Winter Lake Restoration Effectiveness Monitoring

Report: Year 2

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Created by:
Julie Huff, Monitoring Coordinator
Coquille Watershed Association

Gary Vonderohe, Fish Biologist
Oregon Department of Fish and Wildlife
Charleston, OR

Chris Claire, Fish Biologist
Oregon Department of Fish and Wildlife
Charleston, OR

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List of Acronyms

BCI	Body Condition Index
BMP	Best Management Practices
BOD	Biological Oxygen Demand
BSDD	Beaver Slough Drainage District
C3P	China Camp Creek Project
CDD	Coaledo Drainage District
CIT	Coquille Indian Tribe
CoqWA	Coquille Watershed Association
CPUE	Catch per Unit Effort
CCGC	China Camp Gun Club
CVWA	Coquille Valley Wildlife Area
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
ESA	Endangered Species Act
MAMP	Monitoring and Adaptive Management Plan
NAVDD88	North American Vertical Datum of 1988
NHC	Northwest Hydraulic Consultants
NMFS	National Marine and Fisheries Service
OC coho	Oregon Coast coho
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OWEB	Oregon Watershed Enhancement Board
PIT	Passive Integrated Transponder
QA/QC	Quality Assurance/Quality Control
RTU	Remote Terminal Unit
SAP	Sampling and Analysis Plan
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WMP	Water Management Plan
WMT	Weekly Maximum Daily Temperature
WLRP	Winter Lake Restoration Project
WLREM	Winter Lake Restoration Effectiveness Monitoring

Executive Summary

This report summarizes the second year results (Oct. 1, 2019 – Sept. 30, 2020) of an intensive three year monitoring project, Winter Lake Restoration Effectiveness Monitoring, to monitor the effectiveness of the restoration efforts at Winter Lake in the Coquille River Valley on the Southern Oregon Coast. The Winter Lake Project consists of two main activities: tidal wetland restoration and tide gate upgrades (www.tnc.org/tidegates). This report fulfills one of the annual requirements of the Winter Lake Project's Monitoring and Adaptive Management Plan (MAMP), created as part of the federal permitting requirements.

The main objectives of the Winter Lake Project include: 1) restore 400 acres of tidally-influenced palustrine emergent and scrub-shrub wetlands to improve fish passage, increase channel complexity and stability, improve water quality, and restore riparian and floodplain vegetation and 2) provide substantial improvement in the productive capacity of 1,700 acres of over-wintering habitat for coho salmon through water management. The monitoring includes measuring 14 different elements to encompass water quality and quantity, the site's physical and landscape attributes, and the response of salmonids to the restoration.

As with most large restoration and construction projects, the Winter Lake Restoration Project area had sustained a large amount of disturbance during construction in 2018. The project has since had two years to heal with bare dirt being filled in by grass and willows and the movement of macroinvertebrate communities into the newly dug channels. The project is still far from maturity, therefore, results of the monitoring from the second year post-restoration should not be used to judge the success of the project as a whole to meet the long-term restoration goals.

Overall, the Winter Lake Project exceeded many of the performance standards of monitoring parameters set by the MAMP. The total length of tidal channel constructed in the restoration unit exceeded the performance standard (20,000 ft) by more than 10,000 ft for a total of over 30,000 ft constructed and remained the same from the first year. The overall survival of planted trees and shrubs in the restoration unit declined to 62% in the second year, which exceeds the performance standard of a 60% survival rate. A few low elevation ponded areas were identified in the winter of 2018, and to meet MAMP channel connectivity performance standards 3,700 ft of additional channels were constructed in 2019 to alleviate fish stranding potential at these locations. No additional areas of ponding or stranded were identified in the second year. Therefore, the restoration unit is considered to pass the stranding and trapping performance standard of the MAMP.

The winter water temperatures were within the performance threshold of the MAMP. Although summer temperatures were above the performance threshold, the channels were

without vegetative shading and it is anticipated that roughly 4-6 years will be required until the planted trees and shrubs provide sufficient cover to develop and bring temperatures within the desired range. There are currently no performance standards for spring and summer nutrient sampling and the Winter Lake Monitoring Committee chose to forgo nutrient thresholds and instead use the sampling as a tool to better understand the project area. Monitoring indicated that dissolved oxygen (DO) levels are below the performance standard (9mg/L) at both locations within the restoration unit during the summer months. However, it is anticipated that as shading increases so will the summer DO levels. Moderately lower DO levels do not seem to have a substantial negative impact on juvenile coho, as DO levels in the reference site are well below the performance standard and there are high numbers of over-wintering juvenile coho present. Additionally, communication with personnel associated with other wetland projects in Oregon has indicated that DO levels may commonly be lower than full saturation and are still excellent rearing sites for juvenile coho.

The water level performance standards vary by season and hydrological unit (restoration or agricultural). Units 1 and 3 passed most water depth standards except for the period from June to September. The restoration unit (Unit 2) passed water level standards during the over-winter period and the spring transition period but fell below thresholds from June to September. In the summer of 2020, water levels were held below MAMP threshold goals to allow for mechanical re-working of low-lying areas in Unit 2. In the upcoming 2020-2021 year the water levels in all units will be managed more robustly.

Although the MAMP does not include metrics for fish sampling, the monitoring results highlight favorable results with regard to improving habitat for over-wintering juvenile coho. Although the overall number of juvenile coho caught in the Winter Lake Project area were smaller than that at the reference site (Beaver Creek), the average fork length and weight were greater in the Winter Lake Project area, producing a slightly higher average Body Condition Index (BCI) of 1.06 compared to a BCI of 1.04 at Beaver Creek.

After two years in operation, the Winter Lake tide gate replacement and restoration project is already meeting some of its goals. As the landscape matures in the subsequent years, the habitat for juvenile coho, waterfowl and other native species will improve as well as furthering the goal of a landscape for public use and wildlife habitat.

