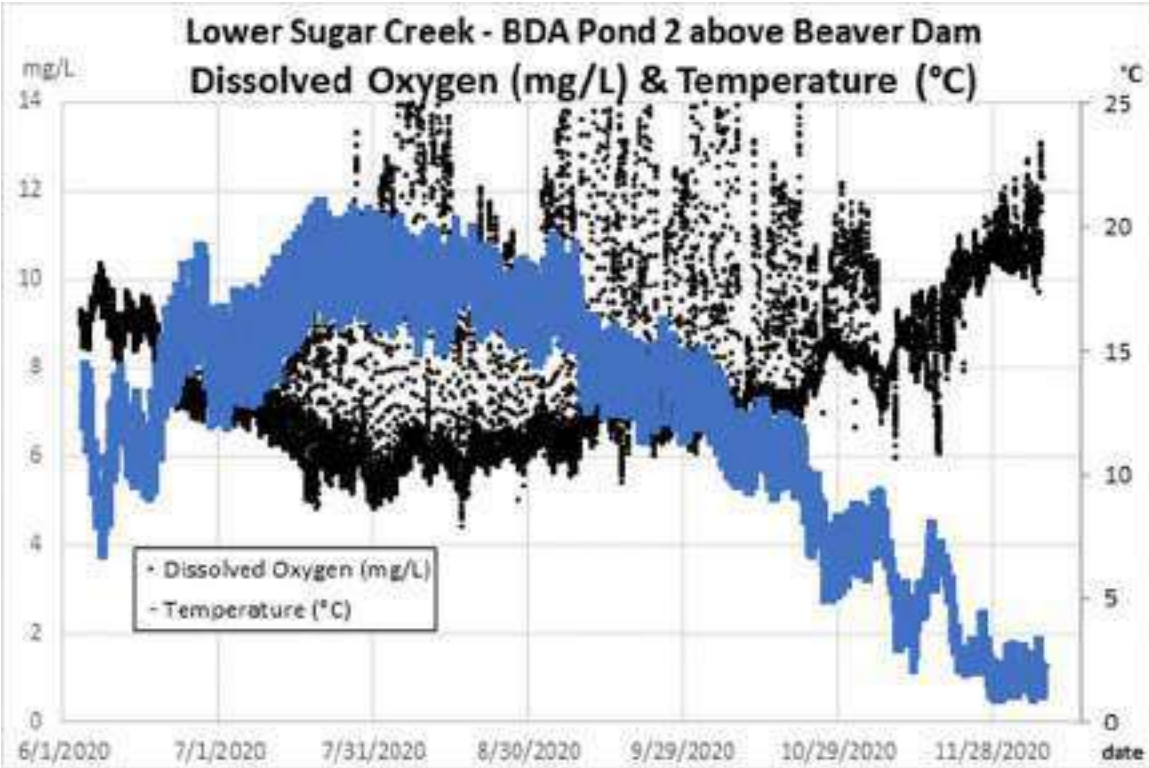

Figure 12. Water temperature (°C) and dissolved oxygen (mg/L) - Sugar Creek Beaver Dam Pond.

Temperature Monitoring – French Creek

Water temperatures in mainstem French Creek at RKM 3.5 are comparable to the water temperatures observed in the mainstem Sugar Creek station (Figure 13). Analysis of the maximum MWAT (°C) during the summer base flow period of each water year illustrates a range of 16.9° C (WY2019 - average water year type) to 18.1° C (WY2018 - critically dry water year type) (Table 11). Winter minimum MWAT (°C) in mainstem French Creek range from 0.7° C to 1.5° C (Table 12).

The Side Channel BDA Ponds have a significant groundwater influence creating significantly cooler temperatures in summer and warmer temperatures in winter. Analysis of the minimum MWAT (°C) in the winter in the Side Channel BDA Ponds illustrates minimum temperatures several degrees warmer than the mainstem temperatures with a range of 4.0° - 5.0° C (Table 13).

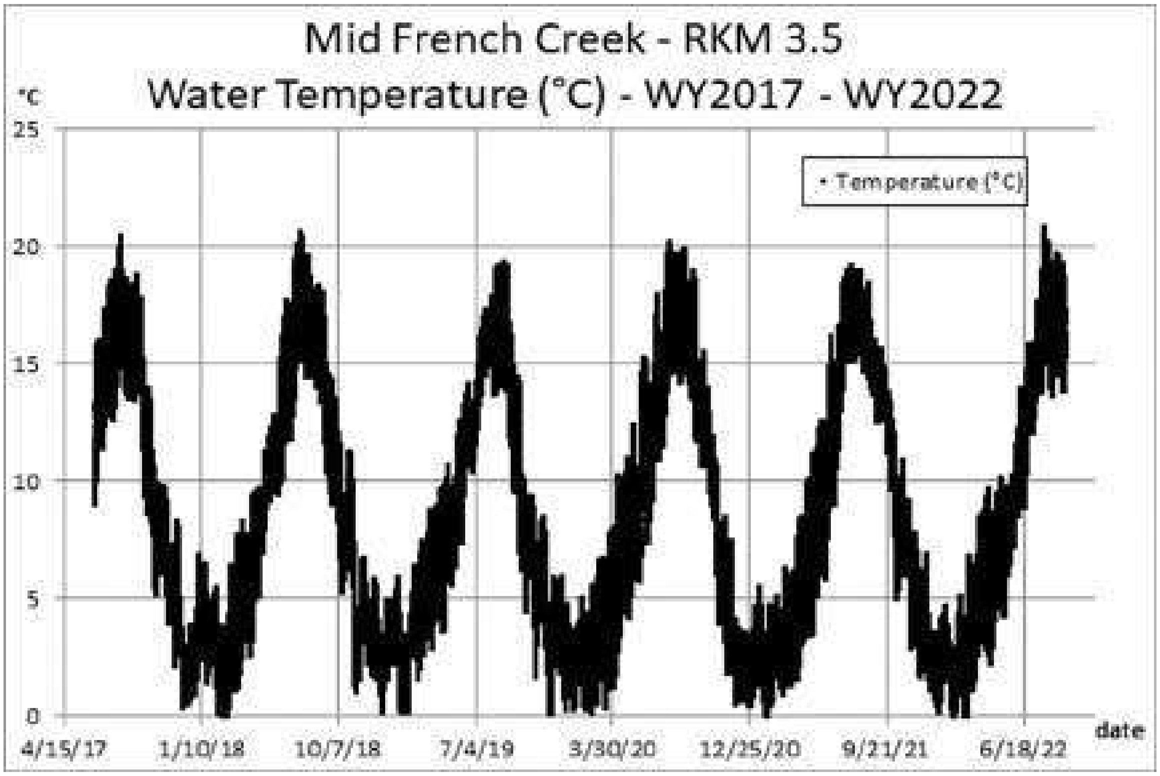

Figure 13. Continuous water temperature (°C) - French Creek - RKM 3.5.

Table 10. Maximum MWAT (°C) and date of occurrence - French Creek - RKM 3.5.

Mid French - RKM 3.5
Maximum MWAT (°C)

WY	Maximum MWAT (°C)	Date
WY2017	17.6	8/5/2017
WY2018	18.1	7/27/2018
WY2019	16.9	8/30/2019
WY2020	17.4	8/20/2020
WY2021	17.5	8/1/2021
WY2022	18.0	8/2/2022

Table 11. Minimum MWAT (°C) and date of occurrence - French Creek - RKM 3.5.

Mid French - RKM 3.5
Minimum MWAT (°C)

WY	Minimum MWAT (°C)	Date
WY2018	0.8	2/25/2018
WY2019	1.5	1/2/2019
WY2020	1.5	1/20/2020
WY2021	1.2	1/29/2021
WY2022	0.7	1/3/2022

Table 12. Minimum MWAT (°C) and date of occurrence - French Side Channel BDA Pond 1.

Mid French Side Channel BDA -Upstream BDA Pond 1
Minimum MWAT (°C)

WY	Minimum MWAT (°C)	Date
WY2018	4.9	12/18/2017
WY2019	4.2	2/20/2019
WY2020	4.8	1/20/2020
WY2021	5.0	1/30/2021
WY2022	4.0	2/26/2022

Water temperature at the outlet of the FRGP SC from its construction in WY2018 to the present illustrates fluctuating maximum water temperatures (Figure 14). Maximum MWAT (°C) by water year illustrates lower maximum temperatures in the average water year type (WY2019) compared to the subsequent critically dry year (Table 14). Of interest, the maximum MWAT (°C) in the two critically dry years after WY2020 are less than the maximum for WY2020 with WY2022 having the lowest maximum water temperatures for the period of record. In WY2021, the water surface elevation in the FRGP SC was increased due to the downstream beaver dam construction. It is hypothesized that the greater water depth and volume reduced the water temperature by increasing the water mass and reducing solar loading. A significant amount of macrophytic aquatic vegetation was observed in the FRGP SC during the winter and summer of WY2022. It is hypothesized that the cooler water observed during the summer base flow period in WY2022 is a result of increased water surface elevation and volume in conjunction with shading generated by the macrophytic aquatic vegetation.

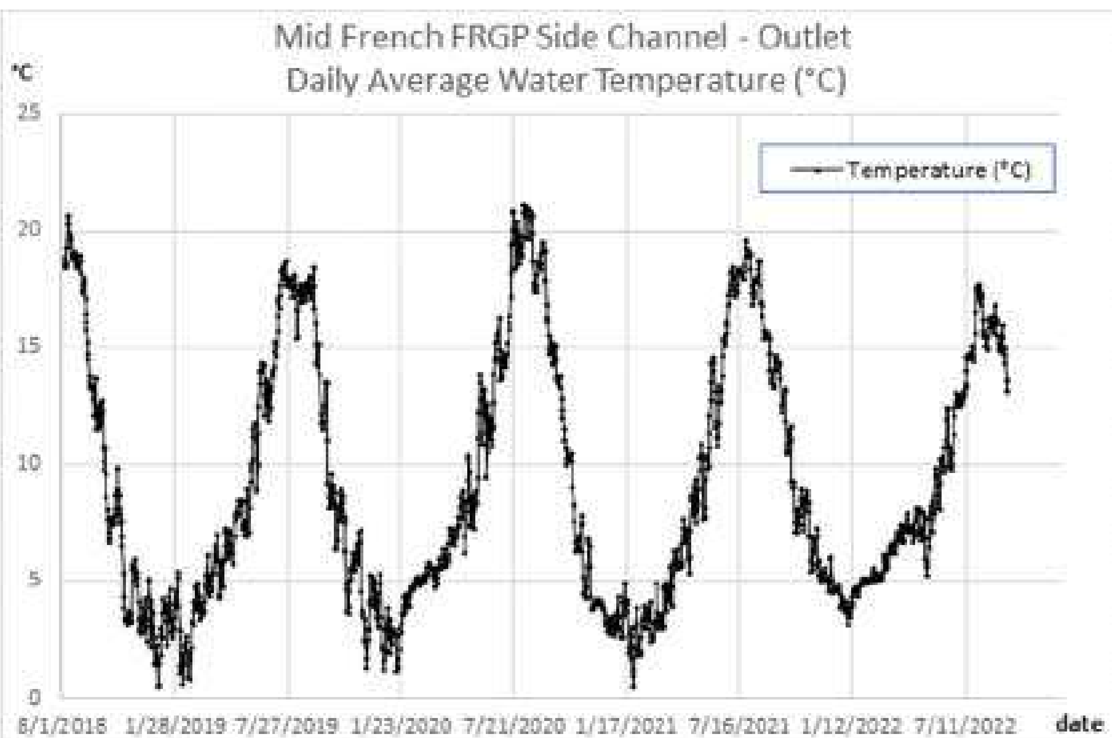

Figure 14. Daily average water temperature (°C) - French FRGP SC Outlet station.

Table 13. Maximum MWAT (°C) and date of occurrence - French Creek - FRGP SC Outlet.

Mid French - FRGP Side Channel Outlet
Maximum MWAT (°C)

WY	Maximum MWAT °C	Date
2018	20.0	8/16/2018
2019	18.4	7/23/2019
2020	20.9	8/11/2020
2021	19.1	8/1/2021
2022	17.5	8/3/2022

Water temperature and dissolved oxygen was monitored in the FRGP SC and the French Side Channel BDA Ponds. Analysis of the dissolved oxygen (mg/L) concentrations in the Side Channel BDA Pond 1 during the winter of WY2021 documents relatively low concentrations during the winter period (Figure 15). Growth and condition of juvenile Coho Salmon utilizing the Side Channel BDA Pond 1 were documented during the winter and early spring of WY2021. Substantial growth and high survival were documented in the fish in this low dissolved oxygen environment.

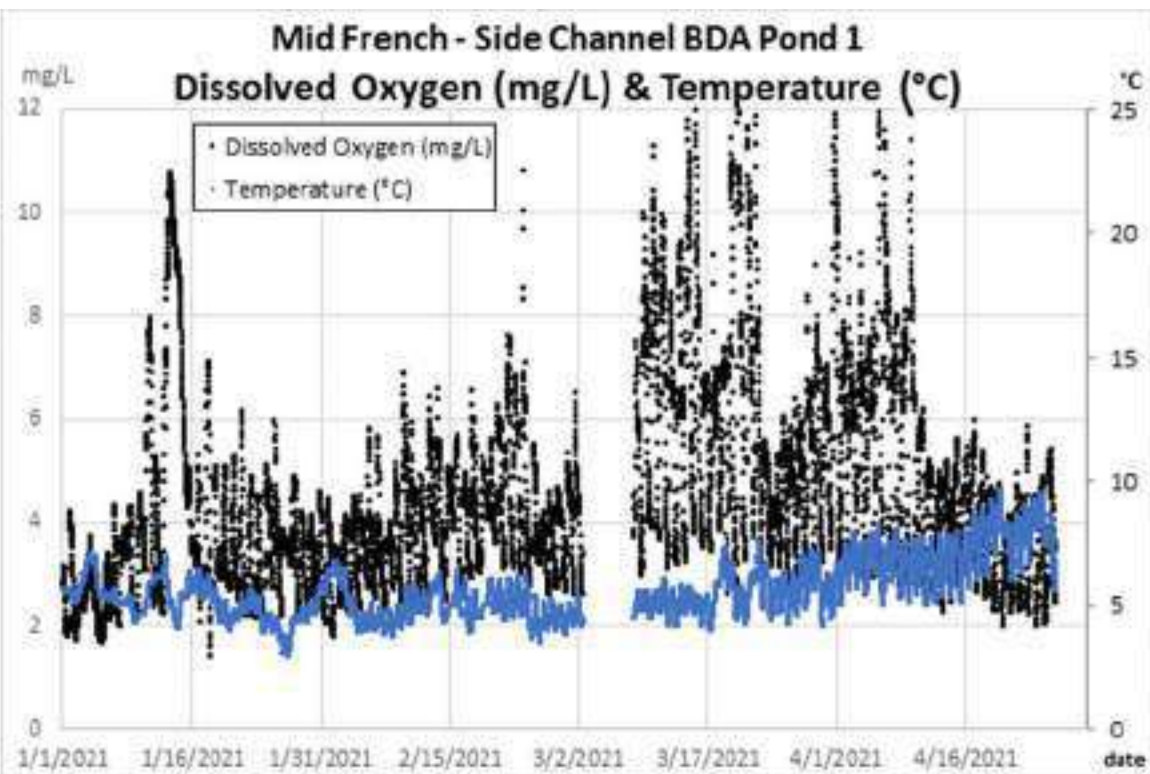

Figure 15. Dissolved oxygen (mg/L) and temperature (°C) - French Side Channel BDA Pond 1.

Water Surface Elevation

Sugar Creek

A network of water surface elevation (WSE) stations was established in Sugar Creek and the adjacent landscape starting in 2014 when the first BDA structures were constructed (Figure 16). The WSE in the Sugar BDA Pond 1 from WY2014 through WY2022 illustrates the effect of water year type on the WSE in the BDA Pond (Figure 17).

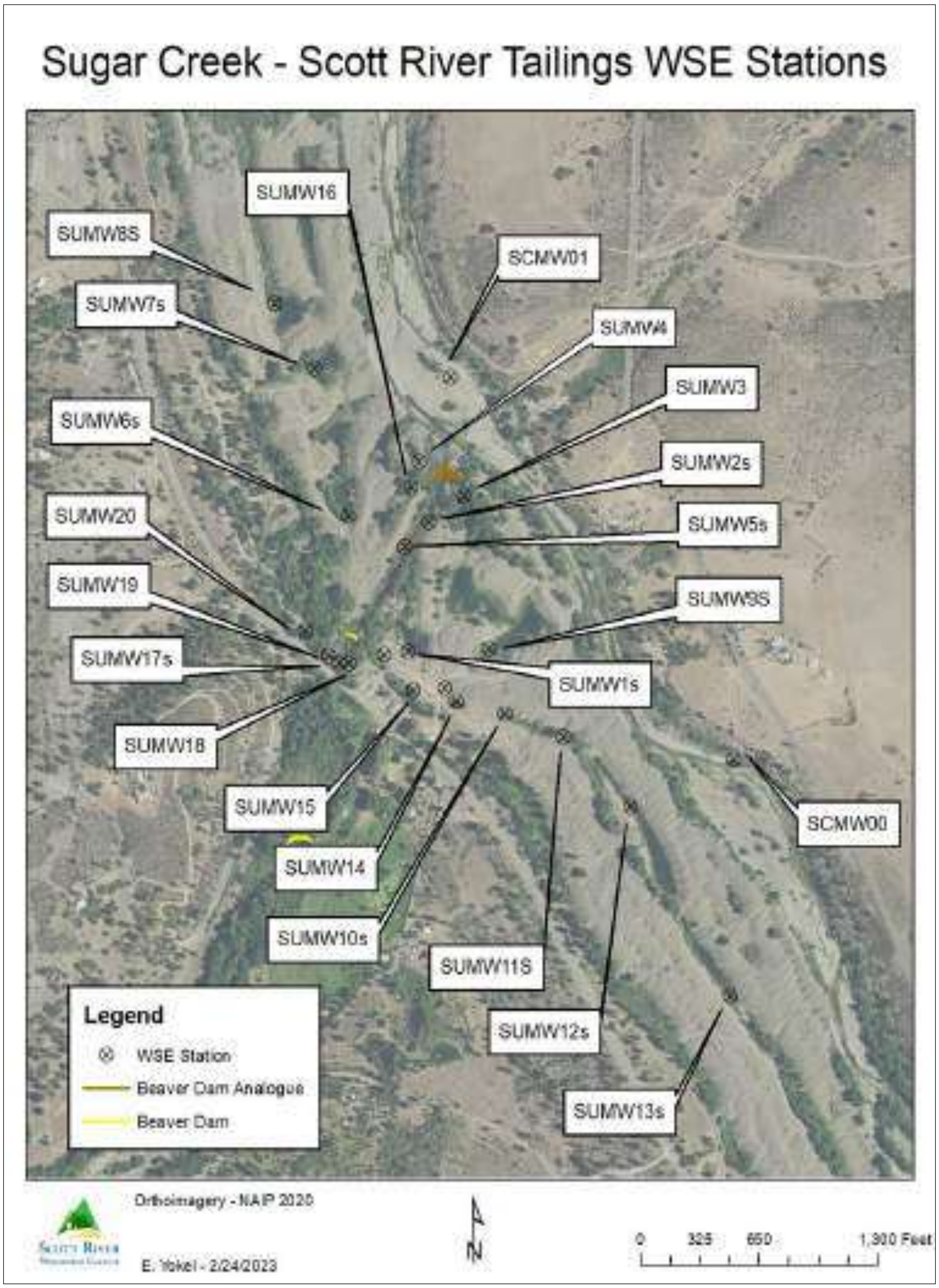

Figure 16. Location of water surface elevation (WSE) stations - Sugar Creek BDA Reach.

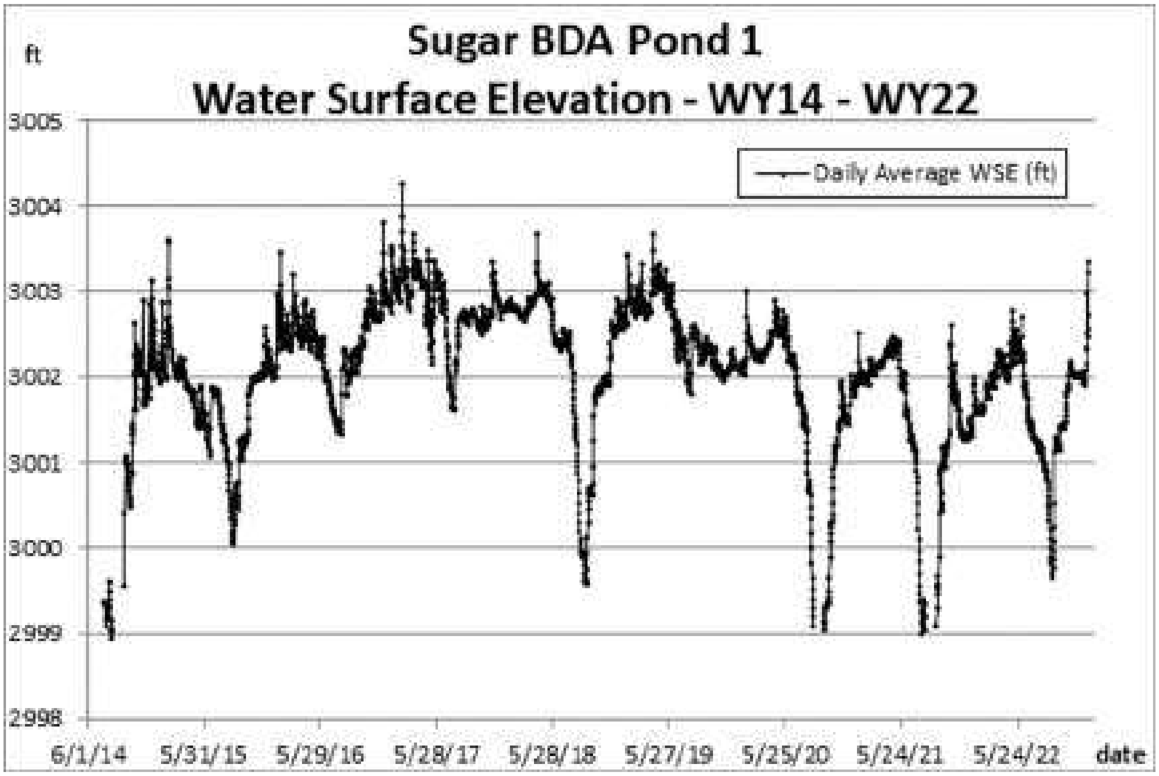

Figure 17. Water surface elevation (ft) - Sugar BDA Pond 1.

The Sugar Creek BDA Reach was dry during the construction of the BDAs during the base flow period of the critically dry WY2014. The BDA Pond 1 maintained water during the dry WY2015 and WY2016 with a significant increase of WSE in WY2016 compared to the previous year. During the wet WY2017, significant structure maintenance was performed to repair the structures after the high winter runoff flows resulting in the maintenance of habitat volume in the BDA Pond through the base flow period. During the critically dry WY2018, the BDA Pond elevation declined to an elevation that resulted in disconnected pools with limited habitat capacity, but the site did not become completely dewatered. In the average WY2019, structure maintenance to reduce porosity was utilized to maintain the pond elevation and habitat capacity throughout the base flow period.

The BDA Ponds became completely dry during the base flow period of the critically dry WY2020 and WY2021 (Figure 18). During the third consecutive critically dry year (WY2022) it was expected that the BDA Ponds would become dry due but disconnected pools were maintained similar to WY2018.

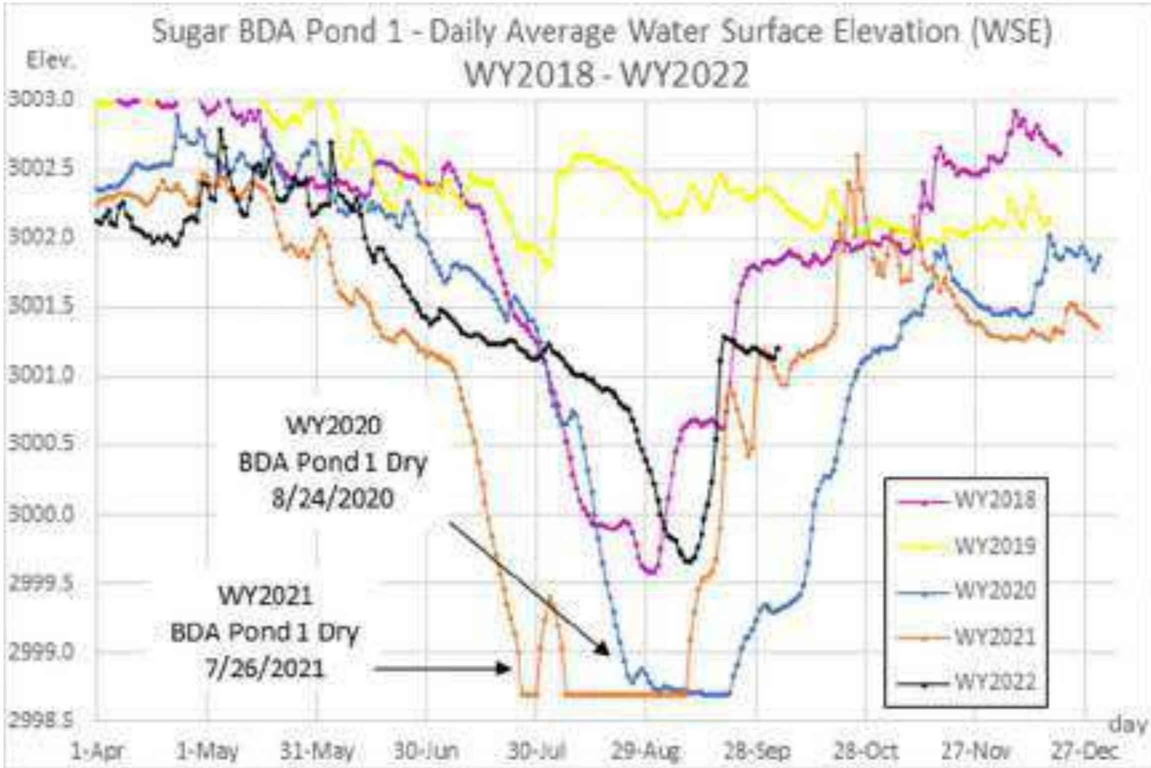

Figure 18. WSE in the Sugar BDA Pond 1 by Julian Day - WY2018 - WY2022.

A beaver dam was constructed at the upstream extent of the BDA 2 Pond during the critically dry WY2018 resulting in a large beaver dam pond. Water surface elevation (WSE) and habitat volume in the natural beaver dam pond was stable during the critically dry WY2020 in which the downstream BDA pond habitats became completely dry (Figure 19). After construction of the beaver dam, the WSE in the beaver dam pond was significantly perched above the WSE in the BDA ponds and the Sugar OCP illustrating the effectiveness of beaver in selecting a site for beaver dam construction and maintenance of beaver dams to maintain pond depth and volume through critically dry periods.

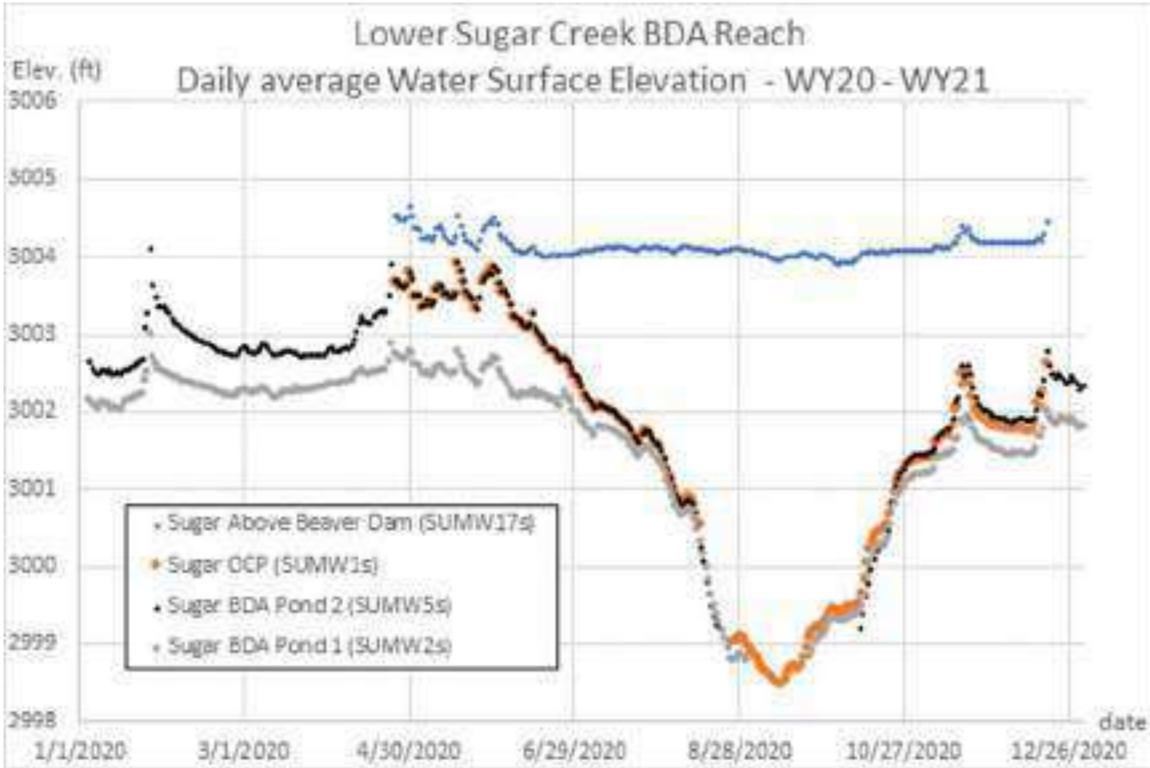

Figure 19. Daily average WSE (ft) in the Sugar Creek BDA Pond 1 & 2, Sugar OCP and natural beaver pond - WY2020

A floodplain was constructed adjacent to the BDA Pond 2 in the Fall of 2020 by grading the tailings to a design elevation that would be inundated during the runoff period of winter. During a large runoff event in January 2021, a large volume of water was observed percolating through the graded surface. Adaptive management treatment was utilized to "seal" the graded surface through the process of injecting imported sand into the interstitial spaces of the substrate of the graded surface. This sealing process significantly reduced the porosity of the graded surface.

Analysis of the water surface elevation in the Sugar BDA Pond 2 and the Sugar Creek Floodplain Restoration Project illustrates a significant decrease in WSE from the stream to the adjacent constructed floodplain (Figure 20). This significant hydraulic gradient away from the perched Sugar Creek into the dredge tailings is hypothesized to be one of the factors leading to the dewatering of the BDA ponds during the critically dry WY2020 and WY2021.

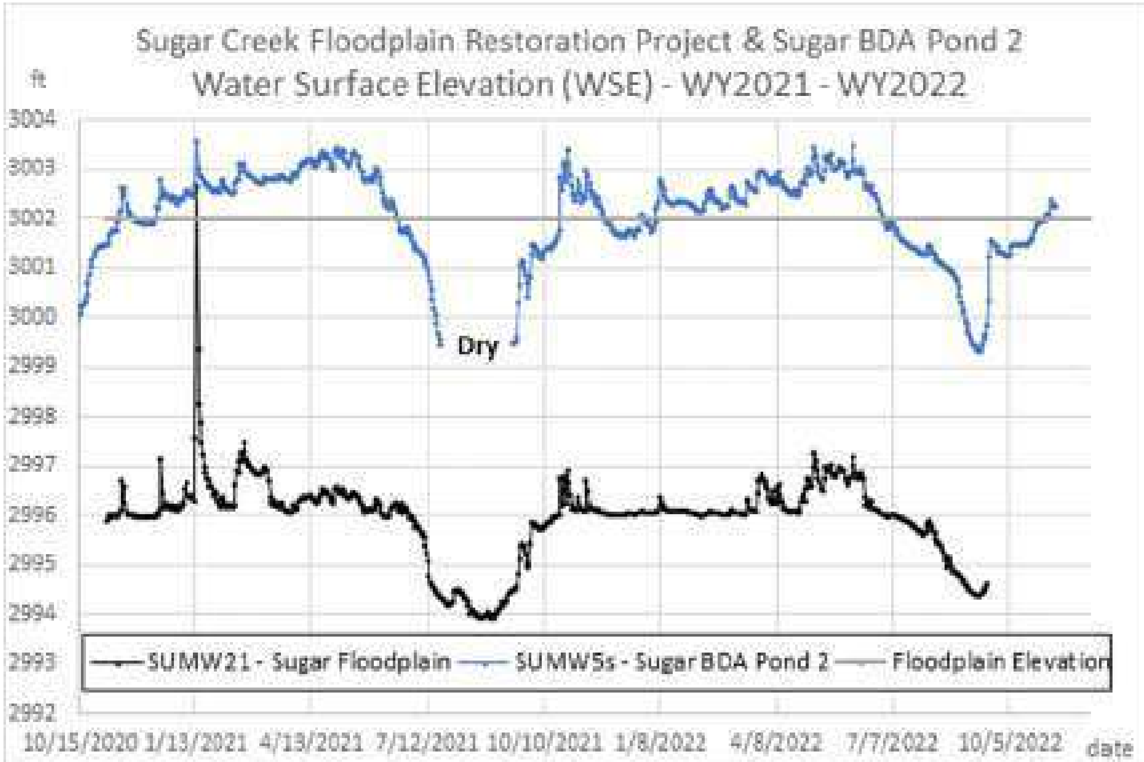

Figure 20. Daily average WSE (ft) in Sugar BDA Pond 2 and at the constructed floodplain.

Four water surface elevation (WSE) stations were installed in 2014 to monitor the effectiveness of the BDA structures on raising the elevation of surface water and adjacent groundwater. After construction of the BDAs and subsequent maintenance to decrease the porosity and increase the WSE in the Sugar Creek BDA Reach local landowners upslope and downslope of Sugar Creek reported that they observed an increase in WSE in the ponds located in the dredge tailings. Additional WSE stations were established in these upslope and downslope ponds to monitor the extent of the effects of BDA maintenance on the groundwater and surface water elevations. A WSE transect extending approximately 3,100 ft upslope of Sugar Creek and 1,300 ft downslope of Sugar Creek was generated for a period of base flow in WY2016 and runoff in WY2017 to determine the hydraulic gradient through the dredge tailings (Figure 21).

A gradual decrease in WSE is observed upslope of Sugar Creek with a dramatic increase in WSE gradient observed downslope of Sugar Creek (Figure 22). The WSE transect indicates that Sugar Creek is the hydraulic control for the water surface elevations upslope with the hydraulic control for the downslope WSE currently unknown. This hypothesis is corroborated by the observed significant increase in WSE upslope of Sugar Creek in association with increases in BDA Pond WSE due to structure maintenance and the less significant increases observed downslope.

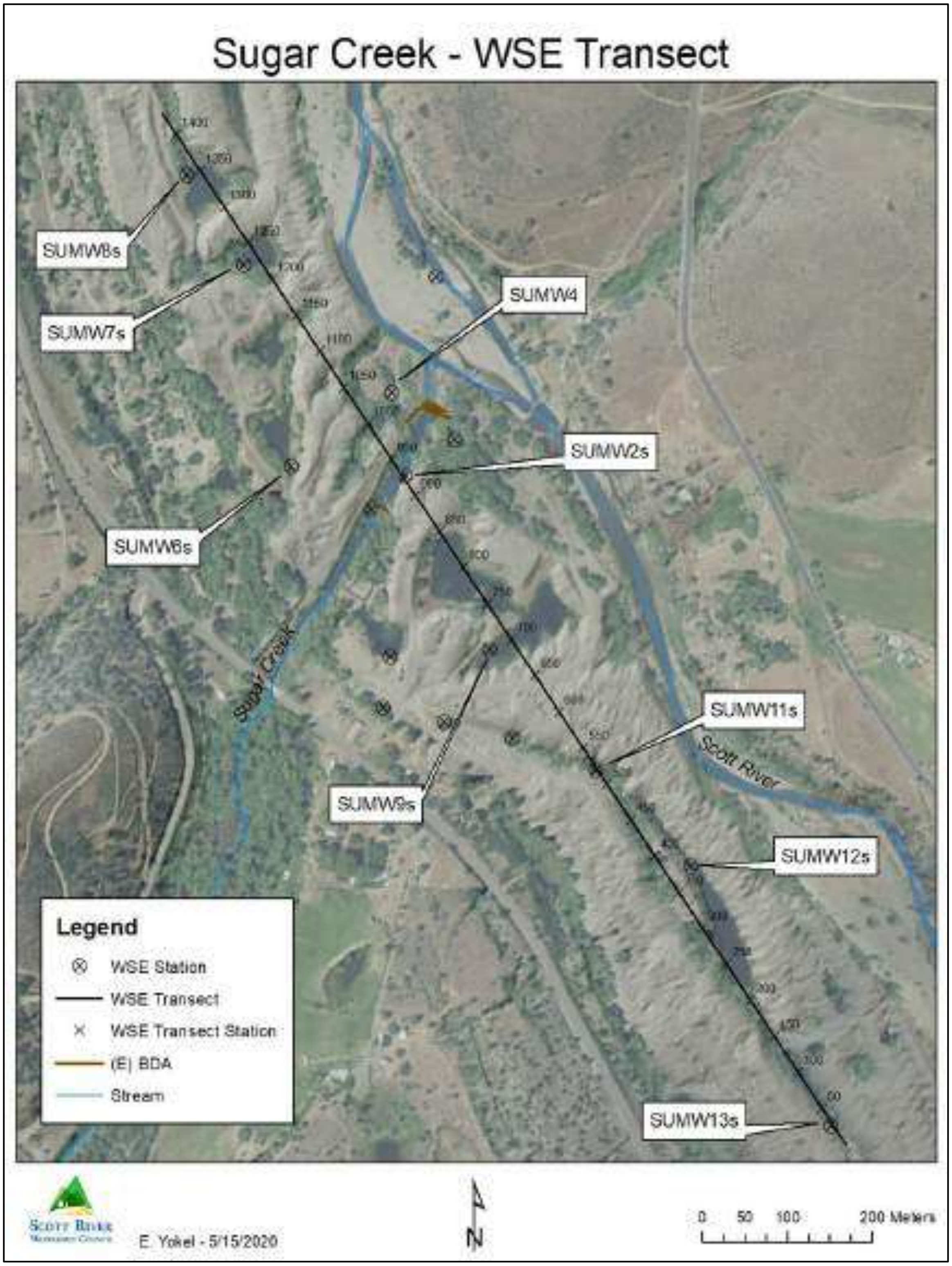

Figure 21. Transect of WSE stations upslope and downslope of Sugar Creek.

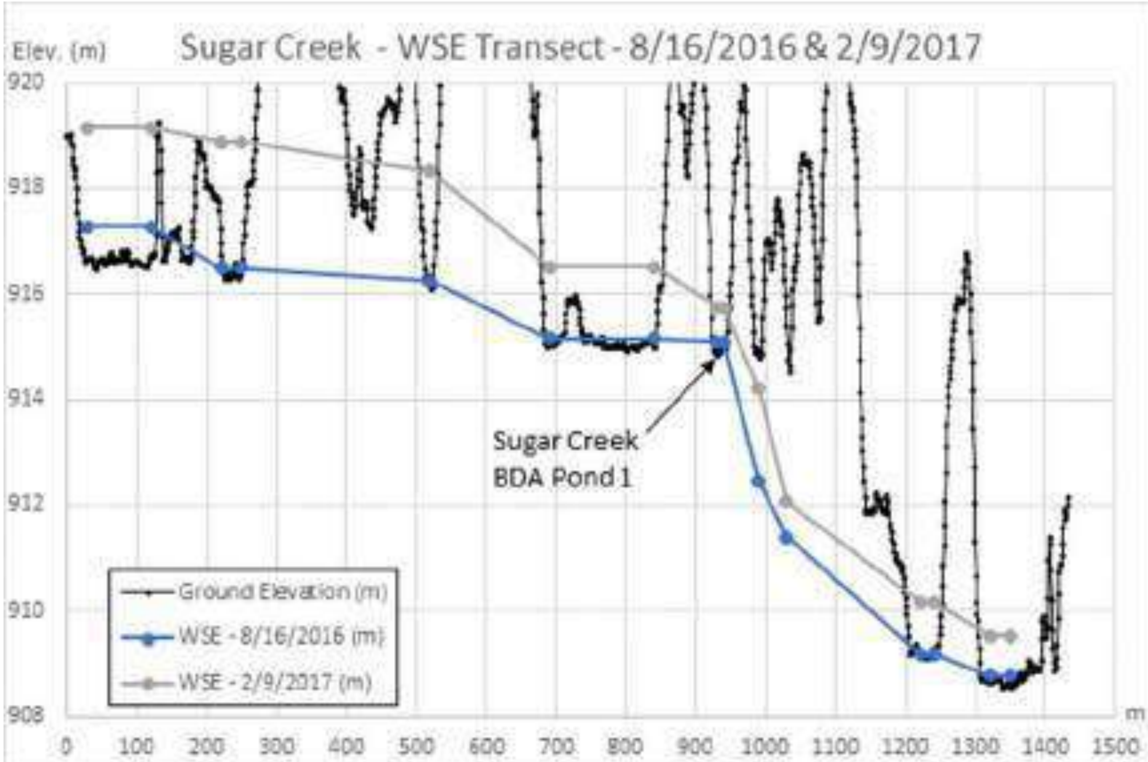

Figure 22. WSE (m) along the transect during base flow (WY2016) and runoff (WY2017).

French Creek

A network of surface water and groundwater water surface elevation (WSE) stations were established in French Creek in spring 2017 prior to the installation of the Side Channel BDA structures during the 2017 summer base flow period. Additional WSE stations were established in French Creek for project effectiveness and project design monitoring (Figure 23).

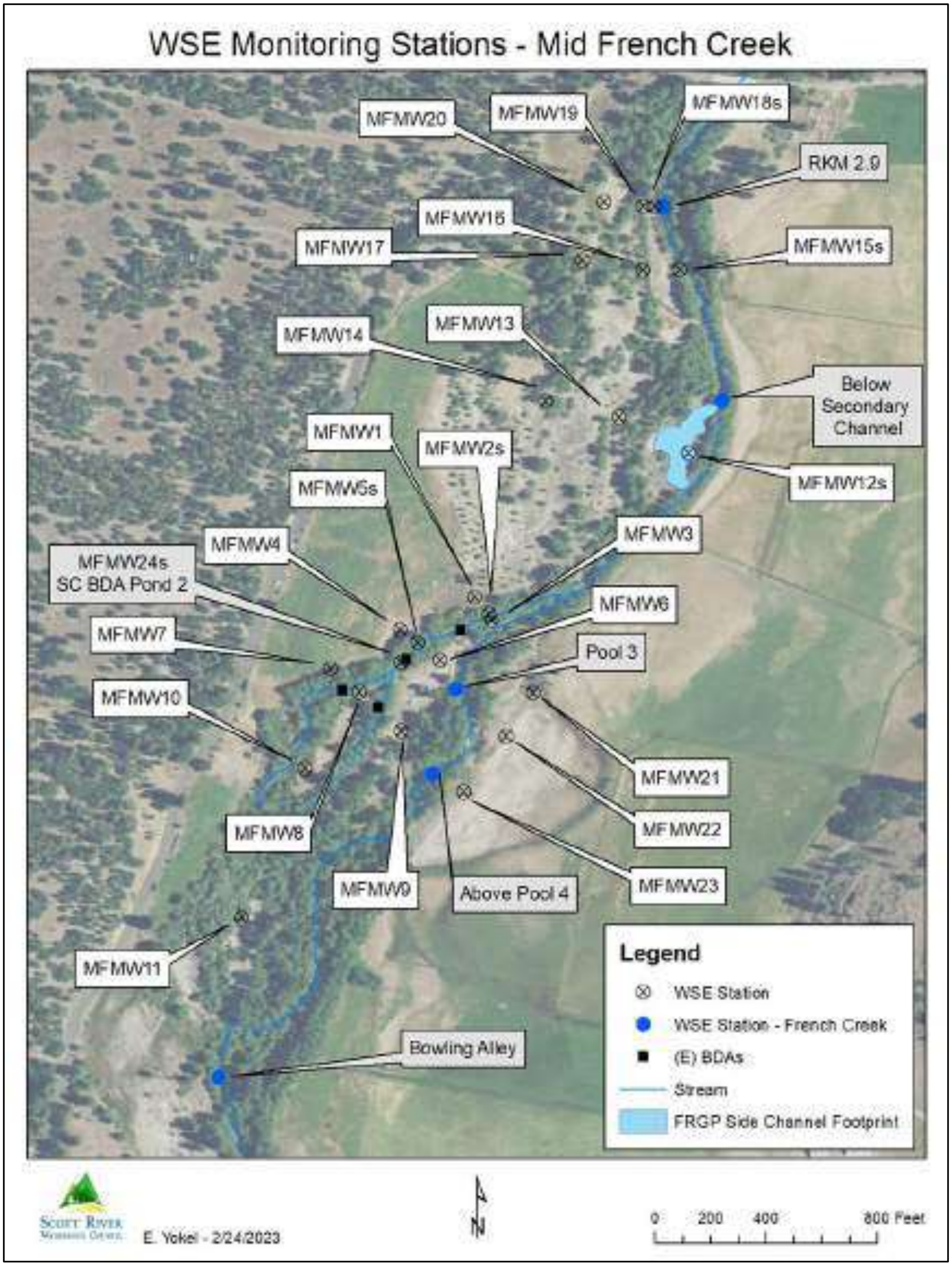

Figure 23. Location of water surface elevation (WSE) stations - Mid French Creek.

A natural experiment occurred when a beaver dam was constructed directly downstream of a surface water - groundwater transect at French Creek RKM 2.9. Beaver constructed a dam at a riffle crest in a shallow flatwater dominated reach of French Creek in September 2021 increasing the surface water elevation approximately 3 feet. Increases in adjacent WSE were observed at the two groundwater wells (MFMW19 and MFMW20) in association with the increase in surface water documenting the role beaver dams have on increasing adjacent groundwater elevations while increasing instream aquatic habitat volume (Figure 24).

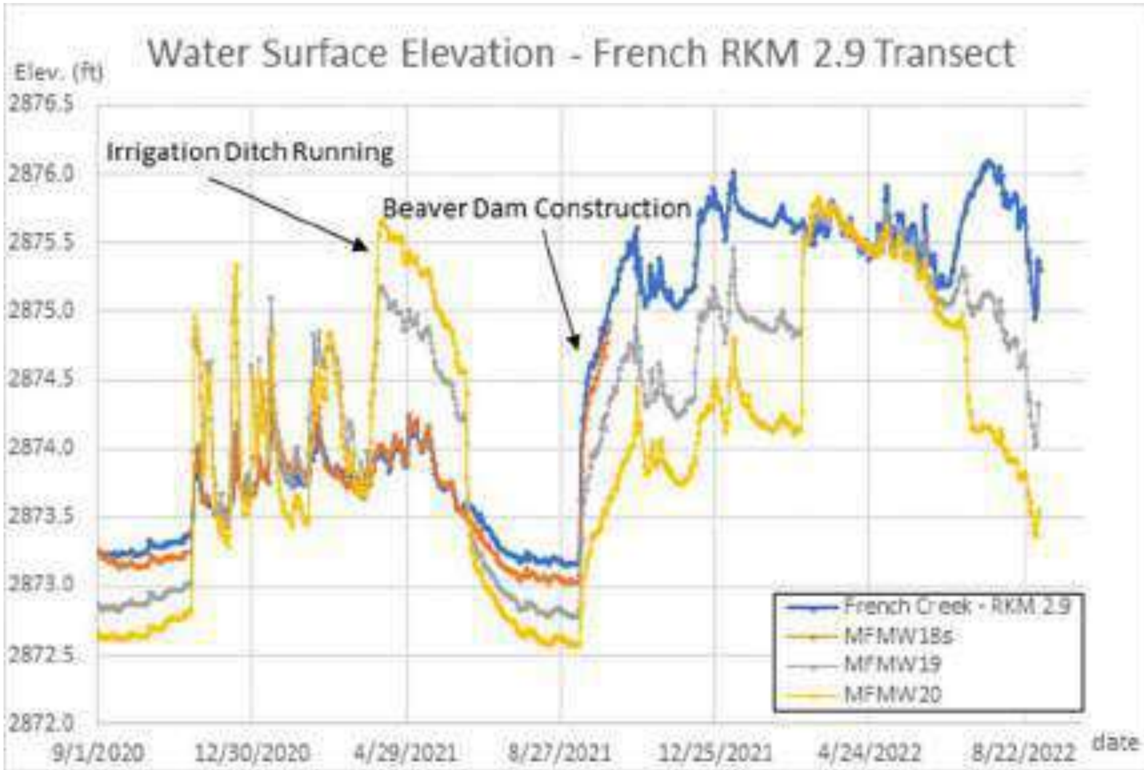

Figure 24. WSE (ft) - French RKM 2.9 Transect.

A water surface elevation station was established in the French Side Channel BDA Pond 2 in 2020. The Side Channel BDA Ponds are not connected to the mainstem of French Creek during the base flow period and become connected during runoff events. Abrupt increases in WSE are observed during these runoff events in the Side Channel BDA Ponds and Coho Salmon have been documented redistributing into and outmigrating from the BDA Ponds in association with the runoff events (Figure 25).

Figure 25. WSE (ft) - French Side Channel BDA Pond 2.

Miners Creek

Water surface elevation (WSE) stations were established in Miners Creek in conjunction with the establishment of the BDA structures in 2015 (Figure 26). Analysis of the WSE in Miners Creek was performed by Miles Munding-Becker in the development of his masters thesis (Munding-Becker 2022).

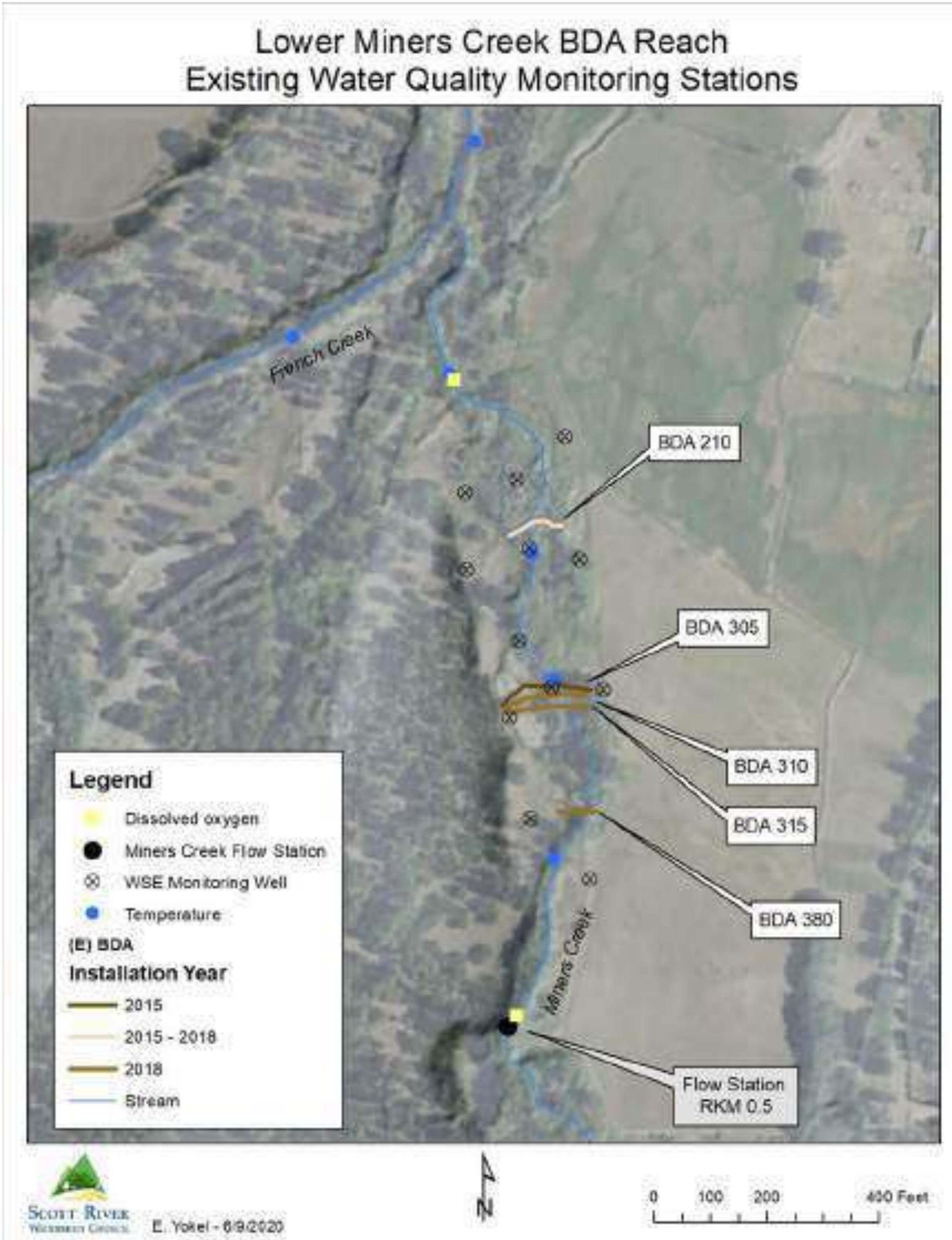

Figure 26. Location of WSE stations - Miners Creek BDA Reach.

Discharge – See Appendix C

Sugar Creek

Stream discharge is monitored in Sugar Creek upstream of the BDA Reach at RKM 2.6 by the California Department of Water Resources (CDWR). Periodic discharge measurements at the upstream extent of the Sugar BDA Reach were performed during the base flow period to document the inflow into the BDA Ponds. A significant decrease in stream discharge between the CDWR RKM 2.6 station and the RKM 0.4 station was observed during the critically dry WY2020 (Figure 27). This loss in stream discharge between the bedrock confined reach at the CDWR station and the highly altered alluvial valley reach of the Sugar Creek BDA Reach is an additional factor in the dewatering of the BDA Ponds during critically dry years.

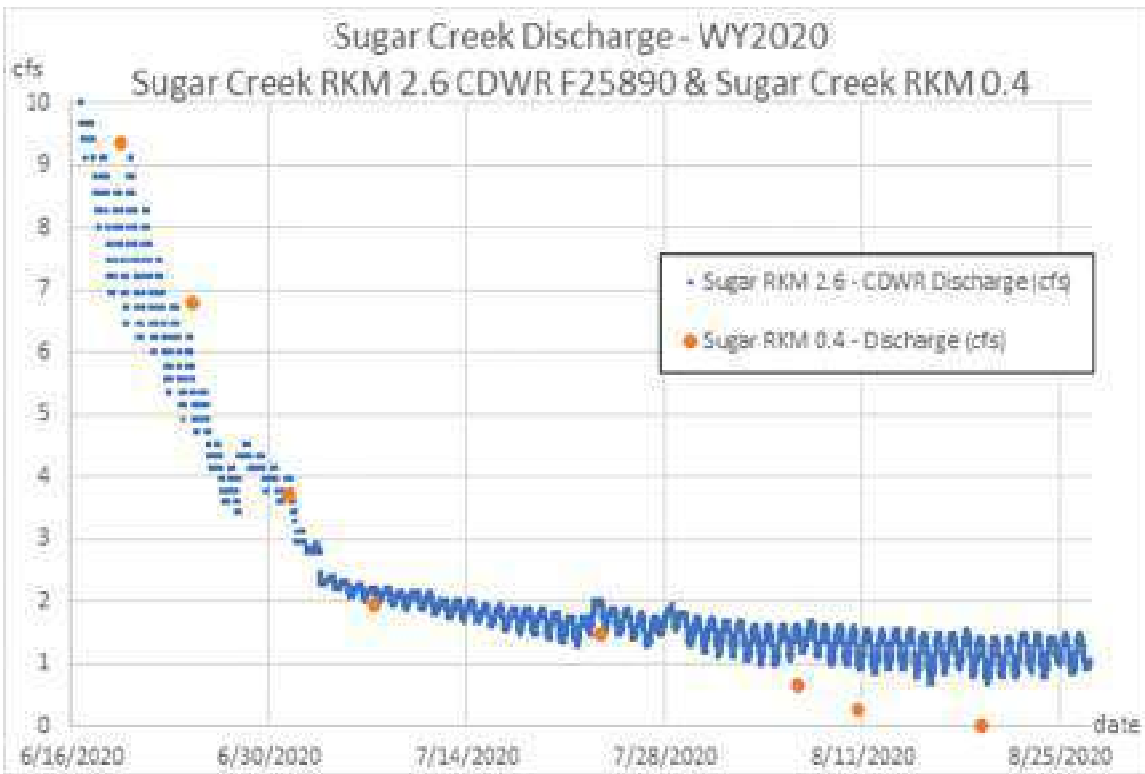

Figure 27. Continuous discharge (cfs) at CDWR RKM 2.6 station and periodic discharge are RKM 0.4.

Salmonid Monitoring

Sugar Creek

Smolt Outmigration and Juvenile Redistribution

For the spring outmigration in 2018, the fall redistribution in 2019 and the spring outmigration in 2019**,** the furthest downstream arrays were placed in BDA pond habitats. From the fall of 2019 onward, arrays were installed downstream of the BDA habitats. Faced with extreme drought conditions in the summer and fall of 2020, SRWC staff considered relocating fish out of warming, drying habitat units but ultimately decided against this action. Drought conditions continued into the following year and in the late summer of 2021, staff relocated a number of fish out of BDA pond habitat into the deeper, cooler off-channel pond (see *Relocation Efforts*). Looking at the spring outmigration data from 2021 and 2022, it would appear that the relocation effort had a significant impact on the survival of PIT tagged fish (Table 15).

Table 14. Percent survival of PIT tagged juvenile Coho Salmon in Sugar Creek, 2018-2022.

	Sugar Creek								
	2018 spring	2018 fall	2019 spring	2019 fall	2020 spring	2020 fall	2021 spring	2021 fall	2022 spring
Tags detected at downstream array	745	33	348	18	765	15	43	6	259
Tags in system	1017	496	467	2004	1986	202	187	293	359
Survival	0.73		0.75		0.39		0.23		0.72

PIT tagged recaptures from in-hand sampling efforts indicate that there is minimal movement between habitat units in low or baseflow periods. In the Sugar Creek BDA Pond 1 from July to September 2019, all recaptured PIT tags had been tagged in the BDA Pond 1. In the same period, all recaptured Coho in BDA Pond 2 had been tagged in BDA Pond 2. Experiments have shown that in this baseflow period juvenile Coho can pass the BDAs volitionally (O'Keefe 2021).

Growth Rates

PIT tagging Coho Salmon and recapturing them at later sampling events allowed for the growth rates of individual fish to be calculated. These rates were compiled for habitat units and presented in the tables below. Additional growth rate comparison tables are available in Appendix C.

Average forklength gain from Coho in the Sugar Creek BDA Pond 1 was slightly higher than average forklength gain in the control pools in late summer 2019 (Table 15). Average forklength gain from Coho in the Sugar Creek BDA Pond 1 was slightly higher than average forklength gain in BDA Pond 2 in winter 2022 (Table 16).

Table 15. Juvenile Coho Salmon growth rates in Sugar Creek BDA Pond 1 and control pools. Late summer 2019.

Sugar Creek - Beaver Dam Analogue Pond 1

Begin Date	End Date	Days Between
9/6/2019	9/28/2019	22

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.15	0.02	0.21	0.57
s.d.	0.07	0.02	0.11	0.34
count	19	19	19	19

Sugar Creek - Control Reach

Begin Date	End Date	Days Between
8/27/2019	10/11/2019	45

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.13	0.02	0.18	0.61
s.d.	0.03	0.01	0.05	0.25
count	8	8	8	8

Table 16. Juvenile Coho Salmon growth rates in Sugar Creek BDA Pond 1 and BDA Pond 2. Winter 2022.

Sugar Creek - Beaver Dam Analogue Pond 1

Begin Date	End Date	Days Between
1/19/2022	3/10/2022	50

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.07	0.03	0.08	0.33
s.d.	0.04	0.01	0.05	0.16
count	23	23	23	23

Sugar Creek - Beaver Dam Analogue Pond 2 - Combined

Begin Date	End Date	Days Between
1/18/2022	3/11/2022	52

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.04	0.02	0.05	0.23
s.d.	0.06	0.01	0.06	0.10
count	18	18	18	18

Biometric Comparisons

Using data from in-hand fish sampling efforts, average juvenile Coho Salmon forklength for distinct habitat units was calculated. This data provides information on the condition of the fish that are rearing in a certain habitat at a given time. During the fall redistribution and spring outmigration periods, changes in average forklength over time may be influenced by Coho leaving one habitat unit to enter another or leaving the study universe altogether. For that reason, it is better to interpret the data presented below by comparing average forklengths across populations at discrete dates, instead of looking at a single habitat's progression over time.

The Sugar Creek control pools and untreated habitat in the mainstem Scott River, located just upstream of the confluence with Sugar Creek, serve as a benchmark against which the restored habitats on Sugar Creek can be measured.

Average forklength of Coho Salmon captured in the BDA Pond 1 was consistently greater than that of Coho captured in the mainstem Scott River at the confluence of Sugar Creek in 2020-21 (Figure 28). Average forklength of Coho Salmon captured in the Off Channel Pond was consistently greater than that of Coho captured in the control pools in 2022 (Figure 29).

The charts below show the average forklength comparisons in two years when the most comparable data was collected from different sites at Sugar Creek. Additional charts from the other years of the grant period can be found in Appendix D.

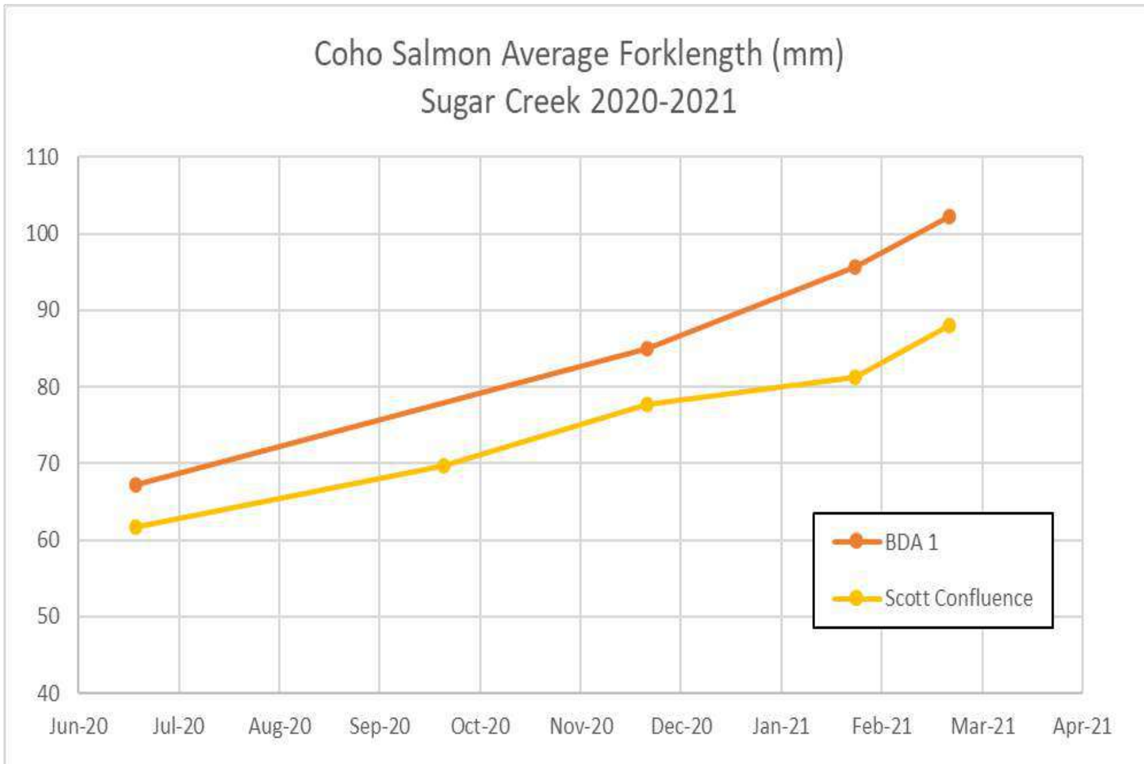

Figure 28. Average forklength of juvenile Coho Salmon captured in BDA Pond 1 and the Sugar Creek-Scott River confluence. 2020-2021.

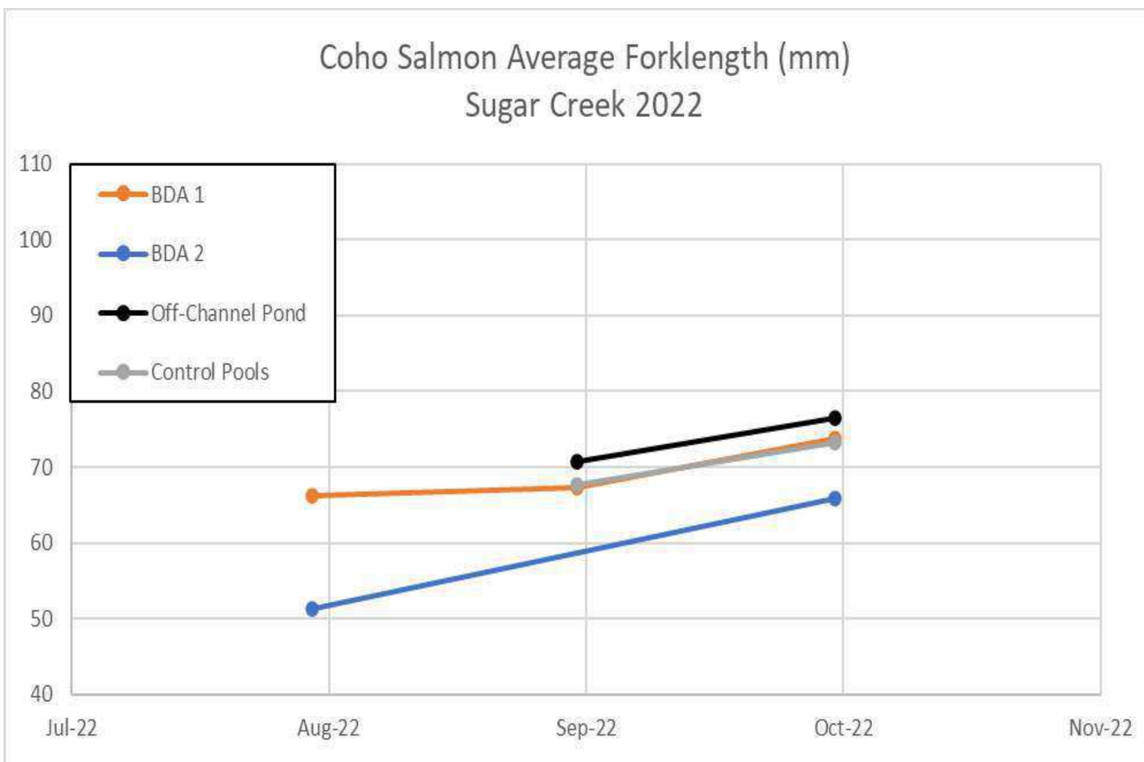

Figure 29. Average forklength of juvenile Coho Salmon captured in Sugar Creek habitat units. 2022.

Adult returns

The California Department of Fish and Wildlife video weir on the mainstem Scott River provided adult Coho return counts during the grant period (Knechtle 2022). In 2017, 382 adult Coho returned to the Scott River and 8 redds were observed on Sugar Creek (Figure 30). In 2018, 739 Coho returned to the Scott and 8 redds were observed on Sugar Creek (including the mainstem Scott River at the confluence of Sugar Creek) (Figure 31).

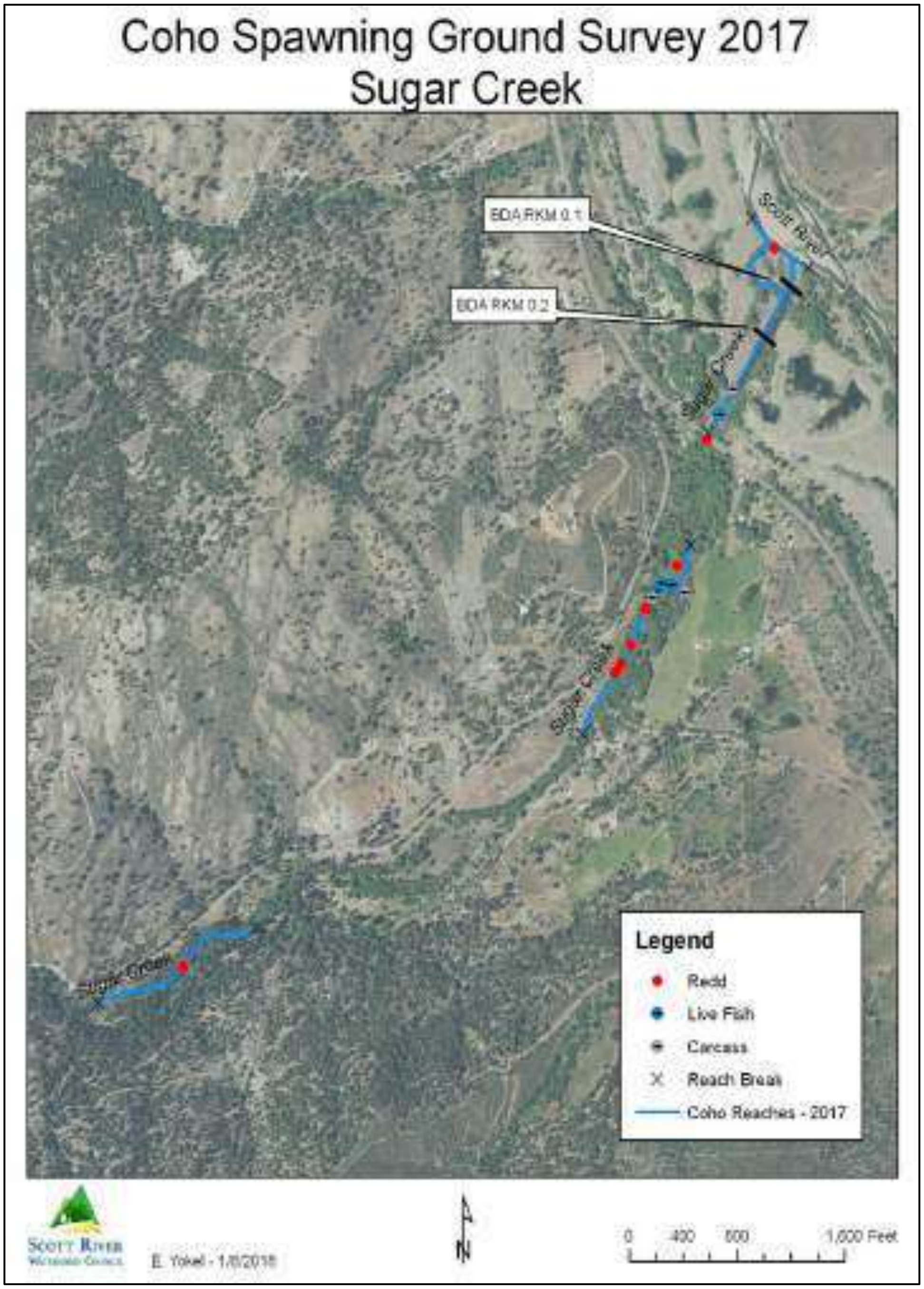

Figure 30. Map of Sugar Creek Coho Salmon spawning ground survey observations. 2017.

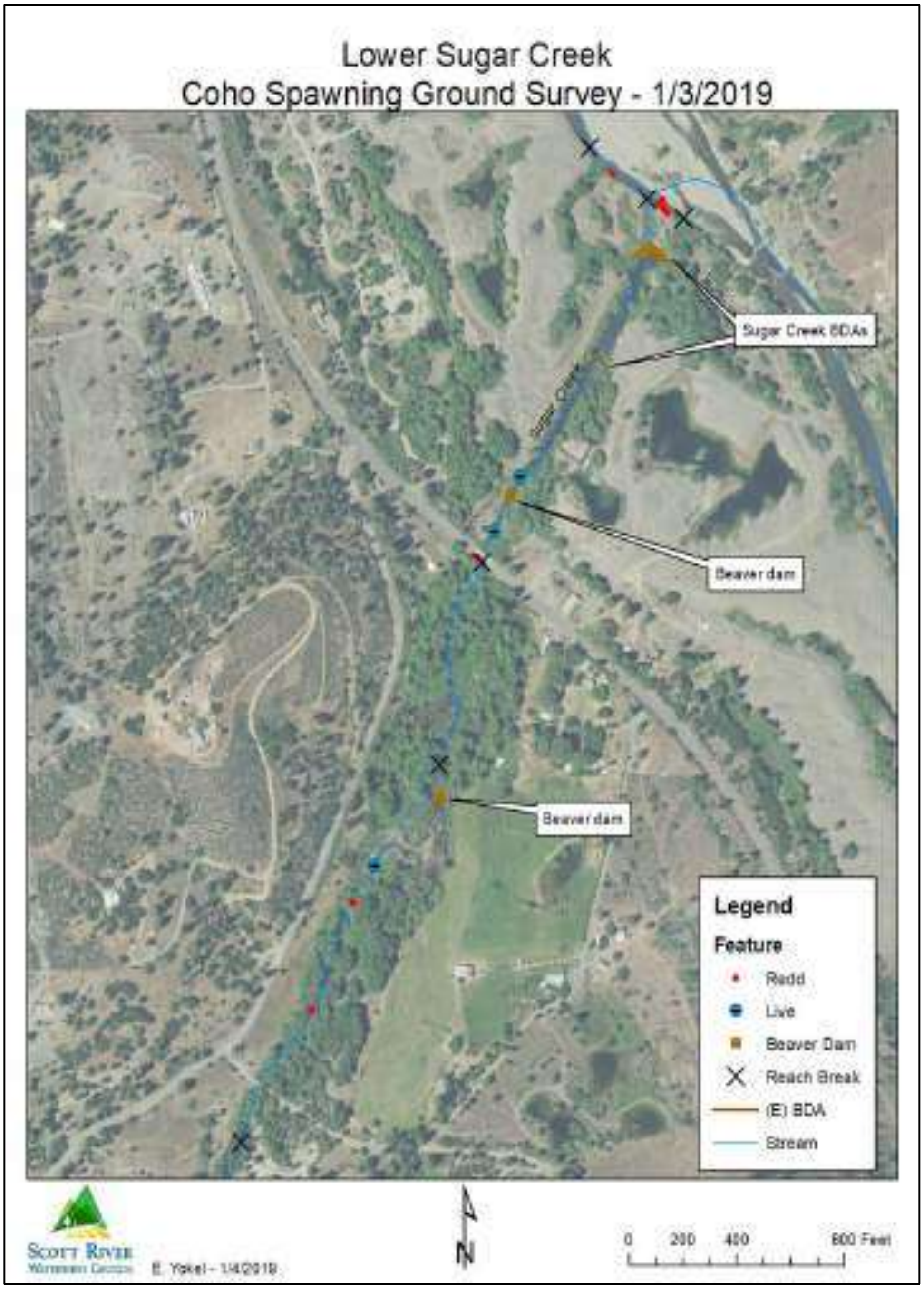

Figure 31. Map of Sugar Creek Coho Salmon spawning ground survey observations. 2018.

In 2019-2020, 1,990 juvenile Coho were tagged in Sugar Creek. In 2022, 14 adult Coho that had been PIT tagged as juveniles on Sugar Creek returned to the Scott Watershed to spawn (Table 17).

Table 17. Coho Salmon tagged in Sugar Creek as juveniles, detected on PIT array network as adults in 2022.

PIT_No	First Array Detection	Date of Tag Implant	Location of Tag Implant
989001027743125	Scott Weir	7/31/2019	Sugar - BDA1 - Above
989001027743076	Sugar 1	7/31/2019	Sugar - BDA1 - Above
989001027743359	Sugar 1	7/31/2019	Sugar - BDA1 - Above
989001030719358	Oasis Mainstem	8/26/2019	Sugar Creek BP2
989001030719595	Sugar 1	8/27/2019	Sugar Creek Control - Above Beaver Dam
989001028156762	Sugar 1	9/27/2019	Sugar - BP2 above Nat. Beaver Dam
989001028156787	Scott Weir	9/27/2019	Sugar - BP2 above Nat. Beaver Dam
989001031380674	Sugar 1	10/31/2019	Sugar BDA1 RR
989001031380948	Scott Weir	10/31/2019	Sugar BDA1 RR
989001031380824	Scott Weir	10/31/2019	Sugar BDA1 RR
989001031380578	Sugar 1	11/5/2019	Sugar - BP2 - Pool at OCP Outlet
989001032566025	French 10	1/7/2020	Sugar - BP2 - Pool at OCP Outlet
989001032566027	Scott Weir	1/8/2020	Sugar Creek - BP1 RR
989001032565987	Scott Weir	1/8/2020	Sugar Marsh DS

French Creek and Miners Creek

Smolt Outmigration and Juvenile Redistribution

In fall 2021, a natural beaver dam was constructed directly downstream of the outmigration arrays on French Creek. This resulted in the creation of significant juvenile Coho rearing habitat on top of the arrays. In contrast to Sugar Creek, survival of PIT tagged juvenile Coho Salmon in French Creek remained relatively stable throughout the grant period (Table 18). This is not surprising given the more suitable instream conditions that were seen in French Creek in the drought periods.

Table 18. Percent survival of PIT tagged juvenile Coho Salmon in French Creek, 2018-2022.

	French Creek							
	2018 fall	2019 spring	2019 fall	2020 spring	2020 fall	2021 spring	2021 fall	2022 spring
Tags detected at downstream array	99	351	240	825	454	655	18	313
Tags in system	527	668	1515	1275	1710	1256	356	570
Survival		0.53		0.65		0.52		0.55

PIT tagged recaptures from in-hand sampling efforts as well as detections from PIT arrays indicate that there is minimal movement between habitat units in low or baseflow periods. From August through October 2022, all PIT tagged juvenile Coho recaptured in the FRGP Side Channel had been tagged in that habitat unit. The FRGP Side Channel is high quality rearing habitat that is not separated from other French Creek habitat units by a flow barrier. In addition, tracking detections at the downstream array on French Creek shows that the number of unique detections stays close to zero until a spike in flow occurs (Table 19 and Figure 32).

Table 19. Number of unique PIT tag detections at the downstream array on French Creek. Winter 2022-2023.

French Creek	Period (2022-23)		
Array F2	11/28 - 12/6	12/6 - 12/21	12/21 - 1/4
Unique Detections	0	1	58

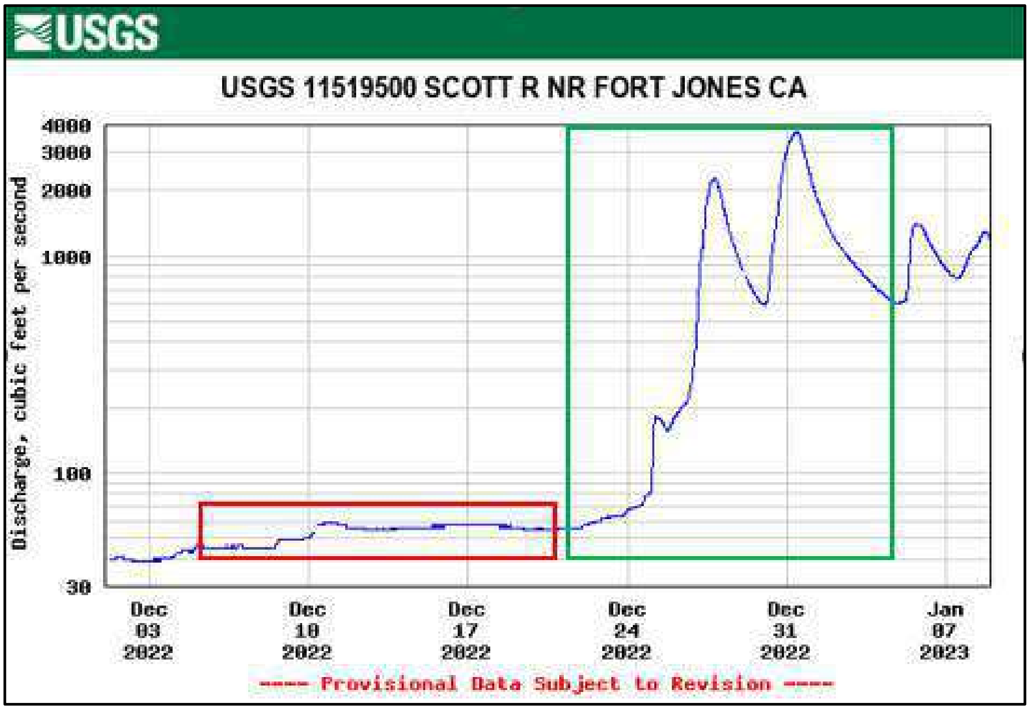

Figure 32. Streamflow at the USGS Ft. Jones gage on the mainstem Scott River. December 2022 to January 2023.

French Side Channel BDA Ponds

The French Creek Side Channel BDA Ponds are not connected to mainstem French Creek during the base flow period of summer. Sufficient connectivity for fish passage into the Side Channel BDA Ponds occurs during significant runoff events during the winter months. A PIT array was established in the Side Channel BDA Pond 1 and PIT tagged Coho Salmon that were marked in the mainstem Control Pool Reach were detected redistributing into the BDA Ponds during a runoff event on January 26, 2020 (Figure 33). Most of the PIT tagged fish were detected redistributing during the upward limb and peak of the hydrograph with a portion migrating during the downward limb.

After a sufficient runoff event occurs to allow for redistribution of Coho Salmon into the Side Channel BDA Ponds the fish have been documented to reside in the habitat until early spring at which time, they outmigrate. The majority of the fish outmigration during April 2019 occurred during a runoff event with the remainder outmigrating during smaller runoff events (Figure 34).

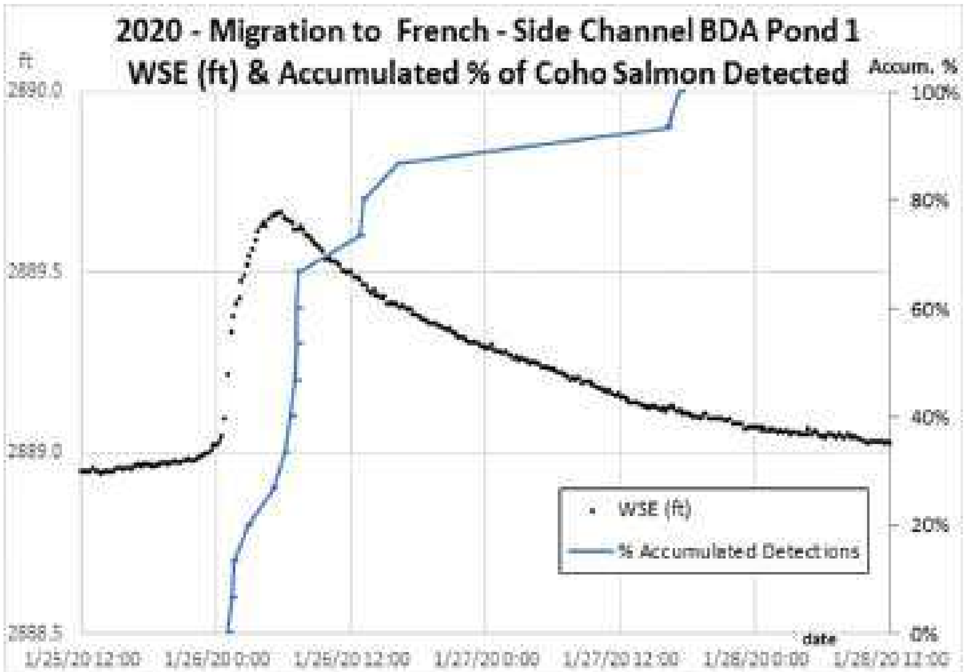

Figure 33. Accumulated percent of unique Coho Salmon detections in French Side Channel BDA Pond 1 (n = 15) and water surface elevation (WSE) above Side Channel BDA Pond 1. January 2020.

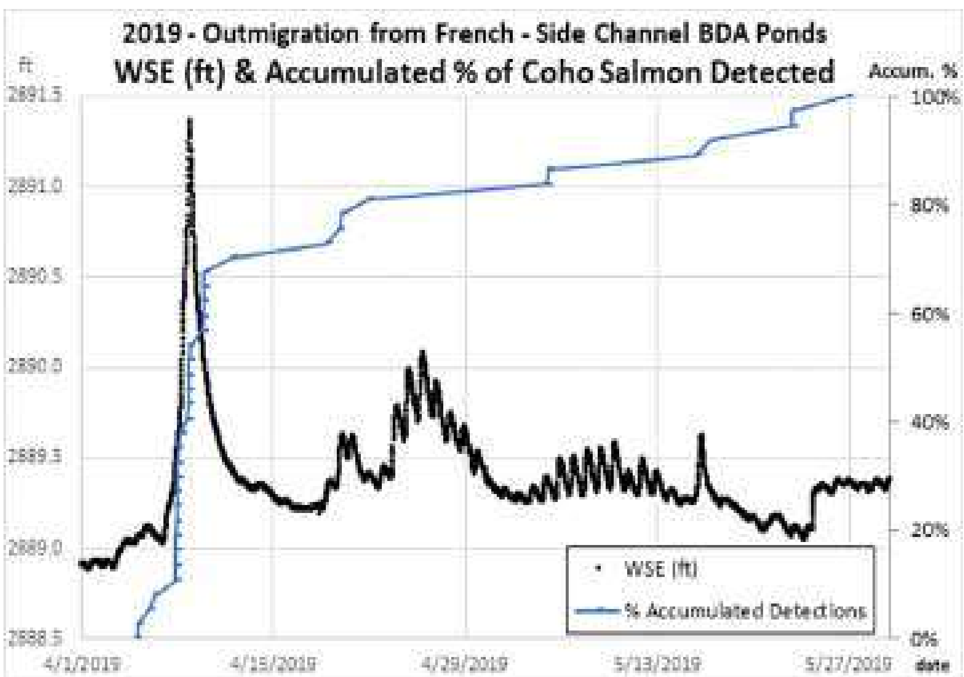

Figure 34. Accumulated percent of unique Coho Salmon tagged in the Side Channel BDA Ponds detected outmigrating at Mid French Creek PIT array (n = 37) and water surface elevation (WSE) above Side Channel BDA Pond 1. 2019.

Growth Rates

PIT tagging Coho Salmon and recapturing them at later sampling events allowed for the growth rates of individual fish to be calculated. These rates were compiled for habitat units and presented in the tables below. Additional growth rate comparison tables are available in Appendix C.

From late July to mid-October 2020, Coho in French Creek ELJ habitat had growth rates, both forklength and weight, that exceeded all untreated habitats on French Creek (Table 20).

Table 20. Growth rates at various French and Miners Creek habitat units. Late summer 2020.

French Creek - Control Pools

Begin Date	End Date	Days Between
7/27 & 7/30/2020	10/7 & 10/9/2020	71

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.05	0.01	0.07	0.17
s.d.	0.05	0.01	0.06	0.22
count	60	60	60	60

French Creek - Mainstem ELJs

Begin Date	End Date	Days Between
7/28/2020	10/9/2020	73

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.01	0.09	0.19
s.d.	0.05	0.01	0.07	0.25
count	33	33	33	33

French Creek - Downstream Miners Creek

Begin Date	End Date	Days Between
7/29/2020	10/12/2020	75

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.04	0.00	0.06	0.10
s.d.	0.03	0.01	0.04	0.13
count	21	21	21	21

Miners Creek - Upstream French Creek

Begin Date	End Date	Days Between
7/29/2020	10/12/2020	75

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.01	0.00	0.02	-0.05
s.d.	0.01	0.01	0.02	0.12
count	10	10	10	10

Biometric Comparisons

Using data from in-hand fish sampling efforts, average juvenile Coho Salmon forklength for distinct habitat units was calculated. This data provides information on the condition of the fish that are rearing in a certain habitat at a given time. During the fall redistribution and spring outmigration periods, changes in average forklength over time may be influenced by Coho leaving one habitat unit to enter another or leaving the study universe altogether. For that reason, it is better to interpret the data presented below by comparing average forklengths across populations at discrete dates, instead of looking at a single habitat's progression over time.

At every sampling event on French Creek during the grant period, either the FRGP Side Channel or the Side Channel BDA Pond habitat eclipsed the control pools in terms of average forklength of Coho Salmon captured in those habitats (Figure 35 and Figure 36).

SRWC was only able to consistently secure access to habitats on Miners Creek for sampling efforts from May 2020 to February 2021. The data collected during this period indicates that juvenile Coho Salmon in the Miners Creek BDA habitats were persistently of a greater size than the Coho rearing in the untreated control habitat (Figure 37).

The charts below show the average forklength comparisons in two years when the most comparable data was collected from different sites at French Creek. Additional charts from the other years of the grant period can be found in Appendix D.

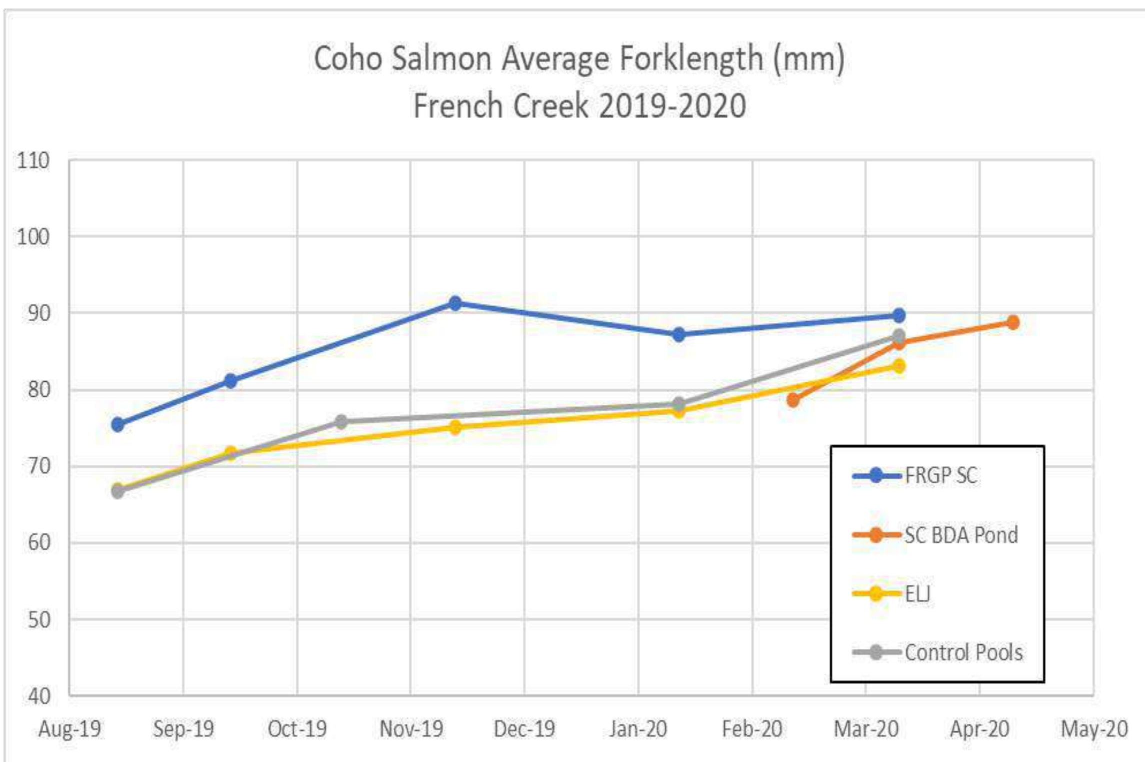

Figure 35. Average forklength of juvenile Coho Salmon captured in French Creek habitat units. 2019-2020.

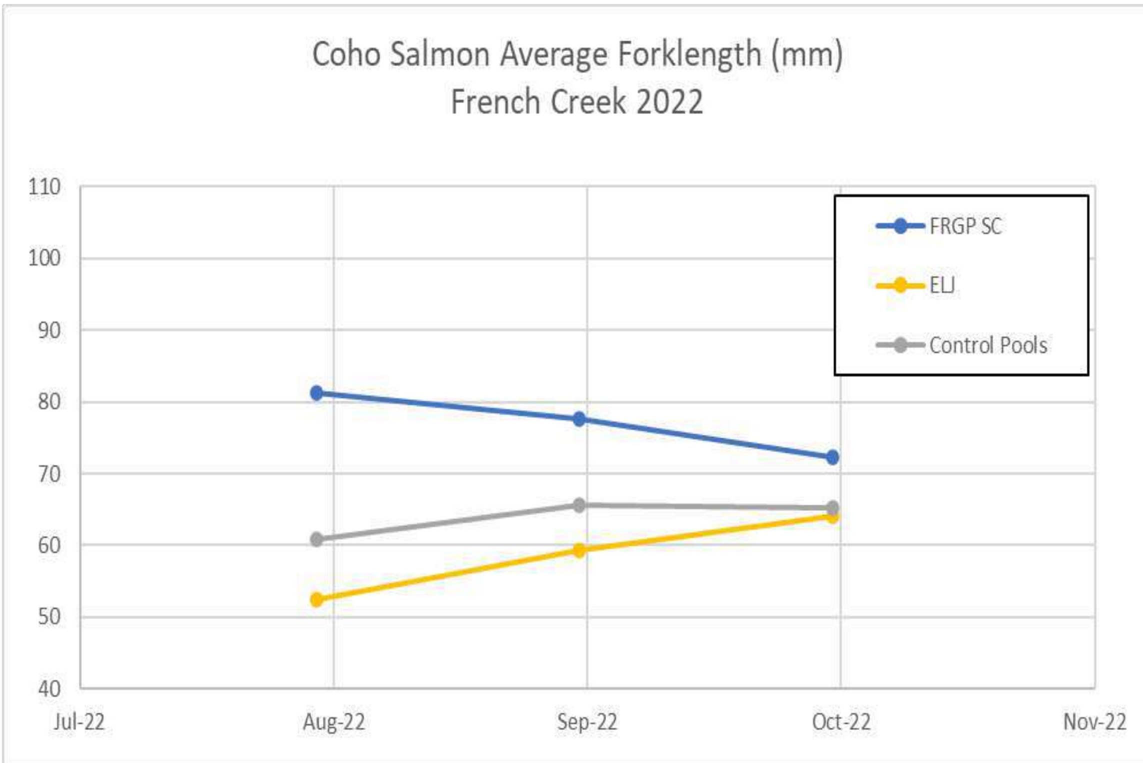

Figure 36. Average forklength of juvenile Coho Salmon captured in French Creek habitat units. 2022.

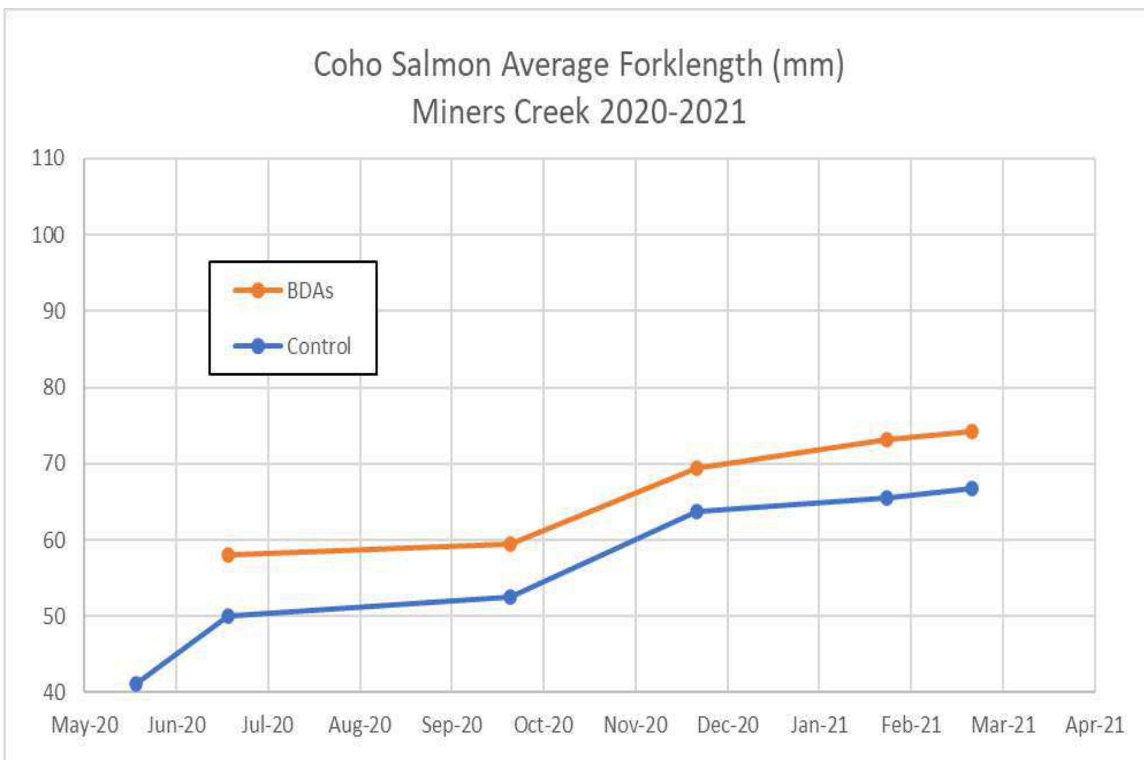

Figure 37. Average forklength of juvenile Coho Salmon captured in MIners Creek habitat units. 2020-2021.

Adult Returns

The California Department of Fish and Wildlife video weir on the mainstem Scott River provided adult Coho return counts during the grant period (Knechtle 2022). In 2017, 382 adult Coho returned to the Scott River and 14 redds were observed on French and Miners Creek (Figure 38). In 2018, 739 Coho returned to the Scott and 34 redds were observed on French and Miners (Figure 38). In 2019, 346 Coho returned to the Scott and 44 redds were observed on French and Miners (Figure 39). In 2020, 1,766 Coho returned to the Scott and 84 redds were observed on French and Miners (Figure 39).

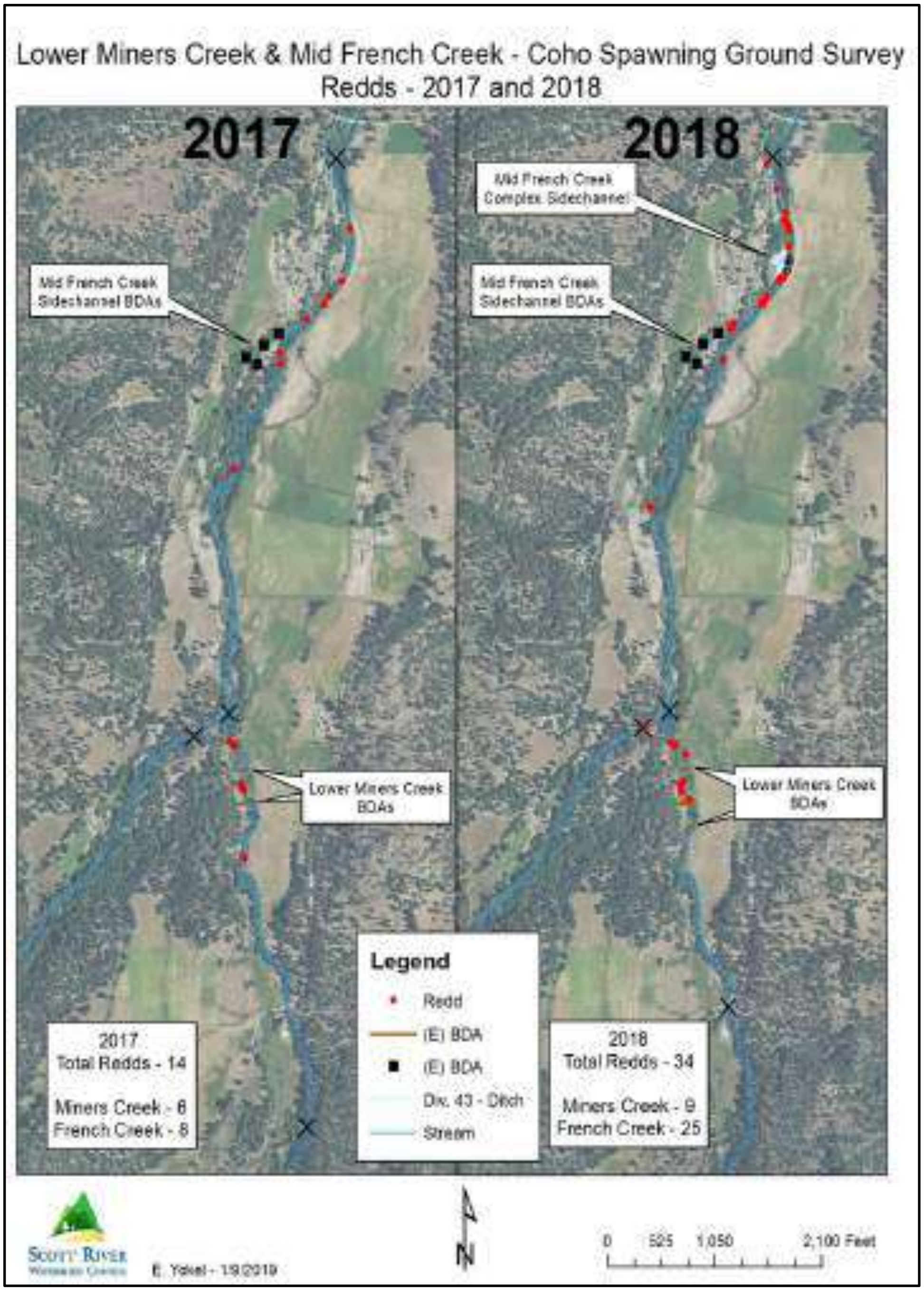

Figure 38.Map of French Creek and Miners Creek Coho Salmon spawning ground survey observations. 2017-2018.

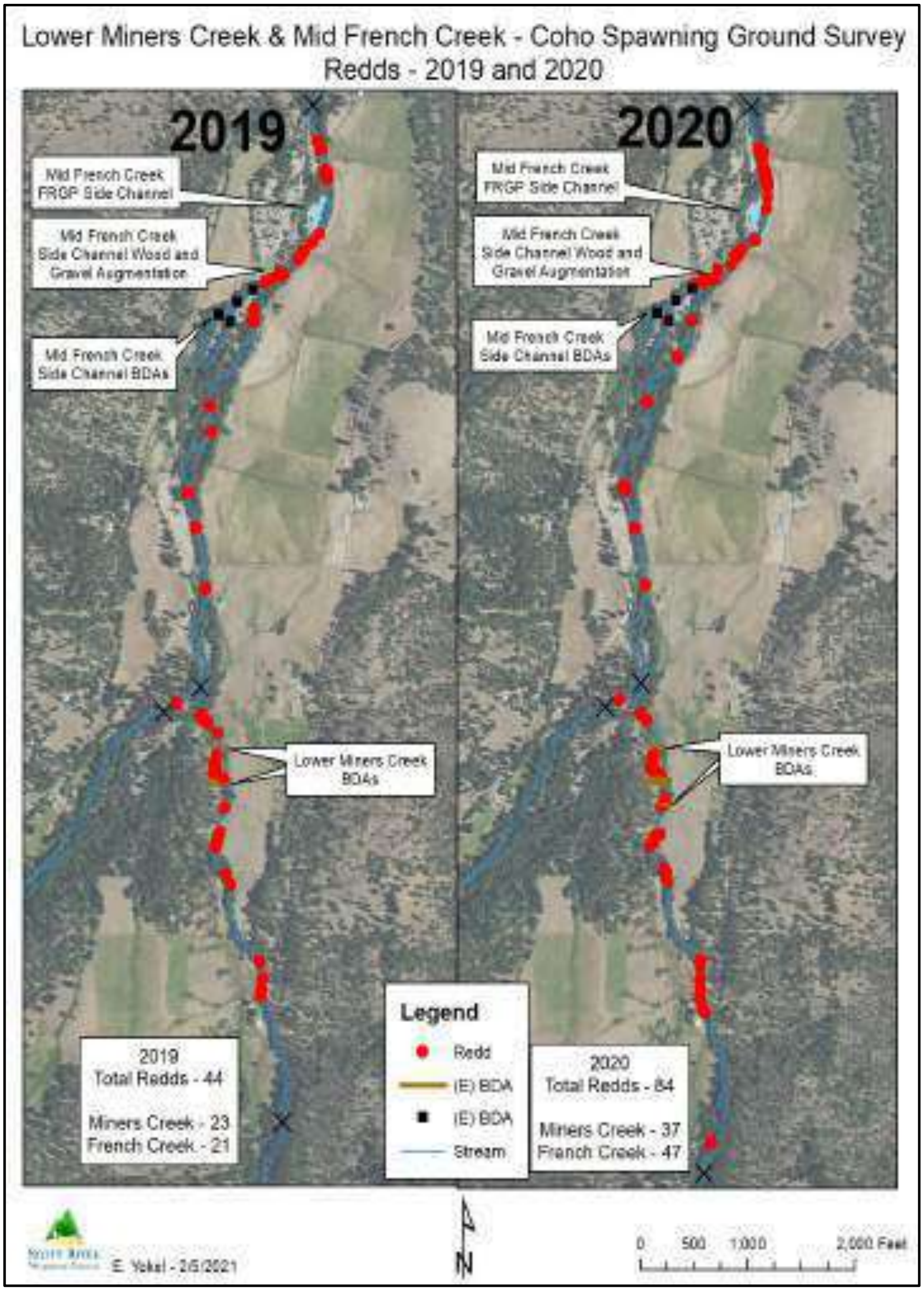

Figure 39. Map of French Creek and Miners Creek Coho Salmon spawning ground survey observations. 2019-2020.

In 2022, six Coho Salmon that had been PIT tagged as juveniles in French Creek returned to the Scott Watershed to spawn (Table 21). 1,990 juveniles had been tagged in French Creek in 2019-2020, when these returning adults would have been rearing.

Table 21. Coho Salmon tagged in French Creek as juveniles, detected on PIT array network as adults. 2022.

PIT_No	First Array Detection	Date of Tag Implant	Location of Tag Implant
989001030719028	French 10	8/22/2019	French Control Pool 1 - DS Log Jam
989001030719030	Scott Weir	8/22/2019	French Creek - ELJs - DS ELJ 3
989001030719206	Scott Weir	8/22/2019	French Control Pool 3
989001030719244	Scott Weir	8/22/2019	French Control Pool 2
989001028156906	Sugar 1	9/24/2019	French Creek - ELJs - US ELJ1
989001031380909	Scott Weir	10/29/2019	French Control Pool 4

Growth Rates and Biometric Comparisons - All Sites

Summer Growth

Summer growth rate data was tracked in four habitat units from 2019-2022 (Table 22). Summer growth rates in 2019, an average water year, were significantly higher at all habitats than in the drought years of 2020 and 2022 (Figure 40-41). Due to adverse environmental conditions prohibiting consistent sampling events during the grant period, it is difficult to compare growth rates across habitat units.

Table 22. Juvenile Coho Salmon summer growth rates. 2019, 2020, 2022.

Summer Growth of Coho Salmon						
Habitat	2019 fl/fl per day*100	2019 g/g per day*100	2020 fl/fl per day*100	2020 g/g per day*100	2022 fl/fl per day*100	2022 g/g per day*100
Sugar Creek BDA Pond 1	0.21	0.57	--	--	0.04	-0.01
Sugar Creek BDA Pond 2	0.27	0.99	--	--	0.00	0.00
French Creek Control Pools	--	--	0.07	0.17	0.04	-0.18
French Creek Mainstem ELJs	0.18	0.27	0.09	0.19	--	--

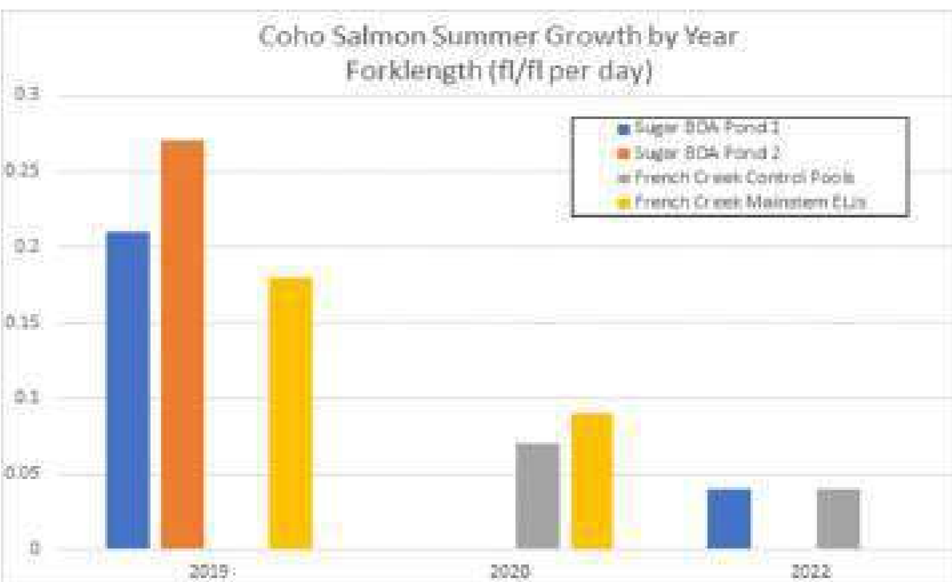

Figure 40. Juvenile Coho Salmon summer relative forklength growth rates. 2019, 2020, 2022.

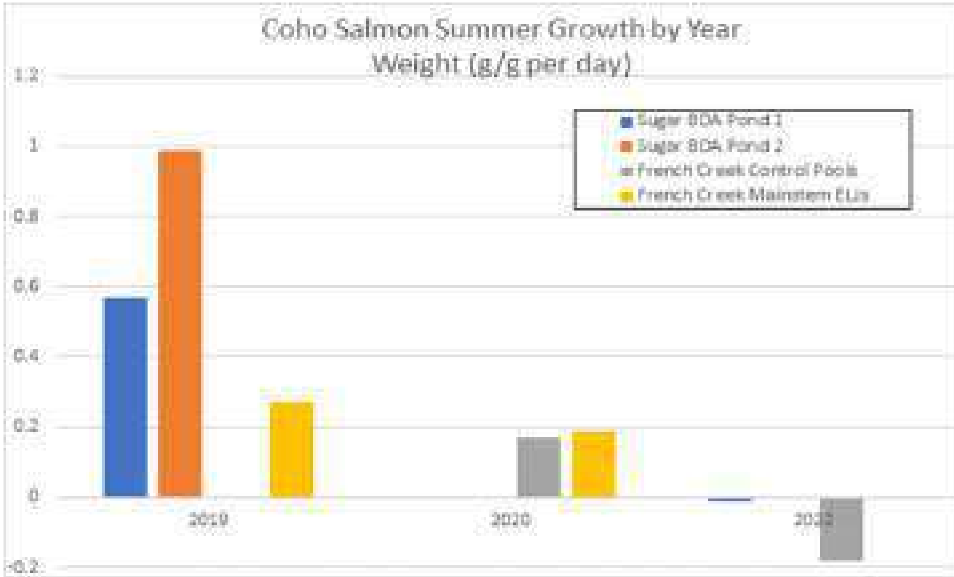

Figure 41. Juvenile Coho Salmon summer relative weight growth rates. 2019, 2020, 2022.

Winter Growth

Winter growth rate data was tracked in four habitat units from 2020-2022 (Table 23). Winter relative growth of Coho Salmon in the French Creek Side Channel BDA Pond exceeded relative growth of Coho in control habitats in all years with sampling effort, with the only exception being equal relative weight growth in 2021 (Figure 42-43).

Table 23. Juvenile Coho Salmon winter growth rates. 2020-2022.

Winter Growth of Coho Salmon Habitat	2020 fl/fl per day*100	2020 g/g per day*100	2021 fl/fl per day*100	2021 g/g per day*100	2022 fl/fl per day*100	2022 g/g per day*100
Sugar Creek BDA Pond 1	0.07	0.23	--	--	0.08	0.33
French Creek Control Pools	0.15	0.53	0.16	0.57	0.08	0.44
French Creek FRGP Side Channel	0.07	0.15	0.08	0.2	0.02	-0.02
French Creek Side Channel BDA Pond	0.2	1.34	0.18	0.57	0.23	0.9

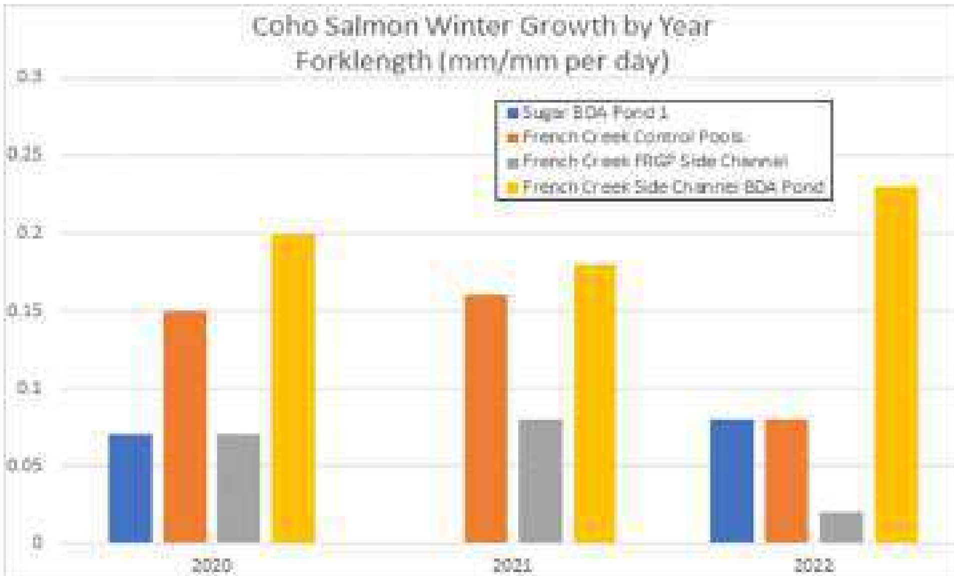

Figure 42. Juvenile Coho Salmon winter relative forklength growth rates. 2020-2022.

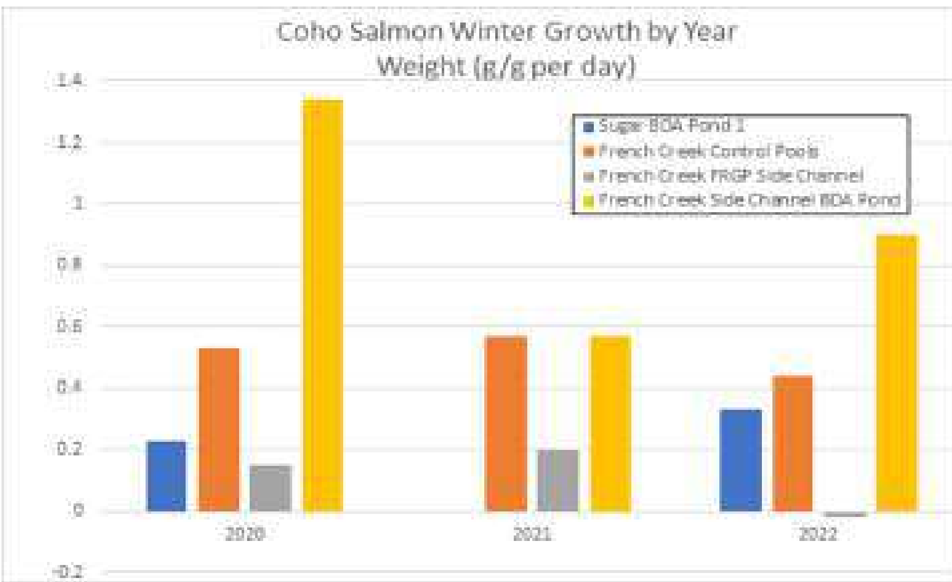

Figure 43. Juvenile Coho Salmon winter relative weight growth rates. 2020-2022.

Biometric Comparisons

The figures below are an amalgamation of the stream-specific comparisons of average forklength across habitat units (Figure 44 and Figure 45).

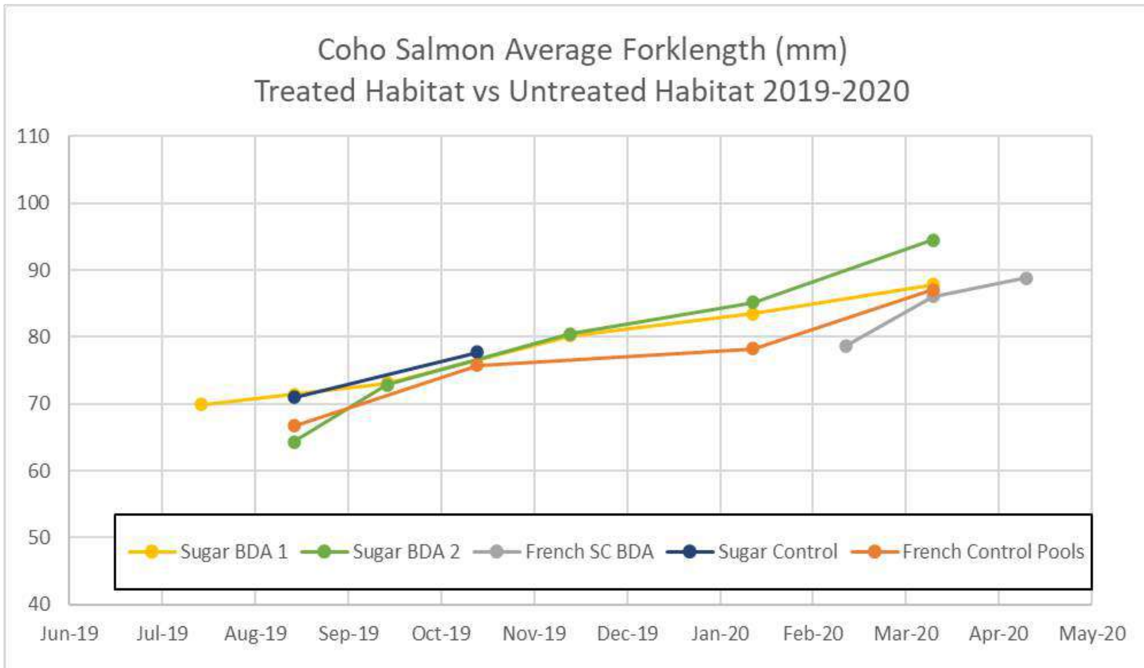

Figure 44. Juvenile Coho Salmon average forklength in all sampled habitats. 2019-2020.

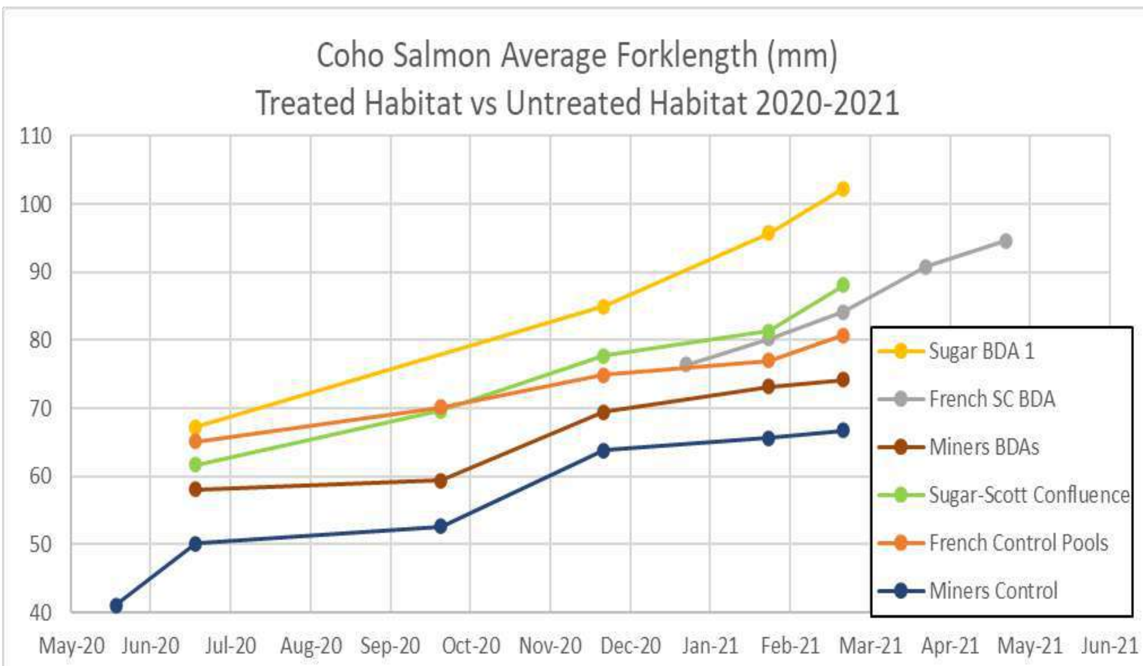

Figure 45. Juvenile Coho Salmon average forklength in all sampled habitats. 2020-2021.

Scott River - Coho Salmon Returns

The California Department of Fish and Wildlife has monitored adult Coho Salmon escapement at the mainstem Scott River counting station since 2007 (Figure 46). Data from the CDFW counting station shows that Brood Year 1 has not been able to recover from a catastrophic population crash that occurred in between the 2013 and 2016 return periods (Figure 47). Brood Years 2 and 3, however, are experiencing positive growth (Figure 48-49).

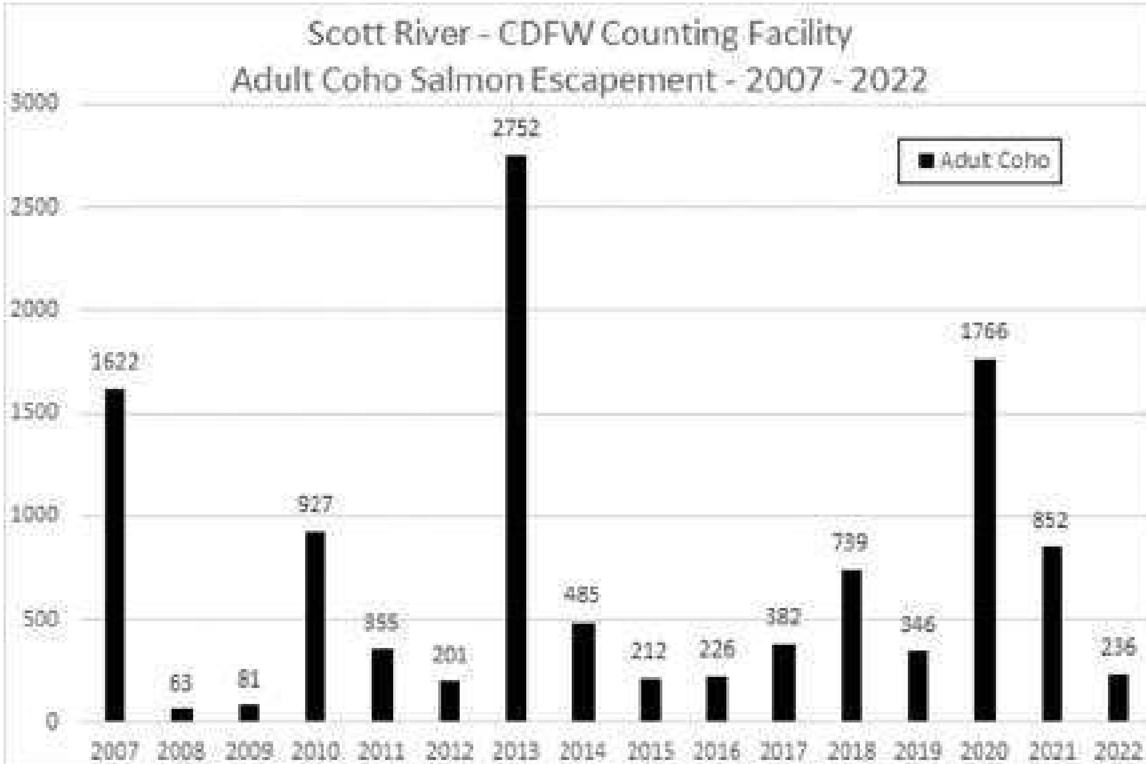

Figure 46. Adult Coho Salmon escapement documented at the Scott River counting station. 2007-2022.

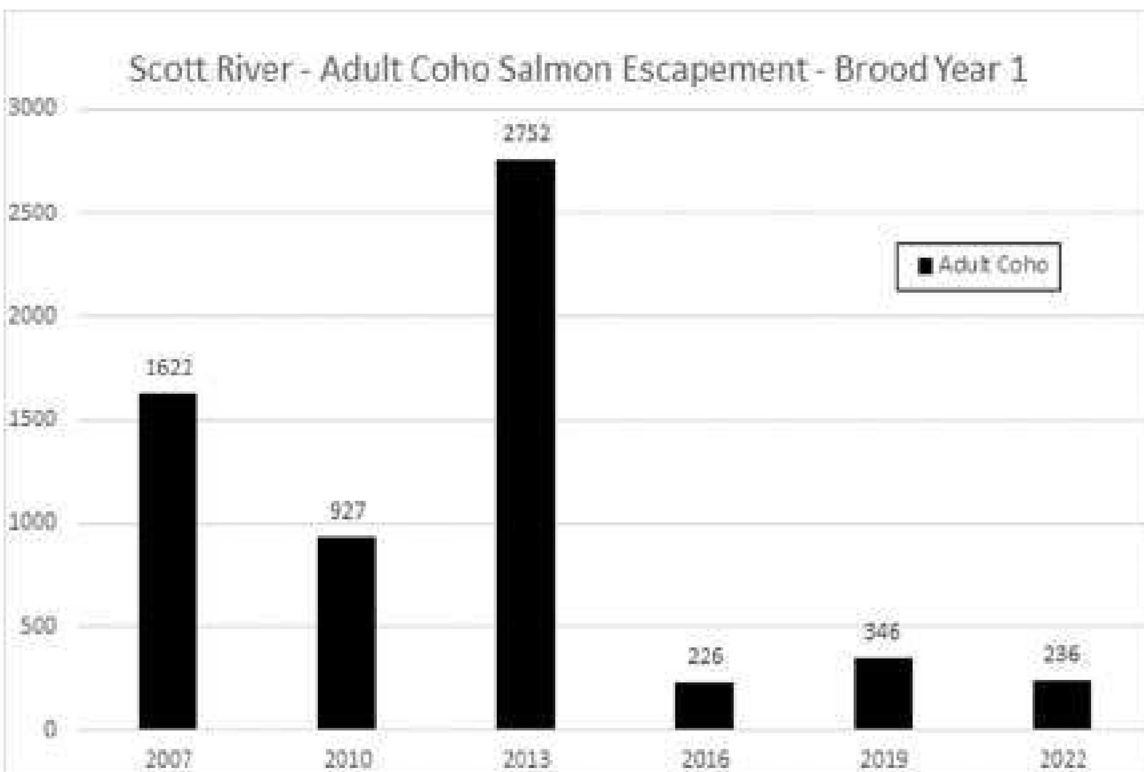

Figure 47. Scott River Coho Salmon Brood Year 1 escapement. 2007-2022.

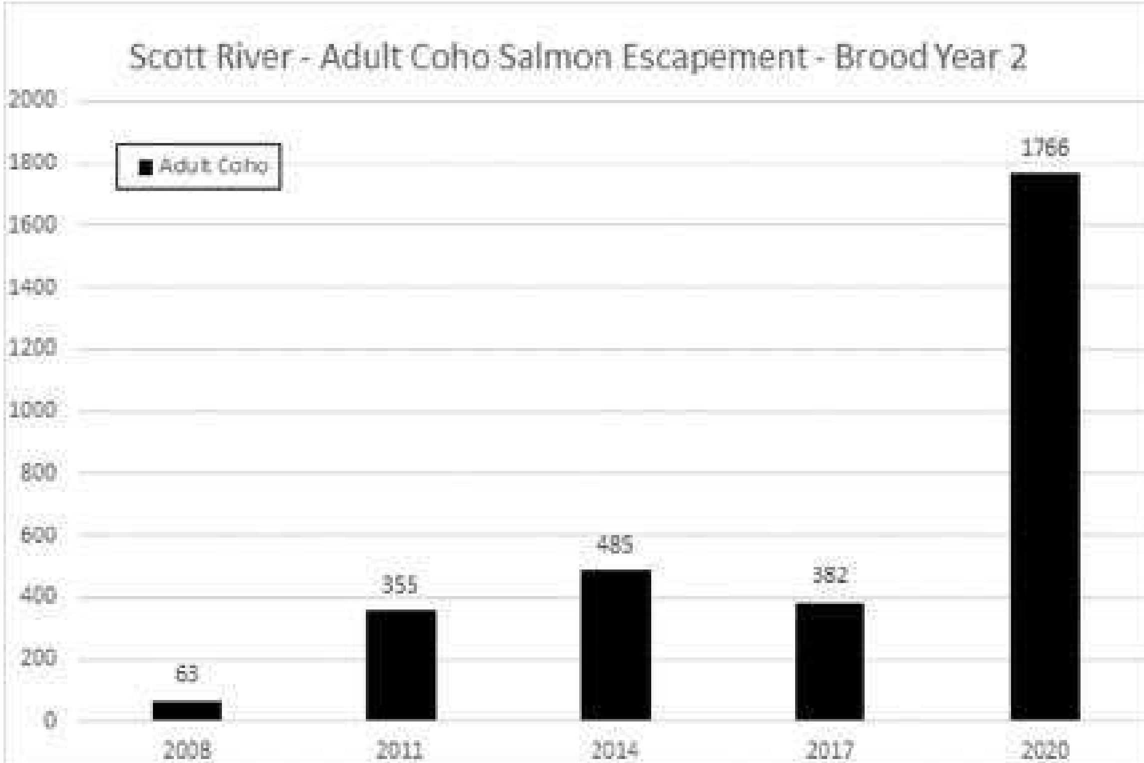

Figure 48. Scott River Coho Salmon Brood Year 2 escapement. 2007-2022.

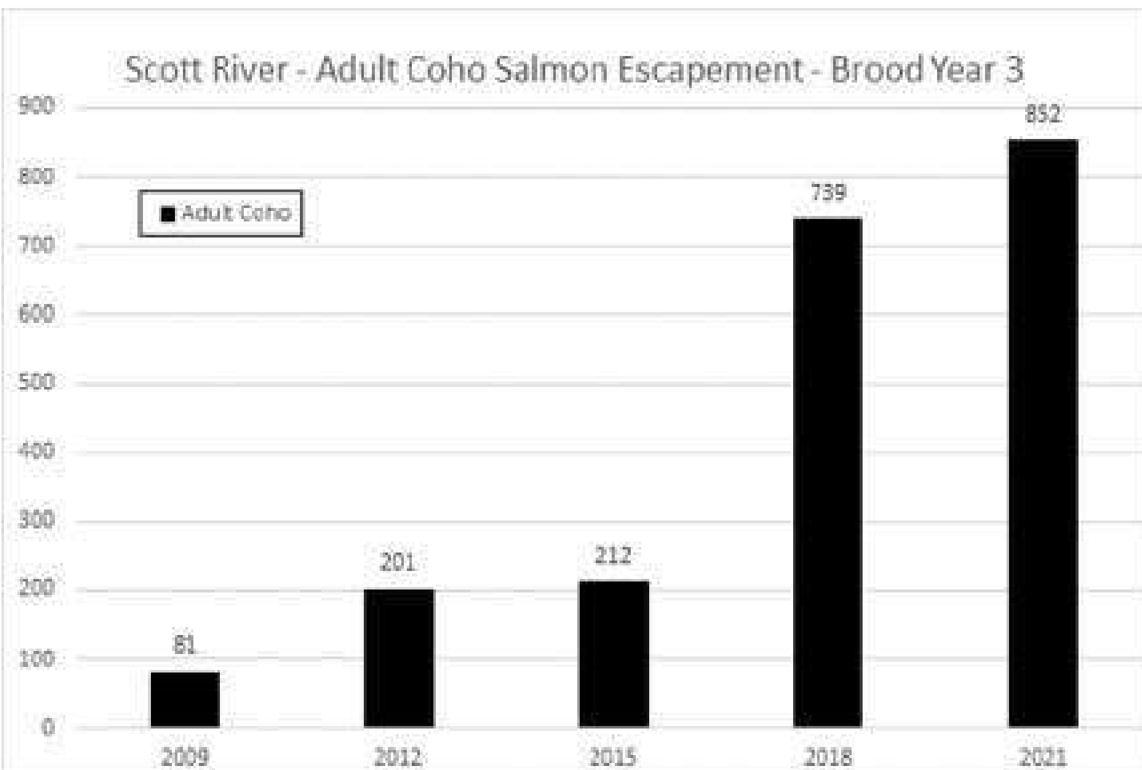

Figure 49. Scott River Coho Salmon Brood Year 1 escapement. 2007-2022.

Discussion - Key Takeaways and Interpretation of results in the context of climate

Effects of BDAs and other restoration on fish and fish populations

The extreme drought conditions that persisted for much of the grant period, coupled with SRWC's commitment to prioritizing the health of the organisms being studied, resulted in a somewhat inconsistent biometric dataset that makes it difficult to tease out the effects of BDAs on fish populations. However, the periods in which comparable data was able to be collected provide numerous examples of the means by which beaver related restoration improves Coho Salmon population viability. Winter growth rates, a crucial factor in producing outmigration-ready smolts prior to the spring runoff, were consistently highest in the French Creek Side Channel BDA Pond. This difference was visible in 2020 and 2021 but was most pronounced in 2022. While 2022 was still an exceptionally dry year in the period of record, it was wetter than the two years preceding it. This indicates that while the benefits of BDAs can be seen in all conditions, they may be magnified in years in which more water is available.

On Sugar Creek, the connection of the off-channel pond to the main channel provided rearing habitat that significantly impacted juvenile Coho populations. The percentage of fish surviving to outmigration in 2022, when thousands of fish were relocated to the off-channel pond, more than tripled when compared to the previous year, when no relocation effort was carried out. As mentioned previously, environmental conditions were similar across these years. Were it not for the access to deep, cool habitat the Sugar Creek Coho population would have presumably faced another significant decline.

In looking at the adult Coho escapement data from the CDFW counting station, one can see that the positive trajectory of Brood Years 2 and 3 correspond to the time period in which beaver related restoration work was undertaken in the Scott watershed (Knechtle 2022). While the factors influencing adult salmon returns are myriad and complex, it stands to reason that the effects of BDAs and other restored habitats on increasing smolt viability would have a positive correlation to adult returns.

Adaptive management requirements

All the restoration sites, whether engineered (French Creek SC and ELJs) or low-tech (BDAs, augmented wood) experienced physical changes during the course of the Project. Adaptive management activities were carried out at the French Creek SC complex, Sugar Creek, and Miners Creek BDAs.

Fish Passage

There was significant evidence that both juvenile and adult Coho Salmon easily passed over the Project BDAs when environmental conditions caused them to do so and life cycle needs require movement, typically fall and spring juvenile redistribution and adult spawner migration. Project experiments indicated that even quite small fry were able to pass the structures (O'Keefe 2021) and that young of the year were able to volitionally jump or swim around BDAs of up to 36.5 cm (Pollock et al. 2021 and O'Keefe 2021). Monitoring data also showed that juvenile Coho seldom voluntarily moved from habitats through the summer baseflow period after spring redistribution is completed until fall redistribution is triggered by an ascending limb of the hydrograph, as exampled by the site fidelity found in repeated sampling events at the connected series of 4 reference pools at French Creek over multiple base flow periods.

Spawning surveys showed evidence of adult Coho passing the BDAs in Miners Creek every year and Sugar Creek in all years but 2020. Casual observation observed adult Coho passing over the French Creek BDAs on occasion (Photo 3).

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Photo 3. Coho passing over a French Creek Side Channel BDA January 2021.

There were times when it did appear that the BDAs possibly obstructed both juvenile and adult passage, but this was associated with the extreme drought conditions and reflected the general lack of passage for adults and juveniles to many areas of the valley that have been historically accessible to them. In 2020, flow conditions were extremely low and fall rains very delayed. The Scott River did not connect through the valley until the end of December and even then, low flow conditions persisted. Sugar Creek immediately upstream of the confluence remained shallow, possibly representing a critical riffle and there was no water spilling over the BDAs during the time frame when spawners were in the system. No adults or redds were identified above the Sugar Creek BDAs in that year. To place this finding in context, only one Scott River tributary, French Creek, was identified as connected and with confirmed spawning, and a second, Shackelford Creek, possibly connected, but no spawning surveys took place to confirm if Coho were able to access the stream.

The natural beaver dams in French and Sugar Creeks never appeared to offer an adult spawner passage barrier (Photo 4). When there was sufficient flow to allow adults access to locations of the dams, spawning activity and fish were documented upstream of the dams.

Photo 4. Beaver working on dam with adult Coho resting in pool French Creek 2021.

In the following summer (2021), juvenile Coho were identified in the Sugar BDA 1 pond, but none above BDA 2. The presumption was that juvenile Coho redistributed into the BDA 1 pond in the spring from spawning in the main stem Scott River, but that none passed over BDA 2 to the upper portion of the stream. It is impossible to determine if the fish were simply unmotivated to move out of the BDA 1 pond habitat or if they were precluded from doing so by the BDA 2.

BDAs, Restoration, and Beaver- Interaction

BDAs are often described as a component of "beaver related restoration" (BRR) "Nash et al 2021), implying that BDAs and beaver are intrinsically linked. Our experience shows there is a complex relationship between historical conditions, restoration- whether BDA or other types- and beaver that is not completely predictable. This complexity is well described in a recent review of BRR that includes the Scott Valley project (Nash et al. 2021).

In the Scott River project, beaver interacted with every restoration site, though it appeared that the amount and intensity of their interaction (frequency and duration of occupation, dam building) corresponded most closely with the intensity of their pre-implementation use of the site than any other variable, indicating that baseline conditions such as amount and type of vegetation, flow, and human pressure were the driving factors for beaver use of a site - not the restoration action, though there were indications that restoration actions may have enhanced and supported the extent of beaver use.

At Sugar Creek, prior to restoration, there was a known and viable population of beaver immediately upstream of the BDA restoration site and evidence of historical beaver use in the form of a remnant historic dam at the site where BDA 1 was constructed. This old dam site was one of the reasons the site was selected; gradient, vegetation and landowner willingness being the others. beaver occupied the site as evidenced by chew sticks, scent mounds, BDA maintenance and game camera captures within a year of BDA construction and have fully maintained the BDA 2 structure since then, meaning that they have consistently placed mud, sticks and other materials on the dam sufficiently to hold water without any human maintenance activities. However, 2018, 2020, 2021, and 2022, all extreme drought years, when the reach either became a series of disconnected pools or completely dewatered, the beaver moved upstream to perennial water during the baseflow period and established themselves there with the construction of a new dam. It is fascinating to note that they first did this approximately 2 weeks prior to the dewatering of the reach with BDAs. It is tempting to speculate that they were attuned to their environment in a manner sufficient to "predict" the pending disconnection, and preemptively moved to a better location.

Using the Sugar Creek experience to reflect retrospectively on-site selection, while there was evidence of old beaver dam building at the time of site selection, it was not fresh. The reach dewatered in the year of construction, 2014, which was a drought year. The SRWC team experienced great optimism when the BDAs held ponded water, with significant Coho populations, through the base flow periods of 2015-2017, however, in 2018, with extended severe drought, the reach again dewatered, as it partially or fully did in subsequent years.

While monitoring showed the Sugar Creek BDAs showed significant positive hydrological effects (see *Water Surface Elevation)*, to the extent that they kept the reach watered in years that it might have otherwise dewatered, the effects in this highly altered mine tailing reach were insufficient to overcome the effects of year over year drought, which are presumed to be indicative of future conditions under climate change. The additional, unquantified factor was the effect of upstream agricultural water extraction on water availability and resulting perennial flow in the reach. Without an ability to understand the amount and timing of water extraction, it is not possible to know if the BDA restoration, in a more natural flow regime, would have maintained perennial flow at the site, allowing continuous beaver occupation.

At the Miners Creek site, there was no evidence of significant beaver utilization prior to BDA construction, and only evidence of transient beaver activity over the course of the project. The reach dewatered every year of the study except the first summer after BDA construction. In retrospect, this was not surprising given that it was dry in the year of BDA construction, 2016, which was an average water year. The Miners Creek site was selected for restoration because of its low gradient, abundant willow and other riparian vegetation, extensive history of Coho spawning, and landowner willingness. Active beaver utilization of the site was not a selection criteria, but there was a hope, and perhaps even an expectation, that beaver would occupy the site after BDA installation and actively maintain the structures. Miners Creek is a comparatively small stream system and has extensive agricultural water extraction, the effects of which were noted by both Munding-Becker and O'Keefe in their graduate studies.

At the French Creek restoration complex consisting of BDAs, wood and gravel augmentation, instream ELJs, and an excavated side channel with riparian planting, beaver interacted with all the restoration elements. However, this was the portion of the creek that they had historically resided and worked in, so their presence cannot be solely attributed to the restoration action.

Munding-Becker, in his study comparing the BDA in Miners Creek and the natural beaver dam in French Creek, concludes that the French Creek and Miners Creek sites were equivalent, and it was the beaver superior dam construction and maintenance skills in comparison to BDA construction and maintenance that resulted in baseflow ponded habitat behind the French Creek beaver dam and the lack thereof at the Miners Creek BDA site. The SRWC conclusion is the opposite; that beaver occupied and built a dam in French Creek at site that had the correct hydrologic and geomorphic properties to support ponding and the failure to achieve this end point at Miners Creek could have been predicted by the lack of beaver activity prior to restoration. This interpretation corresponds with research that indicates that "*BMR (Beaver Mimicry Restoration) design and siting influence the types of hydrologic effects that should be anticipated*" (Bobst 2022).

Lessons Learned: Site selection Criteria and Future Restoration Direction

SRWC has a more sophisticated understanding of site selection for BRR than we did at the start of the BDA project as a result of implementing, managing and monitoring a variety of restoration techniques and unrestored habitats. The first principle for site selection is to evaluate baseline conditions to sufficiently understand primary hydro-geo-morphic conditions to be able to have reasonable prediction of restoration effects. However, this does not mean that complex and expensive analysis is required for BRR, rather the sort of close observation that place-based restoration encompasses is usually sufficient. Are beaver (assuming they are in the watershed) currently using the site? Does the site dry in a drought year? Is it a gaining or losing reach? Is there extensive agricultural water extraction upstream of the project that will influence flow? Are the soils porous or cohesive?

Another principle is that site selection consists of a match between restoration goals and site characteristics. As an example, just because Miners Creek failed to meet the (unrealistic) pre-implementation hope that summer habitat would be maintained, it was not a failure. Significant spawning and early season juvenile Coho rearing were documented at the site every year monitoring was permitted. Photo points documented revitalization of riparian habitat with likely benefits to birds and other non-fish species. The BDAs captured, stored, and sorted sediment, aggrading the channel and also decreasing fine sediment inputs downstream. In Sugar Creek, the BDA reach dried during on-going drought conditions, however in many other years there was a large amount of excellent juvenile Coho habitat that supported the rearing of thousands of juveniles (SRWC 2018) (Appendix E).

All the BDAs initiated channel form changes that increased complexity and habitat diversity, as compared to the very simplified channel forms present at the site's pre-implementation, and that are typical across the watershed. While placing BDAs in losing, alluvial reaches may not create over summer habitat for salmonids on a consistent basis, they can contribute to habitat values such as superior over-wintering habitat, groundwater storage, and improved riparian vegetation. Our monitoring, and the work performed by the graduate students for this project (see *Resulting Publications*), shows that restoration contributes to habitat complexity, offering options that provide ecological benefits under differing conditions. This provides resilience and the opportunity for diverse life history strategies to manifest, therefore being retained in the gene pool.

The Project exposed master variables for site selection- human issues and climate change- that are hard to predict and manage, and a certain humility and flexibility in regard to the impact of these factors must be maintained. Because we were working in the private land setting (which are often the ecologically valuable riverian corridors) human influenced factors dominated the Project. This factor emerged as the impact of significant, variable and untraceable water extraction affected the sites. Changes in the degree of landowner participation altered site management and monitoring plans, and potential changes in ownership threatened access to Project sites altogether. In response, one option was to abandon efforts to restore these habitats, but in the case of the Scott, this pathway would mean abandoning the goal of restoring Coho and Chinook salmon populations, as almost all their spawning and rearing occurs on private lands. An alternate approach is for project proponents, funders, and regulators to accept that landowner and land use issues will affect projects over their course and to attempt to adaptively manage these challenges in a manner similar to natural events.

Climate change, as evidenced by on-going decreases in and timing of precipitation and snow-pack (i.e., drought, change of fall precipitation events) impacted the Project sites. In the normal precipitation years of

2017 and 2019, Sugar Creek reach maintained a significant summer rearing habitat of excellent quality. It is possible that Miners Creek may have maintained summer hydration if the BDAs had been installed in a different climate regime. Investigations into historical evidence of beaver dam building in the Greater Yellowstone Ecosystem demonstrated that beaver abandoned smaller streams that became ephemeral during periods of prolonged drought for larger stream systems and returned again to the smaller systems under wetter conditions (Persico 2013). If we cue into the beaver ability to evaluate sites for perennial water availability, we might be able to improve our ability to predict the effects of beaver mimicry (and other restoration techniques). All evidence points to our being in a period of rapid transition from a wetter to a drier climate, and that embracing this understanding will allow better correlation between site selection and anticipated outcomes.

Restoration, and non-restoration, habitats contributed to salmonid life cycle needs at different times of the year and under different flow conditions. Diverse ecological benefits accrued from all the Project restoration efforts, even when year after year perennial water habitat suitable for salmonids did not result. Our experience correlates with the conclusions of Nash et al: "*The concept of contingency (sensu Gould 1989) is a useful way to understand process-based restoration and to manage expectations around potential outcomes of BRR. Contingency in natural systems suggests that every eventual outcome may be explainable in hindsight, but is often difficult or impossible to predict looking forward because of the critical role of historical antecedents and unanticipated intervening factors. Therefore, although certain elements of a restoration project might proceed along well-articulated and relatively predictable paths, the ultimate outcomes associated with a project can be influenced by processes beyond the spatial, temporal, and physical scope of the project, including those influenced by place, sequence of events, and human response."* Therefore, on-going site surveillance, monitoring and management is required to achieve maximal outcomes and an attitude of humility and commitment is required to proceed in the face of pressing climate change.

Project Resulting Publications

The following manuscripts/thesis/reports are made part of this project and help support the collective understanding of the ecological function of BDAs.

Nicholas J. Corline: When Humans Work Like beaver: Riparian Restoration Enhances Invertebrate Gamma Diversity and Habitat Heterogeneity

Christopher G. O'Keefe: Do Beaver Dam Analogues Act As Passage Barriers To Juvenile Coho Salmon And Juvenile Steelhead Trout?

Miles Munding-Becker: Examining The Impacts of Beaver Dam Analogues and Groundwater Storage on Miners Creek, California

Monica Tonty: Seasonal Growth, Movement, And Survival of Juvenile Coho Salmon (*Oncorhynchus Kisutch*) Utilizing Beaver Dam Analogue Habitat

Michael Pollock: Field experiments to assess passage of juvenile salmonids across beaver dams during low flow conditions in a tributary to the Klamath River, California, USA

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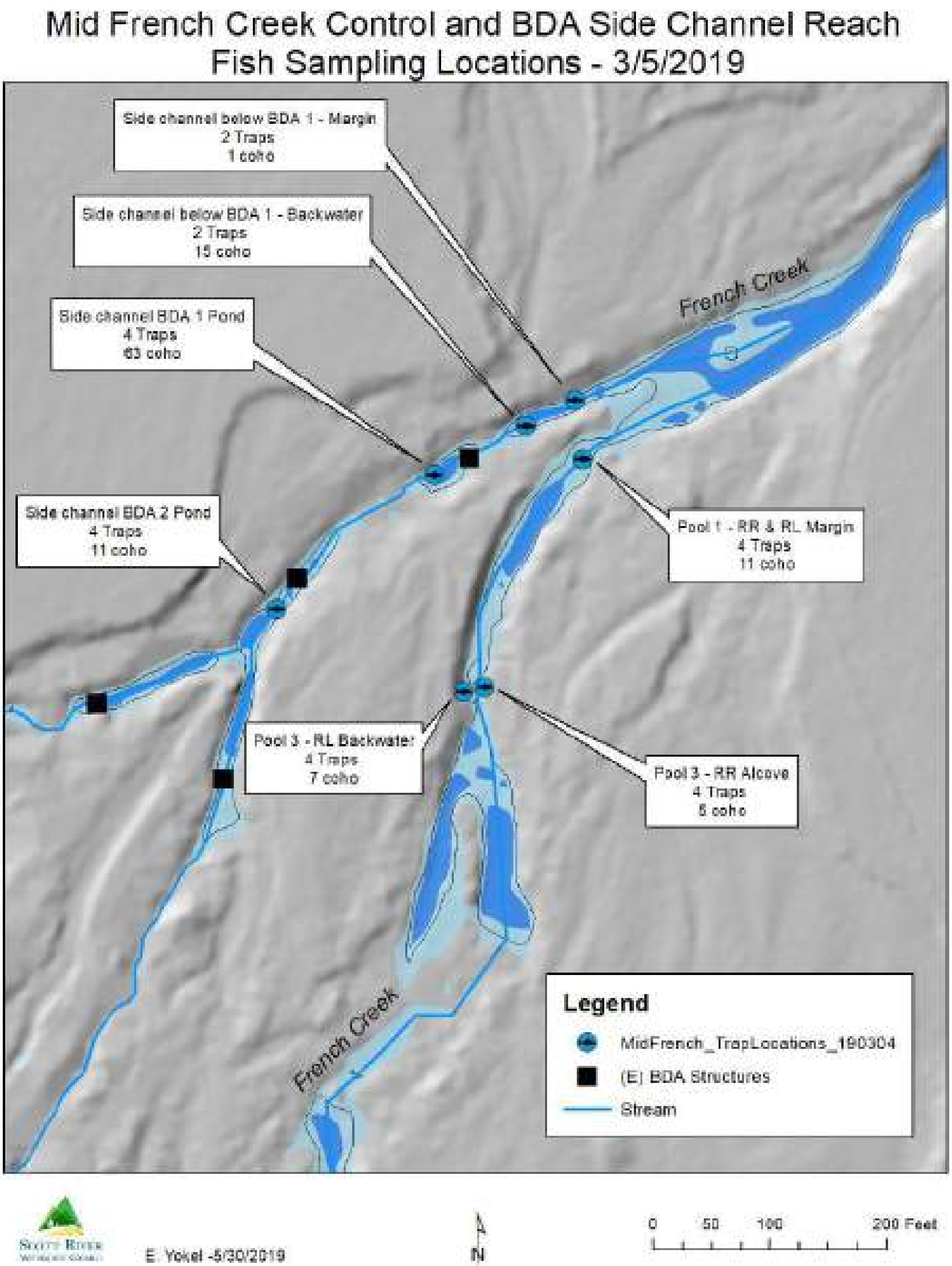
Appendix A:

SRWC Project Interim Field Tech Notes



Map 1 – Fish sampling locations and catch – March 5, 2019

Fish sampling efforts on March 5, 2019 captured Coho Salmon in the Mid French Side Channel BDA 1 and 2 Ponds (Table 1).

3/5/2019 - Julian Week 10
Mid French Creek Control Pools and Side Channel BDA Ponds

	Coho Salmon			Steelhead Trout		
Location	Total Catch	Marked	Recaptured	Total Catch	Marked	Recaptured
Control Pools	23	0	8	7	0	1
Side channel Downstream BDAs	16	0	0	3	0	0
Side Channel BDA 1 Pond	63	0	0	0	0	0
Side Channel BDA 2 Pond	11	0	0	1	0	0

Table 1 - Catch summary – Mid French Control Pools and Side channel BDA Ponds – Julian Week 10

Forklength histograms of captured Coho Salmon in the Mid French Control Pools and side channel below the BDAs (Figure 1) and the Side Channel BDA Ponds (Figure 2) indicate the Coho Salmon captured in the BDA Ponds are significantly larger than those captured in the untreated habitats (Table 2).

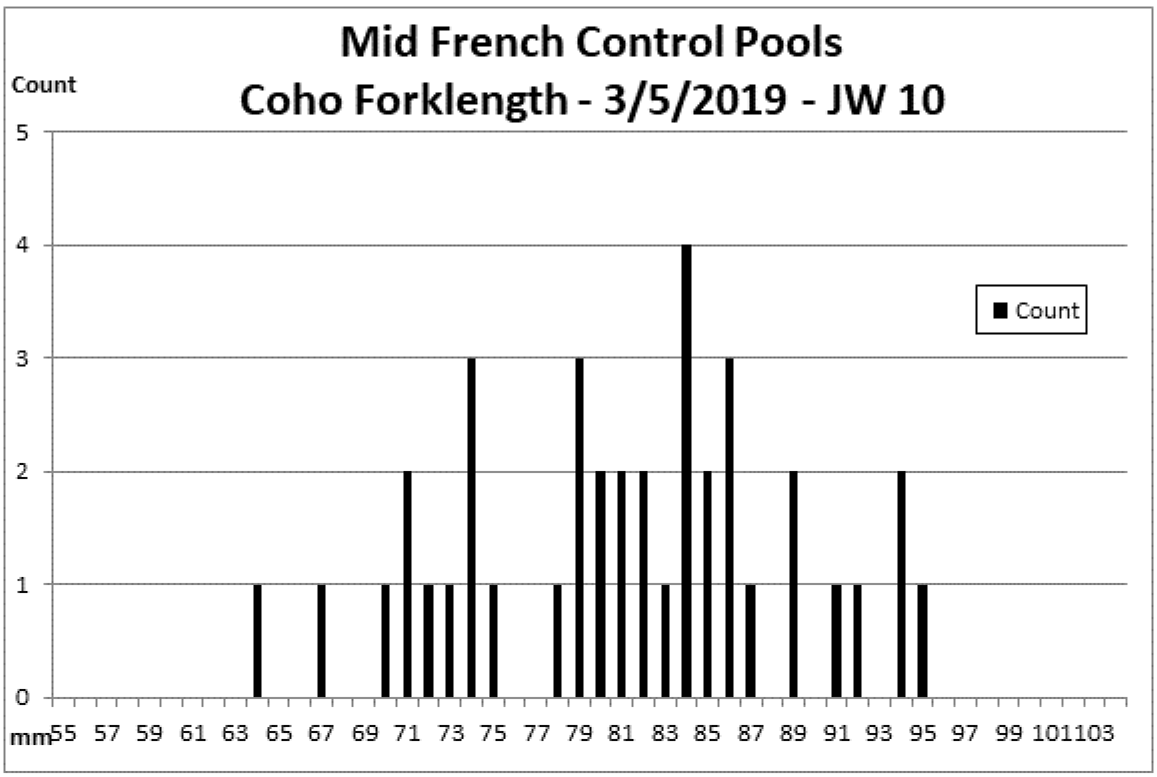


Figure 1 – Mid French Creek Control Pools - Coho Salmon forklength (mm) histogram – Julian week 10

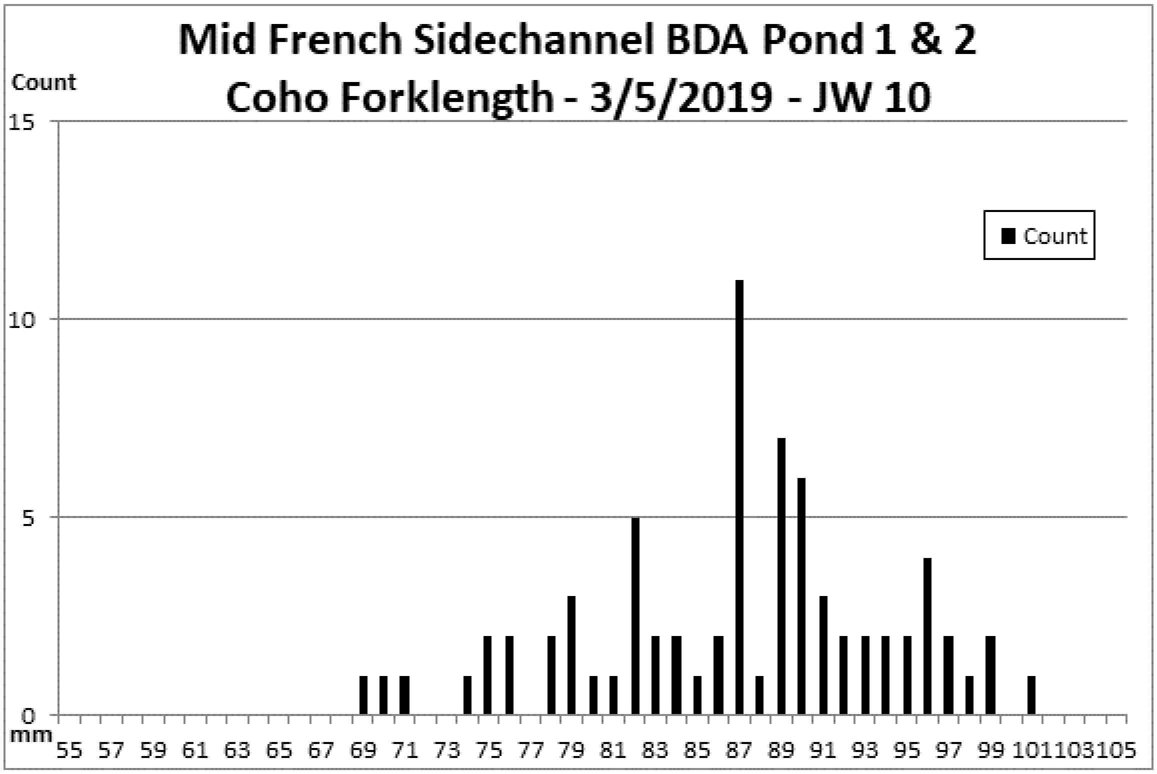


Figure 2 – Mid French Side channel BDA Ponds - Coho Salmon forklength (mm) histogram – Julian week 10

Julian Week - 10 - Coho Salmon Forklength (mm)		
Sample Reach	Mid French Control	BDA Ponds
Average	81	87
Stan. Dev.	7.7	8.5
Minimum	64	69
Maximum	95	125
Count	39	74

Table 2 – Average Coho Salmon forklength (mm) – Mid French Control Pools and Side channel BDA Ponds – Julian week 10

3/22/2019 - Julian Week 12								
Mid French Creek Side Channel BDA Pons								
		Coho				Steelhead		
Location	Total Capture	Marked	Recaptured	Mortality	Total Capture	Marked	Recaptured	Mortality
Side Channel BDA 1 Pond	32	32	0	0	2	1	0	0
Side Channel BDA 2 Pond	10	10	0	0	0	0	0	0
Total BDA Ponds	42	42	0	0	2	1	0	0

Table 3 – Catch summary – Mid French Side channel BDA Ponds – Julian Week 12

Julian Week - 12 - Coho Salmon Forklength (mm)	
Sample Reach	BDA Ponds
Average	96
Stan. Dev.	8.2
Minimum	83
Maximum	122
Count	42

Table 4 - Average Coho Salmon forklength (mm) – Mid French Side channel BDA Ponds – Julian week 12

Forty-two Coho Salmon and one rainbow trout were PIT tagged in the French Creek Side Channel BDA Ponds 1 and 2 on March 22 (Table 3). Thirty-seven (86%) of the tagged fish were detected on the Mid French Creek PIT tag station downstream of the Side Channel BDA Ponds (Figure 3 and Table 5).

