Alena Creek Fish Habitat Enhancement Project

Year 5 Monitoring Report

Prepared for:

Upper Lillooet River Power Limited Partnership
888 Dunsmuir Street, Suite 1100
Vancouver, BC V6C 3K4

April 29, 2022

Prepared by:

Ecofish Research Ltd.

Photographs and illustrations copyright © 2022

Published by Ecofish Research Ltd., 600 Comox Rd., Courtenay, B.C., V9N 3P6

For inquiries contact: Technical Lead documentcontrol@ecofishresearch.com 250-334-3042

Citation:

Thornton, M., R. Chudnow, O. Fitzpatrick, C. Suzanne, D. Greenacre, V. Dimma, D. West, M. Thornton, S. Faulkner, and H. Regehr. 2022. Alena Creek Fish Habitat Enhancement Project: Year 5 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 29, 2022.

Certification: *stamped version on file.*

Senior Reviewer:

Sean Faulkner, M.Sc., R.P.Bio. No. 2242

Fisheries Scientist/Project Manager

Technical Leads:

Jonathan Abell, Ph.D.

Environmental Scientist, Limnologist

David West, M.Sc., P.Eng. No. 41242

Water Resource Engineer/Technical Lead

Sean Faulkner, M.Sc., R.P.Bio. No. 2242

Fisheries Scientist/Project Manager

Disclaimer:

This report was prepared by Ecofish Research Ltd. for the account of Upper Lillooet River Power Limited Partnership. The material in it reflects the best judgement of Ecofish Research Ltd. in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Ecofish Research Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions, based on this report. This numbered report is a controlled document. Any reproductions of this report are uncontrolled and may not be the most recent revision.

EXECUTIVE SUMMARY

This report provides the Year 5 (2021) results of the long-term monitoring program implemented to evaluate the effectiveness of the Fish Habitat Enhancement Project (FHEP) constructed on Alena Creek (also known as Leanna Creek) as per the *Fisheries Act* Authorization (09-HPAC-PA2-00303) issued for the Upper Lillooet Hydro Project (the Project). The FHEP was designed to offset the footprint and operational habitat losses incurred by the Project and monitoring requirements were integrated into the Project's Operational Environmental Monitoring Plan (OEMP) (Harwood *et al.* 2021). Baseline data were collected for Alena Creek in 2013 and 2014. Post-construction (i.e., post enhancement) monitoring started in fall of 2016 and has continued through 2017 (Year 1), 2018 (Year 2), 2019 (Year 3), 2020 (Year 4), and 2021 (Year 5).

Also, note that a second offset project was completed on Alena Creek in September 2021 (Faulkner *et al.* 2021a) for *Fisheries Act* Authorization 19-HPAC-00331 to offset the predicted residual effects of an operational sediment management procedure (Flush Procedure) for the Upper Lillooet Hydro Project (ULHP) (Faulkner *et al.* 2019). Monitoring of this new offset habitat is not part of this report, although observations of the newly constructed habitat were made during on-going monitoring activities.

Fish Habitat

FHEP habitat features (riffles and woody debris) were installed in reaches 1 and 3 in 2016 to enhance fish habitat. A stability assessment was conducted to monitor the stability and functionality of each of the FHEP habitat features and ensure that any remedial action required to maintain their effectiveness is promptly identified and implemented. Excessive erosion that reduces the quality of the constructed habitat has not occurred to date. The channel adjustments that occurred after a peak flow event in November 2016 were modest and have largely stabilized due to vegetation establishment and natural sorting of sediment. However, in Year 3 (2019), multiple locations were identified where remediation was recommended, and instream repairs were conducted during the least risk timing window on August 6, 2020. Repairs were done by hand using gravel, cobble, small boulder, and large wood pieces found on site to improve functionality and limit erosion through bank revetments, flow deflector installation, riffle repairs, and gravel redistribution. Upon inspection in 2021, the repairs appeared to be stable and functioning as intended.

A beaver dam complex located immediately upstream of Reach 3 was causing partial flow bypass and formation of newly cut channels that increased fine sediment deposition within the reach; therefore, the dam height was lowered to prevent further channel erosion. No new beaver activity was observed above Reach 3 in 2021, and the dam was considered inactive in 2021. A newly constructed beaver dam in the lower end of Reach 3, which was previously removed in 2020, had been reconstructed and continued to create moderate backwatering in ALE-XS5, ALE-X06, and ALE-XS7. Beavers were removed from the Alena Creek enhancement area in the fall of 2021 by a licensed trapper from EBB Environmental Consulting Inc. with the objective of ensuring salmon spawner access and spawning riffle functionality.

In Reach 1, a log jam just upstream of ALE-XS1 has formed. However, no backwatering was observed during the stability assessment on October 27, 2021. Associated bank erosion issues from this log jam were partially addressed in 2020 by placing cobble along the head of a cut-off channel that has formed and largely stabilized. During the stability assessment on October 27, 2021, the cobble placement appeared to be stable and functioning as intended.

After 5 years of monitoring, the habitat appears to be physically stable and functioning as intended however, beaver activity has continued to pose a risk to habitat functionality. Recommendations for Year 5 included continued management of beaver activity.

Fish Community

The adult fish community in Alena Creek was assessed by bank walk spawner surveys focused on Bull Trout and Coho Salmon, the latter of which is the dominant species within Alena Creek. Three Bull Trout spawner surveys were completed between September and October 2021, and three Coho Salmon spawners surveys were conducted between November and December 2021. A total of five Bull Trout were observed on one of the three spawning surveys, the highest observed to date apart from 2011. In contrast, Coho Salmon were present in all Coho Salmon spawning surveys and were observed spawning and holding in enhanced habitat in Alena Creek, demonstrating their continued use of this habitat. Within the survey area (which contains enhanced and unenhanced habitat), a peak of 371 live Coho Salmon was observed on December 6, 2021, which was the highest annual peak observed during monitoring to date (previous peak counts ranged from 109 to 218, in 2017 and 2019 respectively). Peak counts provide a general indication of continued and increased use of Alena Creek post-enhancement compared to baseline, although among-year variability in spawner abundance is high.

Minnow trapping surveys were conducted at eight sites (five in the enhanced reaches) on September 27, 2021 to measure catch-per-unit-effort (CPUE) by species and life history stage. Across all sites, the average Cutthroat Trout CPUE in 2021 (1.9 fish per 100 trap hours) was similar to that in previous sampling years excluding 2014 and 2020 when average CPUE was 4.1 and 7.2 fish per 100 trap hours, respectively, noting 2014 CPUE results are biased high due to short set times. The average Coho Salmon CPUE in 2021 was 81.1 fish per 100 trap hours, which is the second highest recorded across monitoring years. Three Bull Trout were captured in minnow traps in Alena Creek in 2021, compared to zero captures in all previous monitoring years. The average Bull Trout CPUE in 2021 was 0.3 fish per 100 trap hours.

Enhancements in Alena Creek were designed to create habitat and increase productivity of the entire system. Overall juvenile and adult abundance appear to be improving over time, particularly juvenile Coho Salmon. These results support that the offset habitat is functioning as intended and is supporting greater fish use relative to pre-project conditions.

Hydrology

Seasonal trends in the Alena Creek hydrograph in the winter and spring of 2021 were consistent with a coastal, snow-dominated watershed. Stage levels remained low in the winter until the beginning of snowmelt early March, reaching peak values on April 18.

On June 28, steady high temperatures in the region increased discharge in the Lillooet River to extreme levels for the summer, inducing an upstream shift in the confluence between a secondary channel of Lillooet River and Alena Creek. The secondary channel also increased in size, causing backwatering from the Lillooet River into Alena Creek. This caused a rise in the recorded stage, from 0.25 m to 1.24 m, along with greater amplitude of daily variation (from < 0.04 m to < 0.2 m, Figure 24). Stage remained very high and under the influence of the Lillooet River for the rest of the summer.

A precipitation event shifted hydrological controls again on December 1, 2021, decreasing base stage level from 0.66 m prior to the event to 0.36 m post event. This event likely disconnected Alena Creek from backwatering by the Lillooet, as indicated by a return to smaller daily oscillations, but low flow stage levels remain higher than in previous years, indicating a shift in creek morphology and making the comparison with previous levels difficult without redefining the stage offset from a local benchmark.

Water Temperature

The objective of water temperature monitoring is to confirm that conditions in the FHEP are suitable for spawning, incubation, and rearing by the target fish species. Water temperature has been monitored continuously since 2013 at two sites: the upstream site (ALE-USWQ1, upstream of all FHEP works) and the downstream site (ALE-BDGWQ, located at the downstream extent of the reaches enhanced by the FHEP). Some data gaps occurred pre-construction in 2014 at the upstream site in winter/early spring 2014. No data gaps were recorded post-construction, with monitoring starting at both sites on November 23, 2016. To inform this report, Year 5 data were available up to September 27, 2021 for both sites.

Alena Creek is a relatively cool stream. In 2021, instantaneous temperature measurements at the upstream (2.8°C to 10.2°C) and downstream sites (0.1°C to 14.2°C) were within the post-construction ranges. Measurements in 2021 were generally consistent with the baseline ranges, although maximum water temperatures measured at each site were 0.2°C greater than those measured during baseline monitoring. Despite the small elevation (11 m) difference and short distance (~1 km) between the two sites, the downstream site exhibits greater seasonal variability in water temperature and is generally warmer than the upstream site in the summer and cooler in the winter, likely due to the influences of groundwater inflow and a tributary that enters Alena Creek between the two sites. The seasonal pattern of differences in water temperature between the two sites is similar between the pre- and post-construction, indicating that there has not been a clear change in seasonal variability in water temperature due to the FHEP construction.

Results to date indicate that the FHEP provides water temperatures typical of stream habitats in the area. Conditions for Coho Salmon and Cutthroat Trout were generally more suitable at the site at the downstream end of the enhanced reach than at the upstream site, although conditions were frequently sub-optimally cool for these species. Temperatures were more suitable for Bull Trout than Coho Salmon and Cutthroat Trout due to the generally cooler optimum temperature ranges preferred by Bull Trout.

Riparian Habitat

The objective of the riparian restoration effectiveness monitoring program is to evaluate revegetation and planting success as specified by the OEMP, including specific stem density targets. In Year 5, the density of trees (35,350 ± 22,275) and the density of shrubs (26,650 ± 12,573) met the stem density targets. Percent vegetation cover was high, and no invasive species were found. Soils appeared stable and no erosion was observed. Photopoint monitoring supported these results and demonstrated that vegetation was healthy and continued to increase in size. Conifer species abundance declined relative to monitoring after restoration in 2016; red alder and black cottonwood were dominant, and vegetation composition was similar to what was found in 2014, prior to instream habitat enhancement activities.

Vegetation in the Alena Creek FHEP area is establishing well and this component of the OEMP program is considered complete. A second offset project was completed on Alena Creek in September 2021 (Faulkner *et al.* 2021a), including a newly planted area. This area will be monitored under a separate monitoring program.

Conclusion

The success of the FHEP was evaluated according to the criteria in the *Fisheries Act* Authorization, namely that the habitat enhancement is physically stable, maintains suitable flows, has been demonstrated to provide spawning and rearing habitat for Coho Salmon and Cutthroat Trout of not less than 2,310 m^2, and supports equivalent or greater fish usage relative to pre-project densities in Alena Creek. The new channel construction and enhancement of existing channels has provided 3,194 m^2 of high-quality instream fish habitat (West *et al.* 2017). Restoration of riparian habitat yielded a further 4,060 m^2 of habitat directly enhanced by the FHEP. The FHEP created further ancillary benefits by providing improved passage to upstream spawning areas while retaining good quality rearing habitat provided by the beaver pond and woody debris jam (West *et al.* 2017). Although some repairs were required for a high flow event that occurred soon after construction, the five-year monitoring period has shown that the habitat is physically stable, provides suitable flows and that fish use is generally higher than pre-project conditions. CPUE for all captured species combined was 0.93 fish per 100 trap hours in 2021 compared to 0.52 fish per 100 trap hours during baseline. Beaver activity continues to pose a risk to habitat functionality and management of this species is recommended to continue to ensure the habitat remains to be function as intended.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

LIST OF APPENDICES

1. INTRODUCTION

This report provides the Year 5 (2021) results of the long-term monitoring program implemented to evaluate the effectiveness of the Fish Habitat Enhancement Project (FHEP) constructed on Alena Creek (also known as Leanna Creek) as per the *Fisheries Act* Authorization (09-HPAC-PA2-00303) issued for the Upper Lillooet Hydro Project (the Project). Ecofish Research Limited (Ecofish) was retained by the Upper Lillooet River Power Limited Partnership (ULRPLP) to monitor the FHEP on Alena Creek, located northwest of Pemberton, BC. The FHEP was designed by Hemmera Envirochem Inc. (Hemmera 2015) and Ecofish (Appendix A) to offset the habitat losses incurred due to the footprint and operation of the Project. The Project is composed of two hydroelectric facilities (HEFs) on the Upper Lillooet River and Boulder Creek, and a 72-km-long 230 kV transmission line. Alena Creek is a tributary to the Upper Lillooet River located approximately 4.1 km downstream of the confluence of Boulder Creek with the Upper Lillooet River and is therefore, downstream of the two HEFs (Map 1).

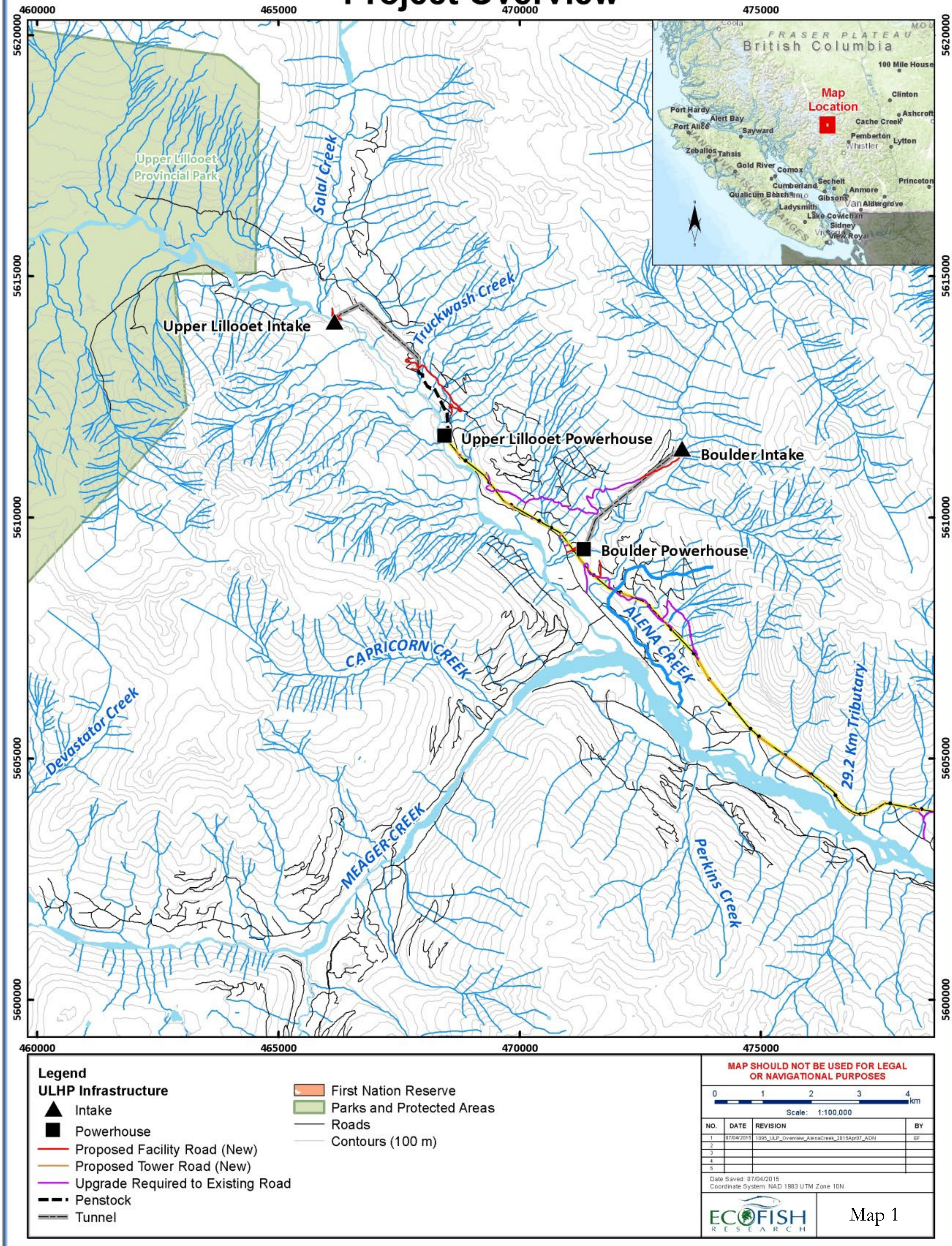
Details of the predicted habitat losses incurred by Project construction and operation are provided in the aquatic and riparian footprint reports for the HEFs and the transmission line (Buchanan *et al.* 2013a, 2013b). These habitat losses were authorized by Fisheries and Oceans Canada (DFO) through the issuance of a *Fisheries Act* Authorization (09-HPAC-PA2-00303) on September 26, 2013. The Authorization was amended on June 17, 2014. The amended Authorization requires the enhancement of 2,310 m^2 of instream habitat to offset the permanent loss of 1,935 m^2 of fish habitat associated with the construction of the Upper Lillooet HEF intake. Under the amended Authorization, there were no offset requirements associated with construction and operation of the Boulder Creek HEF, or with impacts to riparian habitat.

The offsetting plan involved fish habitat enhancement in Alena Creek, which was heavily impacted by the Capricorn/Meager Creek slide (hereafter referred to as the Meager Creek slide). The Meager Creek slide was a natural, catastrophic event that occurred on August 6, 2010, and deposited a large amount of woody debris and a thick slurry of sediment in and around Alena Creek. In addition to heavily impacting aquatic habitat, the slide affected riparian habitat by uprooting trees and smothering root systems with a thick layer of sediment. The FHEP, which was constructed in the summer of 2016, created a new section of channel and enhanced both the aquatic and riparian habitat of Alena Creek. It will therefore benefit Coho Salmon (*Oncorhynchus kisutch*), Cutthroat Trout (*O. clarkii*), and Bull Trout (*Salvelinus confluentus*). The FHEP consists of a downstream (Reach 1) and upstream reach (Reach 3), separated by a naturally recovering low gradient reach (Reach 2) (Map 2). The actual location and geometry of constructed design features was summarized in the as-built drawings (West *et al.* 2017).

Historical fish and fish habitat data from Alena Creek, and long-term monitoring requirements for the FHEP, were originally described in the Alena Creek Long-Term Monitoring Program (Harwood *et al.* 2013). Long-term monitoring requirements were subsequently revised and integrated into Project's Operational Environmental Monitoring Plan (OEMP) (Harwood *et al.* 2021). Monitoring of the FHEP involves monitoring of six components relevant to assessing the effectiveness of the offset habitat: fish habitat, fish community, hydrology, water quality, water temperature, and riparian habitat (Harwood *et al.* 2021). Among these, water quality monitoring was discontinued after Year 1 due to improvements observed and lack of anticipated adverse effects (Harwood *et al.* 2018). Results of Years 1 and 2 of Alena Creek pre-construction (pre-enhancement) monitoring are documented in Harwood *et al.* (2016). Results of Year 1 through 4 (2017-2020) of post-construction monitoring are presented in Harwood *et al.* (2019a, 2019b) and Thornton *et al.* (2020) and Thornton *et al.* (2021). Results from Year 5 (2021) the fifth and final year of monitoring are summarized below.

In addition to Year 5 monitoring, a second offset project was completed on Alena Creek in September 2021 (Faulkner *et al.* 2021a). The project was required to offset the predicted residual effects of an operational sediment management procedure (Flush Procedure) for the Upper Lillooet Hydro Project (ULHP) (Faulkner *et al.* 2019). The total amount of instream habitat required for this second offset project was 123 m^2 which included spawning and rearing habitat for Coho Salmon (*Oncorhynchus kisutch*), Bull Trout (*Salvelinus confluentus*), and Cutthroat Trout (*O. clarkii*) as per *Fisheries Act* Authorization (19-HPAC-00331). The completed offset habitat spans 197 m^2 and consists of a downstream extension of the existing FHEP offset channel that was constructed in Reach 3 of Alena Creek in 2016. Monitoring of this new offset habitat is not part of this report, although observations of the newly constructed habitat were made during on-going monitoring activities.

Project Overview



Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Compensation\1095_ULP_Overview_AlenaCreek_2015Apr07_ADN.mxd

2. OBJECTIVES AND BACKGROUND

2.1. Fish Habitat

FHEP habitat features (riffles and woody debris) were installed in reaches 1 and 3 in 2016 to enhance fish habitat. In Reach 1, 13 riffles and more than 120 pieces of large wood were installed to create 1,387 m^2 of enhanced fish habitat. In Reach 3, a total of 668 m^2 of new instream habitat and 1,139 m^2 of floodplain were created and 12 cobble riffles and over 100 pieces of large woody debris were installed.

A stability assessment has been conducted annually since the construction occurred to monitor the establishment and functionality of each of the FHEP habitat features and promptly identify whether any remedial action is required to maintain their effectiveness. The assessment has been conducted throughout the enhanced reaches and at eight marked transects (transects ALE-XS1 through ALE-XS4 in Reach 1 and transects ALE-XS5 through ALE-XS8 in Reach 3; Map 3) that are revisited each year and where photographs have been taken at photo-points to track changes over time. Details of the habitat features installed are provided in West *et al.* (2017).

A high flow event occurred shortly after construction in 2016 that affected habitat features constructed for the FHEP, which was monitored until 2019 (Year 3), when repairs were proposed to address stability issues in Reach 3. On August 6, 2020, during the least risk timing window (MOE 2006), a crew of four staff from Ecofish and Lil'wat First Nation completed the repairs by hand as recommended in 2019. The repairs were distributed throughout the reach: conditions were enhanced, and erosion protection was installed at roughly every other habitat unit (pool or riffle). Specifically, the repairs included the following actions:

1. Eroding banks were stabilized by creating a revetment composed of cobble, small boulder, and large wood.
2. Flow deflectors were installed to direct flow energy away from banks and towards root wad complexes in pools that have partially infilled with fines. Flow deflectors were composed of a matrix of materials ranging in size from sand to small boulders and large wood.
3. Riffles that had been outflanked were rebuilt and contoured to prevent further bank erosion and keep flow energy focused on gravel deposits for cleaning purposes.
4. Gravel was redistributed from pools and slack water areas into pool tail-outs and riffles where spawning might occur.

Photos of the repairs are included in the Year 4 report (Thornton *et al.* 2021). Inspection of these repairs was included in fish habitat monitoring in the following year (Year 5).

Reach 1 was generally found to be stable after the high flow event except for one location where a channel spanning log had collapsed, creating a wood jam and minor avulsion of the channel around the jam. The channel at this location had largely stabilized and was not expected to continue eroding at an unnatural rate. Some repairs were made in 2020 at this location, but they were restricted to placement of cobble along portion of the avulsed channel that would direct flow energy away from the channel bank and back towards the original channel alignment.

2.2. Fish Community

The goal of enhancing aquatic and riparian habitat in Alena Creek was to provide spawning and rearing habitat for Coho Salmon, Cutthroat Trout, and Bull Trout, and to support equivalent or greater fish use (based on fish abundance) in Alena Creek relative to pre-construction conditions. Fish habitat use in Alena Creek was assessed by comparing adult Coho Salmon spawner abundance and juvenile Cutthroat Trout and Coho Salmon abundance under baseline and post-construction conditions. Bull Trout spawner abundance monitoring on Alena Creek was primarily conducted to be used as a reference against Project streams (i.e., Upper Lillooet River and Boulder Creek). Adults were surveyed by counting fish during bank walks (spawner surveys) during Bull Trout and Coho Salmon spawning seasons in September and October, and early November to early December, respectively. Juvenile fish were sampled using minnow traps deployed at eight sites in Alena Creek (five enhanced, three unenhanced). The objective of minnow trapping was to monitor interannual variation in the relative abundance of juvenile fish, based on catch per unit effort (CPUE), for individual species and life stages in the enhanced and unenhanced reaches of Alena Creek (Map 3) and thereby assess changes in fish abundance over time and before and after construction.

2.3. Hydrology

Water level data provide useful information on inter-seasonal variation in flow and assist in interpreting changes in the other monitoring components (e.g., water temperature and fish abundance). Hydrological monitoring in Alena Creek was undertaken by ULRPLP.

2.4. Water Quality

Sampling at two sites during pre-construction monitoring and Year 1 showed that water quality in Alena Creek has generally improved since pre-construction sampling began in 2013 (Harwood *et al.* 2019a). Furthermore, monitoring data in Year 1 showed that water quality in the FHEP is generally suitable for aquatic life, including salmonids. Considering these observations, and that instream habitat enhancement is not expected to result in adverse effects on water quality, water quality sampling was discontinued after Year 1 based on a recommendation in the Year 1 annual report (Harwood *et al.* 2019a).

2.5. Water Temperature

Changes in water temperature can potentially affect stream biota, including fish. Tolerance to water temperature changes varies among species and life-history stages and according to existing conditions. The objective of water temperature monitoring is to confirm that conditions within the Alena Creek FHEP support migration, spawning, incubation, and rearing by the fish species present. Monitoring entails collecting continuous water temperature data to allow comparison of pre- and post-construction temperature data and monitor changes within the FHEP over time. Water temperature may be influenced by factors that include shading or hydraulic changes by the instream enhancement features, and changes to shade conditions due to maturation of riparian vegetation planted during the habitat restoration.

Water temperature in Alena Creek is being monitored continuously at two sites (Map 2) for the first five years post-construction. One site is located upstream of the restoration works and serves as a control site, and the other site is in the downstream end of the FHEP and serves as an impact site. This Year 5 (2021) annual monitoring data report provides a summary of pre-construction (2013-2014) and post-construction (2016–2021) water temperature monitoring results and providing qualitative assessment of temperature in relation to the fish community monitoring data.

2.6. Riparian Habitat

Riparian areas contribute to fish habitat quality through thermal regulation, minimizing sedimentation by stabilizing stream banks and intercepting run-off, and by providing nutrients, channel-stabilizing large woody debris (LWD), and cover (Gregory *et al.* 1991, Naiman and Decamps 1997, Naiman *et al.* 2000, Richardson 2004). The overall objective of the riparian restoration effectiveness monitoring program, as per the OEMP, is to describe natural revegetation and planting success in riparian areas, and to confirm that a diversity of well-established native tree and shrub species with low observed mortality rates are present within the Alena Creek FHEP area (Harwood *et al.* 2016, Harwood *et al.* 2021).

In the OEMP, successful revegetation is defined by two specific targets: 1) survival of at least 80% of planted vegetation within the first year of planting (DFO and MELP 1998, Harwood *et al.* 2013, Harwood *et al.* 2021); and 2) stem densities equal to or more than 1,200 tree stems/ha and 2,000 shrub stems/ha (Harwood *et al.* 2021). Conifer establishment and riparian species diversity is measured to assess the overall objectives stated in the OEMP and FHEP (Harwood *et al.* 2021, Hemmera 2015).

To evaluate regeneration and planting success, results from the fifth year of monitoring are compared with three benchmarks: 1) data collected post-construction (this includes as-built surveys conducted immediately following instream habitat enhancement and subsequent restoration work in 2016 (Harwood *et al.* 2019a), Year 1 monitoring in 2017 (Harwood *et al.* 2019a), and Year 3 monitoring in 2019 (Thornton *et al.* 2020)); 2) data collected four years after the slide prior to restoration work, in 2014 (Harwood *et al.* 2016); and 3) conditions prior to the Meager Creek slide (as estimated from typical characteristics of floodplain sites in the same biogeoclimatic zone; Green and Klinka 1994).

3. METHODS

3.1. Fish Habitat

Fish habitat was assessed in Year 5 by taking and comparing photographs taken in the same locations (transect repeat photos) throughout the monitoring period. In addition, the repairs completed in Reach 1 and Reach 3 in 2020 were inspected for functionality and long-term stability. Fish habitat monitoring in Year 5 was conducted on October 27, 2021.

Reaches 1 and 3 of Alena Creek were enhanced as a part of the FHEP. To assess the stability of the habitat enhancements, initial photos were taken at photo-points established during the as-built survey (completed shortly following FHEP construction in 2016). A total of eight transects were established (four in each reach) and surveyed at that time. At each transect, a panorama of photos was taken to support evaluation of changes in habitat conditions over time. Photos were taken looking downstream, upstream, from river left to river right, and from river right to river left. The photo aspects were oriented to provide a full view of the bankfull channel and floodplain, with the transect tape included in the photos to provide a visual reference that would aid with analysis of the topographic transect surveys. The transect photos have been repeated during each year since construction, including Year 5, to allow for detection of changes in channel conditions. Additional photos were also taken throughout reaches 1 and 3 at key points.

3.2. Fish Community

3.2.1. Adult Spawner Abundance

Spawner surveys in Alena Creek focused on Coho Salmon; however, Bull Trout were also monitored to provide additional information on Project streams (i.e., Upper Lillooet and Boulder Creek). Spawner surveys for Bull Trout were done through bank walks conducted approximately every two weeks between September 15 and October 21, 2021 (a total of three surveys). Coho Salmon spawner surveys were conducted every two weeks between November 5 and December 6, 2021 (a total of three surveys). Consistent with previous years, bank walks extended from the downstream confluence with the Upper Lillooet River to the upstream end of Alena Creek at the groundwater spring at the Lillooet River Forest Service Road (FSR) crossing at kilometer 36.5. During bank walks, live fish and carcasses were counted. Due to the meandering nature of the Upper Lillooet River, the downstream confluence with Alena Creek has varied over the monitoring years by up to ~1 km. Although survey distance can vary on Alena Creek, it is not expected to have a significant effect on total observations as a small percentage of fish are observed in this section due to the high turbidity influence from the Upper Lillooet and lack of holding habitat.

It is important to note that the carcasses in Alena Creek are quickly consumed by wildlife in the area, as evident by observations that they are not often whole and show signs of being eaten. Often only the pyloric caeca, which animals prefer not to eat, are left behind. Thus, combined counts of spawners and carcass counts may be biased low and not accurately reflect true abundance.

3.2.2. Juvenile Abundance

3.2.2.1. Minnow Trapping

Minnow trapping surveys in Alena Creek for Year 5 monitoring occurred on September 27, 2021. Eight sites were sampled in 2021 (five enhanced, three unenhanced; Map 3), which were also sampled in 2018, 2019, 2020, and 2021; six were sampled in years prior to 2018. In 2021 (as in previous years as of 2018), five traps were installed at each site, except at ALE-MT06, where 10 traps were used because a large pool present at this site required a higher level of sampling effort. Sampling was conducted in five of the six sites sampled in years prior to 2018 (ALE-MT01, ALE-MT02, ALE-MT03, ALE-MT05 and ALE-MT06). Due to American Beaver (*Castor canadensis*) (hereafter, beaver) activity in these years, sampling at ALE-MT04 was discontinued in 2018 through 2021 as recommended in the Year 1 report (Harwood *et al.* 2019a). Additionally, three new sites established in 2018 in FHEP habitat were sampled, one site in Reach 1 (ALE-MT07) and two sites in Reach 3 (ALE-MT08 and ALE-09) (Map 3). The Year 1 OEMP report recommended that one of the additional sites be located just upstream of Reach 1 at the gravel augmentation pile installed as part of the enhancement works; however, due to beaver dam and stability issues at this location, the site was located just downstream of the gravel augmentation pile and in the Reach 1 FHEP area (ALE-MT07). Although more sites were sampled in 2018 to 2021 (eight sites) than in the years before that (six sites), this difference does not affect comparability of CPUE among years since it is a standardized metric.

Minnow traps were baited using salmon roe and left overnight in most years; an exception was 2014 when minnow traps at some sites were left only during the daytime due to bear activity. When the traps were retrieved, captured fish were identified and measured (discussed below), then released.

3.2.2.2. Biological Information

All captured fish were enumerated and identified to species level using standard field keys. Due to the volume of fish captured, only a subset of fish captured at each site were measured and weighed (i.e., approximately 10 of each species and age class per site). The sub-sampled fish were measured for fork length using a measuring board (±1.0 mm) and weighed using a field scale (±0.1 g).

Scale samples to be used for aging analysis were collected from a sub-sample of captured fish and aged at the Ecofish laboratory in Campbell River (i.e., approximately 10 of each species and age class from all sites combined). Three representative scales for each fish included in the sub-sample were examined under a dissecting microscope, photographed, and apparent annuli were noted on a digital image. Fish age was determined by a biologist and QA'd by a senior biologist. Where discrepancies were identified, they were discussed, and final age determination was based on the professional judgement of the senior biologist.

3.2.2.3. Data Analysis

Individual Fish Data

Biological data from the captured fish were analyzed to define age structure, size structure, length-weight relationship, length at age, and condition factor by species. Discrete age classes were based on size bins established using length-frequency histograms and age data from the scale analysis. Discrete age classes were defined for fry (0+), parr (1+), parr (2+), and adults (3+). These discrete classes allowed measured fish to be assigned an age class based on fork length.

The condition of fish, which is an indication of overall health, can be calculated in a variety of ways, such as Fulton K or relative weight (W_r) (Blackwell *et al.* 2000). A potential problem with the use of Fulton K is an assumption of isometric growth (Blackwell *et al.* 2000); however, for this monitoring program, the condition of fish was calculated separately for each age class, so violations of this assumption were not expected. The condition of fish was assessed by calculating Fulton's condition factor (*K*) and creating plots of species-specific length-weight relationships. Fulton's condition factor (*K*) was calculated for each fish captured by species and year using the following equation:

$$K = \left(\frac{W}{L^3}\right) 100{,}000$$

where W is the weight in g, L is the length in mm, and $100{,}000$ is a scaling constant (Blackwell *et al.* 2000).

Relative Abundance

Relative abundance was evaluated using CPUE for minnow trap data, which was calculated as the number of fish captured per 100 trap hours.

3.3. Hydrology

Water level monitoring began at Alena Creek in April 2013. Two water level loggers were originally installed in Alena Creek: one at the Lillooet River FSR crossing (Alena Bridge) and another at the upstream end of the project area (Alena Upstream) (Map 2). Baseline monitoring at these two stations occurred from approximately 2013 to 2015. Post-construction monitoring started in 2016 and is ongoing. Pos-construction water level data has been collected at the Alena Bridge site in every monitoring year. The gauge was reinstalled and moved slightly on November 26, 2019. An offset was applied to data collected after that point to ensure stage data collected before and after removal was comparable.

In addition, a second gauge (R1) was installed based on recommendation by Harwood *et al.* (2018), at approximately 125 m upstream from the Alena Bridge gauge. This gauge was deployed from August 23, 2018, until fall 2019. The purpose of the second gauge was to examine for potential backwater effects that may be caused by the Upper Lillooet River side channel when flows were high, and to ensure the stage data collected were representative of Alena Creek water levels. Results from the Year 3 report (Thornton *et al.* 2020) indicated that backwatering from Upper Lillooet River to the FSR bridge was no longer occurring, and the gauge was removed in November 2019.

3.4. Water Temperature

3.4.1. Study Design

Pre-construction and post-construction water temperature monitoring occurred at two monitoring sites: ALE-USWQ1, located upstream of the enhancement works, and ALE-BDGWQ, located at the downstream end of the works, within the enhanced area and just upstream of the FSR bridge (Table 1, Map 2, Appendix B). Pre-construction water temperature monitoring occurred from April 17, 2013 to December 31, 2014 at the upstream control site (ALE-USWQ1) and from August 27, 2013 to December 31, 2014 at the downstream impact site (ALE-BDGWQ) (Map 2). Post-construction monitoring commenced at both sites on November 23, 2016. Year 5 data are available up to September 27, 2021 for the upstream site and downstream site (Table 1).

Table 1. Summary of water temperature site names, logging details, and periods of data records in Alena Creek pre-construction (2013, 2014) and post-construction (November 2016 through 2021).

Type	Site	UTM Coordinates (10U)		Elevation (masl)[1]	Project Phase[2]	Periods of Record		Number of Data Records	Logging Interval (min.)	No. of Days with Valid Data	% Complete[3]
		Easting	Northing			Start Date	End Date				
Upstream	ALE-USWQ1	472,976	5,606,870	391	Pre-construction	17-Apr-13	30-Dec-14	623	60	561	91
					Post-construction	23-Nov-16	27-Sep-21	1,770	15	1,766	100
Downstream	ALE-BDGWQ	473,336	5,606,095	382	Pre-construction	27-Aug-13	30-Dec-14	491	60	453	94
					Post-construction	23-Nov-16	27-Sep-21	1,770	15	1,767	100

[1] Estimated from Google Earth.

[2] Pre-construction (2013-2014) water temperature was monitored via hydrometric gauges maintained by Knight Piésold Ltd. Post-construction Tidbit temperature loggers were installed.

[3] The pre-construction data gap at the upstream site occurred between mid January and mid March 2014 due to icing concerns. The pre-construction data gap at the downstream site occurred at the end of March through early April 2014, therefore a complete month of data (i.e., more than three weeks) for March are not available during this phase.

3.4.2. Quality Assurance/Quality Control

Processing of water temperature data was conducted by first identifying and removing outliers and then compiling data into a timeseries for all sites. Identification and removal of outliers was conducted as part of a thorough Quality Assurance/Quality Control (QA/QC) process which ensured that suspect or unreliable data were excluded from analysis and presentation. Excluded data included, for example, data collected when the sensor was suspected of being out of the water, affected by snow or ice, or buried in sediment.

During the pre-construction monitoring period, there were gaps in the datasets from mid-January 2014 to mid-March 2014 at the upstream site, and from the end of March through early April 2014 at the downstream site due to the suspected build-up of ice (McCarthy, pers. comm. 2014) (Table 1). At the upstream site, less than three weeks of water temperature data were available for January, February, and March 2014. Therefore, not all summary statistics and temperature metrics (see Section 3.4.4) could be calculated for these months, limiting the available winter season pre-construction data (Table 1). At the downstream site, less than three weeks of data were available for March 2014, limiting the available spring season pre-construction data (Table 1). There have been no data gaps post-construction to date (i.e., data set is 100 % complete; Table 1).