1. Introduction

This report summarizes the second year results (Oct. 1, 2019 – Sept. 30, 2020) of an intensive three year monitoring project, Winter Lake Restoration Effectiveness Monitoring (WLREM), to monitor the effectiveness of the restoration efforts at Winter Lake in the Coquille River Valley on the Southern Oregon Coast (Figure 1). The Coquille Watershed Association (CoqWA) is leading the monitoring effort in collaboration with the Oregon Department of Fish and Wildlife (ODFW) and Beaver Slough Drainage District (BSDD). The Coquille Working Landscapes Project consists of two main activities, tidal wetland restoration (Winter Lake Restoration) and tide gate upgrades (China Camp Creek Project (C3P) www.tnc.org/tide gates). For this report, all activities will be referred to as the Winter Lake Project rather than their individual names. The 1,700 + acre project site includes 407 acres of restored tidal wetland and 1,300 acres of agricultural pasture land. To determine the effectiveness of the restoration project, the subsequent monitoring entails measuring 14 different elements in the restored area and adjacent pasture land to encompass water quality and quantity, the site's physical and landscape attributes, and the response of salmonids to the project.

This report fulfills the requirements of the Winter Lake Project's Monitoring and Adaptive Management Plan (MAMP), created as part of the federal permitting process. (See Appendix A for the full MAMP.)

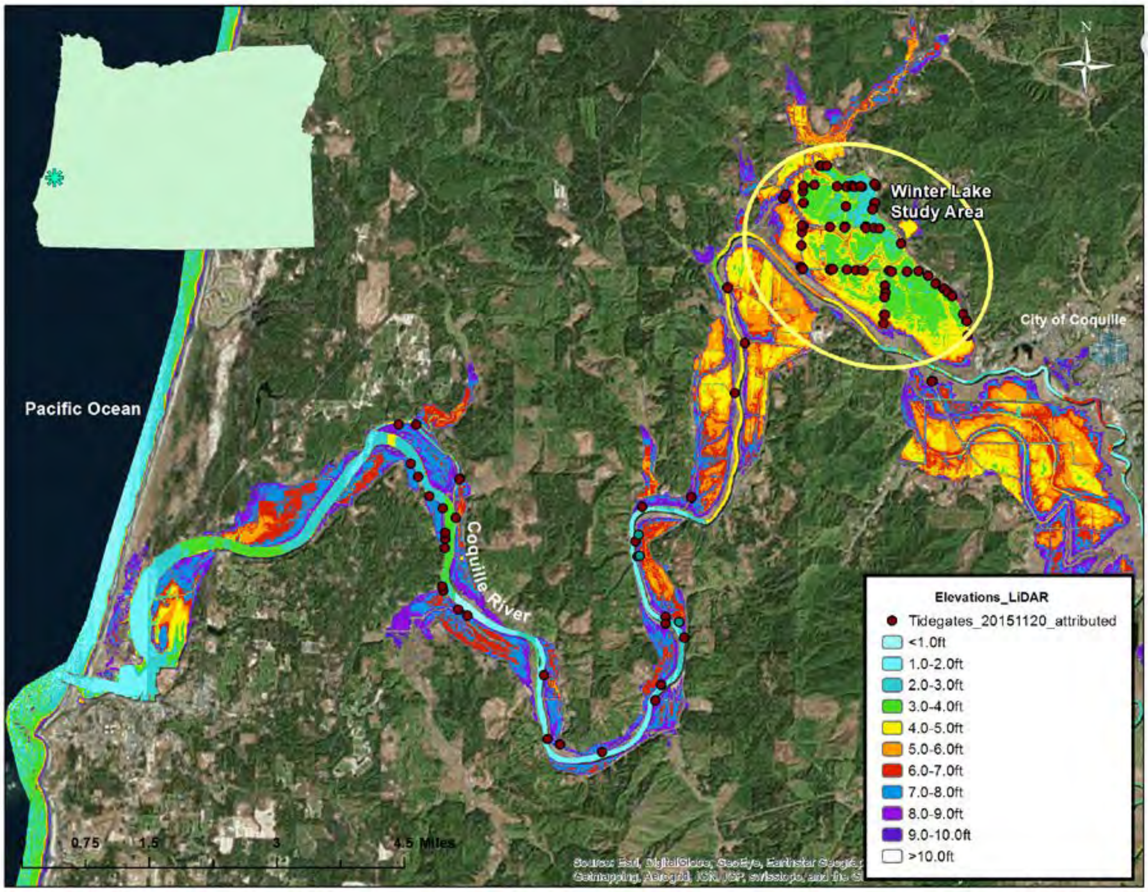

Figure 1. Coquille River Valley and Winter Lake study area.

2. Background

The Coquille River Valley (floodplains of the Lower Coquille River at or below elevation 10ft) historically had an estimated 17,425 acres of estuarine wetlands, (Benner 1991). European settlers began converting wetlands and clearing tree species in the valley for agricultural and other purposes in the late 1800's. By 1992, only 373 acres of the Valley's historic marshes remained, resulting in widespread hydrological and ecological changes to the capacity of the valley lowlands to support native fish and wildlife.

The conversion of tidal wetlands to pasture land required installation of tide gates and berms. This, in turn, prohibited normal tidal inflow from reaching the floodplain wetlands. Tidal floodplains and wetlands are an important ecosystem of the Coquille River. The tidal influence extends approximately 40 miles inland from the mouth of the river and is the longest tidal estuary in Oregon outside the Columbia River. Due to the installation of tide gates and the diminished hydrologic connectivity between tidal channels and the mainstem Coquille River, habitat values have decreased and fish access to critical off-channel, over wintering habitat have been limited since the early 1900's. These actions have contributed substantially to a precipitous decline of the Coquille population of Oregon Coast (OC) coho salmon (*Oncorhynchus kisutch*).

Historical peak abundance of OC coho salmon has been estimated at 310,000 to 417,000 (Lawson et al. 2004). This compares to the recent 2004-2019 period when OC coho abundance averaged 18,314 annually, ranging from a low of 3,357 to a high of 55,667 (OASIS, 2019). As a result of the decline in population abundance that occurred within the OC population as a whole, coho salmon have been listed as Threatened under the Federal Endangered Species Act. In overwhelming agreement, the Coquille Sub-Basin Plan (CIT, 2007), the ODFW Oregon Coast Coho Conservation Plan (ODFW, 2007), and the NMFS Final ESA Recovery Plan for Oregon Coast Coho (NOAA, 2016) have identified the lack of access to and loss of off-channel over winter habitat as one of the primary critical limiting factors for the recovery of OC coho.