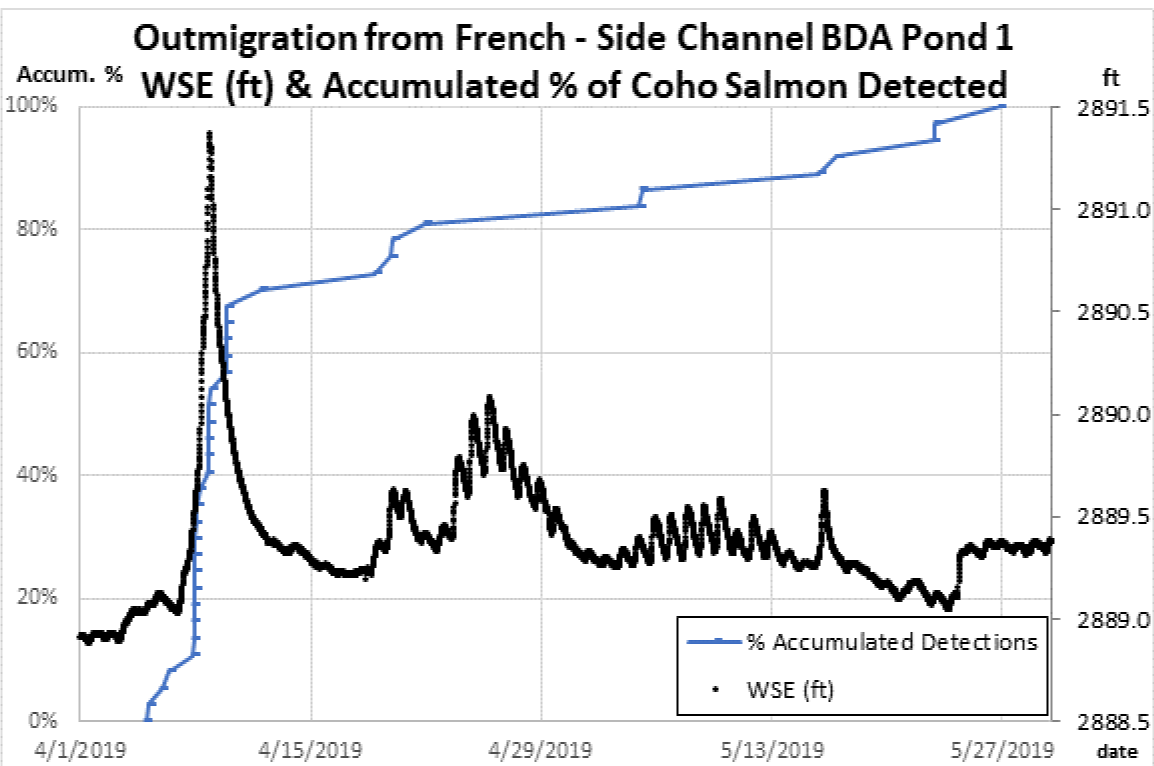


Figure 3 - Accumulated percent of unique Coho Salmon tagged in Side Channel BDA Ponds and detected outmigrating at Mid French Creek PIT array (n = 37) and water surface elevation (WSE) above Side Channel BDA Pond 1 – 2019

Detection of Outmigration of Coho Salmon from French Side Channel BDA Ponds

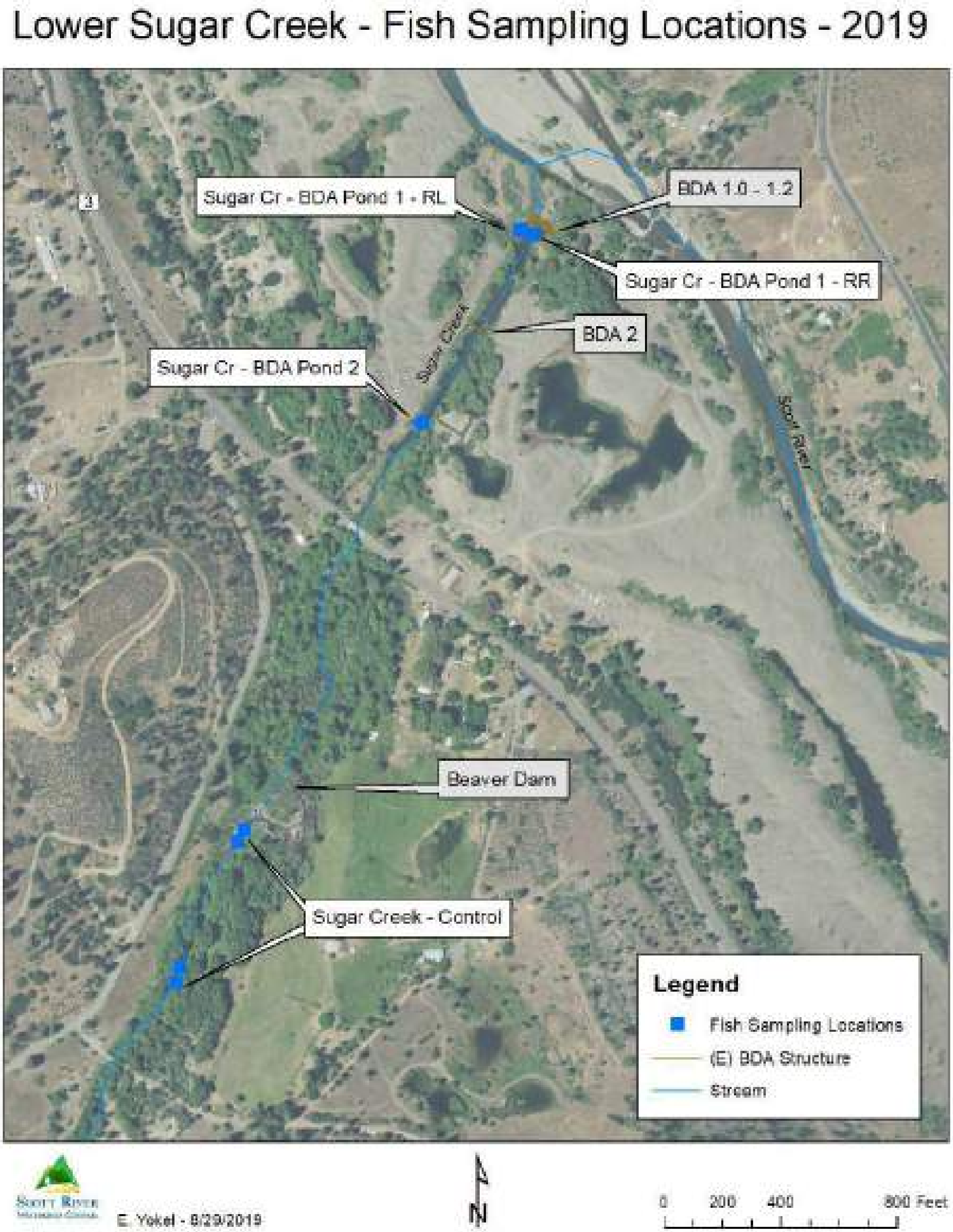
Number of Coho Salmon		Date of Detection	
Tagged	Detected	First	Last
43	37	4/5/2019	5/26/2019

Table 5 – Number of Coho Salmon tagged in French Side Channel BDA Ponds and number detected at downstream Mid Fench Creek PIT array with date of first and last detection

Scott River Watershed Council – Preliminary Base Flow Catch Summary – 2019

Sugar Creek

Picture 2 - Beaver Dam Analogue (BDA) 1.0 (upstream) and 1.1 with BDA Pond 1 in background – August 19, 2019



Map 1 – Fish sampling locations in Sugar Creek

			Coho Salmon			Rainbow Trout		
Date	Location	Gear	Total Catch	Marked	Recap	Total Catch	Marked	Recap
7/31/2019	Sugar - BDA Pond 1	Seine & Traps	381	277	0	69	0	0
8/9/2019	Sugar - below BDA Pond 1	Seine	30	0	12	266	0	0
8/19/2019	Sugar - BDA Pond 1	Seine	354	227	64	46	1	0
8/26/2019	Sugar - BDA Pond 2	Seine	104	45	0	2	0	0
8/27/2019	Sugar - Control	Seine	95	70	0	28	0	0

Table 1 – Catch summary – Sugar Creek BDA Ponds – July 31 – August 27, 2019

Date	7/31/2019
Site	Sugar BDA Pond 1
Average	70
Stand. Dev.	7.2
Minimum	47
Maximum	92
Count	380

Table 2 – Average forklength (mm) of Coho Salmon – Sugar Creek BDA Pond 1 – July 31, 2019

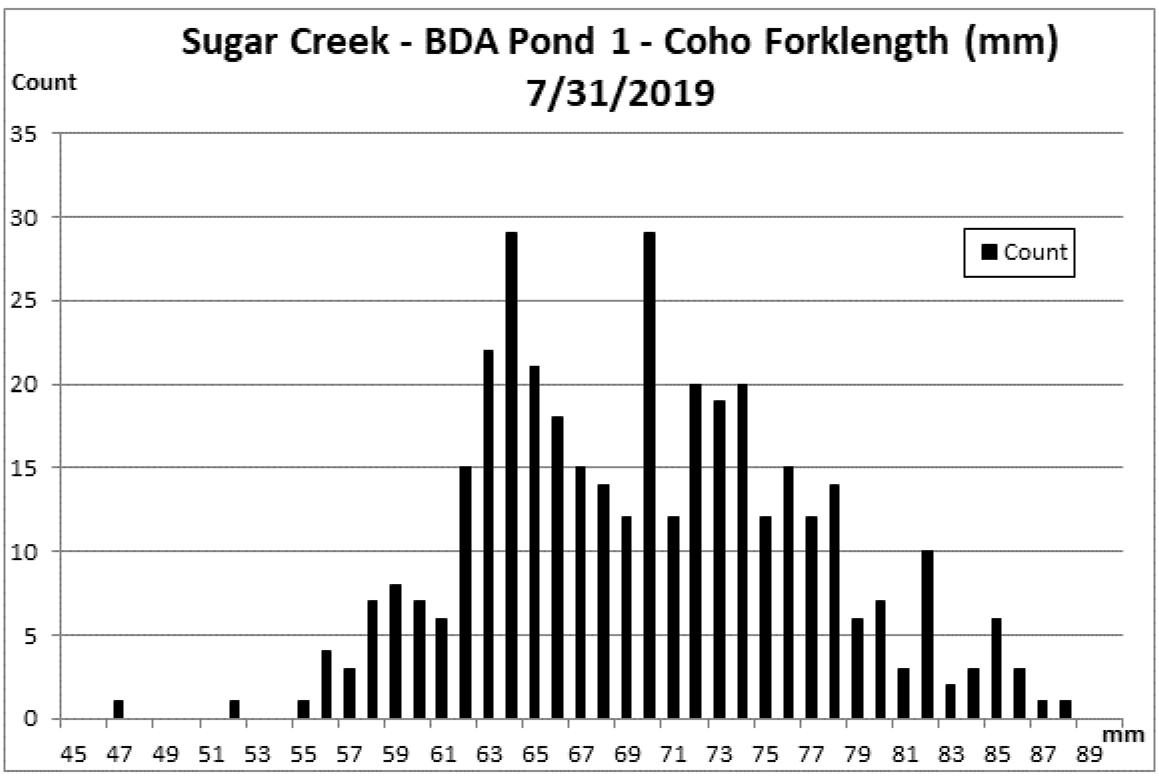


Figure 1 - Forklength (mm) histogram – Coho Salmon captured in Sugar Creek BDA Pond 1 – 7/31/2019

Sugar Creek - 8/19 - 8/27/2019		
	Coho Salmon - Count	
Site	0+ (BY18)	1+ (BY17)
Beaver Pond 1 - RR	310	0
Beaver Pond 1 - RL	41	3
Beaver Pond 2	104	0
Control	91	4
Total	**546**	**7**

Table 3 – Count of 0+ and 1+ Coho Salmon captured in Sugar Creek – 8/19 – 8/27/2019

Date	8/19/2019	8/19/2019	8/19/2019
Site	Sugar BDA Pond 1	Sugar BDA Pond 1 - RR	Sugar BDA Pond 1 - RL
Average	71	71	74
Stand. Dev.	6.6	6.3	8.1
Minimum	57	57	61
Maximum	89	89	87
Count	351	310	41

Table 4 – Average forklength (mm) of Coho Salmon – Sugar Creek BDA Pond 1 – August 19, 2019

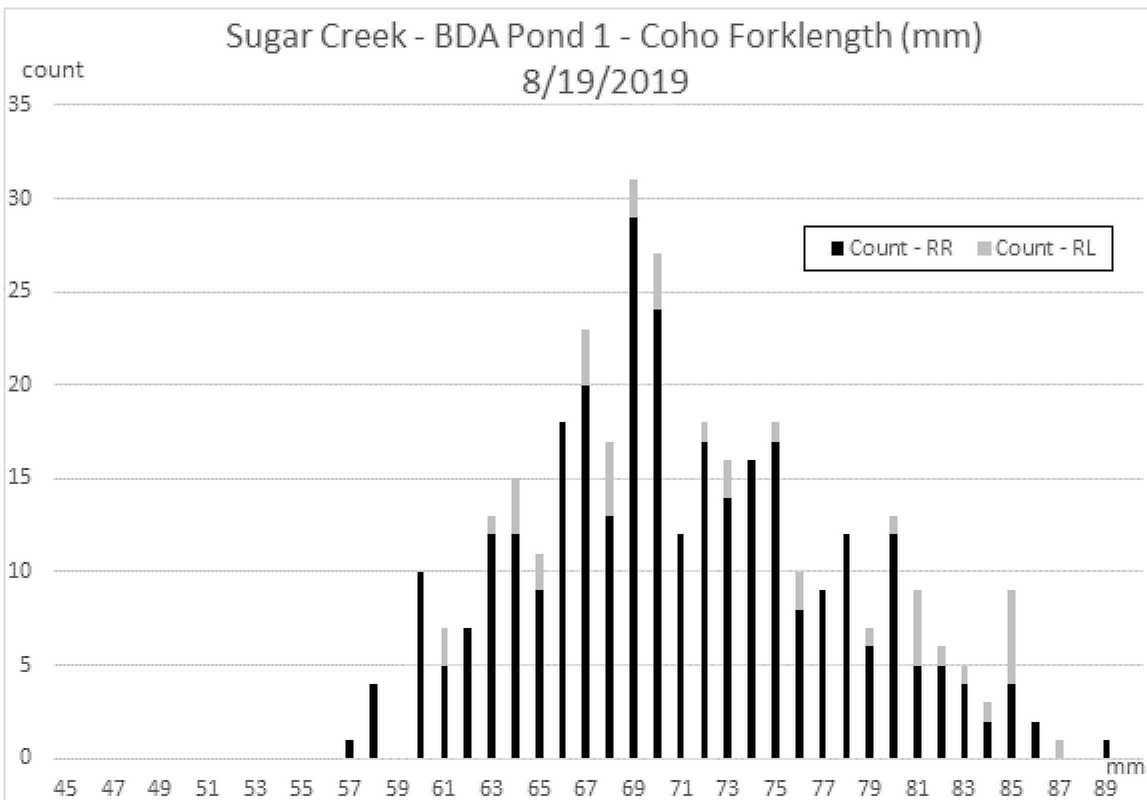


Figure 2 – Forklength (mm) histogram – Coho Salmon captured in Sugar Creek BDA Pond 1 – 8/19/2019

Picture 3 - 1+ and 0+ Coho Salmon captured in Sugar BDA Pond 1 - August 19, 2019

Date	8/26/2019
Site	Sugar BP2
Average	64
Stand. Dev.	5.1
Minimum	47
Maximum	82
Count	104

Table 5 – Average forklength (mm) of Coho Salmon – Sugar Creek BDA Pond 2 – August 26, 2019

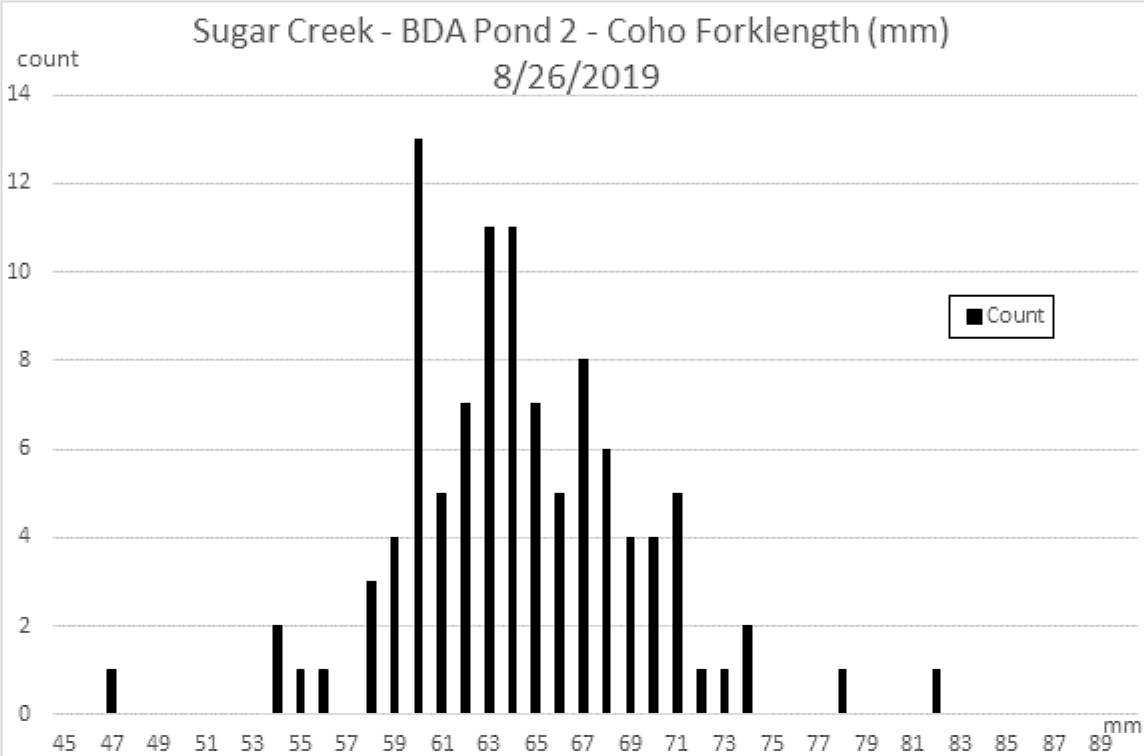


Figure 3 – Forklength (mm) histogram – Coho Salmon captured in Sugar Creek BDA Pond 2 – 8/26/2019

Date	8/27/2019
Site	Sugar Control
Average	69
Stand. Dev.	6.5
Minimum	57
Maximum	90
Count	91

Table 6 – Average forklength (mm) of Coho Salmon – Sugar Creek Control – August 27, 2019

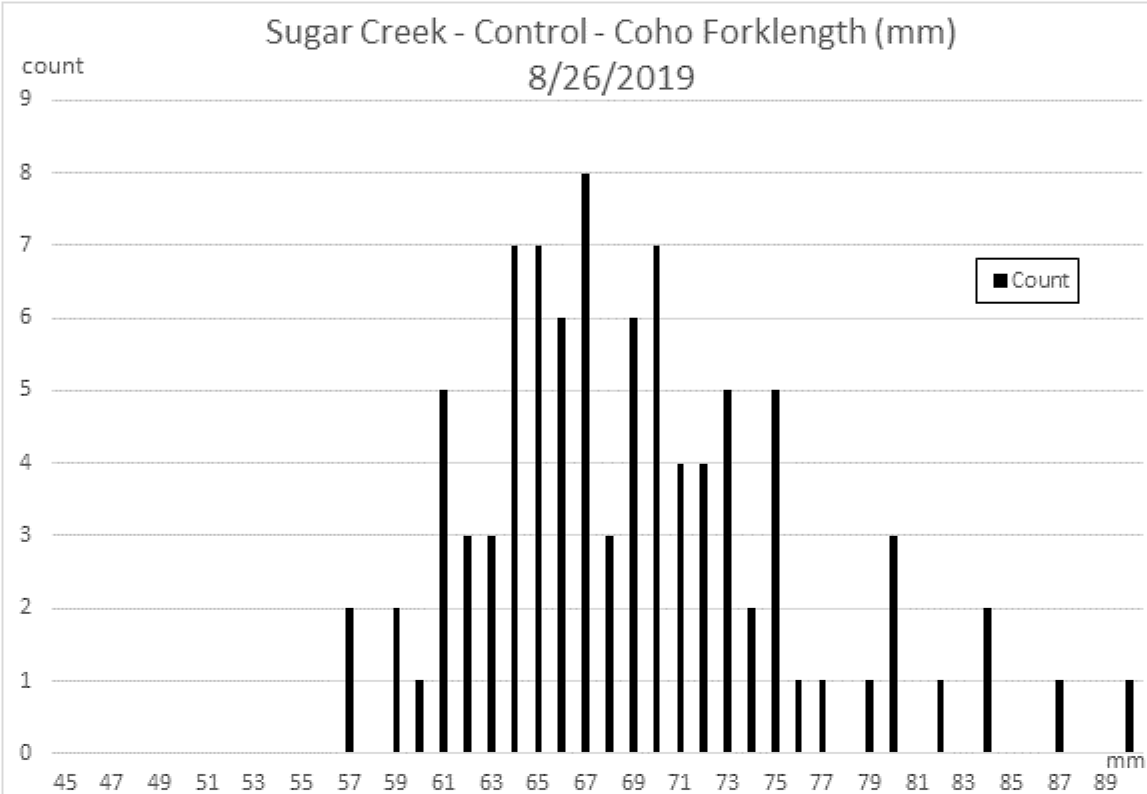


Figure 4 – Forklength (mm) histogram – Coho Salmon captured in Sugar Creek Control – 8/19/2019

9/6/2019 – Sugar BP1

			Coho Salmon			Rainbow Trout		
Date	Location	Gear	Total Catch	Marked	Recap	Total Catch	Marked	Recap
9/6/2019	Sugar BDA Pond 1	Seine	360	193	124	104	0	0

Table 7 – September 6, 2019 – Catch Summary

Date	9/6/2019
Site	Sugar BP1
Average	72
Stand. Dev.	5.9
Minimum	58
Maximum	92
Count	359

Table 7 – Average forklength (mm) of Coho Salmon – Sugar Creek BDA Pond 1 – September 6, 2019

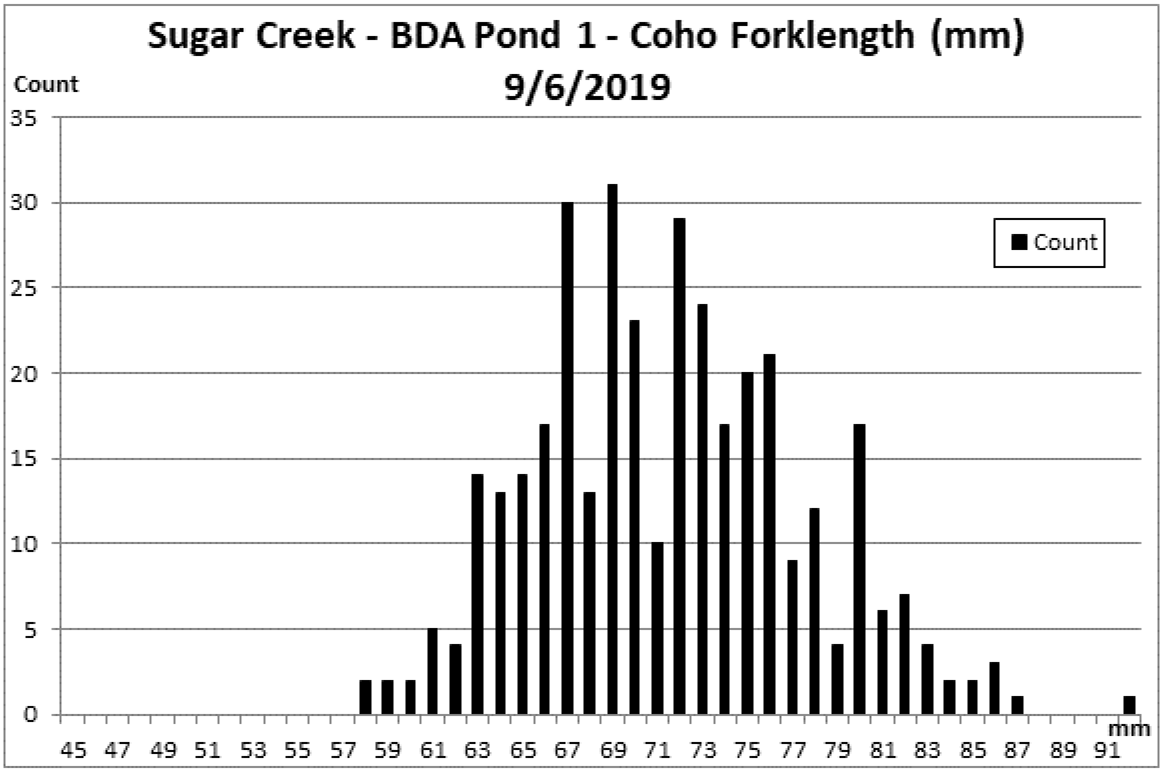


Figure 5 – Forklength (mm) histogram – Coho Salmon captured in Sugar Creek BDA Pond 1 – 9/6/2019

Date	9/28/2019	9/28/2019	9/28/2019
Site	Sugar BP1	Sugar BP1 RR	Sugar BP1 RL
Average	76	75	76
Stand. Dev.	6.5	5.9	7.5
Minimum	52	52	60
Maximum	94	92	94
Count	217	151	66

Table 8 - Forklength Histogram Sugar BP1 – 9/28/2019

Date	9/27/2019	9/27/2019	9/27/2019
Site	Sugar BP2	BP2 Above Beaver Dam	BP2 Below Beave Dam
Average	71	69	72
Stand. Dev.	6.7	8.7	4.8
Minimum	54	54	62
Maximum	94	94	90
Count	134	51	83

Table 9 - Forklength Histogram Sugar BP1 – 9/27/2019

Charnna Gilmore at natural beaver dam in Lower Sugar Creek BDA Treatment Reach

			Coho Salmon			Rainbow Trout		
Date	Location	Gear	Total Catch	Marked	Recap	Total Catch	Marked	Recap
10/31/2019	Sugar Creek - BP1 RR	Seine	397	299	63	23	0	0
11/1/2019	Sugar Creek - BP1 RR and RL	Seine	451	0	130	19	0	0

Table 10 – Catch Summary – Sugar BP1 – Julian Week 44 (JW44)

Date	10/31 - 11/1/2019	11/5/2019
Site	Sugar BP1	Sugar BP2
Average	80	80
Stand. Dev.	6.4	8
Minimum	62	55
Maximum	102	116
Count	848	234

Table 11 – Average Coho Salmon forklength – Sugar Creek Beaver Pond 1 and 2 – Julian week 44 - 45

BDA Pond 1 – Looking upstream

Lower Sugar BDA Pond 1 – Looking Downstream at BDA 1.0

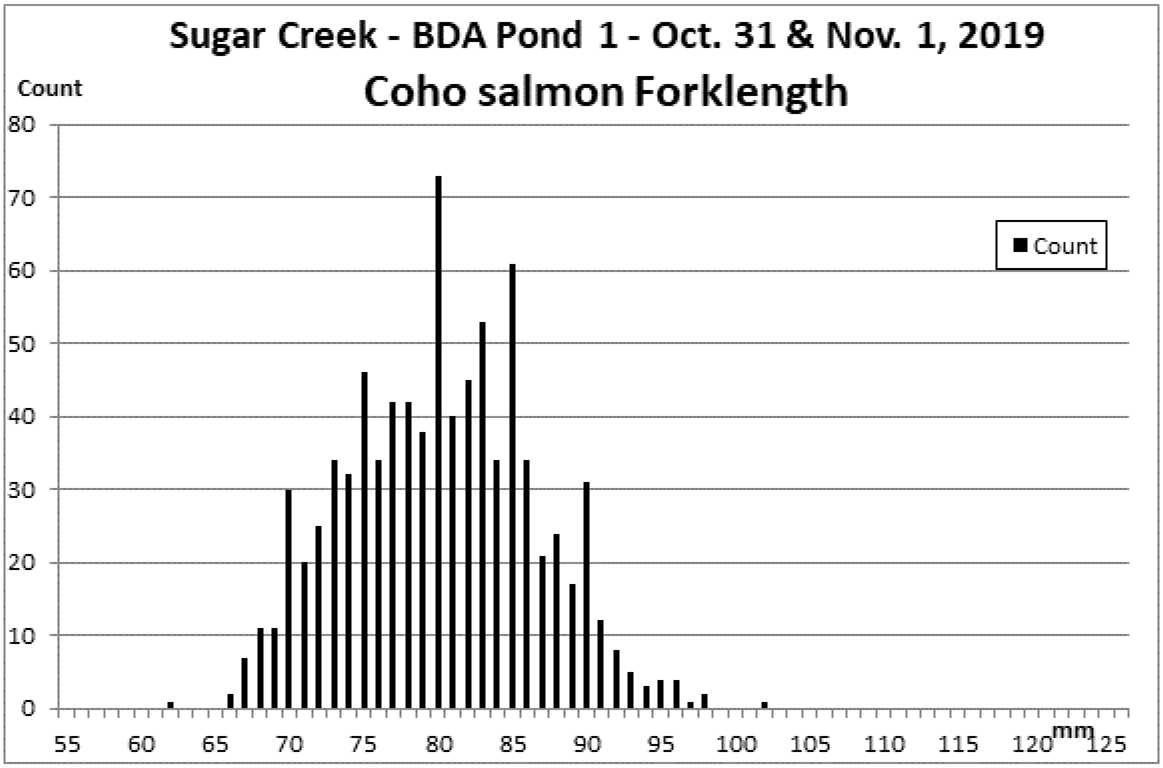


Figure 6 – Coho Salmon forklength (mm) histogram – BDA Pond 1 – Julian Week 44

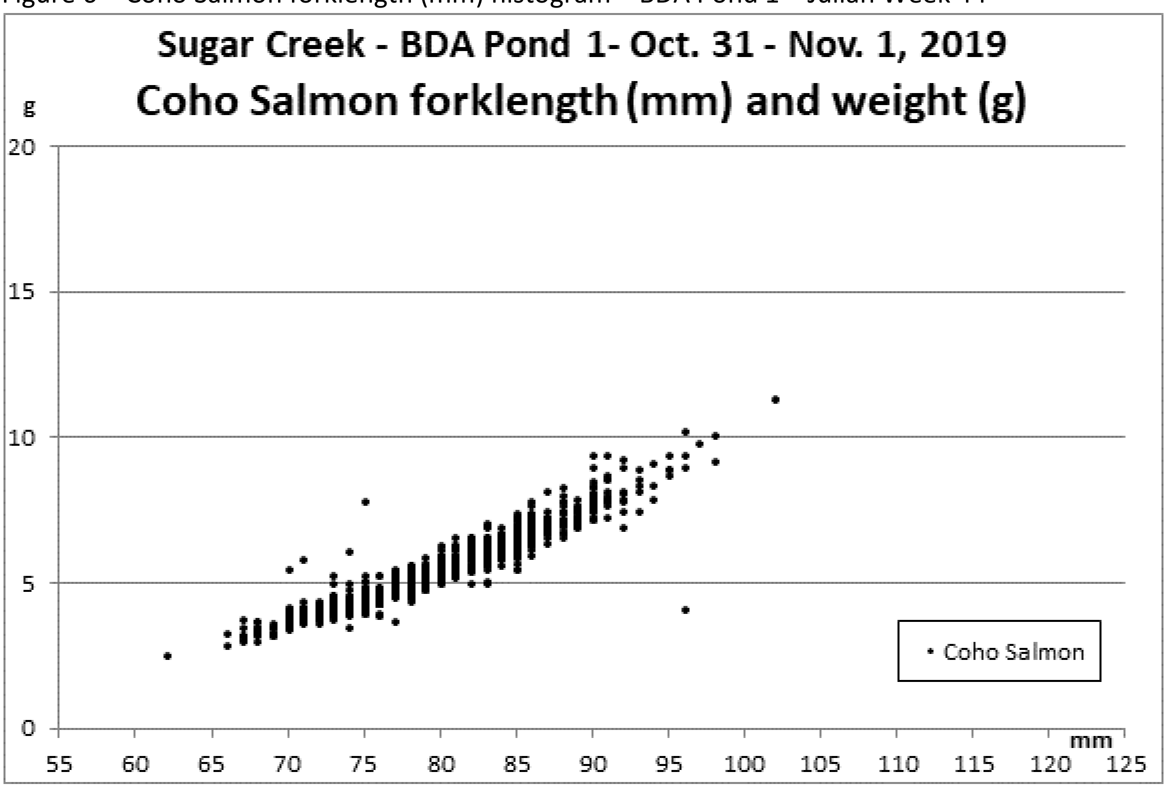


Figure 7 – Weight (g) versus forklength (mm) – Coho Salmon – BDA Pond 1 – Julian Week 44

			Coho Salmon			Rainbow Trout		
Date	Location	Gear	Total Catch	Marked	Recap	Total Catch	Marked	Recap
11/5/2019	Sugar Creek - BP2	Seine	234	151	35	0	0	0

Table 12 – Catch Summary – Sugar BP2 – Julian Week 45 (JW45)

Coho Salmon captured in Sugar BDA Pond 2 – 11/5/2019

Lower Sugar Creek – Beaver Dam Pond 2 – Looking downstream

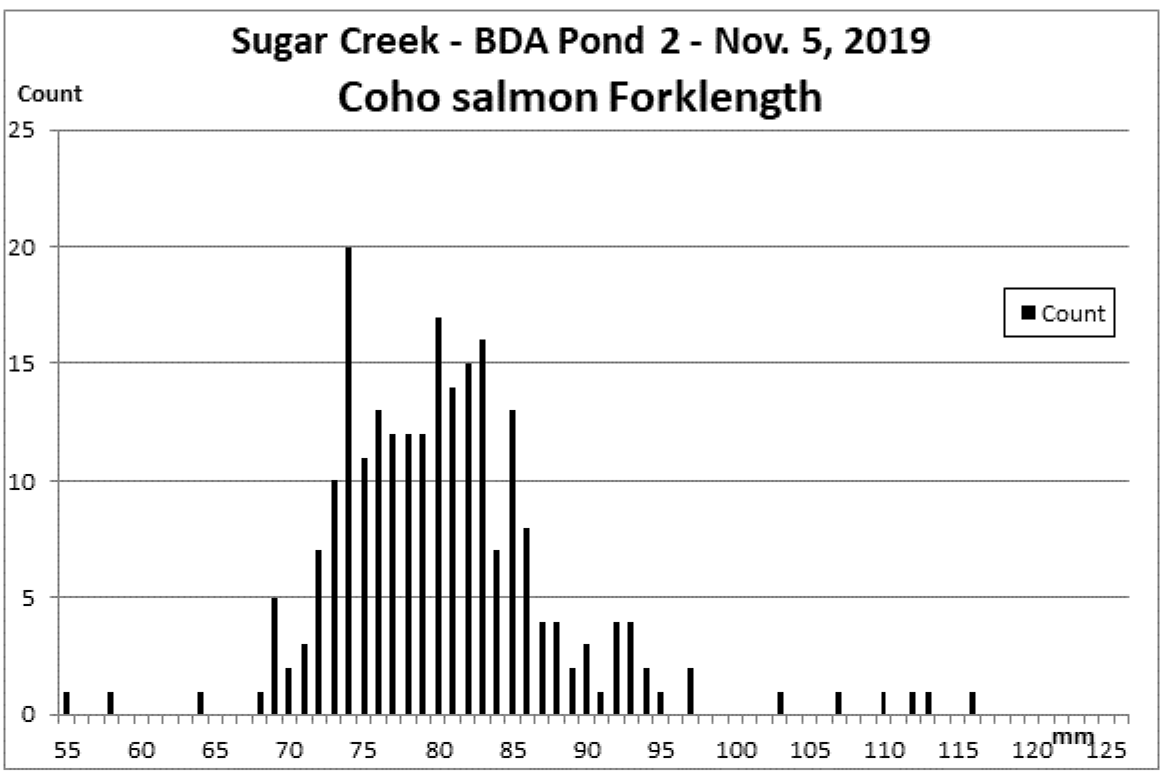


Figure 8 - Coho Salmon forklength (mm) histogram – BDA Pond 2 – Julian Week 45

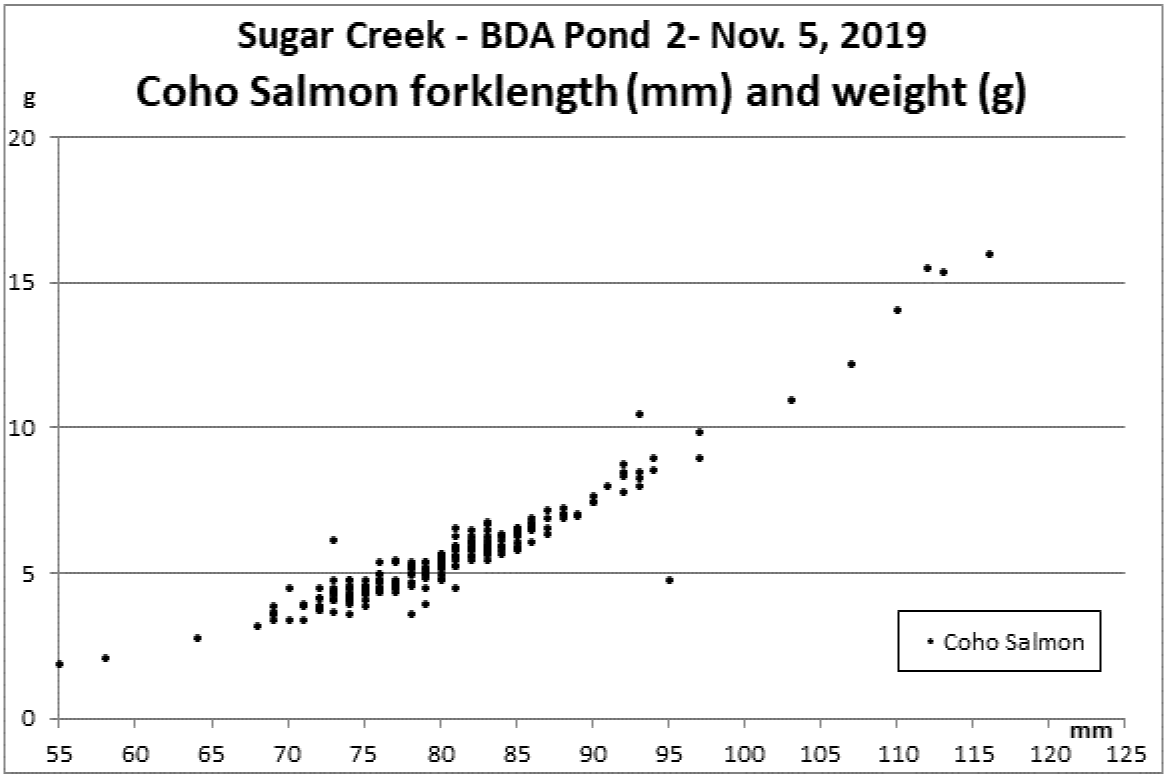
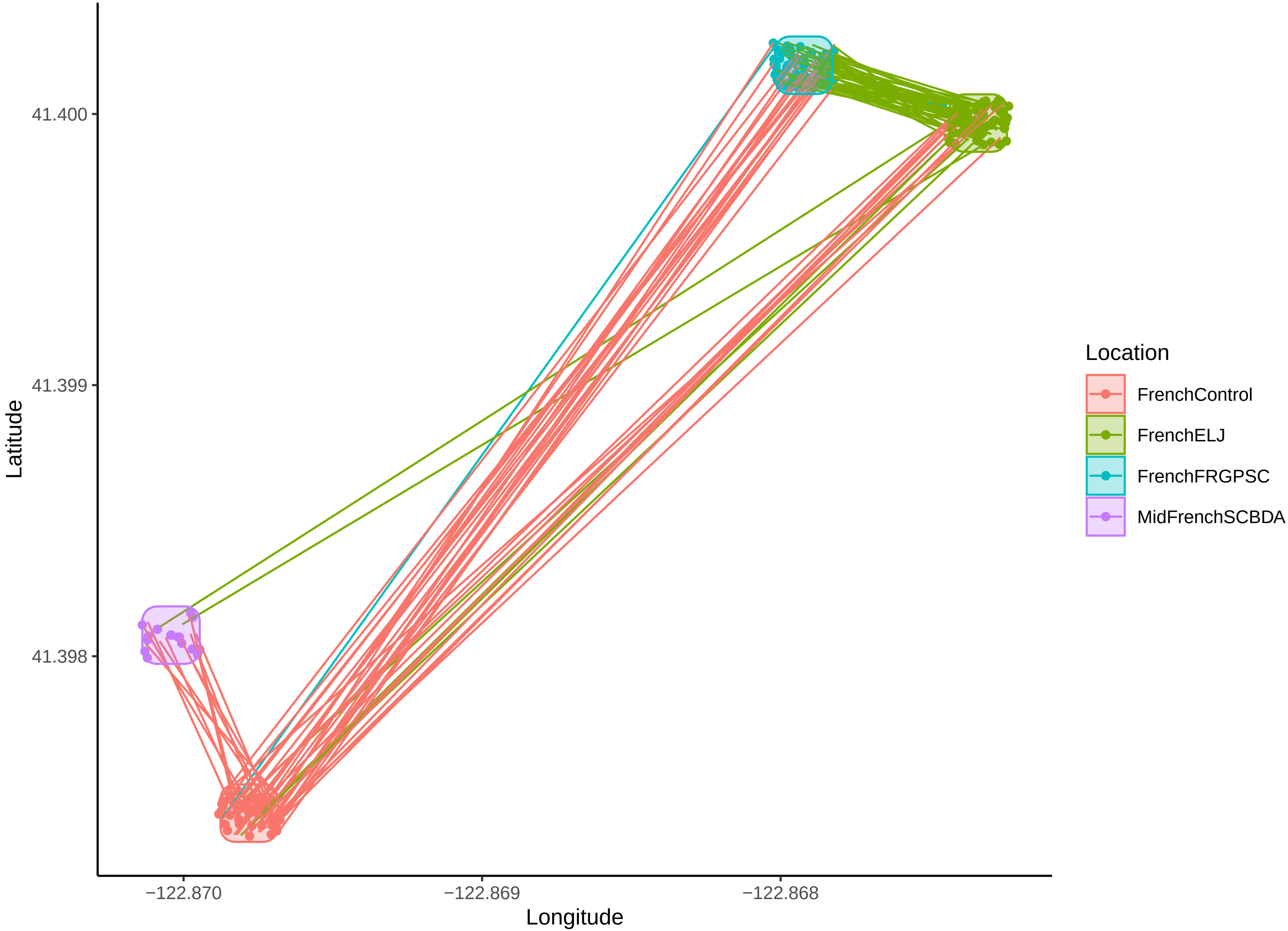


Figure 9 - Weight (g) versus forklength (mm) – Coho Salmon – BDA Pond 1 – Julian Week 44


41.400
41.399
41.398
Latitude
−122.870
−122.869
−122.868
Longitude
Location
FrenchControl
FrenchELJ
FrenchFRGPSC
MidFrenchSCBDA

Detection of movement of PIT tagged Coho Salmon – Sugar Creek Off Channel Pond
JW8 – JW10 - 2020

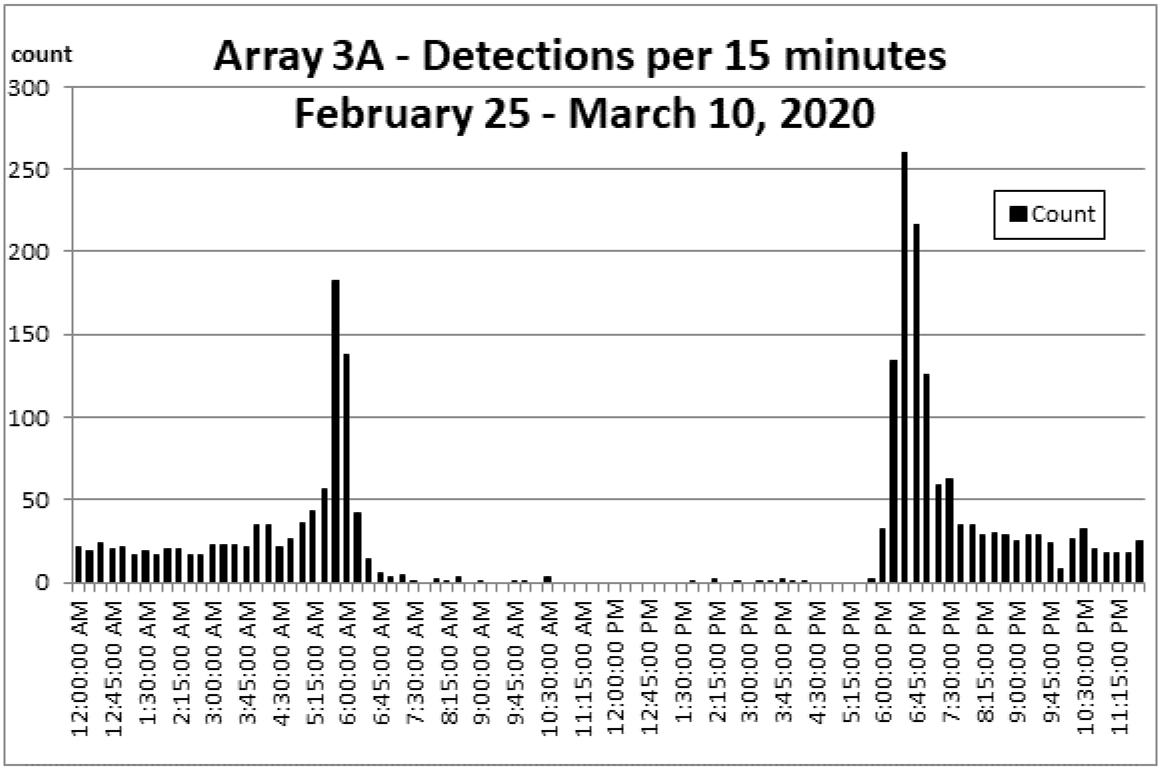


Figure 1 – Count of detections per 15 minute interval at Array 3A (Sugar OCP Channel -Upstream) – February 25 – March 10, 2020

Two PIT tag arrays at the inlet to the Sugar Creek Off Channel Pond (Sugar OCP) detected tagged Coho Salmon moving from and returning to the Sugar OCP. Analysis of the count of detections per 15 minute interval of the fourteen days of detections from February 25 to March 10, 2020 shows a significant increase in movement in the evening and early morning with little to no movement detected during the daylight hours (Figure 1).
Analysis of the detection data from both the upstream and downstream arrays (3A and 3B) of five PIT tagged Coho Salmon indicates that the fish are moving from the Sugar OCP downstream to the Sugar BDA Pond in the evening and returning in the next early morning (Table 1 – 5).

Analysis of the count of detections per 15 minute interval for March 9, 2020 indicates a period of movement downstream from the Sugar OCP in the evening with movement throughout and night and little to no movement during the daylight hours.

Time (seconds)	Direction	AM/PM	Date (PST)
-21	downstream	PM	2/25/2020 18:21
41	upstream	AM	2/26/2020 5:55
-17	downstream	PM	2/26/2020 18:31
101	upstream	AM	2/27/2020 5:47
-24	downstream	PM	2/27/2020 18:25
30	upstream	AM	2/28/2020 5:59
-41	downstream	PM	2/28/2020 18:44
24	upstream	AM	2/29/2020 5:54
-19	downstream	PM	2/29/2020 18:26
26	upstream	AM	3/1/2020 5:53
-40	downstream	PM	3/1/2020 18:29
87	upstream	AM	3/2/2020 4:37
-44	downstream	PM	3/2/2020 18:42
8	upstream	AM	3/3/2020 5:53
-29	downstream	PM	3/3/2020 18:45
29	upstream	AM	3/5/2020 5:51
-15	downstream	PM	3/5/2020 18:22
16	upstream	AM	3/6/2020 5:59
-36	downstream	PM	3/6/2020 18:31
16	upstream	AM	3/7/2020 6:04
-18	downstream	PM	3/7/2020 18:20
13	upstream	AM	3/8/2020 6:00
62	upstream	AM	3/8/2020 21:20
-43	downstream	PM	3/8/2020 21:26
29	upstream	AM	3/9/2020 2:53
-21	downstream	PM	3/9/2020 18:50
15	upstream	AM	3/10/2020 4:58

Table 1 - 989001028113391

Time (seconds)	Direction	AM/PM	Date (PST)
-20	downstream	PM	2/25/2020 18:11
55	upstream	AM	2/26/2020 4:00
-17	downstream	PM	2/26/2020 18:13
21	upstream	AM	2/27/2020 5:54
-15	downstream	PM	2/27/2020 18:02
18	upstream	AM	2/28/2020 4:07
-17	downstream	PM	2/28/2020 18:16
19	upstream	AM	2/29/2020 5:54
-15	downstream	PM	2/29/2020 18:11
87	upstream	AM	3/1/2020 5:51
-18	downstream	PM	3/1/2020 18:25
56	upstream	AM	3/2/2020 4:44
-19	downstream	PM	3/2/2020 18:30
2	upstream	AM	3/3/2020 6:16
-18	downstream	PM	3/3/2020 18:21
192	upstream	AM	3/4/2020 5:40
-16	downstream	PM	3/4/2020 18:19
41	upstream	AM	3/5/2020 5:50
-18	downstream	PM	3/5/2020 18:19
70	upstream	AM	3/6/2020 6:00
-19	downstream	PM	3/6/2020 18:20
29	upstream	AM	3/7/2020 6:05
-18	downstream	PM	3/7/2020 17:58
19	upstream	AM	3/8/2020 6:01
35	upstream	PM	3/8/2020 20:16
-61	downstream	PM	3/8/2020 20:44
82	upstream	PM	3/8/2020 22:44
-42	downstream	PM	3/8/2020 22:58
10	upstream	AM	3/9/2020 4:03
-28	downstream	PM	3/9/2020 18:32

Table 2 - 989001028113554

Time (seconds)	Direction	AM/PM	Date (PST)
-21	downstream	PM	2/25/2020 18:11
51	upstream	AM	2/26/2020 5:50
-14	downstream	PM	2/26/2020 18:13
18	upstream	AM	2/27/2020 5:38
-34	downstream	PM	2/27/2020 18:23
13	upstream	AM	2/28/2020 5:57
-91	downstream	PM	2/28/2020 18:24
30	upstream	AM	2/29/2020 5:44
-17	downstream	PM	2/29/2020 18:15
81	upstream	AM	3/1/2020 0:06
-46	downstream	AM	3/1/2020 0:44
36	upstream	AM	3/1/2020 4:19
-15	downstream	PM	3/1/2020 18:25
34	upstream	AM	3/2/2020 0:08
-14	downstream	PM	3/2/2020 18:27
49	upstream	PM	3/2/2020 23:11
-34	downstream	PM	3/3/2020 18:36
21	upstream	AM	3/4/2020 6:01
-38	downstream	PM	3/4/2020 18:35
30	upstream	AM	3/5/2020 0:45
-186	downstream	AM	3/5/2020 3:09
14	upstream	AM	3/5/2020 5:50
-16	downstream	PM	3/5/2020 18:06
39	upstream	AM	3/6/2020 5:53
-419	downstream	PM	3/6/2020 18:15
26	upstream	AM	3/7/2020 6:07
-49	downstream	PM	3/7/2020 18:19
12	upstream	AM	3/8/2020 6:05
-15	downstream	PM	3/8/2020 18:24
10	upstream	PM	3/8/2020 18:38
80	upstream	PM	3/8/2020 20:07
-26	downstream	PM	3/8/2020 20:33
8	upstream	PM	3/8/2020 20:42
-31	downstream	PM	3/8/2020 23:04
16	upstream	AM	3/9/2020 2:40
-201	downstream	PM	3/9/2020 18:33
18	upstream	AM	3/10/2020 2:37

Table 3 - 989001028113562

Time (seconds)	direction	am/pm	PST
-29	downstream	PM	2/25/2020 18:48
120	upstream	PM	2/25/2020 21:45
-21	downstream	PM	2/26/2020 18:45
46	upstream	AM	2/27/2020 1:44
-18	downstream	PM	2/27/2020 18:41
26	upstream	AM	2/28/2020 0:18
-23	downstream	PM	2/28/2020 18:48
31	upstream	AM	2/29/2020 3:19
-21	downstream	PM	2/29/2020 18:45
34	upstream	AM	3/1/2020 2:09
-39	downstream	PM	3/1/2020 19:15
35	upstream	PM	3/1/2020 21:22
-26	downstream	PM	3/2/2020 20:50
13	upstream	PM	3/2/2020 23:58
-29	downstream	PM	3/3/2020 19:29
24	upstream	AM	3/4/2020 2:07
3	upstream	AM	3/5/2020 0:38
-23	downstream	PM	3/5/2020 18:41
19	upstream	AM	3/6/2020 5:54
-32	downstream	PM	3/6/2020 18:59
11	upstream	AM	3/7/2020 6:02
-30	downstream	PM	3/7/2020 18:21
-19	downstream	PM	3/8/2020 18:43
1	upstream	PM	3/8/2020 21:50
-24	downstream	AM	3/9/2020 1:06
9	upstream	AM	3/9/2020 1:44
-20	downstream	PM	3/9/2020 18:50

Table 4 – 989001028113570

Time (seconds)	direction	am/pm	PST
-26	downstream	PM	2/25/2020 18:43
11	upstream	PM	2/26/2020 5:50
-19	downstream	PM	2/26/2020 18:38
13	upstream	AM	2/27/2020 5:45
-33	downstream	PM	2/27/2020 18:40
15	upstream	AM	2/28/2020 5:55
-39	downstream	PM	2/28/2020 18:39
10	upstream	AM	2/29/2020 5:58
-31	downstream	PM	2/29/2020 18:44
14	upstream	AM	3/1/2020 5:50
-29	downstream	PM	3/1/2020 18:44
17	upstream	AM	3/2/2020 5:07
-28	downstream	PM	3/2/2020 19:08
14	upstream	AM	3/3/2020 5:38
-23	downstream	PM	3/3/2020 18:49
6	upstream	AM	3/4/2020 5:52
-18	downstream	PM	3/4/2020 18:38
-2	downstream	AM	3/5/2020 0:28
-41	downstream	PM	3/5/2020 18:46
3	upstream	AM	3/6/2020 6:01
-25	downstream	PM	3/6/2020 18:41
4	upstream	AM	3/7/2020 6:12
-24	downstream	PM	3/7/2020 18:24
3	upstream	AM	3/8/2020 6:00
-39	downstream	PM	3/8/2020 18:55
10	upstream	PM	3/8/2020 20:32
-23	downstream	PM	3/8/2020 21:55
14	upstream	PM	3/8/2020 22:33
-25	downstream	AM	3/9/2020 0:15
5	upstream	AM	3/9/2020 1:30
-51	downstream	PM	3/9/2020 18:59
4	upstream	AM	3/10/2020 5:49

Table 5 – 989001028113584

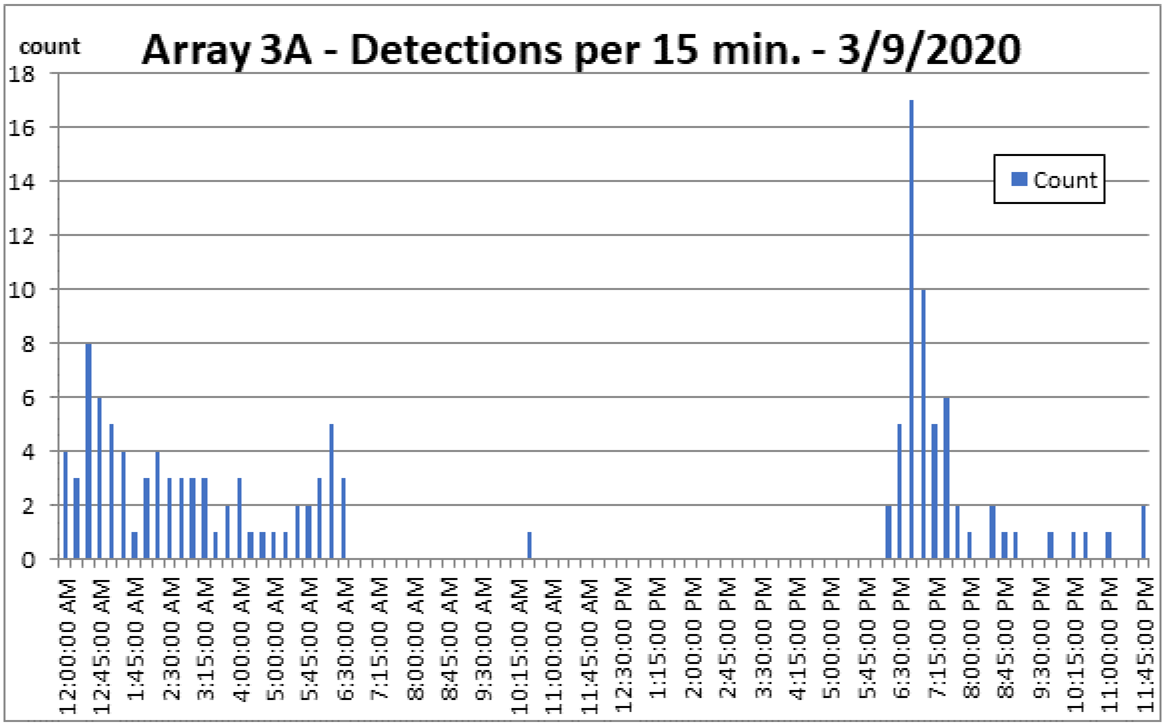


Figure 2 - Count of detections per 15 minute interval at Array 3A (Sugar OCP Channel -Upstream) – March 9, 2020

Scott River - PIT Tag Array Detection Data Summary – April 7 – 14, 2020 – Julian Week 14 – 15
Darrell Mitchell and Erich Yokel – Scott River Watershed Council

The PIT tag arrays operated by the Scott River Watershed Council were downloaded on April 14, 2020 a week after the previous download. The number of unique PIT tag detections at each array observed from April 7 – 14, 2020 are illustrated in Table 1. Map 1 illustrates the locations of the Sugar Creek arrays.

One Week PIT Tag Detection Summary - JW 14 - 15

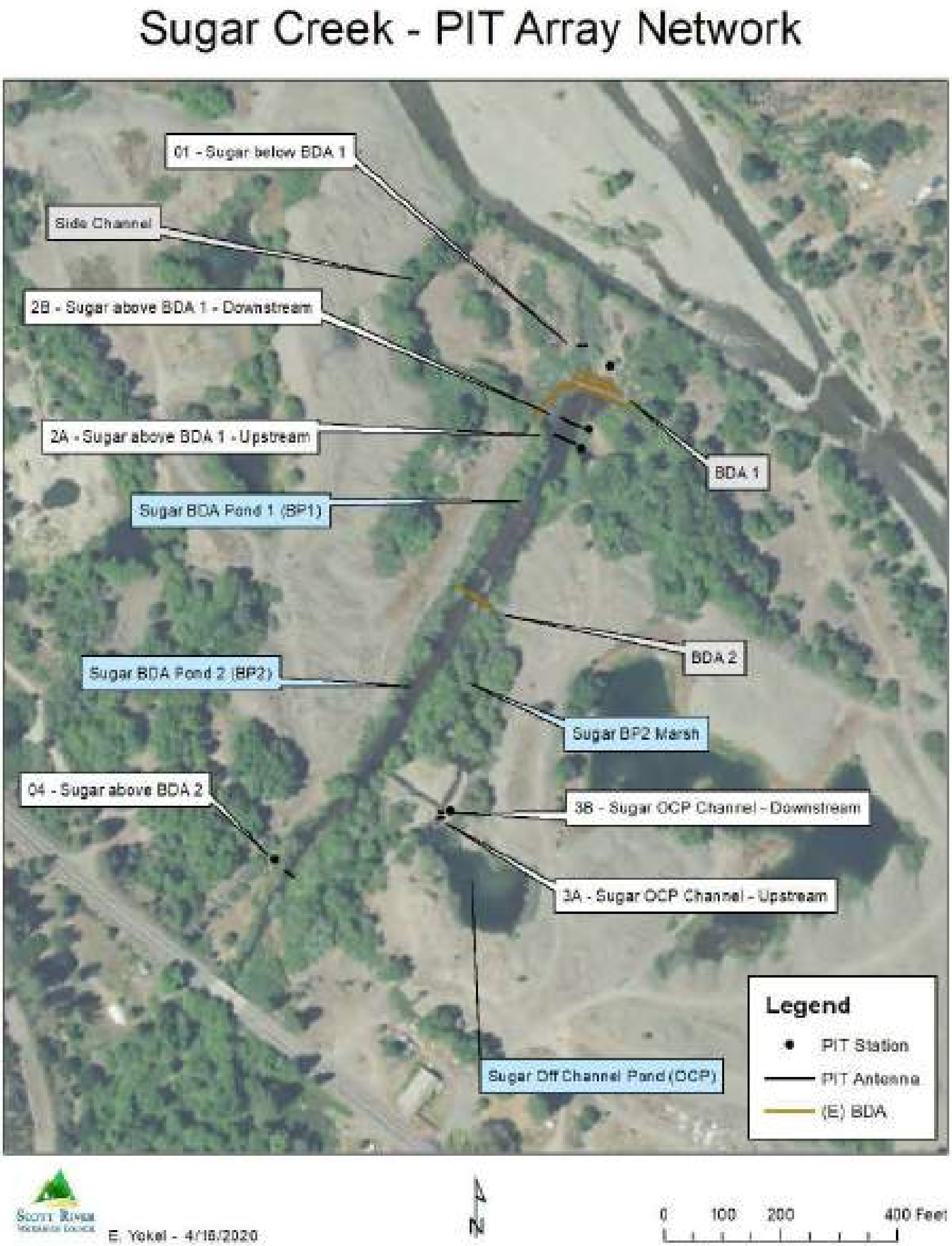
		Date		
Array _ID		**Start**	**End**	**# Unique detections**
1	Sugar below BP1	4/7/2020	4/14/2020	195
2A	Sugar BP1 - US	4/7/2020	4/14/2020	648
2B	Sugar BP1 - DS	4/7/2020	4/14/2020	775
3A	Sugar OCP Channel - US	4/7/2020	4/14/2020	189
3B	Sugar OCP Channel - DS	4/7/2020	4/14/2020	193
04	Sugar BP2 - US	4/7/2020	4/14/2020	141
10	Mid French RKM 2.9 - US	4/7/2020	4/14/2020	47
11	Mid French RKM 2.9 - DS	4/7/2020	4/14/2020	65
12	French FRGP SC Outlet - US	4/7/2020	4/14/2020	100
15	French FRGP SC Outlet - DS	4/7/2020	4/14/2020	62
14	French SC BDA Pond 1	4/7/2020	4/14/2020	31
30	Scott R. - Alexander Pond	4/7/2020	4/14/2020	18

Table 1 – Number of Unique PIT tag detections by array – April 7 – 14, 2020

A significant increase in the unique detections observed at the array on the primary channel of Sugar Creek below the BDA 1 complex was observed during the period of April 7 – 14, 2020 (Table 2). 190 of the 195 PIT tagged fish (97%) were detected a single time - indicative of out migration.

	Date		
Array _ID	**Start**	**End**	**# Unique detections**
1	12/3/2019	12/13/2019	17
1	12/13/2019	12/31/2019	4
1	12/31/2020	1/13/2020	1
1	1/13/2020	1/28/2020	9
1	1/28/2020	2/7/2020	2
1	2/7/2020	2/25/2020	0
1	2/25/2020	3/10/2020	2
1	3/10/2020	3/24/2020	4
1	3/24/2020	4/7/2020	9
1	4/7/2020	4/14/2020	195

Table 2 – Number of Unique detections per period of download – Sugar Creek below BDA 1



Map 1 – Location of Sugar Creek PIT Arrays and fish sample habitat units

The unique detections on the paired arrays at the outlet of the Sugar OCP increased compared to the previous week's downloads (Table 3 & 4). Further analysis of the data is necessary to determine if the detected fish are still rearing in the Sugar BP2 and Sugar OCP habitats at the time of download. It is hypothesized that this data is indicative of tagged fish that have not out migrated at time of download.

	Date		
Array _ID	Start	End	# Unique detections
3A	12/3/2019	12/13/2019	61
3A	12/13/2019	12/31/2019	66
3A	12/31/2020	1/13/2020	95
3A	1/13/2020	1/28/2020	177
3A	1/28/2020	2/7/2020	170
3A	2/7/2020	2/25/2020	144
3A	2/25/2020	3/10/2020	181
3A	3/10/2020	3/24/2020	139
3A	3/24/2020	4/7/2020	149
3A	4/7/2020	4/14/2020	189

Table 3 - Number of Unique detections per period of download – Sugar OCP Channel - Upstream

	Date		
Array _ID	Start	End	# Unique detections
3B	12/3/2019	12/13/2019	61
3B	12/13/2019	12/31/2019	70
3B	12/31/2020	1/13/2020	97
3B	1/13/2020	1/28/2020	175
3B	1/28/2020	2/7/2020	174
3B	2/7/2020	2/25/2020	140
3B	2/25/2020	3/10/2020	176
3B	3/10/2020	3/24/2020	133
3B	3/24/2020	4/7/2020	150
3B	4/7/2020	4/14/2020	193

Table 4 - Number of Unique detections per period of download – Sugar OCP Channel – Downstream

Analysis of the sample habitat units (e.g. the habitat in which the fish were captured and released when first marked) of the unique PIT tagged fish detected in Sugar Creek below BDA 1 (Array 01), the Sugar BDA Pond 1 (BP1) below Sugar Creek BDA 2 (Array 2A & 2B) and in the Alexander Pond in the Scott River Tailings below Sugar Creek (Array 30) indicates that the majority of fish were captured and returned to Sugar BP1 (Table 5). 639 Coho Salmon were marked and returned to habitats above Sugar Creek BDA 2.

Unique Detections at Lower Sugar Creek PIT Arrays and Scott Tailings - JW 14 - 15

Array #	Station Location	Number of Unique Detections	Coho Salmon marked in Sugar BP1	Coho Salmon marked above Sugar BDA 2
01	Sugar below BDA 1	195	174	20
2a & 2b Combined	Sugar BP1	791	753	31
30	Alexander Pond - Scott River Tailings	18	16	2

Table 5 – Number of unique detections at arrays below Sugar BDA 2 and array at Scott Tailings Pond and habitat of marked Coho Salmon detected

Of the 791 unique PIT tags detected in Sugar BP1 (Array 2A & 2B combined) 31 Coho Salmon were captured and returned in sample habitat units above Sugar BDA 2 with 23 from Sugar BP2, 3 from the Sugar BP2 Marsh and 5 from the Sugar Control reach (RKM 0.8 – 1.0).

The origin of the 20 Coho Salmon captured in sample habitat units above Sugar BDA 2 and detected on the array below Sugar BDA 1 (Array 01) is 14 from Sugar BP2, 2 from the Sugar BP2 Marsh and 4 from the Sugar Control reach (RKM 0.8 – 1.0).

It is of note that of the 20 Coho Salmon from above BDA 2 detected at the array below Sugar BDA 1 (Array 01) only 18 were detected on the Sugar BP1 Arrays (Array 2A & 2B combined). This indicates that the Sugar BP1 Arrays are not detecting all tagged fish moving through the BP1 habitat.

Eighteen (18) unique PIT tagged Coho Salmon that were detected at the Alexander Pond - Scott River Tailings RKM 85.6 (Array 30) all of which were tagged in Sugar Creek sample habitat units (Table 5). Only six of these fish were detected at the array on the primary channel of Sugar Creek below BDA 1 (Array 01) during the period of April 7 – 14, 2020. From this observation, it is hypothesized that a significant number of fish are out migrating from Sugar BP1 via the side channel that is not monitored with a PIT array.

Fisheries

Juvenile Coho Salmon – Miners Creek above BDAs – June 17, 2020

Picture 2 – Coho Salmon captured in Miners Creek above BDAs – July 29, 2020

Picture 1 – Coho Salmon captured in Miners Creek above BDAs – October 12, 2020

Coho Salmon - Average forklength (mm)

Date	6/17/2020	7/29/2020	10/12/2020
Site	Miners Creek above BDAs	Miners Creek above BDAs	Miners Creek above BDAs
Average	41	54	53
Stand. Dev.	4.4	8.4	8.0
Minimum	36	39	39
Maximum	50	80	76
Count	48	256	158

Table 1 – Average forklength of sampled Coho Salmon – Miners Creek above BDAs

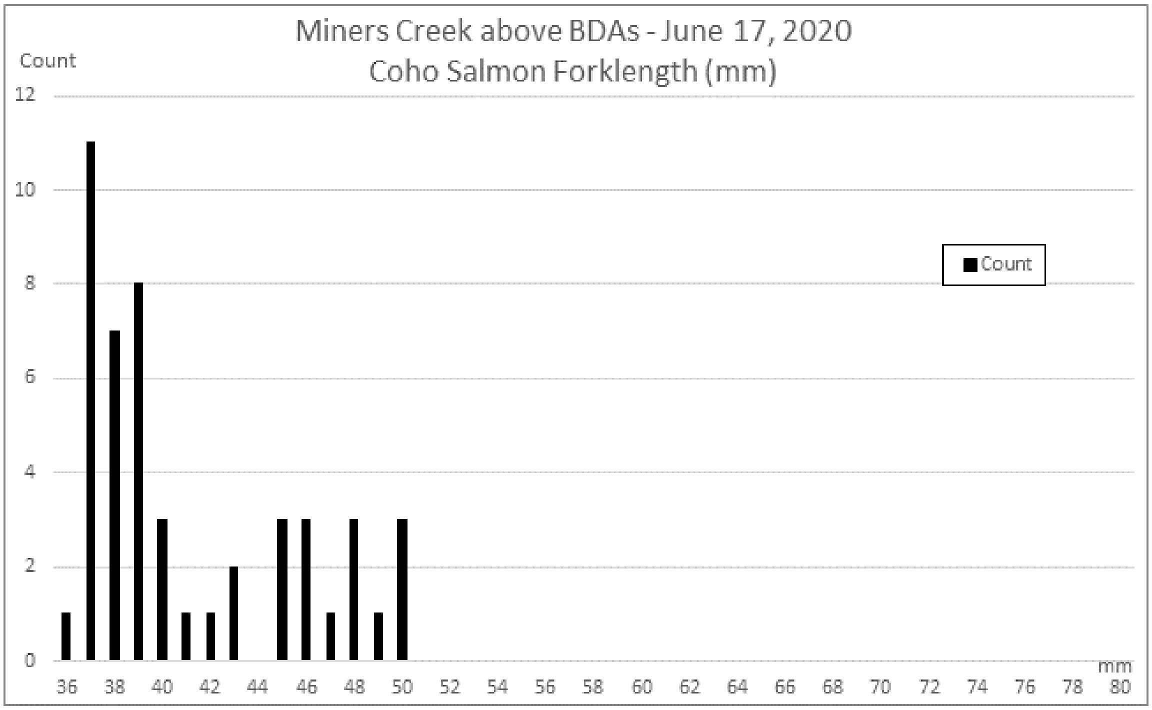


Figure xx – Coho Salmon forklength (mm) histogram – June 17, 2020

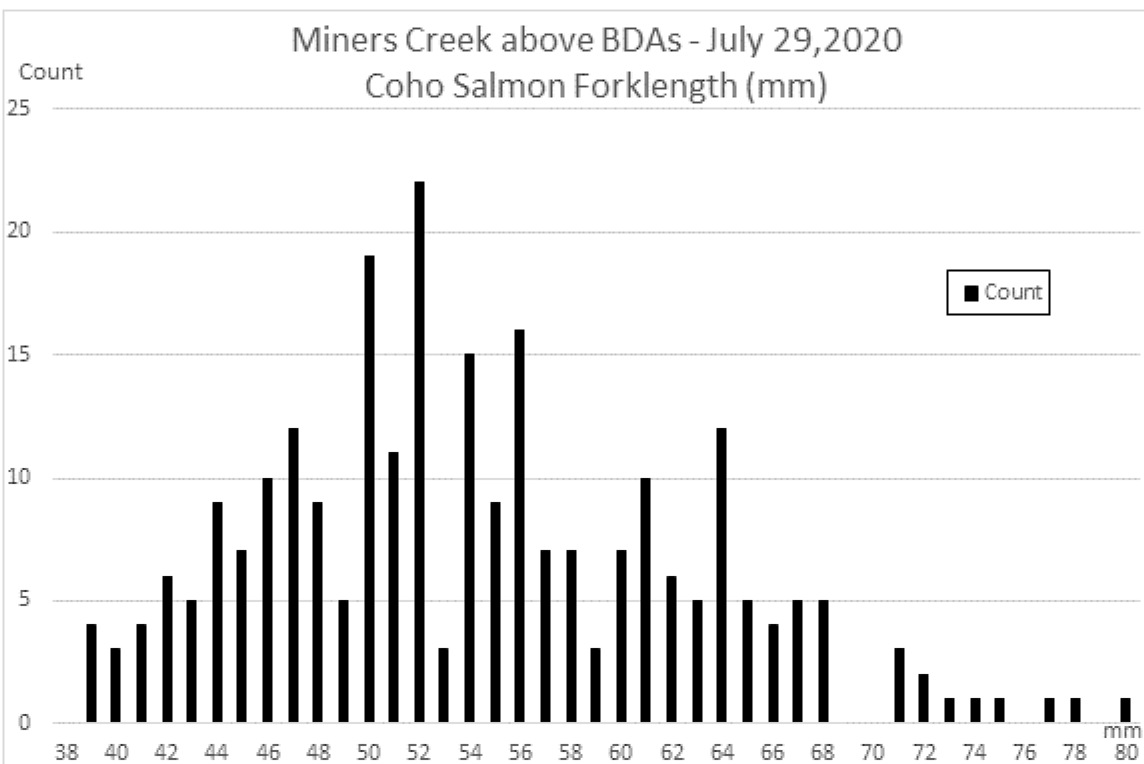


Figure xx – Coho Salmon forklength (mm) histogram – July 29, 2020

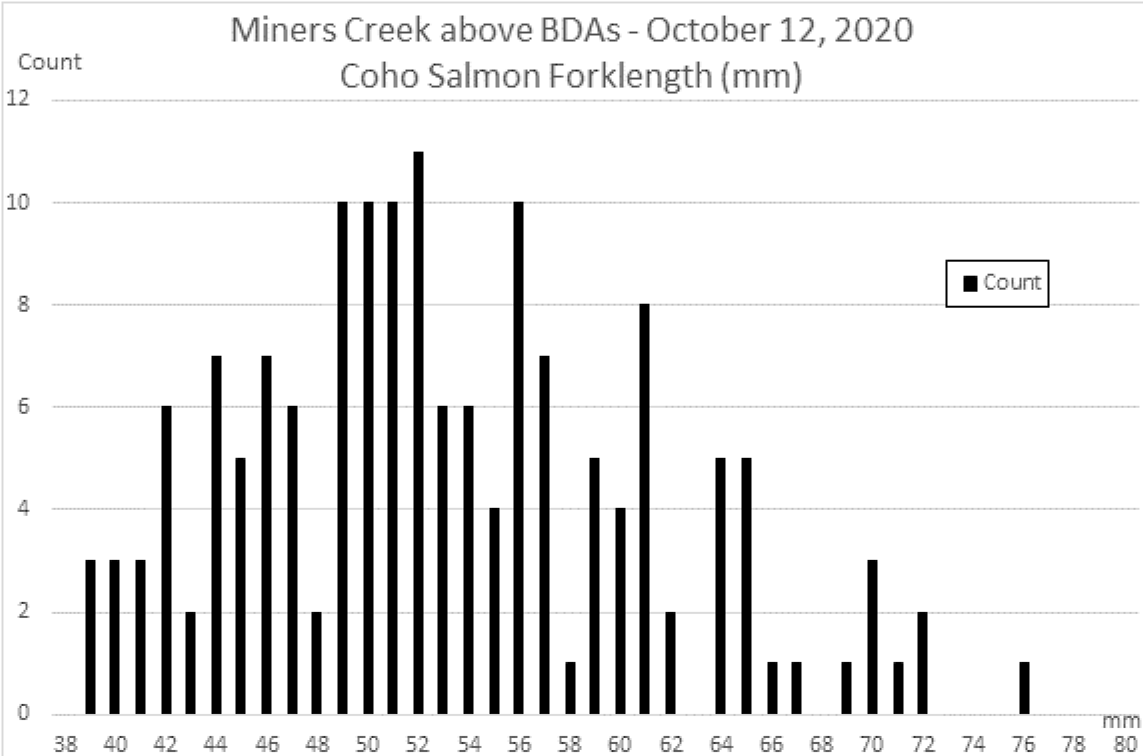


Figure xx – Coho Salmon forklength (mm) histogram – October 12, 2020

FISH SAMPLING SUMMARY

July 2020




SCOTT RIVER WATERSHED COUNCIL
Prepared by Monica Tonty

Photos clockwise from top left: 1+ coho salmon captured in French Creek Control Pools, 0+coho salmon captured in French Creek Control Pools, crew working up fish in French Creek Control Pools, coho salmon swimming in Sugar Creek BDA Pond 1

Contents

All Sites

Table 1. Catch summary by sample unit for all sites sampled between 7/24/2020-7/30/2020. French FRGP Side Channel and French SC BDA site were not sampled due to high water temperatures. Sugar BP2 and Sugar control were not sampled due to no coho salmon observations during snorkel reconnaissance surveys.

		Coho Salmon *(O. kisutch)*			Rainbow Trout *(O. mykiss)*		
Date	Sample Unit	Total Catch	Marked	Recap	Total Catch	Marked	Recap
7/24/2020	Sugar BDA Pond 1	370	165	1	93	0	0
7/24/2020	Scott River above Sugar Creek	58	14	0	11	0	0
7/27/2020	French Creek Control Pools 1-3	388	145	0	83	0	0
7/28/2020	French Engineered Log Jams (ELJs)	617	135	1	84	0	0
7/29/2020	Miners Creek above BDAs	256	30	0	3	0	0
7/29/2020	Miners Creek above French Creek	52	39	0	1	0	0
7/29/2020	French Creek below Miners Creek	134	59	0	4	0	0
7/30/2020	French Creek Control Pool 4	188	59	13	9	0	0
7/30/2020	French Creek Wood/Gravel Side Channel	2	0	0	0	0	0
	Totals	2065	646	15	288	0	0

Table 2. Average Coho Salmon fork length in Sugar BDA pond 1 and French ELJs on 7/7/2020 – Julian week 32. No fish were tagged in this effort.

Date	7/7/2020	7/7/2020
Site	Sugar BP1	French ELJs
Average	61.35	57.48
SD	4.78	6.99
Min	52	42
Max	71	101
Count	31	103

Table 3. Average Coho Salmon fork length in all sites sampled between 7/24/2020-7/30/2020 – Julian week 34-35

Date	7/24/20		7/27-7/30/20	7/28/20	7/29/20				
Site	Sugar BP1	Scott above Sugar	French Control	French ELJs	French below Miners	Miners above French	Miners above BDAs P1	Miners above BDAs P2	Miners above BDAs P3
Avg	68.02	61.67	65.11	61.7	66.01	70.13	58.12	52	48.65
SD	8.91	5.87	9.95	5.51	7.43	10.68	8.06	5.55	6.75
Min	49	39	44	47	52	56	41	39	39
Max	110	79	118	85	95	107	80	64	74
Count	326	58	576	617	134	52	132	52	72

Sugar Creek

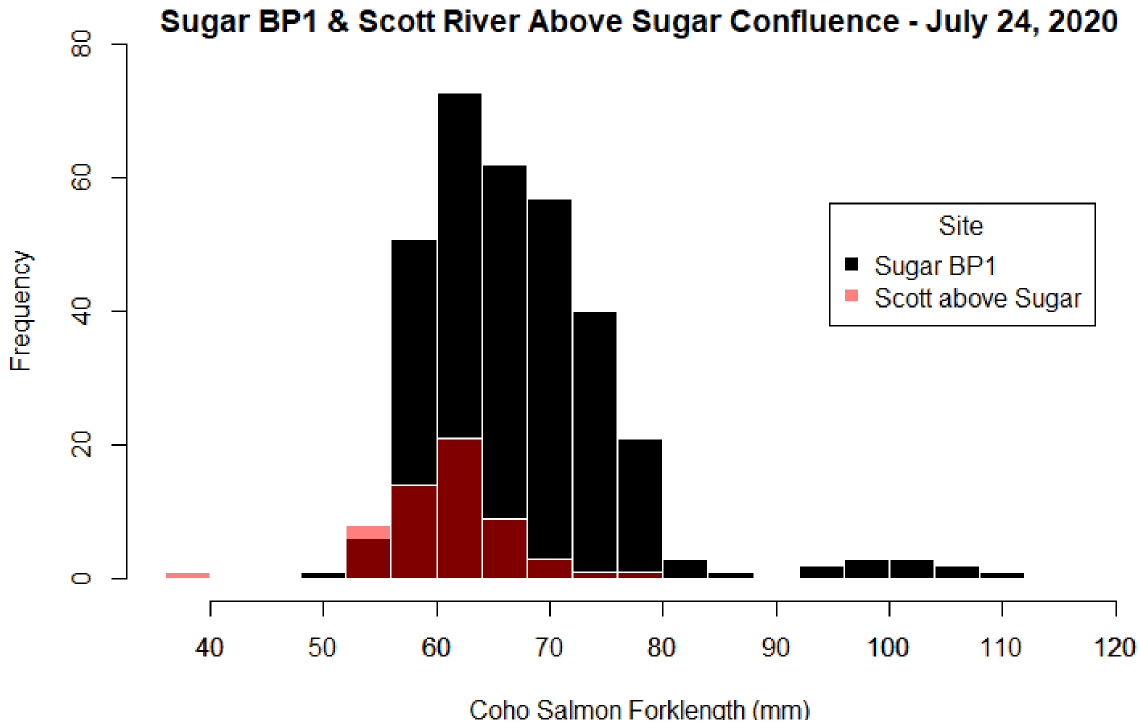


Figure 1. Forklength (mm) histograms of Coho Salmon captured in the Sugar Creek BDA Pond 1 compared to Coho Salmon captured in the Scott River above the Sugar confluence on July 24, 2020.

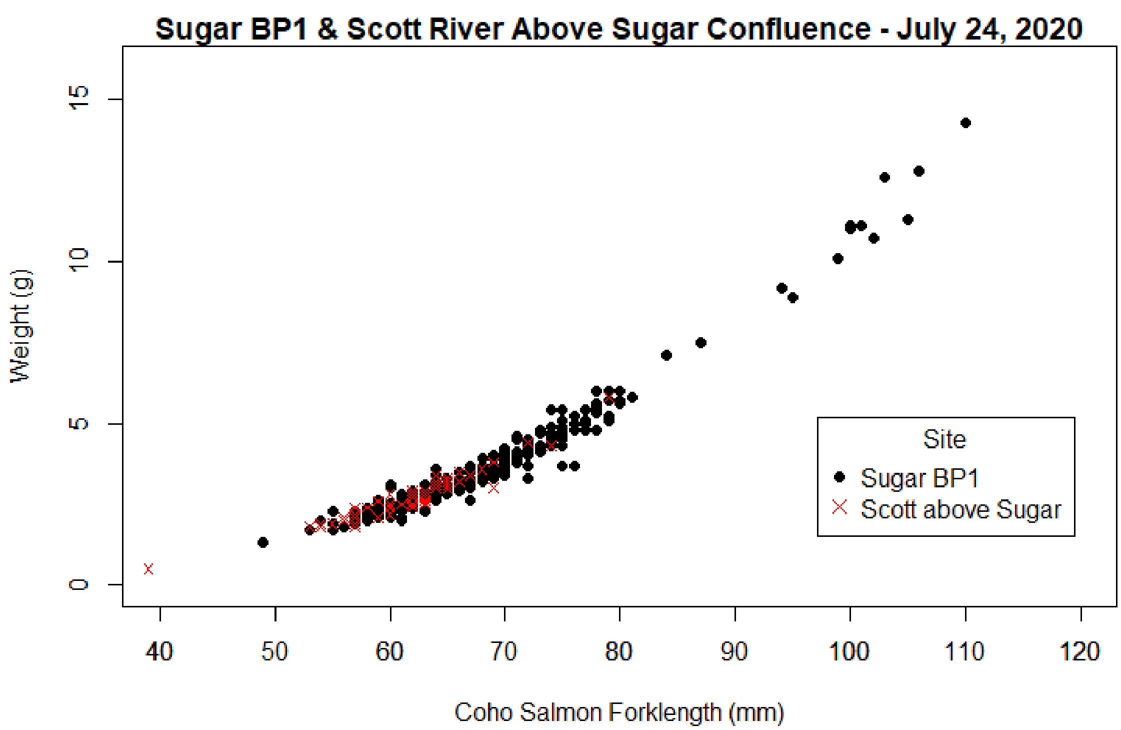


Figure 2. Weight (g) versus forklength (mm) of Coho Salmon captured in the Sugar Creek BDA Pond 1 compared to Coho Salmon captured in the Scott River above the Sugar confluence on July 24, 2020.

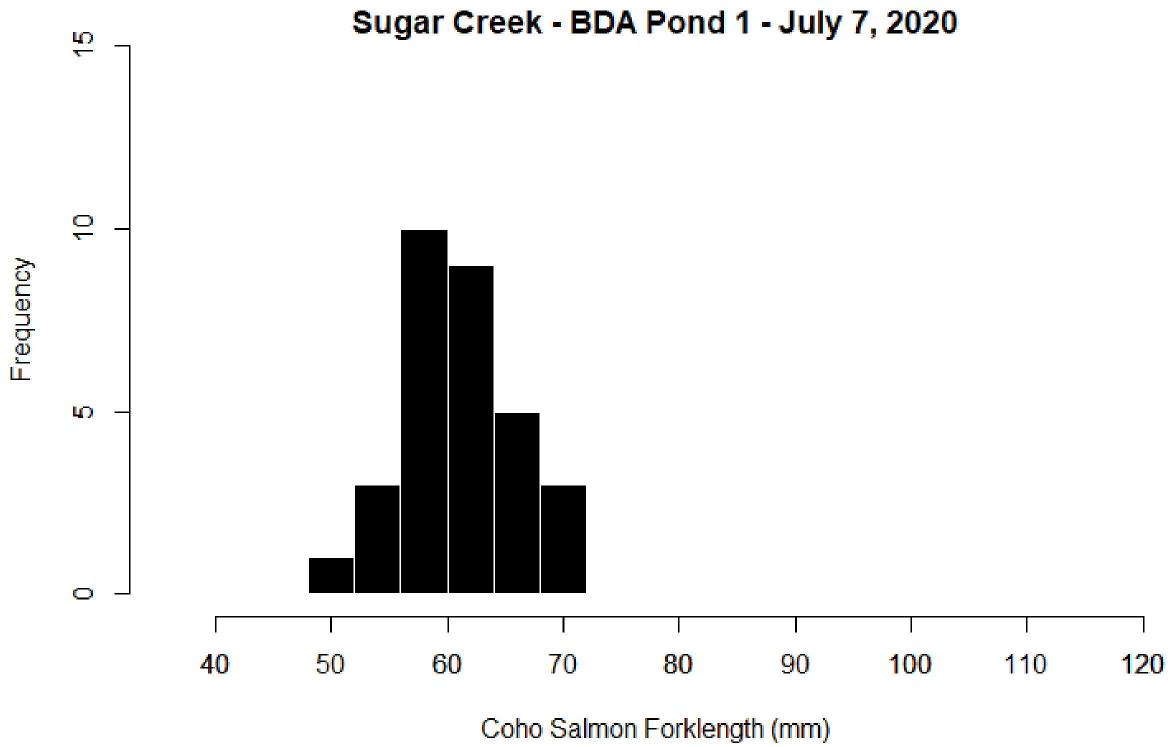


Figure 3. Coho Salmon forklength (mm) histogram – Sugar BDA Pond 1 – July 7, 2020 - Julian Week 28

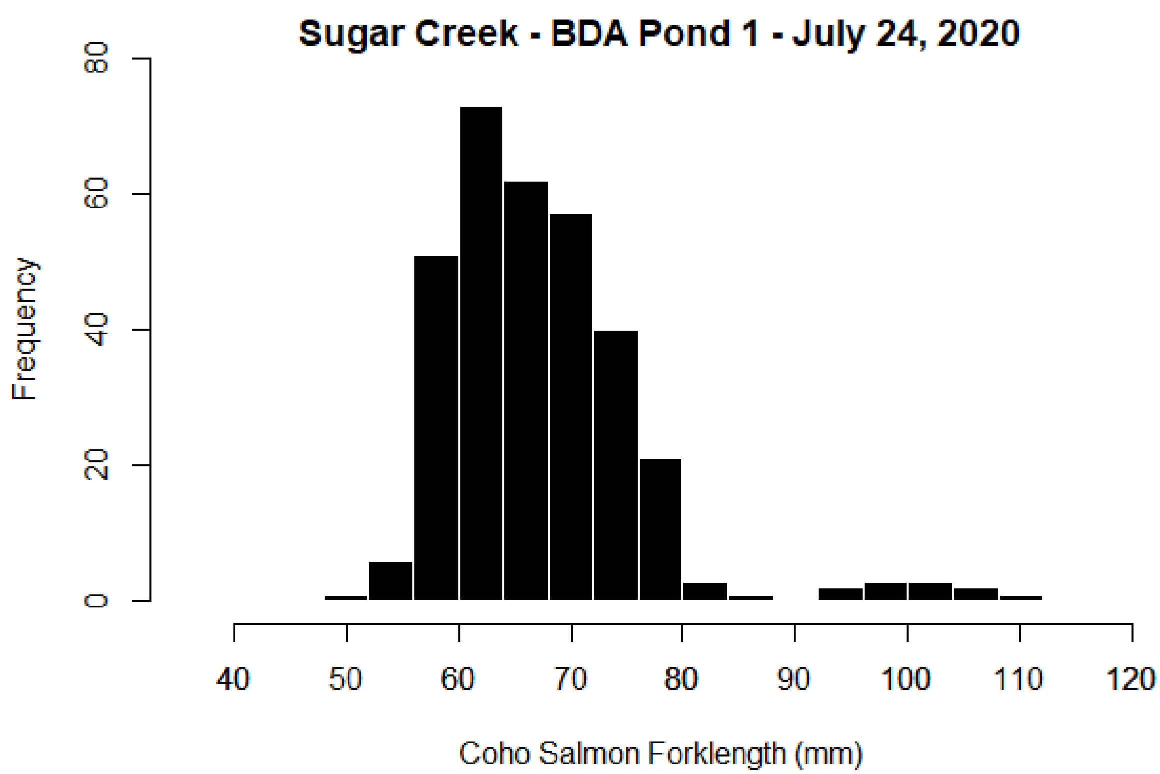


Figure 4. Coho Salmon forklength (mm) histogram – Sugar BDA Pond 1 – July 24, 2020 - Julian Week 30

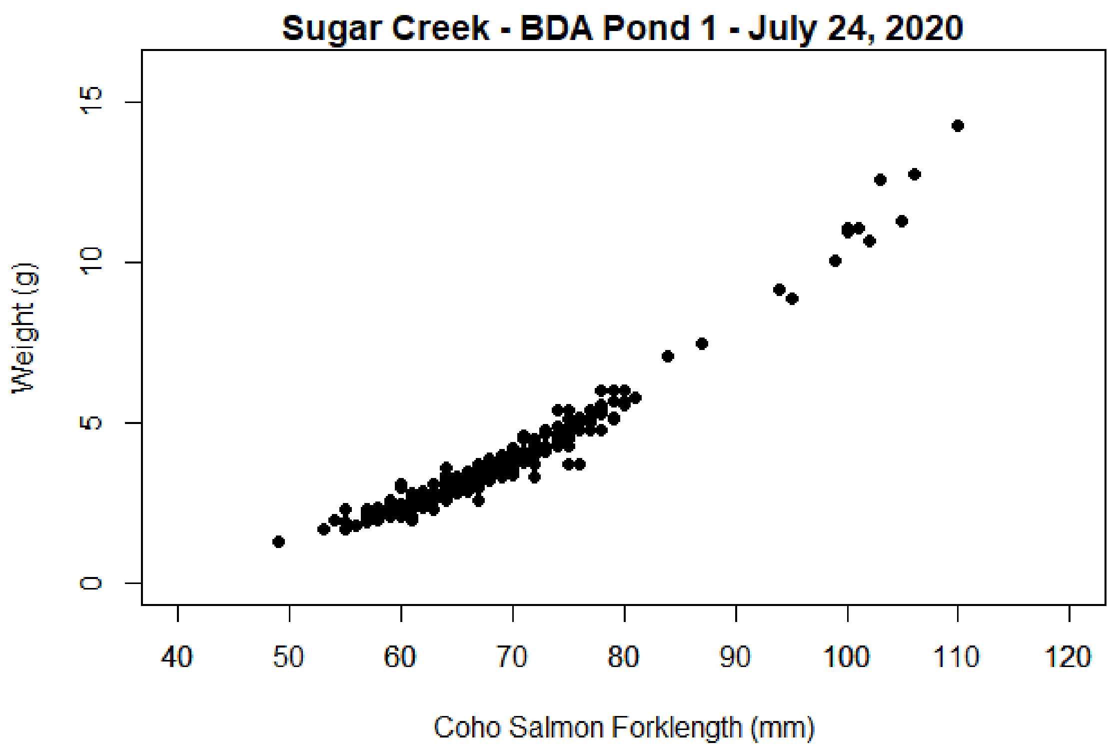


Figure 5. Coho Salmon weight (g) versus forklength (mm) – Sugar Creek BDA Pond 1 –July 24, 2020 - Julian Week 30

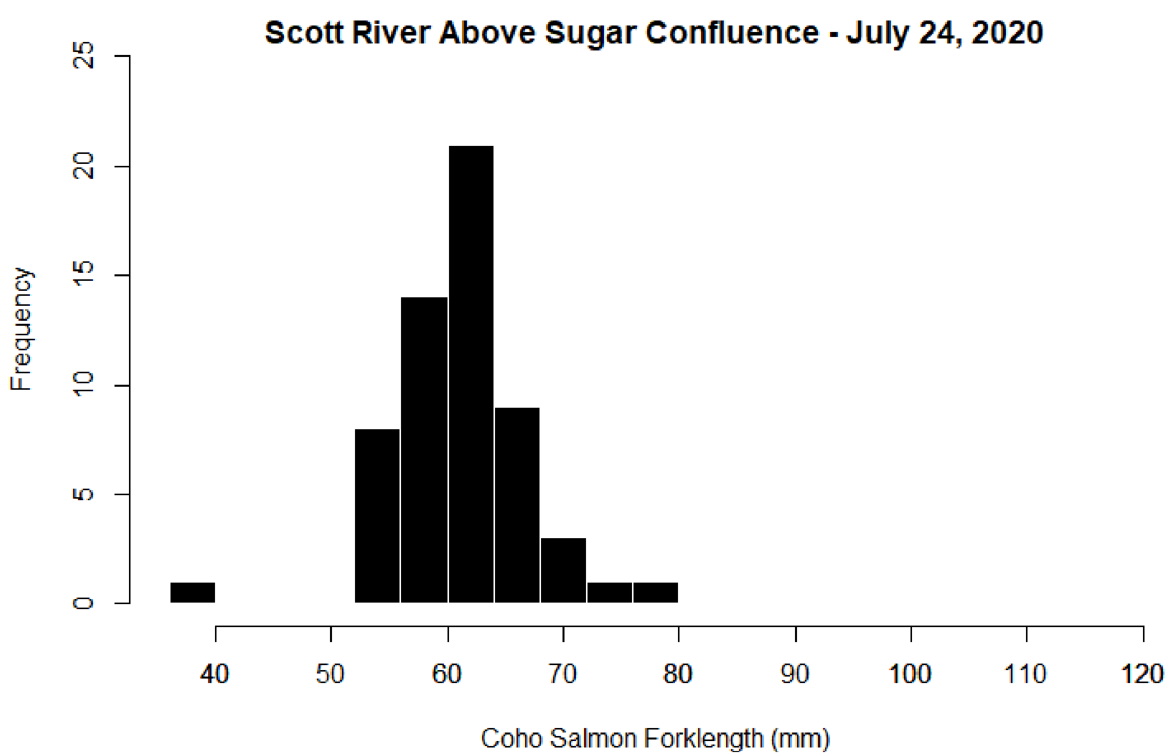


Figure 6. Coho Salmon forklength (mm) histogram –Scott River above Sugar Creek Confluence– July 24, 2020 - Julian Week 30

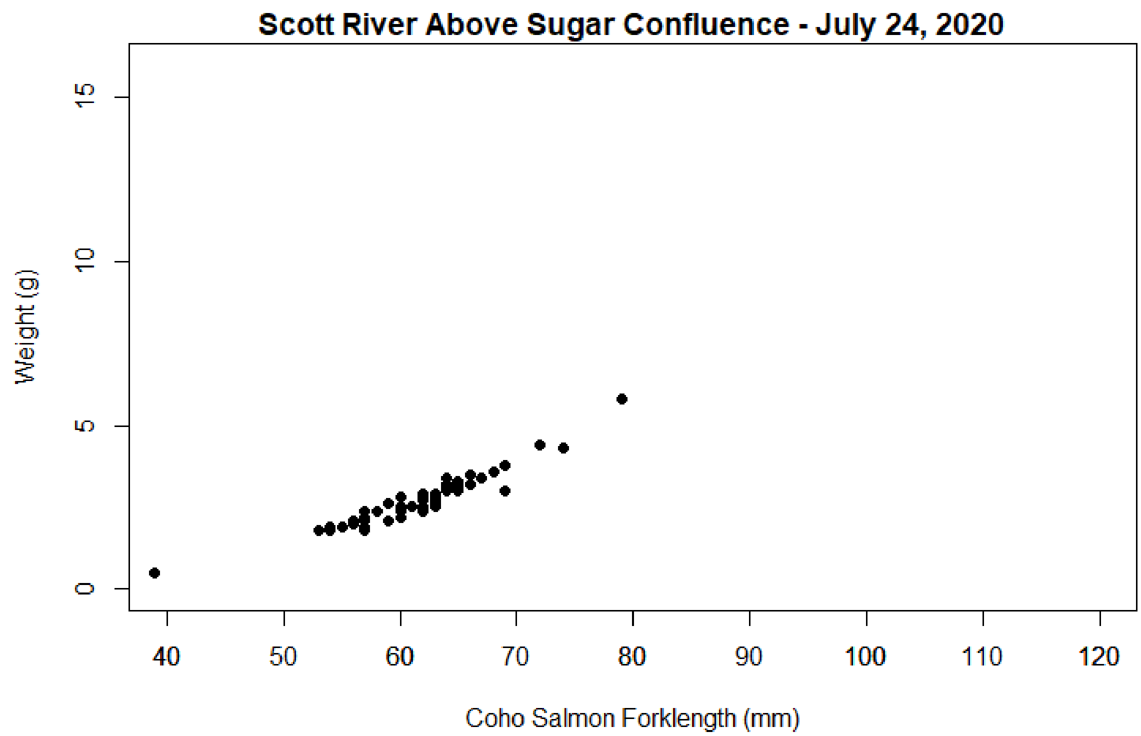


Figure 7. Coho Salmon weight (g) versus forklength (mm) –Scott River above Sugar Creek Confluence– July 24, 2020 - Julian Week 30

French Creek

0+ and 1+ Coho Salmon – French Creek Control Pools

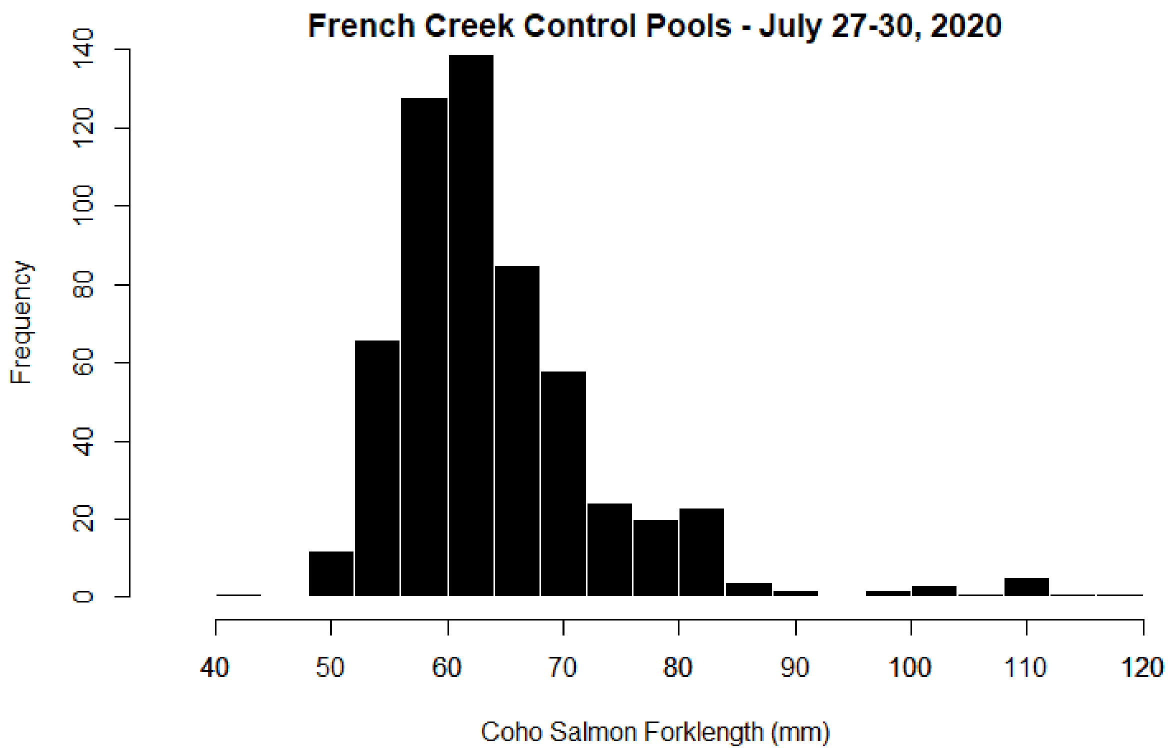


Figure 8. Coho Salmon forklength (mm) histogram – French Creek Control Pools 1-3 sampled on July 27, 2020 and Pool 4 sampled on July 30, 2020 - Julian Week 31.

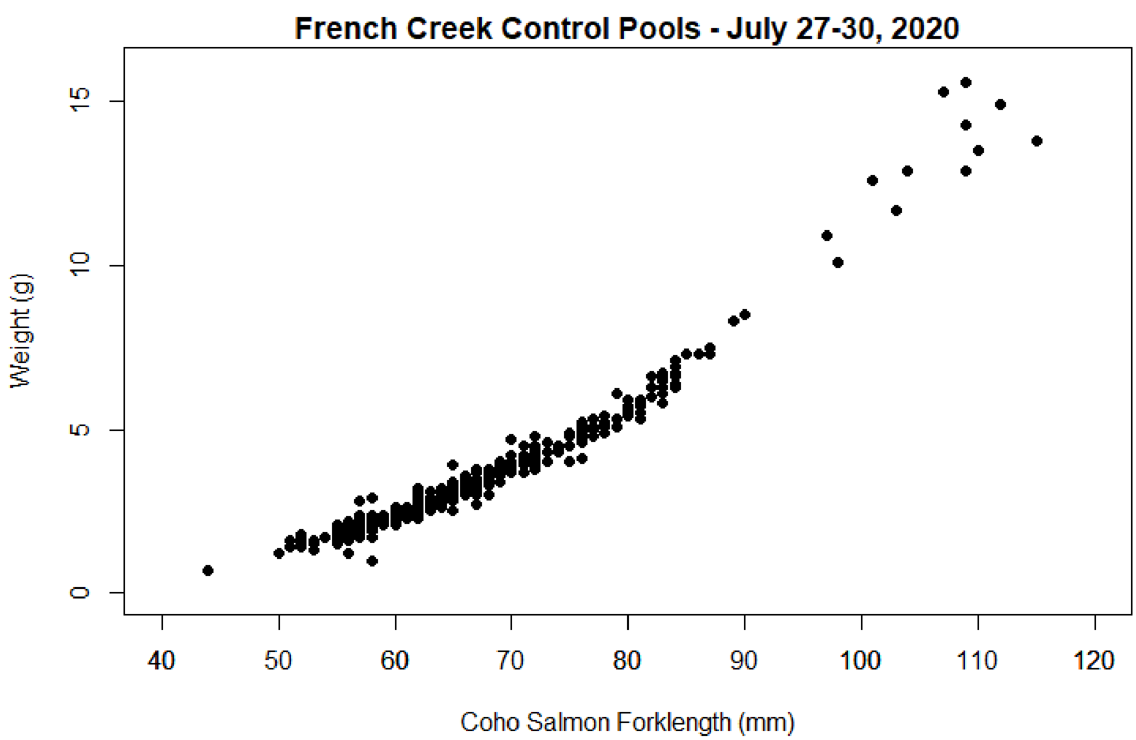


Figure 9. Coho Salmon weight (g) versus forklength (mm) – French Creek Control Pools 1-3 sampled on July 27, 2020 and Pool 4 sampled on July 30, 2020 – Julian Week 31.

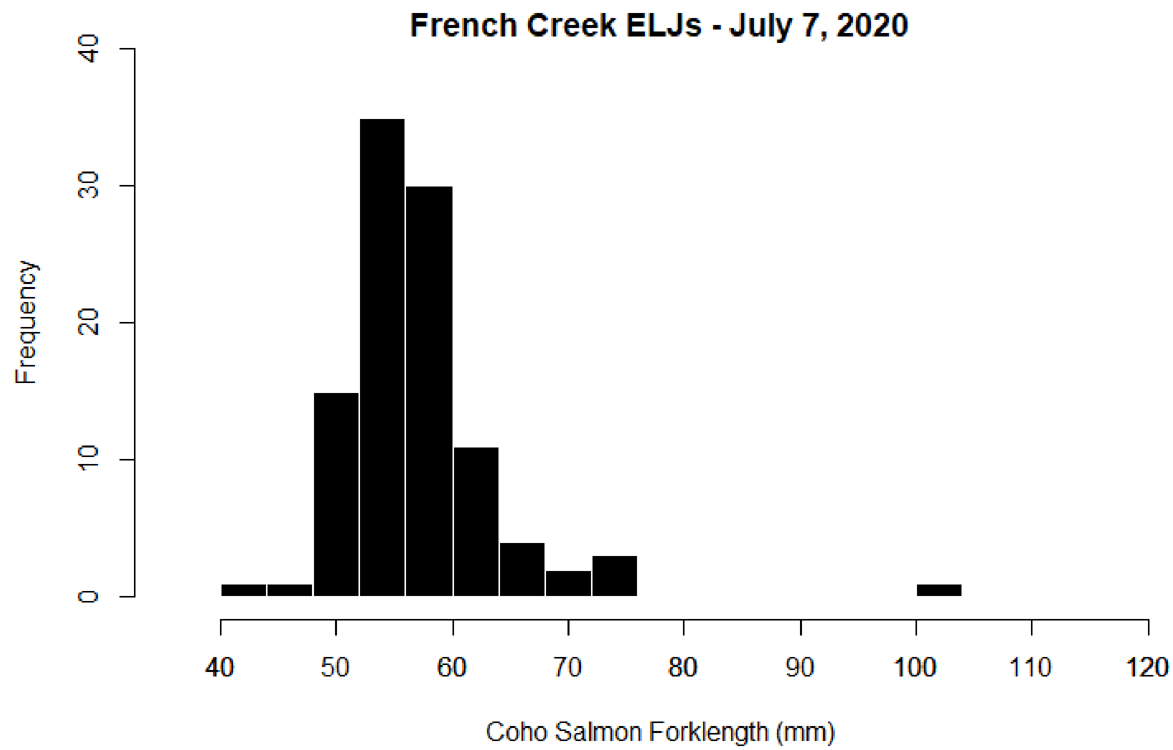


Figure 10. Coho Salmon forklength (mm) histogram – French ELJs – July 7, 2020 - Julian Week 28

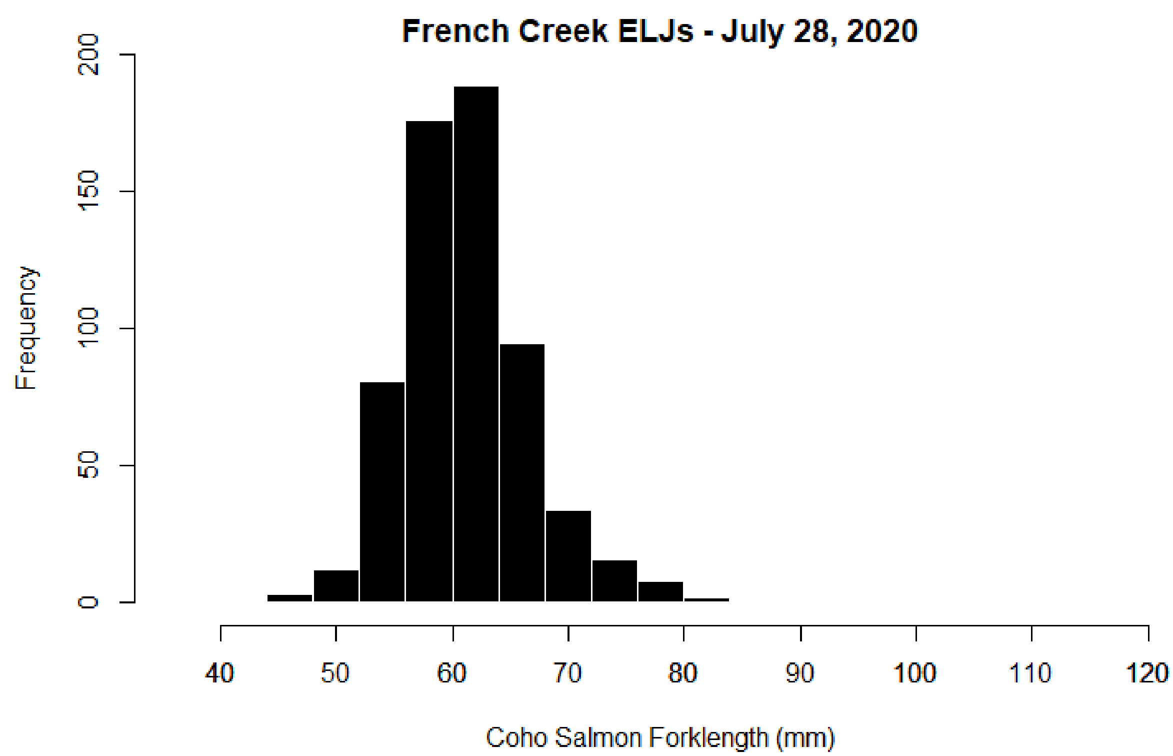


Figure 11. Coho Salmon forklength (mm) histogram – French ELJs – July 28, 2020 - Julian Week 31

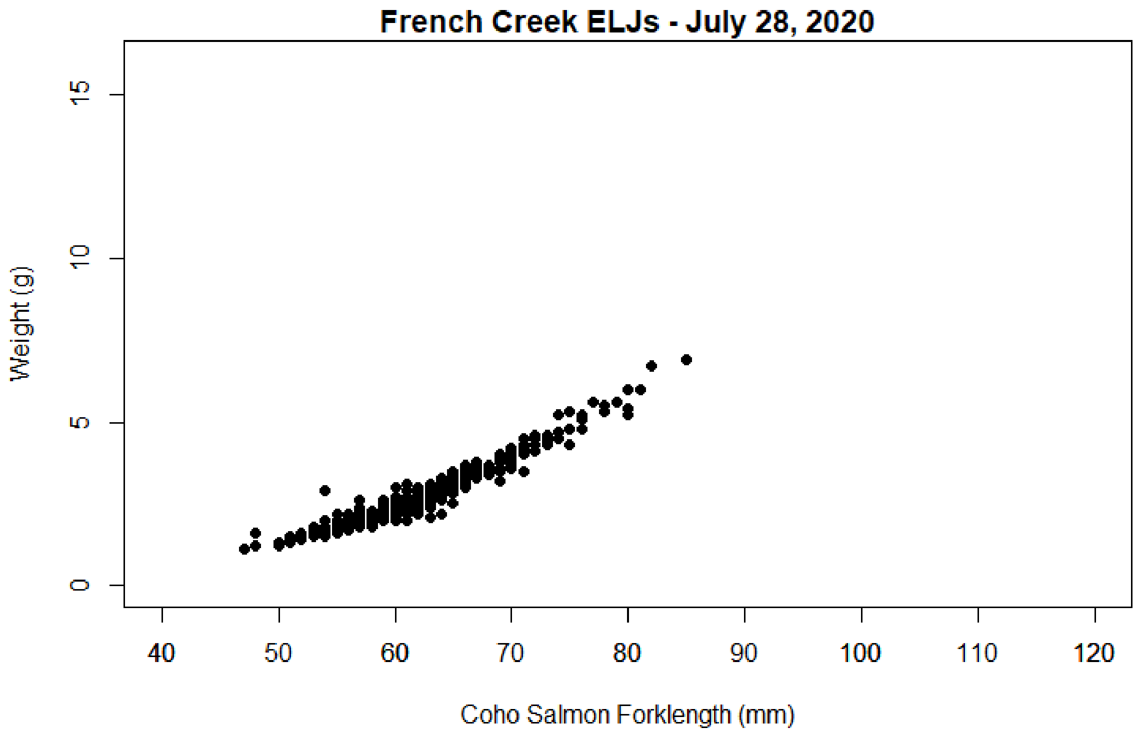


Figure 12. Coho Salmon weight (g) versus forklength (mm) – French Creek ELJs – July 28, 2020 - Julian Week 31.

Miners Creek

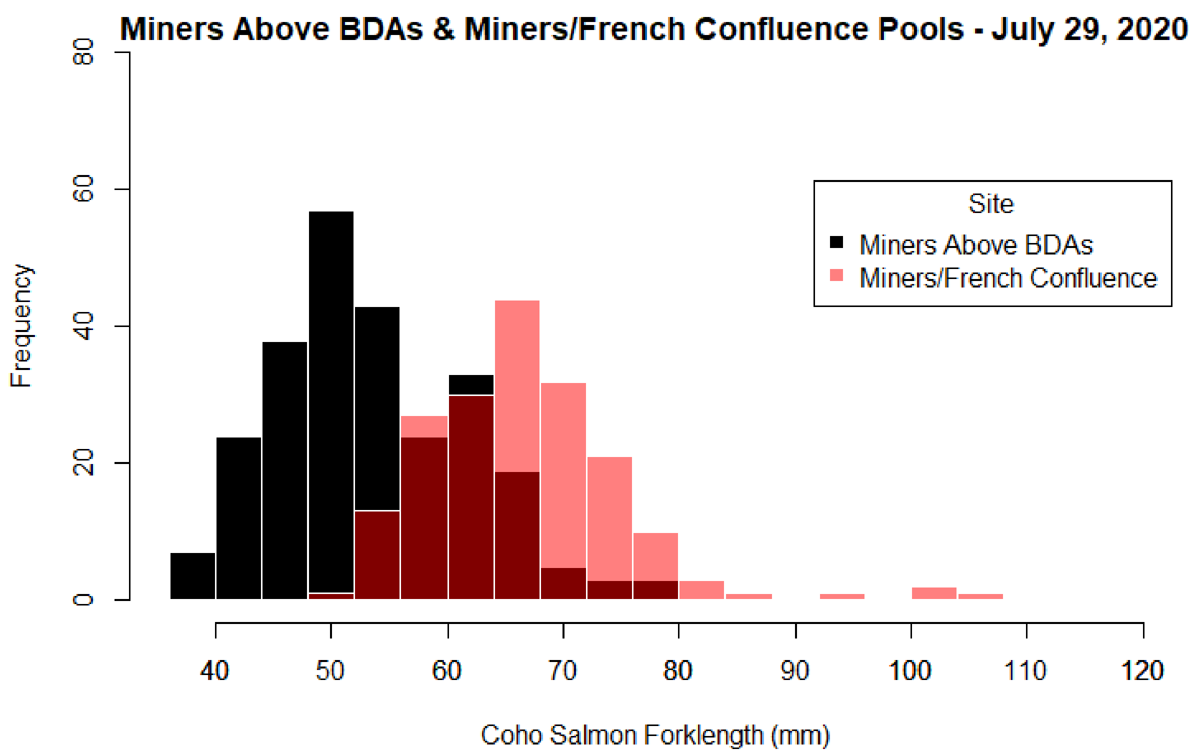


Figure 13. Forklength (mm) histograms of Coho Salmon captured in three pools above the Miners Creek Upper BDA compared to Coho Salmon captured in two pools near the Miners Creek confluence with French Creek on July 29, 2020. One confluence pool was directly below the confluence in French Creek and one pool was directly above the confluence in Miners Creek.

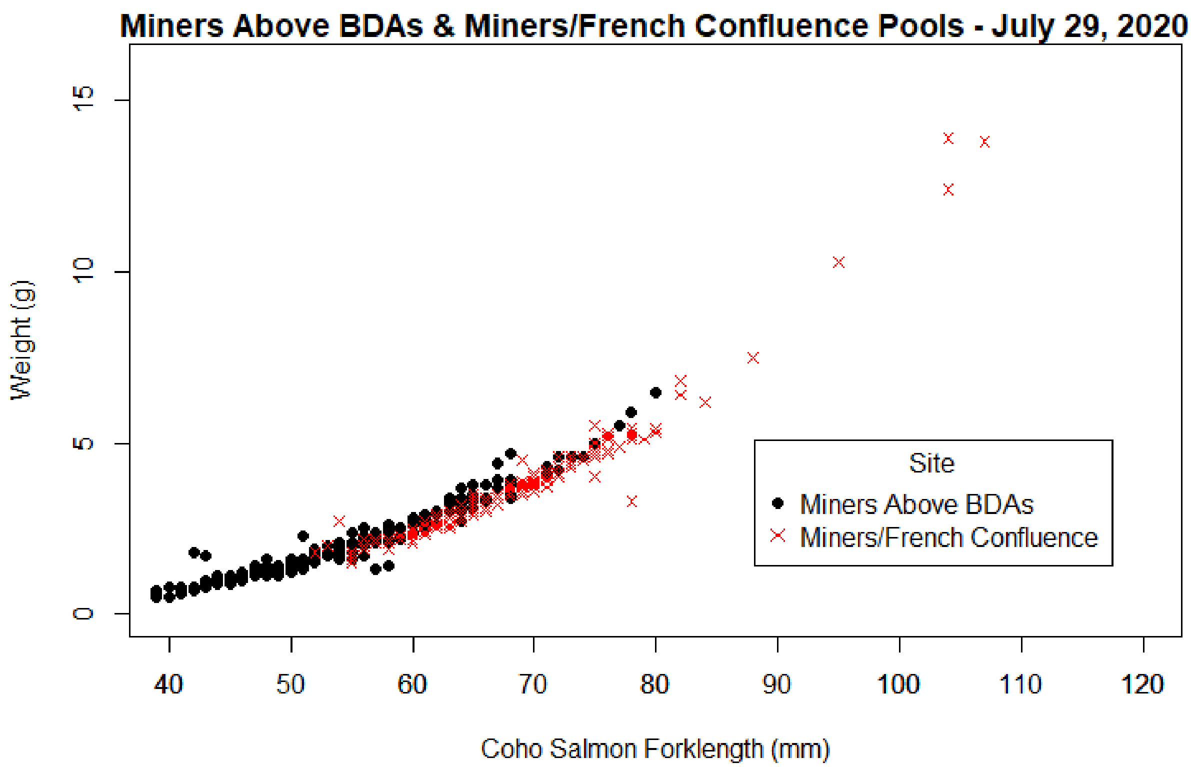


Figure 14. Weight (g) versus forklength (mm) of Coho Salmon captured in three pools above the Miners Creek Upper BDA compared to Coho Salmon captured in two pools near the Miners Creek confluence with French Creek on 7/29/2020. One confluence pool was directly below the confluence in French Creek and one pool was directly above the confluence in Miners Creek.

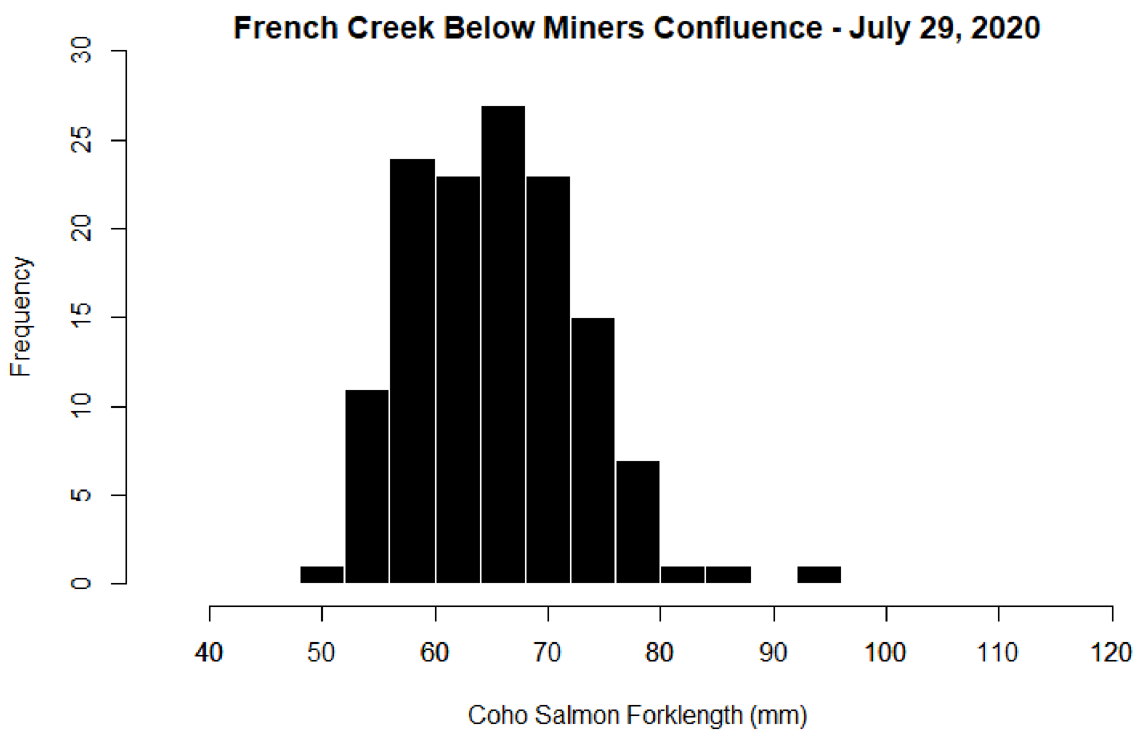


Figure 15. Coho Salmon forklength (mm) histogram – French Creek below Miners Creek confluence– July 29, 2020 - Julian Week 31

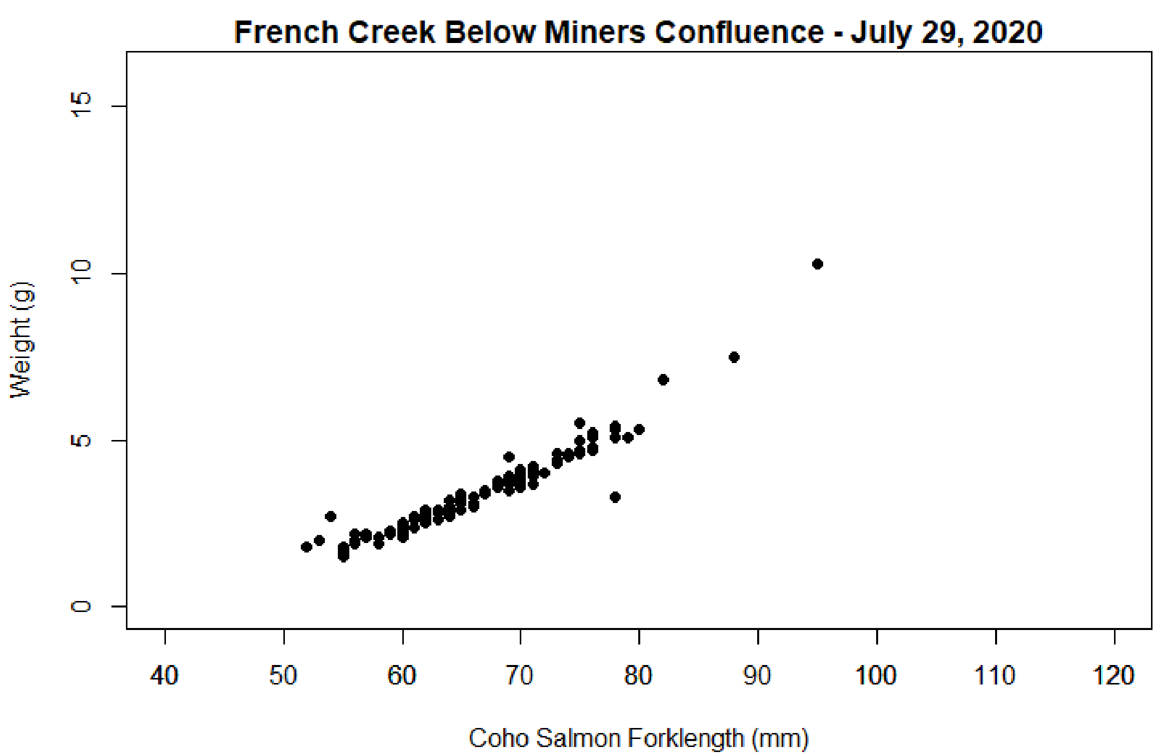


Figure 16. Coho Salmon weight (g) versus forklength (mm) – French Creek below Miners Creek confluence– July 29, 2020 - Julian Week 31

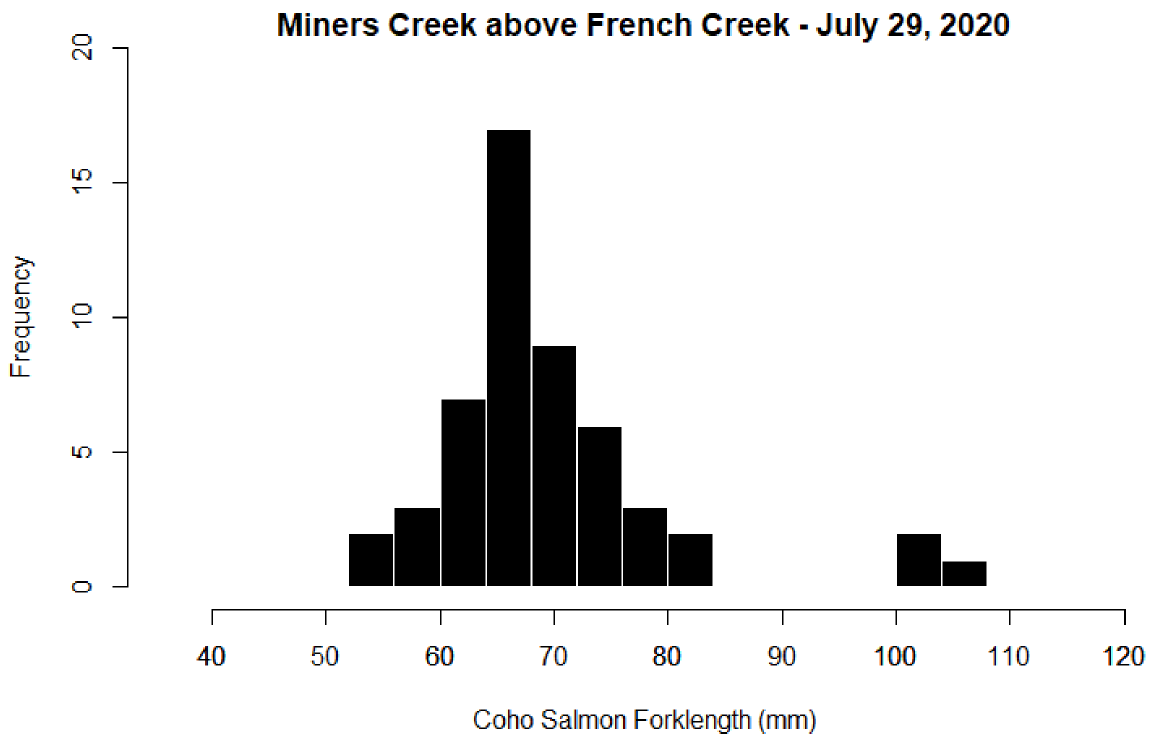


Figure 17. Coho Salmon forklength (mm) histogram – Miners Creek above French Creek confluence– July 29, 2020 - Julian Week 31

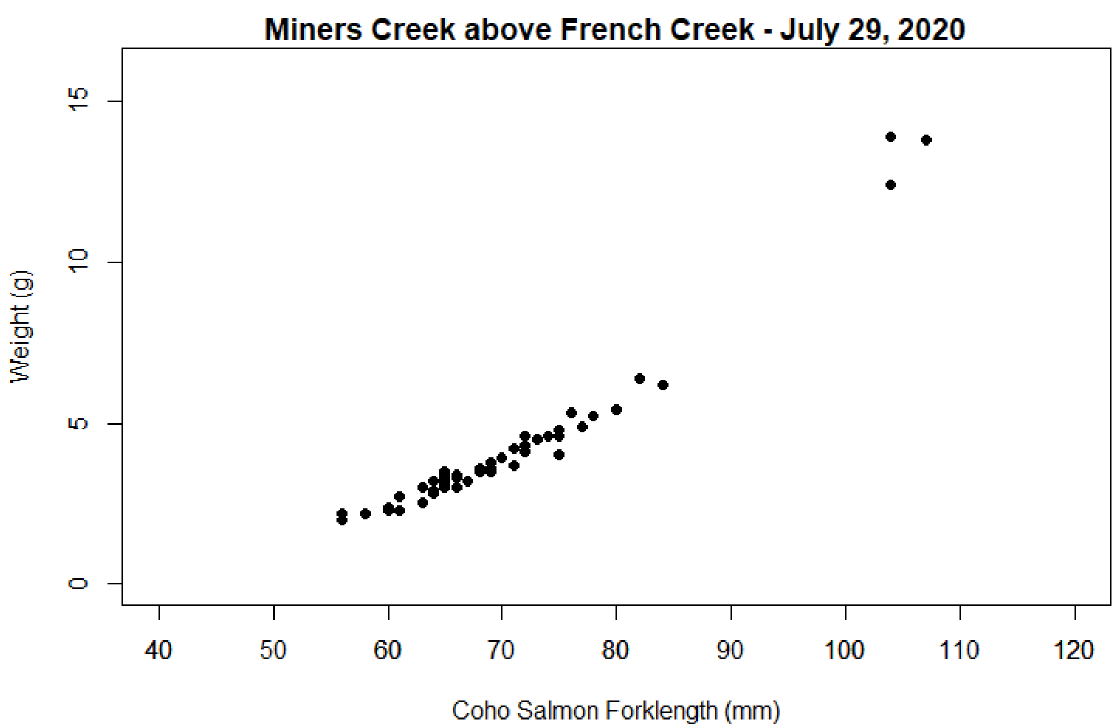


Figure 18. Coho Salmon weight (g) versus forklength (mm) – Miners Creek above French Creek confluence– July 29, 2020 - Julian Week 31

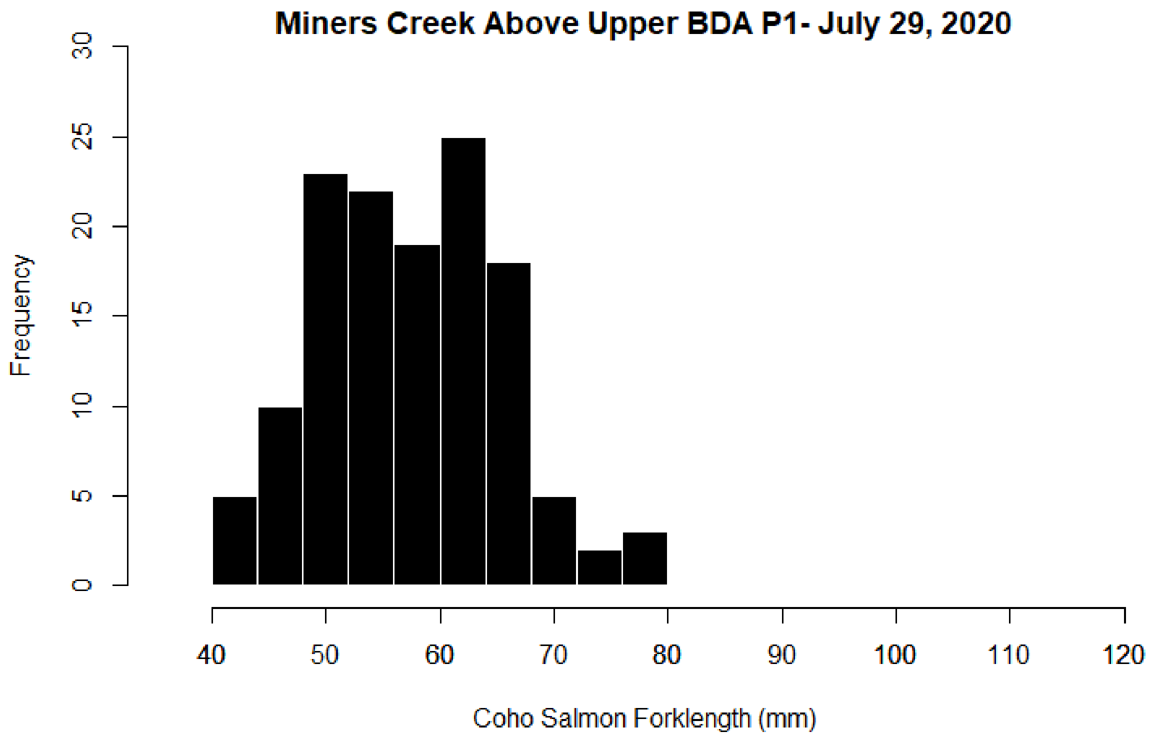


Figure 19. Coho Salmon forklength (mm) histogram – Miners Creek above Upper BDA Pool 1– July 29, 2020 - Julian Week 31

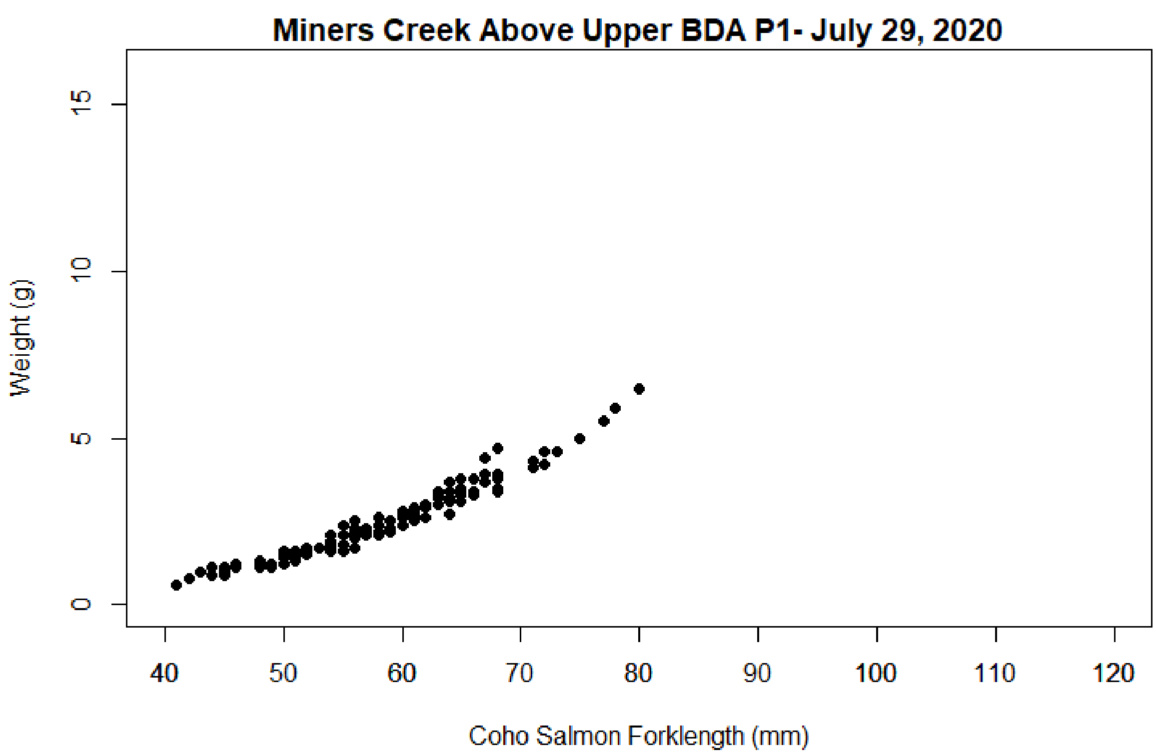


Figure 19. Coho Salmon weight (g) versus forklength (mm) – Miners Creek above Upper BDA Pool 1– July 29, 2020 - Julian Week 31

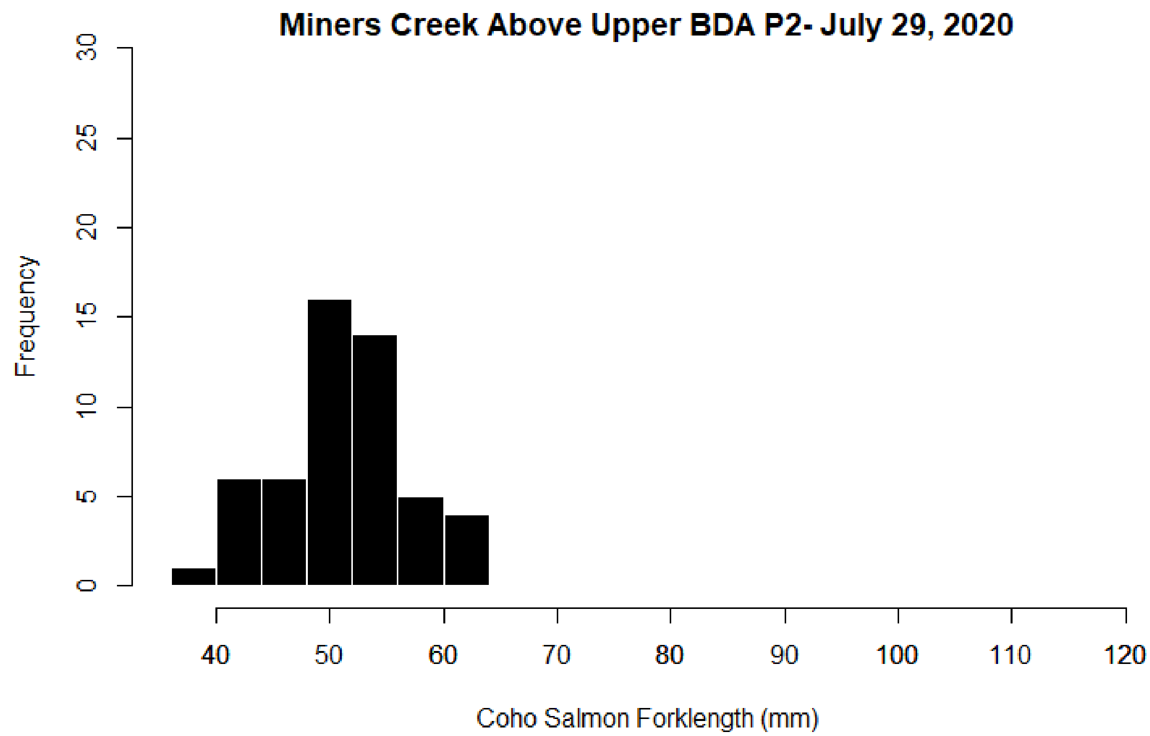


Figure 20. Coho Salmon forklength (mm) histogram – Miners Creek above Upper BDA Pool 2– July 29, 2020 - Julian Week 31

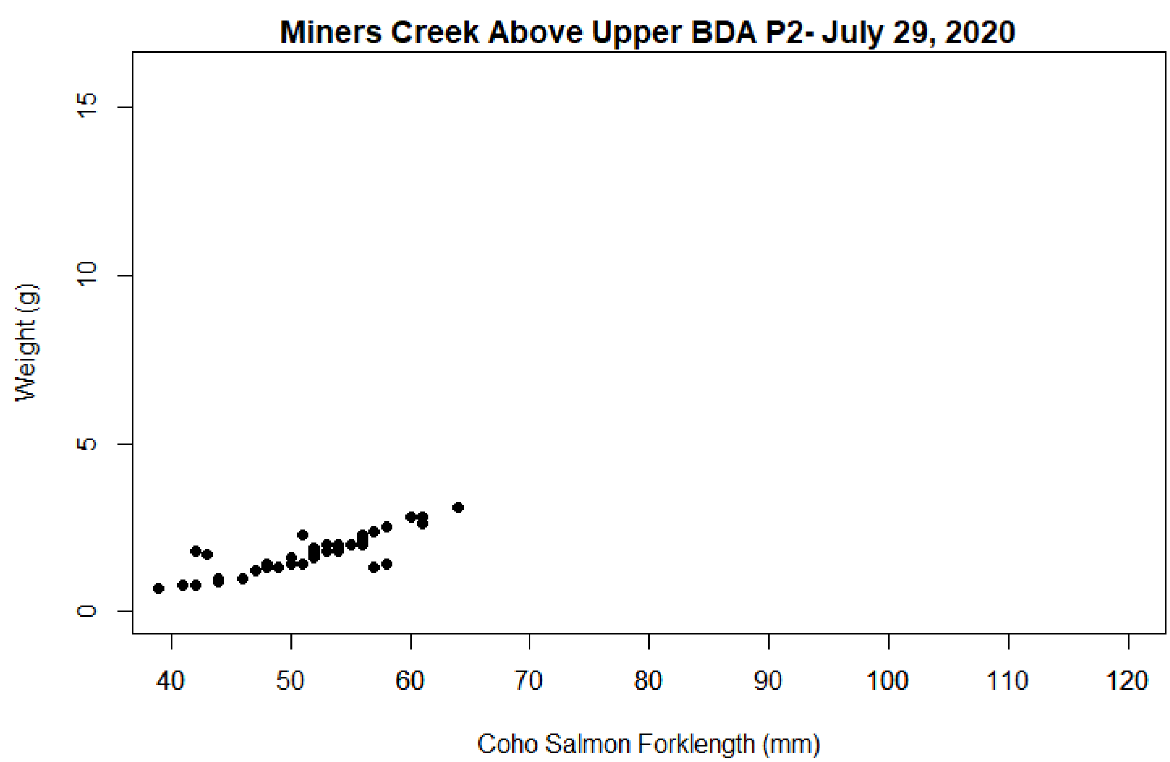


Figure 21. Coho Salmon weight (g) versus forklength (mm) – Miners Creek above Upper BDA Pool 2– July 29, 2020 - Julian Week 31

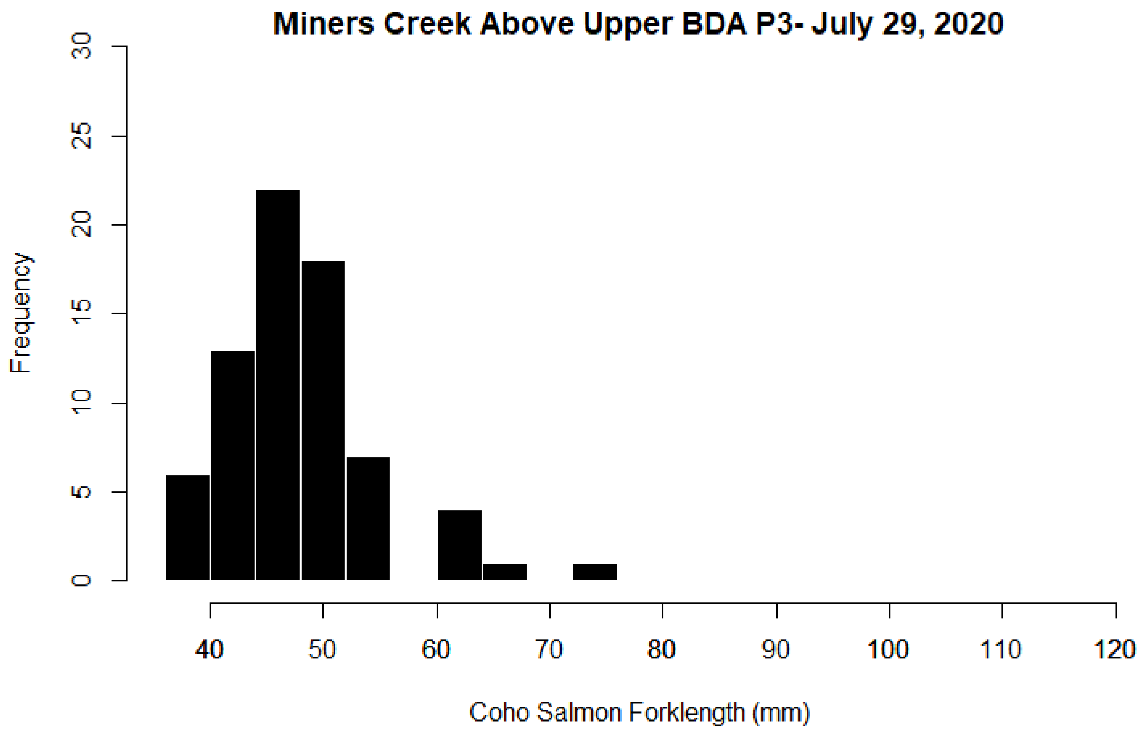


Figure 22. Coho Salmon forklength (mm) histogram – Miners Creek above Upper BDA Pool 3– July 29, 2020 - Julian Week 31

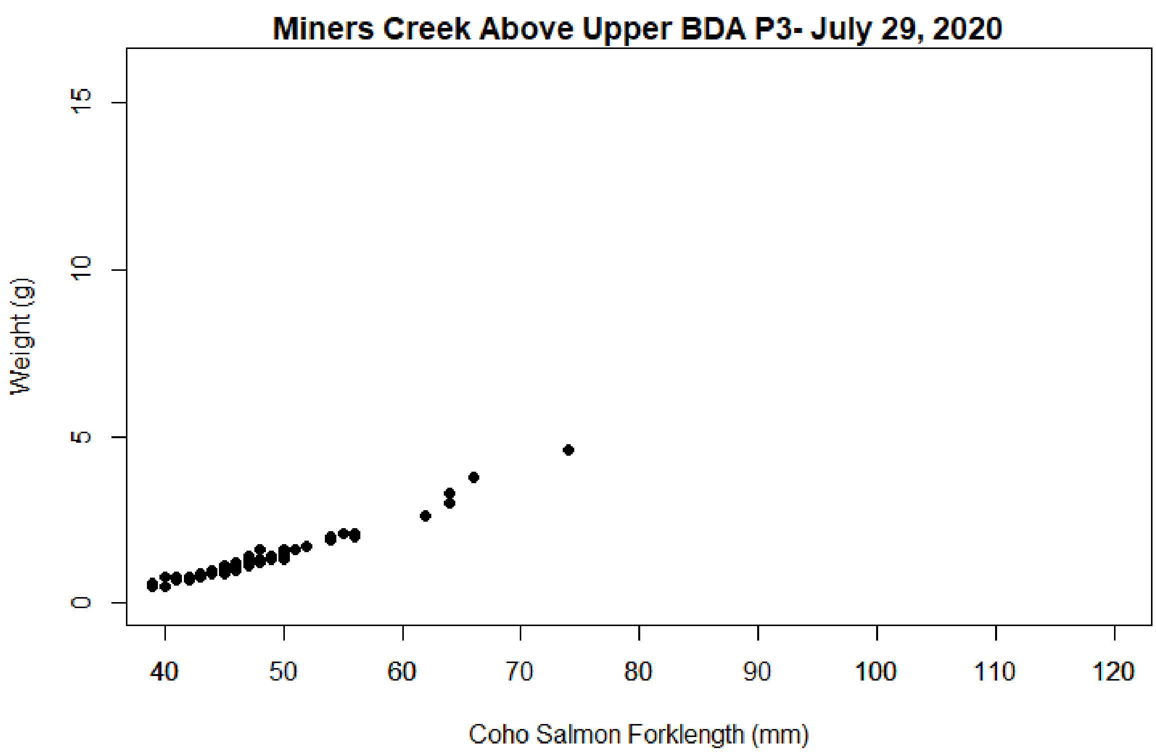


Figure 23. Coho Salmon weight (g) versus forklength (mm) – Miners Creek above Upper BDA Pool 3– July 29, 2020 - Julian Week 31

FISH SAMPLING SUMMARY

October 2020

SCOTT RIVER WATERSHED COUNCIL
Prepared by Monica Tonty & Erich Yokel

Contents

1.0 All Sites

1.1 Catch Summaries

Table 1. Catch summary by sample unit for all sites sampled between 10/5/2020-10/12/2020, Julian weeks 40-41. French FRGP Side Channel and French SC BDA site were not sampled due to water quality. Sugar BDA Pond 1 was not sampled due to dry conditions. Sugar BDA Pond 2 and above the natural beaver dam were seined, but no fish were caught. Movement of fish from BDA Pond 1 upstream was most likely limited.

		Coho Salmon *(O. kisutch)*				Rainbow Trout *(O. mykiss)*		
Date	Sample Unit	Total Catch	Marked	Recap	Morts	Total Catch	Marked	Recap
10/5/2020	Scott River above Sugar Creek	5	2	0	0	20	0	0
	Scott-Sugar Confluence Pool	73	54	2	0	333	0	0
10/7/2020	French Creek Control Pools	457	292	58	0	184	0	0
10/8/2020	French ELJ Reach	341	200	20	1	44	0	0
	French US ELJ Reach	43	24	0	0	8	0	0
10/9/2020	French Creek Control Pools	282	0	188	0	130	0	0
	French ELJ Reach	322	0	104	0	71	0	0
10/12/2020	Miners above upper BDA	158	6	3	0	2	0	0
	Miners above Confluence	26	8	10	0	1	0	0
	French- Miners Confluence	174	99	24	0	4	0	0
	Totals	1881	685	409	1	797	0	0

Table 2. Average Coho Salmon fork length in all sites sampled between 10/5/2020-10/9/2020– Julian week 40-41.

Date	10/5/20		10/7/20	10/8/20		10/9/20		10/12/20		
Site	Scott River above Sugar	Scott-Sugar Confluence	French Control Pools	French ELJ Reach	French US ELJ Reach	French Control Pools	French ELJ Reach	Miners Above Upper BDA	Miners above Confluence	French-Miners Confluence
Avg	66	70	70	67	68	70	67	53	73	72
SD	2.17	4.91	7.31	5.07	4.39	7.57	5.58	7.96	10.59	6.27
Min	63	57	56	52	60	53	57	39	62	60
Max	69	81	118	85	77	117	106	76	102	90
Count	5	73	457	341	43	282	322	158	26	173

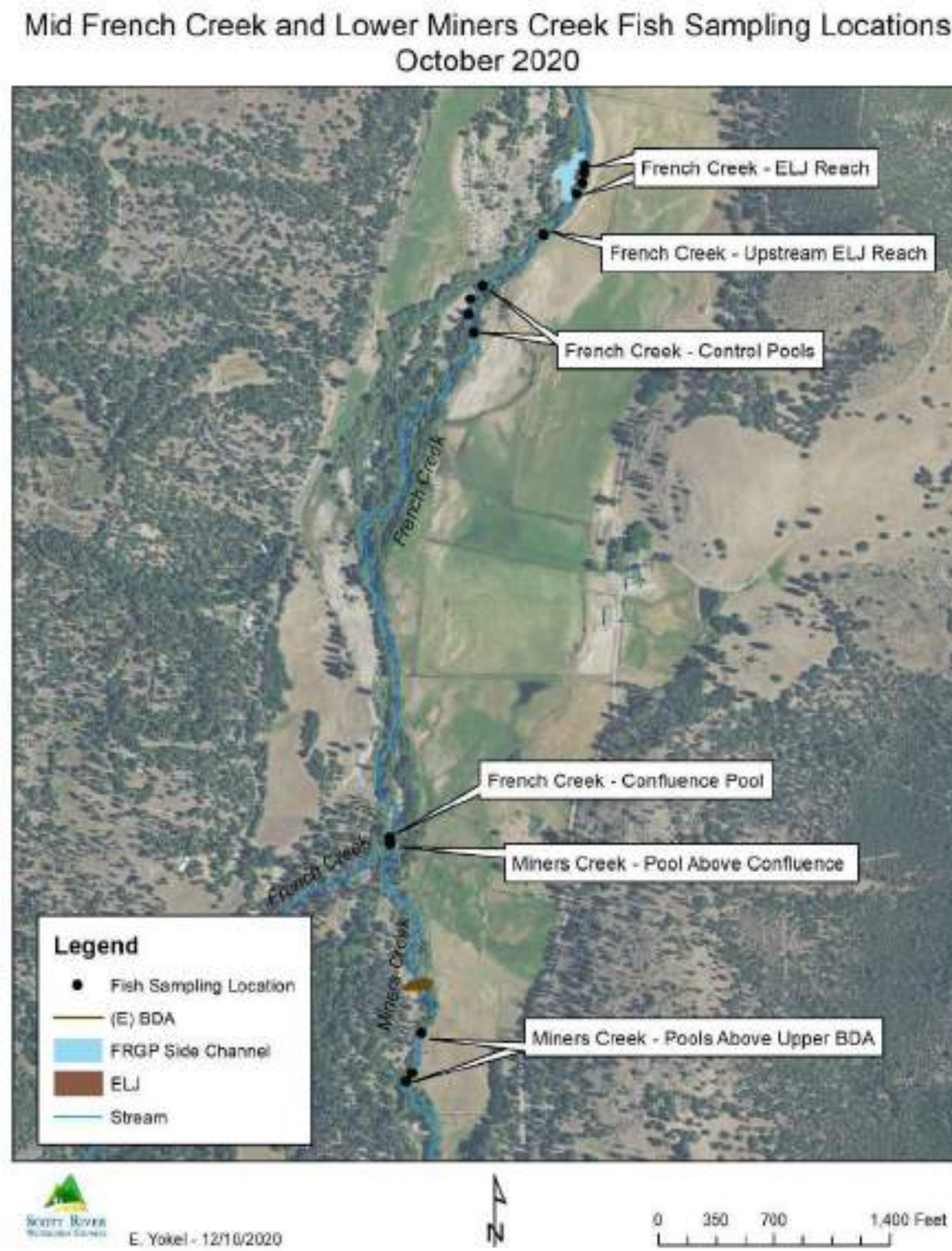


Figure 1. Sampling locations during October 2020 sampling effort on Miners Creek and French Creek.

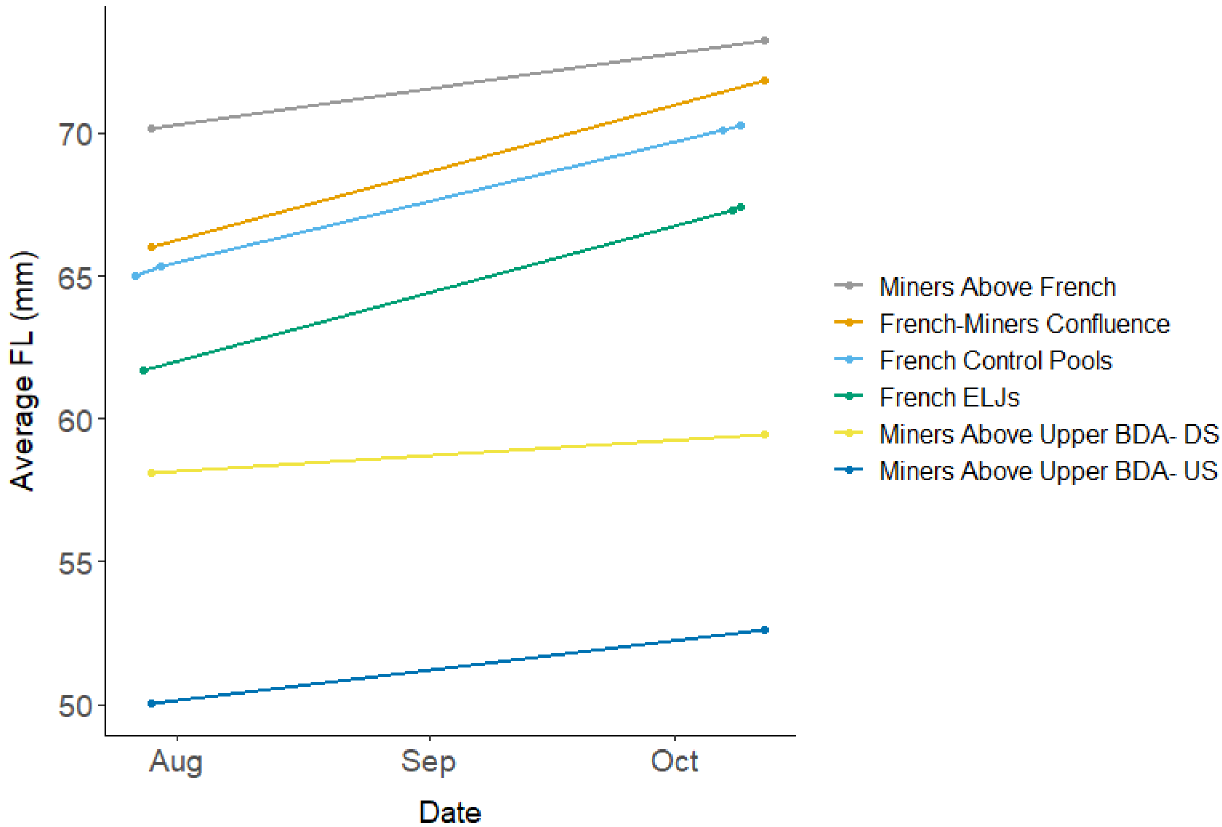


Figure 2. Change in average forklength (mm) between summer and October sampling occasions in sites that were surveyed on both occasions.

1.2 Population Estimates

Table 3. Fall 2020 juvenile coho salmon local population estimates (N). The first population estimate only includes taggable fish (≥ 65 mm), while the second includes those under taggable size (<65 mm). Paired surveys were done between 10/7-10/9/2020.

Site	N ≥ 65mm	SD	2.5% CI	97.5% CI	N incl. <65mm	SD	2.5% CI	97.5% CI
French Control Pools	439	9.76	420	458	537	21.97	494	580
French ELJs	464	23.71	418	511	672	39.56	595	750

Table 4. Comparison of French Control Pool population estimates for coho greater than or equal to 65 mm (N) using different methods: Chapman ratio-based estimator, Huggins Closed Capture Model -a maximum likelihood method (Max LL), and two parameter expanded-data augmented Bayesian approaches: one with constant detection probability (Model0) and one with individual heterogeneity in detection probability (Modelh).

	N	sd	2.5% CI	97.5% CI
Chapman	439	10	420	458
Max LL	457	9	440	474
Model0	457	12	436	482
Modelh	538	23	500	591

2.0 French Creek

2.1 Summer-Fall Comparison

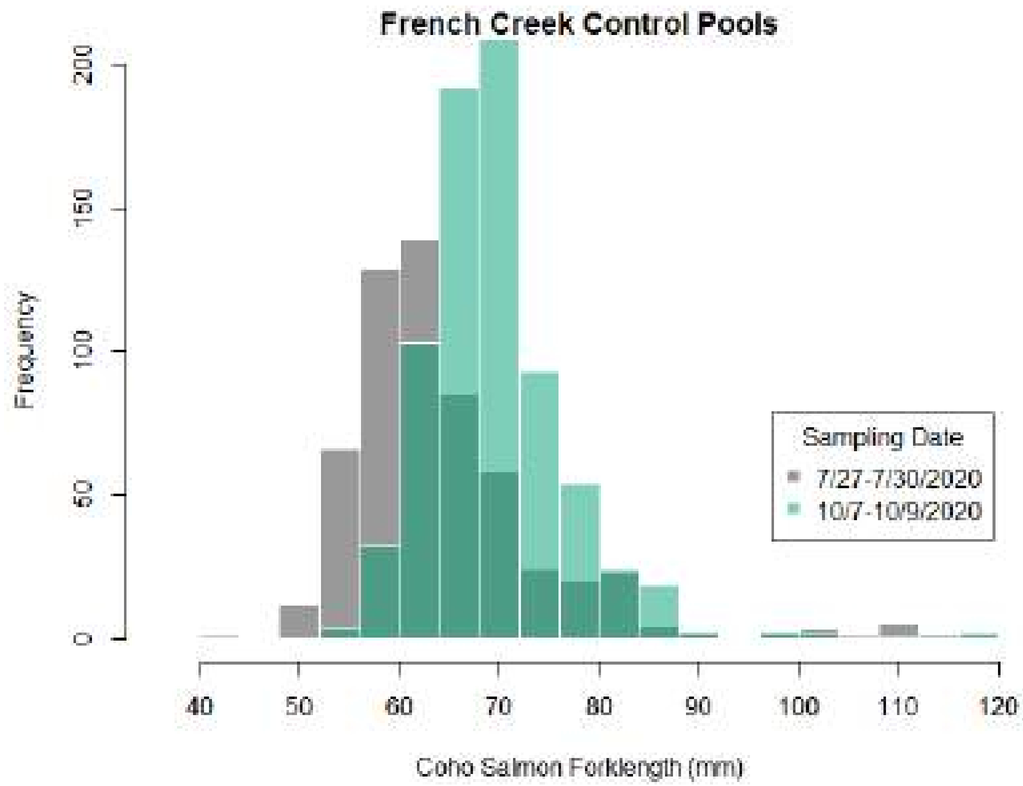
French Control Pool 1 (Looking Upstream) – October 6, 2020

French Control Pool 3 (Looking Upstream) – October 6, 2020

Poor condition coho caught in French Control Pools on 10/07/2020

Healthy coho caught in French Control Pools on 10/07/2020

A)



B)

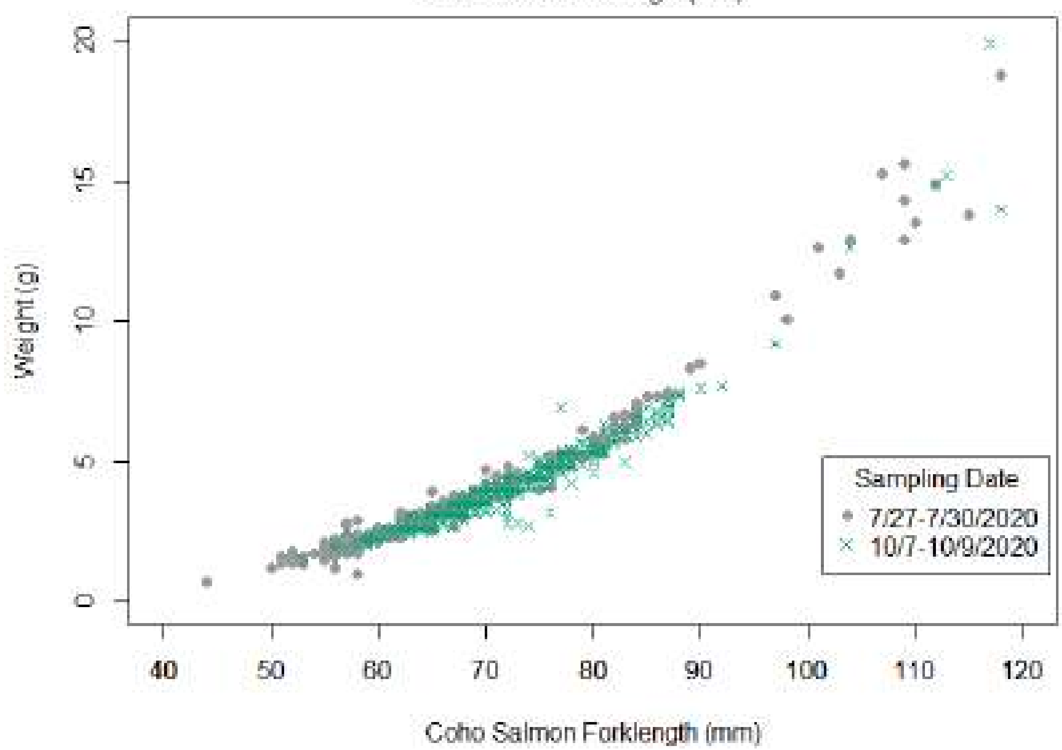


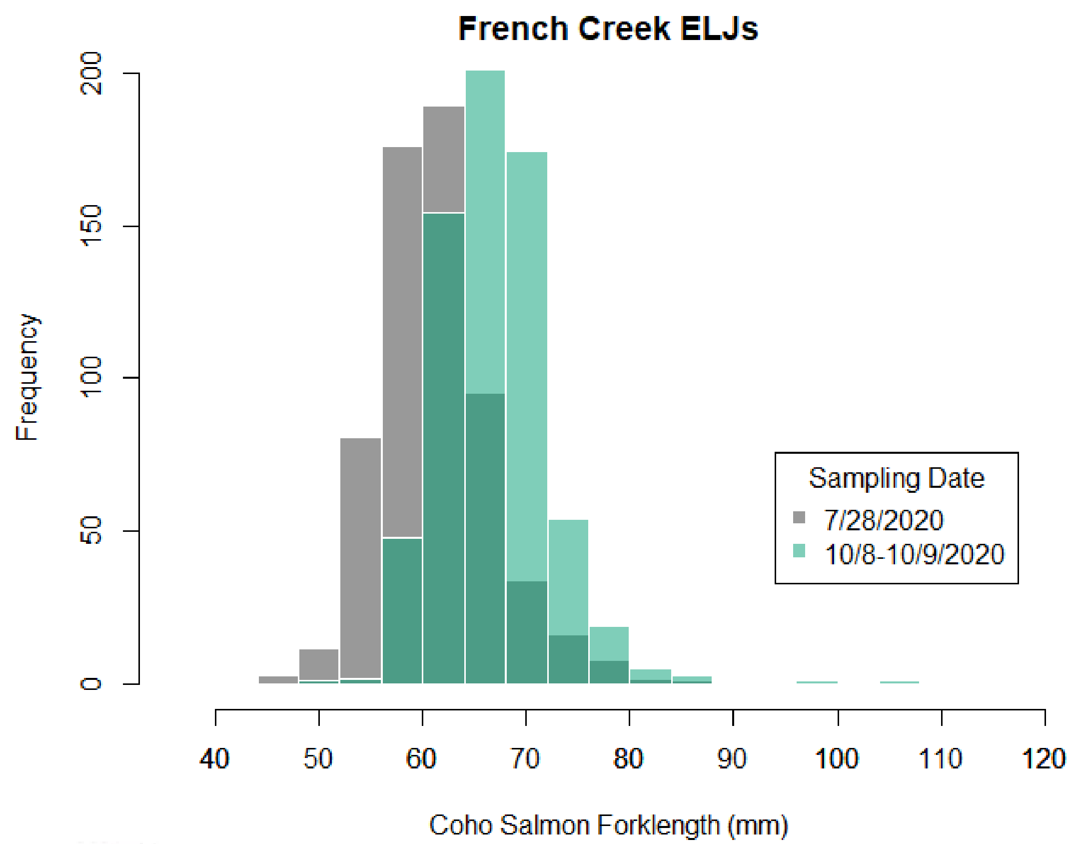
Figure 3. French control pools A) Change in frequency of coho forklengths (mm) from summer (grey) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho weight (g) versus forklength (mm) from summer-fall.

French Creek – downstream Engineered Log Jam 3 (Looking Upstream) – October 9, 2020

French Creek- downstream Engineered Log Jam 2 (Looking Upstream) – October 9, 2020

Two coho salmon caught in French Creek ELJs on 10/8/2020

A)



B)

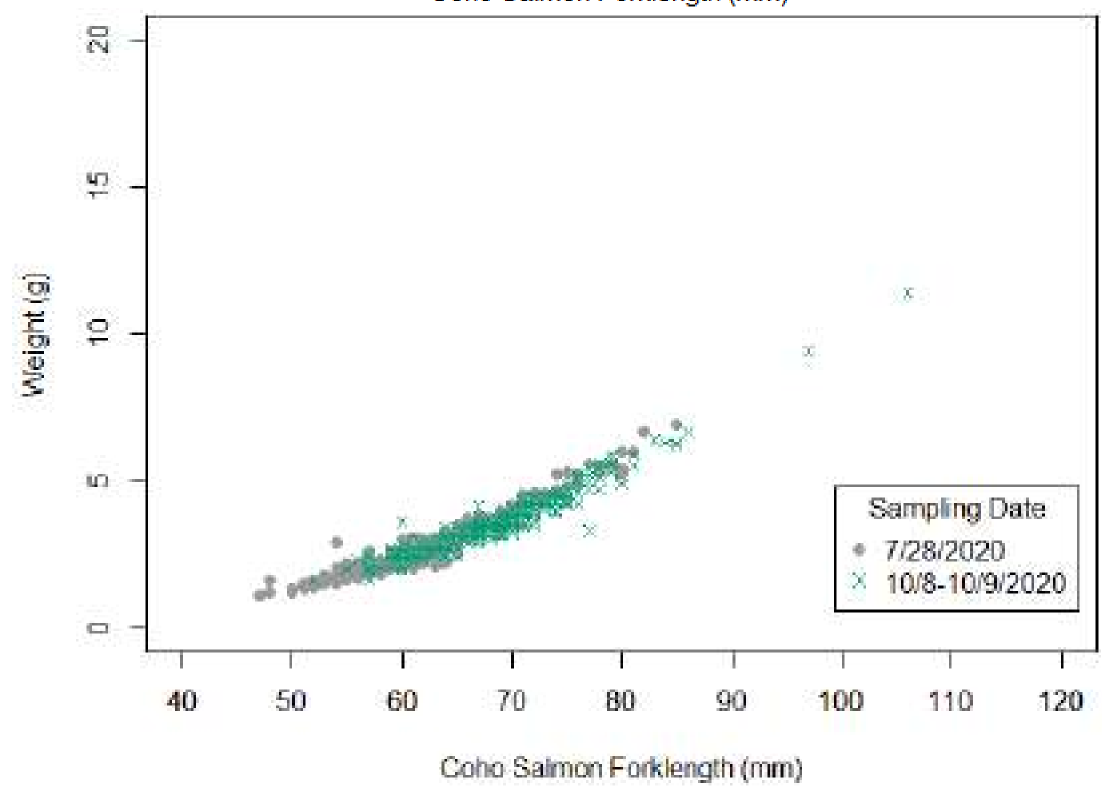


Figure 4. French Creek Engineered Log Jam (ELJ) reach A) Change in frequency of coho forklengths (mm) from summer (grey) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho weight (g) versus forklength (mm) from summer-fall.

2.2 Site Comparisons

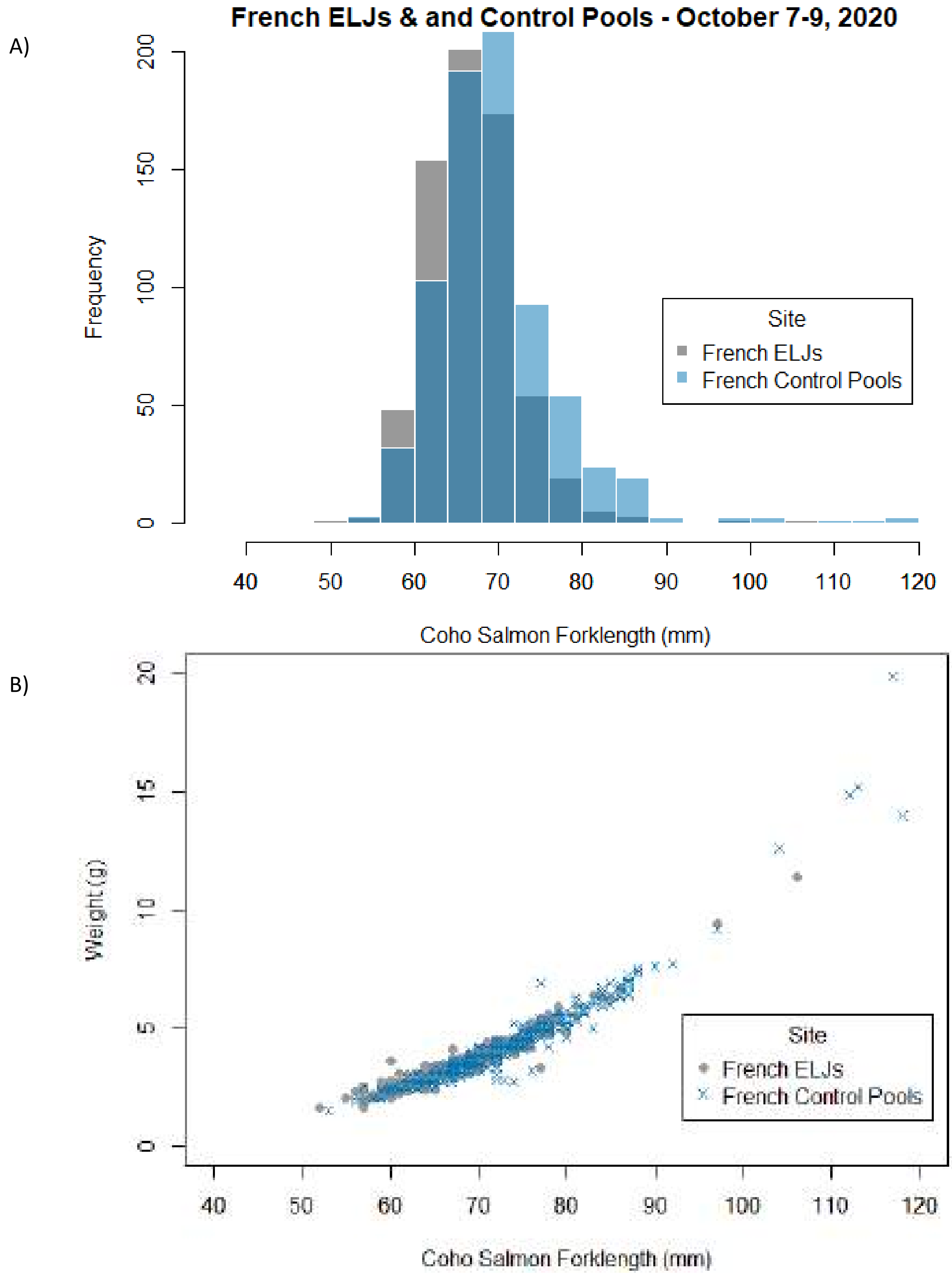


Figure 5. Comparison of French Creek Engineered Log Jam reach (ELJs) (grey) and French Creek Control pools (light blue) from October 7-9, 2020. A) frequency of coho forklengths (mm). Where the histograms overlap is shown in dark blue. B) coho weight (g) versus forklength (mm).

A)

B)

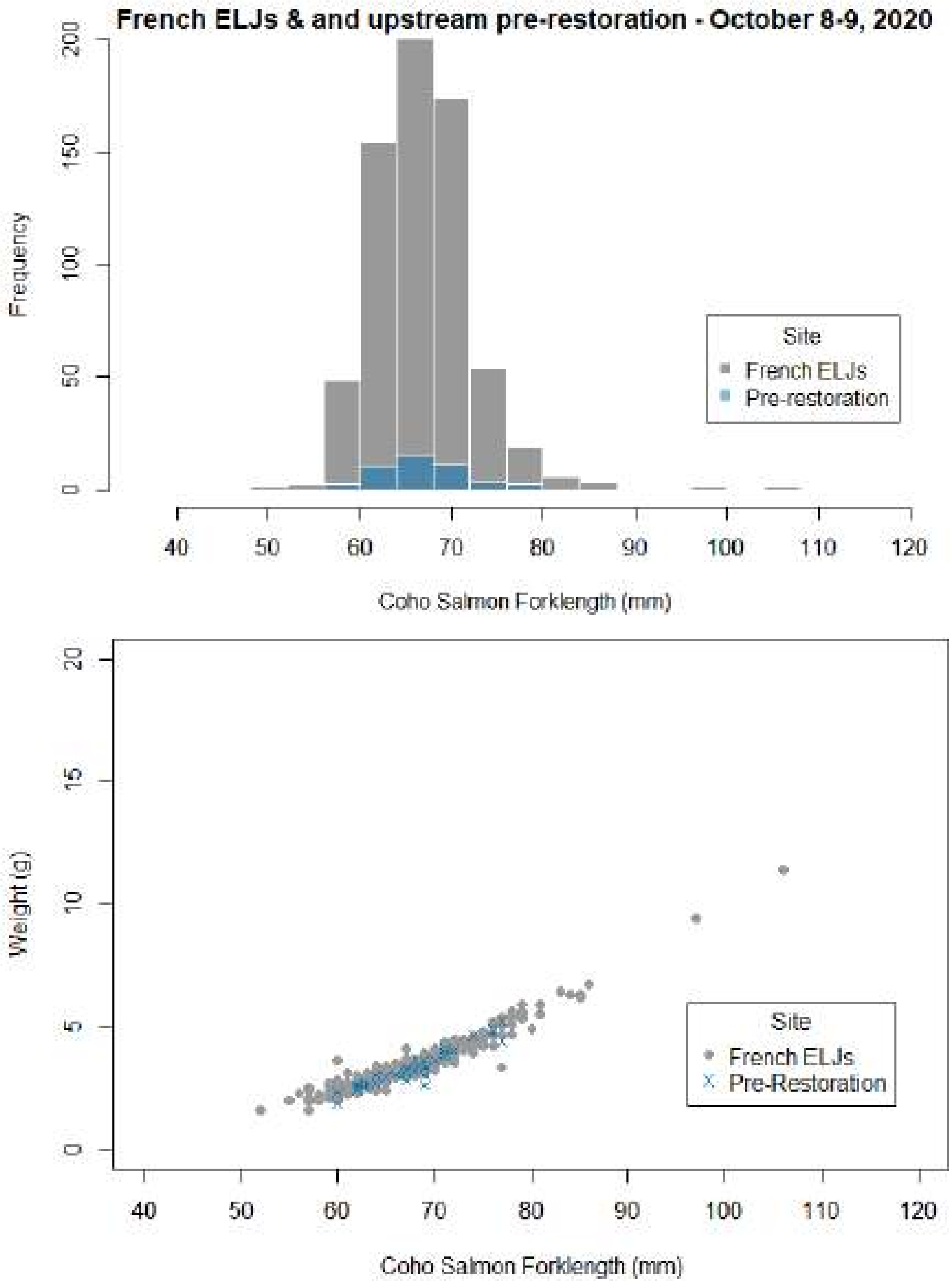


Figure 6. Comparison of French Creek Engineered Log Jam (ELJs) pools (grey) and pre-restoration site upstream of the ELJs (light blue) between October 8-9, 2020. A) frequency of coho forklengths (mm). Where the histograms overlap is shown in dark blue. B) coho weight (g) versus forklength (mm).

3.0 Miners Creek

3.1 Summer- Fall Comparisons

Miners Creek above Upper BDA – US (Looking Upstream) – October 12, 2020

French Creek below Miners Creek (Confluence Pool) (Looking Downstream) – October 12, 2020

Coho salmon caught in Miners Creek above Upper BDA – US on 10/12/2020

Coho salmon caught in Miners Creek above French Creek on 10/12/2020

A)

B)

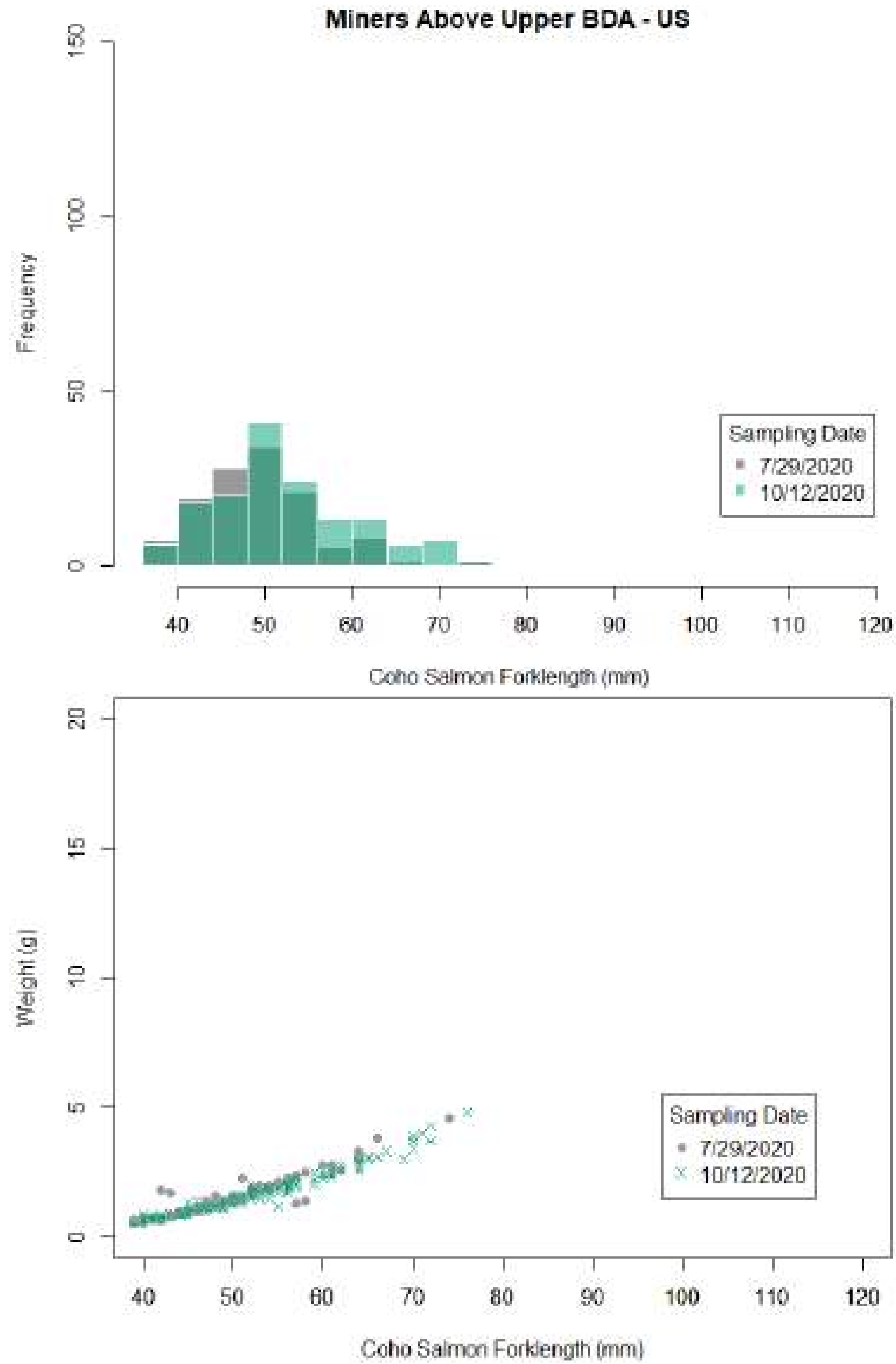
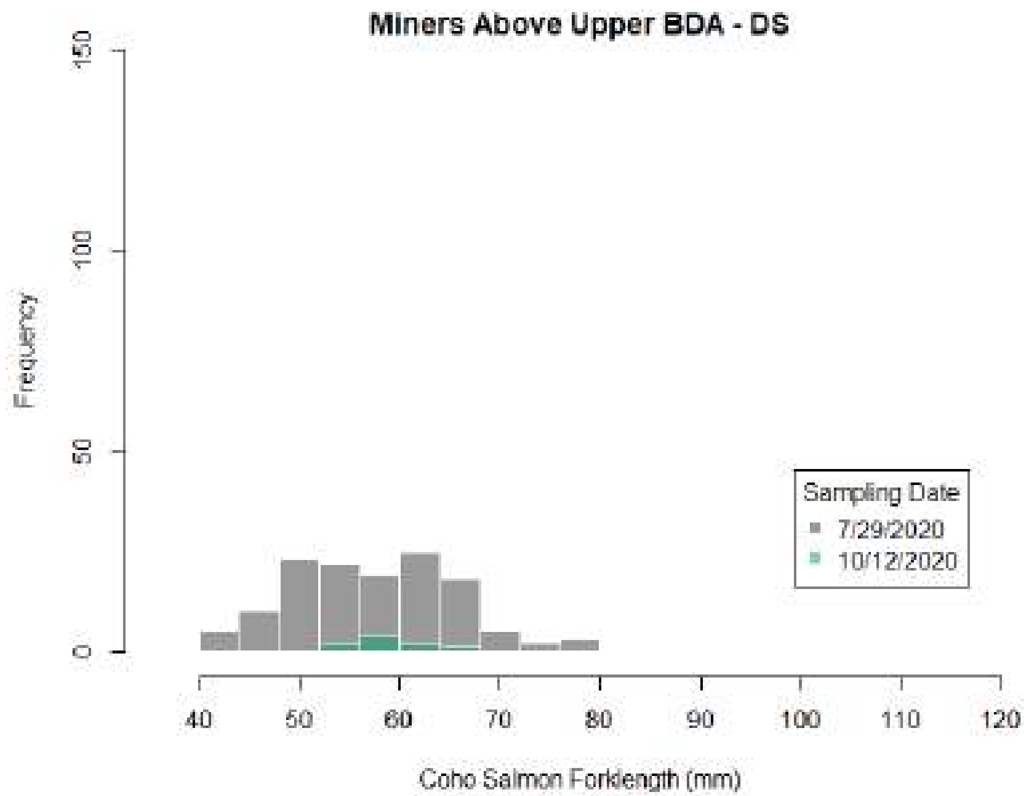


Figure 7. Miners Creek Above Upper BDA upstream pools A) Change in frequency of Coho Salmon forklengths (mm) from summer (black) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho salmon weight (g) versus forklength (mm) from summer-fall.

A)



B)

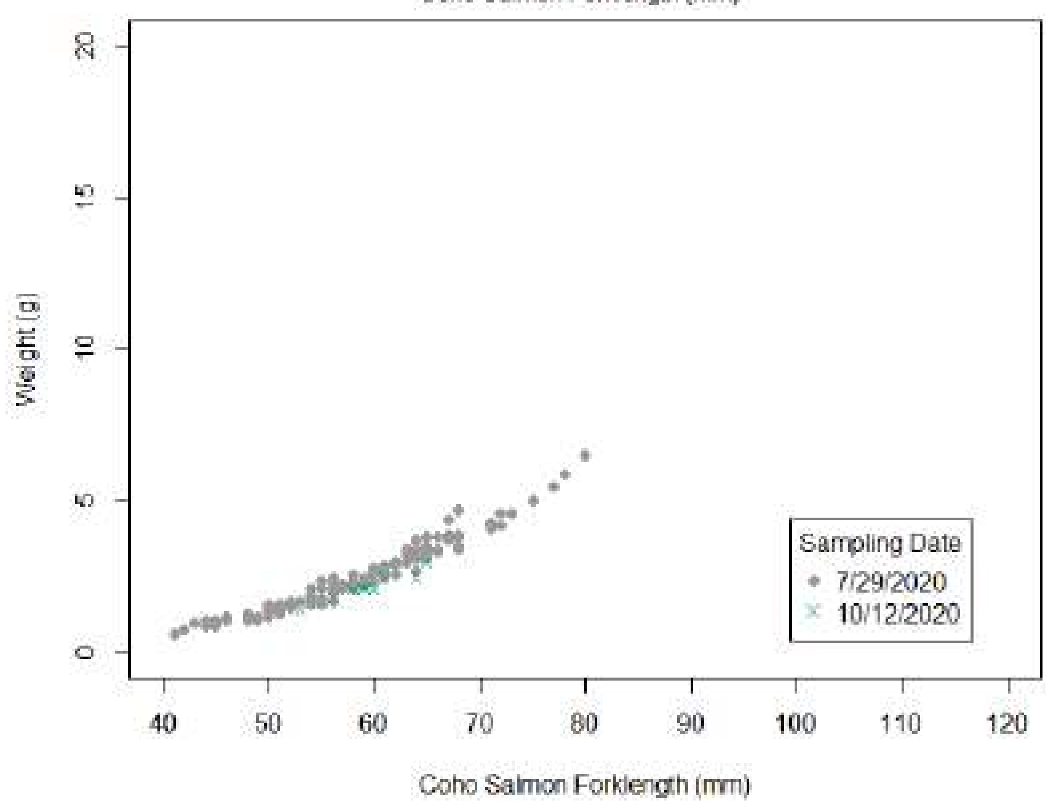


Figure 8. Miners Creek Above Upper BDA downstream pools A) Change in frequency of Coho Salmon forklengths (mm) from summer (black) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho salmon weight (g) versus forklength (mm) from summer-fall.