3.4.3. Data Collection and Analysis

Pre-construction temperature data were recorded at 60-minute intervals using hydrometric gauges maintained by Knight Piésold Ltd. The temperature sensors incorporated into the gauges were installed in aluminum standpipes and had an accuracy of ±0.3°C and a resolution of ±0.001°C. Post-construction temperature data were recorded at 15-minute intervals using self-contained Tidbit v2 loggers made by Onset. The loggers have a range of -20°C to +70°C, are accurate to ±0.2°C, and record data with precision of 0.02°C. Water temperature at ALE-BDGWQ was concurrently logged with two Onset Tidbit loggers installed on separate anchors; this redundancy ensured availability of data in case one of the loggers malfunctioned or was lost. A second Tidbit logger was installed at ALE-USWQ1 in 2019.

After identifying and removing outliers, the records from duplicate loggers were averaged and records from different download dates were combined into a single timeseries for each monitoring site. The timeseries for all sites were then interpolated to a regular interval of 15-minutes (for instances whereby data were not already logged at a 15-minute interval), starting at the full hour. Data are presented in plots that were generated from the resultant 15-minute interval temperature data.

Analysis of the data involved computing mean, minimum, and maximum water temperatures as well as differences in water temperature among sites and mean weekly maximum temperature (MWMxT). Table 2 defines these statistics and describes how they were calculated. MWMxT values were compared to optimum ranges for priority fish species, and daily minimum and maximum temperatures were compared to temperature thresholds for Bull Trout.

After Year 3 reporting, data were subject to further analysis to ensure they were processed according to current standards. As a result, some revisions were made to improve accuracy, and the values presented herein may differ from those presented in previous reports during Year 1 to Year 3. Key changes were:

- Mean Weekly Maximum Temperature (MWMxT) – changes from previous versions of this analysis were:
  - The inclusion of a cut-off whereby a day is excluded from the calculation if it does not include data during the warmest period of the day. By default, a day is excluded when it does not have at least one hourly measurement between 11:00 and 18:00.
  - For growing season, a "week" was calculated as a centred average (i.e., three days before and three days after the day for which MWMxT is being calculated). Therefore, the revised start and end dates of the growing season are three days later/earlier, respectively.

Table 2. Water temperature metrics and method of calculation.

Metric	Description	Method of Calculation
Water temperature	Hourly or 15 minute data	Data (interpolated to 15 minute intervals where necessary) presented in graphical form.
MWMxT (Mean Weekly Maximum Temperature)	Mean, minimum, and maximum on a running weekly (7 day) basis	Mean of the warmest daily maximum water temperature based on hourly data for 7 consecutive days; e.g., if MWMxT = 15°C on August 1, 2008, this is the mean of the daily maximum water temperatures from July 29 to August 4, 2008; this is calculated for every day of the year.

3.4.4. Applicable Guidelines

3.4.4.1. Overview

The water temperature BC Water Quality Guidelines (BC WQG) for the protection of aquatic life define water temperature thresholds and optimum temperature ranges specific to fish species and life stages (Oliver and Fidler 2001, MECCS 2021). The target fish species expected to benefit from enhancement in Alena Creek are Coho Salmon, Cutthroat Trout, and Bull Trout. The relevant water temperature BC WQGs for the protection of aquatic life is summarized in the sub-sections below. Optimum water temperature ranges, as defined by the BC WQG for rearing, spawning, incubation, are provided for the fish species present in Alena Creek in Table 3. The timing of life history stages in Alena Creek (Harwood *et al.* 2016) that were used to define the start and end dates for each of the applicable life stages for Coho Salmon, Cutthroat Trout, and Bull Trout are shown in Table 4.

3.4.4.2. Mean Weekly Maximum Temperature (MWMxT)

The MWMxT is an important indicator of prolonged periods of cold and warm water temperatures that fish are exposed to. The BC WQG for the protection of aquatic life states "Where fish distribution information is available, then mean weekly maximum water temperatures should only vary by ±1.0°C beyond the optimum temperature range of each life history phase (incubation, rearing, migration, and spawning) for the most sensitive salmonid species present" (Oliver and Fidler 2001, MECCS 2021). Accordingly, MWMxT values were compared to the optimum temperature ranges for the fish species present in Alena Creek based on the life history and periodicity (Table 3, Table 4).

Within each life history period, the completeness of the temperature data record (% complete) was calculated and results are only included if at least 50% of the data for the period was available. The minimum and maximum MWMxT values, percentage of data within the optimum range, and percentage of data that exceeded ±1.0°C of the optimal temperature range were calculated for each life history period to evaluate the suitability of the temperature regime for each fish species at each monitoring site, pre- and post-construction.

3.4.4.3. Bull Trout Temperature Guidelines

Additional water temperature BC WQG (MECCS 2021) are specified for streams with Bull Trout and Dolly Varden (Oliver and Fidler 2001; Table 1 in Appendix B). When either of these fish species are present, the guidelines state that:

- Maximum daily water temperature is 15°C;
- Maximum daily incubation temperature is 10°C;
- Minimum daily incubation temperature is 2°C; and
- Maximum daily spawning temperature is 10°C.

The number of days when these thresholds were exceeded were calculated using the appropriate daily maximum or minimum temperature values for each site.

Table 3. Optimum water temperature ranges for Coho Salmon, Cutthroat Trout, and Bull Trout during spawning, incubation, rearing, and migration (MECCS 2021).

Species	Optimum Water Temperature Range (°C)			
	Spawning	Incubation	Rearing	Migration
Coho Salmon	4.4 - 12.8	4.0 - 13.0	9.0 - 16.0	7.2 - 15.6
Cutthroat Trout	9.0 - 12.0	9.0 - 12.0	7.0 - 16.0	-
Bull Trout	5.0 - 9.0	2.0 - 6.0	6.0 - 14.0	-

Table 4. Periodicity of fish species in Alena Creek.

Coho Salmon	Cutthroat Trout	Bull Trout
Spawning (Oct. 15 to Jan. 01)	Spawning (Apr. 01 to Jul. 01)	Spawning (Aug. 01 to Dec. 08)
Incubation (Oct. 15 to Apr. 01)	Incubation (May 01 to Sep. 01)	Incubation (Aug. 01 to Mar. 01)
Rearing (Jan. 01 to Dec. 31)	Rearing (Jan. 01 to Dec. 31)	Rearing (Jan. 01 to Dec. 31)
Migration (Sep. 01 to Dec. 31)	Undefined	Undefined

3.5. Riparian Habitat

Three types of data were evaluated to monitor the success of the riparian restoration works and the overall function of the riparian habitat; these were: (1) vegetation density estimates from permanent revegetation monitoring plots; (2) vegetation ground cover estimates from randomly placed quadrats; and (3) photographs taken over multiple years at permanent photopoint monitoring locations. Methods are discussed in more detail below. Any regionally or provincially designated noxious invasive species were also documented when observed.

3.5.1. Permanent Revegetation Monitoring Plots

Woody vegetation is the primary focus of riparian revegetation monitoring due to its long-term contribution to the maintenance and enhancement of riparian habitat function. Consequently, the density (stems per hectare) of woody vegetation is an important metric and indicator of restored riparian habitat quality. Permanent revegetation monitoring plots are used to sample the density of perennial woody vegetation within 50 m^2 circular plots, as per the BC Silviculture Stocking Survey Procedures (MOF 2009) and vegetation tally procedures employed by the Forest and Range Evaluation Program's Stand Development Monitoring Protocol (MOF 2011).

Four permanent revegetation monitoring plots were established in 2014, prior to construction of the FHEP; however, only one of these four plots (ALE-PRM03) ended up within the restored area due to a revised design. As such, three additional plots were established in 2016, following construction of the FHEP, so that a total of four plots were assessed in 2016 (as-built), and 2017 (Year 1) to 2021 (Year 5). These four permanent revegetation monitoring plots were assessed for the duration of the monitoring program (Map 3). A direct comparison between plots established in 2016 and plots monitored in 2014 is not possible. However, they were all intended to be representative of the riparian zone of Alena Creek, and the 2014 monitoring plots still provide a useful benchmark.

Surveyors counted the number of stems of all native perennial woody plants and conducted health and mortality checks. Perennial woody vegetation includes long-lived species such as trees and shrubs, but excludes forbs, grasses, and mosses. Plants showing signs of abiotic stress, insect damage, fungal blights, or other afflictions were all counted as living, but incidences of the afflictions and the host plant species were noted. Stems were defined as those stems of a plant that were individually distinct at ground level. Tree or shrub seedlings with secondary leaves that were at least the size or length of a quarter were counted. No minimum height requirements were applied.

The DFO and MELP effective revegetation criteria provided a spacing target of 2.0 m for planting (DFO and MELP 1998). When 80% survival is considered, this equates to an overall target of 2,309 stems/ha, as written in the original proposed long-term monitoring program for Alena Creek (Harwood *et al.* 2013). The current OEMP set minimum targets of 1,200 stem/ha for trees and 2,000 stems/ha for shrubs for revegetated areas associated with temporary riparian habitat loss created during project construction (Harwood *et al.* 2021). These target densities for tree and shrub species, as well as overall densities, were considered when assessing whether an adequate density of woody vegetation is growing within the FHEP area. The variability in the stem density estimates was assessed using a two-tailed students t-test and a 90% confidence interval (t value = 2.35). In addition, the presence and relative number of stems of each species were considered to assess if a diverse assemblage of native tree and shrub species is becoming established within the Alena Creek FHEP area, and if the species composition is indicative of expedited succession to a mixed coniferous/ deciduous forest. Planted vegetation was not tracked beyond the first year, so it was not possible to assess survival, but the proportion of dead stems was used to give a general measure of vegetation health.

3.5.2. Percent Vegetation Cover Estimates

Vegetated ground cover, including herbaceous and small woody species, is an indicator of substrate stabilization and suitable growing conditions early in the revegetation process. 80% cover has been adopted as a general indicator of functioning riparian habitat for the monitoring program but is not a monitoring target in the OEMP and is not used to evaluate success (DFO and MELP 1998, Harwood *et al.* 2013, Harwood *et al.* 2021). Quadrat sampling was employed to determine the percent ground cover of all herbaceous and woody vegetation, excluding lichens, fungi, and mosses. Quadrat sampling provides a method for accounting for regeneration of the forb and grass layer, which is not captured by counting perennial woody vegetation within the permanent monitoring plots. This method is most informative during the early vegetation re-establishment period when all vegetation is low to the ground. The quadrat method consists of counting the number of 10 × 10 cm quadrat squares that contain vegetation within the 0.25 m^2 quadrat. Ten quadrat replicates were haphazardly placed in the vicinity of each permanent revegetation monitoring plot (not necessarily within the plot), and results from the ten replicates were averaged to provide an average percent cover for the site. Photos of each quadrat replicate were taken and are available upon request.

3.5.3. Photopoint Comparison

Photopoint monitoring, employed by taking repeat photographs over time, provides insight into how the riparian condition and associated functions change over time. Photographs were taken facing 0° (north), 90° (east), 180° (south) and 270° (west) from 1.3 m above each permanent monitoring plot centre to qualitatively document change over time. The north facing photographs are appended to this report, whereas additional photographs are available upon request. Additional descriptive photographs were also taken of the monitoring sites.

4. RESULTS

4.1. Fish Habitat

4.1.1. Overview

The as-built survey was completed following construction in Year 1 (West *et al.* 2017). The new channel construction and enhancement of existing channels has provided 3,194 m^2 of high-quality instream fish habitat. Restoration of riparian habitat yielded a further 4,060 m^2 of habitat directly enhanced by the FHEP. The FHEP created further ancillary benefits not included in these totals by providing improved passage to upstream spawning areas while retaining good quality rearing habitat provided by the beaver pond and woody debris jam (West *et al.* 2017). This exceeded the target of 2,310 m^2 set out in the *Fisheries Act* Authorization (09-HPAC-PA2-00303); however, monitoring was required to ensure this habitat remained to be functioning as intended over a five-year period.

In Year 5, photos were taken at established photo-point locations (transects) in the enhanced reaches (Reach 1 and Reach 3) of Alena Creek on October 27, 2021. A comparison of all photos taken during the five years of monitoring by transect is available in Appendix C. Transects are shown in Map 3.

Overall, it has been evident during monitoring that the riparian vegetation has increased since 2016 and the channel has remained stable over this time. Grasses, shrubs, and herbaceous vegetation have become established, and are continuing to establish, throughout the reaches. This vegetation is protecting the bank from excessive erosion, while also providing cover for small salmonids. No substantial changes to the stream channel were noted that were not anticipated based on the dynamic stability criteria of the design.

New beaver activity was observed in the lower end of Reach 3. Previous beaver activity upstream of Reach 3 had ceased, but flow was still being partially diverted around the upper portion of Reach 3. Beavers were trapped within the Alena Creek enhancement area and the dams were removed in the fall of 2021 by a licensed trapper from EBB Environmental Consulting Inc. A description of channel condition, geomorphic processes, and instream repair inspection is provided for the two reaches in the following sections. Instream repairs completed on August 6, 2020, are also described. Details of the habitat features installed by transect are provided in West *et al.* (2017).

4.1.2. Reach 1

Reach 1 is the most downstream reach of Alena Creek; it extends from the Lillooet River FSR bridge to approximately 200 m upstream (Map 3). Photos of each transect from each year of monitoring are provided in Appendix C. The following bullets summarize observations of constructed features by transect, including repairs made in 2020 where a channel spanning log had collapsed (near ALE-XS1):

- **ALE-XS1** – The channel had previously avulsed onto the river left floodplain and created a secondary channel less than 10 m long (Figure 1 through Figure 6). This secondary channel remains active in 2021. Following repairs made in 2020, which involved placing cobble upstream of ALE-XS1 along a portion of the avulsed channel, the riffle is still composed of gravel and is relatively free of fines but has some algae growth. Inspection of repairs in 2021 indicated that these repairs were effective in directing flows back to the original channel alignment and reducing bank erosion (Figure 7). There are no concerns for long term stability.

- **ALE-XS2** – The channel is backwatered in this location due to the collapse of one of the channel-spanning logs downstream, and the accumulation of small wood pieces have created a minor log jam (Figure 8). The collapse was identified during the 2019 assessment (Thornton *et al*. 2020). Some undercutting has occurred on river left under a longitudinally aligned log, which appears to be stable and has created good cover. The root wads on river right continue to provide good cover habitat. The log jam has not grown and is not causing excessive fines deposition or full channel avulsion.
- **ALE-XS3** - Channel hydraulic diversity remains as designed, and the riffle has low fines content. The center log has shifted slightly. There are no concerns for long term stability.
- **ALE-XS4** – Pool depth has remained as designed with minimal aggradation of fines. Root wads continue to provide good cover conditions. There are no concerns for long term stability.

Figure 1. Looking from river left to river right at ALE-XS1 on September 19, 2016, showing a single channel.

Figure 2. Looking from river left to river right at ALE-XS1 on November 10, 2017, showing the beginnings of a secondary channel forming on the river left floodplain.

Figure 3. Looking from river left to river right at ALE-XS1 on November 5, 2018, showing further development of a secondary channel on the river left floodplain.

Figure 4. Looking from river left to river right at ALE-XS1 on November 13, 2019; the secondary channel on the river left floodplain is partly obscured by growing vegetation.

Figure 5. Looking from river left to river right at ALE-XS1 on November 7, 2020; the secondary channel on the river left floodplain is partly obscured by growing vegetation.

Figure 6. Looking from river left to river right at ALE-XS1 on October 27, 2021; the secondary channel on the river left floodplain is partly obscured by growing vegetation.

Figure 7. Cobble placement at the head of the side channel upstream of ALE-XS1 on August 06, 2020.

Figure 8. Log jam that has formed at a collapsed channel spanning log approximately 10 m upstream of at ALE-XS2. Photo taken on June 20, 2019.

4.1.3. Reach 3

4.1.3.1. Transect Repeat Photos

Reach 3 extends from approximately 600 m to 800 m upstream of the Lillooet River FSR bridge. A brief description of changes that have occurred to constructed features at each of the monitoring transects is provided in the bullets below, followed by an overview description of changes occurring in the channel. Photos at each transect from each year of monitoring are provided in Appendix C.

- **ALE-XS5** - Due to reoccurring beaver activity in 2021 at the lower end of Reach 3, this section is slightly backwatered. Wetted widths and wetted depths have increased relative to 2019. Channel hydraulic diversity remains as designed, and the riffle has low fines content despite moderate bank erosion upstream. One channel-spanning log has collapsed but is only slightly affecting hydraulics. Rootwads upstream of the riffle continue to provide good cover for juvenile salmonids. There are no concerns for long term stability.
- **ALE-XS6** - A new beaver dam was constructed in this section, causing some moderate backwatering and sand deposition in 2020. Although the beaver dam was dismantled in the fall of 2021, wetted widths and wetted depths have increased relative to 2019. Some sand deposition has occurred on riffle material, with sand likely originating partially from upstream supply and from bank erosion that largely occurred during the November 2016 high flow event and due to an avulsion of the channel around a beaver dam above Reach 3. Grass and herbaceous bank vegetation have established that should prevent excessive erosion in the future. There are no concerns for long term stability.
- **ALE-XS7** – The pool has aggregated with sand to some extent and may now be at an equilibrium depth with the upstream sand supply. There has been an increase in deposition of sand mid channel since 2019. Rootwads continue to provide cover habitat, and riffles are generally free of fines. There are no concerns for long term stability.
- **ALE-XS8** – The riffle is still relatively free of fines and excessive erosion has not occurred. Deposition of fines has occurred on the glide that is unavoidable given upstream sediment supply and the newly cut side channel flowing into the top of Reach 3. There are no concerns for long term stability.

During Year 3 (2019), two channels were identified that formed on the west side of Reach 3 due to a large beaver pond approximately 30–50 m upstream of Reach 3. These channels are cutting into fine sediment and delivering it to Reach 3. The channel that enters Reach 3 approximately 40 m downstream from the head of Reach 3 was flowing throughout 2020 (Figure 9). The other channel that entered Reach 3 further downstream had ceased flowing during 2020, likely due to changes in upstream beaver activity. The beaver dam complex upstream of Reach 3 was considered inactive in 2021. The dams restrict fish migration to the upstream spawning reach, impede gravel supply to Reach 3, and cause diversion of flow around the Reach 3 constructed channel. The dams were managed through 2018, 2019, and 2020 in accordance with best management practices for dam removal provided by a licensed trapper from EBB Environmental Consulting Inc. As recommended in 2019, the dam that is blocking flow to the mainstem was lowered in 2020 to prevent excessive flow diversion.

New beaver activity was observed in the lower end of Reach 3: two reconstructed beaver dams created moderate backwatering at ALE-XS5, ALE-XS6 and ALE-XS7 (Figure 10). Beavers were trapped within the Alena Creek enhancement area and dams were removed in the fall of 2021 by a licensed trapper from EBB Environmental Consulting Inc.

Figure 9. Confluence of overflow channel that formed during 2019 as a result of beaver activity upstream of Reach 3. Photo shows uppermost 20 m of Reach 3 (right) and overflow channel (left). Photo taken on November 13, 2019.

Figure 10. New reconstructed Beaver dam at the lower end of Reach 3 that was identified during fall 2021 and subsequently removed.

4.1.3.2. Instream Repairs

During the stability assessment on October 27, 2021, the repairs in Reach 3 from 2020 were inspected and appeared to be intact, stable, and functioning as intended. The large wood pieces placed along the banks to deflect flow and prevent erosion, have not shifted, and remain intact, thus alleviating previous erosion issues.

4.2. Fish Community

4.2.1. Adult Spawner Abundance

The peak counts of live Coho Salmon spawners observed in 2021 was 371 live fish on December 6, 2021 (Table 5). The peak count of live adult spawning Coho Salmon in 2021 was the highest observed during monitoring to date. Variability in peak counts of live adult spawning Coho Salmon during the last eight years, which ranged from 109 to 218 (in 2017 and 2020 respectively), is evident in Table 6. This comparison of observations among years also highlights the variability in run timing, with the annual peak live count recorded between early November and early December. Peak counts of live spawners provide a general indication of habitat use and demonstrate that Alena Creek supports potentially greater use by Coho Salmon spawners currently than it did pre-construction, although among-year variability in spawner abundance is strongly affected by factors other than spawning habitat quality, such as marine survival. Example photos of adult Coho Salmon holding in enhanced habitat and unenhanced habitat are provided in Figure 11 and Figure 12 respectively. Adult

Coho Salmon were also observed spawning in the newly constructed offset habitat (*Fisheries Act* Authorization 19-HPAC-00331) on December 6, 2021 (Figure 13).

Five Bull Trout were observed in 2021. Counts in previous years ranged from zero to nine individuals (Table 5, Table 7). Bull Trout numbers have been low in small tributaries of Upper Lillooet River since 2011 with an increasing trend in recent years including 29.2 km Tributary (Faulkner *et al.* 2022).

Table 5. Summary of adult fish observed during fall spawner surveys in 2021.

Stream	Date	Survey Time (hh:mm)	Survey Distance (m)	Live Adults[1]		Adult Carcasses[1]	
				BT	CO	BT	CO
Alena Creek	2021-Sep-15	16:00	1,750	0	0	0	0
	2021-Oct-07	14:00	2,300	0	0	0	0
	2021-Oct-21	15:12	2,300	5	37	0	0
	2021-Nov-05	17:36	2,300	0	185	0	21
	2021-Nov-17	04:00	2,300	0	339	0	66
	2021-Dec-06	18:48	2,300	0	371	0	4
Alena Creek Total:		**13:36**	**13,250**	**5**	**932**	**0**	**91**

[1] BT = Bull Trout, CO = Coho Salmon

Table 6. Peak Live Coho Salmon spawner counts during baseline (2010-2011) and post-construction monitoring (2016 - 2021).

Year	Date[1]	Adult Spawning Coho		
		Live	Dead	Total
2010	Nov-05	127	0	127
2011	Dec-02	110	1	111
2016	Nov-14	174	18	192
2017	Nov-26	109	22	131
2018	Nov-05	126	4	130
2019	Dec-09	153	20	173
2020	Nov-19	218	51	269
2021	Dec-06	371	4	375

[1] Date of adult spawning Coho Salmon peak count

Table 7. Peak Live Bull Trout spawner counts during baseline (2011) and post-construction monitoring (2018 - 2021).

Year	Date [1]	Adult Spawning Bull Trout		
		Live	Dead	Total
2011	Oct-04	9	0	9
2018	Oct-11	2	0	2
2019	Oct-01	1	0	1
2020	N/A	0	0	0
2021	Oct-21	5	0	5

[1] Date of adult spawning Bull Trout peak count

Figure 11. Coho Salmon observed holding in enhanced habitat on November 5, 2021.

Figure 12. Spawning Coho Salmon observed in unenhanced habitat on December 6, 2021.

Figure 13. Spawning Coho Salmon observed in new offset habitat on December 6, 2021.

4.2.2. Juvenile Abundance

4.2.2.1. Overview

On September 27, 2021, 45 minnow traps were set overnight in riffle, pool, and glide habitats ranging in depth from 0.2 to 1.4 m (Table 8) at eight sites (Map 3). A total of 1,045 fish (1,017 Coho Salmon and 28 Cutthroat Trout) were captured during minnow trap sampling (Table 8). Three juvenile Bull Trout were captured in 2021. Raw data tables and representative photos of minnow trapping sites are presented in Appendix D.

Table 8. Summary of minnow trapping habitat characteristics and fish captures in Alena Creek on September 27, 2021.

Site	Enhancement Status	# of Traps	Total Soak Time (hrs)	Mesh Size (mm)	Habitat Type	Trap Depth Range (m)	Total Captures [1]		
							BT	CO	CT
ALE-MT01	Enhanced	5	112.6	6.3	Glide, Riffle	0.6 - 1.0	2	29	0
ALE-MT02	Enhanced	5	115.7	3.2 - 6.3	Pool, Riffle	0.3 - 0.9	0	50	1
ALE-MT07	Enhanced	5	119.1	3.2 - 6.3	Pool	0.4 - 0.9	1	60	1
ALE-MT03	Unenhanced	5	121.6	3.2 - 6.3	Pool, Glide	0.3 - 0.9	0	94	3
ALE-MT08	Unenhanced	5	130.3	3.2 - 6.3	Pool	0.2 - 0.7	0	106	1
ALE-MT09	Enhanced	5	134.4	3.2 - 6.3	Pool, Riffle	0.3 - 1.0	0	103	2
ALE-MT05	Enhanced	5	136.2	3.2 - 6.3	Pool, Riffle	0.4 - 1.0	0	189	3
ALE-MT06	Unenhanced	10	248.4	3.2 - 6.3	Pool	0.3 - 1.4	0	386	17
Grand Total:		**45**	**1,118**				**3**	**1,017**	**28**
Grand Average:		**5.6**	**139.8**				**0**	**127**	**4**

[1] BT = Bull Trout, CO = Coho Salmon, CT = Cutthroat Trout

4.2.2.2. Cutthroat Trout

A total of 28 Cutthroat Trout, ranging in length from 52 mm to 128 mm, were captured during the 2021 sampling program at all sites combined (Table 9, Table 10). CPUE ranged from 0.0 fish per 100 trap hours at ALE-MT01 to 6.8 fish per 100 trap hours in ALE-MT06 (Table 9). The average CPUE was 1.9 fish per 100 trap hours (± 2.1 Standard Deviation (SD)) (Table 9). Summary statistics of fish length, weight, and condition factor are presented for each age class in Table 10. Discrete fork length ranges were defined for each age class (Table 11), based on a review of the length-frequency histogram (Figure 14) and aging data from scale analysis (Figure 15).

Cutthroat Trout Fry (0+)

Two Cutthroat Trout fry (0+) were captured in 2021 at ALE-MT06 (unenhanced) (Table 9).

Cutthroat Trout Parr (1+)

Cutthroat Trout parr (1+) were distributed throughout Alena Creek and were captured at all sites except for ALE-MT01 (enhanced) and ALE-MT08 (unenhanced) (Table 9). A total of 18 Cutthroat Trout 1+ parr were captured, with the largest number of fish captured in ALE-MT06 (unenhanced).

Cutthroat Trout Parr (2+)

Eight Cutthroat Trout 2+ parr were captured in 2021. Fish were captured in ALE-MT06 (7) and ALE-MT08 (1) (Table 9).

Cutthroat Trout Adults (≥3+)

No adult Cutthroat Trout were captured in 2021 (Table 9).

Table 9. Catch and CPUE for Cutthroat Trout captured by minnow trapping in Alena Creek on September 27, 2021.

Site	Enhancement Status	# of Traps	Total Soak Time (hrs)	Total CT Catch (# of Fish) [1]	CPUE (# of Fish/100 Trap hrs) [1]	CT Catch (# of Fish)[2]				
						0+	1+	2+	3+	All
ALE-MT01	Enhanced	5	112.6	0	0.0	0	0	0	0	**0**
ALE-MT02	Enhanced	5	115.7	1	0.9	0	1	0	0	**1**
ALE-MT07	Enhanced	5	119.1	1	0.8	0	1	0	0	**1**
ALE-MT03	Unenhanced	5	121.6	3	2.5	0	3	0	0	**3**
ALE-MT08	Unenhanced	5	130.3	1	0.8	0	0	1	0	**1**
ALE-MT09	Enhanced	5	134.4	2	1.5	0	2	0	0	**2**
ALE-MT05	Enhanced	5	136.2	3	2.2	0	3	0	0	**3**
ALE-MT06	Unenhanced	10	248.4	17	6.8	2	8	7	0	**17**
Total:		**45**	**1118.4**	**28**	**15.5**	**2**	**18**	**8**	**0**	**28**
Average:		**5.6**	**139.8**	**3.5**	**1.9**	**0**	**2**	**1**	**0**	**4**
Standard Deviation:				**5.6**	**2.1**	**1**	**3**	**2**	**0**	**6**

[1] Includes all captured fish in the minnow traps

[2] CT = Cutthroat Trout. Only includes fish measured for fork length and assigned an age

Table 10. Summary of fork length, weight, and condition for juvenile Cutthroat Trout captured in Alena Creek in 2021.

Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	52	2	52	50	1	1.70	1.70	1.70	1	1.14	1.14	1.14
Parr (1+)	101	18	101	56	17	12.26	2.40	20.70	17	1.06	0.91	1.37
Parr (2+)	134	8	134	128	8	23.95	20.60	29.20	8	0.99	0.94	1.07
Adult (≥3+)	0	-	-	-	0	-	-	-	0	-	-	-
All	**287**	**9**	**52**	**128**	**26**	**12.64**	**1.70**	**29.20**	**26**	**1.06**	**0.91**	**1.37**

Table 11. Size bins by age class for juvenile Cutthroat Trout captured in Alena Creek in 2021.

Age Class	Fork Length Range (mm)
Fry (0+)	0-53
Parr (1+)	73-126
Parr (2+)	≤ 130

Figure 14. Fork length frequency for juvenile Cutthroat Trout captured (by minnow trapping) in Alena Creek in 2021.

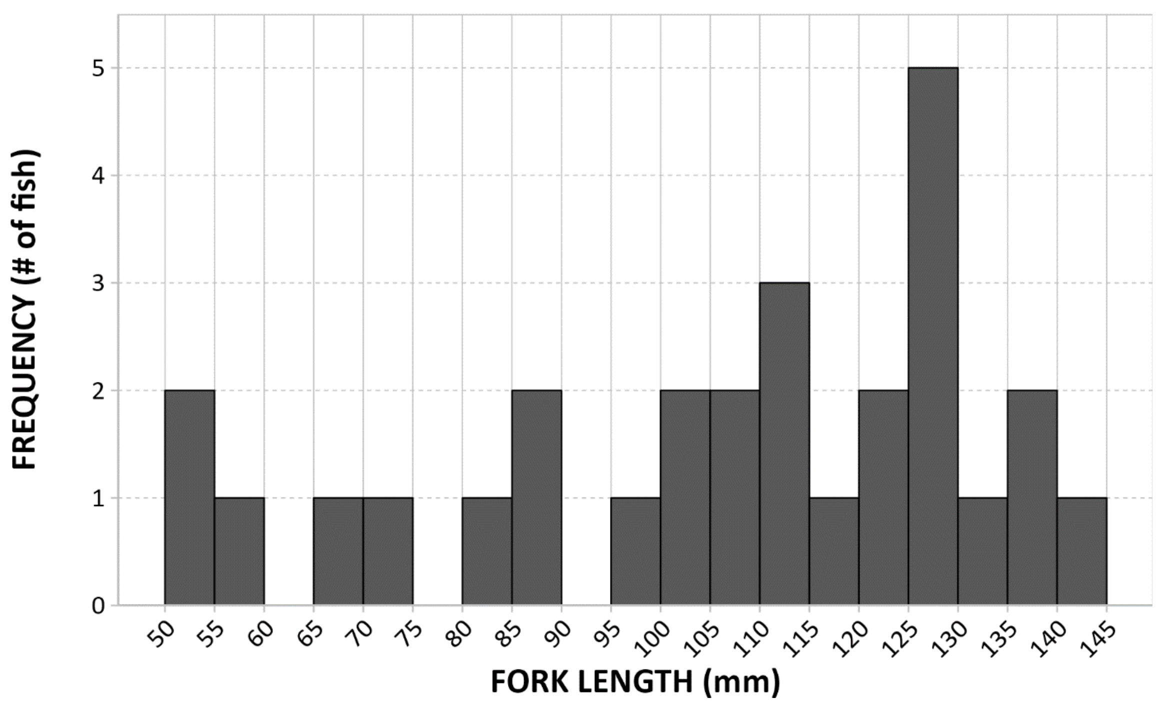
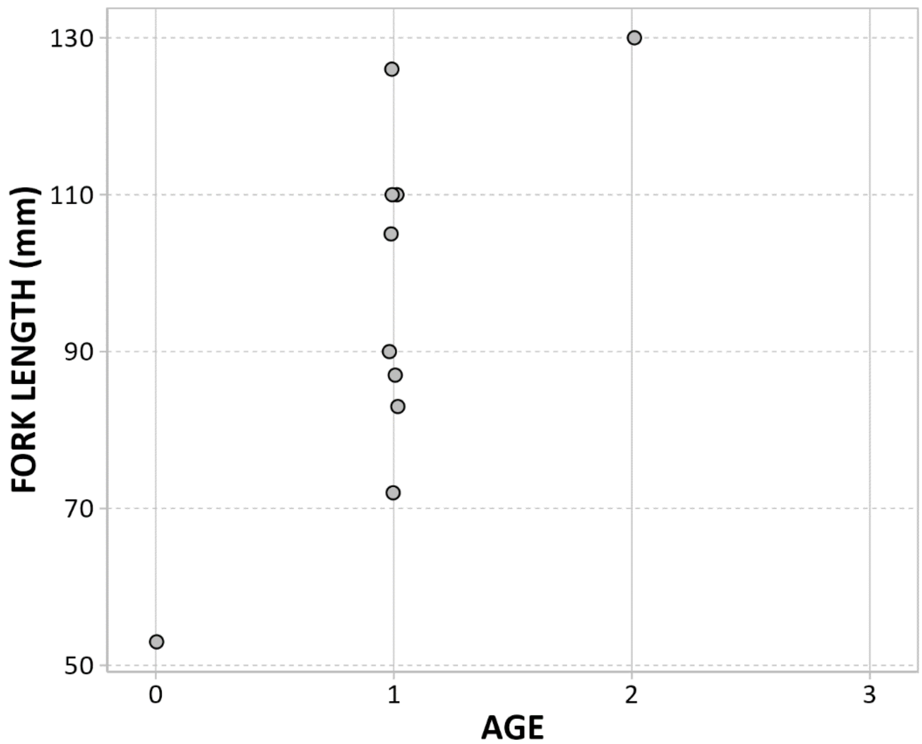


Figure 15. Fork length by age for juvenile Cutthroat Trout captured in Alena Creek in 2021.



4.2.2.3. Coho Salmon

A total of 1,017 juvenile Coho Salmon were captured during minnow trap sampling in Alena Creek on September 27, 2021 (Table 12). CPUE ranged from 25.7 fish per 100 trap hours at ALE-MT01 (enhanced) to 155.4 fish per 100 trap hours in ALE-MT06 (unenhanced) (Table 12). The total average CPUE was 127.1 fish per 100 trap hours (± 115.3 SD) (Table 12). Summary statistics of fish length, weight, and condition factor are presented for each age class in Table 13. Discrete fork length ranges were defined for each age class (Table 13), based on a review of the length-frequency histogram (Figure 16) and aging data from scale analysis (Figure 17).

Coho Salmon Fry (0+)

Coho Salmon fry (0+) were captured at all sampling sites in 2021 and are distributed throughout the sampled reaches of Alena Creek (Table 12). Due to the large volume of Coho Salmon juveniles captured, not all fish were measured for fork length, and therefore not all Coho Salmon could be assigned an age class. Based on total captures, 0+ fry was likely most abundant at ALE-MT03 (unenhanced), ALE-MT06 (unenhanced), and ALE-MT07 (enhanced) (Reach 4).

Coho Salmon Parr (1+)

Coho Salmon 1+ parr were captured at all sites in 2021 (Table 12). Based on total captures, 1+ parr were likely most abundant at ALE-MT03 and ALE-MT06 in the unenhanced reach (Reach 2). The high proportion of 1+ parr could be due to size range selectively, where larger fish access the trap faster and have more difficulty escaping. This has been documented for Coho Salmon juveniles in previous studies (Bloom 1976).

Table 12. Catch and CPUE for Coho Salmon captured in Alena Creek on September 27, 2021.

Site	Enhancement Status	# of Traps	Total Soak Time (hrs)	Total CO Catch (# of Fish)[1]	CPUE (# of Fish/100 Trap hrs)[1]	CO Catch (# of Fish)[2]				
						0+	1+	2+	3+	All
ALE-MT01	Enhanced	5	112.6	29	25.7	8	21	0	0	**29**
ALE-MT02	Enhanced	5	115.7	50	43.2	29	21	0	0	**50**
ALE-MT07	Enhanced	5	119.1	60	50.4	45	15	0	0	**60**
ALE-MT03	Unenhanced	5	121.6	94	77.3	56	38	0	0	**94**
ALE-MT08	Unenhanced	5	130.3	106	81.4	17	11	0	0	**28**
ALE-MT09	Enhanced	5	134.4	103	76.6	16	10	0	0	**26**
ALE-MT05	Enhanced	5	136.2	189	138.8	13	20	0	0	**33**
ALE-MT06	Unenhanced	10	248.4	386	155.4	68	43	0	0	**111**
Total:		**45.0**	**1,118.4**	**1017.0**	**648.8**	**252**	**179**	**0**	**0**	**431**
Average:			**139.8**	**127.1**	**81.1**	**32**	**22**	**0**	**0**	**54**
Standard Deviation:				**115.3**	**45.2**	**22**	**12**	**0**	**0**	**33**

[1] Includes all captured fish in the minnow traps

[2] CO = Coho Salmon. Only includes fish measured for fork length and assigned an age.

Table 13. Summary of fork length, weight, and condition for Coho Salmon captured in Alena Creek in 2021.

Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	252	56	38	74	169	2.43	0.08	5.70	169	1.25	0.09	1.97
Parr (1+)	179	82	75	99	123	6.19	3.70	10.10	123	1.11	0.78	1.37
All	**431**	**69**	**38**	**99**	**292**	**4.31**	**0.08**	**10.10**	**292**	**1.18**	**0.09**	**1.97**

Table 14. Size bins by age class for Coho Salmon captured in Alena Creek in 2021.

Age Class	Fork Length Range (mm)
Fry (0+)	46-74
Parr (1+)	75-99

Figure 16. Fork length frequency for juvenile Coho Salmon captured (minnow trapping) in Alena Creek in 2021.