3. Project Area and Overview

The Winter Lake Project area is located at mile 20 on the Coquille River and lies within the BSDD. Of this land area, roughly ~1,600 acres is below elevation 2.6m (8.5ft) NAVDD 88 and was historically subject to tidal influence (Figure 1). The Winter Lake Project area is subdivided into three hydrologically independent management Units. Units 1 and 3 are managed primarily for agriculture and are owned privately while Unit 2, the restoration unit, is owned by the China Camp Gun Club (CCGC) and ODFW collectively (Figure 2). The main goal of the project is to increase off-channel, over wintering habitat for juvenile OC coho while maintaining a working agricultural pasture grazing landscape. To do this, two main actions were taken: 1) remove and replace older top-hinged style wooden tide gates and corrugated culverts with technologically-advanced tide gates that meet both State and Federal fish passage requirements and 2) develop tidal channel networks in the Restoration Unit that more closely mimic historical conditions.

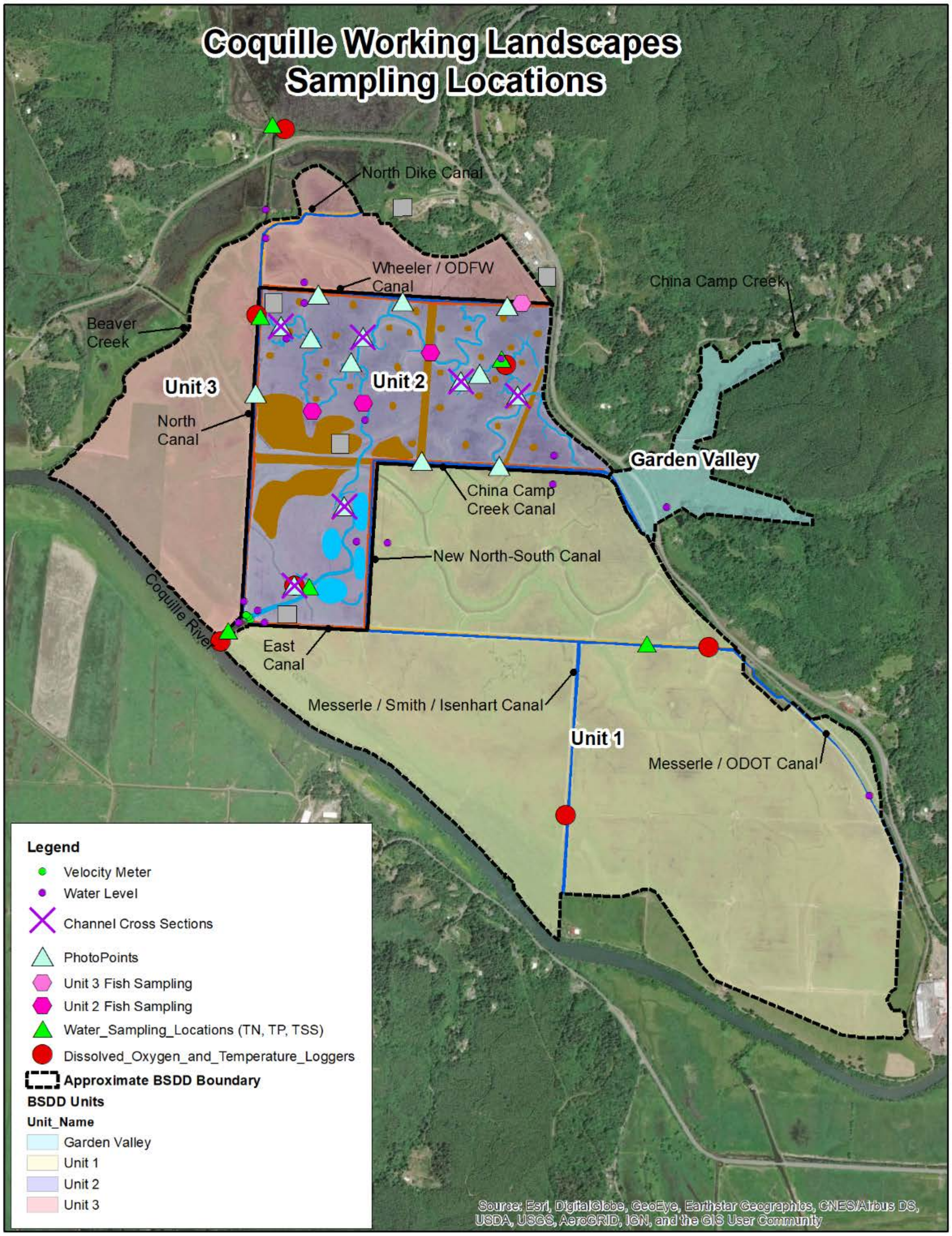

Figure 2. Winter Lake Restoration Effectiveness Monitoring project area with monitoring locations.

In order to address restrictive access for fish entry and egress and improve tidal flows on the 1,700-acre project area, a new concrete box culvert and technologically-advanced tide gate network was installed in 2017. The existing corrugated metal 2.4m (8.0ft) diameter culverts and associated tide gates were removed and infrastructure consisting of seven new concrete box culverts 3.0m in width x 2.4m in height (10ftx8ft, two servicing Unit 1; four servicing Unit 2; and one servicing Unit 3) were constructed between June and October 15th, 2017. Seven slide gates were installed on Units 1, 2, and 3, with secondary backup side-hinged aluminum tide gate doors installed on slide gates 1A, 2C, and 3 (Figure 3). The seven vertical slide gates are designed to be operated independently and allow for precise control of water inflow and outflow to the three Units. The tide gate doors are controlled and programmed through an on-site computer network, with the ability to operate them remotely through a cellular modem connection, which further increases controllability of water flows. The vertical slide gates are raised and lowered by a gearbox and worm drive. The side-hinged backup tide gates (one in each unit) allow for duality of control and act as backup for water outflow if power supply issues occur. The Winter Lake Project also constructed or reinforced berms surrounding the individual Units, effectively isolating Unit 2 from the other Units to achieve each unit's objectives.