A)

B)

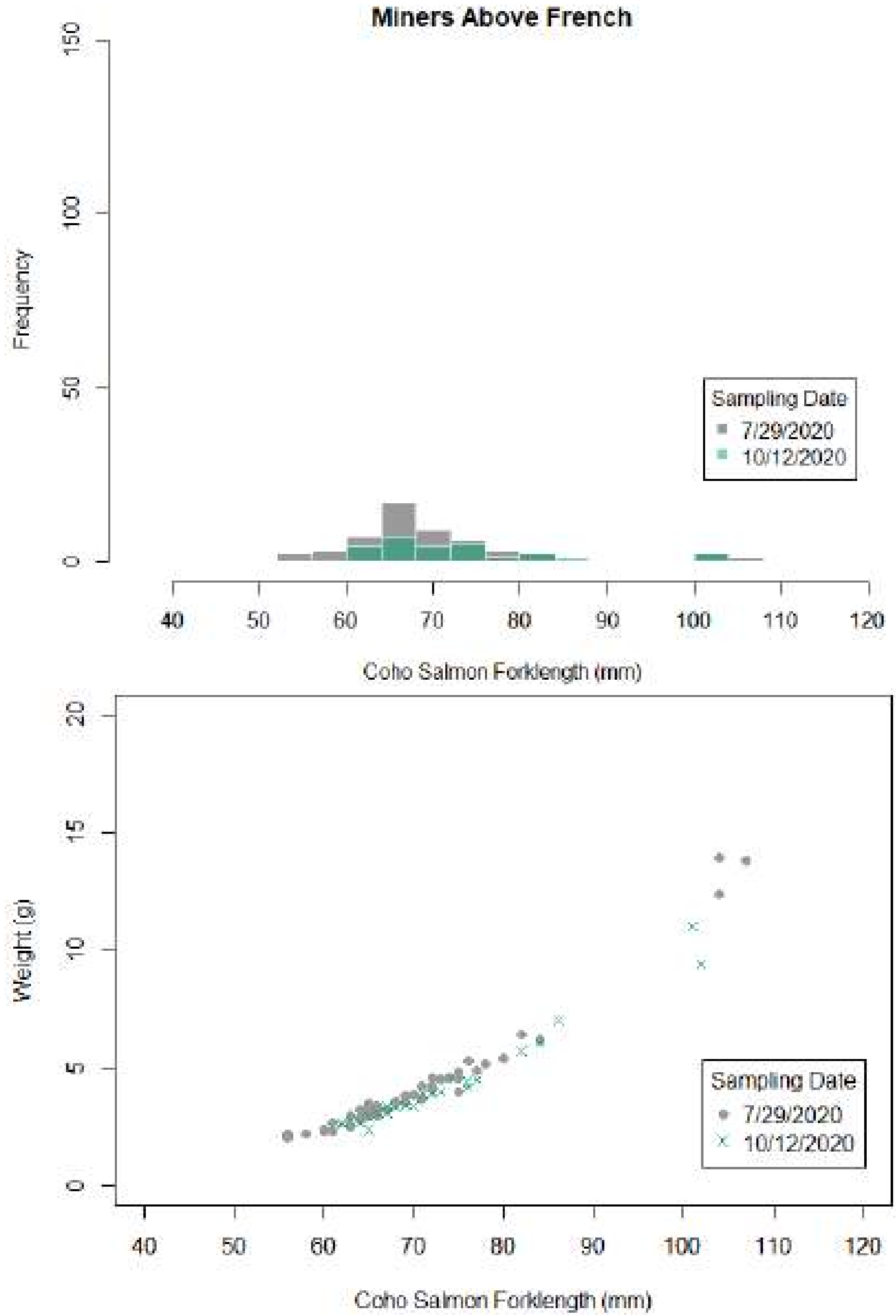
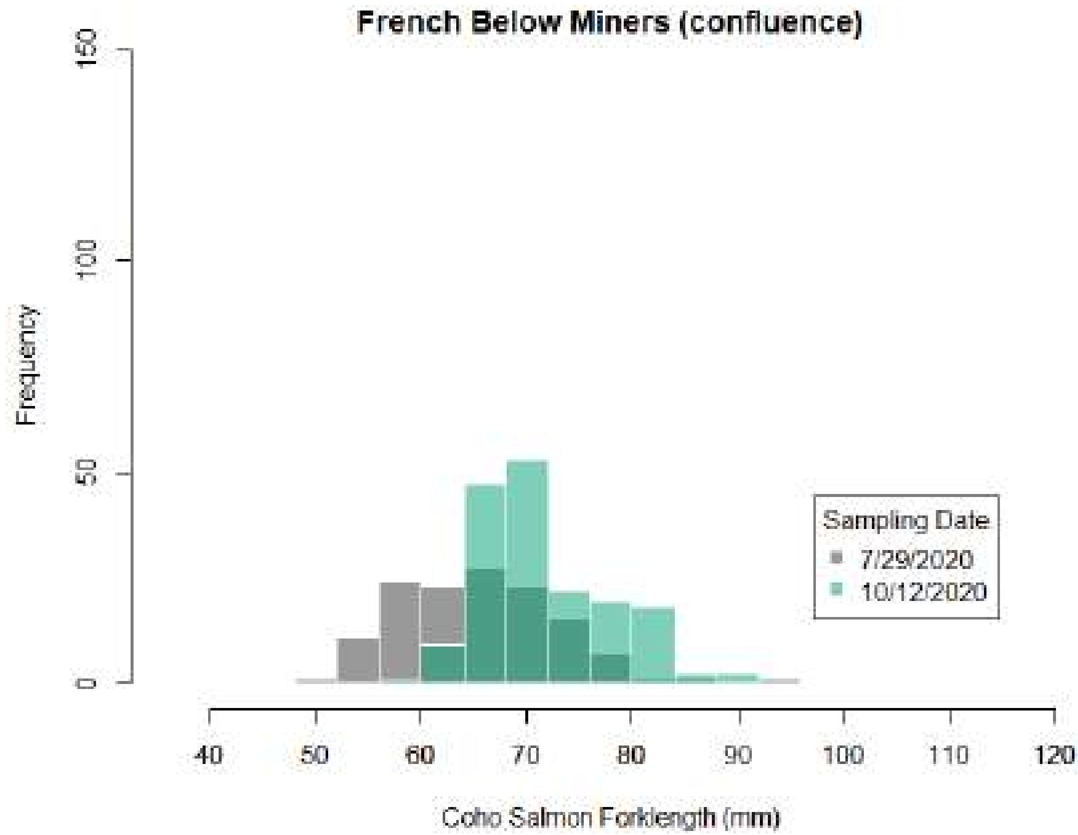


Figure 9. Miners Creek pool above French Creek A) Change in frequency of Coho Salmon forklengths (mm) from summer (black) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho salmon weight (g) versus forklength (mm) from summer-fall.

A)



B)

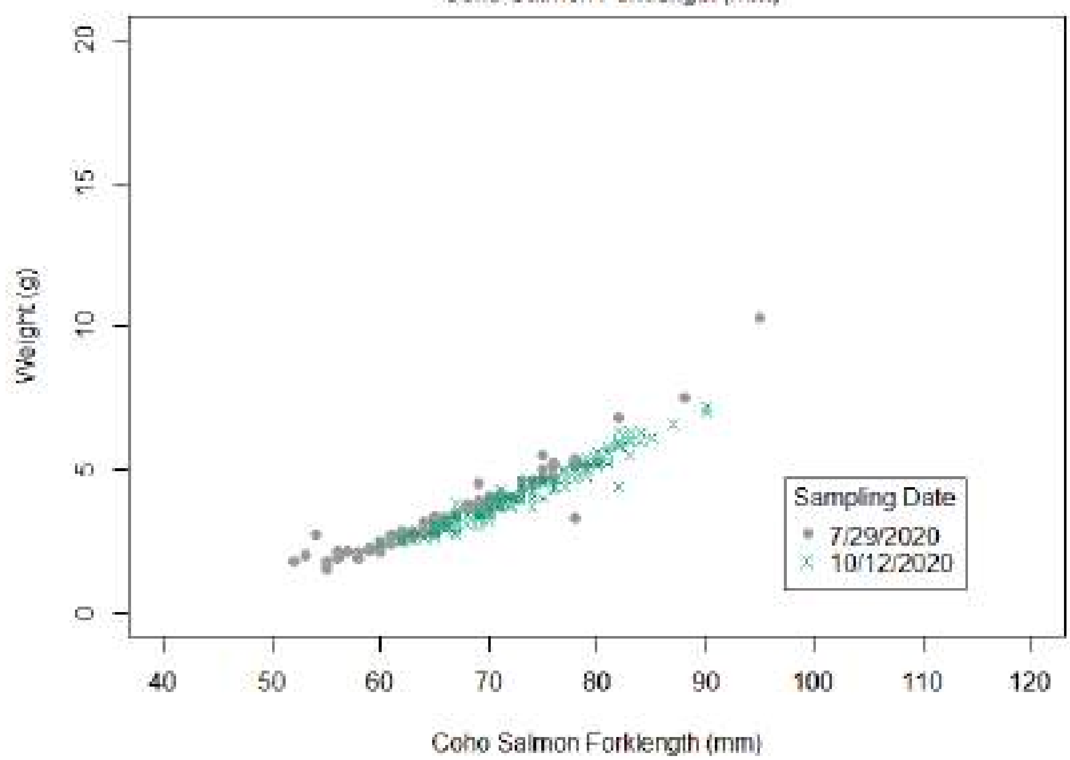


Figure 10. French Creek- Miners Creek confluence pool A) Change in frequency of Coho Salmon forklengths (mm) from summer (black) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho salmon weight (g) versus forklength (mm) from summer-fall.

3.2 Site Comparison

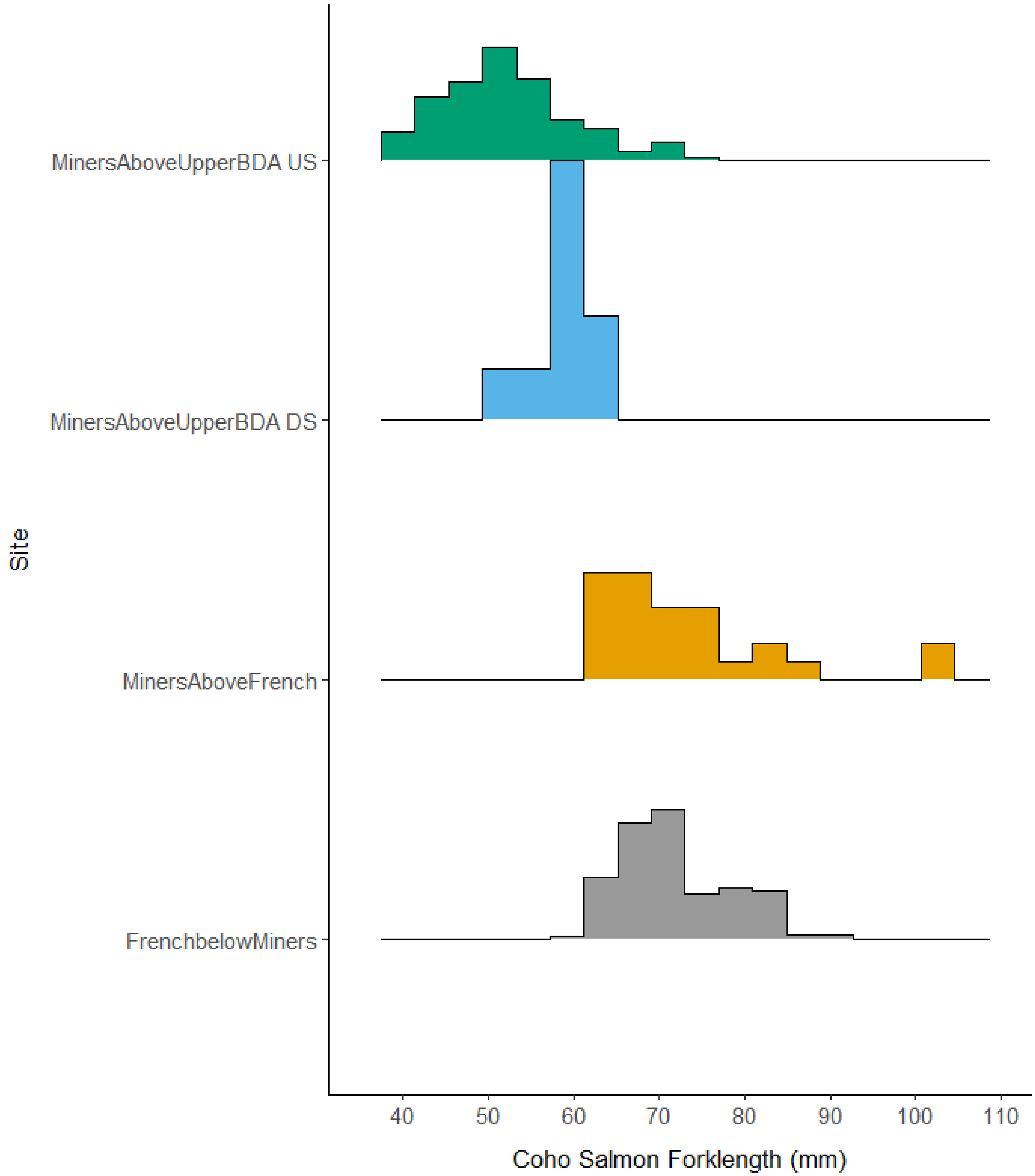


Figure 11. Comparison of forklength (mm) histograms of Coho Salmon captured in three Miners Creek sites and French below Miners Creek confluence on October 12, 2020.

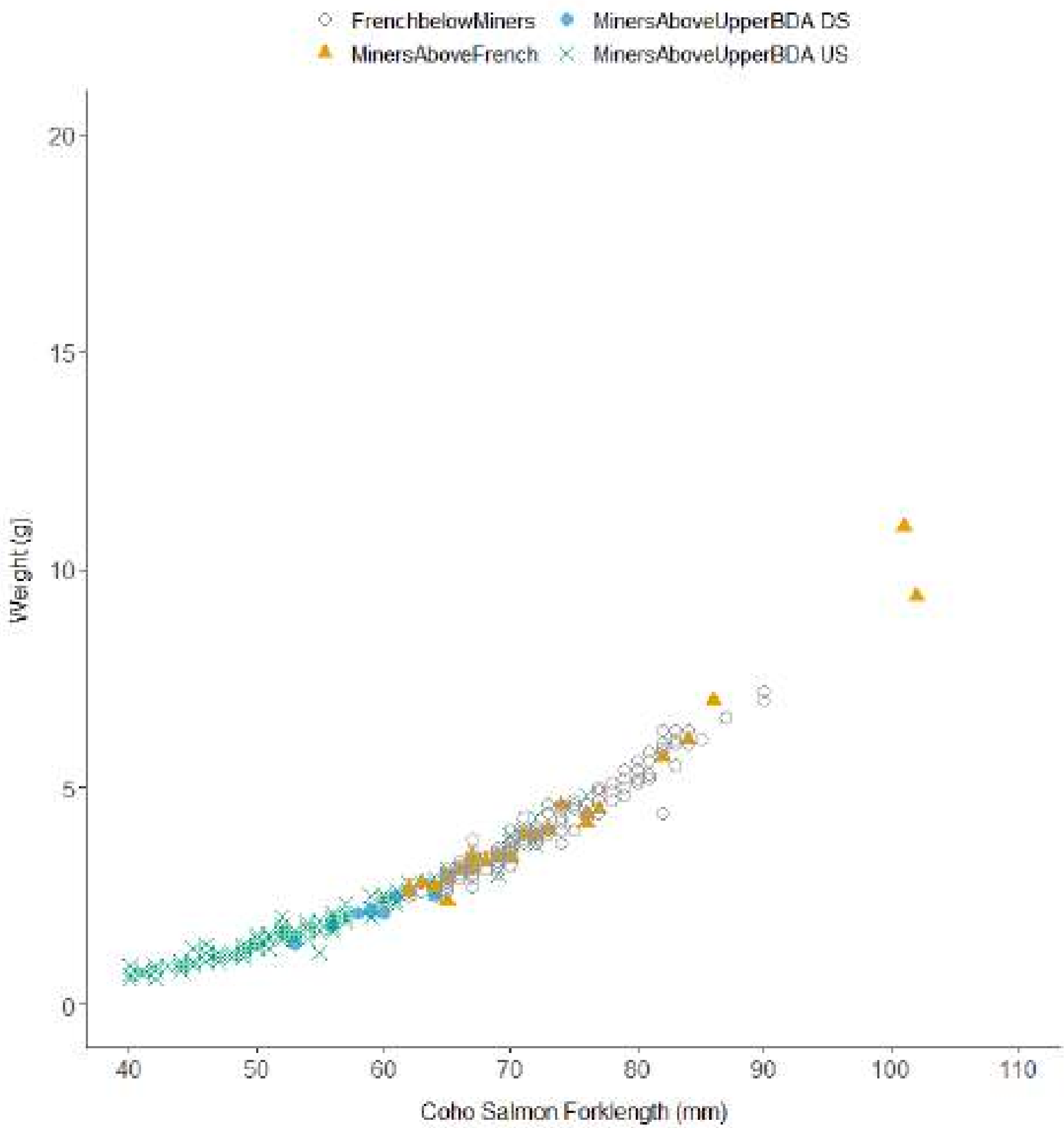
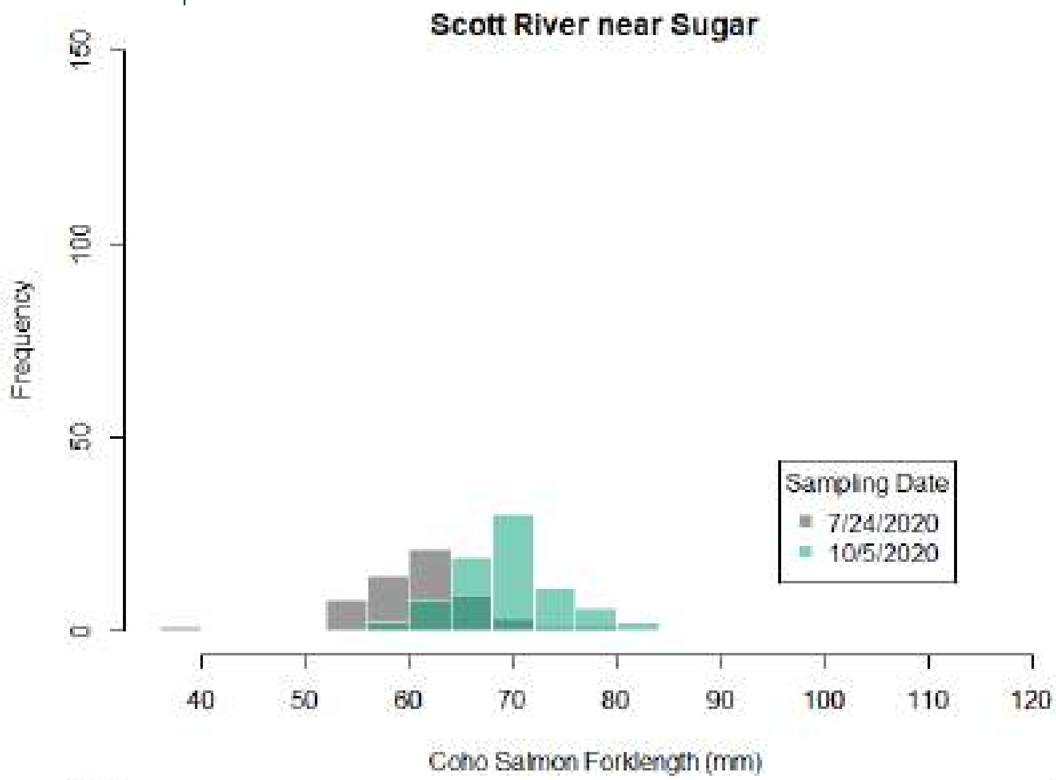


Figure 12. Weight (g) versus forklength (mm) of Coho Salmon captured in three Miners Creek sites and French below Miners Creek confluence on October 12, 2020.

4.0 Scott River

4.1 Summer-Fall Comparison

A)



B)

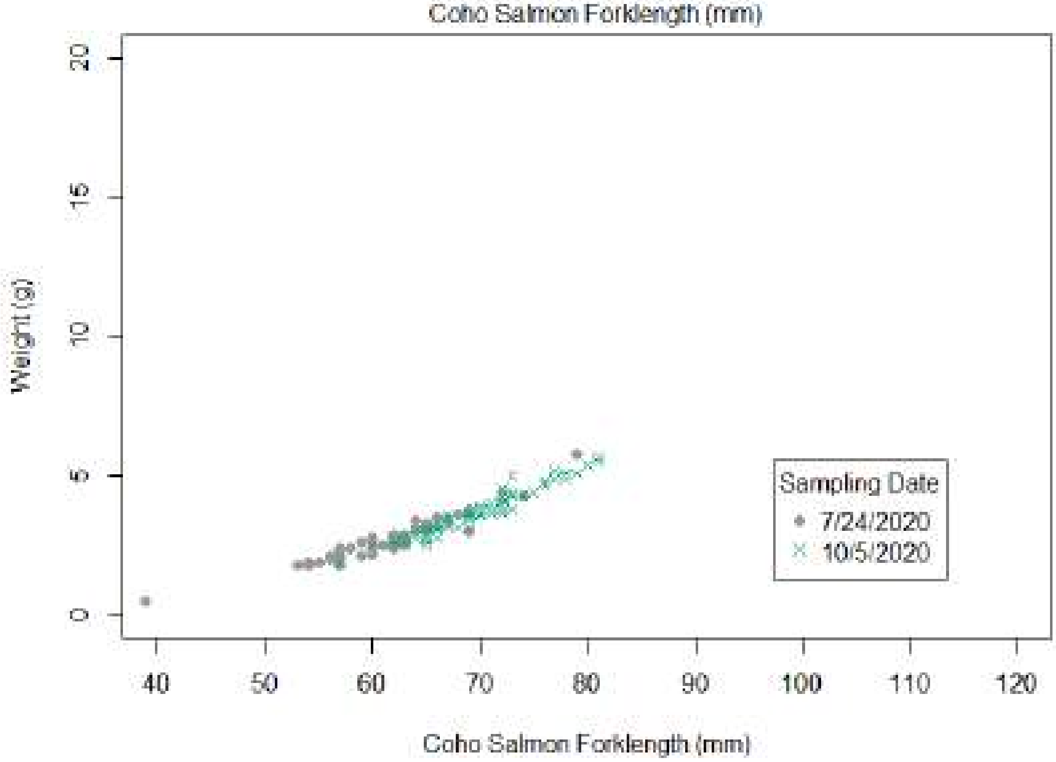


Figure 13. Scott River – Sugar Creek confluence pool A) Change in frequency of Coho Salmon forklengths (mm) from summer (black) to fall (light green). Where the histograms overlap is shown in dark green. B) Change in coho salmon weight (g) versus forklength (mm) from summer-fall.

Scott River Watershed Council - November 2020 PIT Antenna Movement Summary
Monica Tonty, Darrell Mitchell and Erich Yokel

A precipitation event from November 15 - November 17, 2020 generated runoff in Miners and French Creek and a significant increase of PIT tag detections occurred. This report addresses questions regarding fall redistribution during the month of November using the fish that were tagged in 1) Miners Creek - French Confluence, 2) Control Pools and 3) ELJ Reach, and the network of arrays in Mid French: US Array 16 (French RKM 3.5 riffle between Control Pool 3 and Pool 4), DS Paired Array (10 & 11 - RKM 2.9), the paired array at FRGP SC Outlet (12 - US (above Log Structure) and 15 DS (below Log Structure), and HSU round array 90 (US ELJ 1 RR).

1166 coho were tagged during baseflow sampling events between 7/24-7/30/2020 and 10/5-10/12/2020 (Table 1). Another 157 coho were tagged in Sugar BP1, but it is assumed that most if not all perished when it went dry in September, so they were excluded from this analysis. We installed Array 16 (Mid French RKM 3.5) between Pool 3 and Pool 4 on 08/03/2020 to see if there was movement between the two pools during base flow. 15 fish were detected between 8/3-10/6/2020, 130 fish were detected between 10/7-10/31/2020, and 124 fish were detected between 11/1-11/30/2020. October movement of fish mostly occurred the four days immediately after the 10/7/2020 tagging event in the French Control Pools.

41.7% of the fish tagged during the baseflow period were detected on an antenna in November, with the majority detected by antennas in either the French FRGP SC, French ELJs, or Mid-French RKM 2.9 (Table 2). 85% of detected fish were tagged in Mid-French sites and detected on French antennas, though they only made up 73.4% of tagged fish. 10.5% of detected fish were tagged in Miners Creek and the Miners-French confluence and detected on French antennas, though they made up 20.7% of tagged fish. Most fish detected from the Miners Creek area came from Miners-French confluence (FrenchbelowMiners) (Table 5). Very few fish from Miners Creek were detected on antennas (Table 4). Miners was disconnected from French during some of this period. The other fish were tagged in the Scott River near Sugar Creek and detected on the antenna below Sugar BDA 1 (Table 6).

About 20% of the fish tagged in Miners-French Creek Confluence pool and the French Control pools were detected moving downstream by the Mid-French RKM 2.9 antennas (Table 7). 31% of fish tagged in the ELJs and 19% tagged in the French Control Pools moved into the FRGP SC (Table 8). Timing of movement into the FRGP SC aligns with the peak in Scott River discharge, while the timing of movement past the Mid-French RKM 2.9 antennas occurs just after the peak in discharge (Figure 1 and Figure 2).

Table 1. # of coho tagged prior to fall distribution in French Creek, Miners Creek, and Scott River. Tagging occurred 7/24-7/30/2020 and 10/5-10/12/2020.

Tributary	Sampling Site	Coho Tagged
French Creek	ELJ	335
French Creek	FrenchbelowMiners	158
French Creek	FrenchControl	497
French Creek	US ELJs	24
Total French Creek		**1013**
Miners Creek	MinersAboveFrench	47
Miners Creek	MinersAboveUpperBDA DS	28
Miners Creek	MinersAboveUpperBDA US	8
Total Miners Creek		**83**
Scott River	ScottAboveSugar	16
Scott River	ScottSugarConfluence	54
Total Scott River		**70**
Grand Total		*1166*

1) How many of the tagged fish have been detected anywhere during November?

Table 2. 486 of 1166 coho (41.7%) tagged in the July/October sampling effort were detected on any antenna in November 2020. Total # and percent of tagged fish detected at each site in November 2020 shown. Fish can be counted at multiple sites. For example, 16% of the fish tagged in July/October were detected on a Mid French RKM 2.9. Some of the same fish may also be included in the 10% of fish detected on the Mid French RKM 3.5 antenna.

AntennaTributary	Antenna Site	Total Coho	% of Tagged
FRENCH CREEK	FRENCH US ELJ 1 RR	169	14%
FRENCH CREEK	MID FRENCH RKM 2.9	181	16%
FRENCH CREEK	MID FRENCH RKM 3.5	121	10%
FRENCH CREEK	MID FRENCH SC	223	19%
FRENCH CREEK	MID FRENCH SC BDA POND 1	1	0%
SUGAR CREEK	BELOW BDA1	22	2%

a. What percent of tags applied in mid-French Creek have been detected on the French arrays?

Table 3. 413 of 855 coho (48.3%) tagged in the July/October sampling effort in mid- French sites: French Controls, French ELJs, or US ELJs Pre-restoration, were detected on an antenna in French Creek in November 2020. Total # and percent of fish tagged in mid-French sites and detected shown for each French Creek antenna site. Fish can be counted at multiple sites. For

example, 17% of the fish tagged in mid-French were detected on the Mid French RKM 2.9 arrays. Some of the same fish may also be included in the 11% of fish detected on the Mid French RKM 3.5 array.

AntennaTributary	Antenna Site	Total Coho	% of Tagged
FRENCH CREEK	FRENCH US ELJ 1 RR	160	19%
FRENCH CREEK	MID FRENCH RKM 2.9	142	17%
FRENCH CREEK	MID FRENCH RKM 3.5	95	11%
FRENCH CREEK	MID FRENCH SC	203	24%

b. Were fish that were tagged in Miners Creek and/or the French Creek Confluence Pool detected on the array network in Mid French?

Table 4. 3 out of 83 coho (3.6%) tagged in Miners Creek in July/October 2020 were detected moving downstream by the array network in Mid French in November 2020. Total # and percent of fish tagged in Miners Creek and detected at a French Creek antenna site shown. Fish can be counted at multiple sites.

TaggingSite	Antenna Site	Total Coho	% of Tagged
Miners Creek	MID FRENCH RKM 2.9	3	4%
Miners Creek	MID FRENCH SC BDA POND 1	1	1%

Table 5. 48 out of 158 coho (30.4%) tagged in the French below Miners site (confluence pool) in July/October 2020 were detected moving downstream by the array network in Mid French in November 2020. Total # and percent of fish tagged in the French below Miners site and detected at a French Creek antenna site shown. Fish can be counted at multiple sites.

TaggingSite	Antenna Site	Total Coho	% of Tagged
French below Miners	FRENCH US ELJ 1 RR	9	6%
French below Miners	MID FRENCH RKM 2.9	36	23%
French below Miners	MID FRENCH RKM 3.5	26	16%
French below Miners	MID FRENCH SC	20	13%

c. What percent of tags applied in Scott River have been detected on the arrays in Sugar Creek?

Table 6. 22 of 70 coho (31.4%) tagged during the July/October sampling effort in the Scott River were detected on the Sugar Creek antenna below BDA1 in November 2020. Six of these coho were tagged during the July sampling effort and 16 were tagged during the October effort, comprising 42.8% and 28.5% of the tagged fish from each event respectively. The 157 fish

tagged in Sugar Creek BP1 were not detected on any antenna. It is assumed that most if not all perished when it went dry in September, so they were excluded from this table.

AntennaTributary	Antenna Site	Total Coho	% of Tagged
SUGAR CREEK	BELOW BDA1	22	31%

3. Significant numbers of fish were detected on the Mid French RKM 2.9 DS paired arrays (10/11)
    a. which sample units did these fish originate in?

Table 7. 184 unique PIT tags were detected on the Mid French RKM 2.9 DS paired arrays (10/11) in November 2020. Three were 1+ coho tagged during the 2019-20 tagging season in the French Control Pools and are not included in the table. The total # and percent of fish from each tagging site detected shown below. For example, 36 of the 158 fish tagged in French below Miners during the July/October 2020 sampling effort were detected on the French DS paired arrays during November, or 22.8%.

Tributary	Tagging Site	Total Tagged	Total Detected	Percent
French Creek	FrenchbelowMiners	158	36	22.8%
French Creek	FrenchControl	497	97	19.5%
French Creek	ELJ	335	42	12.5%
Miners Creek	MinersAboveUpperBDA US	8	1	12.5%
French Creek	US ELJs	24	3	12.5%
Miners Creek	MinersAboveFrench	47	2	4.3%
Miners Creek	MinersAboveUpperBDA DS	28	0	0%
Scott River	ScottAboveSugar	16	0	0%
Scott River	ScottSugarConfluence	54	0	0%
Sugar Creek	SugarBP1	157	0	0%

    b. It is assumed that these fish migrated downstream through the arrays - can we confirm?

Out of 184 unique tags on the Mid French RKM 2.9 paired arrays, I confirmed that 163 moved downstream. Out of the other 21 fish, three moved upstream and 18 were only detected on one antenna, so I could not confirm direction of movement.

    c. Did we detect these fish in the arrays after they first passed through the DS arrays or have they left the universe of our detection to date?

None of the 184 unique tags detected on the Mid French RKM 2.9 paired arrays in November have been detected on any SRWC antenna from December 1, 2020-January 4, 2021.
The mean first date of detection for fish on the Mid French RKM 2.9 paired arrays was 11/20/2020 (Figure 1).

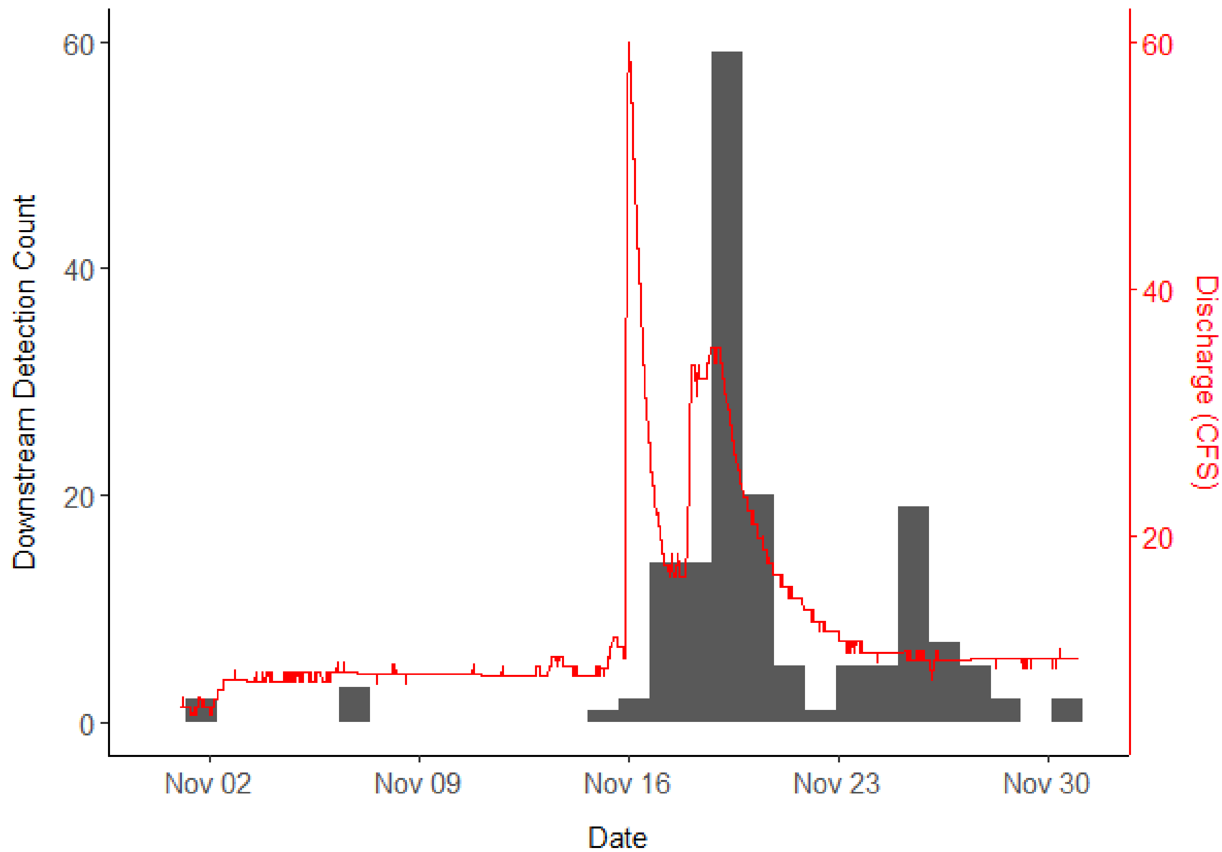


Figure 1. Histogram of PIT detections on the Mid French RKM 2.9 DS paired arrays (10/11) and USGS Scott River @ Fort Jones stream discharge in CFS.

4. Significant numbers of fish were detected on the DS (15) and US (12) arrays at the FRGP SC.
    a. what is the habitat of origin of these fish?

Table 8. 225 unique PIT tags were detected on the French FRGP SC arrays (15/12) in November. A 1+ coho tagged in January 2020 in French Control and one mystery/weird tag are not included in the table. The total # and percent of fish detected from each tagging site shown below. For example, 104 of the 335 coho tagged in French ELJs during the July/October 2020 sampling effort were detected on the French FRGP SC arrays in November, or 31%.

Tributary	Tagging Site	Total Tagged	Total Detected	Percent
French Creek	ELJ	335	104	31%
French Creek	FrenchControl	497	95	19.1%
French Creek	US ELJs	24	4	16.7%
French Creek	FrenchbelowMiners	158	20	12.7%
Miners Creek	MinersAboveFrench	47	0	0%
Miners Creek	MinersAboveUpperBDA DS	28	0	0%
Miners Creek	MinersAboveUpperBDA US	8	0	0%
Scott River	ScottAboveSugar	16	0	0%
Scott River	ScottSugarConfluence	54	0	0%
Sugar Creek	SugarBP1	157	0	0%

b. can we determine that the fish went US into the FRGP SC from the mainstem

I confirmed 165 moved US into the FRGP SC outlet from the mainstem in November. Another 38 were only detected on the DS antenna, so I cannot confirm they went in to the FRGP SC, and 11 were detected on the US outlet antenna without first being detected on the DS antenna. These fish are possibly entering the SC via the inlet, which does not currently have an antenna. An additional 23 moved into the side channel in mid-late October and continued to be detected in November.

The mean first date of detection for fish on the upstream outlet antenna was 11/18/2020 (Figure 2).

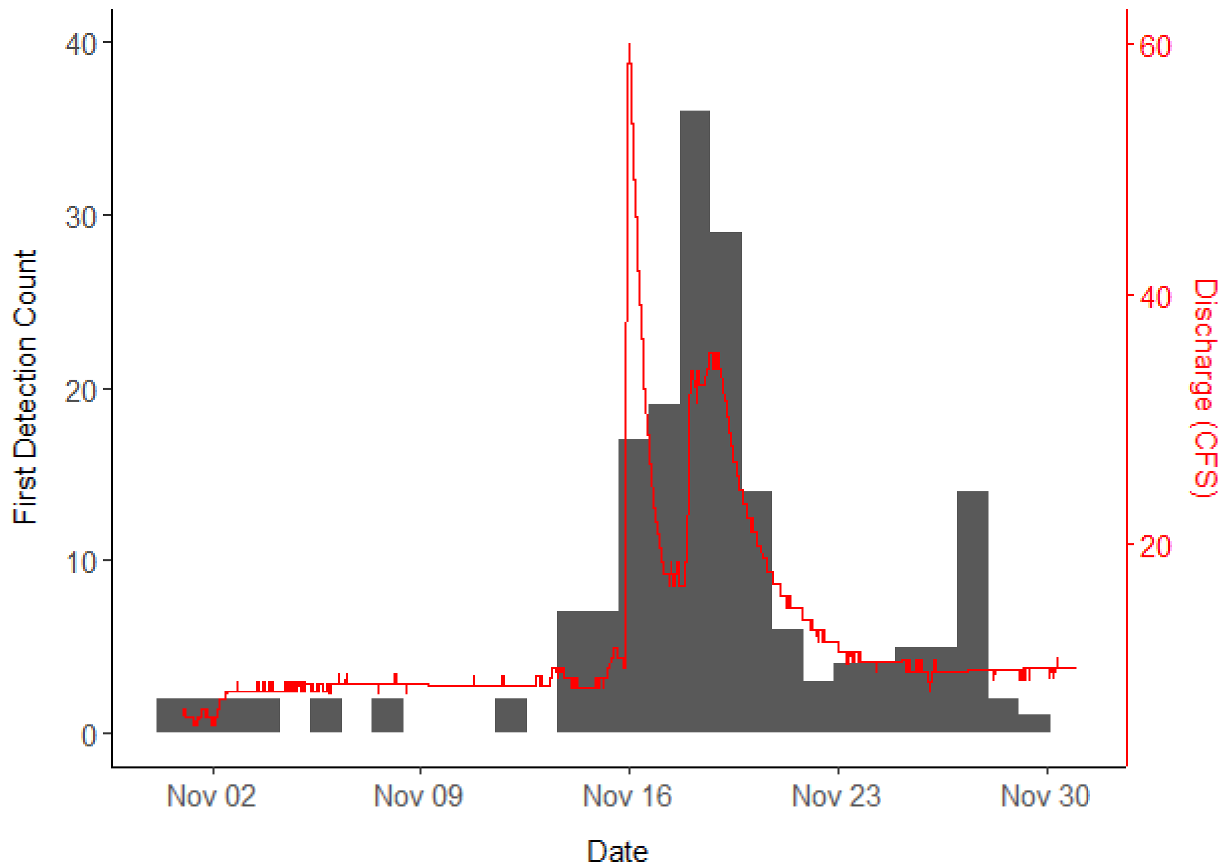


Figure 2. Histogram of first date of detection in the FRGP SC outlet and USGS Scott River @ Fort Jones stream discharge in CFS.

c. Is there any detection of movement back and forth between SC and Mainstem?

Many fish showed back and forth movement over one day after initial arrival. Eleven fish showed more extensive back and forth movement between the SC and the mainstem French over multiple days in November. None of these fish were detected on any other antennas during this time, so it is unclear where they were going.

d. Did we detect all in-hand recaptured fish on the arrays?

All 34 recaps captured in the French FRGP SC during the 12/15/20 sampling event were detected by the outlet antennas. 29 were detected in November. Three of those were only detected on the US antenna, so it is unclear if they came in through the outlet or inlet. The other five recaps were detected in early December, with one of those only detected on the DS antenna. Potentially it never went further upstream and was caught in a minnow trap near the DS antenna, it came into the SC via the inlet, or it was just missed by the US outlet antenna.

Mid French Creek Juvenile Salmonid Fish Sampling – December 2020
Scott River Watershed Council

12/14/2020

Mid French Control Pools

Coho Salmon		
Total Catch	Marked	Recaptured
39	16	14

O. mykiss
Total Catch
30

Wood Gravel Augmented Side Channel

Coho Salmon		
Total Catch	Marked	Recaptured
23	13	2

O. mykiss
Total Catch
17

Table 1 – Total Catch – Mid French Creek Control Pools and Wood and Gravel Augmented Side Channel

12/15/2020

Mid French ELJs Reach

Coho Salmon		
Total Catch	Marked	Recaptured
23	13	2

O. mykiss
Total Catch
17

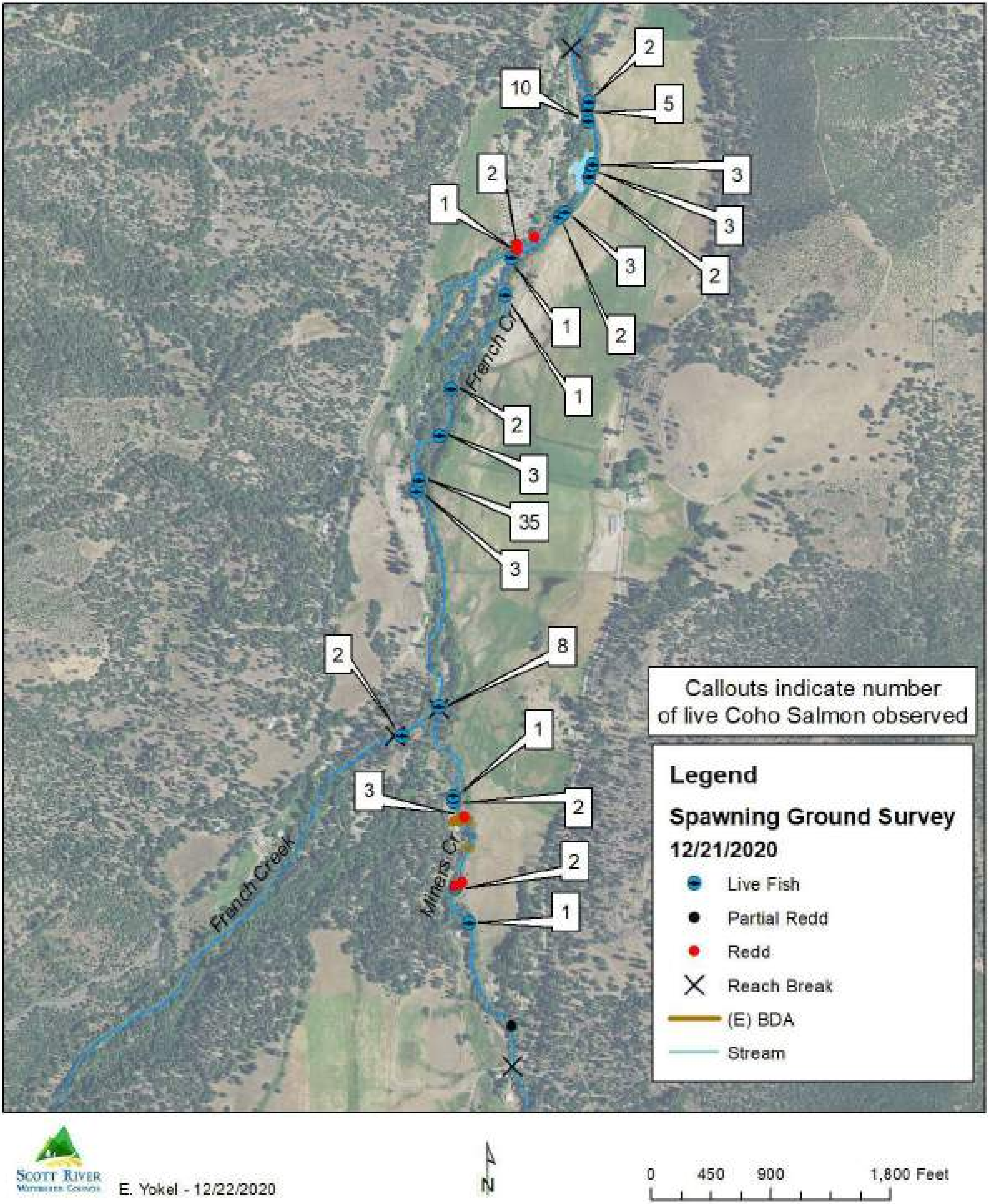
FRGP Side Channel

Coho Salmon		
Total Catch	Marked	Recaptured
441	206	34

O. mykiss
Total Catch
12

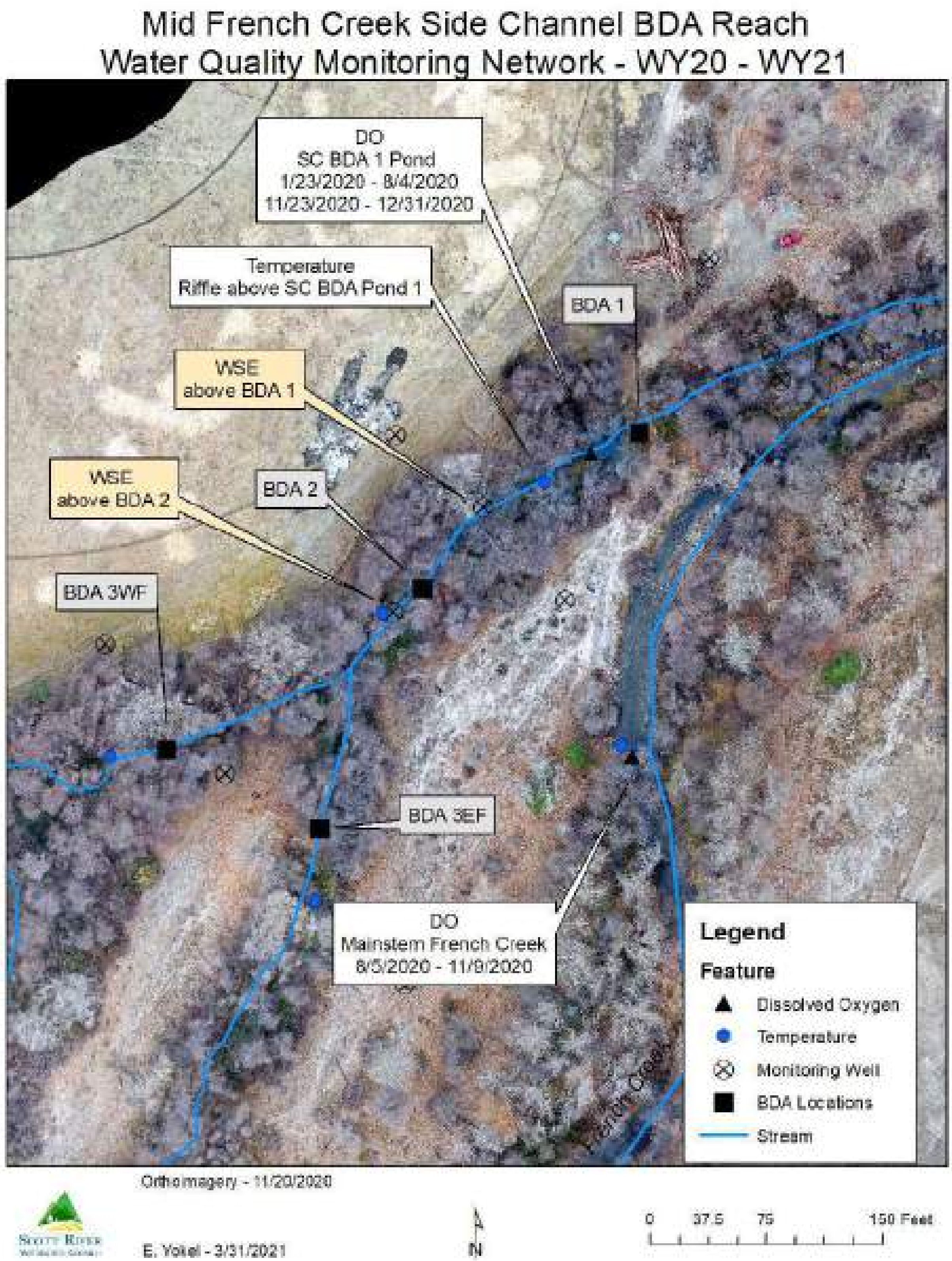
Table 2 – Total Catch – Mid French Creek ELJs Reach and FRGP Side Channel

Lower Miners Creek and Mid French Creek Spawning Ground Survey - 12/21/2020



Scott River Watershed Council

E. Yokel - 12/22/2020



Map xx – Water Quality Monitoring Networks – Mid French Creek Side Channel BDA Reach

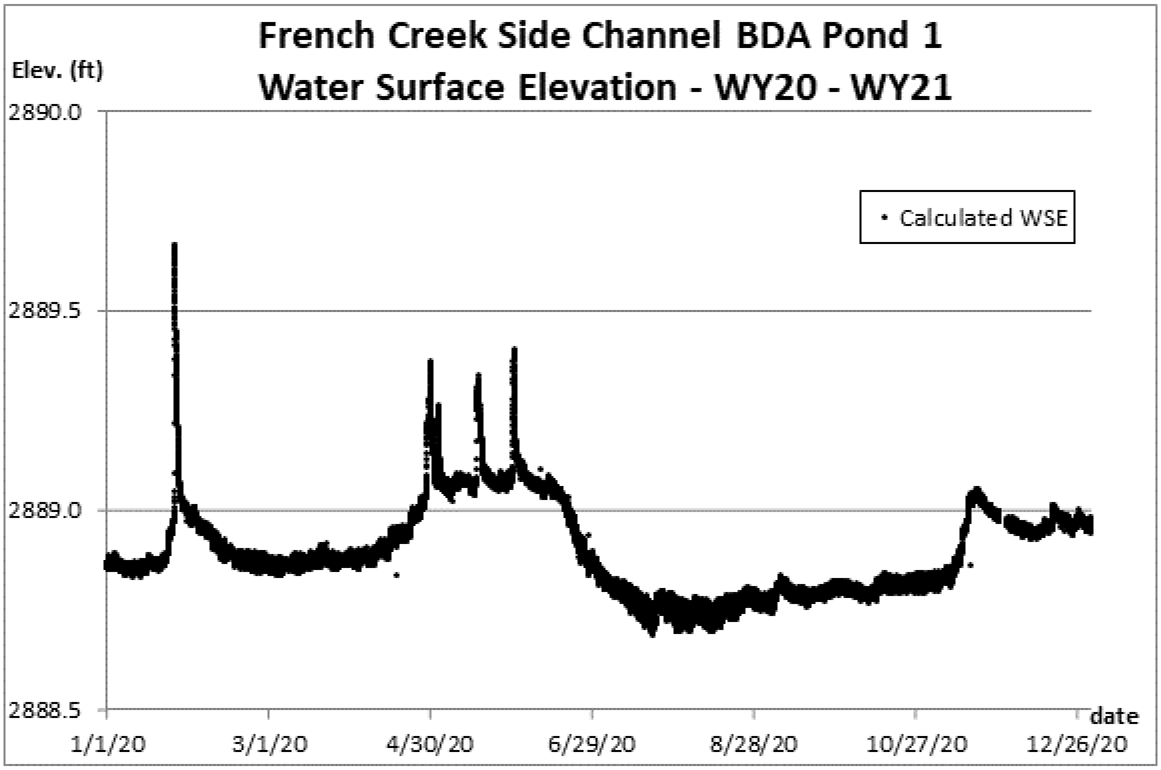


Figure xx – Calculated Water Surface Elevation (WSE) – Side Channel BDA Pond 1

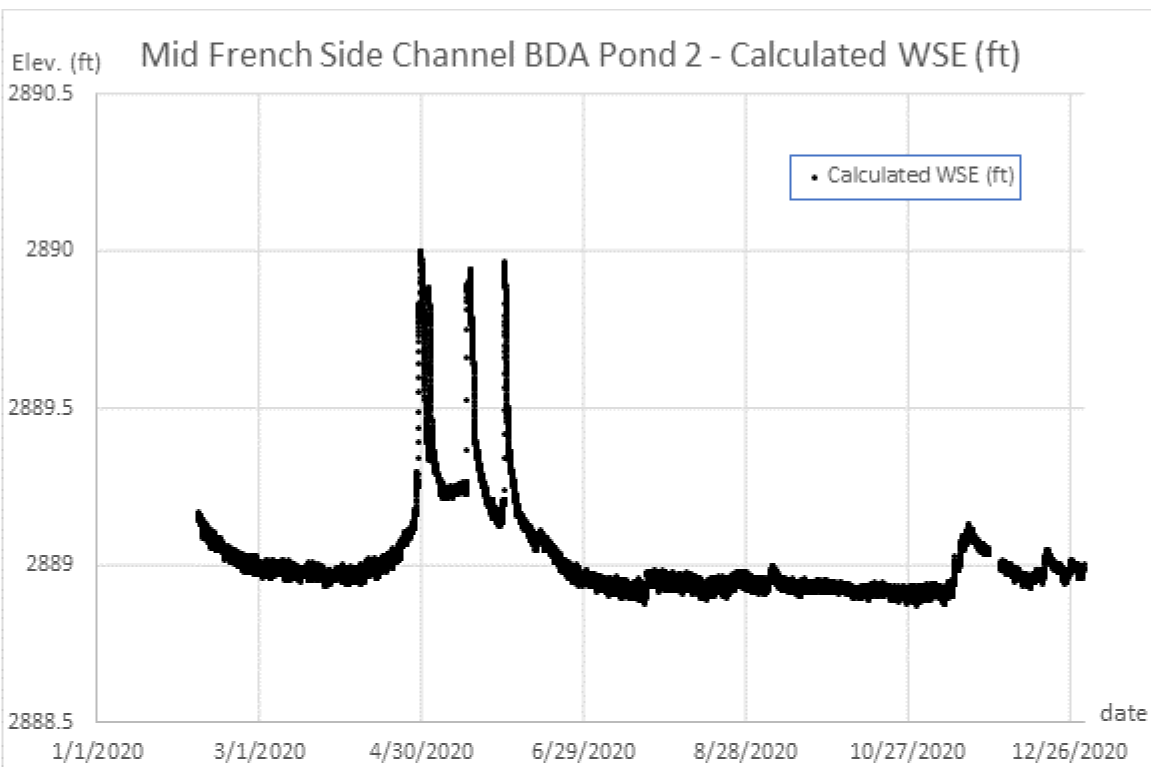


Figure xx – Calculated Water Surface Elevation (WSE) – Side Channel BDA Pond 2

Water surface elevation (WSE) was monitored upstream of the Mid French Side Channel BDA Pond 1, documenting a runoff event on January 26, 2020 that restored connectivity throughout the Side Channel BDA reach creating fish passage into the BDA 1 Pond (Figure xx).
Three additional increases in WSE were documented from April 28 – June 2, 2020.

A continuous WSE station was established in the Mid French Side Channel BDA Pond 2 on February 2, 2020 (Figure xx).

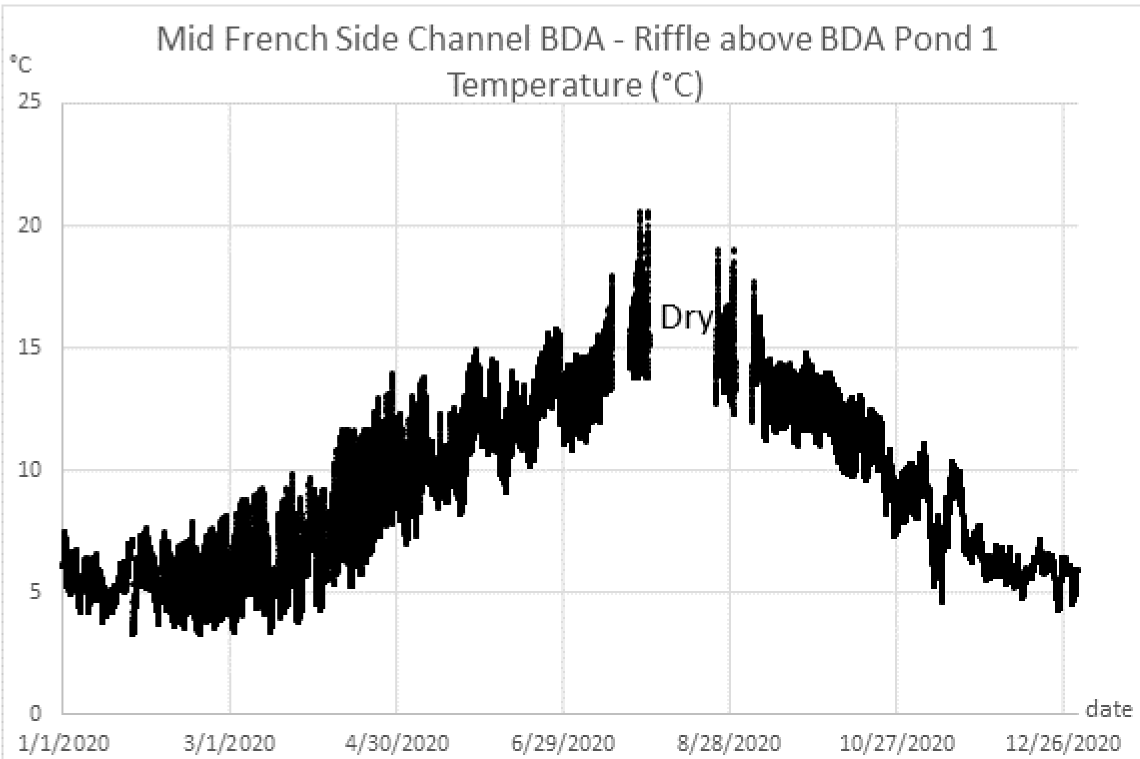


Figure xx – Water Temperature (°C) – Riffle above Side Channel BDA Pond 1

Water temperature (°C) in the riffle above the Side Channel BDA Pond 1 was documented (Figure xx).
The location of the temperature station in the riffle was intermittently dry for a period from July 17 – September 4, 2020.
Comparison of the daily average temperatures from the riffle above the BDA Pond 1 and the DO logger in BDA Pond 1 shows the equivalent temperatures in the two locations for the period of record (Figure xx).
A dissolved oxygen (DO) logger was operated in the BDA Pond 1 from January 23 – August 4, 2020 (Figure xx). The DO logger was removed from the BDA Pond and placed in mainstem French Creek due to the lack of fish utilizing the BDA Pond and the significant population of fish in the mainstem.

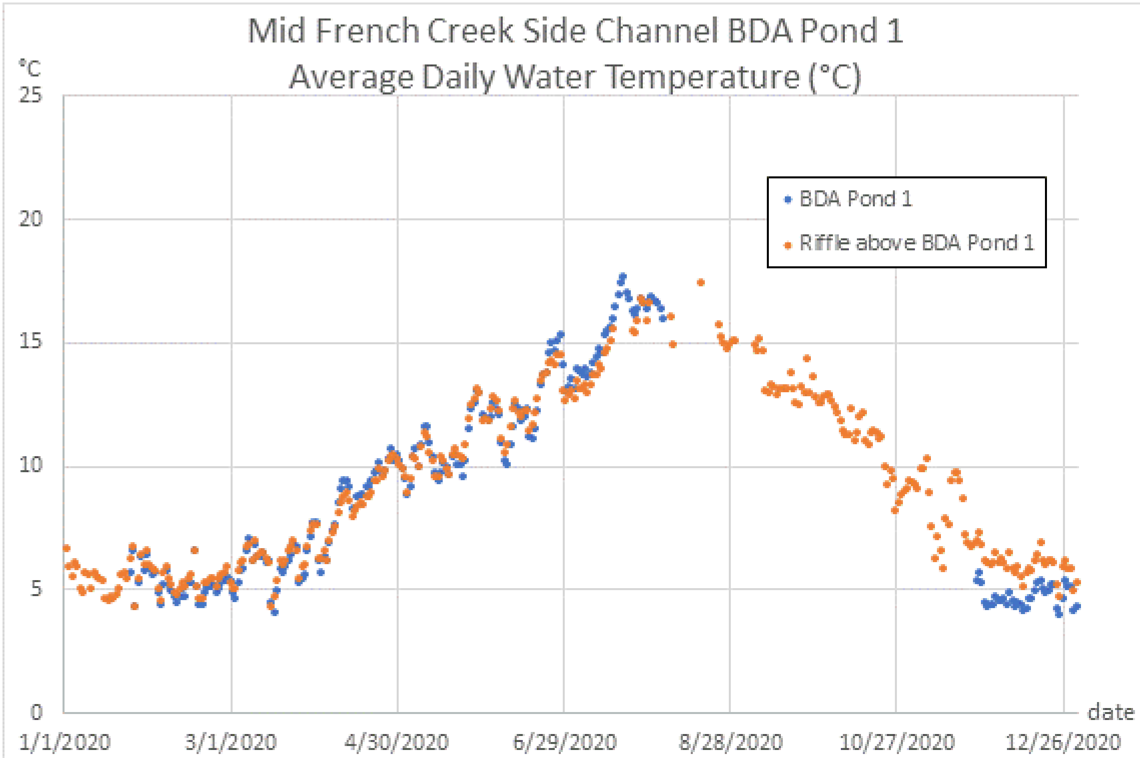


Figure xx – Daily average water temperature (°C) – Side Channel BDA Pond 1 & Riffle above BDA Pond 1

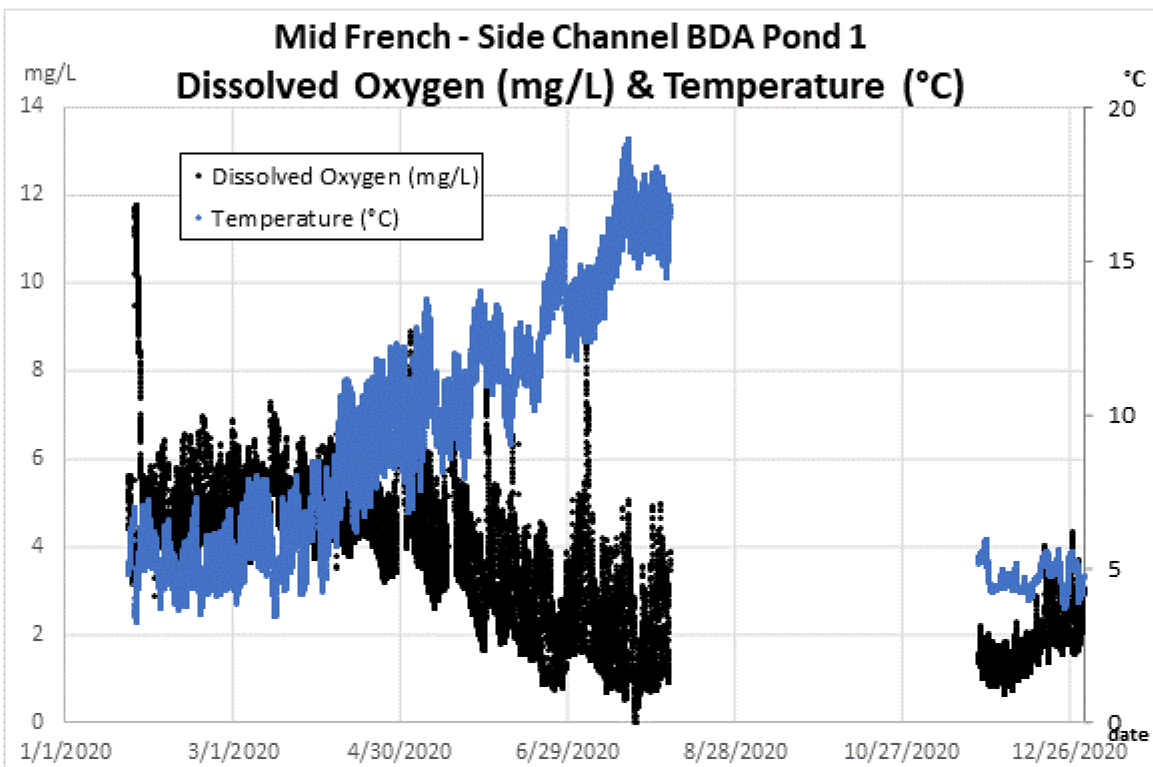


Figure xx – Dissolved oxygen (mg/L) and water temperature (°C) – Side Channel BDA Pond 1 – 2020

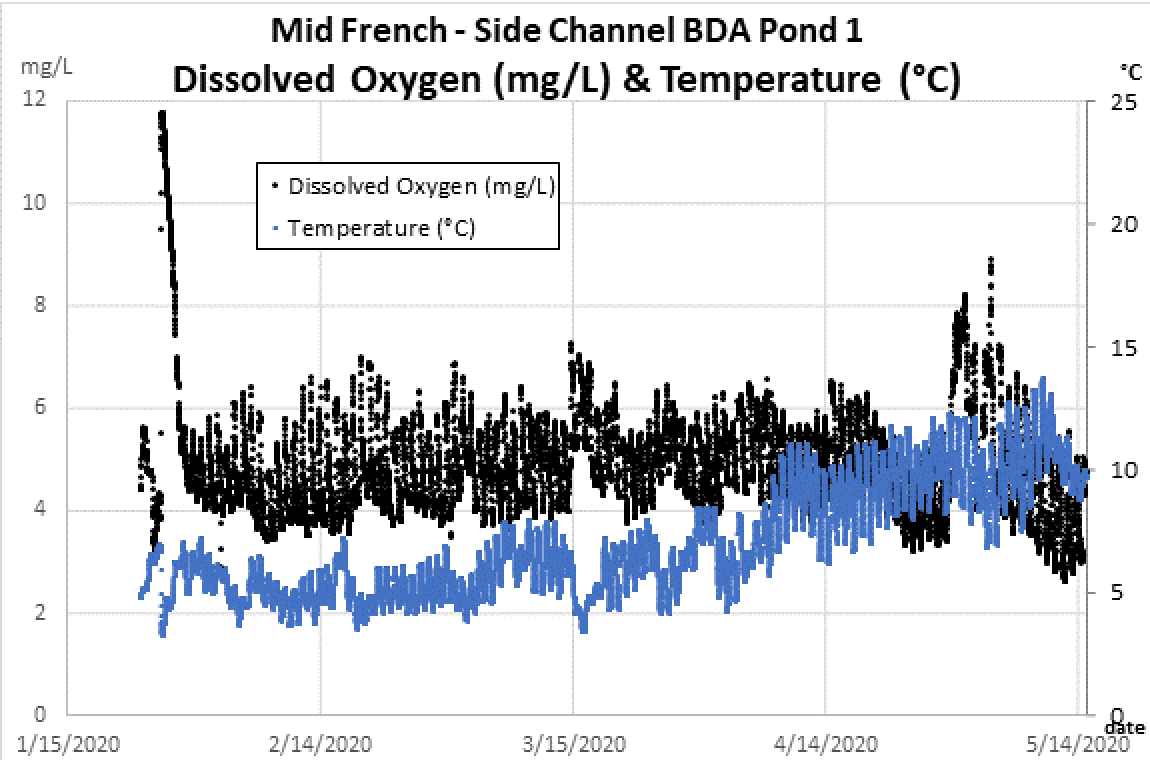


Figure xx – Dissolved oxygen (mg/L) and water temperature (°C) – Side Channel BDA Pond 1 – WY20

14 – Mid French Side Channel BDA Pond 1				
Site	**Start Date**	**End Date**	**# Unique**	**Days of**
14	12/3/2019	12/13/2019	0	10
14	12/13/2019	12/31/2019	off line	18
14	12/31/2019	1/13/2020	off line	13
14	1/13/2020	1/28/2020	16	15
14	1/28/2020	2/3/2020	82	6
14	2/7/2020	2/25/2020	75	18
14	2/25/2020	3/10/2020	72	14
14	3/10/2020	3/24/2020	74	14
14	3/24/2020	4/7/2020	30	14
14	4/7/2020	4/14/2020	31	7
14	4/14/2020	4/21/2020	30	7
14	4/21/2020	4/28/2020	7	7
14	4/28/2020	5/5/2020	8	7
14	5/5/2020	5/12/2020	1	7
14	5/12/2020	5/19/2020	0	7

Table 1 – Unique PIT tags detected in Mid French Side Channel BDA Pond 1

A PIT tag array detected tagged Coho Salmon utilizing the BDA Pond 1 on January 26, 2020, concurrent with the runoff event that restored connectivity through the BDA Reach. The last PIT tagged Coho Salmon was detected in the BDA Pond during the week of May 5 -12, 2020 (Table 1).

The Coho Salmon in the Mid French Side Channel BDA Pond 1 were sampled three times to document growth and condition (Table 2).

During sampling efforts on March 18 – 20, 2020, Coho Salmon were sampled in five habitats in Mid French Creek to compare growth and condition (Table 3).

The final sampling effort on April 15, 2020 captured Coho Salmon in the Side Channel BDA Pond 1 and the step pool downstream of BDA Pond 1 (Table 4).

Coho Salmon - Average forklength (mm)

Date Site	2/2/2020 French SC BDA Pond 1	3/20/2020 French SC BDA Pond 1	4/15/2020 French SC BDA Pond & Step Pool
Average	79	86	89
Stand. Dev.	7.9	7.2	8.6
Minimum	63	71	69
Maximum	104	109	107
Count	82	80	64

Table 2 – Average foklength per sample effort of Coho Salmon – French Side Channel BDA Pond 1

Coho Salmon - Average forklength (mm)

Date Site	3/18/2020 FRGP Side Channel	3/18/2020 ELJ Reach	3/20/2020 Control Pools	3/20/2020 Wood/Gravel SC	3/20/2020 SC BDA Pond 1
Average	90	83	87	86	86
Stand. Dev.	12.1	7.7	9.7	8.0	7.2
Minimum	64	68	73	68	71
Maximum	128	106	115	103	109
Count	230	59	55	23	80

Table 3 – Average foklength of Coho Salmon – Mid French Creek – March 18 – 20, 2020

Coho Salmon - Average forklength (mm)

Date Site	4/15/2020 French SC BDA Pond & Step Pool	4/15/2020 French SC BDA Pond 1	4/15/2020 French SC BDA Step Pool 1.1
Average	89	94	81
Stand. Dev.	8.6	5.7	5.9
Minimum	69	82	69
Maximum	107	107	91
Count	64	37	27

Table 4 – Average foklength of Coho Salmon – French Side Channel BDA Pond 1 and Step Pool 1.1 – April 15, 2020

Scott River Watershed Council – Fish Sampling - Mid French Creek Restored Habitats - January 26, 2021

Mid French Creek – FRGP Side Channel – January 26, 2021

Coho Salmon captured in FRGP Side Channel

A total of 35 baited minnow traps and one fyke net were deployed in four habitats in Mid French Creek – mainstem Engineered Log Jams (ELJs) reach, the FRGP Side Channel and the Side Channel BDA Pond 1 and 2 (Table 1). A total of 603 Coho Salmon were captured including 63 recaptured PIT tagged fish (Table 2). Water temperatures in the mainstem French Creek (0.1° C at 09:30) and the FRGP Side Channel (0.2° C at 11:00) precluded the ability to mark fish. The water temperature in the BDA Ponds were significantly warmer (3.7° C – 4.5° C at 13:00) and a sub sample of the Coho Salmon captured in the Side Channel BDA Pond 1 and 2 were marked.

A total of 14 rainbow trout (*O. mykiss*) were captured in the effort.

		Total Effort	
Date	Sample Unit	Minnow Traps	Fyke Net
1/26/2021	French Creek Engineered Log Jams (ELJs)	7	0
1/26/2021	French Creek FRGP Side Channel	21	0
1/26/2021	French Creek Side Channel BDA Pond 1	5	1
1/26/2021	French Creek Side Channel BDA Pond 2	2	0
	Totals	35	1

Table 1 – Total trap effort by sample unit - January 26, 2021

		Coho Salmon (*O. kisutch*)			Rainbow Trout (*O. mykiss*)
Date	Sample Unit	Total Catch	Marked	Recaptured	Total Catch
1/26/2021	French Creek Engineered Log Jams (ELJs)	55	4	4	12
1/26/2021	French Creek FRGP Side Channel	458	0	50	2
1/26/2021	French Creek Side Channel BDA Pond 1	87	40	9	0
1/26/2021	French Creek Side Channel BDA Pond 2	3	3	0	0
	Totals	603	47	63	14

Table 2 – Total Catch – January 26, 2021

Coho Salmon (FL = 99 mm) captured in Mid French Creek FRGP Side Channel

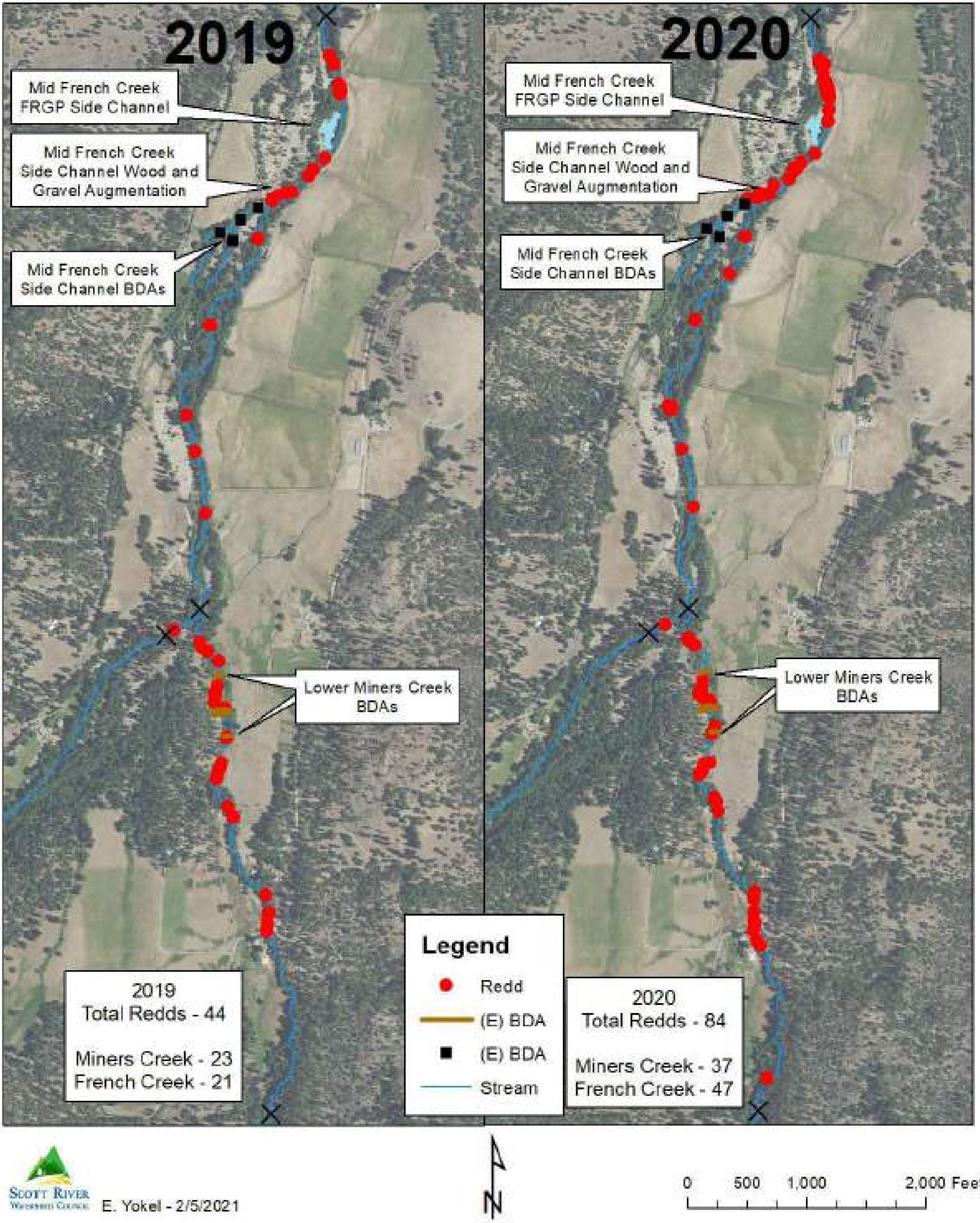
Coho Salmon (FL = 76mm) captured in Mid French Creek FRGP Side Channel

Coho Salmon (FL ≈ 66mm) captured in Mid French Creek FRGP Side Channel

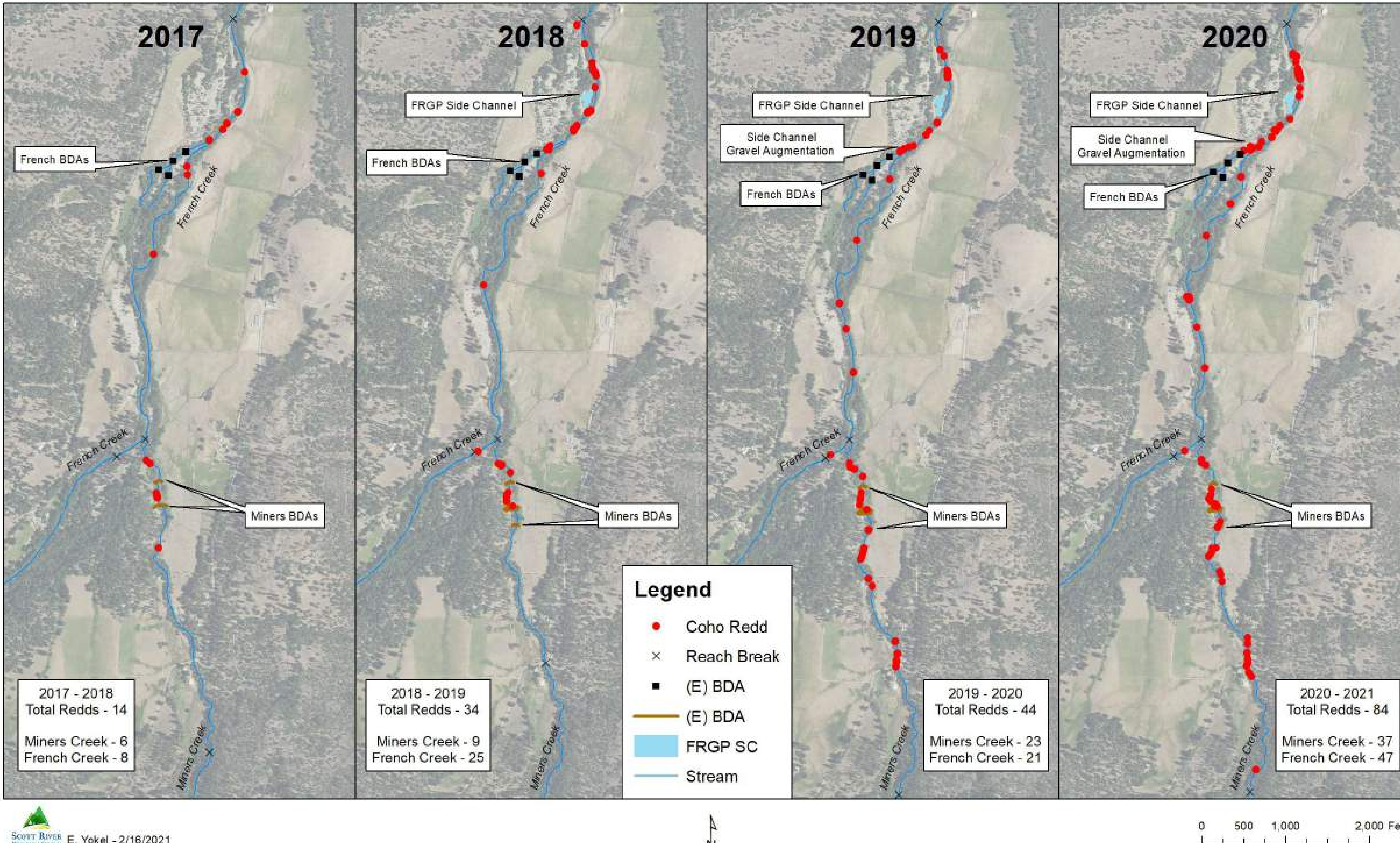
Coho Salmon (FL = 114mm, weight = 14.5g) captured in Mid French Creek Side Channel BDA Pond 2


Retrieving minnow traps in the FRGP Side Channel

Lower Miners Creek & Mid French Creek - Coho Sapwning Ground Survey Redds - 2019 and 2020



Mid French Creek and Lower Miners Creek - Coho Salmon Redds - Brood Year 2017 to Brood Year 2020



Scott River Watershed Council E. Yokel - 2/16/2021

French Creek Side Channel BDA Ponds – Catch Summary – April 26 and May 4, 2021

Scott River Watershed Council

Mid French Side Channel BDA Pond 1 – Looking Upstream

Baited minnow traps were utilized on April 26, 2021 to capture Coho Salmon in the Mid French Side Channel BDA Step Pool 1.1, Pond 1 and Pond 2. A total of 128 Coho Salmon were captured in the three sampled BDA influenced habitats with 61 recaptured PIT tagged Coho (Table 1). No rainbow trout (*O. mykiss*) were captured in the BDA habitats during the sampling effort.

4/26/2021 Coho Sample Summary

Location	Total Catch	Recaptures
French SC BDA Step Pool 1.1	12	4
French SC BDA Pond 1	111	55
French SC BDA Pond 2	5	2
Total	128	61

Table 1 – Total catch by sampled habitat – 4/26/2021

Coho Salmon captured in Mid French Side Channel BDA Pond 1 – April 26, 2021

Coho Salmon Forklength (mm) - April 26, 2021

Site	Side Channel BDA Pond 1 and Step Pool 1.1	Side Channel BDA Pond 2
Average	90	122
Stand. Dev.	7.4	4.2
Minimum	73	115
Maximum	111	126
Count	123	5

Table 2 – Coho Salmon average forklength (mm) in BDA Pond 1 and 2 – April 26, 2021

The Coho Salmon captured in BDA Pond 2 (n = 5) were considerably larger than the Coho captured in BDA Pond 1 and BDA Step Pool 1.1 (n = 123) – Table 2. The forklength histogram for Coho captured in BDA Pond 1 and Step Pool 1.1 illustrates the range of sizes (Figure 1).

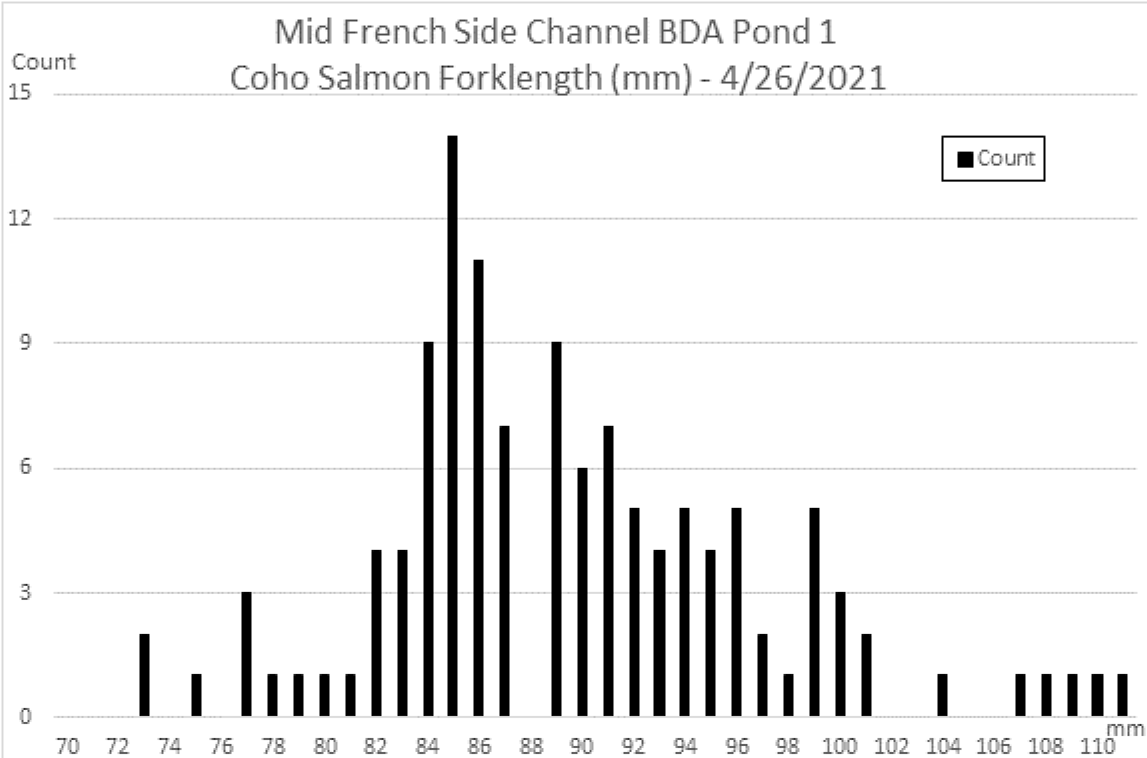


Figure 1 – Forklength (mm) histogram of Coho Salmon captured in BDA Side Channel Pond 1 – 4/26/21

Coho Salmon captured in Mid French Side Channel BDA Pond 2 – April 26, 2021

Date	Species	LocationDetail	PIT Code	FL	WT	Mark	Recap	Days	mm/days	g/days
7/27/2020	Cohsal	French Control Pool 3	989001028113170	84	6.3	y				
10/9/2020	Cohsal	French Control Pool 3	989001028113170	85	6		y	74	0.01	-0.004
1/26/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001028113170	89	7		y	109	0.04	0.009
2/24/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001028113170	95	8		y	29	0.21	0.034
3/23/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001028113170	98	9.2		y	27	0.11	0.044
4/26/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001028113170	104	11.8		y	34	0.18	0.076

Table 3 – Forklength (mm) and weight (g) of PIT tagged Coho Salmon (989001028113170) and rate of growth (mm/days and g/days) between captures

Date	Species	LocationDetail	PIT Code	FL	WT	Mark	Recap	Days	mm/days	g/days
10/7/2020	Cohsal	French Control Pool 2	989001038203265	75	4.6	y				
1/26/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001038203265	80	5.1		y	111	0.05	0.005
2/25/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001038203265	83	5.9		y	30	0.10	0.027
4/26/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001038203265	96	8.5		y	60	0.22	0.043

Table 4 – Forklength (mm) and weight (g) of PIT tagged Coho Salmon (989001038203265) and rate of growth (mm/days and g/days) between captures

Date	Species	LocationDetail	PIT Code	FL	WT	Mark	Recap	Days	mm/days	g/days
10/9/2020	Cohsal	French Control Pool 3	989001038203548	74	4.1		y			
4/26/2021	Cohsal	Mid French Creek SC BDA Pond 2	989001038203548	115	15.9		y	199	0.21	0.059

Table 5 – Forklength (mm) and weight (g) of PIT tagged Coho Salmon (989001038203548) and rate of growth (mm/days and g/days) between captures

Date	Species	LocationDetail	PIT Code	FL	WT	Mark	Recap	Days	mm/days	g/days
10/12/2020	Cohsal	French Creek - below Miners	989001038203755	81	5.2	y				
4/26/2021	Cohsal	Mid French Creek SC BDA Pond 2	989001038203755	123	20.2		y	196	0.21	0.077

Table 6 – Forklength (mm) and weight (g) of PIT tagged Coho Salmon (989001038203755) and rate of growth (mm/days and g/days) between captures

Baited minnow traps were utilized on May 4, 2021 to capture Coho Salmon in the Mid French Side Channel BDA Step Pool 1.1, Pond 1 and Pond 2. A total of 14 Coho Salmon were captured in two of the three sampled BDA influenced habitats with 4 recaptured PIT tagged Coho (Table 1). No Coho Salmon were captured in BDA Pond 2 and no rainbow trout (*O. mykiss*) were captured in the BDA habitats during the sampling effort.

5/4/2021 Coho Sample Summary

Location	Total Catch	Recaptures
French SC BDA Step Pool 1.1	4	2
French SC BDA Pond 1	10	2
French SC BDA Pond 2	0	0
Total	14	4

Table 7 – Total catch by sampled habitat – 5/4/2021

Coho Salmon Forklength (mm) - May 4, 2021

Site	Side Channel BDA Pond 1 and 1.1 Step Pool
Average	95
Stand. Dev.	5.3
Minimum	86
Maximum	105
Count	14

Table 8 – Coho Salmon average forklength (mm) in BDA Pond 1 and 2 – May 4, 2021

Coho Salmon captured in Mid French Side Channel BDA Pond 1 – May 4, 2021

Date	Species	LocationDetail	PIT Code	FL	WT	Mark	Recap	Days	mm/days	g/days
10/7/2020	Cohsal	French Control Pool 3	989001038203588	70	3.7	y				
2/25/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001038203588	80	5.3		y	141	0.07	0.011
3/23/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001038203588	87	6.5		y	26	0.27	0.046
5/4/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001038203588	103	12		y	42	0.38	0.131

Table 9 – Forklength (mm) and weight (g) of PIT tagged Coho Salmon (989001038203588) and rate of growth (mm/days and g/days) between captures

Date	Species	LocationDetail	PIT Code	FL	WT	Mark	Recap	Days	mm/days	g/days
2/24/2021	Cohsal	Mid French Creek SC BDA Pond 1	989001039120218	79	4.7	y				
5/4/2021	Cohsal	Mid French Creek SC BDA step pool	989001039120218	101	10.9		y	69	0.32	0.090

Table 10 – Forklength (mm) and weight (g) of PIT tagged Coho Salmon (989001039120218) and rate of growth (mm/days and g/days) between captures

Mid French Creek – Side Channel BDA Ponds Water Quality

A significant runoff event on January 13, 2021 connected the Mid French Side Channel BDA Ponds (Figure 2). PIT tagged Coho Salmon from the mainstem of French Creek were immediately detected in BDA Pond 1 on January 13.

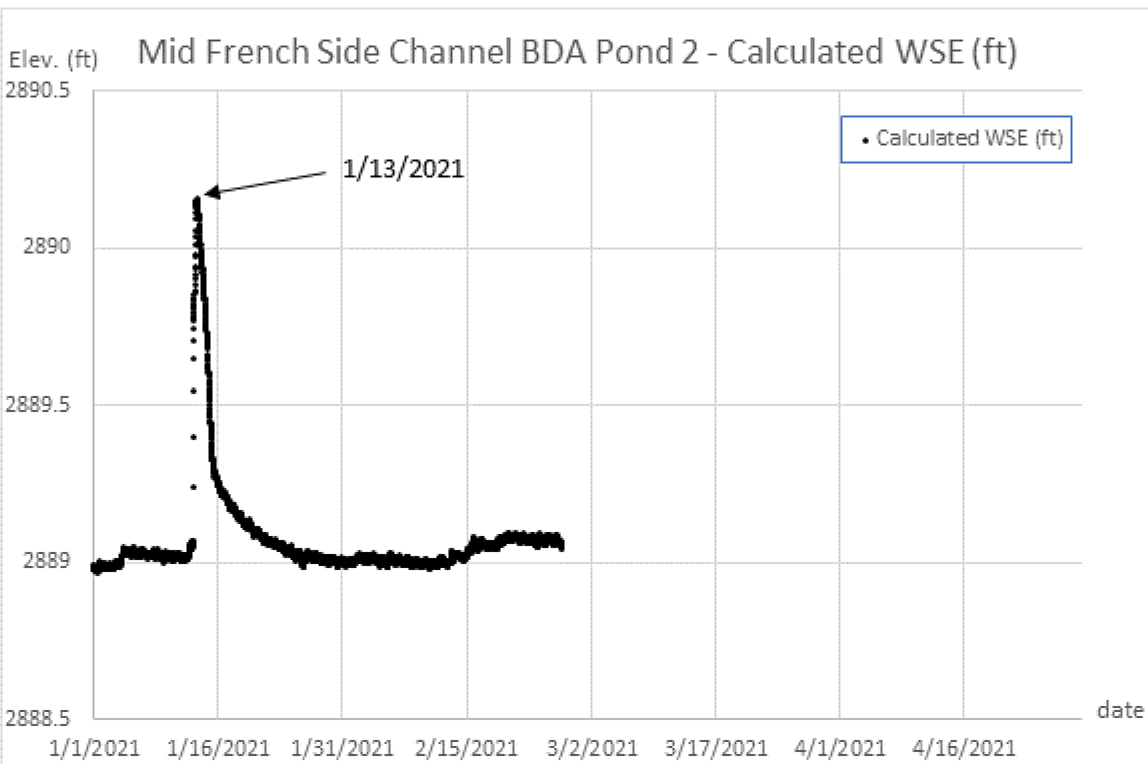


Figure 2 – Water surface elevation (ft) – Mid French Side Channel BDA Pond 2

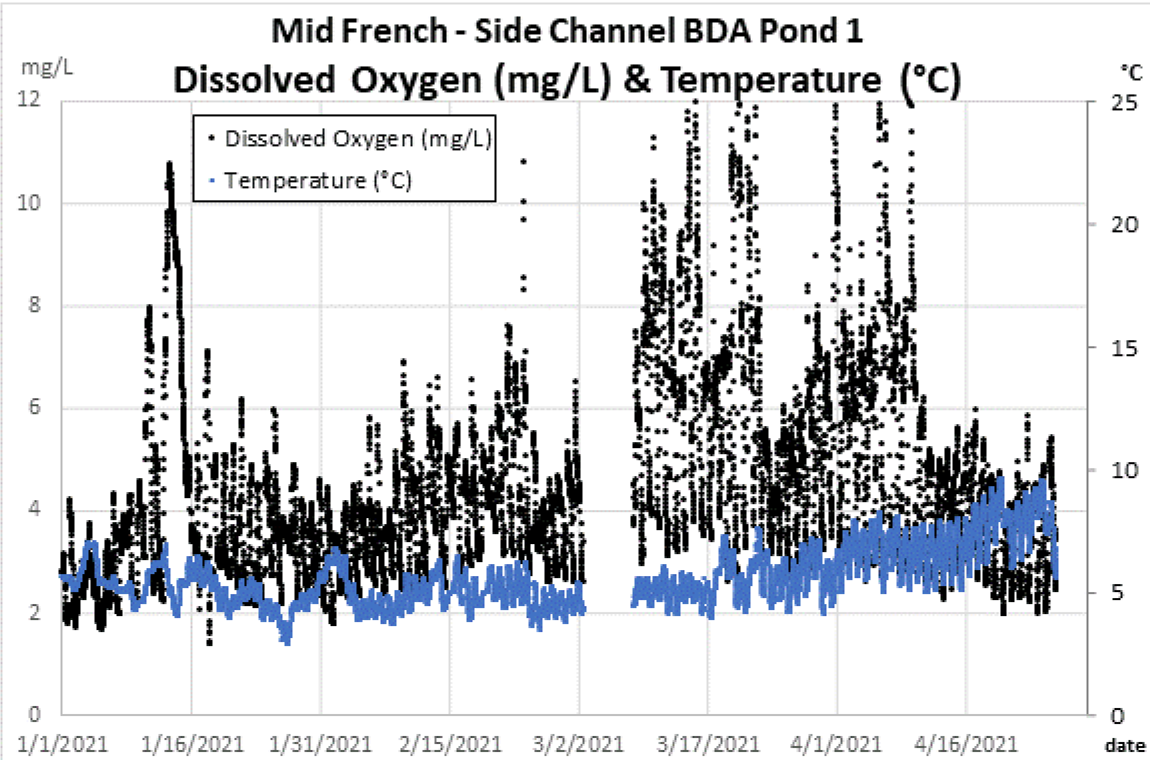


Figure 3 – Dissolved oxygen (mg/L) and temperature (°C) – Side Channel BDA Pond 1

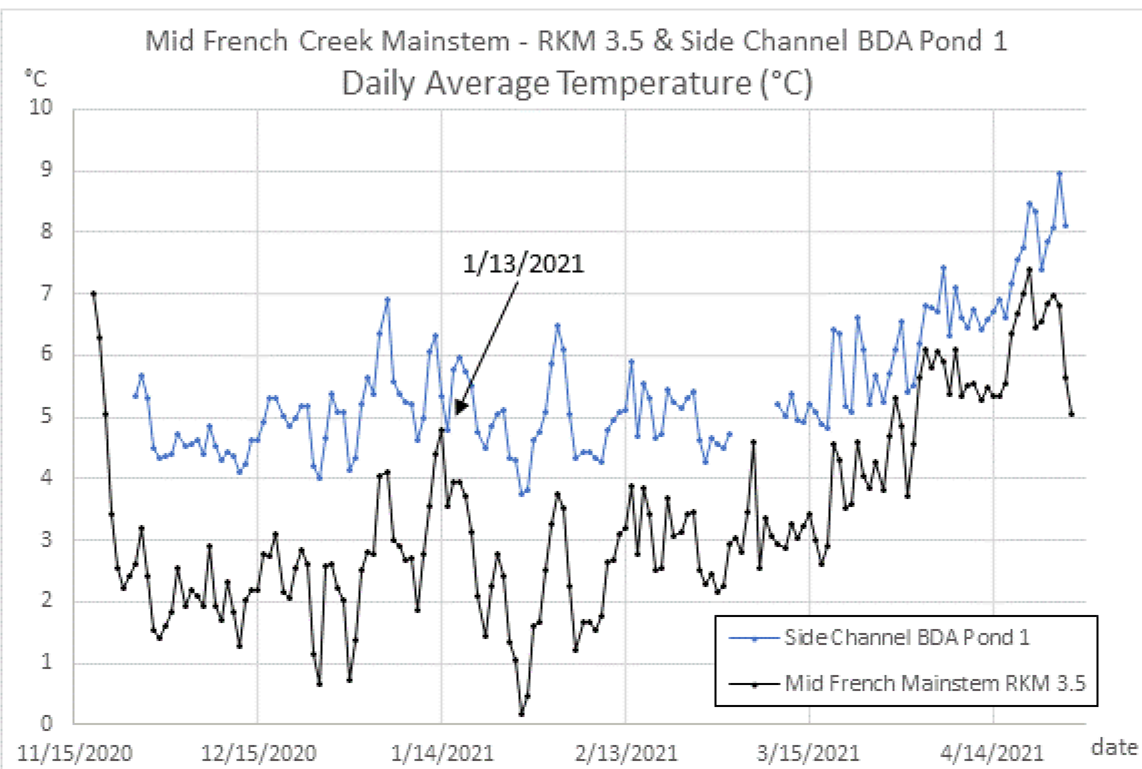


Figure 4 – Daily average temperature (°C) – Mid French mainstem – RKM 3.5 & Side Channel BDA Pond 1

Though the dissolved oxygen in the BDA Pond 1 was relatively low, growth and survival of Coho Salmon in the BDA Ponds was good.

Water temperatures in the Mid French BDA Side Channel were significantly warmer than temperatures in the mainstem (Figure 4). The minimum moving weekly average temperature at the Mid French Creek Mainstem – RKM 3.5 station was 1.2° C on January 29, 2021. The moving weekly average temperature on January 29, 2021 in the Side Channel BDA Pond 1 was 4.4° C – 3.2° C warmer than the mainstem.

Direct observation survey – Sugar Creek and Scott River – June 23, 2021
Erich Yokel – Scott River Watershed Council

A direct observation (snorkel) survey was performed in Lower Sugar Creek and the Scott River above and at the Sugar Creek Confluence on June 23, 2021 to document the presence or absence of Young of the Year (YOY) Coho Salmon (Map 1).

Lower Sugar Creek was surveyed from the SR3 Bridge to the confluence with the Scott River. A few YOY Coho Salmon were observed in the upstream habitats – a natural beaver dam pond and the BDA 2 Pond. YOY Coho Salmon were observed directly below the BDA 2 structure with large amounts of Coho Salmon observed in the deeper areas of the BDA 1 Pond downstream of the thick band of vegetation (e.g. Cattails) – Picture 1. YOY Coho Salmon were observed in the deeper habitats of the BDA 1 Step Pools.

Picture 1 – Juvenile Coho Salmon in Sugar BDA Pond 1

YOY Coho Salmon were observed in the Scott River in the deeper habitats upstream of the Sugar Creek Confluence (Picture 2) and in the Scott River – Sugar Creek Confluence Pool. At the time of the survey the River Left Channel of the Scott River was disconnected with all flow coming from artesian springs on the bank.

A single pool was surveyed at Sugar Creek RKM 1.0 in which approximately 30 YOY Coho Salmon were observed.

Map 1 – Locations of observed Coho Salmon

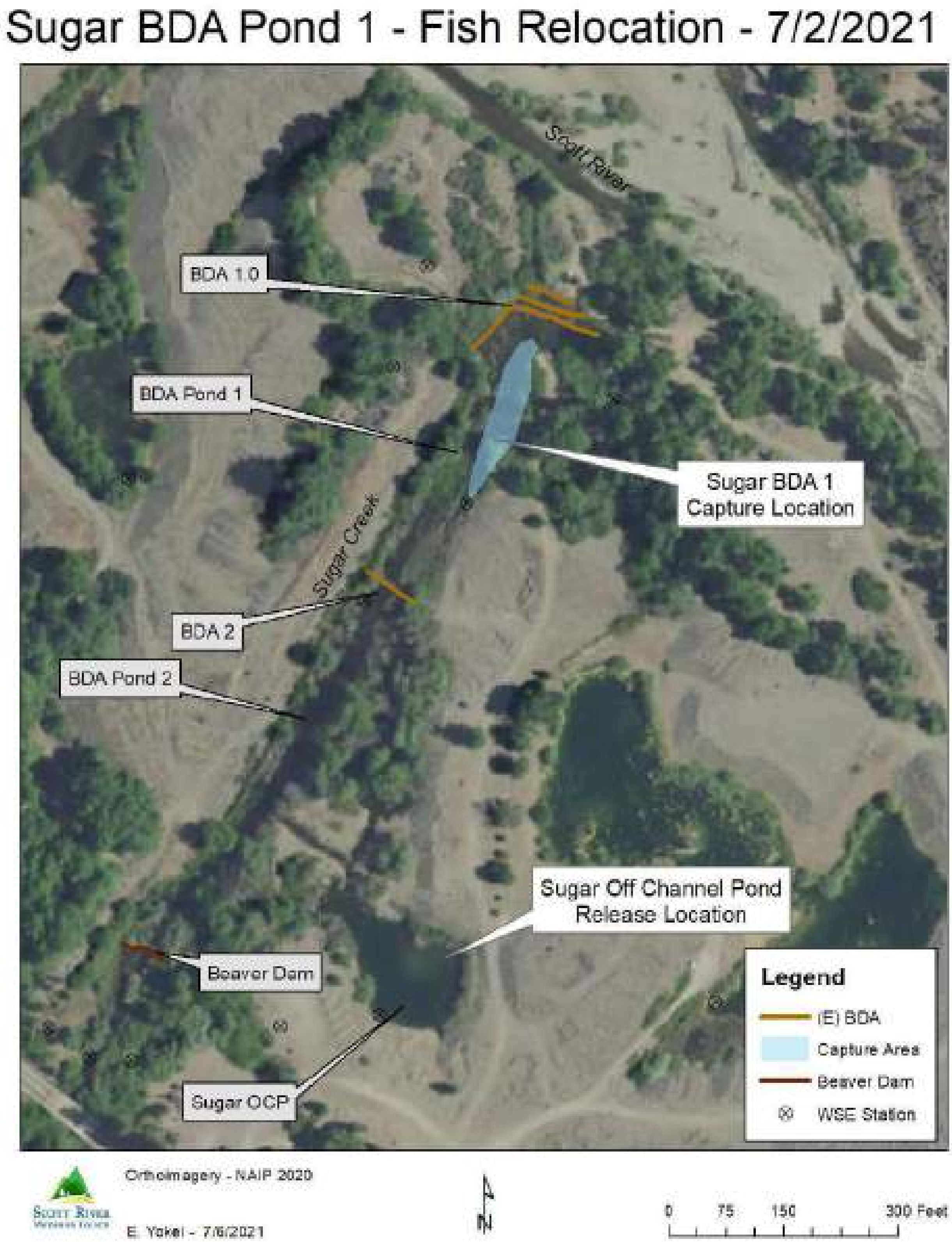

Picture 1 – Juvenile Coho Salmon in Scott River above Sugar Creek

Lower Sugar Creek BDA Pond 1 – Fish Relocation – July 2, 2021
Scott River Watershed Council
Donald Flickinger – NMFS

The Scott River Watershed Council assisted NOAA Fisheries (NMFS) in relocating YOY juvenile Coho Salmon from the Sugar Creek BDA Pond 1 to the Sugar Off Channel Pond (OCP) on the morning of July 2, 2021 (Map 1). A total of approximately 708 Coho Salmon (*O. kisutch*) and 12 Steelhead trout (*O. mykiss*) were captured in Sugar BDA Pond 1 with a seine. Biometrics (forklength (mm) and weight (g)) of a subsample of 59 Coho Salmon were captured (Figures 1 and 2).

Fish were immediately placed in aerated buckets after capture and transported to an aerated large white cooler filled with water from Sugar BDA Pond 1. Water temperature and dissolved oxygen was monitored in the cooler. Fish were transferred in the cooler from the capture site to the release site (Sugar OCP) and immediately released.

Juvenile Coho released into Sugar OCP



Map 1 – Capture and Release location of July 2, 2021 Sugar Creek BDA Pond 1 Fish Relocation Effort


Sugar BDA Pond 1 – Looking Upstream


Approx. 75mm YOY Coho Salmon captured in Sugar BDA Pond 1


Sugar Off Channel Pond (OCP) – Looking towards pond outlet

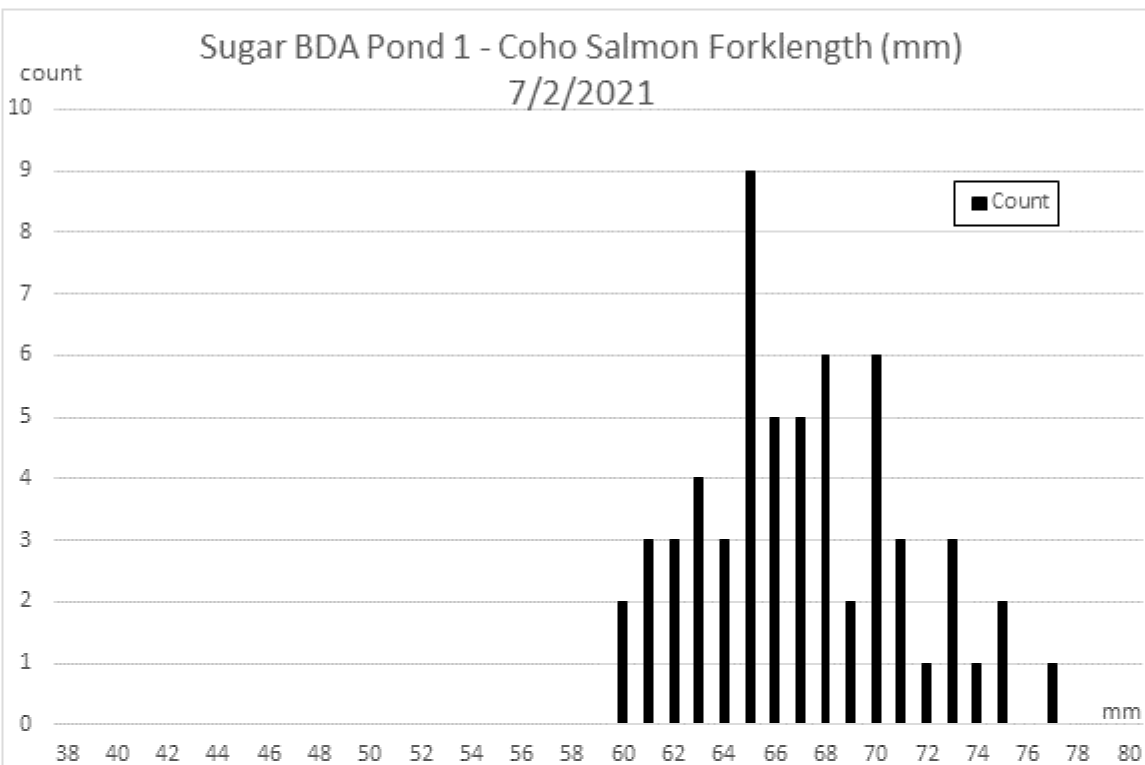


Figure 1 – Forklength (mm) histogram of YOY Coho Salmon – Sugar Creek BDA Pond 1

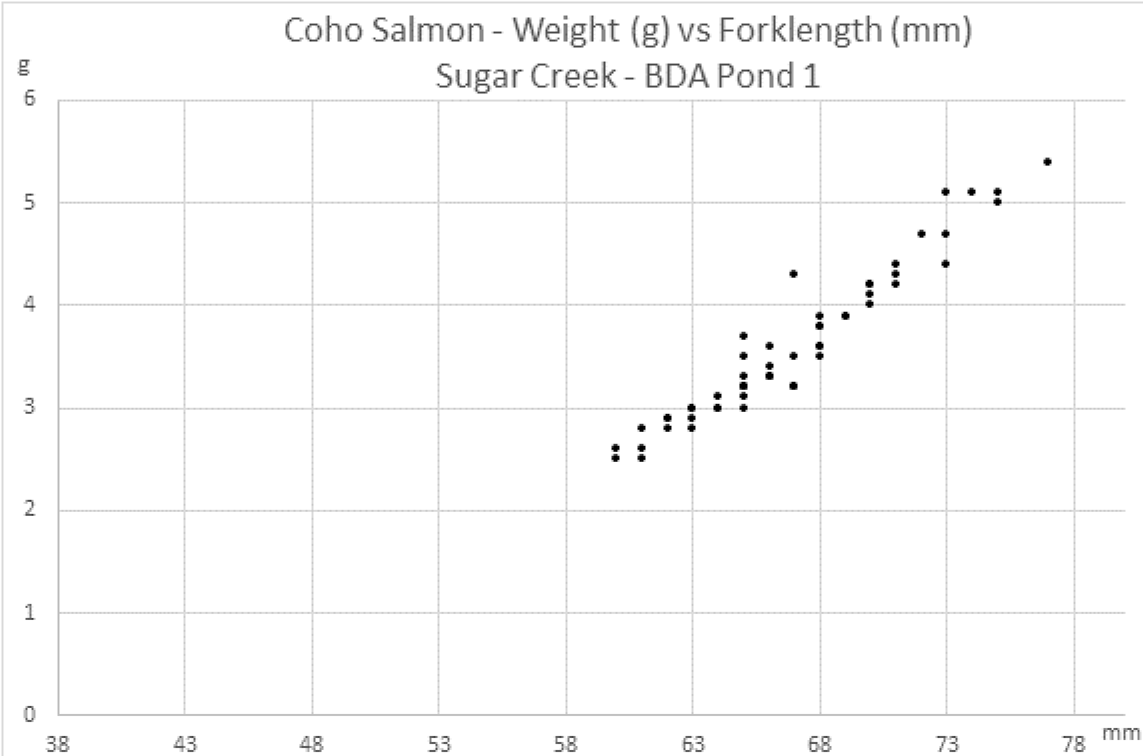


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1

YOY Coho Salmon Forklength – Sugar Creek BDA Pond 1 and Mid French Creek Habitats – July 2 & 5,2021
Scott River Watershed Council

Young of the Year (YOY) juvenile Coho Salmon were captured in Sugar Creek BDA Pond 1 on July 2, 2021 and the Mid French Creek Mainstem ELJ and FRGP Side Channel habitats on July 5, 2021. Approximately 50+ individual Coho captured in each habitat were measured and weighed. A significant difference in forklength (mm) and overall condition was observed in the fish captured in the Sugar BDA Pond compared to those captured in the French Creek habitats (Table 1).


YOY Coho Salmon – Sugar Creek BDA Pond 1 – July 2, 2021


YOY Coho Salmon – French Creek Mainstem – Upstream ELJ1 – July 5, 2021

YOY Coho Salmon – French Creek – FRGP Side Channel – July 5, 2021

Coho Salmon Forklength (mm)

Date Location	7/2/2021 Sugar BDA Pond 1	7/5/2021 French US ELJ 1	7/5/2021 French FRGP SC
Average (mm)	67	46	52
Stand. Deviation (mm)	4	4.7	4.7
Minimum (mm)	60	38	40
Maximum (mm)	77	59	63
Count	59	59	50

Table 1 – Average foklength (mm) of YOY Coho Salmon in sampled habitats – Sugar Creek and Mid French Creek

Analysis of the forklength (mm) histograms (Figure 1 – 3) and the weight (g) versus forklength (mm) plots (Figures 4 – 6) of the Coho Salmon captured at the three different habitats, further illustrates the larger size of the fish captured in the Sugar BDA Pond 1 to those captured in the two habitats of Mid French Creek.

The Coho captured in the French Creek FRGP Side Channel were larger than those captured in mainstem French Creek upstream of ELJ 1.

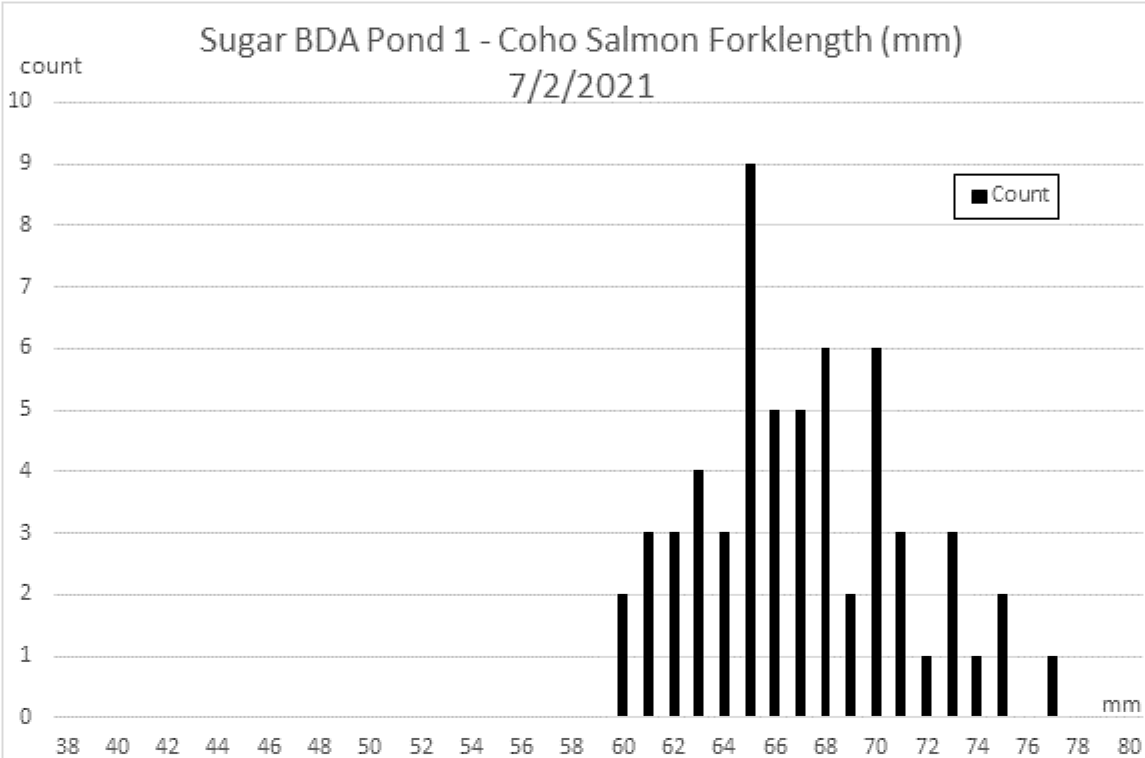


Figure 1 – Forklength (mm) histogram of YOY Coho Salmon – Sugar Creek BDA Pond 1

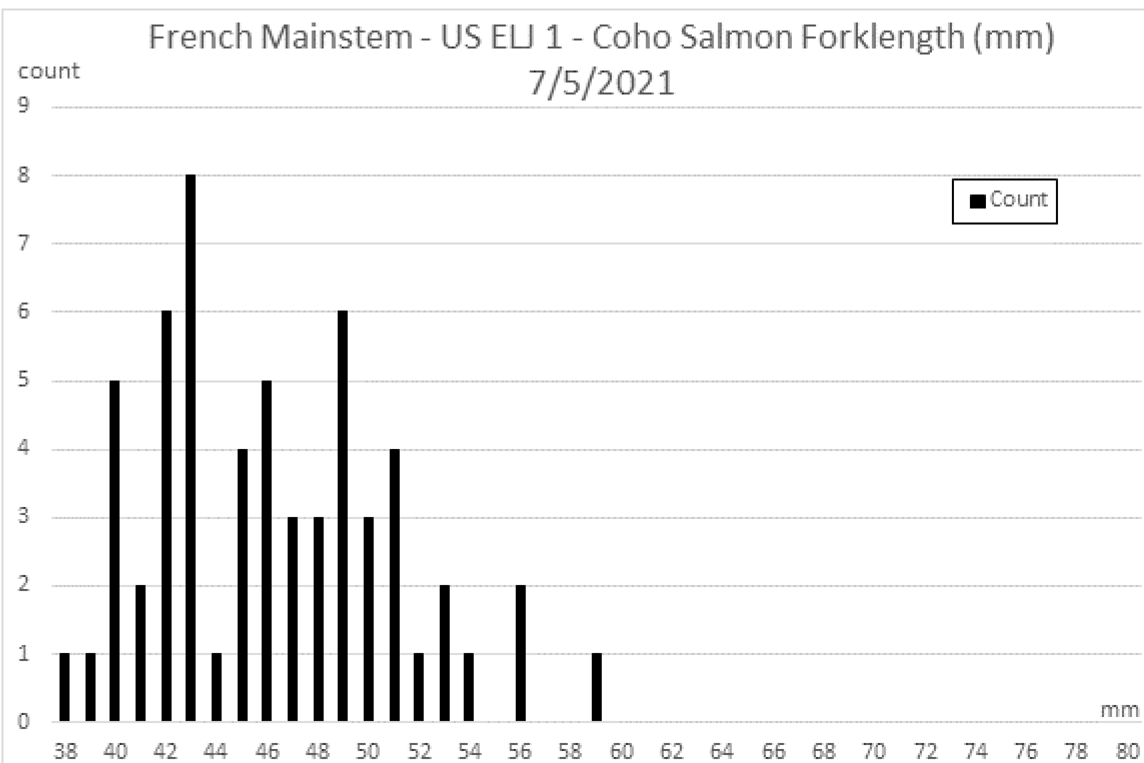


Figure 2 – Forklength (mm) histogram of YOY Coho Salmon – French Cr. Mainstem – Upstream ELJ 1

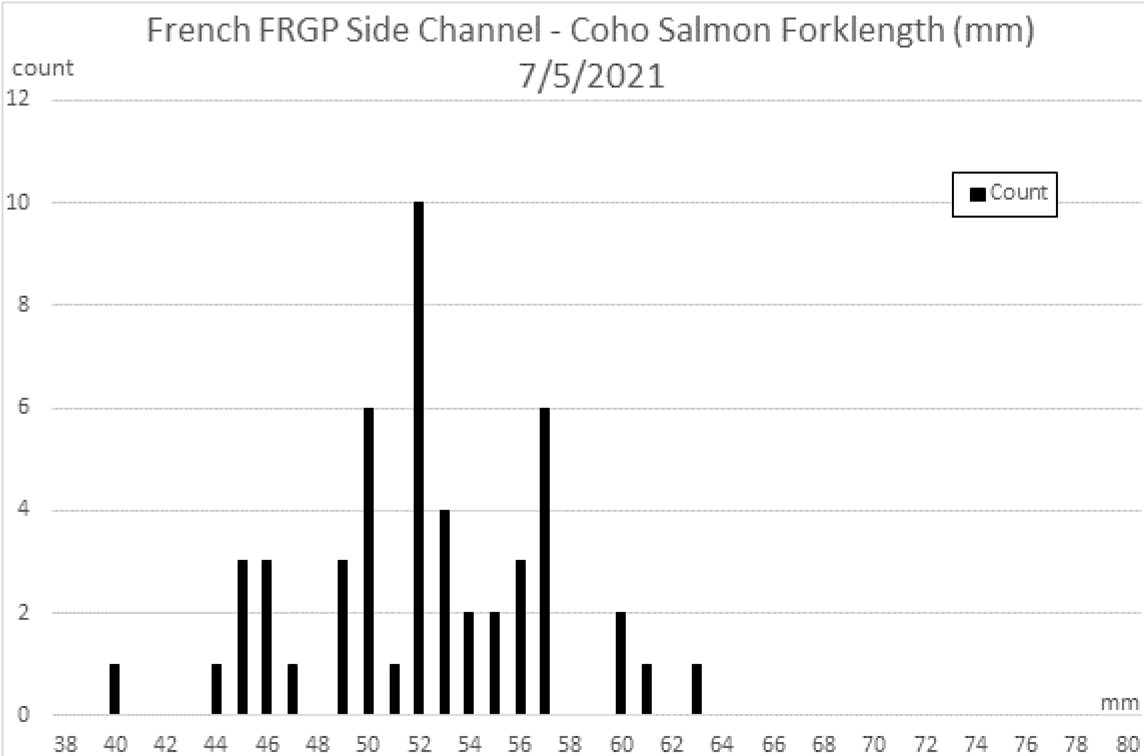


Figure 3 – Forklength (mm) histogram of YOY Coho Salmon – French FRGP Side Channel

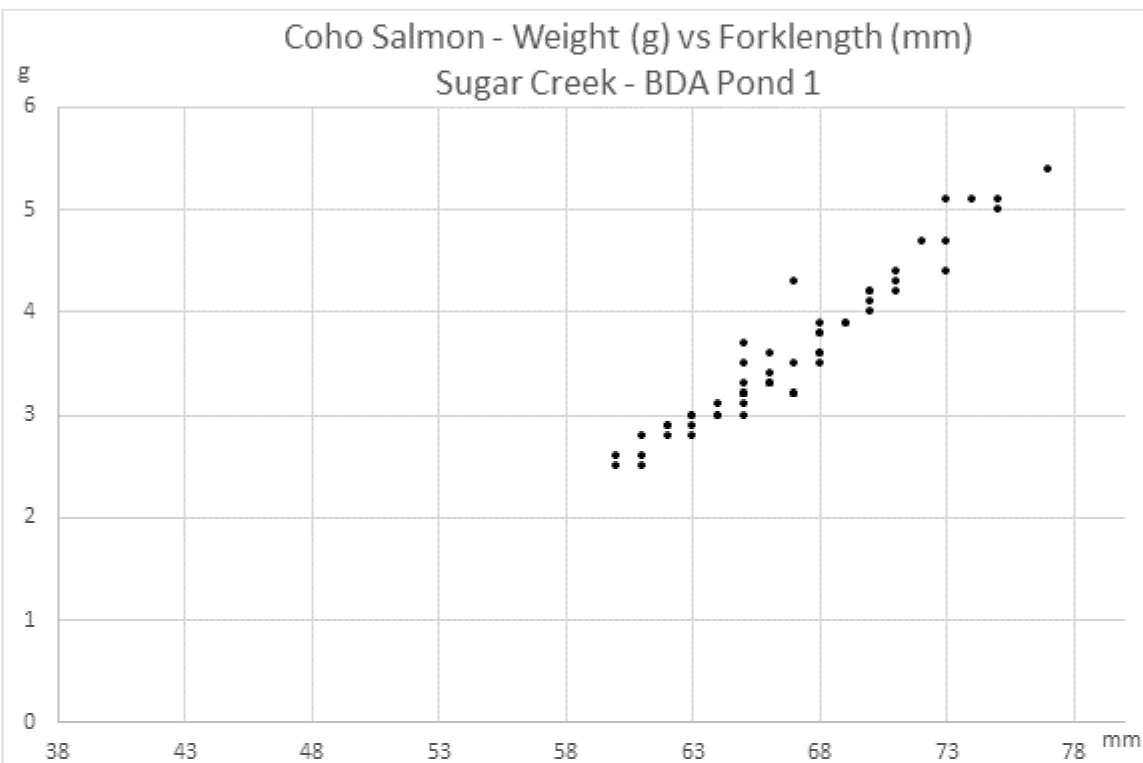


Figure 4 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1

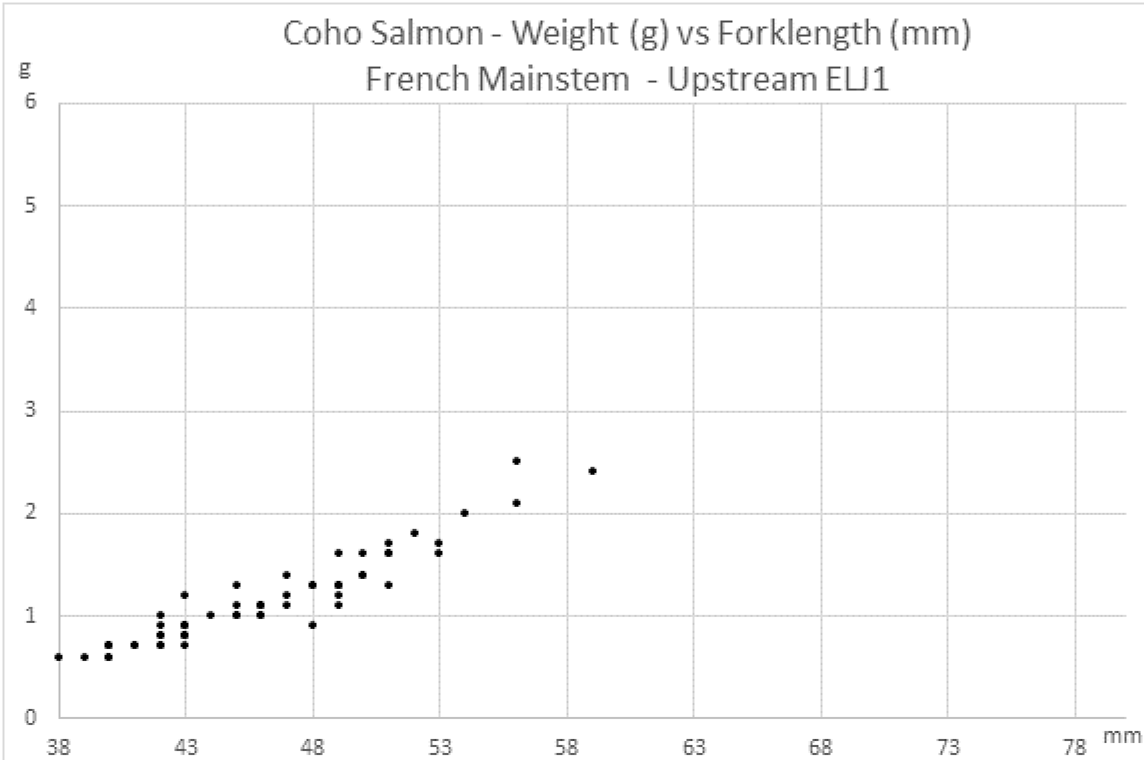


Figure 5 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Cr. Mainstem – Upstream ELJ 1

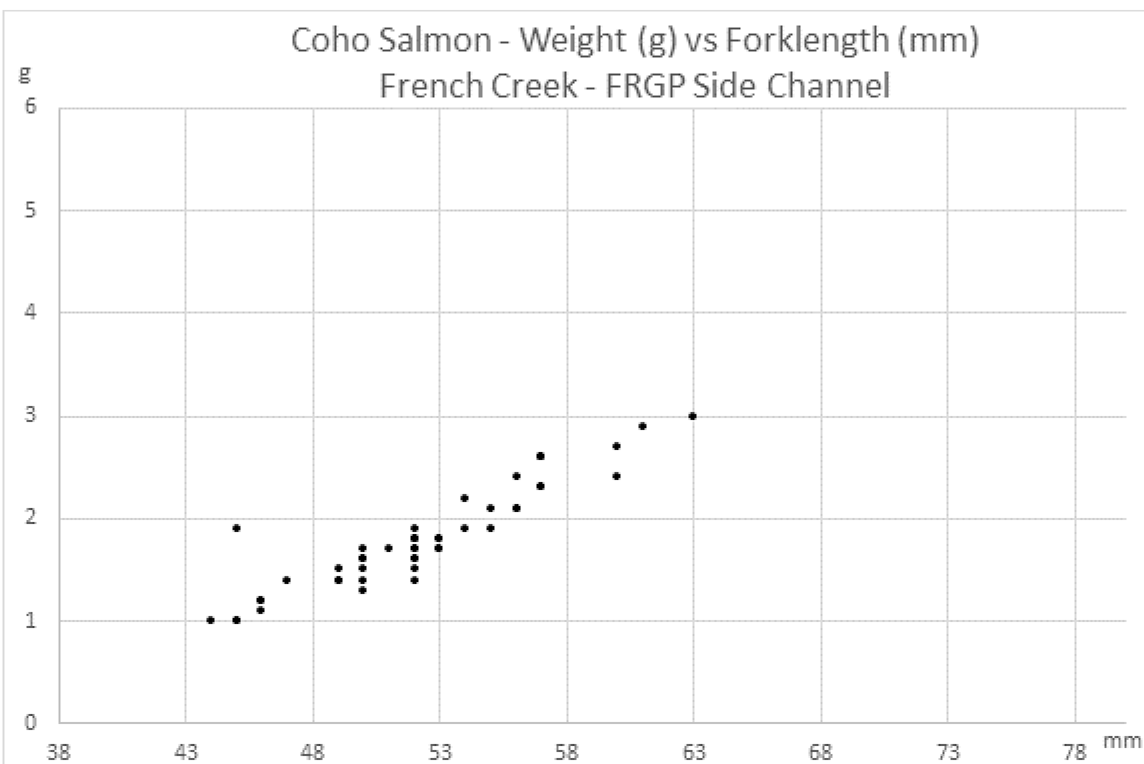


Figure 6 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French FRGP Side Channel

Sugar BDA Pond 1 – Looking Upstream

YOY Coho Salmon captured in Sugar Creek BDA Pond 1 in weighing tray

French Creek Mainstem Upstream ELJ 1 – Looking Downstream

YOY Coho Salmon captured in French Creek Mainstem Upstream ELJ 1 in weighing tray

French Creek FRGP Side Channel – Looking downstream

Approximate 40 mm Coho Salmon captured in mainstem French Creek

Lower Sugar Creek BDA Pond 1 Fish Relocation – July 8. 2021
Scott River Watershed Council
Donald Flickinger – NMFS

The Scott River Watershed Council assisted NOAA Fisheries (NMFS) in relocating YOY juvenile Coho Salmon from the Sugar Creek BDA Pond 1 to the Sugar Off Channel Pond (OCP) and the Sugar Creek Beaver Dam Pond on the morning of July 8, 2021 (Map 1). A total of 187 Coho Salmon (*O. kisutch*) and 27 Steelhead trout (*O. mykiss*) were captured in Sugar BDA Pond 1 with a seine. Biometrics (forklength (mm) and weight (g)) of a subsample of 133 Coho Salmon were measured (Figures 1 and 2). The average forklength of the sampled Coho Salmon was greater on July 8th as compared to the average forklength of the sampled Coho on July 2nd (Table 1).

A subsample of Coho Salmon with forklengths equal to or greater than 65 mm were marked with a 12mm PIT tag. Fifty-three (53) Coho Salmon were PIT tagged and relocated to the Sugar OCP and sixty-two (62) Coho were PIT tagged and relocated to the Sugar Beaver Dam. Additional unmarked fish were released in the two habitats (Table 2). A total of 774 YOY Coho Salmon have been relocated to the Sugar OCP and 121 YOY Coho to the Sugar Beaver Dam between the two efforts on July 2 & July 8, 2021 (Table 3).

Fish were immediately placed in aerated buckets after capture and transported to an aerated large white cooler filled with water from Sugar BDA Pond 1. Water temperature and dissolved oxygen was monitored in the cooler. Fish were transferred in the cooler from the capture site to the release sites (Sugar OCP and Sugar Beaver Dam Pond) and immediately released.

YOY Coho Salmon captured in Sugar BDA Pond 1

Sugar BDA Pond 1 - Fish Relocation - 7/8/2021

Map 1 – Lower Sugar Creek BDA Reach – Locations of Fish Capture and Release – July 8, 2021

Coho Salmon Forklength (mm)

Date	7/2/2021	7/8/2021
Location	Sugar BDA Pond 1	Sugar BDA Pond 1
Average (mm)	67	71
Stand. Deviation (mm)	4	4.6
Minimum (mm)	60	57
Maximum (mm)	77	89
Count	59	133

Table 1 – Coho Salmon average forklength (mm) – Sugar BDA Pond 1 - July 2 and July 8, 2021

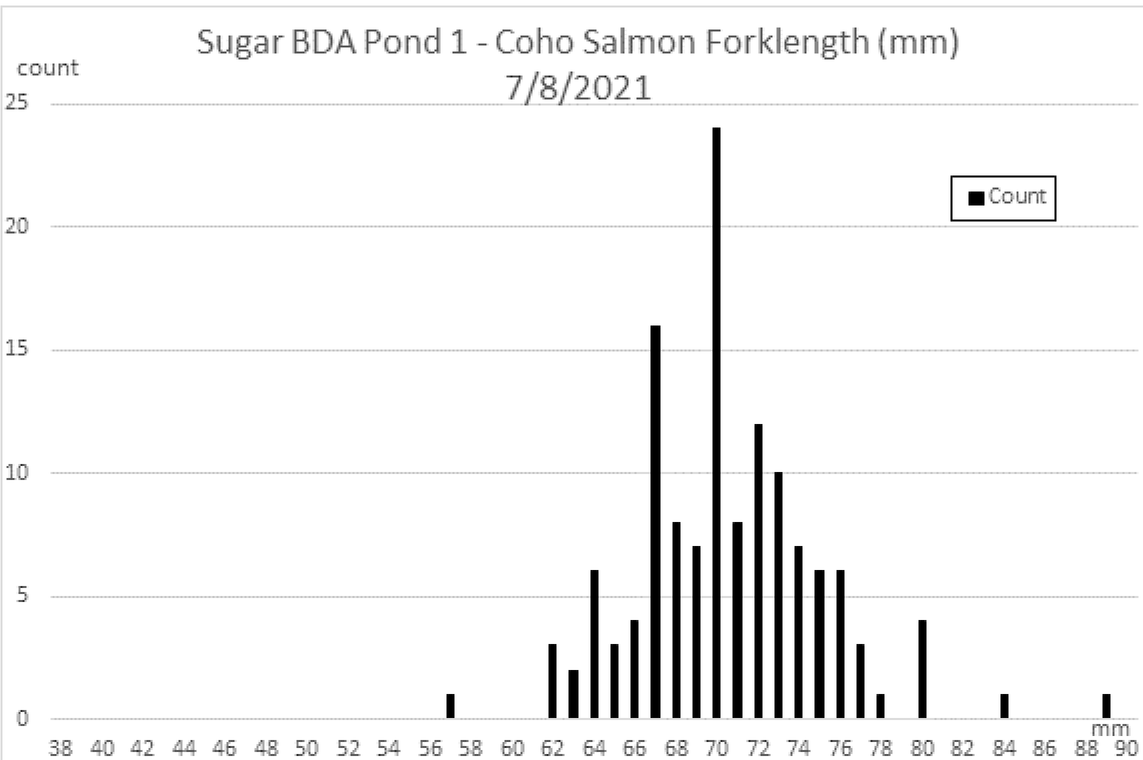


Figure 1 – Forklength (mm) histogram of YOY Coho Salmon – Sugar Creek BDA Pond 1

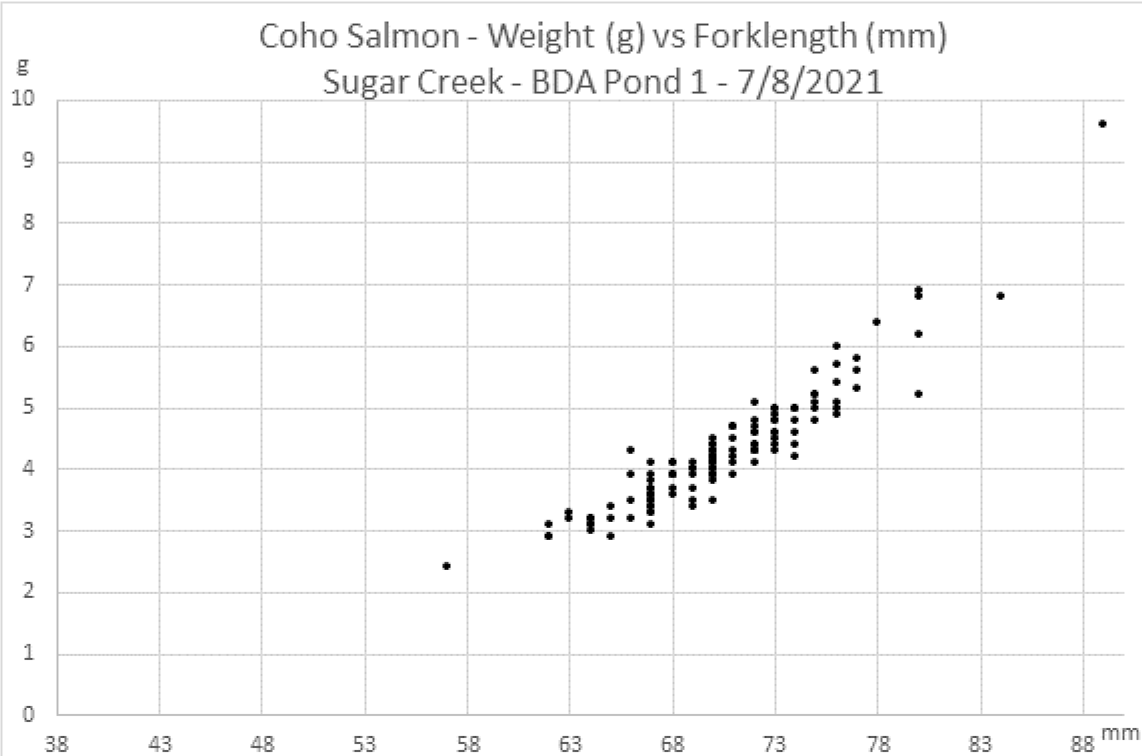


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1

Sugar BDA Pond 1 - Fish Relocation - July 8, 2021

Relocation Habitat	Sugar OCP	Sugar Beaver Dam Pond
Coho Salmon - PIT Marked	53	62
Coho Salmon	13	59
Total Coho Salmon	66	121
Rainbow Trout	4	23

Table 2 – Number of fish relocated to each habitat – July 8, 2021

Sugar BDA Pond 1 - Fish Relocation Totals - July 2 & 8, 2021

Relocation Habitat	Sugar OCP	Sugar Beaver Dam Pond
Coho Salmon - PIT Marked	53	62
Coho Salmon	721	59
Total Coho Salmon	774	121
Rainbow Trout	16	23

Table 3 – Total number of fish relocated to each habitat – July 2 & 8, 2021


Fish relocation transport cooler

Sugar Off Channel Pond (OCP) – Looking towards pond outlet


Beaver Dam

Don Flickinger releasing fish in Beaver Dam Pond

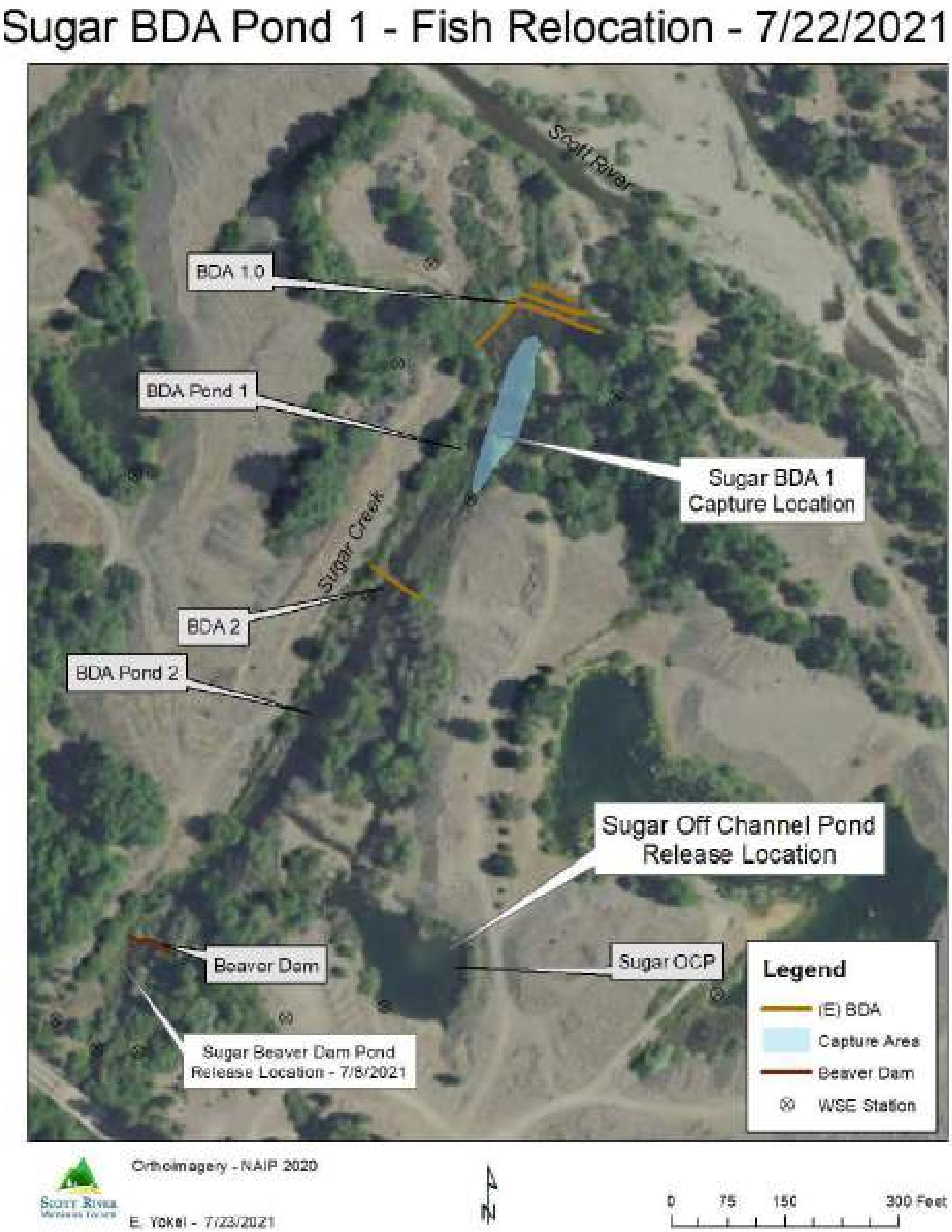
Lower Sugar Creek BDA Pond 1 Fish Relocation – July 23. 2021
Scott River Watershed Council
Donald Flickinger – NMFS

The Scott River Watershed Council assisted NOAA Fisheries (NMFS) in relocating YOY juvenile Coho Salmon from the Sugar Creek BDA Pond 1 to the Sugar Off Channel Pond (OCP) (Map 1). A total of 473 Coho Salmon (*O. kisutch*) and 150 Steelhead trout (*O. mykiss*) were captured in the severely limited remaining pool habitat in the Sugar BDA Pond 1 with un-baited minnow traps and a seine. Biometrics (forklength (mm) and weight (g)) of a subsample of 68 Coho Salmon were measured (Figures 1 and 2). The average forklength of the sampled Coho Salmon was greater on July 23rd as compared to the average forklength of the sampled Coho on July 2nd and July 8th (Table 1).

A subsample of fifty-one (51) Coho Salmon with forklengths equal to or greater than 65 mm were marked with a 12mm PIT tag. A total of 1247 YOY Coho Salmon have been relocated to the Sugar OCP and 121 YOY Coho to the Sugar Beaver Dam between the three efforts on July 2, July 8 & July 22, 2021 (Table 3).

Fish were immediately placed in aerated buckets after capture and transported to an aerated large white cooler filled with water from the Scott River. Water temperature and dissolved oxygen was monitored in the cooler. Fish were transferred in the cooler from the capture site to the release site (Sugar OCP) and immediately released.

YOY Coho Salmon captured in Sugar BDA Pond 1 – Forklength = 82 mm & Weight = 6.3 g



Map 1 – Lower Sugar Creek BDA Reach – Location of Fish Capture and Release – July 22, 2021

Coho Salmon Forklength (mm)

Date	7/2/2021	7/8/2021	7/22/2021
Location	Sugar BDA Pond 1	Sugar BDA Pond 1	Sugar BDA Pond 1
Average (mm)	67	71	74
Stand. Deviation (mm)	4	4.6	4.1
Minimum (mm)	60	57	65
Maximum (mm)	77	89	87
Count	59	133	68

Table 1 – Coho Salmon average forklength (mm) – Sugar BDA Pond 1 - July 2, July 8 and July 22, 2021

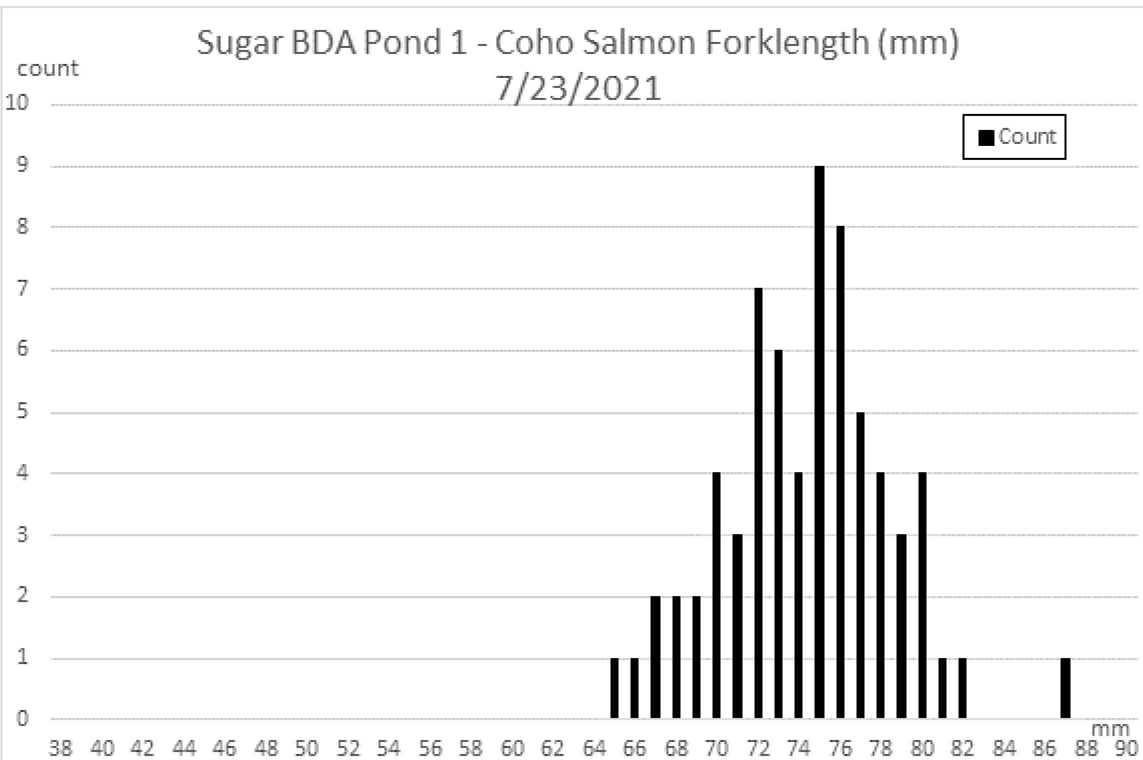


Figure 1 – Forklength (mm) histogram of YOY Coho Salmon – Sugar Creek BDA Pond 1

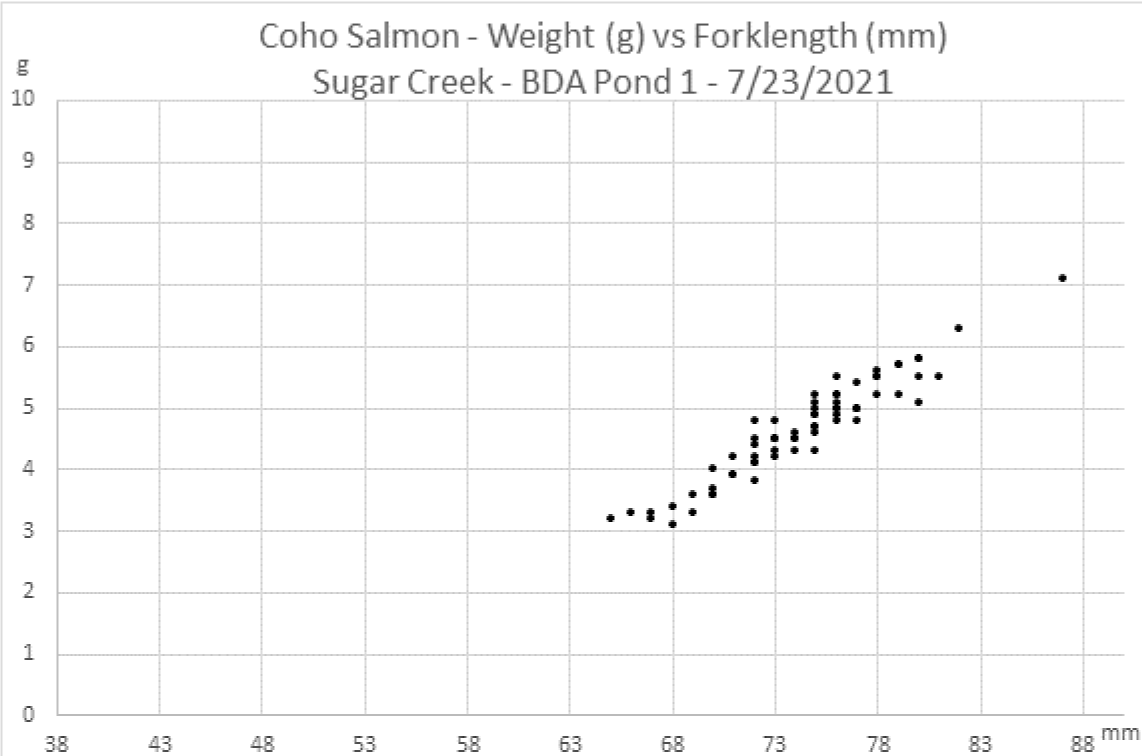


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1

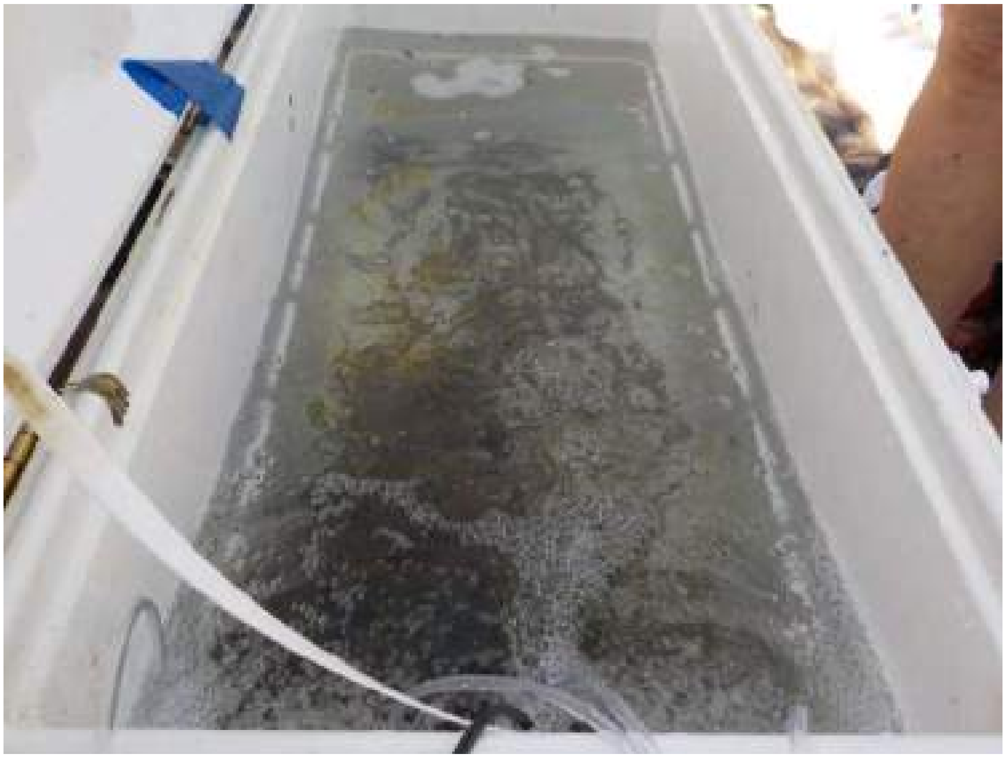
Sugar BDA Pond 1 - Fish Relocation Totals - July 2, 8 & 22, 2021

Relocation Habitat	Sugar OCP	Sugar Beaver Dam Pond
Coho Salmon - PIT Marked	104	62
Coho Salmon	1143	59
Total Coho Salmon	1247	121
Rainbow Trout	166	23

Table 2 – Total number of fish relocated to each habitat – July 2 & 8, 2021


YOY Steelhead trout (*O. mykiss*)


Sugar Beaver Dam Pond 1 – July 22, 2021



Fish relocation transport cooler

Donald Flickinger and Charnna Gilmore (SRWC) counting and recording relocated fish


Releasing fish into Sugar OCP

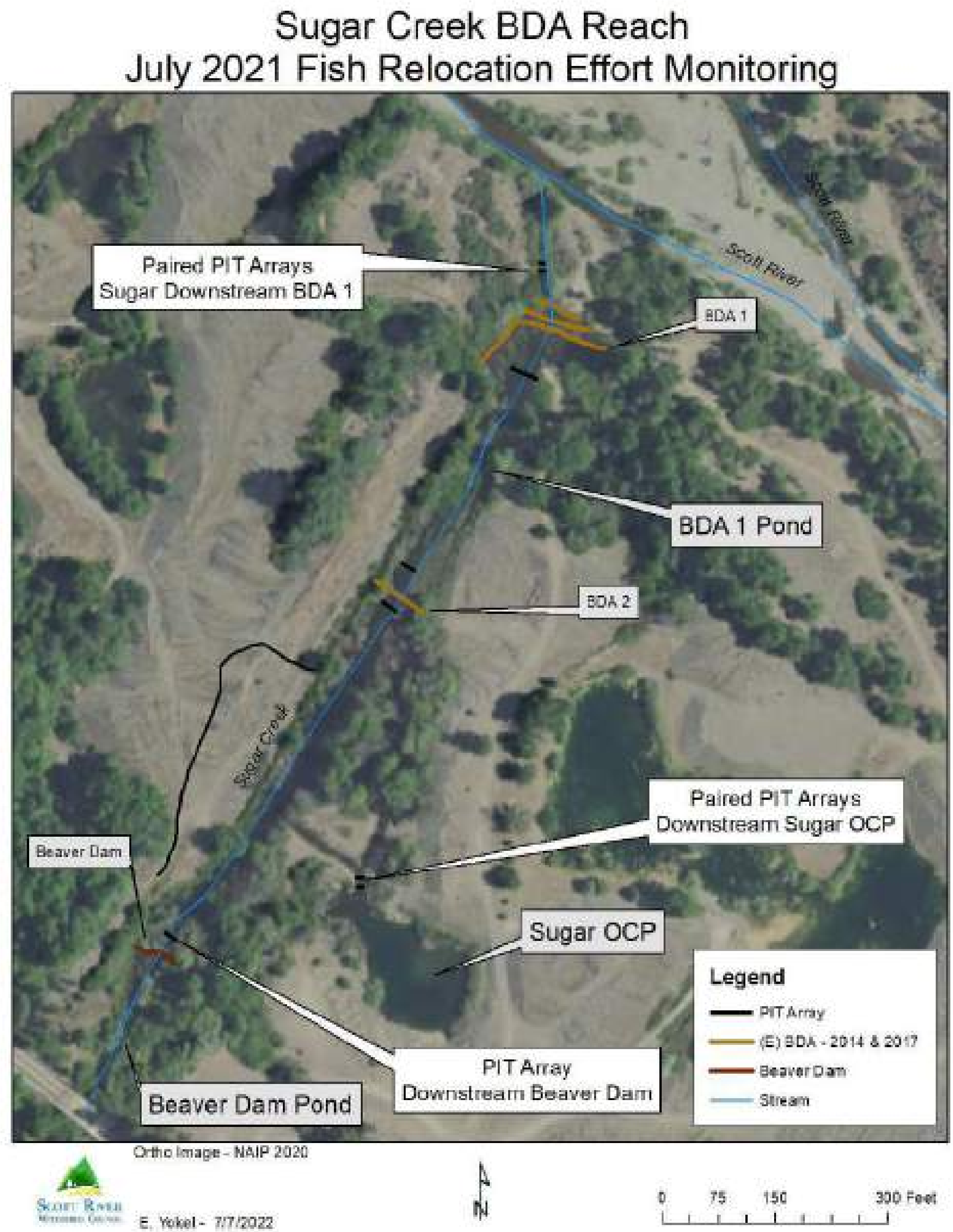

Sugar Off Channel Pond (OCP) – Looking towards pond outlet

Lower Sugar Creek BDA Pond 1 Fish Relocation – July 2021
Detection of PIT marked relocated Coho Salmon
Scott River Watershed Council


YOY Coho Salmon captured in Sugar BDA Pond 1- 7/23/2021 – Forklength = 82 mm & Weight = 6.3 g

The Scott River Watershed Council assisted NOAA Fisheries in relocating YOY juvenile Coho Salmon (*O. kisutch*) and steelhead trout (*O. mykiss*) from the Sugar Creek BDA Pond 1 to two habitats in Lower Sugar Creek during three efforts in July 2021. Fish were relocated to the Sugar Off Channel Pond (Sugar OCP) and the natural beaver dam pond (Map 1).

Direct observation surveys performed in late June 2021 documented Coho Salmon rearing in the Sugar Creek BDA Pond 1 with no fish observed in the Sugar Creek BDA Pond 2, natural beaver dam pond and Sugar OCP habitats. WY2021 was the second year of critical drought that began in WY2020. The Sugar BDA 1 Pond habitat became completely dry during the base flow period of 2020 resulting in total loss of the Coho Salmon marked before disconnection while the Sugar OCP and natural beaver dam maintained suitable quality habitat through the summer of 2020. Due to the certainty that the BDA 1 Pond would become dry during the summer of 2021 and the presence of Coho in the BDA 1 Pond and absence of Coho in the Sugar OCP and natural beaver dam a relocation effort was performed to relocate the fish.



Map 1 – Location of fish capture and release and PIT array stations

No marking of Coho Salmon was planned during the initial relocation effort performed on July 2, 2021, due to the observations from previous years' fish sampling efforts that Coho Salmon have not reached suitable size (FL => 65mm) for applying a PIT tag in early July. Fifty-nine (59) Coho captured on July 2 were measured documenting that a portion of the population was suitable size for marking with PIT tags (Table 1). The entire July 2 catch was relocated to the Sugar OCP (Table 2).

Coho Salmon Forklength (mm)

Date Location	7/2/2021 Sugar BDA Pond 1	7/8/2021 Sugar BDA Pond 1	7/22/2021 Sugar BDA Pond 1
Average (mm)	67	71	74
Stand. Deviation (mm)	4	4.6	4.1
Minimum (mm)	60	57	65
Maximum (mm)	77	89	87
Count	59	133	68

Table 1 – Coho Salmon average forklength (mm) – Sugar BDA Pond 1 - July 2, July 8 and July 22, 2021

During the second effort on July 8, 2021, a subsample of suitably sized Coho Salmon were marked with a PIT tag and relocated to the Sugar OCP and Beaver Dam Pond to document the effectiveness of the relocation effort. Fifty-three (53) Coho were PIT marked and relocated to the Sugar OCP and sixty-two (62) Coho were PIT marked and relocated to the natural beaver dam. Additional unmarked Coho Salmon and steelhead trout were placed in both relocation habitats.

Relocation Effort	7/2/2021	7/8/2021	7/22/2021	Total
Coho Salmon - PIT Marked - Relocated to Sugar OCP	0	53	51	104
Coho Salmon - PIT Marked - Relocated to Beaver Dam Pond	0	62	0	62
Coho Salmon - Relocated to Sugar OCP	708	13	473	1194
Coho Salmon - Relocated to Beaver Dam Pond	0	59	0	59
Steelhead trout - Relocated to Sugar OCP	12	4	150	166
Steelhead trout - Relocated to Beaver Dam Pond	0	23	0	23

Table 2 – Number of marked and unmarked Coho Salmon relocated to each habitat per effort

The third and final relocation effort occurred on July 22, 2021, when the Sugar BDA Pond 1 habitat had significantly decreased in volume into an isolated pool. Fifty-one (51) Coho Salmon were PIT marked and the entire catch was relocated to the Sugar OCP. Fish were not relocated to the natural beaver dam habitat due to a concern regarding the potential failure of this habitat during the base flow period of WY2021 and analysis of the depth of water quality of the Sugar OCP during the base flow period of WY2020.

Over the three efforts a total of 1,247 Coho Salmon (104 PIT Marked) and 166 steelhead trout were relocated to the Sugar OCP and 121 (62 PIT Marked) and 23 steelhead trout were relocated to the natural beaver dam (Table 3). 8.3% of the Coho Salmon relocated to the Sugar OCP were marked with a PIT tag and 51.2% of the Coho Salmon relocated to the natural beaver dam were marked with a PIT tag. A total of 1,368 Coho Salmon and 189 steelhead trout were relocated from Sugar BDA Pond 1 during the three efforts in July 2021.

Sugar BDA Pond 1 - Fish Relocation Totals - July 2, 8 & 22, 2021

Relocation Habitat	Sugar OCP	Sugar Beaver Dam Pond
Coho Salmon - PIT Marked	104	62
Coho Salmon	1143	59
Total Coho Salmon	1247	121
Steelhead trout	166	23

Table 3 – Total number of fish relocated to each habitat – July 2, 8 & 22, 2021

A network of stationary PIT array detection stations was maintained downstream of the Sugar OCP and beaver dam and downstream of the Sugar BDA 1 Complex to detect marked fish (Map 1). Marked fish migrating from the Sugar OCP should be detected by the channel spanning paired arrays in the constructed channel connecting the Sugar OCP to Sugar Creek. The single array in the mainstem of Sugar Creek downstream of the beaver dam was installed before the beaver dam was built during the drought of 2018. The beaver dam created multiple side channel that circumvent the single array allowing marked fish to pass the array without being detected. Marked fish migrating from the BDA ponds in Lower Sugar Creek should be detected on the channel spanning paired arrays in the mainstem downstream of the BDA 1 Complex (paired outmigrant PIT arrays). All three array locations were dry during the base flow period of WY2021.

Approximately two thirds of the relocated fish were detected on a stationary PIT array after the reach reconnected (Table 4). The detection efficiency of the paired arrays downstream the Sugar OCP is significantly greater than the detection efficiency of the single array downstream of the beaver dam. Approximately half of the relocated fish were detected on the paired outmigrant PIT arrays downstream of Sugar BDA 1 Complex (Table 5). 58 of the 104 (56%) marked Coho relocated to the Sugar OCP and 26 of the 62 (42%) of the marked Coho relocated to the beaver dam pond were detected at the paired outmigrant PIT arrays.

A total of 78 of the 104 (75 %) marked Coho relocated to the Sugar OCP were detected on the paired arrays downstream of the Sugar OCP after the reach reconnected. 58 of the 78 (74%) marked Coho detected on the paired arrays downstream of the Sugar OCP were detected on the outmigrant paired arrays downstream of the Sugar BDA 1 Complex. All of the 58 marked individuals detected on the paired outmigrant arrays were detected on the paired arrays downstream of the OCP.

In contrast, only 11 of the 26 marked Coho relocated to the natural beaver dam that were detected at the paired outmigrant PIT arrays were detected at the single PIT array downstream of the natural beaver dam. Sixteen (16) marked Coho relocated to the natural beaver dam were detected at the single PIT array downstream of the beaver dam, eight of these detected fish were detected at the paired arrays downstream of the Sugar OCP and eleven were detected at the paired outmigrant arrays. An additional four marked fish that were relocated to the natural beaver dam were detected on the paired PIT arrays downstream of the Sugar OCP and not detected on the single PIT array downstream of the beaver dam. The low detection efficiency of the PIT array below the beaver dam precludes the ability to determine apparent survival over the base flow period for the fish relocated to the beaver dam pond.

Sample date	Sample Habitat	# Marks	Comment	Number Detected	Percent Detected
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	37	70%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	31	50%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	41	80%
Total		166		109	66%

Table 4 – Number of marked relocated Coho Salmon detected on Sugar Creek PIT Array

Sample Date	Sample Habitat	# Marks	Comment	Outmigrants Detected	Percent Detected
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	26	49%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	26	42%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	32	63%
Total		166		84	51%

Table 5 – Number of marked relocated Coho Salmon detected on paired outmigrant PIT Arrays

Conclusion:

A total of 1,368 Coho Salmon were relocated from the drying Sugar BDA Pond 1 habitat to the adjacent Sugar OCP and natural beaver dam habitats in July 2021. 104 PIT marked Coho were relocated to the Sugar OCP and 62 PIT marked Coho were relocated to the natural beaver dam. 75% of the marked Coho relocated to the Sugar OCP were detected on a stationary PIT array after the reach reconnected and 56% of the marked fish relocated to the Sugar OCP were detected on the paired outmigrant PIT arrays. 42% of the marked Coho relocated to the natural beaver dam were detected on the outmigrant PIT arrays.

Mid French Creek Fish Sampling – August 2, 2021
Scott River Watershed Council


YOY Coho Salmon – Mid French Creek Mainstem – August 2, 2021

Three habitats in the Mid French Creek Mainstem RKM 3.1 – RKM 3.3 (Upstream ELJ 1, Beaver Dam Pond and the Wood Gravel Restoration Project Phase II Reach) were sampled on August 2, 2021. Biometrics (forklength (mm) and weight (g)) from the captured Coho Salmon were measured (Table 1 and Figures 1 – 2). No rainbow trout (*O. mykiss*) were captured in the effort. The captured Coho were significantly smaller than Coho sampled during the same time period in 2020 (Table 2).

Coho Salmon Forklength (mm)

Date	8/2/2021	8/2/2021	8/2/2021	8/2/2021
Location	Mid French Creek US ELJ 1	Mid French Creek Beaver Dam Pond	Mid French Creek Wood/Gravel Phase II	Mid French Creek Combined
Average (mm)	51	50	51	51
Stand. Deviation (mm)	5.7	4.8	6.2	5.6
Minimum (mm)	40	39	34	34
Maximum (mm)	65	57	62	65
Count	66	57	65	188

Table 1 – Coho Salmon average forklength (mm) – Mid French Creek Mainstem – August 2, 2021

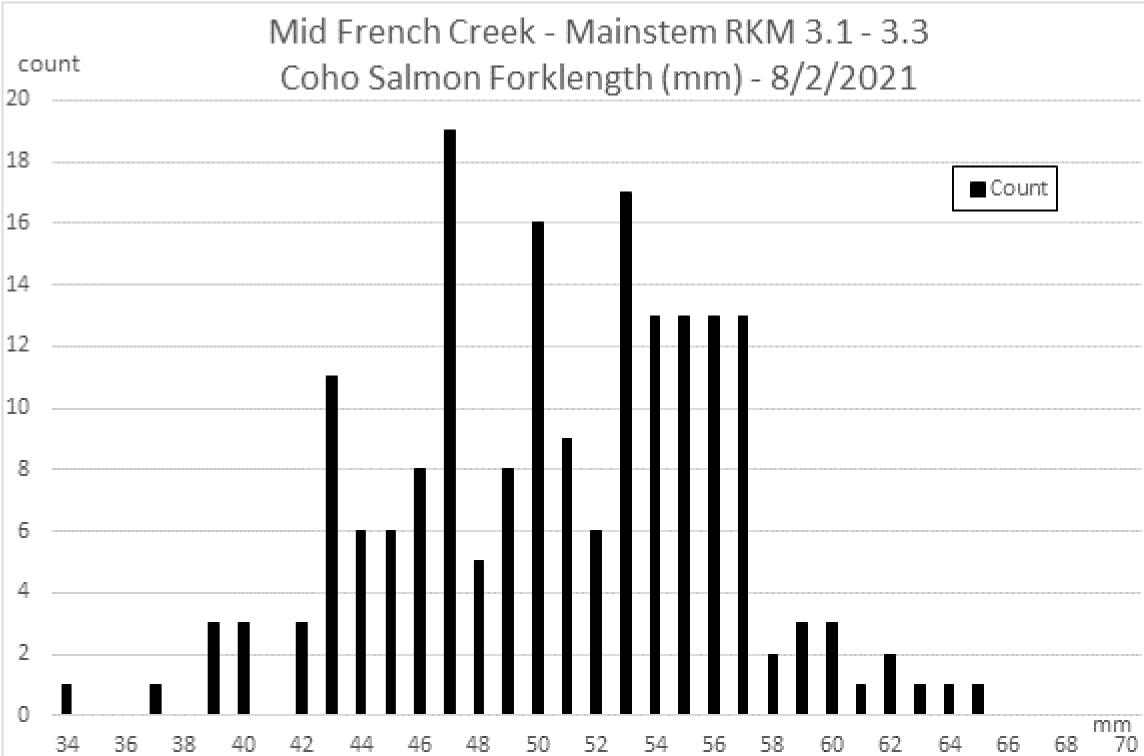


Figure 1 – Forklength (mm) histogram of YOY Coho Salmon – Mid French Creek – Mainstem

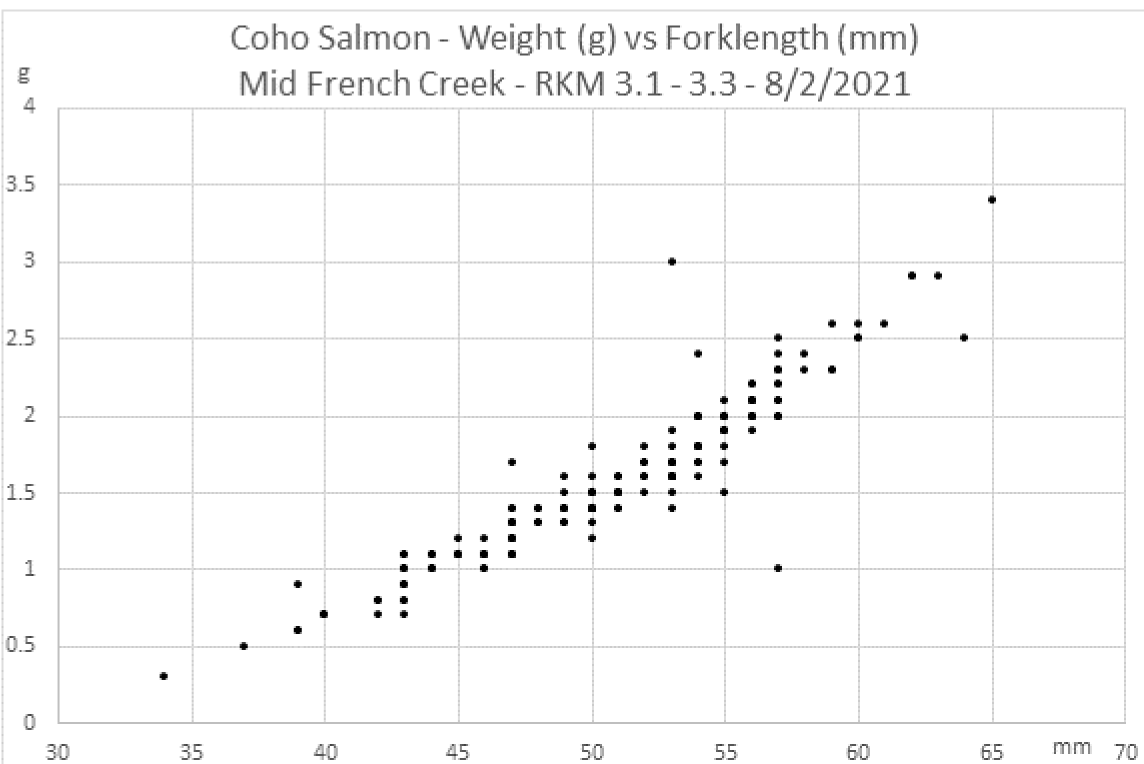


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Mid French Creek – Mainstem

YOY Coho captured in Mid French Mainstem – August 2, 2021

Coho Salmon Forklength (mm)

Date	7/7/2020	7/28/2020	8/2/2021
Location	Mid French ELJs	Mid French ELJs	Mid French Combined
Average (mm)	57	62	51
Stand. Deviation (mm)	7	5.5	5.6
Minimum (mm)	42	47	34
Maximum (mm)	101	85	65
Count	103	617	188

Table 2 - Coho Salmon average forklength (mm) – Mid French Cr Mainstem – July 2020 & August 2, 2021


YOY Coho captured in Mid French Mainstem – August 2, 2021

Upstream ELJ 1 – Looking Downstream


Beaver Dam Pond – Looking Upstream

Wood Gravel Restoration Project Phase II – Looking Downstream

Mid French Creek – FRGP Side Channel Fish Sampling – August 4, 2021
Scott River Watershed Council

Mid French Creek FRGP Side Channel – August 4, 2021

The Mid French FRGP Side Channel was sampled on August 4, 2021. A total of 85 Coho Salmon (*O. kisutch*) and one rainbow trout (*O. mykiss*) were captured in the effort (Table 1). A significant number of speckled dace (*R. ocsulus*) were captured in the FRGP Side Channel – no dace were captured during the sampling in the mainstem habitats on August 2, 2021. Biometrics (forklength (mm) and weight (g)) from the captured Coho Salmon were measured (Table 2 and Figures 1 – 2). Two captured Coho were determined to be 1+ fish due to forklengths greater than 95 mm. The captured Coho in the FRGP Side Channel were significantly larger than the Coho sampled in the mainstem on August 2nd.