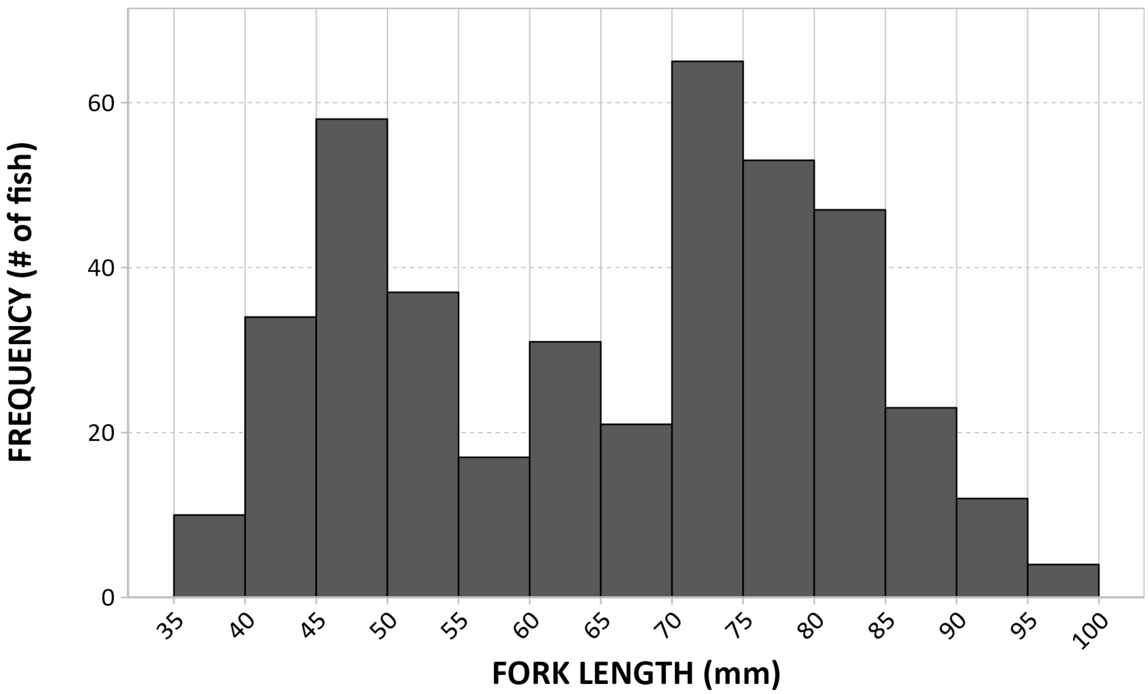
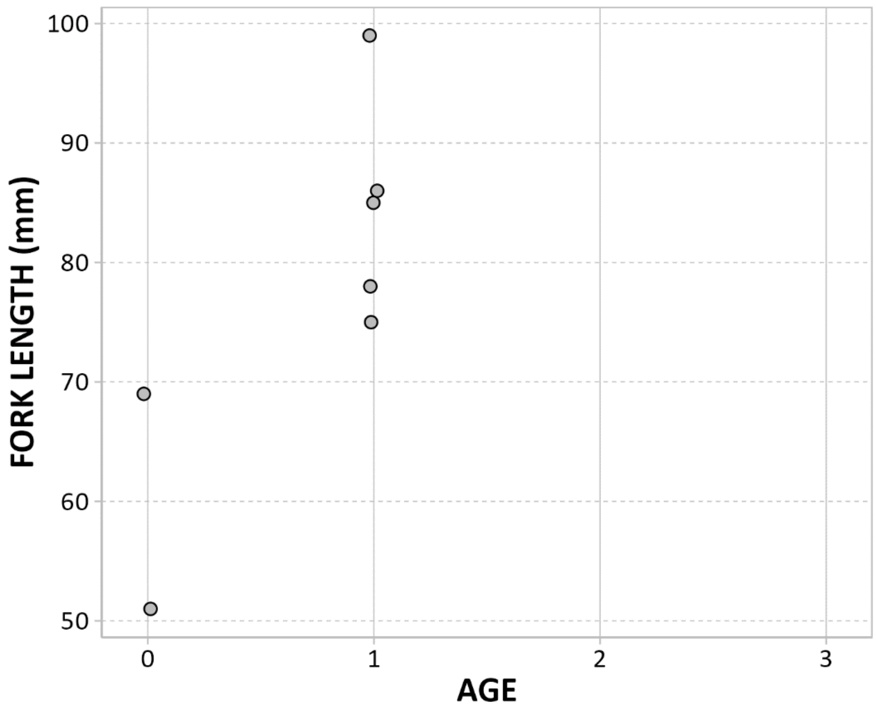


Figure 17. Fork length by age for Coho Salmon captured in Alena Creek in 2021.



4.2.2.4. Bull Trout

A total of three Bull Trout, ranging in length from 120 mm to 196 mm, were captured during the 2021 sampling program at all sites combined (Table 15, Table 10). CPUE ranged from 0.0 fish per 100 trap hours at ALE-MT02, ALE-MT03, ALE-MT05, ALE-MT06, ALE-MT08, AND ALE-MT09 to 1.8 fish per 100 trap hours in ALE-MT01 (Table 9). The average CPUE was 0.3 fish per 100 trap hours (± 0.7 Standard Deviation (SD)) (Table 9). Summary statistics of fish length, weight, and condition factor are presented for each age class in Table 16. Discrete fork length ranges were defined for each age class (Table 17), based on a review of the length-frequency histogram (7) and aging data from scale analysis (Figure 15).

Bull Trout Fry (0+)

No Bull Trout fry (0+) were captured in 2021 (Table 15).

Bull Trout Parr (1+)

Two Bull Trout parr (1+) were captured in 2021. One individual was captured at ALE-MT01 and one at ALE-MT07 (Table 15).

Bull Trout Parr (2+)

One Bull Trout parr (1+) was captured in 2021 at ALE-MT01 (Table 15).

Bull Trout Adults (≥3+)

No adult Bull Trout were captured in 2021 (Table 9).

Table 15. Catch and CPUE for Bull Trout captured in Alena Creek on September 27, 2021.

Site	Enhancement Status	# of Traps	Total Soak Time (hrs)	Total BT Catch (# of Fish) [1]	CPUE (# of Fish/100 Trap hrs) [1]	BT Catch 0+	1+	2+	3+	All
ALE-MT01	Enhanced	5	112.6	2	1.8	0	1	1	0	2
ALE-MT02	Enhanced	5	115.7	0	0.0	0	0	0	0	0
ALE-MT07	Enhanced	5	119.1	1	1.0	0	1	0	0	1
ALE-MT03	Unenhanced	5	121.6	0	0.0	0	0	0	0	0
ALE-MT08	Unenhanced	5	130.3	0	0.0	0	0	0	0	0
ALE-MT09	Enhanced	5	134.4	0	0.0	0	0	0	0	0
ALE-MT05	Enhanced	5	136.2	0	0.0	0	0	0	0	0
ALE-MT06	Unenhanced	10	248.4	0	0.0	0	0	0	0	0
Total:		**45.0**	**1,118.4**	**3.0**	**2.8**	**0**	**2**	**1**	**0**	**3**
Average:			**139.8**	**0.4**	**0.3**	**0**	**0**	**0**	**0**	**0**
Standard Deviation:				**0.7**	**0.7**	**0**	**0**	**0**	**0**	**1**

[1] Includes all captured fish in the minnow traps

[2] BT = Bull Trout. Only includes fish measured for fork length and assigned an age.

Table 16. Summary of fork length, weight, and condition for Bull Trout captured in Alena Creek in 2021.

Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	0	-	-	-	0	-	-	-	0	-	-	-
Parr (1+)	2	129	120	138	2	18.1	16.8	19.4	2	0.86	0.74	0.97
Parr (2+)	1	196	196	196	1	67.6	67.6	67.6	1	0.90	0.90	0.90
Adult (≥3+)	0	-	-	-	0	-	-	-	0	-	-	-
All	**3**	**163**	**120**	**196**	**3**	**42.85**	**16.80**	**67.60**	**3**	**0.88**	**0.74**	**0.97**

Table 17. Size bins by age class for Bull Trout captured in Alena Creek in 2021.

Age Class	Fork Length Range (mm)
Fry (0+)	N/A
Parr (1+)	120-138
Parr (2+)	≤ 139

ECOFISH RESEARCH

Figure 18. Fork length frequency for juvenile Bull Trout captured (minnow trapping) in Alena Creek in 2021.

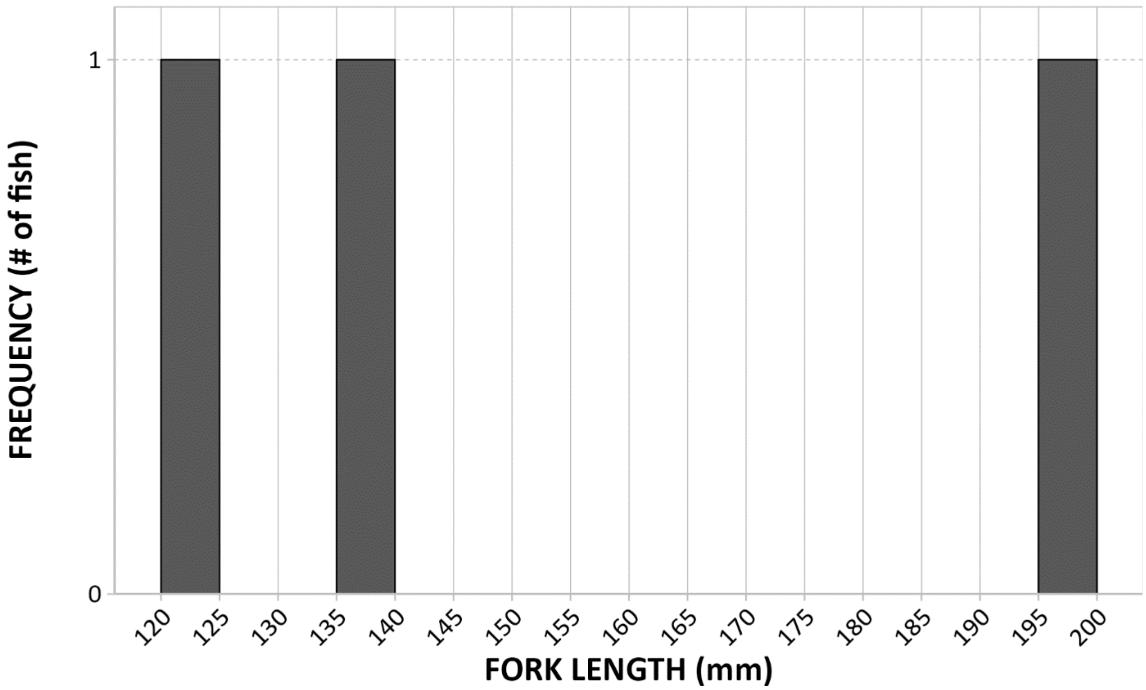
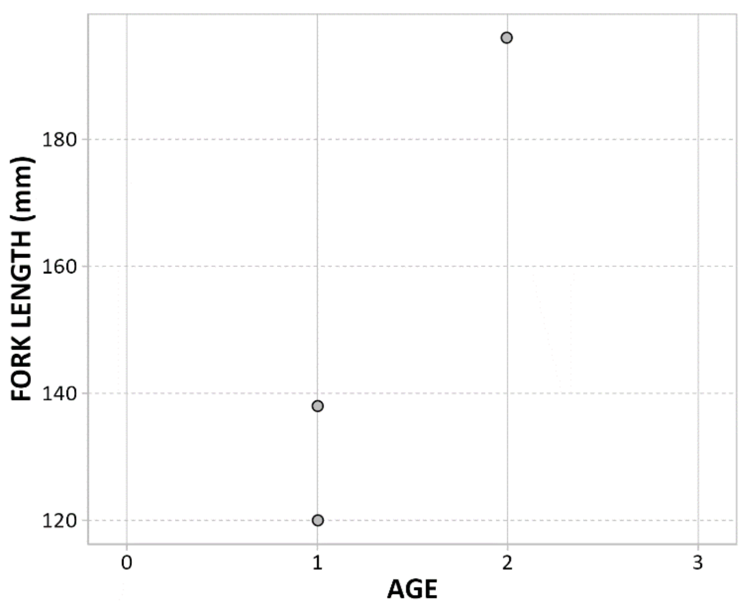


Figure 19. Fork length by age for Bull Trout captured in Alena Creek in 2021.



4.2.2.5. Comparison Among Years

Cutthroat Trout

The average Cutthroat Trout CPUE in 2021 (1.9 fish per 100 trap hours) was similar to that in previous sampling years excluding 2014 and 2020 (Figure 24), when average CPUE was 4.1 and 7.2 fish per 100 trap hours, respectively. The 2014 CPUE results are, however, biased high because the minnow traps were left only during the daytime in this year at some sites (due to bear activity) and soak times were therefore shorter than in other years (Harwood *et al.* 2016). Given that catchability is not likely constant throughout the trap soak time, and that there is likely a high initial catch rate that diminishes over time (Harwood *et al.* 2016), a shorter soak time would result in an apparent higher CPUE. Between 2018 and 2021 there were more sites sampled than in previous years (eight sites versus six sites), although this should not affect comparability of CPUE among years since it is a standardized metric.

A comparison of CPUE by sampling site and year suggests Cutthroat Trout were relatively evenly distributed in relatively low abundances throughout Alena Creek in 2021 (Figure 21). In 2021, CPUE ranged from 0 to 2.5 fish per 100 trap hours across sites excluding ALE-MT06 (unenhanced), where CPUE was more than two times higher than all other sites (6.8 fish per 100 trap hours). The distribution of CPUE across sites was similar in 2021 to previous years, except in 2014 and 2020 when higher CPUE was recorded.

The capture of Cutthroat Trout in the enhanced sites in 2021 (average CPUE 1.1 Cutthroat/100 trap hours) provides evidence of use and suggests that habitat in the enhanced sites is high quality. Higher CPUE in unenhanced verse unenhanced sites (average CPUE 3.4 Cutthroat/100 trap hours) could be due to the presence of proportionally more pool type habitat in unenhanced compared to enhanced sites.

Figure 20. Comparison of minnow trap CPUE for Cutthroat Trout during baseline (2013 and 2014) and post-construction (2017-2021) sampling. Error bars represent standard error. Note that in 2014 trap soak times were shorter than in other years; thus, CPUE is biased high relative to other years.

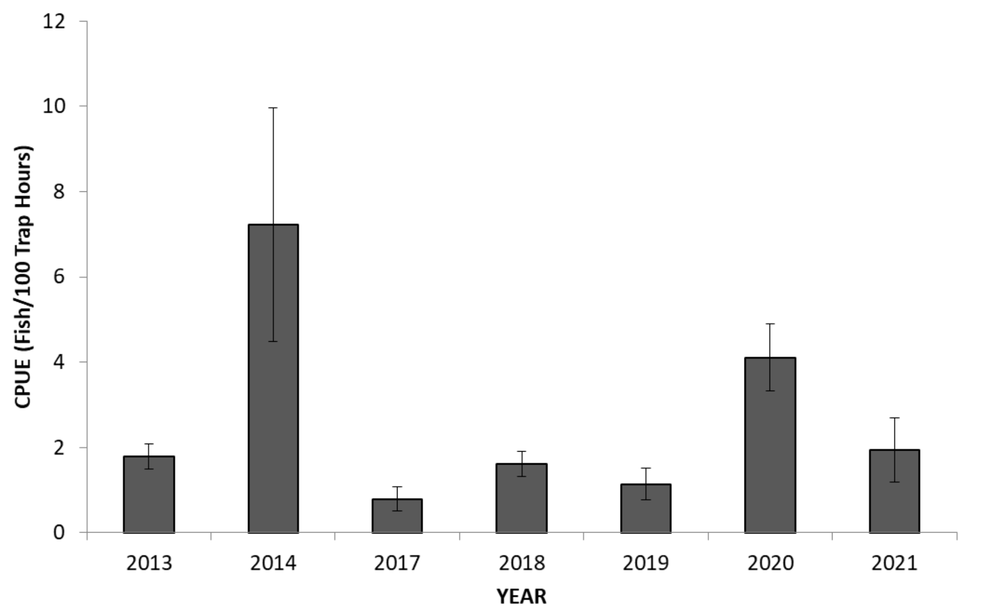
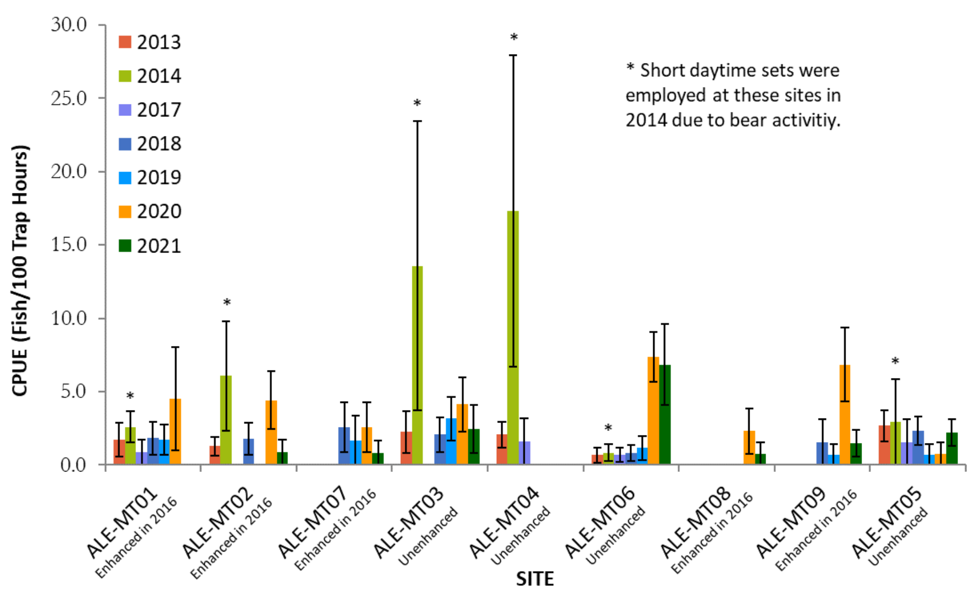


Figure 21. Comparison of minnow trap CPUE for Cutthroat Trout at each site during baseline (2013 and 2014) and post-construction (2017-2021) sampling. Error bars represent standard error. Note that in 2014 trap soak times were shorter than in other years; thus, CPUE is biased high relative to other years.



Coho Salmon

The average Coho Salmon CPUE in 2021 was 81.1 fish per 100 trap hours, which is the second highest recorded across monitoring years (Figure 22). CPUE in 2021 was similar to that in 2020 and 2018 and higher than in baseline years. It is important to note that 2014 CPUE results are biased high by the short daytime sets (as described for Cutthroat Trout above). It should be noted, that CPUE of Coho Salmon is around 80 fish per hour for multiple years, suggesting this may be near trap capacity.

In 2021, Coho Salmon fry and parr were captured at all sites. CPUE of Coho Salmon at individual sites in 2021 was generally similar to that in more than one previous year of sampling, with the exception of ALE-MT02 (enhanced), where CPUE was notably higher in 2021 than in all previous years except 2018 (Figure 23).

The capture of Coho in the enhanced sites in 2021 (average CPUE 66.9 Coho/100 trap hours) provides evidence of use and suggests that habitat in the enhanced sites is high quality. Higher CPUE in unenhanced verse enhanced sites (average CPUE 104.7 Coho/100 trap hours) could be due to the presence of proportionally more pool type habitat in unenhanced compared to enhanced sites.

Figure 22. Comparison of minnow trap CPUE for Coho Salmon during baseline (2013 and 2014) and post-construction (2017-2021) sampling. Error bars represent standard error. Note that in 2014 trap soak times were shorter than in other years; thus, CPUE is biased high relative to other years.

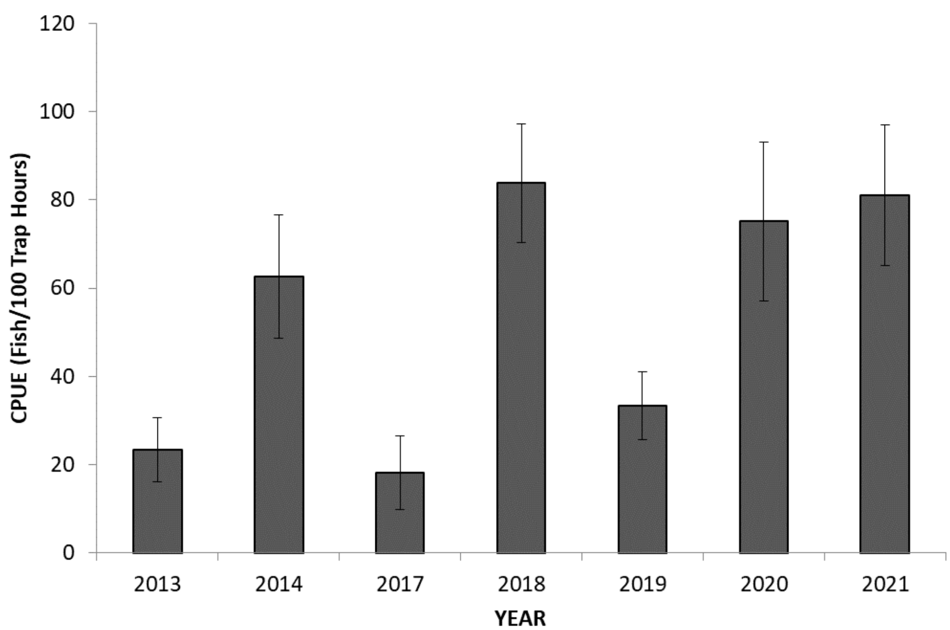
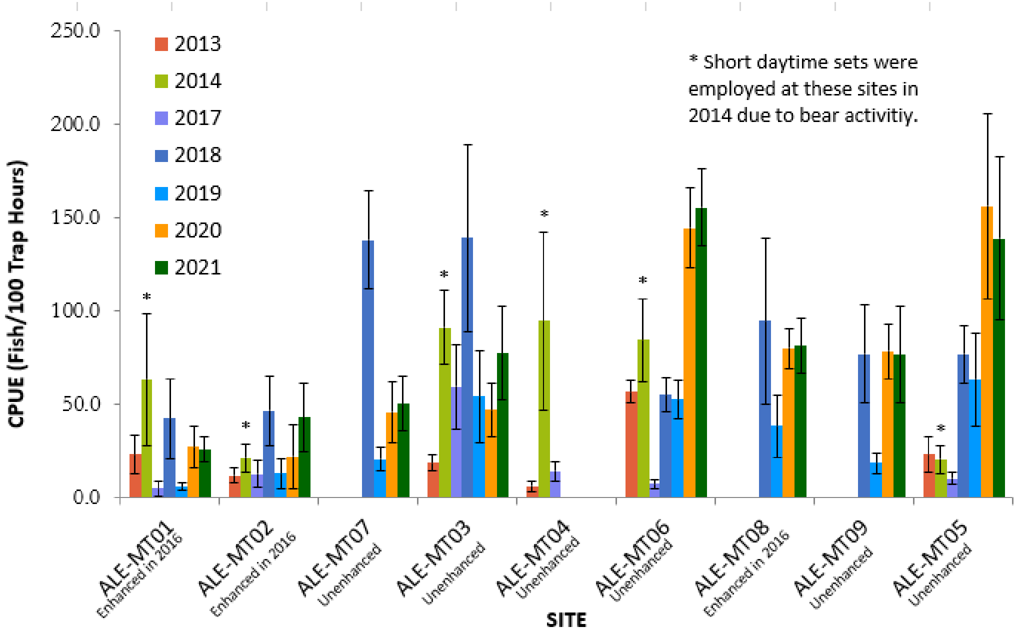


Figure 23. Comparison of minnow trap CPUE for Coho Salmon at each site during baseline (2013 and 2014) and post-construction (2017-2021) sampling. Error bars represent standard error. Note that in 2014 trap soak times were shorter than in other years; thus, CPUE is biased high relative to other years



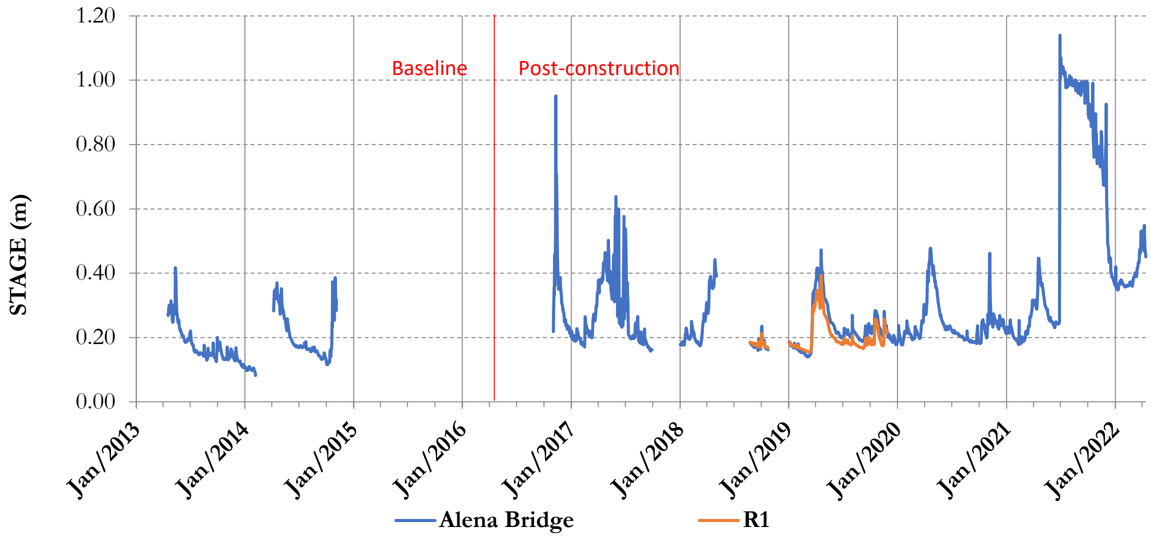
4.3. Hydrology

Seasonal trends in the Alena Creek hydrograph in the winter and spring of 2021 were consistent with a coastal, snow-dominated watershed. Stage levels remained low in the winter until the beginning of snowmelt early March, reaching peak values on April 18.

On June 28, steady high temperatures in the region increased discharge in the Lillooet River to extreme levels for the summer, inducing an upstream shift in the confluence between a secondary channel of Lillooet River and Alena Creek. The secondary channel also increased in size, causing backwatering from the Lillooet River into Alena Creek. This caused a rise in the recorded stage, from 0.25 m to 1.24 m, along with greater amplitude of daily variation (from < 0.04 m to < 0.2 m, Figure 24). Stage remained very high and under the influence of the Lillooet River for the rest of the summer.

A precipitation event shifted hydrological controls again on December 1, 2021, decreasing base stage level from 0.66 m prior to the event to 0.36 m post event. This event likely disconnected Alena Creek from backwatering by the Lillooet, as indicated by a return to smaller daily oscillations, but low flow stage levels remain higher than in previous years, indicating a shift in creek morphology and making the comparison with previous levels difficult without redefining the stage offset from a local benchmark.

Figure 24. Stage in Alena Creek at the Lillooet River FSR bridge during baseline (April 2013 to November 2014), and post-construction monitoring (November 2016 to March 2022).



4.4. Water Temperature

4.4.1. Spatiotemporal Variability

The current post-construction period of record is from November 23, 2016 to September 27, 2021 (Table 1, Map 2). Monitoring in Years 1–5 (2017– 2021) complete nearly five full years of post-construction water temperature data collection at the upstream (control; ALE-USWQ1) and downstream (impact; ALE-BDGWQ) sites. Data availability is based on the most recent date when data were downloaded from water temperature loggers.

Daily average, maximum, and minimum water temperature at ALE-USWQ1 and ALE-BDGWQ are shown in Figure 25. Pre-construction minimum and maximum instantaneous temperatures ranged from 2.8°C (December 2014) to 10.0°C (July and August 2014) at the upstream site and 0.0°C (February 2014) to 14.0°C (July 2014) at the downstream site (Figure 25). Post-construction (December 2016 to September 2021), instantaneous minimum and maximum temperatures ranged from 0.8°C (February 2017) to 11.8°C (August 2019) at the upstream site and 0.0°C (January 2019 and 2020) to 14.5°C (August 2019) at the downstream site (Figure 25). In 2021, instantaneous temperatures at the upstream (2.8°C to 10.2°C) and downstream sites (0.1°C to 14.2°C) were within the post-construction ranges.

In general, seasonal variability in water temperature upstream (ALE-USWQ1) was less variable than observed downstream (ALE-BDGWQ) (Figure 25). The seasonal pattern of differences in water temperature between the two sites is largely the same pre- and post-construction, as evident from comparison of the cumulative frequency distributions between the sites, which show similar differences in temperature between the two sites during the two periods (Figure 26). Despite the small difference in elevation (11 m) and short distance (~1 km) between the sites, the downstream site has generally been warmer than the upstream site in the summer and cooler in the winter (Figure 25). These differences are considered to be at least partly due to the temperature-regulating influence of groundwater at the upstream site, and to the influence of a tributary that enters Alena Creek between the two sites, which may account for some of the cooler temperatures downstream in the winter and warmer temperatures downstream in the summer (Figure 25, Figure 26, Map 2). The daily average temperatures recorded at both sites were higher post-construction (November 2016 to September 2021) than pre-construction (April 2013 to December 2014) in the warmer months and the increase is more pronounced at the downstream site.

Water temperature site photos, annual water temperature figures, and BC WQG for water temperature are presented in Appendix B.

Figure 25. Daily average (a), maximum (b), and minimum (c) temperature in Alena Creek pre-construction (April 17, 2013 to December 30, 2014) and post-construction (November 23, 2016 to September 27, 2021) recorded at the upstream control (ALE-USWQ1) and downstream impact (ALE-BDGWQ) sites.

a) Daily Average

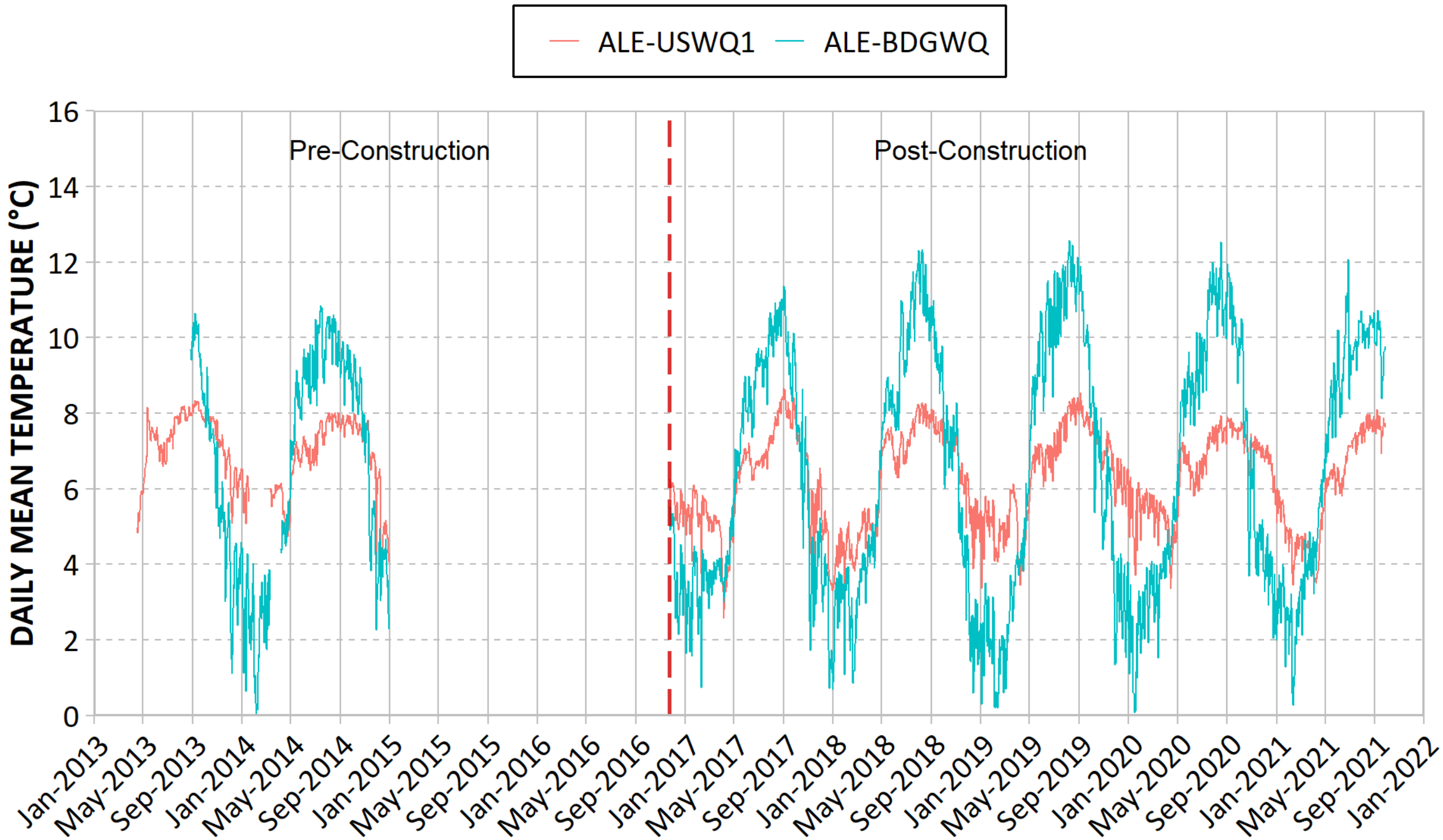


Figure 25. Continued (2 of 3).

b) Daily Maximum

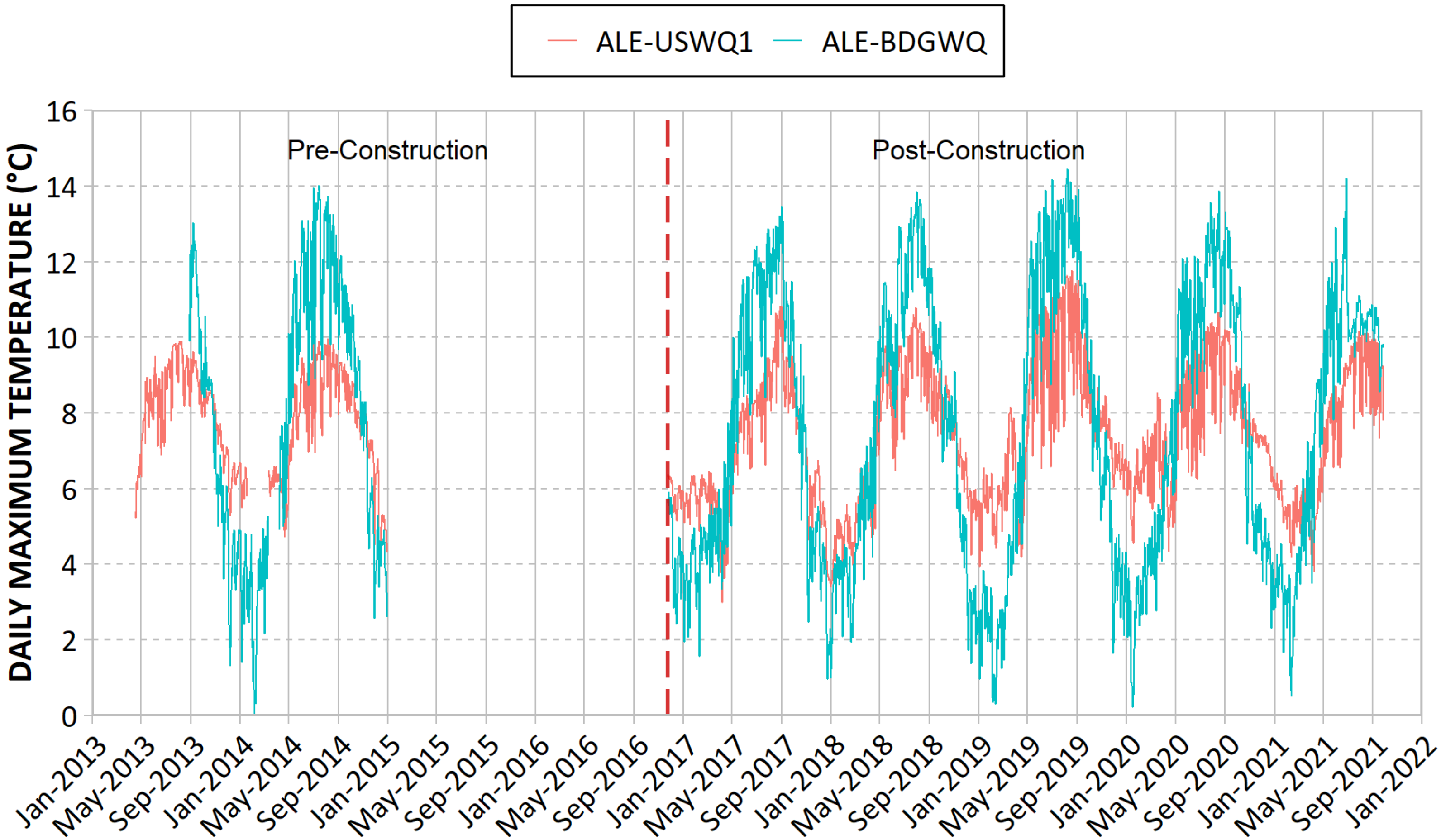


Figure 25. Continued (3 of 3).