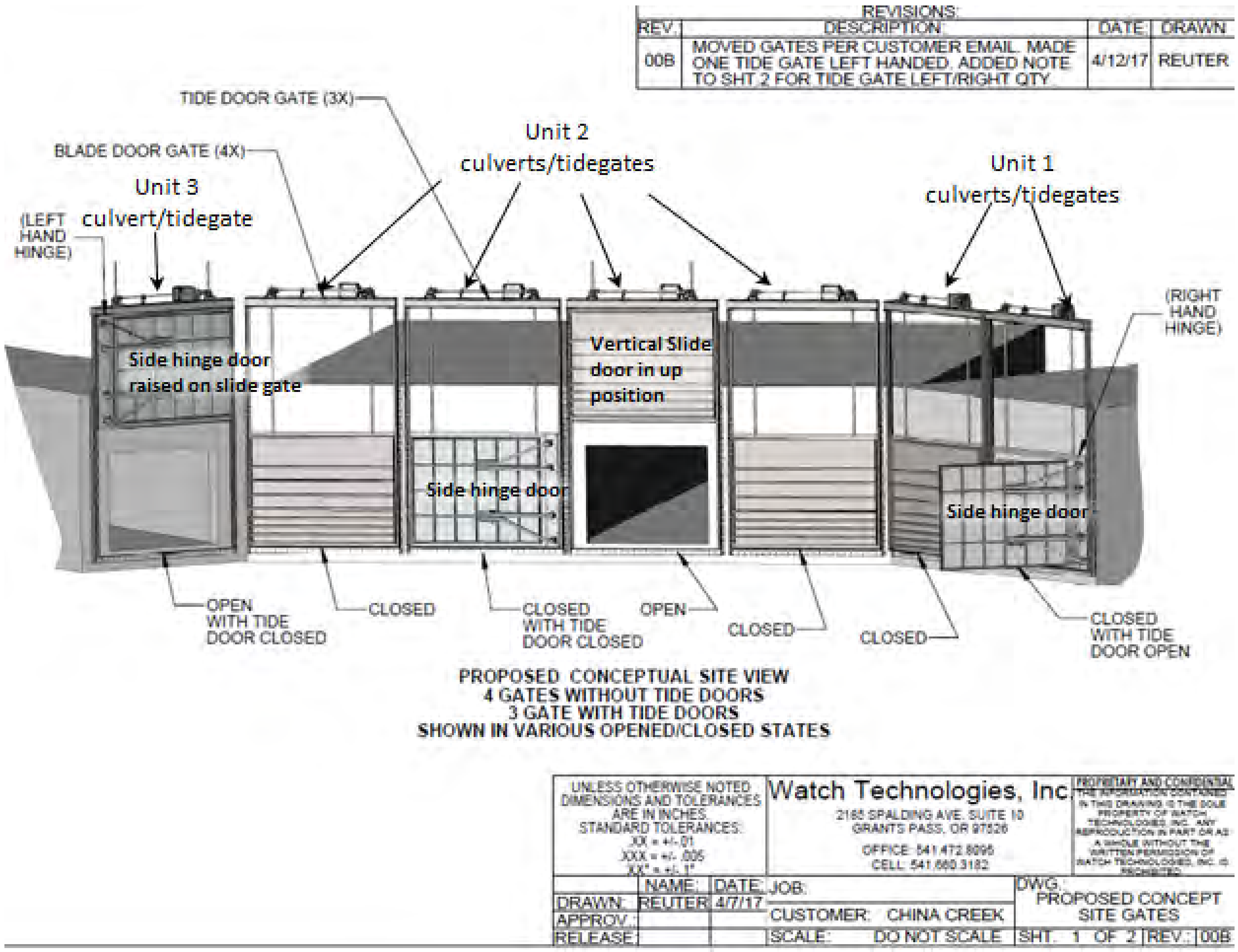

Figure 3. Winter Lake Project tide gate reconstruction design drawing for box culverts and tide gates. Each Unit has one side-hinged tide gate door.

Tidal wetland restoration was implemented in Unit 2 of the Winter Lake Project (Figure 2) to increase overwintering, off-channel habitat for juvenile OC coho, other native fish, and waterfowl. The Restoration Unit (Unit 2) is comprised of 407 acres, with 122 acres privately owned by CCGC and 285 acres owned by ODFW. The ODFW property is a constituent within the larger Coquille Valley Wildlife Area (CVWA). The restoration efforts within Unit 2 are aimed at reestablishing the highly productive floodplain ecological system and included the following objectives: reconstruction and reconnection of 12.6 km of remnant channels (Figure 4); creation of four tidal depressions; rebuilding perimeter berms to hydrologically isolate Unit 2 up to elevation 2.3 m NAVDD 88 from neighboring properties; removal of 2.4 km of interior canals and 4.8 km of interior berms; and planting ~110,000 native trees and shrubs. With the intensive restoration and tide gate replacements, complete water management is now available to control tidal inflow and outflow to all Units and has greatly improved accessibility for migrating fish into the Winter Lake Project area.

Figure 4. Winter Lake Unit 2 restoration channels following completion of installation, October 2018.

Additional infrastructure upgrades are in the initial design phase (Winter Lake Phase III) for interior culverts and tide gates in Units 1 and 3 (Figure 2). These complementary actions on working lands adjacent to Unit 2 will result in improved fish passage and access to an additional 1,300 acres of habitat. The tide gate replacements (Phase I) and the Unit 2 habitat restoration (Phase II) projects have provided largescale improvement for water quality, fish access, and overall hydrologic function of the Winter Lake Project. A combination of these upgraded culvert and tide gate infrastructures, modified tide gate operations, and improved water quality due to tidal flushing in Units 1 and 3 will give an even greater boost to the over-wintering juvenile coho of the Coquille Valley. The future work (Phase III; replacement of interior tide gates in Units 1 and 3 and channel construction) will bring the activities closer to reaching the greater restoration project goal; enhancing habitat for coho recovery and other fish and wildlife species. Phase III will also greatly reduce fish stranding potential, and increase summer irrigation potential for landowners when salmonid fishes are not present. The Winter Lake Project serves as a model of partnership and collaboration to demonstrate how restored wetlands can co-exist with working agricultural landscapes, hunting, public recreation, and tribal interests.