Total Catch - Mid French FRGP Side Channel - August 4, 2021

	Total Captured	Marked	Recaptured
YOY Coho Salmon	83	12	0
1+ Coho Salmon	2	2	0
Rainbow Trout (*O. mykiss*)	1	0	0
Speckled Dace	117	--	--

Table 1 – Total catch – FRGP Side Channel – August 4, 2021

Date	8/2/2021	8/4/2021
Location	French Mainstem RKM 3.1 - 3.3	Mid French FRGP Side Channel
Average (mm)	51	60
Stand. Deviation (mm)	5.6	7.6
Minimum (mm)	34	43
Maximum (mm)	65	89
Count	188	83

Table 2 - Coho Salmon average forklength (mm) – Mid French Creek Mainstem and FRGP Side Channel – August 2 and August 4, 2021

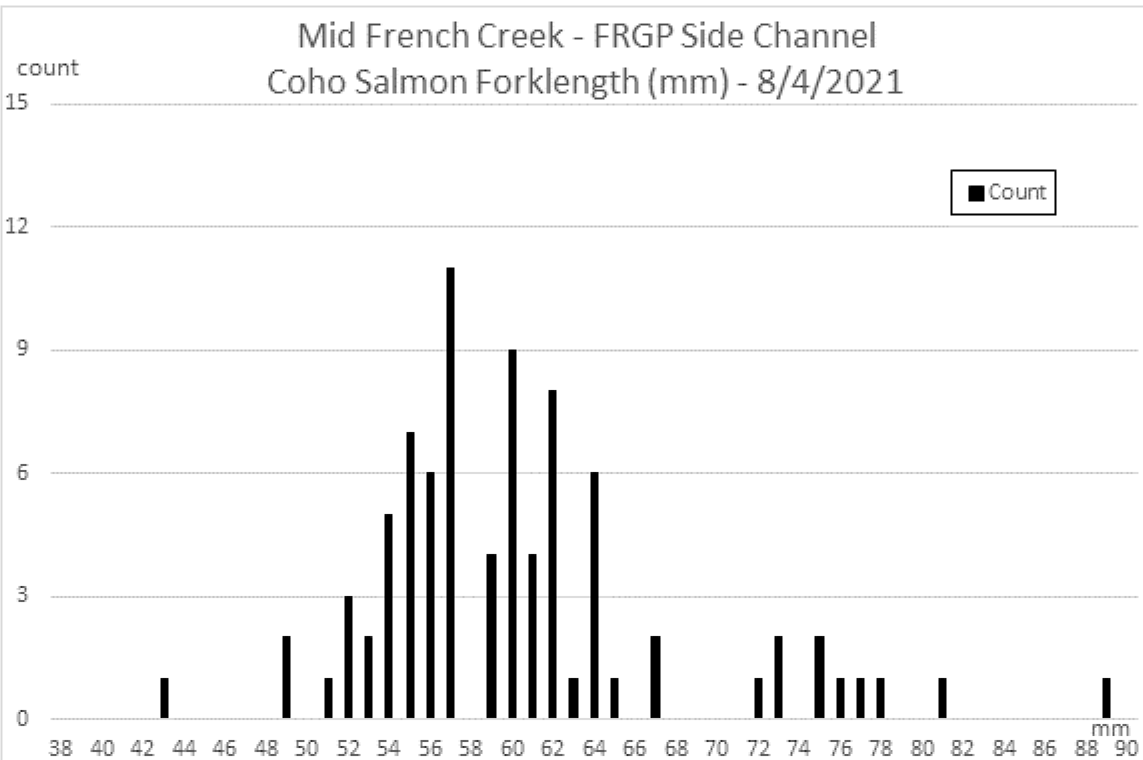


Figure 1 – Forklength (mm) histogram of YOY Coho Salmon – Mid French – FRGP Side Channel

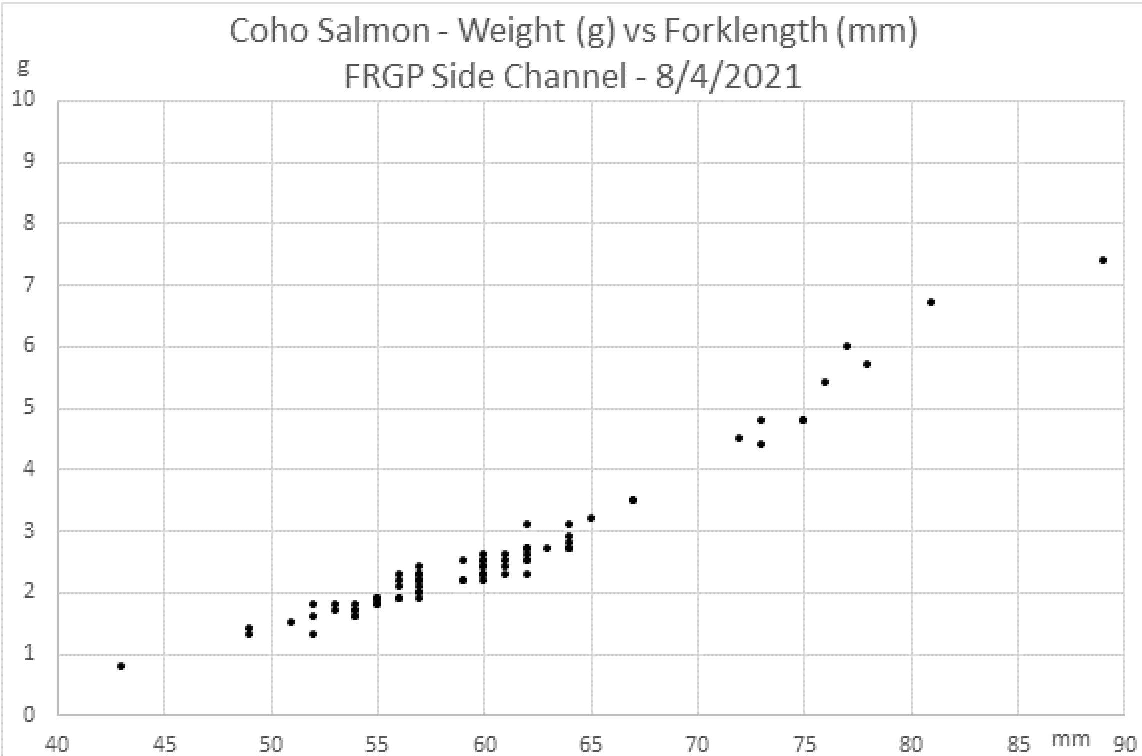


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Mid French – FRGP Side Channel


YOY Coho Salmon – Mid French Creek FRGP Side Channel – August 4, 2021

1+ Coho Salmon – Mid French Creek FRGP Side Channel – August 4, 2021

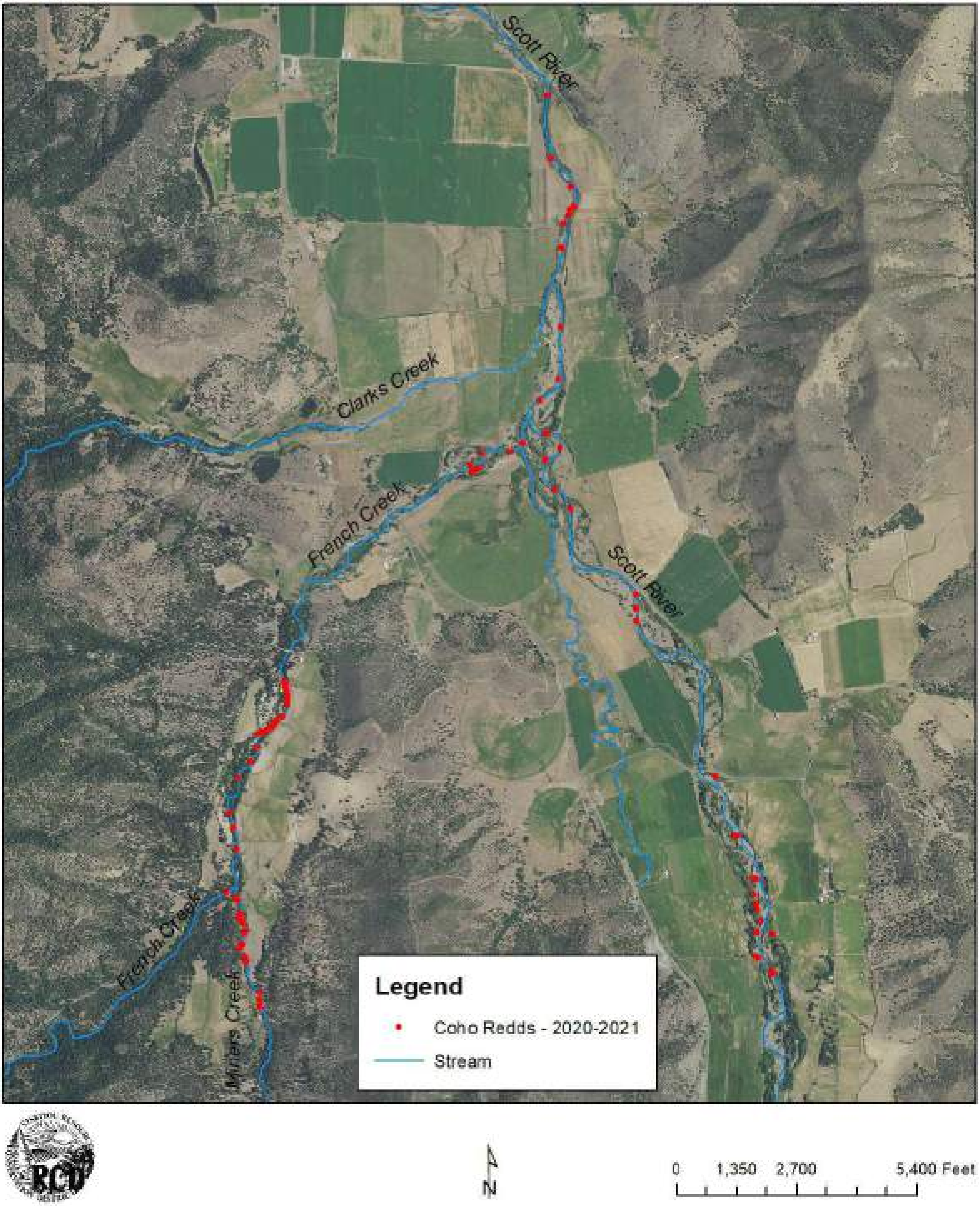
2020-2021 Coho SGS Results Table- Preliminary results, subject to change

Stream	**Redds**		**Carcasses**	
Scott River mainstem	Number	Percentage	Number	Percentage
Reach 16	30	10.6%	1	1.3
Reach 15	33	11.7%	3	3.8%
Reach 14	0	0%	0	0%
Reach 13	1	0.35%	0	0%
Reach 9	8	2.8%	1	1.3%
Reach 8	0	0%	0	0%
Scott River mainstem Total	**72**	**26%**	**5**	**6%**
Tributaries (North to South)				
Mill Creek	55	20%	17	22%
Shackleford Creek	67	24%	**27**	**35%**
Miners Creek	30	10%	15	19%
French Creek	58	20%	14	18%
Sugar Creek	0	0	0	0
South Fork	0	0	0	0

Total Redds= 282
Total Carcasses= 78
Total Live Fish= 466

Stream	**Live Fish**	
Scott River mainstem	Number	Percentage
Reach 16	13	2.7%
Reach 15	18	3.9%
Reach 14	0	0%
Reach 13	3	0.64%
Reach 9	14	3%
Reach 8	1	0.21%
Scott River mainstem Total	**49**	**11%**
Tributaries (North to South)		
Mill Creek	58	12%
Shackleford Creek	103	22%
Miners Creek	67	14%
French Creek	186	40%
Sugar Creek	3	1%
South Fork	0	0%

Scott River Coho Spawning Ground Surveys
Coho Redds - 2020 - 2021



Sugar Creek BDA Pond 1 – Water Surface Elevation
Scott River Watershed Council – 6/28/2021

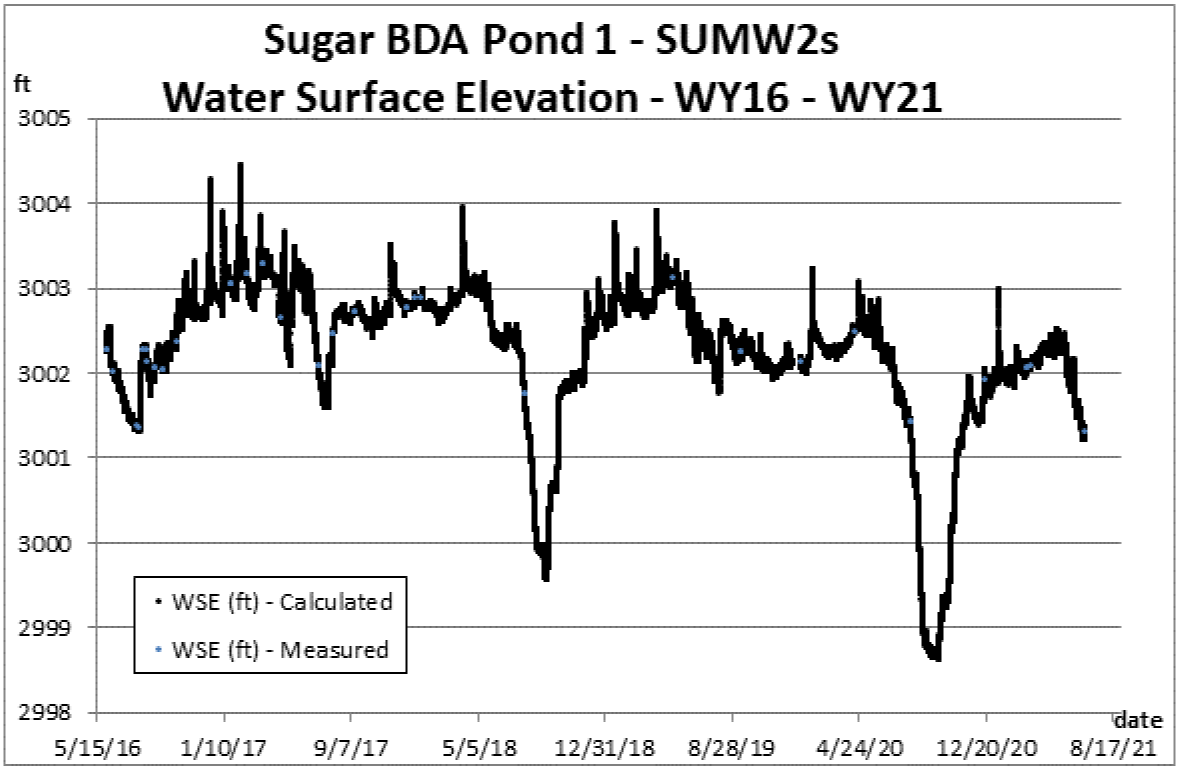


Figure 1 – Sugar BDA Pond 1 – Water Surface Elevation (WSE) – WY15 – WY21

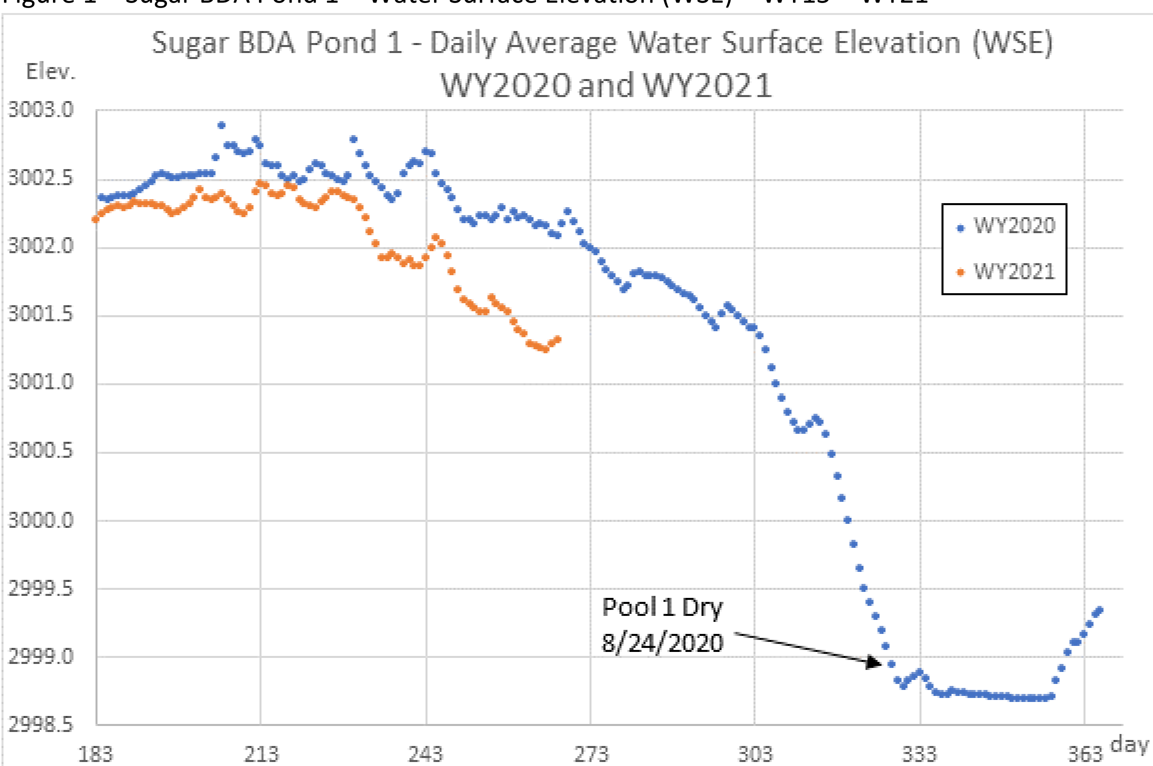


Figure 2 – Sugar BDA Pond 1 – Daily Average (WSE) – WY15 – WY21

Water surface elevation (WSE) has been monitored in BDA Pond 1 since WY2014. Continuous WSE from WY16 to present documented the low WSE during the critically dry WY18 and WY20 (Figure 1). In WY18, the WSE in BDA Pond 1 dropped to a point in which there were isolated pools but the reach did not become completely dry and fish survived in the remnant pool habitats of BDA Pond 1. In WY20, BDA Pond 1 was completely dry.

In WY2020, BDA Pond 1 was observed to be completely dry on 8/24/2020 with a WSE = 2998.8 ft at the WSE station (Figure 2). It is important to note that the WSE dropped approximately 1.8’ in a thirteen-day period from August 11 – August 24.

Figure 2 illustrates the daily average WSE for the same Julian Day during WY2020 and WY2021 – note Julian Day 183 is April 1, 2021 and March 31, 2020 due to the leap year. The WSE on 6/24/2021 (Day 267) in BDA Pond 1 was 3001.3’. In WY2020 the WSE was 3001.3’ on 7/30/2020 – 36 days later than the WY2021 and 25 days before BDA Pond 1 became completely dry.

Sugar Creek RKM 1.0 – Stream Discharge
Erich Yokel – Scott River Watershed Council
6/30/2021

The Scott River Watershed Council established a stream discharge station at RKM 1.0 on May 26, 2021 to document the flow above the Sugar Creek BDA Reach. Four discharge measurements have been performed from May 26 – June 30, 2021 documenting a range of discharge from 0.8 – 11.9 cfs – Table 1. A rating curve was developed from the periodic discharge measurements and the continuous (15 minute) stream discharge was calculated (Figure 1).

Date (PST)	Q (cfs)
5/26/2021 16:57	11.9
6/7/2021 15:00	7.9
6/23/2021 14:44	2.1
6/30/2021 12:10	0.8

Table 1 – Periodic discharge measurements – Sugar Creek RKM 1.0

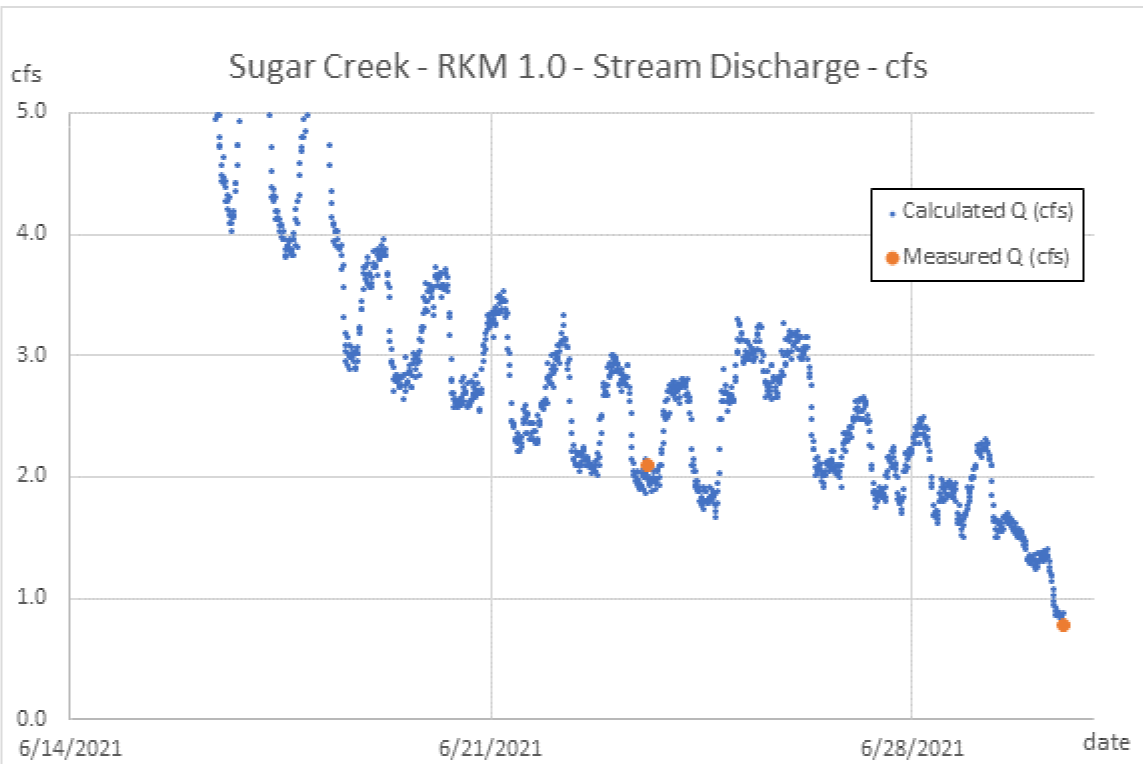


Figure 1 – Calculated and measured discharge (cfs) – Sugar Creek RKM 1.0

The California Department of Water Resources (CDWR) operates a stream discharge station on Sugar Creek at RKM 2.6 (F25890). Continuous (15 minute) stream stage data was retrieved from CDEC on 6/30/2021 and converted to provisional discharge data using Rating Table 5. The provisional continuous discharge data from the CDWR RKM 2.6 station was converted to daily average data and compared to the daily average discharge at the RKM 1.0 station (Figure 2). The provisional average daily discharge at the Sugar Creek CDWR RKM 2.6 station is consistently less than the average daily discharge at the RKM 1.0 station. This is considered suspect due to the lack of surface water inputs between the RKM 2.6 and RKM 1.0 stations. The CDWR F25890 Site Report for WY2020 (9/20/2020) notes – Problems and recommendations for improvements - "Flow measurement sections are hard to find on this stream; therefore, the quality of measurements is usually fair." And that the Quality of Data is "The quality of gage height and low flow discharge data is rated fair".

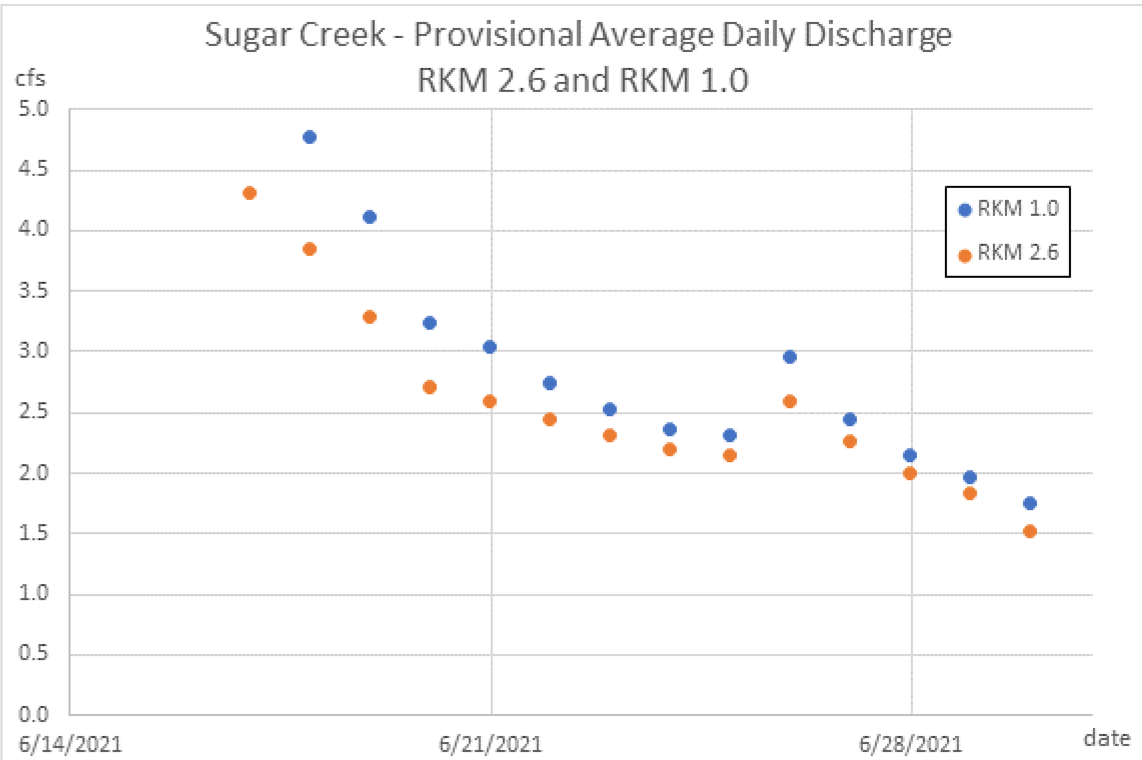


Figure 2 – Provisional average daily discharge (cfs) – Sugar Creek RKM 1.0 and RKM 2.6

Sugar Creek BDA Pond 1 – Water Surface Elevation
Scott River Watershed Council – 7/19/2021

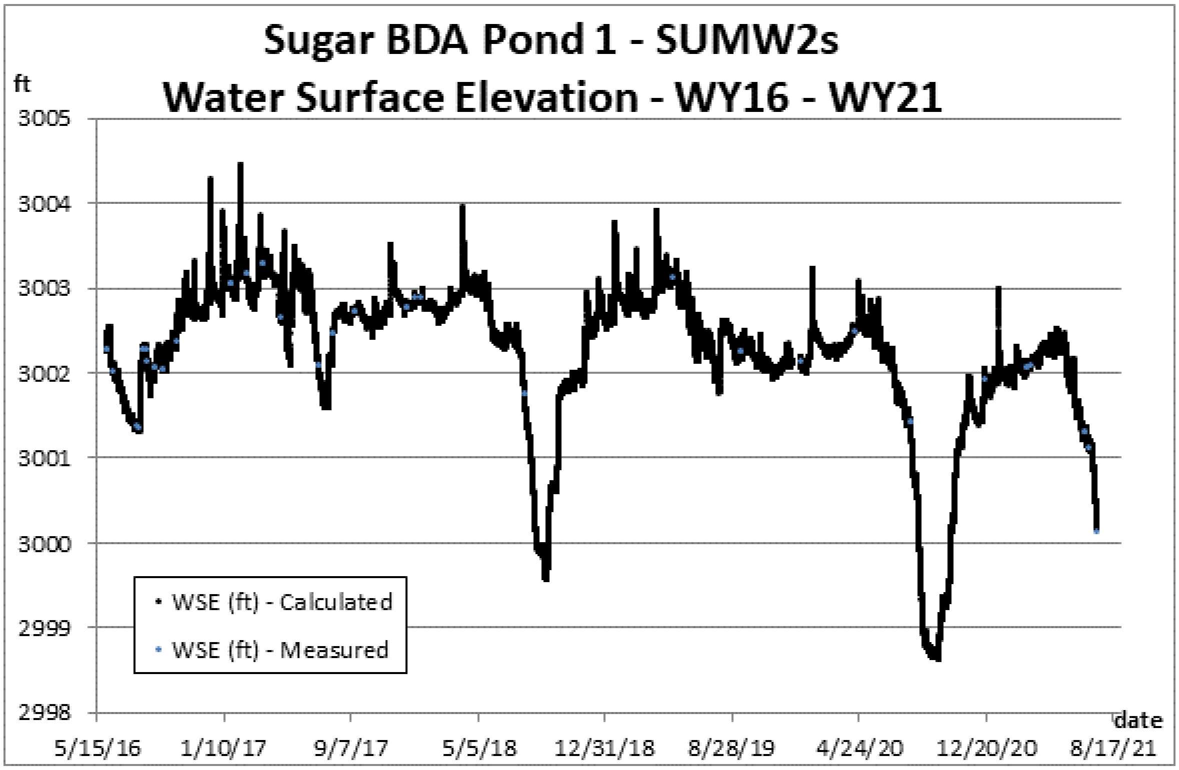


Figure 1 – Sugar BDA Pond 1 – Water Surface Elevation (WSE) – WY15 – WY21

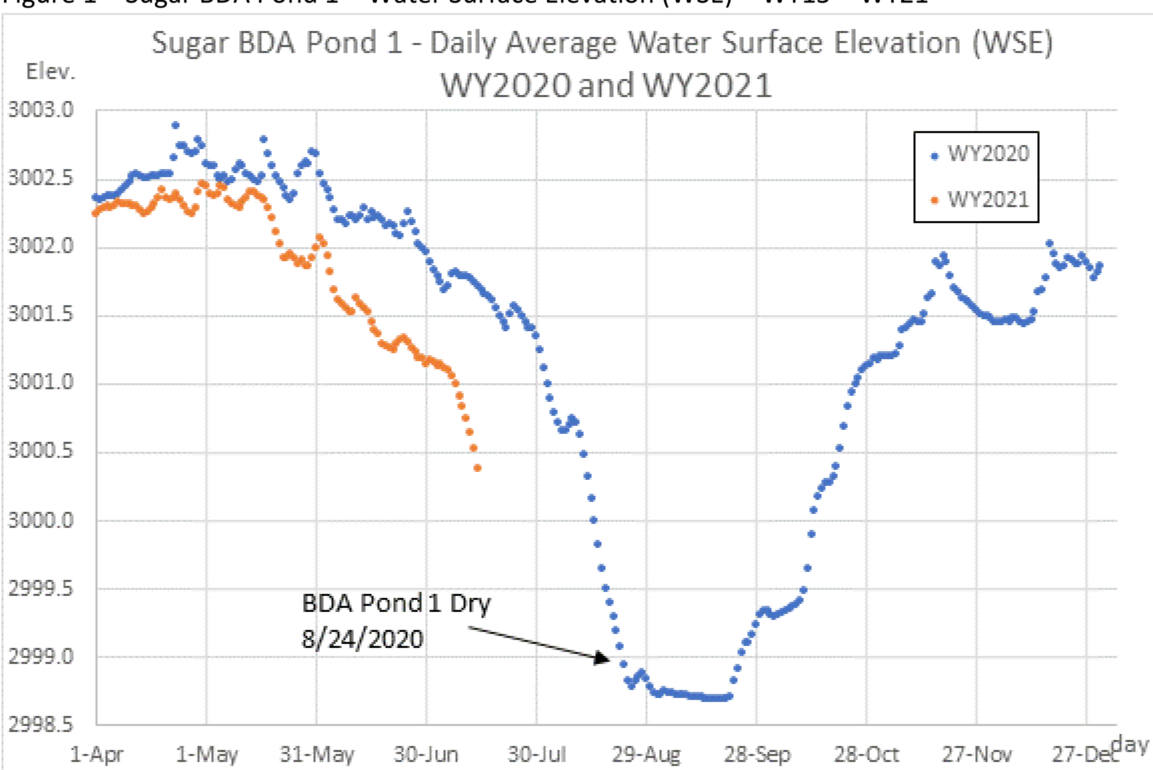


Figure 2 – Sugar BDA Pond 1 – Daily Average (WSE) – WY15 – WY21

Water surface elevation (WSE) has been monitored in BDA Pond 1 since WY2014. Continuous WSE from WY16 to present documented the low WSE during the critically dry WY18 and WY20 (Figure 1). In WY18, the WSE in BDA Pond 1 dropped to a point in which there were isolated pools but the reach did not become completely dry and fish survived in the remnant pool habitats of BDA Pond 1. In WY20, BDA Pond 1 was completely dry.

In WY2020, BDA Pond 1 was observed to be completely dry on 8/24/2020 with a WSE = 2998.8 ft at the WSE station (Figure 2). It is important to note that the WSE dropped approximately 1.8' in a thirteen-day period from August 11 – August 24.

Figure 2 illustrates the daily average WSE for the same Julian Day during WY2020 and WY2021 – note Julian Day 183 is April 1, 2021 and March 31, 2020 due to the leap year. The WSE on 7/15/2021 (Day 288) in BDA Pond 1 was 3000.4'. In WY2020 the WSE was 3000.4' on 8/12/2020 – 28 days later than the WY2021 and 12 days before BDA Pond 1 became completely dry.

A rapid decline in WSE has been observed in July 2021. The WSE declined approximately 0.9 ft in Sugar BDA Pond 1 in the eight-day period from July 8 – July 16 – significantly reducing the volume of available habitat in the BDA Pond (Photo 1 & 2). Additionally, the BDA 1 Step Pools and Sugar Creek Channel from BDA 1.2 to the Scott River were connected on July 8 and dry on July 16 (Photo 3 & 4).


Photo 1 - Sugar BDA Pond 1 – 7/8/2021


Photo 2 - Sugar BDA Pond 1 – 7/16/2021


Photo 3 - Sugar BDA 1 Step Pool – 7/8/2021

Photo 4 - Sugar BDA 1 Step Pool – 7/16/2021

Sugar Creek Beaver Dam Pond (SUMW17s) – Water Quality – WY2020 and WY2021
Scott River Watershed Council

Sugar Creek Beaver Dam Pond – Location of SUMW17s – July 16, 2021

Sugar Creek Beaver Dam – July 16, 2021

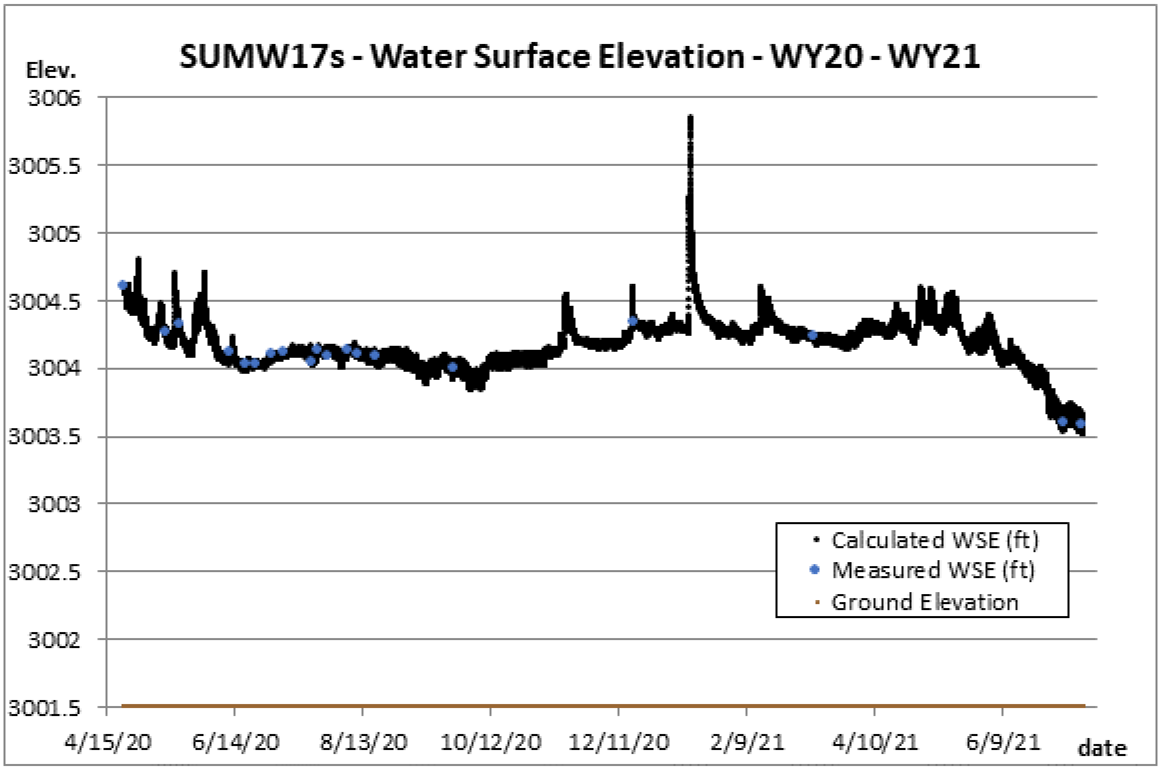


Figure 1 – Calculated and measured water surface elevation – WY2020 – WY2021

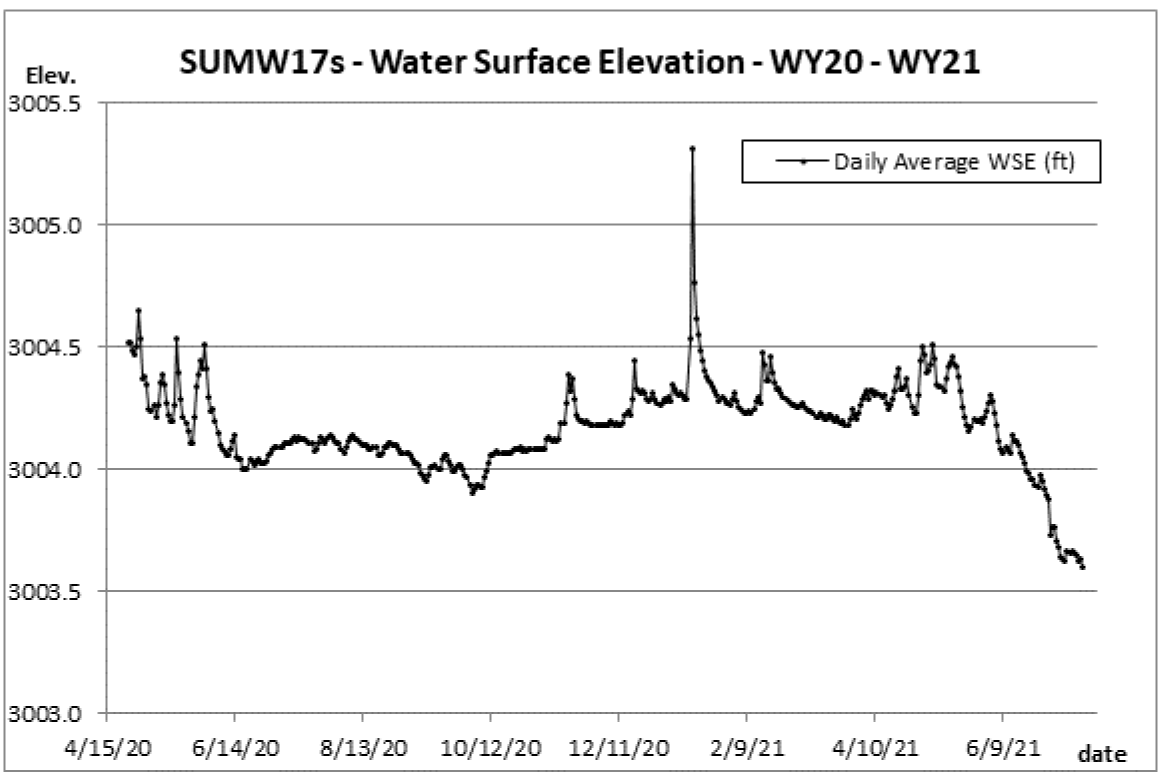


Figure 2 – Daily average water surface elevation – WY2020 – WY2021

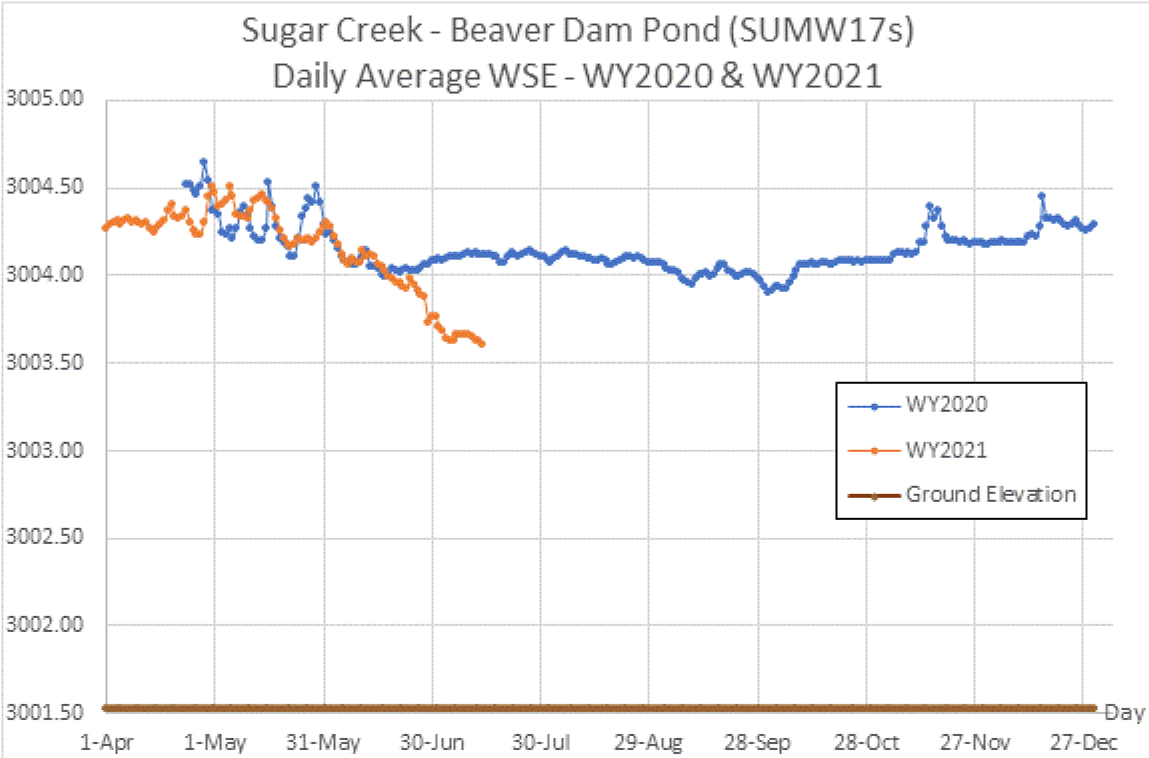


Figure 3 – Daily average water surface elevation by Day – WY2020 and WY2021

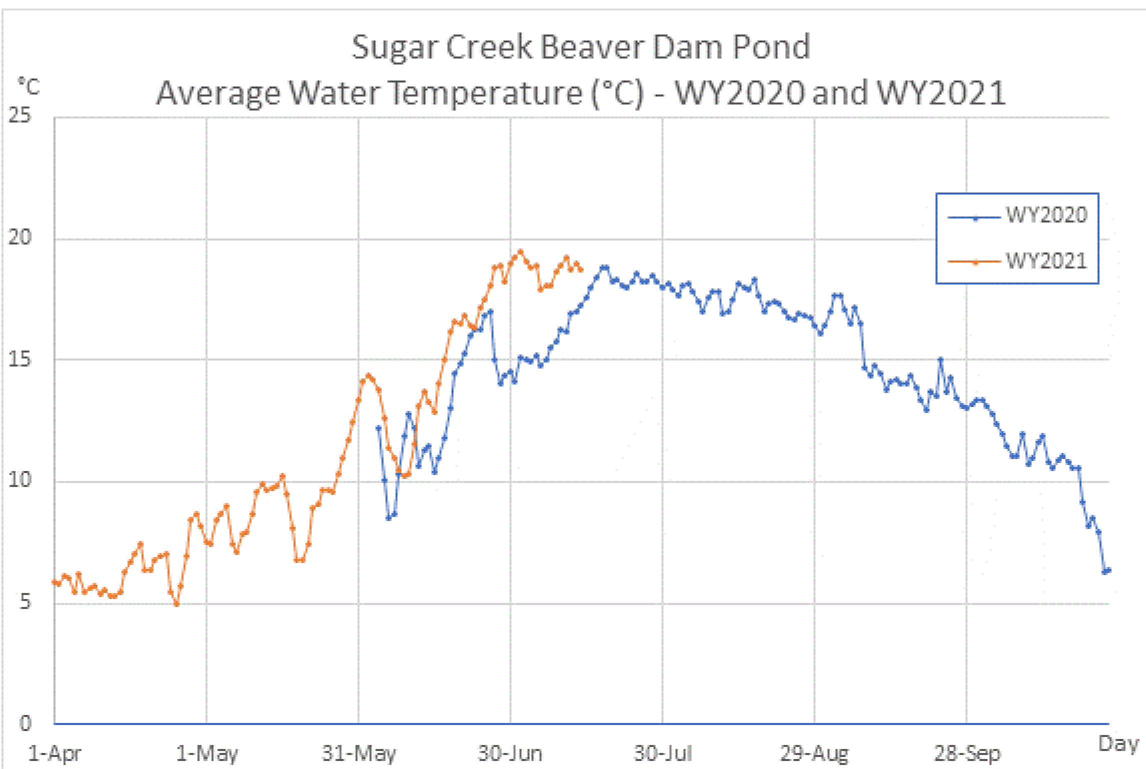


Figure 4 – Daily average temperature (°C) by Day – WY2020 and WY2021

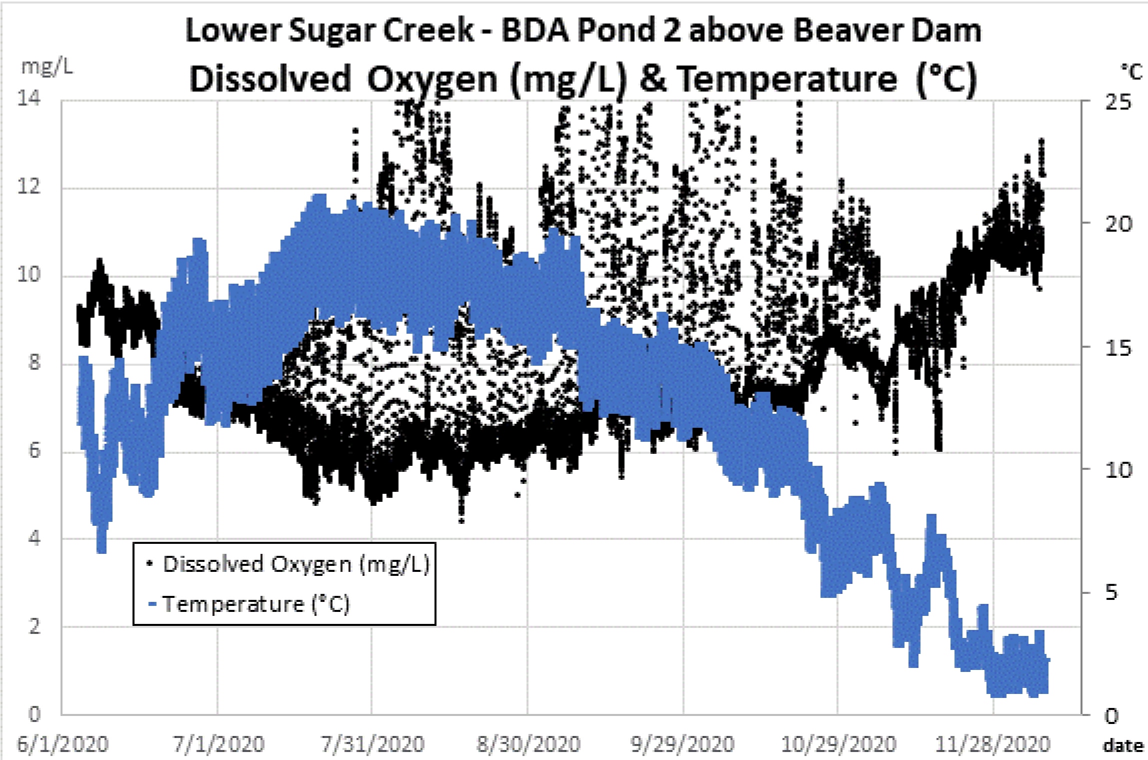


Figure 5 – Dissolved oxygen (mg/L) and temperature (°C) – WY2020 – WY2021

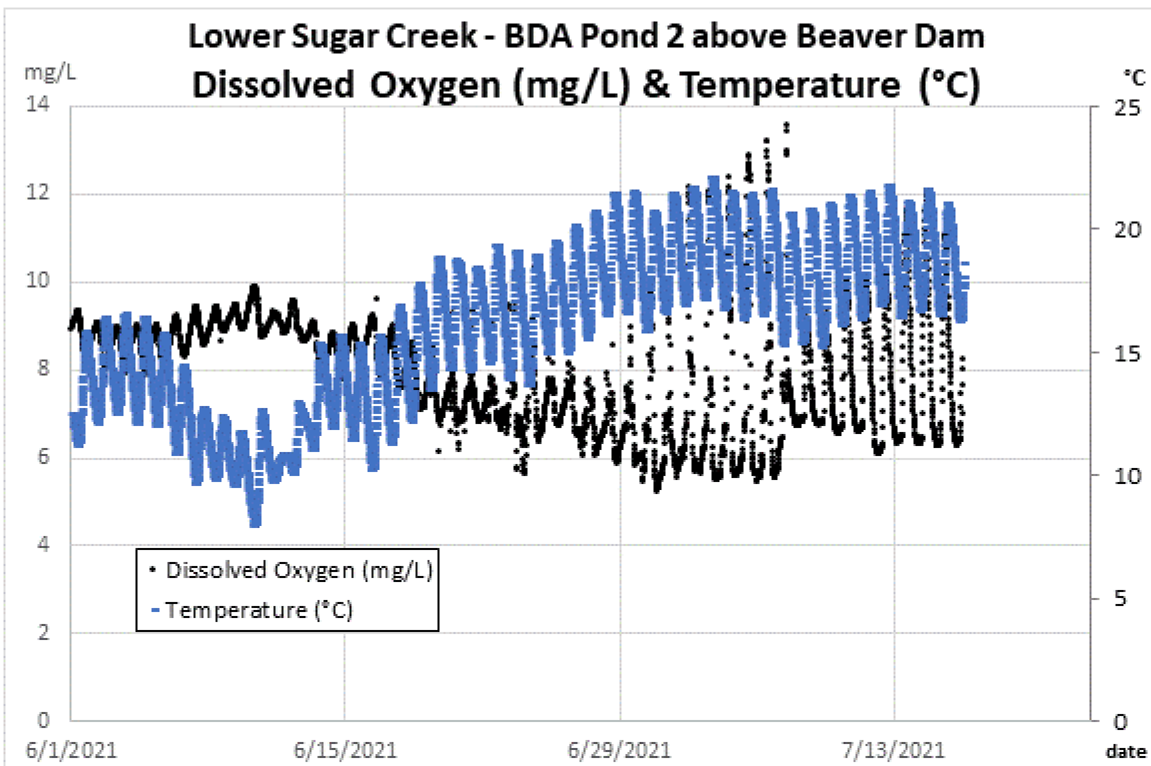


Figure 6 – Dissolved oxygen (mg/L) and temperature (°C) – WY2021

Sugar Off Channel Pond (OCP) – Water Surface Elevation - Dissolved oxygen and temperature – WY2020 & WY2021
Scott River Watershed Council

Sugar OCP – Outlet in Background – July 16, 2021

Water surface elevation (WSE) has been monitored in the Sugar OCP since 2014. Two channels were constructed in Fall of 2015 to connect the Sugar OCP to Sugar Creek. This project was implemented by the Siskiyou RCD and funded by the USFWS Partners Program.

In WY2020 the WSE logger became dry for a period during the rapid decline in WSE necessitating moving to a lower elevation station.

The minimum WSE in the Sugar OCP during WY2020 was 2998.5 ft (Figure 1). At a WSE of 2998.5' a significant area and volume of water existed in the Sugar OCP with maximum depths greater than 10 ft during the base flow period of 2020 (Map 1).

In WY2021 the WSE in the Sugar OCP is declining at a similar trajectory as that observed in WY2020 but approximately one month earlier – as observed at Sugar BDA Pond 1. It is likely that the WSE of the Sugar OCP will be lower during the base flow period of WY2021 than it was in WY2020 but the significant depth of the pond will likely ensure that there is still water with suitable water quality through the base flow period of WY2021.

The Sugar OCP outlet channel was observed to be dry on July 16, 2021.

Sugar OCP Outlet – July 16, 2021

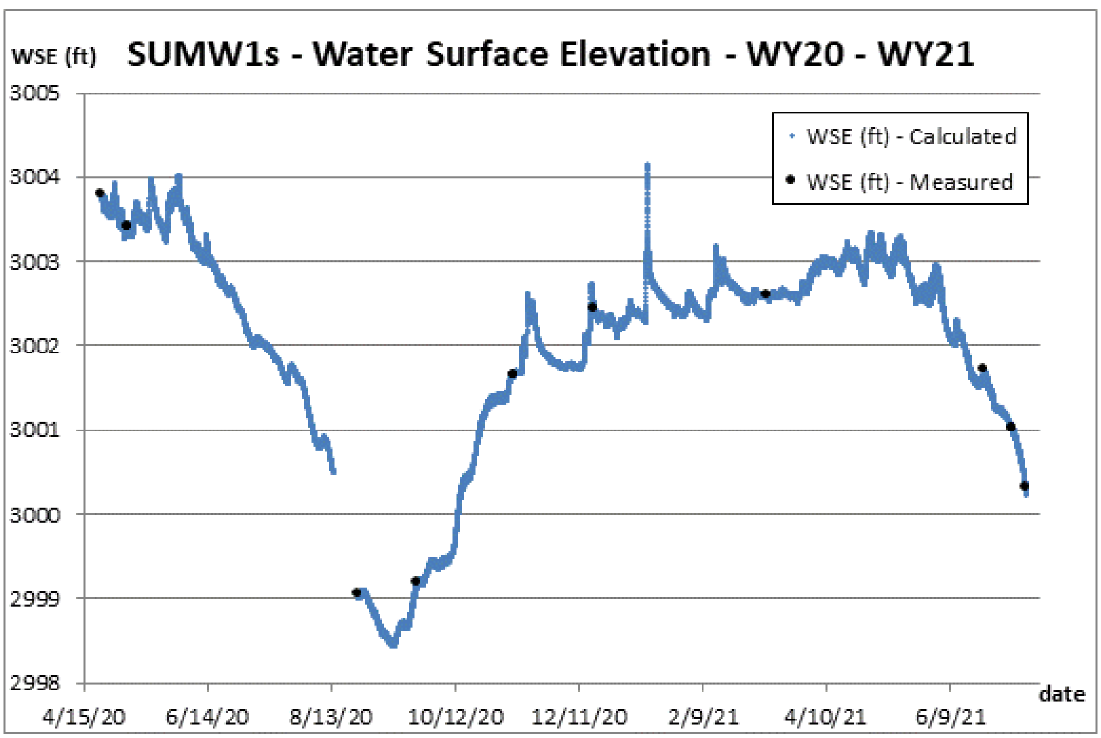


Figure 1 – Water Surface Elevation (WSE) – Sugar OCP (SUMW1s) – WY2020 – WY2021

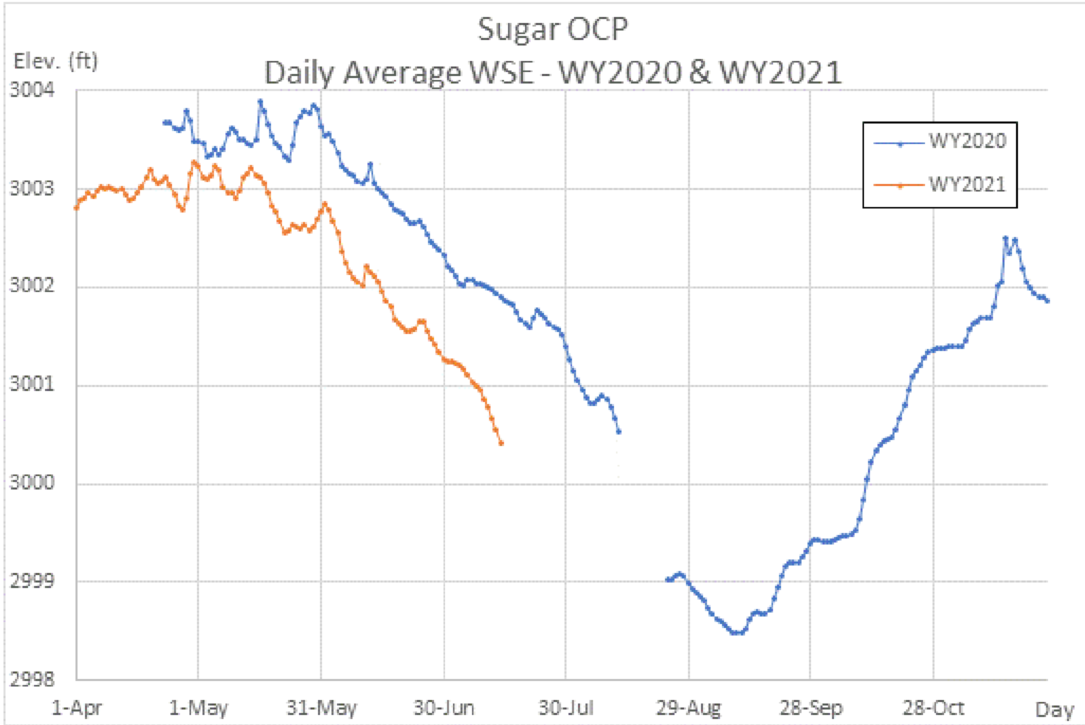
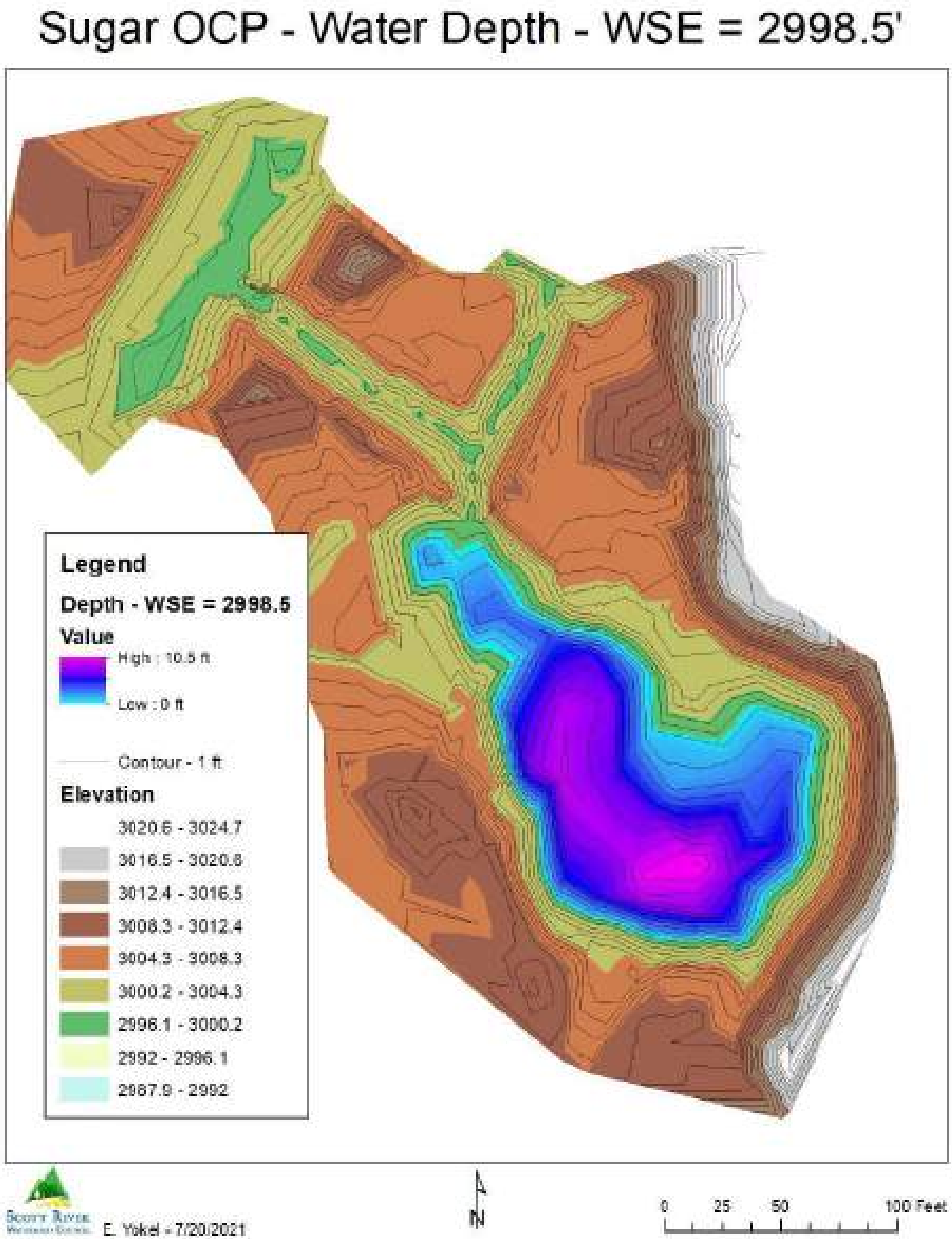


Figure 2 – Water Surface Elevation (WSE) by Julian Day – Sugar OCP (SUMW1s) – WY2020 & WY2021



Map 1 – Water depth in Sugar OCP at WSE = 2998.5’

Dissolved Oxygen and Temperature

An Onset Hobo U26 dissolved oxygen and temperature logger was deployed in the Sugar Off Channel Pond (OCP) in April 2020. Continuous (15 minute) dissolved oxygen (mg/L) and temperature (°C) was documented (Figure 1). Due to the rapid decline in water surface elevation the logger was dewatered from mid-August through early September. The logger was placed at a lower elevation in early September. Dissolved oxygen in the Sugar OCP was greater than 6 mg/L for the majority of the period of record with a few instances of DO less than 6 mg/L in October.

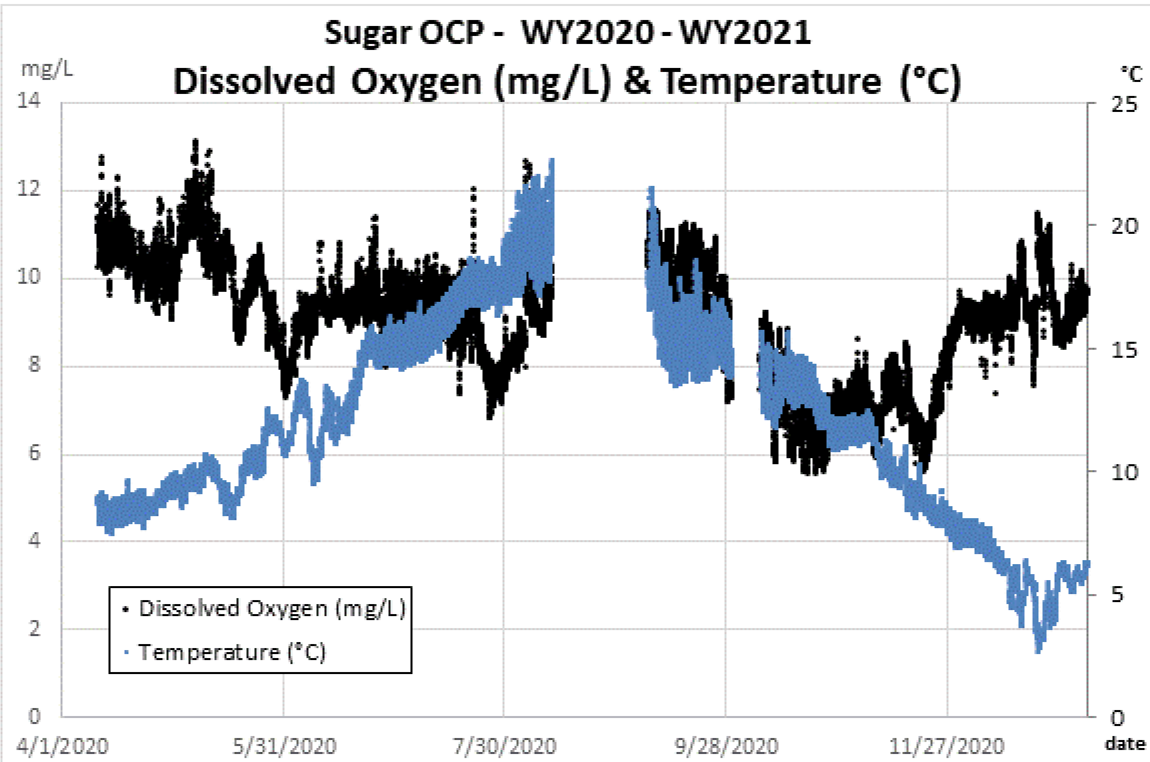


Figure 1 – Dissolved oxygen (mg/L) and temperature (°C) – Sugar OCP – WY2020 – WY2021

The dissolved oxygen logger is currently deployed in the Sugar OCP (Figure 2). The logger was observed to be in the water but on the top of the water column on 7/16/2021 at which time the logger was moved to a deeper section of the Sugar OCP. The Sugar OCP is temperature stratified – on 7/16/2021 the temperature at the surface location of the logger was 19.9° C and the temperature at the deeper location was 17.1° C. The dissolved oxygen concentration was approximately the same at the two locations – 7.5 mg/L.

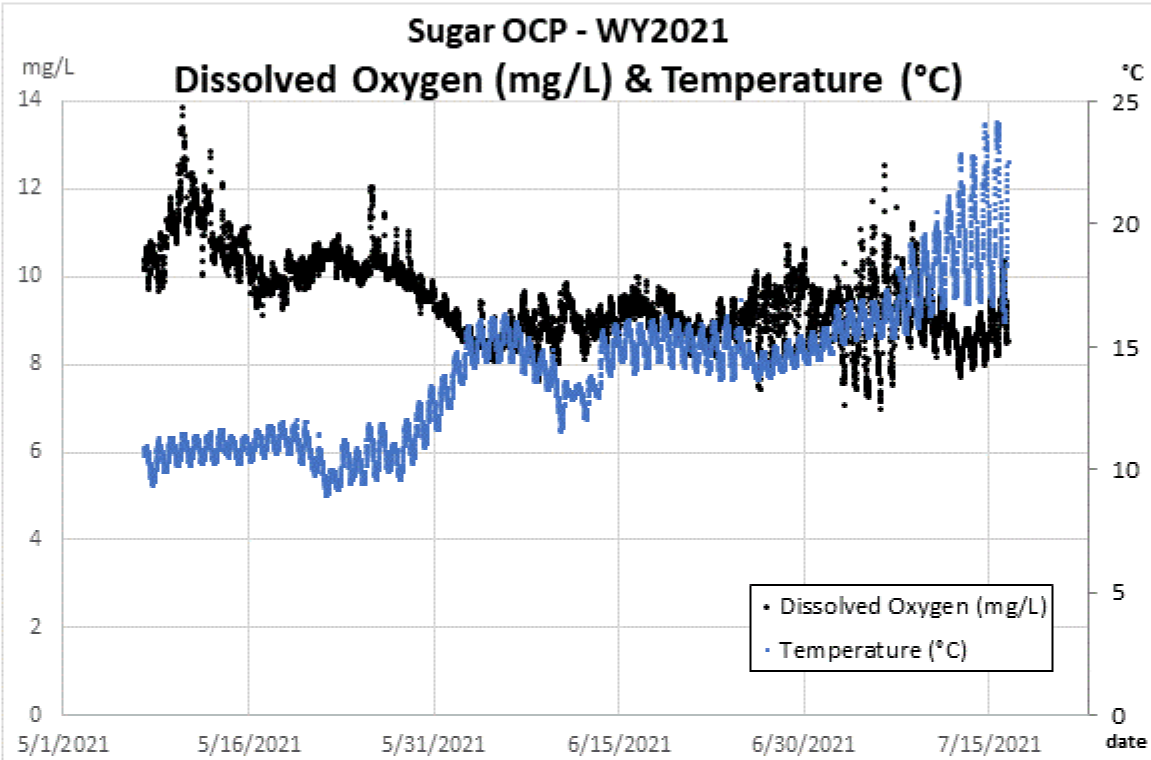


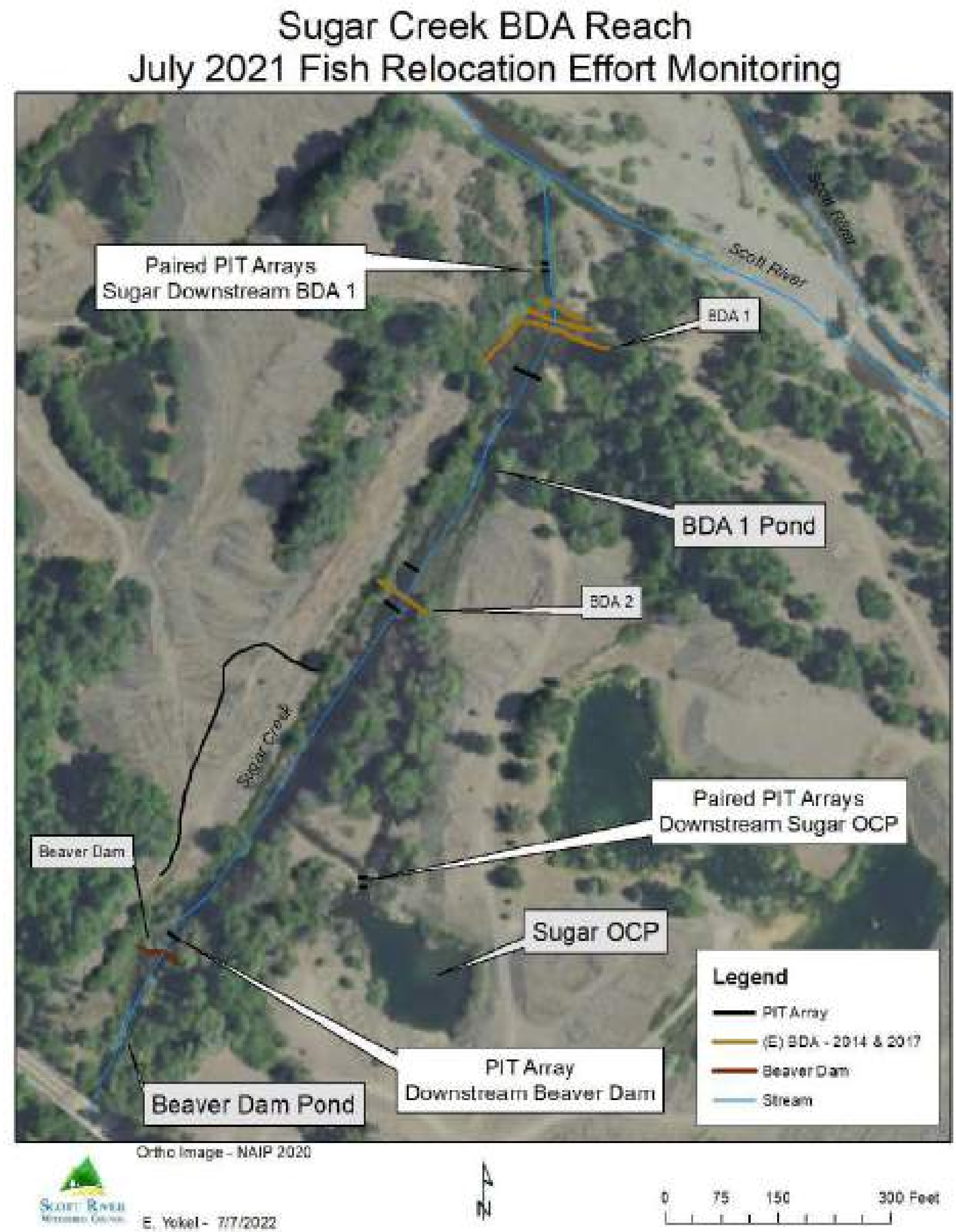
Figure 2 – Dissolved oxygen (mg/L) and temperature (°C) – Sugar OCP – WY2021

Lower Sugar Creek BDA Pond 1 Fish Relocation – July 2021
Detection of PIT marked relocated Coho Salmon
Scott River Watershed Council

YOY Coho Salmon captured in Sugar BDA Pond 1- 7/23/2021 – Forklength = 82 mm & Weight = 6.3 g

The Scott River Watershed Council assisted NOAA Fisheries in relocating YOY juvenile Coho Salmon (*O. kisutch*) and steelhead trout (*O. mykiss*) from the Sugar Creek BDA Pond 1 to two habitats in Lower Sugar Creek during three efforts in July 2021. Fish were relocated to the Sugar Off Channel Pond (Sugar OCP) and the natural beaver dam pond (Map 1).

Direct observation surveys performed in late June 2021 documented Coho Salmon rearing in the Sugar Creek BDA Pond 1 with no fish observed in the Sugar Creek BDA Pond 2, natural beaver dam pond and Sugar OCP habitats. WY2021 was the second year of critical drought that began in WY2020. The Sugar BDA 1 Pond habitat became completely dry during the base flow period of 2020 resulting in total loss of the Coho Salmon marked before disconnection while the Sugar OCP and natural beaver dam maintained suitable quality habitat through the summer of 2020. Due to the certainty that the BDA 1 Pond would become dry during the summer of 2021 and the presence of Coho in the BDA 1 Pond and absence of Coho in the Sugar OCP and natural beaver dam a relocation effort was performed to relocate the fish.



Map 1 – Location of fish capture and release and PIT array stations

No marking of Coho Salmon was planned during the initial relocation effort performed on July 2, 2021, due to the observations from previous years' fish sampling efforts that Coho Salmon have not reached suitable size (FL => 65mm) for applying a PIT tag in early July. Fifty-nine (59) Coho captured on July 2 were measured documenting that a portion of the population was suitable size for marking with PIT tags (Table 1). The entire July 2 catch was relocated to the Sugar OCP (Table 2).

Coho Salmon Forklength (mm)

Date Location	7/2/2021 Sugar BDA Pond 1	7/8/2021 Sugar BDA Pond 1	7/22/2021 Sugar BDA Pond 1
Average (mm)	67	71	74
Stand. Deviation (mm)	4	4.6	4.1
Minimum (mm)	60	57	65
Maximum (mm)	77	89	87
Count	59	133	68

Table 1 – Coho Salmon average forklength (mm) – Sugar BDA Pond 1 - July 2, July 8 and July 22, 2021

During the second effort on July 8, 2021, a subsample of suitably sized Coho Salmon were marked with a PIT tag and relocated to the Sugar OCP and Beaver Dam Pond to document the effectiveness of the relocation effort. Fifty-three (53) Coho were PIT marked and relocated to the Sugar OCP and sixty-two (62) Coho were PIT marked and relocated to the natural beaver dam. Additional unmarked Coho Salmon and steelhead trout were placed in both relocation habitats.

Relocation Effort	7/2/2021	7/8/2021	7/22/2021	Total
Coho Salmon - PIT Marked - Relocated to Sugar OCP	0	53	51	104
Coho Salmon - PIT Marked - Relocated to Beaver Dam Pond	0	62	0	62
Coho Salmon - Relocated to Sugar OCP	708	13	473	1194
Coho Salmon - Relocated to Beaver Dam Pond	0	59	0	59
Steelhead trout - Relocated to Sugar OCP	12	4	150	166
Steelhead trout - Relocated to Beaver Dam Pond	0	23	0	23

Table 2 – Number of marked and unmarked Coho Salmon relocated to each habitat per effort

The third and final relocation effort occurred on July 22, 2021, when the Sugar BDA Pond 1 habitat had significantly decreased in volume into an isolated pool. Fifty-one (51) Coho Salmon were PIT marked and the entire catch was relocated to the Sugar OCP. Fish were not relocated to the natural beaver dam habitat due to a concern regarding the potential failure of this habitat during the base flow period of WY2021 and analysis of the depth of water quality of the Sugar OCP during the base flow period of WY2020.

Over the three efforts a total of 1,247 Coho Salmon (104 PIT Marked) and 166 steelhead trout were relocated to the Sugar OCP and 121 (62 PIT Marked) and 23 steelhead trout were relocated to the natural beaver dam (Table 3). 8.3% of the Coho Salmon relocated to the Sugar OCP were marked with a PIT tag and 51.2% of the Coho Salmon relocated to the natural beaver dam were marked with a PIT tag. A total of 1,368 Coho Salmon and 189 steelhead trout were relocated from Sugar BDA Pond 1 during the three efforts in July 2021.

Sugar BDA Pond 1 - Fish Relocation Totals - July 2, 8 & 22, 2021

Relocation Habitat	Sugar OCP	Sugar Beaver Dam Pond
Coho Salmon - PIT Marked	104	62
Coho Salmon	1143	59
Total Coho Salmon	1247	121
Steelhead trout	166	23

Table 3 – Total number of fish relocated to each habitat – July 2, 8 & 22, 2021

A network of stationary PIT array detection stations was maintained downstream of the Sugar OCP and beaver dam and downstream of the Sugar BDA 1 Complex to detect marked fish (Map 1). Marked fish migrating from the Sugar OCP should be detected by the channel spanning paired arrays in the constructed channel connecting the Sugar OCP to Sugar Creek. The single array in the mainstem of Sugar Creek downstream of the beaver dam was installed before the beaver dam was built during the drought of 2018. The beaver dam created multiple side channel that circumvent the single array allowing marked fish to pass the array without being detected. Marked fish migrating from the BDA ponds in Lower Sugar Creek should be detected on the channel spanning paired arrays in the mainstem downstream of the BDA 1 Complex (paired outmigrant PIT arrays). All three array locations were dry during the base flow period of WY2021.

Approximately two thirds of the relocated fish were detected on a stationary PIT array after the reach reconnected (Table 4). The detection efficiency of the paired arrays downstream the Sugar OCP is significantly greater than the detection efficiency of the single array downstream of the beaver dam. Approximately half of the relocated fish were detected on the paired outmigrant PIT arrays downstream of Sugar BDA 1 Complex (Table 5). 58 of the 104 (56%) marked Coho relocated to the Sugar OCP and 26 of the 62 (42%) of the marked Coho relocated to the beaver dam pond were detected at the paired outmigrant PIT arrays.

A total of 78 of the 104 (75 %) marked Coho relocated to the Sugar OCP were detected on the paired arrays downstream of the Sugar OCP after the reach reconnected. 58 of the 78 (74%) marked Coho detected on the paired arrays downstream of the Sugar OCP were detected on the outmigrant paired arrays downstream of the Sugar BDA 1 Complex. All of the 58 marked individuals detected on the paired outmigrant arrays were detected on the paired arrays downstream of the OCP.

In contrast, only 11 of the 26 marked Coho relocated to the natural beaver dam that were detected at the paired outmigrant PIT arrays were detected at the single PIT array downstream of the natural beaver dam. Sixteen (16) marked Coho relocated to the natural beaver dam were detected at the single PIT array downstream of the beaver dam, eight of these detected fish were detected at the paired arrays downstream of the Sugar OCP and eleven were detected at the paired outmigrant arrays. An additional four marked fish that were relocated to the natural beaver dam were detected on the paired PIT arrays downstream of the Sugar OCP and not detected on the single PIT array downstream of the beaver dam. The low detection efficiency of the PIT array below the beaver dam precludes the ability to determine apparent survival over the base flow period for the fish relocated to the beaver dam pond.

Sample date	Sample Habitat	# Marks	Comment	Number Detected	Percent Detected
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	37	70%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	31	50%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	41	80%
Total		166		109	66%

Table 4 – Number of marked relocated Coho Salmon detected on Sugar Creek PIT Array

Sample Date	Sample Habitat	# Marks	Comment	Outmigrants Detected	Percent Detected
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	26	49%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	26	42%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	32	63%
Total		166		84	51%

Table 5 – Number of marked relocated Coho Salmon detected on paired outmigrant PIT Arrays

Conclusion:

A total of 1,368 Coho Salmon were relocated from the drying Sugar BDA Pond 1 habitat to the adjacent Sugar OCP and natural beaver dam habitats in July 2021. 104 PIT marked Coho were relocated to the Sugar OCP and 62 PIT marked Coho were relocated to the natural beaver dam. 75% of the marked Coho relocated to the Sugar OCP were detected on a stationary PIT array after the reach reconnected and 56% of the marked fish relocated to the Sugar OCP were detected on the paired outmigrant PIT arrays. 42% of the marked Coho relocated to the natural beaver dam were detected on the outmigrant PIT arrays.

Mid French Creek RKM 3.5 Stream Discharge and Temperature – WY2020 and WY2021
Scott River Watershed Council

Stream discharge (cfs) was monitored in Mid French Creek at RKM 3.5 during the drought years of WY2020 and WY2021. Twenty (20) periodic discharge measurements were performed during WY2020 (Table 1) to develop a rating curve and calculate continuous (15 minute) stream discharge (Figure 1). The maximum discharge measured during WY2020 was approximately 85.5 cfs and the minimum discharge measured was approximately 0.7 cfs. Calculated discharge greater than 100 cfs is considered "beyond the rating table" and is not presented. Daily average discharge was calculated (Figure 2).

Date	Q (cfs)
1/23/2020 14:13	16.3
2/7/2020 14:32	28.5
2/27/2020 13:39	19.3
3/31/2020 9:45	22.9
4/23/2020 8:20	85.5
4/24/2020 11:17	61.4
5/19/2020 10:05	59.8
6/24/2020 12:04	12.0
6/26/2020 11:43	9.9
6/30/2020 9:24	8.7
7/7/2020 8:29	5.6
7/24/2020 10:00	3.1
8/5/2020 13:09	1.3
8/10/2020 10:23	1.2
8/17/2020 9:55	0.7
8/25/2020 11:21	2.6
9/2/2020 8:45	2.0
9/8/2020 9:30	1.5
9/16/2020 9:56	1.8
9/25/2020 10:56	2.2

Table 1 – Periodic discharge measurements performed at French Creek RKM 3.5 – WY2020

Figure 1 – Calculated and measured stream discharge (cfs) – French RKM 3.5 – WY2020

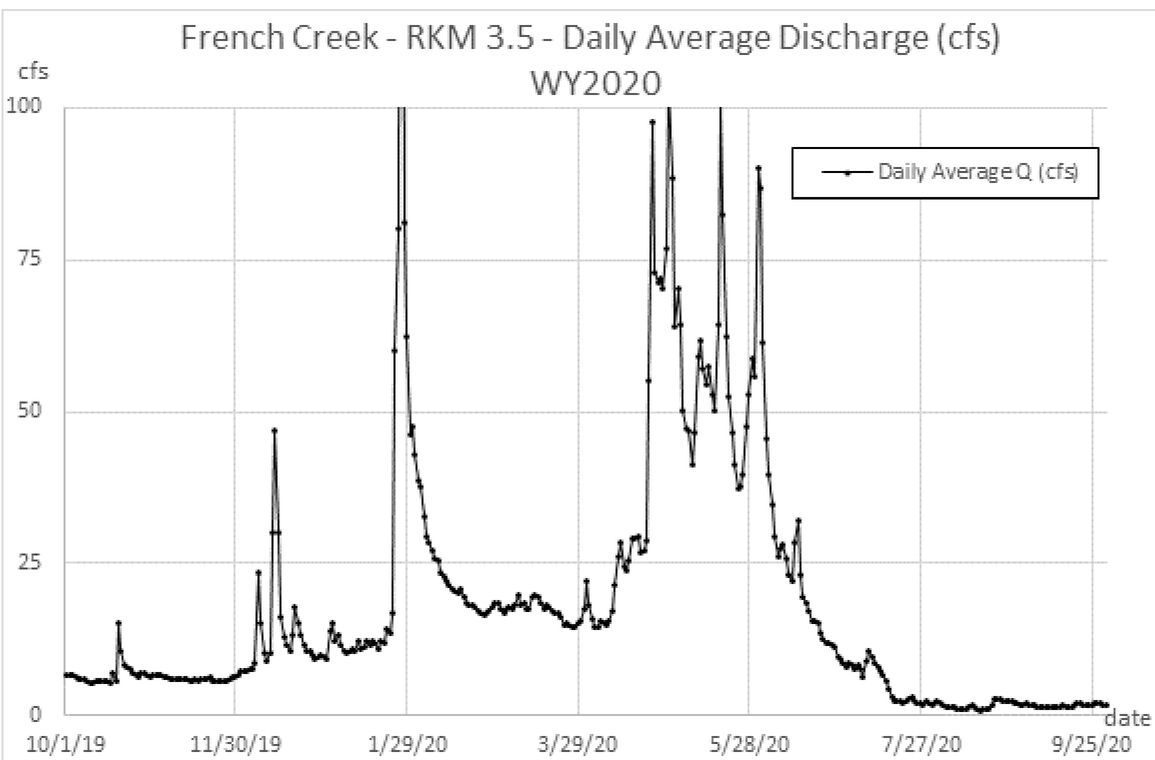


Figure 2 – Daily average stream discharge (cfs) - French RKM 3.5 – WY2020

Five periodic measurements were performed in WY2021 to verify that the rating curve developed in WY2020 was applicable in WY2021 (Table 2). Continuous and daily average was calculated for WY2021 (Figures 3 and 4).

Date	Q (cfs)
5/18/2021 14:57	42.6
6/22/2021 11:57	7.8
7/16/2021 14:23	2.1
7/28/2021 15:06	1.2
8/31/2021 9:47	0.7

Table 2 – Periodic discharge measurements performed at French Creek RKM 3.5 – WY2021

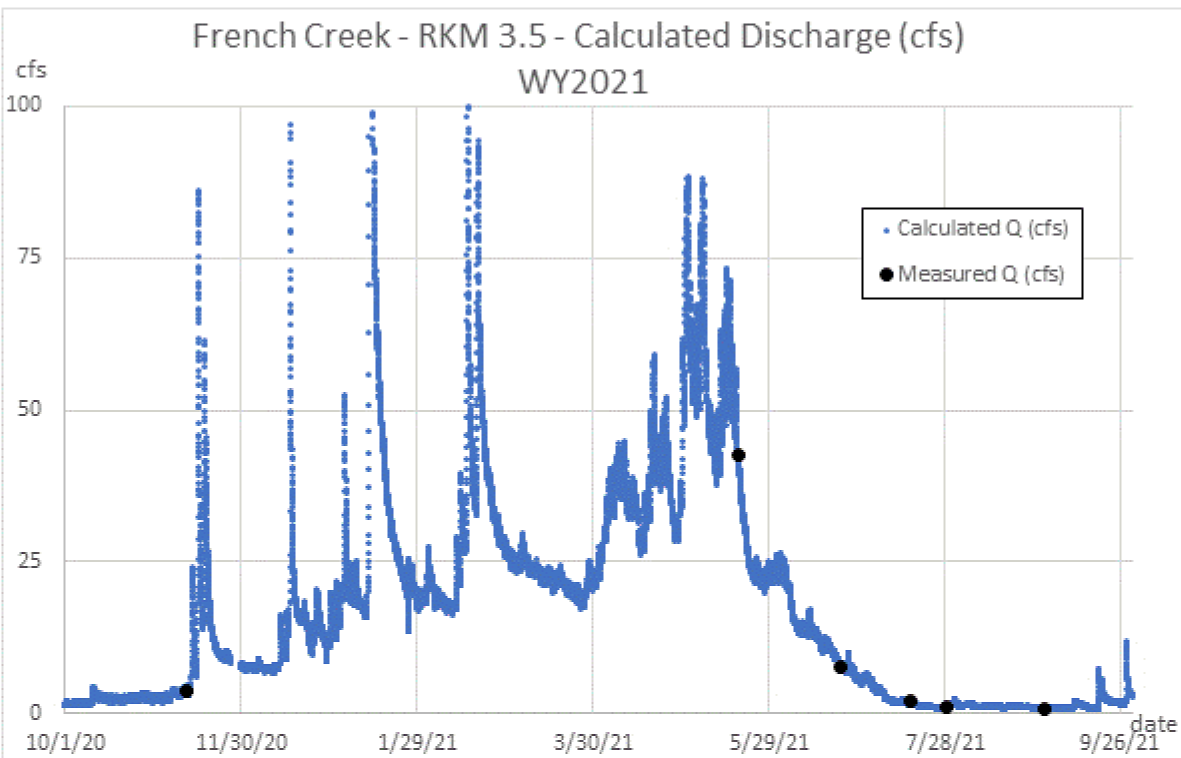


Figure 3 – Calculated and measured stream discharge (cfs) – French RKM 3.5 – WY2021

Figures 5 – 7 illustrate the daily average discharge for WY2020 and WY2021. Stream discharge in WY2021 was less than the discharge in WY2020 during the month of October and during the period of Mid May through July. The average discharge during the base flow period of the two years was similar until a voluntary forbearance of an upstream water right was executed on August 20, 2020 (Figure 7).

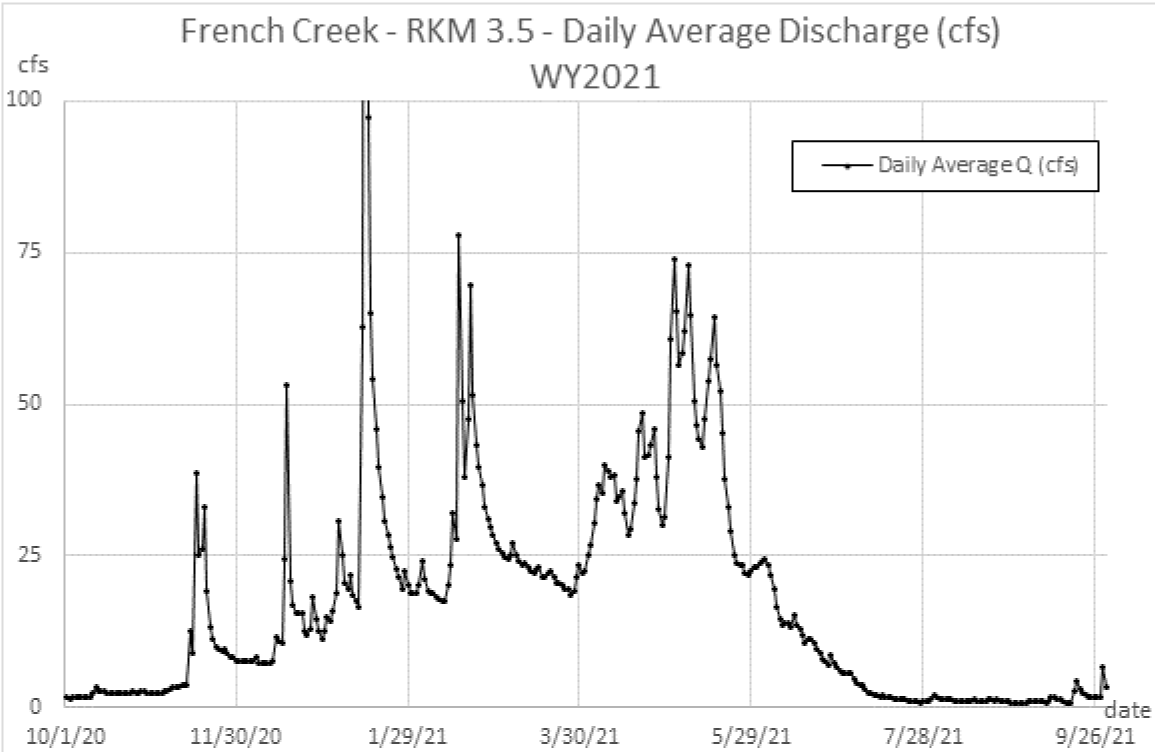


Figure 4 – Daily average stream discharge (cfs) - French RKM 3.5 – WY2021

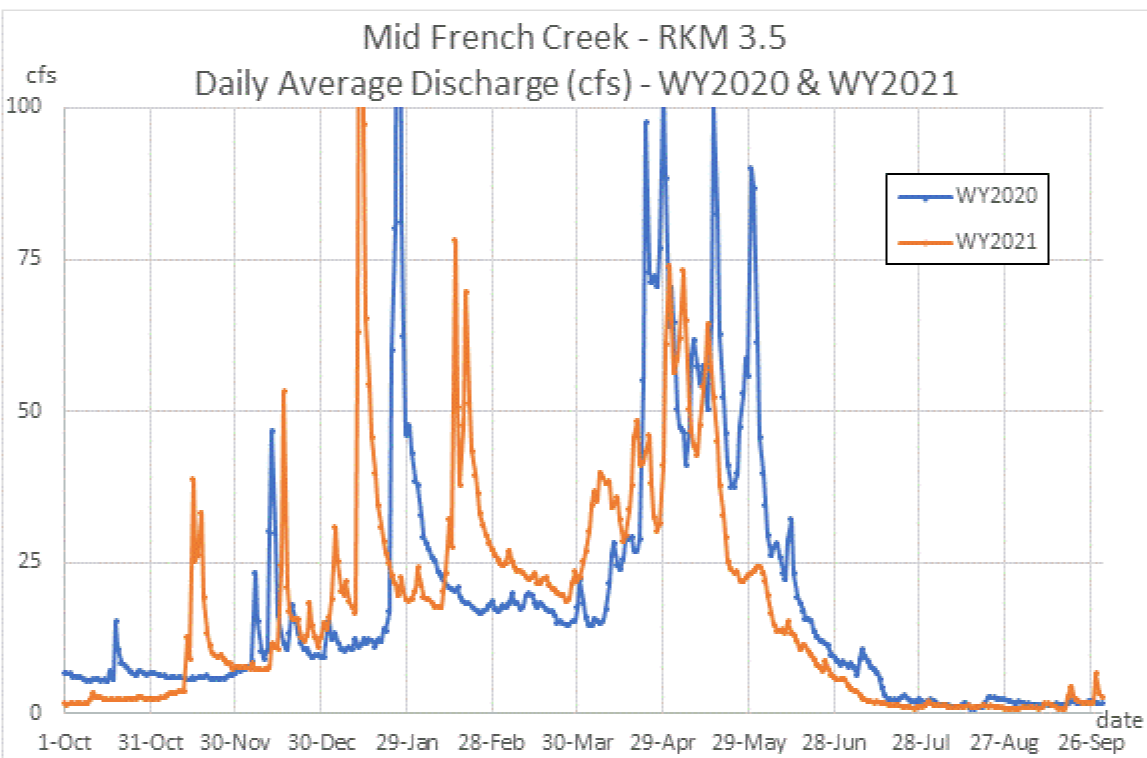


Figure 5 – Daily average stream discharge (cfs) - French RKM 3.5 – WY2020 & WY2021

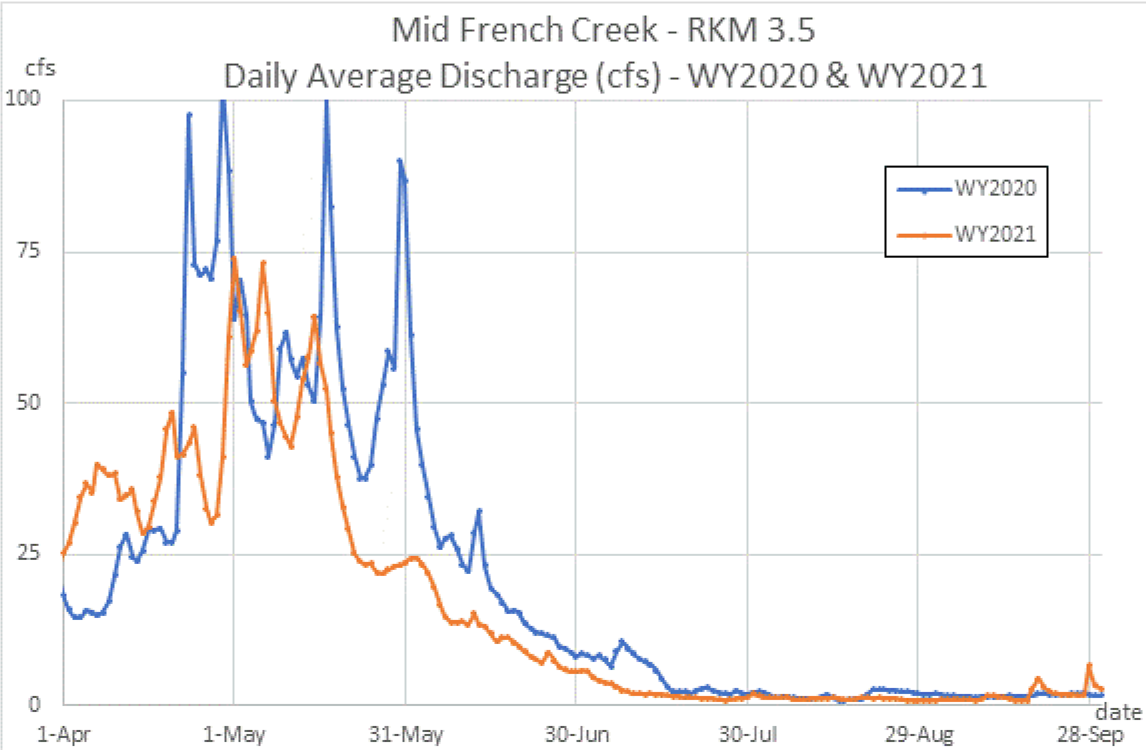


Figure 6 – Daily average stream discharge (cfs) - French RKM 3.5 – WY2020 & WY2021

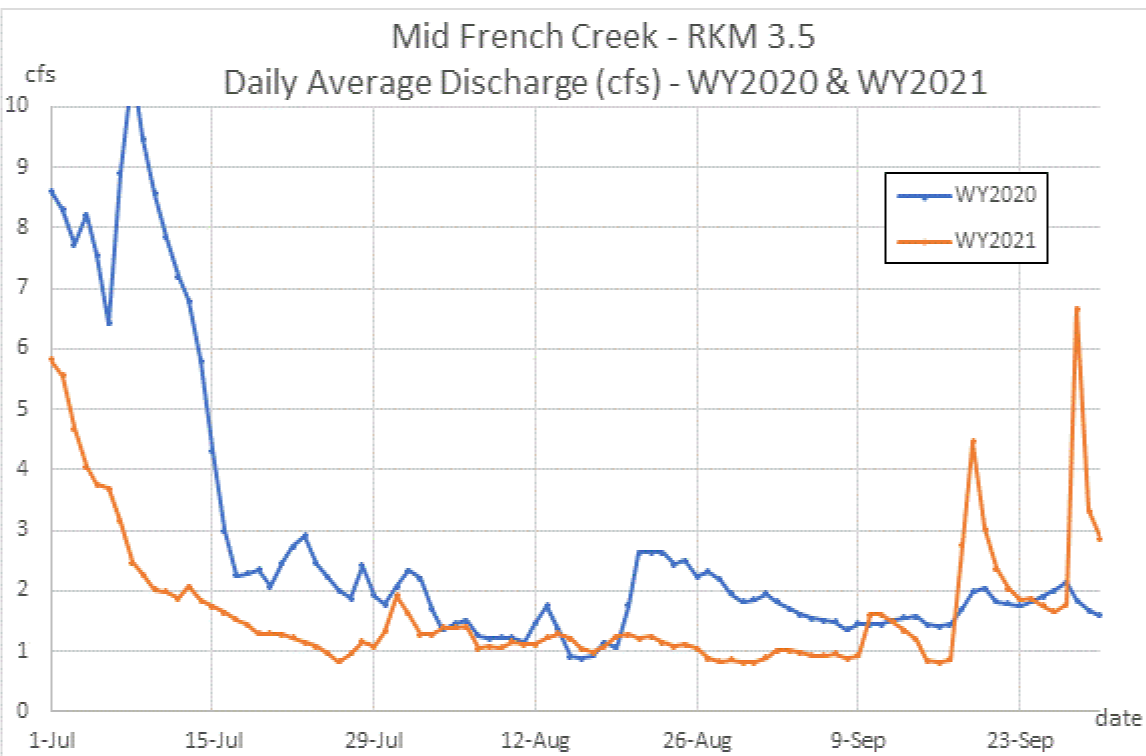


Figure 7 – Daily average stream discharge (cfs) - French RKM 3.5 – WY2020 & WY2021

Average daily water temperature (°C) at French Creek RKM 3.5 during 2020 and 2021 was calculated from the continuous (15 minute) data at the stream discharge station (Figure 8). The maximum MWAT (°C) (Moving Weekly Average Temperature - °C) during WY2021 was warmer and occurred earlier than the maximum MWAT (°C) in WY2020 – both maximum MWATs were less than 18° C (Table 3).

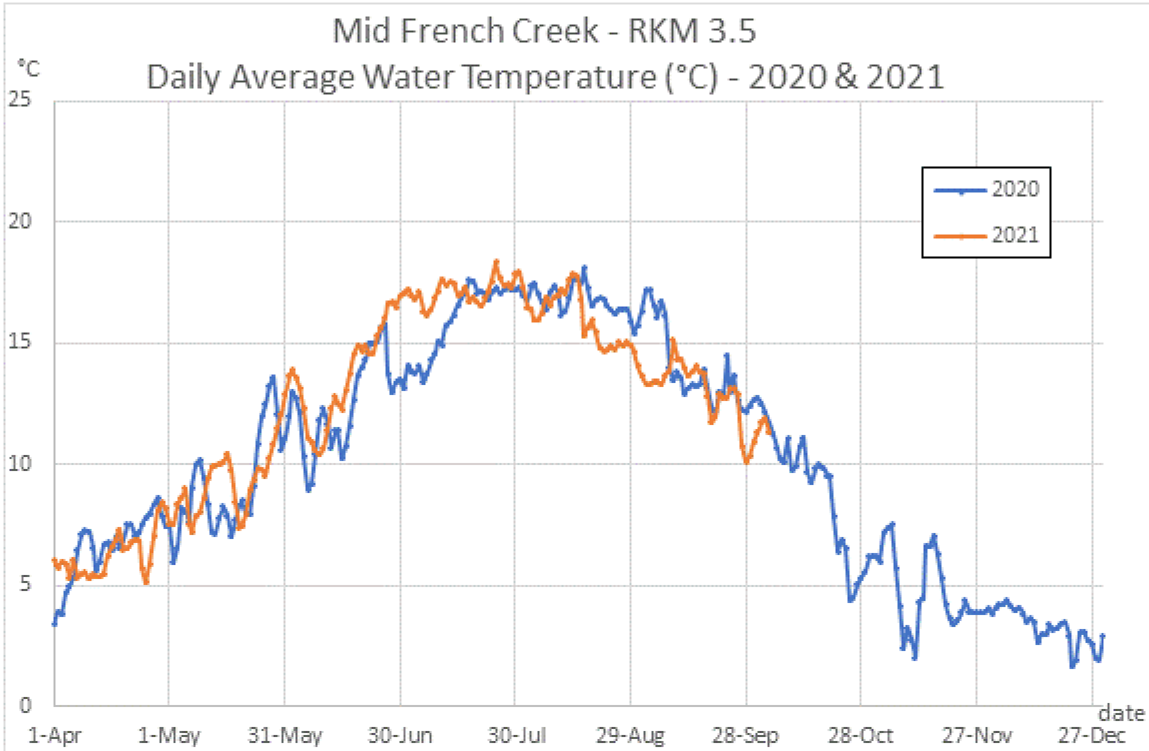


Figure 8 - Daily average water temperature (°C) - French RKM 3.5 –2020 & 2021

Maximum MWAT (°C)

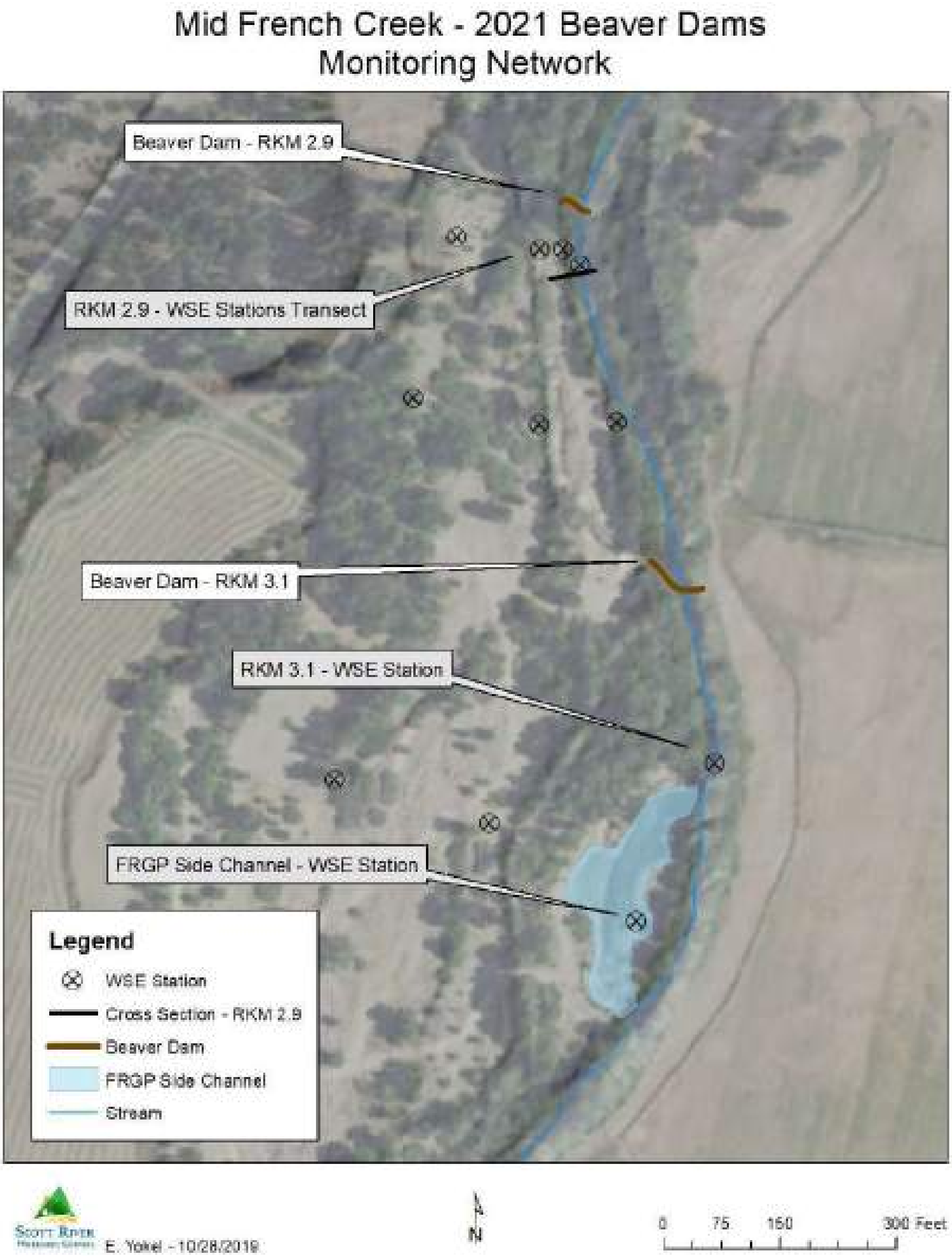
WY	°C	Date
2021	17.7	8/1/2021
2020	17.4	8/20/2020

Table 3 – Maximum MWAT (°C) and date of occurrence – French RKM 3.5

Effect of Beaver Dams on Water Surface Elevation and Water Quality –French Creek RKM 3.1 & RKM 2.9
Scott River Watershed Council


Beaver Dam at French RKM 2.9 during October 22, 2021 runoff event

Mid French Creek supports a critical population of all life stages of Southern Oregon Northern California Coast (SONCC) Coho Salmon. Two beaver dams were built in Mid French Creek during the base flow period of WY2021. Beaver first built a dam at French RKM 3.1 starting in late June and subsequently built a dam downstream at French Creek RKM 2.9 in early September. An existing network of water surface elevation and temperature monitoring stations in Mid French Creek documented the beaver dam's affects on the surface water and groundwater elevations and stream temperatures (Map 1). The monitoring network documented that the beaver dams significantly increased water surface elevations and habitat volume during the period of summer rearing of juvenile Coho Salmon.



Map 1 – Location of beaver dams and monitoring stations in Mid French Creek

French Creek RKM 3.1 Beaver Dam

French Creek RKM 3.1 Beaver Dam – Looking Upstream

Beaver began building a dam in French Creek at RKM 3.1 in late June, 2021. A WSE increase of 0.4 ft was documented at the RKM 3.1 Station from June 27 to July 27, 2021 (Figure 1). Comparison of the WSE on the same calendar day for 2020 and 2021 documents an increase in WSE of 0.5 ft on July 27, 2021 compared to July 27, 2020 (Figure 2). The WSE in the beaver dam pond increased to a maximum elevation of 2878.6 ft on September 11, 2021 – yielding water depths 0.8 ft greater than the minimum depth observed in WY2020.

In addition to increasing the depth in the beaver dam pond, the increase in WSE and habitat depth extends upstream to a constructed complex off channel habitat (FRGP Side Channel) that is supporting a significant population of YOY and 1+ Coho Salmon in the critically dry base flow period of WY2021 (Figure 3). Increases in the WSE of 0.9 feet were observed in the FRGP Side Channel after the creation of the beaver dam in 2021 compared to the same period of 2020.

In addition to the increase in WSE in the FRGP Side Channel, the mid column water temperatures in the side channel were significantly cooler in 2021 after the beaver dam was created compared to the same period of 2020 (Figure 4). It is hypothesized that the increase in water depth and volume in the side channel reduced the increase in water temperature.

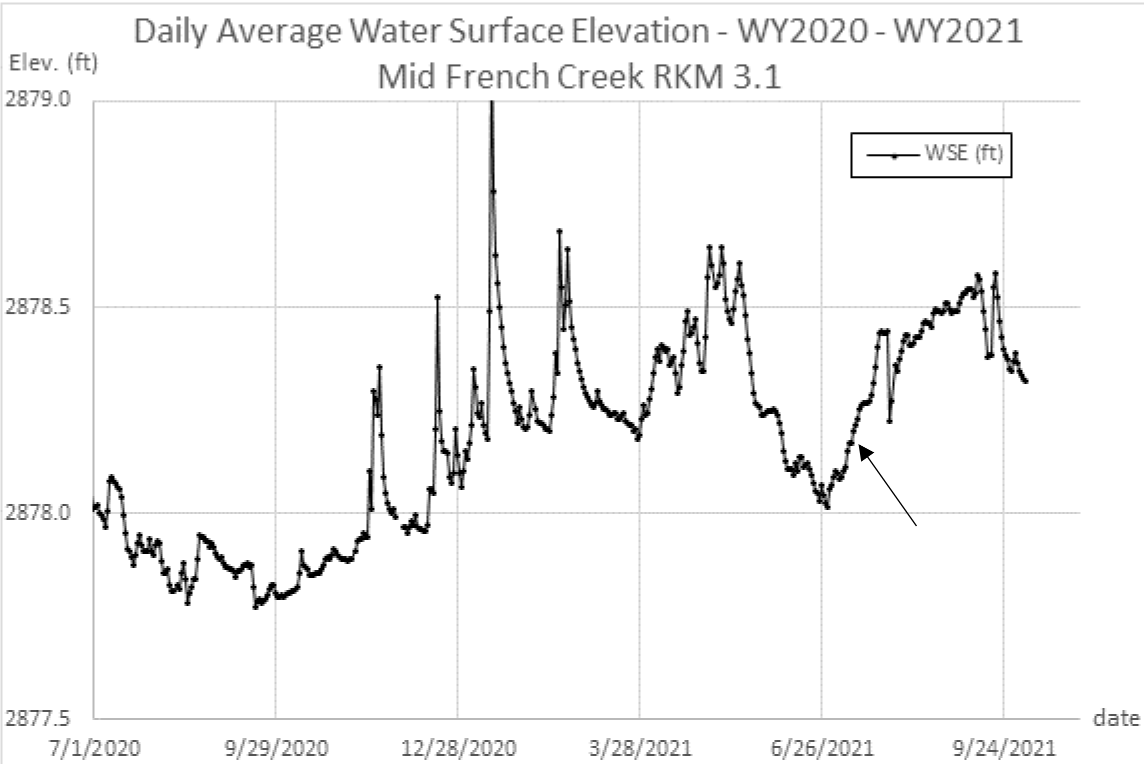


Figure 1 – Daily average water surface elevation (WSE) – Mid French Creek RKM 3.1

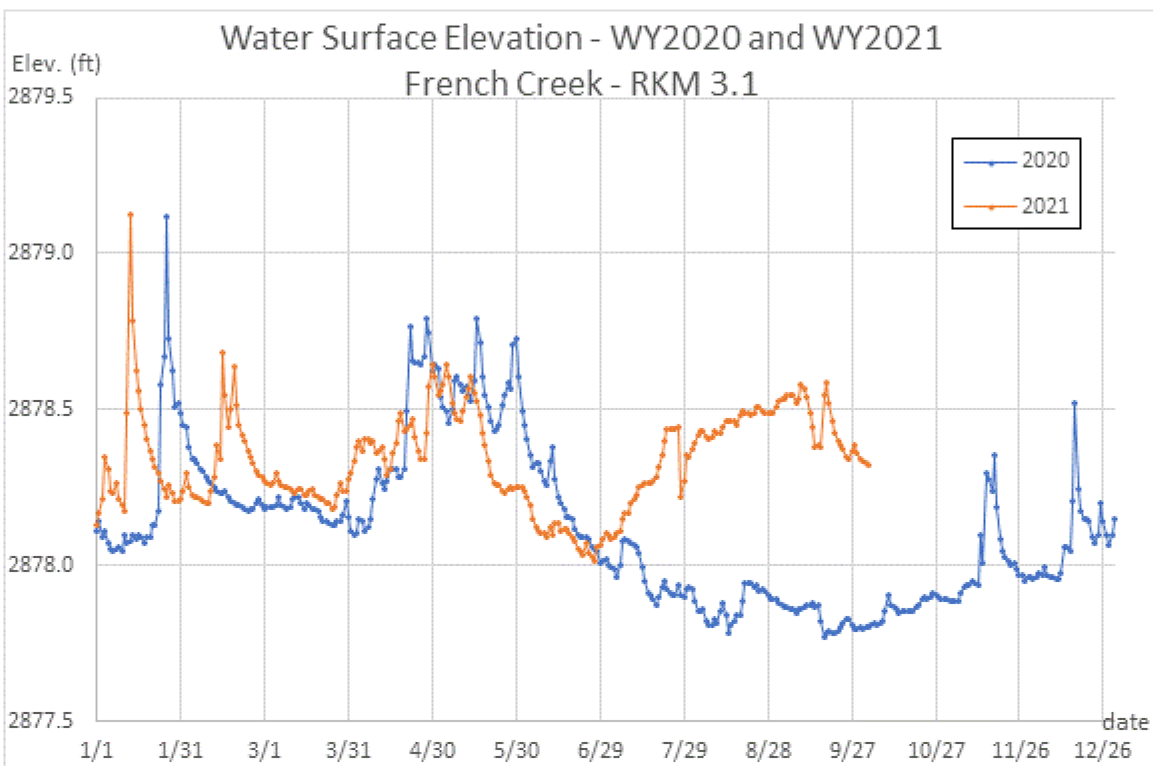


Figure 2 - Comparison of daily average WSE at French Creek RKM 3.1 – WY2020 & WY2021

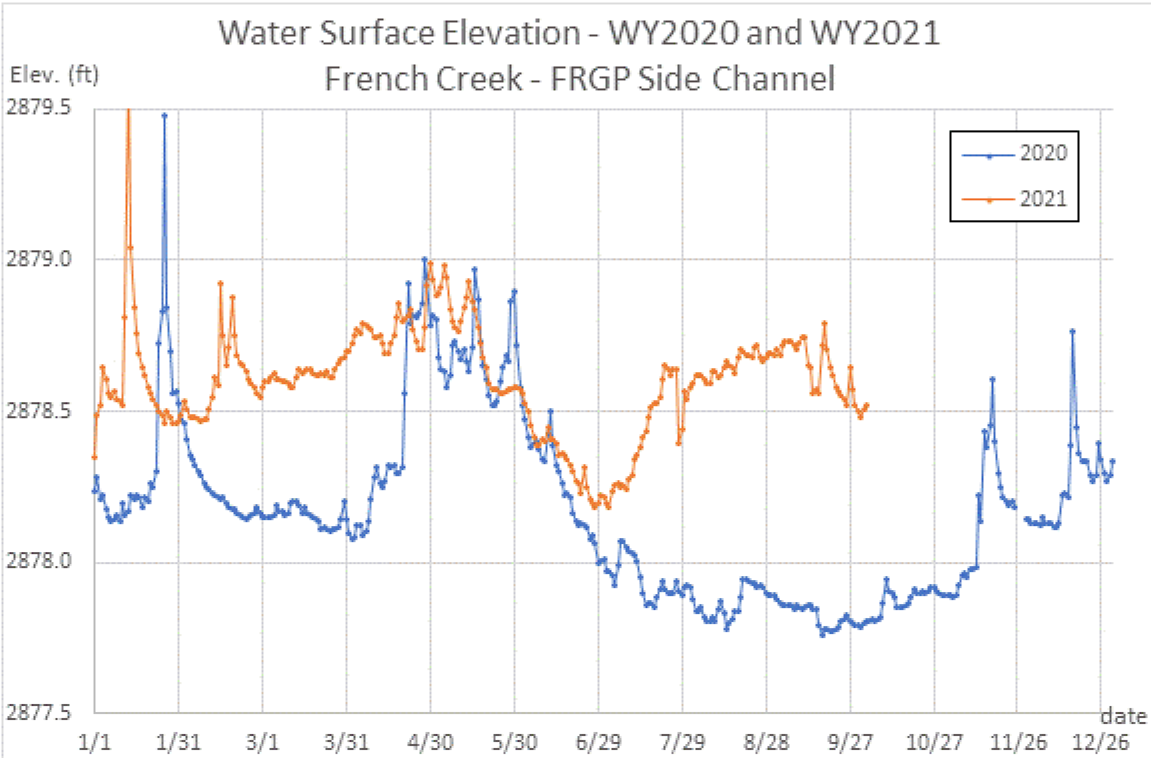


Figure 3 - Comparison of daily average WSE at French Creek FRGP Side Channel – WY2020 & WY2021

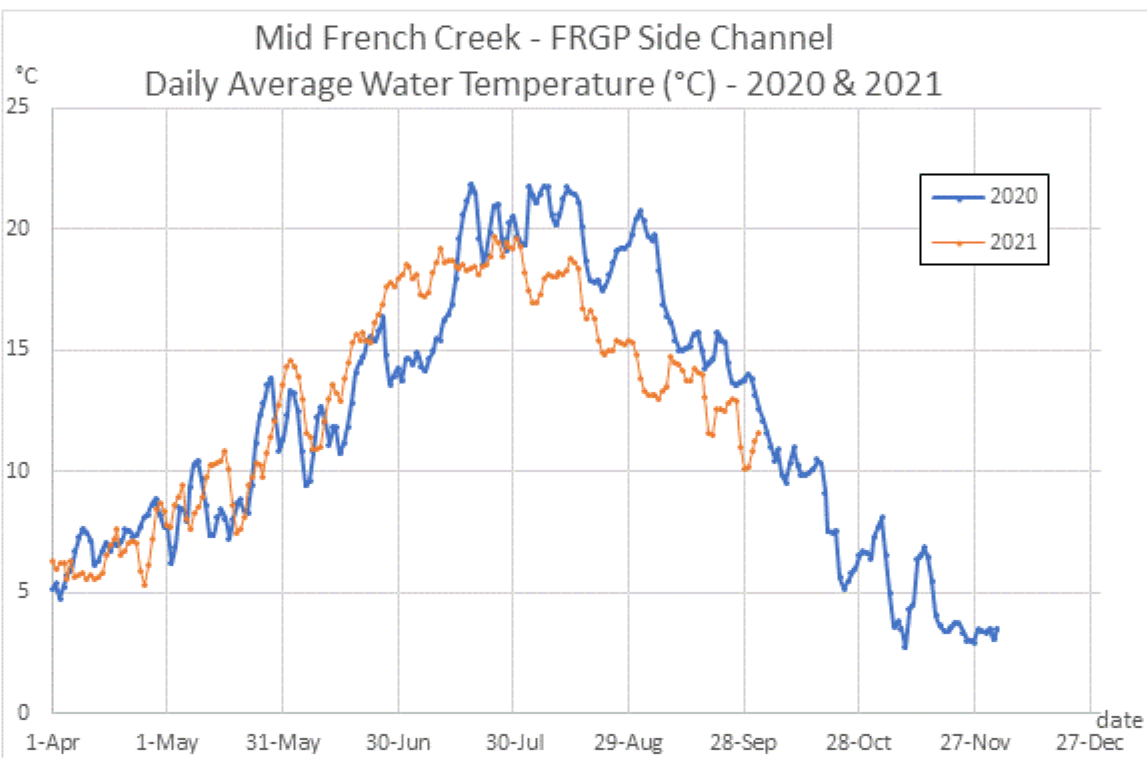


Figure 4 - Comparison of daily average temperature (°C) at FRGP Side Channel – WY2020 & WY2021

Mid French Creek FRGP Side Channel – Looking Downstream

A dissolved oxygen logger was placed in the RKM 3.1 Beaver Dam Pond in late July 2021 to document the dissolved oxygen and temperature conditions (Figure 5). Dissolved oxygen levels were stable in the beaver dam pond with average values greater than 6 mg/L for the period of record.

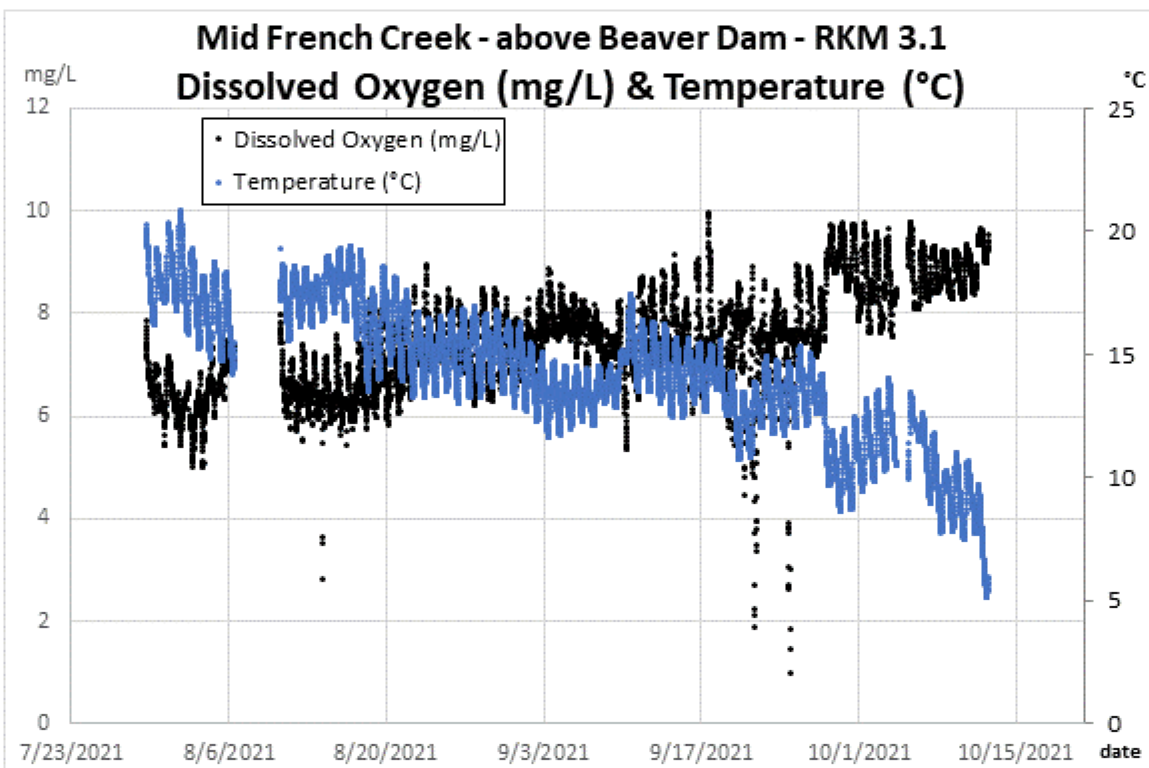


Figure 5 - Dissolved oxygen (mg/L) and temperature (°C)

French Creek RKM 2.9 Beaver Dam

French Creek RKM 2.9 Beaver Dam – Looking Upstream

An increase in water surface elevation above the beaver dam at the French RKM 2.9 water surface elevation (WSE) station was first observed on September 11, 2021. The water surface elevation upstream of the RKM 2.9 beaver dam increased 1.9 ft from September 10 to August 4, 2021 (Figure 6).

The WSE in the RKM 2.9 beaver dam pond in September and October 2021 was significantly greater than the WSE during the same period in 2020 (Figure 7).

Concomitant to the increase in surface water elevation, the increase in WSE was observed in a transect of groundwater monitoring wells at RKM 2.9 (Figure 8). A WSE increase greater than one foot was observed in the groundwater approximately 200 feet from the wetted channel.

A representative stream cross section in the RKM 2.9 beaver dam pond was utilized to illustrate the increase in stream depth and wetted area from the creation of the beaver dam (Figure 9). A longitudinal profile of the channel's thalweg was utilized to illustrate the extent of the RKM beaver dam pond's increased water depths and wetted volume (Figure 10). More than 400 feet of the stream habitat was affected by the beaver dam.

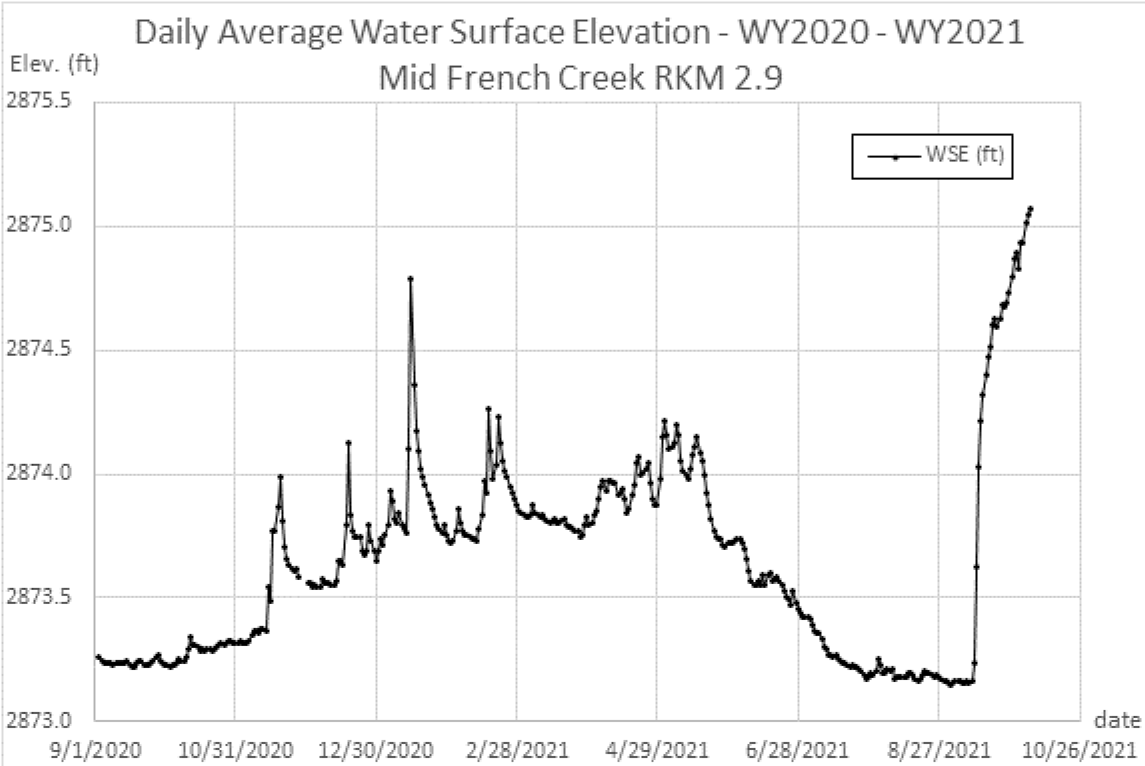


Figure 6 – Daily average water surface elevation (WSE) at French Creek RKM 2.9 – WY 2020 - 2021

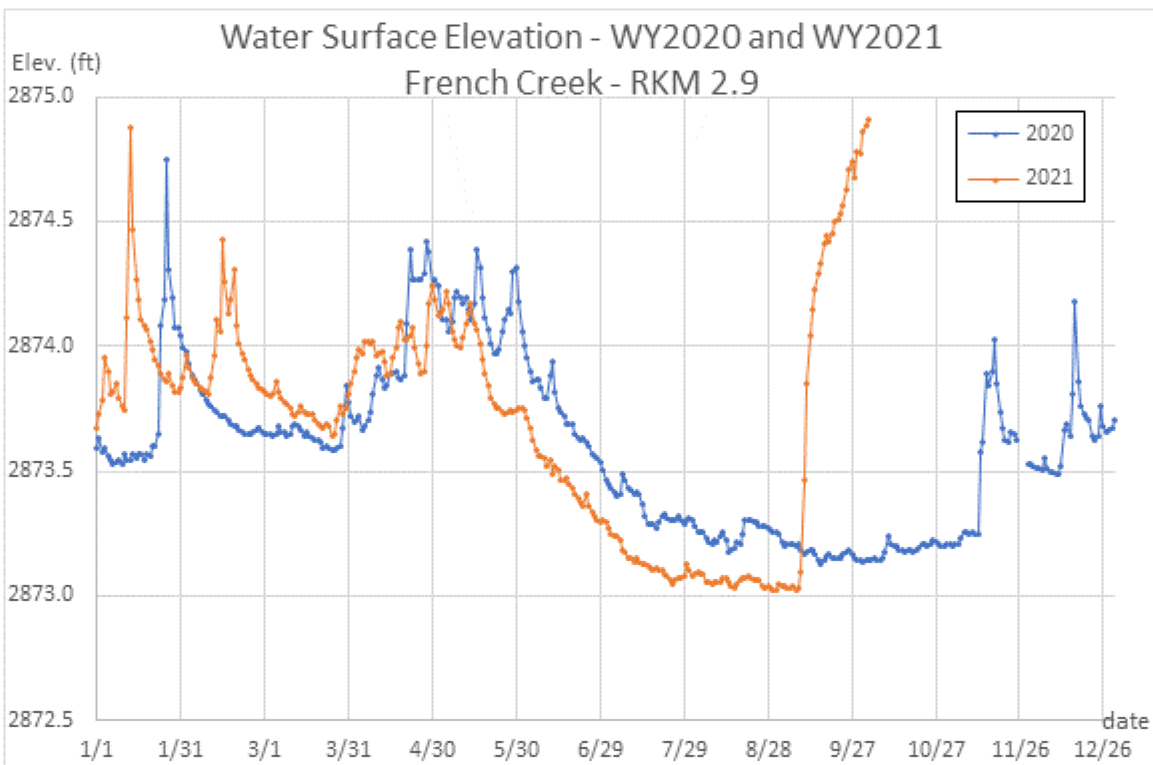


Figure 7 – Comparison of daily average WSE at French Creek RKM 2.9 – WY2020 & WY2021

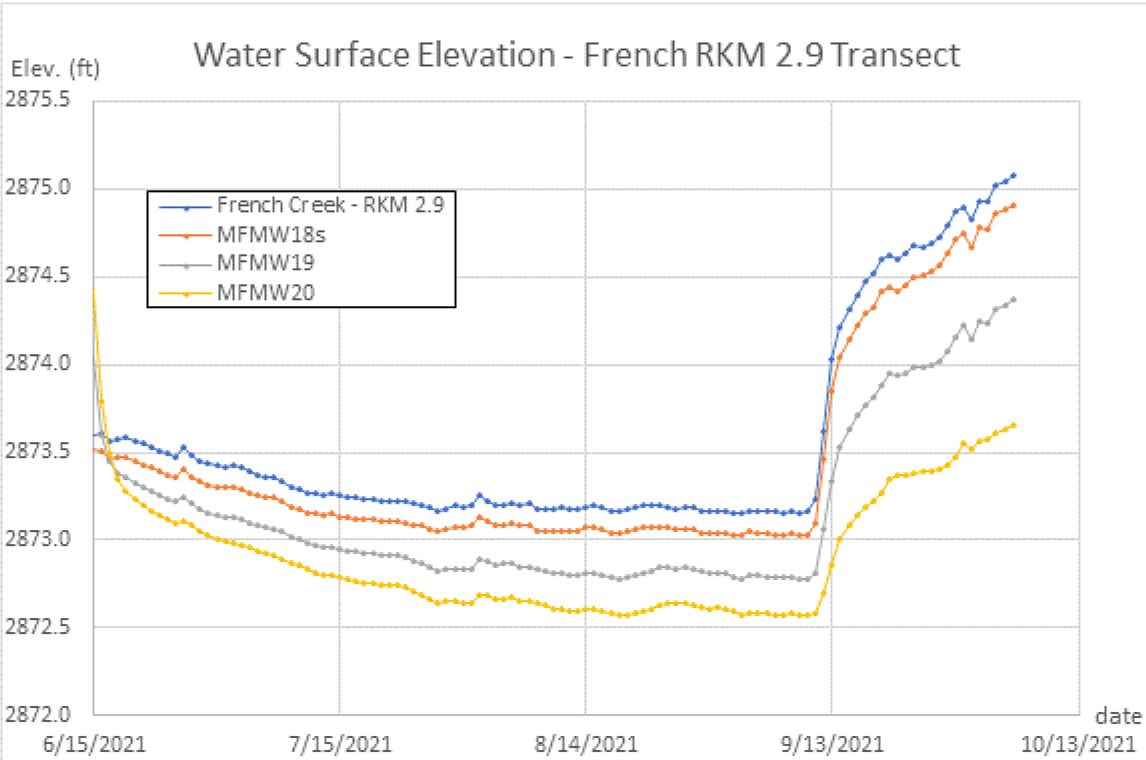


Figure 8 – Daily average WSE at French Creek RKM 2.9 Transect

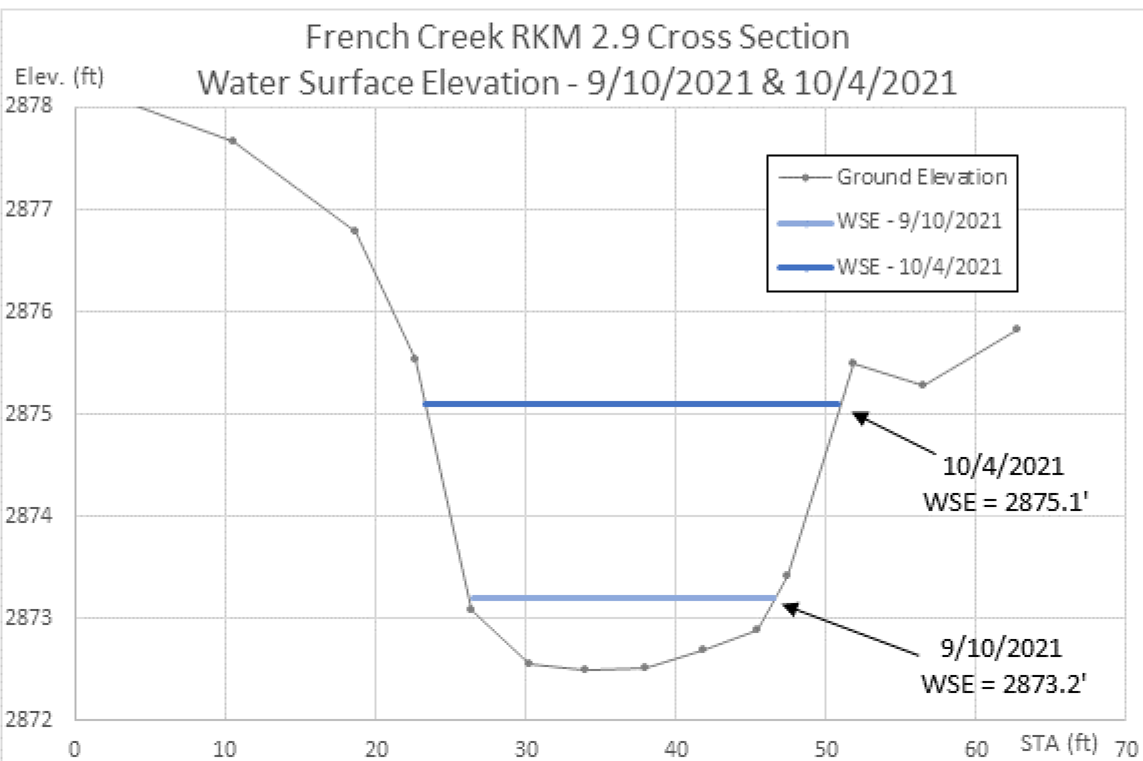


Figure 9 – Increase in WSE in at French Creek RKM 2.9 Cross Section – 9/10/2021 to 10/4/2021

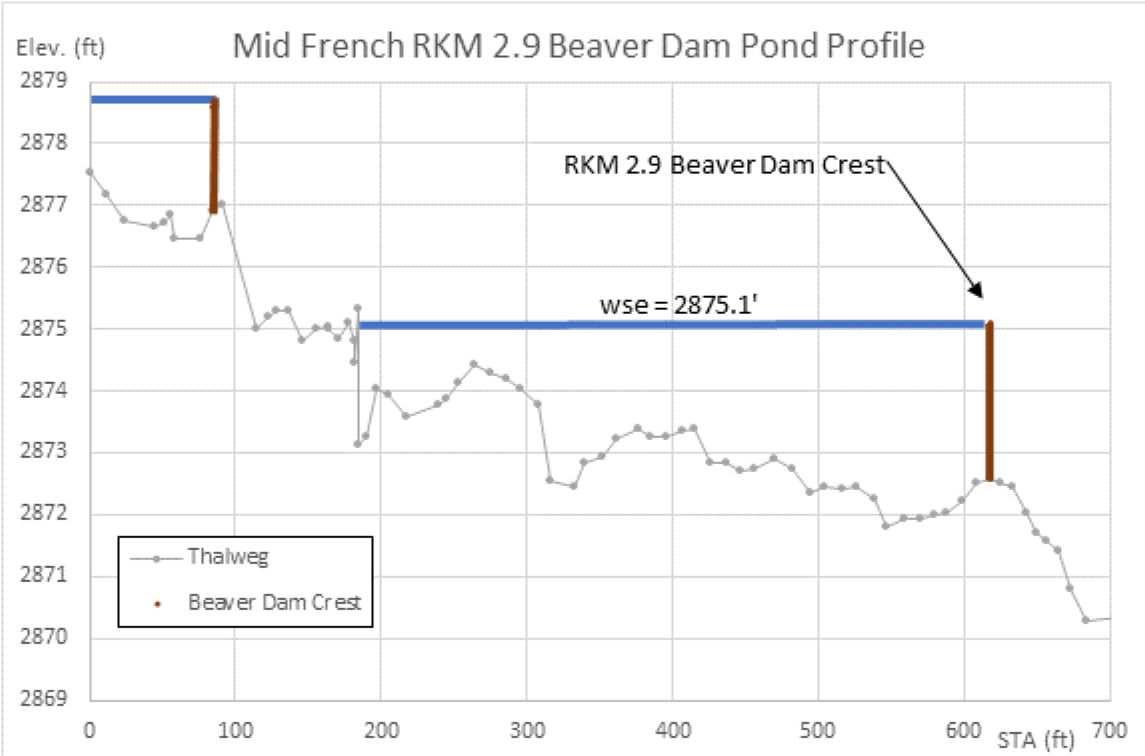


Figure 10 – Longitudinal Profile of Mid French Creek and water level of RKM 2.9 Beaver Dam Pond

Accumulated discharge at Scott River USGS Gage and Dry Ranking (WY1942 – WY2021) – WY2014 – WY2021
Scott River Watershed Council

	October 1 - September 30		October 1 - March 31		April 1 - September 30		August 1 - September 30	
	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank
WY2014	122	7	92	11	31	3	0.88	6
WY2015	295	27	269	51	26	2	0.91	7
WY2016	508	50	324	53	184	42	1.94	20
WY2017	864	75	570	73	294	67	6.27	43
WY2018	191	11	99	13	92	16	0.85	5
WY2019	411	43	163	33	249	63	3.57	28
WY2020	120	5	63	5	57	7	0.99	10
WY2021	110	3	61	4	49	5	1.19	11
Average (n = 80)	439		255		184		5.78	

Table 1 – Accumulated discharge (TAF) and dry ranking – WY2014 – WY2021

	October 1 - September 30	October 1 - March 31	April 1 - September 30	August 1 - September 30
	Dry Rank	Dry Rank	Dry Rank	Dry Rank
WY2014	7	11	3	6
WY2015	27	51	2	7
WY2016	50	53	42	20
WY2017	75	73	67	43
WY2018	11	13	16	5
WY2019	43	33	63	28
WY2020	5	5	7	10
WY2021	3	4	5	11

Table 2 – Dry ranking of accumulated discharge

Coho Salmon Catch Summary
Sugar Creek BDA Ponds and Mid French Creek Habitats – January 18 – 21, 2022

Scott River Watershed Council


Sugar Creek BDA Pond 1 – Looking Upstream

Fish sampling efforts were performed in the Lower Sugar Creek BDA Ponds and Mid French Creek Habitats from January 18 to 21, 2022 (Julian Week 3). Baited minnow traps and a fyke net were utilized to capture fish. All catch was identified by species and Coho Salmon were measured (mm) and weighted (g). Coho in good condition with forklength greater than or equal to 70 mm were marked with a PIT tag. Significant differences in the size and condition of the sampled Coho were observed between the Sugar Creek and French Creek habitats.

A total of 679 Coho were captured in French Creek with 332 PIT tags applied during the two-day sampling effort in four sample units. A total of 132 Coho were captured in Sugar Creek with 118 PIT tags applied during the two-day sampling effort in two sample units.
Eight Coho that were marked and relocated from the Sugar BDA Pond 1 to the Sugar Off Channel Pond (Sugar OCP) or Sugar BDA Pond 2 Natural Beaver Dam Pond in July 2021 were recaptured in Sugar BDA Pond 2 and the Natural Beaver Dam Pond during the January effort.

Sugar Creek BDA Ponds

Coho Salmon captured in Sugar Creek BDA Ponds

Sampling effort was performed in two habitat units in Lower Sugar Creek – Sugar Creek BDA Pond 1 and Sugar Creek BDA Pond 2. A total of 63 Coho and 46 Rainbow Trout were captured in Sugar Creek BDA Pond 1 (Table 1). No recaptures were encountered in BDA Pond 1.

Total Catch -Sugar Creek BDA Pond 1 - January 19, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	63	61	0
Rainbow Trout (*O. mykiss*)	46	0	0

Table 1 – Sugar Creek BDA Pond 1 – Total Catch

A total of 69 Coho and 11 trout were captured in BDA Pond 2 with 8 recaptured Coho (Figure 2).

Total Catch -Sugar Creek BDA Pond 2 - January 18, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	69	57	8
Rainbow Trout (*O. mykiss*)	11	0	0

Table 2 – Sugar Creek BDA Pond 2 – Total Catch

The average forklength (mm) of the Coho Salmon captured in Sugar BDA Pond 1 was slightly greater than the average of the Coho captured in Sugar BDA Pond 2 (Table 3).

Coho Salmon Forklength (mm)

Date	1/19/2022	1/18/2022
Location	Sugar BDA Pond 1	Sugar BDA Pond 2
Average (mm)	97	95
Stand. Deviation (mm)	5.3	5.9
Minimum (mm)	85	81
Maximum (mm)	113	113
Count	63	69

Table 3 - Average forklength (mm) of Coho Salmon in sampled habitats – Sugar Creek BDA Ponds

The forklength histograms for the Coho captured in the BDA 1 Pond and BDA 2 Pond are illustrated in Figures 1 and 3, respectively. The relationship between individual fish weight (g) and length for the Coho captured in the BDA 1 Pond and BDA 2 Pond is illustrated in Figures 2 and 4, respectively.

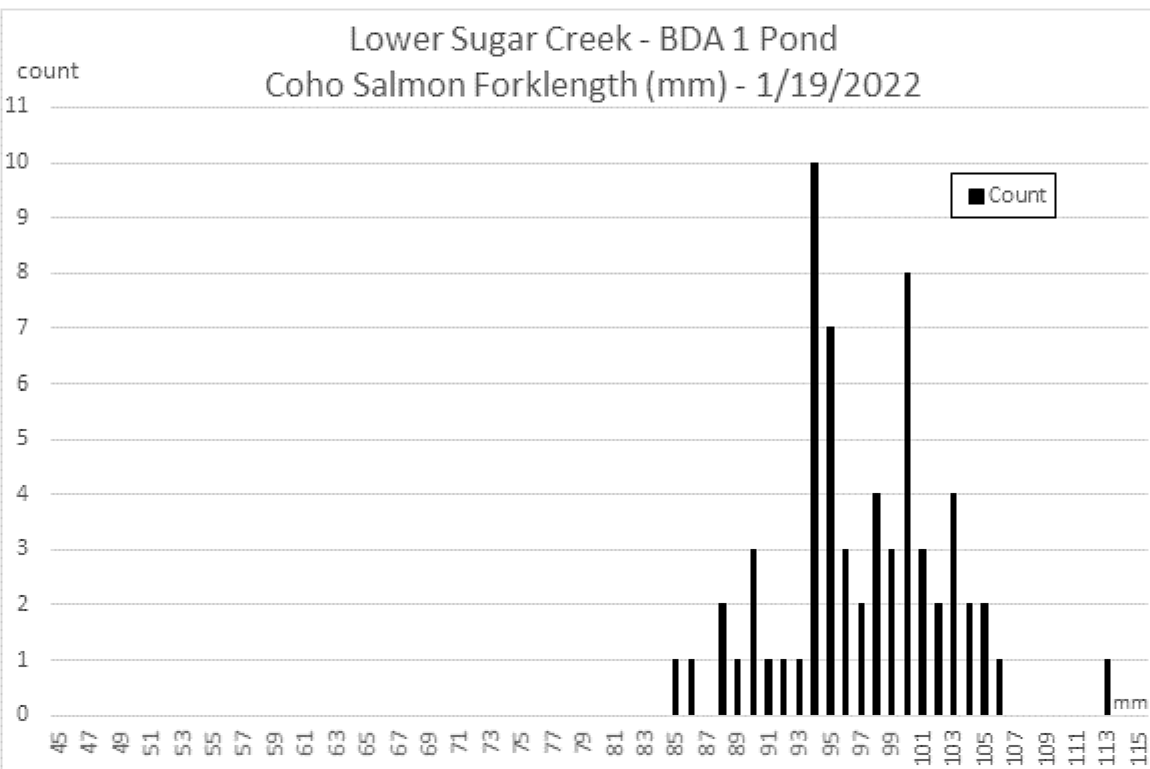


Figure 1 - Forklength (mm) histogram of Coho Salmon – Sugar Creek BDA Pond 1

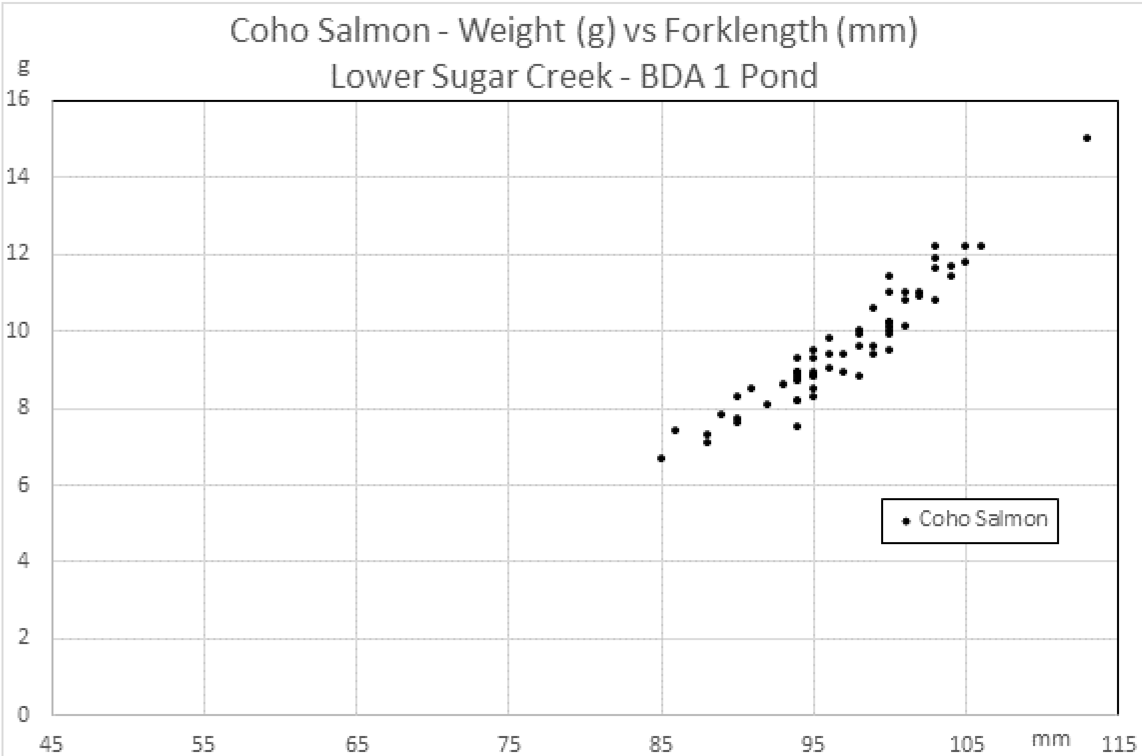


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1

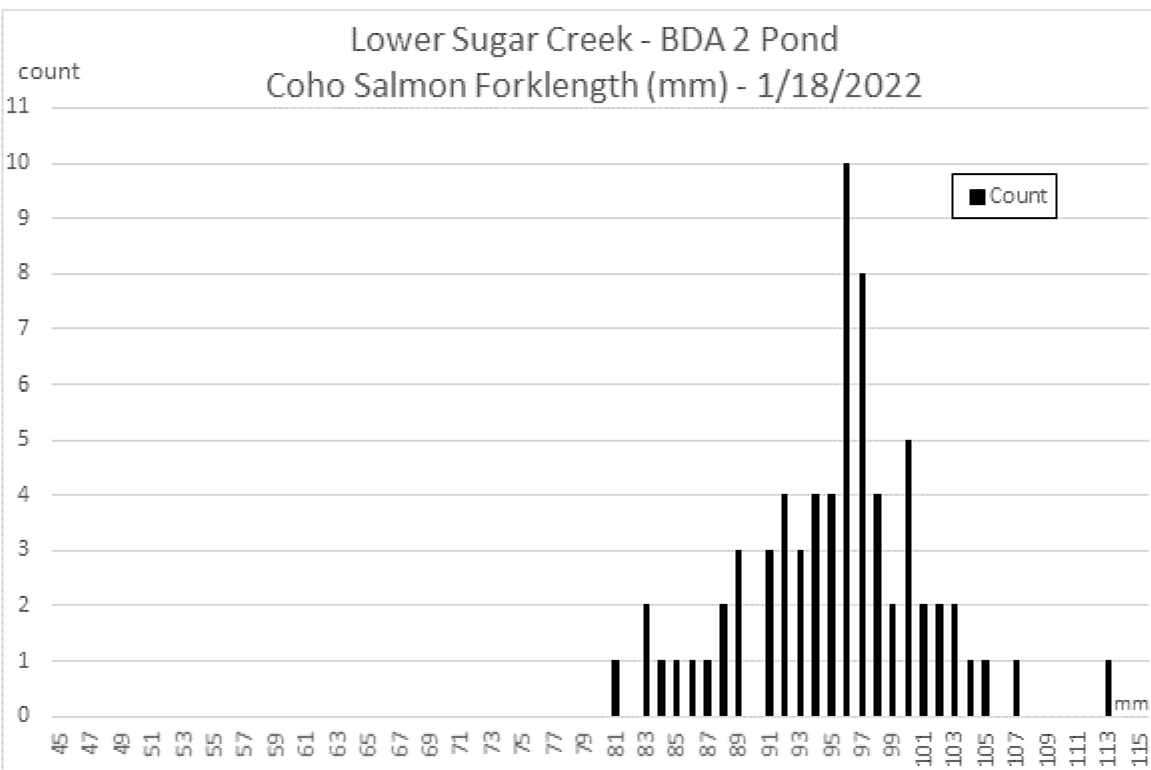


Figure 3 - Forklength (mm) histogram of Coho Salmon – Sugar Creek BDA Pond 2

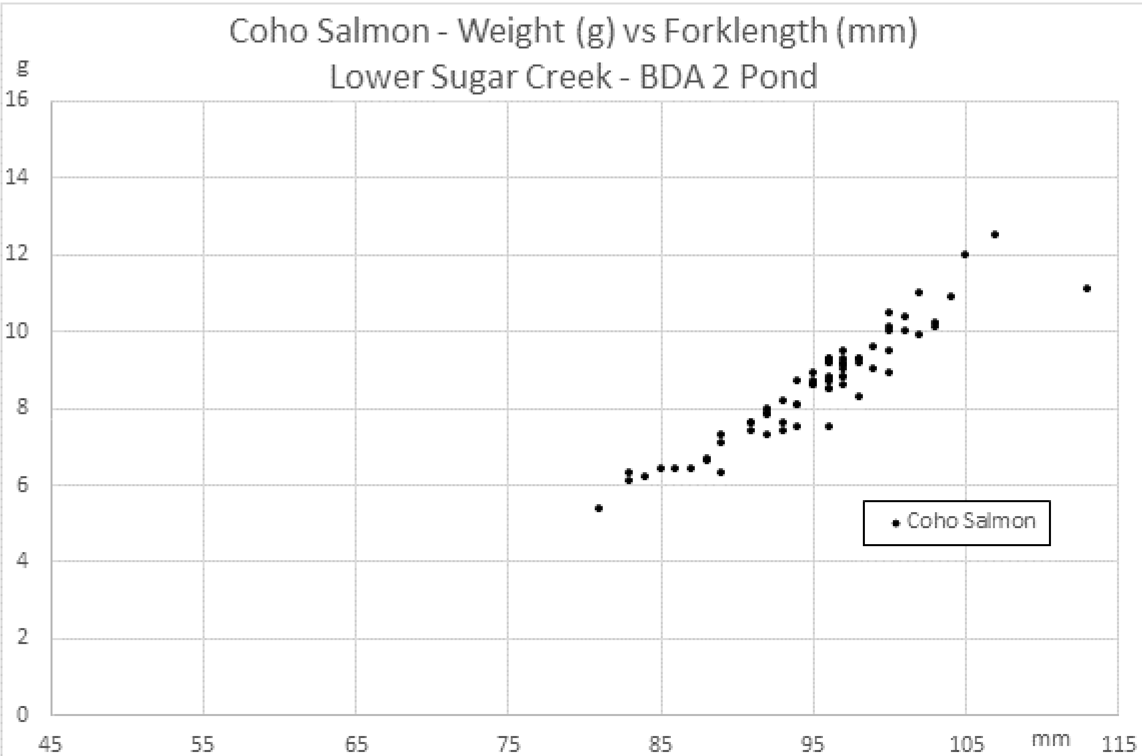


Figure 4 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 2

In July 2021, three efforts were performed to assist NOAA Fisheries staff to relocate fish from the Sugar BDA Pond 1 habitat due to the imminent dewatering in the BDA Pond. The majority of the relocated fish were placed in the Sugar Off Channel Pond (Sugar OCP) with fish additionally relocated into the Natural Beaver Dam Pond in Sugar BDA Pond 2. A subsample of the relocated fish in both habitats were marked with PIT tags to track survival of the relocation effort (Table 4).

Sugar BDA Pond 1 - Fish Relocation Totals - July 2, 8 & 22, 2021

Relocation Habitat	Sugar OCP	Sugar Beaver Dam Pond
Coho Salmon - PIT Marked	104	62
Coho Salmon	1143	59
Total Coho Salmon	1247	121
Rainbow Trout	166	23

Table 4 - Total number of marked & unmarked fish relocated to each habitat – July 2 – 22, 2021

Eight of the marked relocated Coho were recaptured during the January 18th sampling effort in Sugar BDA Pond 2 (Table 5). Four of the recaptured fish were captured in the Beaver Dam Pond – three of the four were relocated into the Beaver Dam Pond with the fourth relocated into the Sugar OCP. Four of the recaptured fish were captured in the Sugar BDA Pond 2 – these fish were relocated into the Sugar OCP.

Comparison of the biometric data from July 2021 and January 2022 illustrates that all the relocated fish have grown significantly between the two sampling efforts.

Date	Species	Sample Location	PIT Code	FL	WT	Mark	Recap	Comment
7/21/2021	Coho	Sugar BDA Pond 1	989001039966589	77	5	Y		Relocated to Sugar OCP
1/18/2022	Coho	Sugar BDA Pond 2 - Beaver Dam Pond	989001039966589	92	7.8		Y	
7/8/2021	Coho	Sugar BDA Pond 1	989001039966667	76	5.4	Y		Relocated to SugarBeaver Dam Pond
1/18/2022	Coho	Sugar BDA Pond 2 - Beaver Dam Pond	989001039966667	104	10.9		Y	
7/8/2021	Coho	Sugar BDA Pond 1	989001039966650	74	4.8	Y		Relocated to SugarBeaver Dam Pond
1/18/2022	Coho	Sugar BDA Pond 2 - Beaver Dam Pond	989001039966650	98	8.3		Y	
7/8/2021	Coho	Sugar BDA Pond 1	989001039966585	70	4.1	Y		Relocated to SugarBeaver Dam Pond
1/18/2022	Coho	Sugar BDA Pond 2 - Beaver Dam Pond	989001039966585	99	9		Y	
7/21/2021	Coho	Sugar BDA Pond 1	989001039966239	77	5	Y		Relocated to Sugar OCP
1/18/2022	Coho	Sugar BDA Pond 2	989001039966239	98	9.2		Y	
7/8/2021	Coho	Sugar BDA Pond 1	989001039966301	70	3.9	Y		Relocated to Sugar OCP
1/18/2022	Coho	Sugar BDA Pond 2	989001039966301	91	7.6		Y	
7/21/2021	Coho	Sugar BDA Pond 1	989001039966646	73	4.5	Y		Relocated to Sugar OCP
1/18/2022	Coho	Sugar BDA Pond 2	989001039966646	92	8		Y	
7/8/2021	Coho	Sugar BDA Pond 1	989001039966304	70	4.2	Y		Relocated to Sugar OCP
1/18/2022	Coho	Sugar BDA Pond 2	989001039966304	102	9.9		Y	

Table 5 – Biometric data of recaptured relocated Coho – January 18, 2022

Mid French Creek

Mid French Creek Control Pool 1 – Looking downstream

Sampling effort was performed in four habitat units in Mid French Creek during January 2022 – the four mainstem control pools, the wood and gravel augmented side channel project, the side channel BDA 1 Pond and the FRGP Side Channel project.
No previously marked fish were recaptured during the two-day effort in Mid French Creek. A total of 679 Coho Salmon and 23 Rainbow Trout were captured across the four habitats with a total of 322 PIT tag marks applied (Tables 6 – 9).

Total Catch -Mid French Creek Mainstem Control Pools - January 20, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	179	116	0
Rainbow Trout (*O. mykiss*)	17	0	0

Table 6 – French Creek Control Pools – Total Catch

Total Catch -Mid French Wood Gravel Side Channel - January 20, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	99	32	0
Rainbow Trout (*O. mykiss*)	5	0	0

Table 7 – French creek Wood Gravel Side Channel – Total Catch

Total Catch -Mid French Side Channel BDA 1 Pond - January 20, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	33	22	0
Rainbow Trout (*O. mykiss*)	0	0	0

Table 8 – French Creek Side Channel BDA 1 Pond – Total Catch

Total Catch -Mid French FRGP Side Channel - January 21, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	368	162	0
Rainbow Trout (*O. mykiss*)	1	0	0

Table 9 – French FRGP Side Channel – Total Catch

The average forklength (mm) of the Coho Salmon captured in all sampled habitats of Mid French Creek was significantly smaller than the average forklength of the Coho captured in the Sugar Creek BDA Ponds (Table 10). The fish captured in the mainstem control pools and side channel BDA 1 Pond were larger on average than the fish captured in the FRGP Side Channel and wood gravel augmented side channel.

Coho Salmon Forklength (mm)

Date	1/20/2022	1/20/2022	1/20/2022	1/21/2022
Location	French Mainstem Control Pools	Mid French Wood Gravel Side Channel	Mid French Side Channel BDA 1 Pond	Mid French FRGP Side Channel
Average (mm)	76	69	75	71
Stand. Deviation (mm)	10.9	9.5	8.3	10.6
Minimum (mm)	53	51	59	48
Maximum (mm)	112	113	97	111
Count	179	99	32	368

Table 10 - Average foklength (mm) of Coho Salmon in sampled habitats – Mid French Creek

Juvenile Coho Salmon captured in Mid French Creek Control Pools

A diversity of sizes of fish was encountered in all sampled habitats in Mid French Creek with forklengths ranging from 48 mm to 113 mm. The diversity of sizes observed in Mid French Creek (standard deviation of forklength – 8.3 – 10.9 mm) was greater than the diversity of sizes of Coho observed in the Sugar BDA Ponds (standard deviation of forklength – 5.3 – 5.9 mm).

The forklength histogram for the Coho captured in the Mid French habitats are illustrated in Figures 5, 7, 9 and 11. The relationship between individual fish weight (g) and length for the Coho captured in the Mid French habitats are illustrated in Figures 6, 8, 10 and 12.

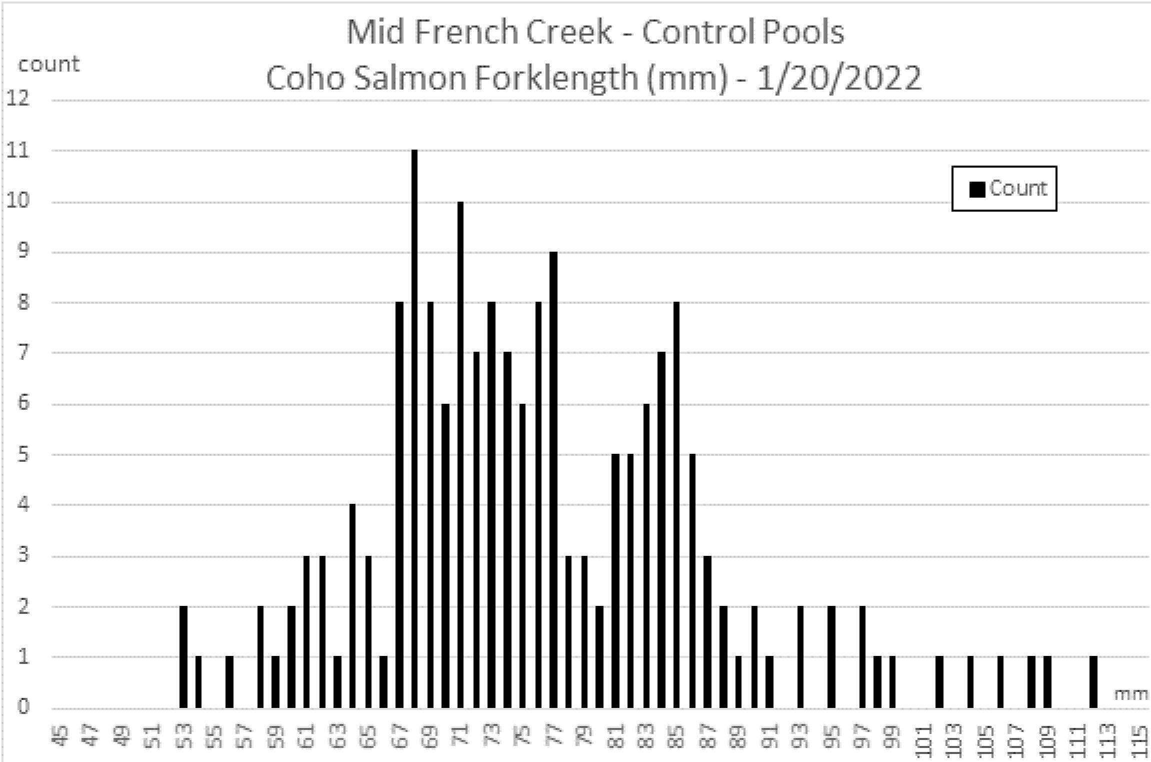


Figure 5 - Forklength (mm) histogram of Coho Salmon – French Control Pools

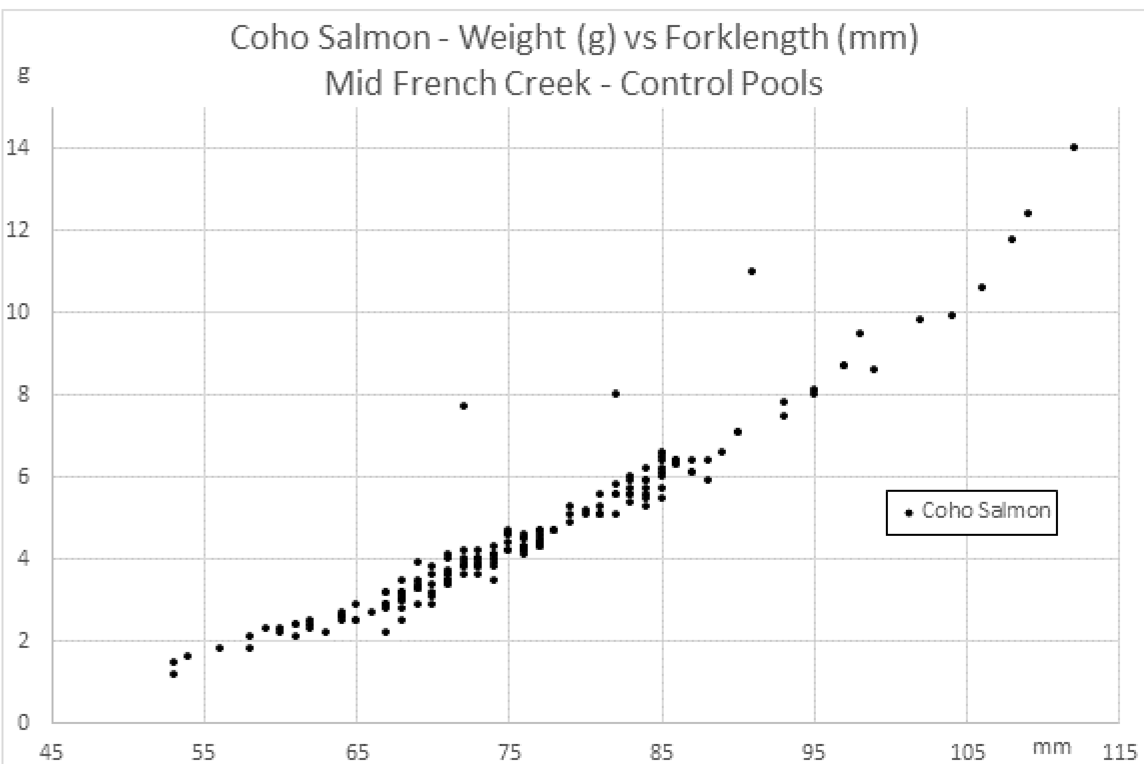


Figure 6 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Control Pools

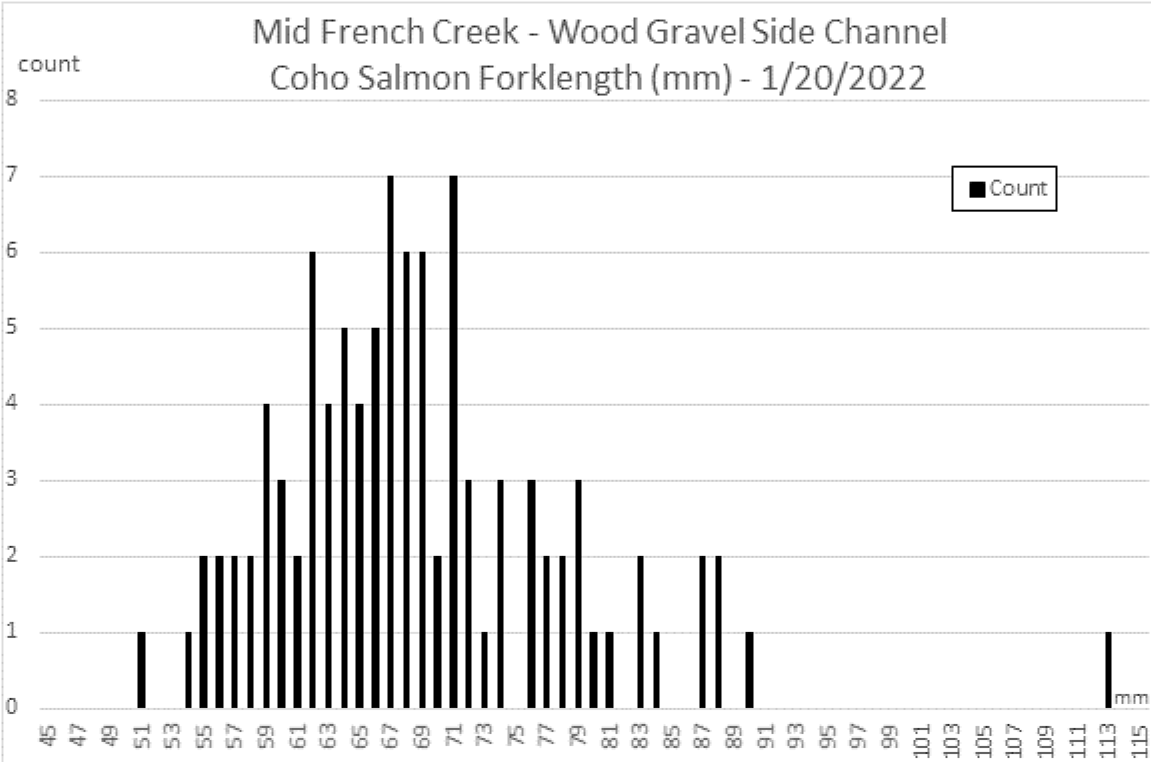


Figure 7 - Forklength (mm) histogram of Coho Salmon – French Wood Gravel Side Channel

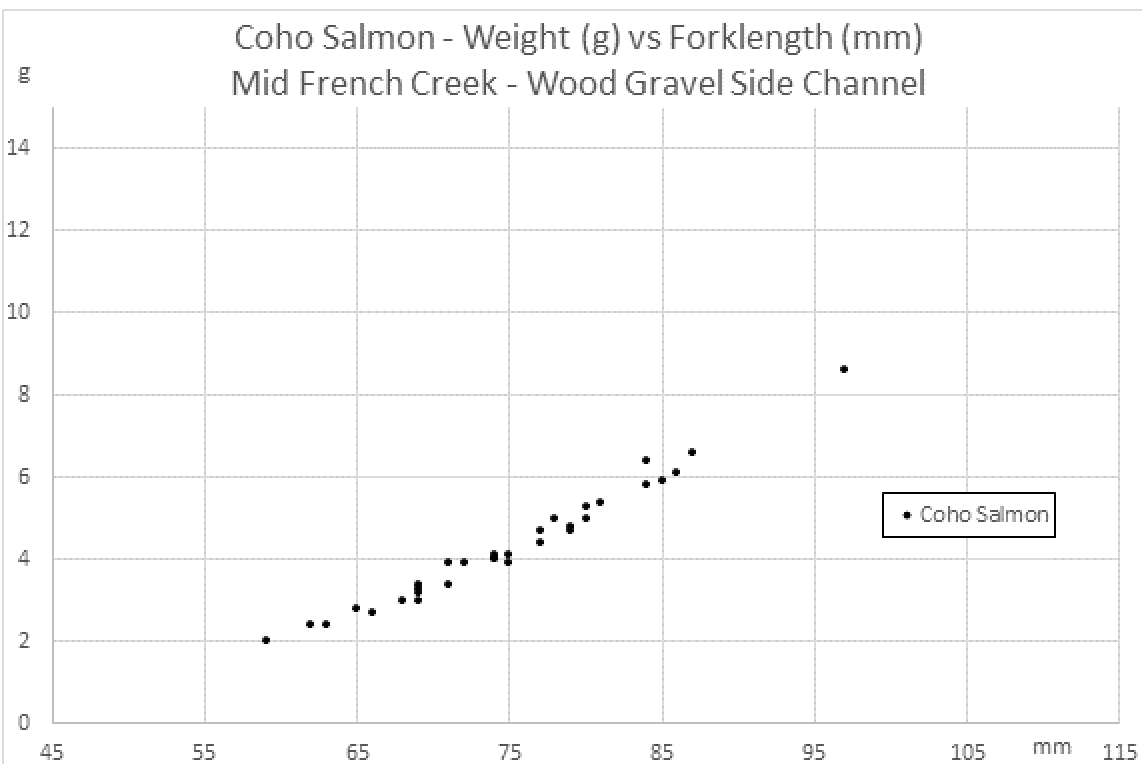


Figure 8 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Wood Gravel Side Channel

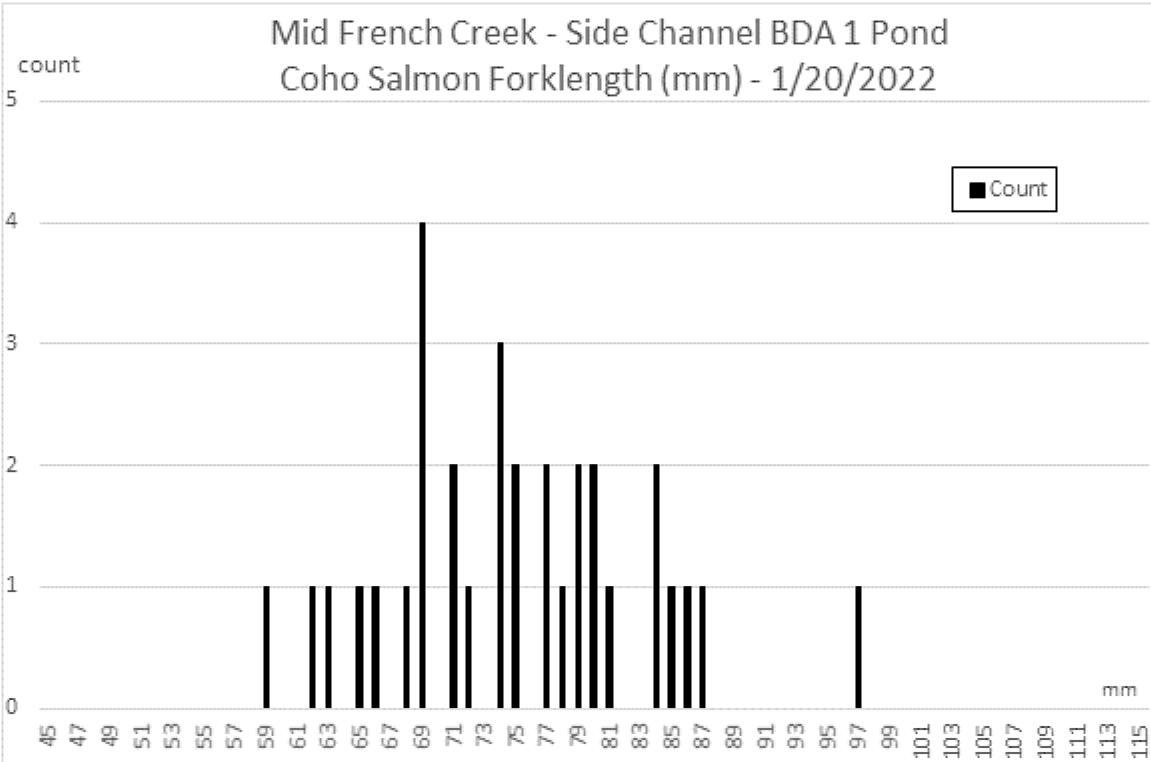


Figure 9 - Forklength (mm) histogram of Coho Salmon – French Side Channel BDA 1 Pond

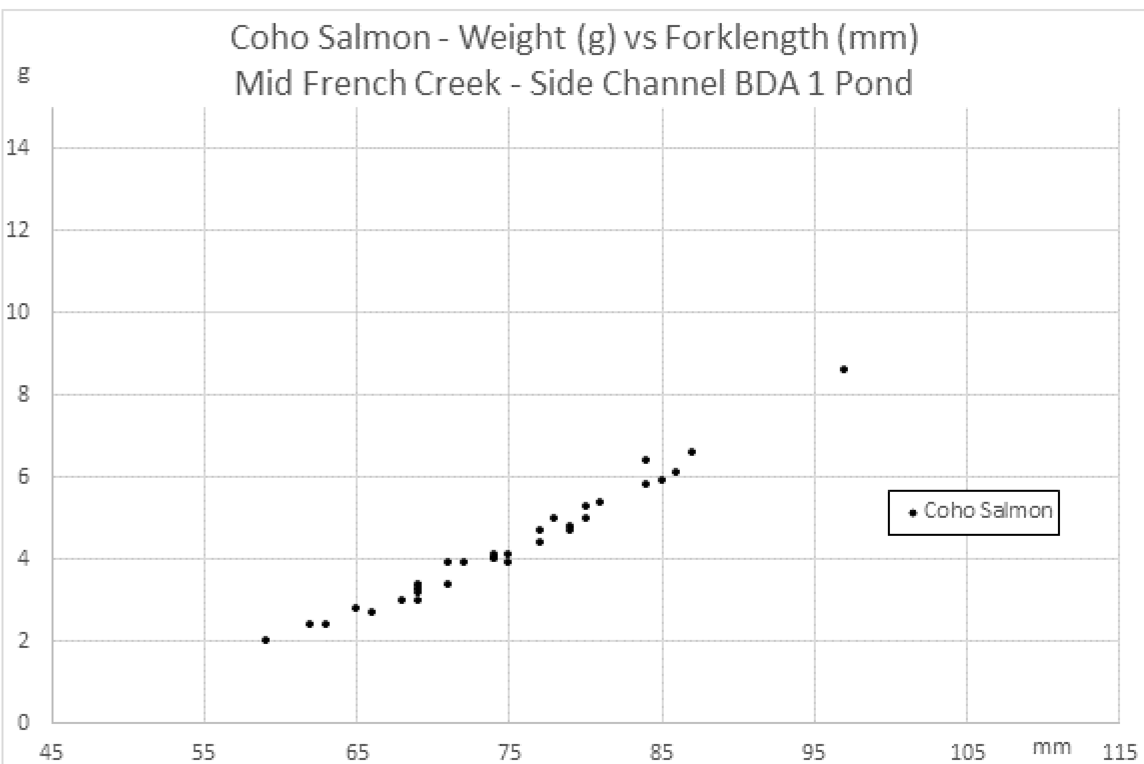


Figure 10 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Side Channel BDA 1 Pond

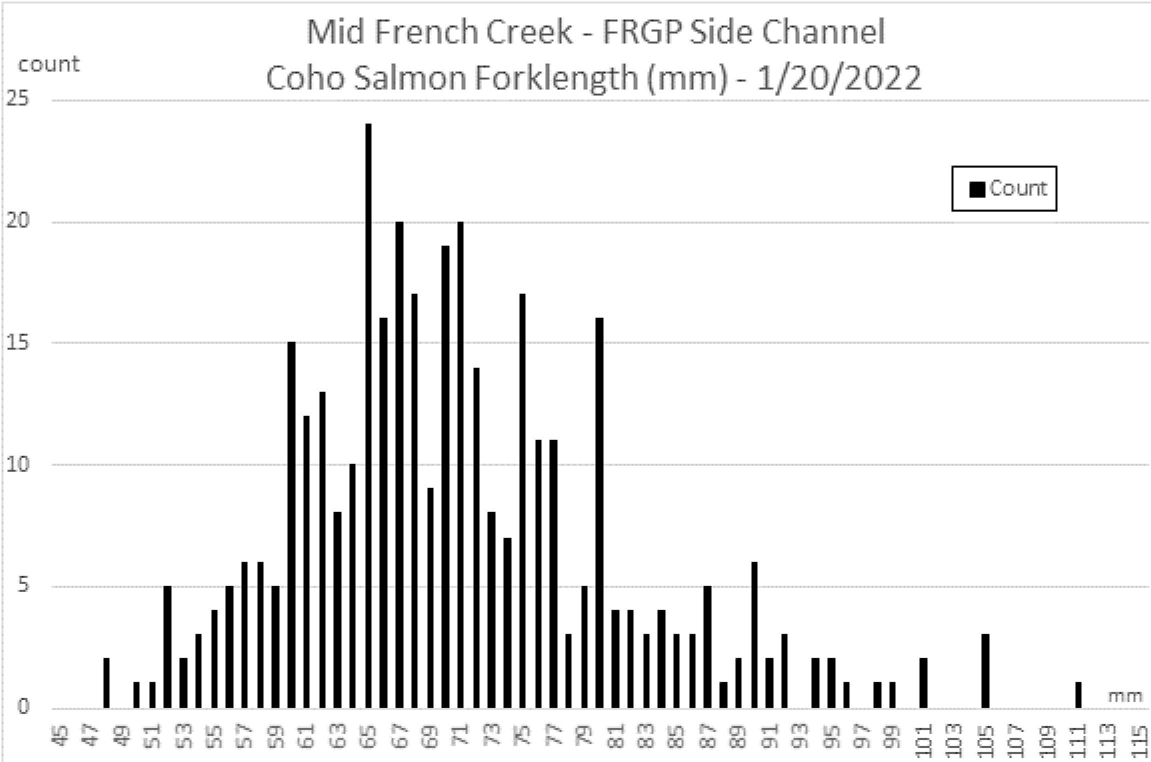


Figure 11 - Forklength (mm) histogram of Coho Salmon – French FRGP Side Channel

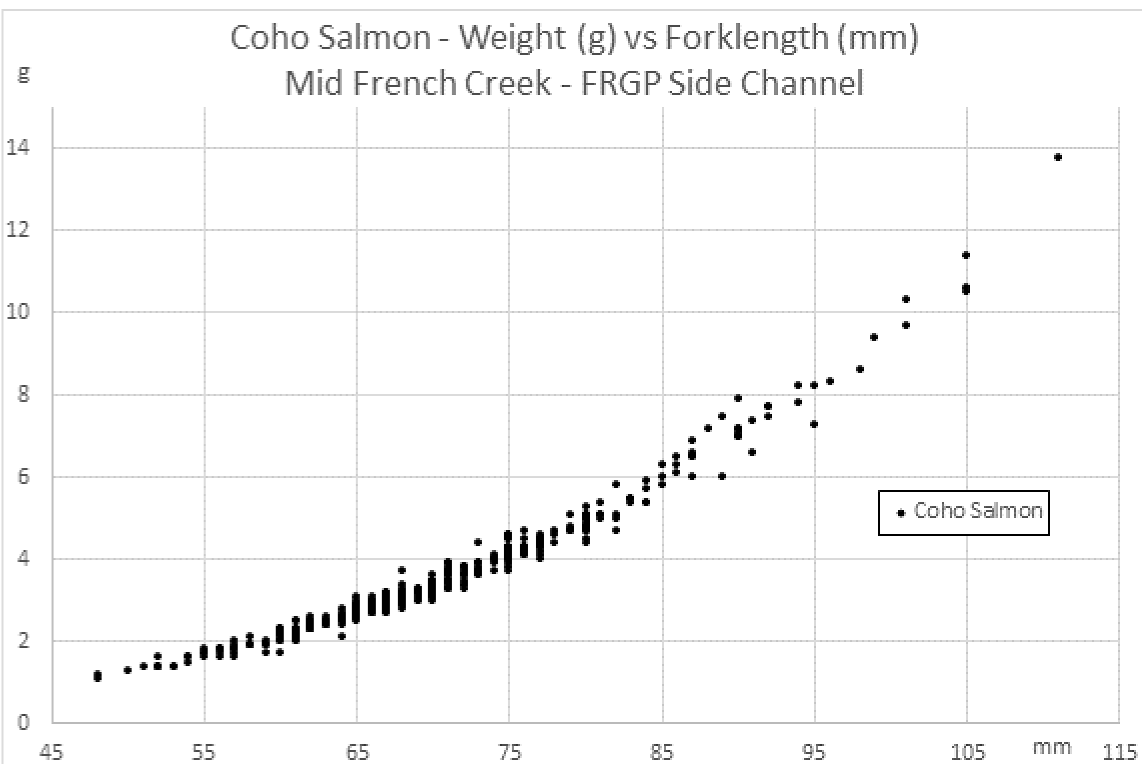


Figure 12 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French FRGP Side Channel


Coho Salmon captured in FRGP Side Channel


Mid French FRGP Side Channel – looking downstream

Discussion:

Sampling effort performed in the Sugar Creek BDA Ponds and Mid French Creek habitats during Julian Week 3 documented a significantly larger fish on average in the Sugar BDA Ponds (Figure 13). Analysis of the weight vs length relationship of the fish captured in the two habitats further illustrates the greater condition of the fish captured in the Sugar Creek BDA Ponds (Figure 14). It does not appear that the trend in the weight to length ratio is greater in the Coho captured in the Sugar BDA Ponds compared to the Coho captured in the French mainstem pools.