c) Daily Minimum

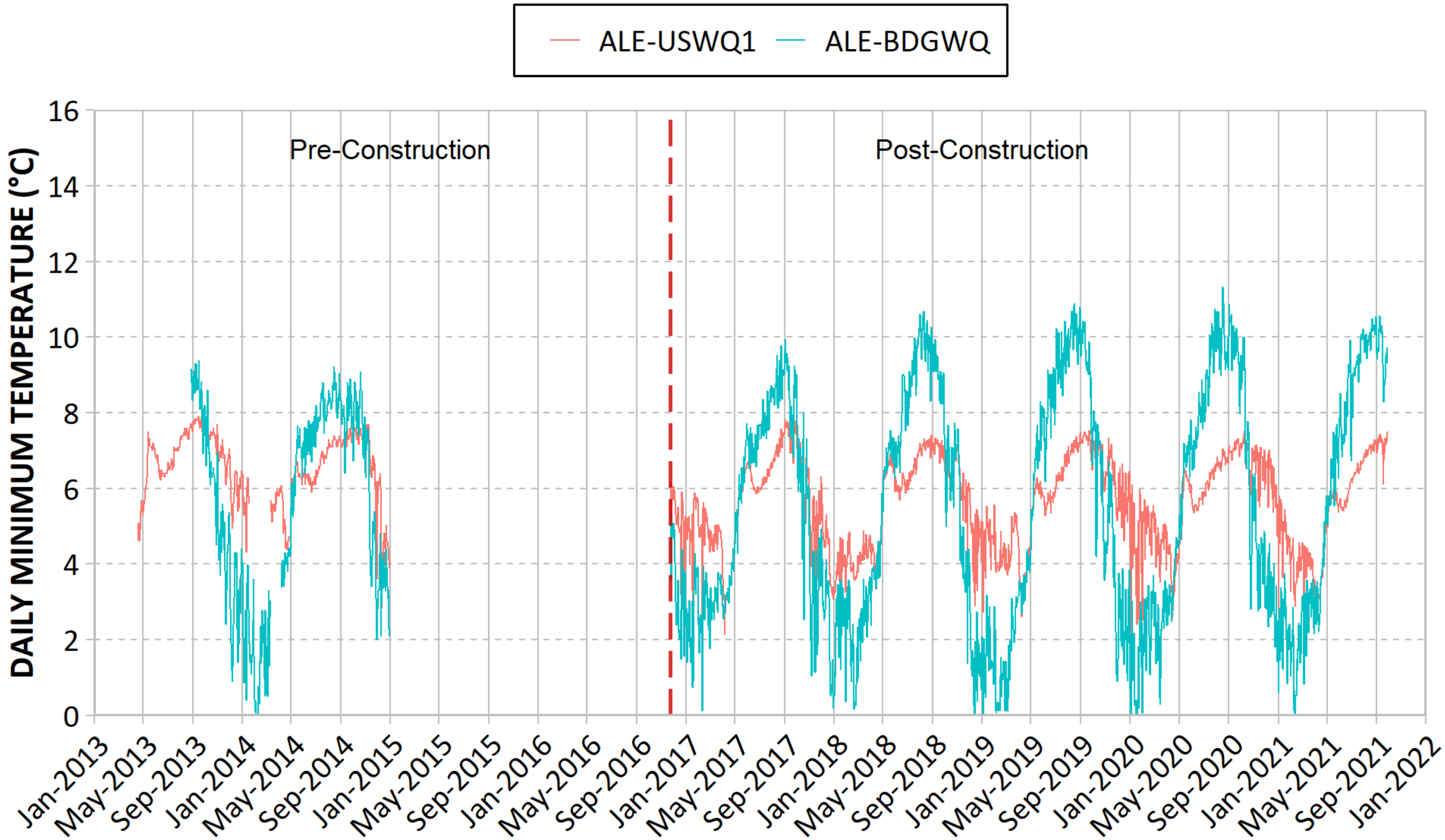
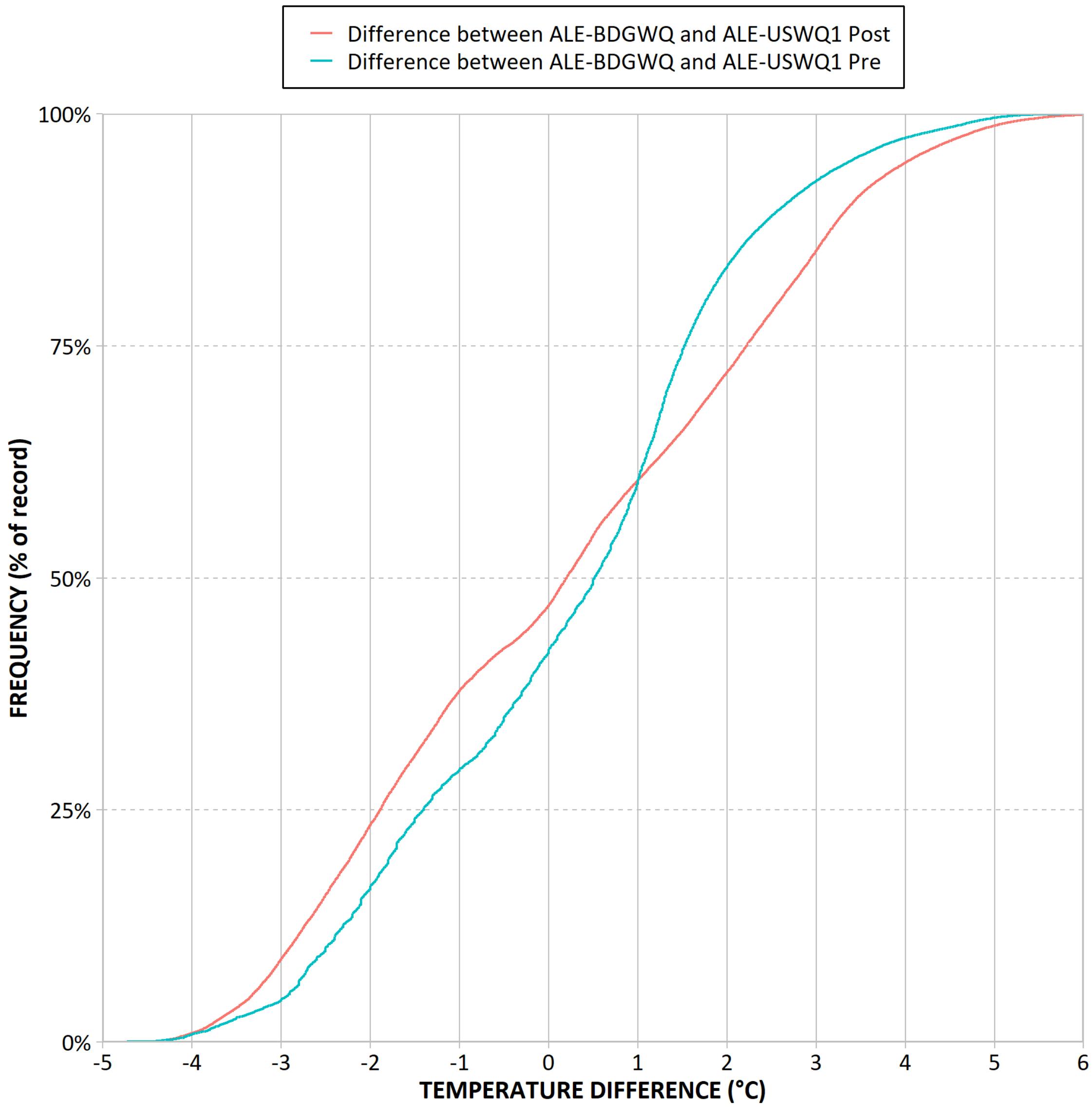


Figure 26. **Cumulative frequency distribution of differences in pre-construction (April 2013 to December 2014) and post-construction (November 2016 to September 2021) instantaneous water temperature between the downstream site (ALE-BDGWQ) and the upstream site (ALE USWQ1) (positive values indicate warmer temperatures at ALE-BDGWQ).**



4.4.2. Mean Weekly Maximum Temperatures (MWMxT)

4.4.2.1. Overview

MWMxT temperature data collected at the upstream site and the downstream site were compared to optimum temperature ranges for Coho Salmon (Table 18, Table 19), Cutthroat Trout (Table 20, Table 21), and Bull Trout (Table 22, Table 23) using pre- and post-construction data.

Each of the tables provides the percent complete of the data record for each life stage, along with the minimum and maximum optimum MWMxT in each period. The percentage of data within each optimum temperature range is provided to evaluate the overall suitability of the observed temperatures for each fish species life stage. Data outside of the BC WQG range (greater than ±1°C outside the optimum ranges) are highlighted in each summary table (blue indicates MWMxTs are cooler than the lower guideline and red indicates temperatures are higher than the upper guidelines). The year-round range in MWMxT temperature corresponds to the rearing life stage for all the fish species. In 2021, MWMxT values were within the range observed in previous post-construction monitoring years.

At the upstream site, post-construction, MWMxT ranged from 3.5°C to 11.5°C, while pre-construction MWMxTs ranged from 4.4°C to 9.9°C (Table 18, Table 20, Table 22). During February 2014 data were not included due to icing concerns, therefore the minimum MWMxT value may not be representative of the pre-construction period. The highest MWMxT value of 11.5°C was recorded in 2019.

At the downstream site, post-construction, MWMxT ranged from 0.6°C to 14.0°C, while pre-construction MWMxTs ranged from 1.7°C to 13.7°C. The lowest value at the downstream site was recorded in 2018, 2019, and 2020, whereas the highest MWMxT was recorded in 2019 (0.6°C to 14.0°C) (Table 19, Table 21, Table 23).

The correspondence of MWMxT values to species-specific optimal temperature ranges differed by species and location. Bull Trout prefer cooler temperatures overall in comparison to Cutthroat Trout and Coho Salmon (Table 3), therefore fewer values below the cooler temperature limits were observed for this species. In general, values below the cooler temperature limits were more prevalent at the downstream site (ALE-BDGWQ). The upstream location (ALE-USWQ) was warmer during the winter months, likely due to the influence of groundwater at this location. General trends for each species are discussed below.

4.4.2.2. Coho Salmon

During pre- and post-construction periods, at the upstream site, MWMxT values for Coho Salmon were largely within optimal temperature ranges during spawning and incubation but were sub-optimally cool on occasion during migration and rearing (blue shading in Table 18). During pre- and post-construction periods at the downstream site, values >1°C below the lower bounds of the optimum ranges (blue shading) were observed during all life stages, while no exceedances of the upper temperature limits were observed (Table 19).

4.4.2.3. Cutthroat Trout

During pre- and post-construction periods, at the upstream site, MWMxT values for Cutthroat Trout were sub-optimally cool on occasion during spawning, incubation, and rearing (blue shading in Table 20). During pre- and post-construction periods at the downstream site, values >1°C below the lower bounds of the optimum ranges were observed during all life stages; however, sub-optimally cool water temperatures were generally observed less frequently during incubation than for other life stages and occasional exceedances of the higher temperature limits (red shading) were observed during incubation and spawning (post-construction only; Table 21). MWMxT values were generally within the optimum range for Cutthroat Trout rearing for the majority of each year, including 54% (upstream site) and 62% (downstream site) of the time in 2021.

4.4.2.4. Bull Trout

During pre- and post-construction periods, at the upstream site, MWMxT values were largely within optimal ranges with exceedances of the upper limit during incubation and occasionally during spawning (post-construction only). Occasionally, values >1°C below the lower bounds of the optimum ranges were observed during rearing (Table 22). During pre- and post-construction periods at the downstream site, values >1°C below the lower bounds of the optimum ranges were observed during all life stages; however, this was observed less frequently during incubation (none during pre-construction) and exceedances of the higher temperature limits (red shading) were observed during incubation and spawning (Table 23).

The occurrence of warmer surface waters during Bull Trout incubation at the upstream site may be partially mitigated by groundwater upwelling, which would result in lower temperature within potential redds during the warmer months at the start of the incubation period (Table 22).

Warmer MWMxTs occurred in 2019 than in previous years; however, in 2021 MWMxT data available to date were within the post-construction range. Evaluation of any increased heating or cooling attributable to the FHEP will be completed following final data collection. Overall, no substantial change in the ranges of MWMxTs were observed between pre- and post-construction phases recognizing that there were data gaps during the cooler months in the pre-construction dataset.

Table 18. Coho Salmon periodicity and life stage MWMxT ranges during pre-construction (April 2013 to December 2014) and post-construction (November 2016 to September 2021) water temperature monitoring in Alena Creek at ALE-USWQ1.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon (ALE-USWQ1)	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2013	100.0	5.6	9.4	6.6	63.1	0.0
			122	2014	95.1	4.4	9.3	21.6	62.9	0.0
			122	2016	28.7	-	-	-	-	-
			122	2017	100.0	3.5	10.5	43.4	44.3	0.0
			122	2018	100.0	5.3	9.3	23.8	55.7	0.0
			122	2019	100.0	6.4	10.4	0.0	68.0	0.0
			122	2020	100.0	6.1	10.1	1.6	82.8	0.0
			122	2021	19.7	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2013	100.0	5.6	8.5	0.0	100.0	0.0
			79	2014	91.1	4.4	7.9	0.0	98.6	0.0
			79	2016	45.6	-	-	-	-	-
			79	2017	100.0	3.5	7.8	0.0	84.8	0.0
			79	2018	100.0	5.2	8.6	0.0	100.0	0.0
			79	2019	100.0	6.4	8.2	0.0	100.0	0.0
			79	2020	100.0	6.1	8.0	0.0	100.0	0.0
			79	2021	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2013	67.5	5.6	8.5	0.0	100.0	0.0
			169	2014	42.6	-	-	-	-	-
			169	2016	74.6	4.6	6.3	0.0	100.0	0.0
			169	2017	100.0	3.5	7.8	0.0	91.1	0.0
			169	2018	99.4	4.8	8.6	0.0	100.0	0.0
			170	2019	100.0	4.9	8.2	0.0	100.0	0.0
			169	2020	100.0	4.6	8.0	0.0	100.0	0.0
			169	2021	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2013	70.1	5.6	9.9	35.9	23.4	0.0
			365	2014	83.0	4.4	9.7	53.5	18.5	0.0
			366	2016	9.6	-	-	-	-	-
			365	2017	99.7	3.5	10.6	70.3	11.0	0.0
			365	2018	100.0	3.5	10.5	56.7	20.8	0.0
			365	2019	99.7	4.7	11.5	54.4	27.7	0.0
			366	2020	100.0	4.9	10.3	59.6	16.1	0.0
			365	2021	73.2	4.3	9.9	58.4	26.2	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 19. Coho Salmon periodicity and life stage MWMxT ranges during pre-construction (August 2013 to December 2014) and post-construction (November 2016 to September 2021) water temperature monitoring in Alena Creek at ALE BDGWQ.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon (ALE-BDGWQ)	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2013	99.2	2.1	12.5	43.0	49.6	0.0
			122	2014	96.7	3.5	11.7	39.0	59.3	0.0
			122	2016	29.5	-	-	-	-	-
			122	2017	100.0	1.6	12.9	50.0	44.3	0.0
			122	2018	100.0	2.3	11.5	43.4	54.9	0.0
			122	2019	100.0	2.6	12.8	42.6	45.1	0.0
			122	2020	100.0	3.2	12.8	50.0	41.8	0.0
			122	2021	18.9	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2013	98.7	2.1	8.8	9.0	70.5	0.0
			79	2014	93.7	3.5	9.1	0.0	75.7	0.0
			79	2016	46.8	-	-	-	-	-
			79	2017	100.0	1.6	8.1	19.0	45.6	0.0
			79	2018	100.0	2.2	8.1	38.0	59.5	0.0
			79	2019	100.0	2.6	8.1	21.5	51.9	0.0
			79	2020	100.0	3.2	8.4	7.6	77.2	0.0
			79	2021	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2013	83.4	1.7	8.8	15.6	48.9	0.0
			169	2014	43.8	3.5	9.1	0.0	90.5	0.0
			169	2016	75.1	2.8	5.7	1.6	58.3	0.0
			169	2017	100.0	1.6	8.1	14.2	53.3	0.0
			169	2018	100.0	0.6	8.1	50.9	38.5	0.0
			169	2019	100.0	0.6	8.1	15.9	47.6	0.0
			170	2020	100.0	1.2	8.4	15.4	58.0	0.0
			169	2021	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2013	33.7	-	-	-	-	-
			365	2014	89.6	1.7	13.7	44.6	49.8	0.0
			366	2016	9.8	-	-	-	-	-
			365	2017	99.7	1.6	13.1	56.3	37.6	0.0
			365	2018	100.0	1.8	13.4	53.2	41.9	0.0
			365	2019	100.0	0.6	14.0	53.7	43.0	0.0
			366	2020	100.0	0.6	13.0	53.6	43.4	0.0
			365	2021	72.9	1.2	13.2	39.8	53.4	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 20. Cutthroat Trout periodicity and life stage MWMxT ranges during pre-construction (April 2013 to December 2014) and post-construction (November 2016 to September 2021) water temperature monitoring in Alena Creek at ALE-USWQ1.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout (ALE-USWQ1)	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2013	79.3	5.9	8.9	42.5	0.0	0.0
			92	2014	98.9	5.0	9.3	58.2	6.6	0.0
			92	2016	0.0	-	-	-	-	-
			92	2017	98.9	3.5	8.4	87.9	0.0	0.0
			92	2018	100.0	5.3	9.7	44.6	26.1	0.0
			92	2019	100.0	4.7	10.4	35.9	35.9	0.0
			92	2020	100.0	5.0	8.8	55.4	0.0	0.0
			92	2021	100.0	4.3	9.2	71.7	9.8	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2013	100.0	6.9	9.9	16.1	35.5	0.0
			124	2014	99.2	6.3	9.7	18.7	37.4	0.0
			124	2016	0.0	-	-	-	-	-
			124	2017	99.2	6.3	10.6	40.7	22.8	0.0
			124	2018	100.0	7.3	10.5	10.5	58.9	0.0
			124	2019	100.0	7.6	11.5	2.4	73.4	0.0
			124	2020	100.0	6.3	10.3	16.9	37.9	0.0
			124	2021	100.0	6.7	9.9	29.0	52.4	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2013	70.1	5.6	9.9	3.1	78.1	0.0
			365	2014	83.0	4.4	9.7	13.9	66.0	0.0
			366	2016	9.6	-	-	-	-	-
			365	2017	99.7	3.5	10.6	40.4	46.7	0.0
			365	2018	100.0	3.5	10.5	33.7	55.1	0.0
			365	2019	99.7	4.7	11.5	21.7	62.9	0.0
			366	2020	100.0	4.9	10.3	8.2	67.5	0.0
			365	2021	73.2	4.3	9.9	37.1	53.9	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 21. Cutthroat Trout periodicity and life stage MWMxT ranges during pre-construction (August 2013 to December 2014) and post-construction (November 2016 to September 2021) water temperature monitoring in Alena Creek at ALE-BDGWQ.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout (ALE-BDGWQ)	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2013	0.0	-	-	-	-	-
			92	2014	92.4	5.8	12.7	24.7	60.0	0.0
			92	2016	0.0	-	-	-	-	-
			92	2017	98.9	4.4	12.2	38.5	41.8	0.0
			92	2018	100.0	5.7	12.6	23.9	60.9	0.0
			92	2019	100.0	5.1	13.1	26.1	45.7	4.3
			92	2020	100.0	5.5	11.3	34.8	62.0	0.0
			92	2021	100.0	5.8	13.2	17.4	51.1	2.2
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2013	2.4	-	-	-	-	-
			124	2014	99.2	8.5	13.7	0.0	61.0	13.8
			124	2016	0.0	-	-	-	-	-
			124	2017	99.2	7.5	13.1	4.1	58.5	0.8
			124	2018	100.0	8.8	13.4	0.0	59.7	12.1
			124	2019	100.0	9.8	14.0	0.0	35.5	18.5
			124	2020	100.0	7.4	13.0	1.6	65.3	0.0
			124	2021	100.0	8.5	13.2	0.0	87.9	1.6
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2013	33.7	-	-	-	-	-
			365	2014	89.6	1.7	13.7	34.3	59.9	0.0
			366	2016	9.8	-	-	-	-	-
			365	2017	99.7	1.6	13.1	46.4	50.5	0.0
			365	2018	100.0	1.8	13.4	40.0	55.6	0.0
			365	2019	100.0	0.6	14.0	41.9	51.8	0.0
			366	2020	100.0	0.6	13.0	41.5	50.3	0.0
			365	2021	72.9	1.2	13.2	33.1	62.4	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 22. Bull Trout periodicity and life stage MWMxT ranges during pre-construction (April 2013 to December 2014) and post-construction (November 2016 to September 2021) water temperature monitoring in Alena Creek at ALE-USWQ1.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout (ALE-USWQ1)	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2013	100.0	5.6	9.9	0.0	73.8	0.0
			130	2014	98.5	5.8	9.7	0.0	71.1	0.0
			130	2016	9.2	-	-	-	-	-
			130	2017	100.0	5.2	10.6	0.0	71.5	9.2
			130	2018	100.0	5.7	10.3	0.0	76.9	1.5
			130	2019	100.0	6.4	11.5	0.0	67.7	27.7
			130	2020	100.0	7.2	10.3	0.0	68.5	8.5
			130	2021	42.3	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2013	79.3	5.6	9.9	0.0	5.9	64.5
			213	2014	69.0	4.4	9.7	0.0	14.3	78.2
			213	2016	44.6	-	-	-	-	-
			213	2017	100.0	3.5	10.6	0.0	50.7	41.3
			213	2018	99.5	4.8	10.3	0.0	41.0	47.6
			213	2019	100.0	4.9	11.5	0.0	5.1	54.2
			213	2020	100.0	4.6	10.3	0.0	23.5	64.8
			213	2021	25.8	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2013	70.1	5.6	9.9	0.0	96.9	0.0
			365	2014	83.0	4.4	9.7	3.0	86.1	0.0
			366	2016	9.6	-	-	-	-	-
			365	2017	99.7	3.5	10.6	9.9	59.6	0.0
			365	2018	100.0	3.5	10.5	15.1	66.3	0.0
			365	2019	99.7	4.7	11.5	3.8	78.3	0.0
			366	2020	100.0	4.9	10.3	0.3	91.8	0.0
			365	2021	73.2	4.3	9.9	8.6	62.9	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 23. Bull Trout periodicity and life stage MWMxT ranges during pre-construction (August 2013 to December 2014) and post-construction (November 2016 to September 2021) water temperature monitoring in Alena Creek at ALE-BDGWQ.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout (ALE-BDGWQ)	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2013	76.9	2.1	12.5	6.0	47.0	25.0
			130	2014	99.2	3.5	13.3	3.9	29.5	48.1
			130	2016	10.0	-	-	-	-	-
			130	2017	100.0	3.3	13.1	6.2	26.9	43.8
			130	2018	100.0	2.4	13.4	5.4	36.9	34.6
			130	2019	100.0	2.6	14.0	10.0	39.2	43.1
			130	2020	100.0	4.3	13.0	0.0	32.3	53.8
			130	2021	41.5	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2013	83.1	1.7	12.5	0.0	54.2	36.2
			213	2014	69.5	3.5	13.3	0.0	31.1	67.6
			213	2016	45.1	-	-	-	-	-
			213	2017	100.0	1.6	13.1	0.0	51.6	40.8
			213	2018	100.0	0.6	13.4	3.3	45.5	46.0
			214	2019	100.0	0.6	14.0	1.9	46.7	40.7
			213	2020	100.0	1.2	13.0	0.0	52.6	39.4
			213	2021	25.4	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2013	33.7	-	-	-	-	-
			365	2014	89.6	1.7	13.7	30.0	65.4	0.0
			366	2016	9.8	-	-	-	-	-
			365	2017	99.7	1.6	13.1	42.3	53.6	0.0
			365	2018	100.0	1.8	13.4	30.7	59.7	0.0
			365	2019	100.0	0.6	14.0	34.2	57.5	0.0
			366	2020	100.0	0.6	13.0	32.8	58.5	0.0
			365	2021	72.9	1.2	13.2	26.7	66.9	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

4.4.3. Bull Trout Temperature Guidelines

Water temperate guidelines for Bull Trout (see Section 3.4.4) were compared to the pre- and post-construction water temperature records by calculating the number of days of exceedance of the minimum and maximum temperature thresholds (Table 24). In BC, Bull Trout are considered to have the highest thermal sensitivity of the native salmonids evaluated in Oliver and Fidler (2001); therefore, more restrictive guidelines are applied to streams with this species. In 2021, the numbers of days when measurements were outside of the ranges bounded by the minimum and maximum temperature thresholds were within the ranges observed in previous post-construction years.

During both pre- and post-construction monitoring periods, the highest maximum daily temperatures did not exceed the prescribed threshold for rearing (15°C) at either site (Table 24).

The number of days when daily maximum water temperatures were outside the Bull Trout thresholds for spawning and incubation (i.e., >10°C) were higher at the downstream site (ALE-BDGWQ) than at the upstream site (ALE-USWQ1) during both pre- and post-construction monitoring periods. This is due to warmer temperatures in August and September at the downstream site (Table 24, Figure 25), which is likely before the main spawning period for Bull Trout on Alena Creek based on data collected to date (Thornton *et al.* 2021).

The number of days when the minimum temperature was less than the incubation threshold (i.e., <2°C) was also higher at the downstream site due to cooler temperatures at this site during the winter months in comparison to the upstream site which exhibits a warmer temperature regime in the winter likely due to the groundwater input (Figure 25). These results suggest that the temperature regime may be more suitable for Bull Trout at the upper end of the FHEP during spawning and incubation where there were fewer days with temperatures >10°C and <2°C. (Table 24).

Table 24. Summary of the number of days where the daily minimum or maximum water temperature (°C) exceeds the Bull Trout thresholds BC WQG (MECCS 2021) in Alena Creek at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Site	Project Phase	Year	n (days)[1]	Temperature Thresholds			
				Rearing (Year Round)	Spawning (Aug. 1 - Dec. 8)	Incubation (Aug. 1 - Mar. 1)	
				T_{water} > 15°C	T_{water} > 10°C	T_{water} < 2°C	T_{water} > 10°C
ALE-USWQ1[2]	Pre-construction	2013	256	0	0	0	0
		2014	305	0	0	0	0
	Post-construction	2016	38	-	-	-	-
		2017	364	0	14	0	14
		2018	365	0	9	0	9
		2019	364	0	28	1	28
		2020	366	0	18	0	18
		2021	269	0	8	0	8
ALE-BDGWQ	Pre-construction	2013	125	0	28	44	28
		2014	328	0	57	0	57
	Post-construction	2016	38	-	-	-	-
		2017	364	0	52	48	52
		2018	365	0	46	76	46
		2019	365	0	54	46	54
		2020	366	0	69	36	69
		2021	269	0	43	0	43

[1] n is the number of days that have observations for at least 23 hours.

T_{water} is the total number of days where the minimum or maximum water temperature is outside the BC WQG (MECCS 2021) for the Bull Trout incubation period: August 1 to March 1, spawning period: August 1 to December 8, and rearing period: January 1 to December 31.

[2] Pre-construction data collected at the upstream site excludes February 2014 data based on suspected ice/frozen temperature loggers.

"-" indicates that there were not enough data to calculate the metric.

[3] To date, post-construction water temperature Tidbit monitoring commenced on November 23, 2016 and ended on January 30, 2019.

4.5. Riparian Habitat

The Year 5 monitoring results indicate that revegetation is progressing well, and resemble conditions seen prior to instream habitat enhancement and subsequent riparian restoration in 2016. Estimated stem densities met the targets for shrubs and trees in all individual plots. The vegetation cover and photopoint monitoring results further demonstrate that riparian vegetation is healthy and continues to develop. No erosion was noted, and no invasive species were observed.

4.5.1. Permanent Revegetation Density Monitoring Plots

In Year 5, the mean estimated stem density of woody vegetation for all four monitoring plots was 62,000 ± 24,951 stems/ha (Table 25). Stem densities in individual plots ranged from 35,000 stems/ha to 85,200 stems/ha. The overall estimated stem density is a slight drop from Year 3 of monitoring, when it was 79,900 ± 48,103 stems/ha (Thornton *et al.* 2020). However, this is not a source of concern, as current stem density remains above the targets, and is higher than would be expected in a more mature stand, which is the goal of revegetation. Furthermore, mean estimated stem density remains higher than in 2014, prior to instream habitat enhancement work, when it was estimated as 46,250 ± 32,469 stems/ha (Harwood *et al.* 2016). Stem density is expected to decrease as vegetation matures and increases in size, and competition for resources results in thinning. As trees mature and increase in size, they provide deeper roots for ground and bank stabilization, larger canopies for thermoregulation (including shade) and litter drop, and eventually provide larger woody debris contributions to the stream channel (Hemmera 2015).

The mean estimated density of trees was 35,350 ± 22,275 stems/ha, which exceeded the target for mature trees of 1,200 stems/ha (Table 26). Similarly, the overall density of shrubs in the FHEP area was 26,650 ± 12,573 stems/ha, which exceeded the shrub specific target of 2,000 stems/ ha (Table 26). The density of trees decreased slightly from Year 3 monitoring, primarily due to decreases in red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera*) stem counts. Shrub density increased from Year 3 monitoring, due to increases in species such as thimbleberry (*Rubus parviflorus*), red raspberry (*Rubus ideaus*), black raspberry (*Rubus leucodermis*), willow(s) (*Salix* spp.), and red-osier dogwood (*Cornus stolonifera*). No dead stems were observed (Table 27).

The abundance of coniferous tree species declined from Year 3 of monitoring: no Douglas-fir (*Pseudotsuga menziesii*) was detected during monitoring in Year 5, and estimated western redcedar (*Thuja plicata)* stem density dropped from 1,600 stems/ha to 500 stems/ha (Table 26; Figure 27). This was primarily due to a decrease in western redcedar stem counts at ALE-PRM06, which dropped from 21 stems to 4 stems. Immediately after instream habitat enhancement efforts in 2016, estimated stem densities of all three coniferous species were higher than in Year 5, and the overall proportion of coniferous trees was greater: for example, western redcedar had an estimated stem density of 800 stems/ha in 2016, whereas black cottonwood was just 250 stems/ha. This was likely due to planting prescriptions that favoured coniferous species, particularly western redcedar (West *et al.* 2017), in an attempt to hasten succession as per the recommendations of FHEP (Hemmera 2015). Although a direct comparison to 2014 is not possible as only one plot remained in the same position after enhancement, just one Douglas-fir stem and one western redcedar stem were observed in all 4 plots in 2014.

In Year 5, the number of woody tree and shrub species remained similar to previous monitoring years, both before and after instream habitat enhancement and restoration. Four tree species and 10 shrub species were observed in Year 5, including willow shrubs which were identified to the genus level. Two new shrub species were observed in 2021: red raspberry and western mountain-ash (*Sorbus scopulina*; Table 26). In 2016, immediately after instream habitat enhancement and subsequent restoration, there were five tree species and eight shrub species (Harwood *et al.* 2019). In 2014, prior to instream habitat enhancement, four tree species and 11 woody shrub species were present in the original monitoring plots (Harwood *et al.* 2016). In Year 5, black cottonwood was the most abundant tree species in the monitoring plots, with a mean estimated stem density of 25,500 stems/ha, followed by red alder at 9,300 stems/ha. The willow species were the most abundant shrub(s), with a mean estimated density of 15,500 stems/ha, followed by thimbleberry with 4,600 stems/ha (Figure 28). These species were the most abundant in Year 3 monitoring as well. In comparison, in 2016 after instream habitat enhancement and restoration, red alder was the most abundant tree species and western redcedar was the second-most abundant tree species. Devil's club (*Oploplanax horridus*) and red-osier dogwood were in the most abundant shrub species. In 2014, red alder and black cottonwood were the most abundant tree species, and willow species and red-osier dogwood were the most abundant shrub species. No invasive species were observed in Year 5 monitoring. The potential invasive thistle species (*Cirsium* sp.) that was present at ALE-PRM03 in 2019 was not observed and was therefore not identified to species level in Year 5 (Thornton *et al.* 2020).

Vegetation data for the Meager Creek slide area and for the Alena Creek FHEP area prior to the landslide are limited, but similar sites within the Coastal Western Hemlock southern dry sub maritime biogeoclimatic zone (CWHds1) provide some information (Green and Klinka 1994). In high-bench and mid-bench riparian habitats in this zone, stands of red alder and black cottonwood contain small amounts of western redcedar or Sitka spruce (*Picea sitchensis*; Green and Klinka 1994). Monitoring in 2014 indicated that prior to the Meager Creek slide, ALE-PRM03 was in an area that was dominated by mature red alder (Harwood *et al.* 2016) and post-slide, the area remained dominated by red alder and black cottonwood. Riparian vegetation composition in Year 5 monitoring appears to resemble most closely the 2014 or pre-slide conditions and has revegetated since enhancement and subsequent restoration in 2016 (Figure 29).

Table 25. Summary of riparian habitat data collected for the Alena Creek FHEP from Year 1 (2017) to Year 5 (2021) of effectiveness monitoring; in 2016 (baseline), immediately after riparian restoration works; and in 2014, four years after the Meager Creek slide.

Permanent Revegetation Monitoring Plot	UTM (Zone 10U) Easting	UTM (Zone 10U) Northing	Year[1]	Woody Vegetation Density: Live Stems/Plot	Woody Vegetation Density: Dead Stems/Plot	Woody Vegetation Density: Estimated Live Vegetation Density (stems/ha)	Estimated Vegetation Cover (%)	Revegetation Area (Site) Comments
ALE-PRM03	473335	5606225	2021	175	0	35,000	98	Dense natural regeneration ~3-4.5 m high with red alder and cottonwood. Abundant grasses, fireweed, horsetail, ferns and sedges.
			2019	122	0	24,400	100	Lots of natural regeneration, some invasive thistle observed in the site. Generally good survival of the planted stock and abundant ground cover. Two planted western redcedar along the stream bank are dead. Leaves have dropped from deciduous trees.
			2017	62	3	12,400	80	Good revegetation with horsetail, grass, and ferns. Most of the planted plugs have survived.
			2016	60	0	12,000	30	-
			2014[2]	305	0	61,000	88	Extensive natural regeneration of red alder under a mostly dead red alder overstory, with a few large living red alder.
ALE-PRM05	473014	5606707	2021	350	0	70,000	62	Excellent natural revegetation: alder, willow, cottonwood, horsetail, fireweed, thimbleberry. Excellent survival of planted stock ~1.0-1.5m high.
			2019	409	0	81,800	97	Lots of natural regeneration. Abundant horsetail ground cover. Planted stock is thriving and growing tall. Leaves have dropped from deciduous trees.
			2017	107	2	21,400	37	Some natural revegetation occurring, especially along and within 10 m of the streambank.
			2016	18	0	3,600	8	-
ALE-PRM06	473348	5606089	2021	426	0	85,200	78	Excellent dense revegetation ~2.0-3.0 m height: alder, willow, fireweed, grasses, blackberry, fireweed. Planted stock is healthy and thriving. New beaver dam at this site.
			2019	612	0	122,400	64	Dense natural regeneration, including abundant grass and other ground cover vegetation. 100% survival for planted conifers and lots of western redcedar regeneration. Leaves have dropped from deciduous trees.
			2017	327	0	65,400	59	Good natural regeneration, high survival of planted vegetation.
			2016	22	0	4,400	16	-
ALE-PRM07	473338	5606166	2021	289	0	57,800	87	Dense revegetation ~3-4 m in height, lots of fireweed. Planted stock is thriving with excellent survival rate.
			2019	455	0	91,000	89	Dense natural regeneration. Lots of grass, moss, and fireweed. All planted conifers have survived and are looking very healthy.
			2017	368	0	73,600	66	Good natural regeneration of horsetail, grass, bunchberry, fireweed, ferns, red alder and black cottonwood, especially in concave microtopographies.
			2016	14	0	2,800	39	-
2021 Expected Density (stems/ha)						**62,000**		
Confidence Interval (±stems/ha)						**24,951**		
2019 Expected Density (stems/ha)						**79,900**		
Confidence Interval (±stems/ha)						**48,103**		
2017 Expected Density (stems/ha)						**43,200**		
Confidence Interval (±stems/ha)						**36,210**		
2016 Expected Density (stems/ha)						**5,700**		
Confidence Interval (±stems/ha)						**5,002**		

[1]Compensation/ restoration treatments were conducted in 2016, thus 2016 is considered the baseline as-built survey for the restoration works. 2017 was Year 1 of the effectiveness monitoring program for Alena Creek. A baseline survey was also conducted in 2014, prior to restoration works.

[2]ALE-PRM03 was the only plot (of four) established in 2014 prior to restoration works, that fell within the construction area and was thus sampled again from 2016 - 2021.

Table 26. Live species counted within each of the permanent revegetation monitoring plots in Year 5 (2021). Stem density summaries are included for Year 3 (2019), Year 1 (2017), and 2016 (baseline).