The three-year effectiveness monitoring project, WLREM, has been funded by OWEB to ensure the Winter Lake Project is meeting the project objectives, informing adaptive management needs on the project site, and informing future restoration efforts along the Oregon Coast. The main objectives of the Winter Lake Project include 1) restore 400 acres of tidally-influenced palustrine emergent and scrub-shrub wetlands to improve fish passage, increase channel complexity and stability, improve water quality and restore riparian and floodplain vegetation and 2) provide substantial improvement in the productive capacity of 1,700 acres of over-wintering habitat for coho salmon through water management. The monitoring includes measuring 14 different elements to encompass water quality and quantity, the site's physical and landscape attributes, and the response of salmonids to the restoration. These elements are noted as part of the reporting required by the federal permits and are summarized in Table 1.

Table 1. Winter Lake Restoration Effectiveness Monitoring project elements.

Para-meter ID	Parameter	Method and Equipment	Frequency/Timing	Sampling Locations	Protocol citation(s)
a	Channel depth	Manual stream cross sections at 6 permanent plots	Annually in Aug. 2018-2021	Unit 2	Roegner et al. 2008.
a	Connectivity	Unmanned Aircraft System (UAS) flight	Annually in Sept. 2018-2021	Unit 2	Smith et al. 2016, Peterson et al. 2015, Roegner et al. 2008.
a	Tide gate door open	7 electronic sensors (1 in each tide gate)	Continually, 15-min interval 2018-2021	Unit 1, 2 & 3	BSDD and Coos Watershed
a	Velocity in tide gates	3 SonTek loggers in sub sample of tide gates	Continually, 15-min interval 2018-2021	Unit 1, 2 & 3	Coos Watershed Association, SonTek suggested protocol
b	Channel complexity	UAS flight	Annually in Sept. 2018-2021	Unit 2	Smith et al. 2016, Peterson et al. 2015, Roegner et al. 2008.
b	Channel stability	UAS flight and 9 on the ground photo points	Annually in Sept. 2018-2021	Unit 2.	Smith et al. 2016, Peterson et al. 2015, Roegner et al. 2008.
c	Surface water and ground water level	17 water level loggers throughout the site	Continually, 15-min interval 2018-21	Unit 1, 2 & 3 and Beaver Creek	Winter Lake SAP, DEQ 2020[1]
d	Water Quality (TkN)	6 water samples, Lab Analysis	April, June, Aug. 2018-2021	Unit 1, 2 & 3 and Beaver Creek	Winter Lake SAP, DEQ 2020
d	Water Quality (TP)	6 water samples, Lab Analysis	April, June, Aug. 2018-2021	Unit 1, 2 & 3 and Beaver Creek	Winter Lake SAP, DEQ 2020

[1] *DEQ-approved Sampling and Analysis Plan (SAP) titled Volunteer Water Quality Monitoring: Winter Lake Restoration Effectiveness Monitoring Project, Coquille OR*

Table 1. Continued

Para-meter ID	Parameter	Method and Equipment	Frequency/Timing	Sampling Locations	Protocol citation(s)
d	Water Quality (TSS)	6 water samples, Lab Analysis	April, June, Aug. 2018-2021	Unit 1, 2 & 3 and Beaver Creek	Winter Lake SAP, DEQ 2020
d	Dissolved Oxygen and Temperature	7 HOBO Dissolved oxygen and temperature loggers	Continually, 15-min interval 2018-21	Unit 1, 2 & 3 and Beaver Creek	Winter Lake SAP, DEQ 2020
e	Vegetation Composition and Survival	Vegetation survival plots	Annually in Sept. 2019-2021	Unit 2	Coos Watershed Association 2003, USDA 1999
e	Vegetation Composition and Survival	Photo points, 7 points in addition to the vegetation captured in channel stability photos	Annually in Sept. 2019-2021	Unit 2	Coos Watershed Association 2003, USDA 1999
f	Relative fish abundance	Trapping with hoop nets	Seasonally from Nov – April, weekly basis, 2018-2021	Unit 2 & 3 and Beaver Creek	ODFW 2015, Lebreton et al. 2009
f	Body Condition Index and survival	PIT tagging to obtain MR and change in condition	Seasonally from Nov – April, weekly basis, 2018-2021	Unit 2 & 3 and Beaver Creek	ODFW 2015, Lebreton et al. 2009

4. MAMP Requirements

The results of the second year of monitoring the Winter Lake Project will be compared to the thresholds set by the MAMP to determine the effectiveness of the project for parameters listed in Table 2. As with most large restoration and construction projects, the Winter Lake Project area had sustained a large amount of disturbance during construction. Therefore, when construction was completed in October of 2018 much of the ground was bare dirt, the channels had no woody vegetation and little to no vegetative riparian component. Within the water column there was some algae growth, but little if any macrophytic vegetation and no established aquatic or benthic macroinvertebrate communities. The project has had two years to heal with bare dirt being filled in by grass and willows and the movement of macroinvertebrate communities into the newly dug channels. The project is still far from maturity, therefore, results of data obtained from most categories from the second year post-restoration should not be used to judge the success of the project as a whole to meet the long-term restoration goals. Through maturity of the Winter Lake landscape, vegetative complexity, and overall ecological production the expectation is for the project habitats to meet and likely exceed the objectives. Throughout the results section references will be made to the thresholds set by the MAMP listed in Table 2.

Table 2. Monitoring metrics and thresholds set by the MAMP, Appendix A. All interpretations of these metrics have been described in each parameters report section.