Understanding the driving factors creating the observed differences in fish size between the two tributaries is a potential next step in our understanding of Coho growth and survival in the Scott River. One hypothesis is that the density of juvenile Coho in French Creek is significantly greater than the density in the Sugar Creek BDA Ponds leading to density dependent differences in growth. Additional factors considered include differences in food, water quality and habitat characteristics (e.g., velocity, depth and cover) in the two sampled streams.

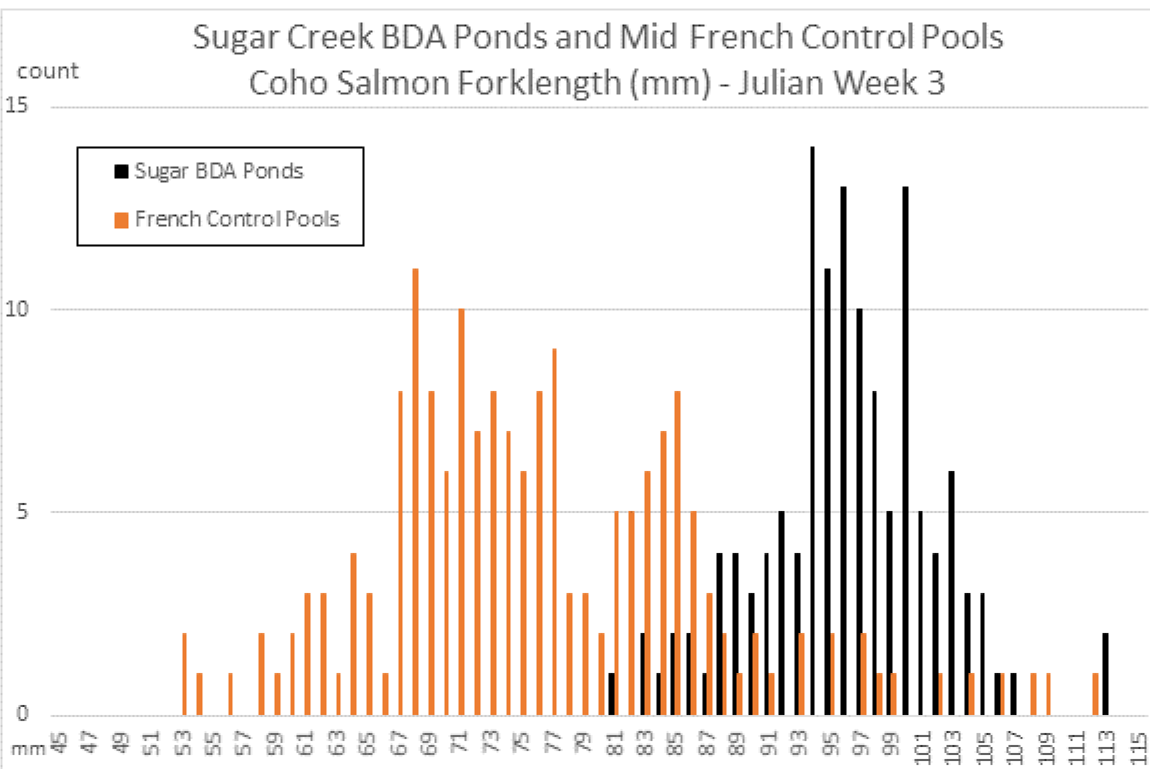


Figure 13 – Forklength (mm) histogram of Coho Salmon - Sugar BDA Ponds and Mid French Control Pools

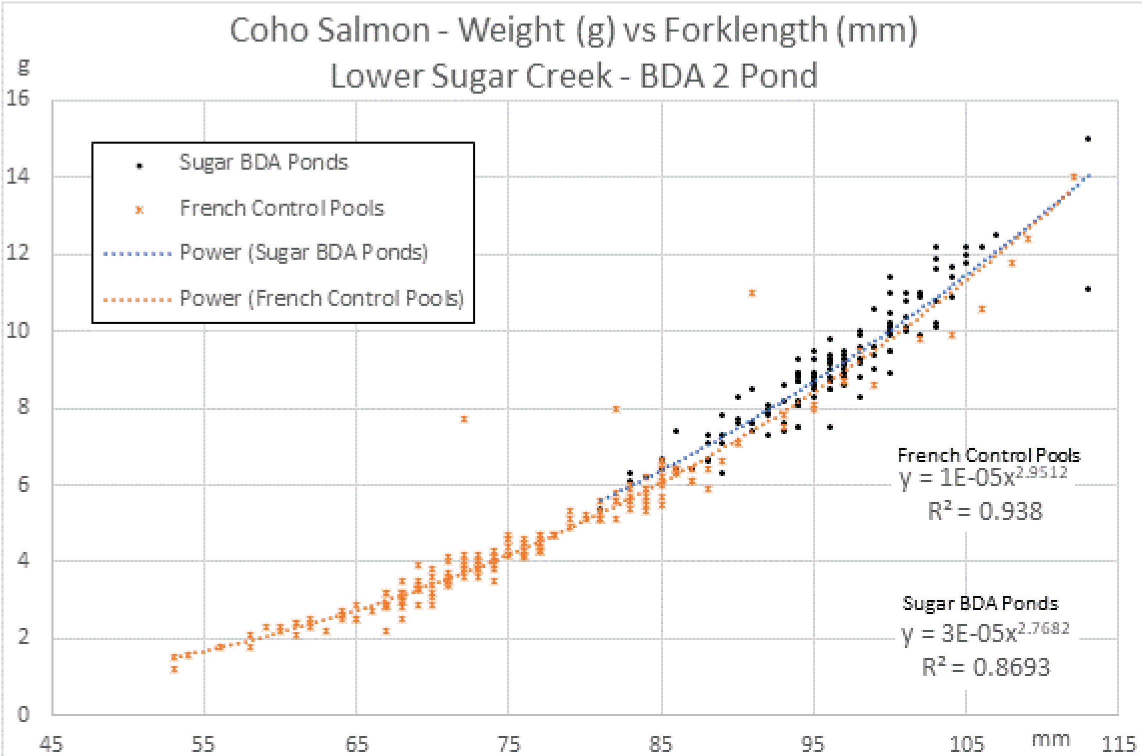


Figure 14 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar BDA Ponds and Mid French Control Pools

Coho Salmon Catch Summary
Sugar Creek BDA Ponds and Mid French Creek Habitats – March 11-12 & March 15 – 16, 2022
Scott River Watershed Council

Sugar Creek BDA Ponds

Sugar Creek BDA Pond 1 – Looking Upstream

Sugar Creek BDA Pond 1 was sampled on March 11, 2022 with baited minnow traps and a fyke net. A total of 57 Coho Salmon were captured with 23 recaptured fish (Table 1). In addition to the captured Coho Salmon, a significant number of rainbow trout (*O. mykiss*) were captured in the Sugar BDA Pond 1.

The 23 recaptured Coho Salmon were all tagged in the previous sampling effort in the Sugar BDA Pond 1 on January 19, 2022. No movement of tagged fish between BDA Pond 1 and BDA Pond 2 was observed between the January and March sampling efforts.

Total Catch -Sugar Creek BDA Pond 1 - March 11, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	57	32	23
Rainbow Trout (*O. mykiss*)	54	0	0

Table 1 – Sugar Creek BDA Pond 1 – Total Catch

Rainbow trout (*O. mykiss*) captured in BDA Pond 1

A total of 65 Coho Salmon with 23 recaptures were captured in the Sugar BDA Pond 2 and the natural beaver dam pond upstream of the BDA Pond 2 during the March 12,2022 sampling effort (Table 2). 16 of the recaptures were tagged in the previous sampling effort on January 18, 2022 and 8 of the recaptures were tagged and relocated from BDA Pond 1 in July 2021. No movement of tagged fish between BDA Pond 2 and the natural beaver dam was observed between the January and March sampling efforts.

Total Catch -Sugar Creek BDA Pond 2 - March 12, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	65	40	23
Rainbow Trout (*O. mykiss*)	12	0	0

Table 2 – Sugar Creek BDA Pond 2 – Total Catch

The average forklength (mm) of the Coho Salmon captured in Sugar BDA Pond 1 was slightly greater than the average of the Coho captured in Sugar BDA Pond 2 (Table 3). This trend was observed during the January 2022 sampling effort.

Coho Salmon Forklength (mm)

Date	3/10/2022	3/11/2022
Location	Sugar BDA Pond 1	Sugar BDA Pond 2
Average (mm)	101	98
Stand. Deviation (mm)	5.8	5.1
Minimum (mm)	82	88
Maximum (mm)	110	111
Count	57	65

Table 3 - Average forklength (mm) of Coho Salmon in sampled habitats – Sugar Creek BDA Ponds

The forklength histograms for the Coho captured in the BDA 1 Pond and BDA 2 Pond are illustrated in Figures 1 and 3, respectively. The relationship between individual fish weight (g) and length for the Coho captured in the BDA 1 Pond and BDA 2 Pond is illustrated in Figures 2 and 4, respectively.

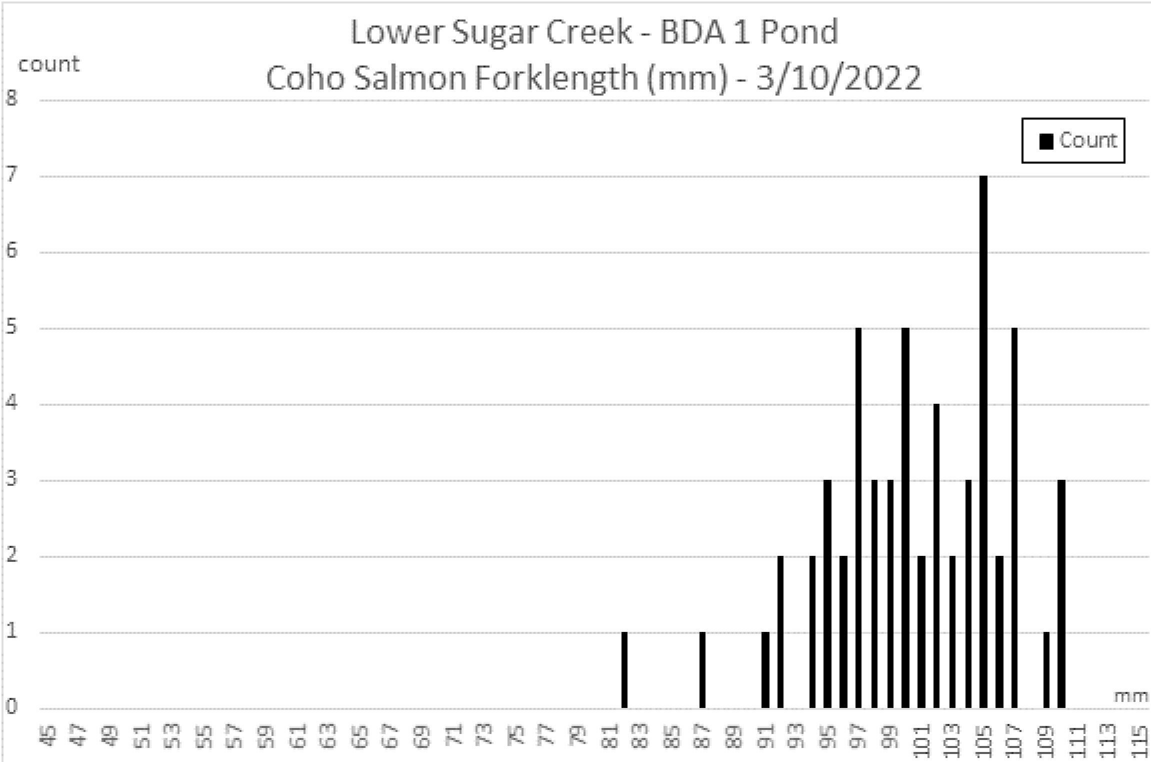


Figure 1 - Forklength (mm) histogram of Coho Salmon – Sugar Creek BDA Pond 1

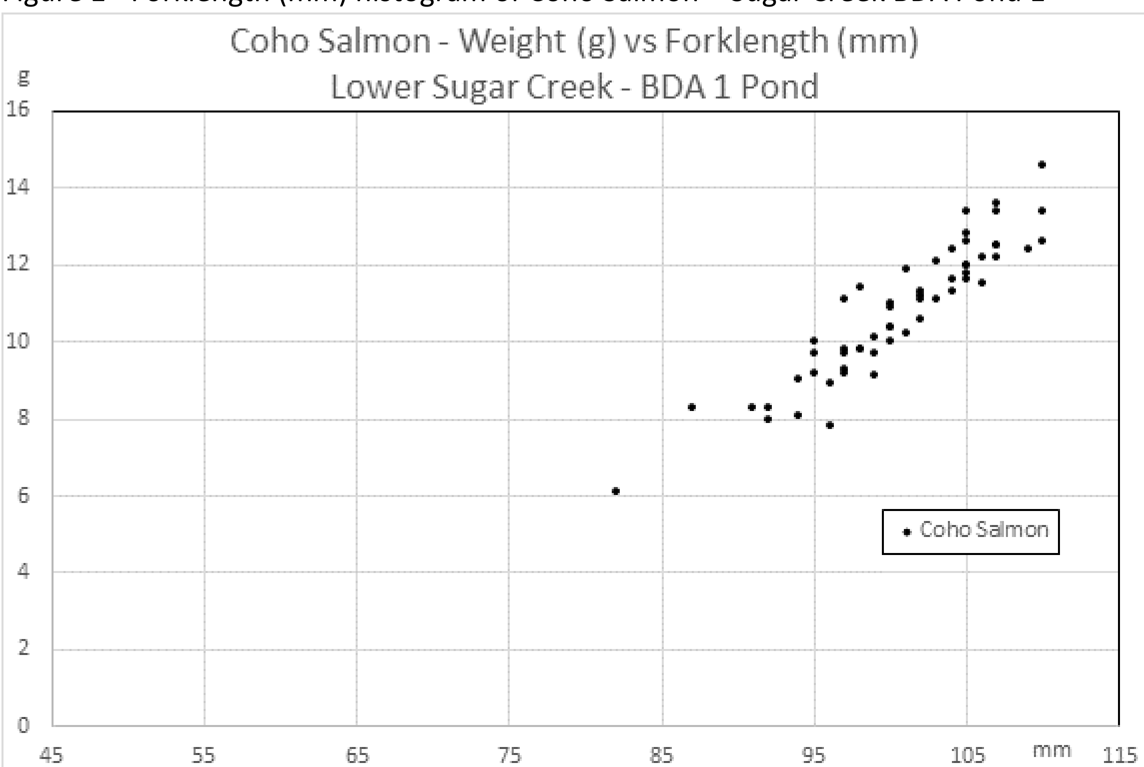


Figure 2 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1

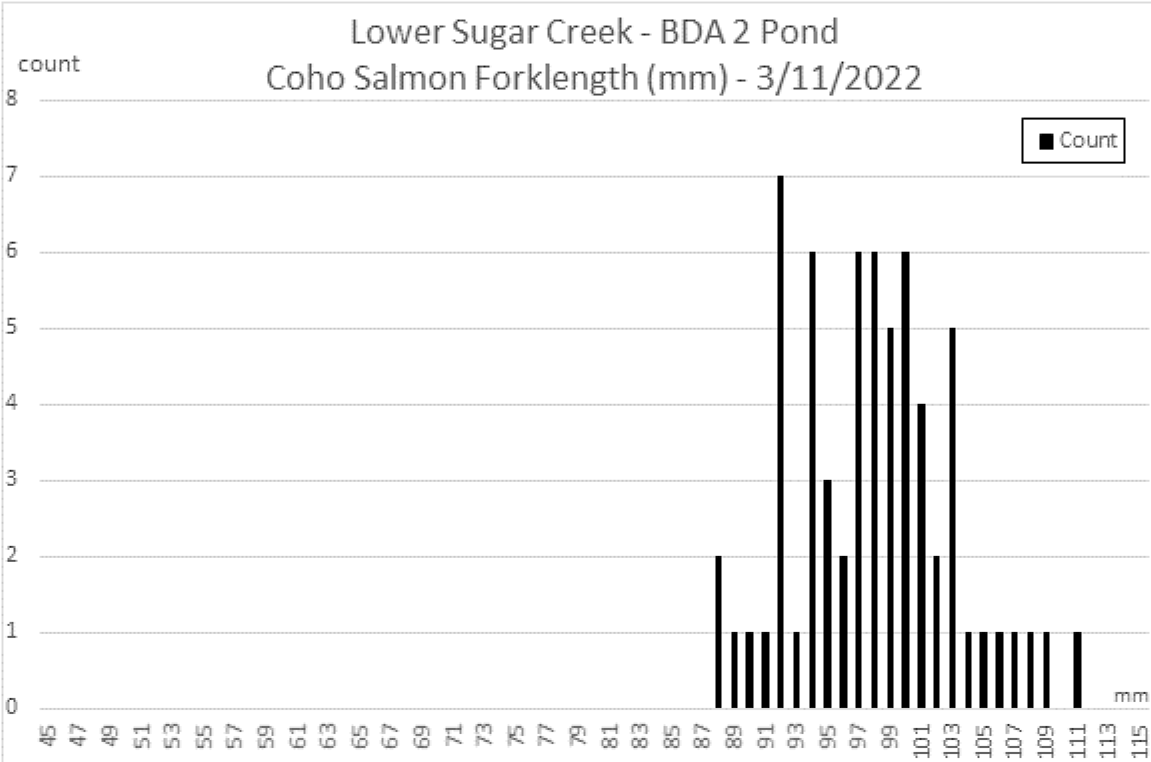


Figure 3 - Forklength (mm) histogram of Coho Salmon – Sugar Creek BDA Pond 2

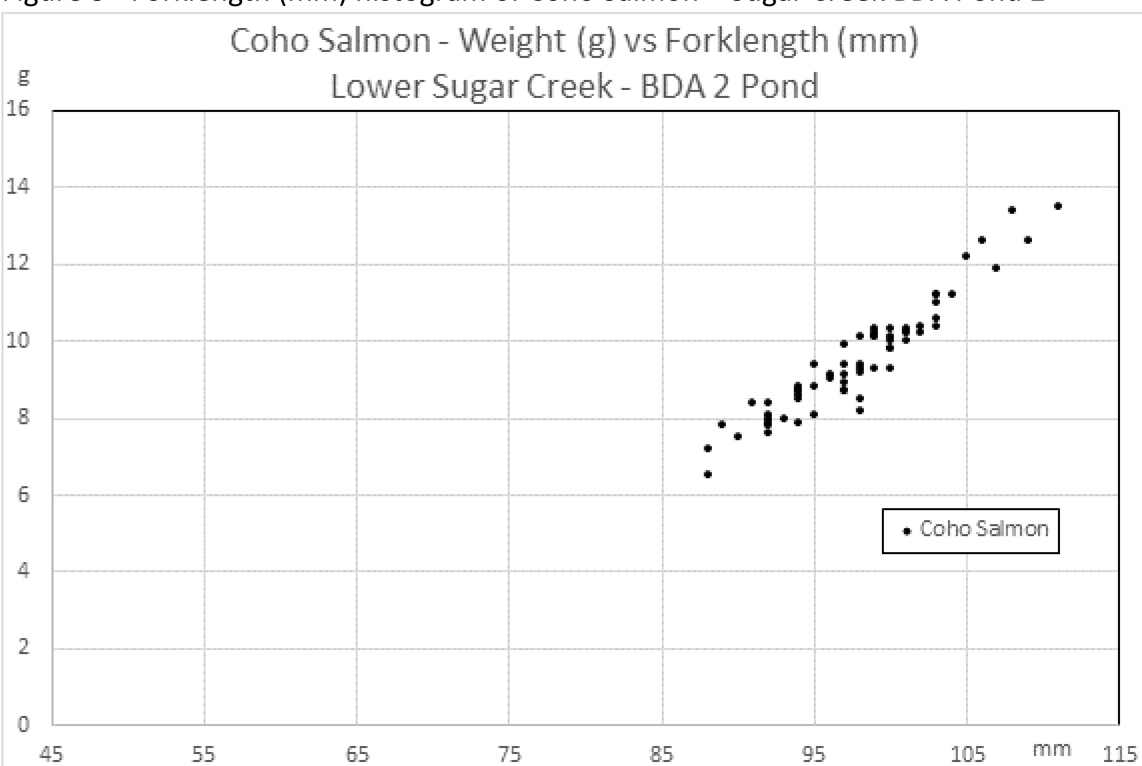


Figure 4 – Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 2

Mid French Creek

French Creek – Habitat upstream mainstem ELJ 1 – Looking Upstream

Sampling effort was performed in five habitat units in Mid French Creek during March 15 – 16, 2022 – the four mainstem control pools, the wood and gravel augmented side channel project, the side channel BDA 1 Pond, the FRGP Side Channel and mainstem Engineered Log Jams (ELJs) project.

Recaptures of fish tagged during the previous January 2022 effort were captured in all sampled habitats with the exception of the mainstem ELJ habitat which was not sampled in January. Catch summaries for each sampled habitat in French Creek are contained in Tables 4 – 8.

Total Catch -Mid French Creek Mainstem Control Pools - March 16, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	112	45	32
Rainbow Trout (*O. mykiss*)	4	0	0

Table 4 – French Creek Control Pools – Total Catch

Total Catch -Mid French Wood Gravel Side Channel -March 16, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	76	27	8
Rainbow Trout (*O. mykiss*)	3	0	0

Table 5 – French Creek - Wood Gravel Side Channel – Total Catch

Total Catch -Mid French Side Channel BDA 1 Pond - March 16, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	13	7	5
Rainbow Trout (*O. mykiss*)	0	0	0

Table 6 – French Creek - Side Channel BDA 1 Pond – Total Catch

Total Catch -Mid French FRGP Side Channel - March 15, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	433	126	36
Rainbow Trout (*O. mykiss*)	1	0	0

Table 7 – French Creek - FRGP Side Channel – Total Catch

Total Catch -Mid French Mainstem ELJs - March 15, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	78	27	0
Rainbow Trout (*O. mykiss*)	10	2	0

Table 8 – French Creek – Mainstem ELJs – Total Catch

Significant numbers of smaller Coho Salmon were captured in the sampled habitats in French Creek with larger Coho in good condition also observed. The average forklength of the sampled fish in French Creek was smaller in all habitats than the fish sampled in the Sugar Creek BDA Ponds (Table 9). The average size of Coho Salmon captured in Sugar Creek has been larger than those captured in French Creek during all sampling efforts from July 2021 through March 2022.

Coho salmon captured in FRGP Side Channel – March 15, 2022

Coho Salmon Forklength (mm)

Date	3/16/2022	3/16/2022	3/16/2022	3/15/2022	3/15/2022
Location	French Mainstem Control Pools	Mid French Wood Gravel Side Channel	Mid French Side Channel BDA 1 Pond	Mid French FRGP Side Channel	Mid French Mainstem ELJs
Average (mm)	75	71	87	73	69
Stand. Deviation (mm)	8.8	8.1	8.3	10.2	7.3
Minimum (mm)	56	51	68	49	53
Maximum (mm)	105	93	100	113	86
Count	112	76	13	433	78

Table 9 - Average foklength (mm) of Coho Salmon in sampled habitats – Mid French Creek

The forklength histogram for the Coho captured in the Mid French habitats are illustrated in Figures 5, 7, 9, 11 and 13. The relationship between individual fish weight (g) and length for the Coho captured in the Mid French habitats are illustrated in Figures 6, 8, 10, 12 and 14.

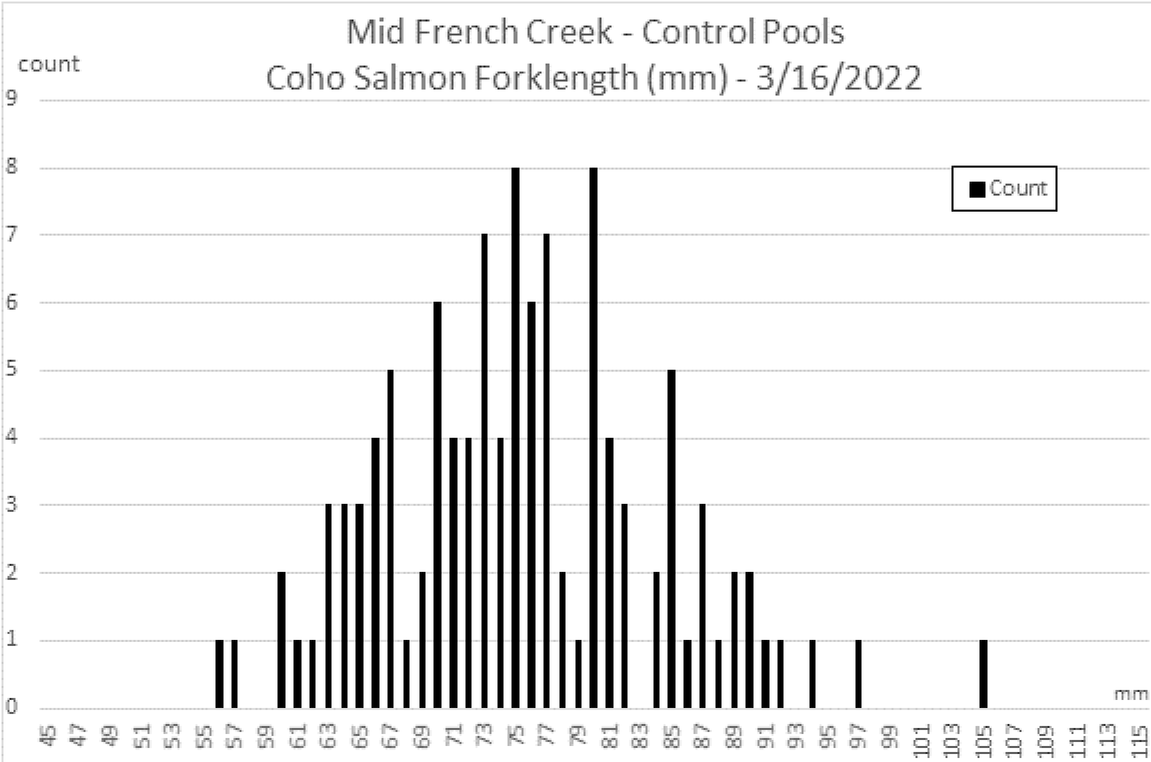


Figure 5 - Forklength (mm) histogram of Coho Salmon – French Control Pools

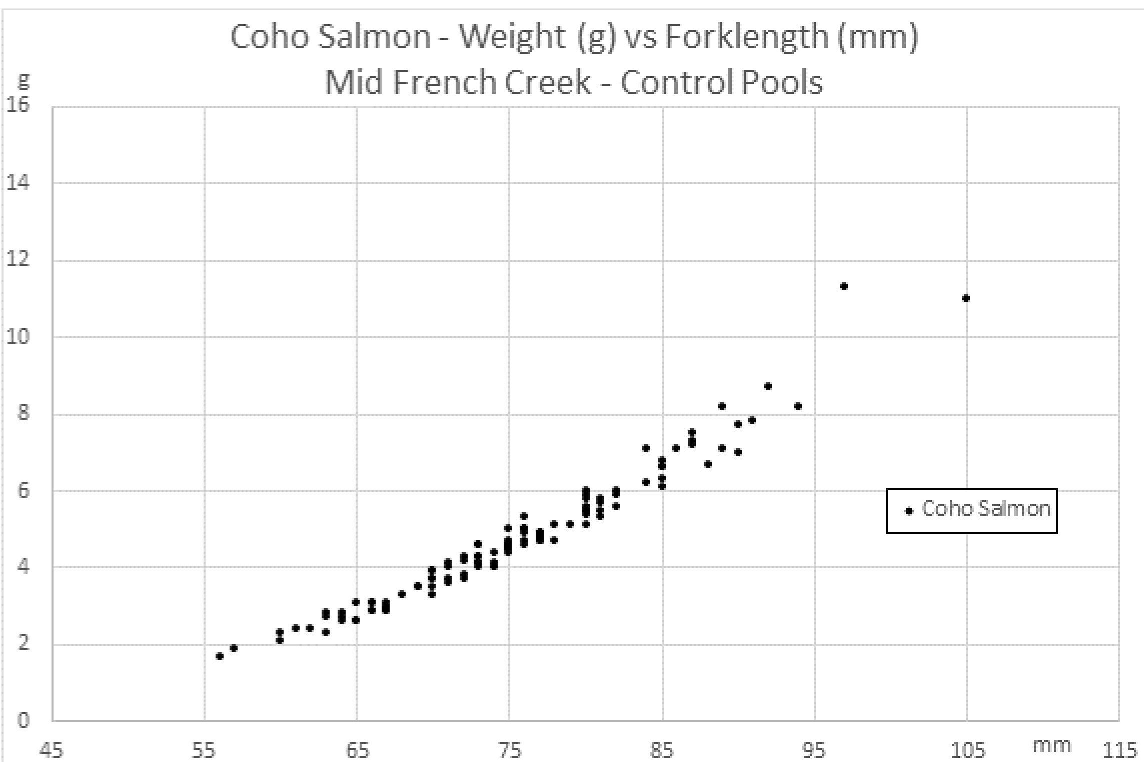


Figure 6 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Control Pools

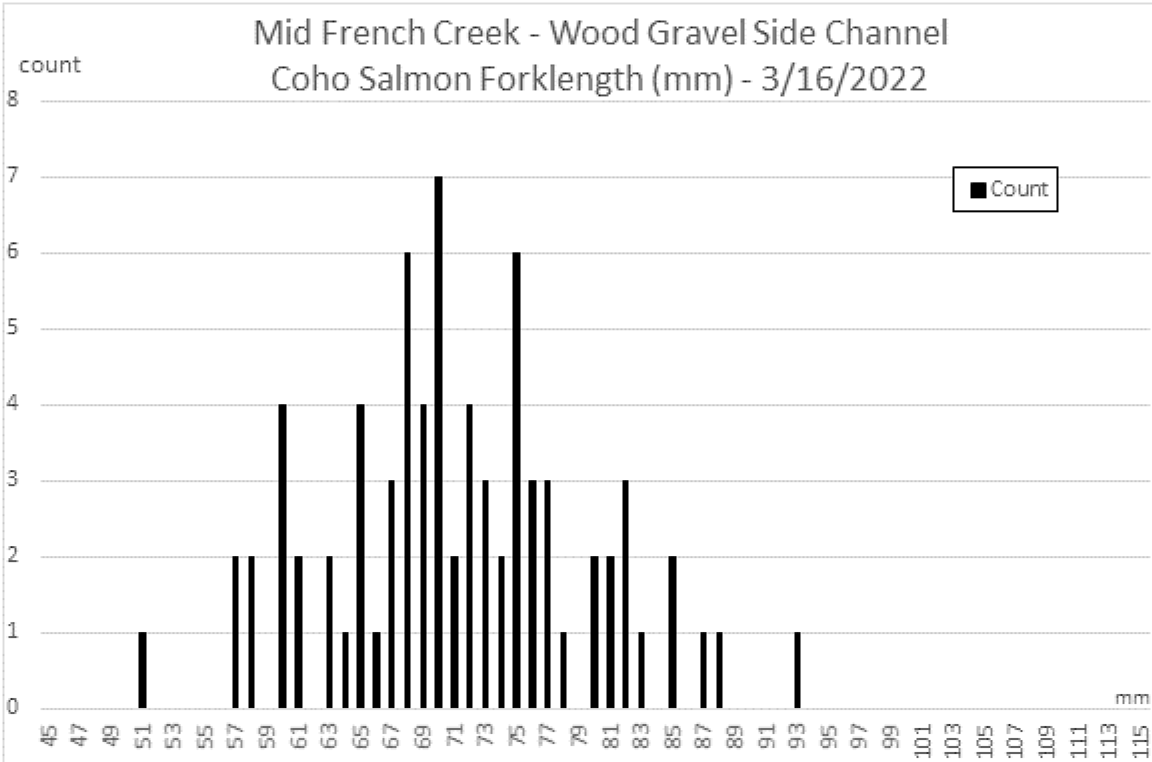


Figure 7 - Forklength (mm) histogram of Coho Salmon – French Wood Gravel Side Channel

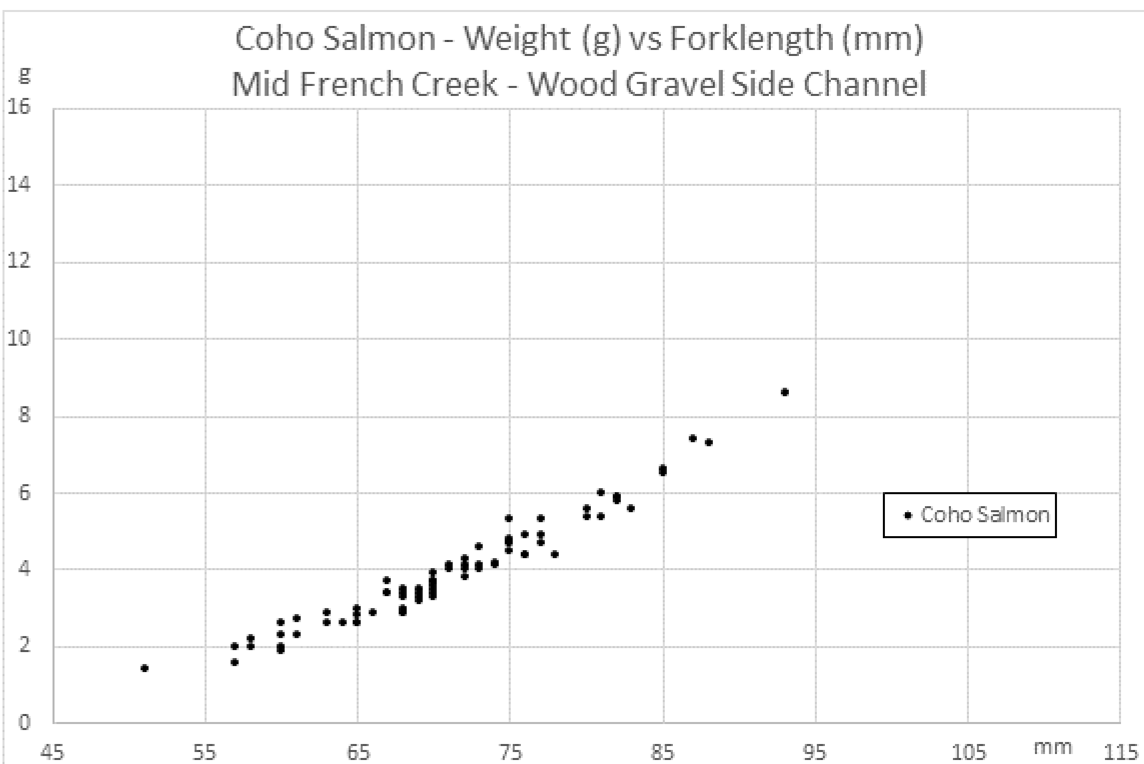


Figure 8 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Wood Gravel Side Channel

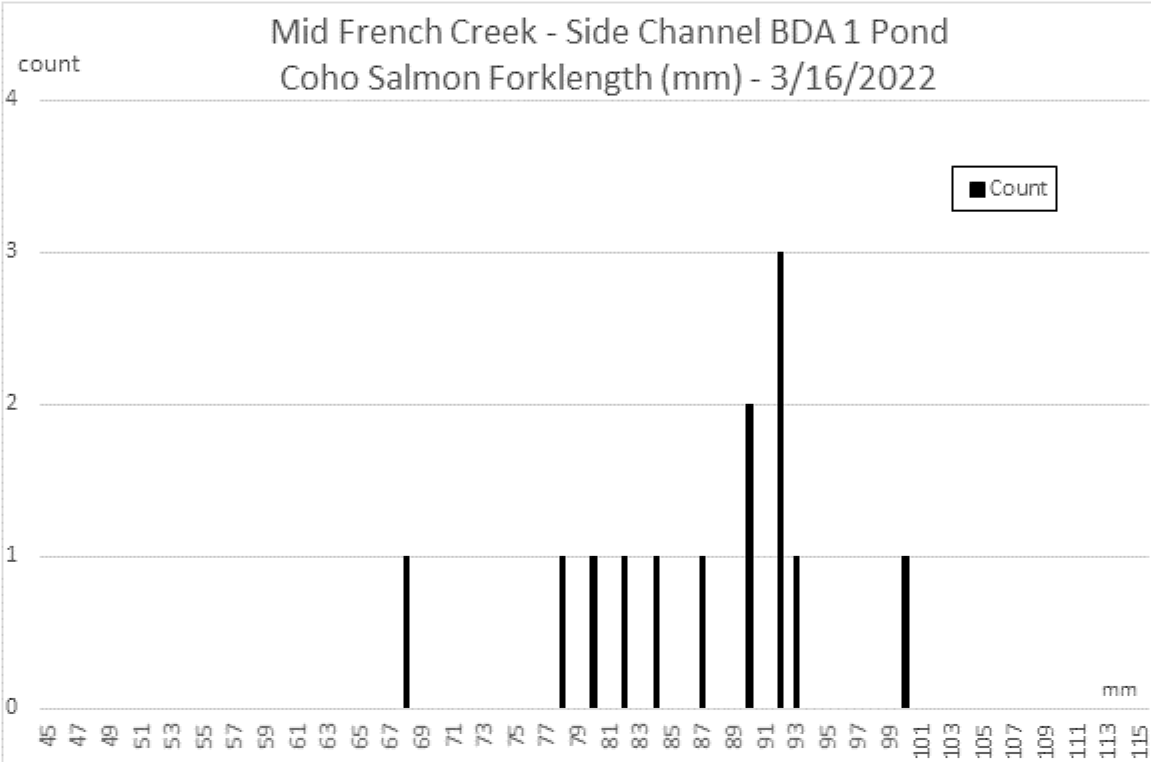


Figure 9 - Forklength (mm) histogram of Coho Salmon – French Side Channel BDA 1 Pond

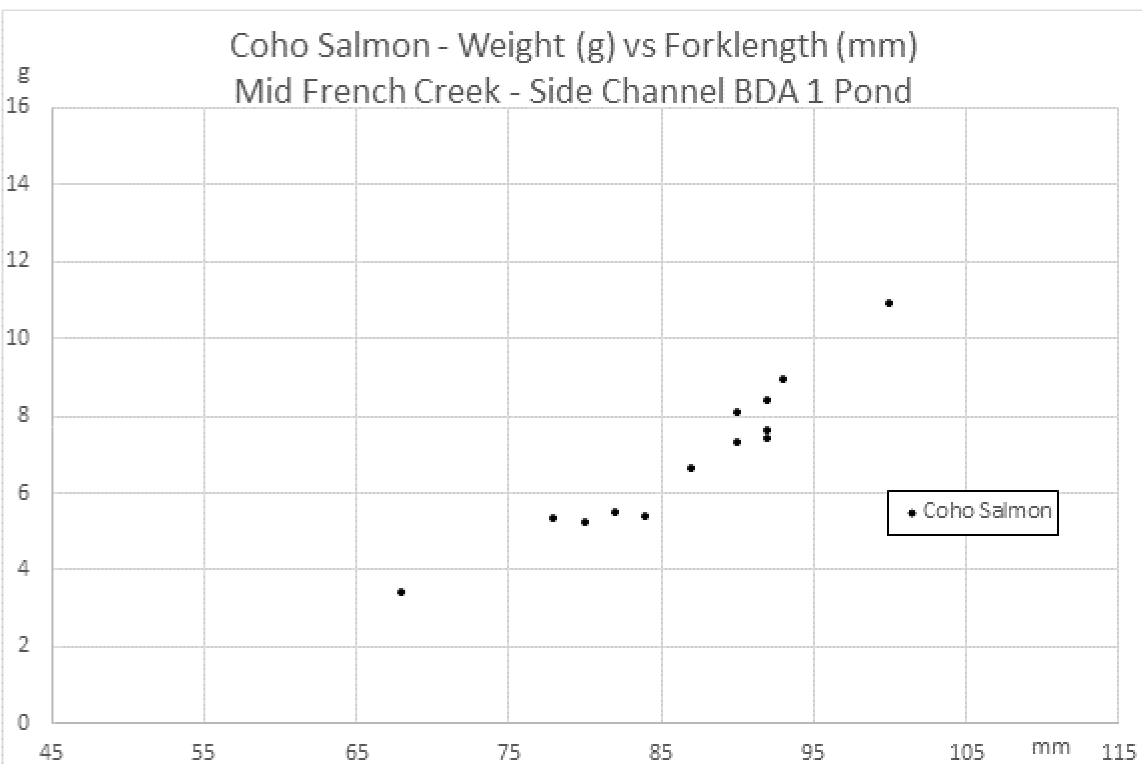


Figure 10 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Side Channel BDA 1 Pond

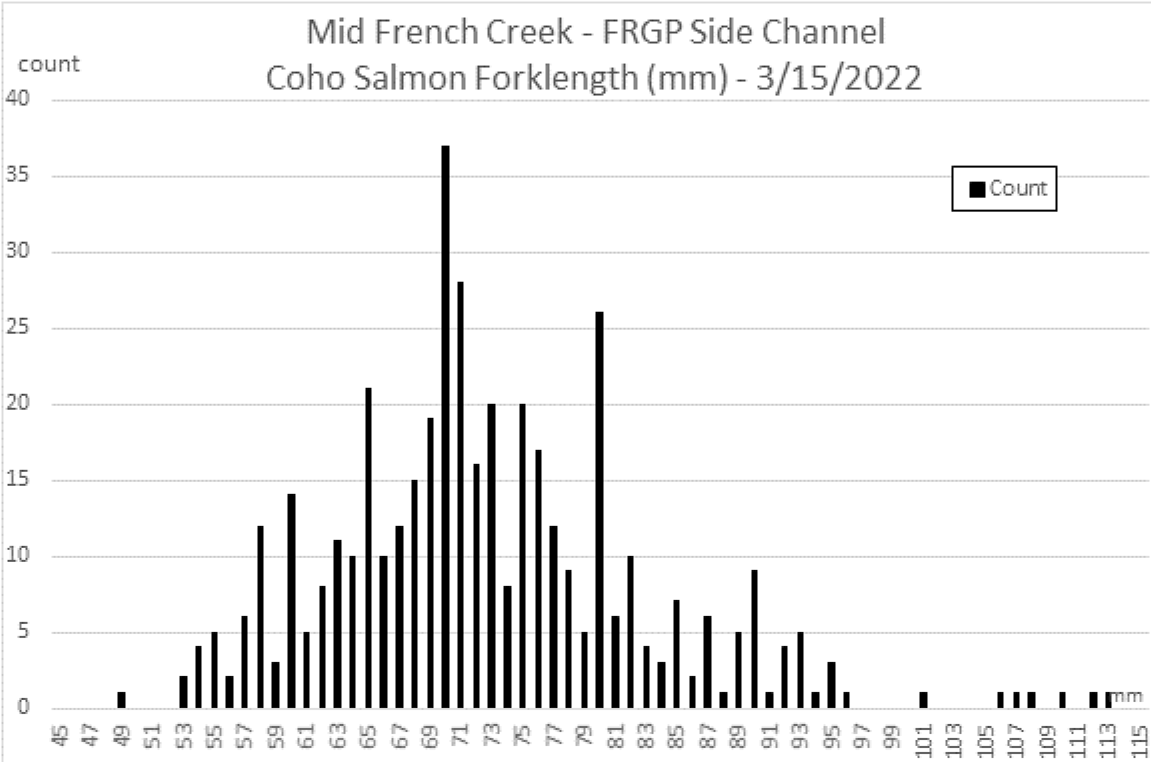


Figure 11 - Forklength (mm) histogram of Coho Salmon – French FRGP Side Channel

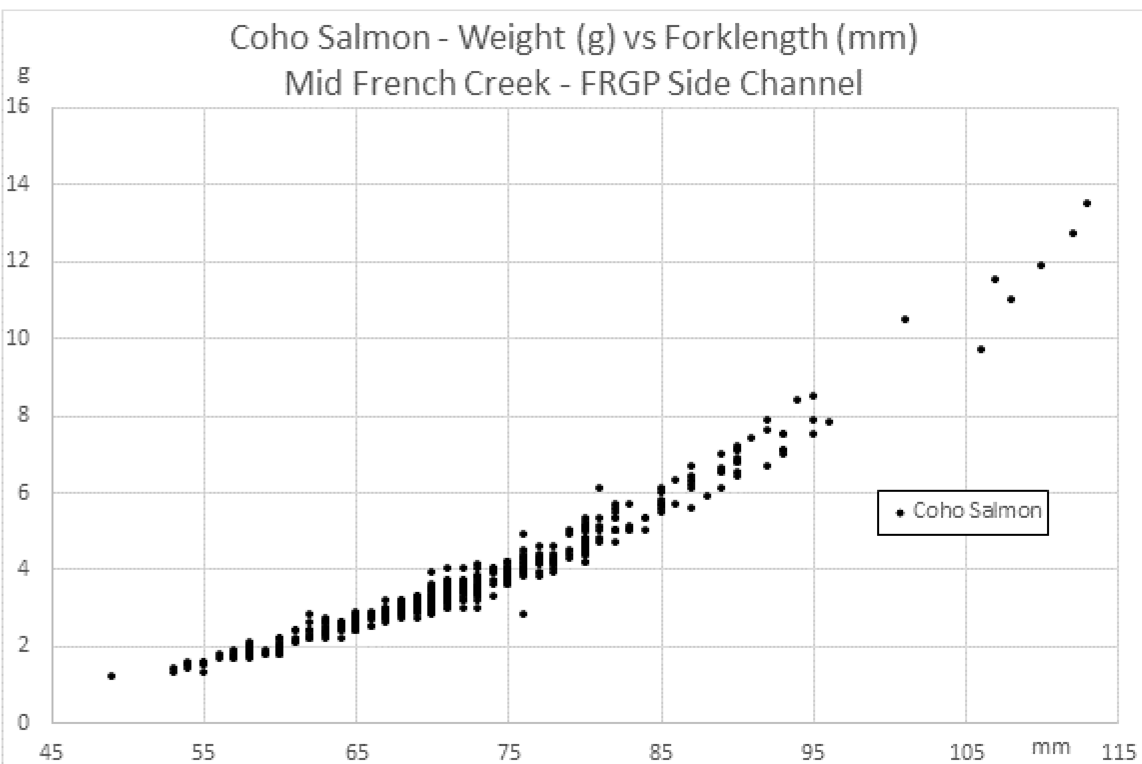


Figure 12 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French FRGP Side Channel

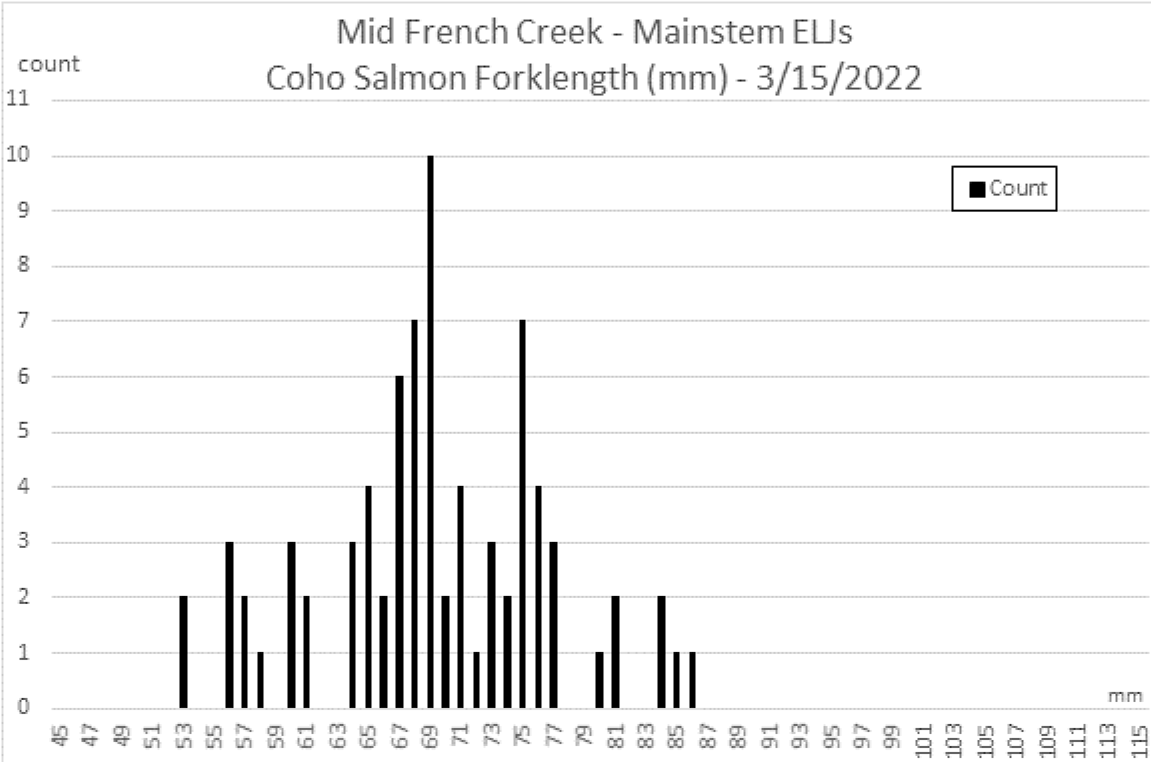


Figure 13 - Forklength (mm) histogram of Coho Salmon – French FRGP Side Channel

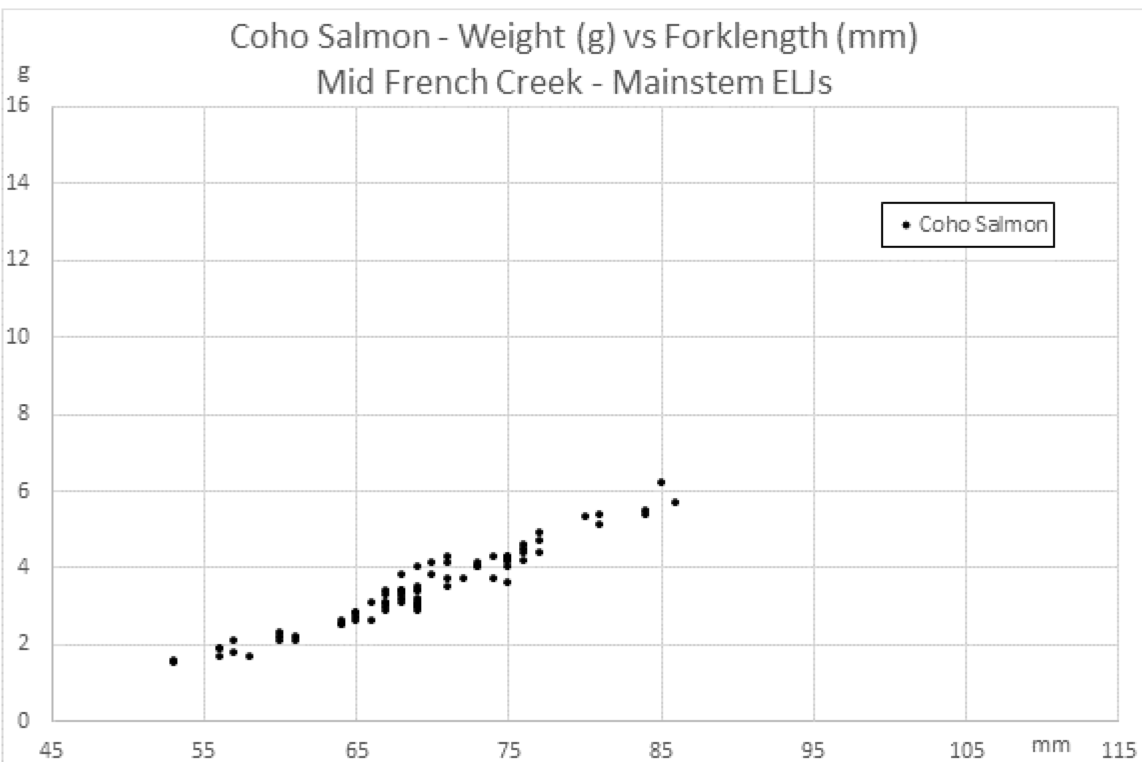


Figure 14 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French FRGP Side Channel


Coho Salmon captured in the FRGP Side Channel – March 15, 2022

Winter Growth
Sugar Creek BDA Ponds

Growth of captured Coho Salmon between the sampling efforts in January and March were calculated for each sample unit for the population as a whole and for individual tagged fish. The average forklength of captured fish in the Sugar BDA Pond 1 increased by 4 mm over the 50 day period between sampling events and the average forklength in Sugar BDA Pond 2 increased 3 mm over the 52 day period between sampling events (Table 10).

Coho Salmon Forklength (mm)

Date	1/19/2022	3/10/2022	1/18/2022	3/11/2022
Location	Sugar BDA Pond 1	Sugar BDA Pond 1	Sugar BDA Pond 2	Sugar BDA Pond 2
Average (mm)	97	101	95	98
Stand. Deviation (mm)	5.3	5.8	5.9	5.1
Minimum (mm)	85	82	81	88
Maximum (mm)	113	110	113	111
Count	63	57	69	65

Table 10 – Average forklength (mm) - Coho Salmon – January & March 2022 – Sugar BDA Ponds

Analysis of the forklength (mm) and weight (g) growth of individual tagged fish encountered in January and March 2022 shows greater growth in Sugar BDA Pond 1 (n = 23) compared to Sugar BDA Pond 2 (n = 18) – Table 11. On average the recaptured fish in Sugar BDA Pond 1 grew 0.07

mm and 0.03 grams per day and the recaptured fish in Sugar BDA Pond 2 grew 0.04 mm and 0.02 grams per day.
Analysis of the ratio of growth (e.g., increase in forklength divided by forklength on January) per day was calculated for each sampled habitat.

Sugar Creek - Beaver Dam Analogue Pond 1

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.07	0.03	0.0008	0.0033
s.d.	0.04	0.01	0.0005	0.0016
count	23	23	23	23

Sugar Creek - Beaver Dam Analogue Pond 2

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.06	0.02	0.0006	0.0028
s.d.	0.07	0.01	0.0008	0.0015
count	5	5	5	5

Sugar Creek - Beaver Dam Analogue Pond 2 - Above Natural Beaver Dam

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.04	0.02	0.0004	0.0021
s.d.	0.06	0.01	0.0005	0.0007
count	13	13	13	13

Sugar Creek - Beaver Dam Analogue Pond 2 - Combined

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.04	0.02	0.0005	0.0023
s.d.	0.06	0.01	0.0006	0.0010
count	18	18	18	18

Table 11 – Winter growth rates of Coho Salmon in Sugar Creek habitats

Winter Growth
Mid French Creek Habitats

Analysis of the increase in average forklength (mm) of fish captured in French Creek during the January and March sampling effort shows no growth in the Control Pools, 2 mm of growth in the Wood Gravel Side Channel and 12 mm of growth in the Side Channel BDA 1 Pond in the 55-day period between sampling events (Tables 12 & 13). 2 mm of growth was observed on average in the FRGP Side Channel over the 53-day period between sampling efforts (Table 13).

Coho Salmon Forklength (mm)

Date / Location	1/20/2022 French Mainstem Control Pools	3/16/2022 French Mainstem Control Pools	1/20/2022 Mid French Wood Gravel Side Channel	3/16/2022 Mid French Wood Gravel Side Channel
Average (mm)	76	75	69	71
Stand. Deviation (mm)	10.9	8.8	9.5	8.1
Minimum (mm)	53	56	51	51
Maximum (mm)	112	105	113	93
Count	179	112	99	76

Table 12 – Average forklength (mm) - Coho Salmon – January & March 2022 – French Control Pools and Wood Gravel Side Channel

Coho Salmon Forklength (mm)

Date / Location	1/20/2022 Mid French Side Channel BDA 1 Pond	3/16/2022 Mid French Side Channel BDA 1 Pond	1/21/2022 Mid French FRGP Side Channel	3/15/2022 Mid French FRGP Side Channel
Average (mm)	75	87	71	73
Stand. Deviation (mm)	8.3	8.3	10.6	10.2
Minimum (mm)	59	68	48	49
Maximum (mm)	97	100	111	113
Count	32	13	368	433

Table 13 – Average forklength (mm) - Coho Salmon – January & March 2022 – French Side Channel BDA 1 Pond and FRGP Side Channel

Analysis of the forklength (mm) and weight (g) growth of individual tagged fish encountered in January and March 2022 shows the greatest growth in the French Side Channel BDA 1 Pond (n = 5), equivalent growth in the French Control Pools (n = 34) and Wood Gravel Side Channel (n = 8) and the least growth in the FRGP Side Channel (n = 34) – Table 14.
On average the recaptured fish in the French Side Channel BDA 1 Pond grew 0.18 mm and 0.05 grams per day, the recaptured fish in the French Control Pools and the Wood Gravel Side Channel grew 0.06 mm and 0.02 grams per day and the recaptured fish in the FRGP Side Channel grew 0.02 mm and 0.00 grams per day.
Analysis of the ratio of growth (e.g., increase in forklength divided by forklength in January) per day was calculated for each sampled habitat.

French Creek - Control Pools

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.06	0.02	0.0008	0.0044
s.d.	0.03	0.01	0.0004	0.0021
count	34	34	34	34

French Creek - Wood Gravel Side Channel

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.06	0.02	0.0008	0.0037
s.d.	0.03	0.01	0.0004	0.0019
count	8	8	8	8

French Creek - Side Channel BDA Pond 1

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.18	0.05	0.0023	0.0090
s.d.	0.08	0.02	0.0012	0.0036
count	5	5	5	5

French Creek - FRGP Side Channel

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day	g/g per day
average	0.02	0.00	0.0002	-0.0002
s.d.	0.02	0.01	0.0003	0.0013
count	34	34	34	34

Table 14 – Winter growth rates of Coho Salmon in French Creek habitats

Discussion:

Winter growth between January and March 2022 of individual recaptured fish was approximately the same in all sampled habitats in Sugar Creek and French Creek with the exemption of the French Creek Side Channel BDA 1 Pond with the greatest growth observed and the French Creek FRGP Side Channel with the least growth observed.

During the March 2022 effort, the average forklength of the Coho Salmon captured in French Creek is significantly less than the average forklength of the Coho Salmon captured in the Sugar Creek BDA Ponds. There is significantly greater variance in size of the fish captured in French Creek habitats (FRGP Side Channel forklength standard deviation = 10.2 mm) compared to those captured in Sugar Creek (Sugar Creek BDA Pond 1 forklength standard deviation = 5.8 mm).

The sampled Coho Salmon in Sugar Creek have been significantly larger on average than those captured in French Creek throughout the sampling effort from July 2021 through March 2022 (Figure 15).

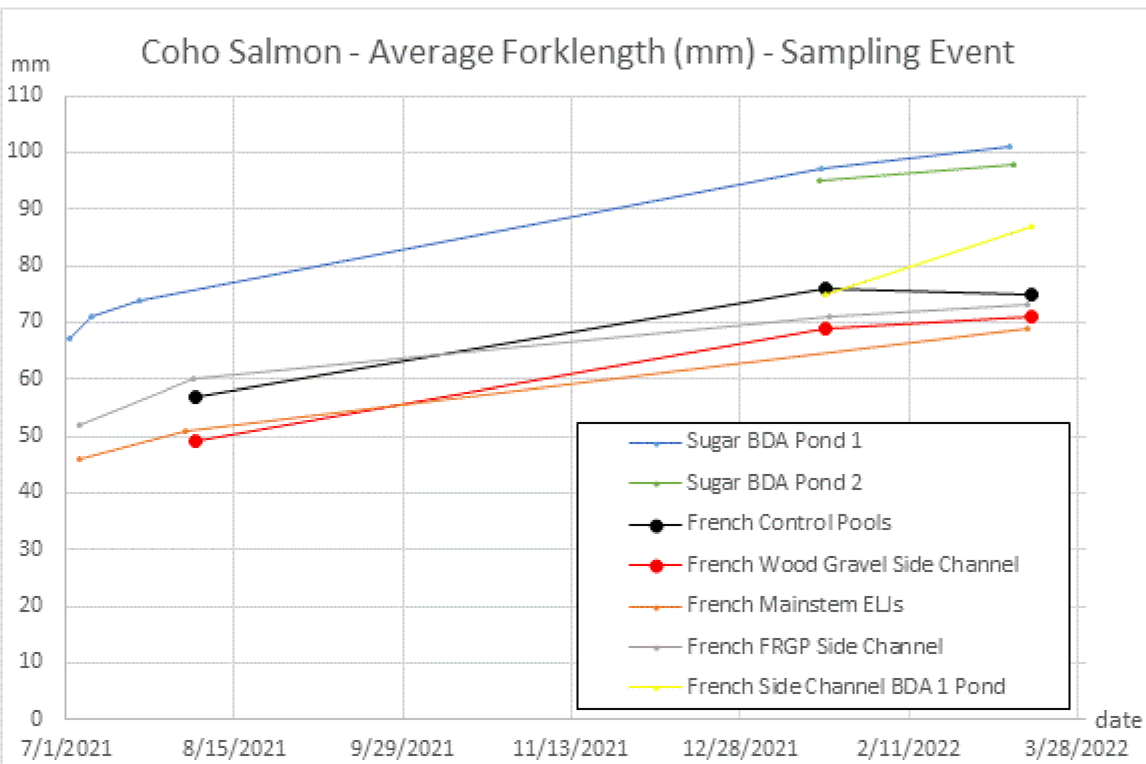


Figure 15 – Average forklength (mm) per sampling event in each sampled habitat – 2021 - 2022

It is hypothesized that high densities of juvenile Coho in French Creek are a major factor in the limited growth observed 2021 to 2022 in French Creek compared to Sugar Creek. Analysis of the average forklength of Coho Salmon captured in the mainstem ELJ reach on August 2, 2021 illustrates an average forklength that is less than that observed in the same habitat on July 7, 2020 (Table 15). Large numbers of adult Coho Salmon were observed spawning in the Mid French Creek reach during the 2020-2021 escapement. There are likely additional environmental factors affecting the differences in growth between the Sugar Creek BDA Ponds and the sampled French Creek habitats.

Coho Salmon Forklength (mm)

Date	7/7/2020	7/28/2020	8/2/2021
Location	Mid French ELJs	Mid French ELJs	Mid French Mainstem Combined
Average (mm)	57	62	51
Stand. Deviation (mm)	7	5.5	5.6
Minimum (mm)	42	47	34
Maximum (mm)	101	85	65
Count	103	617	188

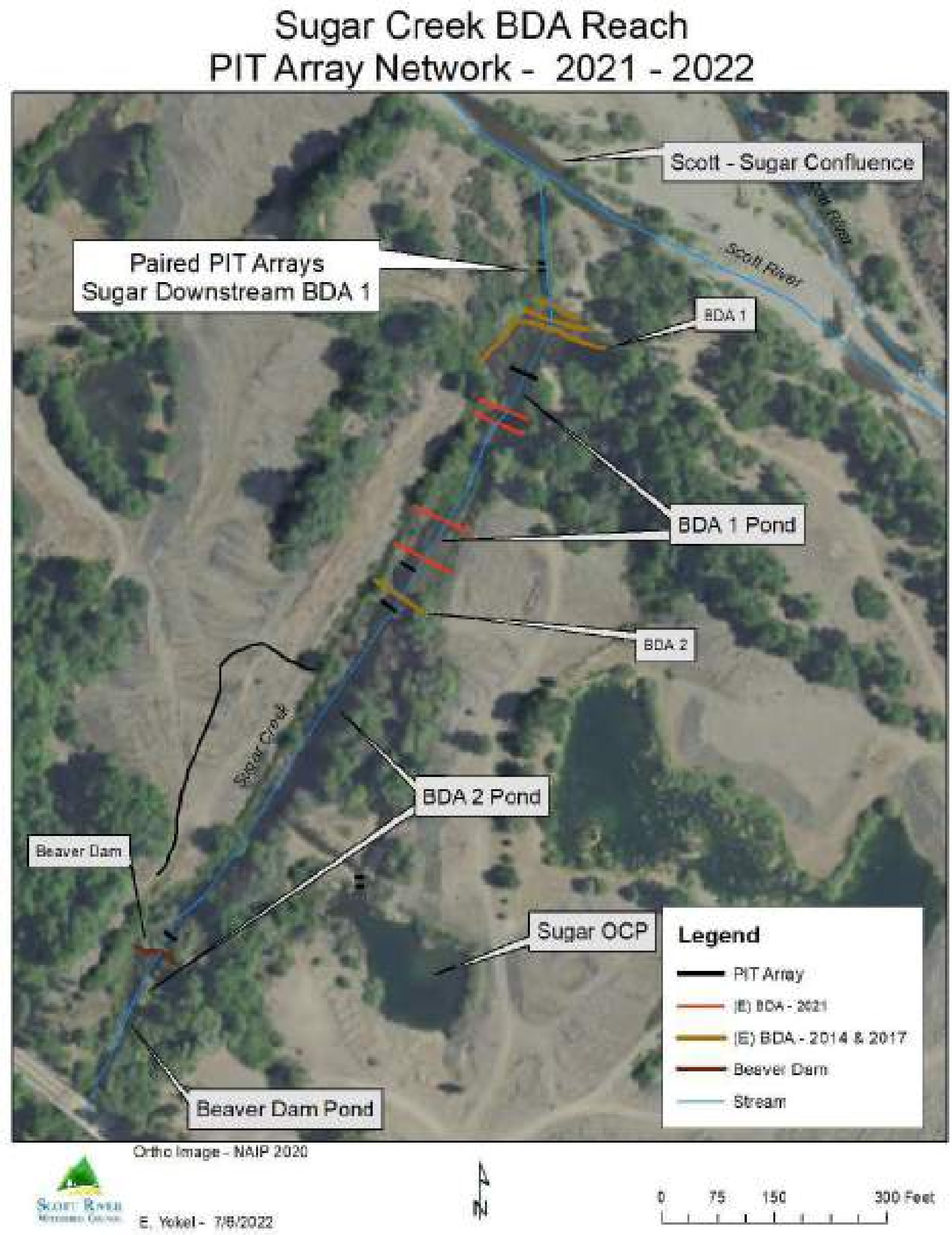
Table 15 – Average forklength (mm) in French Mainstem ELJs – July 2020 & August 2, 2021

Sugar Creek BY2020 Coho Salmon Smolt Outmigration – PIT Tag Detection Summary – 6/16/2022
Scott River Watershed Council

PIT tagged Coho Salmon were detected outmigrating from Sugar Creek at paired PIT arrays downstream of the lower BDA Complex during the period of outmigration in spring 2022 (Map 1). A total of 365 BY2020 Coho Salmon in Sugar Creek and 26 in the Scott River at the Sugar Creek Confluence were marked from July 8, 2021 to March 11, 2022. 166 of these fish were captured in Sugar BDA 1 and relocated to the Sugar Off Channel Pond (Sugar OCP) (n = 104) and natural beaver dam pond (n = 62) during two efforts on July 8 and July 21, 2021. Percent of survival to outmigration of marked fish was calculated by sample habitat (Table 1).

Sample Date	Sample Habitat	# Marks	Comment	Outmigrants Detected	Percent Survival
7/8/2021	Sugar BDA 1 Pond	53	Relocated to OCP	26	49%
7/8/2021	Sugar BDA 1 Pond	62	Relocated to Beaver Dam Pond	26	42%
7/21/2021	Sugar BDA 1 Pond	51	Relocated to OCP	32	63%
8/6/2021	Scott-Sugar Confluence	26		10	38%
8/9/2021	Sugar Control Reach	9		7	78%
1/18/2022	Sugar BDA 2 Pond	57		41	72%
1/19/2022	Sugar BDA 1 Pond	61		55	90%
3/10/2022	Sugar BDA 1 Pond	32		28	88%
3/11/2022	Sugar BDA 2 Pond	40		35	88%
Total		391		260	66%
Total - Relocated Fish		166		84	51%
Total without Scott-Sugar Confluence		365		250	68%
Total - Fish Tagged in 2022		190		159	84%

Table 1 – Number of PIT tag marked Coho Salmon by Sample Unit and outmigrants detected



Map 1 – Sugar Creek Sample Habitats and PIT Arrays

Significant numbers of outmigrating Coho Salmon were detected during periods of increased stream discharge in Sugar Creek (Figure 1). Provisional stream discharge (cfs) at the California Department of Water Resources Sugar Creek RKM 2.6 station (F25890) was acquired from cdec.water.ca.gov. The daily total count of outmigrating marked fish was calculated. The last marked outmigrant was detected on May 31, 2022 and no marked fish were detected on any of the PIT arrays in Sugar Creek from June 1 through June 16. It is assumed that all surviving marked fish outmigrated from Sugar Creek prior to the June 16th download.

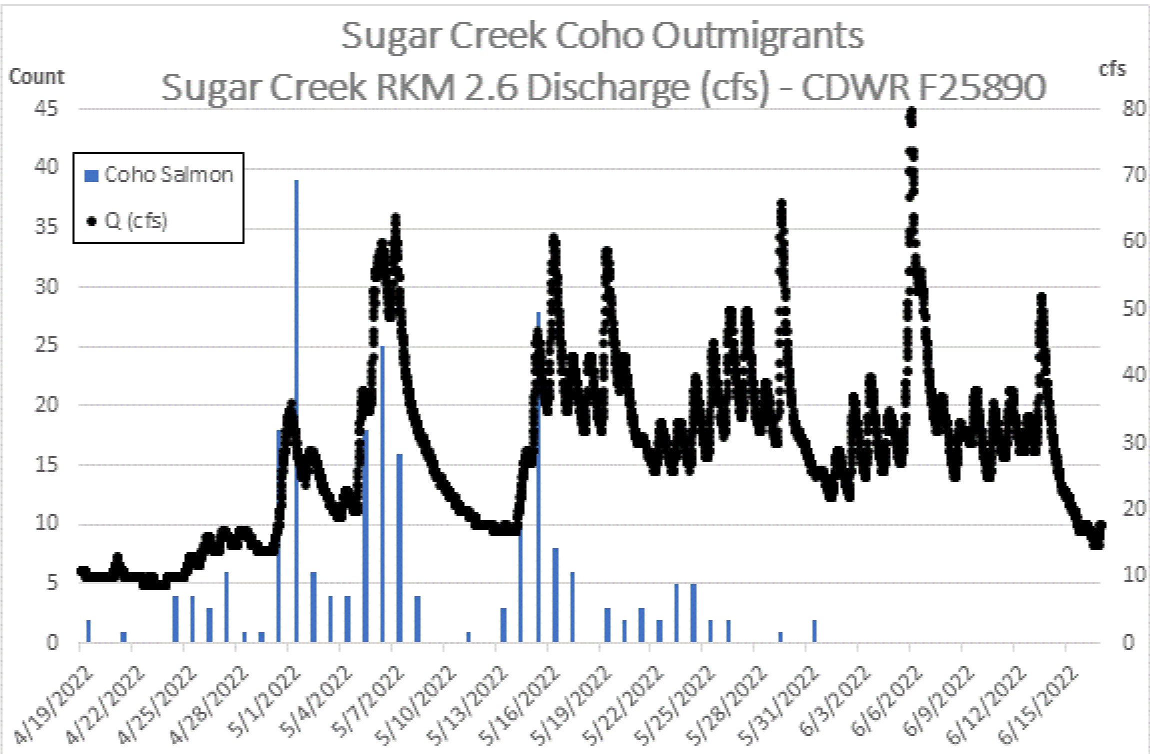


Figure 1 – Total count of outmigrants detected on Array 1A per day and Sugar Creek discharge (cfs)

The timing of outmigration was calculated by determining the count of fish that outmigrated per hour (PST) – Figure 2. The majority of marked fish outmigrated during the dusk with the hour of peak migration occurring at 9 PM (PST).

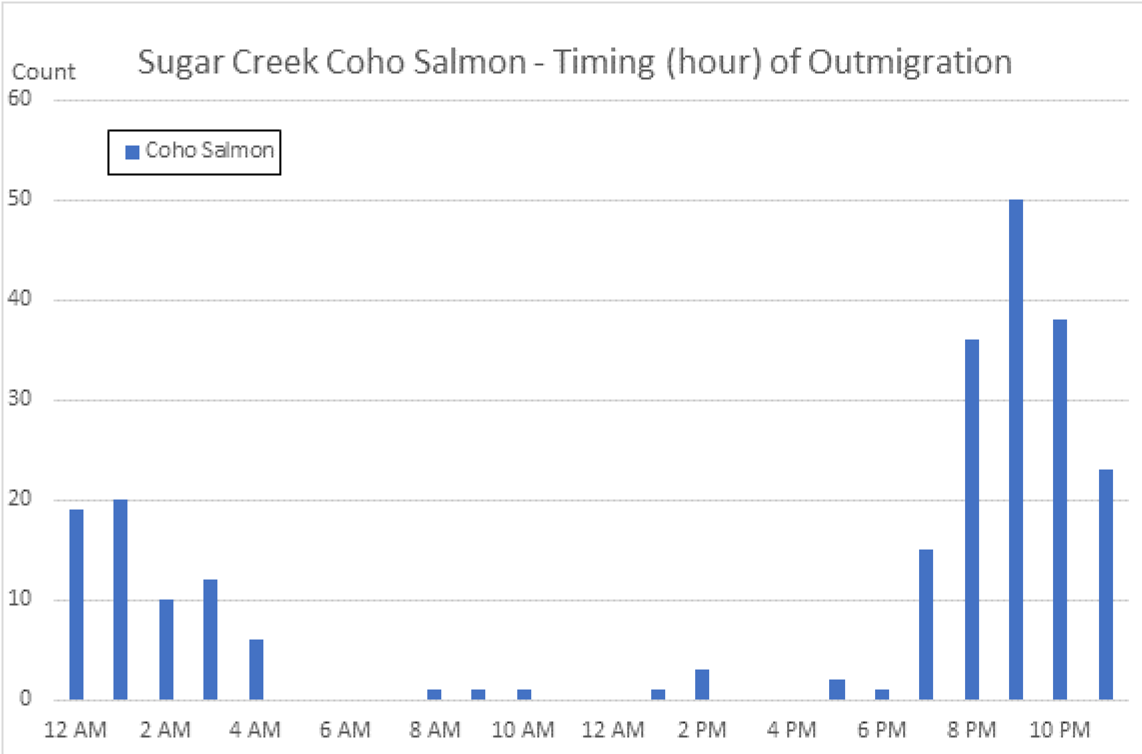


Figure 2 – Total count of outmigrants detected on Array 1A per hour (PST)

Coho Salmon Catch Summary
Sugar Creek BDA Ponds and Mid French Creek Habitats – August 1 - 4 & August 10, 2022
Scott River Watershed Council

Sugar Creek BDA Ponds

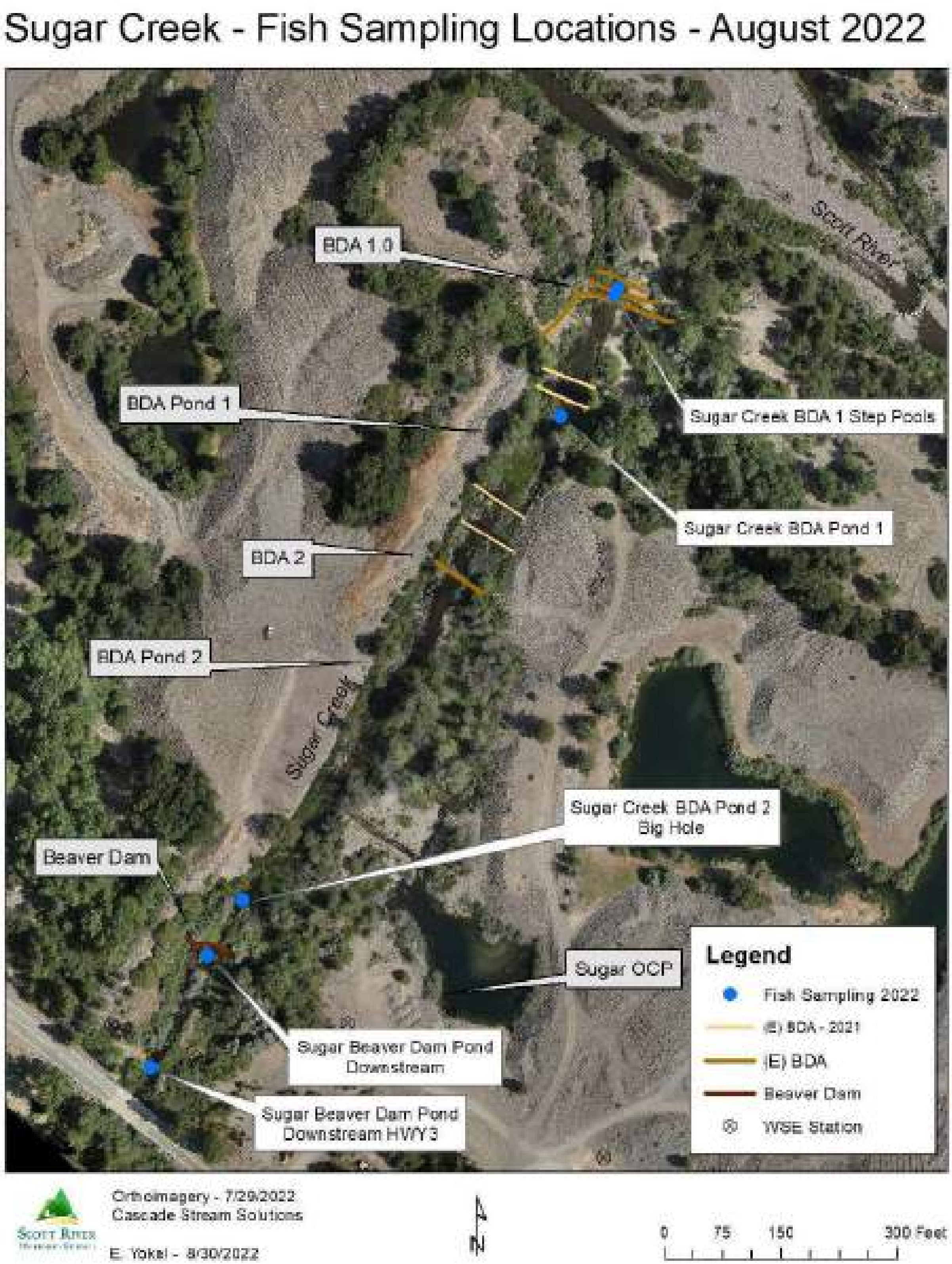
Sugar Creek BDA Pond 1 and the BDA 1 Step Pools were sampled for the first time in the summer of 2022 on August 1, 2022 with a seine net. Juvenile young of the year (YOY) Coho Salmon (*O. kisutch*) (Brood Year 2021) and juvenile Chinook Salmon (*O. tshawytscha*) were captured in both sampled habitats. A significant number of rainbow trout (*O. mykiss*) were captured in the Sugar BDA 1 Step Pools (Tables 1 and 2).

Coho Salmon with a forklength 65 mm and greater were marked with a PIT tag.

YOY Chinook Salmon and YOY Coho Salmon – Sugar BDA 1 Step Pools – August 1, 2022

The biometrics (forklength (mm) and weight (g)) of individual captured Coho Salmon were measured. The average forklength of the captured sample was greater in the Sugar BDA Pond 1 than the average forklength of the fish captured in the BDA Step Pools (Table 3).

The forklength histograms for the Coho captured in the BDA Pond 1 and BDA 1 Step Pools are illustrated in Figure 1. The relationship between individual fish weight (g) and length for the Coho captured in the two habitats is illustrated in Figure 2.



Map 1 - Sugar Creek – Fish sampling locations – August 2022


Sugar BDA 1 Step Pool

Total Catch -Sugar Creek BDA Pond 1 - August 1, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	310	168	0
Chinook Salmon	3	0	0
Rainbow Trout (*O. mykiss*)	11	0	0

Table 1 – Sugar Creek BDA Pond 1 – Total Catch

Total Catch -Sugar Creek BDA 1 Step Pools - August 1, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	77	20	0
Chinook Salmon	10	0	0
Rainbow Trout (*O. mykiss*)	199	0	0

Table 2 – Sugar Creek BDA 1 Step Pools – Total Catch


YOY Coho Salmon (FL ≈ 80 mm) – Sugar BDA 1 Pond – August 1, 2022

Coho Salmon Forklength (mm)

Date	8/1/2022	8/1/2022	8/1/2022
Location	Sugar Creek BDA 1 Step Pools & BDA 1 Pond	Sugar Creek BDA 1 Step Pools	Sugar Creek BDA 1 Pond
Average (mm)	66	61	67
Stand. Deviation (mm)	8.5	6.9	8.4
Minimum (mm)	47	47	49
Maximum (mm)	92	77	92
Count	387	77	310

Table 3 - Average forklength (mm) of Coho Salmon in sampled habitats – Sugar Creek BDA 1

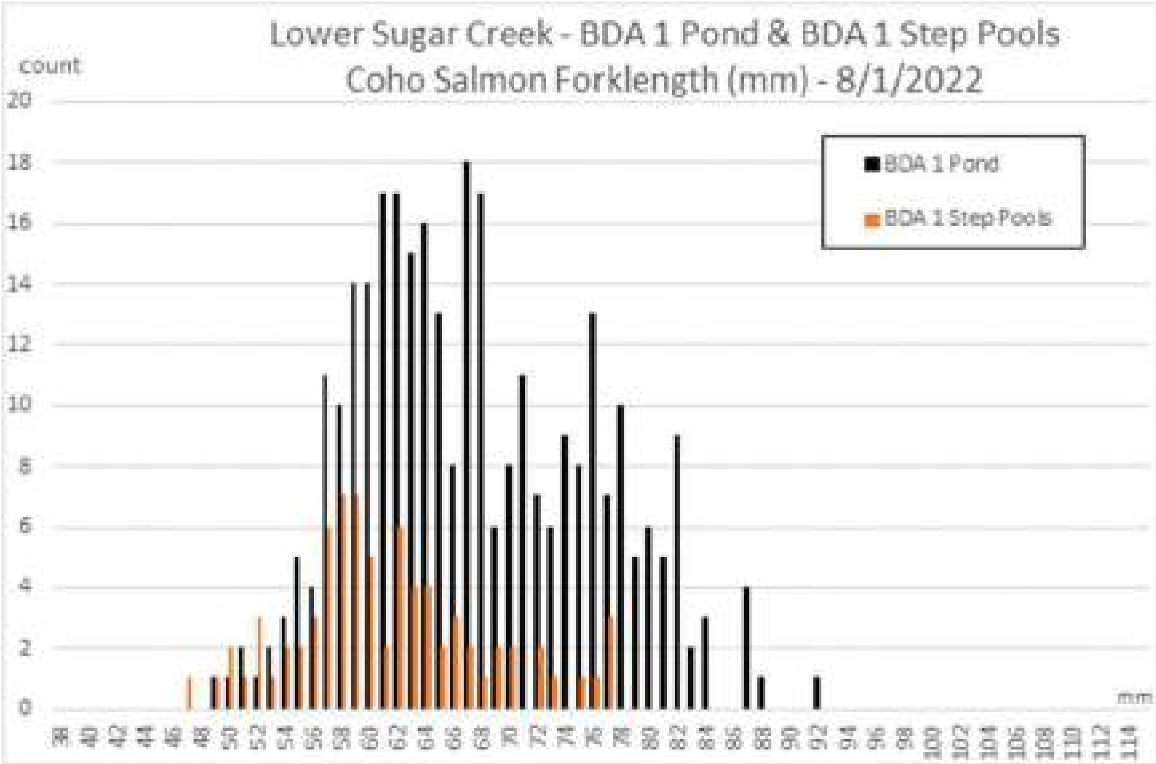


Figure 1 – Forklength (mm) histogram of Coho Salmon – Sugar Creek BDA Pond 1 & BDA 1 Step Pools

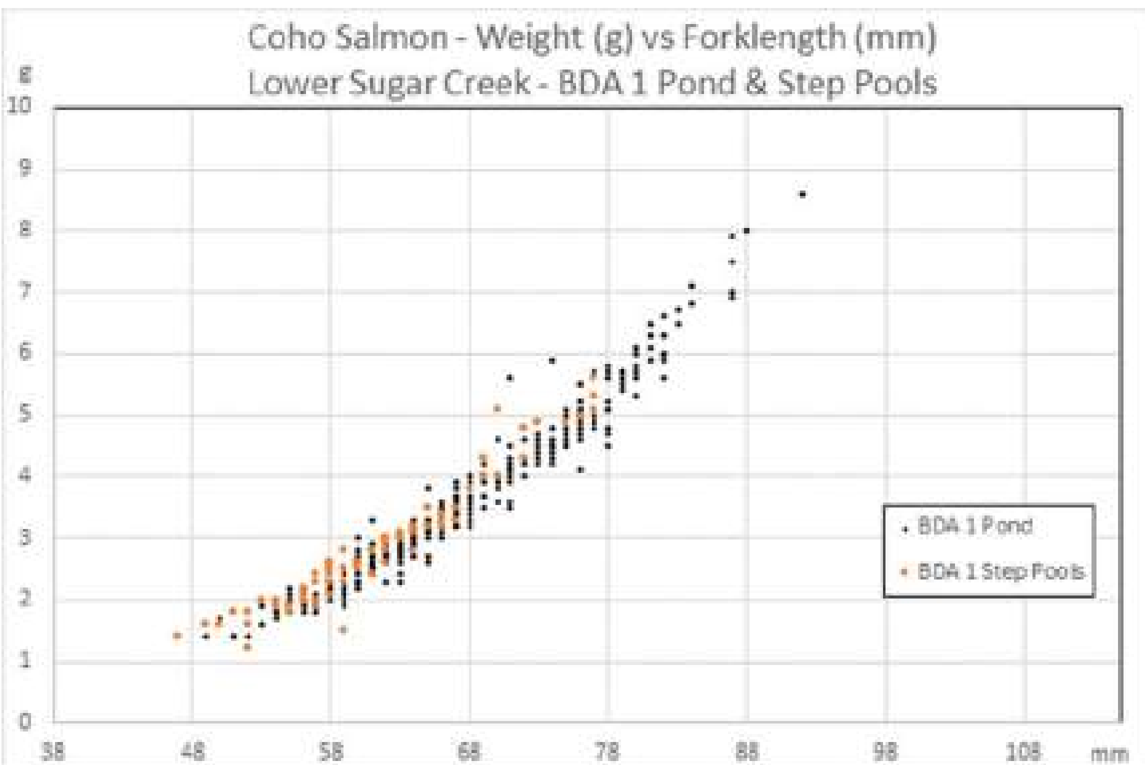


Figure 2 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 1 & BDA 1 Step Pools

Three habitats upstream of the Sugar Creek BDA 2 structure were sampled on August 4, 2022. YOY Coho Salmon were captured in the large deep pool (Big Hole) downstream of the natural beaver dam and in two locations upstream of the beaver dam (Tables 4 – 6). No Chinook Salmon and limited rainbow trout were captured.

Total Catch -Sugar Creek BDA Pond 2 - Big Hole - August 4, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	120	14	0
Chinook Salmon	0	0	0
Rainbow Trout (*O. mykiss*)	6	0	0

Table 4 – Sugar Creek BDA Pond 2 – Big Hole – Total Catch

Total Catch -Sugar Creek Beaver Dam Pond - Downstream - August 4, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	66	8	0
Chinook Salmon	0	0	0
Rainbow Trout (*O. mykiss*)	0	0	0

Table 5 – Sugar Creek Beaver Dam Pond – Downstream – Total Catch

Total Catch -Sugar Creek Beaver Pond - Downstream HWY3 - August 4, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	145	51	0
Chinook Salmon	0	0	0
Rainbow Trout (*O. mykiss*)	1	0	0

Table 6 – Sugar Creek Beaver Pond – Downstream HWY 3 – Total Catch

The average forklength of Coho Salmon captured in the sample locations upstream of the BDA 2 structure were significantly smaller than the average forklength of the fish captured in the BDA 1 habitats (Table 7).

The forklength histograms for the Coho captured in the BDA Pond 2 and Beaver Dam Pond are illustrated in Figure 3. The relationship between individual fish weight (g) and length (mm) for the Coho captured in the two habitats is illustrated in Figure 4.

Coho Salmon Forklength (mm)

Date	8/4/2022	8/4/2022	8/4/2022	8/4/2022	8/4/2022
Location	BDA 2 Pond - All Habitats	Beaver Dam Pond	Beaver Dam Pond - Downstream	Beaver Dam Pond - Downstream HWY3	Big Hole Downstream Beaver Dam
Average (mm)	55	57	53	59	51
Stand. Deviation (mm)	11.9	12.5	11	12.7	9.8
Minimum (mm)	39	39	39	39	39
Maximum (mm)	86	86	82	86	80
Count	331	211	66	145	120

Table 7 – Average foklength (mm) of Coho Salmon in sampled habitats – Upstream Sugar BDA 2

YOY Coho Salmon (FL ≈ 40 mm) – Beaver Dam Pond – August 4, 2022

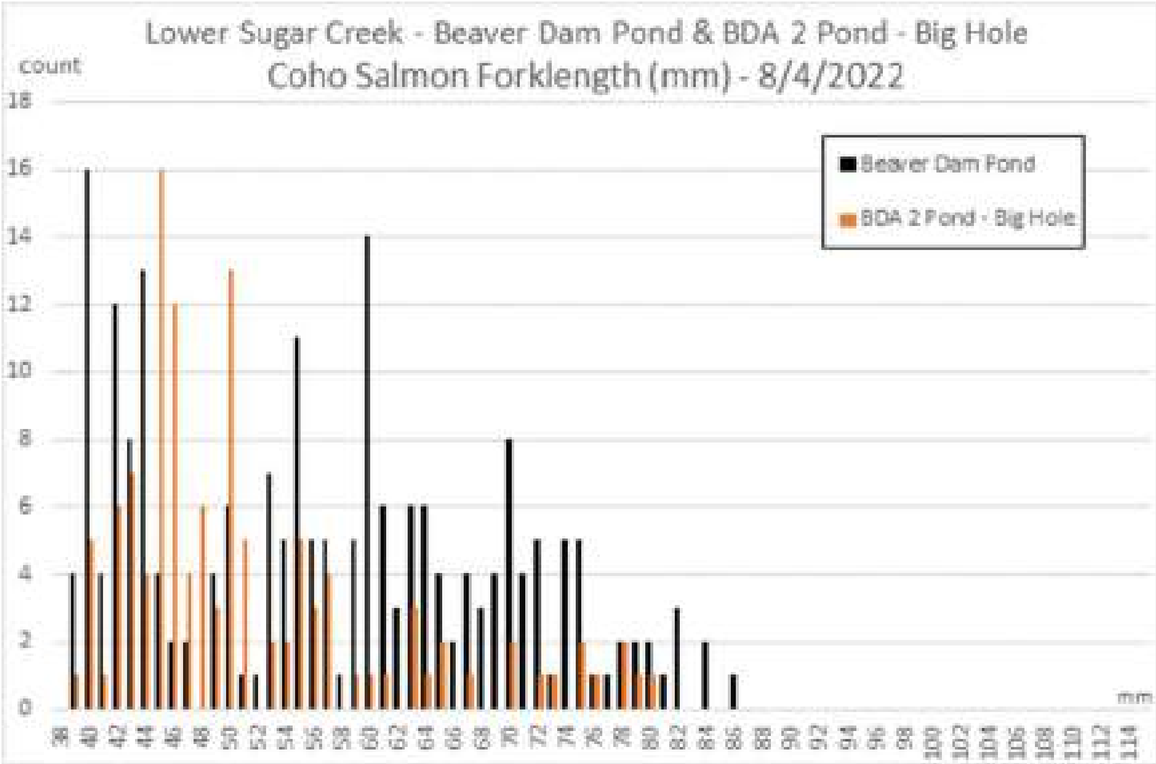


Figure 3 – Forklength (mm) histogram of Coho Salmon – Sugar Creek BDA Pond 2 & Beaver Dam Pond

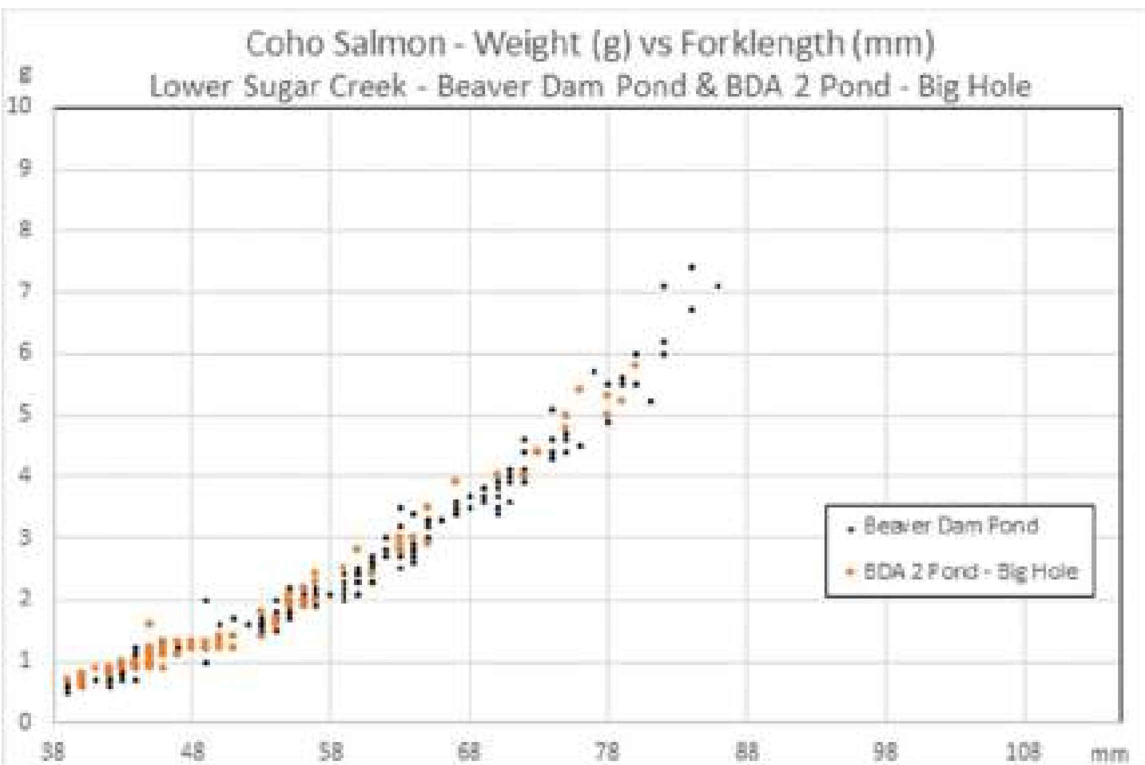
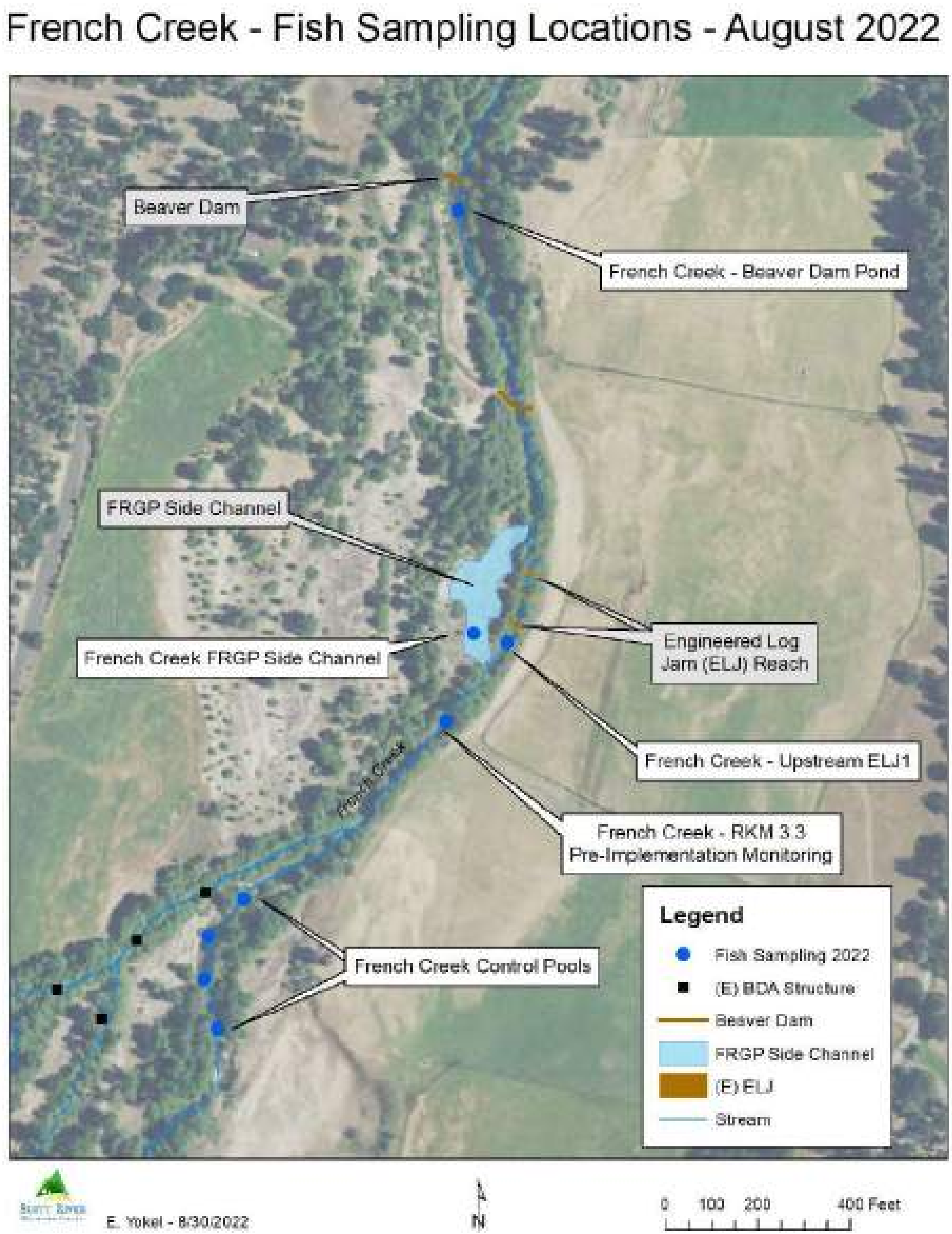


Figure 4 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Sugar Creek BDA Pond 2 & Beaver Dam Pond

French Creek

1+ Coho (FL ≈ 90 mm) and YOY Coho (FL ≈ 70 mm) – French Control Pools – August 3, 2022

1+ Coho (FL ≈ 90 mm) and YOY Coho (FL ≈ 50 mm) – FRGP Side Channel – August 2, 2022



Map 2 – French Creek – Fish sampling locations – August 2022

Five habitats in Mid French Creek were sampled on August 2nd & 3rd, 2022 (Map 2) – the FRGP Side Channel, upstream of the mainstem Engineered Log Jam 1 (ELJ 1), an flatwater habitat in the future RKM 3.3 restoration site, the Control Pools and the beaver dam pond at RKM 2.9. A significant amount of 1+ Coho Salmon were captured in the FRGP Side Channel, Control Pools and beaver dam pond. A forklength histogram of all fish captured in Mid French Creek during the August 2nd and 3rd effort was generated in order to identify the forklength cutoff between young of the year (YOY) and yearling (1+) Coho Salmon (Figure 5). It was determined that a fish with a forklength greater than 80 mm would be identified as a 1+ fish and those with a forklength less than or equal to 80 mm would be identified as YOY. Captured Coho Salmon were parsed into the two age classes utilizing the identified forklength cutoff.

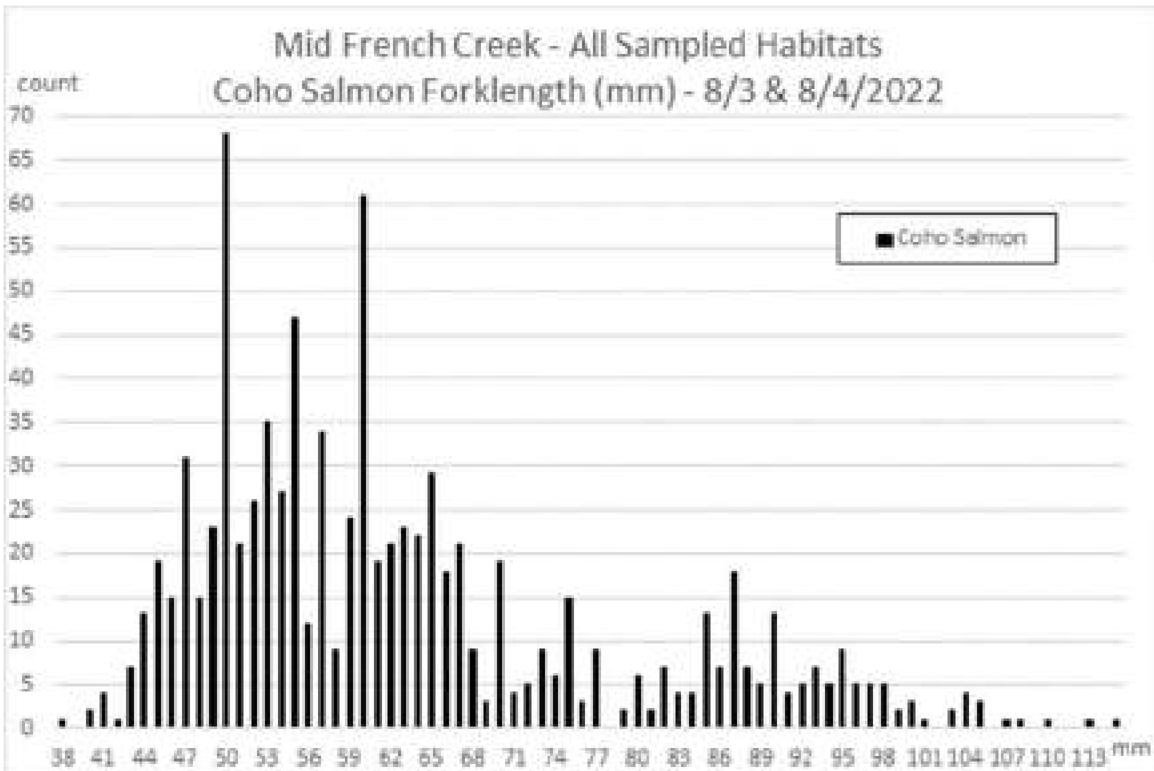


Figure 5 - Forklength (mm) histogram of Coho Salmon – French Creek – All Habitats

Baited minnow traps were utilized in the FRGP Side Channel to capture fish and a seine net was utilized in the four other sampled habitats. The catch totals for each sampled habitat are summarized in Tables 8 – 12.

Total Catch -French Creek Control Pools - August 3, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	532	106	0
Coho Salmon - 1+ (BY2020)	59	59	0
Rainbow Trout (*O. mykiss*)	25	0	0

Table 8 – French Creek Control Pools – Total Catch

Total Catch - French Creek FRGP Side Channel - August 2, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	26	18	0
Coho Salmon - 1+ (BY2020)	64	63	1
Rainbow Trout (*O. mykiss*)	0	0	0

Table 9 – French Creek FRGP Side Channel – Total Catch

Total Catch - French Creek Upstream Mainstem ELJ 1 - August 2, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	86	9	0
Coho Salmon - 1+ (BY2020)	1	1	0
Rainbow Trout (*O. mykiss*)	6	0	0

Table 10 – French Creek Upstream Mainstem ELJ 1 – Total Catch

Total Catch - French RKM 3.3 - Pre Implementation Monitoring - August 2, 202

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	5	1	0
Coho Salmon - 1+ (BY2020)	0	0	0
Rainbow Trout (*O. mykiss*)	0	0	0

Table 11 – French Creek – RKM 3.3 – Total Catch

Total Catch - French Creek Beaver Dam Pond - August 2, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	89	24	0
Coho Salmon - 1+ (BY2020)	21	21	0
Rainbow Trout (*O. mykiss*)	0	0	0

Table 12 - French Creek Beaver Dam Pond – Total Catch

The average forklength of YOY Coho Salmon for each sampled habitat illustrates significantly larger fish in the FRGP Side Channel with significantly smaller fish in the flatwater habitat upstream of the Mainstem ELJ 1 (Table 13). Average forklength for the fish captured in the French RKM 3.3 Pre-Implementation Monitoring site were not calculated due to the small sample size (n = 5).

YOY Coho Salmon Forklength (mm)

Date	8/2/2022	8/2/2022	8/2/2022	8/3/2022
Location	French Creek FRGP Side Channel	French Creek Upstream Mainstem ELJ1	French Creek Beaver Dam Pond	French Creek Control Pools
Average (mm)	68	52	60	57
Stand. Deviation (mm)	9.7	7.1	7.5	8.4
Minimum (mm)	50	41	47	38
Maximum (mm)	80	75	80	80
Count	26	86	89	532

Table 13 - Average foklength (mm) of YOY Coho Salmon in sampled habitats – French Creek

Forklength histograms for the YOY and 1+ Coho Salmon captured in the four habitats (Control Pools, FRGP Side Channel, Upstream Mainstem ELJ 1 and beaver dam pond) are illustrated in Figures 6, 8, 10 & 12, respectively.

The relationship between individual fish weight (g) and length (mm) for the Coho captured in the four habitats (Control Pools, FRGP Side Channel, Upstream Mainstem ELJ 1 and beaver dam pond) are illustrated in Figures 7, 9, 11 & 13, respectively.

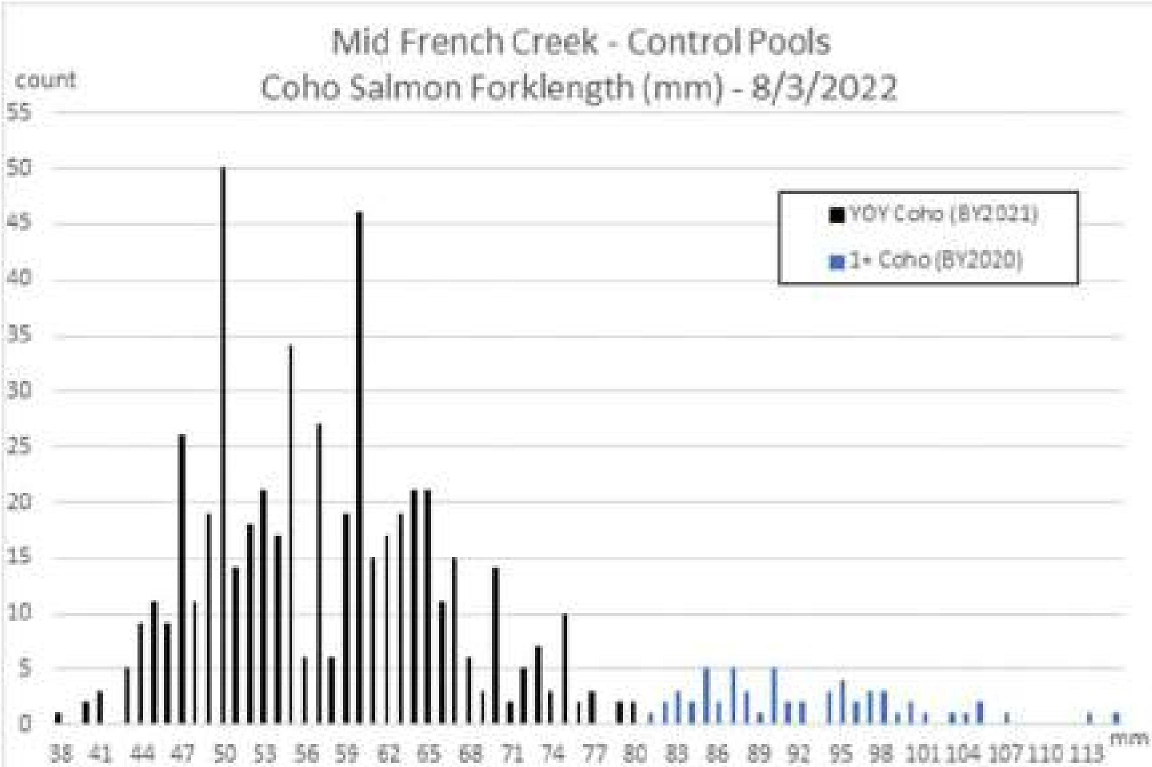


Figure 6 – Forklength (mm) histogram of Coho Salmon – French Creek – Control Pools

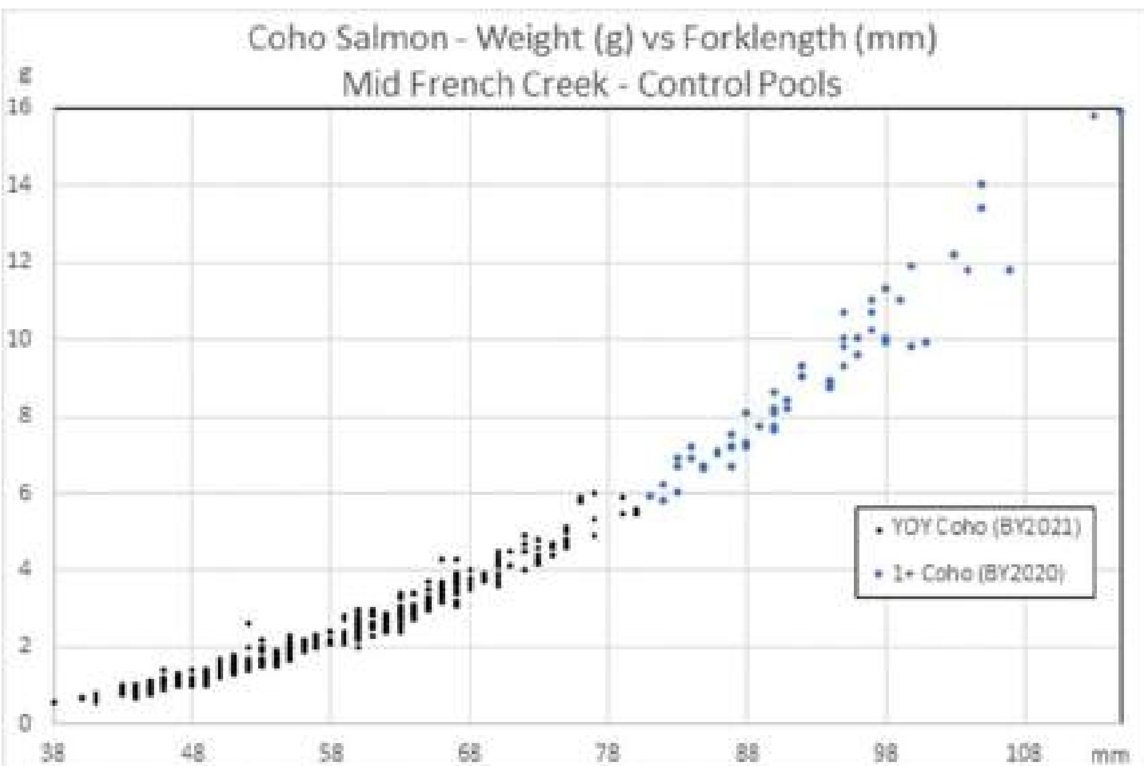


Figure 7 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Control Pools

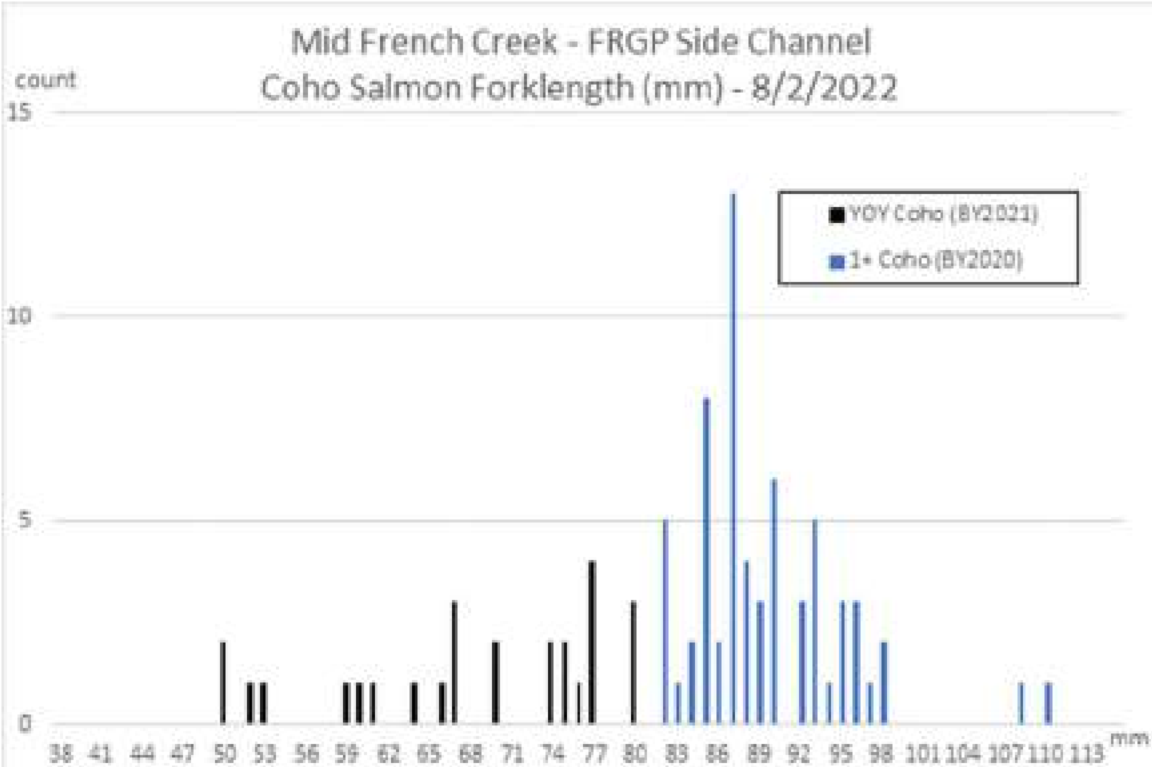


Figure 8 – Forklength (mm) histogram of Coho Salmon – French Creek – FRGP Side Channel

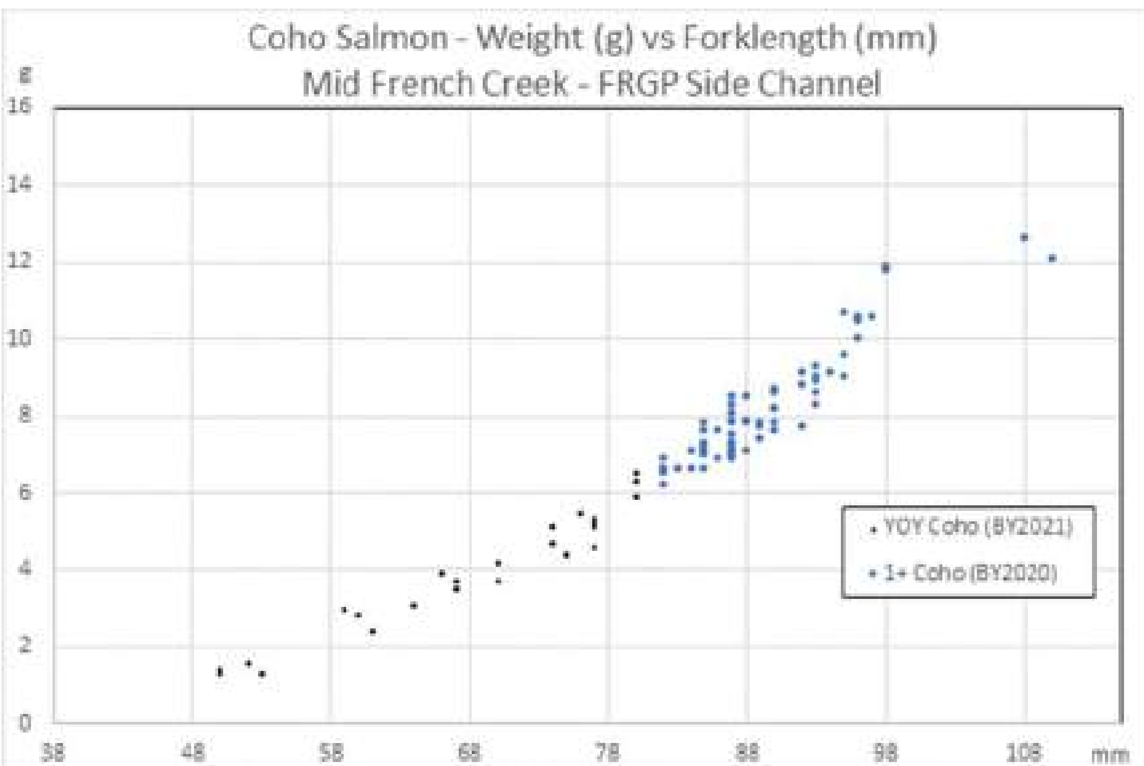


Figure 9 - Weight (g) vs forklength (mm) of YOY Coho Salmon – FRGP Side Channel

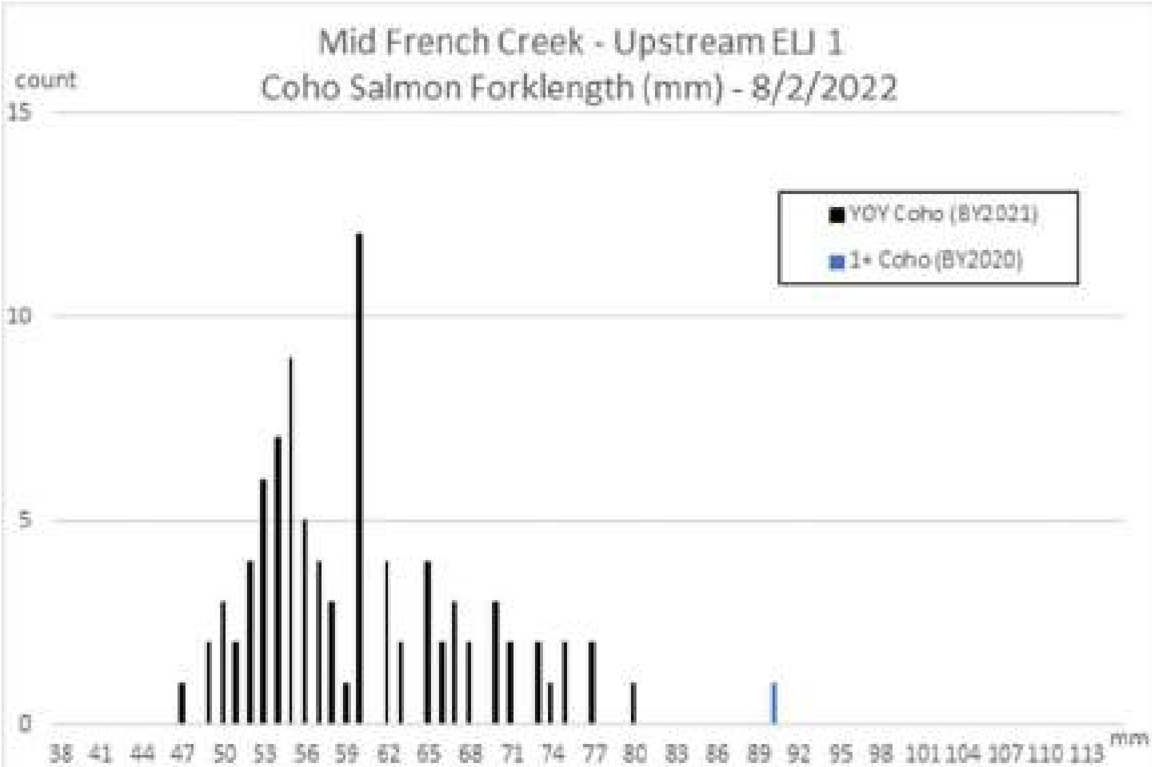


Figure 10 – Forklength (mm) histogram of Coho Salmon – French Creek – Upstream Mainstem ELJ 1

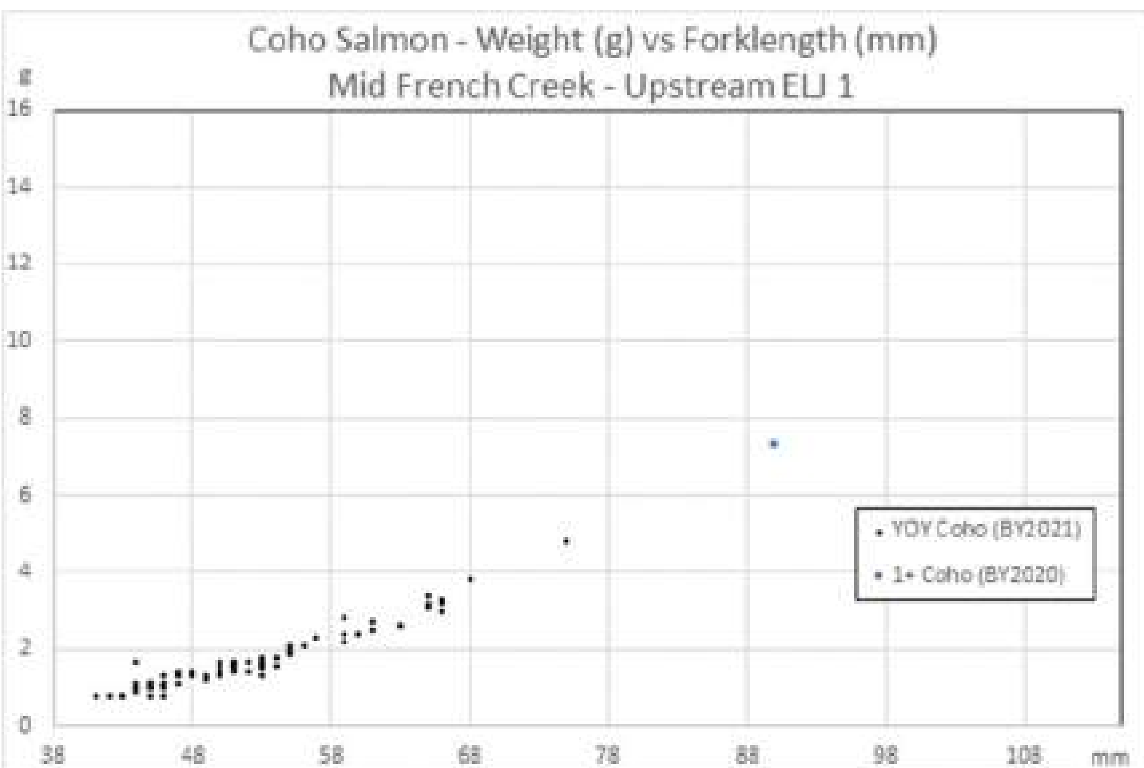


Figure 11 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Upstream Mainstem ELJ 1

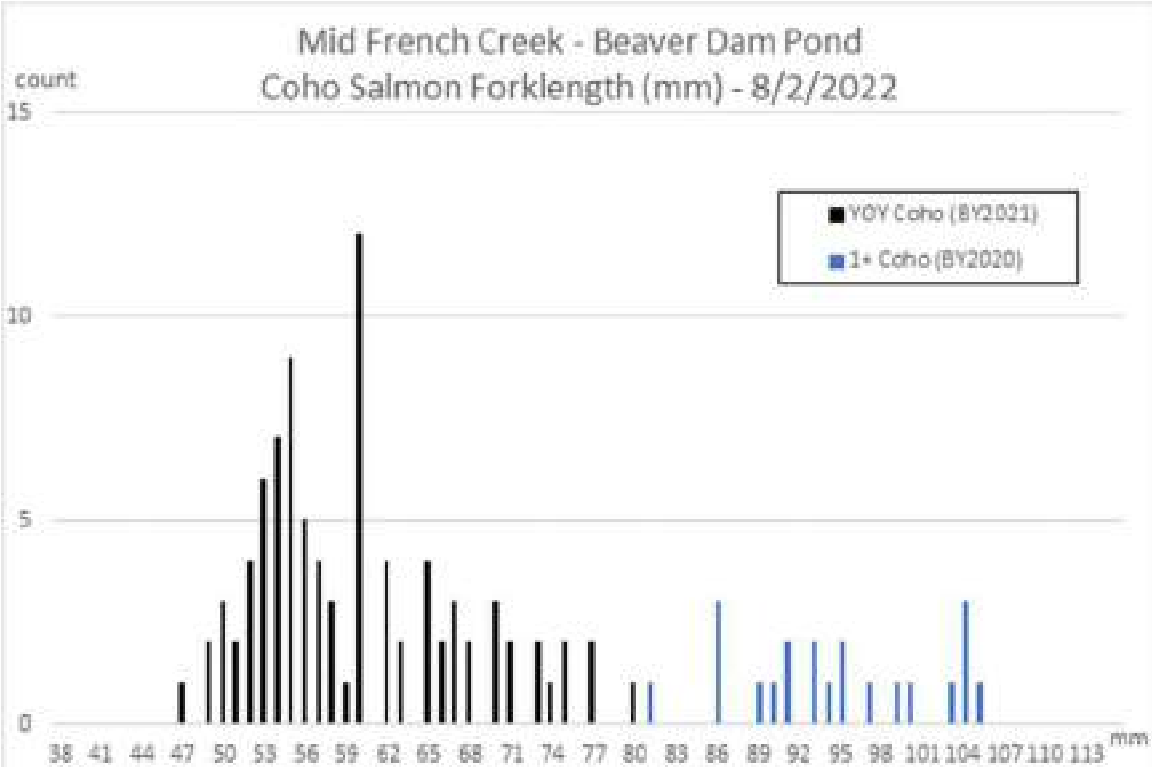


Figure 12 – Forklength (mm) histogram of Coho Salmon – French Creek – Beaver Dam Pond

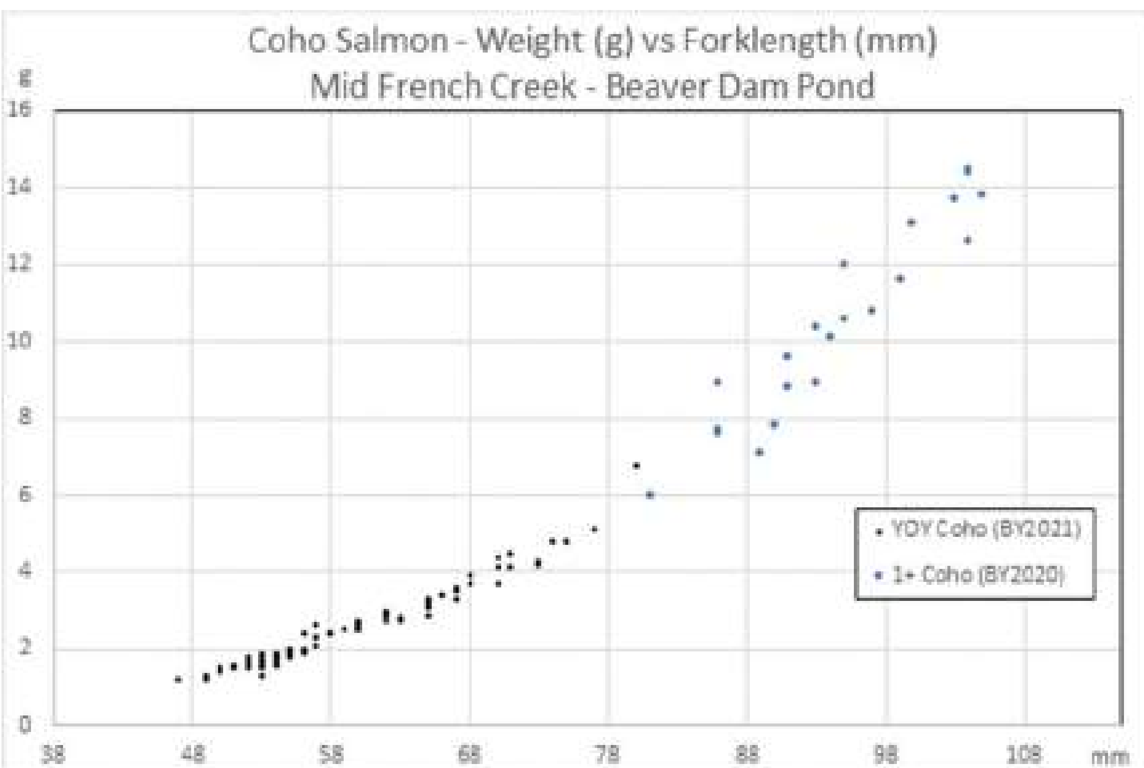


Figure 13 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Beaver Dam Pond

A single 1+ Coho Salmon that was captured in the FRGP Side Channel and marked on March 15, 2022 was recaptured in the FRGP Side Channel on August 2, 2022 – verifying the presence of 1+ fish in the sampled habitats. The growth rate from the marking event to the recapture event was calculated for this fish (Table 14).

Mark

Date	Location	FL (mm)	WT (g)
3/15/2022	FRGP Side Channel	70	3.4

Recapture

Date	Location	FL (mm)	WT (g)
8/2/2022	FRGP Side Channel	96	10

Forklength Growth

(mm/day)	(mm/mm/day)*100
0.19	0.27

Weight Growth

(g/day)	(g/g/day)*100
0.05	1.39

Table 14 – Growth rate of recaptured 1+ Coho Salmon

French Creek Sampling – August 10, 2022

FRGP Side Channel – looking downstream


French RKM 2.9 beaver dam and pond – looking upstream

The French Creek FRGP Side Channel and RKM 2.9 beaver dam pond were sampled on August 10, 2022. Minnow traps were utilized in the FRGP Side Channel and the beaver dam pond was sampled with a seine net. Analysis of the forklength histogram of Coho Salmon captured in both sampled habitats (Figure 14) and the change in forklength of the recaptured fish that were marked on the August 2nd effort indicated that there was little to no growth between the sampling events (Table 15). For this reason, the forklength cutoff (> 80 mm for 1+) developed from the previous week's sampling effort was maintained.
The total catch parsed by age class for the FRGP Side Channel and beaver dam pond are illustrated in Tables 16 and 17, respectively. The sample size for the FRGP Side Channel is considerably less than the sample size for the beaver dam pond – largely due to the difficulty of capturing fish with minnow traps in comparison to the seine net.

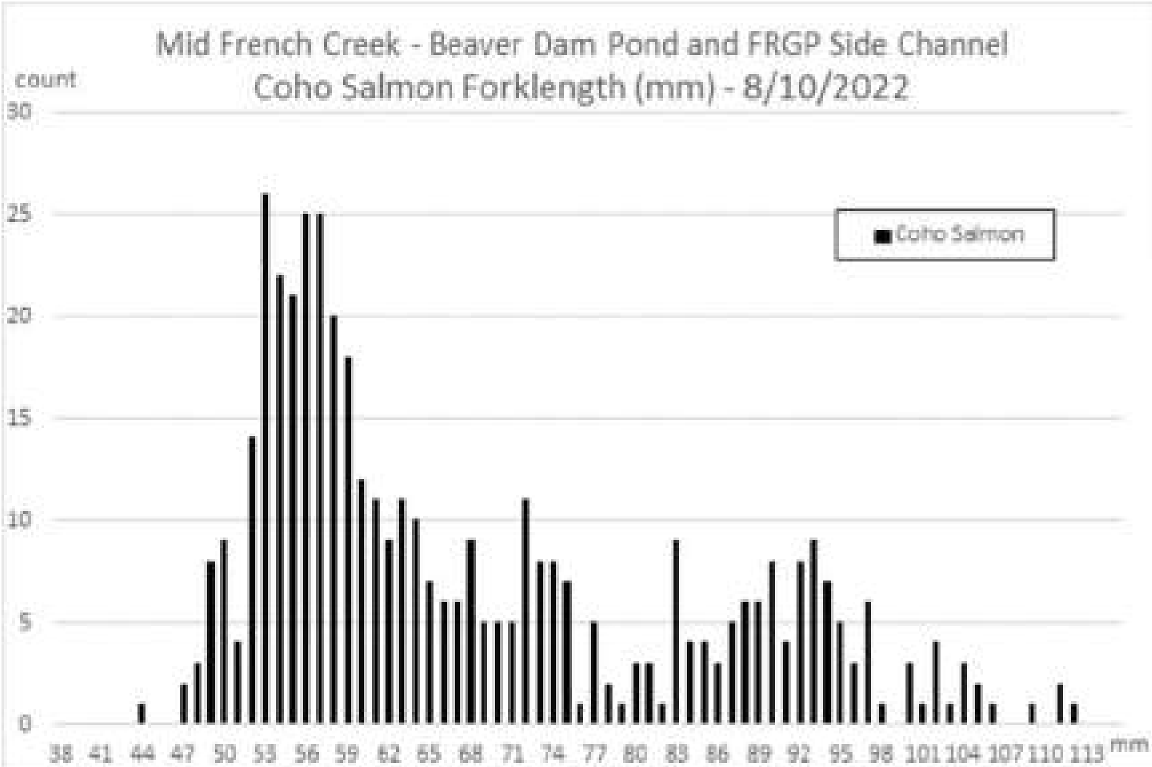


Figure 14 – Forklength (mm) histogram of Coho Salmon – French Creek – All Habitats

	Total Recaps by Age Class	FL Delta = 0 mm	FL Delta = 1 mm
Coho Salmon - YOY (BY2021)	9	6	2
Coho Salmon - 1+ (BY2020)	18	11	6

Table 15 – Change in forklength (mm) of recaptured fish

Total Catch - French Creek FRGP Side Channel - August 10, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	38	19	1
Coho Salmon - 1+ (BY2020)	50	39	11
Rainbow Trout (*O. mykiss*)	0	0	0

Table 16 - French Creek FRGP Side Channel – Total Catch

Total Catch -French Creek Beaver Dam Pond - August 10, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY2021)	302	59	8
Coho Salmon - 1+ (BY2020)	61	50	9
Rainbow Trout (*O. mykiss*)	4	0	0

Table 17 - French Creek Beaver Dam Pond – Total Catch

The average forklength (mm) of the YOY Coho Salmon captured in the two habitats on August 10, 2022 is illustrated in Table 18. The average forklength for the Coho Salmon captured in the FRGP Side Channel on August 10th (64 mm) is less than the average forklength of the fish captured in the FRGP Side Channel on August 2nd (68 mm). It is hypothesized that the small sample size of the two efforts is the cause. The average forklength of YOY Coho Salmon sampled in the beaver dam pond was the same for the two efforts (60mm).

YOY Coho Salmon Forklength (mm)

Date	8/10/2022	8/10/2022
Location	French Creek FRGP Side Channel	French Creek Beaver Dam Pond
Average (mm)	64	60
Stand. Deviation (mm)	7.4	7.7
Minimum (mm)	53	44
Maximum (mm)	74	80
Count	38	302

Table 18 - Average foklength (mm) of YOY Coho Salmon in sampled habitats – French Creek

Forklength histograms for the YOY and 1+ Coho Salmon captured in the FRGP Side Channel and French RKM 2.9 beaver dam pond are illustrated in Figures 15 & 17, respectively.

The relationship between individual fish weight (g) and length (mm) for the Coho captured in captured in the FRGP Side Channel and French RKM 2.9 beaver dam pond are illustrated in Figures 16 & 18, respectively.

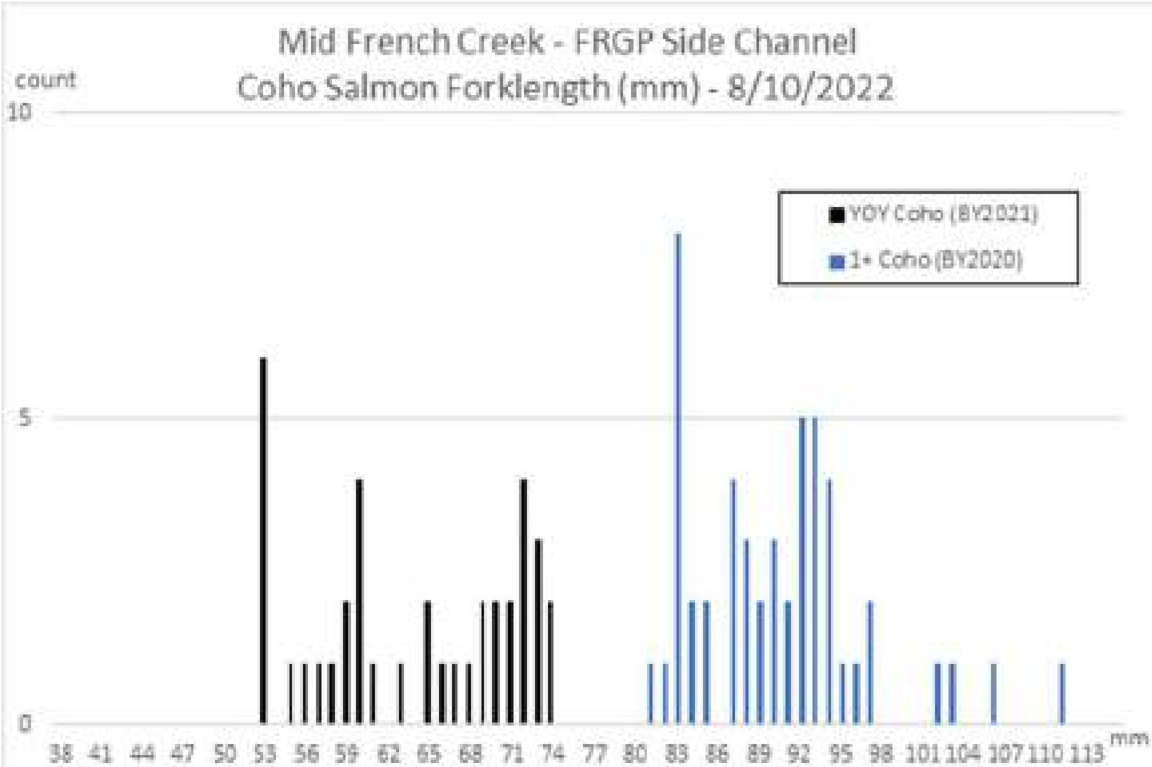


Figure 15 – Forklength (mm) histogram of Coho Salmon – French Creek – FRGP Side Channel

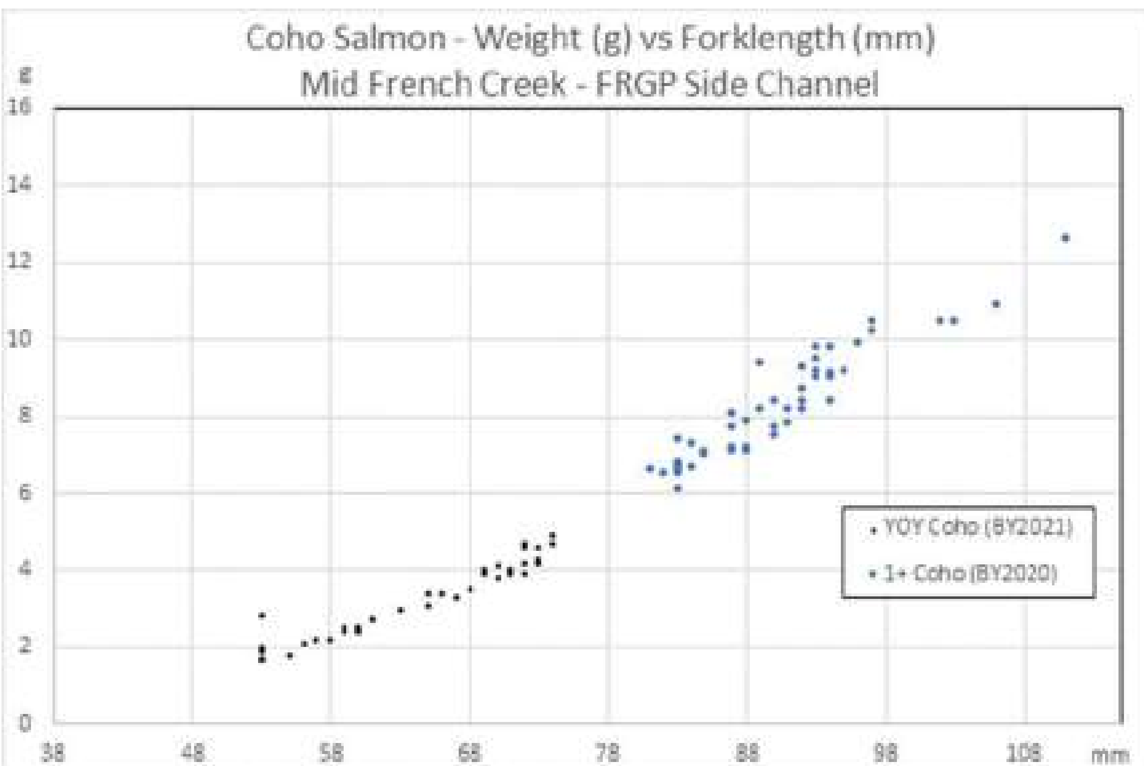


Figure 16 - Weight (g) vs forklength (mm) of YOY Coho Salmon – FRGP Side Channel

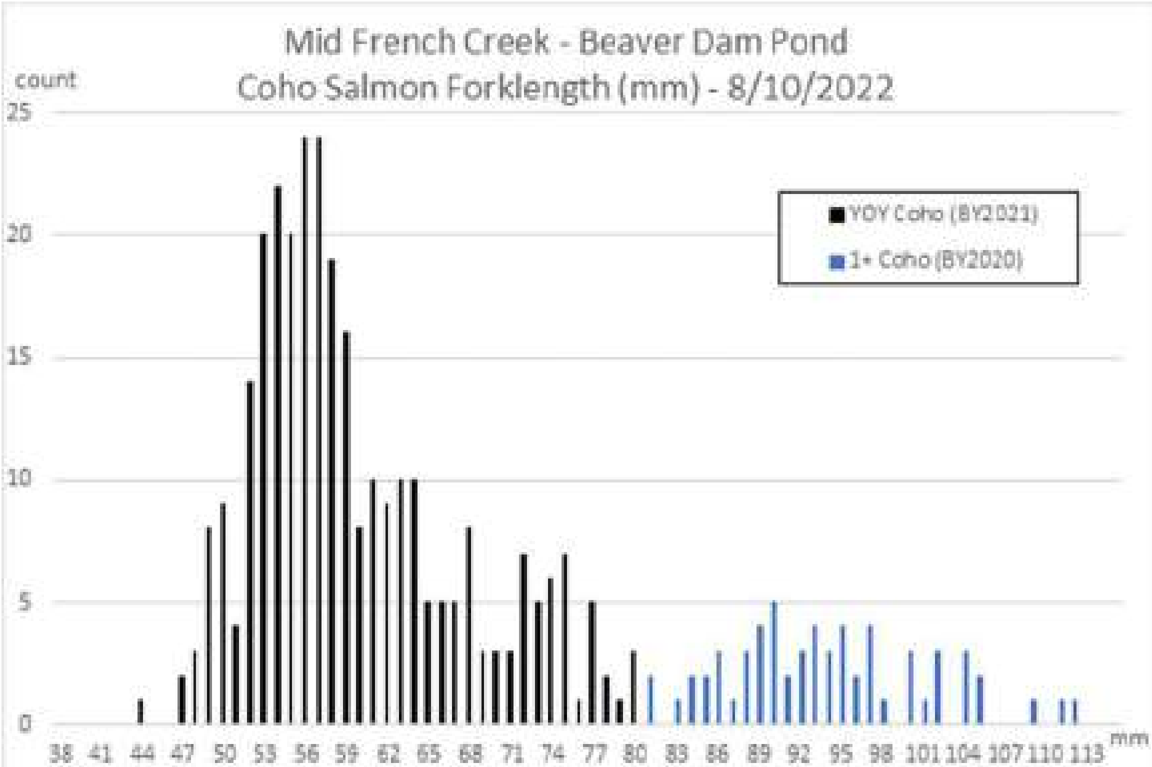


Figure 17 – Forklength (mm) histogram of Coho Salmon – French Creek – Beaver Dam Pond

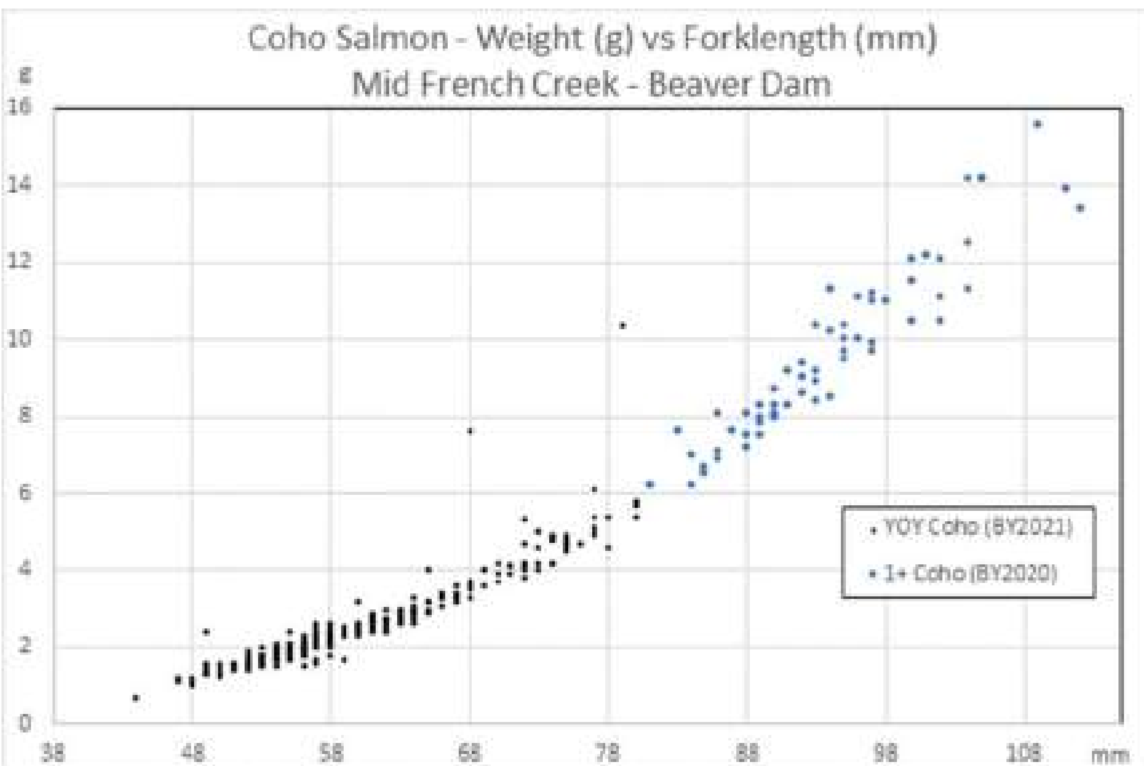


Figure 18 - Weight (g) vs forklength (mm) of YOY Coho Salmon – Beaver Dam Pond

Two 1+ Coho Salmon that were marked on January 21, 2022 and March 15, 2022 were recaptured in the FRGP Side Channel. The growth rate for each recaptured fish was calculated (Table 19 and 20).

Mark

Date	Location	FL (mm)	WT (g)
1/21/2022	FRGP Side Channel	71	3.6

Recapture

Date	Location	FL (mm)	WT (g)
8/10/2022	FRGP Side Channel	97	10.5

Forklength Growth

(mm/day)	(mm/mm/day)*100
0.13	0.18

Weight Growth

(g/day)	(g/g/day)*100
0.03	0.95

Table 19 - Growth rate of recaptured 1+ Coho Salmon

Mark

Date	Location	FL (mm)	WT (g)
3/15/2022	FRGP Side Channel	70	3.2

Recapture

Date	Location	FL (mm)	WT (g)
8/10/2022	FRGP Side Channel	87	7.7

Forklength Growth

(mm/day)	(mm/mm/day)*100
0.11	0.16

Weight Growth

(g/day)	(g/g/day)*100
0.03	0.95

Table 20 - Growth rate of recaptured 1+ Coho Salmon

Discussion

Yearling (1+) Coho Salmon have been captured in Mid French Creek in limited numbers during past base flow sampling events. The amount of 1+ Coho Salmon captured in Mid French Creek during the August 2022 sampling efforts is unprecedented.

Previous sampling performed in late April 2022 in Mid French Creek documented a significant number of very small Coho Salmon (Figure 19). It is hypothesized that these smaller fish were not of suitable condition to undergo the smoltification process and therefore reared for an additional base flow period and were observed in summer of 2022. Furthermore, it is hypothesized that these fish will out migrate during the early runoff period in fall approximately a half year after most of the cohort outmigrated in spring. Stationary PIT arrays in French Creek should detect the fish during out migration (and redistribution) testing the hypothesis.

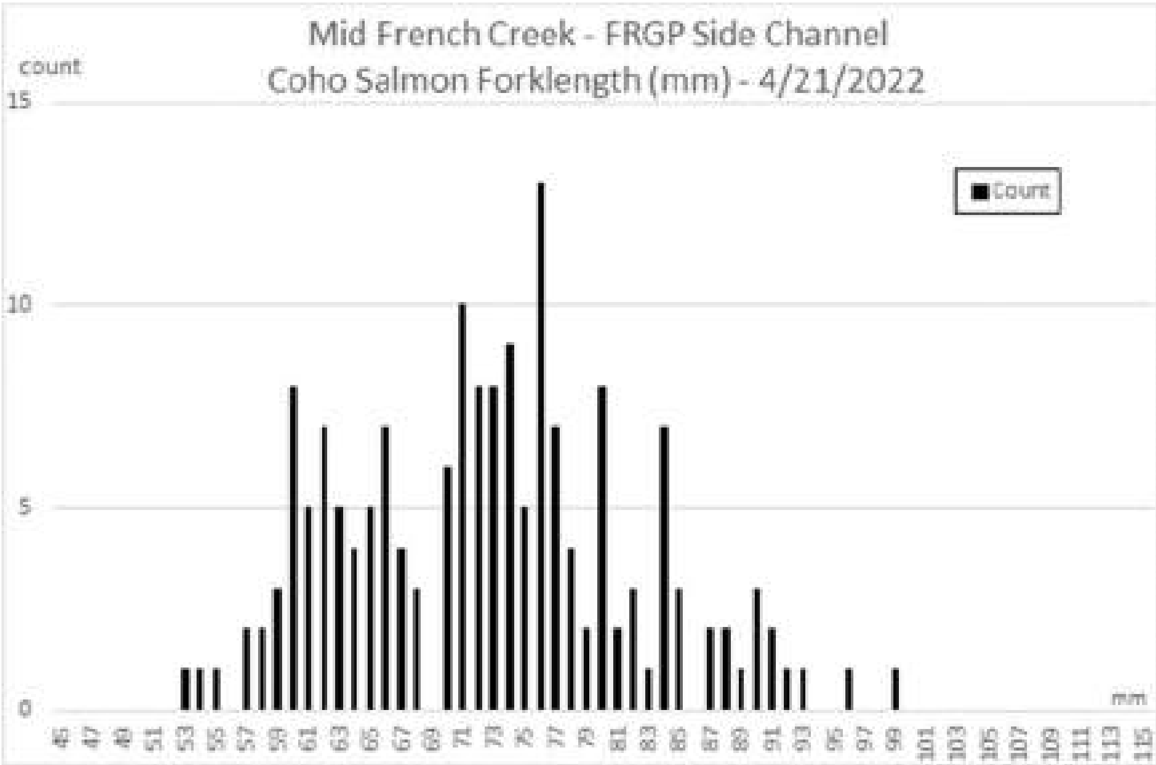


Figure 19 - Forklength (mm) histogram of Coho Salmon – French FRGP Side Channel – April 21, 2022

Coho Salmon Catch Summary

Sugar Creek and Mid-French Creek Habitats

September 19 – 22, 2022

Scott River Watershed Council

Sugar Creek

On September 19th, 2022 three Sugar Creek habitats were sampled: BDA Pond 1, Beaver Dam Pond and Off-Channel Pond. BDA Pond 1 and the Beaver Dam Pond were sampled with a seine net while the Off-Channel Pond was sampled with minnow traps. On September 20th, the Sugar Creek Control Pools were sampled with a seine (Map 1). Juvenile Coho Salmon (*O. kisutch*), Chinook Salmon *(O. tshawytscha*) and rainbow trout/steelhead (*O. mykiss*) were captured in BDA Pond 1, Beaver Dam Pond and the Off-Channel Pond, while only Coho Salmon were captured in the Control Pools (Tables 2, 4, 6 and 8).

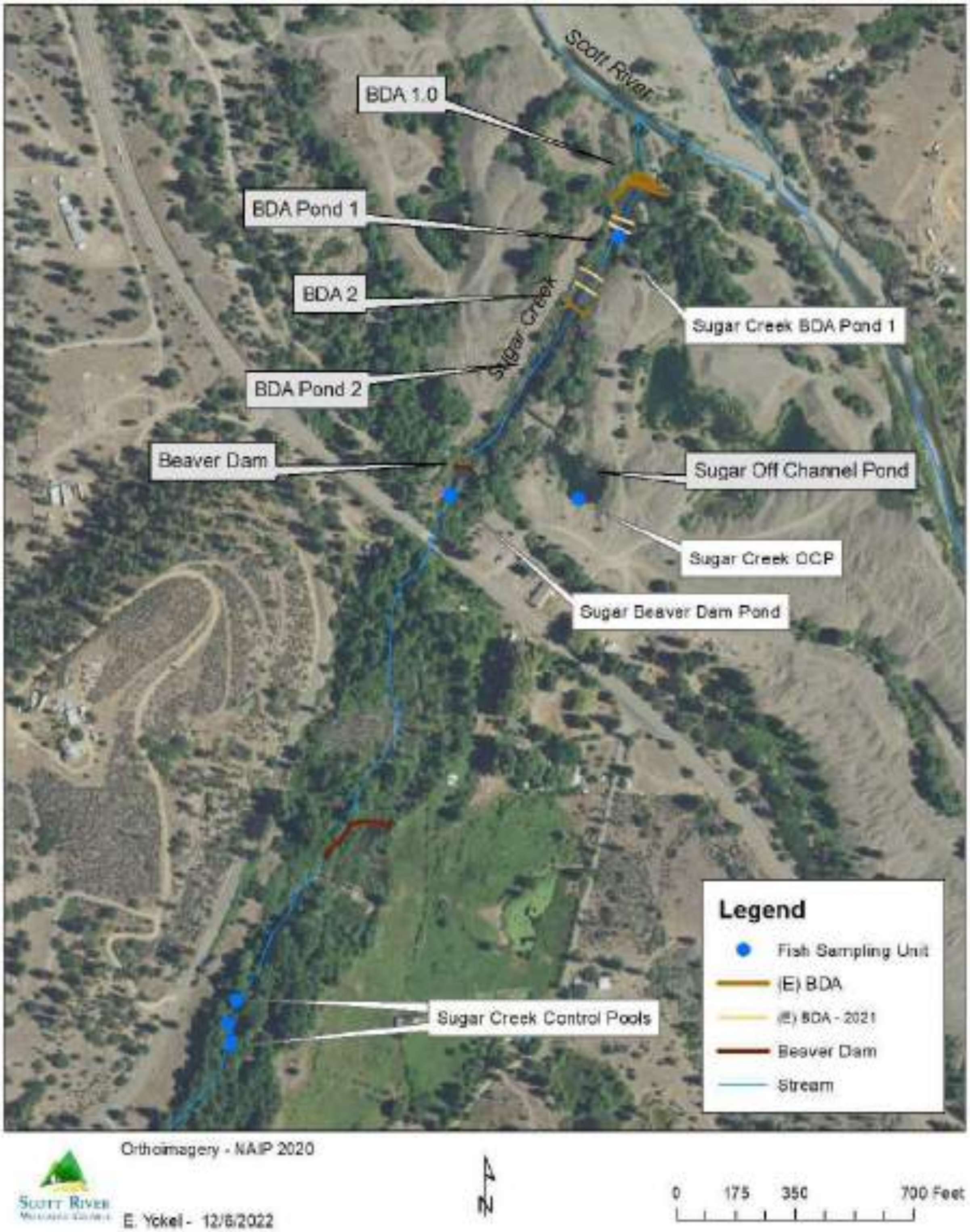
Coho Salmon with a forklength 65 mm and greater were scanned for PIT tags and were candidates to have PIT tags implanted if they did not already have a tag.

The biometrics (forklength (mm) and weight (g)) of individual captured Coho Salmon were measured. Coho Salmon average forklength was greatest in the Off-Channel Pond (Table 1).

Date	9/19/2022	9/19/2022	9/19/2022	9/20/2022
Location	Sugar Creek BDA Pond 1	Sugar Creek Beaver Dam Pond	Sugar Creek Off-Channel Pond	Sugar Creek Control Pools
Average (mm)	65	61	71	68
Stand. Deviation	7	11.1	8.7	5.9
Minimum (mm)	51	43	53	53
Maximum (mm)	90	87	87	85
Count	255	89	17	196

Table 1 – Average forklength (mm) of Coho Salmon in sampled habitats – Sugar Creek

Sugar Creek - Fish Sampling Locations - September 2022



Map 1 – Sugar Creek – Sampling Locations – September 2022

BDA Pond 1

Total Catch - Sugar Creek BDA Pond 1 - September 19, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	255	115	9
Rainbow Trout (*O. mykiss*)	102	13	0
Chinook Salmon	5	0	0

Table 2 – Sugar Creek BDA Pond 1 – Total Catch

Coho Salmon Forklength

Date	8/1/2022	9/19/2022
Location	BDA Pond 1	BDA Pond 1
Average (mm)	67	65
Standard Deviation (mm)	8.4	7.0
Minimum (mm)	49	51
Maximum (mm)	92	90
Count	310	255

Table 3 – Comparison of Coho Salmon forklengths (mm) in August and September – Sugar Creek BDA Pond 1

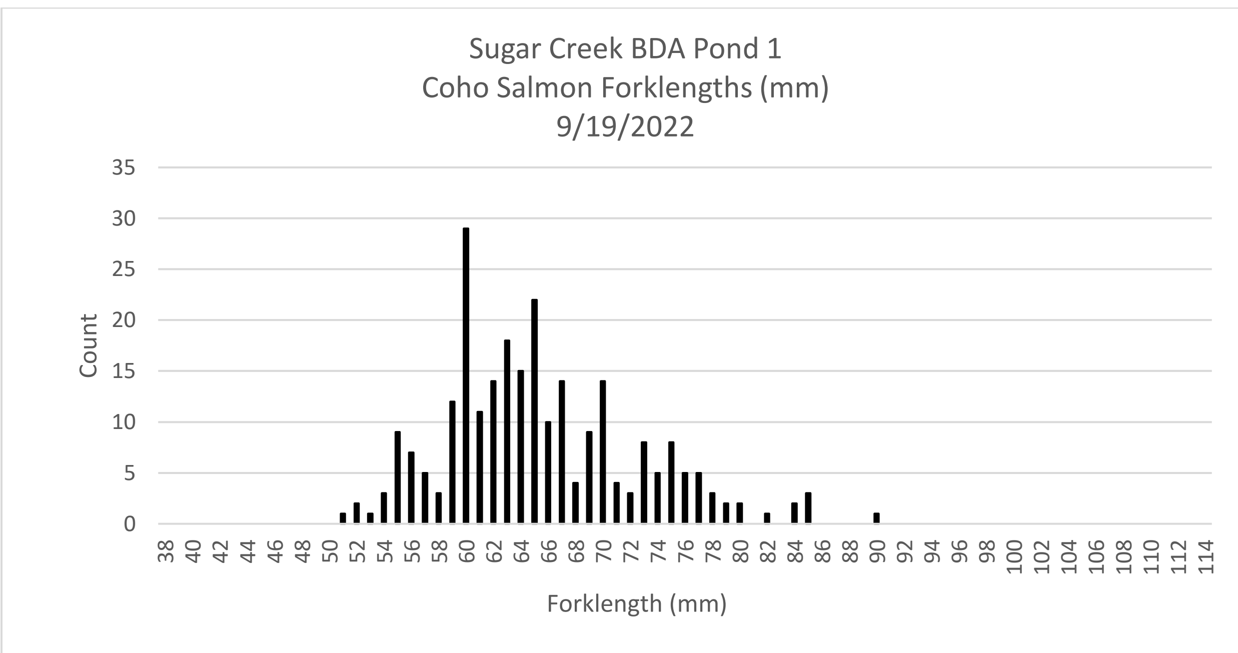


Figure 1 – Forklength (mm) histogram of Coho Salmon - Sugar Creek BDA Pond 1

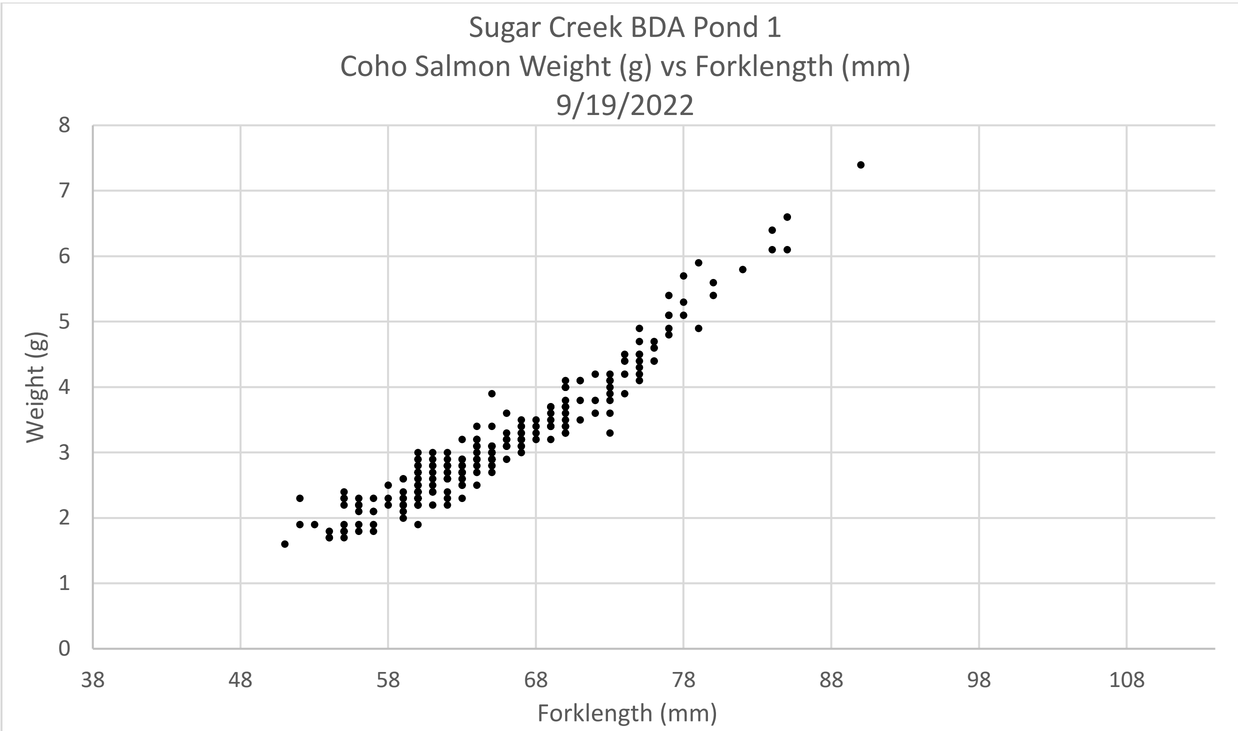


Figure 2 – Weight (g) vs forklength (mm) of Coho Salmon – Sugar Creek BDA Pond 1

Beaver Dam Pond

Total Catch - Sugar Creek Beaver Pond - September 20, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	89	29	4
Rainbow Trout (*O. mykiss*)	0	0	0
Chinook Salmon	1	0	0

Table 4 – Sugar Creek Beaver Dam Pond – Total Catch

Coho Salmon Forklength

Date	8/4/2022	9/20/2022
Location	Beaver Dam Pond	Beaver Dam Pond
Average (mm)	57	61
Standard Deviation (mm)	12.5	11.1
Minimum (mm)	39	43
Maximum (mm)	86	87
Count	211	89

Table 5 – Comparison of Coho Salmon forklengths (mm) in August and September – Sugar Creek Beaver Dam Pond

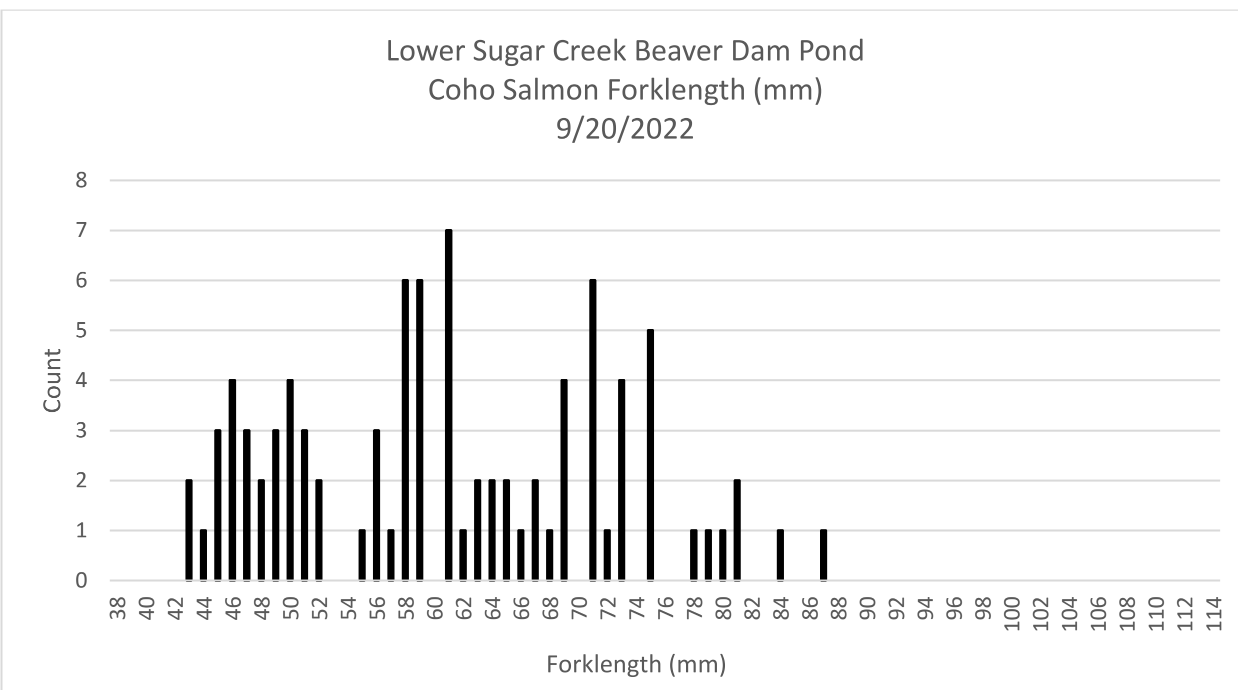


Figure 3 – Forklength (mm) histogram of Coho Salmon - Sugar Creek Beaver Dam Pond

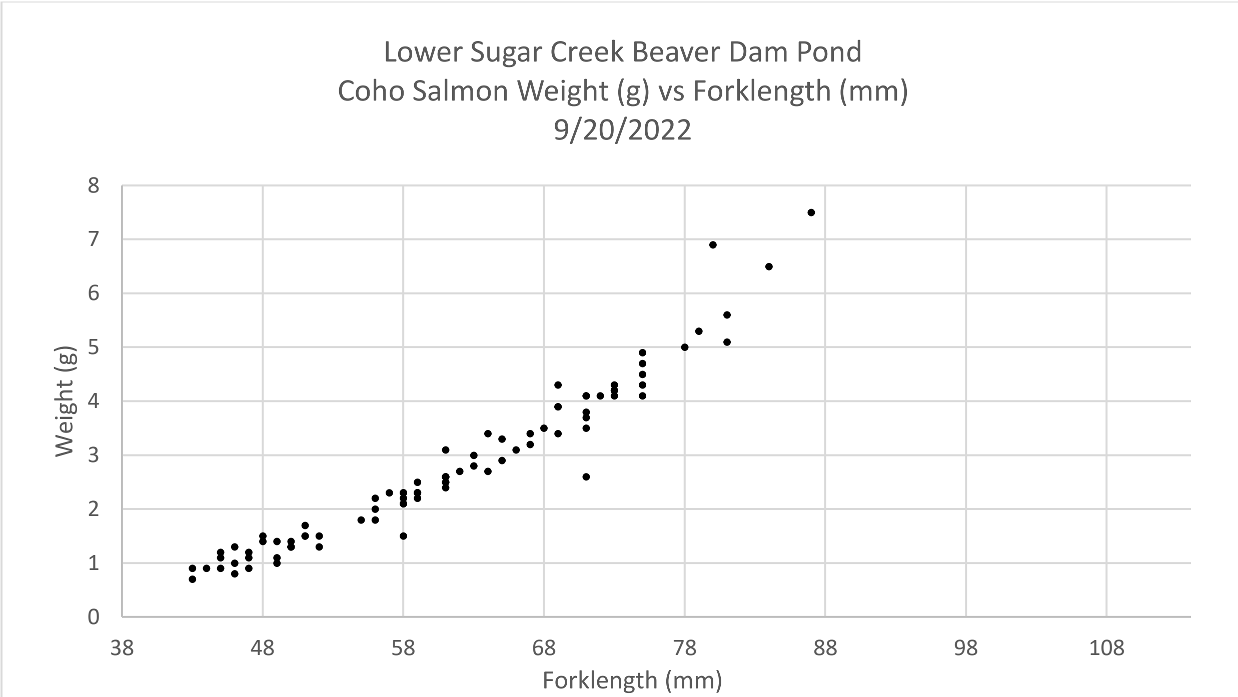


Figure 4 – Weight (g) vs forklength (mm) of Coho Salmon – Sugar Creek Beaver Dam Pond

Off-Channel Pond

Total Catch - Sugar Creek OCP - September 19, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	17	12	0
Rainbow Trout (*O. mykiss*)	2	1	0
Chinook Salmon	5	0	0

Table 6 – Sugar Creek Off Channel Pond – Total Catch

Coho Salmon Forklength

Date	9/19/2022
Location	Sugar OCP
Average (mm)	71
Standard Deviation (mm)	8.7
Minimum (mm)	53
Maximum (mm)	87
Count	17

Table 7 –Coho Salmon forklengths (mm) in September – Sugar Creek Off Channel Pond

Control Pools

Three pools in a pool riffle reach were sampled in the Sugar Creek Control Reach.