Permanent Revegetation Monitoring Plot	Trees						Shrubs														Total
	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	Douglas-fir (*Pseudotsuga menziesii*)	red alder (*Alnus rubra*)	western hemlock (*Tsuga heterophylla*)	western redcedar (*Thuja plicata*)	*Trees Subtotal*	black raspberry (*Rubus leucodermis*)	devil's club (*Oplopanax horridus*)	falsebox (*Paxistima myrsinites*)	hardhack (*Spiraea douglasii*)	red elderberry (*Sambucus racemosa*)	red raspberry (*Rubus idaeus*)	red-osier dogwood (*Cornus stolonifera*)	salmonberry (*Rubus spectabilis*)	Sitka willow (*Salix sitchensis*)	thimbleberry (*Rubus parviflorus*)	trailing blackberry (*Rubus ursinus*)	western mountain-ash (*Sorbus scopulina*)	willow (unknown species) (*Salix* sp.)	*Shrubs Subtotal*	
ALE-PRM03	10	0	24	0	1	*35*	20	19	0	0	1	0	0	12	0	62	0	0	26	*140*	**175**
ALE-PRM05	197	0	30	0	3	*230*	0	0	0	0	0	1	8	0	0	16	0	1	94	*120*	**350**
ALE-PRM06	177	0	43	1	4	*225*	1	0	0	1	0	21	37	0	0	12	0	0	129	*201*	**426**
ALE-PRM07	126	0	89	0	2	*217*	2	0	0	1	0	0	6	0	0	2	0	0	61	*72*	**289**
Mean (stems/plot)	127.50	0.00	46.50	0.25	2.50	*176.75*	5.75	4.75	0.00	0.50	0.25	5.50	12.75	3.00	0.00	23.00	0.00	0.25	77.50	*133.25*	**310.00**
Confidence Interval (stems/plot)	98.66	0.00	34.62	0.59	1.52	*111.38*	11.22	11.18	0.00	0.68	0.59	12.17	19.44	7.06	0.00	31.37	0.00	0.59	51.96	*62.87*	**124.76**
2021 Expected Density (stems/ha)	**25,500**	**0**	**9,300**	**50**	**500**	***35,350***	**1,150**	**950**	**0**	**100**	**50**	**1,100**	**2,550**	**600**	**0**	**4,600**	**0**	**50**	**15,500**	***26,650***	**62,000**
Confidence Interval (± stems/ha)	**19,732**	**0**	**6,924**	**118**	**304**	***22,275***	**2,244**	**2,236**	**0**	**136**	**118**	**2,434**	**3,888**	**1,412**	**0**	**6,274**	**0**	**118**	**10,391**	***12,573***	**24,951**
2019 Expected Density (stems/ha)	**33,700**	**50**	**23,950**	**50**	**1,600**	***59,350***	**0**	**1,000**	**50**	**650**	**50**	**0**	**1,650**	**550**	**0**	**1,750**	**850**	**0**	**14,000**	***20,550***	**79,900**
Confidence Interval (± stems/ha)	**26,356**	**118**	**25,831**	**118**	**2,078**	***45,222***	**0**	**2,353**	**118**	**1,110**	**118**	**0**	**2,967**	**824**	**0**	**2,616**	**2,000**	**0**	**10,657**	***11,491***	**48,103**
2017 Expected Density (stems/ha)	**23,100**	**0**	**15,800**	**50**	**700**	***39,650***	**0**	**650**	**0**	**0**	**350**	**0**	**650**	**450**	**0**	**1,100**	**250**	**0**	**100**	***3,550***	**43,200**
Confidence Interval (± stems/ha)	**20,115**	**0**	**17,600**	**118**	**781**	-	**0**	**1,377**	**0**	**0**	**353**	**0**	**703**	**778**	**0**	**1,129**	**588**	**0**	**235**	-	**36,210**
2016 Expected Density (stems/ha)[1]	**250**	**100**	**1,350**	**150**	**800**	***2,650***	**200**	**850**	**0**	**0**	**50**	**0**	**700**	**350**	**500**	**250**	**0**	**0**	**150**	***3,050***	**5,700**
Confidence Interval (± stems/ha)	**445**	**235**	**3,177**	**225**	**508**	-	**471**	**1,542**	**0**	**0**	**118**	**0**	**804**	**556**	**891**	**353**	**0**	**0**	**353**	-	**5,002**

[1] 2016 is the baseline, measured immediately after restoration work

Table 27. Dead tree species counted within each of the permanent revegetation monitoring plots in Year 5 (2021). Summaries of dead trees are included for Year 1 (2017), Year 3 (2019), and baseline (2016).

Permanent Vegetation Monitoring Plot	western hemlock (*Tsuga heterophylla*)	western redcedar (*Thuja plicata*)	Douglas-fir (*Pseudotsuga menziesii*)	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red alder (*Alnus rubra*)	Total
ALE-PRM03	0	0	0	0	0	**0**
ALE-PRM05	0	0	0	0	0	**0**
ALE-PRM06	0	0	0	0	0	**0**
ALE-PRM07	0	0	0	0	0	**0**
Mean (stems/ plot)	0.00	0.00	0.00	0.00	0.00	**0.00**
Confidence Interval (± stems/plot)	0.00	0.00	0.00	0.00	0.00	**0.00**
2021 Expected Density (stems/ha)	**0**	**0**	**0**	**0**	**0**	**0**
Confidence Interval (± stems/ha)	**0**	**0**	**0**	**0**	**0**	**0**
2019 Expected Density (stems/ha)	**0**	**0**	**0**	**0**	**0**	**0**
Confidence Interval (± stems/ha)	**0**	**0**	**0**	**0**	**0**	**0**
2017 Expected Density (stems/ha)	**0**	**150**	**50**	**0**	**50**	**250**
Confidence Interval (± stems/ha)	**0**	**225**	**118**	**0**	**118**	**353**
2016 Expected Density (stems/ha)[1]	**0**	**0**	**0**	**0**	**0**	**0**
Confidence Interval (± stems/ha)	**0**	**0**	**0**	**0**	**0**	**0**

[1] 2016 is the baseline, measured immediately after restoration work

4.5.2. Percent Vegetation Cover Estimates

In Year 5, the percent cover of vegetation ranged from 62% at ALE-PRM05 to 98% at ALE-PRM03 (Table 25). This is similar to 2014, when cover ranged from 64% to 98 (albeit in different plots), and higher than immediately after enhancement and restoration in 2016, when cover ranged from 8% to 30% (Table 25). Herbaceous and woody ground cover is primarily monitored because it stabilizes soil and provides sediment interception and erosion control early in the revegetation process. Woody shrubs or trees also contribute to these functions. The combination of high percent cover values and lack or erosion in the revegetation areas, along with high stem densities, means that there are no concerns regarding vegetation ground cover and associated riparian functions.

4.5.3. Photopoint Comparison

Standard photographs taken in 2016, 2017, 2019 and 2021 from 1.3 m above the plot centre, facing 0 degrees (north) are presented in Appendix E to compare site and vegetation condition among years at each plot. Representative photos of the general site conditions surrounding each permanent monitoring plot are also provided. Additional photographs taken in the remaining three cardinal directions (east, south, west) from 1.3 m above the plot centre are available upon request.

In Year 5, sampling occurred in early September, whereas in previous years sampling occurred in early to late October. It is therefore difficult to compare growth directly, as many leaves had senesced by late October. Regardless, the replicate standard photographs appear to show an increase in vegetation abundance and cover since 2016, as well as increases in the size of individual plants (Figure 30). Therefore, photographic monitoring supports the stem density results (Section 4.5.1) and vegetation cover results (Section 4.5.2) that demonstrate an increase in stem density and ground cover since instream habitat enhancement and restoration in 2016.

Figure 27. Western redcedar approximately 1 m in height at ALE-PRM05, on September 01, 2021.

Figure 28. Diversity of woody species observed at ALE-PRM06, with red-osier dogwood in foreground. Western redcedar visible in right of photograph. Photograph taken on September 01, 2021.

Figure 29. Abundant black cottonwood and red alder at ALE-PRM07 on September 01, 2021.

Figure 30. Tall vegetation at ALE-PRM03 on September 01, 2021.

5. SUMMARY AND RECOMMENDATIONS

The success of the FHEP was evaluated according to the criteria in the *Fisheries Act* Authorization, namely that the habitat enhancement is physically stable, maintains suitable flows, has been demonstrated to provide spawning and rearing habitat for Coho Salmon and Cutthroat Trout of not less than 2,310 m^2, and supports equivalent or greater fish usage relative to pre-project densities in Alena Creek. Year 5 monitoring results suggest the FHEP is meeting criteria outlined in the *Fisheries Act* Authorization.

5.1. Fish Habitat

The overall function and quality of the FHEP remains high, despite the flood event that occurred a few months after construction. Instream repairs completed on August 6, 2020 have enhanced the stream conditions and increased erosion protection.

Continuous beaver activity was observed in the lower end of Reach 3 near ALE-XS5 and upstream of ALE-XS6 and ALE-XS7. The newly formed dams created moderate backwatering in the lower portion of Reach 3 which has been managed in accordance with best management practices for dam removal provided by a licensed trapper from EBB Environmental Consulting Inc. Although the beaver complex upstream of Reach 3 was considered to be inactive in 2020, we recommend ongoing management of beaver dams; in particular, we recommend ensuring that the beaver dam complex above Reach 3 does not grow or further redirect flows around the constructed channel, and monitoring of the dams in the lower section of Reach 3. We also recommend removing or lowering any dams that cause backwatering of habitat that would otherwise be suitable for spawning.

Establishment of herbaceous plants along the constructed channel banks has been successful in protecting the channel banks. Installing additional live stakes was considered but is not recommended at this time because it could increase local beaver activity.

5.2. Fish Community

The fish community component of the Alena Creek FHEP monitoring was successfully implemented in 2021. The 2021 monitoring documented the highest abundance of adult Coho Salmon to date and CPUE of juvenile Coho Salmon during minnow trapping was high. Minnow trapping CPUE of juvenile Cutthroat Trout was similar to previous years monitoring. Comparison of CPUE for all captured species combined (i.e., Bull Trout, Coho Salmon, and Cutthroat Trout) demonstrates that CPUE was higher in 2021 relative to in baseline sampling. In baseline monitoring, CPUE across captured species was 0.3 fish per 100 trap hours and 0.75 fish per 100 trap hours in 2013 and 2014, respectively. It is important to note that CPUE estimates for 2014 are biased high due to reduced set length as a result of safety concerns surrounding bear activity in the sampling areas. Despite this bias, CPUE in 2021 was higher than the average CPUE across baseline monitoring years (0.93 fish per 100 trap hours in 2021, 0.52 fish per 100 trap hours during baseline). A total of five adult Bull Trout were observed in 2021 during spawner bank walks compared to counts in previous years which ranged from zero to nine individuals. Three juvenile Bull Trout were captured during minnow trapping compared to zero in all previous years, except 2013 where one was captured.

5.3. Hydrology

The hydrology monitoring program has reached the five years length post-construction recommended by the OEMP (Harwood *et al.* 2021).

5.4. Water Temperature

The 2021 water temperature regime was within the temperature ranges observed in previous post-construction monitoring (2016 to 2020) and 2019 remains the year with the highest (11.7°C) and lowest (1.2°C) monthly average temperatures on record, both occurring at the downstream water temperature monitoring site. To date, the instantaneous temperature ranges observed at both sites were similar between the pre- (0.0°C to 14°C) and post-construction (0.0°C to 14.5°C) periods.

Results to date indicate that the FHEP provides water temperatures typical of the area, with beneficial moderating effects due to groundwater inflow upstream of the habitat. Overall temperatures are more suitable for Bull Trout than Coho Salmon and Cutthroat Trout due to the generally cooler optimum temperature ranges for Bull Trout.

5.5. Riparian Habitat

Year 5 monitoring indicates that vegetation is healthy and dense, although the abundance of conifers has declined since restoration in 2016. Therefore, further restoration as proposed by the FHEP does not appear to be necessary for riparian functioning and this component of the OEMP program is considered complete. A second offset project was completed on Alena Creek in September 2021 (Faulkner *et al.* 2021a), including a newly planted area. This area will be monitored under a separate monitoring plan.

6. CLOSURE

The monitoring objectives for Year 5 monitoring of the Alena Creek FHEP were achieved, as described in the OEMP (Harwood *et al.* 2021). The success of the FHEP was evaluated according to the criteria in the *Fisheries Act* Authorization, namely that the habitat enhancement is physically stable, maintains suitable flows, has been demonstrated to provide spawning and rearing habitat for Coho Salmon and Cutthroat Trout of not less than 2,310 m^2, and supports equivalent or greater fish usage relative to pre-project densities in Alena Creek. The new channel construction and enhancement of existing channels has provided 3,194 m^2 of high-quality instream fish habitat exceeding the requirement (West *et al.* 2017). Although some repairs were required for a high flow event that occurred soon after construction, the five-year monitoring period has shown that the habitat is physically stable, provides suitable flows and that fish use is generally higher than pre-project conditions. Beaver activity continues to pose a risk to habitat functionality and management of this species is recommended to continue to ensure the habitat remains to be function as intended.

REFERENCES

Blackwell, B.G, Brown, M.L., and D.W. Willis. 2000. Relative Weight (Wr) Status and Current Use in Fisheries Assessment and Management. Rev. Fish. Sci., 8: 1-44.

Bloom, Arthur. 1976. Evaluation of Minnow Traps for Estimating Populations of Juvenile Coho Salmon and Dolly Varden. April 1976. Available online at: https://books.google.ca/books?id=qO8gAAAAMAAJ&pg=RA1-PA99&lpg=RA1-PA99&dq=Does+minnow+trapping+have+a+max+capacity+of+fish+captures&source=bl&ots=YRBiMd4SlU&sig=ACfU3U0liB4OGoeX95FK7zHJs0_mKqt6qg&hl=en&sa=X&ved=2ahUKEwiltNay6YL3AhVuGjQIHaInDosQ6AF6BAggEAM#v=onepage&q=Does%20minnow%20trapping%20have%20a%20max%20capacity%20of%20fish%20captures&f=false. Accessed on April 8, 2022.

Buchanan, S., A. Newbury, S. Faulkner, A. Harwood, and D. Lacroix. 2013a. Upper Lillooet Hydro Project: Upper Lillooet River Hydroelectric Facility Summary of Aquatic and Riparian Footprint Impacts. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., May 2, 2013.

Buchanan, S., A. Harwood, A. Newbury, and D. Lacroix. 2013b. Upper Lillooet Hydro Project: Boulder Creek Hydroelectric Facility Summary of Aquatic and Riparian Footprint Impacts. Consultant's report prepared for Boulder Creek Power Limited Partnership by Ecofish Research Ltd., May 2, 2013.

DFO and MELP (Fisheries and Oceans Canada and Ministry of Environment, Land and Parks). 1998. Riparian Revegetation. Available online at: https://waves-vagues.dfo-mpo.gc.ca/Library/315523.pdf Accessed on November 24, 2014.

Faulkner, S., A. Parsamanesh, I. Girard, S. Nicholl, and A. Lewis. 2019. Upper Lillooet Hydroelectric Facility - DFO Request for Review: Quick Flush Procedure Assessment of Serious Harm. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., February 12, 2019.

Faulkner, S., M. Bartlett, V. Dimma, V. Woodruff, D. West, and T. Hicks. 2021a. Upper Lillooet River Power Limited Partnership. Alena Creek Fish Habitat Offset Project 2021 – Construction Monitoring Summary Report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., November 30, 2021.

Faulkner, S, M. Thornton, O. Fitzpatrick, S. Braig, T. Jensma, K. Ganshorn, V. Dimma, A. Newbury, and H. Regehr. 2021b Upper Lillooet Hydro Project Operational Environmental Monitoring: Year 3. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd., April 29, 2021.

Faulkner *et. al.* 2022. Upper Lillooet Hydro Project Operational Environmental Monitoring: Year 4 Draft V1. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd., April 14, 2022.

Green, R.N. and Klinka, K. 1994. A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region, Land Management Handbook Number 28. Province of British Columbia. Available online at: https://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh28.pdf Accessed on April 13, 2020.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41: 540–51.

Harwood, A., A. Yeomans-Routledge, S. Faulkner, and A. Lewis. 2013. Upper Lillooet Hydro Project: Pre-construction and LTMP Report for Alena Creek Compensation Habitat. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd. August 15, 2013.

Harwood, A., E. Smyth, D. McDonnell, A. Newbury, P. Dinn, A. Baki, T. Jensma, and D. Lacroix. 2016. Alena Creek Fish Habitat Enhancement Project: Aquatic Baseline Report Years 1 & 2. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., July 14, 2016.

Harwood, A., V. Woodruff, A. Parsamanesh, S. Faulkner, A. Baki, S. Buchanan, T. Jensma, K. Ganshorn, A. Newbury, and D. Lacroix. 2019a. Alena Creek Fish Habitat Enhancement Project: Year 1 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., March 12, 2019.

Harwood, A., S. Sharron, T. Hicks, S. Faulkner, T. Jensma, K. Ganshorn, A. Newbury, and D. Lacroix. 2019b. Alena Creek Fish Habitat Enhancement Project: Year 2 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 25, 2019.

Hemmera (Hemmera Envirochem Inc.). 2015. Upper Lillooet Hydro Project Offsetting Plan. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership by Hemmera Envirochem Inc. January 2015.

MECCS (British Columbia Ministry of Environment and Climate Change Strategy). 2021. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary. Water Quality Guideline Series, WQG-20. Prov. B.C., Victoria B.C. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf. Accessed on February 10, 2022.

MOE (Ministry of Environment). 2006. South Coast Region. Periods of Least Risk for Instream Works by Fish Species. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/work_windows_low_main.pdf. Accessed on March 9, 2022.

MOF (BC Ministry of Forests). 2009. Silviculture Surveys Procedures Manual: stocking and free-growing. Forest Practices Branch, Ministry of Forests Lands, and Natural Resource Operations. Available online at: http://www.for.gov.bc.ca/hfp/publications/00099/Surveys/Silviculture%20Survey%20Procedures%20Manual-April%201%202009.pdf. Accessed on October 30, 2014.

MOF (BC Ministry of Forests). 2011. FREP Stand Development Monitoring Protocol. Ministry of Forests, Lands, and Natural Resource Operations. Available online at: https://www.for.gov.bc.ca/ftp/hfp/external/!publish/FREP%20-%20Website/Indicators%20and%20Protocols/FREP%20SDM%20Protocol_Mar2015.pdf Accessed on October 30, 2014.Naiman, R.J. and H. Decamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics. 28: 621-658

Naiman, R.J., R.E. Bilby, and P.A. Bisson. 2000. Riparian Ecology and Management in the Pacific Coastal Rainforest. Bioscience. 50: 996-1011.

Naiman, R.J., and H. Decamps. 1997. The Ecology of Interfaces: Riparian Zones. Annual Review of Ecology and Systematics. 28: 621-658.

Oliver, G.G. and L.E. Fidler. 2001. Towards a water quality guideline for temperature in the Province of British Columbia. Prepared for Ministry of Environment, Lands and Parks, Water Management Branch, Water Quality Section, Victoria, B.C. Prepared by Aspen Applied Sciences Ltd., Cranbrook, B.C., 53 pp + appnds. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/temperature-tech.pdf. Accessed February 10, 2022.

Richardson, J.S. 2004. Meeting the conflicting objectives of stream conservation and land use through riparian management: another balancing act. Pp. 1 - 6 In: G. J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita (Eds.) Forest-Land-Fish Conference II - Ecosystem Stewardship Through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

Thornton, M., L. Ballin, T. Jensma, T. Brown, D. West, S. Faulkner, K. Ganshorn, J. Abell. 2020. Alena Creek Fish Habitat Enhancement Project: Year 3 Monitoring Report. Draft V1. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 28, 2020.

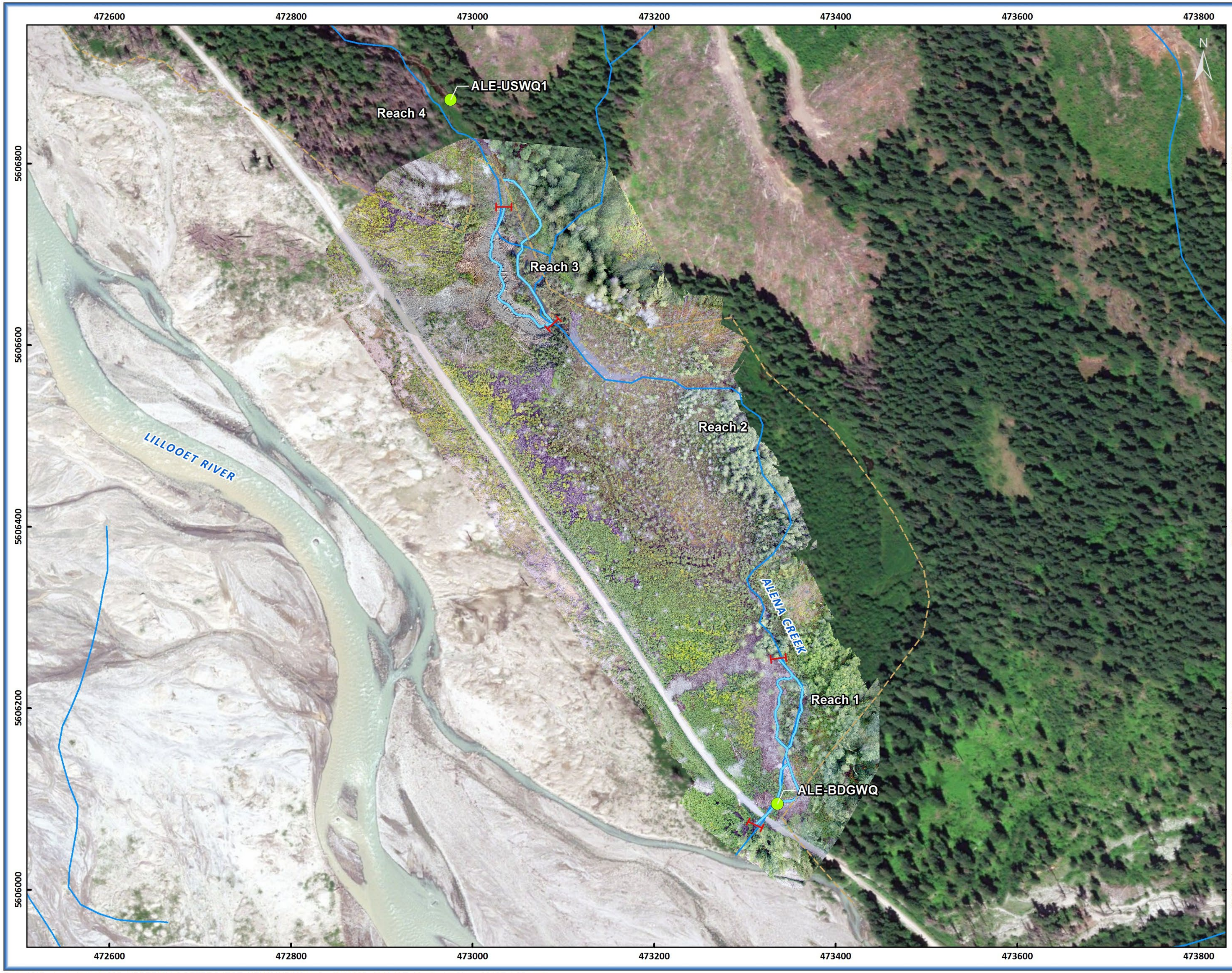
Thornton, M., T. Jensma, V. Dimma, D. West, S. Faulkner, K. Ganshorn, D. Stanyer, and H. Regehr. 2021. Alena Creek Fish Habitat Enhancement Project: Year 4 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 28, 2021.

West. D, V. Woodruff and A. Harwood. 2017. Alena Creek Fish Habitat Enhancement Project As-Built Survey. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd., March 7, 2017.

Personal Communications

McCarthy, C. 2014. Senior Engineer, Knight Piésold Ltd., Vancouver, BC. Email communication with J. Mancinelli, Innergex Renewable Energy Inc., March 31, 2014.

PROJECT MAPS



UPPER LILLOOET HYDRO PROJECT

Alena Creek Water Temperature Monitoring Sites

Legend

- Water Temperature Monitoring Site
- Reach Break — The extent of enhanced habitat is delineated by Reach 1 (downstream) and Reach 3 (upstream)
- Meager Creek Slide Extent
- Enhanced Reaches
- Streams (Hedberg)

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 25 50 100 150 200 m

Scale: 1:4,000

NO.	DATE	REVISION	BY
1	24/04/2019	1095_ALN_WT_MonitoringSites_2019Feb25	SPK
2			
3			
4			
5			

Date Saved: 24/04/2019
Coordinate System: NAD 1983 UTM Zone 10N

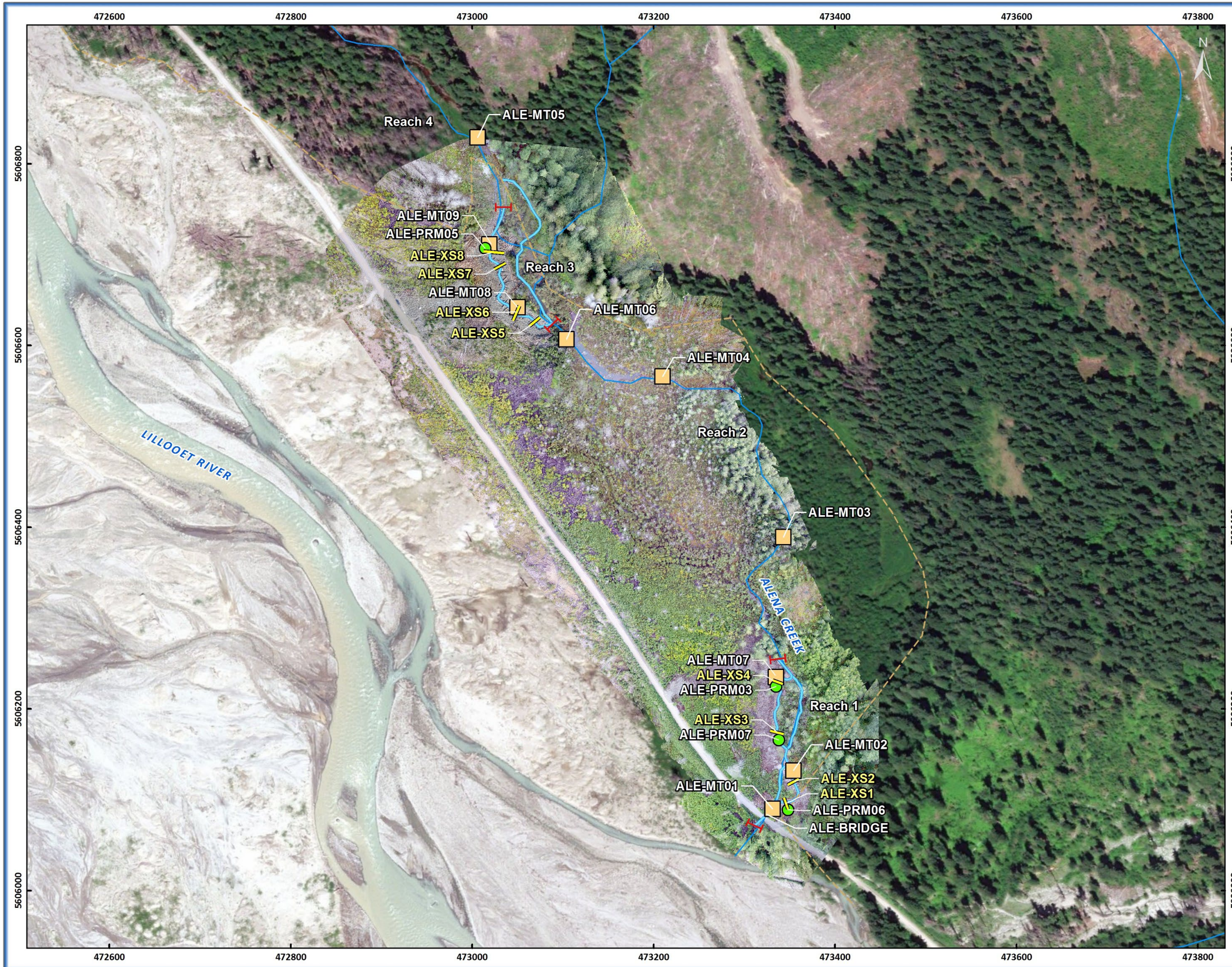
ECOFISH RESEARCH

Map 2

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\WaterQuality\1095_ALN_WT_MonitoringSites_2019Feb25.mxd

UPPER LILLOOET HYDRO PROJECT

Alena Creek Fish Abundance Sampling and Riparian Monitoring Sites



Legend

- Minnow Traps
- Permanent Vegetation Monitoring Plots
- Reach Break — The extent of enhanced habitat is delineated by Reach 1 (downstream) and Reach 3 (upstream)
- Transect Sites
- Meager Creek Slide Extent
- Enhanced Reaches
- Streams (Hedberg)

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 25 50 100 150 200 m

Scale: 1:4,000

NO.	DATE	REVISION	BY
1	24/04/2019	1095_ALN_FishAbundanceRipMonSites_2019Mar26	SPK
2			
3			
4			
5			

Date Saved: 24/04/2019
Coordinate System: NAD 1983 UTM Zone 10N

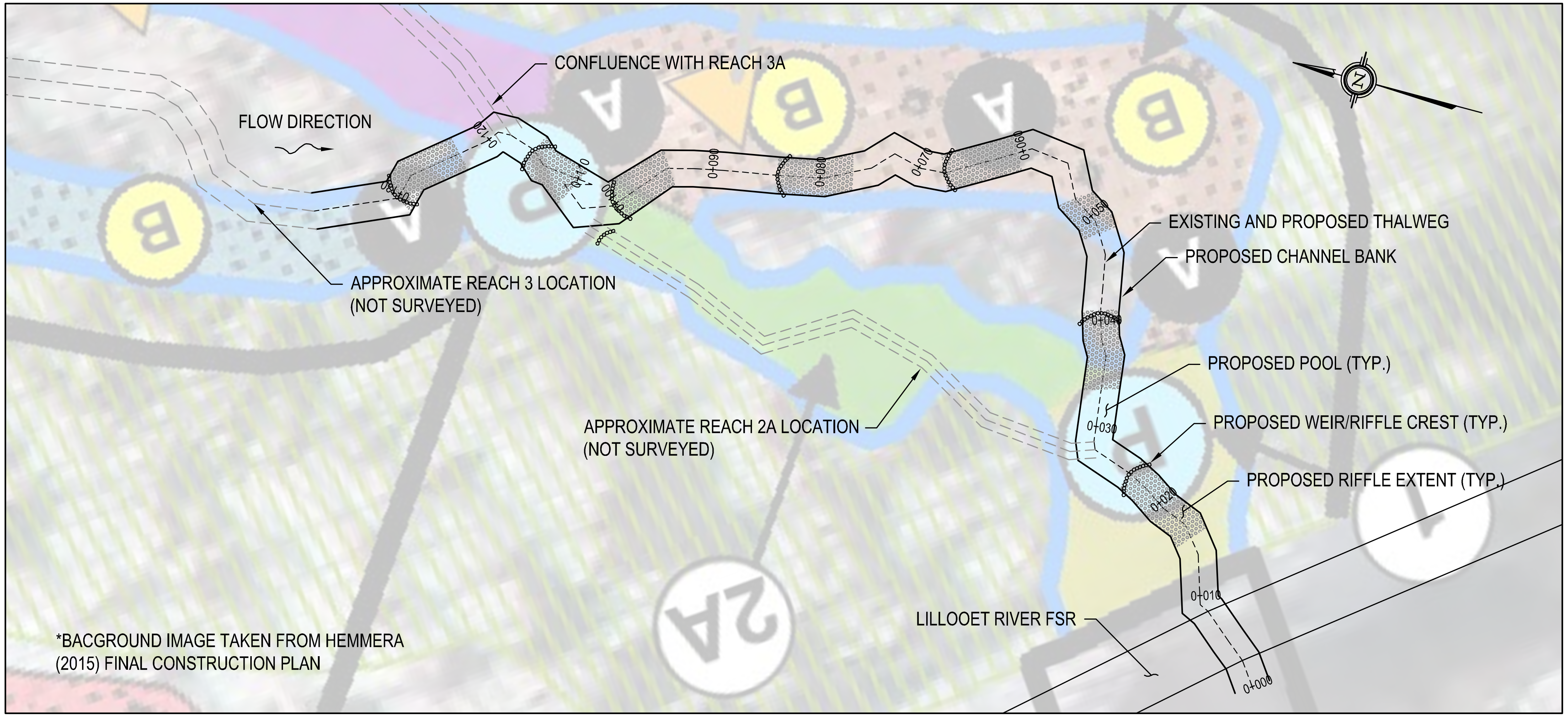
ECOFISH RESEARCH

Map 3

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Fisheries\1095_ALN_FishAbundanceRipMonSites_2019Mar26.mxd

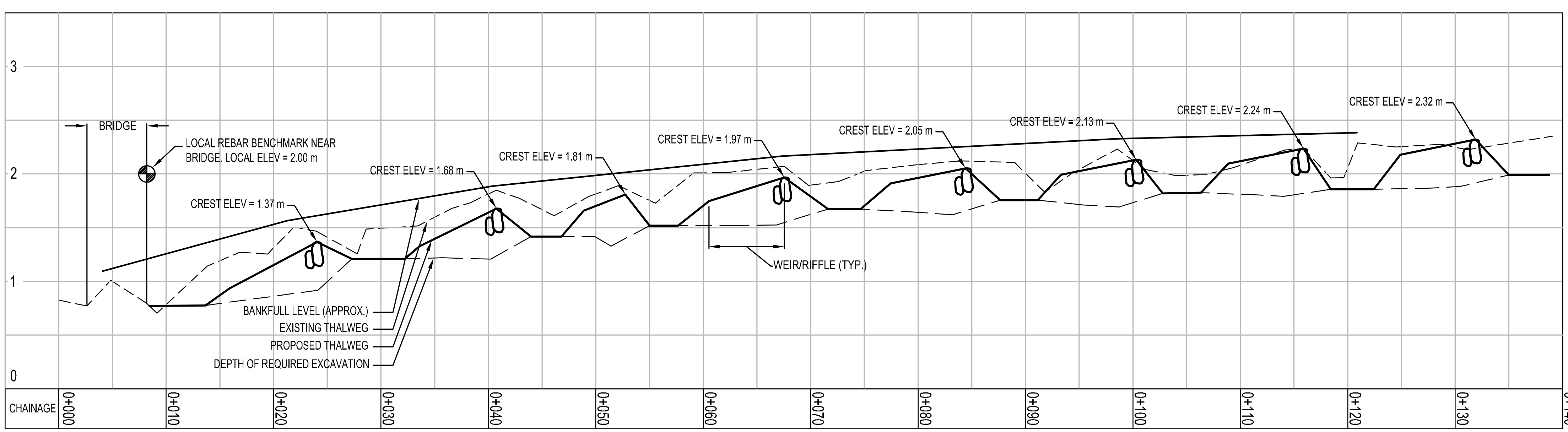
APPENDICES

Appendix A. Final Design Drawings of the Alena Creek Fish Habitat Enhancement Project



REACH 1, 2, & 2A PLANVIEW

1:500



REACH 1, 2, & 2A PROFILE

1:500

GENERAL NOTES

1. THE CONTRACTOR SHALL PROVIDE THE CONSULTING ENGINEER OR GEOMORPHOLOGIST 48 HOURS NOTICE PRIOR TO COMMENCING WORK.
2. THIS SET OF DRAWINGS SHALL BE READ IN CONJUNCTION WITH ACCOMPANYING FINAL CONSTRUCTION PLAN (HEMMERA, 2015).
3. ALL DRAWINGS SHALL BE USED FOR CONSTRUCTION. DO NOT SCALE FROM PLANFORM DRAWING.
4. ALL MEASUREMENTS FOR THIS PROJECT ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE INDICATED.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LAYOUT, SURVEY AND LOCATION OF ALL UTILITIES.
6. LOCATION OF FEATURES AND EXTENT OF WORKS SHALL BE REVIEWED AND APPROVED BY ENVIRONMENTAL MONITOR.
7. ALL WORKS SHALL BE SUPERVISED, INSPECTED AND APPROVED BY A ENVIRONMENTAL MONITOR.
8. ALL WORKS AND MATERIALS SHALL BE IN ACCORDANCE WITH APPLICABLE MUNICIPAL AND/OR PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS.
9. ALL GENERAL BACKFILL SHALL BE APPROVED MATERIAL COMPACTED TO 85% STANDARD PROCTOR DENSITY.
10. ALL UNSUITABLE AND/OR EXCESS MATERIALS SHALL BE DEPOSITED IN A SPOIL AREA DETERMINED BYENVIRONMENTAL MONITOR.
11. IMMEDIATELY AFTER CONSTRUCTION, ALL DISTURBED AREAS SHALL BE STABILIZED AND/OR RESTORED TO ORIGINAL CONDITION.
12. THE CONTRACTOR SHALL REMOVE ALL SEDIMENT CONTROLS AFTER VEGETATION HAS ESTABLISHED. WORKS WILL NOT BE CONSIDERED COMPLETE UNTIL ALL TEMPORARY SEDIMENT CONTROLS ARE REMOVED.

WATERCOURSE PROTECTION

1. MITIGATION MEASURES SECTION OF HEMMERA (2015) FINAL CONSTRUCTION PLAN TO BE REVIEWED AND ADHERED TO.
2. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AS PER APPLICABLE PLANS.
3. ADDITIONAL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED IF IT IS DETERMINED THAT APPROVED CONTROLS DO NOT ADEQUATELY PREVENT EROSION AND RELEASE OF SEDIMENT.
4. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS NOT REQUIRED, EQUIPMENT SHALL NOT BE OPERATED IN SUCH AREAS.
5. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS REQUIRED, THE USE OF EQUIPMENT WITHIN THE WATERCOURSE SHALL BE MINIMIZED.
6. WORK IN A WATERCOURSE AND ON WATERCOURSE BANKS SHALL BE COMPLETED IN THE DRY IN AN ISOLATED WORK AREA DURING LOW-FLOW CONDITIONS.
7. THE WEATHER FORECAST SHALL BE CONTINUALLY MONITORED TO ENSURE THAT CONSTRUCTION ACTIVITIES MAY PROCEED UNDER FAVOURABLE CONDITIONS.
8. EXCAVATION OF THE WATERCOURSE BED AND PLACEMENT OF MATERIALS SHALL BE STAGED SO THAT NO EXCAVATED AREAS REMAIN EXPOSED AT THE END OF EACH WORKING DAY.
9. IF FLOWS WITHIN A WATERCOURSE ARE OBSERVED TO RISE TO A LEVEL APPROACHING THE PUMPING CAPACITY, PLACEMENT OF MATERIALS IN EXCAVATED AREAS MUST BE COMPLETED AS SOON AS POSSIBLE, AFTER WHICH WORK MUST BE SHUT DOWN UNTIL THE FLOW RETURNS TO A LEVEL WITHIN THE PROVIDED PUMPING CAPACITY.
10. ALL EQUIPMENT SHALL BE CLEAN AND FREE OF PETROLEUM PRODUCTS.
11. ALL MAINTENANCE, REFUELING AND STORAGE OF EQUIPMENT SHALL BE CONTROLLED SO AS TO PREVENT ANY DISCHARGE OF PETROLEUM PRODUCTS. VEHICULAR MAINTENANCE AND REFUELING SHALL BE CONDUCTED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.
12. CONSTRUCTION MATERIAL, EXCESS MATERIAL, CONSTRUCTION DEBRIS AND EMPTY CONTAINERS SHALL BE STORED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.