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Applicability
Aerial photo/UAS-video or ground based GPS	Channel Length	20,000 feet	1. > 20,000 feet (Pass) 2. < 20,000 feet (Fail)	Entire channel
Data loggers	Maximum Weekly Temperature	72˚ by year four post project. 68˚maximum during summer at year 10	1. < 72 F (Pass) 2. > 72° (Fail)	Entire channel
Data loggers	Dissolved Oxygen	9 mg/L DO	1. >9 mg/L DO (Pass) 2. <9 mg/L DO (Fail)	Entire channel
Data loggers	Total Nitrogen	TBD*	TBD	Entire channel
Data loggers	Total Phosphorous	TBD*	TBD	Entire channel
Data loggers	Organic Matter	TBD*	TBD	Entire channel
Survival plots	Percent Survival	60% survival	1. > 60% survival required (Pass) 2. < 60% survival (Fail)	Unit 2 Banks and Wetlands
Visual inspection	Connectivity	Surface connectivity	1. Side channel providing fish passage/flow between channel and pond (Pass) 2. Side channel not providing fish passage/flow between channel and pond (Fail)	Side channels
Visual inspection	Stranding/Trapping	Depth of main channel thalweg of sufficient depth to allow passage of fish present / tidal depressions	1. Continuous flow (low-flow depth) of at least 2-3” (Pass) 2. Discontinuous or very shallow flow depth (Fail)	Thalweg
Water Level Data Logger	Water Depth – Unit 2 June to September; Basic Flush Level	3.5 to 4.0 Feet NAVD88	1. >3.5 and <4.0 Ft (Pass) 2. <3.5 or >4.0 Ft (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 1-3 Oct.-March; After first flood event transition to Over Winter Habitat Level	4.5 to 5.5 Feet NAVD88	1. >4.5 and <5.5 (Pass) 2. <4.5 or >5.5 (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 2 Oct.-March; Complete transition to Over Winter Habitat Level	4.5 to 5.5 Feet NAVD88	1. >4.5 and <5.5 (Pass) 2. <4.5 or >5.5 (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 1-3 April to May; Maximum Dry Out – maximum elevation	2.0 to 4.0 Feet NAVD88	1. >2.0 and <4.0 (Pass) 2. <2.0 or >4.0 (Fail)	Inside tide gate

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Applicability
Water Level Data Logger	Water Depth – Unit 1-3 April to May; Transition to Basic Flush Level as conditions allow	3.0 to 3.5 Feet NAVD88	1. >3.0 and <3.5 (Pass) 2. <3.0 or >3.5 (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 2 April to May; Transition back to Basic Flush Level	3.5 to 4.0 Feet NAVD88	1. >3.5 and <4.0 (Pass) 2. <3.5 or >4.0 (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 1-3 June to September;	3.0 to 3.5 Feet NAVD88	1. >3.0 and <3.5 (Pass) 2. <3.0 or >3.5 (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 1-3 June to September;	4.0 to 4.5 Feet NAVD88	1. >4.0 and <4.5 (Pass) 2. <4.0 or >4.5 (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 2 June to September; Basic Flush Level	3.5 to 4.0 Feet NAVD88	1. >3.5 and <4.0 Ft (Pass) 2. <3.5 or >4.0 Ft (Fail)	Inside tide gate
Water Level Data Logger	Water Depth – Unit 2 June to September; Sept to October begin transition to Over Winter Habitat Level	4.5 to 5.5 Feet NAVD88	1. >4.5 or <5.5 Ft (Pass) 2. <4.5 or >5.5 Ft (Fail)	Inside tide gate

5. Sampling Parameters

Note: For parameters within Table 1 for which there were DEQ protocols, most sampling methods followed the procedures outlined in the DEQ-approved Sampling and Analysis Plan (SAP) titled Volunteer Water Quality Monitoring: Winter Lake Restoration Effectiveness Monitoring Project, Coquille OR and those not requiring an SAP followed protocols cited in the Elements Table above (Table 1).

Sampling locations for all of the monitoring parameters were chosen based on the following objectives: 1) sites that are representative of the project, 2) reference locations that are similar to project area, 3) a balance of accessibility, safety and cost. Additionally, continuous data loggers are used to measure water temperature, surface water level, groundwater level, dissolved oxygen and water velocity through the culvert structure. All data was collected at 15-minute intervals.

A. *Water Quality Grab Samples*

Background and Methods

Water quality grab samples, specifically Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN) and Total Suspended Solids (TSS), are measured to assess how the improved water management practices affect these key nutrients and water quality parameters. Although thresholds for TP, TKN and TSS have not been set in the MAMP, the Winter Lake Monitoring Committee has determined the monitoring objective for this project as follows.

> The focus of nutrient sampling at the Winter Lake restoration site is to understand 1) the current state of water quality and 2) how water quality will fluctuate, both short and long-term, as the restoration project matures. The first year of sampling will be used as a baseline as no pre-restoration nutrient sampling data is available.

The percent reduction or increase in nutrient concentrations will be calculated over the length of the monitoring project to assess the long-term trend as the site matures. These will be compared with the goals of the draft TMDL for the Coquille River.

Water quality grab samples were collected by CoqWA staff at three different time periods throughout the summer months (April, June and August). At each sampling event the water collected was from a location at least 4 feet from the edge of the channel and 2 feet deep to ensure the sample was representative of the entire channel. This was accomplished by attaching the sample bottles to a long handled rake and gently dipping the rake into the water from the bank to minimize disturbance and collect representative samples. The samples to be tested for Total Kjeldahl Nitrogen (TKN) and Total Phosphorus (TP) were preserved with sulfuric acid. All samples were then placed immediately on ice and shipped to the laboratory (Apex Laboratories, LLC in Tigard, OR) via UPS. Apex Laboratories is an ODEQ approved lab and follows ODEQ approved analyses for water quality samples. To ensure accuracy of sampling procedures 10% of field samples incorporated duplicates, which were collected and analyzed.

Grab samples (Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN) and Total Suspended Solids (TSS), were located within canal and channel networks to assess how much tidal exchange is occurring along the lengths of the channels and canals (Figure 4) and capture if there are effects to these parameters due to tidal exchange. All grab samples were collected during the outgoing tide cycle to ensure the sample did not capture water from the Coquille River.