Total Catch - Sugar Creek Control Pools - September 20, 2022

	Total Captured	Marked	Recaptured
Coho Salmon	196	116	0
Rainbow Trout (*O. mykiss*)	0	0	0
Chinook Salmon	0	0	0

Table 8 – Sugar Creek Control Pools – Total Catch

Coho Salmon Forklength

Date	9/20/2022
Location	Control Pools
Average (mm)	68
Standard Deviation (mm)	5.9
Minimum (mm)	53
Maximum (mm)	85
Count	196

Table 9 –Coho Salmon forklengths (mm) in September – Sugar Creek Control Pools

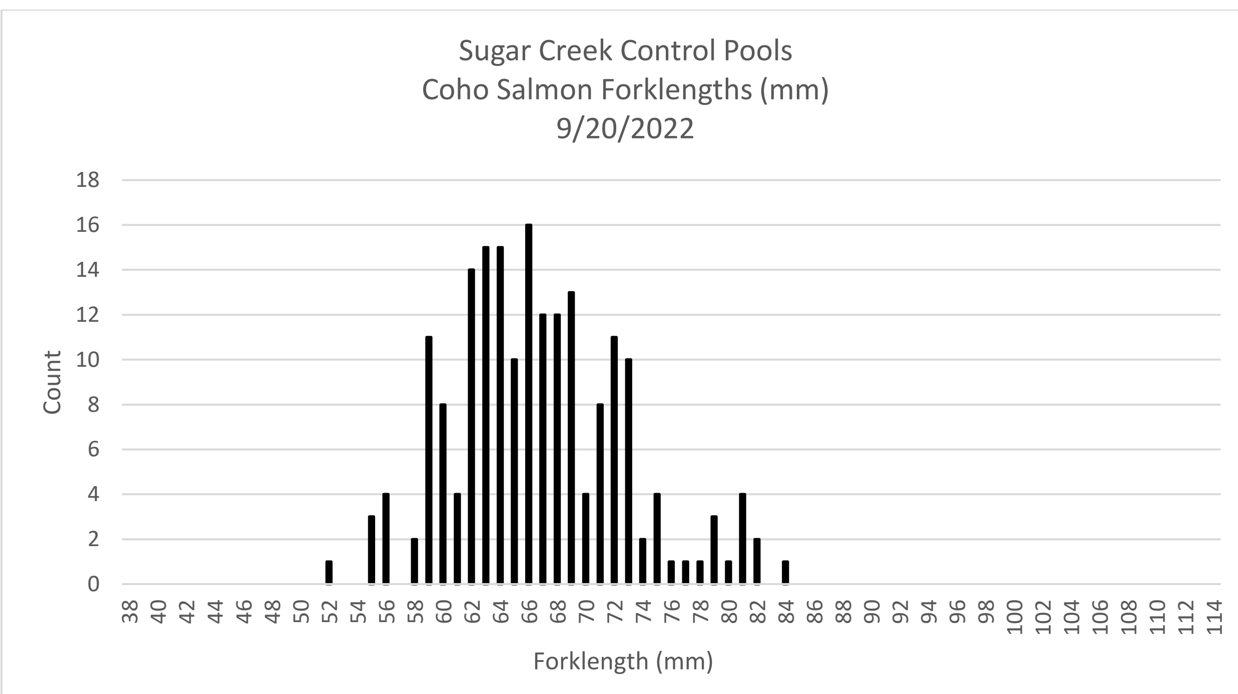


Figure 5 – Forklength (mm) histogram of Coho Salmon - Sugar Creek Control Pools

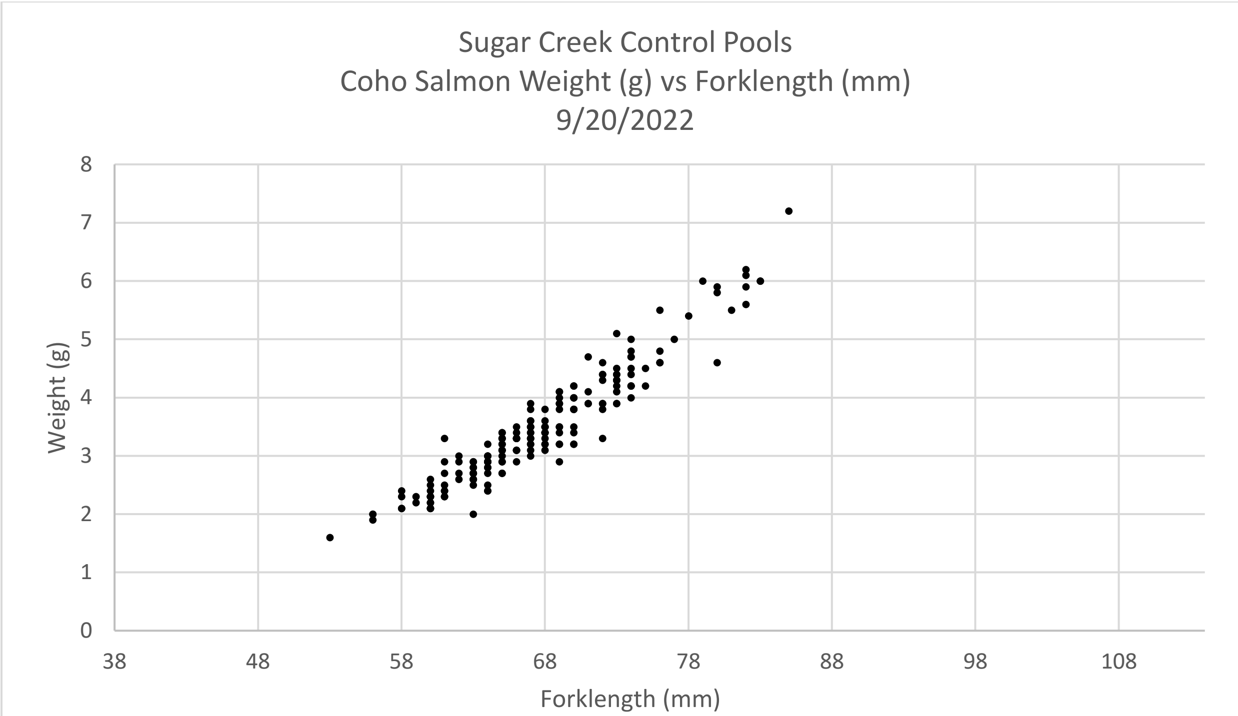


Figure 6 – Weight (g) vs forklength (mm) of Coho Salmon – Sugar Creek Control Pools

All Sampled Habitats

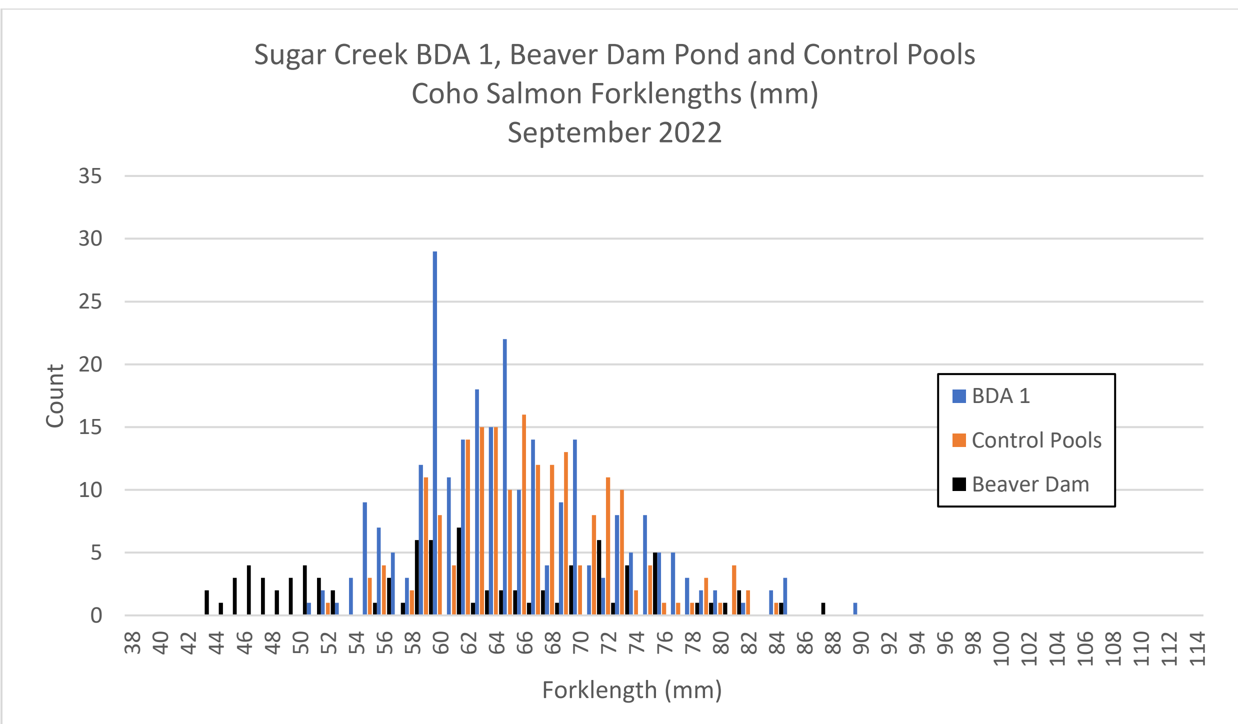


Figure 7 – Forklength (mm) histogram of Coho Salmon - Sugar Creek BDA Pond 1, Beaver Dam Pond and Control Pools

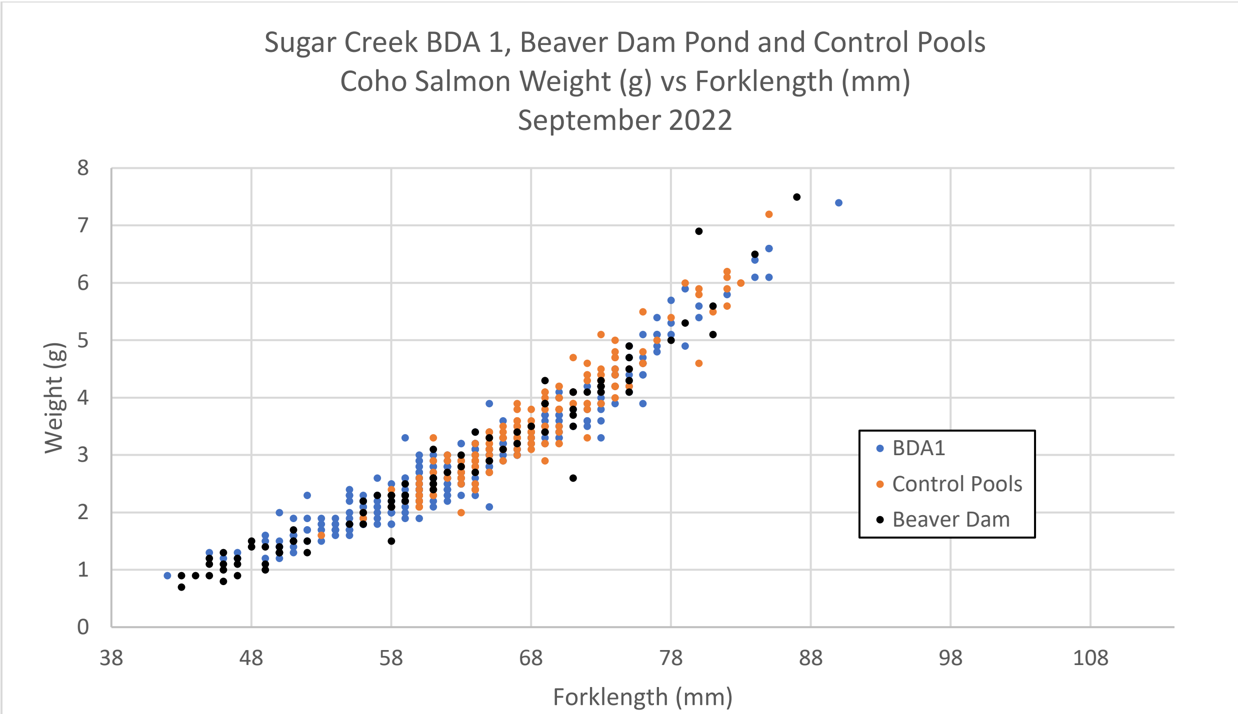


Figure 8 – Weight (g) vs forklength (mm) of Coho Salmon – Sugar Creek BDA Pond 1, Beaver Dam Pond and Control Pools

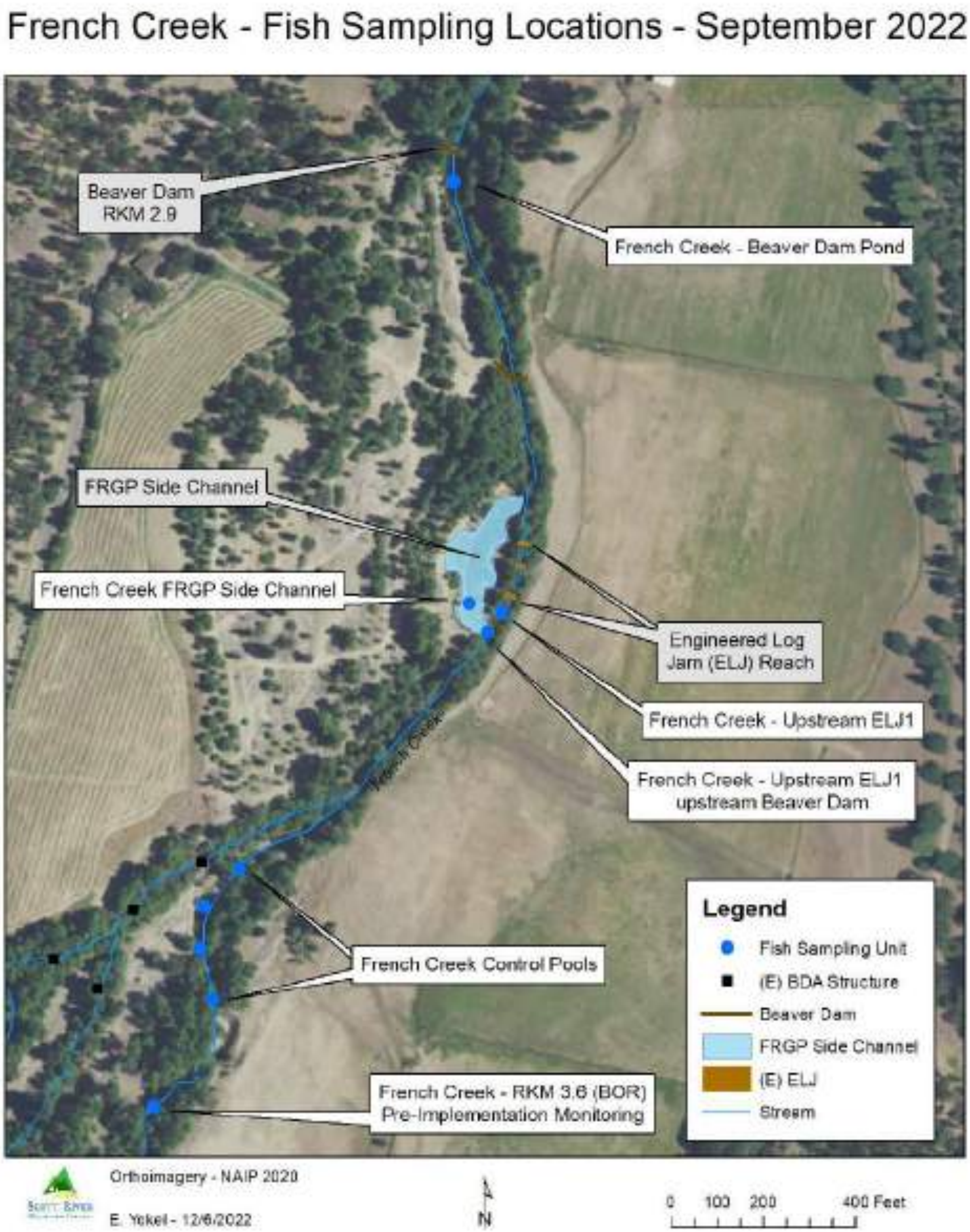
French Creek

On September 21, 2022 three French Creek habitats were sampled: FRGP Side Channel, Beaver Dam Pond, and ELJ Upstream New Beaver Dam. The FRGP Side Channel was sampled with minnow traps while the other units were sampled with a seine net. On September 22, the French Creek Control Pools and Pre-Implementation site at RKM 3.6 were sampled with a seine (Map 2). Juvenile Coho Salmon (*O. kisutch*), Chinook Salmon *(O. tshawytscha*) and rainbow trout/steelhead (*O. mykiss*) were captured in BDA Pond 1, Beaver Dam Pond and the Off-Channel Pond, while only Coho Salmon were captured in the Control Pools (Tables 1, 3, 5 and 7).

Coho Salmon with a forklength 65 mm and greater were scanned for PIT tags and were candidates to have PIT tags implanted if they did not already have a tag.

The biometrics (forklength (mm) and weight (g)) of individual captured Coho Salmon were measured. Coho Salmon average forklength was greatest in the Off-Channel Pond (Table 6).

It was determined that a fish with a forklength greater than 80 mm would be identified as a yearling (1+) fish and those with a forklength less than or equal to 80 mm would be identified as young of the year (YOY). Captured Coho Salmon were parsed into the two age classes utilizing the identified forklength cutoff.



Map 2 - French Creek – Sampling Locations – September 2022

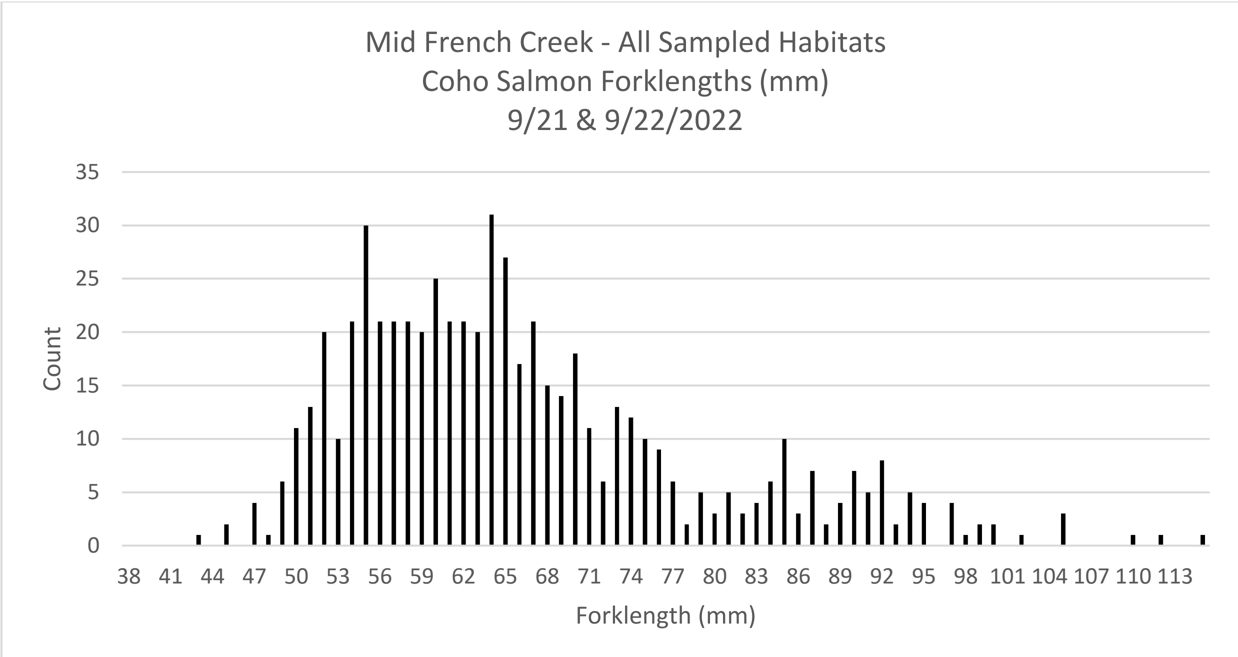


Figure 9 – Forklength (mm) histogram of Coho Salmon – Mid-French Creek – All sampled habitats

Total Catch - French Creek FRGP Side Channel - September 21, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY 2021)	80	49	6
Coho Salmon - 1+ (BY 2020)	59	36	17
Rainbow Trout (*O. mykiss*)	4	0	0
Chinook Salmon	2	1	1

Table 10 – French Creek FRGP Side Channel – Total Catch

Total Catch - French Creek Beaver Dam - September 21, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY 2021)	56	29	0
Coho Salmon - 1+ (BY 2020)	3	2	1
Rainbow Trout (*O. mykiss*)	1	0	0
Chinook Salmon	0	0	0

Table 11 – French Creek Beaver Dam – Total Catch

Total Catch - French Creek ELJ Upstream New Beaver Dam - September 21, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY 2021)	173	21	0
Coho Salmon - 1+ (BY 2020)	2	1	0
Rainbow Trout (*O. mykiss*)	5	0	0
Chinook Salmon	0	0	0

Table 12 – French Creek ELJ Upstream New Beaver Dam – Total Catch

Total Catch - French Creek Control Pools - September 22, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY 2021)	180	51	11
Coho Salmon - 1+ (BY 2020)	27	17	9
Rainbow Trout (*O. mykiss*)	9	0	0
Chinook Salmon	0	0	0

Table 13 – French Creek Control Pools – Total Catch

Total Catch - French Creek Pre-Implementation RKM 3.6 - September 22, 2022

	Total Captured	Marked	Recaptured
Coho Salmon - YOY (BY 2021)	20	4	0
Coho Salmon - 1+ (BY 2020)	0	0	0
Rainbow Trout (*O. mykiss*)	0	0	0
Chinook Salmon	0	0	0

Table 14 – French Creek Pre-Implementation RKM 3.6 (BOR) – Total Catch

Date	9/21/2022	9/21/2022	9/22/2022	9/21/2022	9/22/2022
Location	French Creek FRGP Side Channel	French Creek Beaver Dam Pond	French Creek Control Pools	French Creek Upstream Mainstem ELJ 1	French Creek RKM 3.6 Pre-Implementation Monitoring Site
Average (mm)	69	65	62	59	59
Stand. Deviation	6.5	7.6	7.2	6.4	6.9
Minimum (mm)	52	51	43	47	45
Maximum (mm)	80	80	80	79	70
Count	80	56	180	173	20

Table 15 – Average forklength (mm) of YOY Coho Salmon in sampled habitats

Location	French Creek FRGP Side Channel		French Creek Beaver Dam Pond		French Creek Upstream Mainstem ELJ 1		French Creek Control Pools	
Date	8/2/2022	9/21/2022	8/2/2022	9/21/2022	8/2/2022	9/21/2022	8/3/2022	9/22/2022
Average (mm)	68	69	60	65	52	59	57	62
Stand. Deviation	9.7	6.5	7.5	7.6	7.1	6.4	8.4	7.2
Minimum (mm)	50	52	47	51	41	47	38	43
Maximum (mm)	80	80	80	80	75	79	80	80
Count	26	80	89	56	86	173	532	180

Table 16 – Comparison of average forklength (mm) of YOY Coho Salmon in sampled habitats from August to September

FRGP Side Channel

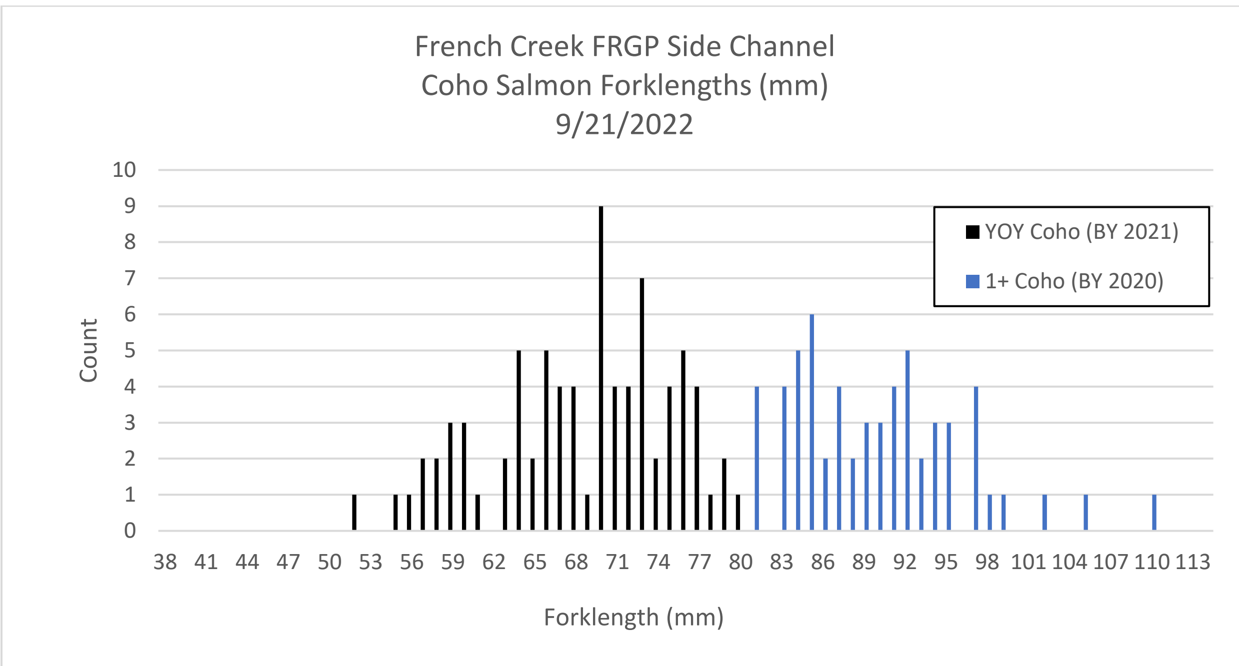


Figure 10 – Forklength (mm) histogram of YOY and 1+ Coho Salmon – French Creek FRGP Side Channel

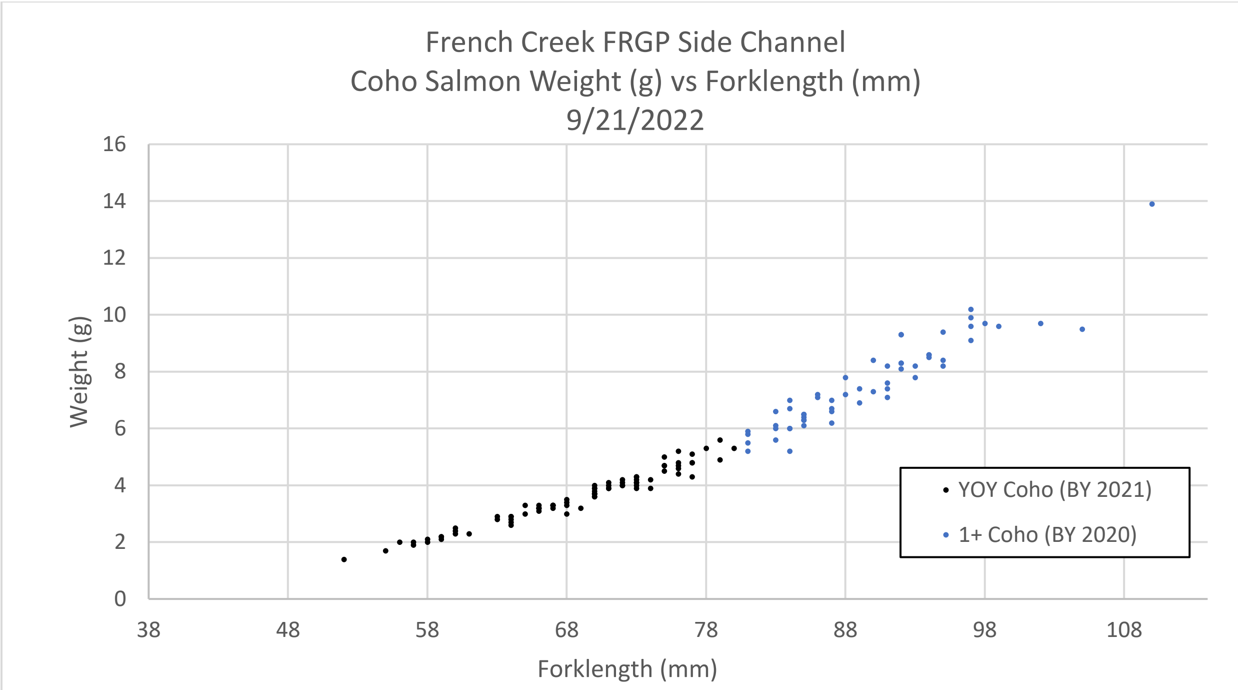


Figure 11 – Weight (g) vs forklength (mm) of YOY and 1+ Coho Salmon – French Creek FRGP Side Channel

Beaver Dam Pond

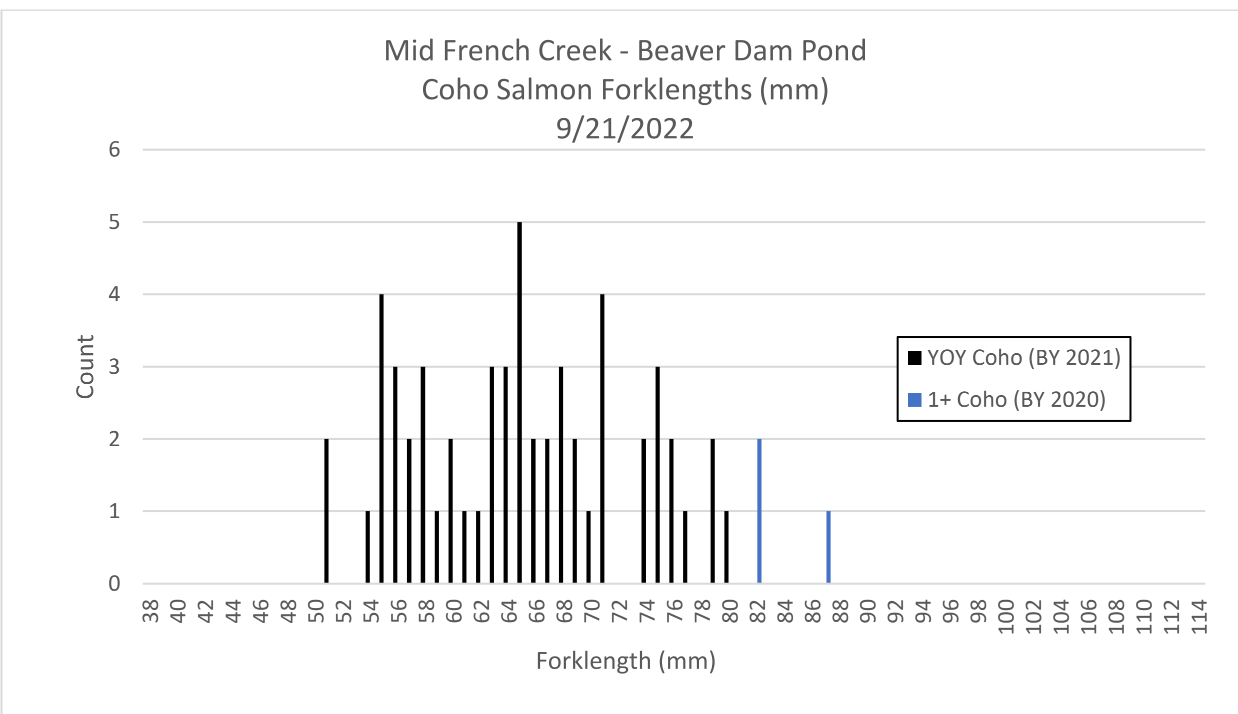


Figure 12 – Forklength (mm) histogram of YOY and 1+ Coho Salmon – French Creek Beaver Dam Pond

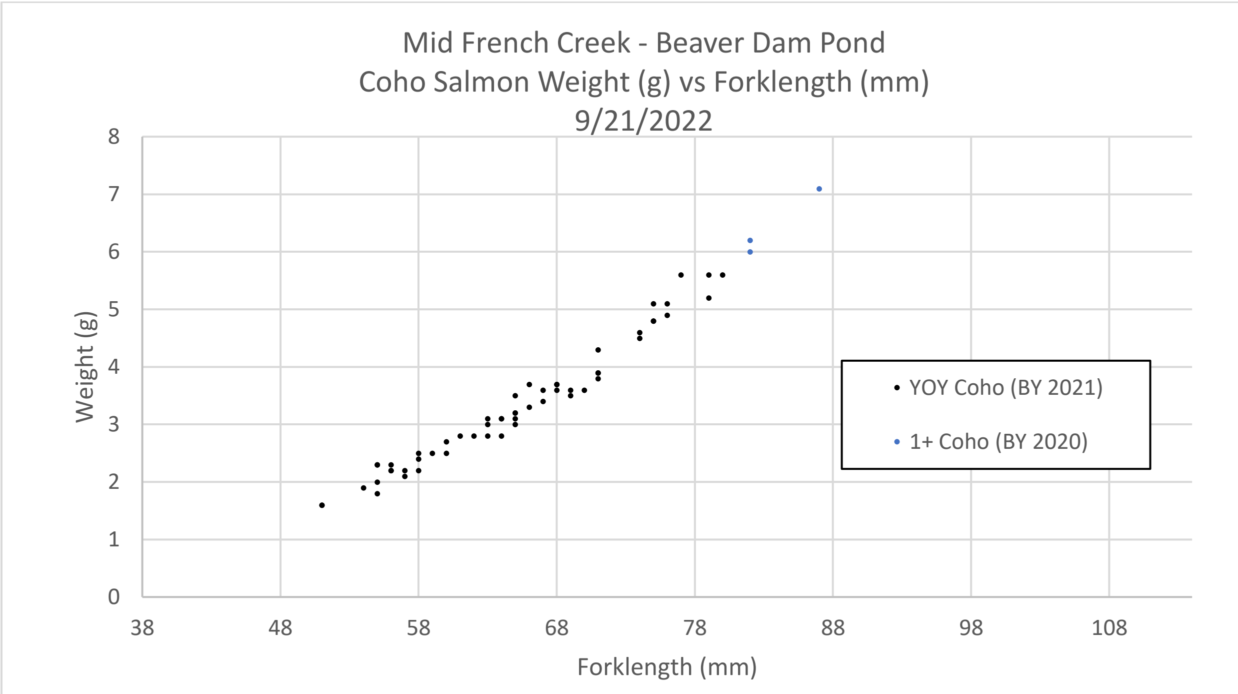


Figure 13 – Weight (g) vs forklength (mm) of YOY and 1+ Coho Salmon – French Creek Beaver Dam Pond

Upstream Mainstem ELJ

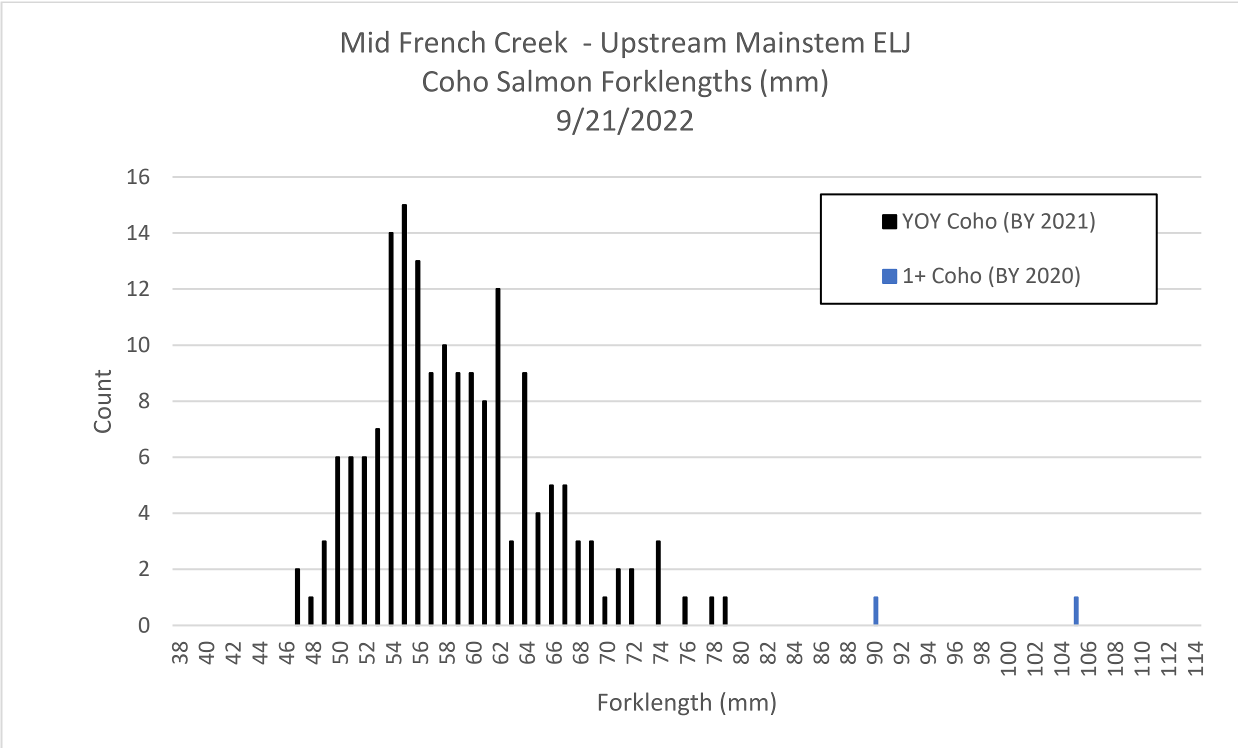


Figure 14 – Forklength (mm) histogram of YOY and 1+ Coho Salmon – French Creek Upstream Mainstem ELJ

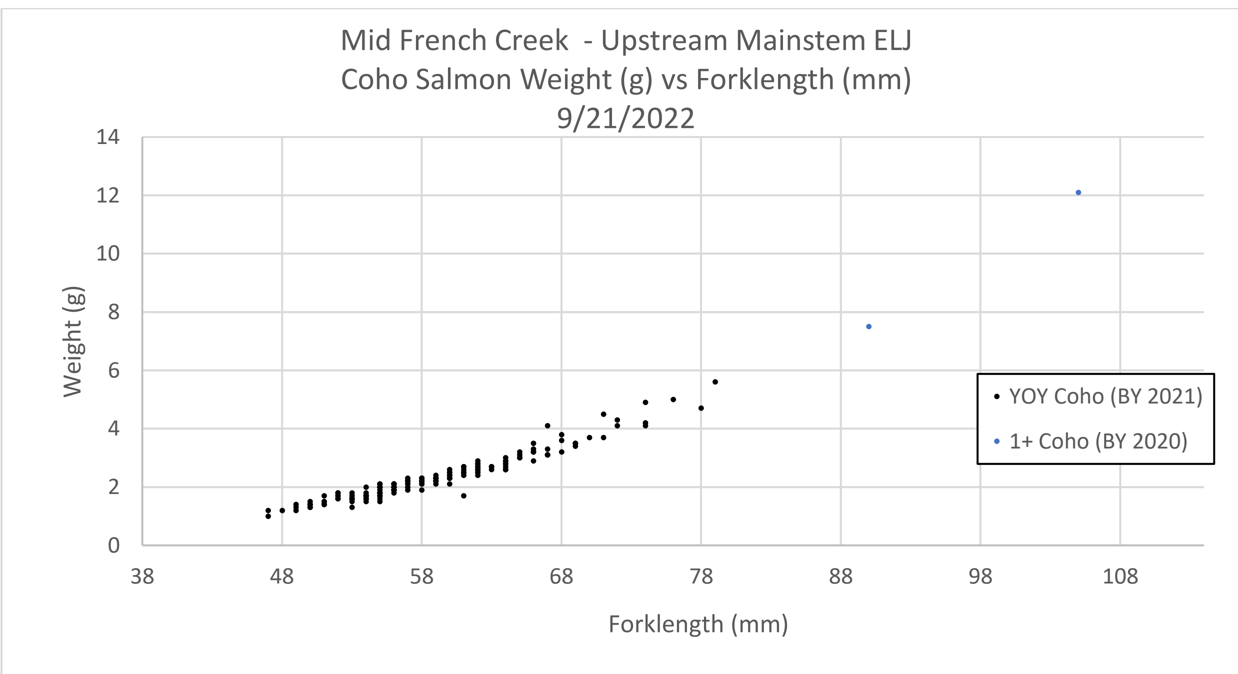


Figure 15 – Weight (g) vs forklength (mm) of YOY and 1+ Coho Salmon – French Creek Upstream Mainstem ELJ

Control Pools

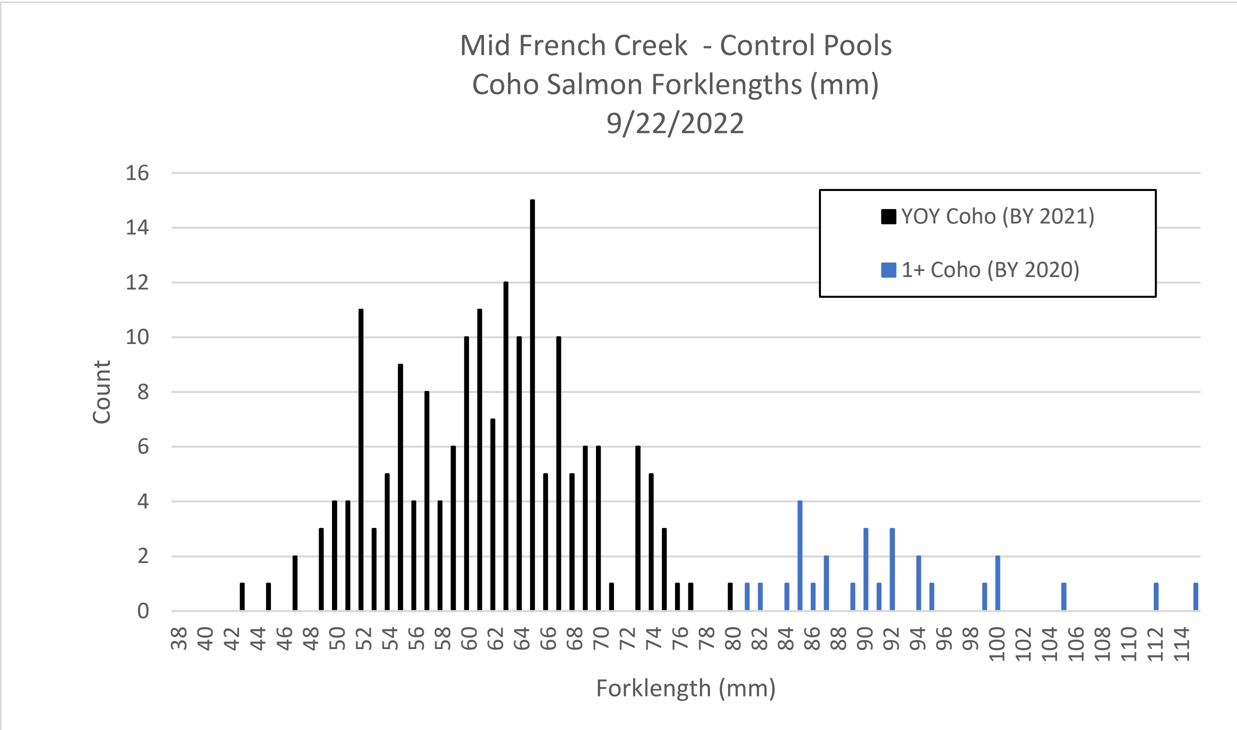


Figure 16 – Forklength (mm) histogram of YOY and 1+ Coho Salmon – French Creek Control Pools

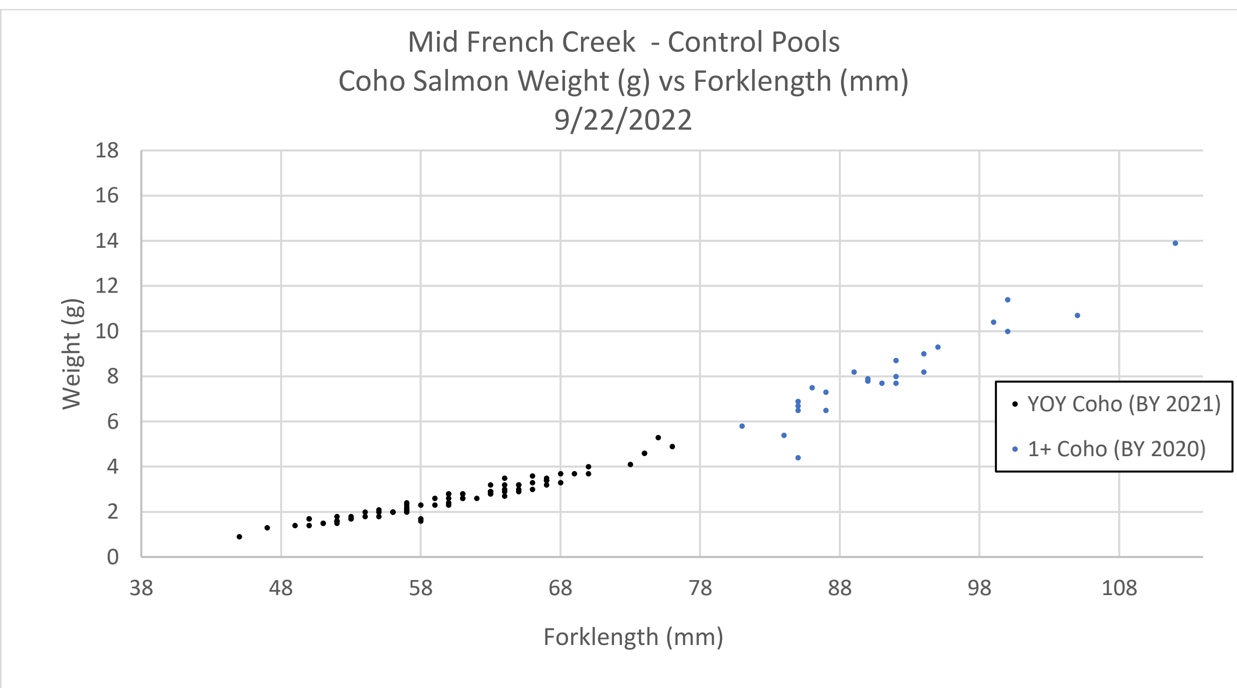


Figure 17 – Weight (g) vs forklength (mm) of YOY and 1+ Coho Salmon – French Creek Control Pools

Pre-Implementation Site at RKM 3.6

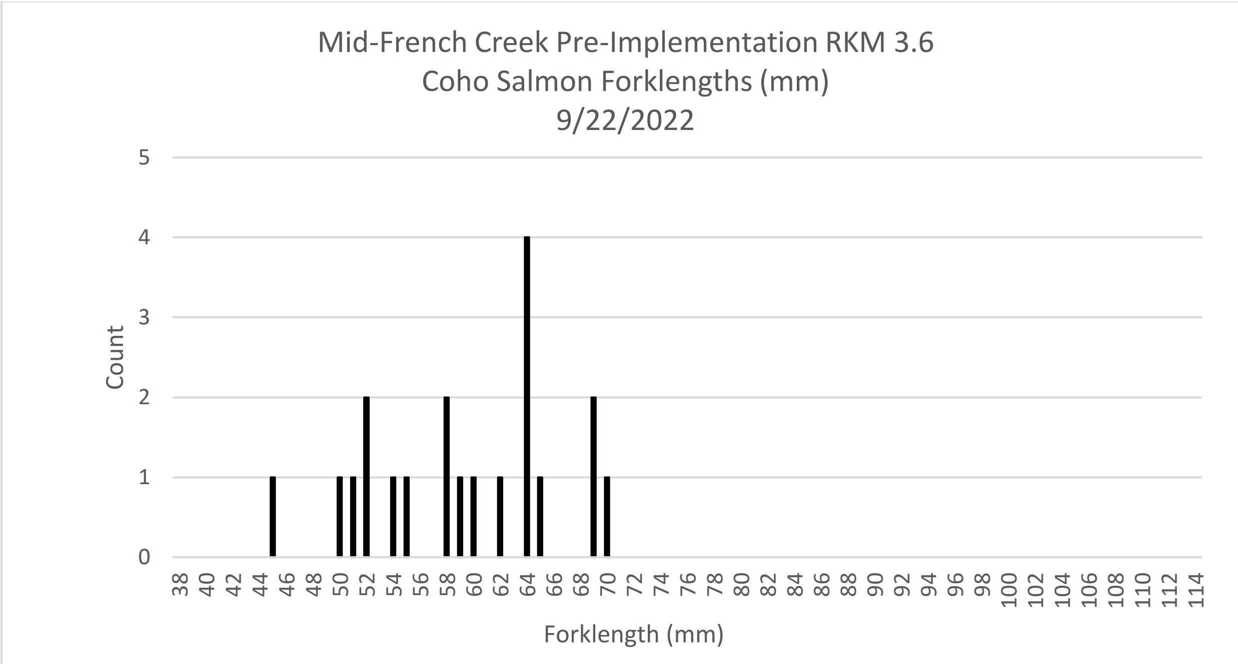


Figure 18 – Forklength (mm) histogram of YOY and 1+ Coho Salmon – French Creek Pre-implementation RKM 3.6

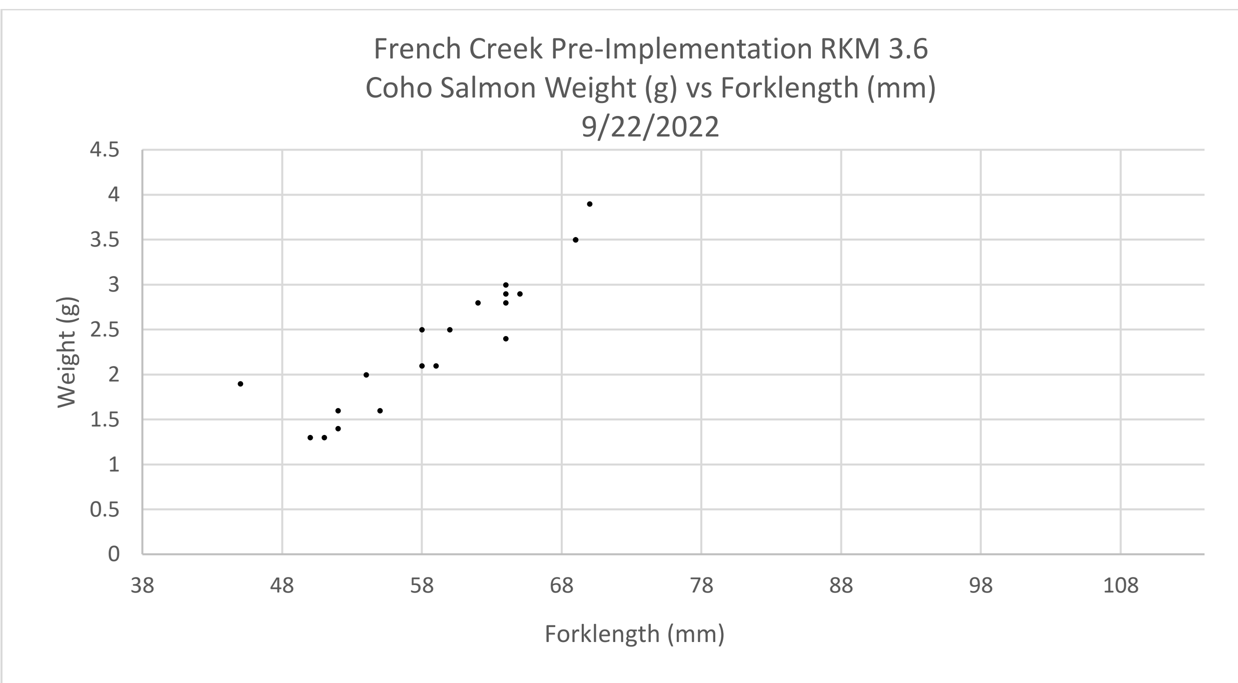


Figure 19 – Weight (g) vs forklength (mm) of YOY and 1+ Coho Salmon – French Creek Pre-implementation RKM 3.6

All Sampled Habitats

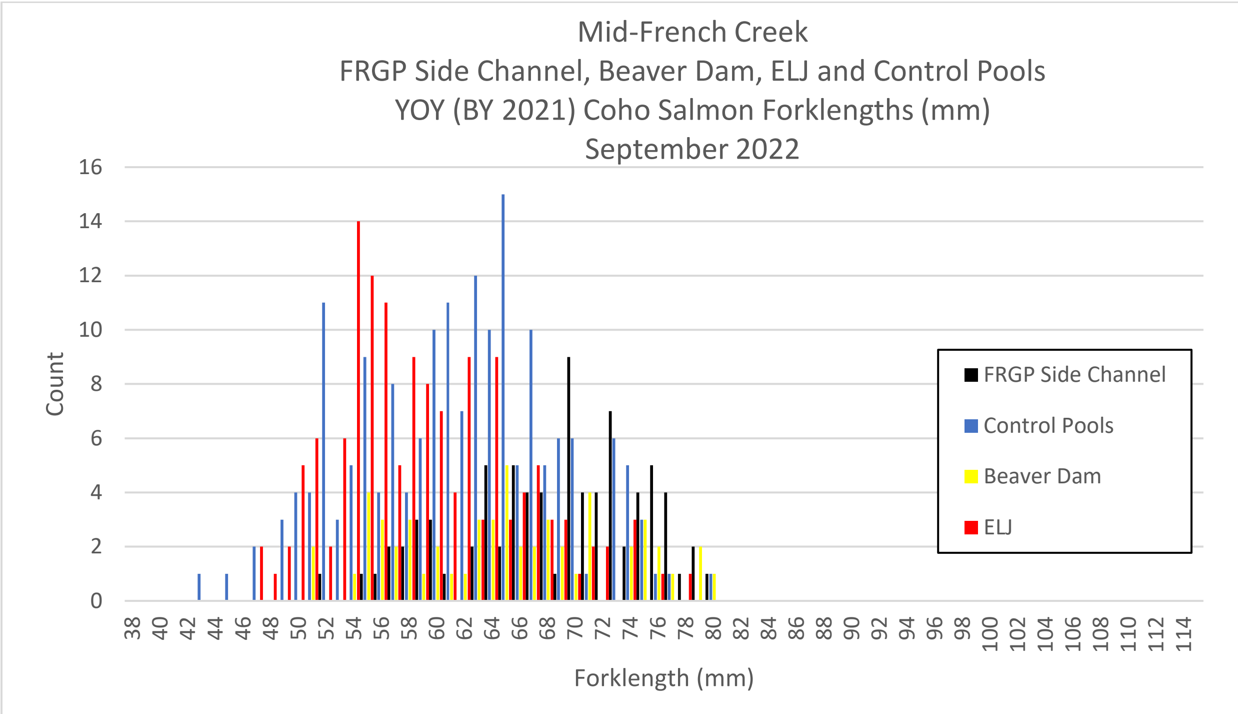


Figure 20 – Forklength (mm) histogram of YOY Coho Salmon – French Creek FRGP Side Channel, Beaver Dam, Upstream Mainstem ELJ and Control Pools

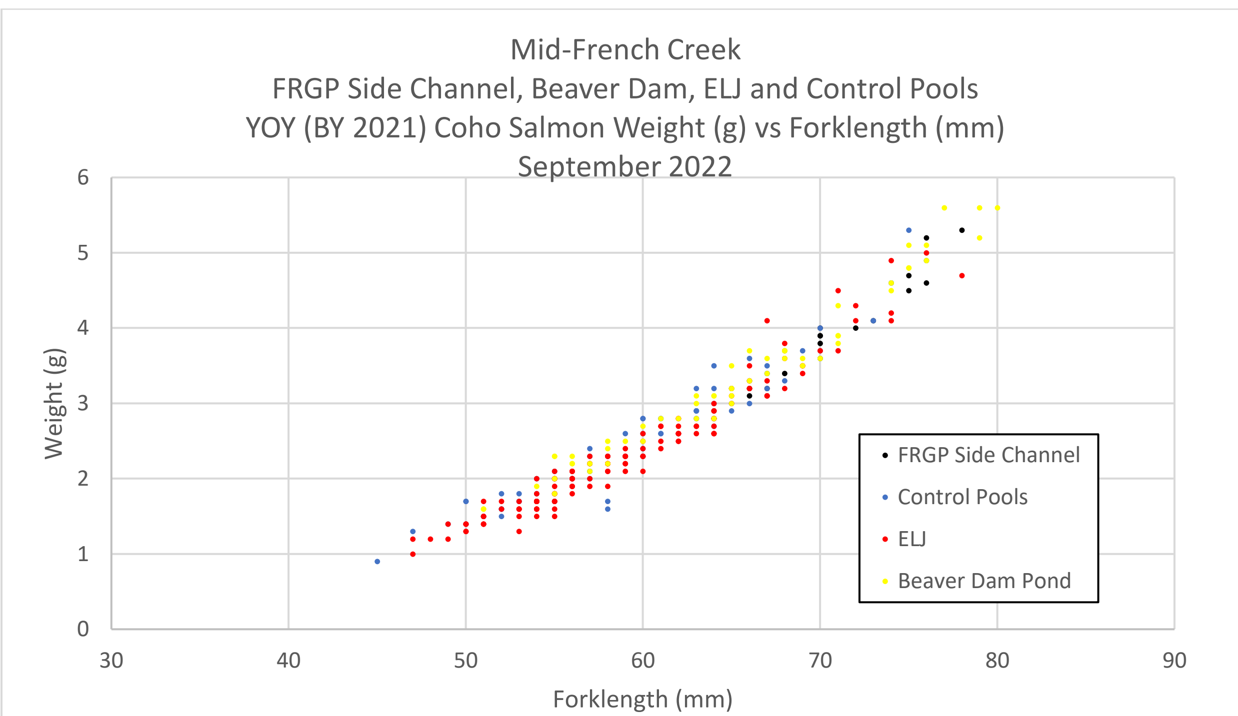


Figure 21 – Weight (g) vs forklength (mm) of YOY Coho Salmon – French Creek FRGP Side Channel, Beaver Dam, Upstream Mainstem ELJ and Control Pools

August to September Growth

During the September sampling event, several Coho Salmon were recaptured that had been PIT tagged during the August event: 8 on Sugar Creek and 41 on French Creek. On average, recaptured fish showed gains in forklength but losses in weight (Table 17, 18 and 19).

Sugar Creek BDA Pond 1				
	FL Gain (mm/day)	Weight (g/day)	(mm/mm/day)x100	(g/g/day)x100
Average	0.028	-0.001	0.039	-0.014
Standard Dev.	0.038	0.005	0.052	0.113
Count	8	8	8	8

Table 17 – Coho Salmon growth and relative growth from August to September – Sugar Creek BDA Pond 1

French Creek Control Pools				
	FL Gain (mm/day)	Weight (g/day)	(mm/mm/day)x100	(g/g/day)x100
Average	0.041	-0.003	0.059	0.026
Standard Dev.	0.039	0.014	0.058	0.219
Count	20	18	20	18

Table 18 – Coho Salmon growth and relative growth from August to September – French Creek Control Pools

French Creek FRGP Side Channel				
	FL Gain (mm/day)	Weight (g/day)	(mm/mm/day)x100	(g/g/day)x100
Average	0.036	-0.007	0.049	-0.031
Standard Dev.	0.041	0.015	0.061	0.254
Count	23	22	23	22

Table 19 – Coho Salmon growth and relative growth from August to September – French Creek FRGP Side Channel

A total of 8,691 coho salmon were captured and 3,184 coho salmon were marked with PIT tags during fish sampling efforts in calendar year 2022. In Sugar Creek, 254 Brood Year 2020 (BY2020) coho salmon were captured and 190 marked during efforts from January 18 to March 11, 2022 and 3,359 BY2021 coho salmon were captured and 1,386 were marked during efforts from August 1 to November 2, 2022 (Table xx and XX). In French Creek, 1,863 BY2020 coho salmon were captured and 571 were marked in efforts from January 20 – April 21, 2022 and 3,215 BY2021 coho salmon were captured and 1,037 marked during efforts from August 2 to November 4, 2022 (Table xx and XX).

BY2020

Date	Stream	Sample Reach	Coho TC	Coho Marks	Coho Recaptures	Steelhead TC	Steelhead Marks	Steelhead Recap
1/18/2022	Sugar	Sugar BDA 2 Pond	69	57	8	11	0	0
1/19/2022	Sugar	Sugar BDA 1 Pond	63	61	0	46	0	0
3/10/2022	Sugar	Sugar BDA 1 Pond	57	32	23	54	0	0
3/11/2022	Sugar	Sugar BDA 2 Pond	65	40	23	12	0	0
		Total	254	190	54	123	0	0

Table xx – 2022 Fish Sampling Effort Sugar Creek – BY2020

BY2021

Date	Stream	Sample Reach	Coho TC	Coho Marks	Coho Recaptures	Steelhead TC	Steelhead Marks	Steelhead Recap
8/1/2022	Sugar	Sugar Creek - BDA Step Pools and BDA 1 Pool	387	188	0	210	0	0
8/4/2022	Sugar	Sugar Creek - BP2 and Beaver Dam	331	73	0	7	0	0
9/2/2022	Sugar	Sugar BDA 1	347	189	18	10	0	0
9/19/2022	Sugar	Sugar BDA 1	255	116	8	102	13	0
9/19/2022	Sugar	Sugar OCP	17	12	0	2	1	0
9/20/2022	Sugar	Sugar - US Beaver Dam and Control A	285	145	4	0	0	0
10/26/2022	Sugar	Sugar BDA 2, US Beaver Dam and US HWY3 Pool	197	90	12	0	0	0
10/26/2022	Sugar	Sugar OCP	42	33	1	3	0	0
10/27/2022	Sugar	Sugar BDA 2, US Beaver Dam and US HWY3 Pool, BDA 1	164	75	16	12	0	0
10/27/2022	Sugar	Sugar OCP	40	36	1	0	0	0
10/28/2022	Sugar	Sugar BDA 1, Scott Confluence	294	262	11	55	0	0
10/31/2022	Sugar	Sugar BDA 1	442	0	99	107	0	0
10/31/2022	Sugar	Sugar Control	207	136	40	0	0	0
11/1/2022	Sugar	Sugar Control	161	0	70	0	0	0
11/2/2022	Scott River	Scott Confluence	190	31	17	0	0	0
		Total	3359	1386	297	508	14	0

Table xx – 2022 Fish Sampling Effort Sugar Creek – BY2021

BY2020

Date	Stream	Sample Reach	Coho TC	Coho Marks	Coho Recaptures	Steelhead TC	Steelhead Marks	Steelhead Recap
1/20/2022	French	French Control Pools and SC Habitats	294	163	0	22	0	0
1/20/2022	French	Mid French SC BDA 1 Pond	17	14	0	0	0	0
1/21/2022	French	French FRGP Side Channel	368	162	0	1	0	0
3/15/2022	French	French FRGP Side Channel & ELJs	511	153	36	11	0	0
3/16/2022	French	French Control Pools and SC Habitats	191	74	41	7	0	0
3/16/2022	French	Mid French SC BDA 1 Pond	10	5	4	0	0	0
4/20/2022	French	French Control Pools and SC Habitats	263	0	27	5	0	0
4/20/2022	French	Mid French SC BDA 1 Pond	24	0	0	0	0	0
4/21/2022	French	French FRGP Side Channel & ELJs	185	0	22	1	0	0
		Totals	1863	571	130	47	0	0

Table xx – 2022 Fish Sampling Effort French Creek – BY2020

BY2021

Date	Stream	Sample Reach	Coho TC	Coho Marks	Coho Recaptures	Steelhead TC	Steelhead Marks	Steelhead Recap
8/2/2022	French	FRGP Side Channel	90	81	1	0	0	0
8/2/2022	French	Mid French Creek - ELJ 1 and Beaver Dam Pond	202	56	0	6	0	0
8/3/2022	French	Mid French Creek - Control Pools	591	165	0	25	0	0
8/10/2022	French	French - Beaver Dam Pond	363	109	17	4	0	0
8/10/2022	French	FRGP Side Channel	88	58	12	0	0	0
9/21/2022	French	French - Beaver Dam Pond and ELJ	234	53	1	6	0	0
9/21/2022	French	French FRGP Side Channel	140	85	24	4	0	0
9/22/2022	French	French - Control Pools and 2023 Restoration Site	227	72	20	11	0	0
10/24/2022	French	French - Natural Beaver Dam Inlet	47	12	4	1	0	0
10/24/2022	French	French - Pool 3	203	70	28	9	0	0
10/24/2022	French	French - Pool 4	115	32	11	0	0	0
10/24/2022	French	French - Pre-treatment 3.2	2	0	0	2	0	0
10/24/2022	French	French FRGP Side Channel	138	89	15	10	0	0
10/25/2022	French	French Control Pools & Mainstem Habitats	505	97	86	30	0	0
10/25/2022	French	French FRGP Side Channel	90	20	9	16	0	0
11/3/2022	French	French - BOR Pre Treatment	7	0	0	0	0	0
11/3/2022	French	French Beaver Dam Pond	67	38	9	2	0	0
11/4/2022	French	French Beaver Dam Pond	76	0	15	1	0	0
11/4/2022	French	French Control Pools 1 & 2	30	0	2	7	0	0
		Totals	3215	1037	254	134	0	0

Table xx – 2022 Fish Sampling Effort French Creek – BY2021

Sugar Creek BDA Pond 1 – Water Surface Elevation and Sugar Creek RKM 2.6 (CDWR F25890) Discharge
Scott River Watershed Council – 7/17/2022

Sugar Creek BDA Pond 1 Water Surface Elevation

The Scott River Watershed Council (SRWC) has documented the water surface elevation (WSE) in the Sugar Creek BDA Pond 1 since the installation of the Beaver Dam Analogues (BDAs) during the base flow period of WY2014. The WSE (NAVD88) in the Sugar BDA Pond 1 has rapidly declined during the base flow period of the critical drought years of WY2018, WY2020 and WY2021 with the BDA Pond 1 becoming completely dry in WY2020 and WY2021 (Figure 1).

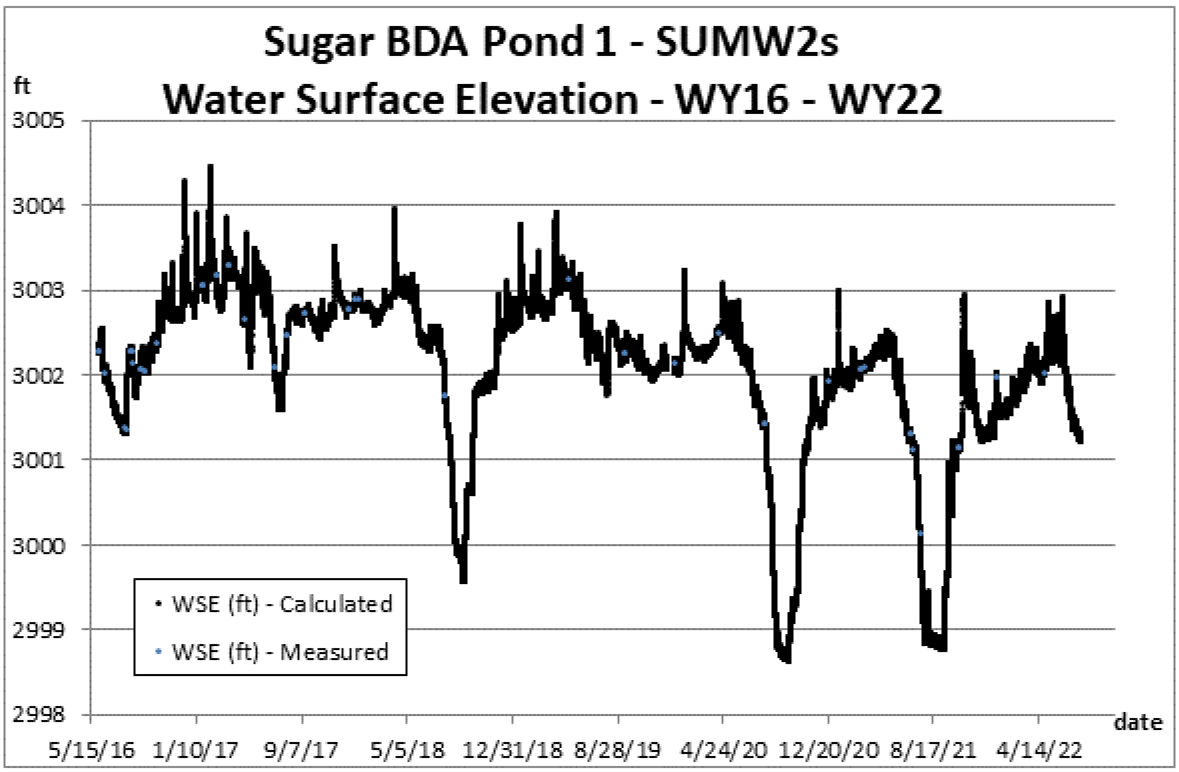


Figure 1 – Sugar BDA Pond 1 – Water Surface Elevation (WSE) – WY16 – WY22

Sugar Creek BDA Pond 1 becomes completely dry when the WSE equals 2998.8’. In WY2020, BDA Pond 1 became dry on August 24, 2020 (Figure 2). In WY2021, the second year of critical drought, BDA Pond 1 became dry on July 26, 2021 - 29 days earlier than WY2020. In both water years the WSE of BDA Pond 1 dropped rapidly from 3001.0’ to 2998.8’ (Table 1a & 1b). In WY2020, BDA Pond 1 became dry in 22 days after the WSE = 3001.0’ and in WY2021 the site became dry in 17 days.

Analysis of the WSE in WY2022 to date indicates that the WY2022 WSE is between the WY2020 (less than) and WY2021 WSE (greater than) in mid-July (Figure 2). On July 17, 20022 the WSE in BDA Pool 1 is 3001.3’.

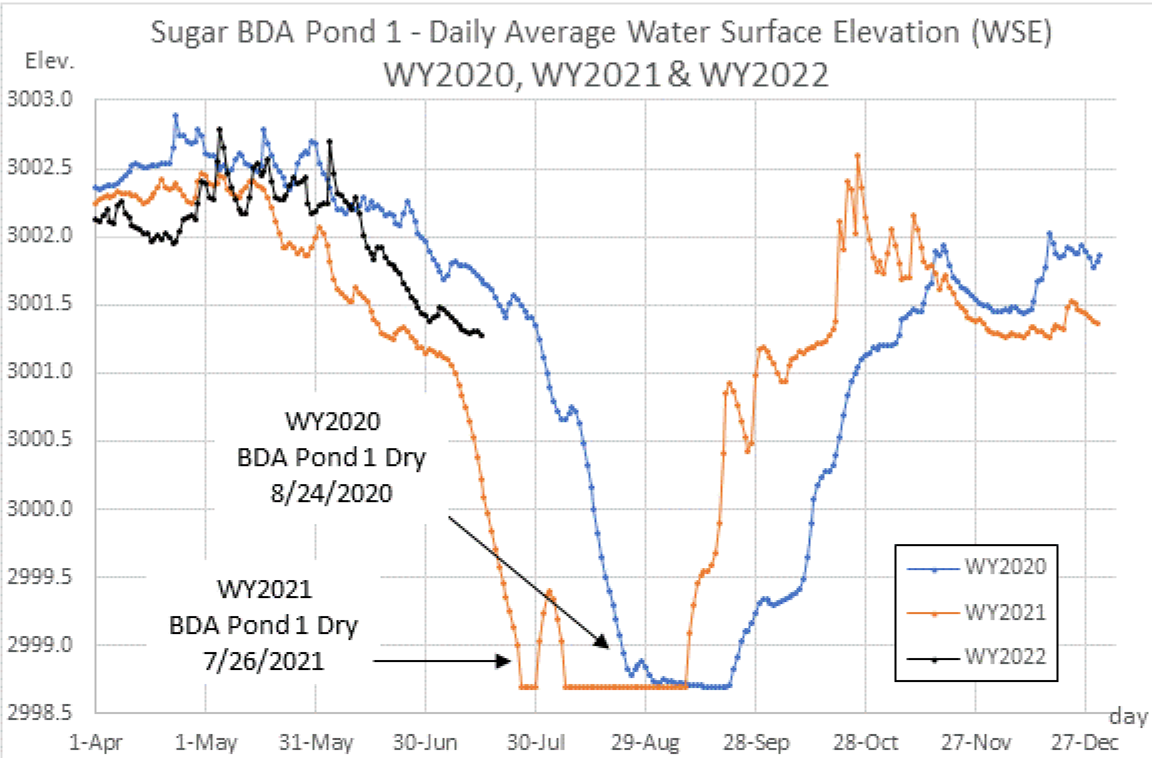


Figure 2 – Sugar BDA Pond 1 – Daily Average (WSE) – WY2020, WY2021 & WY2022

Sugar BDA 1 Pond Water Surface Elevation (NAVD88)

	Date Water Surface Elevation equaled XXXX.X'					Dry
	3001.5'	3001.0'	3000.5'	3000.0'	2999.5'	2998.8'
WY2020	7/26/2020	8/2/2020	8/12/2020	8/15/2020	8/18/2020	8/24/2020
WY2021	6/15/2021	7/9/2021	7/14/2021	7/18/2021	7/22/2021	7/26/2021
WY2022	7/5/2022					

	Days Between						
	3001.5' - 3001.0'	3001.0' - 3000.5'	3000.5' - 3000.0'	3000.0' - 2999.5'	2999.5' - 2998.8'	3001.0' - 2998.8'	3001.5' - 2998.8'
WY2020	7	10	3	3	6	22	29
WY2021	24	5	4	4	4	17	41

Tables 1a & 1b – Date Sugar BDA Pond 1 WSE (ft) equals elevation and days between elevations

Sugar Creek Discharge

The California Department of Water Resources (CDWR) operates a stream discharge gage on Sugar Creek at RKM 2.6 (CDWR F25890). Continuous “Raw” 15 minute discharge data was for the period of WY2010 to 3/22/2022 was retrieved from the CDWR Water Data Library (https://wdl.water.ca.gov/) and provisional real time 15 minute discharge data for the period after 3/22/2022 was retrieved from the CDWR California Data Exchange Center (https://cdec.water.ca.gov/). Of note, the discharge data retrieved from CDEC is reported as a whole number while the data retrieved from WDL is reported to the tenth.

The SRWC established a stream discharge station at RKM 1.0 in WY2021. Periodic discharge measurements at RKM 1.0 correlate closely with the provisional discharge at the CDWR RKM 2.6 gage (Figure 3).

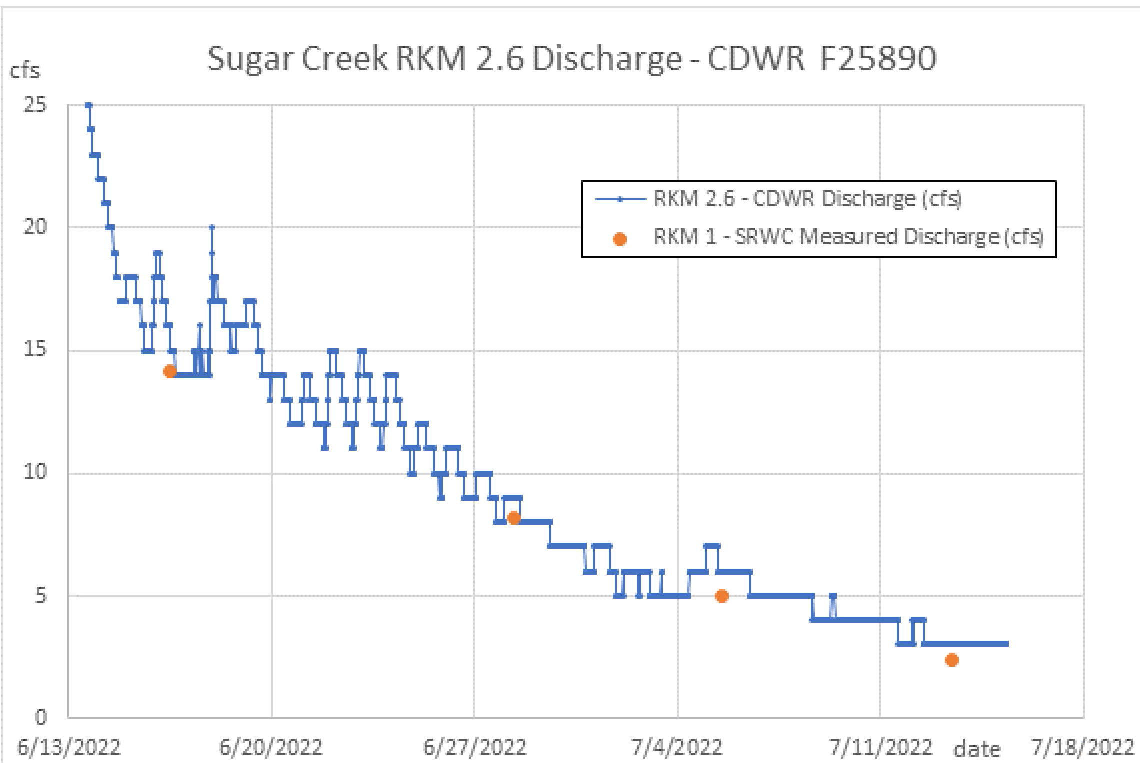


Figure 3 – Continuous discharge at Sugar RKM 2.6 and periodic discharge at RKM 1.0 – WY2022

Daily average discharge (cfs) was calculated for the CDWR Sugar RKM 2.6 station. Analysis of the daily average discharge after April 1st for WY2020, WY2021 and WY2022 illustrates that the discharge in WY2022 has been greater than the discharge in WY2020 and WY2021 since the beginning of June (Figure 4). The average daily discharge at Sugar Creek RKM 2.6 in WY2021 was significantly less than the discharge in WY2020 and WY2022 starting in Mid-May. It is hypothesized that the lower discharge in late spring in WY2021 was a major factor in the earlier dewatering of the Sugar BDA 1 Pond in WY2021. The date that the Sugar RKM 2.6 discharge was less than the thresholds of 10 cfs, 5 cfs, 2 cfs and 1 cfs and the minimum discharge for the water year was recorded for WY2017 through WY2022 to date (Table 2a & 2b).

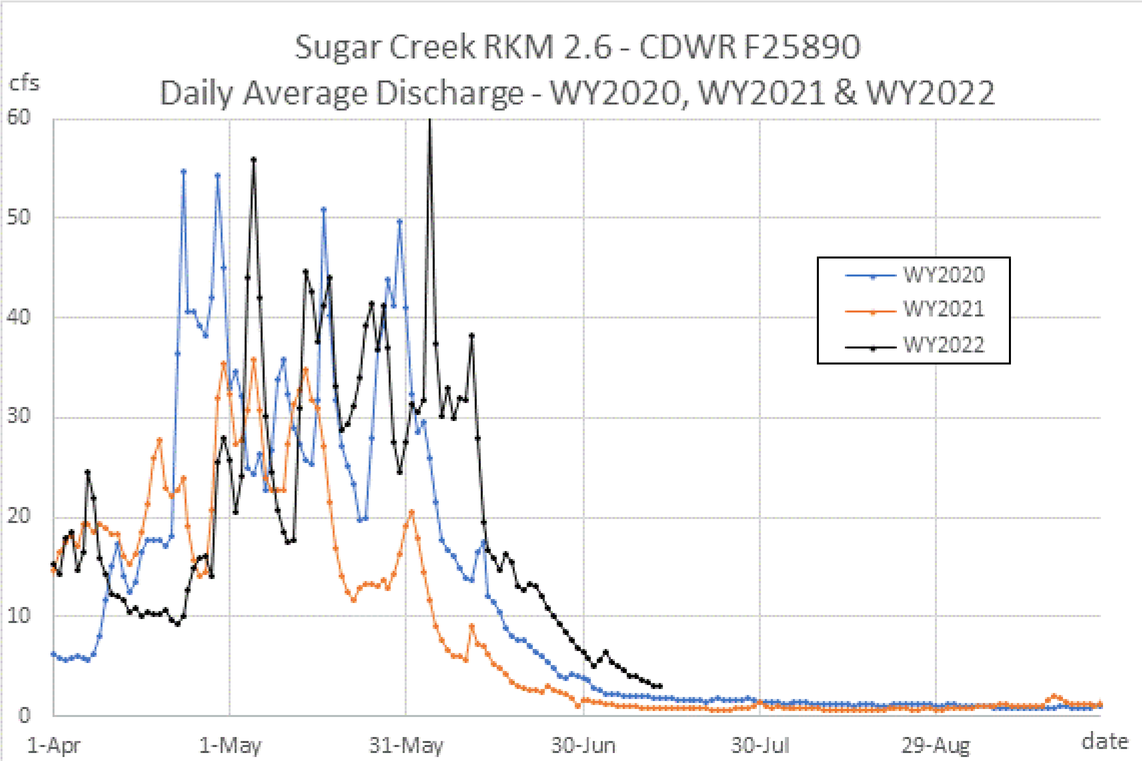


Figure 4 – Sugar Creek RKM 2.6 - Daily average discharge – WY2020, WY2021 and WY2022

Sugar Creek - RKM 2.6 - CDWR F25890

Date of Discharge (cfs) less than xx cfs

WY	<10 cfs	<5 cfs	<2 cfs	<1 cfs	Minimum Q (cfs)
WY2017	7/15/2017	7/25/2017	8/25/2017		1.7
WY2018	6/6/2018	6/19/2018	7/5/2018	7/28/2018	0.7
WY2019	6/29/2019	7/12/2019	7/27/2019		1.4
WY2020	6/17/2020	6/25/2020	7/12/2020	9/8/2020	0.8
WY2021	6/7/2021	6/17/2021	6/29/2021	7/11/2021	0.6
WY2022	6/27/2022	7/8/2022			

Days Between

WY	<10 cfs to <5 cfs	<5 cfs to <2 cfs	<2 cfs to <1 cfs
WY2017	10	31	
WY2018	13	16	23
WY2019	13	15	
WY2020	8	17	58
WY2021	10	12	12
WY2022	11		

Table 2a & 2b - Date Sugar Creek RKM 2.6 discharge equals threshold and days between thresholds

The minimum discharge in all three drought years (WY2018, WY2020 and WY2021) in which rapid decrease of the WSE in Sugar BDA 1 was observed was less than 1 cfs and the minimum discharge was greater than 1 cfs during the wet WY2017 and average WY2019 (Table 2a). The Sugar RKM 2.6 discharge in WY2021 was below the 10 cfs threshold on June 7th (ten days earlier than the occurrence in WY2020) and decreased to less than 1 cfs in thirty four (34) days after going below the 10 cfs threshold. In WY2020 there were 83 days between the 10 cfs and 1 cfs thresholds. The discharge at Sugar RKM 2.6 cfs is 3 cfs to date.

Sugar Creek BDA Ponds – Habitat Condition Status Update – 8/8/2022
Scott River Watershed Council

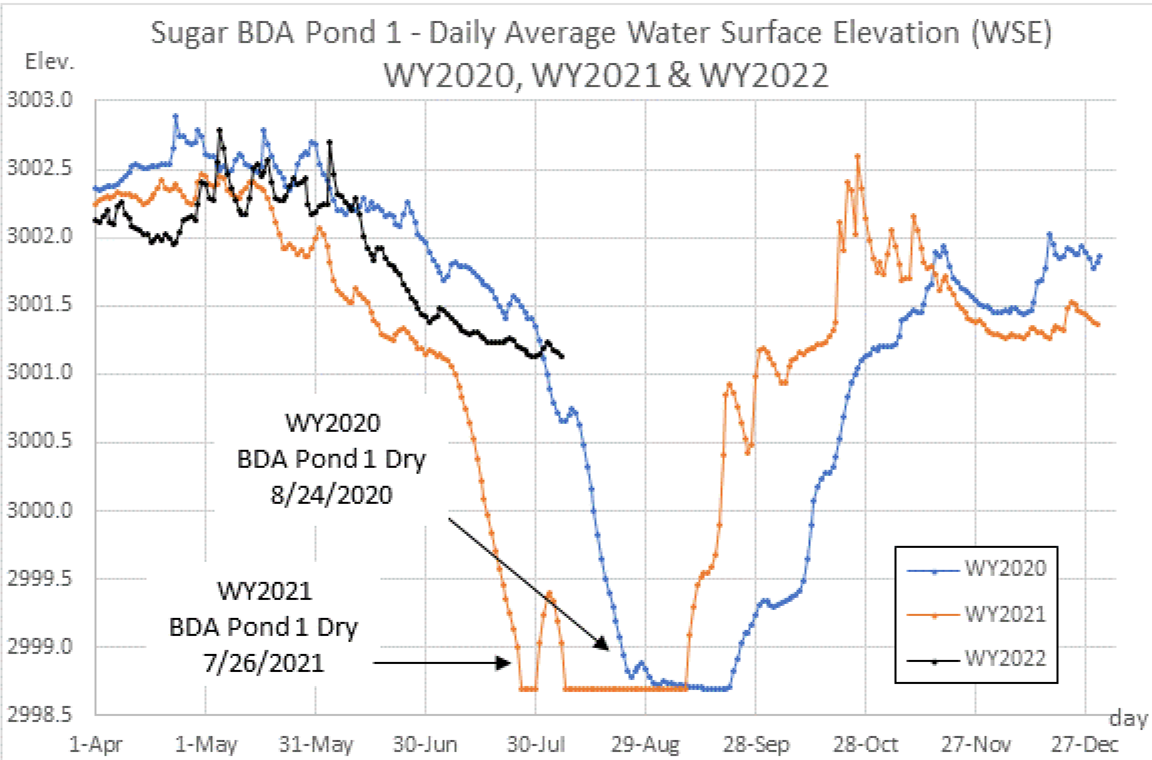


Figure 1 - Sugar BDA Pond 1 – Daily average water surface elevation – WY2020, WY2021 and WY2022

The water surface elevation (WSE) in the Sugar BDA Pond 1 was 3001.1' on August 7, 2022 (Figure 1). The WSE of 3001.1' was achieved on August 1, 2020 in WY2020 – 23 days before the BDA Pond 1 became completely dry. In WY2020, the WSE was 3000.7' on August 7th.

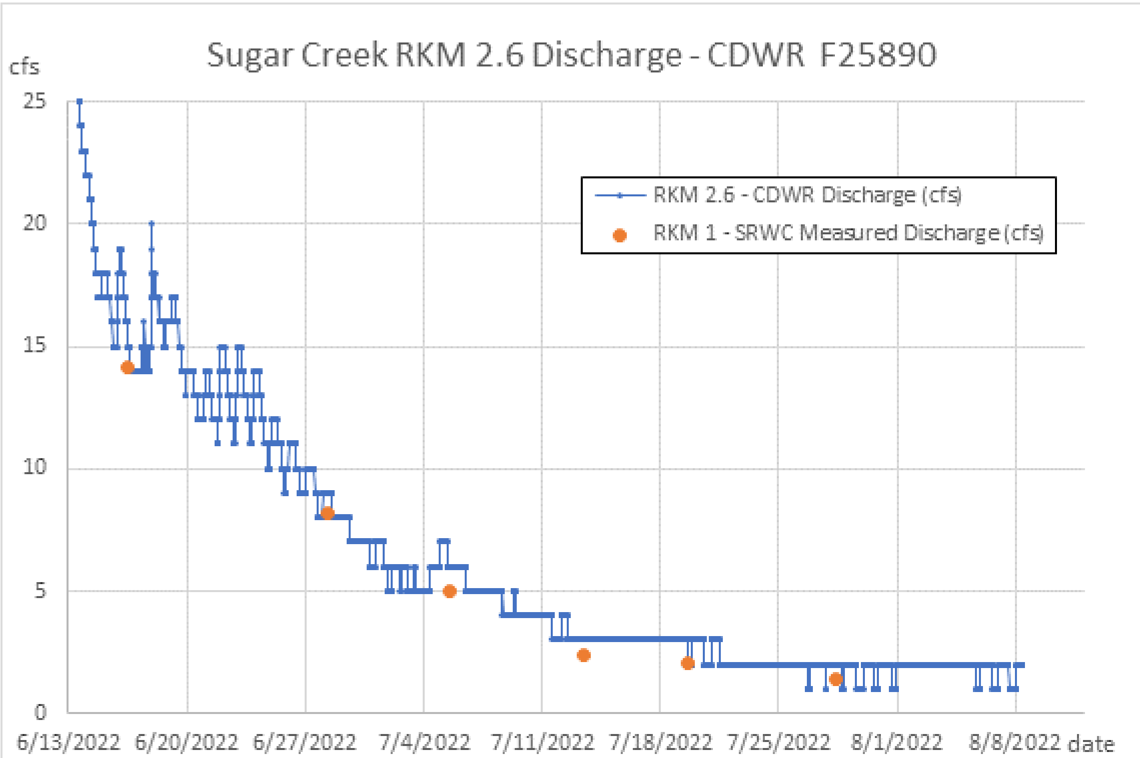


Figure 2 – Sugar Creek RKM 2.6 (CDWR F25890) – Provisional Discharge (cfs) – RKM 1.0 periodic measured discharge (cfs)

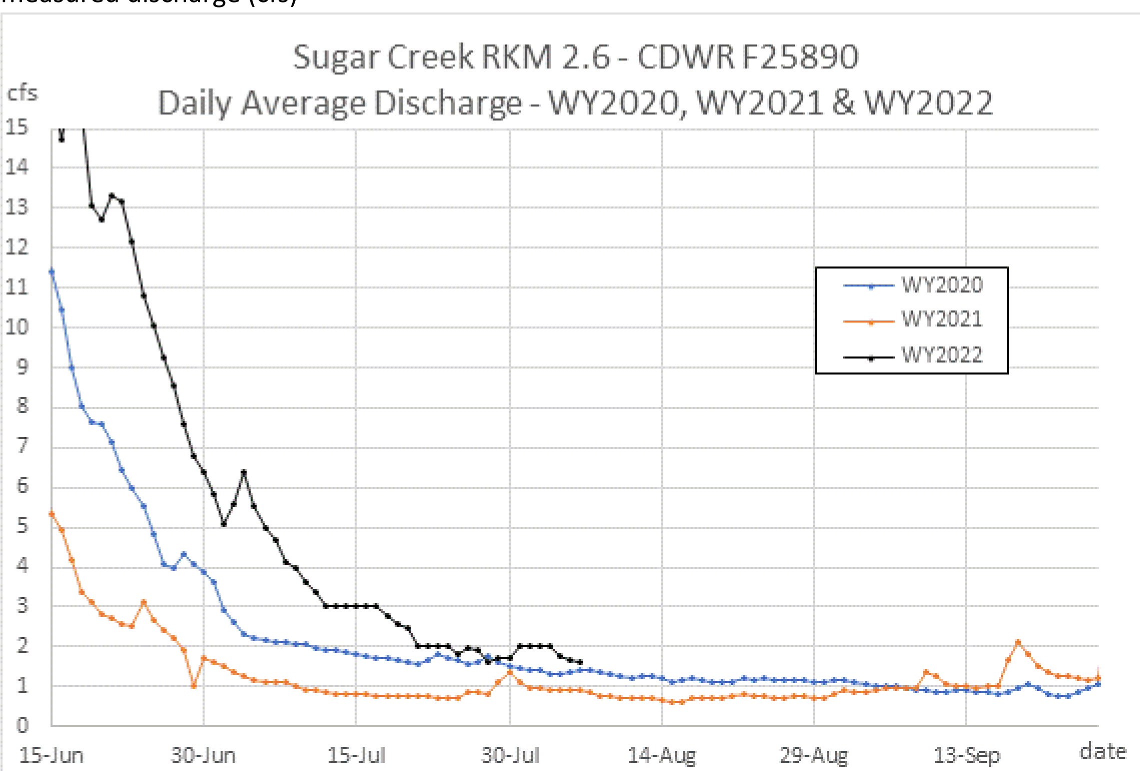


Figure 3 - Sugar Creek RKM 2.6 (CDWR F25890) – Daily average discharge (cfs) – WY2020, WY2021 and WY2022

Sugar Creek BDA Pond 1 Water Surface Elevation
Scott River Watershed Council
8/31/2022

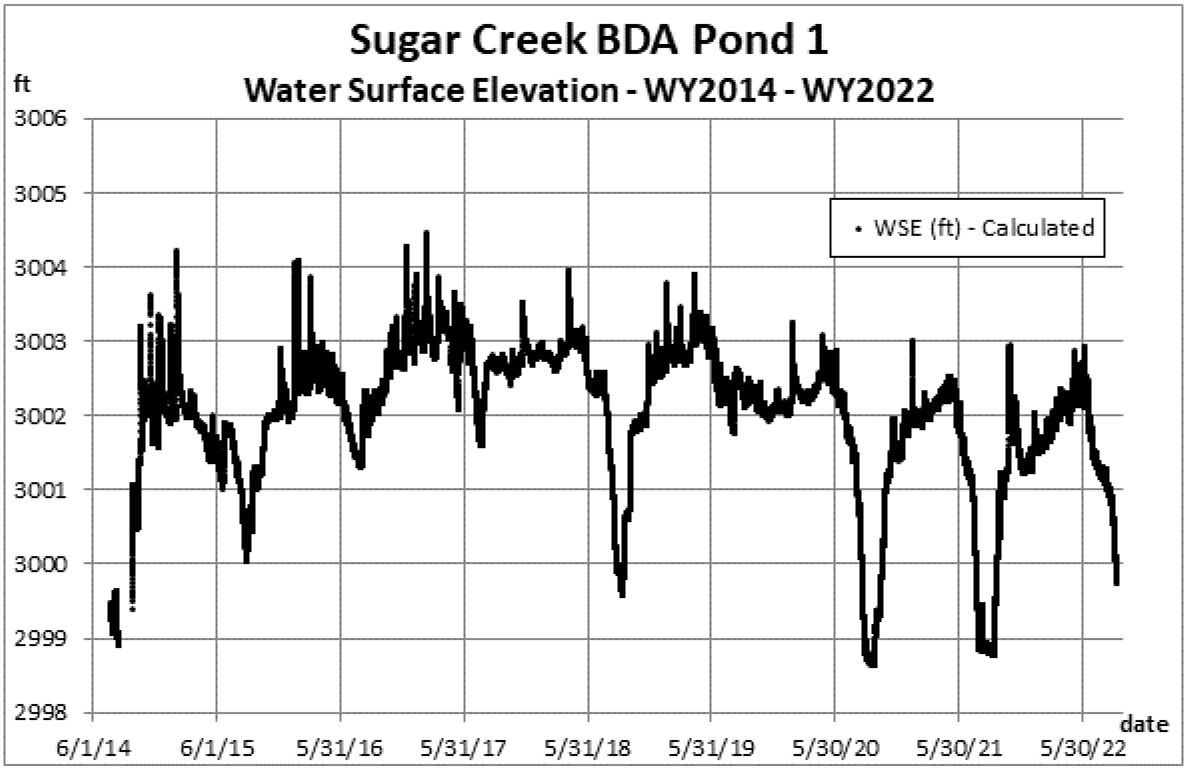


Figure 1 – Water surface elevation – WY2014 – WY2022

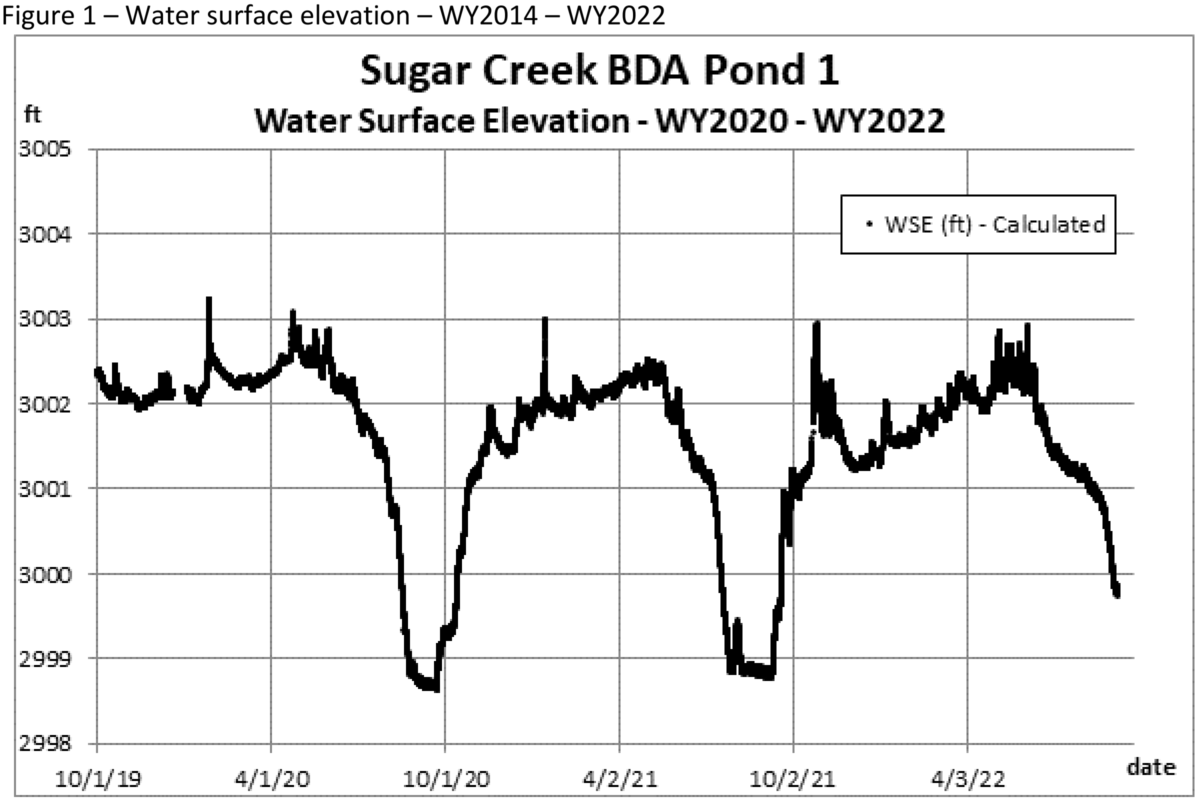


Figure 2 – Water surface elevation – WY2020 – WY2022

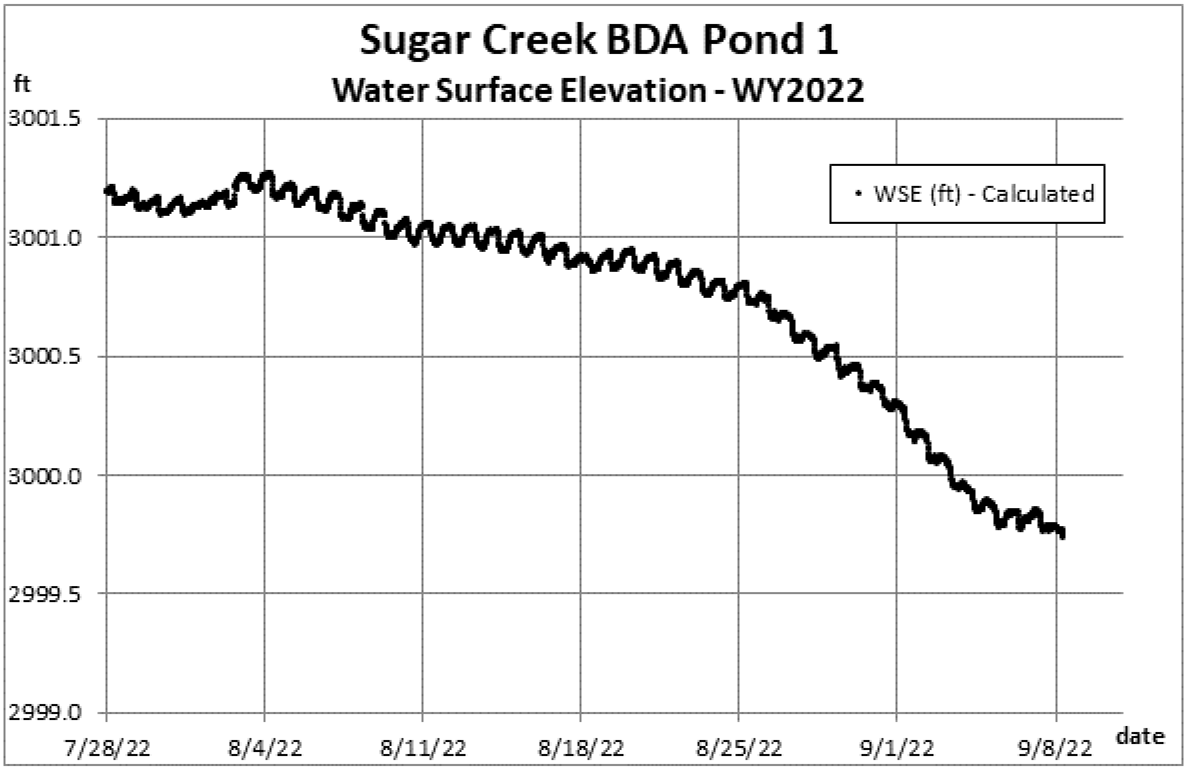


Figure 3 – Water surface elevation – WY2022

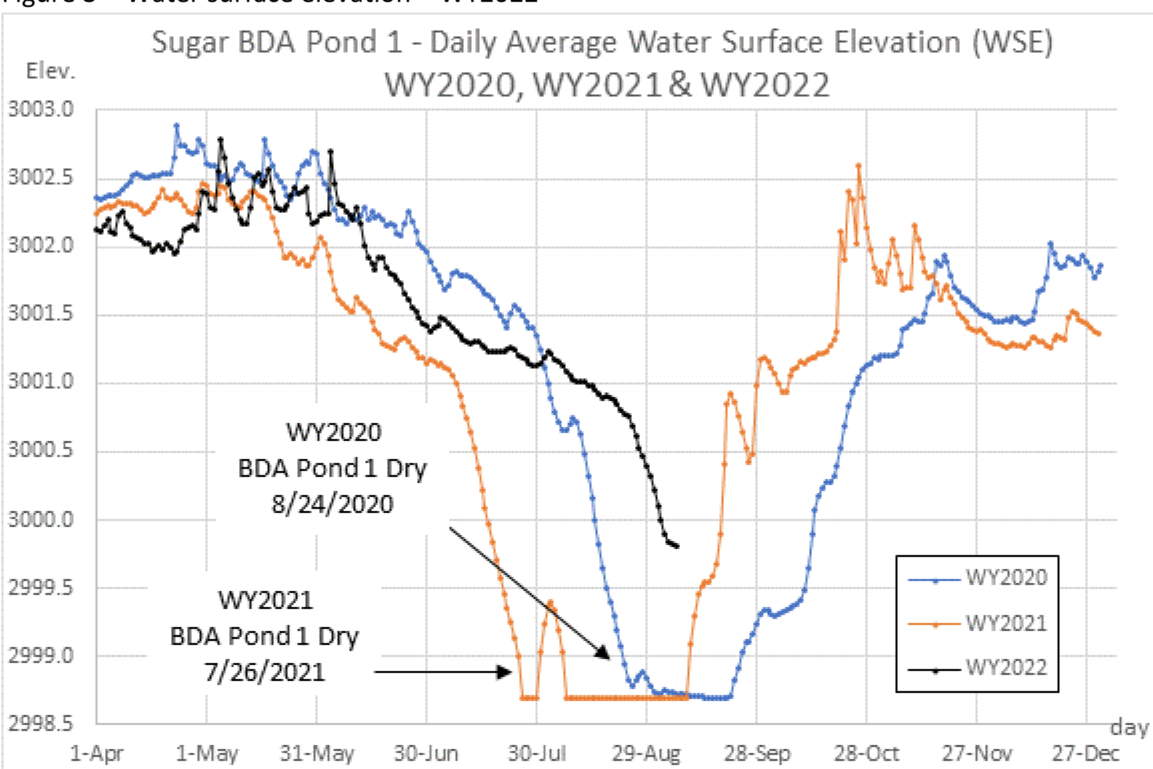


Figure 4 – Daily average water surface elevation – WY2020, WY2021 and WY2022

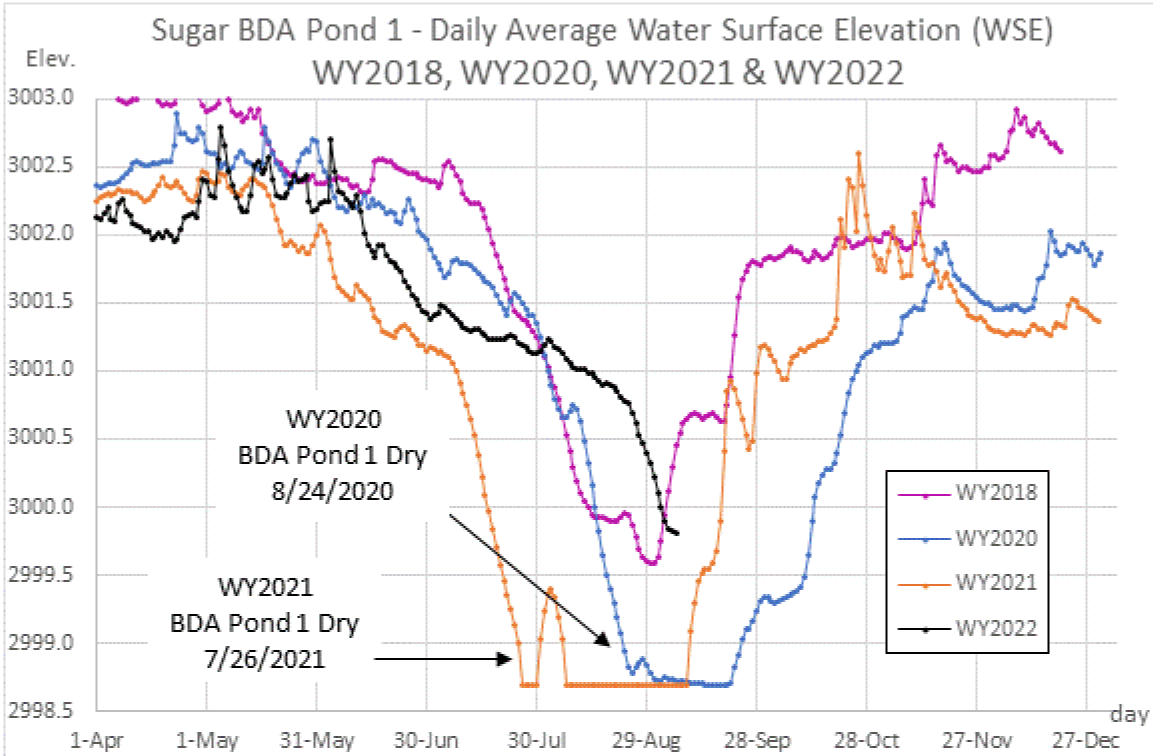


Figure 5 – Daily average water surface elevation – WY2018, WY2020, WY2021 and WY2022

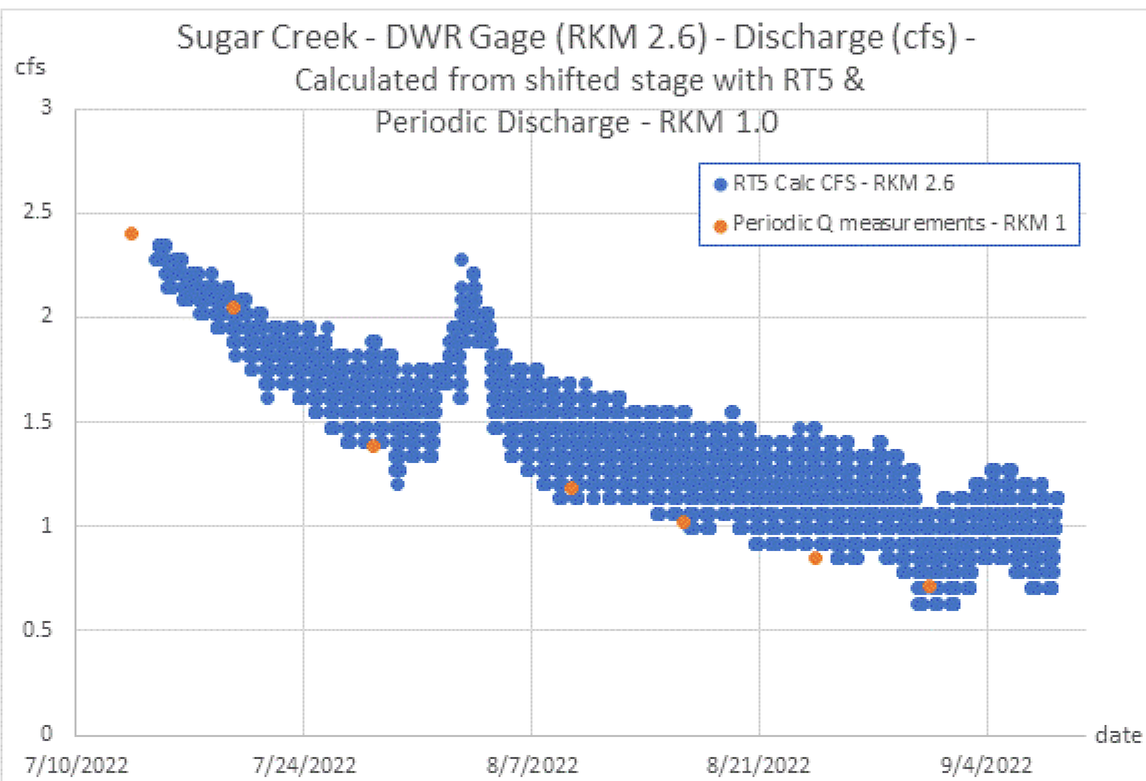


Figure 6 – Provisional calculated discharge (cfs) – Sugar Creek RKM 2.6 (CDWR F25890)

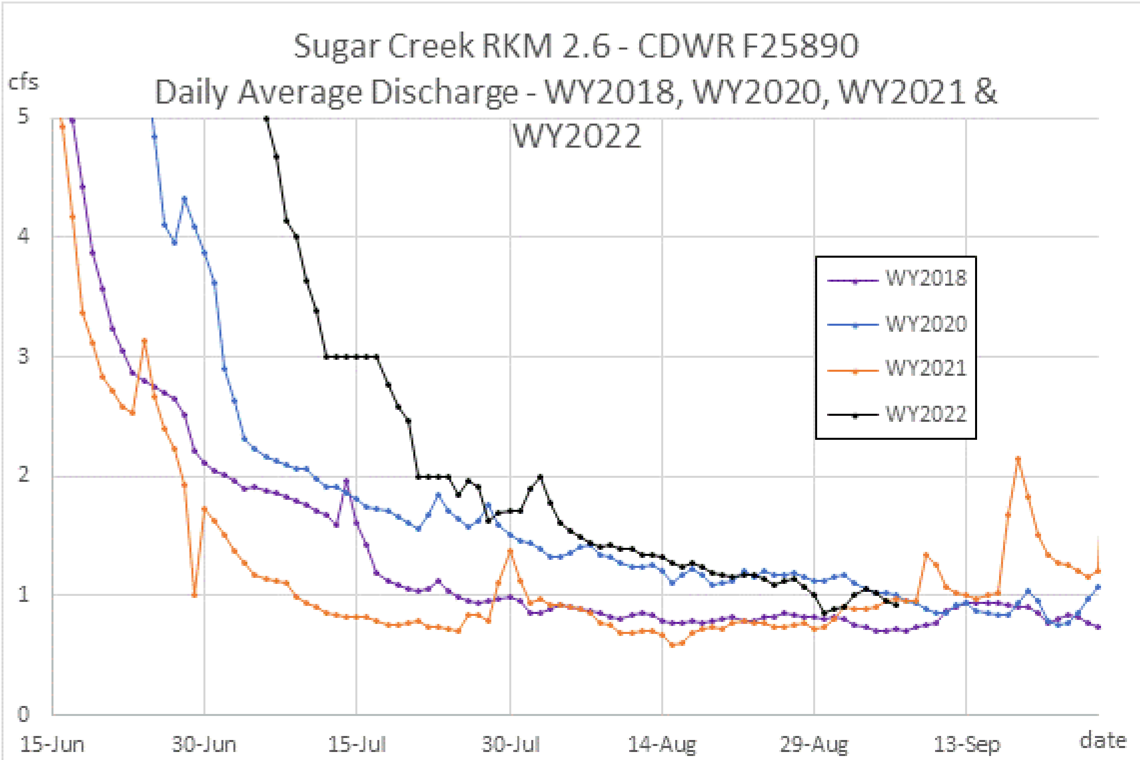


Figure 7 - Sugar Creek RKM 2.6 (CDWR F25890) – Daily average discharge (cfs) – WY2018, WY2020, WY2021 and WY2022

Siskiyou County Drought Monitor Categories

Retrieved from https://droughtmonitor.unl.edu/

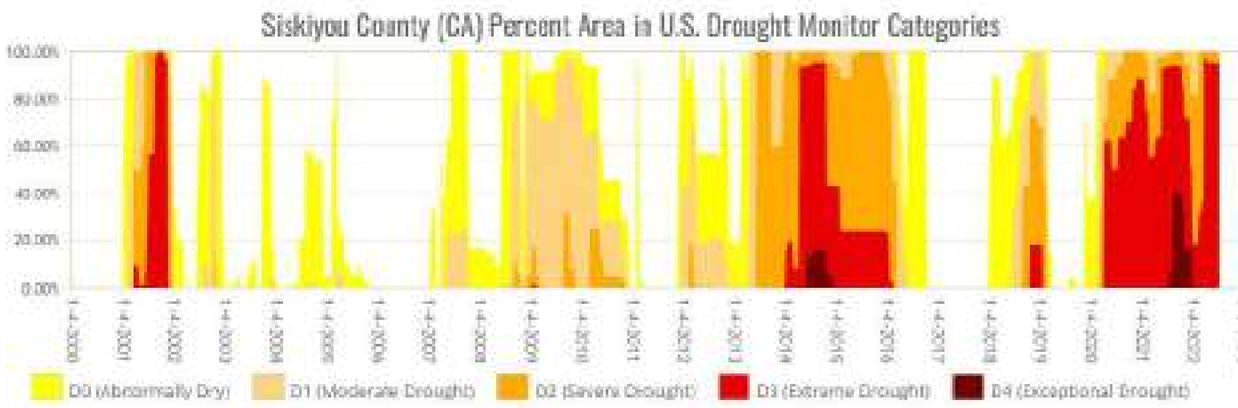


Figure 1 – Percent of Siskiyou County in DO to D4 drought categories – January 2000 – July 2022

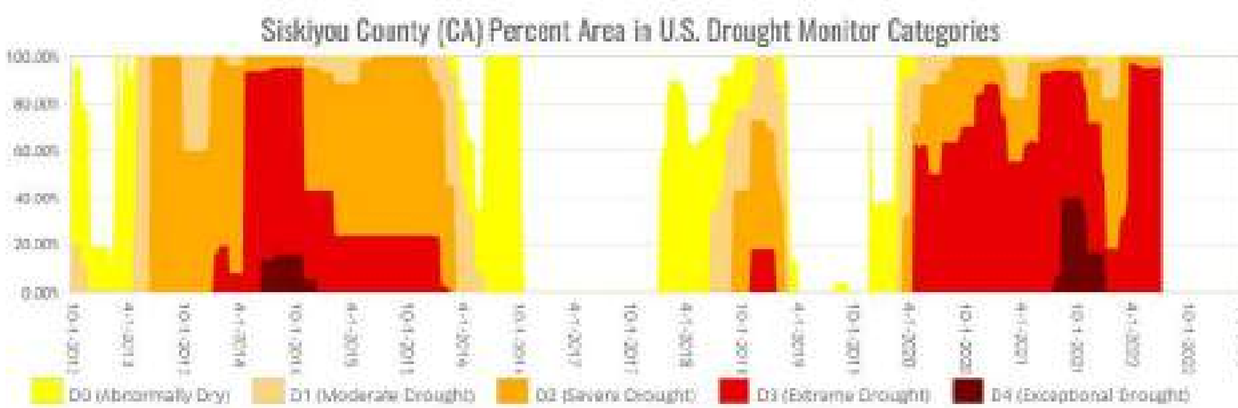


Figure 2 – Percent of Siskiyou County in DO to D4 drought categories – WY2013 – WY2022

Siskiyou County - Percent of Area in Drought Category - July 1

WY	None	D0	D1	D2	D3	D4
WY2013	0	0	0	100	0	0
WY2014	0	0	0	6	81	13
WY2015	0	0	0	76	24	0
WY2016	0	100	0	0	0	0
WY2017	100	0	0	0	0	0
WY2018	20	45	35	0	0	0
WY2019	100	0	0	0	0	0
WY2020	0	0	12	38	50	0
WY2021	0	0	2	5	93	0
WY2022	0	0	0	5	95	0

Table 1 – Percent of Siskiyou County Area in Drought Category per Water Year on July 1

Siskiyou County - Percent of Area in Drought Category - August 1

WY	None	D0	D1	D2	D3	D4
WY2013	0	0	0	100	0	0
WY2014	0	0	0	5	80	16
WY2015	0	0	0	76	24	0
WY2016	0	100	0	0	0	0
WY2017	100	0	0	0	0	0
WY2018	9	49	43	0	0	0
WY2019	100	0	0	0	0	0
WY2020	0	0	6	31	63	0
WY2021	0	0	1	5	88	7

Table 2 – Percent of Siskiyou County Area in Drought Category per Water Year on August 1

Accumulated Precipitation at Fort Jones

Retrieved from https://cdec.water.ca.gov/

Water Year	Acc. Prec. (in) Oct. 1 - April 1	Dry Rank	Acc. Prec. (in) Oct. 1 - July 1	Dry Rank	Acc. Prec. (in) Oct. 1 - Sept.30	Dry Rank	April 1 Snowpack Water Equivalence % Average
WY13	15.7	36	19.2	42	21.4	44	40%
WY14	8.5	7	9.8	4	12.1	5	9%
WY15	16.6	41	18.7	40	19.6	36	<1%
WY16	21.3	64	23.5	54	23.6	53	97%
WY17	29.3	81	32.3	77	33.5	79	100%
WY18	8.1	5	12.2	7	12.2	6	36%
WY19	16.6	42	19.2	41	20.8	41	134%
WY20	7.0	4	9.5	4	10.1	3	44%
WY21	9.7	14	10.2	6	11.3	6	71%
WY22	8.9	9	12.8	13	--	--	18%
Average (85 Years)	17.0	--	19.8	--	21.2	--	--

Table 3 – Accumulated precipitation (inches) by water year for different intervals and dry ranking – WY13 – WY22

Accumulated Discharge at USGS Gage below Fort Jones

Retrieved from https://cdec.water.ca.gov/

	October 1 - September 30		**October 1 - March 31**		**April 1 - September 30**		**August 1 - September 30**	
	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank	Accumulated Discharge (TAF)	Dry Rank
WY2013	233	17	143	27	90	14	1.35	13
WY2014	122	7	92	11	31	3	0.88	6
WY2015	295	27	269	51	26	2	0.91	7
WY2016	508	50	324	53	184	42	1.94	20
WY2017	864	75	570	73	294	67	6.27	43
WY2018	191	11	99	13	92	16	0.85	5
WY2019	411	43	163	33	249	63	3.57	28
WY2020	120	5	63	5	57	7	0.99	10
WY2021	110	3	61	4	49	5	1.19	11
Average (n = 80)	439		255		184		5.78	

Table 3 – Accumulated discharge (TAF) by water year for different intervals and dry ranking – WY13 – WY22

Sugar Creek – DWR Gage – Date of Occurrence of discharge thresholds – WY13 – WY22

Date of occurrence of discharge less than xx cfs

WY	10 cfs	5 cfs	2 cfs	1 cfs	Minimum Q
WY2013	6/26/2013	7/5/2013	7/11/2013	7/16/2013	0.4
WY2014	5/29/2014	6/12/2014	7/4/2014	8/7/2014	0.7
WY2015	6/7/2015	6/13/2015	7/22/2015	9/10/2015	0.7
WY2016	7/4/2016	7/12/2016	7/29/2016	--	1.7
WY2017	7/15/2017	7/25/2017	8/25/2017	--	1.7
WY2018	6/6/2018	6/19/2018	7/5/2018	7/28/2018	0.7
WY2019	6/29/2019	7/12/2019	7/27/2019	--	1.4
WY2020	6/17/2020	6/25/2020	7/12/2020	9/8/2020	0.8
WY2021	6/7/2021	6/17/2021	6/29/2021	7/11/2021	0.6
WY2022	6/27/2022	7/8/2022	--	--	--

Table 1 – Date discharge drops and stays below discharge threshold

	Days Between			
WY	10 cfs - 5 cfs	5 cfs - 2 cfs	2 cfs - 1 cfs	10 cfs - 1 cfs
WY2013	9	6	5	20
WY2014	14	22	34	70
WY2015	6	39	50	95
WY2016	8	17	--	--
WY2017	10	31	--	--
WY2018	13	16	23	52
WY2019	13	15	--	--
WY2020	8	17	58	83
WY2021	10	12	12	34
WY2022	11	--	--	--

Table 2 – Days between discharge thresholds

WY	<5 cfs	>5 cfs	Days <5 cfs	2 cfs	2 cfs	Days <2 cfs	1 cfs	1 cfs	Days < 1 cfs
WY2013	7/5/2013	1/29/2014	208	7/11/2013	9/30/2013	81	7/16/2013	8/23/2013	38
WY2014	6/12/2014	10/20/2014	130	7/4/2014	10/15/2014	103	8/7/2014	9/18/2014	42
WY2015	6/13/2015	12/2/2015	172	7/22/2015	10/26/2015	96	9/10/2015	10/12/2015	32
WY2016	7/12/2016	10/14/2016	94	7/29/2016	10/14/2016	77	--		0
WY2017	7/25/2017	11/9/2017	107	8/25/2017	9/19/2017	25	--		0
WY2018	6/19/2018	12/10/2018	174	7/5/2018	11/22/2018	140	7/28/2018	10/22/2018	86
WY2019	7/12/2019	12/12/2019	153	7/27/2019	9/18/2019	53	--		0
WY2020	6/25/2020	11/13/2020	141	7/12/2020	10/1/2020	81	9/8/2020	9/25/2020	17
WY2021	6/17/2021	10/22/2021	127	6/29/2021	9/28/2021	91	7/11/2021	9/27/2021	78

Table 3 – Duration (days) discharge is less than discharge threshold

Mid French FRGP Side Channel – Water Temperature

Water temperature (°C) at the French Creek constructed side channel (FRGP Side Channel) has been monitored in several locations since construction in WY2018. Continuous and daily average water temperature (°C) at the shallower location at the side channel outlet illustrates a different temperature regime in winter and summer of WY2022 compared to the previous water years (Figures 1 & 2). Calculation of the maximum and minimum Moving Weekly Average Temperature (MWAT) for each water year corroborates this observation (Tables 1 & 2). The maximum MWAT in WY2022 (17.5 °C) is significantly cooler than all previous water years including the average water year of WY2019 (18.4 °C). The minimum MWAT in WY2022 is significantly warmer (3.6 °C) than the minimum MWAT during the three previous winters.

Comparison of the daily average temperature by Julian Day for WY2022 and WY2021 further illustrates the warmer winter temperatures and cooler summer temperatures in WY2022 compared to the previous water year (Figure 3).

Dense aquatic macrophytes were observed throughout the deep water of the FRGP side channel in the winter of WY2022. It is hypothesized that the dense macrophytes provided shade to the water during the summer base flow period leading to cooler water temperatures. Understanding the cause of the warmer winter water temperatures is more complicated. In general, warmer winter temperatures are indicative of a groundwater input. It is hypothesized that the dense macrophytes reduced the flow through and velocity of surface water in the constructed side channel leading to preservation of the groundwater influence on the temperature regime.

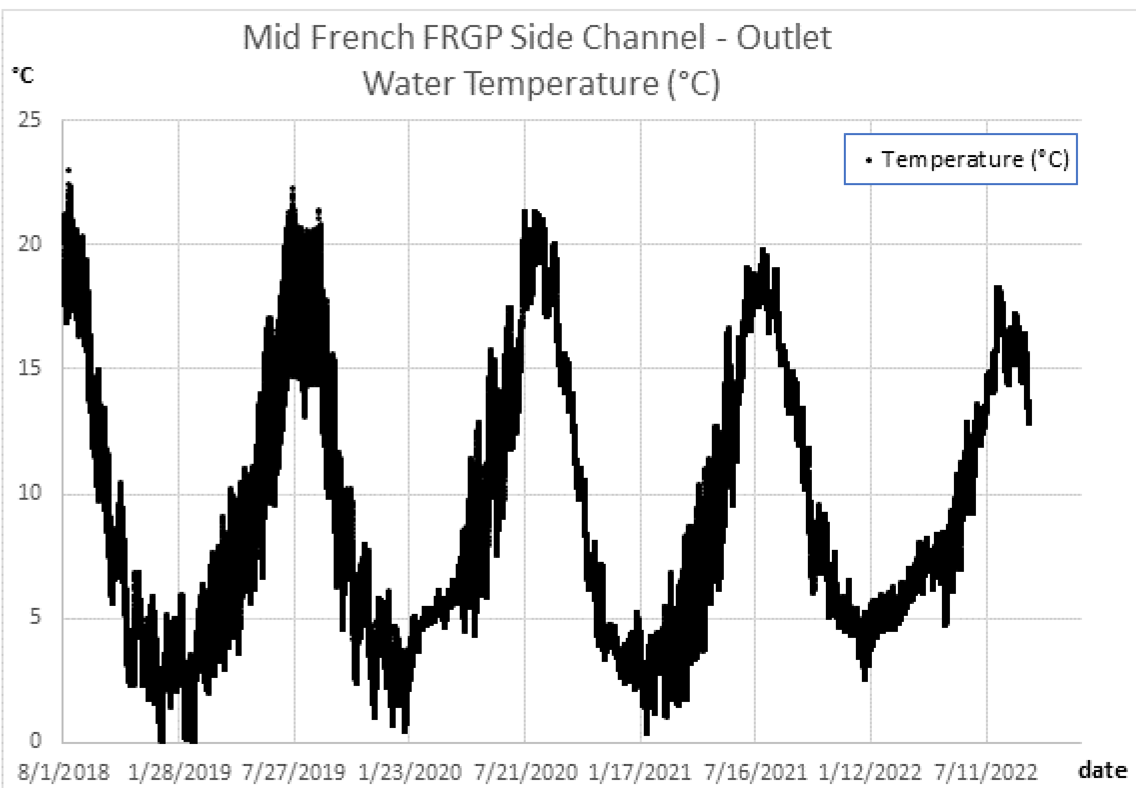


Figure 1 – Water temperature (°C) – Mid French FRGP Side Channel – Outlet – WY2018 – WY2022

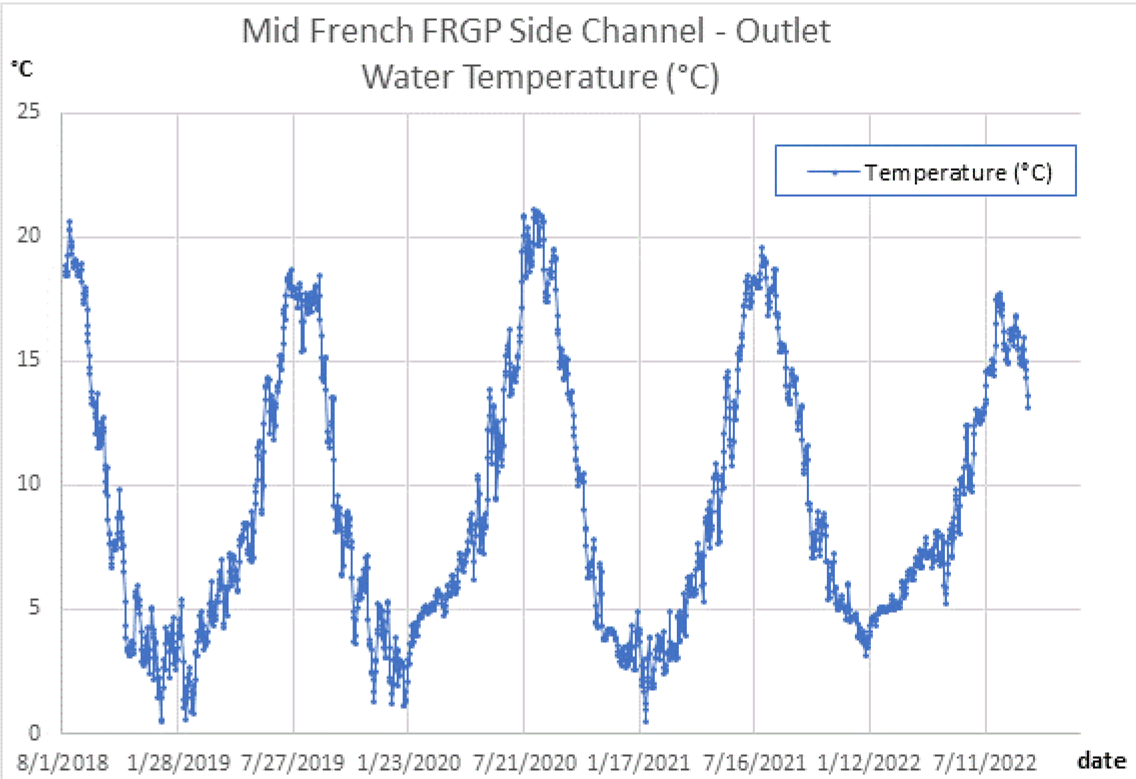


Figure 2 – Daily average water temperature (°C) –FRGP Side Channel – Outlet – WY18 – WY22

Mid French - FRGP Side Channel Outlet
Maximum MWAT (°C)

WY	Maximum MWAT °C	Date
2018	20.0	8/16/2018
2019	18.4	7/23/2019
2020	20.9	8/11/2020
2021	19.1	8/1/2021
2022	17.5	8/3/2022

Table 1 – Maximum MWAT °C and date of occurrence by water year

Mid French - FRGP Side Channel Outlet
Minimum MWAT (°C)

WY	Minimum MWAT °C	Date
2019	1.3	2/11/2019
2020	1.6	1/20/2020
2021	1.5	1/30/2021
2022	3.6	1/9/2022

Table 2 – Minimum MWAT °C and date of occurrence by water year

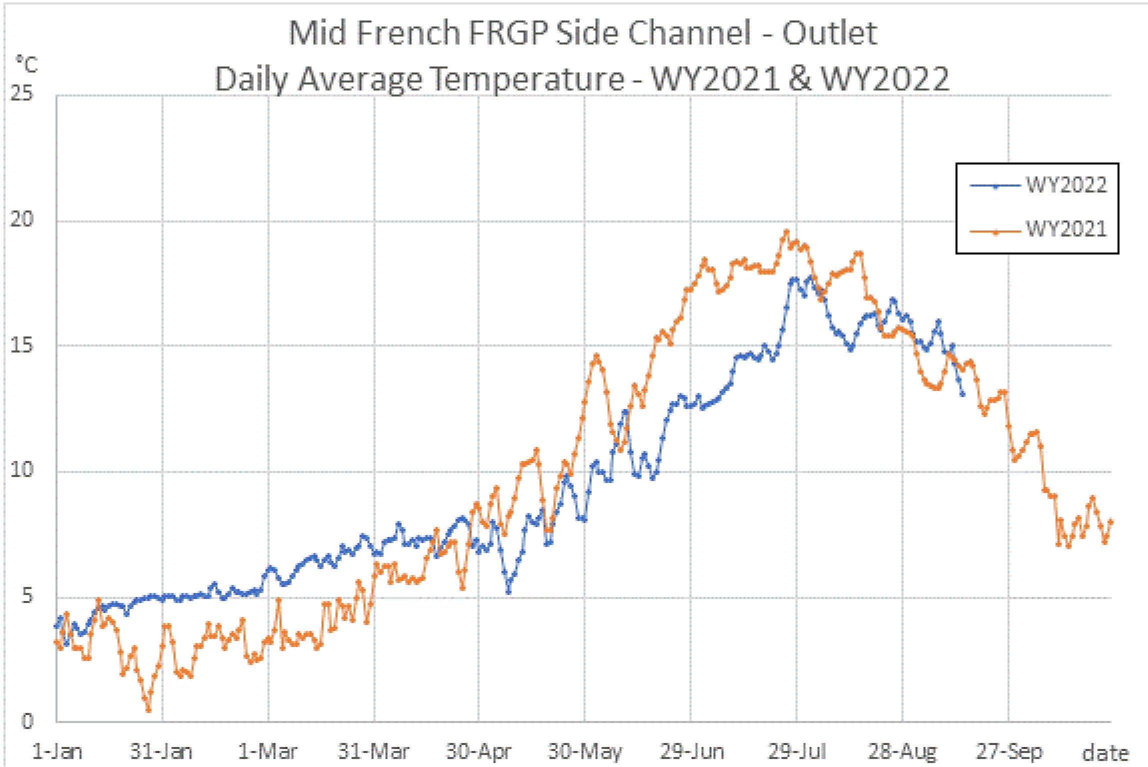
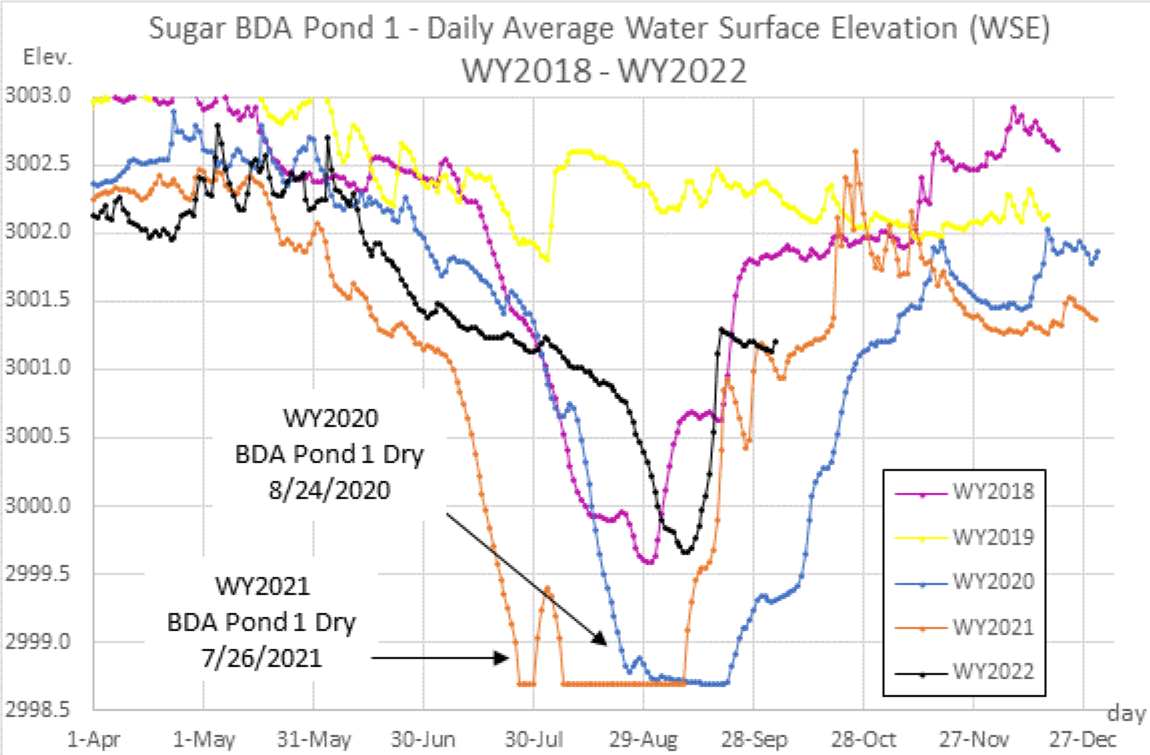
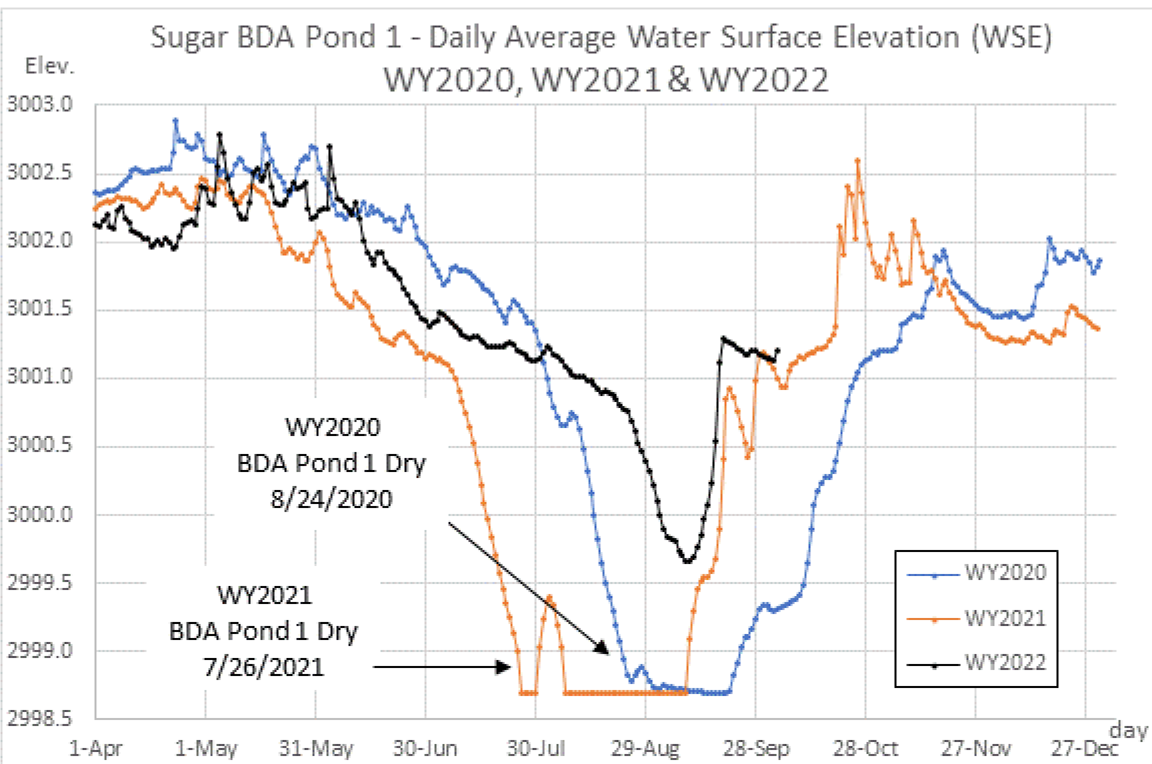
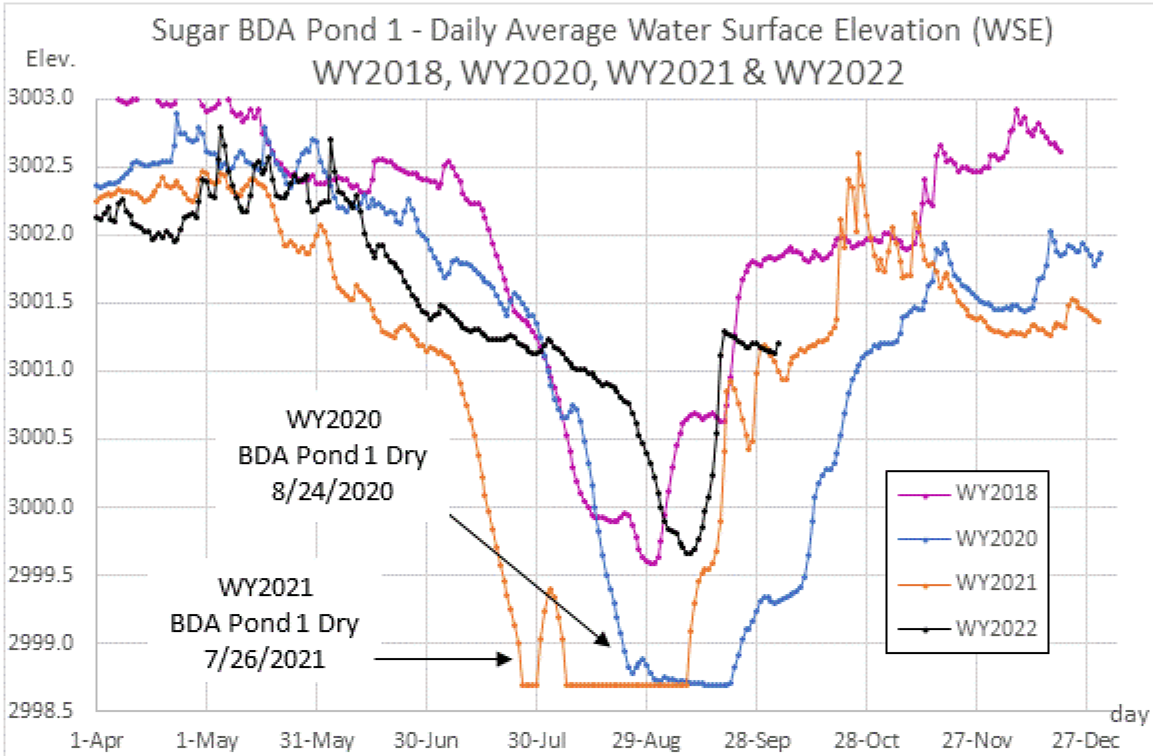


Figure 3 – Daily average water temperature (°C) – WY2021 & WY2022

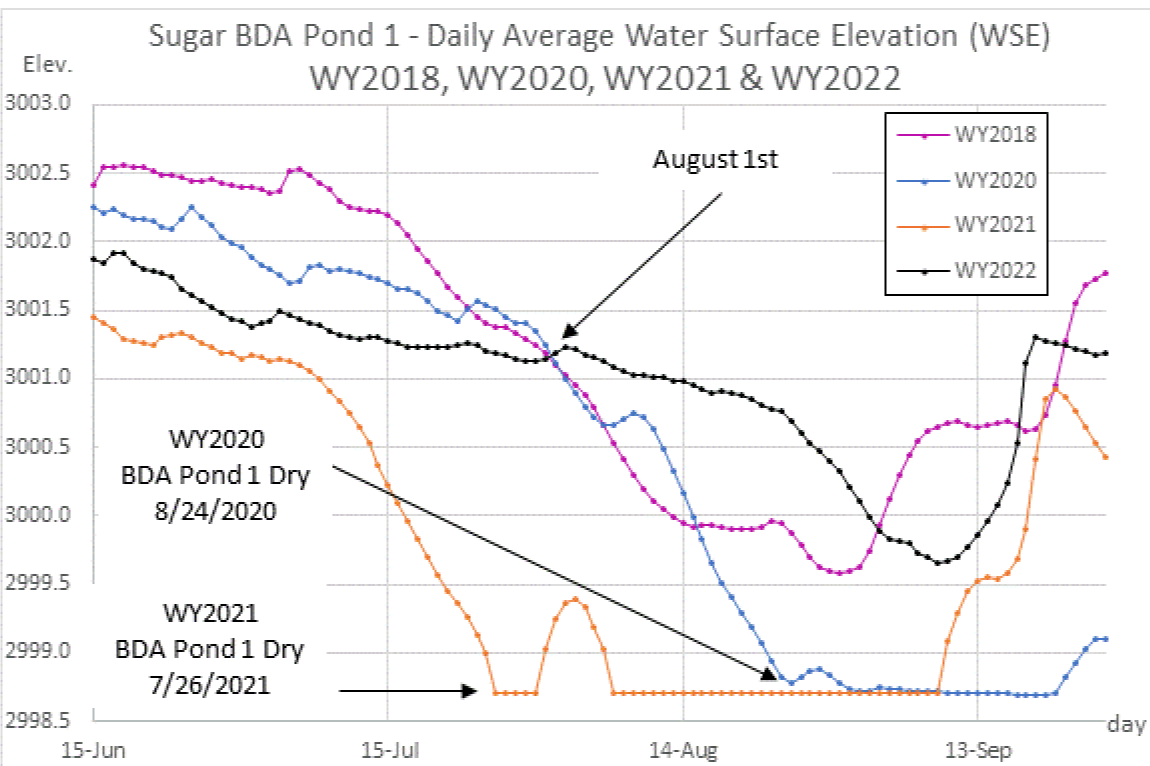
Sugar BDA Pond 1 – Water Surface Elevation – WY2018 – WY2022







Sugar BDA Pond 1 - Daily Average Water Surface Elevation (WSE)
WY2018, WY2020, WY2021 & WY2022
Elev.
3003.0
3002.5
3002.0
3001.5
3001.0
3000.5
3000.0
2999.5
2999.0
2998.5
1-Apr
1-May
31-May
30-Jun
30-Jul
29-Aug
28-Sep
28-Oct
27-Nov
27-Dec
day
WY2020
BDA Pond 1 Dry
8/24/2020
WY2021
BDA Pond 1 Dry
7/26/2021
WY2018
WY2020
WY2021
WY2022



Sugar BDA Pond 1 - Daily Average Water Surface Elevation (WSE)
WY2018, WY2020, WY2021 & WY2022
Elev.
3003.0
3002.5
3002.0
3001.5
3001.0
3000.5
3000.0
2999.5
2999.0
2998.5
15-Jun
15-Jul
14-Aug
13-Sep
day
August 1st
WY2020
BDA Pond 1 Dry
8/24/2020
WY2021
BDA Pond 1 Dry
7/26/2021
WY2018
WY2020
WY2021
WY2022

Sugar Creek BDA Pond 1 Water Surface Elevation
Scott River Watershed Council – 10/6/2022

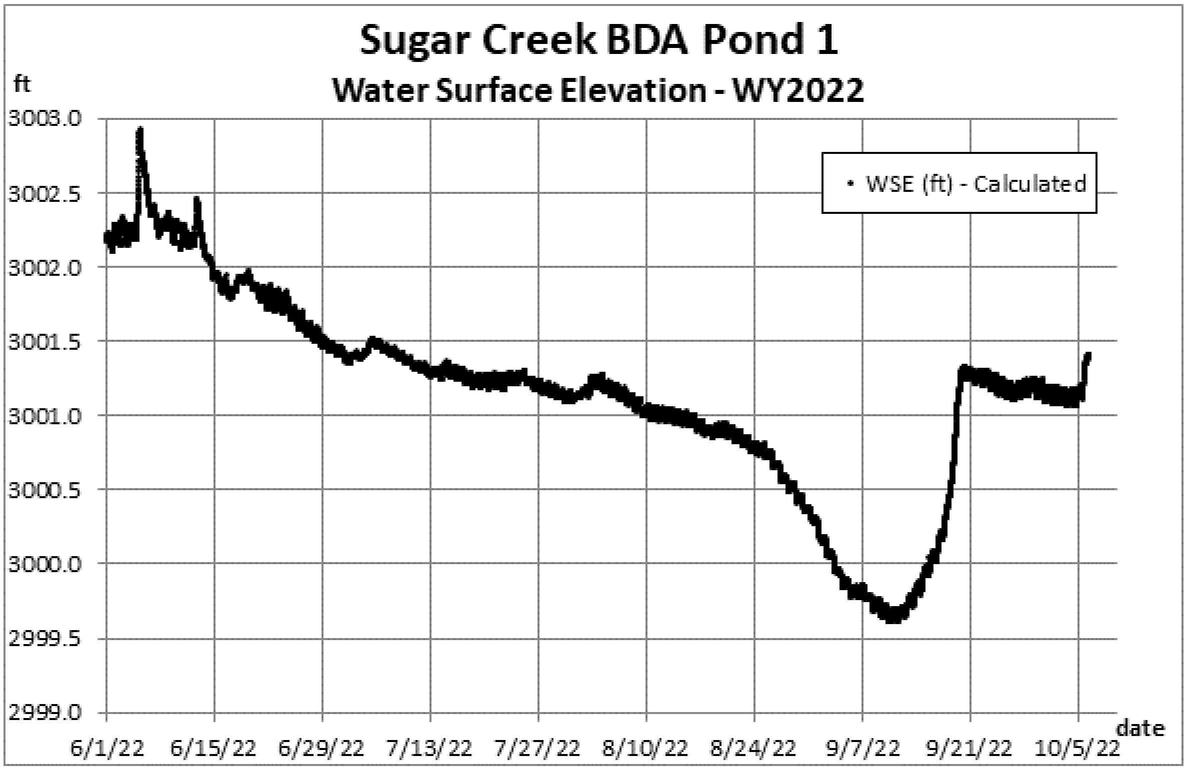


Figure 1 – Calculated Water Surface Elevation

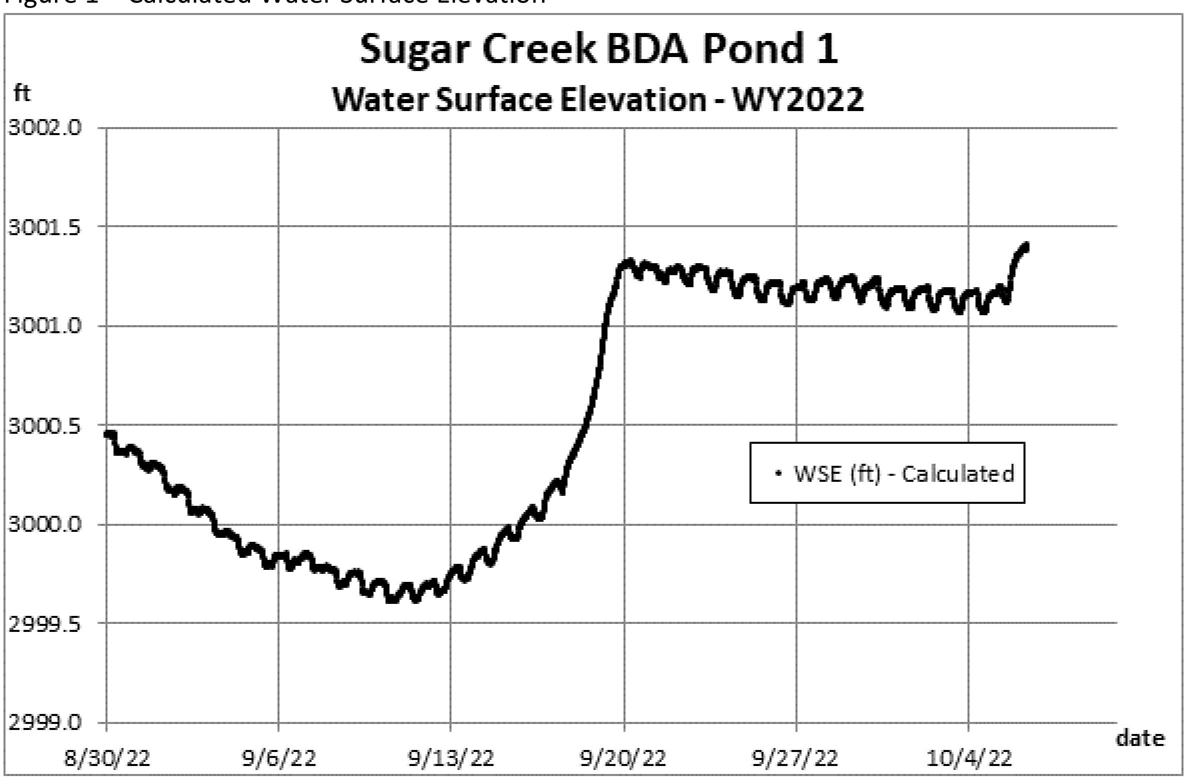
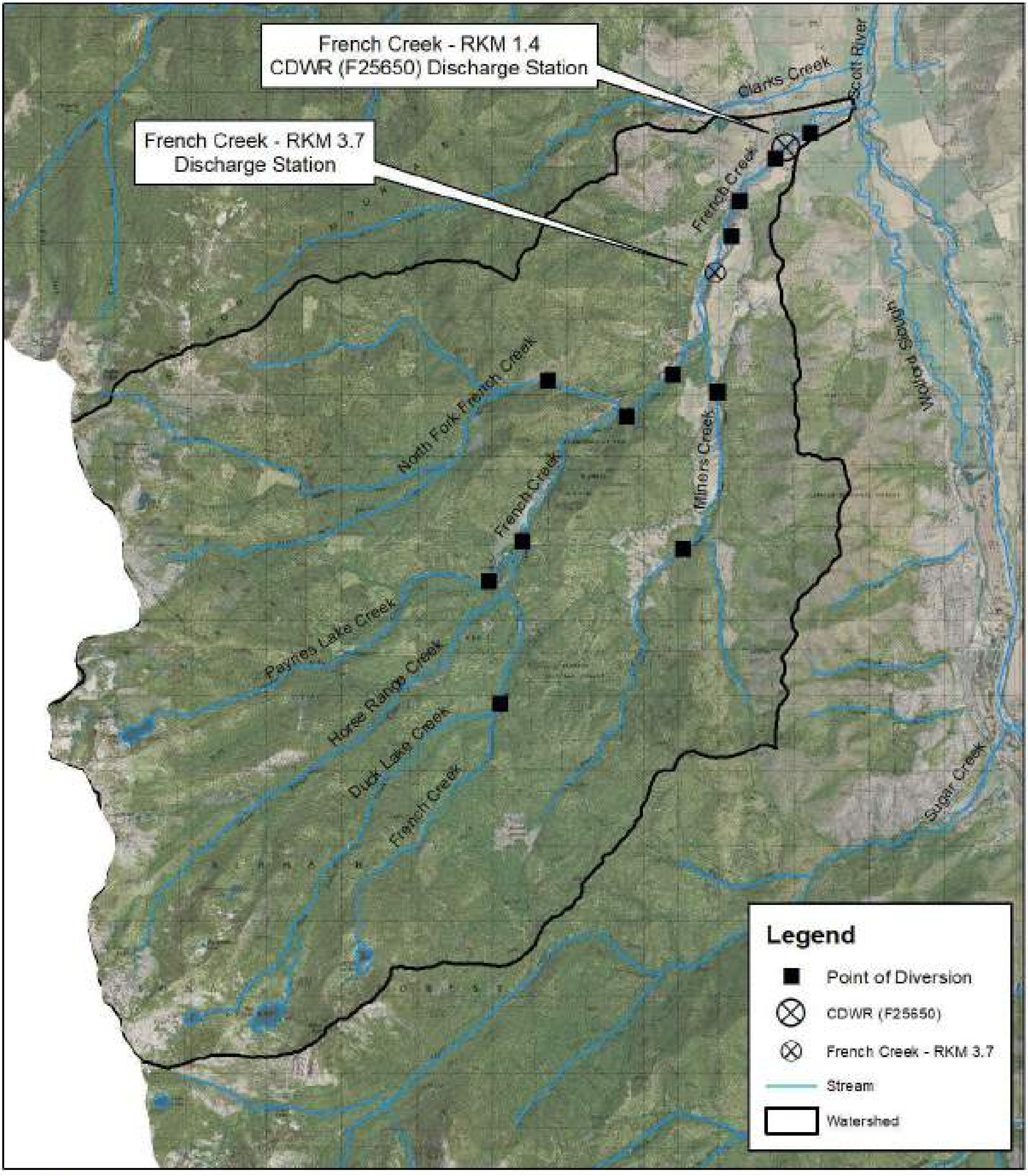


Figure 2 – Calculated Water Surface Elevation

Figure 3 – Daily average Water Surface Elevation

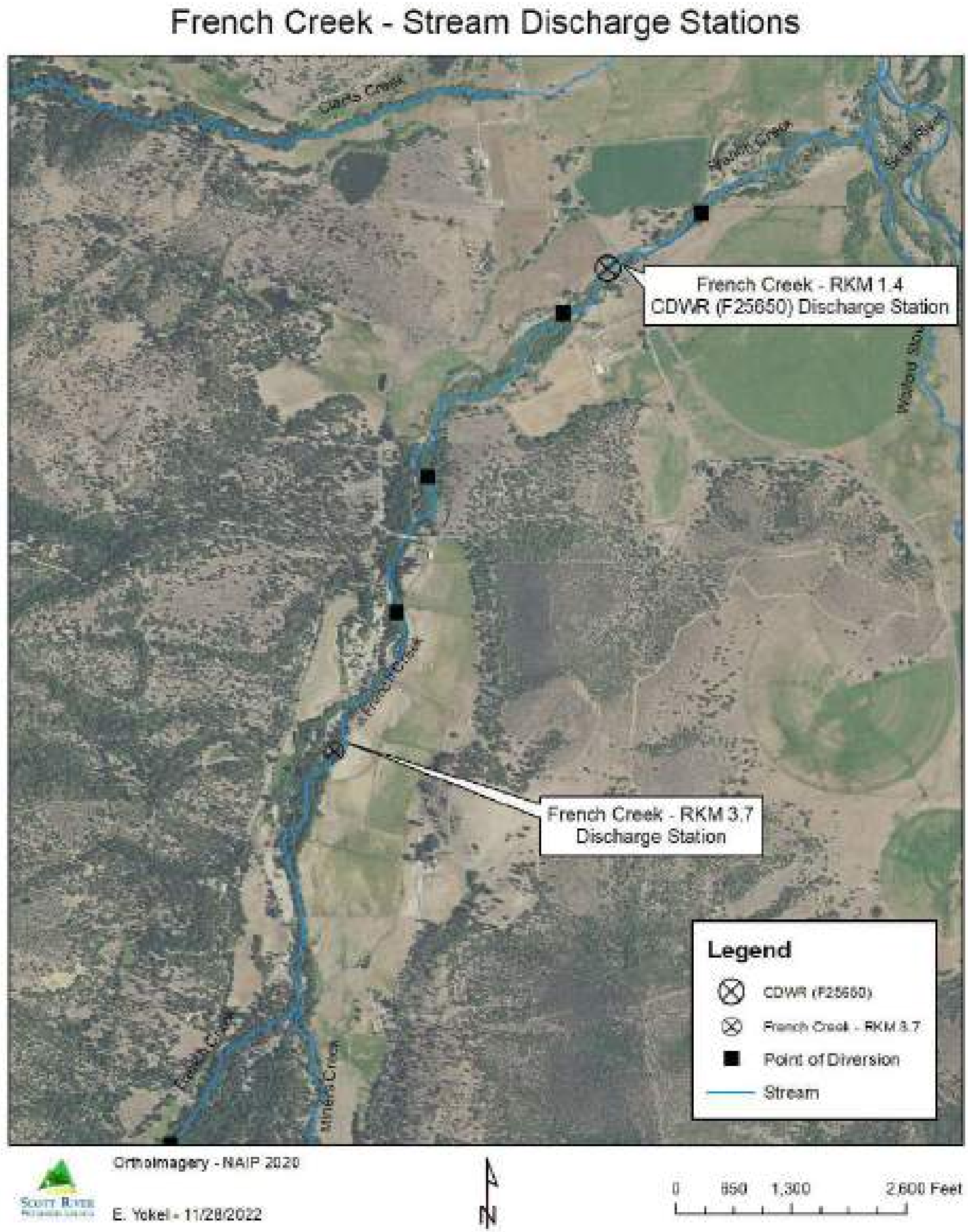
French Creek Watershed



Scott River Watershed Council

E. Yokel - 11/28/2022

French Creek RKM 3.7 Discharge
Scott River Watershed Council



Map 1 – French Creek Stream Discharge Stations

Periodic discharge measurements were performed at the French Creek RKM 3.7 discharge station (Map 1) in WY2022 to develop a rating curve – Table 1.

Continuous and daily average discharge (cfs) was calculated - Figures 1 & 2.

French Creek - RKM 3.7

Date (PST)	Q (cfs)
3/30/22 12:23	40.1
6/15/22 9:05	27.6
6/20/22 10:33	22.8
6/27/22 12:00	14.5
7/7/22 12:19	10.8
7/15/22 10:54	6.6
7/20/22 9:08	5.7
7/27/22 8:07	4.4
8/10/22 12:10	2.5
8/15/22 12:55	1.9
8/24/22 13:46	1.1
8/31/22 13:08	1.5
9/6/22 13:40	1.4
10/10/22 10:50	1.4

Table 1 – Periodic discharge measurements

Daily mean discharge (cfs) at the CDWR French Creek RKM 1.4 gage (F25650) for WY2021 and WY2022 was retrieved from the CDWR Water Data Library (wdl.water.ca.gov). The daily mean discharge at RKM 1.4 and RKM 3.7 in WY2022 was compared - Figure 3 & 4.

The daily mean discharge (cfs) documented at French Creek RKM 1.4 in WY2021 and WY2022 was compared by Julian day – Figures 5 & 6.