	07-10-16	D.W.	ISSUED FOR CONSTRUCTION
	DATE	BY	REVISIONS

DESIGNED BY:	D.W.	CHECKED BY:	D.W.
DRAWN BY:	D.W.	DATE:	AUGUST 10, 2015

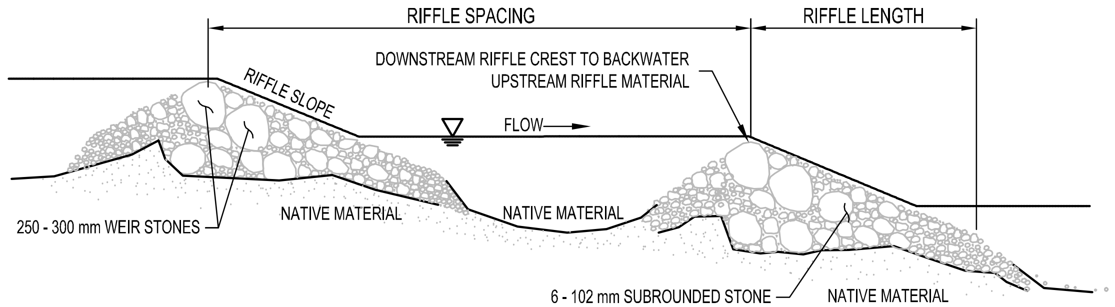
July 10, 2016
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. T. WEST
41242

ECOFISH RESEARCH

ALENA CREEK FHEP DETAILED CONSTRUCTION PLAN

REACH 1 AND 2
PLANFORM AND PROFILE

PROJECT No.:	1095.16	DRAWING No.:	GEO-1
SCALE:	AS SHOWN	SHEET 1 OF 3	

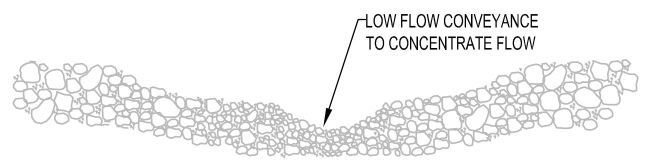


TYPICAL RIFFLE SEQUENCE PROFILE

N.T.S.

CONSTRUCTION NOTES

1. CREST TO CREST CHANNEL GRADIENT IN REACHES 3 TO 6 TO MATCH EXISTING UNLESS OTHERWISE INSTRUCTED BY ENVIRONMENTAL MONITOR.
2. DIG DEPRESSIONS INTO THE BED TO STABILIZE RIFFLE MATERIALS.
3. PLACE LARGEST MATERIAL (KEY STONE) AT RIFFLE CREST (HIGHEST POINT).
4. ENSURE THAT LARGEST ROCKS PROTRUDE INTO FLOW.
5. THICKNESS OF RIFFLE SUBSTRATE AT CREST IS APPROXIMATELY 400 mm.
6. FILL VOIDS IN RIFFLE WITH NATIVE MATERIALS.
7. TAPER GRAIN SIZE AND BED THICKNESS DOWNSTREAM AND UPSTREAM OF CREST.
8. RIFFLE MATERIALS SHOULD EXTEND OVER LIP OF THE DEPRESSION.
9. SPREAD REMAINING ROCK ON RIFFLE TO ATTAIN RIFFLE ANGLE.
10. RIFFLE LENGTH IS DETERMINED FROM PROFILE WHERE SHOWN.
11. SUBSTRATE TO BE MECHANICALLY COMPACTED WITH EXCAVATOR BUCKET TO MINIMIZE INTERSTITIAL SPACING.

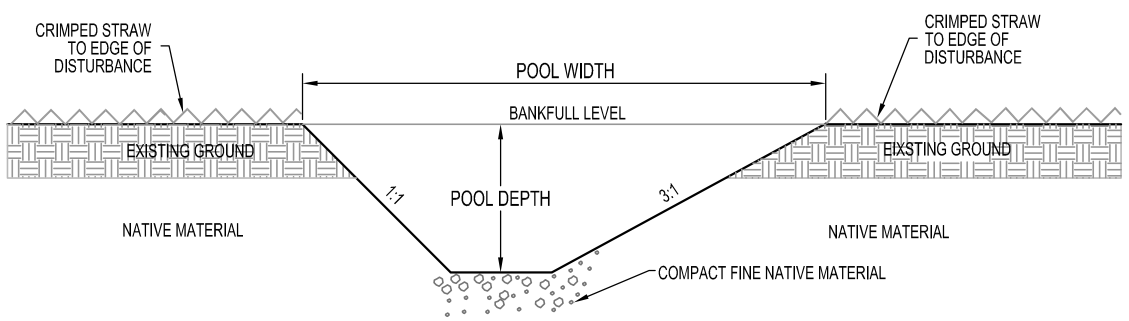


CROSS-SECTION

N.T.S.

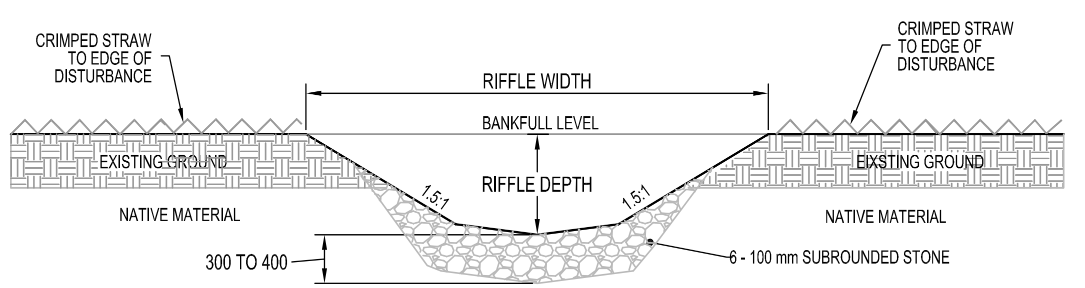
WEIR/RIFFLE CONSTRUCTION DETAILS

N.T.S.



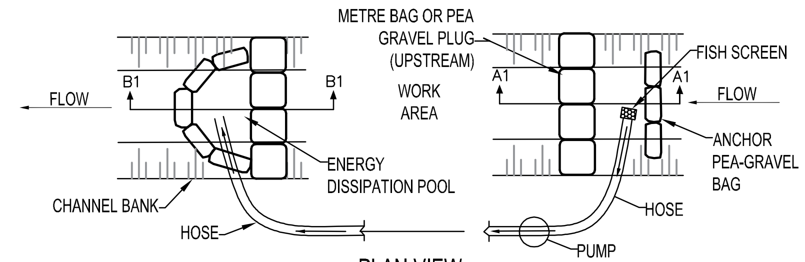
TYPICAL POOL CROSS SECTION

N.T.S.

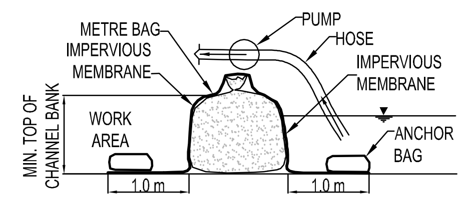


TYPICAL RIFFLE CROSS SECTION

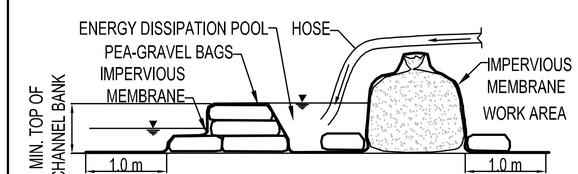
N.T.S.



PLAN VIEW



SECTION A1-A1



SECTION B1-B1

NOTES

1. COFFERDAM BARRIER BAGS TO BE FILLED WITH PEA GRAVEL OR SAND IF PEA GRAVEL IS UNAVAILABLE.
2. IMPERVIOUS MEMBRANE SHALL COVER THE METRE BAGS TO LIMIT WATER ENTRY INTO WORK AREA.
3. PUMPING CAPACITY TO BE A MINIMUM OF 2 - 75 mm (3 in) DIAMETER PUMPS.
4. SCREEN TO BE INSTALLED AT INTAKE END OF HOSE TO LIMIT FISH MORTALITY. FISH SCREEN TO BE 1.25 m^2 WITH A 15 mm MESH SIZE/OPENING.
5. PUMPED WATER SHALL BE DISCHARGED INTO THE ENERGY DISSIPATION POOL.
6. A BACKUP PUMP AND HOSE SHALL BE KEPT ONSITE IN THE EVENT THAT INCREASED FLOWS CANNOT BE PUMPED IN THE PRIMARY SYSTEM.
7. THE CONTRACTOR SHALL MONITOR WEATHER CONDITIONS AND WILL NOT PROCEED WITH WORKS IN THE EVENT OF A STORM EVENT, OR IF IT IS ANTICIPATED THAT FLOWS CANNOT BE PUMPED AROUND AS REQUIRED.

COFFERDAM BARRIER

N.T.S.

CHANNEL GEOMETRY FOR EACH REACH

REACH	RIFFLE SLOPE	RIFFLE LENGTH	RIFFLE SPACING	RIFFLE WIDTH (m)	MAX. RIFFLE DEPTH (m)	POOL WIDTH (m)	MAX. POOL DEPTH (m)
1	SEE GEO-1	SEE GEO-1	SEE GEO-1	2.7	0.35	4.1	0.7
2	SEE GEO-1	SEE GEO-1	SEE GEO-1	2.7	0.35	4.1	0.7
3	2 TO 3 %	5 - 10 m	15 - 18 m	2.7	0.35	4.1	0.7
4	2 TO 3 %	5 - 10 m	15 - 18 m	2.7	0.35	4.1	0.7
5	2 TO 3%	3 - 6 m	10 - 14 m	2.0	0.30	2.9	0.6
6	2 TO 3 %	4 - 8 m	13 - 16 m	2.5	0.35	3.6	0.7

GENERAL NOTES

1. THE CONTRACTOR SHALL PROVIDE THE CONSULTING ENGINEER OR GEOMORPHOLOGIST 48 HOURS NOTICE PRIOR TO COMMENCING WORK.
2. THIS SET OF DRAWINGS SHALL BE READ IN CONJUNCTION WITH ACCOMPANYING FINAL CONSTRUCTION PLAN (HEMMERA, 2015).
3. ALL DRAWINGS SHALL BE USED FOR CONSTRUCTION. DO NOT SCALE FROM PLANFORM DRAWING.
4. ALL MEASUREMENTS FOR THIS PROJECT ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE INDICATED.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LAYOUT, SURVEY AND LOCATION OF ALL UTILITIES.
6. LOCATION OF FEATURES AND EXTENT OF WORKS SHALL BE REVIEWED AND APPROVED BY ENVIRONMENTAL MONITOR.
7. ALL WORKS SHALL BE SUPERVISED, INSPECTED AND APPROVED BY A ENVIRONMENTAL MONITOR.
8. ALL WORKS AND MATERIALS SHALL BE IN ACCORDANCE WITH APPLICABLE MUNICIPAL AND/OR PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS.
9. ALL GENERAL BACKFILL SHALL BE APPROVED MATERIAL COMPACTED TO 85% STANDARD PROCTOR DENSITY.
10. ALL UNSUITABLE AND/OR EXCESS MATERIALS SHALL BE DEPOSITED IN A SPOIL AREA DETERMINED BYENVIRONMENTAL MONITOR.
11. IMMEDIATELY AFTER CONSTRUCTION, ALL DISTURBED AREAS SHALL BE STABILIZED AND/OR RESTORED TO ORIGINAL CONDITION.
12. THE CONTRACTOR SHALL REMOVE ALL SEDIMENT CONTROLS AFTER VEGETATION HAS ESTABLISHED. WORKS WILL NOT BE CONSIDERED COMPLETE UNTIL ALL TEMPORARY SEDIMENT CONTROLS ARE REMOVED.

WATERCOURSE PROTECTION

1. MITIGATION MEASURES SECTION OF HEMMERA (2015) FINAL CONSTRUCTION PLAN TO BE REVIEWED AND ADHERED TO.
2. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AS PER APPLICABLE PLANS.
3. ADDITIONAL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED IF IT IS DETERMINED THAT APPROVED CONTROLS DO NOT ADEQUATELY PREVENT EROSION AND RELEASE OF SEDIMENT.
4. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS NOT REQUIRED, EQUIPMENT SHALL NOT BE OPERATED IN SUCH AREAS.
5. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS REQUIRED, THE USE OF EQUIPMENT WITHIN THE WATERCOURSE SHALL BE MINIMIZED.
6. WORK IN A WATERCOURSE AND ON WATERCOURSE BANKS SHALL BE COMPLETED IN THE DRY IN AN ISOLATED WORK AREA DURING LOW-FLOW CONDITIONS.
7. THE WEATHER FORECAST SHALL BE CONTINUALLY MONITORED TO ENSURE THAT CONSTRUCTION ACTIVITIES MAY PROCEED UNDER FAVOURABLE CONDITIONS.
8. EXCAVATION OF THE WATERCOURSE BED AND PLACEMENT OF MATERIALS SHALL BE STAGED SO THAT NO EXCAVATED AREAS REMAIN EXPOSED AT THE END OF EACH WORKING DAY.
9. IF FLOWS WITHIN A WATERCOURSE ARE OBSERVED TO RISE TO A LEVEL APPROACHING THE PUMPING CAPACITY, PLACEMENT OF MATERIALS IN EXCAVATED AREAS MUST BE COMPLETED AS SOON AS POSSIBLE, AFTER WHICH WORK MUST BE SHUT DOWN UNTIL THE FLOW RETURNS TO A LEVEL WITHIN THE PROVIDED PUMPING CAPACITY.
10. ALL EQUIPMENT SHALL BE CLEAN AND FREE OF PETROLEUM PRODUCTS.
11. ALL MAINTENANCE, REFUELING AND STORAGE OF EQUIPMENT SHALL BE CONTROLLED SO AS TO PREVENT ANY DISCHARGE OF PETROLEUM PRODUCTS. VEHICULAR MAINTENANCE AND REFUELING SHALL BE CONDUCTED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.
12. CONSTRUCTION MATERIAL, EXCESS MATERIAL, CONSTRUCTION DEBRIS AND EMPTY CONTAINERS SHALL BE STORED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.

DATE	BY	REVISIONS
07-10-16	D.W.	ISSUED FOR CONSTRUCTION

DESIGNED BY: D.W. CHECKED BY: D.W.

DRAWN BY: D.W. DATE: AUGUST 10, 2015

July 10, 2016

PROFESSIONAL ENGINEER · PROVINCE OF BRITISH COLUMBIA · D. T. WEST # 41242

ECOFISH RESEARCH

ALENA CREEK FHEP DETAILED CONSTRUCTION PLAN

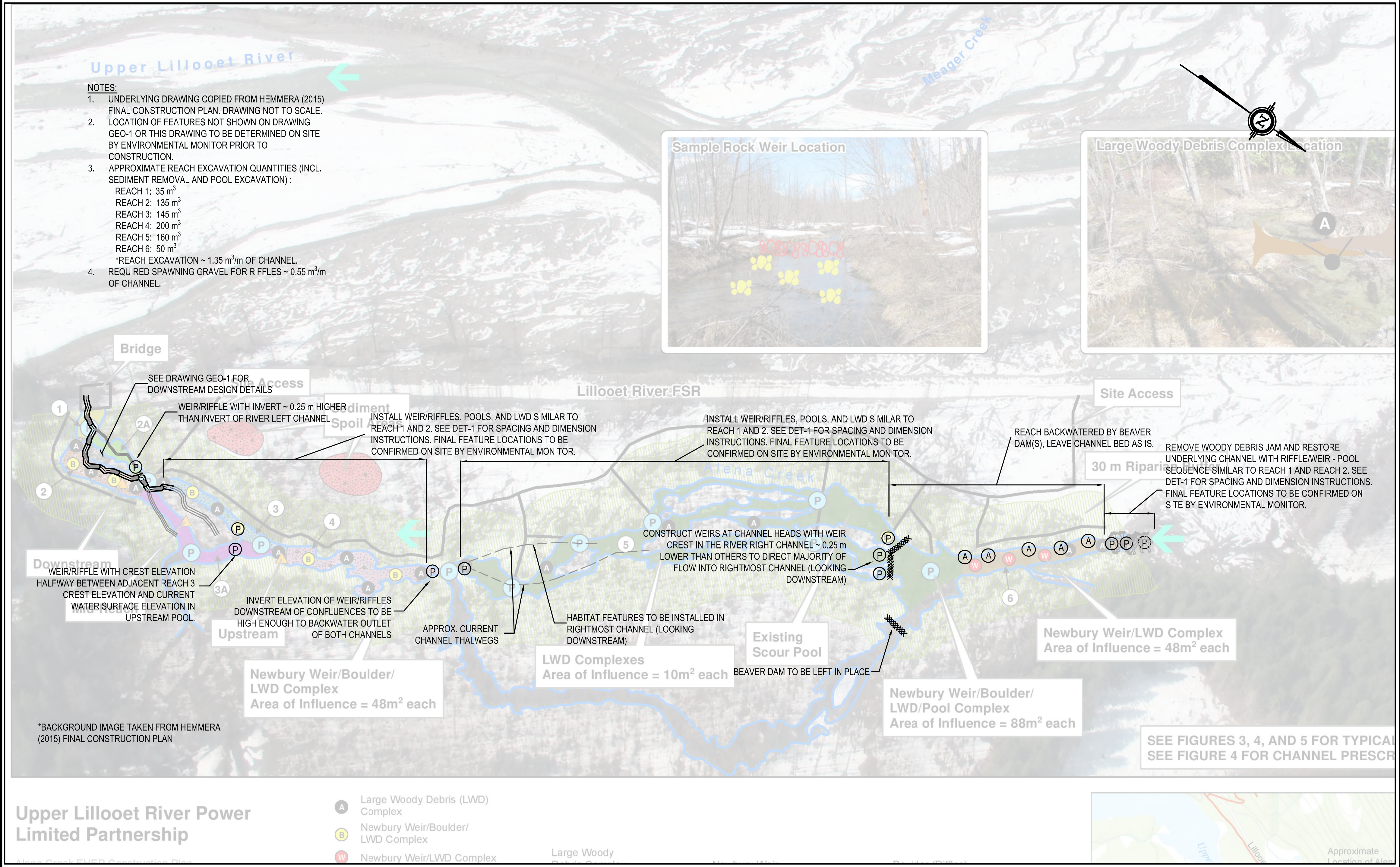
CHANNEL GEOMETRY DETAILS

PROJECT No.: 1095.16 DRAWING No.: DET-1

SCALE: AS SHOWN SHEET 2 OF 3

NOTES:

1. UNDERLYING DRAWING COPIED FROM HEMMERA (2015) FINAL CONSTRUCTION PLAN. DRAWING NOT TO SCALE.
2. LOCATION OF FEATURES NOT SHOWN ON DRAWING GEO-1 OR THIS DRAWING TO BE DETERMINED ON SITE BY ENVIRONMENTAL MONITOR PRIOR TO CONSTRUCTION.
3. APPROXIMATE REACH EXCAVATION QUANTITIES (INCL. SEDIMENT REMOVAL AND POOL EXCAVATION) :
   - REACH 1: 35 m^3
   - REACH 2: 135 m^3
   - REACH 3: 145 m^3
   - REACH 4: 200 m^3
   - REACH 5: 160 m^3
   - REACH 6: 50 m^3
   - *REACH EXCAVATION ~ 1.35 m^3/m OF CHANNEL.
4. REQUIRED SPAWNING GRAVEL FOR RIFFLES ~ 0.55 m^3/m OF CHANNEL.



PLANVIEW

N.T.S.

RECOMMENDED CONSTRUCTION SEQUENCE

* MITIGATION MEASURES SECTION OF HEMMERA (2015) FINAL CONSTRUCTION PLAN TO BE ADHERED TO. IF AN APPARENT INCONSISTENCY IS IDENTIFIED, THE ENVIRONMENTAL MONITOR IS TO BE CONSULTED.

PHASE 1 (REACH 1):

1. ISOLATE REACH 1 BY INSTALLING COFFERDAM AND PUMPING OR FLUMING FLOW AROUND SITE.
2. FISH RESCUE OF REACH 1 TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
3. COMPLETE CHANNEL WORKS IN REACH 1 AND REACTIVATE FLOW BY DISMANTLING COFFERDAM.

PHASE 2 (REACH 2 & 2A):

4. ISOLATE REACH 2 BY INSTALLING COFFERDAM AT UPSTREAM EXTENT TO DIVERT FLOW THROUGH REACH 2A.
5. FISH RESCUE OF REACH 1 TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
6. COMPLETE CHANNEL WORKS IN REACH 2 AND REACTIVATE CHANNEL BY SLOWLY DISMANTLING COFFERDAM.
7. ISOLATE REACH 2A BY INSTALLING COFFERDAM AT UPSTREAM EXTENT TO DIVERT FLOW THROUGH REACH 2.
8. CONSTRUCT RIFFLE/WEIR AT HEAD OF REACH 2A WITH CREST ~ 0.25 m HIGHER THAN ADJACENT REACH 2 CREST.

PHASE 3 (REACH 3 & 3A):

9. FEATURE LOCATIONS TO BE ESTABLISHED ON SITE BY ENVIRONMENTAL MONITOR.
10. ISOLATE REACH 3 BY INSTALLING COFFERDAM AT UPSTREAM EXTENT TO DIVERT FLOW THROUGH REACH 3A.
11. FISH RESCUE OF REACH 3 TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
12. COMPLETE CHANNEL WORKS IN REACH 3 BY FOLLOWING INSTALLATION INSTRUCTIONS ON DRAWING DET-1 IN CONSULTATION WITH ECOFISH TECHNICIAN.
13. REACTIVATE REACH 3 BY SLOWLY DISMANTLING COFFERDAM.
14. ISOLATE HEAD OF REACH 3A BY INSTALLING COFFERDAMS ABOVE AND BELOW PROPOSED WEIR LOCATION.
15. FISH RESCUE OF ISOLATED AREA TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
16. PUMP FLOW FROM REACH 4 FORK INTO REACH 3A AT A NATURAL RATE.
17. CONSTRUCT RIFFLE/WEIR AT HEAD OF REACH 3A WITH CREST ELEVATION HALFWAY BETWEEN ADJACENT REACH 3 CREST ELEVATION AND CURRENT WATER SURFACE ELEVATION IN UPSTREAM POOL.
18. REACTIVATE ISOLATED AREA BY DISMANTLING COFFERDAM.

PHASE 4 (REACH 4):

19. FEATURE LOCATIONS TO BE ESTABLISHED ON SITE BY ENVIRONMENTAL MONITOR.
20. ISOLATE FEATURE LOCATIONS ONE AT A TIME BEGINNING AT DOWNSTREAM BY INSTALLING COFFERDAM ABOVE AND BELOW EXTENTS OF FEATURE AND PUMPING OR FLUMING FLOW AROUND ISOLATED AREA.
21. FISH RESCUE OF ISOLATED AREAS TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
22. PHASE 5 (REACH 5):
23. FEATURE LOCATIONS TO BE ESTABLISHED ON SITE BY ENVIRONMENTAL MONITOR.
24. ISOLATE FEATURE LOCATIONS ONE AT A TIME BEGINNING AT DOWNSTREAM BY INSTALLING COFFERDAM ABOVE AND BELOW EXTENTS AND PUMPING OR FLUMING FLOW AROUND. DIVERSION OF FLOWS INTO ADJACENT CUTOFF CHANNELS MAY ALSO BE FEASIBLE AND WILL BE DISCUSSED WITH ENVIRONMENTAL MONITOR PRIOR TO DIVERSION.
25. FISH RESCUE OF ISOLATED AREAS TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
26. FOR EACH CUTOFF CHANNEL OF REACH 5, COMPLETE STEPS 28 TRHOUGH 32.
27. ISOLATE HEAD OF CUTOFF CHANNEL BY INSTALLING COFFERDAMS ABOVE AND BELOW PROPOSED WEIR LOCATIONS ONE BY ONE.
28. PUMP FLOW AROUND ISOLATED AREA AT A NATURAL RATE.
29. FISH RESCUE OF ISOLATED AREA TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
30. INSTALL RIFFLE/WEIR NEAR HEAD OF CUTOFF CHANNEL DOWNSTREAM OF BEAVERDAM. CREST ELEVATION OF RIGHTMOST CHANNEL TO BE LOWEST. CREST ELEVATIONS TO BE DETERMINED IN FIELD BY ENVIRONMENTAL MONITOR.
31. REACTIVATE ISOLATED AREA BY DISMANTLING COFFERDAM.

PHASE 6 (REACH 6):

32. ISOLATE WOODY DEBRIS JAM BY INSTALLING COFFERDAM ABOVE AND BELOW EXTENTS AND PUMPING OR FLUMIING AROUND.
33. FISH RESCUE OF ISOLATED AREAS TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
34. REMOVE WOODY DEBRIS PIECES AND DEPOSIT IN SPOIL AREA APPROVED BY ENVIRONMENTAL MONITOR.
35. FEATURES TO BE INSTALLED AT LOCATIONS SPECIFIED BY ENVIRONMENTAL MONITOR ON SITE.
36. REACTIVATE ISOLATED AREA BY DISMANTLING COFFERDAM.

	07-10-16	D.W.	ISSUED FOR CONSTRUCTION
	DATE	BY	REVISIONS

DESIGNED BY:	D.W.	CHECKED BY:	D.W.
DRAWN BY:	D.W.	DATE:	AUGUST 10, 2015

July 10 2016

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. T. WEST # 41242

ECOFISH RESEARCH

ALENA CREEK FHEP DETAILED CONSTRUCTION PLAN

FULL SITE PLANFORM AND PHASING

PROJECT No.:	1095.16	DRAWING No.:	PESC-1
SCALE:	AS SHOWN	SHEET 3 OF 3	

Appendix B. Water Temperature Guidelines, Data Summary, and Site Photographs

LIST OF FIGURES

LIST OF TABLES

1. WATER TEMPERATURE GUIDELINES

Table 1. Water temperature guidelines for the protection of freshwater aquatic life (Oliver and Fidler 2001).

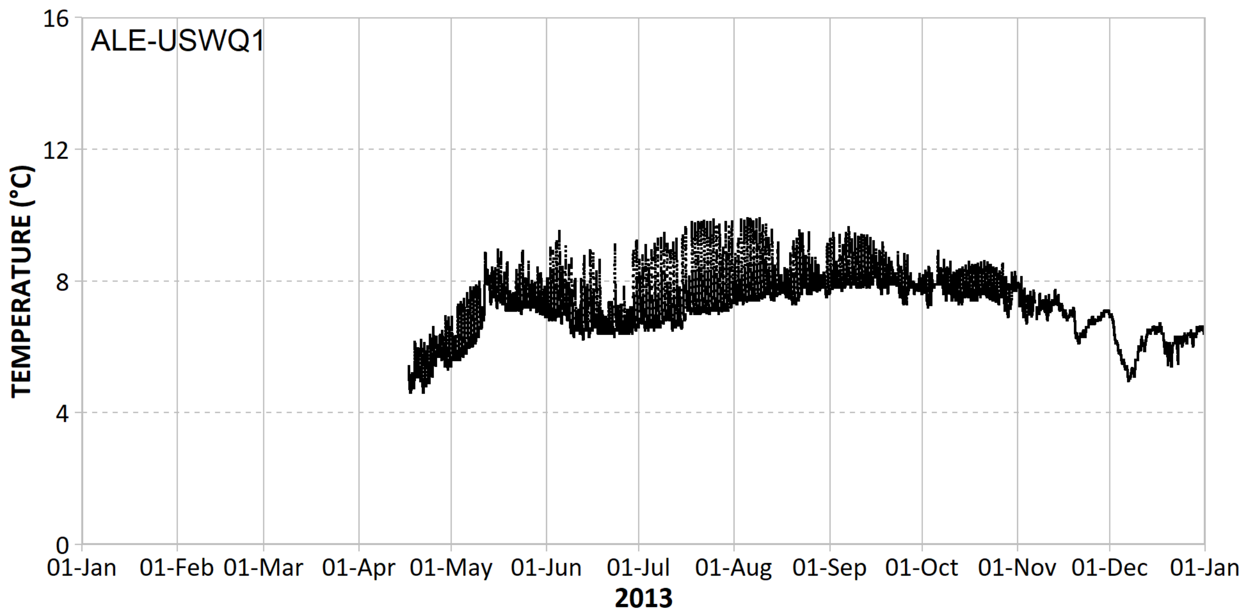
Category	Guideline[1]
All Streams	the rate of temperature change in natural water bodies not to exceed 1°C/hr
	temperature metrics to be described by the mean weekly maximum temperature (MWMxT)
Streams with Known Fish Presence	mean weekly maximum water temperatures should not exceed ±1°C beyond the optimum temperature range for each life history phase of the most sensitive salmonid species present[1]
Streams with Bull Trout or Dolly Varden	maximum daily temperature is 15°C
	maximum incubation temperature is 10°C
	minimum incubation temperature is 2°C
	maximum spawning temperature is 10°C
Streams with Unknown Fish Presence	salmonid rearing temperatures not to exceed MWMxT of 18°C
	maximum daily temperature not to exceed 19°C
	maximum temperature for salmonid incubation from June until August not to exceed 12°C

[1] The guidelines state that "the natural temperature cycle characteristic of the site should not be altered in amplitude or frequency by human activities". Accordingly, it is implied that when conditions are naturally outside of guidelines, human activities should not increase the magnitude and/or frequency to which conditions are outside of guidelines.

2. ANNUAL WATER TEMPERTURE PLOTS

2.1. ALE-USWQ1

Figure 1. ALE-USWQ1 pre-construction annual plots (2013 to 2014).



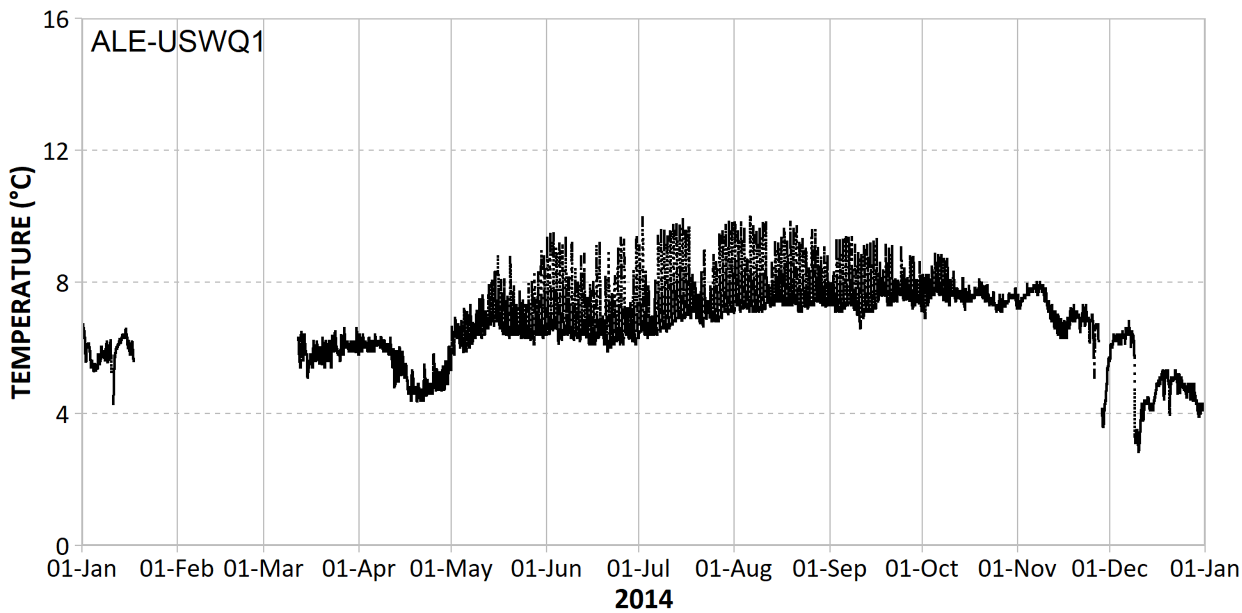
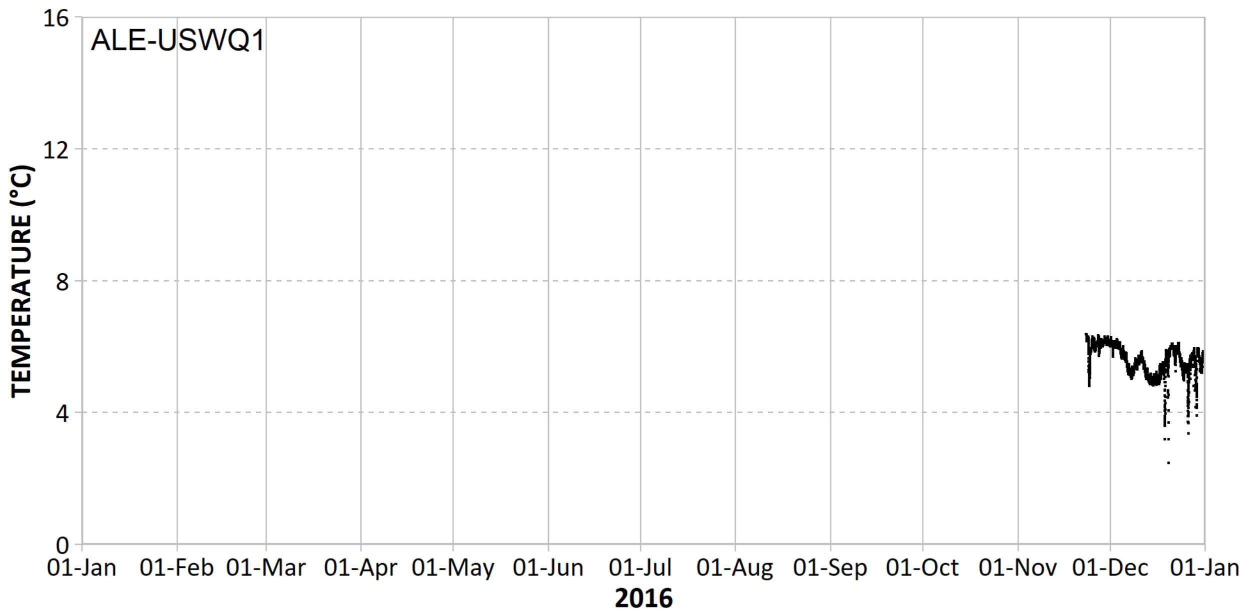


Figure 2. ALE-USWQ1 post-construction annual plots (2016 to 2021).



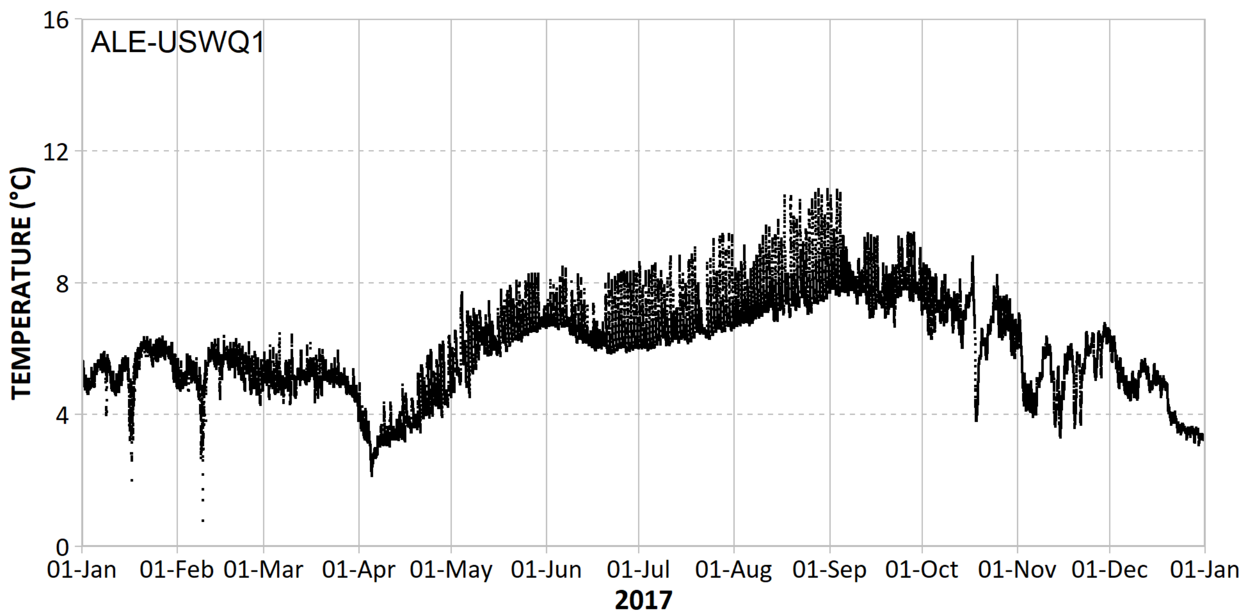
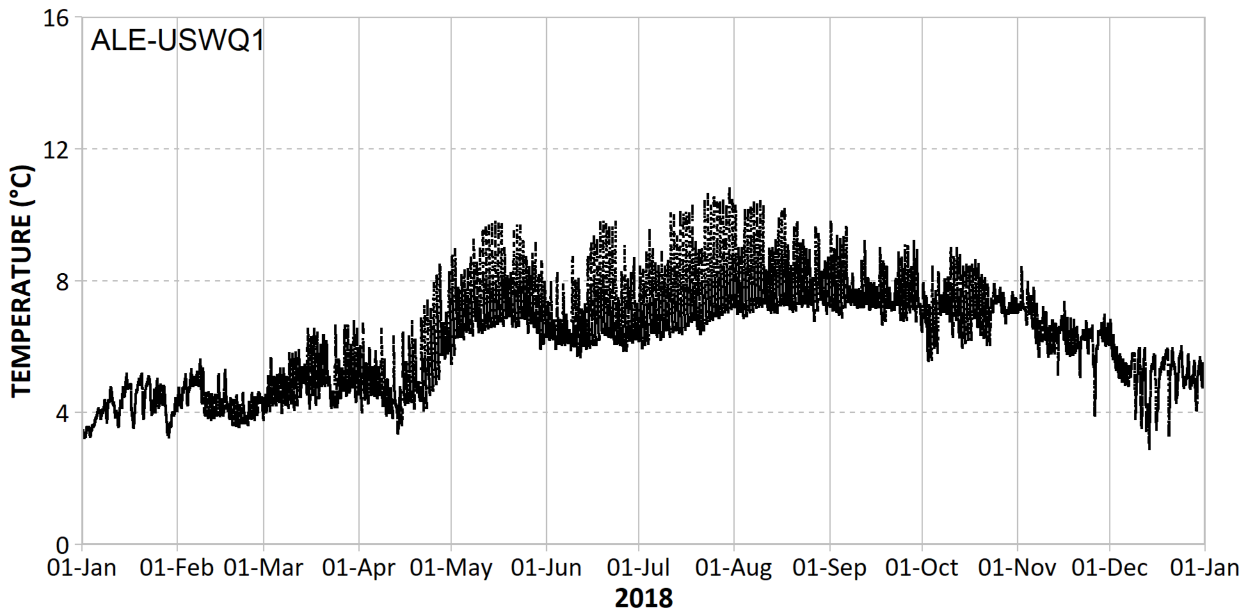


Figure 2. Continued.