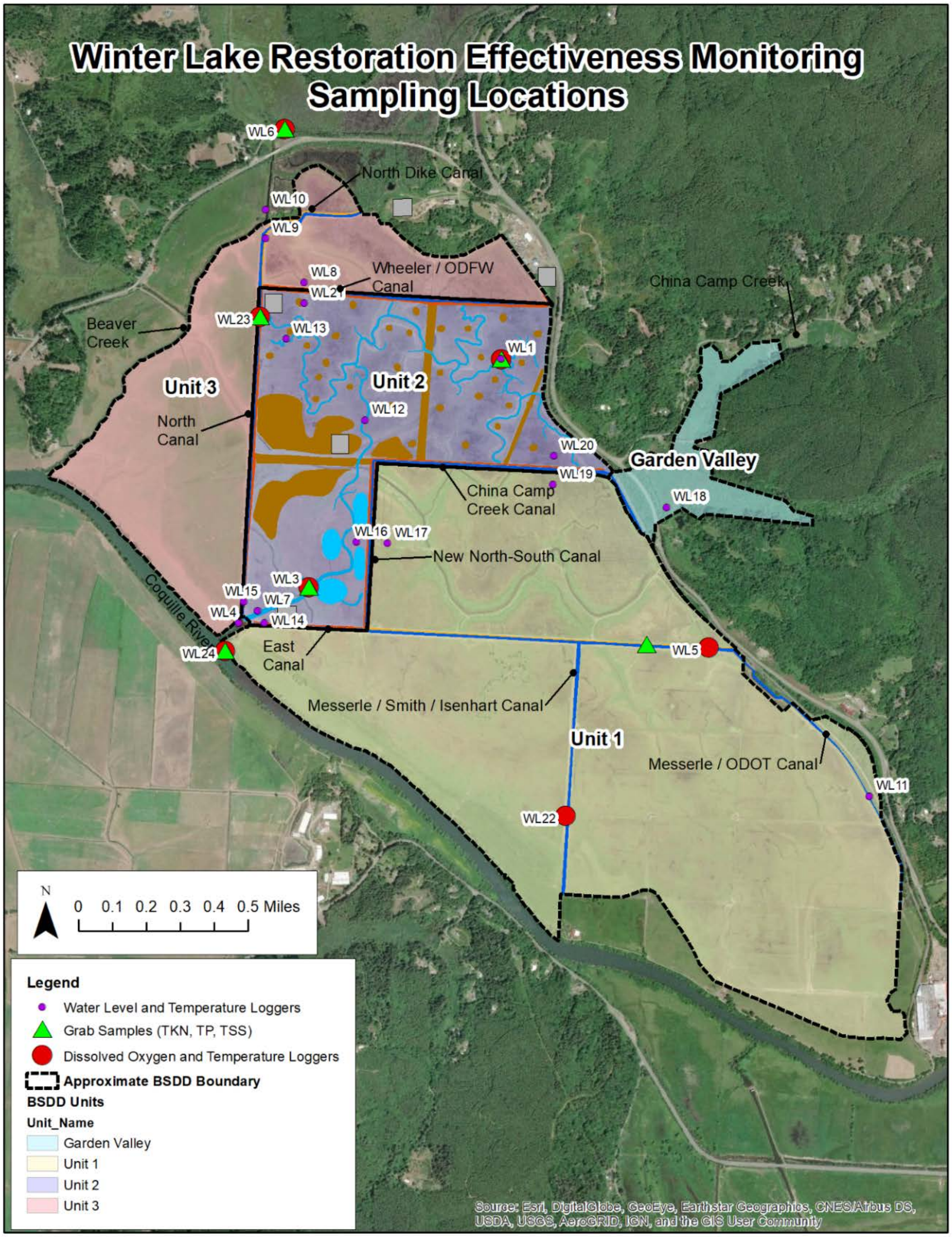

Figure 4. Sampling locations for the Winter Lake Restoration Effectiveness Monitoring Project. Grab samples (TKN, TP, TSS) are green triangles, dissolved oxygen (DO) continuous data loggers are red circles and both groundwater and surface water continuous data loggers are small purple circles. Temperature is monitored at all DO and water level logger locations.

Results and Discussion

Total Phosphorus

Phosphorus is an essential nutrient for both plants and animals in aquatic systems yet it tends to naturally occur in small quantities. Phosphorus is often the limiting factor for aquatic production therefore, when an increase of phosphorus occurs it encourages plant and algae growth possibly leading to algae blooms. In turn when the algae die the bacteria breaking it down consume copious amounts of oxygen and decreases the water body's dissolved oxygen levels.

Levels of TP at the Winter Lake site varied from non-detectable to 0.11 mg/L (Figure 5), with the only detectable levels seen in the agricultural units (Unit 1) during the April and June sampling dates. During the first year of monitoring the highest levels detected were 0.287 mg/L in Unit 1 and were detected at lower levels in Unit 1 and 2 and in Beaver Creek at least once throughout the sampling season. Water levels remained relatively low in the Coquille River and behind the tide gates compared to the previous year which could be the reason for drastically different results. Duplicate samples were taken at sites WL1, WL6 and WL24 to ensure accuracy in sampling methods. All duplicate samples exhibited the same result as the original sample which is non-detectable.

The U.S. Environmental Protection Agency (EPA) survey results of TP from watersheds where agriculture was the primary use, noted that 85% of those watersheds had TP levels of 0.1 mg/L or above and 13% had total phosphorus levels that were >0.5mg/L (Mueller and Spahr, 2005; Figure 6). As phosphorus is often the limiting factor in aquatic systems for ecological function it has the capability of producing unwanted levels of aquatic plant growth when above background levels. Phosphorus was at 0.11 mg/L in Unit 1 in April, which is sufficient supply for heavy aquatic plant growth but phosphorus is limited at the other sites.