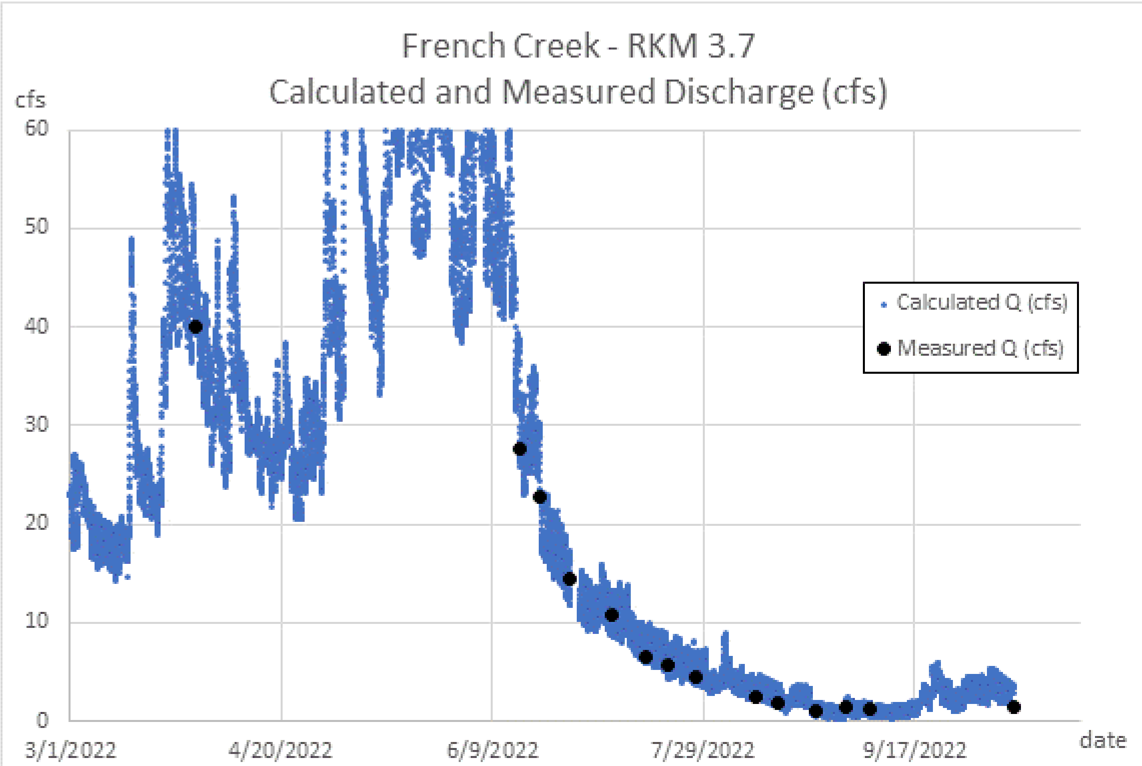


Figure 1 – Calculated and measured discharge (cfs) – French Creek RKM 3.7

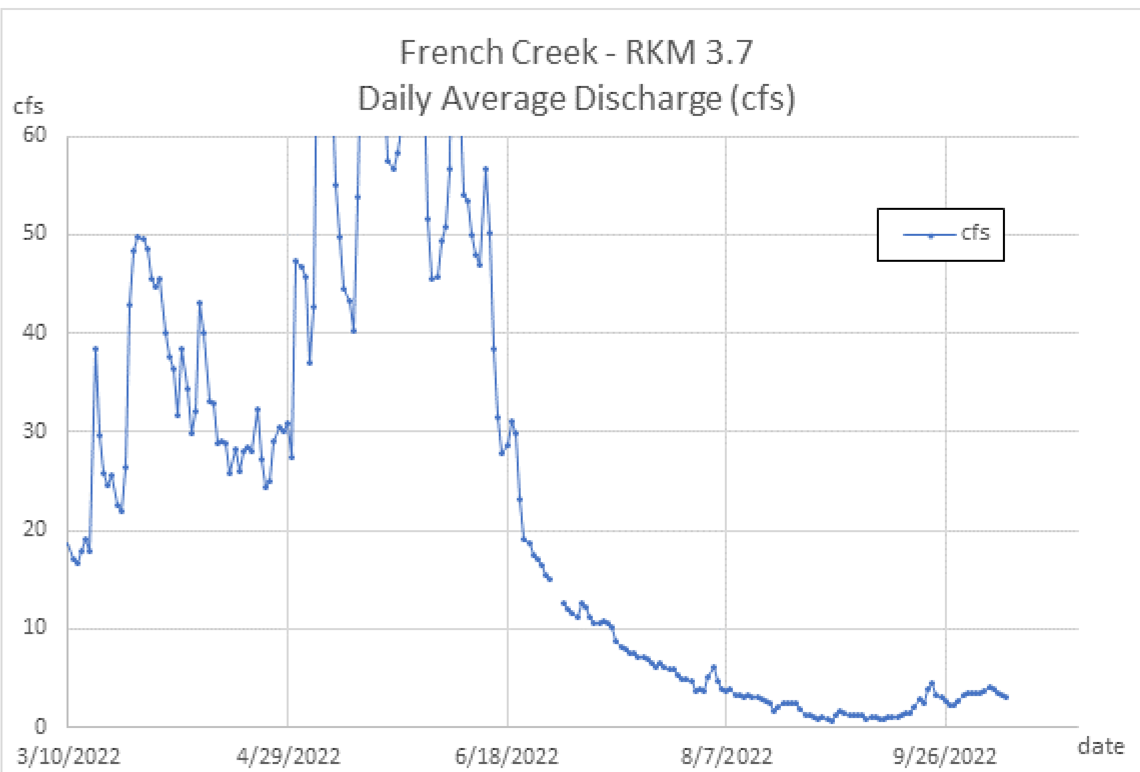


Figure 2 – Daily average discharge (cfs) – French Creek RKM 3.7

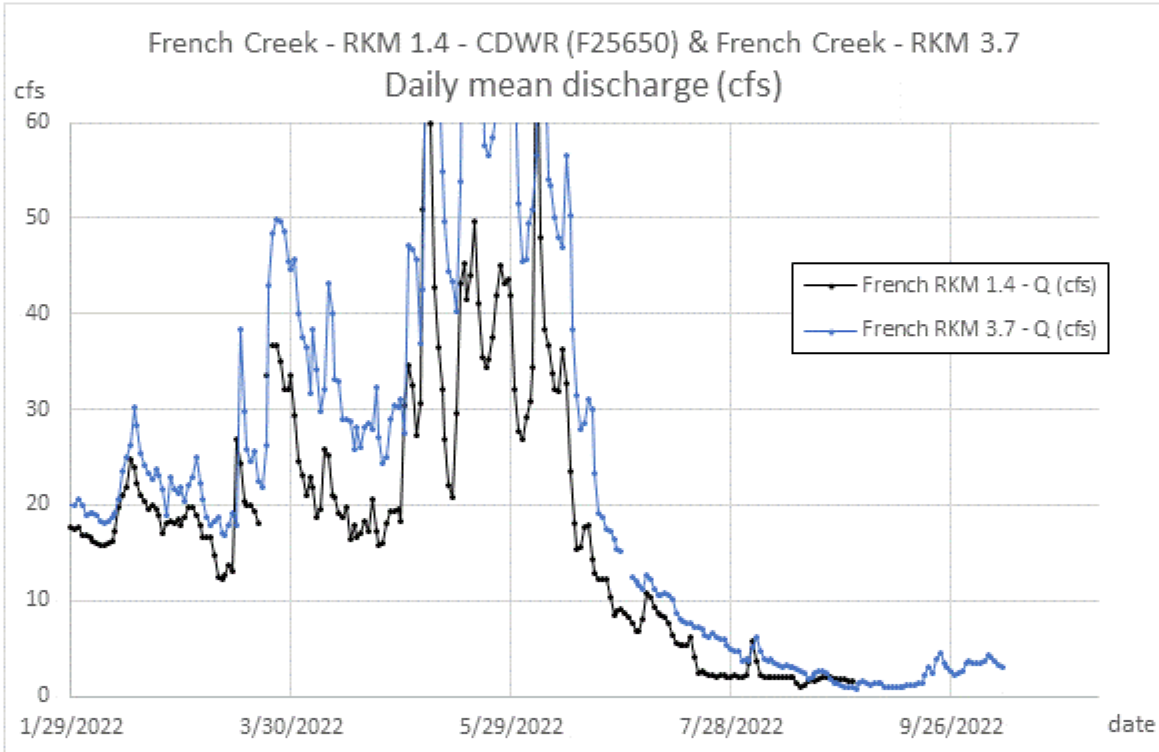


Figure 3 – Daily mean discharge – RKM 1.4 & RKM 3.7

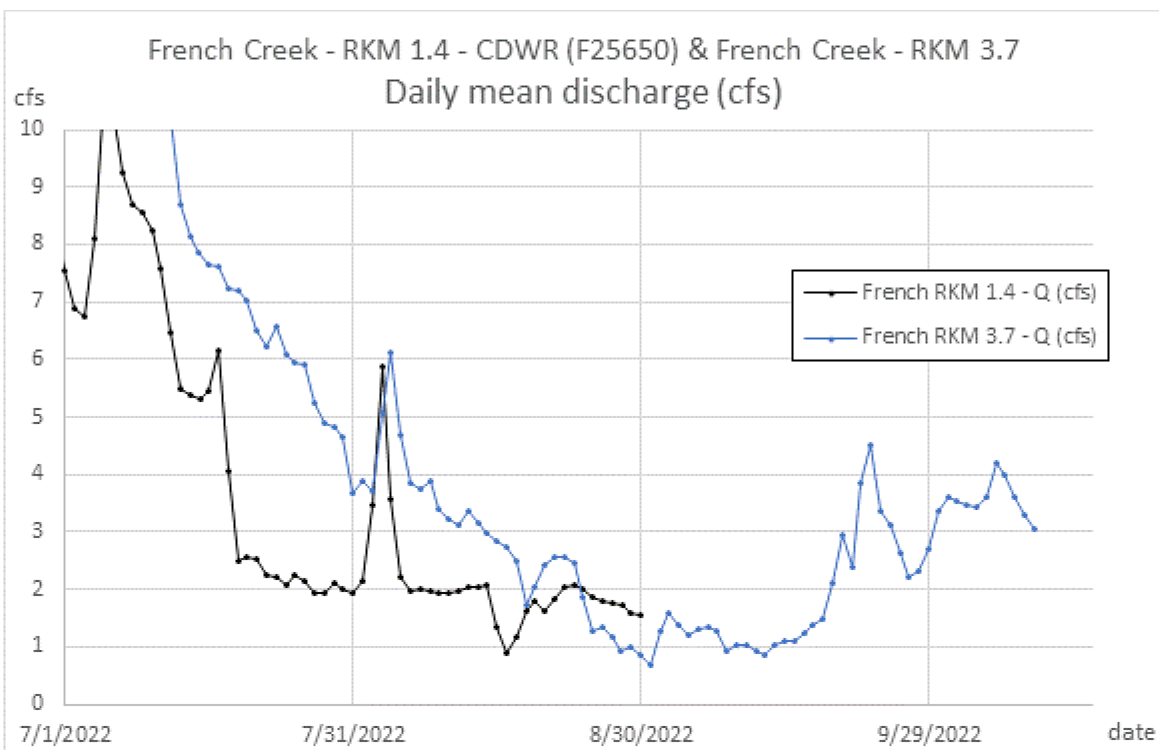


Figure 4 – Daily mean discharge – RKM 1.4 & RKM 3.7

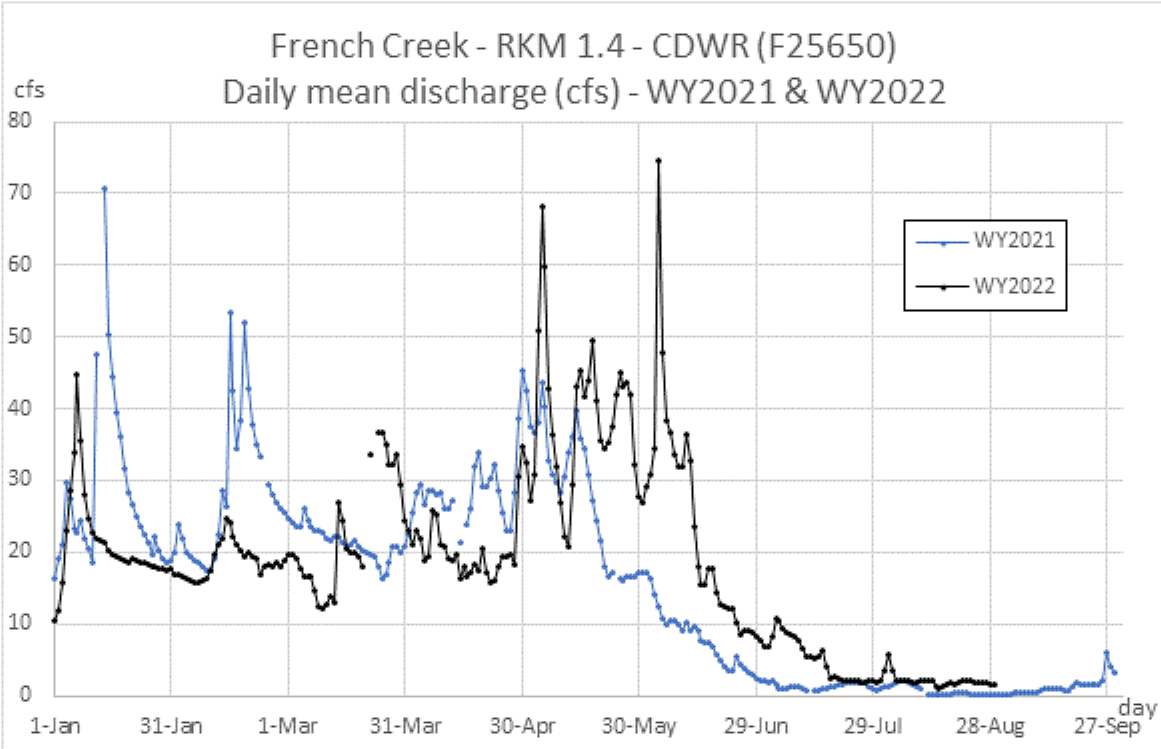


Figure 5 – French RKM 1.4 – Daily mean discharge (cfs) by Julian day – WY2021 & WY2022

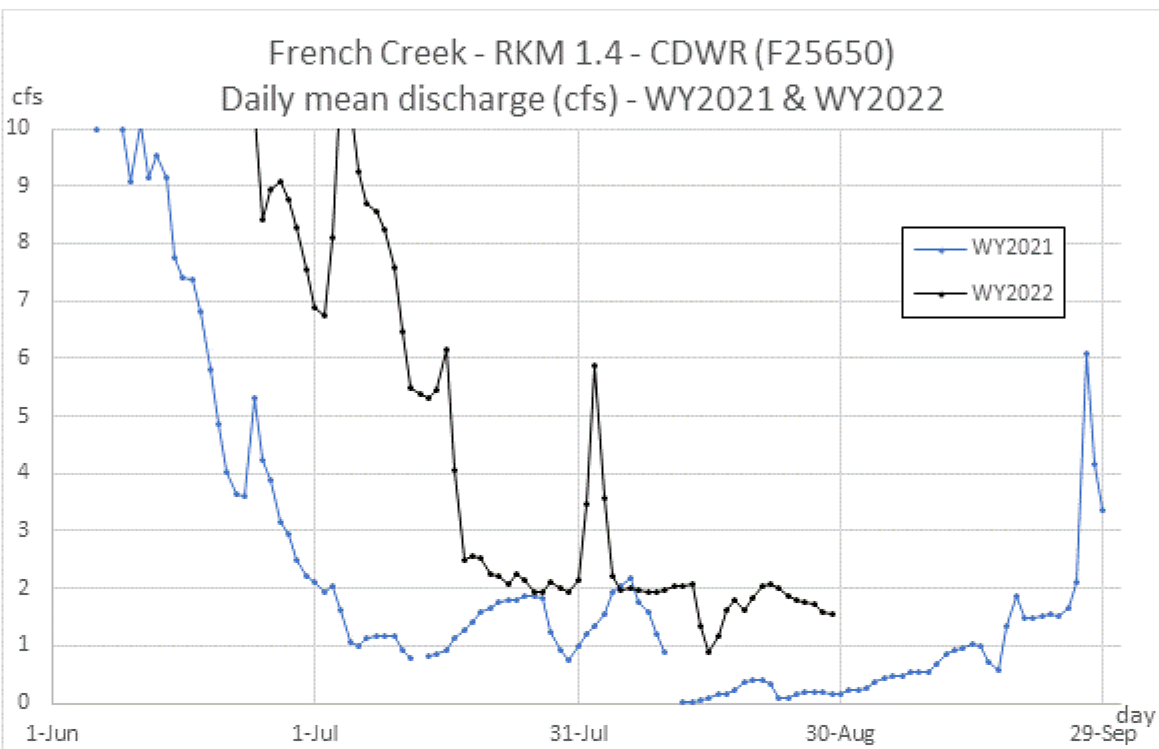


Figure 6 – French RKM 1.4 – Daily mean discharge (cfs) by Julian Day – WY2021 & WY2022

Appendix B:

SRWC Project Outreach Presentations

Scott River BDA Program

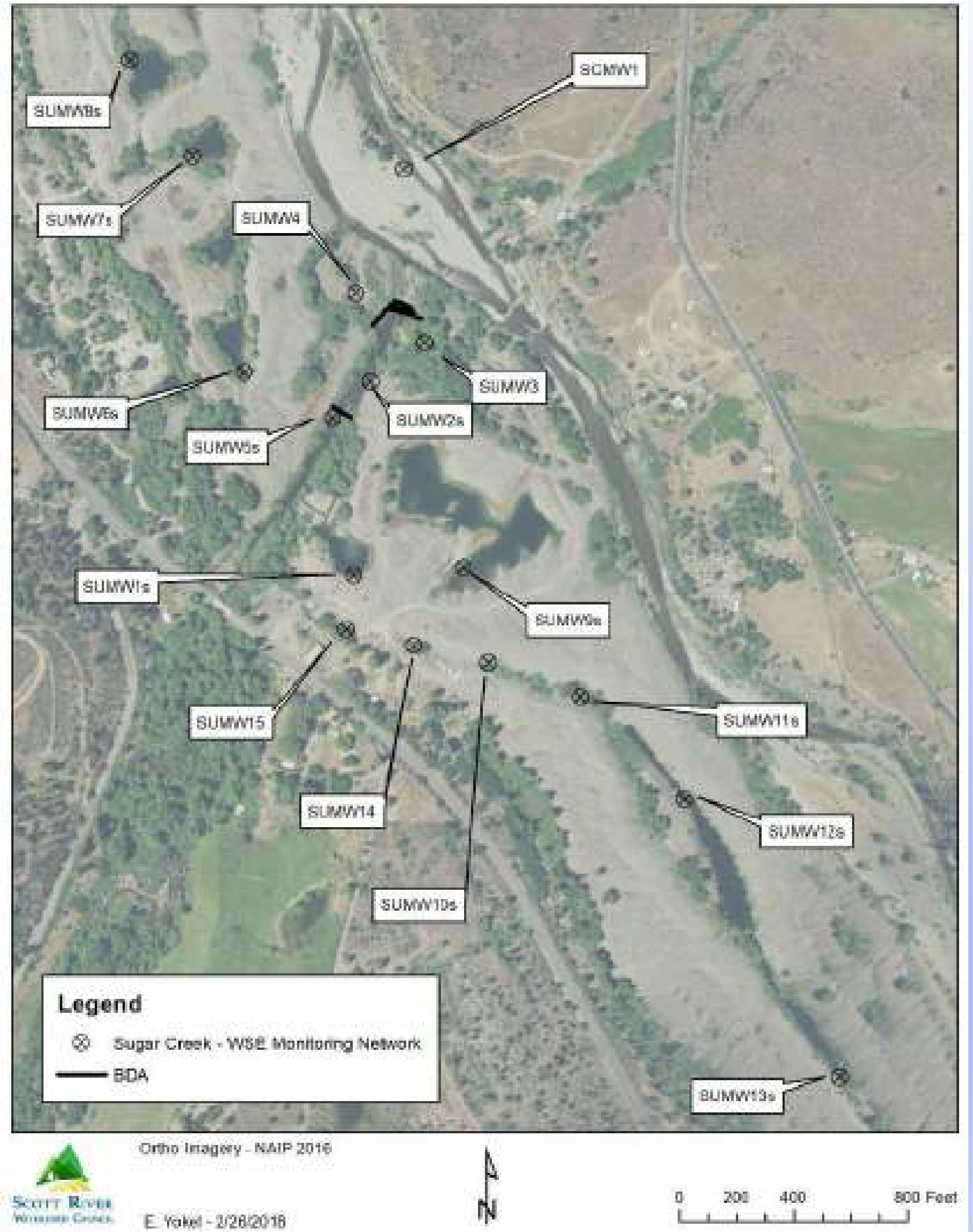
Where we have been
What we have learned
Where we are going

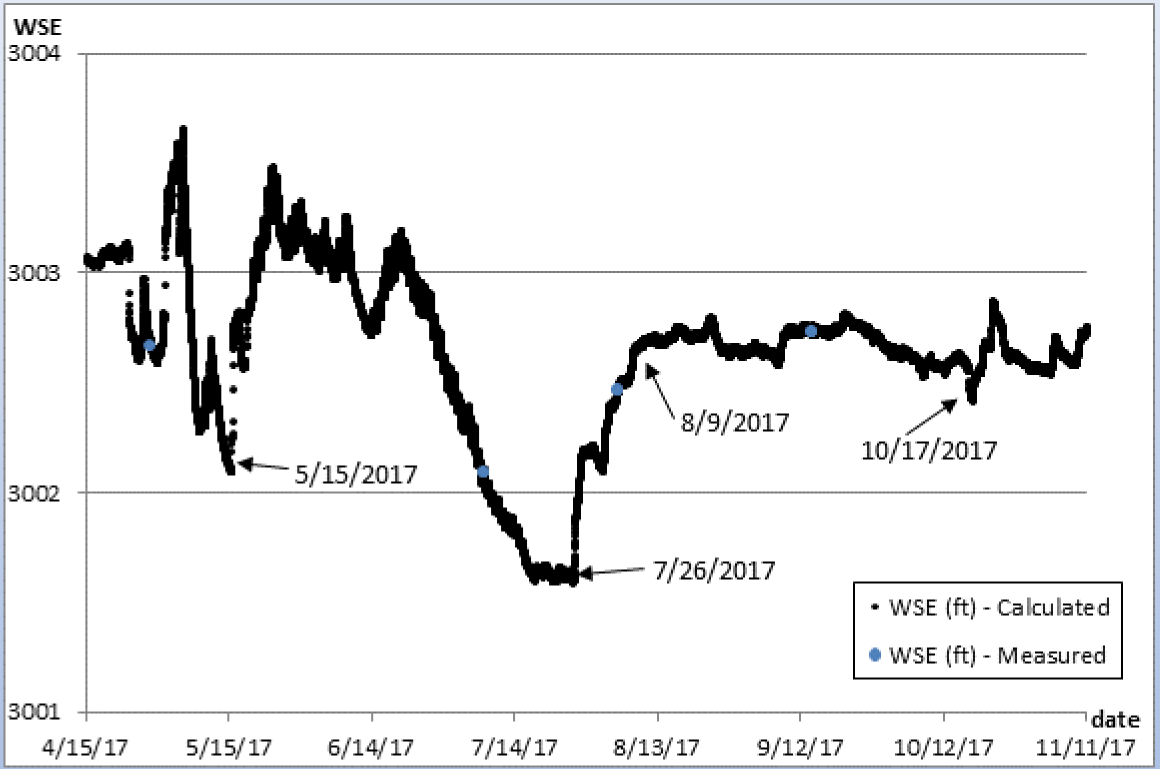
Erich Yokel, Betsy Stapleton, Charnna Gilmore,
Shari Witmore, Kristen Sellmer and Michael M. Pollock

Acknowledgements: Bob Pagliuco*, NOAA Restoration Center*; Serena Doose, Ryan Fogerty, Shari Hagwood, Dave Johnson & Rebecca Reeves, *US Fish and Wildlife Service Partners Program*; Anne Butterfield & Colleen Walters, *National Fish and Wildlife Foundation;* Demian Ebert*, PacifiCorp;* Annie Yates & the Board of Directors*, Bella Vista Foundation*; Eli Scott, Jake Shannon & Jonathan Warmerdam of the *North Coast Regional Water Quality Control Board;* Curt Babcock, Jennifer Bull, Mike Harris, Mary Olswang, Janae Scruggs, Mark Smelser*, California Department of Fish and Wildlife*; Joey Howard, PE., *Cascade Stream Solutions*; Kenneth Brink, Mike Polmateer, Toz Soto & Clayton Tuttle, *Karuk Tribe*; Sarah Rockwell, Jeff & Jaime Stephens, *Klamath Bird Observatory*; *Scott Valley Landowners* Samual Betzen, Mike Kalpin, Jerry Lewis, Bill & Jeffy Marx, Michael & Betsy Stapleton, Becky Schenone, the Farmers Ditch Company, the Tobias Ranch & the Whipple Ranch*;* Brian Cluer & Don Flickinger, *NOAA Fisheries*; Bill & Patty Parry *of North Rivers Construction*; Rocco Fiori, *Fiori Geosciences*; Darren Ward, Professor, *Humboldt State University*; Lindsay Magranet*, Siskiyou Resource Conservation District*; Sarah Beesley, *Yurok Tribe*, Will Harling, *Mid Klamath Watershed Council* and Michael & Lynn Thamer, *Community Members*. *Scott River Watershed Council* Board of Directors Larry Alexander, Dan Gerson, Jeff Horner, Michael Stapleton, Craig Thompson and Steve Ziegler; and most important of all, the fine field and office staff of the *Scott River Watershed Council* that served in 2017- Linda Bailey, Isis Hayden, Jess McArthur, Collin McCloskey, Dale Munson, Joe Pedro, Amanda Schmalenberger, Kristen Sellmer, Jennifer Silveira, Earl Summers, Wade Dedobbeleer and Peter Thamer.

Lower Sugar Creek – BDA Treatment Reach

Water Surface Elevation

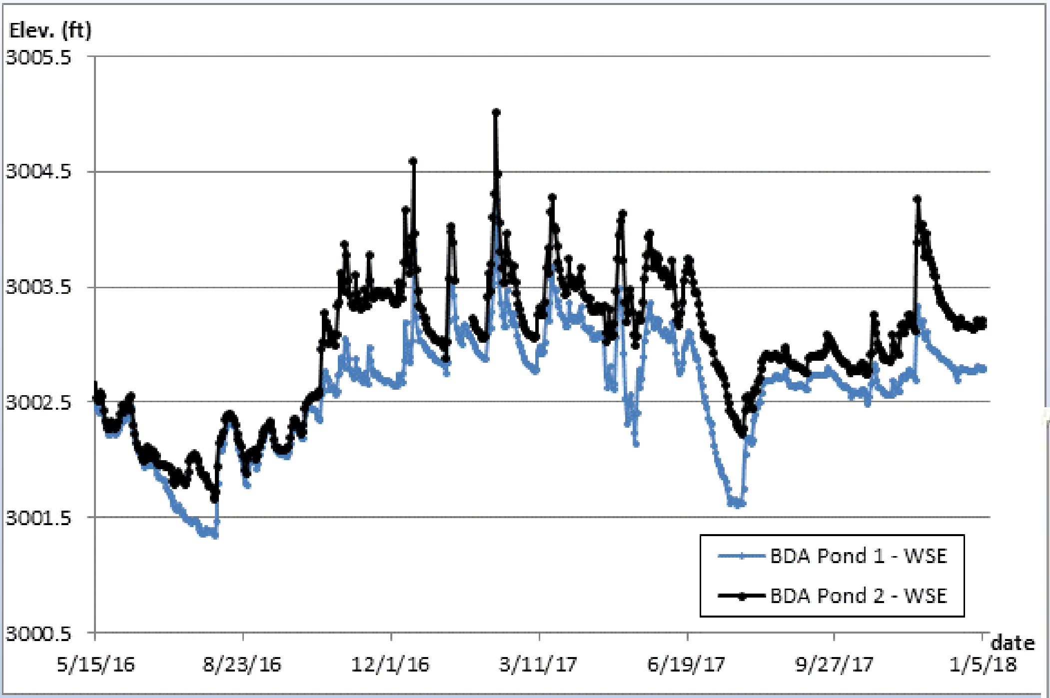




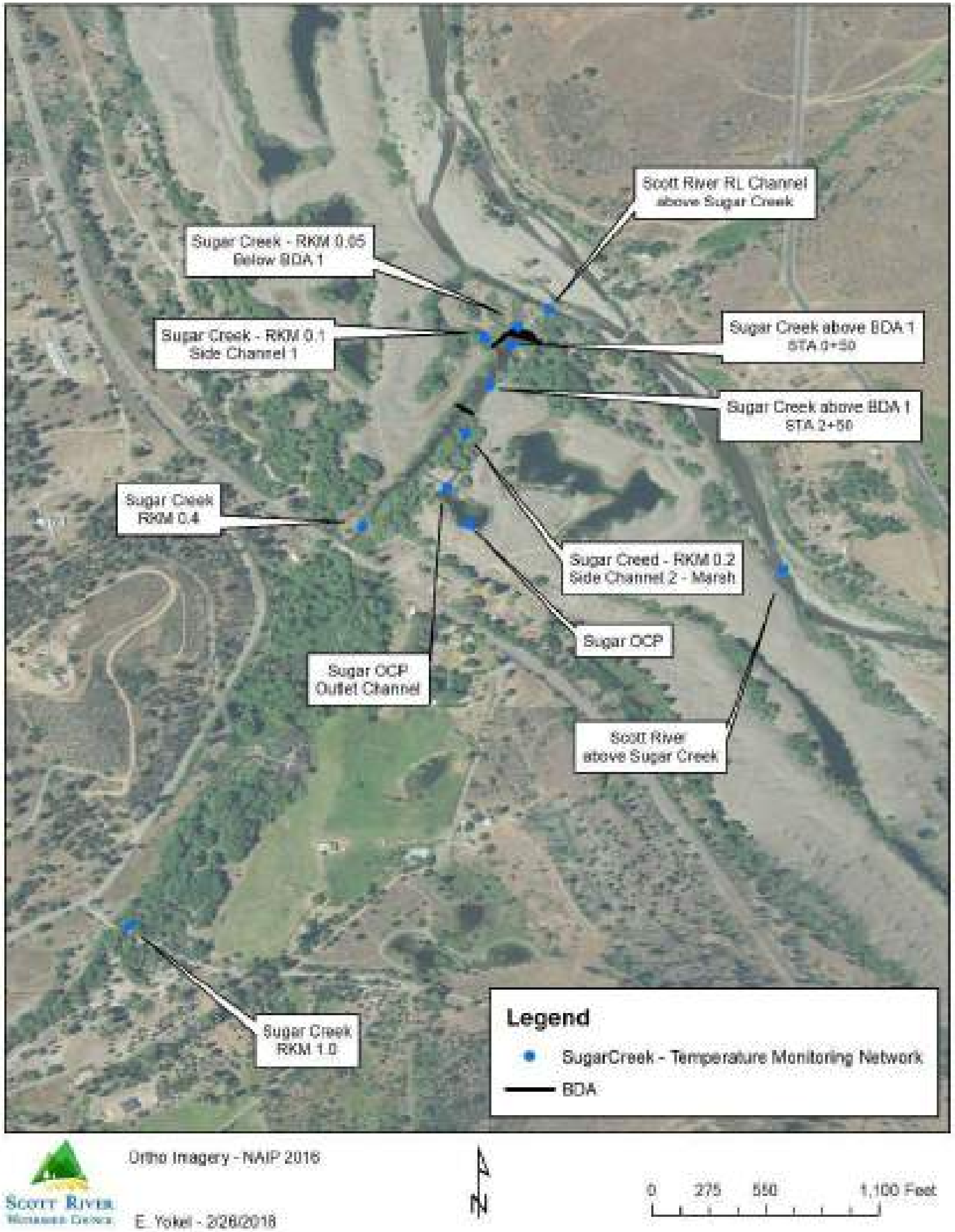
Water Surface Elevation in Sugar BDA 1 Pond – WY 17

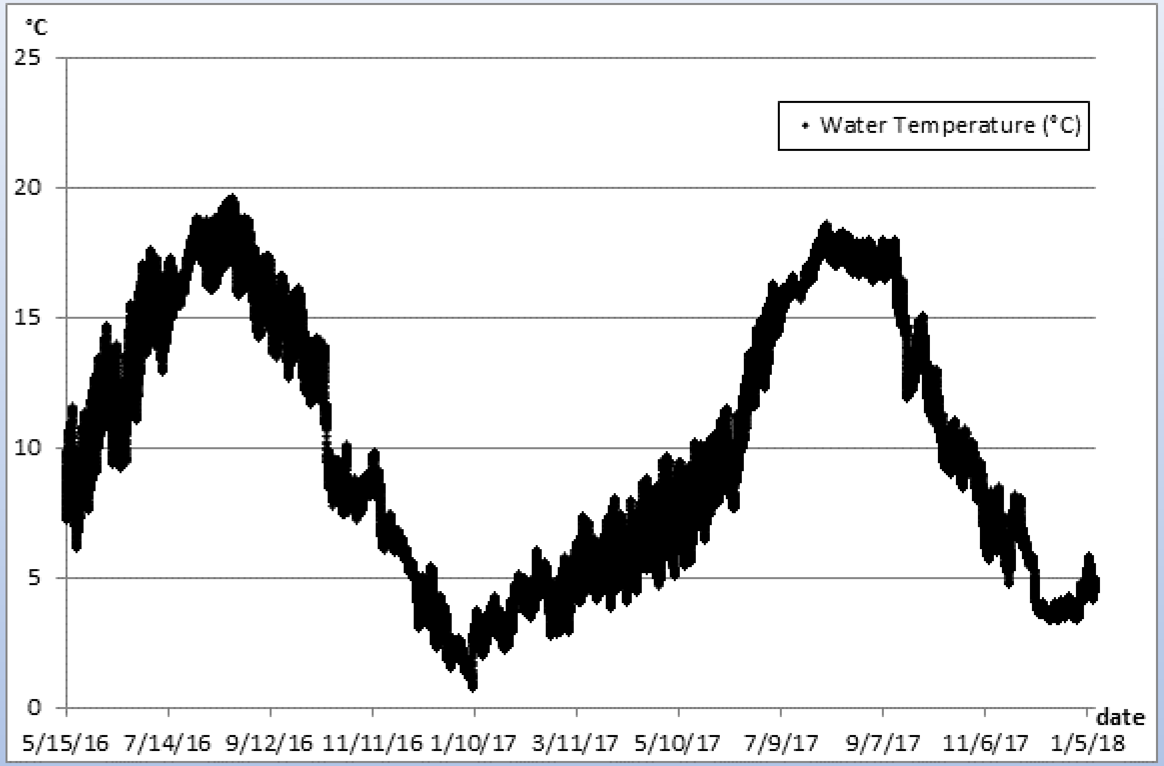
Water surface elevation during the base flow period of summer has increased every year since the installation of the BDAs in Lower Sugar

Beaver have maintained the upper BDA in Lower Sugar Creek significantly increasing the water surface elevation

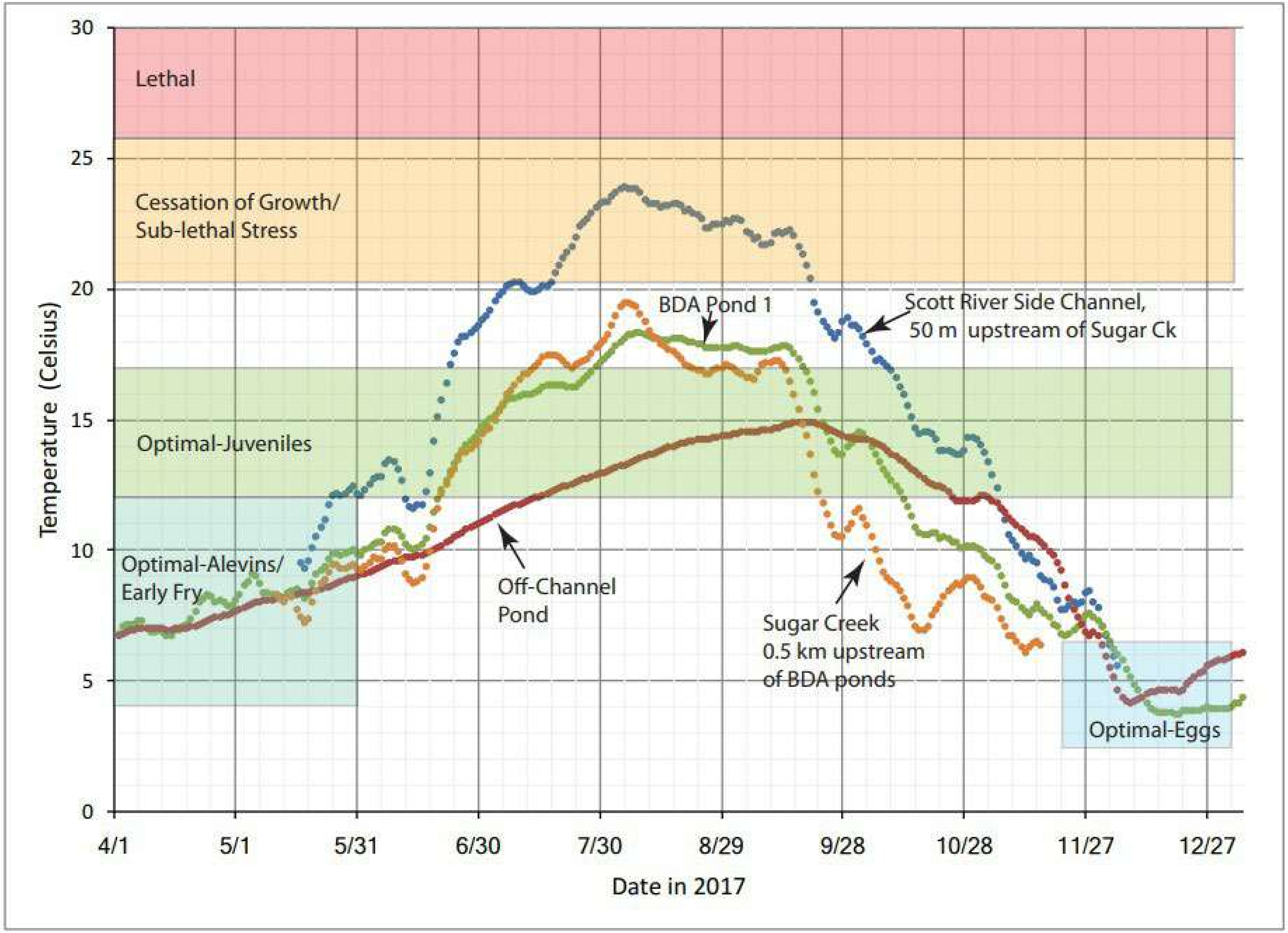


Water Temperature





Water Temperature (°C) in Sugar BDA 1 Pond – WY 16 - 17



Lethal
Cessation of Growth/
Sub-lethal Stress
Optimal-Juveniles
Optimal-Alevins/
Early Fry
Optimal-Eggs
BDA Pond 1
Scott River Side Channel,
50 m upstream of Sugar Ck
Off-Channel
Pond
Sugar Creek
0.5 km upstream
of BDA ponds
Temperature (Celsius)
30
25
20
15
10
5
0
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date in 2017

Fish Utilization

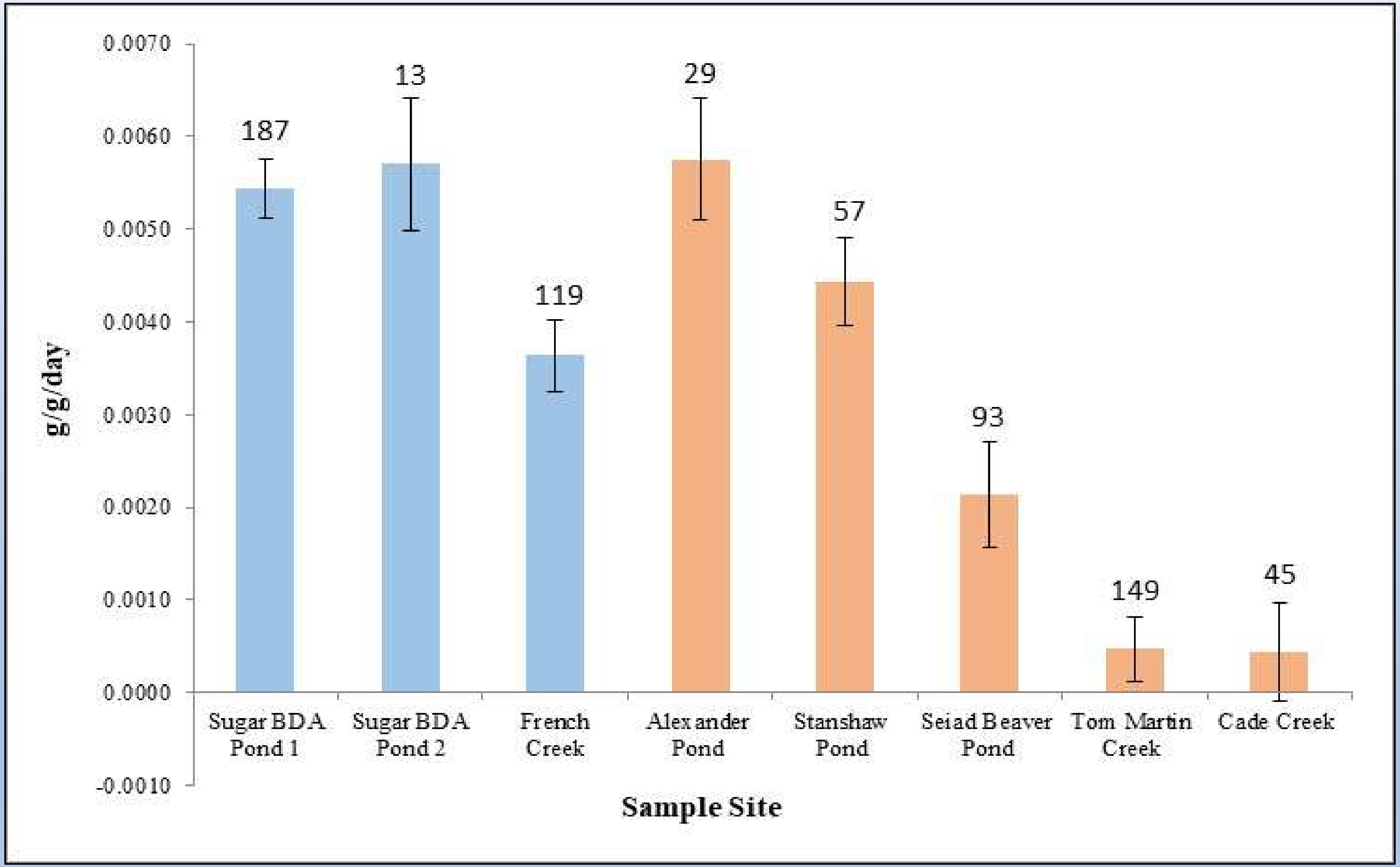
Fish Sampling

Number of PIT Tagged fish in 2017

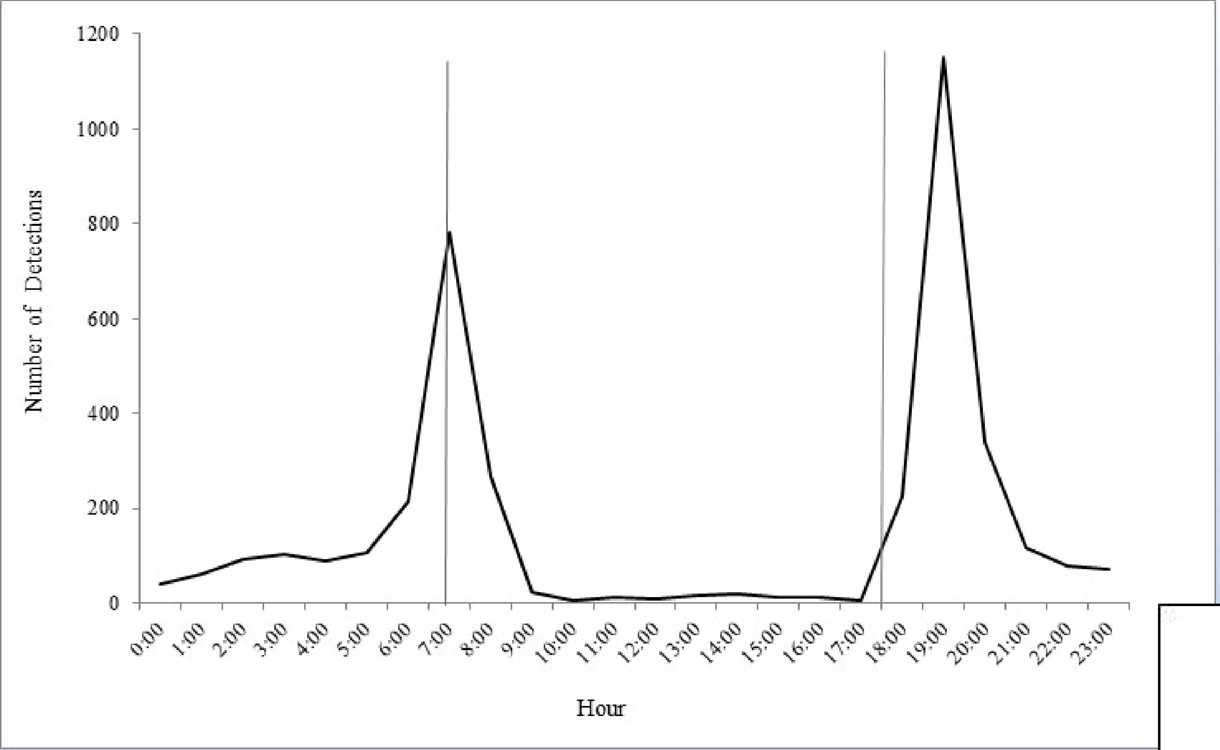
Stream	Total Marked	Coho (%)	Steelhead (%)	Chinook (%)
French Creek	392	81.4%	16.6%	2.3%
Sugar Creek	1,272	80.8%	18.8%	0.4%
Miners Creek	75	92.0%	8.0%	0.0%

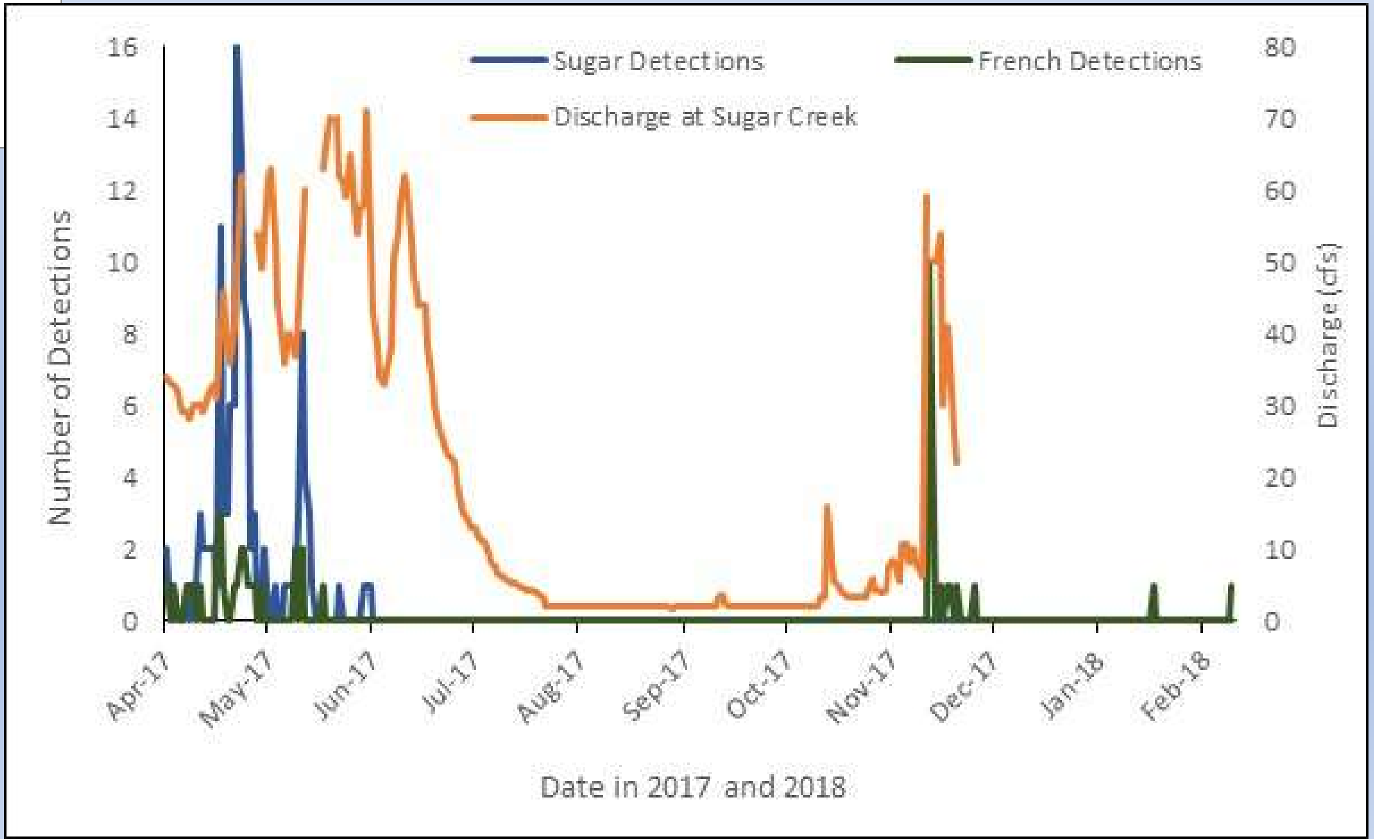
	Coho	Steelhead	Chinook
French Creek	319	65	9
Sugar Creek	1028	239	5
Miners Creek	69	6	0

Coho salmon summer growth rates in Sugar Creek and Klamath River Sites



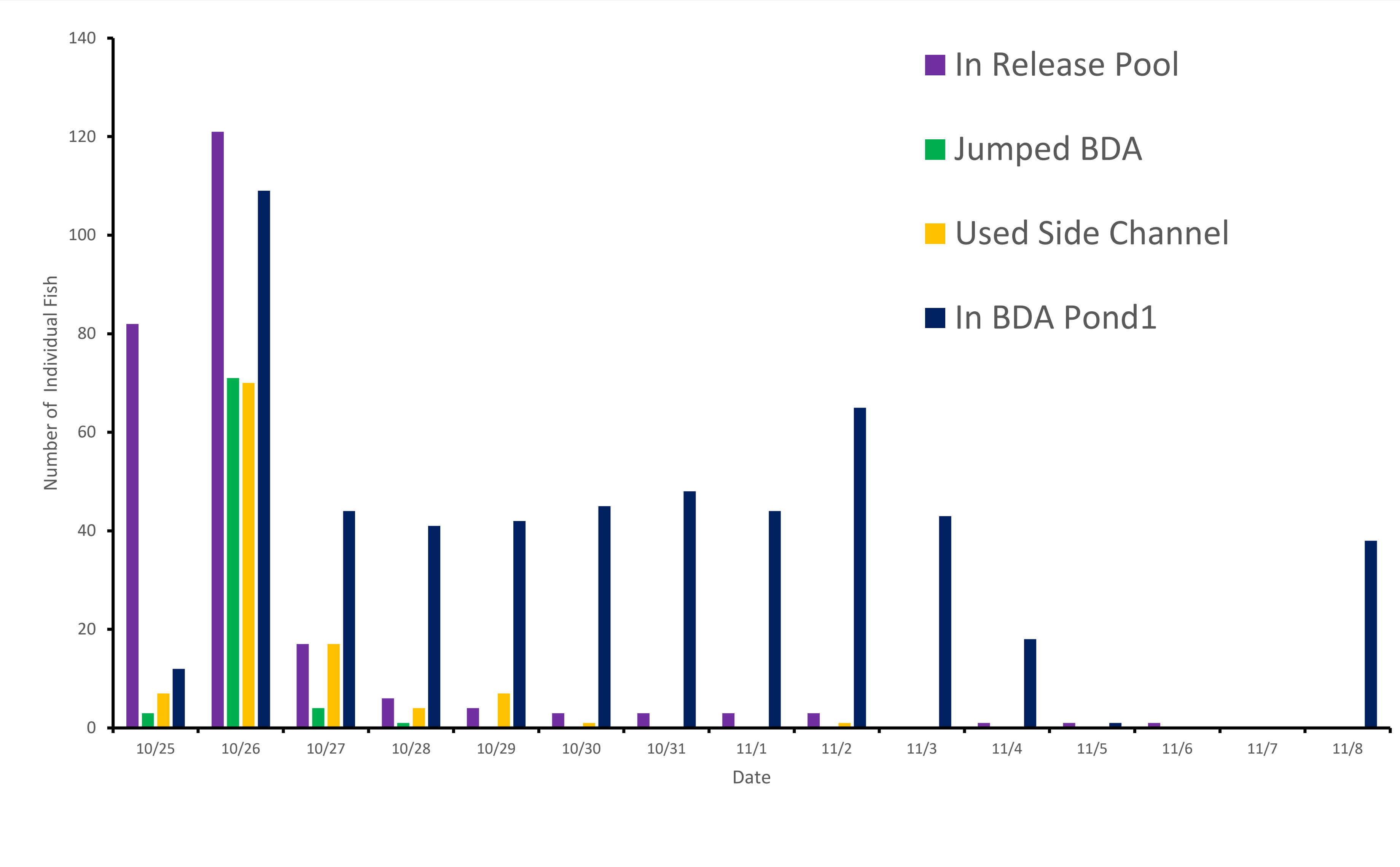
Detection of fish movement with PIT tag detection arrays



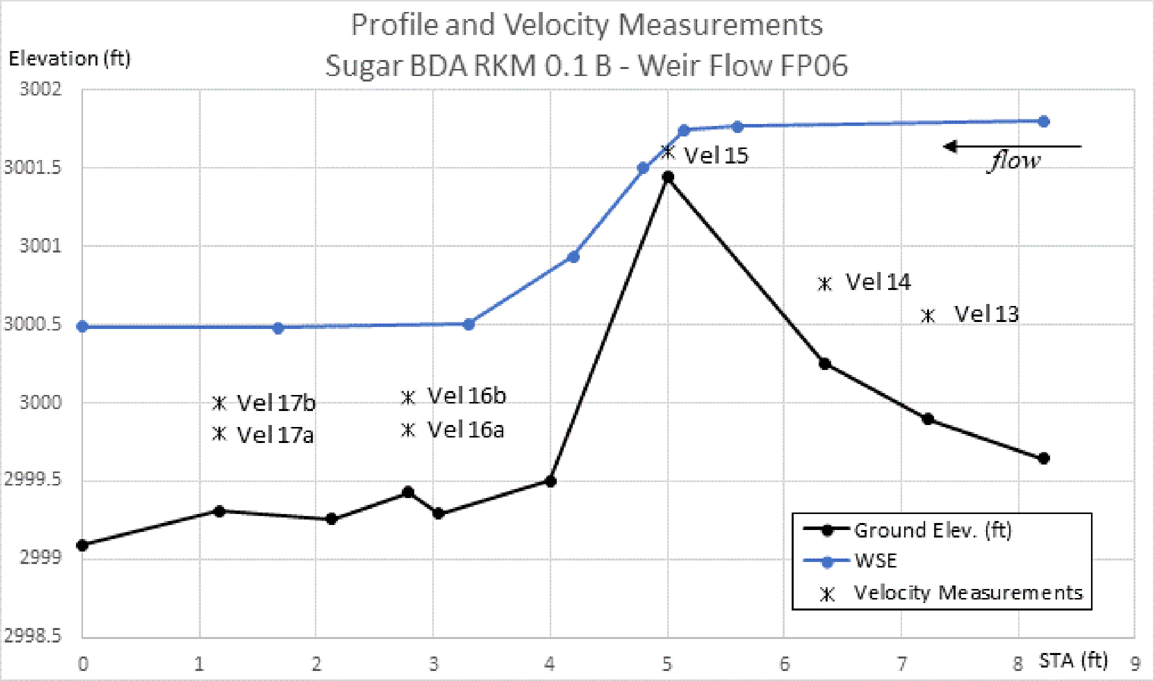


Documenting fish passage at Sugar Creek BDA 1 Structures

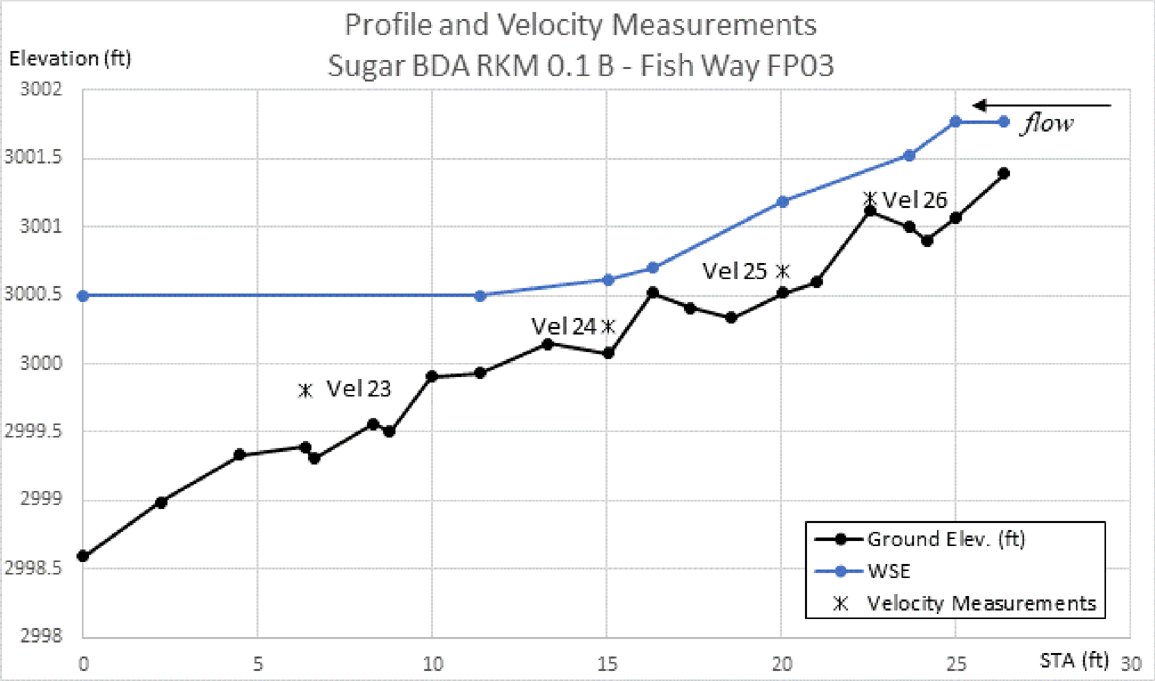
Location of detected fish- Sugar Creek BDA fish passage experiment



Jump route with most detections



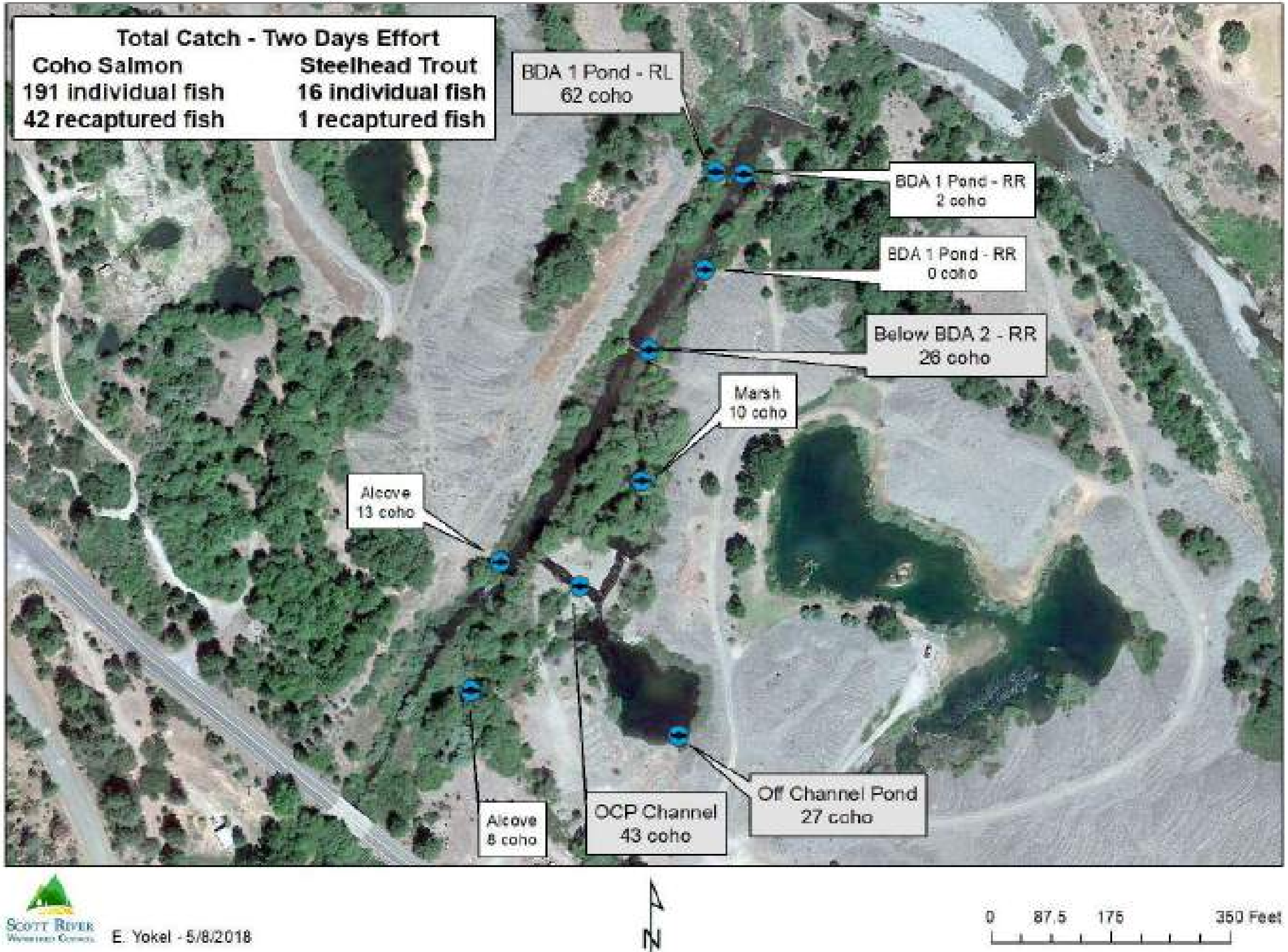
Side channel with most detections



BDA B - Weir Flow - FP08					
	Depth (ft)		Velocity (ft/s)		
Site	**Water Column**	**V meas.**	V_x	V_y	**Velocity**
Vel 18	1.9	0.8	0.15	-0.15	0.2
Vel 19	1.25	0.5	0.32	-0.19	0.4
Vel 20	0.4	0.2	2.42	-1.04	2.6
Vel 21a	1.9	0.8	-0.27	0.24	0.4
Vel 21b	1.9	1.2	0.95	0.1	1.0
Vel 22a	1.7	0.7	0.26	0.22	0.3
Vel 22b	1.7	1	0.58	0.15	0.6

BDA B - Fish Way - FP03					
	Depth (ft)		Velocity (ft/s)		
Site	**Water Column**	**V meas.**	V_x	V_y	**Velocity**
Vel 23	1.05	0.4	0.12	0.06	0.1
Vel 24	0.5	0.2	0.14	0.03	0.1
Vel 25	0.4	0.2	0.2	0.08	0.2
Vel 26	0.25	0.1	0.32	0.06	0.3

Lower Sugar Creek Fish Sampling - April 2 & 4, 2018

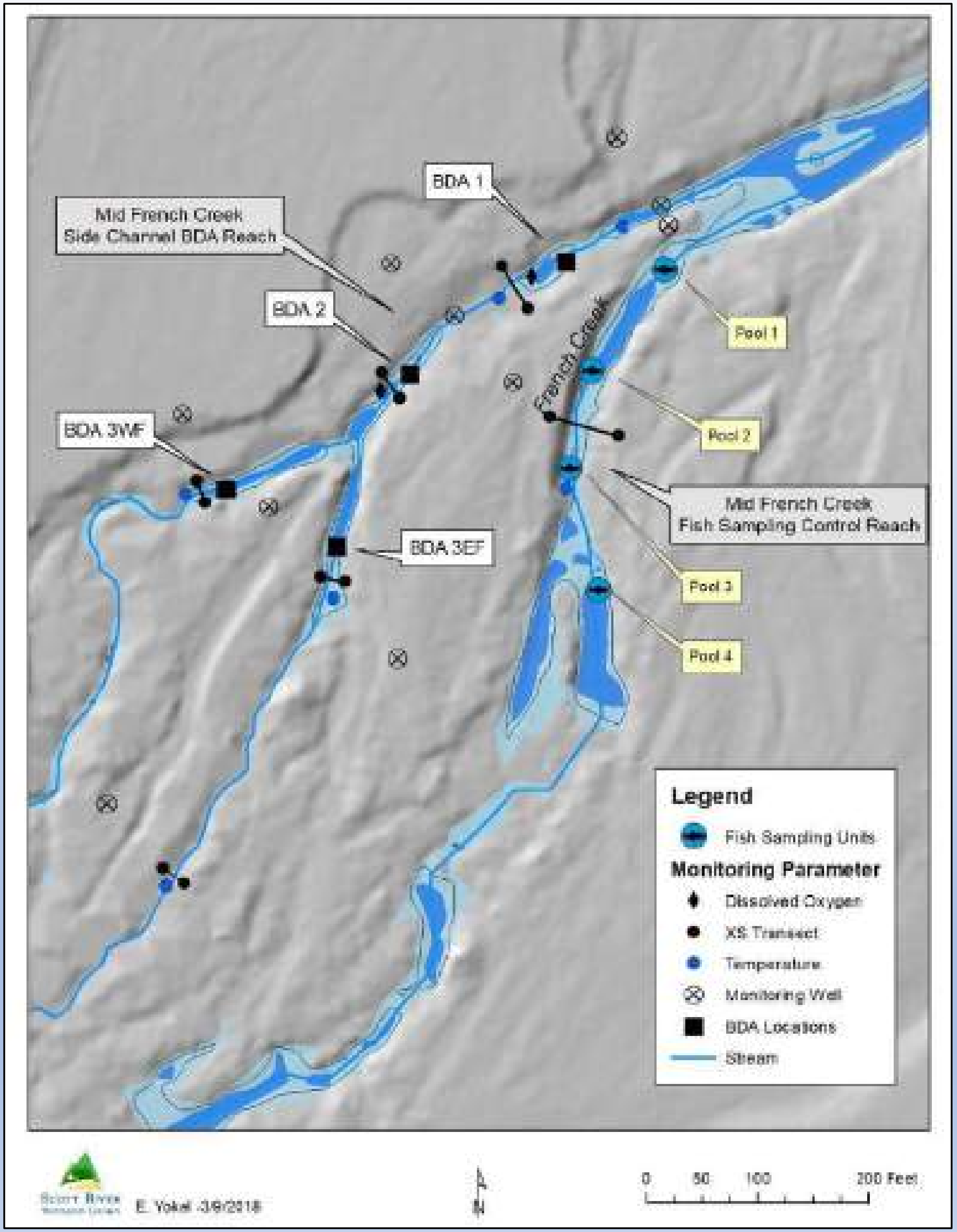


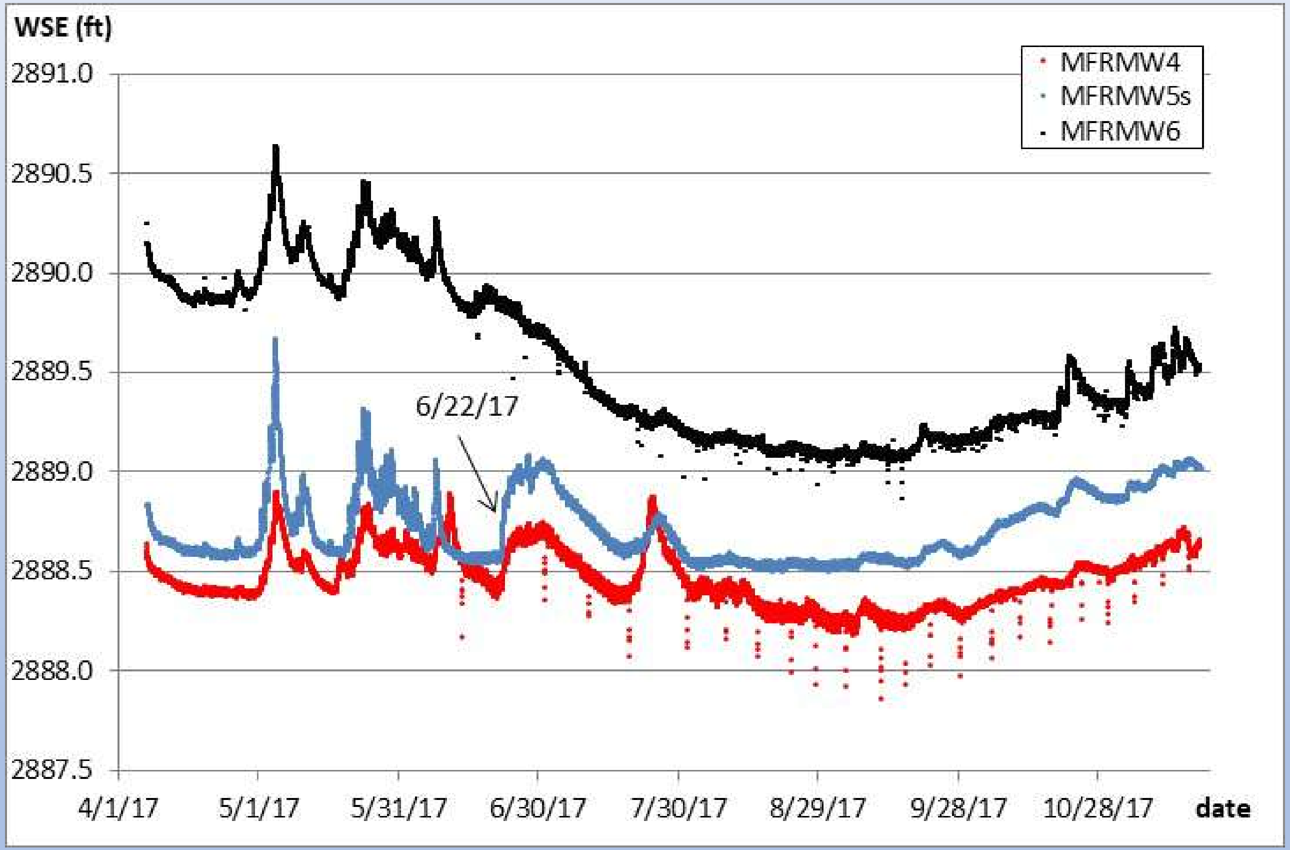
Scott River Watershed Council

E. Yokel - 5/8/2018

Riparian Planting

Mid French Creek Side Channel BDA Treatment Reach





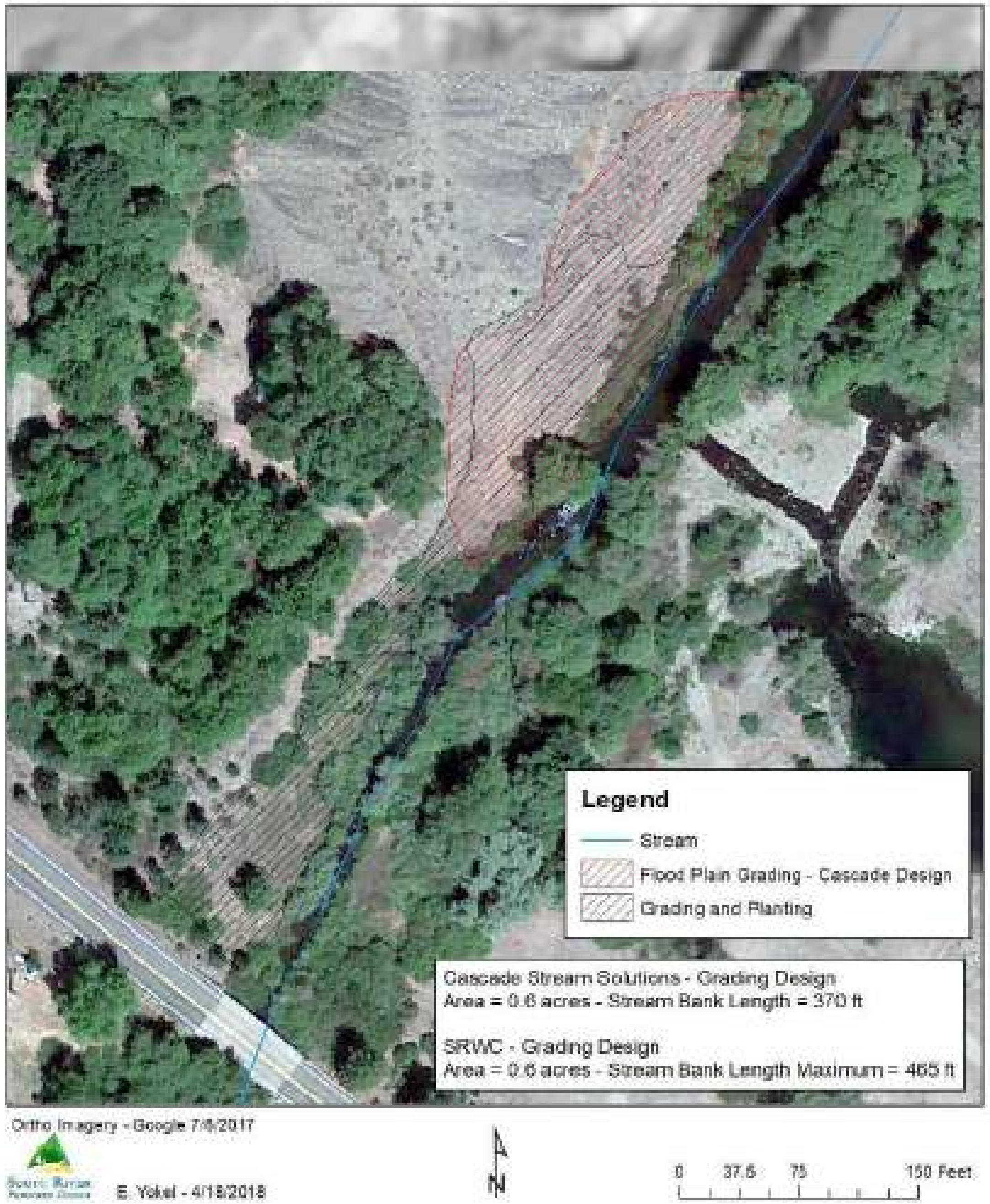
Water Surface Elevation – Mid French Creek Side Channel Above BDA 1


Lower Miners Creek BDA Treatment Site

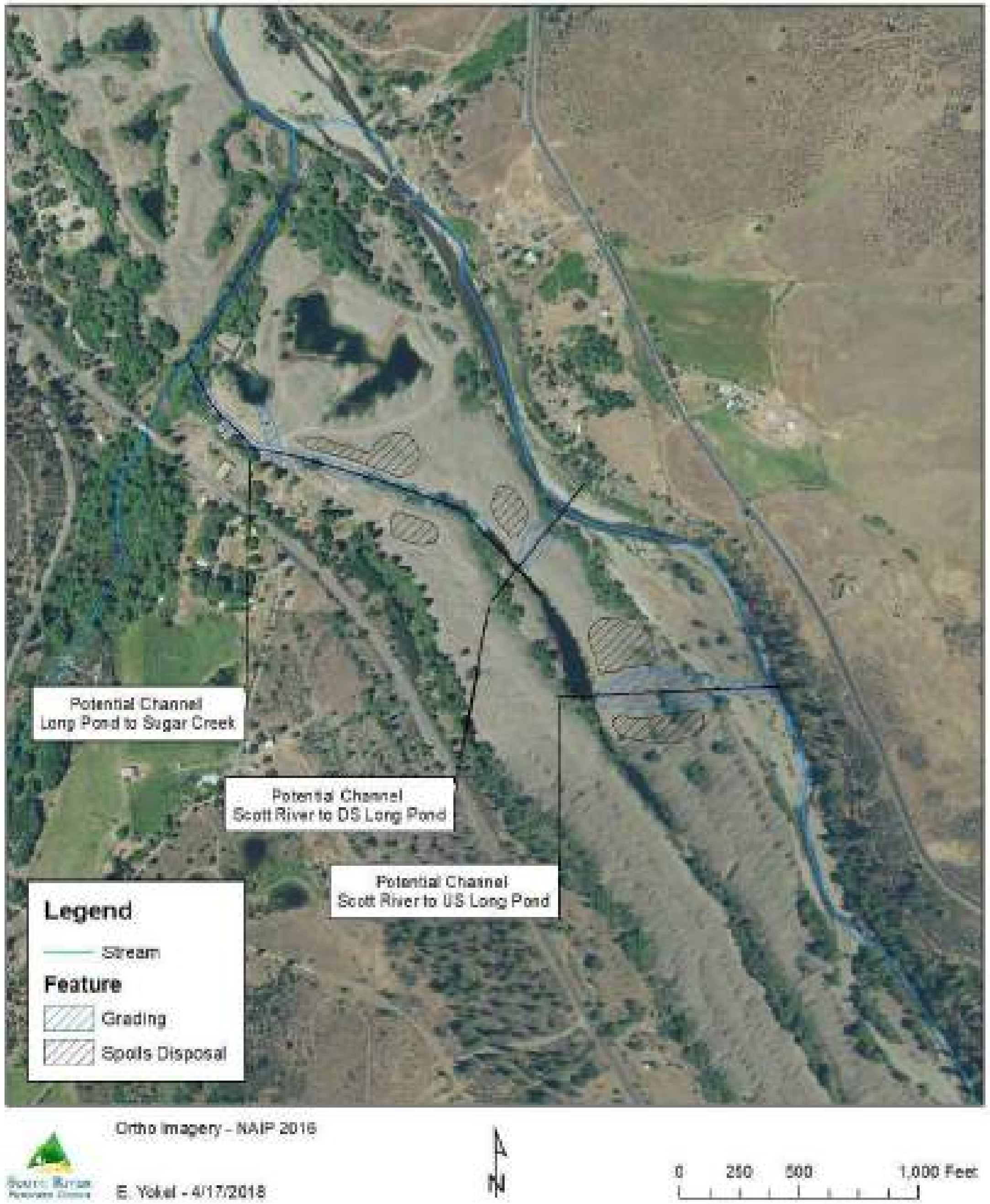
Childs Meadow

Next Steps

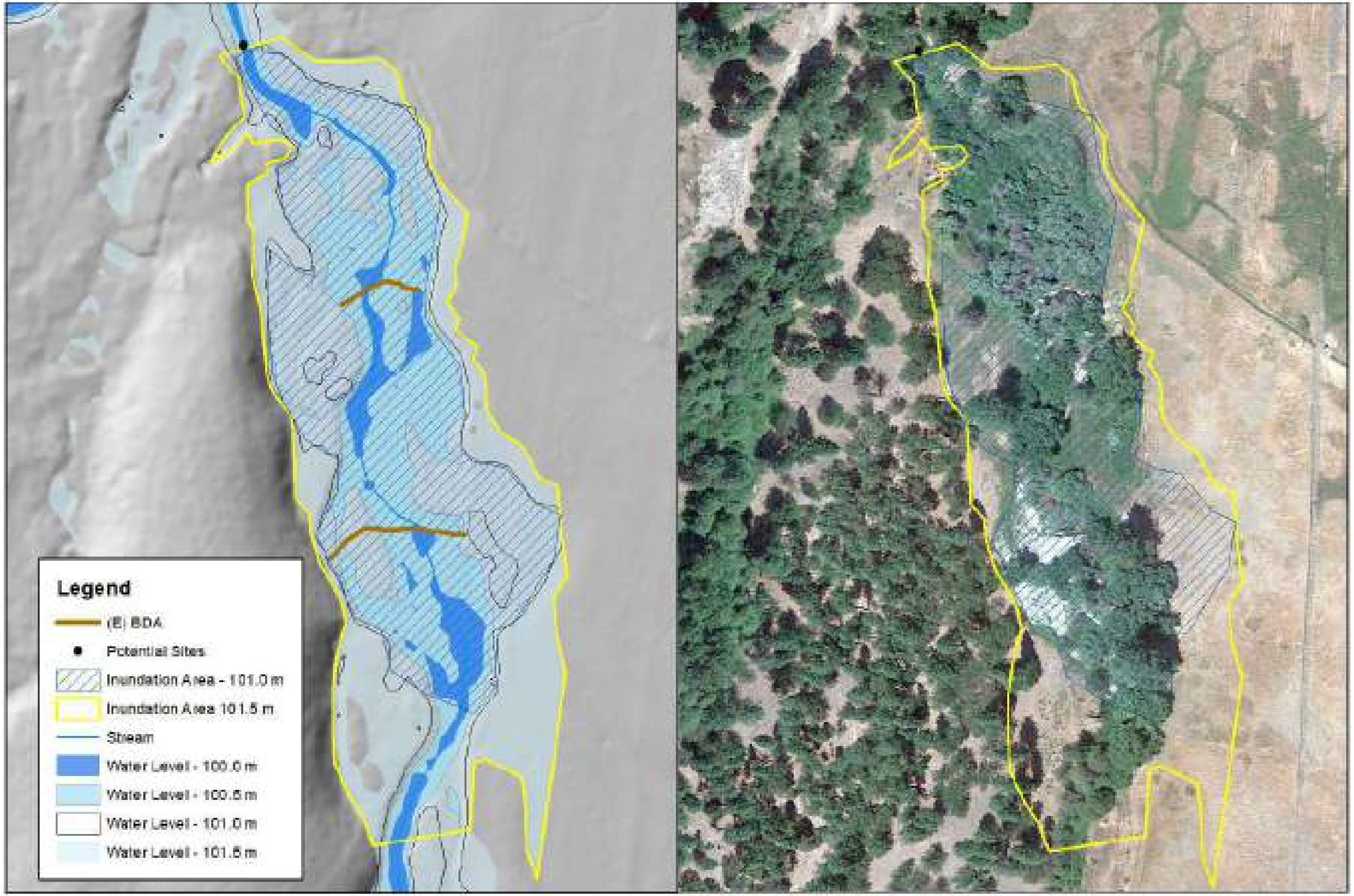
Lower Sugar Creek - Floodplain Enhancement Project
Grading and Planting



Potential Constructed Channel Alignments - Long Pond Project



Miners Creek - Potential Floodplain Restoration Site18a



SCOTT RIVER

E. Yokel - 3/30/2018

N

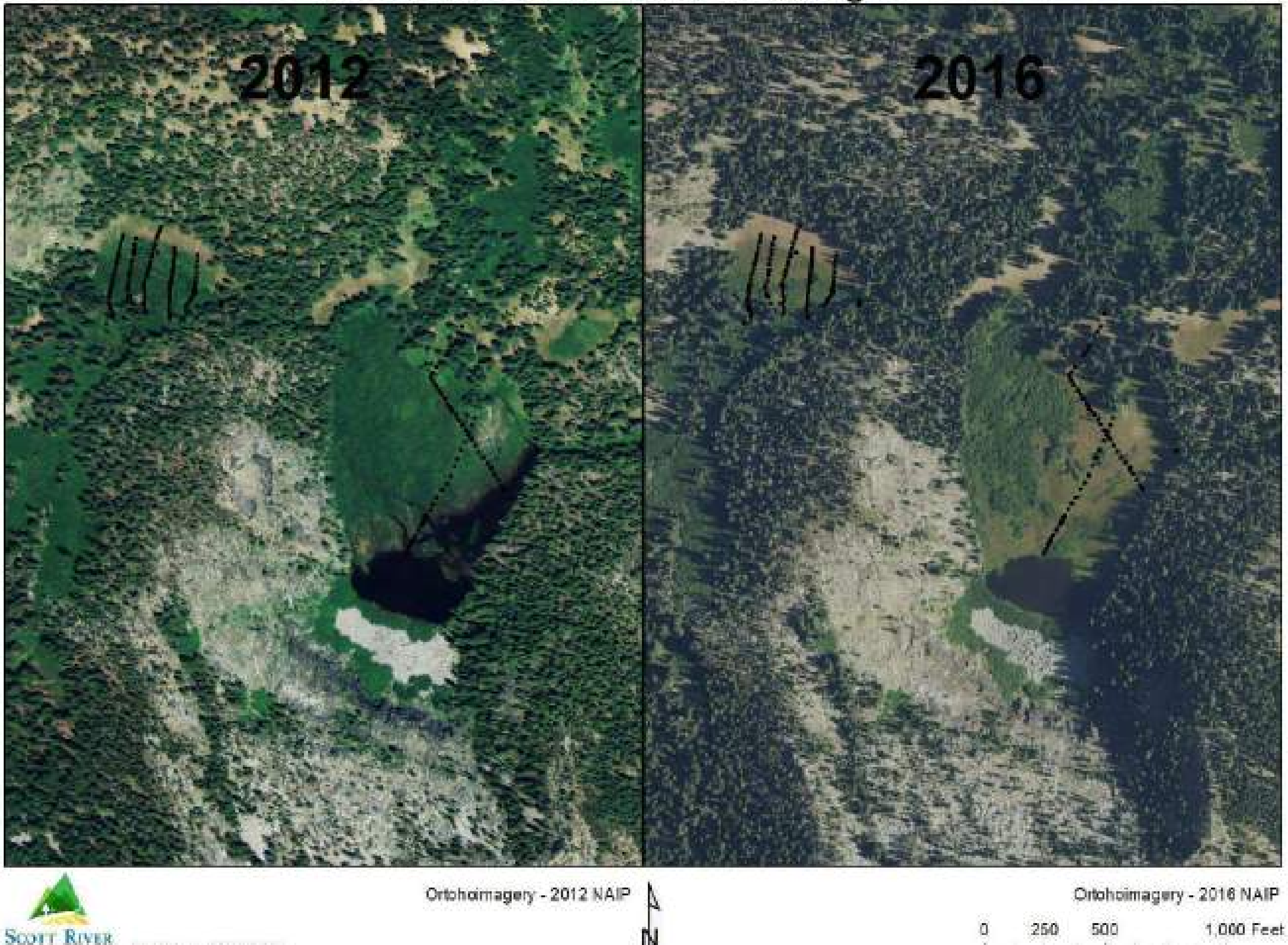
0 75 150 300 Feet

Meeks Meadow

UNITED STATES YOUTH CONSERVATION CORPS

FOREST SERVICE U S DEPARTMENT AGRICULTURE

Meeks Meadow - Historic Images



Scott River Watershed Council

E. Yokel - 8/25/2017

Meeks Meadow - WSE Monitoring Network

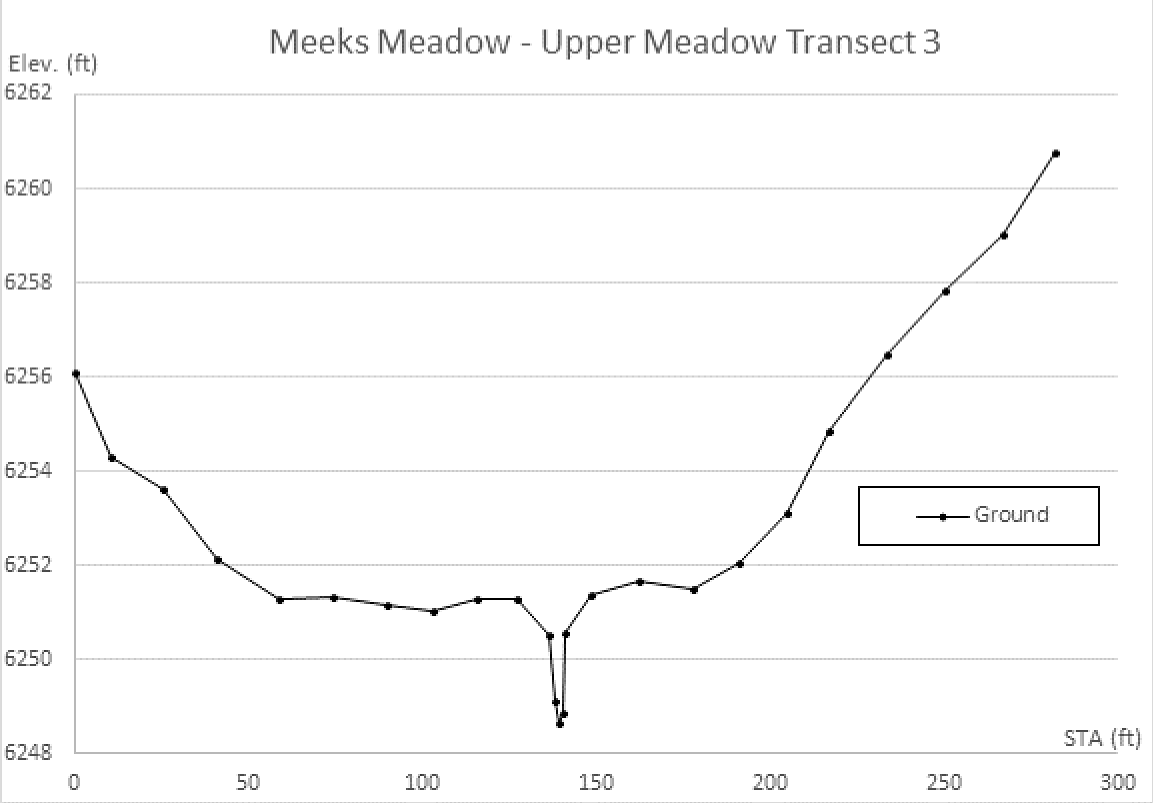
Ortohoimagery - 2016 NAIP

Scott River Watershed Council

E. Yokel - 4/30/2018

N

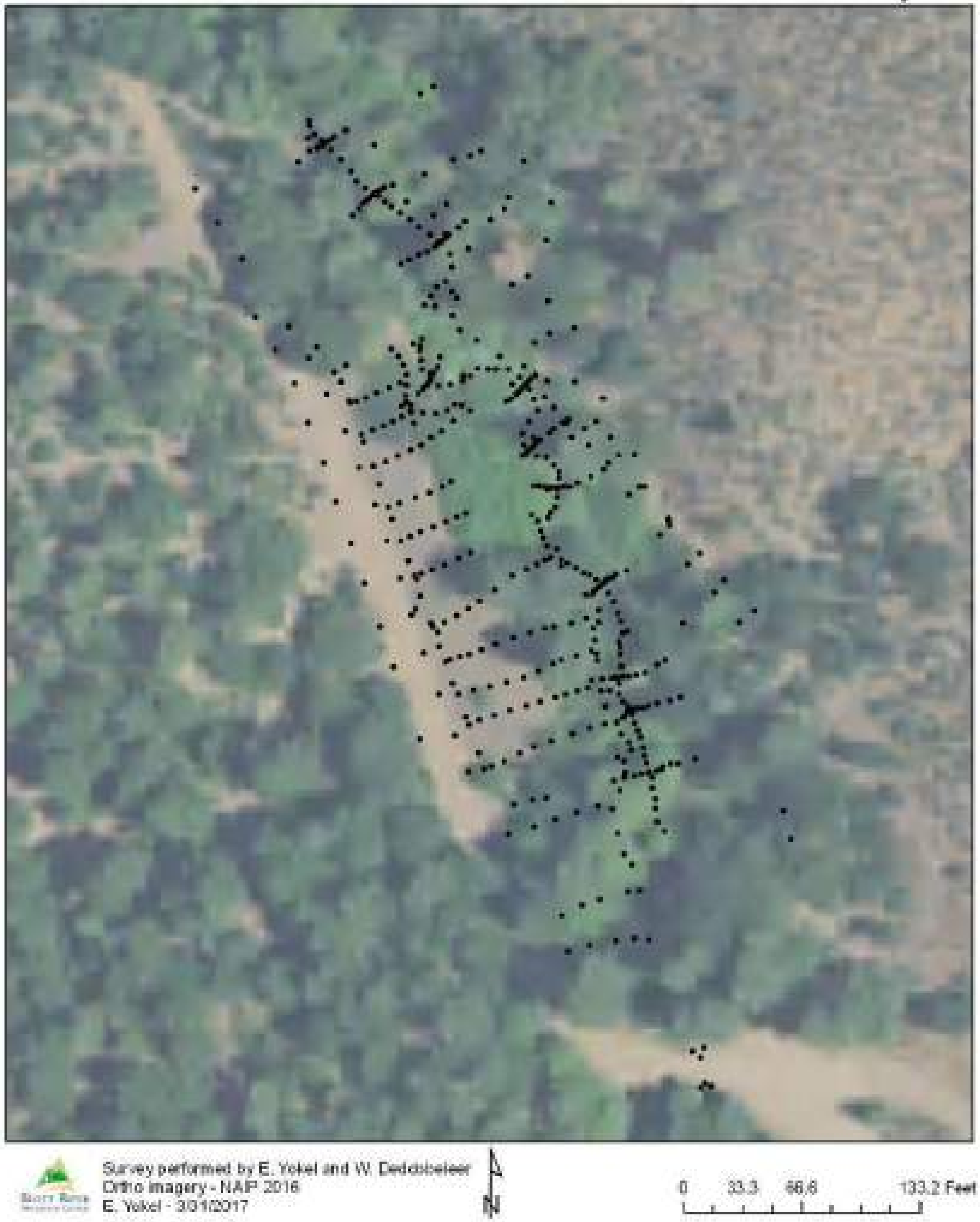
0 150 300 600 Feet



Meeks Meadow - Upper Meadow Transect 3
Elev. (ft)
6262
6260
6258
6256
6254
6252
6250
6248
STA (ft)
0
50
100
150
200
250
300
Ground

Rattlesnake Creek

Rattlesnake Creek - BDA Treatment Reach - Survey



Survey performed by E. Yokel and W. Dedobbeleer
Ortho imagery - NAIP 2016
E. Yokel - 3/01/2017

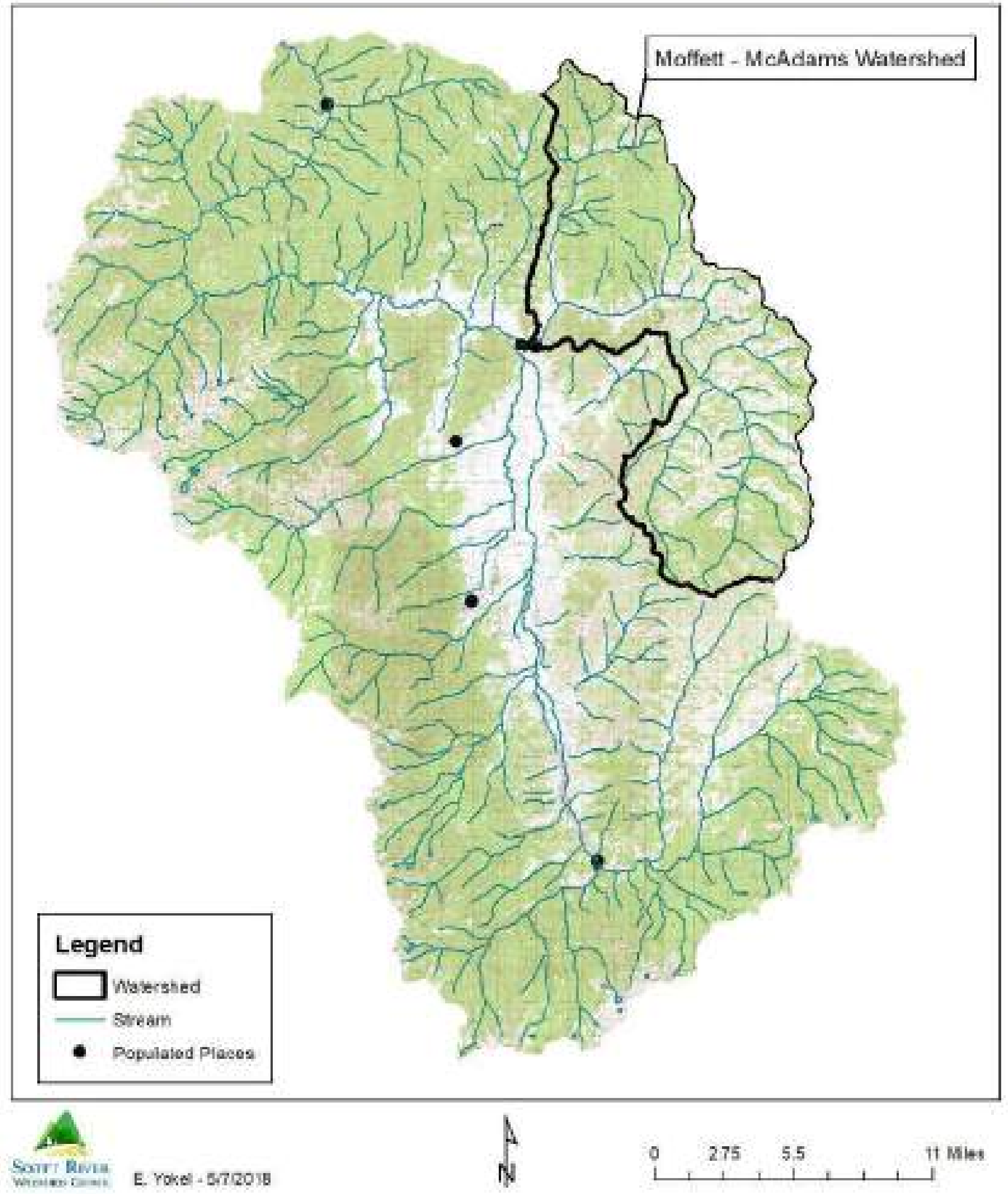

04 25 2018 09:30

Baseline bird and vegetation monitoring to measure restoration effectiveness of beaver dam analogues in the Scott Valley, CA

Sarah M. Rockwell and Jaime L. Stephens
Klamath Bird Observatory
Rep. No. KBO-2017-0013
December 22, 2017

Klamath Bird Observatory

Moffett - McAdams Creek Watershed



Coho Salmon Response to Restoration Produced Ecosystem Heterogeneity

Scott River Watershed Council

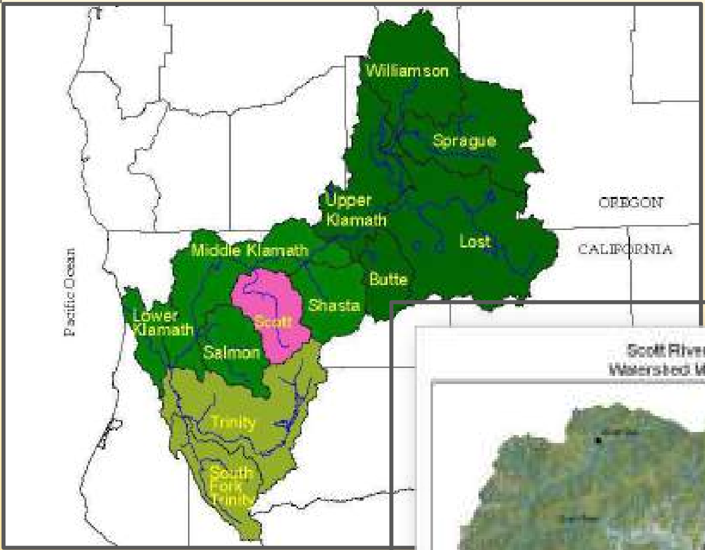
Betsy Stapleton, SRWC

Michael M. Pollock PhD, NOAA

Shari Witmore, NOAA

Erich Yokel, SRWC

Charnna Gilmore, SRWC



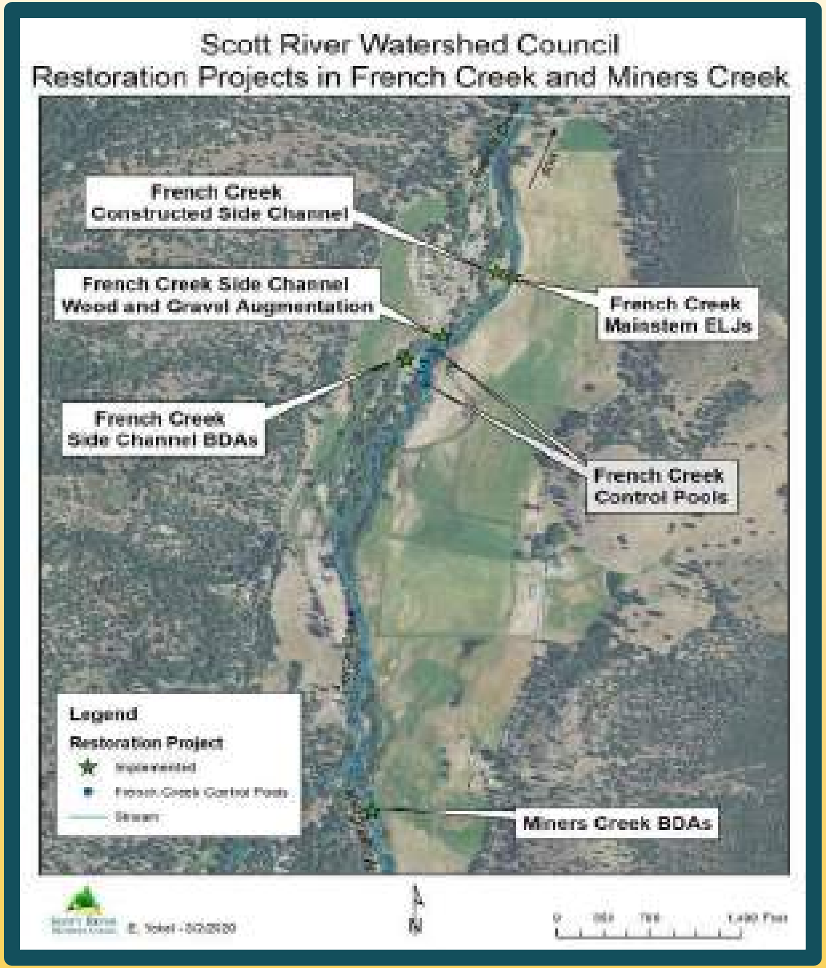
French Creek

"Every system is perfectly designed to get the results you get"

Limiting Factors: Both Summer and Winter Juvenile Rearing, Spawning

French-Miners Restoration Projects:

- **ELJs & Gravel Augmentation**
- **BDAs French Side Channel**
- **Wood and Gravel Augmentation**
- **Constructed Side Channel**
- **BDAs Miners Creek**

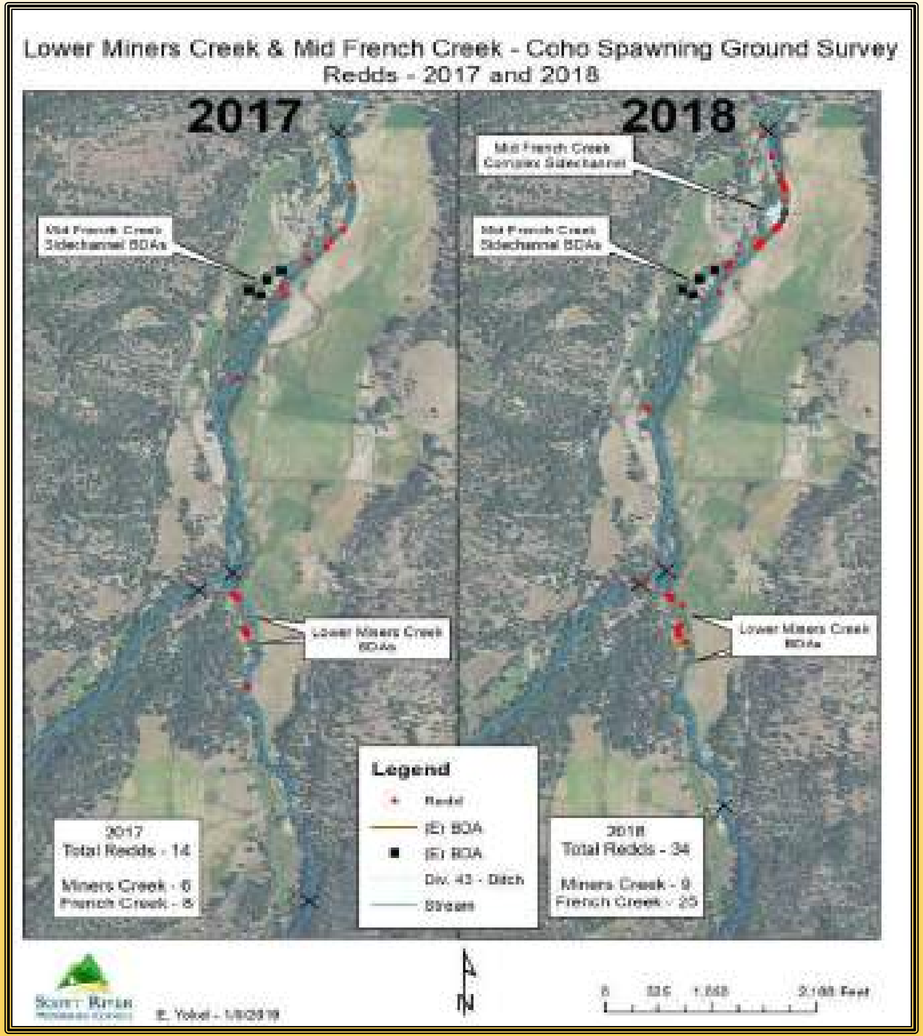


Restoration Project: Side Channel, ELJs, Gravel Supplementation.

Goals:

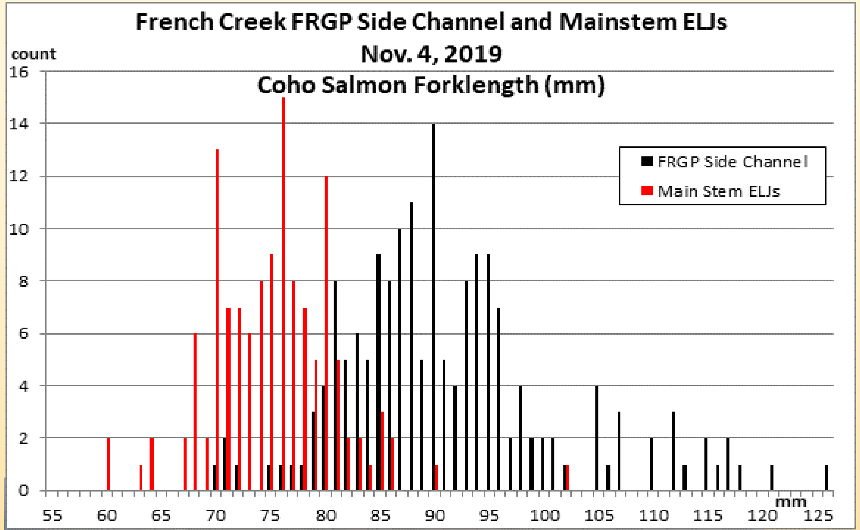
Summer and Winter Rearing Habitat, Habitat Complexity, Support Spawning.

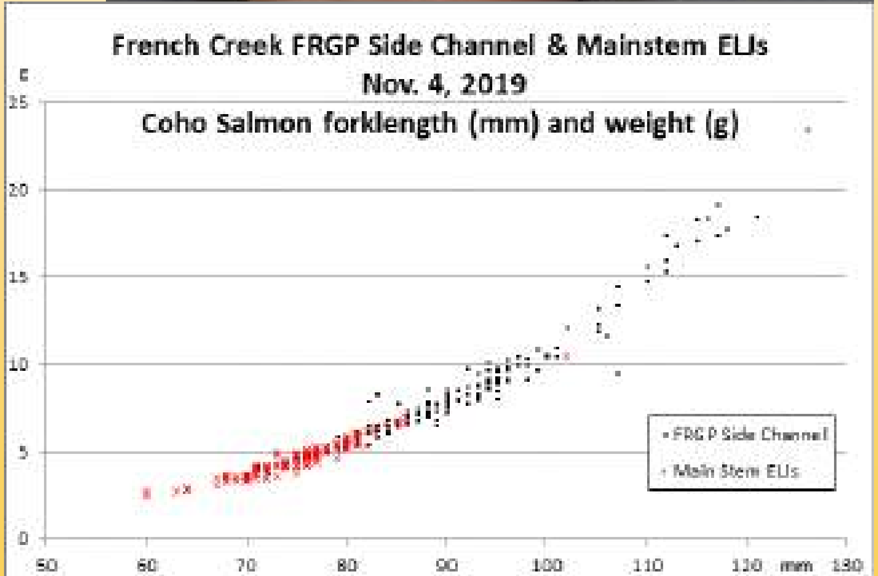
Coho Adult Utilization

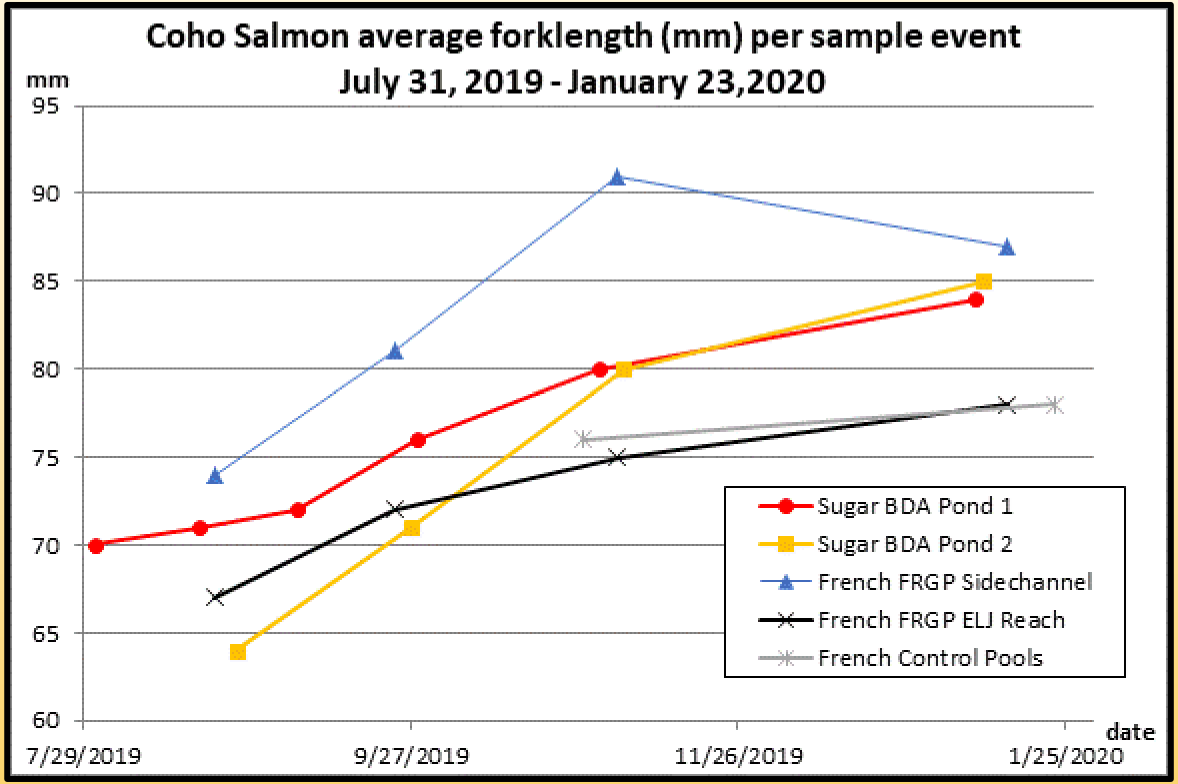


Coho Utilization: Juvenile

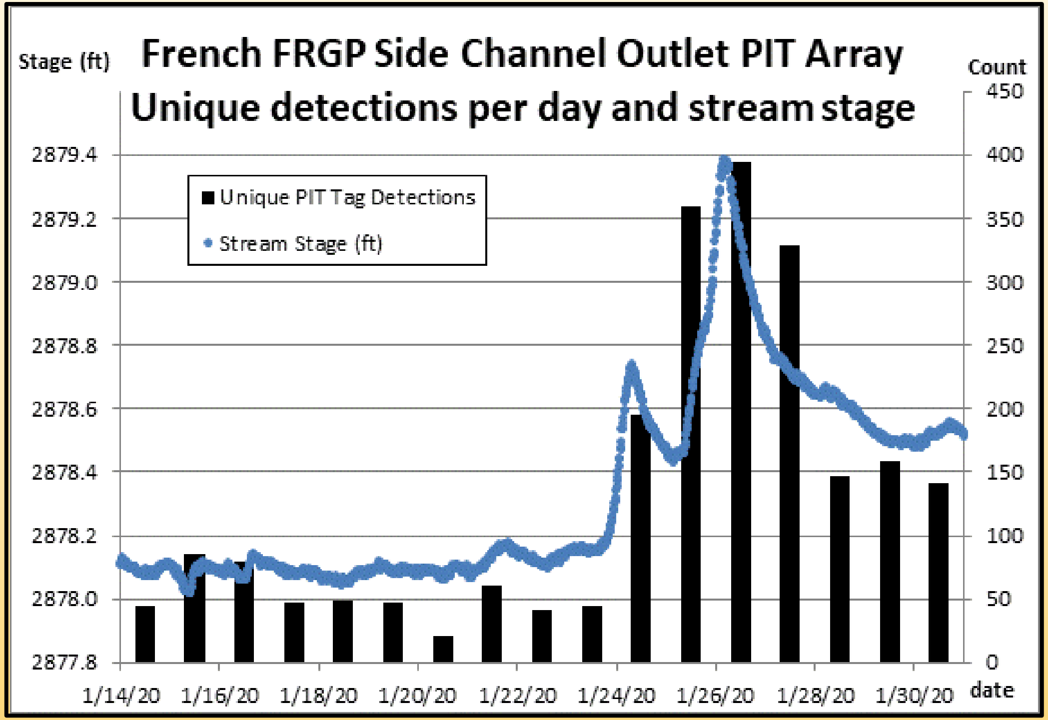
CALIFORNIA DEPARTMENT OF FISH & WILDLIFE


French Creek FRGP Side Channel and Mainstem ELJs
Nov. 4, 2019
Coho Salmon Forklength (mm)
count
16
14
12
10
8
6
4
2
0
55 60 65 70 75 80 85 90 95 100 105 110 115 120 125
mm
FRGP Side Channel
Main Stem ELJs


French Creek FRGP Side Channel & Mainstem ELJs
Nov. 4, 2019
Coho Salmon forklength (mm) and weight (g)
25
20
15
10
5
0
50 60 70 80 90 100 110 120 mm 130
FRGP Side Channel
Main Stem ELJs

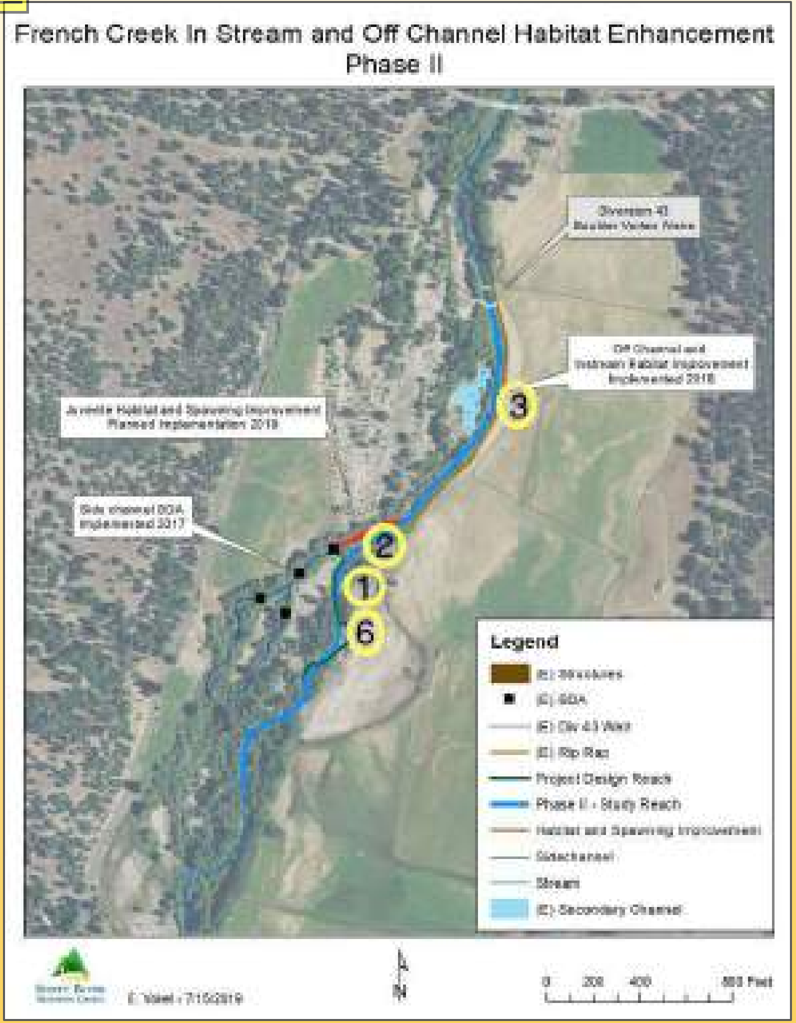


Did the Fish get smaller?

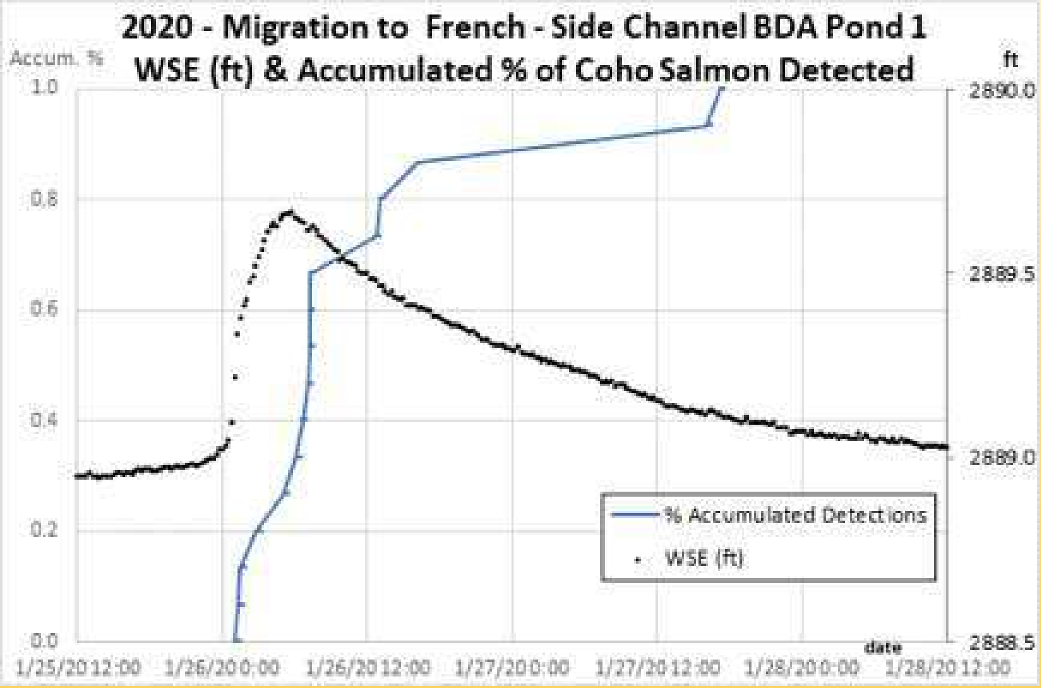


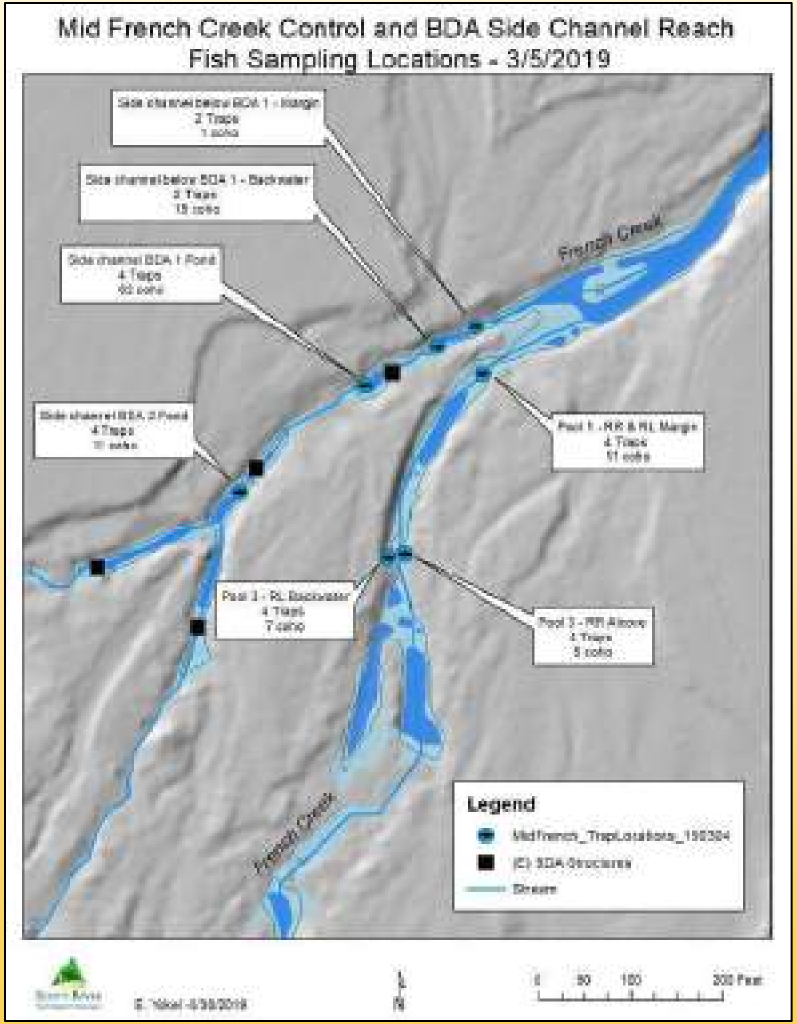
Correlating fish movement with stream runoff events

French Creek BDAs- Will fish use them?

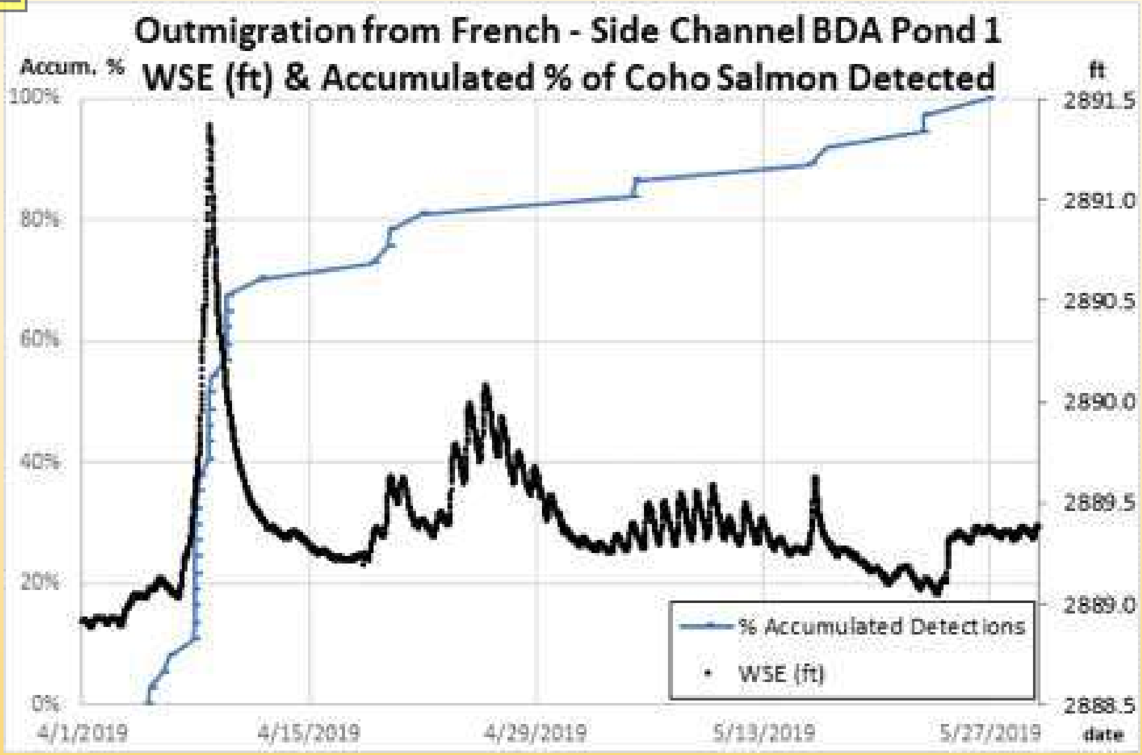


Juvenile Entry into Over Winter Habitat:
In with the opportunity.





Julian Week - 10 - Coho Salmon Forklength (mm)		
Sample Reach	Mid French Control	BDA Ponds
Average	81	87
Stan. Dev.	7.7	8.5
Minimum	64	69
Maximum	95	125
Count	39	74



Smolt Outmigration:

Out with the Flow

Detection of Outmigration of Coho Salmon from French Side Channel BDA Ponds

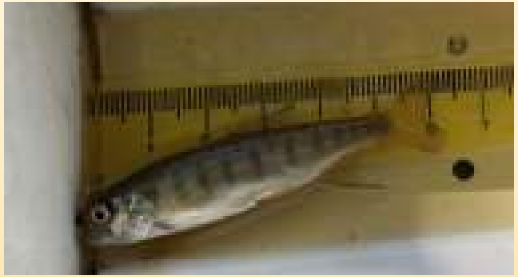
Number of Coho Salmon		Date of Detection	
Tagged	Detected	First	Last
43	37	4/5/2019	5/26/2019

Miners Creek BDAs:
Drying reach with lots of spawning every year.

Did we perennialize? No.

Early Season Fish Passage Experiments

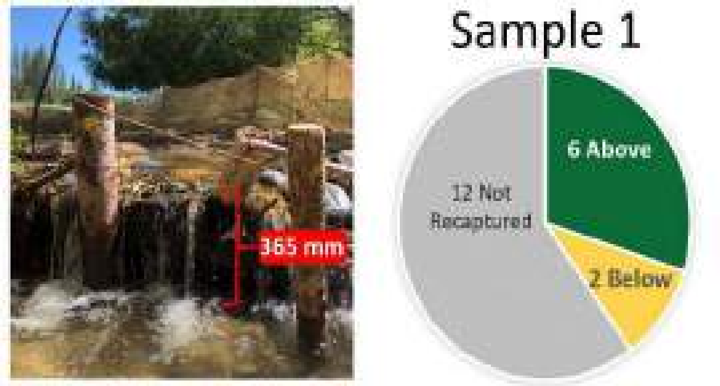
Methods

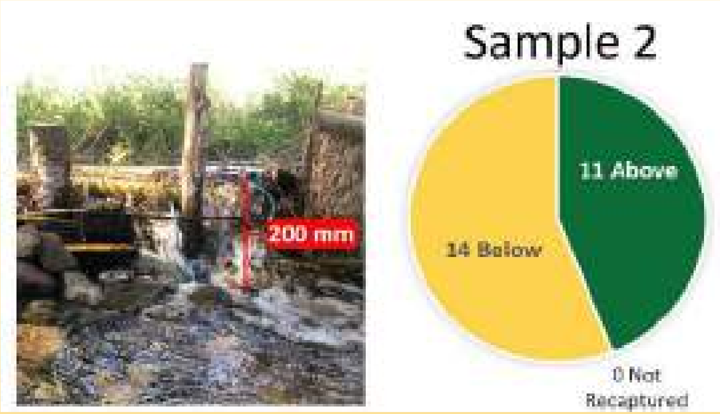


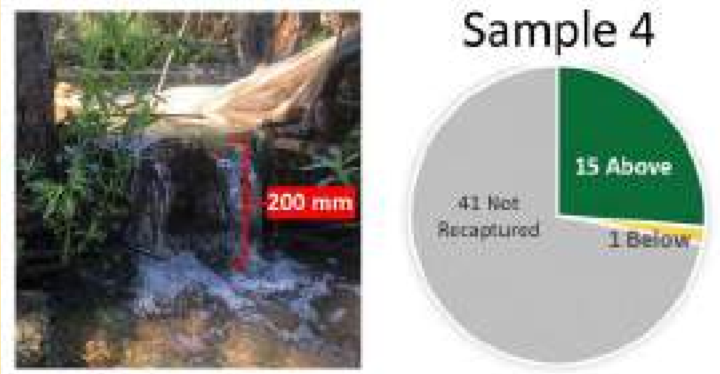
Miners Creek BDAs

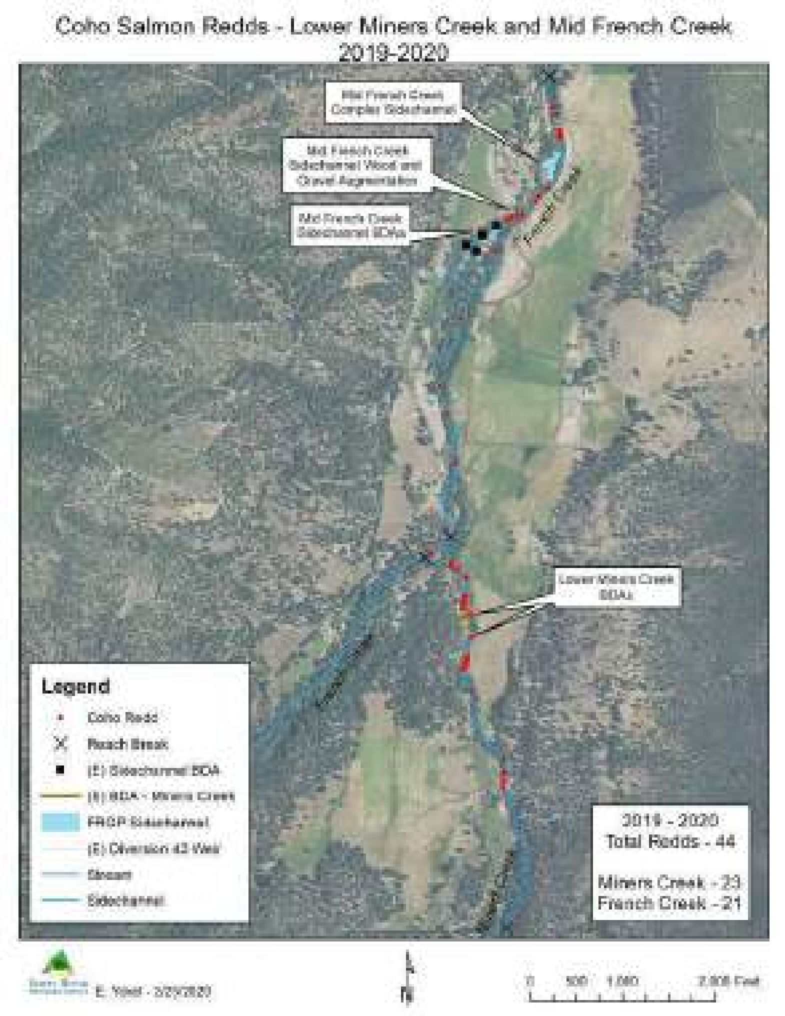
Early Season Fish Passage Experiments

Results





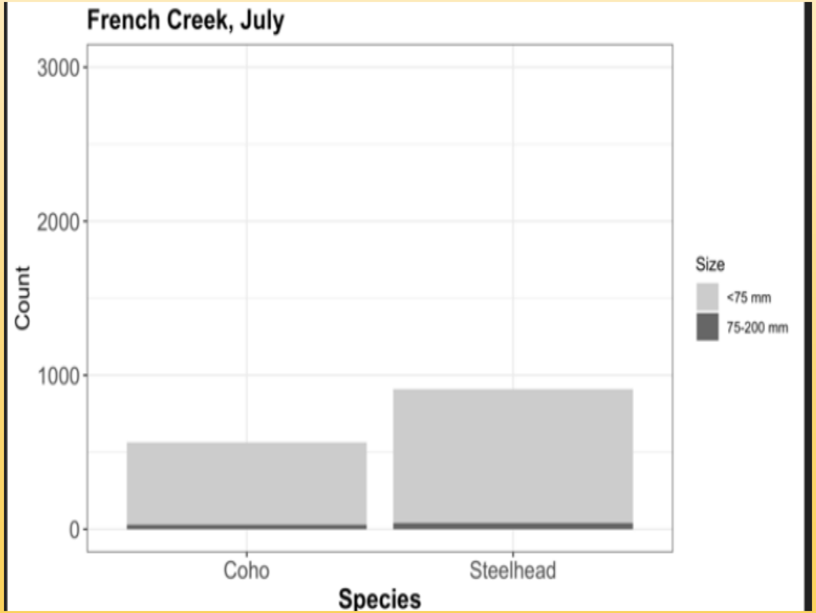


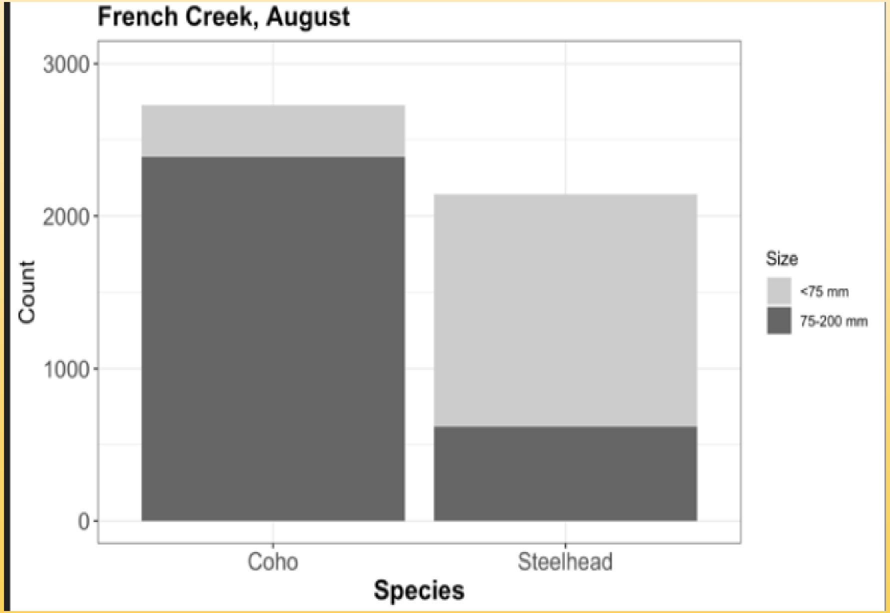


Substrate sorting, more spawning.
Fry nursery?

French Creek: Fish on the move Cleo Woelfle-Erskine, Ph.D.
School of Marine and Environmental Affairs, UW Seattle

- Mostly small salmonids in July with a few 1+ steelhead
- Increase in fish count from July to August, especially of larger coho
- Movement downstream from tributaries (e.g. Miners Cr.)?







Mid French Creek Wood & Gravel Augmentation

Conclusion:
Habitat Heterogeneity Makes a Difference
Do it All: Whatever You Can, Wherever you Can

"Every system is perfectly designed to get the results you get".
We have got to do things differently!

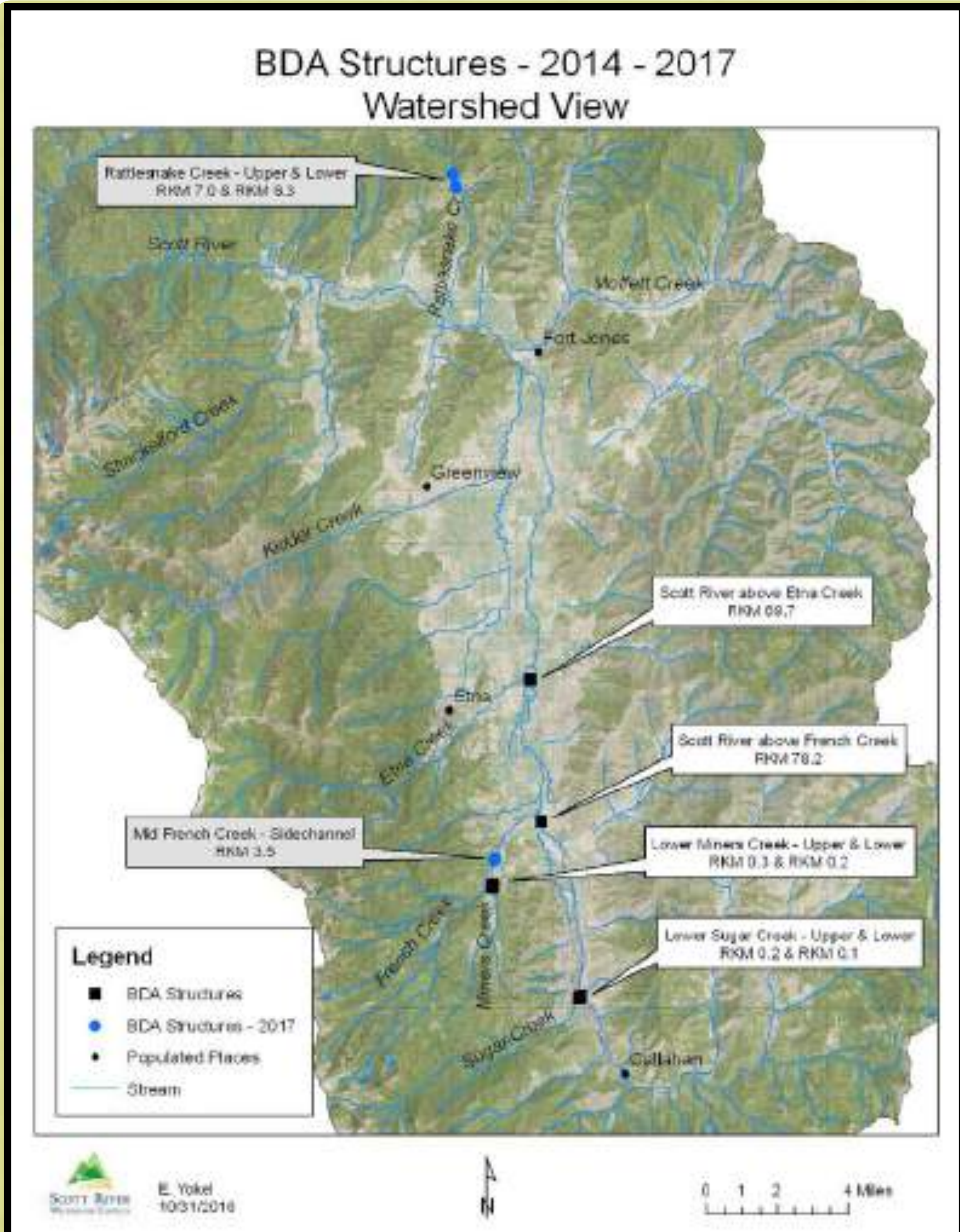
DEVELOPING AN ADAPTIVELY MANAGED RESTORATION TECHNIQUE FOR CALIFORNIA

BEAVER DAM ANALOGUES (BDAS)

Scott River Watershed Council

Betsy Stapleton

Funding for SRWC BDA Program:
US Fish and Wildlife Service – Construction, Maintenance, Monitoring
CEF/NWFW – Monitoring
NOAA – Project design, monitoring
Community Donations and Volunteer Labor



2014

Construction

2 Project Sites - Scott River

1 Project Site - Sugar Creek

2015

Construction

1 Project Site – Miners Creek

Maintenance

2 BDA Structures – Scott River

2 BDA Structures – Sugar Creek

2016

Maintenance

2 BDA Structures – Sugar Creek

2 BDA Structures – Miners Creek

2017

Construction

1 Project Site – French Creek

1 Project Site – Rattlesnake

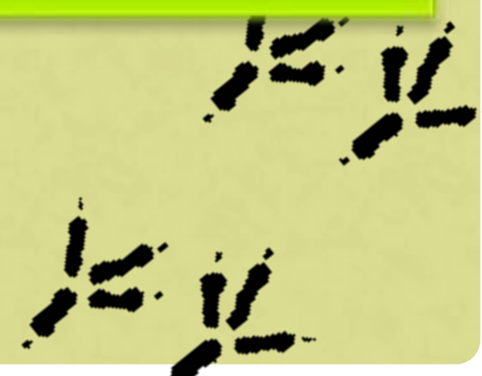
Maintenance

Scott River BDAs

Potential Benefits and Characteristics :

- Dynamic
- Reduce velocities and disperse flows
- Maintain and/or prolong instream flows
- Create ponds, pools, and wetlands
- Potential increase to surrounding groundwater
- Increases riparian and aquatic plant health
- Encourages beaver activity
- Requires adaptive management/multiple treatments

What are BDAs ?
Working Definition:
"Structures completely or partially built by humans that mimic many of the functions of natural beaver dams"



SUGAR CREEK AT INSTALLATION 8/2014
&
TWO YEARS LATER 9/2016

Miners Creek
Upper & Lower
RKM 0.3 & RKM 0.2

Constructed - 2015
Maintenance - 2016

UPPER MINERS TWO YEARS LATER: THREE FEET OF SEDIMENT

Scott River, above Etna Creek
RKM 69.7
Constructed - 2014
Maintained - 2015

BEAVERS AT WORK

MONITORING

- Fish Utilization
- Water Quality
- Beaver Utilization
- Surface and groundwater elevations
- Geomorphic Change
- Fish Passage
- Habitat Characterization
- Multi-species benefit
- Food Web (funding dependent 2

Klamath Bird Observatory

Bella Vista FOUNDATION

UCDAVIS

U.S. FISH & WILDLIFE SERVICE

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

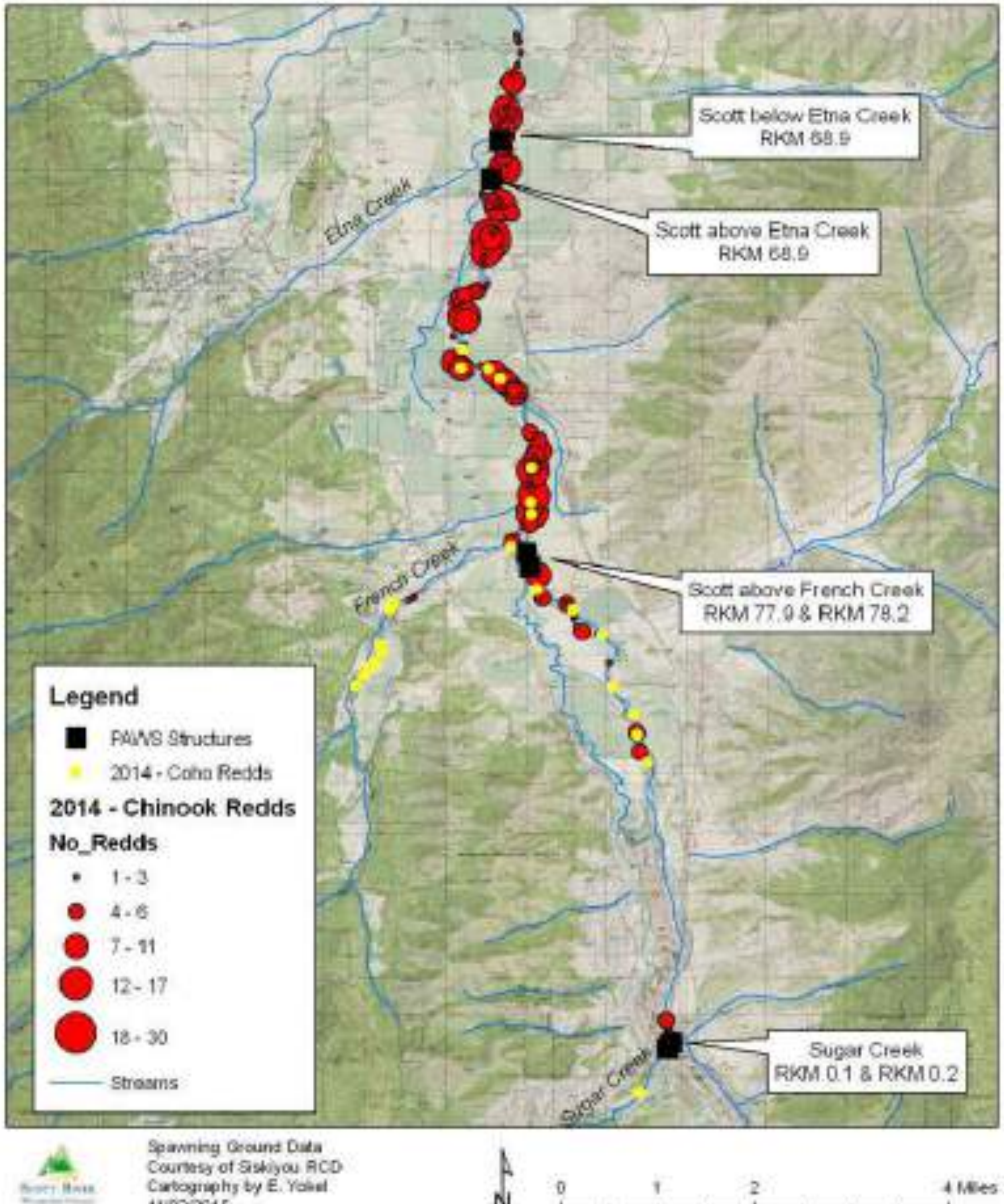
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NOAA U.S. DEPARTMENT OF COMMERCE

SISKIYOU RESOURCE CONSERVATION DISTRICT RCD

“FRY WAY” 10% GRADE

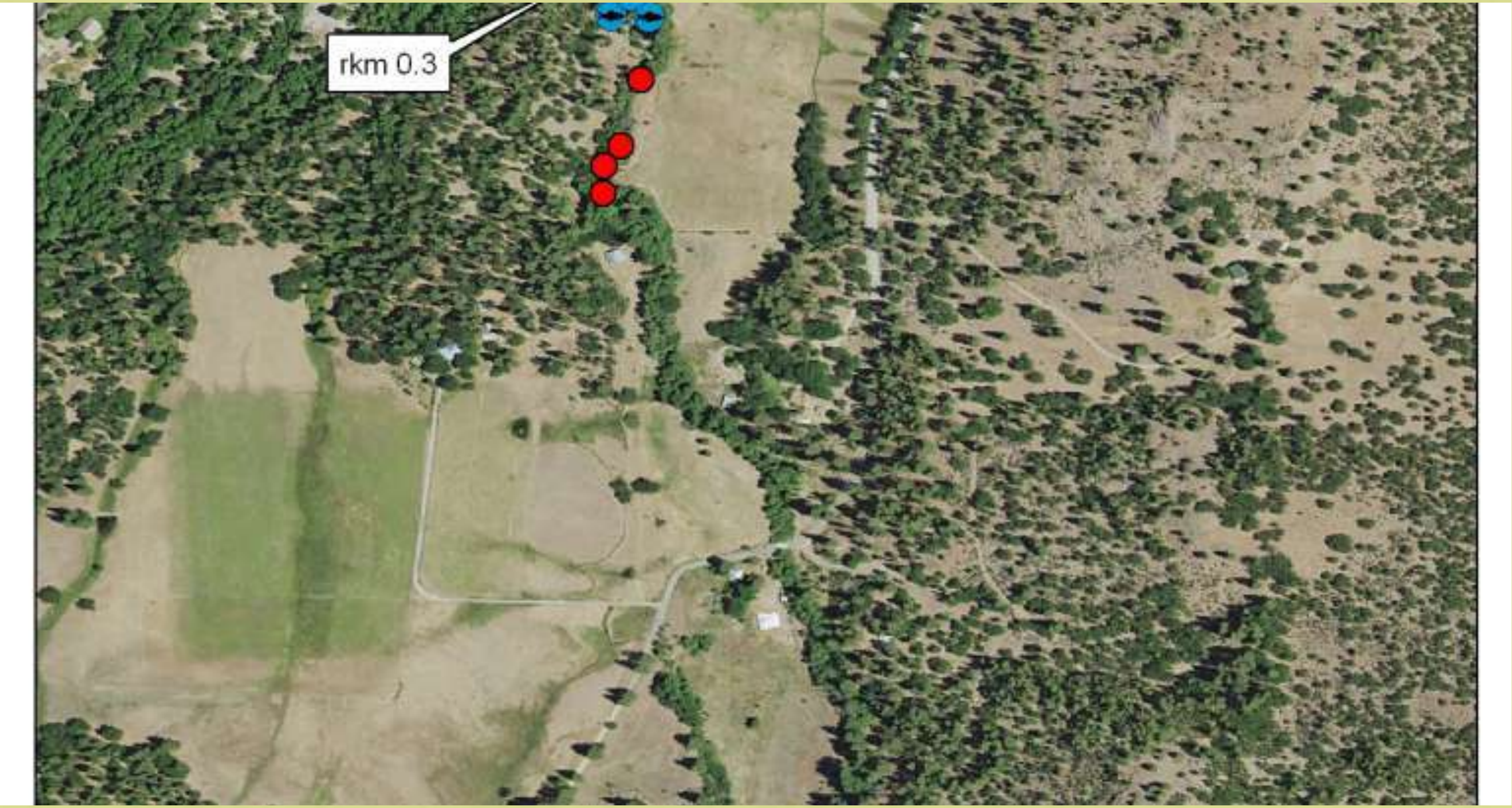
FISH PASSAGE

2014 Chinook and coho redds



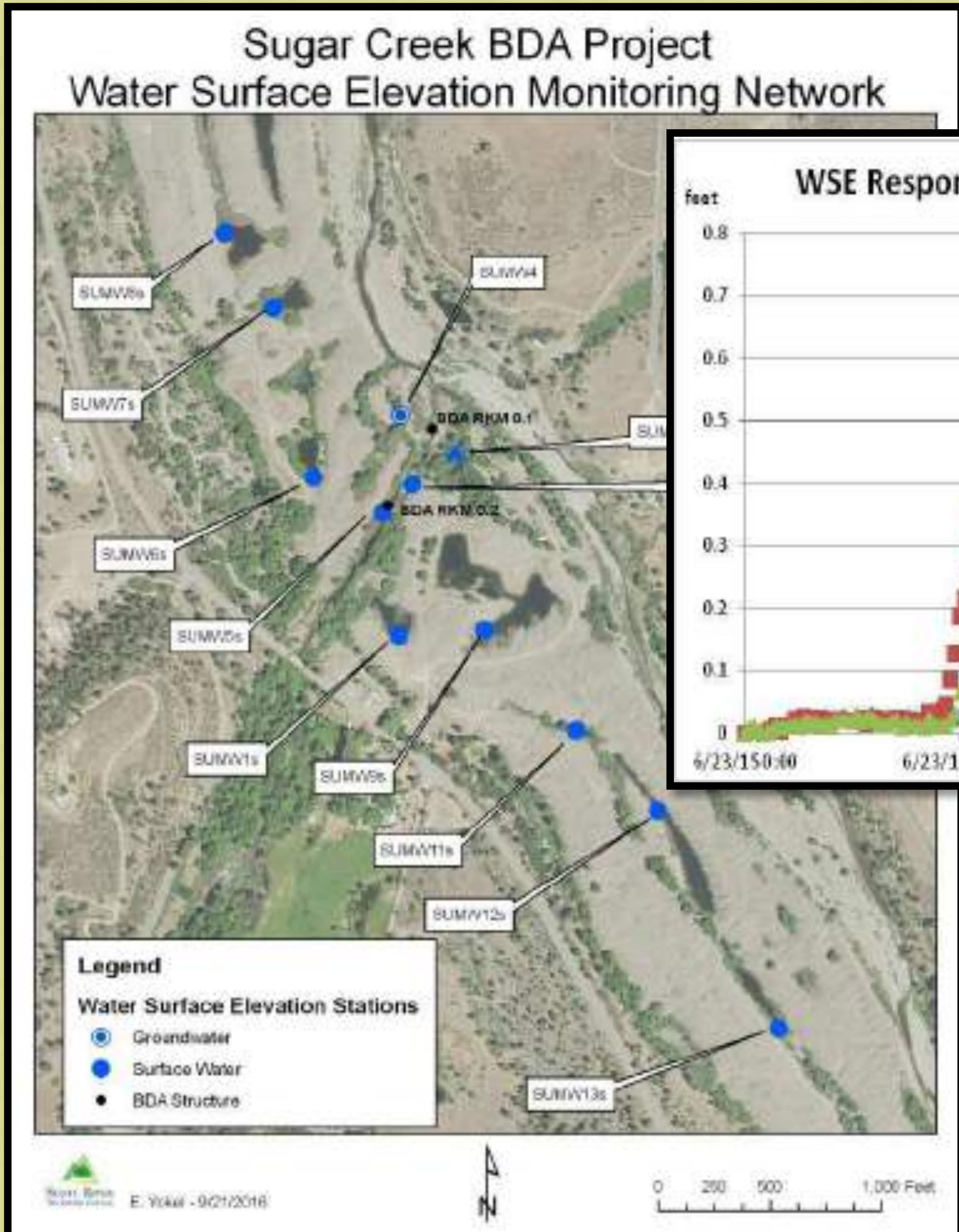
Erich Yokel

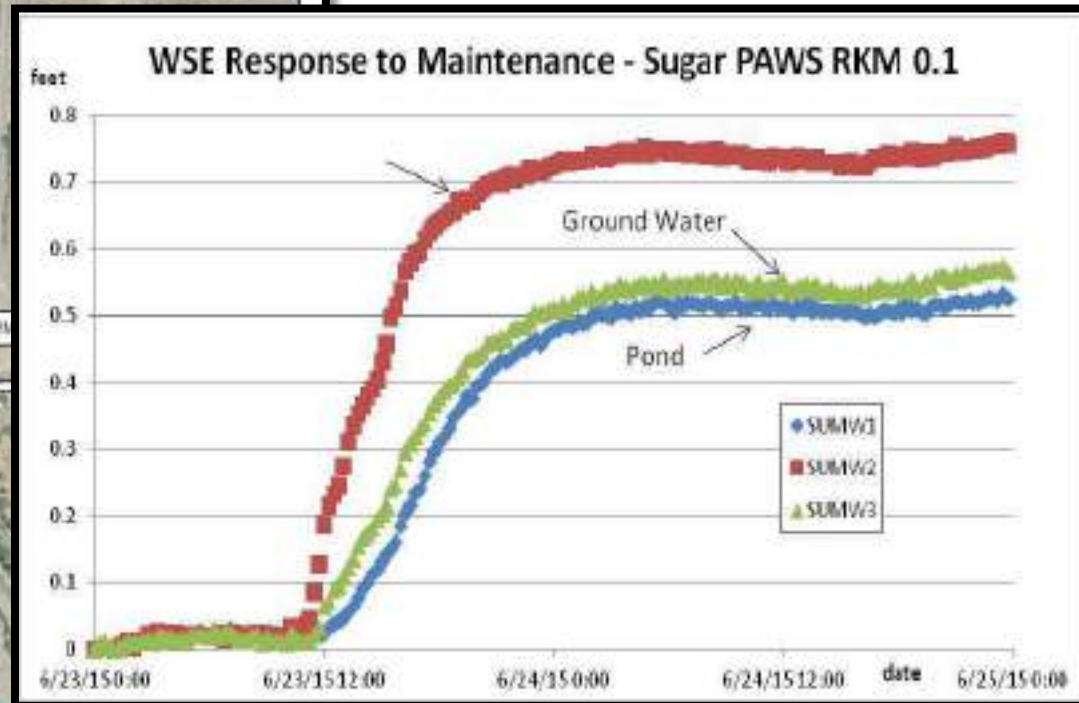
MINERS CREEK 2015



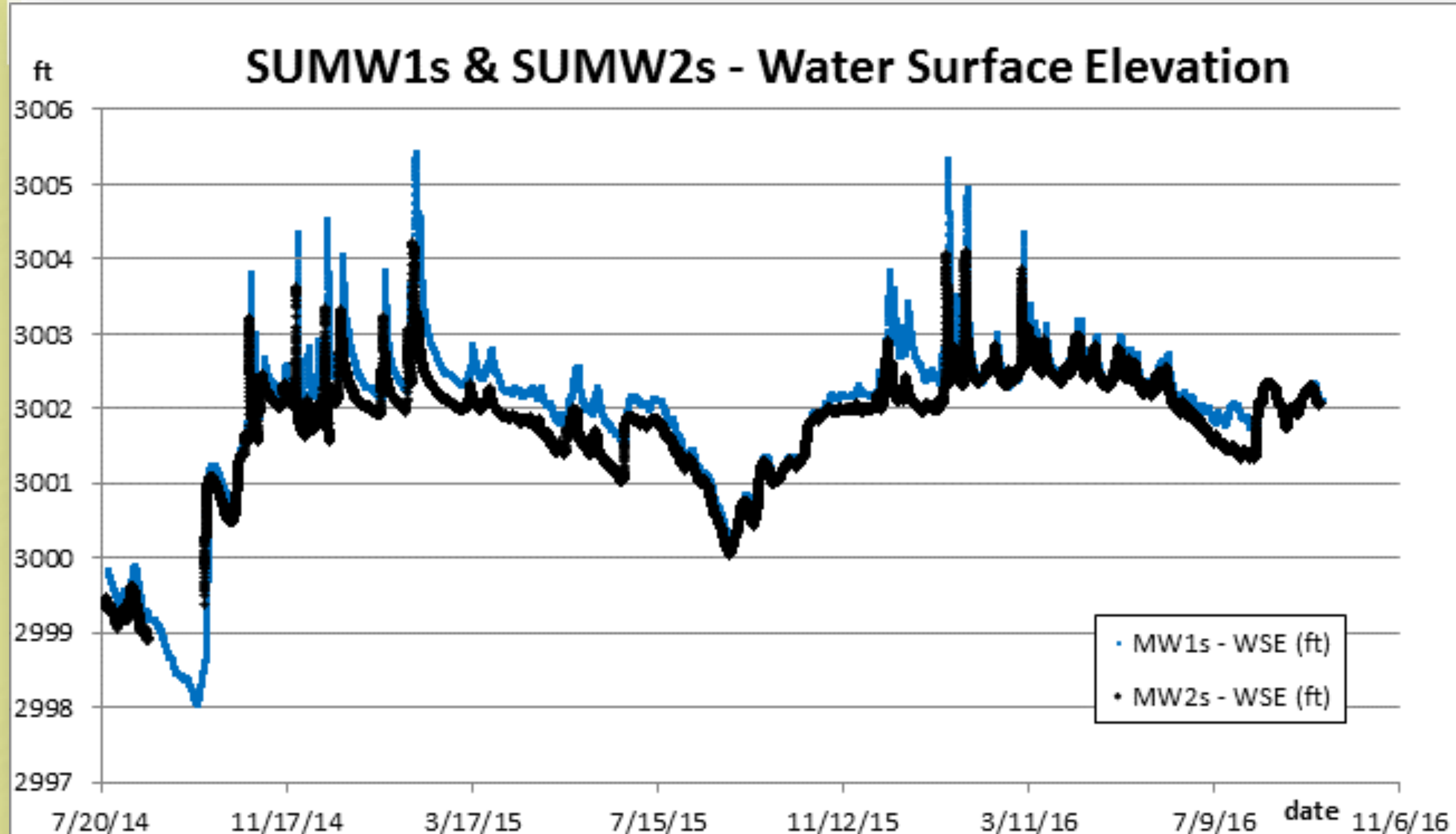
Scott River PIT Tag Program

	Coho salmon			Steelhead Trout		
	Total Catch	Total Marks	Total Recaps	Total Catch	Total Marks	Total Recaps
Lower Sugar Creek	**2521**	**833**	**414**	**1575**	**219**	**57**
Mid French Creek	**962**	**316**	**339**	**1031**	**76**	**22**


Sugar Creek BDA Project
Water Surface Elevation Monitoring Network
SUMW8s
SUMW7s
SUMW4
BDA RKM 0.1
BDA RKM 0.2
SUMW6s
SUMW5s
SUMW1s
SUMW9s
SUMW11s
SUMW12s
SUMW13s
Legend
Water Surface Elevation Stations
Groundwater
Surface Water
BDA Structure
N
0 250 500 1,000 Feet


WSE Response to Maintenance - Sugar PAWS RKM 0.1
feet
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Ground Water
Pond
SUMW1
SUMW2
SUMW3
6/23/15 0:00
6/23/15 12:00
6/24/15 0:00
6/24/15 12:00
date
6/25/15 0:00

Sugar Creek 2014 through 2016, Water Surface Elevations



ADAPTIVE MANAGEMENT

- Ensure Fish Passage
- Monitoring Response of Structures/System
- Adapt and Design Around Structure/System Responses

Estimated Costs for Construction of a BDA

- Materials (Approx. 200 Ft BDA)
  - Posts: $2,000 ($10 per post, set at 12” center)
  - Willow: $500 (4-5 Loads)
  - Berm: (cobble, straw, fines): $800
  - Misc: $300
- Subcontract/Labor
  - Post Installation: $1,200
  - Hand Labor: (post preparation, willow cutting and hauling, willow weaving, berm, site clean up) $2,500-
  - Project Management $2,000

Estimated Costs $9,300 for a 200’ BDA

(not including permitting and administrative costs)

- Maintenance – Remember AMM!!
  - Minor tweaks – Unknown
  - Major repair - Unknown

PERMITS FOR SCOTT RIVER BDAS

Agency	Permit	2014-2016	2017
State Water Resources Control Board	401 Water Quality Certification for Small Habitat Restoration Projects	✓	✓
Army Corp of Engineers Section 7 Consultation	404 Clean Water Coverage	✓	✓
California Department of Fish and Wildlife	1600 Permit, Lake and Streambed Alteration Agreement	✓	
CEQA Determination	CEQA Categorical Exemption, Class 6 CDFW	✓	
	CEQA Exemption for Small Habitat Restoration Waterboard	✓	✓
California Department of Fish and Wildlife	Habitat Restoration and Enhancement Act **(HREA)** providing LSAA and CESA coverage		✓
Local Grading or Flood Plain Encroachment	N/A	N/A	N/A

WANT TO JOIN THE BEAVER RESTORATION MOVEMENT?
JUNE 19-23

Dr. Michael Pollock, Dr. Brian Cluer, CDFW, Waterboard, USFWS, Rocco Fiori, SRWC

ScottRiverWatershedCouncil.com 5104stapleton@gmail.com

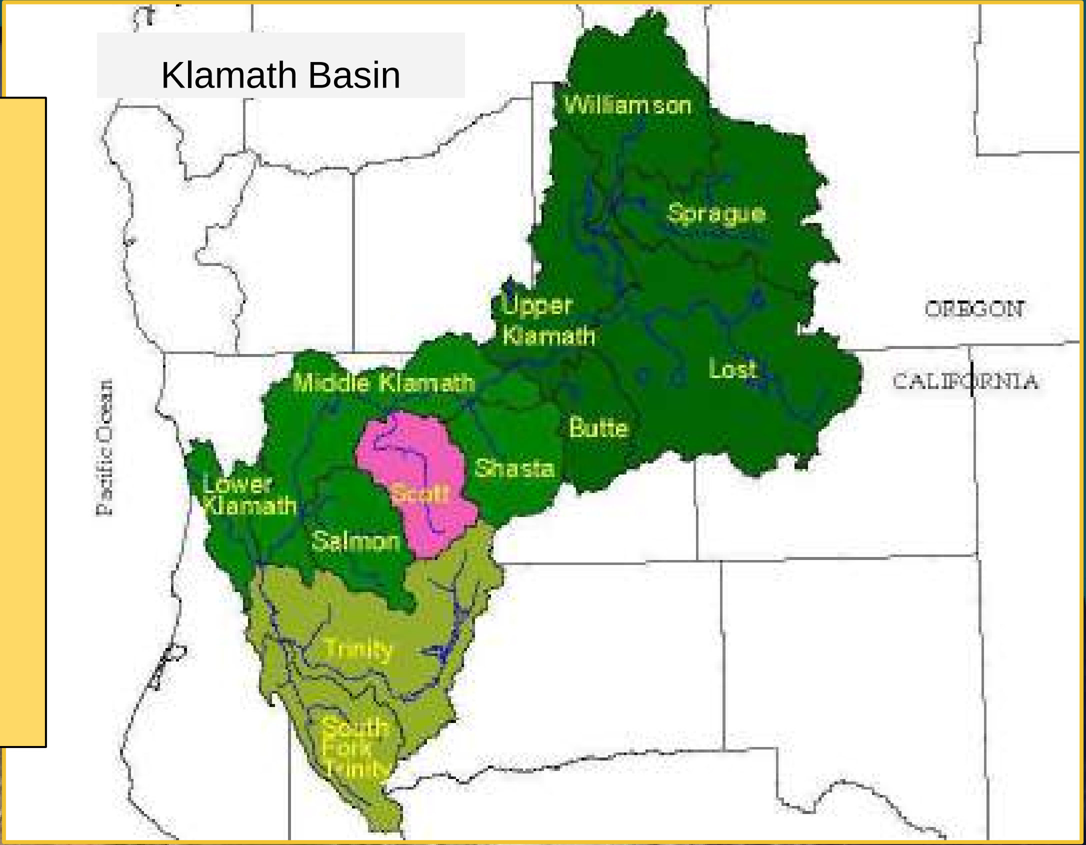
Developing an Adaptively Managed Restoration Technique for California

Beaver Dam Analogues

May 1, 2018
Charnna Gilmore
Executive Director
Scott River Watershed Council

Scott River Watershed

- 814 square miles
- 58 river miles on mainstem
- 274 miles of anadromous salmonid habitat
- Semi-arid, 21” rain average
- 33,000 irrigated acres
- 55% private ownership
- 45% federal ownership



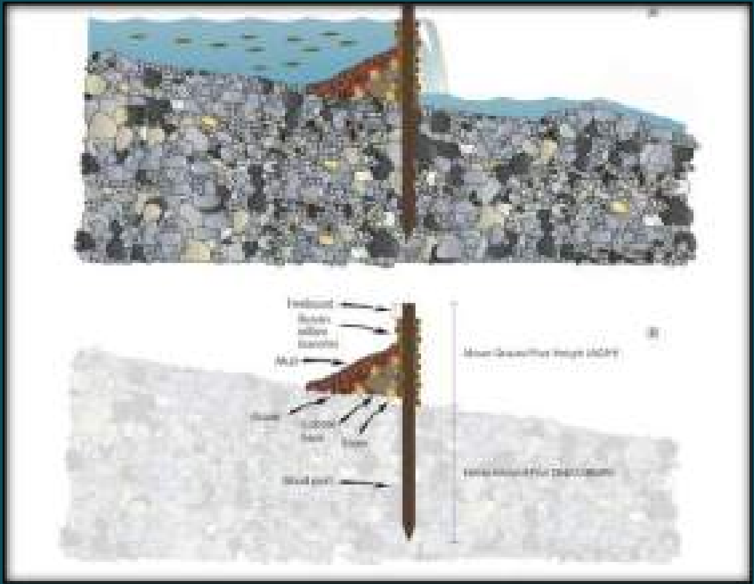
Legacy and Ongoing Anthropogenic Impacts

- Beaver extirpation
- Mining
- Channelizing
- Logging
- Development
- Water diversion
- Groundwater extraction
- Climate change


Why beavers?

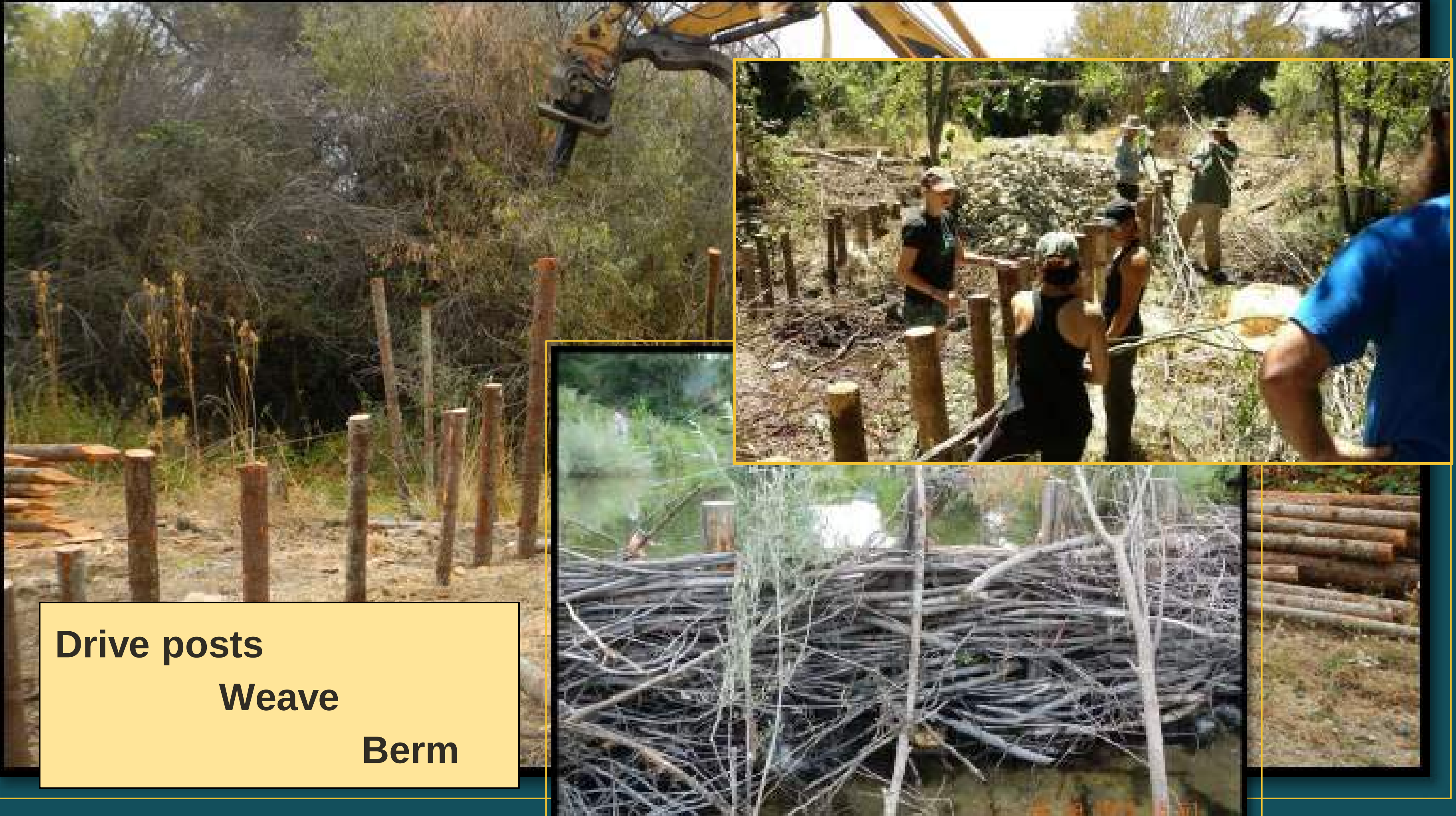

07/2014


10.08.2017



What are BDAs ?

Structures completely or partially built by humans that mimic many of the functions of natural beaverdams, hence Beaver Dam Analogues (BDA)



Drive posts

Weave

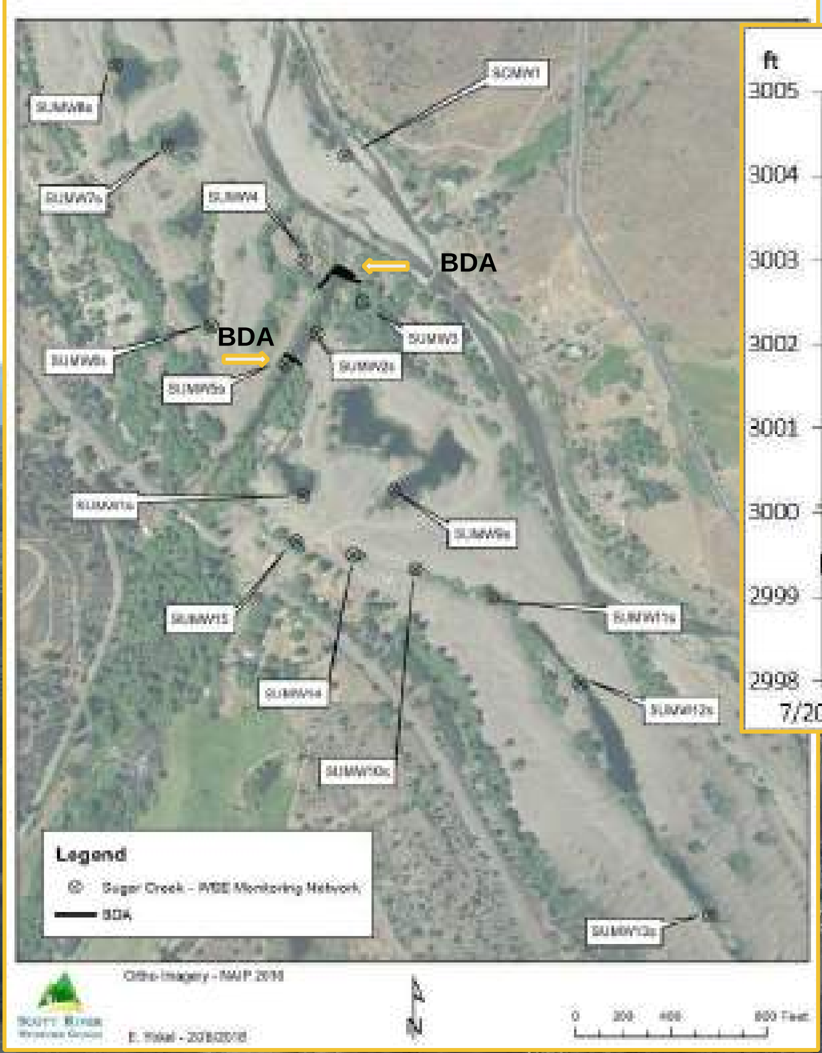
Berm

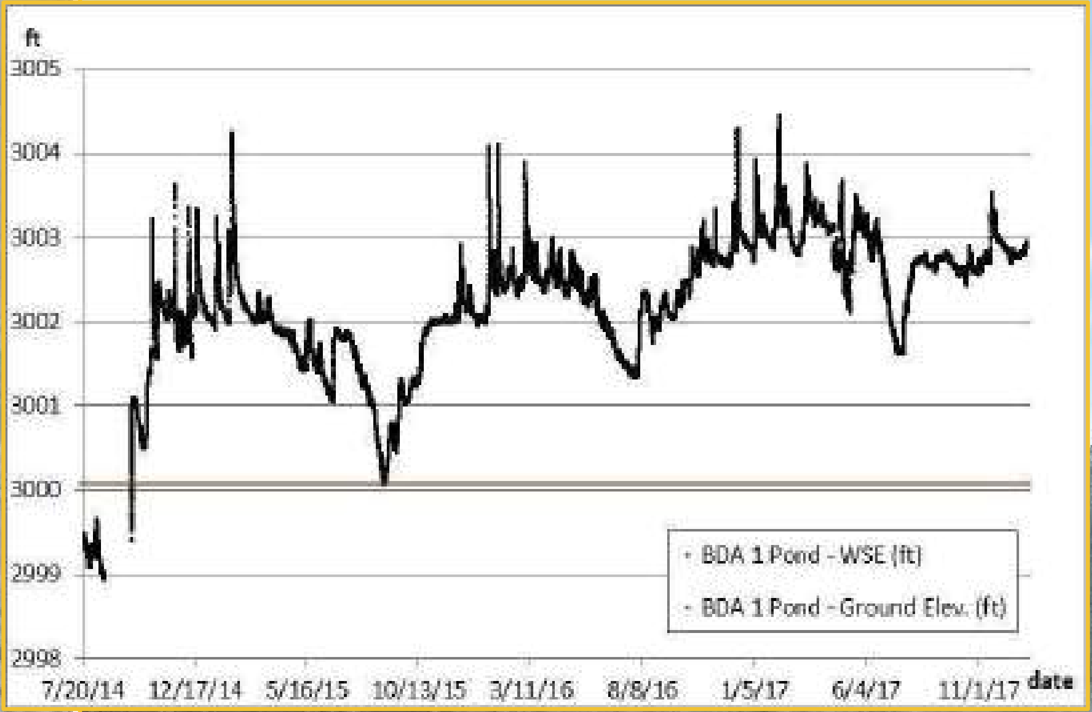
California's First BDAs

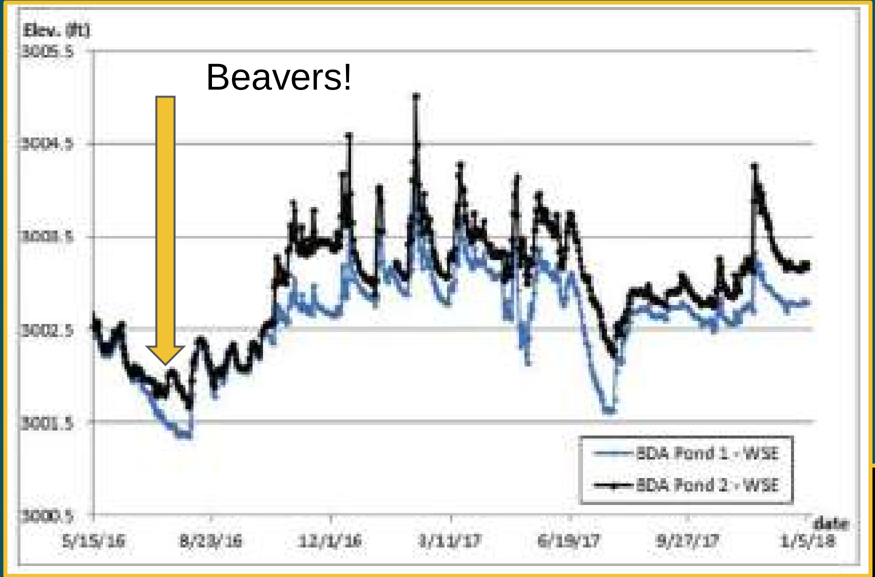
2014 - 3 sites, 6 BDAs

Present - 5 sites, 14 BDAs

2018 - 2 sites


BDA
BDA
Legend
Sugar Creek - WSE Monitoring Network
BDA
Ortho Imagery - NAIP 2016
0
200
400
800 Feet


ft
3005
3004
3003
3002
3001
3000
2999
2998
7/20/14
12/17/14
5/16/15
10/13/15
3/11/16
8/8/16
1/5/17
6/4/17
11/1/17
date
BDA 1 Pond - WSE (ft)
BDA 1 Pond - Ground Elev. (ft)



Adaptive Management Mandatory- AMM!

Sugar Creek

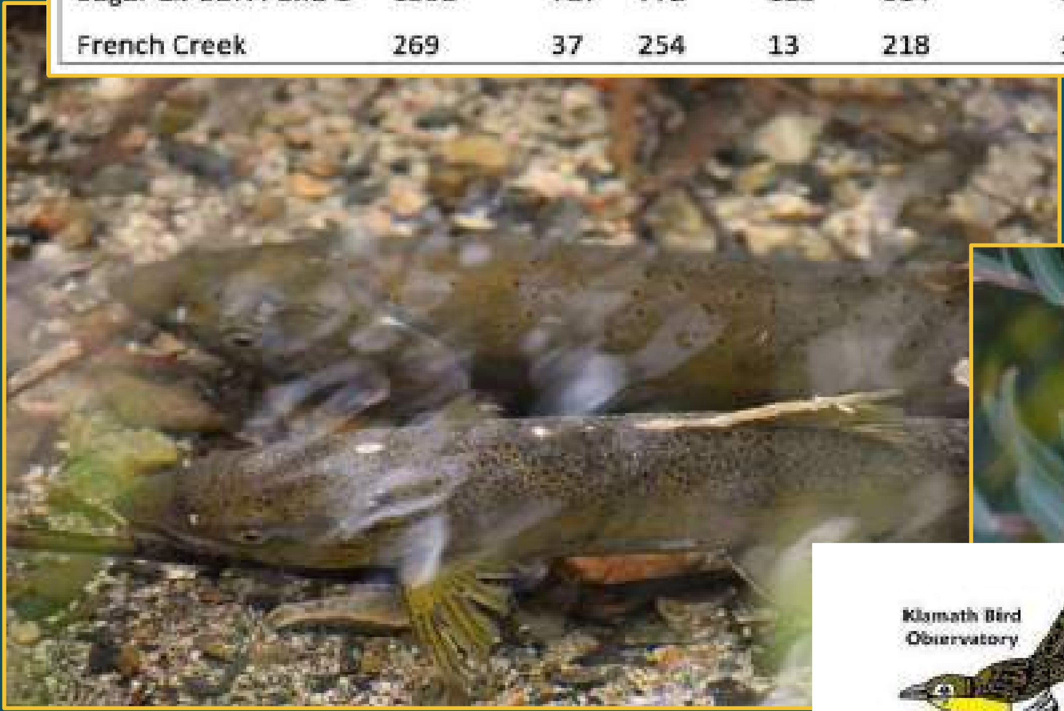
Water Year	Minimum WSE (ft)	Date Minimum WSE Recorded
2014	2998.1	9/18/2014
2015	3000.0	8/31/2015
2016	3001.3	8/3/2016
2017	3001.6	7/21/2017

Sugar & French Creek - juvenile coho salmon populations estimates 2017

Site	July	SD	August	SD	September	SD
Sugar Ck-BDA Pond 1	1996	787	772	125	914	144
French Creek	269	37	254	13	218	13

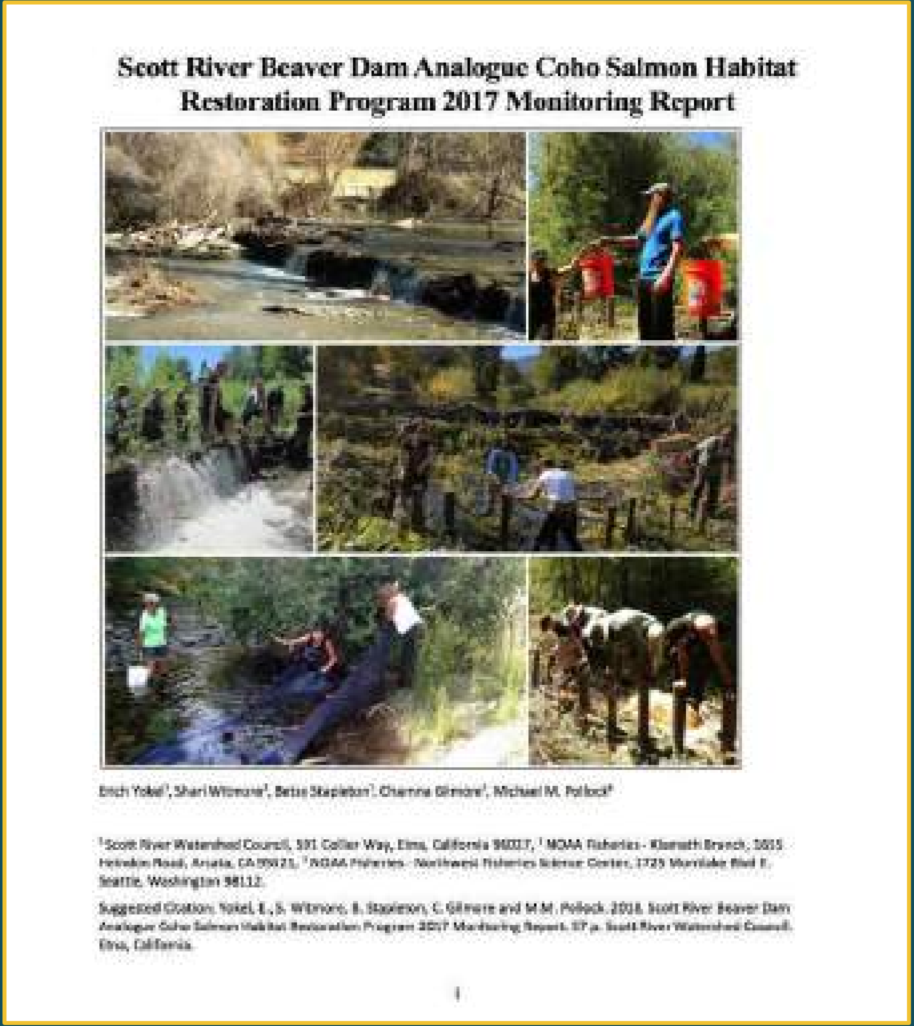
Foodweb - organic matter, suspended chlorophyll, benthic algae, water chemistry, and stream invertebrates

UCDAVIS



Bewick's Wren - Photo by Frank Lospalluto 2017

Klamath Bird Observatory



Scott River Beaver Dam Analogue Coho Salmon Habitat Restoration Program 2017 Monitoring Report

Erich Yokel[1], Sari Witmore[1], Betsy Stapleton[1], Charnna Gilmore[1], Michael M. Pollock[3]

[1]Scott River Watershed Council, 591 Collier Way, Etna, California 96027, [2] NOAA Fisheries - Klamath Branch, 1655 Heindon Road, Arcata, CA 95521, [3]NOAA Fisheries - Northwest Fisheries Science Center, 2725 Montlake Blvd E, Seattle, Washington 98112.