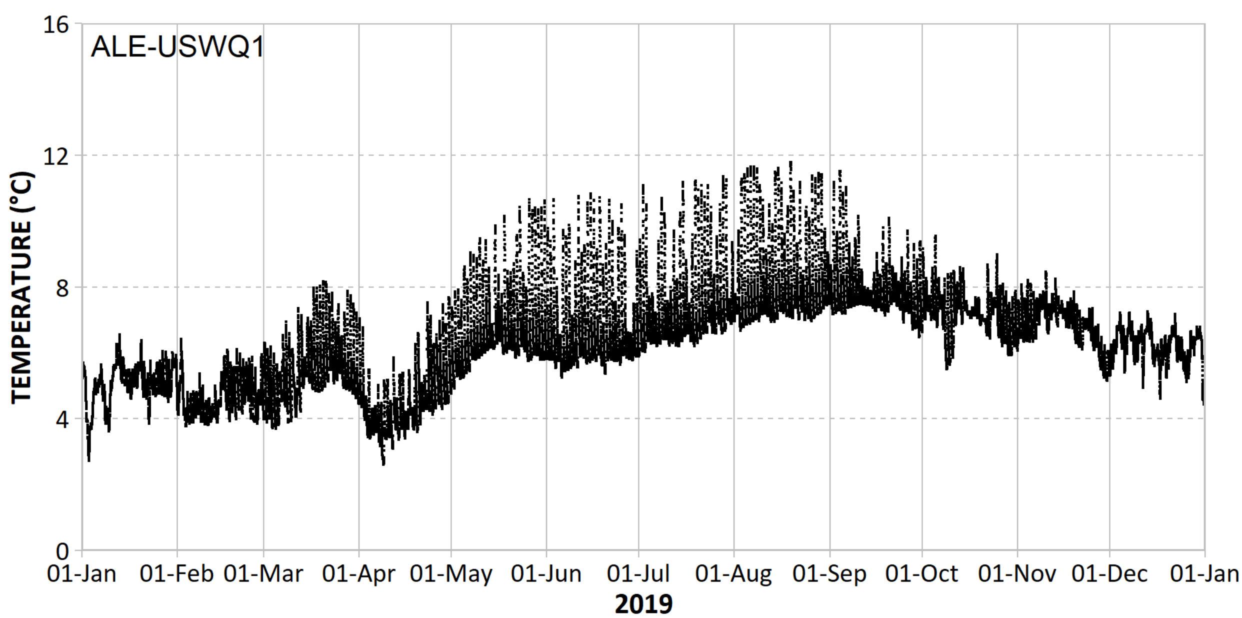
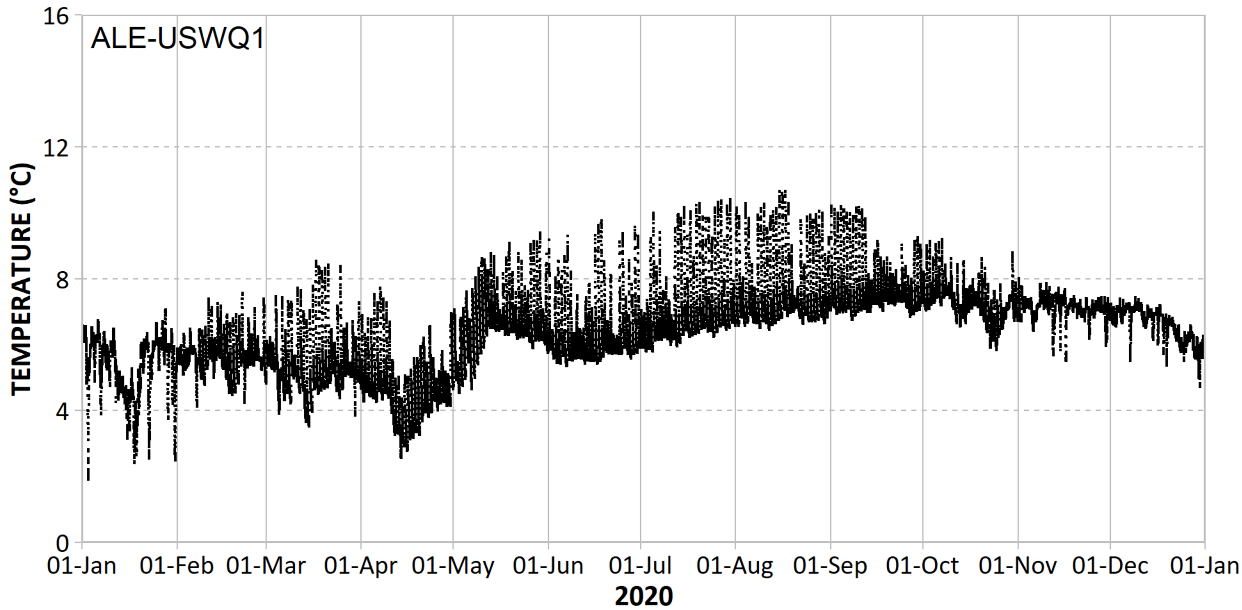
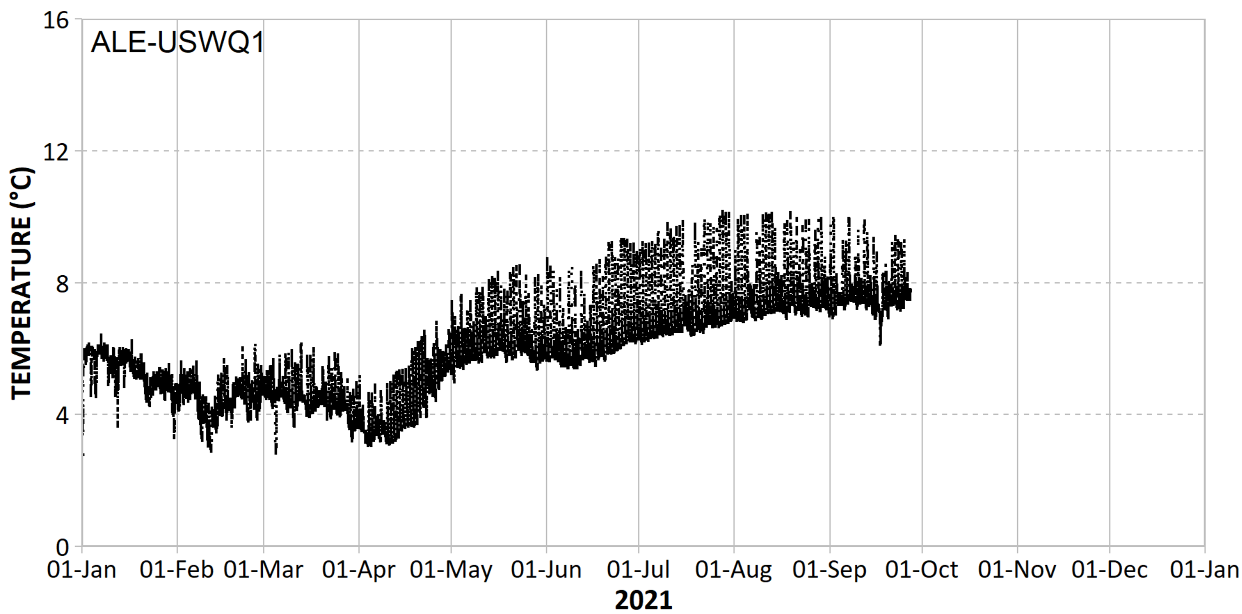


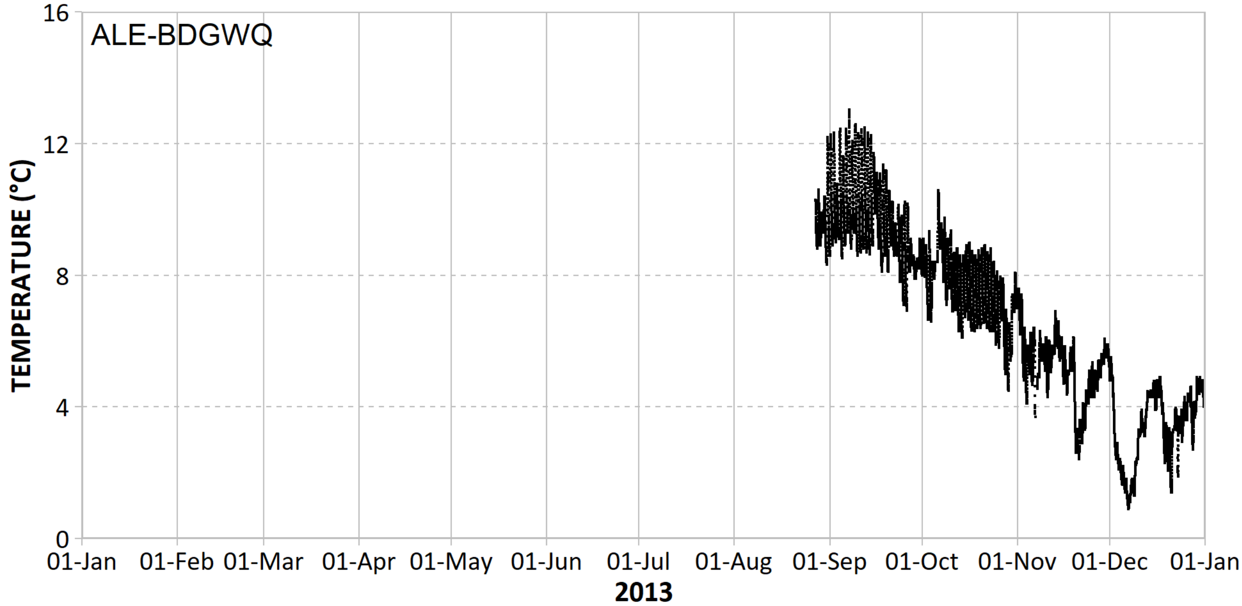
Figure 2. Continued.





2.2. ALE-BDGWQ

Figure 3. ALE-BDGWQ pre-construction annual plots (2013 to 2014).



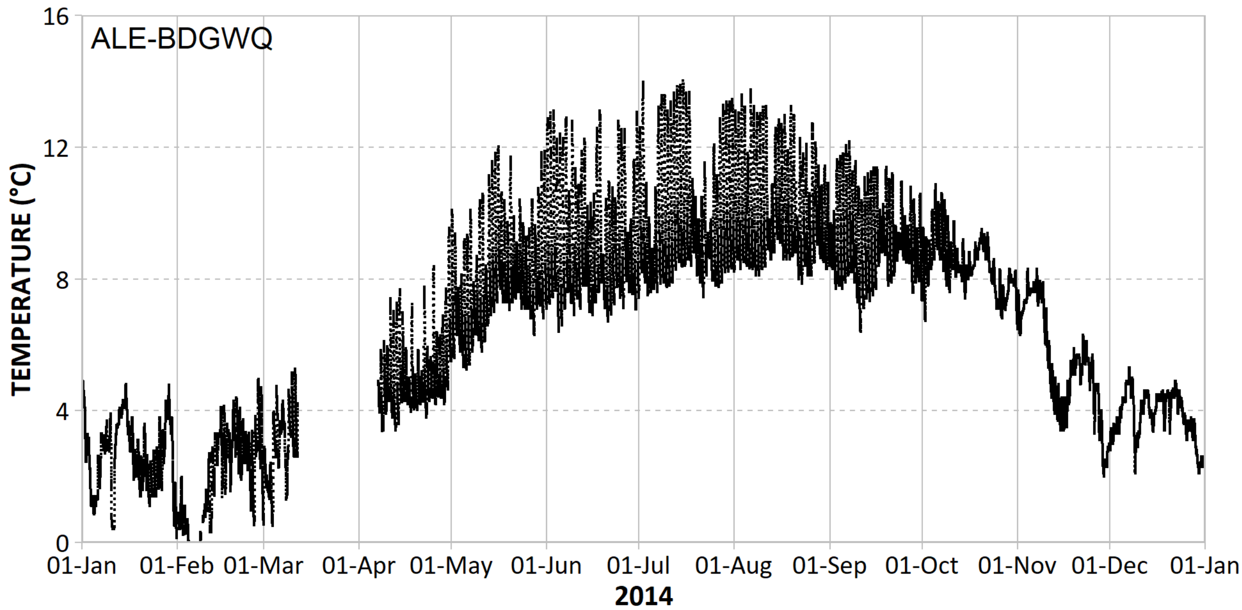
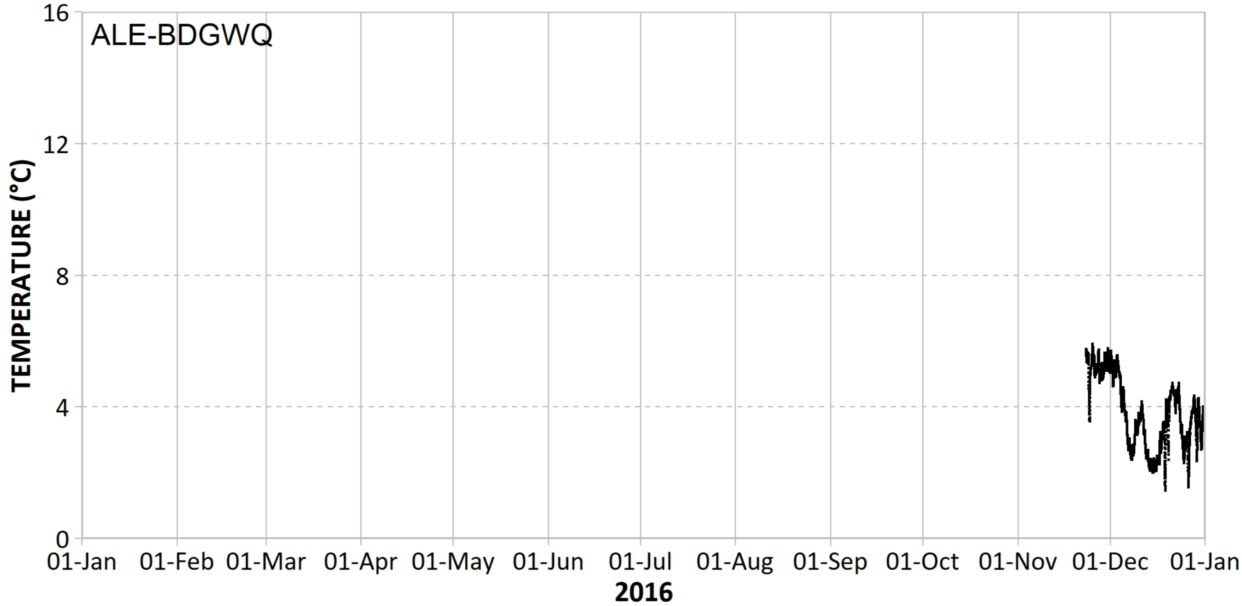


Figure 4. ALE-BDGWQ post-construction annual plots (2016 to 2021).



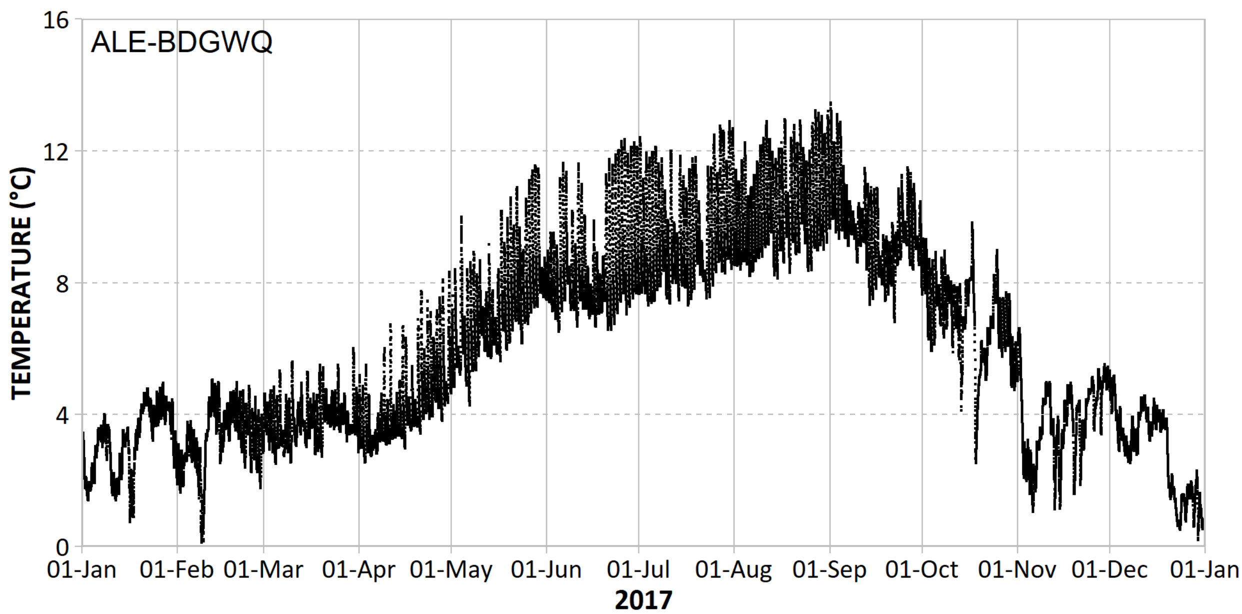
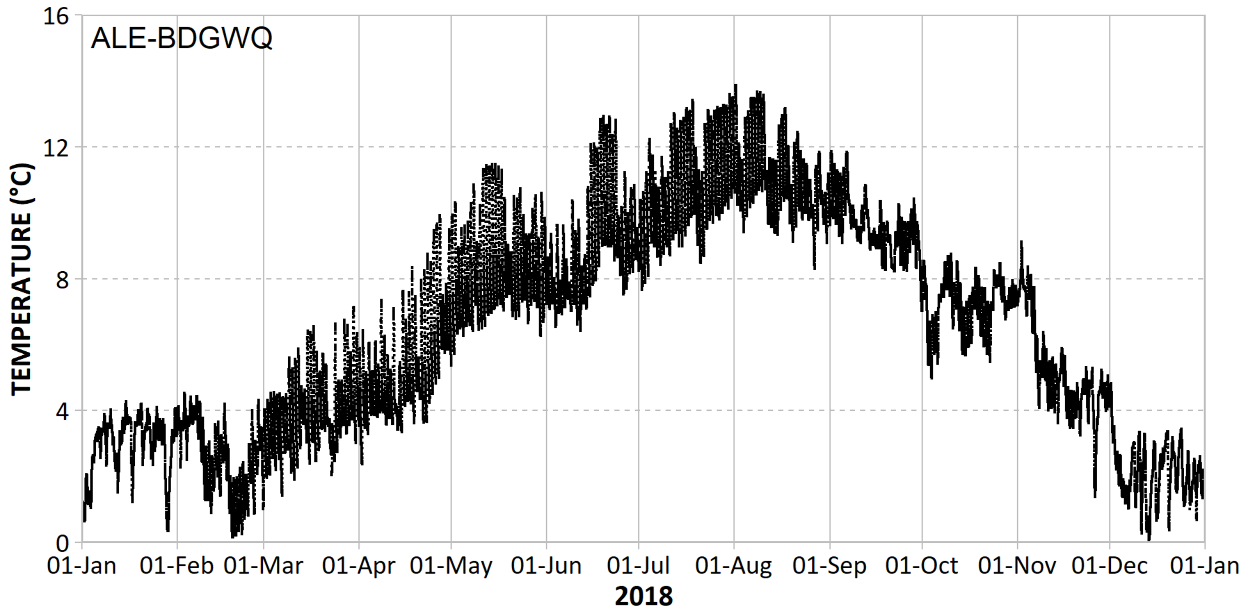


Figure 4. Continued.



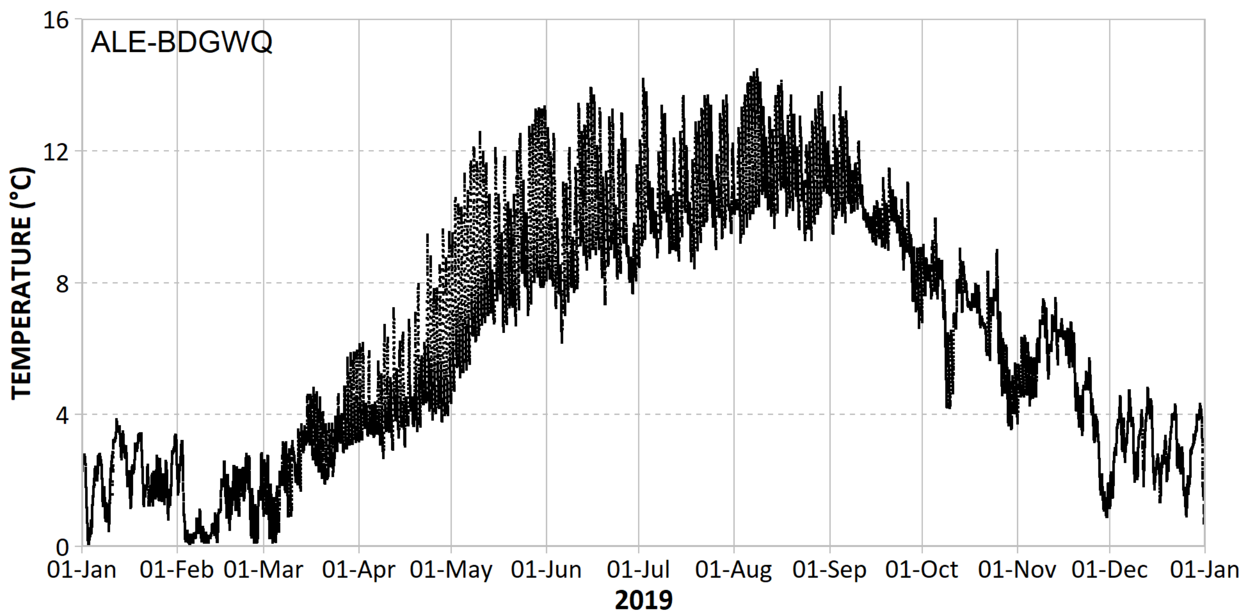
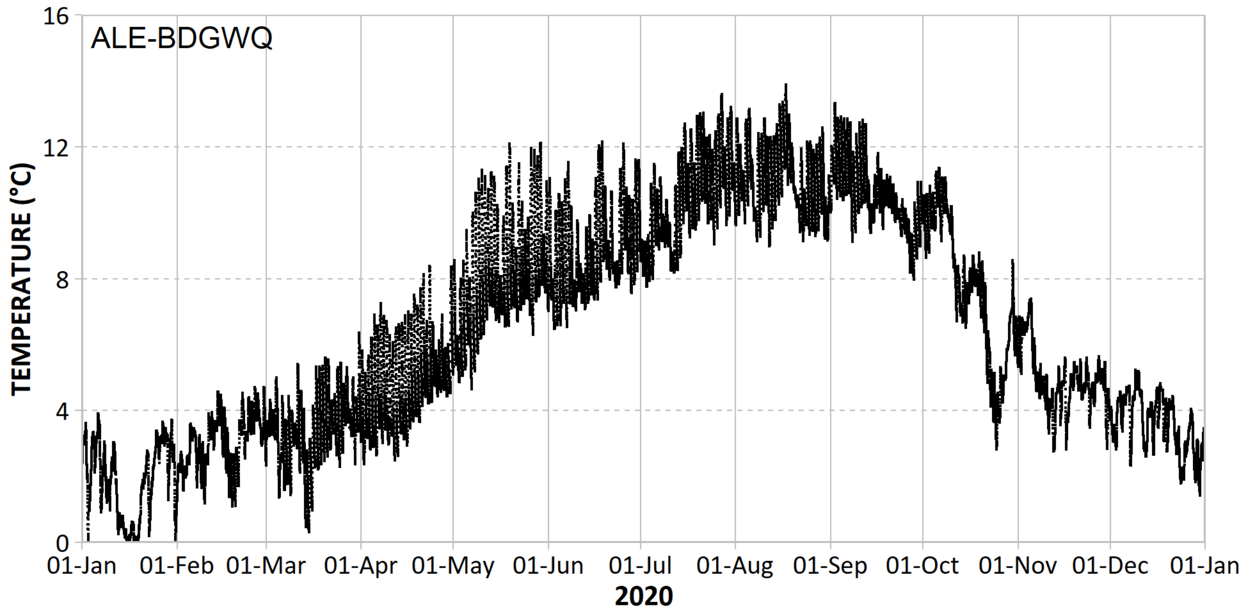
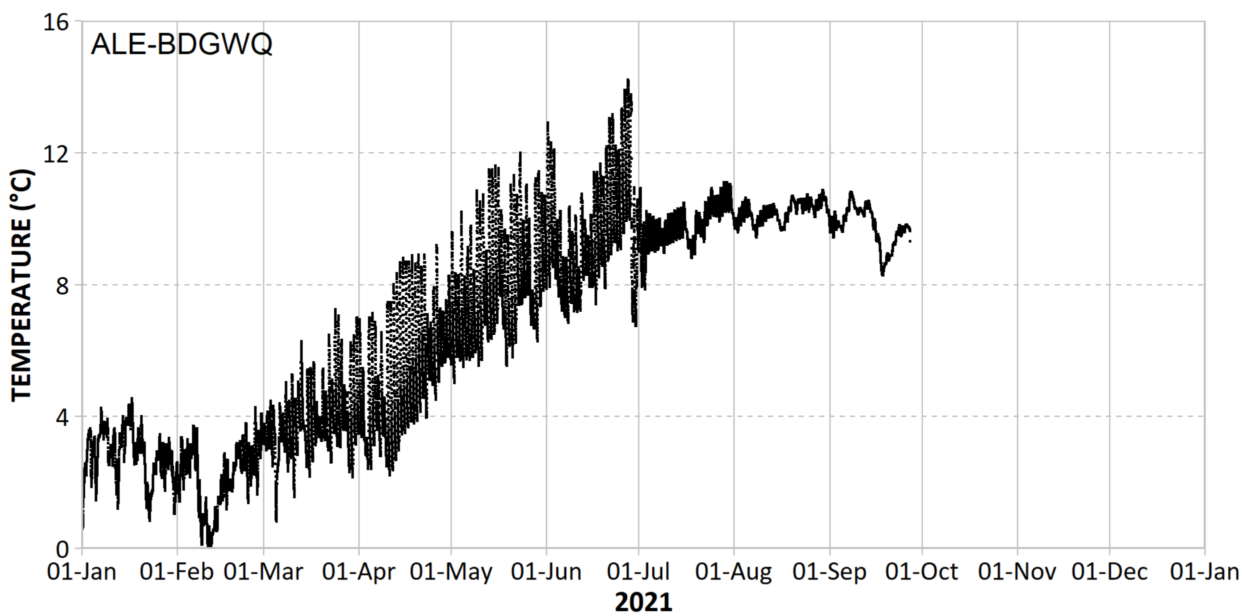


Figure 4. Continued.





3. REPRESENTATIVE WATER TEMPERATURE SITE PHOTOGRAPHS

Figure 5. Looking downstream at ALE-BDGWQ on September 27, 2021.

Figure 6. Looking upstream at ALE-BDGWQ on September 27, 2021.

Figure 7. Looking RR-RL at ALE-USWQ1 on September 27, 2021.

Figure 8. Looking at ALE-USWQ1 Tidbits on September 27, 2021.

REFERENCES

Oliver, G.G. and L.E. Fidler. 2001. Towards a water quality guideline for temperature in the Province of British Columbia. Prepared for Ministry of Environment, Lands and Parks, Water Management Branch, Water Quality Section, Victoria, B.C. Prepared by Aspen Applied Sciences Ltd., Cranbrook, B.C., 53 pp + appnds. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/temperature-tech.pdf. Accessed February 10, 2022.

Appendix C. Photographs of Alena Creek Fish Habitat Enhancement Project Stability Assessment Year 5 Monitoring

LIST OF FIGURES

Figure 1. ALE-XS1 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 2. ALE-XS1 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 3. ALE-XS1 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 4. ALE-XS1 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 5. ALE-XS1 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 6. ALE-XS1 on October 27, 2021.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 7. ALE-XS2 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 8. ALE-XS2 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 9. ALE-XS2 on November 05, 2018.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 10. ALE-XS2 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 11. ALE-XS2 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 12. ALE-XS2 on October 27, 2021.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 13. ALE-XS3 on September 19, 2016.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 14. ALE-XS3 on November 10, 2017.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 15. ALE-XS3 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 16. ALE-XS3 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 17. ALE-XS3 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 18. ALE-XS3 on October 27,2021.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 19. ALE-XS4 on September 19, 2016.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 20. ALE-XS4 on November 10, 2017.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 21. ALE-XS4 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 22. ALE-XS4 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 23. ALE-XS4 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 24. ALE-XS4 on October 27, 2021.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 25. ALE-XS5 on September 19, 2016.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 26. ALE-XS5 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 27. ALE-XS5 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 28. ALE-XS5 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 29. ALE-XS5 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 30. ALE-XS5 on October 27, 2021.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 31. ALE-XS6 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 32. ALE-XS6 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 33. ALE-XS6 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 34. ALE-XS6 on November 13, 2019.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 35. ALE-XS6 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 36. ALE-XS6 on October 27, 2021.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 37. ALE-XS7 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 38. ALE-XS7 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 39. ALE-XS7 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 40. ALE-XS7 on November 13, 2019.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 41. ALE-XS7 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

ECOFISH RESEARCH

Figure 42. ALE-XS7 on October 27, 2021.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 43. ALE-XS8 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 44. ALE-XS8 on November 10, 2017.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 45. ALE-XS8 on November 05, 2018.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 46. ALE-XS8 on November 13, 2019.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 47. ALE-XS8 on November 07, 2020

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 48. ALE-XS8 on October 27, 2021

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Appendix D. Raw Data Tables and Representative Photographs from Fish Community Surveys

LIST OF FIGURES

LIST OF TABLES

Figure 1. Minnow trap #1 at sampling site ALE-MT01 on September 27, 2021.

Figure 2. Minnow trap #3 at sampling site ALE-MT02 on September 27, 2021.

Figure 3. Minnow trap #2 at sampling site ALE-MT03 on September 27, 2021.

Figure 4. Minnow trap #3 at sampling site ALE-MT05 on September 27, 2021.

Figure 5. Minnow trap #10 at sampling site ALE-MT06 on September 27, 2021.

Figure 6. Minnow trap #1 at sampling site ALE-MT07 on September 27, 2021.

Figure 7. Minnow trap #2 at sampling site ALE-MT08 on September 27, 2021.

Figure 8. Minnow trap #4 at sampling site ALE-MT09 on September 27, 2021.

Table 1. Summary of minnow traps soak times and capture data at each site.

Site	Trap #	Mesh Size (mm)	Date In	Time In	Date Out	Time Out	Trap Depth	Soak Time (hrs)	Catch[1]	
									CO	CT
ALE-MT01	1	6.4	27/Sep/21	10:24	28/Sep/21	09:00	0.57	22.60	7	0
ALE-MT01	2	6.4	27/Sep/21	10:26	28/Sep/21	09:00	0.68	22.57	2	0
ALE-MT01	3	6.4	27/Sep/21	10:28	28/Sep/21	09:00	0.90	22.53	4	0
ALE-MT01	4	6.4	27/Sep/21	10:29	28/Sep/21	09:00	0.97	22.52	5	0
ALE-MT01	5	6.4	27/Sep/21	10:32	28/Sep/21	09:00	0.60	22.47	11	0
ALE-MT02	1	6.4	27/Sep/21	11:11	28/Sep/21	10:23	0.30	23.20	12	1
ALE-MT02	2	6.4	27/Sep/21	11:14	28/Sep/21	10:23	0.50	23.15	5	0
ALE-MT02	3	3.2	27/Sep/21	11:15	28/Sep/21	10:23	0.75	23.13	25	0
ALE-MT02	4	6.4	27/Sep/21	11:16	28/Sep/21	10:23	0.90	23.12	8	0
ALE-MT02	5	3.2	27/Sep/21	11:16	28/Sep/21	10:23	0.50	23.12	0	0
ALE-MT07	1	3.2	27/Sep/21	11:29	28/Sep/21	11:19	0.45	23.83	14	0
ALE-MT07	2	6.4	27/Sep/21	11:30	28/Sep/21	11:20	0.90	23.83	10	1
ALE-MT07	3	6.4	27/Sep/21	11:32	28/Sep/21	11:21	0.90	23.82	23	0
ALE-MT07	4	3.2	27/Sep/21	11:33	28/Sep/21	11:22	0.45	23.82	1	0
ALE-MT07	5	3.2	27/Sep/21	11:35	28/Sep/21	11:22	0.55	23.78	12	0
ALE-MT03	1	6.4	27/Sep/21	11:53	28/Sep/21	12:14	0.43	24.35	32	2
ALE-MT03	2	6.4	27/Sep/21	11:54	28/Sep/21	12:14	0.45	24.33	10	1
ALE-MT03	3	3.2	27/Sep/21	11:55	28/Sep/21	12:14	0.70	24.32	35	0
ALE-MT03	4	3.2	27/Sep/21	11:56	28/Sep/21	12:14	0.35	24.30	5	0
ALE-MT03	5	3.2	27/Sep/21	11:57	28/Sep/21	12:14	0.90	24.28	12	0
ALE-MT06	1	3.2	27/Sep/21	13:01	28/Sep/21	13:54	0.30	24.88	24	0
ALE-MT06	2	6.4	27/Sep/21	13:03	28/Sep/21	13:55	0.50	24.87	40	5
ALE-MT06	3	3.2	27/Sep/21	13:03	28/Sep/21	13:56	0.80	24.88	62	0
ALE-MT06	4	3.2	27/Sep/21	13:05	28/Sep/21	13:56	0.95	24.85	72	0
ALE-MT06	5	6.4	27/Sep/21	13:06	28/Sep/21	13:57	1.20	24.85	28	1
ALE-MT06	6	6.4	27/Sep/21	13:08	28/Sep/21	13:57	1.00	24.82	33	4
ALE-MT06	7	3.2	27/Sep/21	13:09	28/Sep/21	13:58	0.45	24.82	34	0
ALE-MT06	8	3.2	27/Sep/21	13:10	28/Sep/21	13:58	1.40	24.80	38	2
ALE-MT06	9	6.4	27/Sep/21	13:10	28/Sep/21	13:58	1.00	24.80	22	5
ALE-MT06	10	6.4	27/Sep/21	13:12	28/Sep/21	13:58	0.45	24.77	33	0
ALE-MT08	1	6.4	27/Sep/21	13:40	28/Sep/21	15:45	0.45	26.08	20	0
ALE-MT08	2	3.2	27/Sep/21	13:40	28/Sep/21	15:45	0.65	26.08	24	0
ALE-MT08	3	6.4	27/Sep/21	13:41	28/Sep/21	15:45	0.30	26.07	25	1
ALE-MT08	4	3.2	27/Sep/21	13:43	28/Sep/21	15:45	0.45	26.03	30	0
ALE-MT08	5	6.4	27/Sep/21	13:45	28/Sep/21	15:45	0.23	26.00	7	0
ALE-MT09	1	6.4	27/Sep/21	13:26	28/Sep/21	16:20	0.75	26.90	16	0
ALE-MT09	2	3.2	27/Sep/21	13:27	28/Sep/21	16:20	0.30	26.88	7	1
ALE-MT09	3	6.4	27/Sep/21	13:28	28/Sep/21	16:21	1.00	26.88	6	0
ALE-MT09	4	6.4	27/Sep/21	13:29	28/Sep/21	16:22	0.45	26.88	34	1
ALE-MT09	5	3.2	27/Sep/21	13:30	28/Sep/21	16:23	0.40	26.88	40	0
ALE-MT05	1	3.2	27/Sep/21	14:00	28/Sep/21	17:15	0.45	27.25	79	0
ALE-MT05	2	3.2	27/Sep/21	14:00	28/Sep/21	17:15	1.00	27.25	35	1
ALE-MT05	3	3.2	27/Sep/21	14:01	28/Sep/21	17:15	0.50	27.23	24	1
ALE-MT05	4	3.2	27/Sep/21	14:02	28/Sep/21	17:15	0.45	27.22	43	1
ALE-MT05	5	6.4	27/Sep/21	14:03	28/Sep/21	17:15	0.36	27.20	8	0

[1] CO = Coho Salmon, CT = Cutthroat Trout

Table 2. Detailed fish capture, fork length and age assigned data.