Suggested Citation: Yokel, E., S. Witmore, B. Stapleton, C. Gilmore and M.M. Pollock. 2018. Scott River Beaver Dam Analogue Coho Salmon Habitat Restoration Program 2017 Monitoring Report. 57 p. Scott River Watershed Council. Etna, California.

i

Questions:

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charnnagilmore@gmail.com

Thank you to our funders:

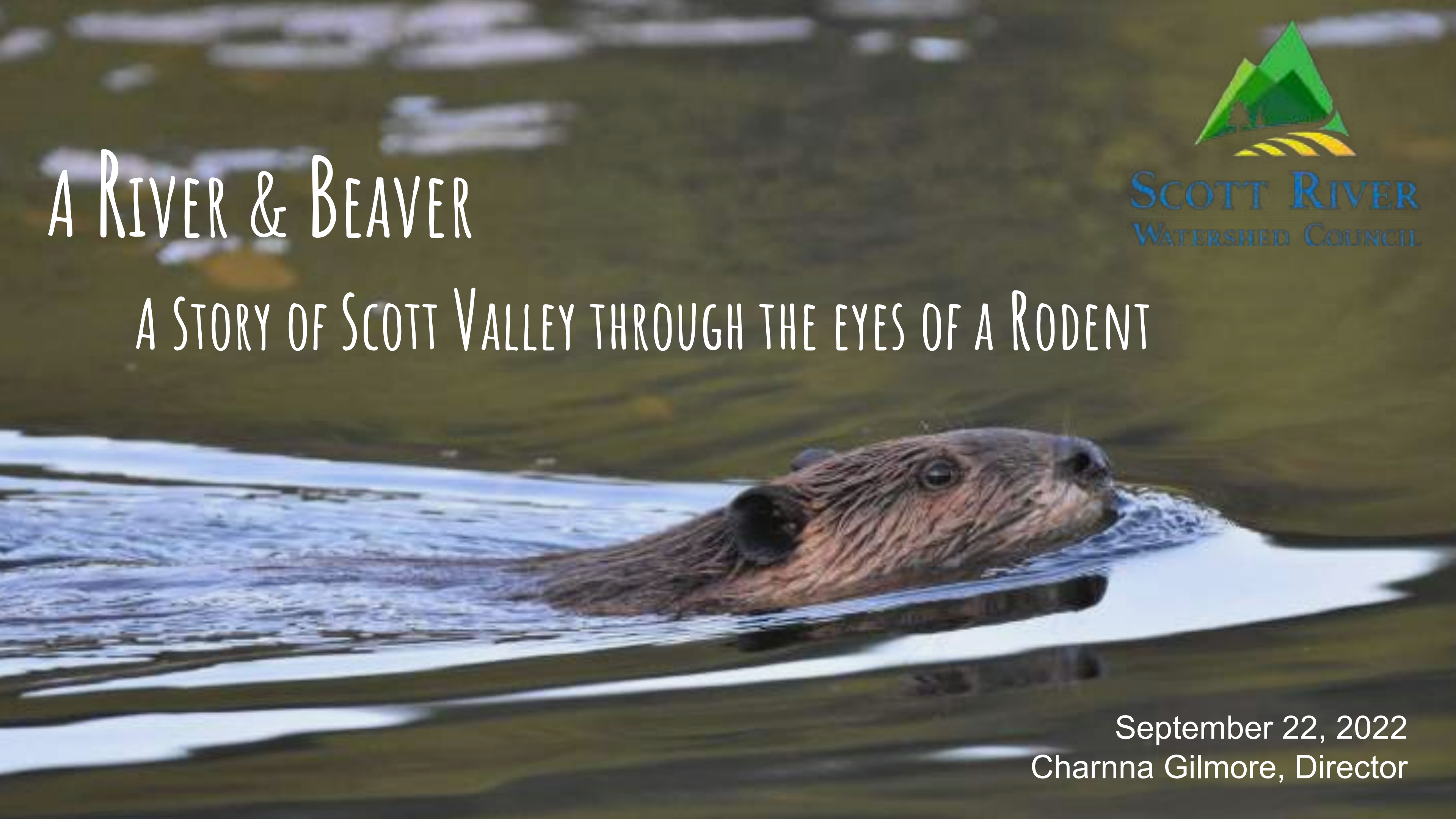
Bella Vista Foundation

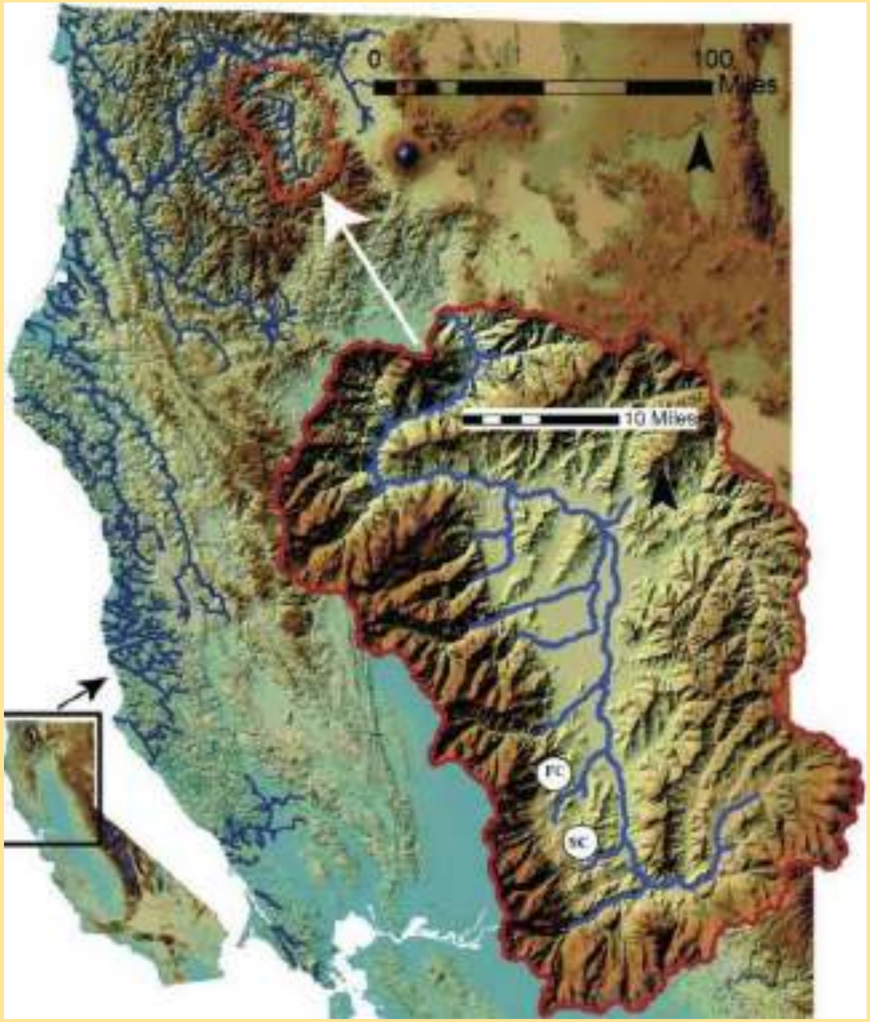
PacifiCorp

NFWF

NOAA

U.S. Fish & Wildlife Service


Scott River
Watershed Council
a River & Beaver
a Story of Scott Valley through the eyes of a Rodent
September 22, 2022
Charnna Gilmore, Director

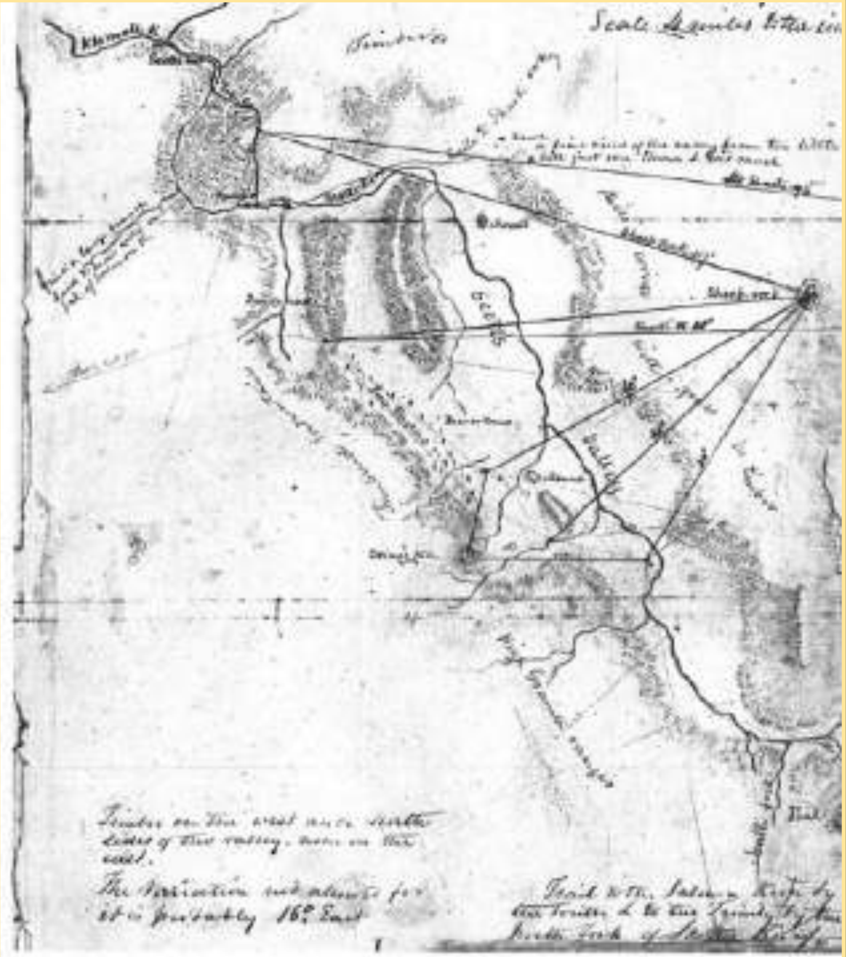


Welcome to Beaver Valley

Indigenous Tribes of Shasta and Kurak inhabited the Klamath and Siskiyou Mountains for thousands of years prior to first contact with European settlers.

A subbasin to the larger Klamath River basin, the watershed encompassing 813 square miles.

Today, 45% in federal and 55% in private lands. The Quartz Valley Indian Reservation owns 170 acres and is located in the Quartz Valley area, a subwatershed of the larger Scott River watershed.



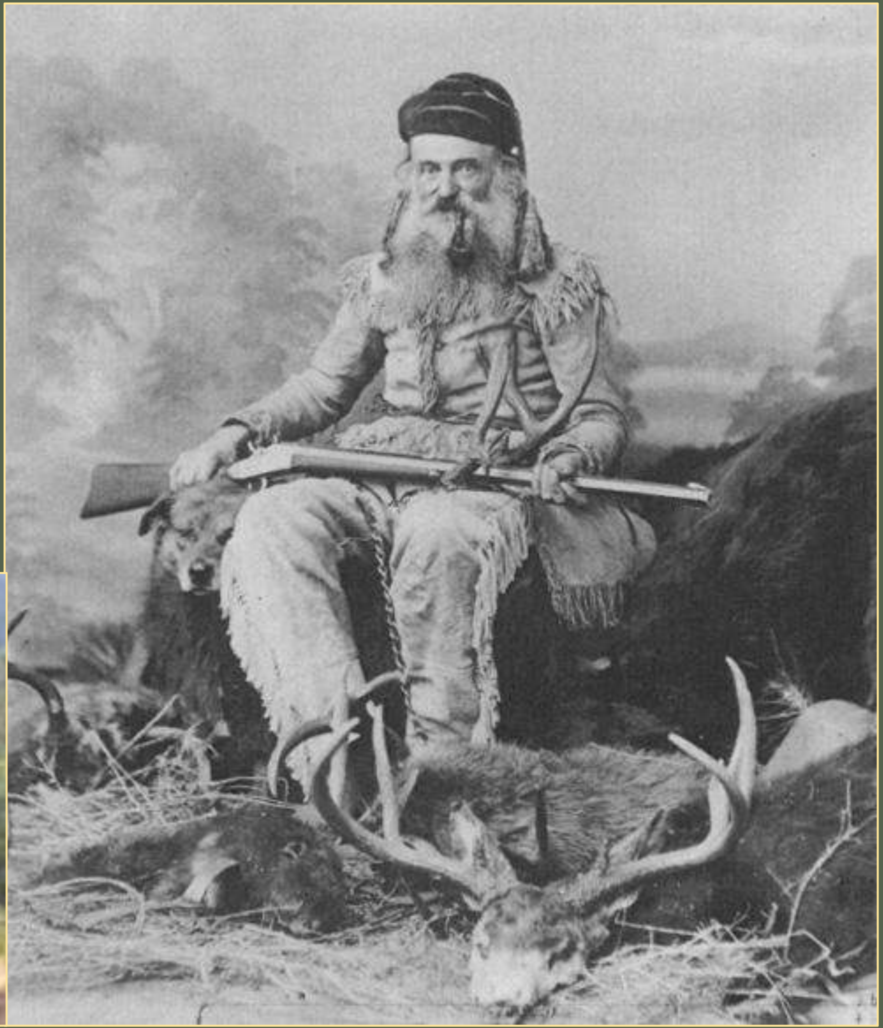
1852 Map of Scott Valley by Lieutenant R. S. Williamson

The first documented European contact was in 1830s, during what is known as the “Fur Rush” which was followed by the Gold Rush. It was believed that much of the valley basin was occupied by beaver dams.

Initially called Beaver Valley by the European trappers due to the impressive beaver population. Unfortunately, shortly thereafter, the first significant anthropogenic impact occurred. It is reported that 1800 - 2000 beaver were trapped and removed from the system in a single month.

Stephen Meek, Hudson Bay fur trapper, known best for his involvement in the initial beaver removal efforts, returned to Scott Valley later in life and is buried in the Etna Cemetery.

One trapper claimed that Scott Valley was *“**the richest place for beaver I ever saw***”, and described the Scott River as being “***all one swamp***” owing to the high number of beaver dams found there.



Fun Facts on Beaver

- ➔ Large semi-aquatic rodents:
  - The American beaver (*Castor canadensis)*
  - Typically weighing approximately 60 lbs.
- ➔ Thick, buoyant and waterproof fur, closable ears and nostrils and transparent eye membranes - all aid for a life in water
- ➔ Herbivorous, eating riparian plants including willow, cottonwood and grasses
- ➔ They have a set of upper and lower large incisors that continuously grow therefore they need to chew on woody material to keep the teeth at an appropriate length

More Fun Facts on Beaver

- ➔ Family Structure - Adults are generally monogamous
- ➔ “Families” of beavers, consisting of parents, yearlings and kits The younger siblings stay with their parents for up to 2 years, helping with infant care, food collection, dam and den construction.
- ➔ Lifespan of wild beaver is estimated 10-15 years and 20 years in captivity
- ➔ Beaver build lodges or bank dens, with the entrance directly into the water for safety
- ➔ Beaver use their tail to splash the water to alert of dangers (*this a tail slap photo*)

Scott Valley Beavers

Water, food and low gradient systems

Bank, Lodge or Dam Builders?

Beaver, the Ecosystem Engineers

CHALLENGES

Jefferson State Flixx Festival's Spirit of Jefferson Award 2019

Slow Water & Coho Salmon

- ➔ Coho salmon (*Oncorhynchus kisutch),* one of five anadromous Pacific Ocean salmonids
- ➔ Coho salmon require freshwater for two different life stages:
  - ◆ Adult spawners create nests or “redds” in the winter, preferably in tributaries;
  - ◆ Juvenile Coho salmon emerge from the redds in spring and remain in the system for nearly a year, both summer & winter, before they outmigrate to the ocean;
  - ◆ They remain in the ocean for two years before they return as adults and the cycle begins again;
  - ◆ There are 3 of these cycles and are referred to as cohorts.
- ➔ Coho salmon are listed as an endangered species, meaning at risk of extinction.

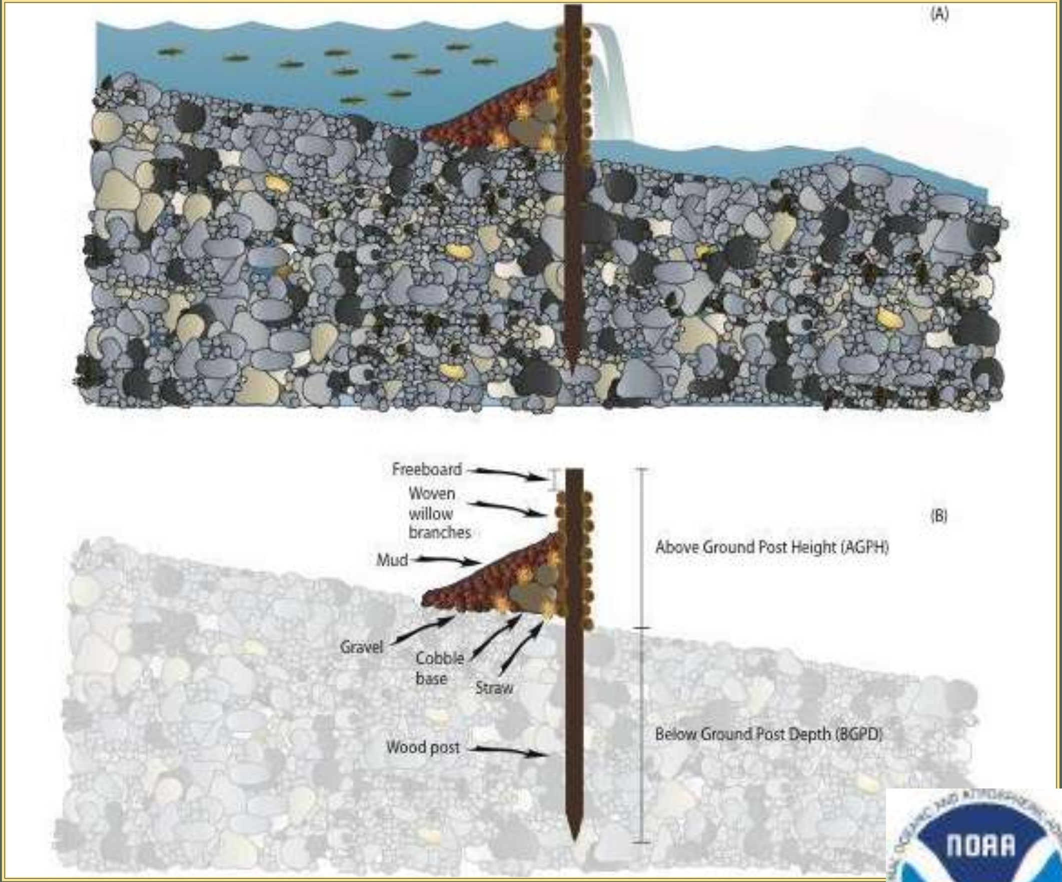
Wetlands & Their Benefits

- ➔ An estimated 53% of all wetlands have been eliminated around the nation, with much greater loss, over 90% within California.
- ➔ Wetlands and floodplains play a critical role in the biological, geomorphic, and hydrologic cycles including groundwater recharge, all of which impact the overall ecological fitness of a watershed.
- ➔ Climate change is anticipated to cause further negative impacts on the hydrology of most regions. Changes in the amount and timing of precipitation, and increased frequency and magnitude of drought events are expected to amplify ecosystem stresses.

Scott River Beaver Dam Analogues (BDAs)

In 2014, SRWC in partnership with Scott Valley landowners, National Oceanic & Atmospheric Administration (NOAA), United States Fish & Wildlife Service (USFWS) and California Department Fish & Wildlife (CDFW), California's first BDA's were constructed in the Scott Valley.

BDA Concepts

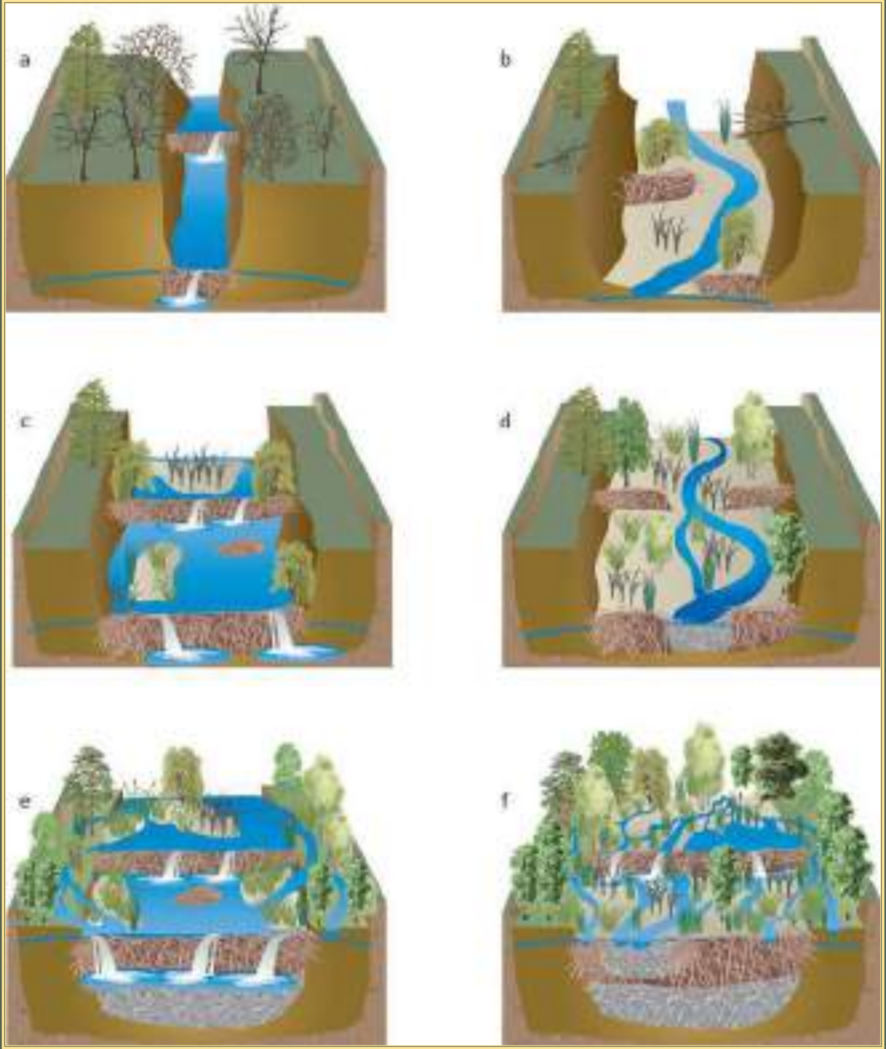


Stream channel evolution

"Slow it, sink it, store it."

Brock Doleman

Co-Director for the Occidental Arts and Ecology Center



Scott River BDAs

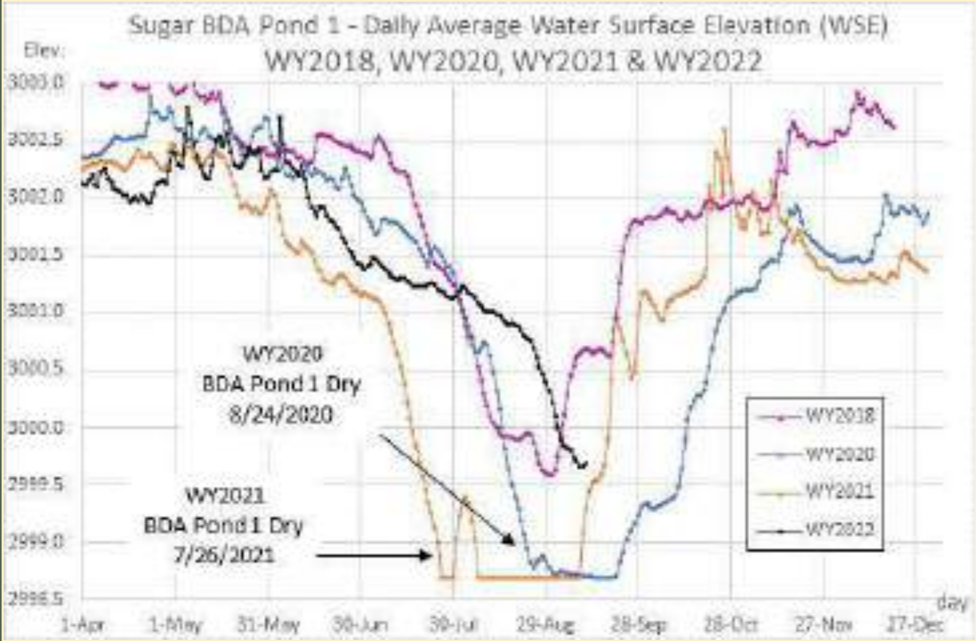
Pound

WEAVE

Stuff & rock

Monitoring efforts

- → Fish Utilization
- → Water Quality
- → Beaver Utilization
- → Surface and groundwater elevations
- → Geomorphic Change
- → Fish Passage
- → Habitat Characterization
- → Multi-species benefit
- → Food Web



Groundwater, Surface Water and Water Quality Networks:

- ➔ 90+ Surface water elevations loggers
- ➔ 20+ Temperature loggers
- ➔ 5 Dissolved oxygen loggers

Fish Utilization, both juvenile & spawners:

- ➔ Movement, habitat use, biometrics

We use two methods: Direct observation and PIT (Passive Integrated Transponder) with pass-through or pass-by antennas

Bella Vista
FOUNDATION

UCDAVIS
UNIVERSITY OF CALIFORNIA

Living Laboratory

Who Is SRWC?

Scott River Watershed Council's Mission

Originally established in 1992, the SRWC became a nonprofit in 2011.
Our office is located in Etna, California.

The mission of the Scott River Watershed Council is to facilitate communication and science based collaborative solutions for natural resource concerns in Scott Valley.

We promote and support education, restoration, and scientific planning and monitoring in order to ensure the sustainability of the natural and human communities of the watershed, now and for future generations.

Our leadership in addressing these complex issues works to bring effective solutions to our local community and beyond.

Besides working with Beaver

➔ Wood loading, both engineered and “chop & drop” techniques

➔ Off-channel features

➔ Floodplain enhancement and riparian planting

Besides working with Beaver

- ➔ Youth Environmental Summer Studies (YESS) Program
- ➔ Upland Forest Management
- ➔ Siskiyou Prescribed Burn Association
- ➔ Mountain Meadow Restoration
- ➔ Community Outreach & Education

Home to the

Etna Farmers Market

Etna Community garden

FARMERS MARKET

514 NORTH HWY 3

We would like to give thanks to all our valued partners and extra thanks to the landowners of Scott Valley. Without your commitment to our watershed, none of our work would be possible.

Beaver & BDA Related Reference Material
(Scott Valley specific & more general)

Ranchers, Beavers and Stream Restoration: Experimenting with Beaver Dam Analogues in the Scott River Basin, California

Scott River Beaver Dam Analogue Coho Salmon Habitat Restoration Program 2017 Monitoring Plan

The Beaver Restoration Handbook

Low-Tech Process Based Restoration of Riverscapes

More can be found on our website:

www.ScottRiver.org

Questions?

Scott River Watershed Council

www.scottriver.org

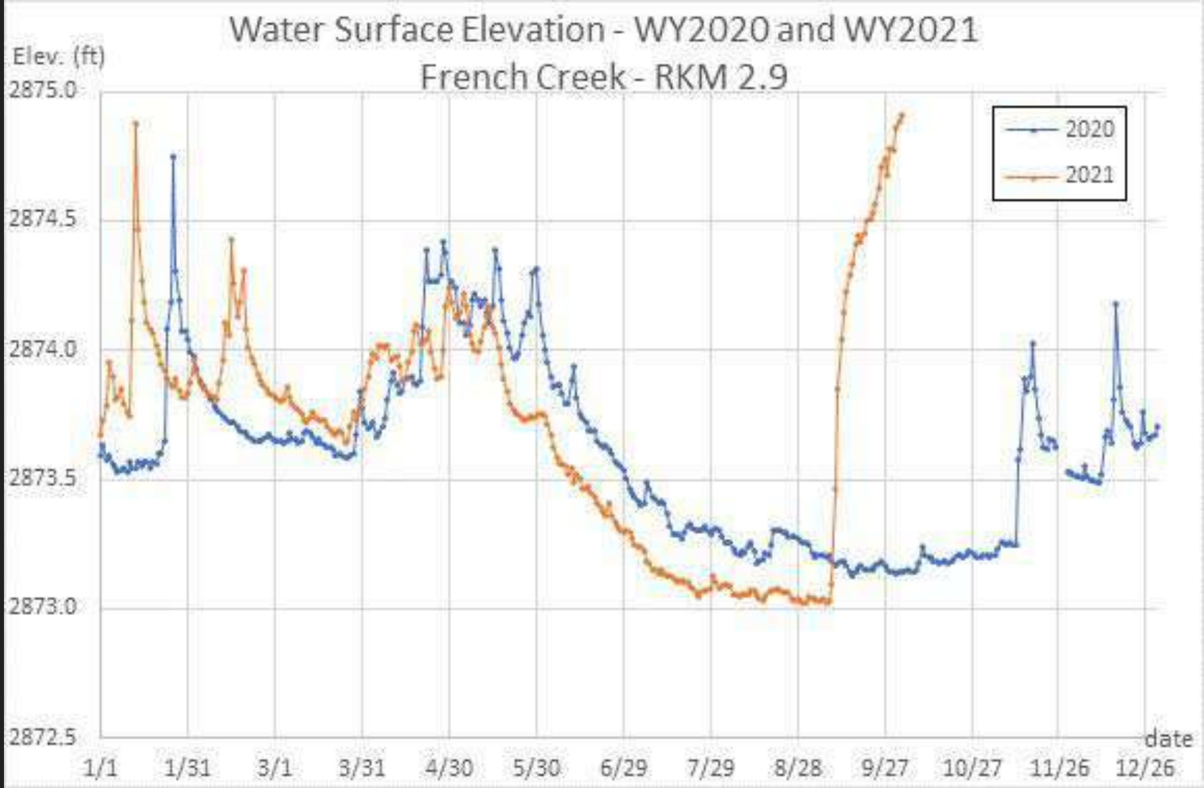
Charnna Gilmore, Executive Director
charnna@scottriver.org

Beavers in Working Landscapes

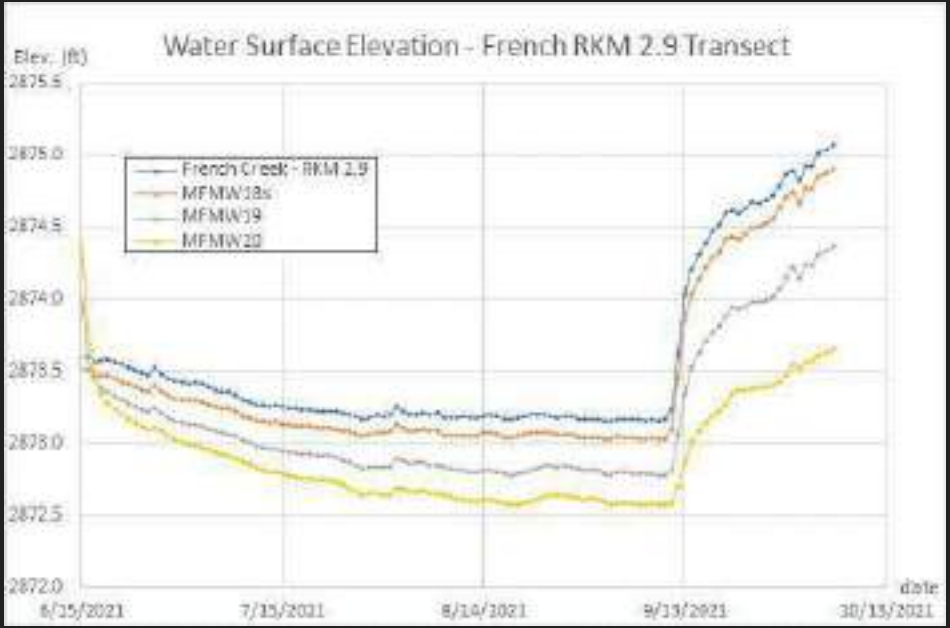
Natural Resource Use and Natural Resource Protection

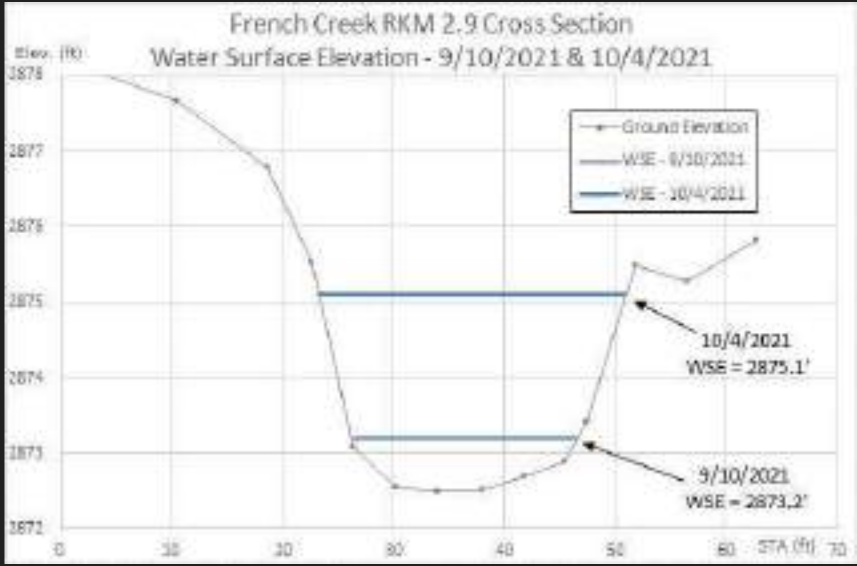
Beavers are a Pain!

Beavers are an Amazing Asset



Beavers: Ground and Surface Water





Beaver Mimicry: Beaver Dam Analogues

Legal and Regulatory Concerns

- Fish Passage
- “Losing Water”
- Liability
- “Critical Habitat”

Is It Worth It?

Appendix C:

Scott River, French Creek, and Sugar Creek Discharge

WY 2018-2022

Scott River, French Creek and Sugar Creek Discharge – WY2018 – WY2022
Scott River – USGS 11519500

Stream discharge data for the Scott River USGS Discharge Station (11519500) was retrieved from the USGS National Water Information System: Web Interface (https://waterdata.usgs.gov/nwis/uv?site_no=11519500&legacy=1).

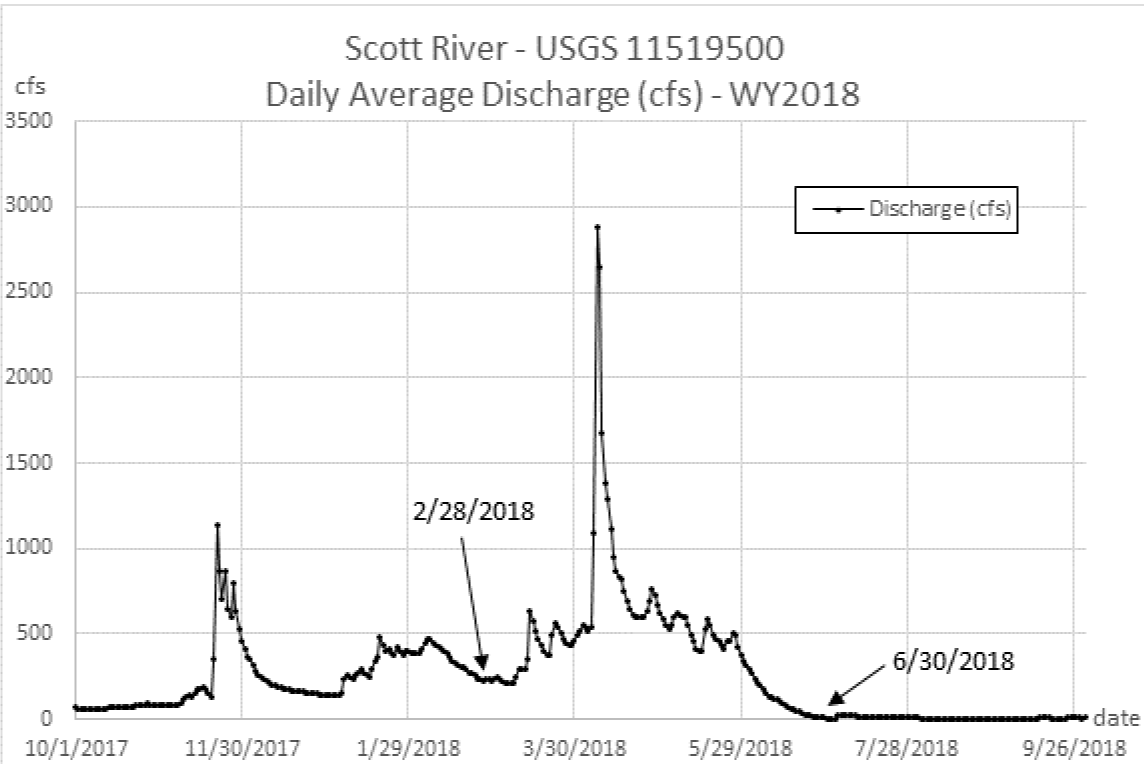


Figure 1 – Scott River Discharge – WY2018

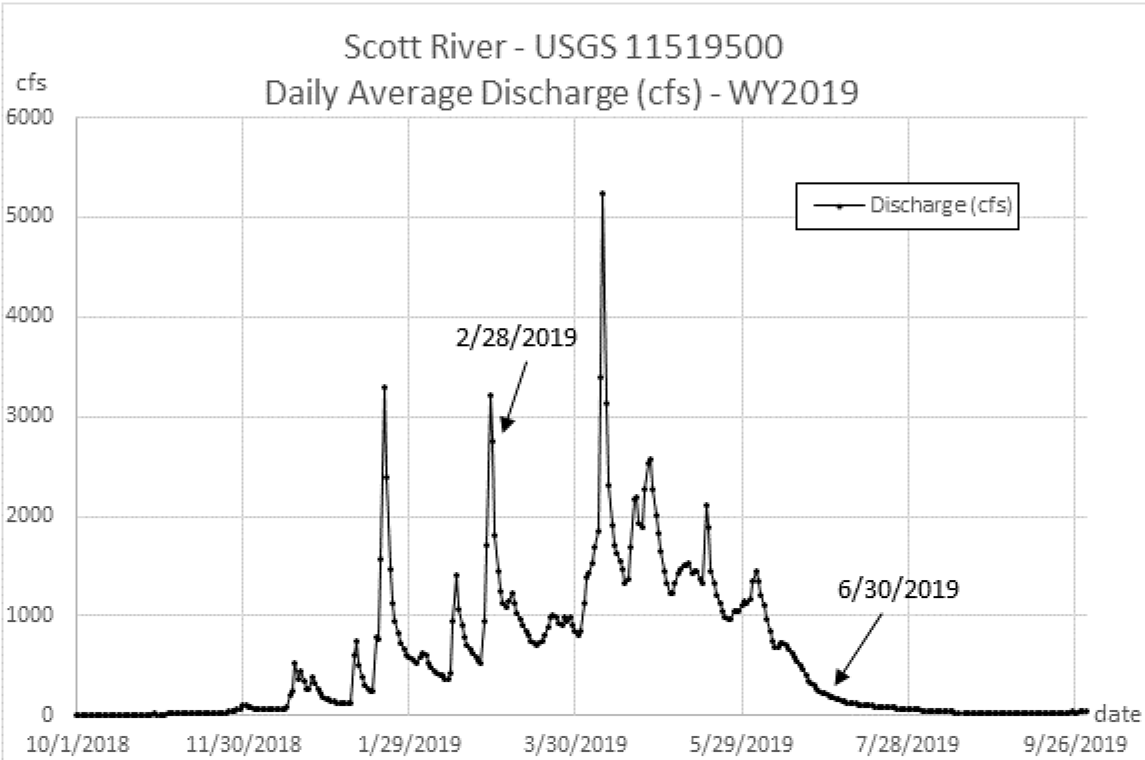


Figure 2 – Scott River Discharge – WY2019

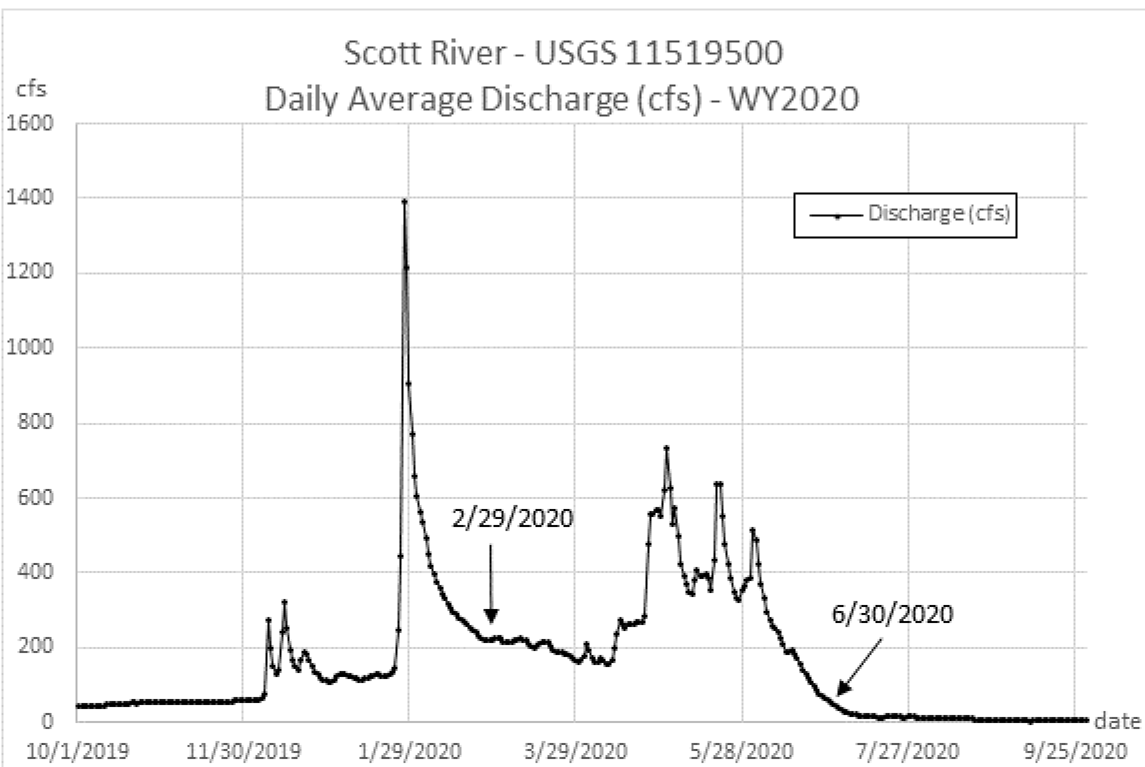


Figure 3 – Scott River Discharge – WY2020

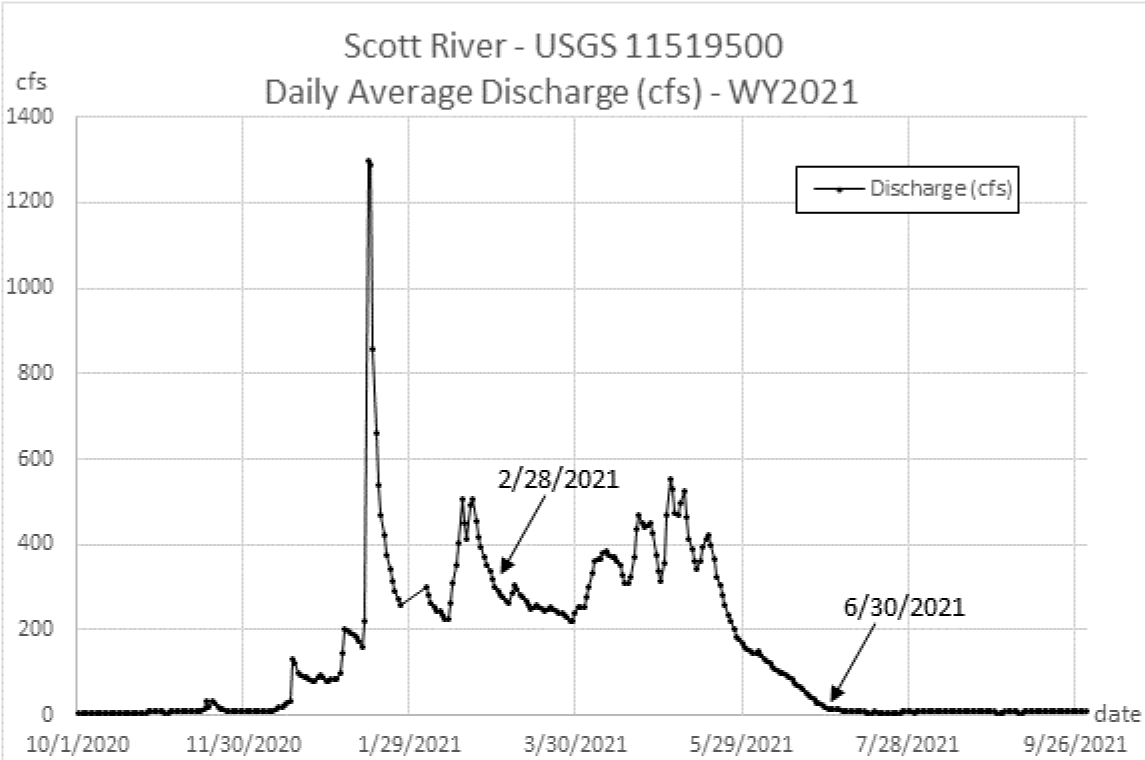


Figure 4 – Scott River Discharge – WY2021

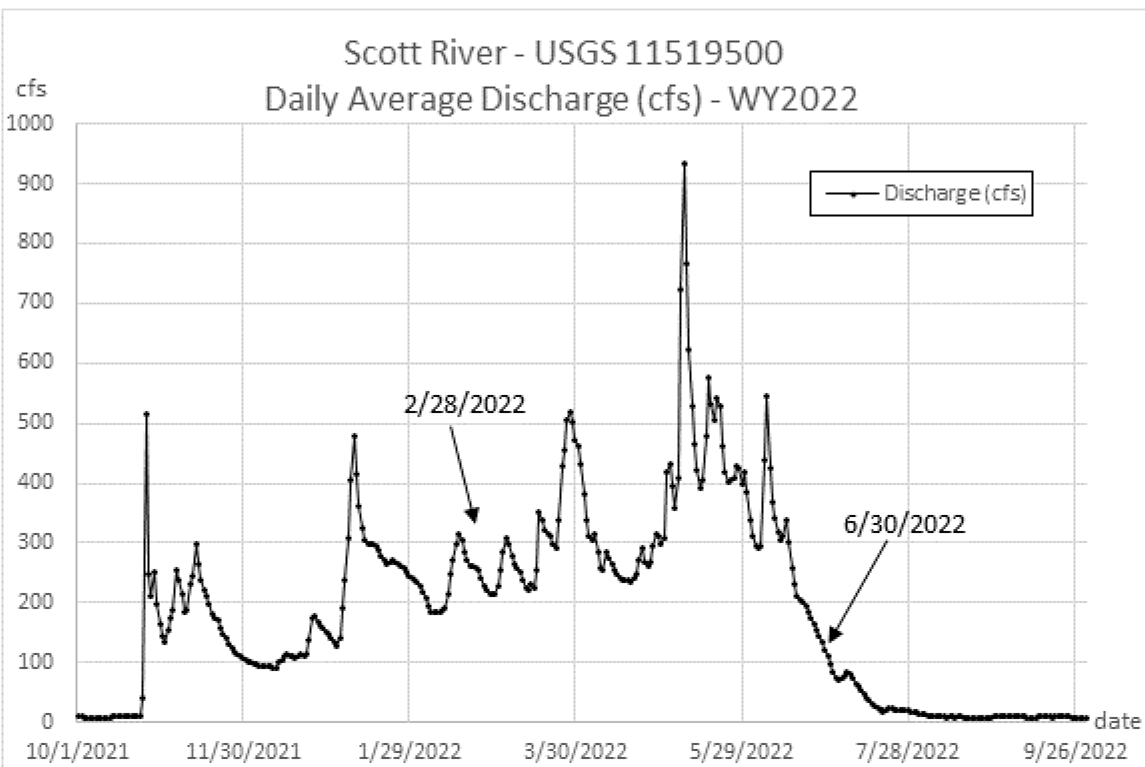


Figure 5 – Scott River Discharge – WY2022

French Creek – CDWR F25650

Stream discharge data for the French Creek CDWR Discharge Station (F25650) was retrieved from the California Department of Water Resources Water Data Library (https://wdl.water.ca.gov/).

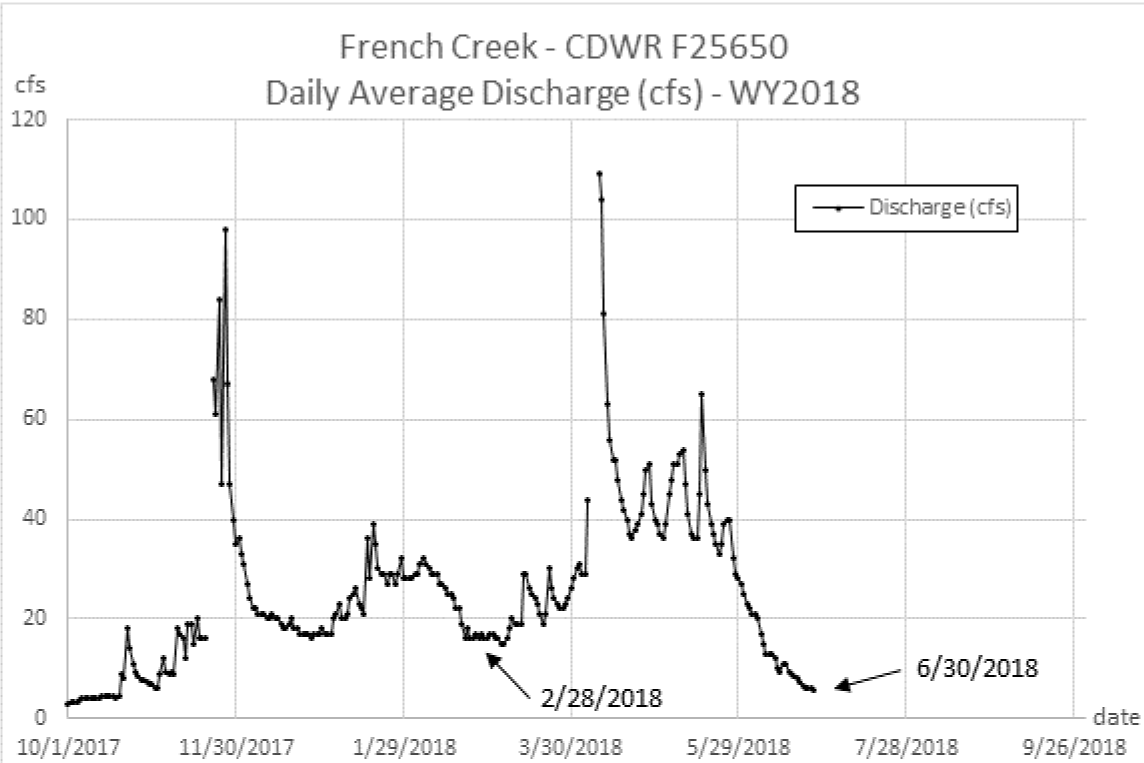


Figure 6 – French Creek Discharge – WY2018

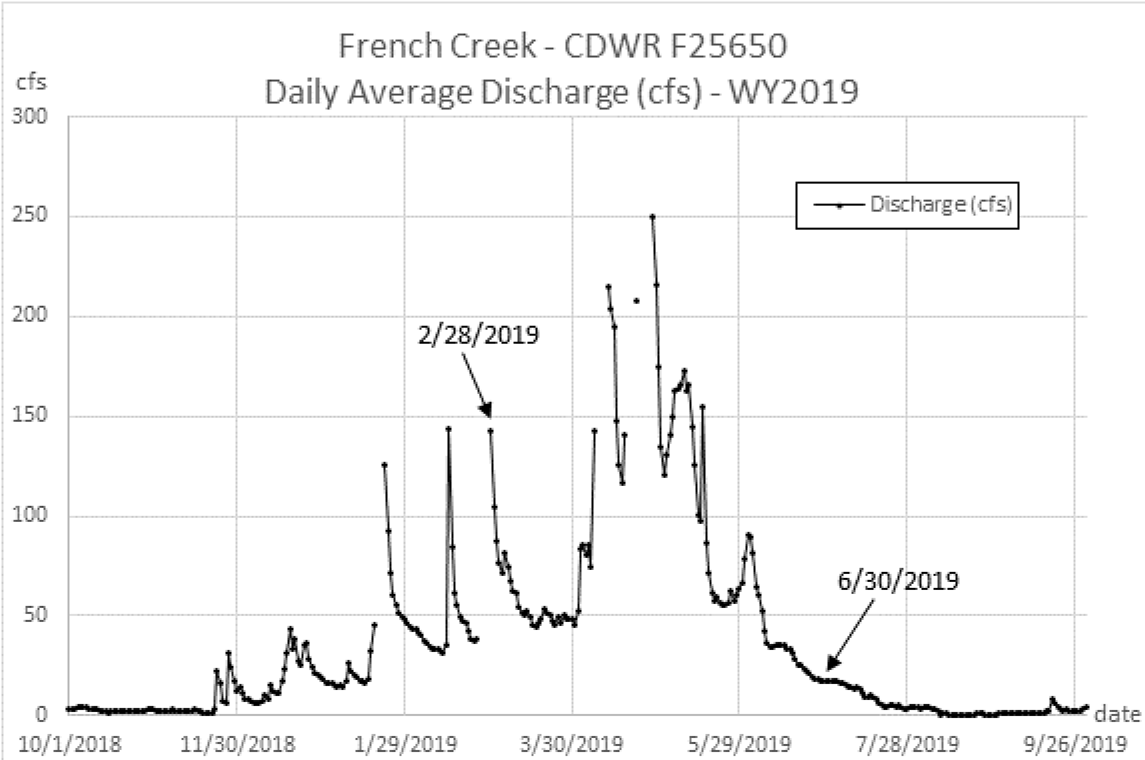


Figure 7 – French Creek Discharge – WY2019

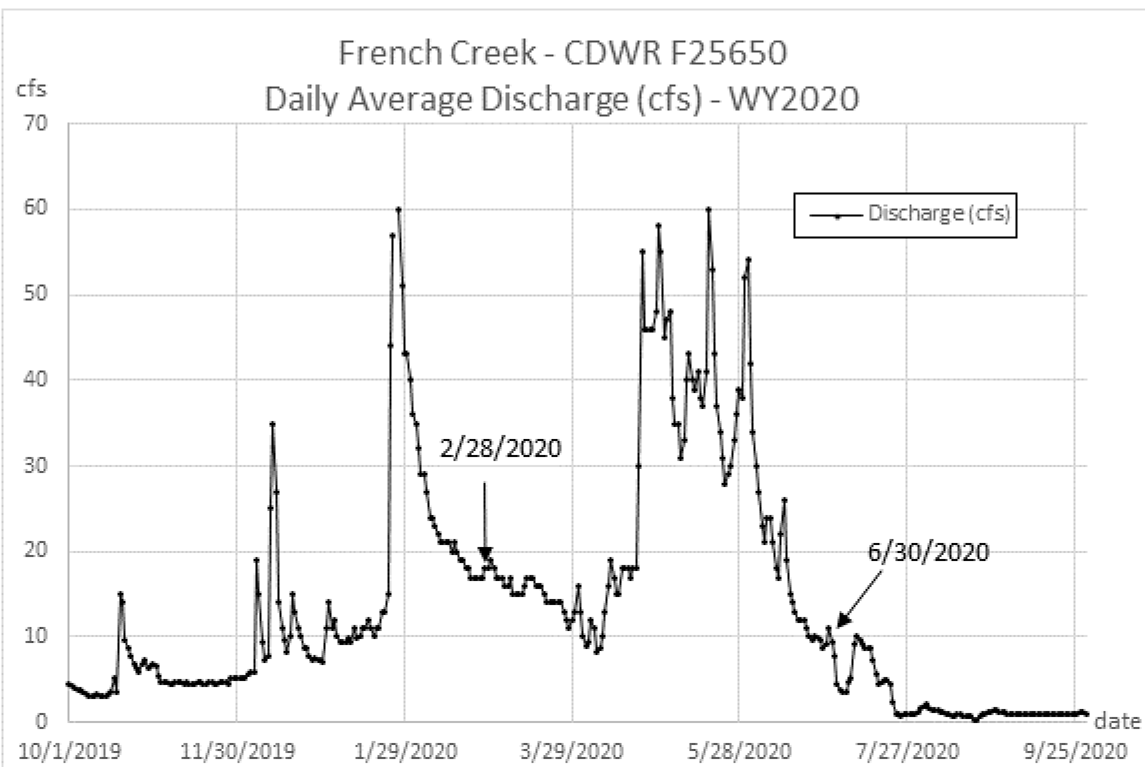


Figure 8 – French Creek Discharge – WY2020

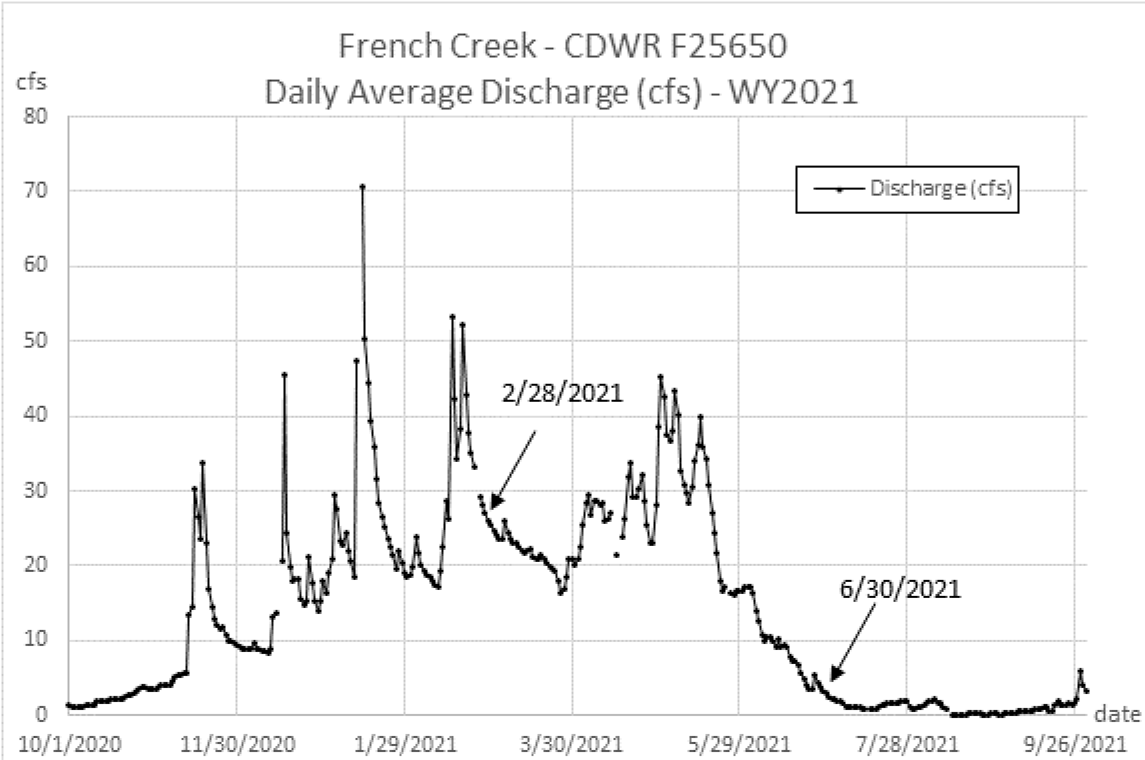


Figure 9 – French Creek Discharge – WY2021

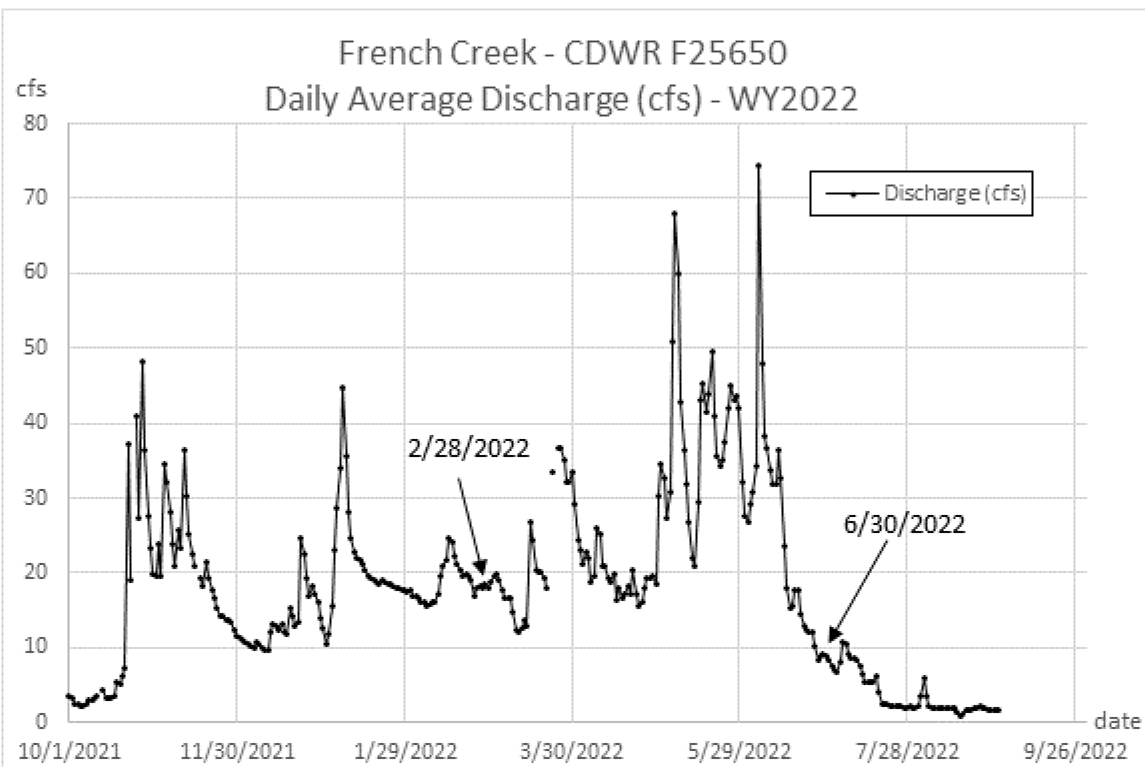


Figure 10 – French Creek Discharge – WY2022

Sugar Creek – CDWR F25890

Stream discharge data for the Sugar Creek CDWR Discharge Station (F25890) was retrieved from the California Department of Water Resources Water Data Library (https://wdl.water.ca.gov/).

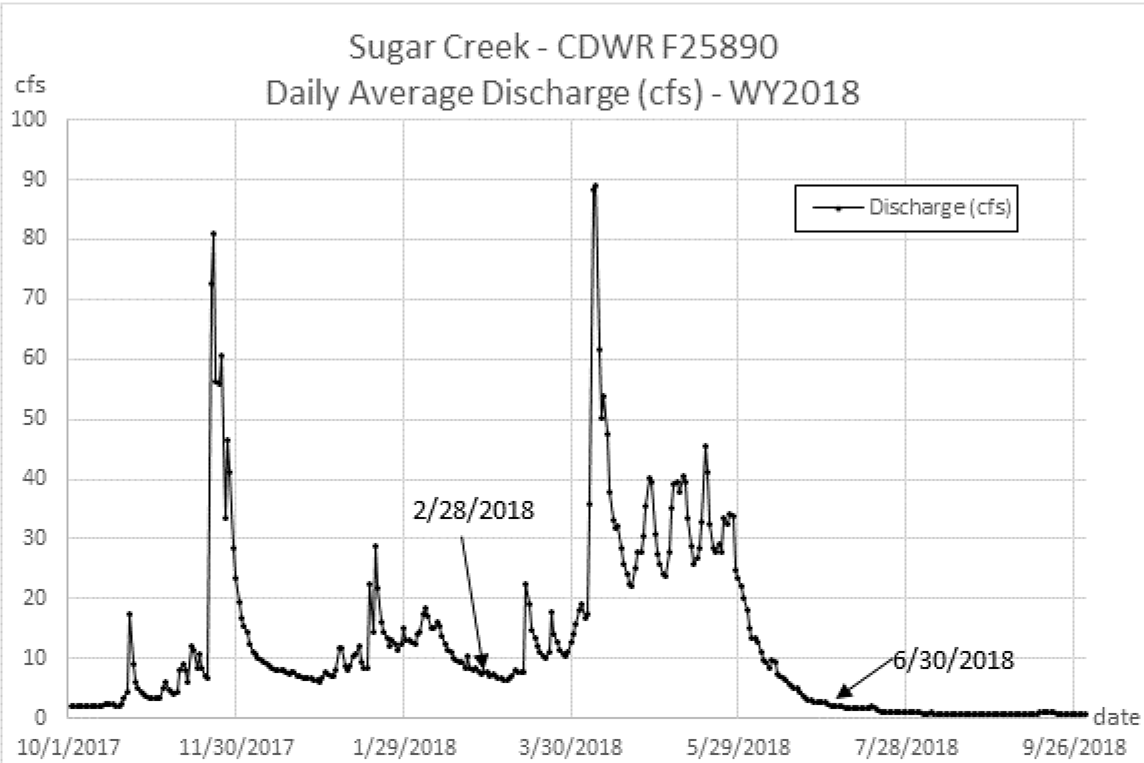


Figure 11 – Sugar Creek Discharge – WY2018

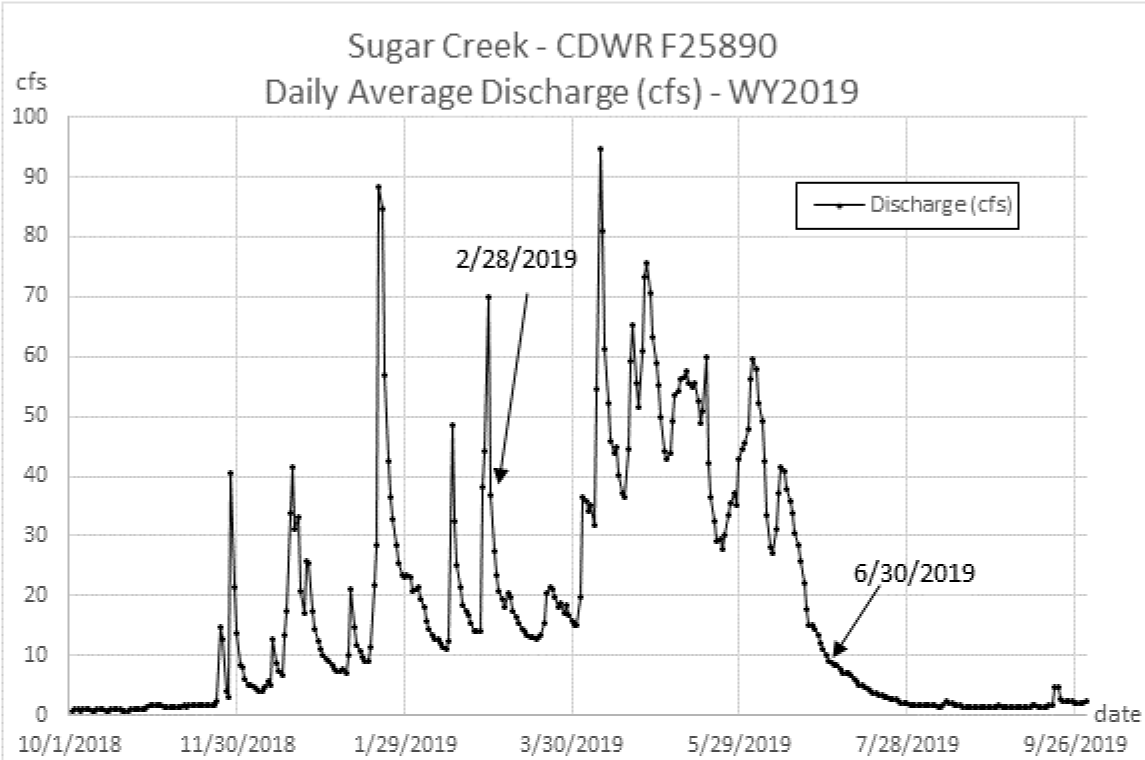


Figure 12 – Sugar Creek Discharge – WY2019

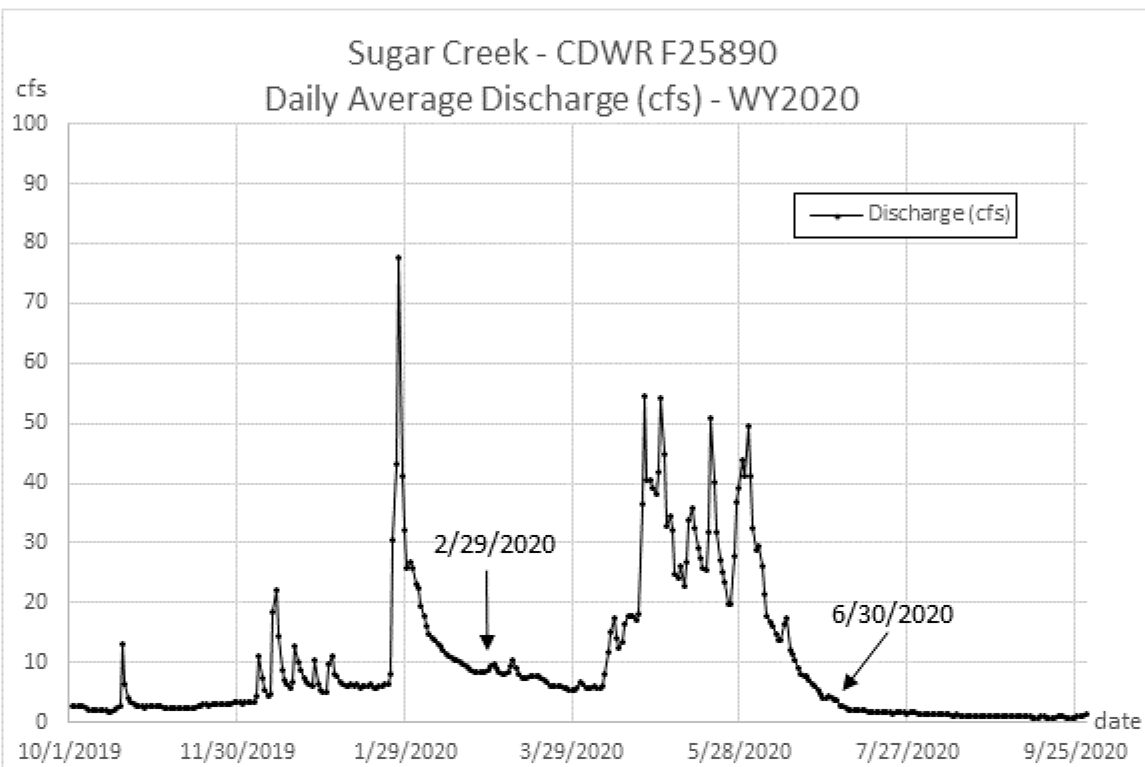


Figure 13 – Sugar Creek Discharge – WY2020

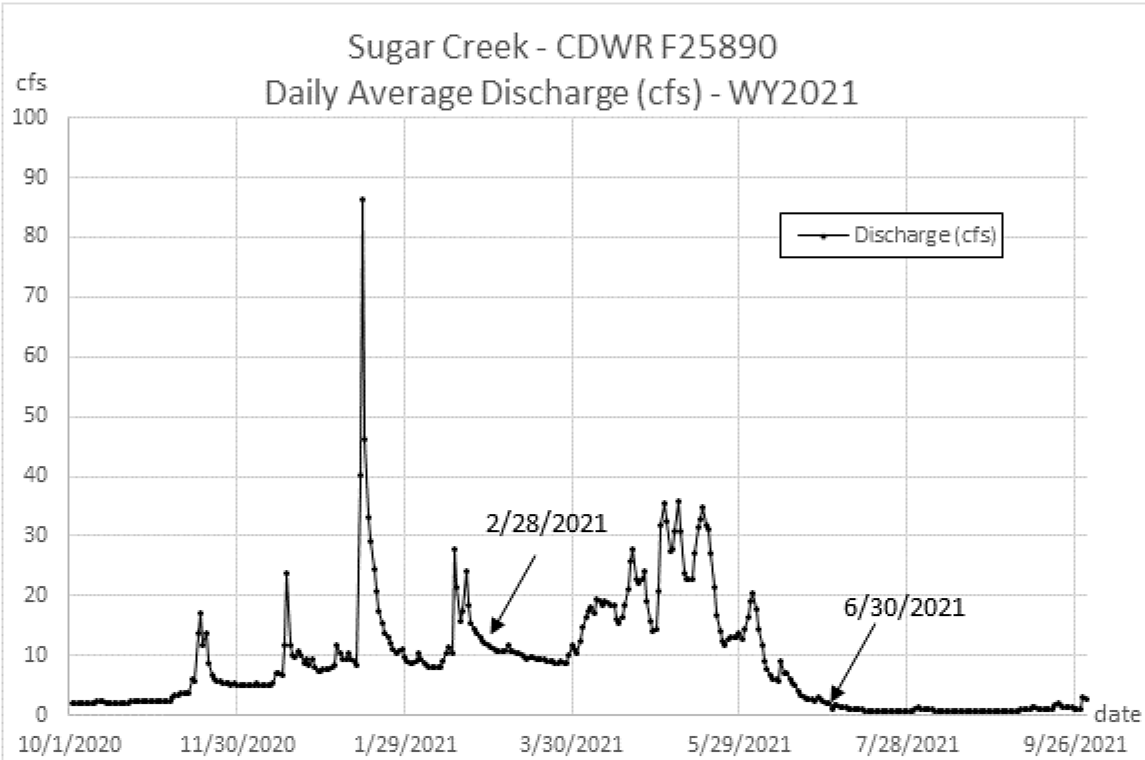


Figure 14 – Sugar Creek Discharge – WY2021

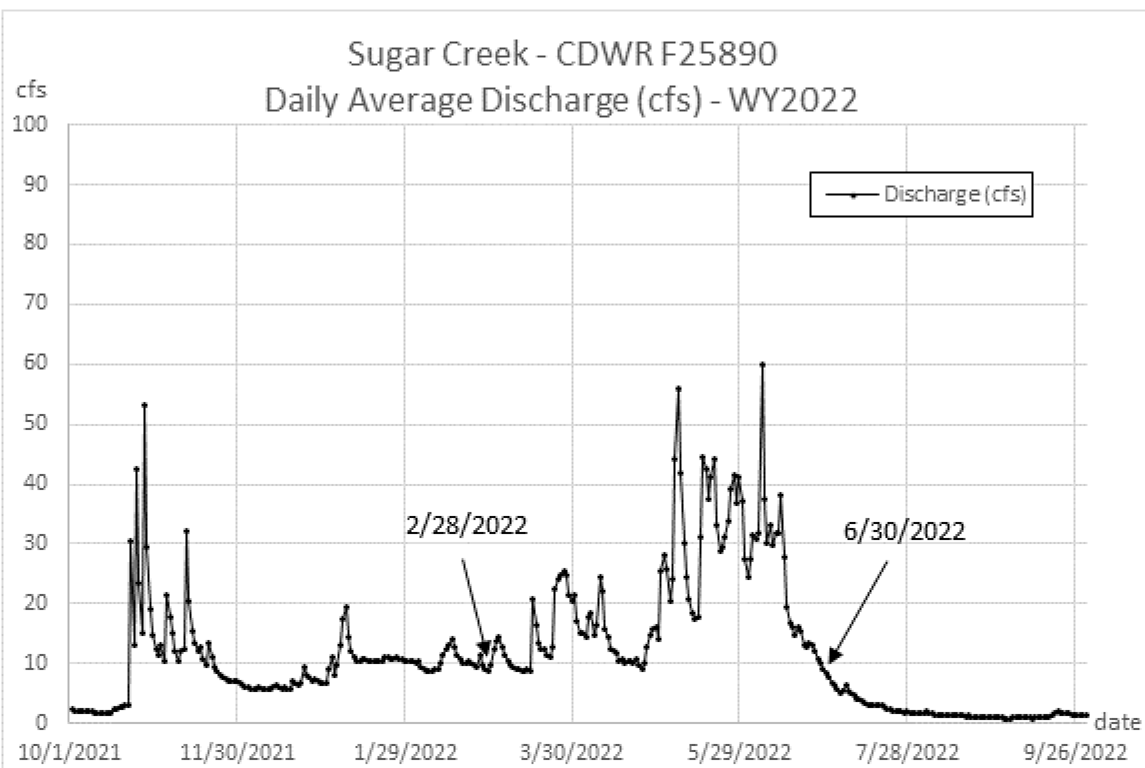


Figure 15 – French Creek Discharge – WY2022

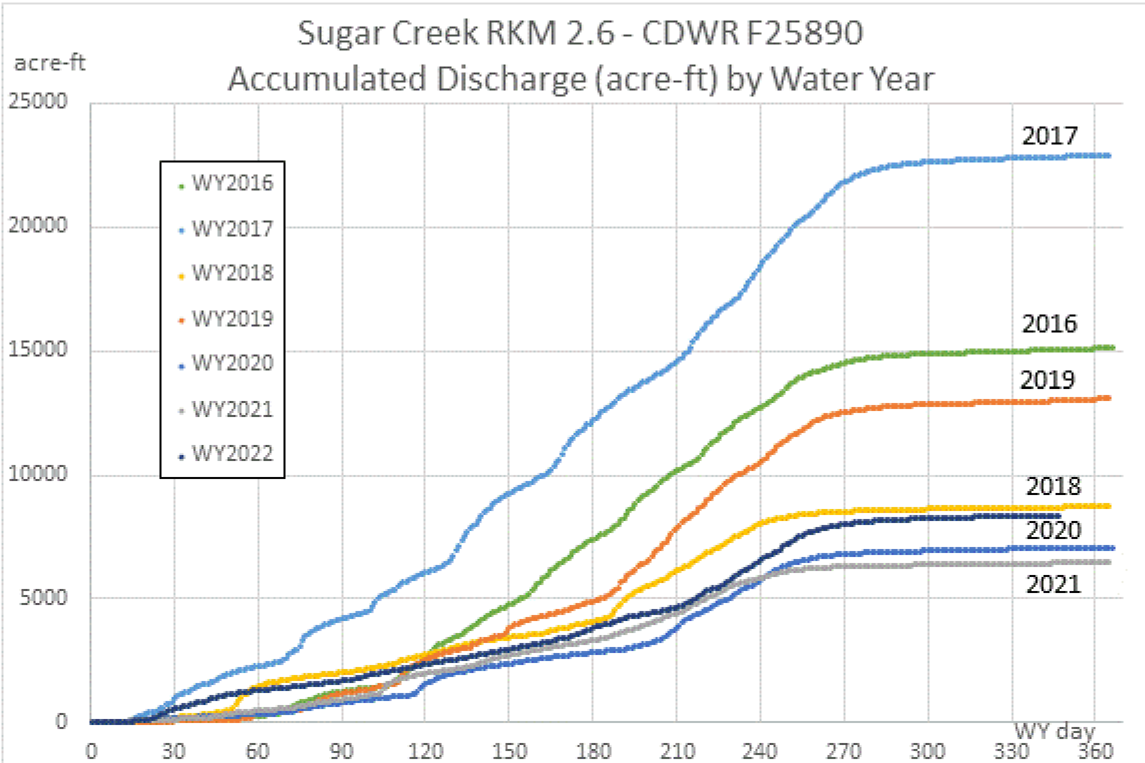


Figure 16 – Accumulated discharge (acre-ft) by Water Year – WY2017 – WY2022

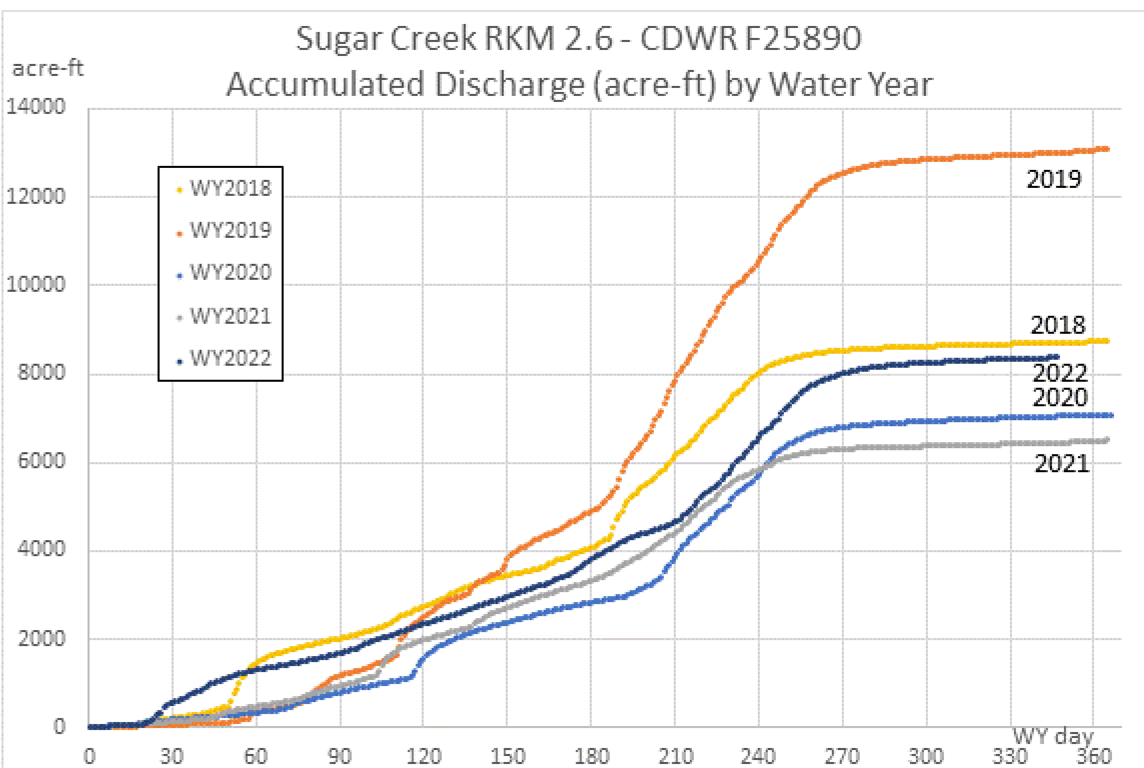


Figure 17 – Accumulated discharge (acre-ft) by Water Year – WY2018 – WY2022

Appendix D:

Growth Rates for all Sites – 2019-2022

Summer Growth – 2019

Sugar Creek - Beaver Dam Analogue Pond 1

Begin Date	End Date	Days Between
9/6/2019	9/28/2019	22

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.15	0.02	0.21	0.57
s.d.	0.07	0.02	0.11	0.34
count	19	19	19	19

Sugar Creek - Beaver Dam Analogue Pond 2

Begin Date	End Date	Days Between
8/26/2019	9/27/2019	32

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.18	0.03	0.27	0.99
s.d.	0.04	0.01	0.07	0.42
count	13	13	13	13

Sugar Creek - Control Reach

Begin Date	End Date	Days Between
8/27/2019	10/11/2019	45

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.13	0.02	0.18	0.61
s.d.	0.03	0.01	0.05	0.25
count	8	8	8	8

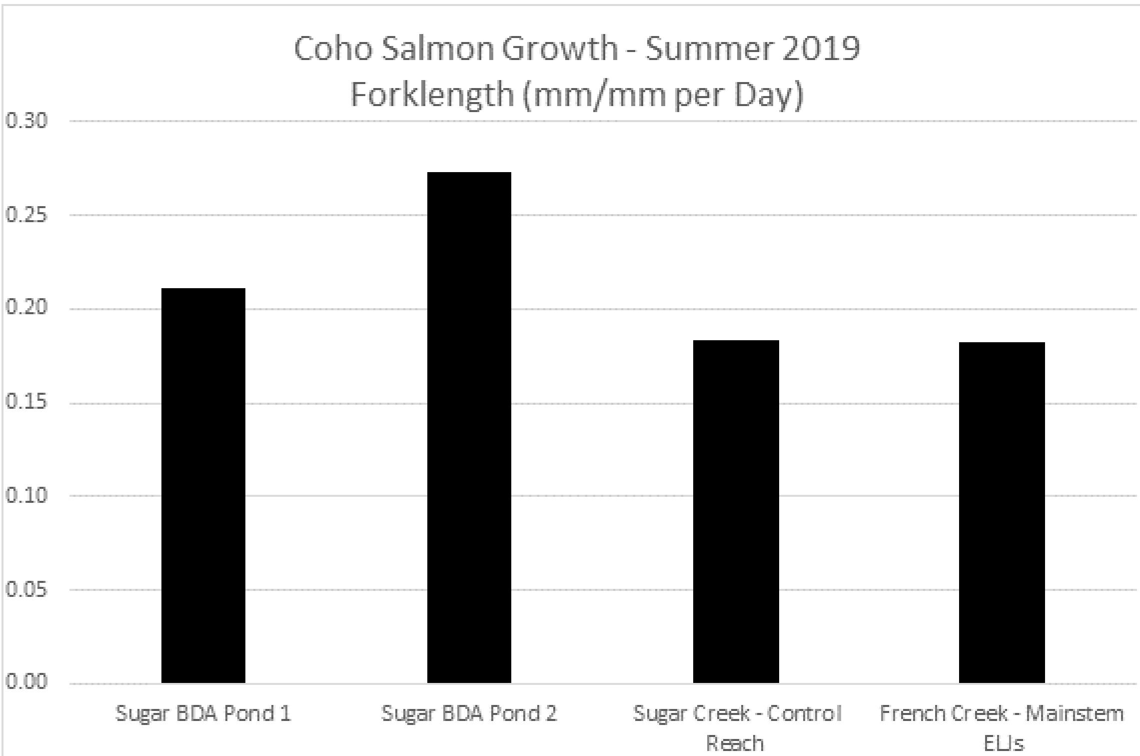
French Creek - Mainstem ELJs

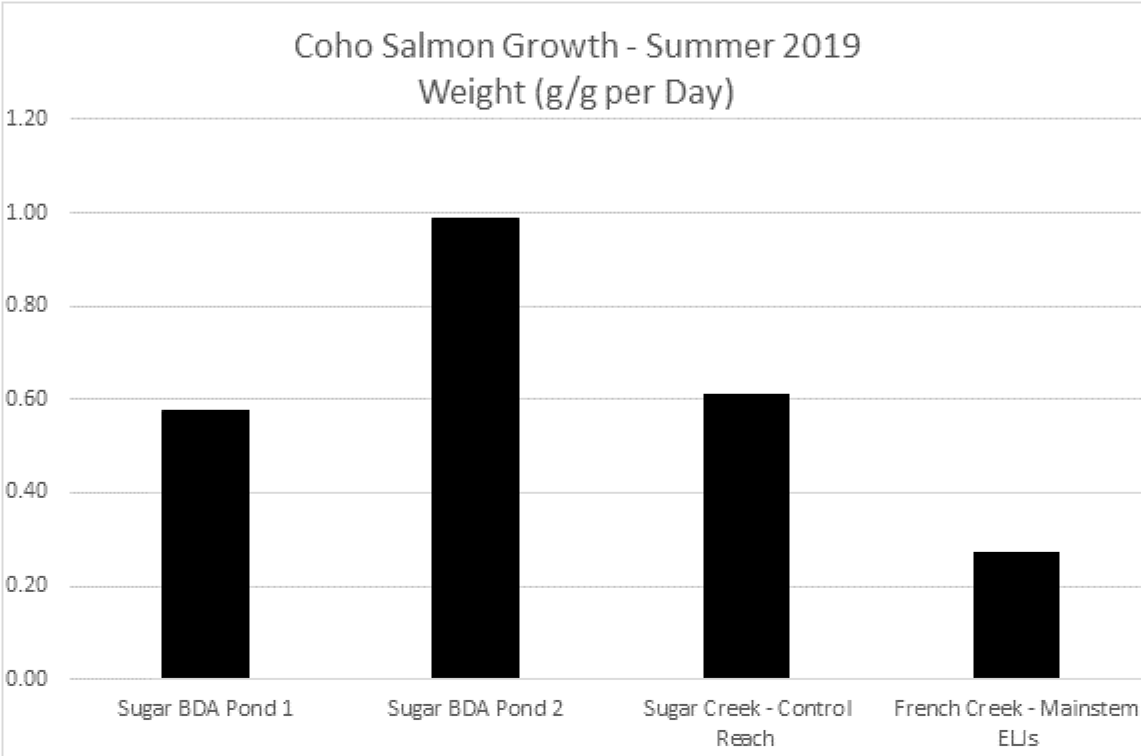
Begin Date	End Date	Days Between
8/22/2019	9/24/2019	33

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.13	0.01	0.18	0.27
s.d.	0.05	0.01	0.07	0.36
count	11	11	11	11

Base Flow Summer Growth - 2019

	fl/fl per day*100	g/g per day*100
Sugar BDA Pond 1	0.21	0.57
Sugar BDA Pond 2	0.27	0.99
Sugar Creek - Control Reach	0.18	0.61
French Creek - Mainstem ELJs	0.18	0.27





Summer Growth – 2020

French Creek - Control Pools

Begin Date	End Date	Days Between
7/27 & 7/30/2020	10/7 & 10/9/2020	71

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.05	0.01	0.07	0.17
s.d.	0.05	0.01	0.06	0.22
count	60	60	60	60

French Creek - Mainstem ELJs

Begin Date	End Date	Days Between
7/28/2020	10/9/2020	73

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.01	0.09	0.19
s.d.	0.05	0.01	0.07	0.25
count	33	33	33	33

French Creek - Downstream Miners Creek

Begin Date	End Date	Days Between
7/29/2020	10/12/2020	75

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.04	0.00	0.06	0.10
s.d.	0.03	0.01	0.04	0.13
count	21	21	21	21

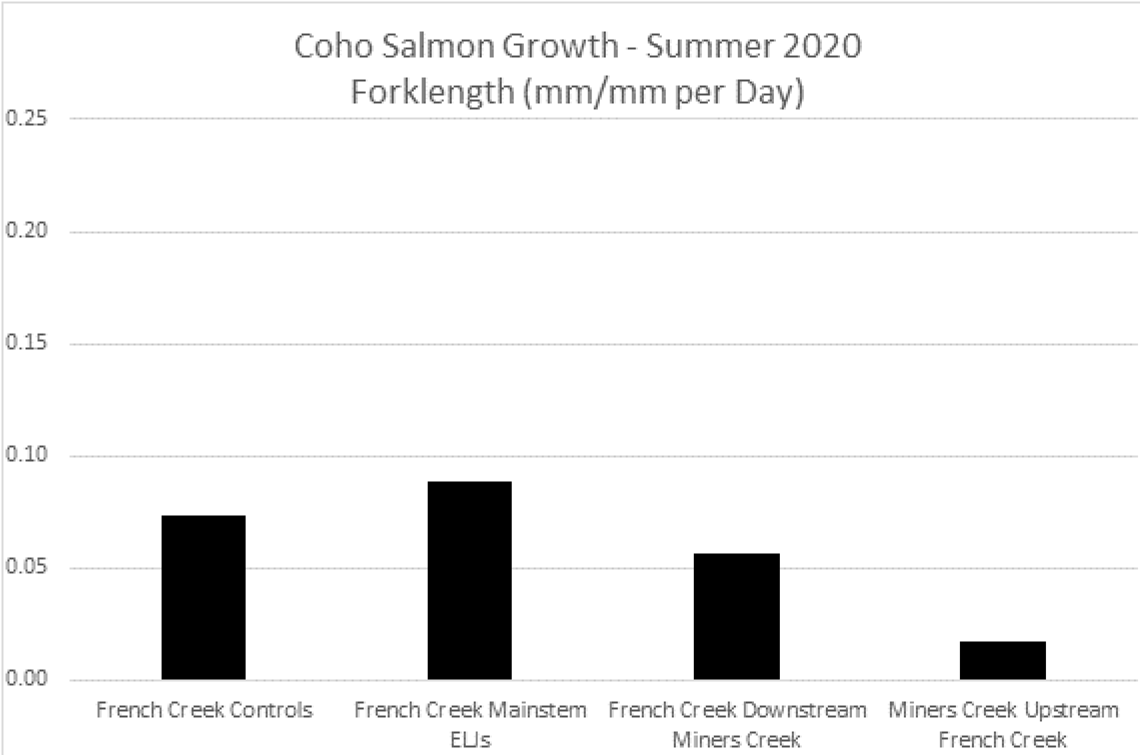
Miners Creek - Upstream French Creek

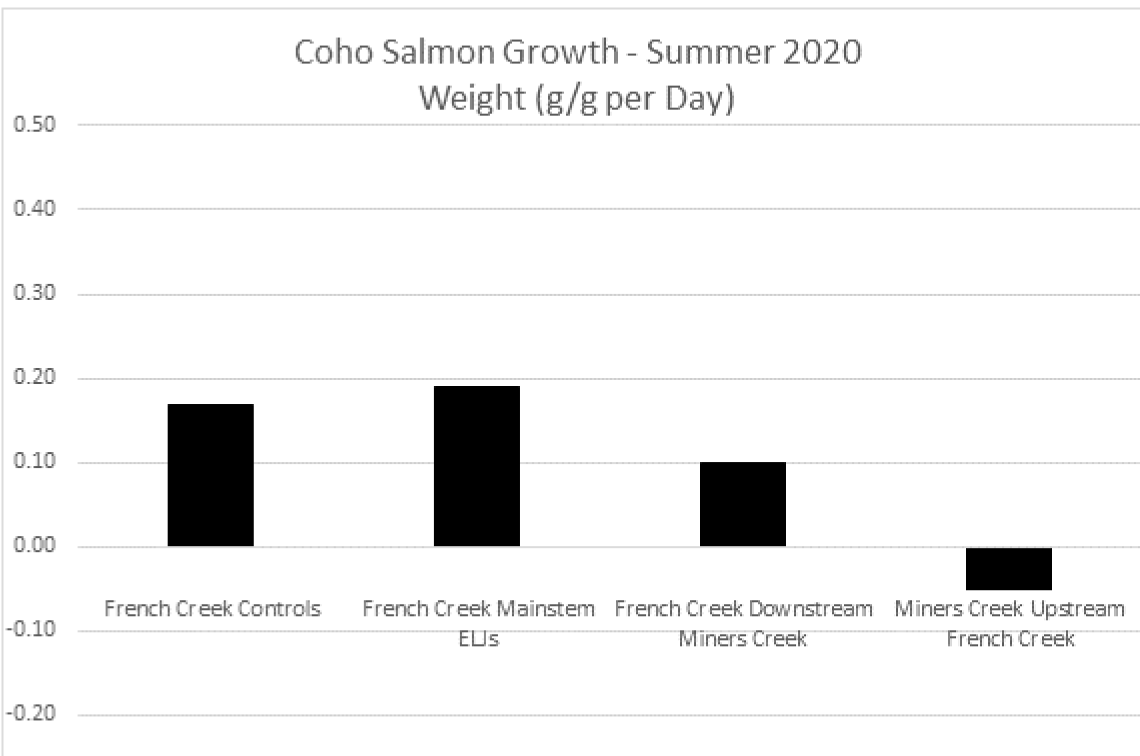
Begin Date	End Date	Days Between
7/29/2020	10/12/2020	75

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.01	0.00	0.02	-0.05
s.d.	0.01	0.01	0.02	0.12
count	10	10	10	10

Summer Growth - July 2020 - October 2020

	fl/fl per day*100	g/g per day*100
French Creek Controls	0.07	0.17
French Creek Mainstem ELJs	0.09	0.19
French Creek Downstream Miners Creek	0.06	0.10
Miners Creek Upstream French Creek	0.02	-0.05





Summer Growth – 2022

Sugar Creek - Beaver Dam Analogue Pond 1

Begin Date	End Date	Days Between
8/1/2022	9/19/2022	49

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.03	0.00	0.04	-0.01
s.d.	0.04	0.01	0.06	0.12
count	8	8	8	8

Sugar Creek - Beaver Dam Pond - Upstream BDA 2

Begin Date	End Date	Days Between
8/4/2022	9/20/2022	47

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.01	0.00	0.00	0.00
s.d.	0.01	0.01	0.00	0.00
count	4	4	4	4

French Creek - Control Pools

Begin Date	End Date	Days Between
8/3/2022	9/22/2022	50

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.03	-0.01	0.04	-0.18
s.d.	0.04	0.03	0.06	0.66
count	20	20	20	20

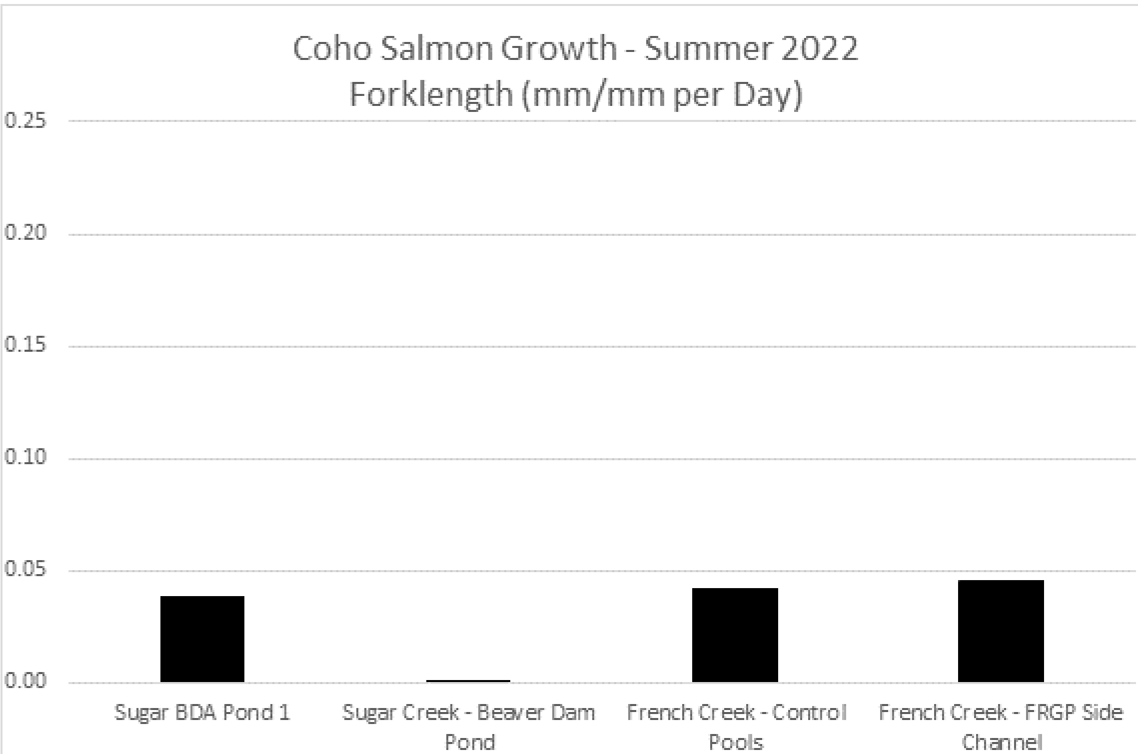
French Creek - FRGP Side Channel

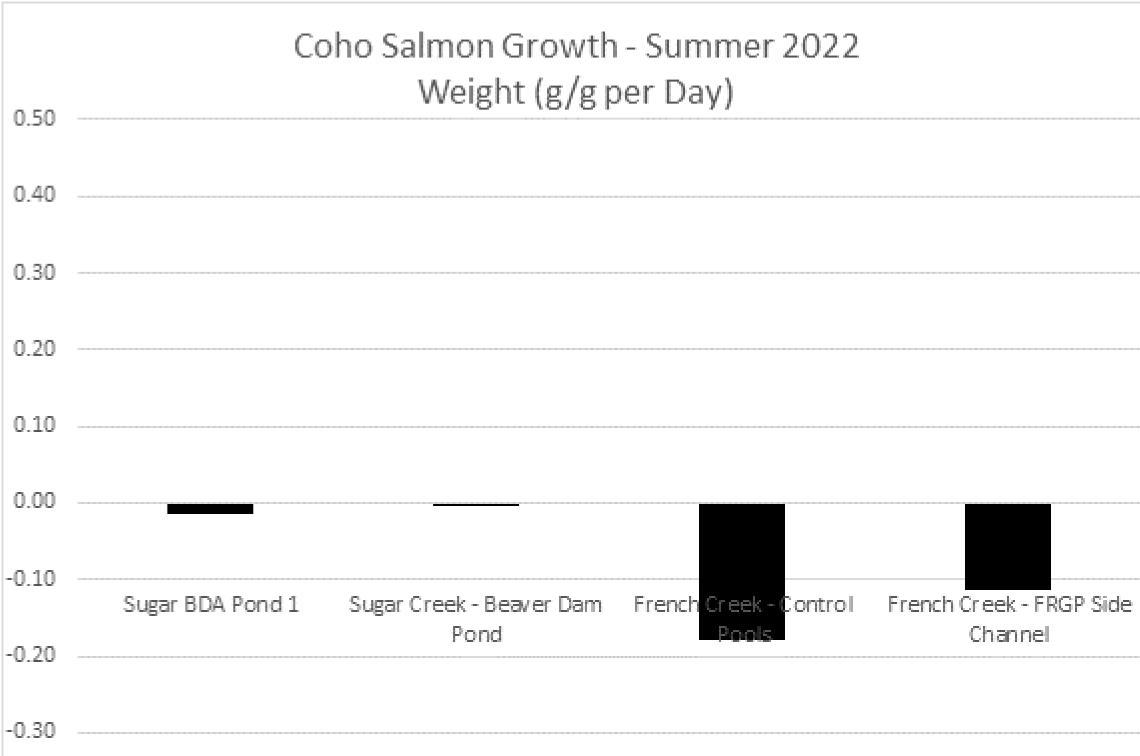
Begin Date	End Date	Days Between
8/2/2022 & 8/10/2022	9/21/2022	50

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.03	-0.01	0.05	-0.11
s.d.	0.04	0.03	0.06	0.48
count	24	24	24	24

Base Flow Summer Growth - 2022

	fl/fl per day*100	g/g per day*100
Sugar BDA Pond 1	0.04	-0.01
Sugar Creek - Beaver Dam Pond	0.00	0.00
French Creek - Control Pools	0.04	-0.18
French Creek - FRGP Side Channel	0.05	-0.11





Summer Growth of Coho Salmon

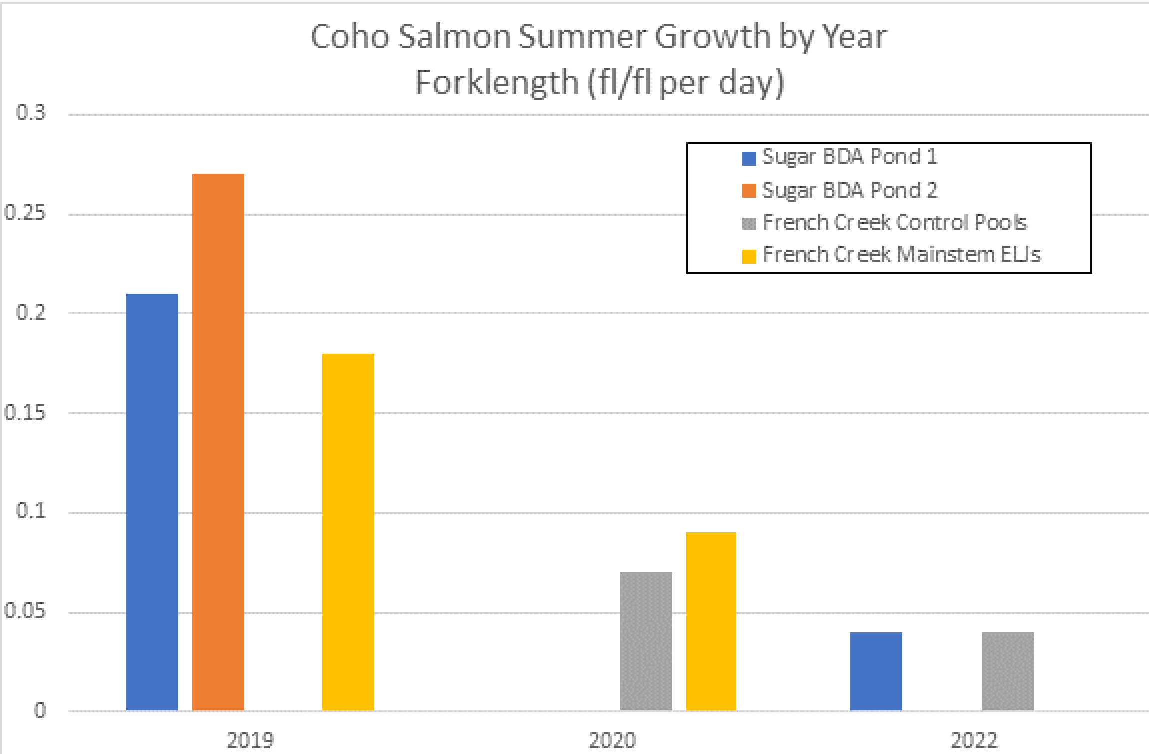
Habitat	2019 fl/fl per day*100	2019 g/g per day*100	2020 fl/fl per day*100	2020 g/g per day*100	2022 fl/fl per day*100	2022 g/g per day*100
Sugar Creek BDA Pond 1	0.21	0.57	--	--	0.04	-0.01
Sugar Creek BDA Pond 2	0.27	0.99	--	--	0.00	0.00
French Creek Control Pools	--	--	0.07	0.17	0.04	-0.18
French Creek Mainstem ELJs	0.18	0.27	0.09	0.19	--	--

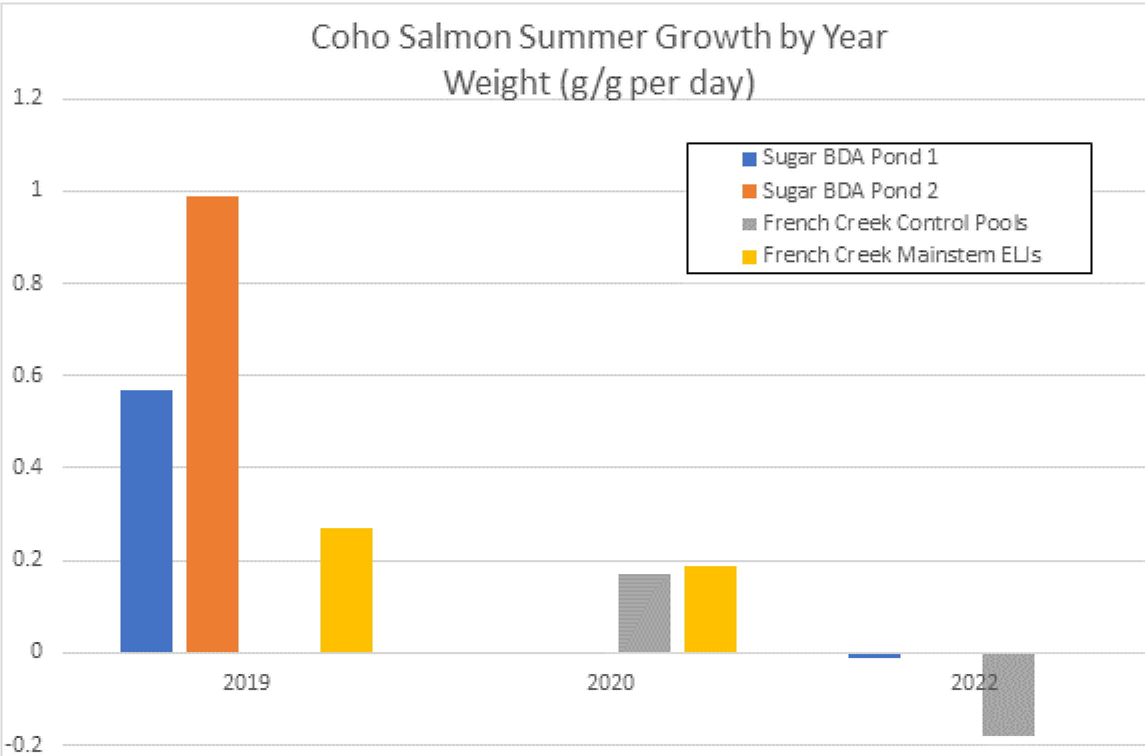
Summer Growth of Coho Salmon - Forklength

Habitat	2019 fl/fl per day*100	2020 fl/fl per day*100	2022 fl/fl per day*100
Sugar Creek BDA Pond 1	0.21	--	0.04
Sugar Creek BDA Pond 2	0.27	--	0.00
French Creek Control Pools	--	0.07	0.04
French Creek Mainstem ELJs	0.18	0.09	--

Summer Growth of Coho Salmon - Weight

Habitat	2019 g/g per day*100	2020 g/g per day*100	2022 g/g per day*100
Sugar Creek BDA Pond 1	0.57	--	-0.01
Sugar Creek BDA Pond 2	0.99	--	0.00
French Creek Control Pools	--	0.17	-0.18
French Creek Mainstem ELJs	0.27	0.19	--





Winter Growth - 2020

Sugar Creek - Beaver Dam Analogue Pond 1

Begin Date	End Date	Days Between
1/8/2020	3/19/2020	71

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.01	0.07	0.23
s.d.	0.03	0.01	0.03	0.12
count	44	44	44	44

French Creek - Control Pools

Begin Date	End Date	Days Between
1/23/2020	3/20/2020	57

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.12	0.03	0.15	0.53
s.d.	0.02	0.00	0.04	0.24
count	7	7	7	7

French Creek - FRGP Side Channel

Begin Date	End Date	Days Between
1/14/2020	3/18/2020	64

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.01	0.07	0.15
s.d.	0.04	0.01	0.04	0.18
count	10	10	10	10

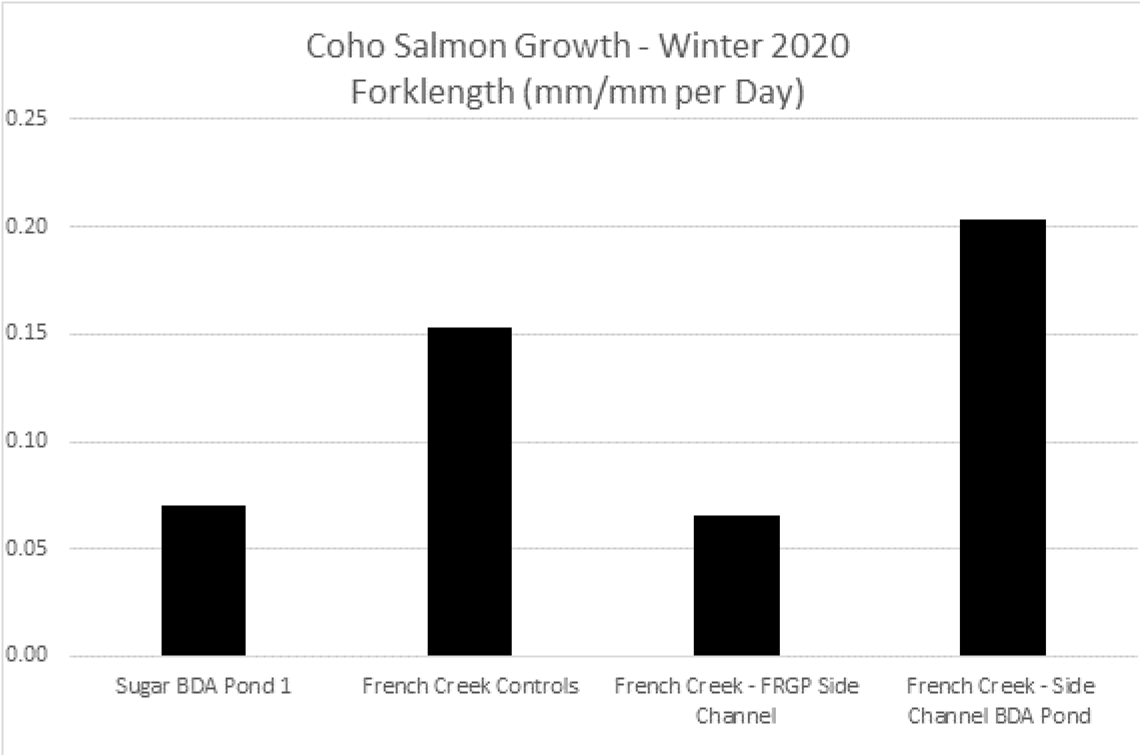
French Creek - Side Channel BDA Pond 1

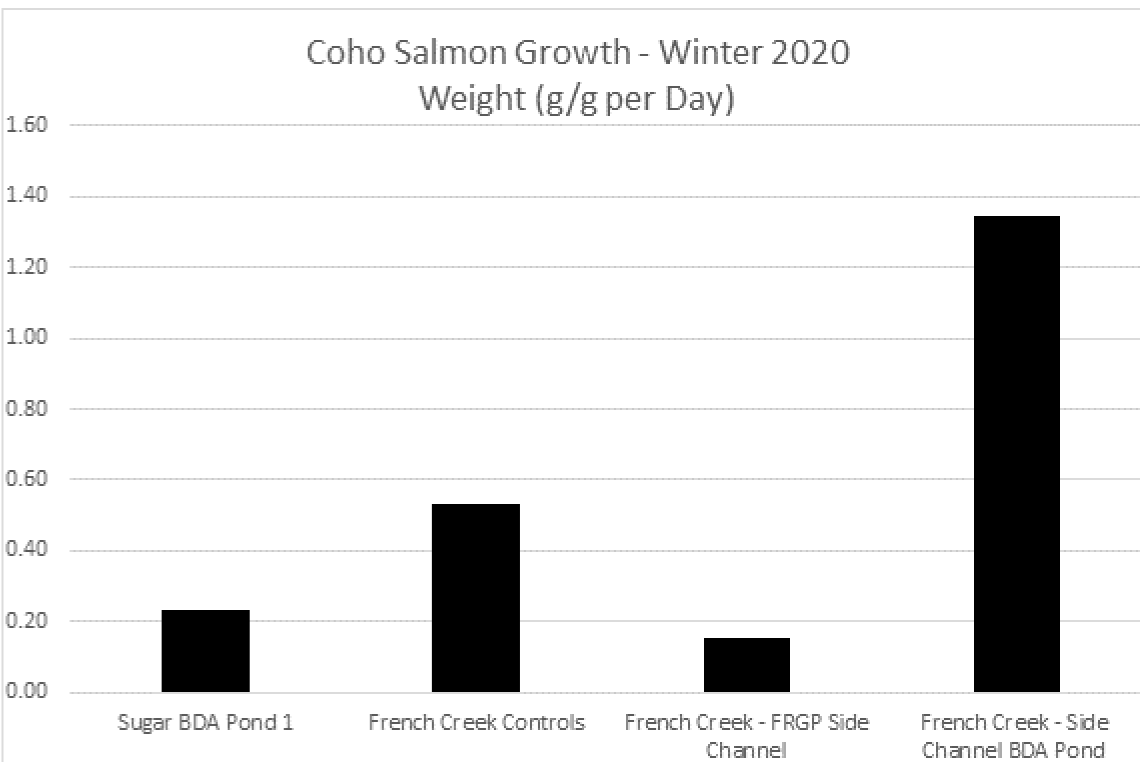
Begin Date	End Date	Days Between
1/8/2020	3/19/2020	71

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.16	0.08	0.20	1.34
s.d.	0.04	0.32	0.06	4.06
count	44	44	44	44

Winter Growth - January 2020 - March 2020

	fl/fl per day*100	g/g per day*100
Sugar BDA Pond 1	0.07	0.23
French Creek Controls	0.15	0.53
French Creek - FRGP Side Channel	0.07	0.15
French Creek - Side Channel BDA Pond	0.20	1.34





Winter Growth 2021

French Creek - Side Channel BDA Pond

Begin Date	End Date	Days Between
2/24/2021	3/23/2021	27

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.14	0.03	0.18	0.57
s.d.	0.06	0.02	0.09	0.37
count	41	41	41	41

French Creek - Side Channel BDA Pond

Begin Date	End Date	Days Between
2/24/2021	4/26/2021	61

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.19	0.05	0.25	0.95
s.d.	0.06	0.02	0.08	0.38
count	58	58	58	58

French Creek - Side Channel BDA Pond

Begin Date	End Date	Days Between
3/23/2021	4/26/2021	34

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.22	0.06	0.26	1.01
s.d.	0.08	0.02	0.10	0.43
count	29	29	29	29

French Creek - Control Pools and Wood Gravel Side Channel

Begin Date	End Date	Days Between
2/25/2021	3/23/2021	26

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.13	0.03	0.16	0.57
s.d.	0.02	0.01	0.04	0.33
count	4	4	4	4

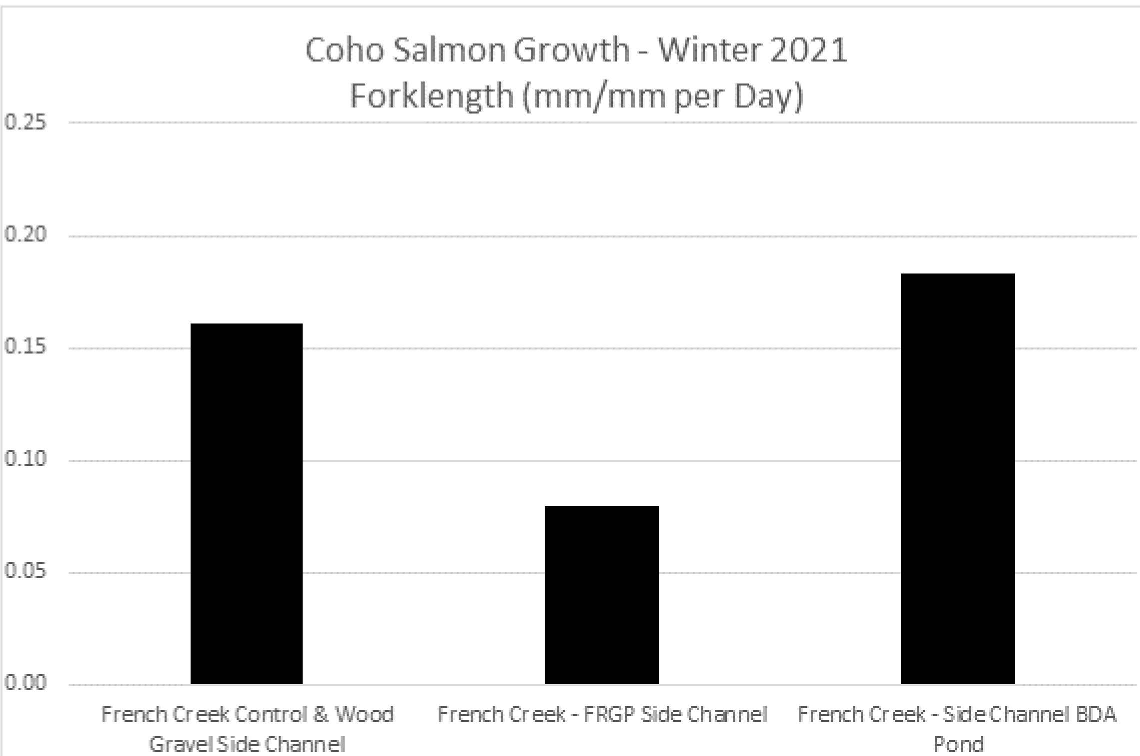
French Creek - FRGP Side Channel

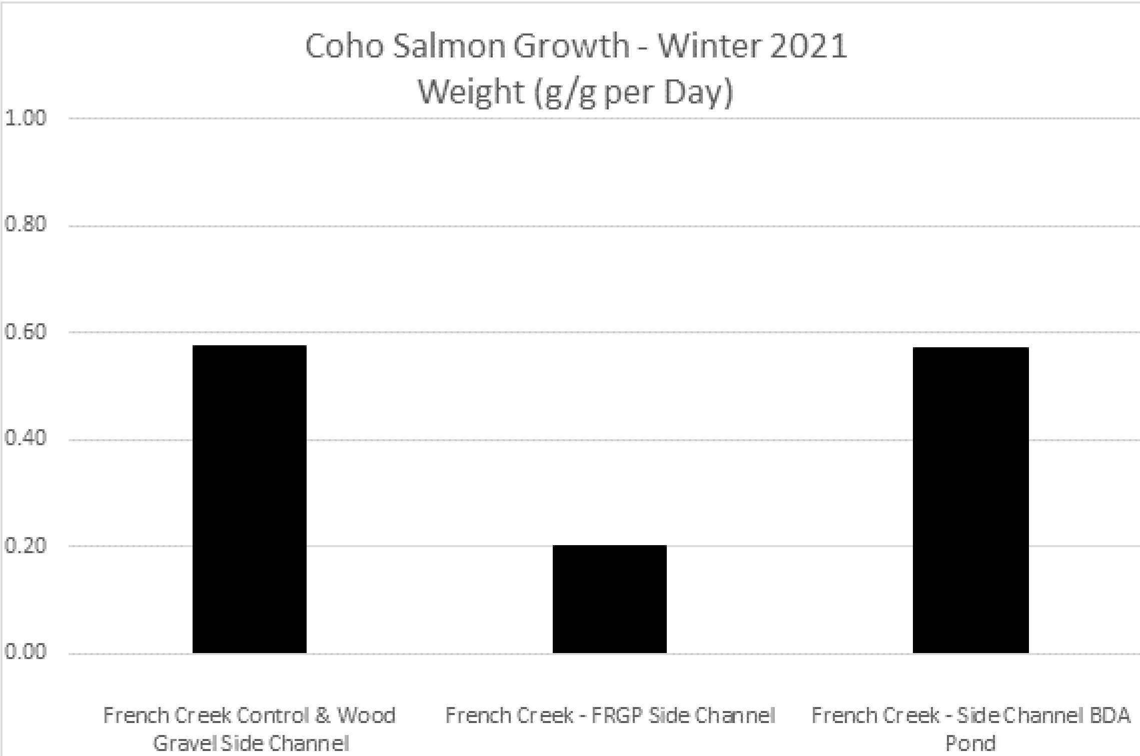
Begin Date	End Date	Days Between
2/23/2021	3/22/2021	27

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.01	0.08	0.20
s.d.	0.07	0.01	0.10	0.25
count	32	32	32	32

Winter Growth -February 2021 - March 2021

	fl/fl per day*100	g/g per day*100
French Creek Control & Wood Gravel Side Channel	0.16	0.57
French Creek - FRGP Side Channel	0.08	0.20
French Creek - Side Channel BDA Pond	0.18	0.57





Winter Growth 2022

Sugar Creek - Beaver Dam Analogue Pond 1

Begin Date	End Date	Days Between
1/19/2022	3/10/2022	50

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.07	0.03	0.08	0.33
s.d.	0.04	0.01	0.05	0.16
count	23	23	23	23

Sugar Creek - Beaver Dam Analogue Pond 2 - Combined

Begin Date	End Date	Days Between
1/18/2022	3/11/2022	52

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.04	0.02	0.05	0.23
s.d.	0.06	0.01	0.06	0.10
count	18	18	18	18

French Creek - Control Pools

Begin Date	End Date	Days Between
1/20/2022	3/16/2022	55

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.02	0.08	0.44
s.d.	0.03	0.01	0.04	0.21
count	34	34	34	34

French Creek - Wood Gravel Side Channel

Begin Date	End Date	Days Between
1/20/2022	3/16/2022	55

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.06	0.02	0.08	0.37
s.d.	0.03	0.01	0.04	0.19
count	8	8	8	8

French Creek - FRGP Side Channel

Begin Date	End Date	Days Between
1/21/2022	3/15/2022	53

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.02	0.00	0.02	-0.02
s.d.	0.02	0.01	0.03	0.13
count	34	34	34	34

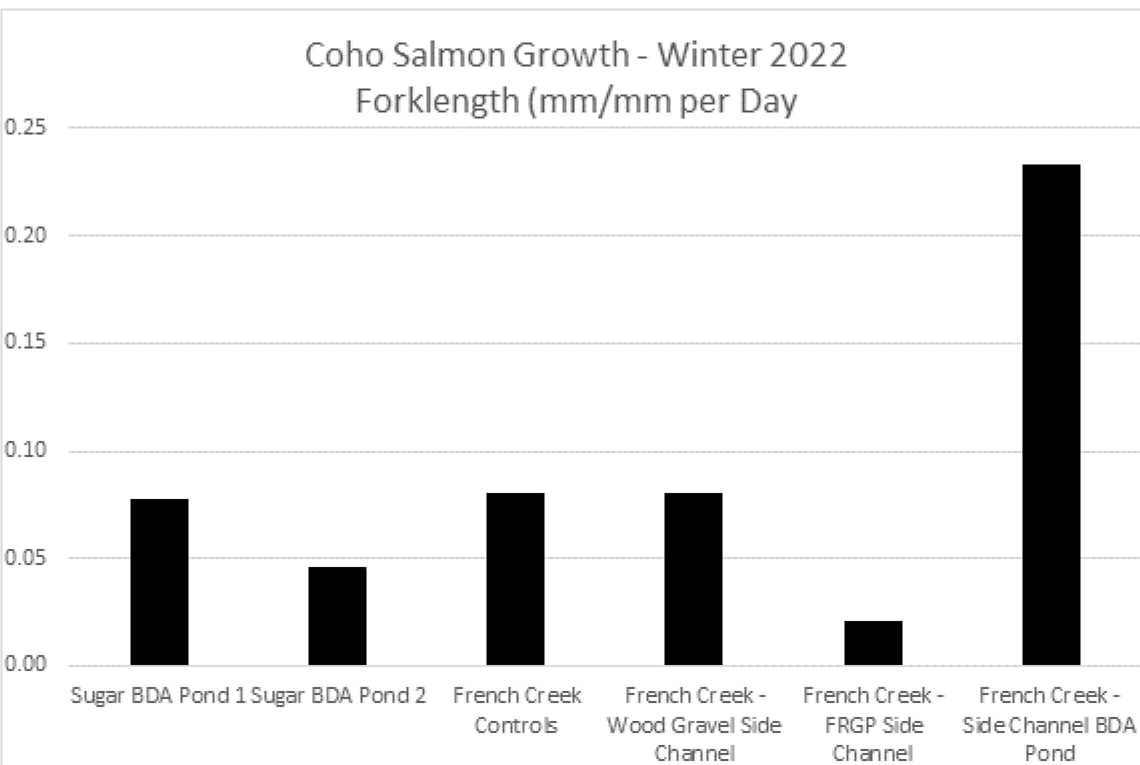
French Creek - Side Channel BDA Pond 1

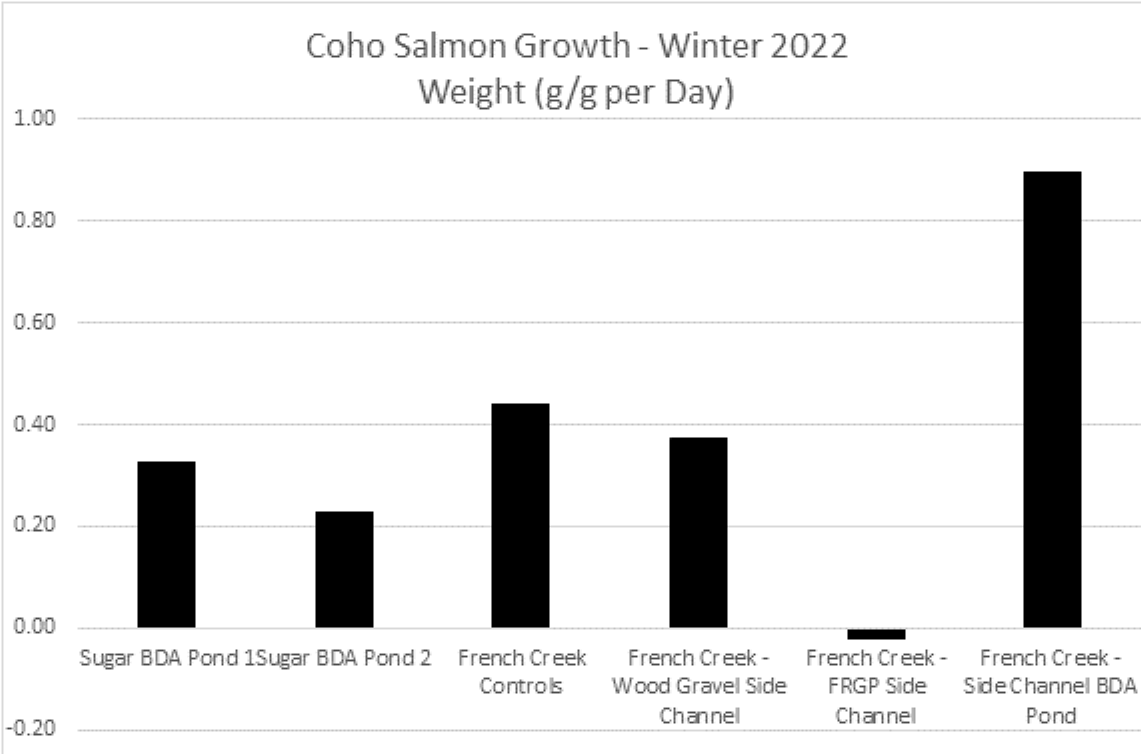
Begin Date	End Date	Days Between
1/20/2022	3/16/2022	55

	FL Gain (mm/day)	Weight Gain (g/day)	fl/fl per day*100	g/g per day*100
average	0.18	0.05	0.23	0.90
s.d.	0.08	0.02	0.12	0.36
count	5	5	5	5

Winter Growth - January 2022 - March 2022

	fl/fl per day*100	g/g per day*100
Sugar BDA Pond 1	0.08	0.33
Sugar BDA Pond 2	0.05	0.23
French Creek Controls	0.08	0.44
French Creek - Wood Gravel Side Channel	0.08	0.37
French Creek - FRGP Side Channel	0.02	-0.02
French Creek - Side Channel BDA Pond	0.23	0.90





Winter Growth of Coho Salmon

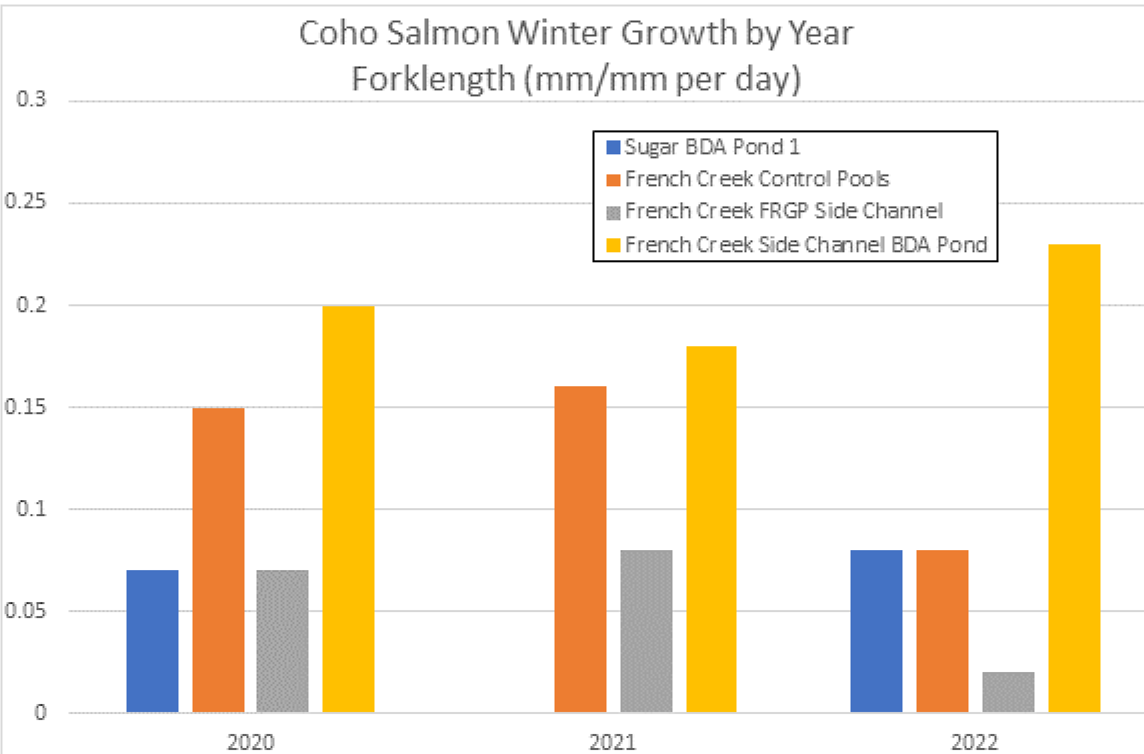
Habitat	2020 fl/fl per day*100	2020 g/g per day*100	2021 fl/fl per day*100	2021 g/g per day*100	2022 fl/fl per day*100	2022 g/g per day*100
Sugar Creek BDA Pond 1	0.07	0.23	--	--	0.08	0.33
French Creek Control Pools	0.15	0.53	0.16	0.57	0.08	0.44
French Creek FRGP Side Channel	0.07	0.15	0.08	0.2	0.02	-0.02
French Creek Side Channel BDA Pond	0.2	1.34	0.18	0.57	0.23	0.9

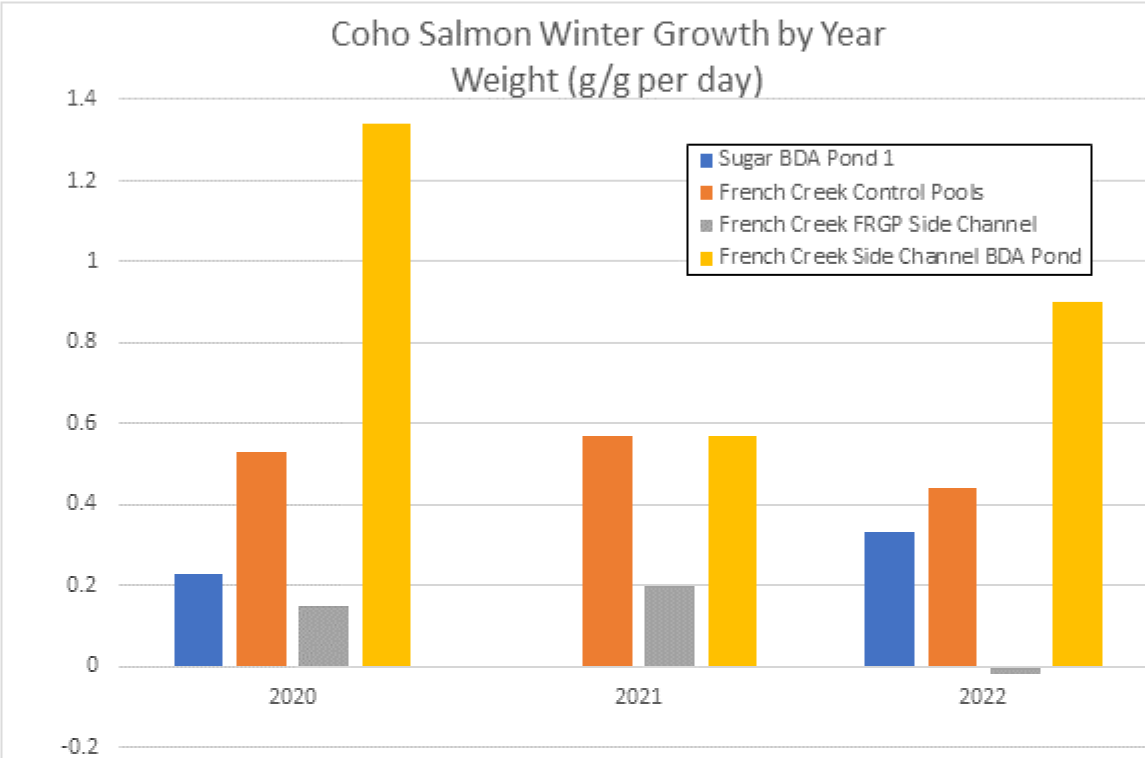
Winter Growth of Coho Salmon - Forklength

Habitat	2020 fl/fl per day*100	2021 fl/fl per day*100	2022 fl/fl per day*100
Sugar Creek BDA Pond 1	0.07	--	0.08
French Creek Control Pools	0.15	0.16	0.08
French Creek FRGP Side Channel	0.07	0.08	0.02
French Creek Side Channel BDA Pond	0.2	0.18	0.23

Winter Growth of Coho Salmon - Weight

Habitat	2020 g/g per day*100	2021 g/g per day*100	2022 g/g per day*100
Sugar Creek BDA Pond 1	0.23	--	0.33
French Creek Control Pools	0.53	0.57	0.44
French Creek FRGP Side Channel	0.15	0.2	-0.02
French Creek Side Channel BDA Pond	1.34	0.57	0.9





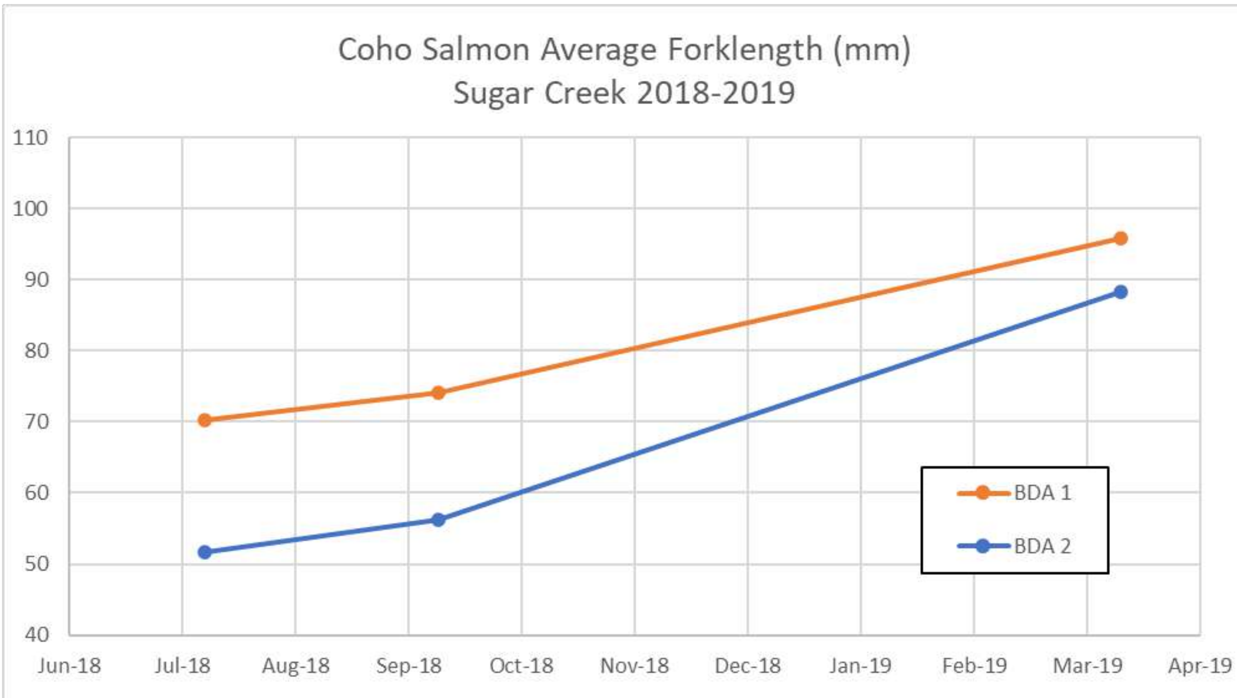
Coho Salmon Winter Growth by Year
Weight (g/g per day)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
2020
2021
2022
Sugar BDA Pond 1
French Creek Control Pools
French Creek FRGP Side Channel
French Creek Side Channel BDA Pond

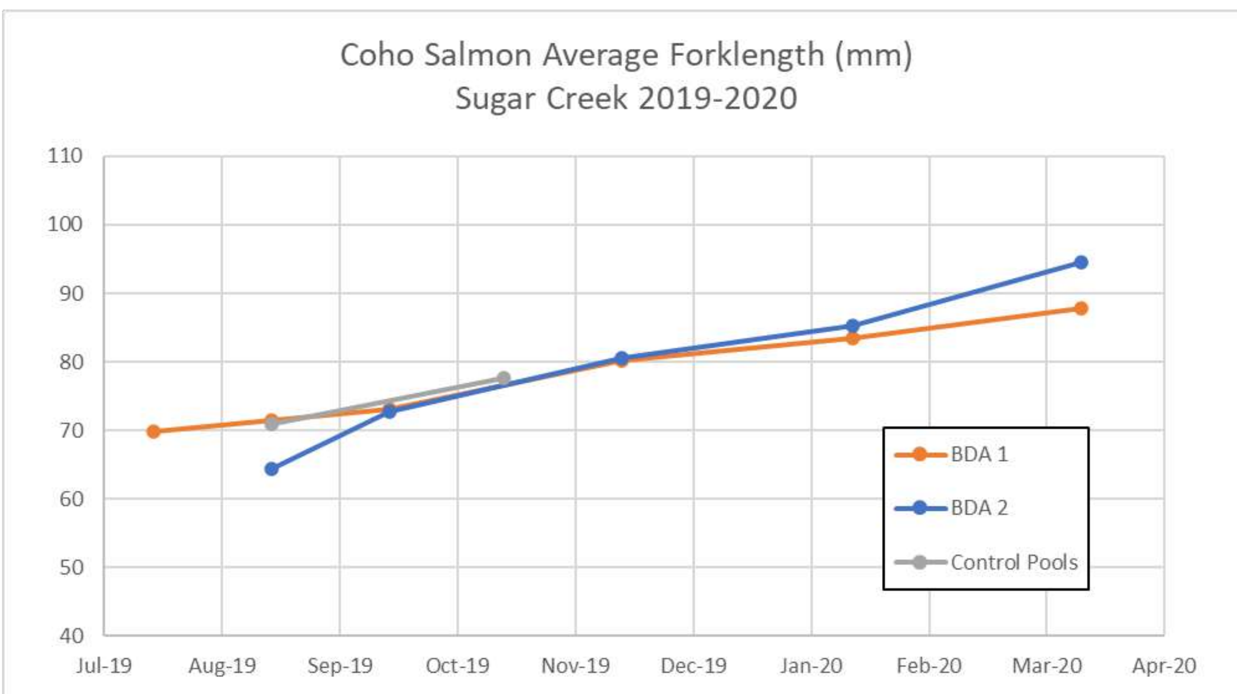
Appendix E:

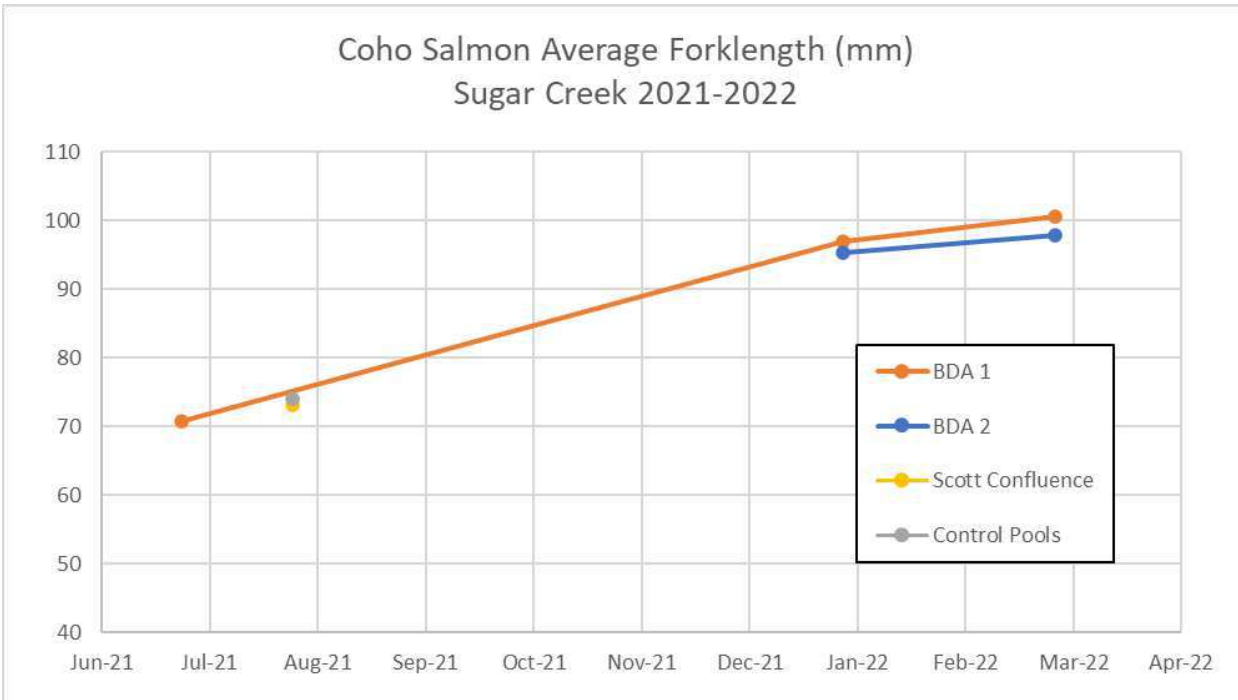
Additional Biometric Comparison Charts

Additional Biometric Comparison Charts

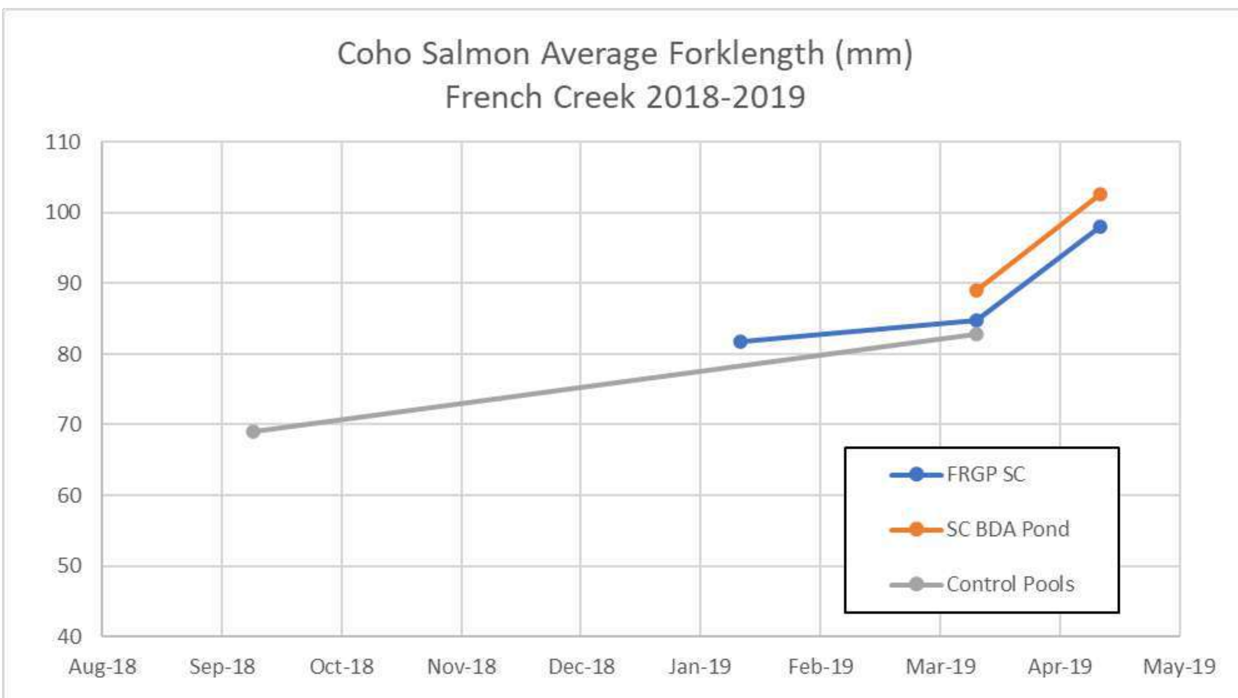
Sugar Creek

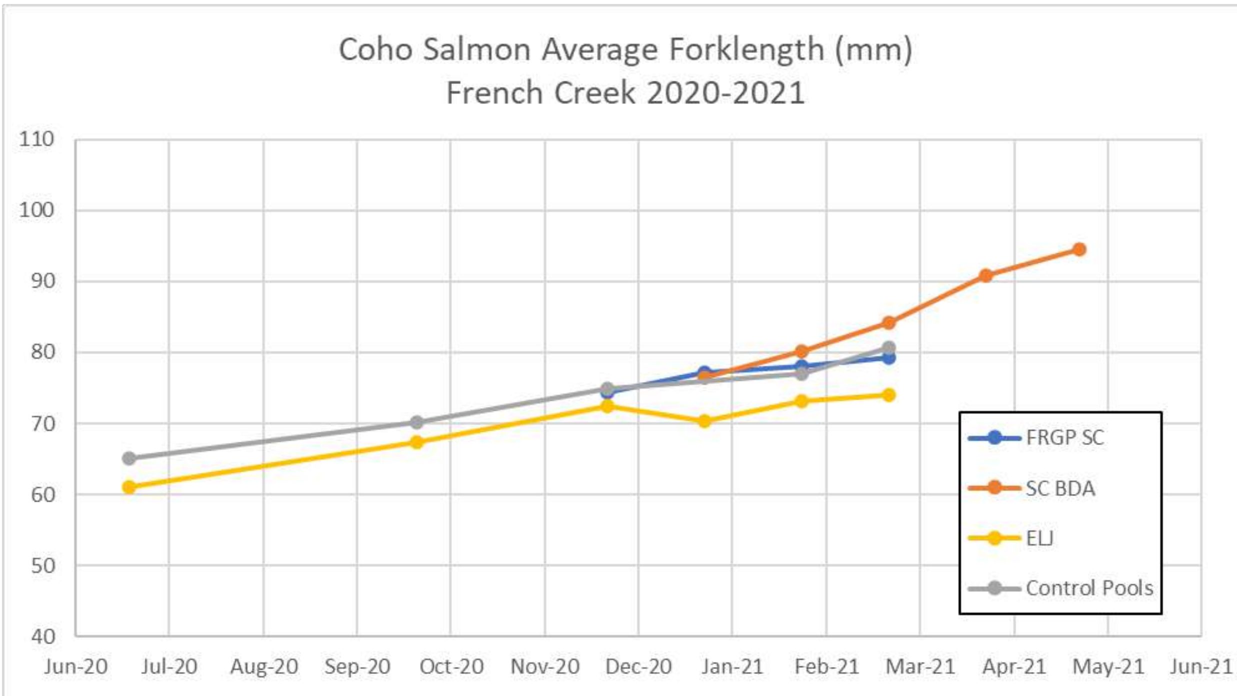


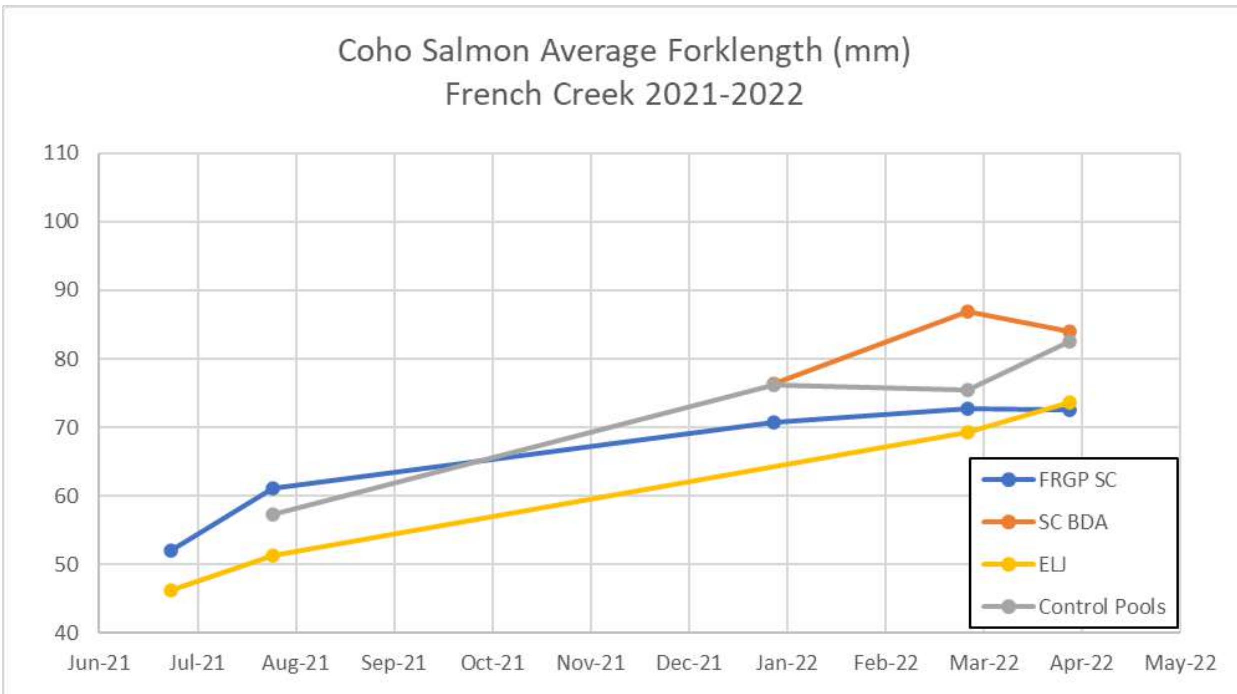




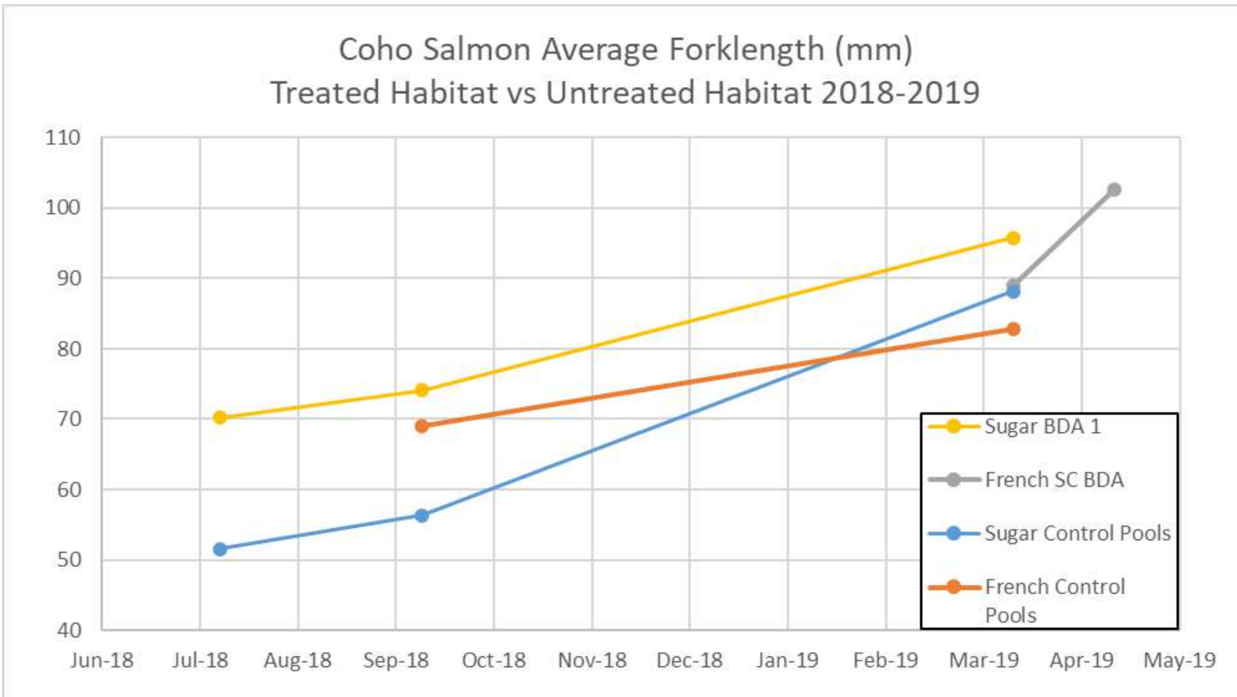
French Creek

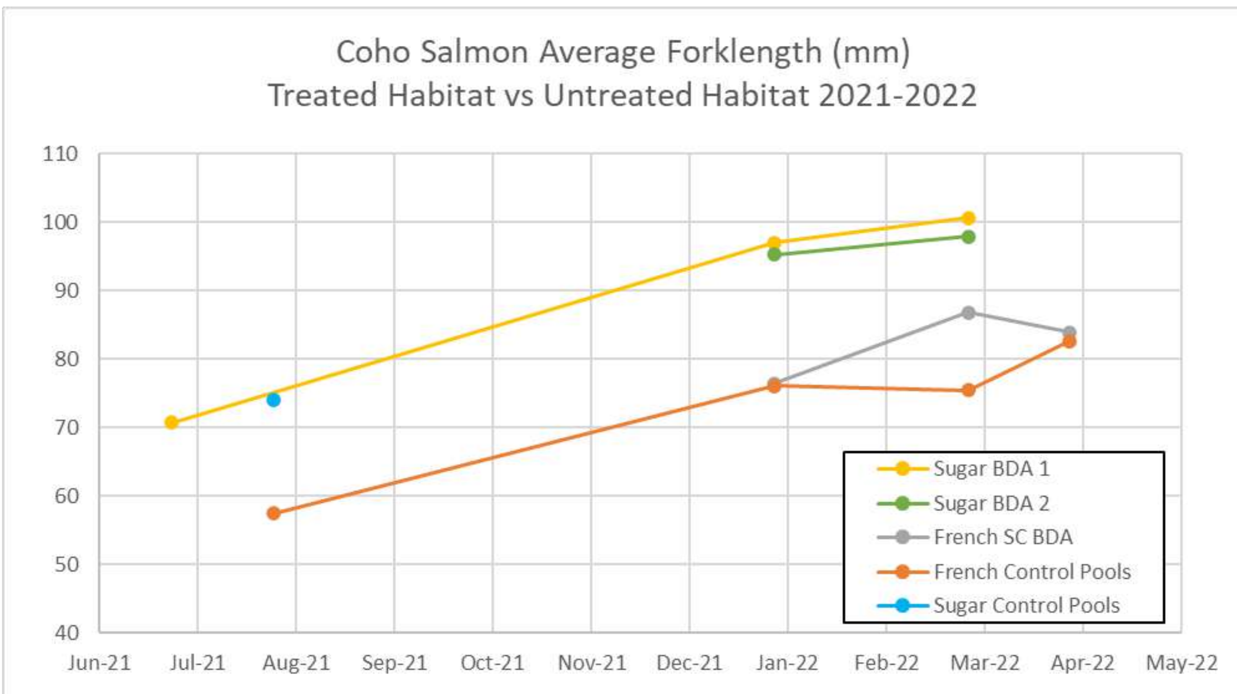


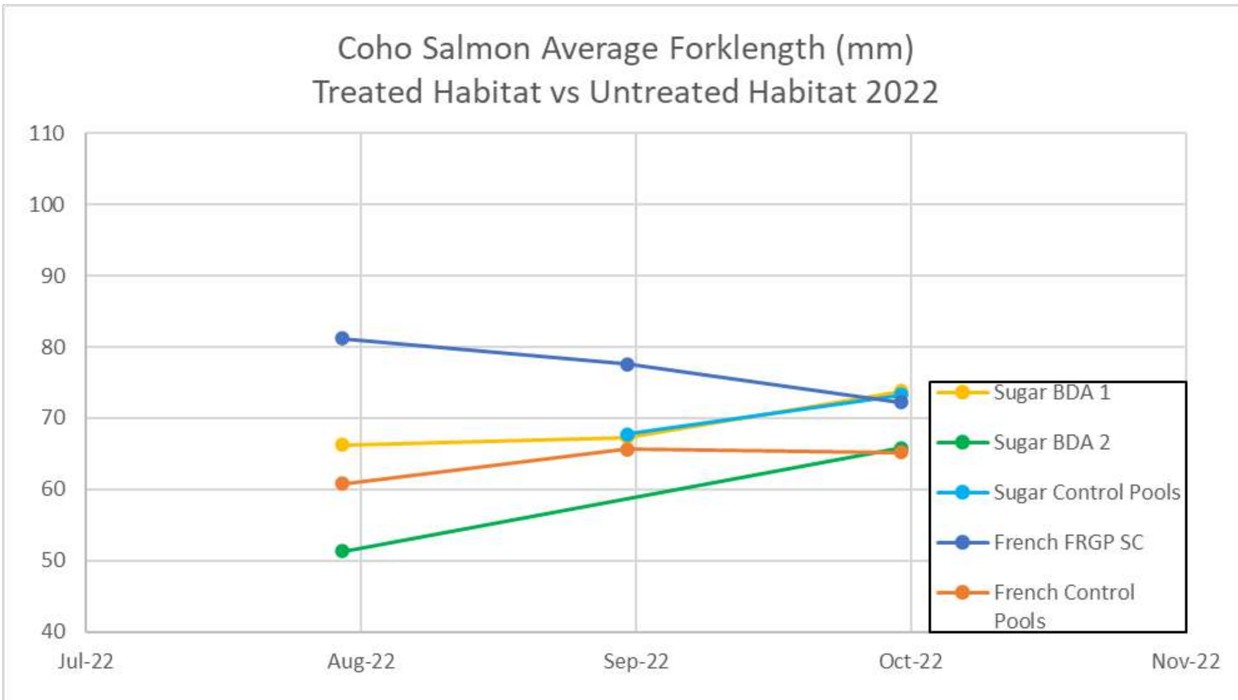

Coho Salmon Average Forklength (mm)
French Creek 2020-2021
110
100
90
80
70
60
50
40
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21
FRGP SC
SC BDA
ELJ
Control Pools


Coho Salmon Average Forklength (mm)
French Creek 2021-2022
110
100
90
80
70
60
50
40
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
FRGP SC
SC BDA
ELJ
Control Pools

All Sites


Coho Salmon Average Forklength (mm)
Treated Habitat vs Untreated Habitat 2018-2019
110
100
90
80
70
60
50
40
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Sugar BDA 1
French SC BDA
Sugar Control Pools
French Control Pools


Coho Salmon Average Forklength (mm)
Treated Habitat vs Untreated Habitat 2021-2022
110
100
90
80
70
60
50
40
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Sugar BDA 1
Sugar BDA 2
French SC BDA
French Control Pools
Sugar Control Pools



Coho Salmon Average Forklength (mm)
Treated Habitat vs Untreated Habitat 2022
110
100
90
80
70
60
50
40
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Sugar BDA 1
Sugar BDA 2
Sugar Control Pools
French FRGP SC
French Control Pools

Appendix F:
Additional Fish Sampling Data – All Sites
2019-2022

2018 – 2019 Fish Sampling

French Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
9/25/2018	French	Control Pools	425	325	0	113
9/26/2018	French	Control Pools	145	45	64	19
3/5/2019	French	Control Pools	38	0	8	8

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/19/2018	French	Mid French - Mainstem	195	13	0	26
7/31/2018	French	Mid French - Mainstem	188	21	0	13

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/31/2019	French	FRGP Side Channel	138	123	6	14
3/4/2019	French	FRGP Side Channel	360	198	24	11
4/30/2019	French	FRGP Side Channel	19	0	2	0

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
3/5/2019	French	Side Channel BDA Ponds	75	0	0	3
3/22/2019	French	Side Channel BDA Ponds	42	42	0	2
4/30/2019	French	Side Channel BDA Ponds	19	0	4	0

Miners Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/31/2018	Miners	Lower Miners	172	33	0	12

Scott River

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/16/2018	Scott R	Scott - Sugar Confluence	74	33	0	126
7/30/2018	Scott R	Scott - Sugar Confluence	88	61	11	81

Sugar Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/16/2018	Sugar	BDA 1 Pond	81	52	0	2
7/30/2018	Sugar	BDA 1 Pond	82	74	3	8
9/13/2018	Sugar	BDA 1 Pond	151	134	10	1
9/27/2018	Sugar	BDA 1 Pond	264	229	35	11
3/8/2019	Sugar	BDA 1 Pond	21	0	10	1

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/17/2018	Sugar	BDA 2 Pond	152	3	0	9
8/2/2018	Sugar	BDA 2 Pond	53	4	0	3
3/8/2019	Sugar	BDA 2 Pond	40	4	2	0

2019 – 2020 Fish Sampling

French Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/22/2019	French	Control Pools	448	234	0	73
10/28/2019	French	Control Pools	295	197	75	74
10/29/2019	French	Control Pools	288	113	155	45
1/23/2020	French	Control Pools	133	84	43	2
3/20/2020	French	Control Pools	55	0	26	6

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/22/2019	French	FRGP Side Channel	84	81	0	8
9/24/2019	French	FRGP Side Channel	23	22	0	3
11/4/2019	French	FRGP Side Channel	173	152	19	18
1/14/2020	French	FRGP Side Channel	484	156	51	14
1/15/2020	French	FRGP Side Channel	218	13	30	10
3/18/2020	French	FRGP Side Channel	234	0	51	45

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/22/2019	French	Mainstem ELJs	151	92	0	11
9/24/2019	French	Mainstem ELJs	235	196	13	35
11/4/2019	French	Mainstem ELJs	129	50	28	17
1/14/2020	French	Mainstem ELJs	25	19	4	9
1/15/2020	French	Mainstem ELJs	58	0	13	9
3/18/2020	French	Mainstem ELJs	59	0	8	5

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/23/2020	French	Wood Gravel Side Channel	16	11	1	0
3/20/2020	French	Wood Gravel Side Channel	23	0	2	5

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
2/2/2020	French	French Side Channel BDA Ponds	82	71	7	0
3/20/2020	French	French Side Channel BDA Ponds	80	0	46	1
4/15/2020	French	French Side Channel BDA Ponds	64	0	27	2

Sugar Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/31/2019	Sugar	BDA 1 Pond	365	265	0	53
8/19/2019	Sugar	BDA 1 Pond	354	227	64	46
9/6/2019	Sugar	BDA 1 Pond	360	193	124	0
9/28/2019	Sugar	BDA 1 Pond	218	31	51	4
10/11/2019	Sugar	BDA 1 Pond	15	0	13	1
10/31/2019	Sugar	BDA 1 Pond	397	299	63	23
11/1/2019	Sugar	BDA 1 Pond	451	0	130	19
1/8/2020	Sugar	BDA 1 Pond	218	149	62	14
1/9/2020	Sugar	BDA 1 Pond	268	187	77	19
3/19/2020	Sugar	BDA 1 Pond	565	0	213	28

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/26/2019	Sugar	BDA 2 Pond	104	45	0	2
9/27/2019	Sugar	BDA 2 Pond	86	67	13	5
11/5/2019	Sugar	BDA 2 Pond	218	151	34	0
1/10/2020	Sugar	BDA 2 Pond	277	182	55	9
3/17/2020	Sugar	BDA 2 Pond	1	0	0	0
3/26/2020	Sugar	BDA 2 Pond	182	0	61	3

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
9/27/2019	Sugar	BDA 2 Above Beaver Dam	55	35	0	4
11/5/2019	Sugar	BDA 2 Above Beaver Dam	16	0	1	0
3/26/2020	Sugar	BDA 2 Above Beaver Dam	16	0	1	2

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/27/2019	Sugar	Sugar Creek Control Reach	95	70	0	28
10/11/2019	Sugar	Sugar Creek Control Reach	24	8	8	7

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/7/2020	Sugar	Sugar OCP Channels	47	40	7	8
1/8/2020	Sugar	Sugar Marsh	11	10	0	0
1/9/2020	Sugar	Sugar Marsh	16	13	3	2
1/10/2020	Sugar	Sugar Marsh	22	18	4	2
3/17/2020	Sugar	Sugar OCP Outlet	6	0	2	1

2020 – 2021 Fish Sampling

French Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/27/2020	French	Control Pools	388	145	0	75
7/30/2020	French	Control Pool 4	188	59	13	9
10/7/2020	French	Control Pools	457	292	58	184
10/9/2020	French	Control Pools	282	0	187	130
12/14/2020	French	Control Pools	39	16	14	30
2/25/2021	French	Control Pools	68	37	17	18
3/23/2021	French	Control Pools	24	0	10	9

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/7/2020	French	Mainstem ELJs	103	0	0	9
7/28/2020	French	Mainstem ELJs	617	135	1	84
10/8/2020	French	Mainstem ELJs	341	199	20	64
10/9/2020	French	Mainstem ELJs	342	0	104	52
12/15/2020	French	Mainstem ELJs	15	9	4	7
1/26/2021	French	Mainstem ELJs	55	4	4	12
2/23/2021	French	Mainstem ELJs	80	50	8	6
3/22/2021	French	Mainstem ELJs	23	0	2	3

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
12/15/2020	French	FRGP Side Channel	441	206	34	12
1/26/2021	French	FRGP Side Channel	458	0	50	2
2/23/2021	French	FRGP Side Channel	409	238	48	8
2/24/2021	French	FRGP Side Channel	161	0	28	3
3/22/2021	French	FRGP Side Channel	209	0	58	2
5/4/2021	French	FRGP Side Channel	2	0	0	1

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/30/2020	French	Wood Gravel Side Channel	2	0	0	0
12/14/2020	French	Wood Gravel Side Channel	23	13	2	17
2/25/2021	French	Wood Gravel Side Channel	30	22	2	7
3/23/2021	French	Wood Gravel Side Channel	12	0	3	3

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/26/2021	French	Side Channel BDA Ponds	90	43	9	0
2/24/2021	French	Side Channel BDA Ponds	56	35	21	0
2/25/2021	French	Side Channel BDA Ponds	82	23	51	0
3/23/2021	French	Side Channel BDA Ponds	56	0	46	0
4/26/2021	French	Side Channel BDA Ponds	128	0	61	0
5/4/2021	French	Side Channel BDA Ponds	14	0	4	0

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/29/2020	French	French below Miners	134	59	0	4
10/12/2020	French	French below Miners	174	99	24	4

Miners Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/29/2020	Miners	Miners above BDAs	256	30	0	3
10/12/2020	Miners	Miners above BDAs	158	6	3	2
12/18/2020	Miners	Upper BDAs	138	70	3	34
2/26/2021	Miners	Upper BDAs	316	122	14	22
3/25/2021	Miners	Upper BDAs	170	0	17	7

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/29/2020	Miners	Miners above French	52	39	0	1
10/12/2020	Miners	Miners above French	26	8	10	1

Scott River at Sugar Creek Confluence

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/24/2020	Scott R	Scott - Sugar Confluence	58	14	0	11
10/5/2020	Scott R	Scott - Sugar Confluence	78	56	2	353
12/17/2020	Scott R	Scott - Sugar Confluence	70	63	5	45
2/22/2021	Scott R	Scott - Sugar Confluence	8	3	4	8
3/24/2021	Scott R	Scott - Sugar Confluence	18	0	6	6

Sugar Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/7/2020	Sugar	BDA 1 Pond	43	0	0	146
7/24/2020	Sugar	BDA 1 Pond	370	165	1	93
12/17/2020	Sugar	BDA 1 Pond	1	1	0	1
2/22/2021	Sugar	BDA 1 Pond	14	8	6	0
3/24/2021	Sugar	BDA 1 Pond	18	0	6	3

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
12/17/2020	Sugar	BDA 1 Step Pools	27	26	1	19
2/22/2021	Sugar	BDA 1 Step Pools	3	2	1	6
3/24/2021	Sugar	BDA 1 Step Pools	4	0	1	5

2021 – 2022 Fish Sampling

French Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/5/2021	French	Control Pool 3	92	10	0	1
1/20/2022	French	Control Pools	179	116	0	17
3/16/2022	French	Control Pools	112	45	32	4
4/20/2022	French	Control Pools	142	0	21	3

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/5/2021	French	Mainstem ELJs	75	0	0	1
8/2/2021	French	Mainstem ELJs	66	0	0	0
3/15/2022	French	Mainstem ELJs	78	27	0	10
4/21/2022	French	Mainstem ELJs	17	0	0	1

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/5/2021	French	FRGP Side Channel	50	0	0	8
8/4/2021	French	FRGP Side Channel	85	14	0	71
1/21/2022	French	FRGP Side Channel	368	162	0	1
3/15/2022	French	FRGP Side Channel	433	126	36	1
4/21/2022	French	FRGP Side Channel	168	0	22	0

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/5/2021	French	Wood Gravel Side Channel	15	0	0	0
1/20/2022	French	Wood Gravel Side Channel	99	32	0	5
3/16/2022	French	Wood Gravel Side Channel	76	27	8	3
4/20/2022	French	Wood Gravel Side Channel	58	0	2	2

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/20/2022	French	French Side Channel BDA Pond	50	36	0	0
3/16/2022	French	French Side Channel BDA Pond	13	7	5	0
4/20/2022	French	French Side Channel BDA Pond	87	0	4	0

Scott River at Sugar Creek Confluence

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/6/2021	Scott R	Scott - Sugar Confluence	27	26	0	19

Sugar Creek

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
7/2/2021	Sugar	BDA 1 Pond	708	0	0	12
7/8/2021	Sugar	BDA 1 Pond	187	115	0	27
7/22/2021	Sugar	BDA 1 Pond	473	51	0	150
1/19/2022	Sugar	BDA 1 Pond	63	61	0	25
3/10/2022	Sugar	BDA 1 Pond	57	32	23	54

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/18/2022	Sugar	BDA 2 Pond	39	33	4	9
3/11/2022	Sugar	BDA 2 Pond	24	18	5	12

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
1/18/2022	Sugar	BDA 2 Above Beaver Dam	30	24	4	2
3/11/2022	Sugar	BDA 2 Above Beaver Dam	41	22	18	0

Date	Stream	Sample Reach	Coho Salmon Total Catch	Coho Marked	Coho Recaptured	*O. mykiss* Total Catch
8/9/2021	Sugar	Sugar Creek Control Reach	10	9	0	15