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT01	2021-Sep-27	1	CO	61		2.2	0.97					0
ALE-MT01	2021-Sep-27	1	CO	69		3.4	1.03	SC	1	FC	1	0
ALE-MT01	2021-Sep-27	1	CO	72		4.4	1.18					1
ALE-MT01	2021-Sep-27	1	CO	75		5.8	1.37					1
ALE-MT01	2021-Sep-27	1	CO	78		3.7	0.78					1
ALE-MT01	2021-Sep-27	1	CO	80		4.2	0.82					1
ALE-MT01	2021-Sep-27	1	CO	85		5.2	0.85					1
ALE-MT01	2021-Sep-27	2	CO	74		5.3	1.31					1
ALE-MT01	2021-Sep-27	2	CO	99		8.6	0.89	SC	3	FC	3	1
ALE-MT01	2021-Sep-27	3	CO	54		3.1	1.97					0
ALE-MT01	2021-Sep-27	3	CO	54		3.1	1.97	SC	5	FC	5	0
ALE-MT01	2021-Sep-27	3	CO	94		7.3	0.88					1
ALE-MT01	2021-Sep-27	3	CO	95		8.9	1.04					1
ALE-MT01	2021-Sep-27	4	CO	52		2.5	1.78					0
ALE-MT01	2021-Sep-27	4	CO	83		7.0	1.22					1
ALE-MT01	2021-Sep-27	4	CO	85		6.2	1.01	SC	6	FC	6	1
ALE-MT01	2021-Sep-27	4	CO	89		7.5	1.06					1
ALE-MT01	2021-Sep-27	4	CO	92		9.3	1.19					1
ALE-MT01	2021-Sep-27	5	CO	65		3.6	1.31					0
ALE-MT01	2021-Sep-27	5	CO	75		4.9	1.16					1
ALE-MT01	2021-Sep-27	5	CO	78		4.7	0.99					1
ALE-MT01	2021-Sep-27	5	CO	80		6.4	1.25					1
ALE-MT01	2021-Sep-27	5	CO	82		5.9	1.07					1
ALE-MT01	2021-Sep-27	5	CO	84		5.1	0.86					1
ALE-MT01	2021-Sep-27	5	CO	85		5.6	0.91					1
ALE-MT01	2021-Sep-27	5	CO	89		7.5	1.06					1
ALE-MT01	2021-Sep-27	5	CO	90		6.7	0.92					1
ALE-MT01	2021-Sep-27	5	CO	93		8.3	1.03					1
ALE-MT01	2021-Sep-27	5	CO	95		8.3	0.97					1
ALE-MT02	2021-Sep-27	1	CO	42		1.0	1.35					0
ALE-MT02	2021-Sep-27	1	CO	45		1.0	1.10					0
ALE-MT02	2021-Sep-27	1	CO	54		1.8	1.14					0
ALE-MT02	2021-Sep-27	1	CO	54		2.3	1.46					0
ALE-MT02	2021-Sep-27	1	CO	56		1.9	1.08					0
ALE-MT02	2021-Sep-27	1	CO	65		3.4	1.24					0
ALE-MT02	2021-Sep-27	1	CO	67		4.6	1.53					0
ALE-MT02	2021-Sep-27	1	CO	73		4.2	1.08					1
ALE-MT02	2021-Sep-27	1	CO	75		4.7	1.11					1
ALE-MT02	2021-Sep-27	1	CO	82		6.8	1.23					1
ALE-MT02	2021-Sep-27	1	CO	83		6.0	1.05					1
ALE-MT02	2021-Sep-27	1	CO	86		7.3	1.15	SC	2	FC	2	1
ALE-MT02	2021-Sep-27	1	CT	83		5.6	0.98	SC	1	FC	1	1
ALE-MT02	2021-Sep-27	2	CO	59		2.3	1.12					0
ALE-MT02	2021-Sep-27	2	CO	70		3.8	1.11					1
ALE-MT02	2021-Sep-27	2	CO	86		7.8	1.23					1
ALE-MT02	2021-Sep-27	2	CO	92		8.3	1.07					1
ALE-MT02	2021-Sep-27	2	CO	97		9.8	1.07	SC	3	FC	3	1

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

ECOFISH RESEARCH

Table 2. Continued (2 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT02	2021-Sep-27	3	CO	43		1.2	1.51					0
ALE-MT02	2021-Sep-27	3	CO	47		1.2	1.16					0
ALE-MT02	2021-Sep-27	3	CO	49		1.6	1.36					0
ALE-MT02	2021-Sep-27	3	CO	50		1.5	1.20					0
ALE-MT02	2021-Sep-27	3	CO	54		2.3	1.46					0
ALE-MT02	2021-Sep-27	3	CO	55		1.9	1.14					0
ALE-MT02	2021-Sep-27	3	CO	55		1.9	1.14					0
ALE-MT02	2021-Sep-27	3	CO	59		2.4	1.17					0
ALE-MT02	2021-Sep-27	3	CO	60		2.3	1.06					0
ALE-MT02	2021-Sep-27	3	CO	63		2.9	1.16					0
ALE-MT02	2021-Sep-27	3	CO	65		3.0	1.09					0
ALE-MT02	2021-Sep-27	3	CO	65		3.1	1.13					0
ALE-MT02	2021-Sep-27	3	CO	73		4.1	1.05					1
ALE-MT02	2021-Sep-27	3	CO	75		4.4	1.04					1
ALE-MT02	2021-Sep-27	3	CO	78		6.1	1.29					1
ALE-MT02	2021-Sep-27	3	CO	80		5.4	1.05					1
ALE-MT02	2021-Sep-27	3	CO	81		5.9	1.11					1
ALE-MT02	2021-Sep-27	3	CO	81		6.2	1.17					1
ALE-MT02	2021-Sep-27	3	CO	82		6.3	1.14					1
ALE-MT02	2021-Sep-27	3	CO	82		6.5	1.18					1
ALE-MT02	2021-Sep-27	3	CO	85		7.1	1.16					1
ALE-MT02	2021-Sep-27	3	CO	88		7.3	1.07					1
ALE-MT02	2021-Sep-27	3	CO	88		8.1	1.19					1
ALE-MT02	2021-Sep-27	3	CO	90		8.4	1.15					1
ALE-MT02	2021-Sep-27	3	CO	97		9.7	1.06					1
ALE-MT02	2021-Sep-27	4	CO	51		1.6	1.21	SC	4	FC	4	0
ALE-MT02	2021-Sep-27	4	CO	65		3.1	1.13					0
ALE-MT02	2021-Sep-27	4	CO	68		3.9	1.24					0
ALE-MT02	2021-Sep-27	4	CO	69		3.9	1.19					0
ALE-MT02	2021-Sep-27	4	CO	73		4.3	1.11					1
ALE-MT02	2021-Sep-27	4	CO	74		4.6	1.14					1
ALE-MT02	2021-Sep-27	4	CO	86		7.8	1.23					1
ALE-MT02	2021-Sep-27	4	CO	88		8.0	1.17					1
ALE-MT02	2021-Sep-27	5	NFC									
ALE-MT07	2021-Sep-27	1	CO	44		1.0	1.17					0
ALE-MT07	2021-Sep-27	1	CO	45								0
ALE-MT07	2021-Sep-27	1	CO	47		1.4	1.35					0
ALE-MT07	2021-Sep-27	1	CO	50		1.5	1.20					0
ALE-MT07	2021-Sep-27	1	CO	50								0
ALE-MT07	2021-Sep-27	1	CO	50								0
ALE-MT07	2021-Sep-27	1	CO	53								0
ALE-MT07	2021-Sep-27	1	CO	54		1.7	1.08					0
ALE-MT07	2021-Sep-27	1	CO	68		3.1	0.99	SC	1	FC	1	0
ALE-MT07	2021-Sep-27	1	CO	75		4.7	1.11					1
ALE-MT07	2021-Sep-27	1	CO	77		5.1	1.12					1
ALE-MT07	2021-Sep-27	1	CO	80		5.7	1.11					1
ALE-MT07	2021-Sep-27	1	CO	83		7.5	1.31	SC	2	FC	2	1
ALE-MT07	2021-Sep-27	1	CO	85								1

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (3 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT07	2021-Sep-27	2	CO	50								0
ALE-MT07	2021-Sep-27	2	CO	55								0
ALE-MT07	2021-Sep-27	2	CO	60								0
ALE-MT07	2021-Sep-27	2	CO	65								0
ALE-MT07	2021-Sep-27	2	CO	70								1
ALE-MT07	2021-Sep-27	2	CO	75								1
ALE-MT07	2021-Sep-27	2	CO	75								1
ALE-MT07	2021-Sep-27	2	CO	85								1
ALE-MT07	2021-Sep-27	2	CO	86								1
ALE-MT07	2021-Sep-27	2	CO	90								1
ALE-MT07	2021-Sep-27	2	CT	110		16.5	1.24	SC	3	FC	3	1
ALE-MT07	2021-Sep-27	3	CO	45								0
ALE-MT07	2021-Sep-27	3	CO	45								0
ALE-MT07	2021-Sep-27	3	CO	46		1.4	1.44					0
ALE-MT07	2021-Sep-27	3	CO	50		1.6	1.28					0
ALE-MT07	2021-Sep-27	3	CO	50		1.6	1.28					0
ALE-MT07	2021-Sep-27	3	CO	50								0
ALE-MT07	2021-Sep-27	3	CO	50								0
ALE-MT07	2021-Sep-27	3	CO	50								0
ALE-MT07	2021-Sep-27	3	CO	52		1.8	1.28					0
ALE-MT07	2021-Sep-27	3	CO	52								0
ALE-MT07	2021-Sep-27	3	CO	56		2.4	1.37					0
ALE-MT07	2021-Sep-27	3	CO	60		2.5	1.16					0
ALE-MT07	2021-Sep-27	3	CO	60								0
ALE-MT07	2021-Sep-27	3	CO	65		3.5	1.27					0
ALE-MT07	2021-Sep-27	3	CO	67		3.5	1.16					0
ALE-MT07	2021-Sep-27	3	CO	68								0
ALE-MT07	2021-Sep-27	3	CO	70								1
ALE-MT07	2021-Sep-27	3	CO	72								1
ALE-MT07	2021-Sep-27	3	CO	78								1
ALE-MT07	2021-Sep-27	3	CO	80		5.6	1.09					1
ALE-MT07	2021-Sep-27	3	CO	80		5.7	1.11					1
ALE-MT07	2021-Sep-27	3	CO	80								1
ALE-MT07	2021-Sep-27	4	CO	50								0
ALE-MT07	2021-Sep-27	5	CO	47		1.2	1.16					0
ALE-MT07	2021-Sep-27	5	CO	47		1.5	1.44					0
ALE-MT07	2021-Sep-27	5	CO	49		1.9	1.61					0
ALE-MT07	2021-Sep-27	5	CO	50		1.7	1.36					0
ALE-MT07	2021-Sep-27	5	CO	55		2.0	1.20					0
ALE-MT07	2021-Sep-27	5	CO	55		2.1	1.26					0
ALE-MT07	2021-Sep-27	5	CO	55		2.1	1.26					0
ALE-MT07	2021-Sep-27	5	CO	62		2.7	1.13					0
ALE-MT07	2021-Sep-27	5	CO	67		3.6	1.20					0
ALE-MT07	2021-Sep-27	5	CO	70		3.6	1.05					1
ALE-MT07	2021-Sep-27	5	CO	74		4.9	1.21					1
ALE-MT07	2021-Sep-27	5	CO	77		4.7	1.03	SC	5	FC	5	1
ALE-MT03	2021-Sep-27	1	CO	45		1.4	1.54					0
ALE-MT03	2021-Sep-27	1	CO	50		1.3	1.04					0

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (4 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT03	2021-Sep-27	1	CO	50								0
ALE-MT03	2021-Sep-27	1	CO	50								0
ALE-MT03	2021-Sep-27	1	CO	52		1.4	1.00					0
ALE-MT03	2021-Sep-27	1	CO	54		1.7	1.08					0
ALE-MT03	2021-Sep-27	1	CO	54		1.8	1.14					0
ALE-MT03	2021-Sep-27	1	CO	55		1.8	1.08					0
ALE-MT03	2021-Sep-27	1	CO	60		3.1	1.44					0
ALE-MT03	2021-Sep-27	1	CO	62								0
ALE-MT03	2021-Sep-27	1	CO	62								0
ALE-MT03	2021-Sep-27	1	CO	64								0
ALE-MT03	2021-Sep-27	1	CO	65		3.7	1.35					0
ALE-MT03	2021-Sep-27	1	CO	70								1
ALE-MT03	2021-Sep-27	1	CO	73		4.2	1.08					1
ALE-MT03	2021-Sep-27	1	CO	73								1
ALE-MT03	2021-Sep-27	1	CO	73								1
ALE-MT03	2021-Sep-27	1	CO	75		4.8	1.14					1
ALE-MT03	2021-Sep-27	1	CO	75		5.0	1.19					1
ALE-MT03	2021-Sep-27	1	CO	75								1
ALE-MT03	2021-Sep-27	1	CO	75								1
ALE-MT03	2021-Sep-27	1	CO	77								1
ALE-MT03	2021-Sep-27	1	CO	78								1
ALE-MT03	2021-Sep-27	1	CO	80								1
ALE-MT03	2021-Sep-27	1	CO	80								1
ALE-MT03	2021-Sep-27	1	CO	80								1
ALE-MT03	2021-Sep-27	1	CO	82		6.5	1.18					1
ALE-MT03	2021-Sep-27	1	CO	82								1
ALE-MT03	2021-Sep-27	1	CO	84		5.9	1.00					1
ALE-MT03	2021-Sep-27	1	CO	84								1
ALE-MT03	2021-Sep-27	1	CO	86		7.3	1.15					1
ALE-MT03	2021-Sep-27	1	CO	92		9.1	1.17	SC	1	FC	1	1
ALE-MT03	2021-Sep-27	1	CT	72		4.8	1.29	SC	2	FC	2	1
ALE-MT03	2021-Sep-27	1	CT	87		6.3	0.96	SC	3	FC	3	1
ALE-MT03	2021-Sep-27	2	CO	40								0
ALE-MT03	2021-Sep-27	2	CO	40								0
ALE-MT03	2021-Sep-27	2	CO	41								0
ALE-MT03	2021-Sep-27	2	CO	43								0
ALE-MT03	2021-Sep-27	2	CO	45								0
ALE-MT03	2021-Sep-27	2	CO	45								0
ALE-MT03	2021-Sep-27	2	CO	50								0
ALE-MT03	2021-Sep-27	2	CO	50								0
ALE-MT03	2021-Sep-27	2	CO	52								0
ALE-MT03	2021-Sep-27	2	CO	83								1
ALE-MT03	2021-Sep-27	2	CT	110		14.4	1.08	SC	4	FC	4	1
ALE-MT03	2021-Sep-27	3	CO	45								0
ALE-MT03	2021-Sep-27	3	CO	47								0
ALE-MT03	2021-Sep-27	3	CO	50		1.5	1.20					0
ALE-MT03	2021-Sep-27	3	CO	50								0
ALE-MT03	2021-Sep-27	3	CO	50								0

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (5 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT03	2021-Sep-27	3	CO	50								0
ALE-MT03	2021-Sep-27	3	CO	52		1.6	1.14					0
ALE-MT03	2021-Sep-27	3	CO	55								0
ALE-MT03	2021-Sep-27	3	CO	59								0
ALE-MT03	2021-Sep-27	3	CO	60		2.3	1.06					0
ALE-MT03	2021-Sep-27	3	CO	61								0
ALE-MT03	2021-Sep-27	3	CO	65								0
ALE-MT03	2021-Sep-27	3	CO	65								0
ALE-MT03	2021-Sep-27	3	CO	65								0
ALE-MT03	2021-Sep-27	3	CO	65								0
ALE-MT03	2021-Sep-27	3	CO	67								0
ALE-MT03	2021-Sep-27	3	CO	70		4.1	1.20					1
ALE-MT03	2021-Sep-27	3	CO	70								1
ALE-MT03	2021-Sep-27	3	CO	70								1
ALE-MT03	2021-Sep-27	3	CO	72		3.9	1.04					1
ALE-MT03	2021-Sep-27	3	CO	72								1
ALE-MT03	2021-Sep-27	3	CO	73		5.7	1.47					1
ALE-MT03	2021-Sep-27	3	CO	73								1
ALE-MT03	2021-Sep-27	3	CO	75								1
ALE-MT03	2021-Sep-27	3	CO	78		5.9	1.24					1
ALE-MT03	2021-Sep-27	3	CO	80								1
ALE-MT03	2021-Sep-27	3	CO	80								1
ALE-MT03	2021-Sep-27	3	CO	81								1
ALE-MT03	2021-Sep-27	3	CO	82								1
ALE-MT03	2021-Sep-27	3	CO	83								1
ALE-MT03	2021-Sep-27	3	CO	85								1
ALE-MT03	2021-Sep-27	3	CO	85								1
ALE-MT03	2021-Sep-27	3	CO	87								1
ALE-MT03	2021-Sep-27	3	CO	92								1
ALE-MT03	2021-Sep-27	3	CO	95								1
ALE-MT03	2021-Sep-27	4	CO	58		2.0	1.03					0
ALE-MT03	2021-Sep-27	4	CO	58		2.8	1.44					0
ALE-MT03	2021-Sep-27	4	CO	65		3.2	1.17					0
ALE-MT03	2021-Sep-27	4	CO	79		5.6	1.14					1
ALE-MT03	2021-Sep-27	4	CO	80		5.4	1.05					1
ALE-MT03	2021-Sep-27	5	CO	61		3.0	1.32					0
ALE-MT03	2021-Sep-27	5	CO	65		3.0	1.09					0
ALE-MT03	2021-Sep-27	5	CO	66		3.7	1.29					0
ALE-MT03	2021-Sep-27	5	CO	71		4.1	1.15					1
ALE-MT03	2021-Sep-27	5	CO	75		4.5	1.07					1
ALE-MT03	2021-Sep-27	5	CO	75		5.0	1.19					1
ALE-MT03	2021-Sep-27	5	CO	75		5.1	1.21					1
ALE-MT03	2021-Sep-27	5	CO	78		5.3	1.12					1
ALE-MT03	2021-Sep-27	5	CO	78		5.7	1.20					1
ALE-MT03	2021-Sep-27	5	CO	79		5.3	1.07	SC	5	FC	5	1
ALE-MT03	2021-Sep-27	5	CO	80		5.6	1.09					1
ALE-MT03	2021-Sep-27	5	CO	85		6.6	1.07					1
ALE-MT08	2021-Sep-27	1	CO	38		0.7	1.28					0

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

ECOFISH RESEARCH

Table 2. Continued (6 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT08	2021-Sep-27	1	CO	38		0.9	1.64					0
ALE-MT08	2021-Sep-27	1	CO	42		1.0	1.35					0
ALE-MT08	2021-Sep-27	1	CO	42		1.1	1.48					0
ALE-MT08	2021-Sep-27	1	CO	45		1.1	1.21					0
ALE-MT08	2021-Sep-27	1	CO	45		1.2	1.32					0
ALE-MT08	2021-Sep-27	1	CO	47		1.6	1.54	SC	1	FC	1	0
ALE-MT08	2021-Sep-27	1	CO	50		1.9	1.52					0
ALE-MT08	2021-Sep-27	1	CO	51		1.9	1.43					0
ALE-MT08	2021-Sep-27	1	CO	75		5.1	1.21					1
ALE-MT08	2021-Sep-27	1	CO	82		6.8	1.23					1
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	1	CO									
ALE-MT08	2021-Sep-27	2	CO	50		1.8	1.44					0
ALE-MT08	2021-Sep-27	2	CO	52		1.9	1.35					0
ALE-MT08	2021-Sep-27	2	CO	72		5.2	1.39					1
ALE-MT08	2021-Sep-27	2	CO	73		4.2	1.08					1
ALE-MT08	2021-Sep-27	2	CO	74		4.5	1.11					1
ALE-MT08	2021-Sep-27	2	CO	78		6.0	1.26	SC	2	FC	2	1
ALE-MT08	2021-Sep-27	2	CO	80		6.0	1.17					1
ALE-MT08	2021-Sep-27	2	CO	85		7.1	1.16					1
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	2	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (7 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CO									
ALE-MT08	2021-Sep-27	3	CT	132		21.8	0.95					2
ALE-MT08	2021-Sep-27	4	CO	54		2.3	1.46					0
ALE-MT08	2021-Sep-27	4	CO	56		3.1	1.77					0
ALE-MT08	2021-Sep-27	4	CO	61		3.0	1.32					0
ALE-MT08	2021-Sep-27	4	CO	76		4.7	1.07					1
ALE-MT08	2021-Sep-27	4	CO	77		5.7	1.25					1
ALE-MT08	2021-Sep-27	4	CO	80		5.5	1.07					1
ALE-MT08	2021-Sep-27	4	CO	80		5.8	1.13					1
ALE-MT08	2021-Sep-27	4	CO	85		6.8	1.11					1
ALE-MT08	2021-Sep-27	4	CO	85		6.9	1.12					1
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (8 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	4	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT08	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	1	CO	76		5.6	1.28					1
ALE-MT09	2021-Sep-27	1	CO	84		7.1	1.20					1
ALE-MT09	2021-Sep-27	1	CO	85		6.8	1.11	SC	1	FC	1	1
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	1	CO									
ALE-MT09	2021-Sep-27	2	CO	45		1.1	1.21					0
ALE-MT09	2021-Sep-27	2	CO	70		4.4	1.28					1
ALE-MT09	2021-Sep-27	2	CO	73		4.7	1.21					1
ALE-MT09	2021-Sep-27	2	CO	92		8.7	1.12					1
ALE-MT09	2021-Sep-27	2	CO									
ALE-MT09	2021-Sep-27	2	CO									
ALE-MT09	2021-Sep-27	2	CO									
ALE-MT09	2021-Sep-27	2	CT	121		18.2	1.03					1
ALE-MT09	2021-Sep-27	3	CO									
ALE-MT09	2021-Sep-27	3	CO									
ALE-MT09	2021-Sep-27	3	CO									
ALE-MT09	2021-Sep-27	3	CO									
ALE-MT09	2021-Sep-27	3	CO									
ALE-MT09	2021-Sep-27	3	CO									
ALE-MT09	2021-Sep-27	4	CO	48		1.2	1.09					0
ALE-MT09	2021-Sep-27	4	CO	50		1.8	1.44					0
ALE-MT09	2021-Sep-27	4	CO	69		3.5	1.07					0
ALE-MT09	2021-Sep-27	4	CO	75		4.6	1.09					1
ALE-MT09	2021-Sep-27	4	CO	75		4.9	1.16					1
ALE-MT09	2021-Sep-27	4	CO	79		5.9	1.20					1
ALE-MT09	2021-Sep-27	4	CO	80		5.6	1.09					1
ALE-MT09	2021-Sep-27	4	CO	81		5.9	1.11					1

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (9 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CO									
ALE-MT09	2021-Sep-27	4	CT	56		2.4	1.37					1
ALE-MT09	2021-Sep-27	5	CO	40		0.6	0.94					0
ALE-MT09	2021-Sep-27	5	CO	40		0.9	1.41					0
ALE-MT09	2021-Sep-27	5	CO	45		1.2	1.32					0
ALE-MT09	2021-Sep-27	5	CO	46		1.4	1.44					0
ALE-MT09	2021-Sep-27	5	CO	50		1.7	1.36					0
ALE-MT09	2021-Sep-27	5	CO	50		1.7	1.36					0
ALE-MT09	2021-Sep-27	5	CO	54		1.6	1.02					0
ALE-MT09	2021-Sep-27	5	CO	55		2.0	1.20					0
ALE-MT09	2021-Sep-27	5	CO	65		2.9	1.06					0
ALE-MT09	2021-Sep-27	5	CO	73		4.6	1.18					1
ALE-MT09	2021-Sep-27	5	CO	75		4.6	1.09	SC	2	FC	2	1
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (10 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT09	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	1	CO	43		1.2	1.51					0
ALE-MT06	2021-Sep-27	1	CO	45								0
ALE-MT06	2021-Sep-27	1	CO	48		1.5	1.36					0
ALE-MT06	2021-Sep-27	1	CO	49		1.1	0.93					0
ALE-MT06	2021-Sep-27	1	CO	50								0
ALE-MT06	2021-Sep-27	1	CO	50								0
ALE-MT06	2021-Sep-27	1	CO	50								0
ALE-MT06	2021-Sep-27	1	CO	52		2.1	1.49					0
ALE-MT06	2021-Sep-27	1	CO	60								0
ALE-MT06	2021-Sep-27	1	CO	72								1
ALE-MT06	2021-Sep-27	1	CO	73								1
ALE-MT06	2021-Sep-27	1	CO	74								1
ALE-MT06	2021-Sep-27	1	CO	75								1
ALE-MT06	2021-Sep-27	1	CO	75								1
ALE-MT06	2021-Sep-27	1	CO	78								1
ALE-MT06	2021-Sep-27	1	CO	85								1
ALE-MT06	2021-Sep-27	1	CO	85								1
ALE-MT06	2021-Sep-27	1	CO	88								1
ALE-MT06	2021-Sep-27	1	CO	88								1
ALE-MT06	2021-Sep-27	1	CO	90								1
ALE-MT06	2021-Sep-27	1	CO	90								1
ALE-MT06	2021-Sep-27	1	CO	90								1
ALE-MT06	2021-Sep-27	1	CO	91								1
ALE-MT06	2021-Sep-27	1	CO	94		9.1	1.10					1
ALE-MT06	2021-Sep-27	2	CO	43		0.1	0.11					0
ALE-MT06	2021-Sep-27	2	CO	44		0.1	0.09					0
ALE-MT06	2021-Sep-27	2	CO	44		1.1	1.29					0
ALE-MT06	2021-Sep-27	2	CO	44		1.5	1.76					0
ALE-MT06	2021-Sep-27	2	CO	45		1.0	1.10					0

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (11 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	2	CO	45		1.3	1.43					0
ALE-MT06	2021-Sep-27	2	CO	45		1.3	1.43					0
ALE-MT06	2021-Sep-27	2	CO	46		1.3	1.34					0
ALE-MT06	2021-Sep-27	2	CO	49		1.3	1.10					0
ALE-MT06	2021-Sep-27	2	CO	49		1.8	1.53					0
ALE-MT06	2021-Sep-27	2	CO	50		1.5	1.20					0
ALE-MT06	2021-Sep-27	2	CO	50		1.9	1.52					0
ALE-MT06	2021-Sep-27	2	CO	50								0
ALE-MT06	2021-Sep-27	2	CO	51		2.1	1.58					0
ALE-MT06	2021-Sep-27	2	CO	52		1.3	0.92					0
ALE-MT06	2021-Sep-27	2	CO	53		1.6	1.07					0
ALE-MT06	2021-Sep-27	2	CO	65		2.9	1.06					0
ALE-MT06	2021-Sep-27	2	CO	72		4.2	1.13					1
ALE-MT06	2021-Sep-27	2	CO	72		4.8	1.29					1
ALE-MT06	2021-Sep-27	2	CO	77		5.2	1.14					1
ALE-MT06	2021-Sep-27	2	CO	80								1
ALE-MT06	2021-Sep-27	2	CO		50							0
ALE-MT06	2021-Sep-27	2	CO		50							0
ALE-MT06	2021-Sep-27	2	CO		60							0
ALE-MT06	2021-Sep-27	2	CO		60							0
ALE-MT06	2021-Sep-27	2	CO		60							0
ALE-MT06	2021-Sep-27	2	CO		60							0
ALE-MT06	2021-Sep-27	2	CO		60							0
ALE-MT06	2021-Sep-27	2	CO		70							1
ALE-MT06	2021-Sep-27	2	CO		70							1
ALE-MT06	2021-Sep-27	2	CO		70							1
ALE-MT06	2021-Sep-27	2	CO		80							1
ALE-MT06	2021-Sep-27	2	CO		80							1
ALE-MT06	2021-Sep-27	2	CO		80							1
ALE-MT06	2021-Sep-27	2	CO		80							1
ALE-MT06	2021-Sep-27	2	CO		90							1
ALE-MT06	2021-Sep-27	2	CO		90							1
ALE-MT06	2021-Sep-27	2	CO		90							1
ALE-MT06	2021-Sep-27	2	CO		90							1
ALE-MT06	2021-Sep-27	2	CO		90							1
ALE-MT06	2021-Sep-27	2	CT	53		1.7	1.14	SC	2	FC	2	0
ALE-MT06	2021-Sep-27	2	CT	105		11.9	1.03	SC	3	FC	3	1
ALE-MT06	2021-Sep-27	2	CT	122		18.6	1.02					1
ALE-MT06	2021-Sep-27	2	CT	126		20.7	1.03	SC	4	FC	4	1
ALE-MT06	2021-Sep-27	2	CT	130		22.2	1.01	SC	1	FC	1	2
ALE-MT06	2021-Sep-27	3	CO	40		1.1	1.72					0
ALE-MT06	2021-Sep-27	3	CO	40								0
ALE-MT06	2021-Sep-27	3	CO	40								0
ALE-MT06	2021-Sep-27	3	CO	40								0
ALE-MT06	2021-Sep-27	3	CO	45		1.1	1.21					0
ALE-MT06	2021-Sep-27	3	CO	45		1.4	1.54					0
ALE-MT06	2021-Sep-27	3	CO	45		1.4	1.54					0
ALE-MT06	2021-Sep-27	3	CO	45								0

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (12 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	3	CO	46		1.6	1.64	SC	5	FC	5	0
ALE-MT06	2021-Sep-27	3	CO	48								0
ALE-MT06	2021-Sep-27	3	CO	50								0
ALE-MT06	2021-Sep-27	3	CO	50								0
ALE-MT06	2021-Sep-27	3	CO	52								0
ALE-MT06	2021-Sep-27	3	CO	60								0
ALE-MT06	2021-Sep-27	3	CO	65								0
ALE-MT06	2021-Sep-27	3	CO	71		3.8	1.06					1
ALE-MT06	2021-Sep-27	3	CO	72		4.2	1.13					1
ALE-MT06	2021-Sep-27	3	CO	75								1
ALE-MT06	2021-Sep-27	3	CO	78								1
ALE-MT06	2021-Sep-27	3	CO	80		5.2	1.02					1
ALE-MT06	2021-Sep-27	3	CO	80								1
ALE-MT06	2021-Sep-27	3	CO	80								1
ALE-MT06	2021-Sep-27	3	CO	83								1
ALE-MT06	2021-Sep-27	3	CO	85		6.7	1.09					1
ALE-MT06	2021-Sep-27	3	CO	90								1
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

ECOFISH RESEARCH

Table 2. Continued (13 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	3	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (14 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	4	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (15 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CO									
ALE-MT06	2021-Sep-27	5	CT	115		15.6	1.03	SC	6	FC	6	1
ALE-MT06	2021-Sep-27	6	CO	42		0.9	1.21					0
ALE-MT06	2021-Sep-27	6	CO	55		1.8	1.08					0
ALE-MT06	2021-Sep-27	6	CO	65		3.2	1.17					0
ALE-MT06	2021-Sep-27	6	CO	72		4.0	1.07					1
ALE-MT06	2021-Sep-27	6	CO	75		3.8	0.90					1
ALE-MT06	2021-Sep-27	6	CO	75		4.4	1.04					1
ALE-MT06	2021-Sep-27	6	CO	79		5.6	1.14					1
ALE-MT06	2021-Sep-27	6	CO	80		5.7	1.11					1
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CO									
ALE-MT06	2021-Sep-27	6	CT	100		10.9	1.09					1
ALE-MT06	2021-Sep-27	6	CT	112		13.3	0.95					1
ALE-MT06	2021-Sep-27	6	CT	128		20.7	0.99					2
ALE-MT06	2021-Sep-27	6	CT	130		20.6	0.94					2

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (16 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	7	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (17 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CO									
ALE-MT06	2021-Sep-27	8	CT	50								0
ALE-MT06	2021-Sep-27	8	CT	70								1
ALE-MT06	2021-Sep-27	9	CO	64		3.0	1.14					0
ALE-MT06	2021-Sep-27	9	CO	73		4.7	1.21					1
ALE-MT06	2021-Sep-27	9	CO	75		4.6	1.09					1
ALE-MT06	2021-Sep-27	9	CO	79		5.1	1.03					1
ALE-MT06	2021-Sep-27	9	CO	82		6.5	1.18					1
ALE-MT06	2021-Sep-27	9	CO	85		7.1	1.16					1
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									
ALE-MT06	2021-Sep-27	9	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (18 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT06	2021-Sep-27	9	CT	120		16.1	0.93					1
ALE-MT06	2021-Sep-27	9	CT	130		23.5	1.07					2
ALE-MT06	2021-Sep-27	9	CT	140		26.1	0.95					2
ALE-MT06	2021-Sep-27	9	CT	140		27.5	1.00					2
ALE-MT06	2021-Sep-27	9	CT	143		29.2	1.00					2
ALE-MT06	2021-Sep-27	10	CO	50		1.5	1.20					0
ALE-MT06	2021-Sep-27	10	CO	55		2.7	1.62					0
ALE-MT06	2021-Sep-27	10	CO	59		2.3	1.12					0
ALE-MT06	2021-Sep-27	10	CO	65		3.7	1.35					0
ALE-MT06	2021-Sep-27	10	CO	79		5.2	1.05					1
ALE-MT06	2021-Sep-27	10	CO	81		6.8	1.28					1
ALE-MT06	2021-Sep-27	10	CO	84		6.4	1.08					1
ALE-MT06	2021-Sep-27	10	CO	85		7.2	1.17					1
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT06	2021-Sep-27	10	CO									
ALE-MT05	2021-Sep-27	1	CO	45		1.4	1.54					0
ALE-MT05	2021-Sep-27	1	CO	49		1.3	1.10	SC	2	FC	2	0
ALE-MT05	2021-Sep-27	1	CO	50		1.2	0.96					0
ALE-MT05	2021-Sep-27	1	CO	53		2.0	1.34					0
ALE-MT05	2021-Sep-27	1	CO	63		2.5	1.00					0
ALE-MT05	2021-Sep-27	1	CO	75		4.4	1.04					1
ALE-MT05	2021-Sep-27	1	CO	75		5.4	1.28					1
ALE-MT05	2021-Sep-27	1	CO	82		6.0	1.09					1
ALE-MT05	2021-Sep-27	1	CO	90		7.6	1.04	SC	1	FC	1	1
ALE-MT06	2021-Sep-27	10	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (19 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (20 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	1	CO									
ALE-MT05	2021-Sep-27	2	CO	71		4.6	1.29					1
ALE-MT05	2021-Sep-27	2	CO	72		4.4	1.18					1
ALE-MT05	2021-Sep-27	2	CO	73		4.0	1.03					1
ALE-MT05	2021-Sep-27	2	CO	75		4.8	1.14					1
ALE-MT05	2021-Sep-27	2	CO	75		4.8	1.14					1
ALE-MT05	2021-Sep-27	2	CO	76		5.1	1.16					1
ALE-MT05	2021-Sep-27	2	CO	80		6.0	1.17					1
ALE-MT05	2021-Sep-27	2	CO	85		6.9	1.12					1
ALE-MT05	2021-Sep-27	2	CO	89		7.4	1.05					1
ALE-MT05	2021-Sep-27	2	CO	96		10.1	1.14					1
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (21 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CO									
ALE-MT05	2021-Sep-27	2	CT	105		11.9	1.03	SC	3	FC	3	1
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CO									
ALE-MT05	2021-Sep-27	3	CT	90		7.3	1.00	SC	4	FC	4	1
ALE-MT05	2021-Sep-27	4	CO	46		1.3	1.34					0
ALE-MT05	2021-Sep-27	4	CO	50		1.4	1.12					0
ALE-MT05	2021-Sep-27	4	CO	50		1.6	1.28					0
ALE-MT05	2021-Sep-27	4	CO	70		3.6	1.05					1
ALE-MT05	2021-Sep-27	4	CO	78		5.3	1.12					1
ALE-MT05	2021-Sep-27	4	CO	81		6.5	1.22					1
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Table 2. Continued (22 of 22).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Number	Age Assigned
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CO									
ALE-MT05	2021-Sep-27	4	CT	115		13.9	0.91					1
ALE-MT05	2021-Sep-27	5	CO	74		5.1	1.26					1
ALE-MT05	2021-Sep-27	5	CO	75		4.6	1.09					1
ALE-MT05	2021-Sep-27	5	CO	75		5.1	1.21					1
ALE-MT05	2021-Sep-27	5	CO	76		4.6	1.05					1
ALE-MT05	2021-Sep-27	5	CO	79		5.4	1.10					1
ALE-MT05	2021-Sep-27	5	CO	80		5.3	1.04					1
ALE-MT05	2021-Sep-27	5	CO	81		5.8	1.09					1
ALE-MT05	2021-Sep-27	5	CO	87		7.5	1.14					1

[1] CO = Coho Salmon, CT = Cutthroat Trout, NFC = No Fish Captured.

Appendix E. Revegetation Assessment – Riparian Revegetation Monitoring Photographs for the Compensation Channel 2021

LIST OF FIGURES

1. ALE-PRM03

Figure 1. ALE-PRM03, taken from plot centre at 0º.

a) On October 25, 2016.

b) On October 5, 2017.

c) On October 29, 2019.

d) On September 01, 2021.

Figure 2. Representative photo of ALE-PRM03.

a) On October 5, 2017.

b) On October 29, 2019.

c) On September 1, 2021.

2. ALE-PRM05

Figure 3. ALE-PRM05, taken from plot centre at 0º.

a) On October 25, 2016.

b) On October 5, 2017.

c) On October 29, 2019.

d) On September 01, 2021.

Figure 4. Representative photo of ALE-PRM05.

a) On October 5, 2017.

b) On October 29, 2019.

c) On September 1, 2021.

3. ALE-PRM06

Figure 5. ALE-PRM06 taken from plot centre at 0º.

a) On October 25, 2016.

b) On October 5, 2017.

c) On October 29, 2019.

d) On September 1, 2021.

Figure 6. Representative photo of ALE-PRM06.

a) On October 5, 2017.

b) On October 29, 2019.

c) On September 1, 2021.

4. ALE-PRM07

Figure 7. ALE-PRM07 taken from plot centre at 0º.

a) On October 25, 2016.

b) On October 5, 2017.

c) On October 29, 2019.

d) On September 1, 2021.

Figure 8. Representative photo of ALE-PRM07.

a) On October 5, 2017.

b) On October 29, 2019.

c) On September 1, 2021.