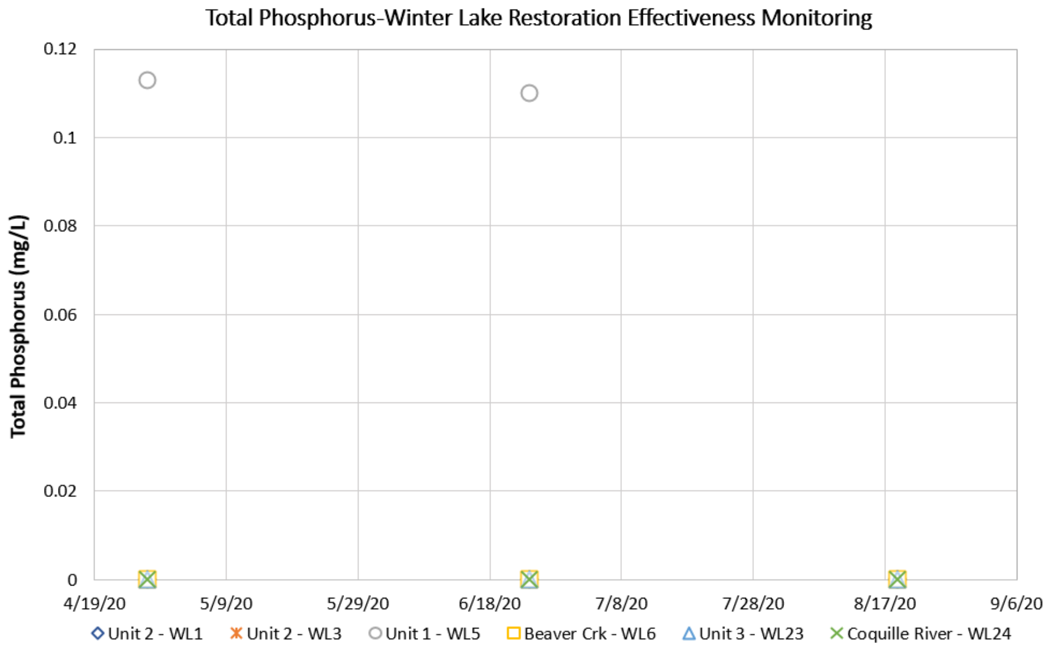

Figure 5. Total Phosphorus sampling results of the Winter Lake Restoration Effectiveness Monitoring project, Coquille Oregon.

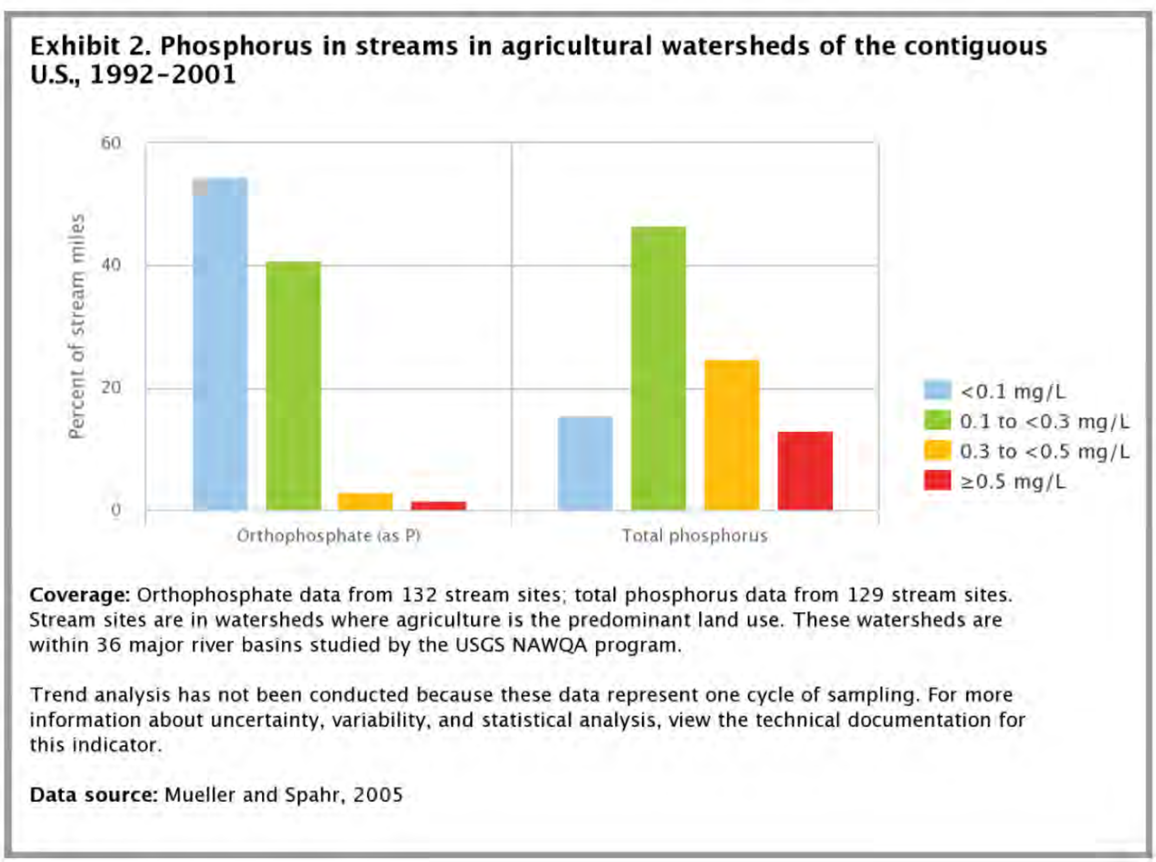

Figure 6. Results of the U.S. Environmental Protection Agency (EPA) study of Phosphorus levels in U.S. streams. Chart from Mueller and Spahr, 2005.

Total Kjeldahl Nitrogen

Nitrogen (N) is commonly found in aquatic systems in both inorganic and organic forms. TKN is a combination of organic N, ammonia, and ammonium. Organic N is typically higher in forest and grass lands but ammonia and ammonium usually occur near animal waste run-off.

TKN levels at the sampling locations varied from non-detectable to a high of 1.19 mg/L, Figure 7, which is greater than the first year's results. TKN is high in Unit 2 at WL1, this could be due to high organic N because of the high grass content in the unit with lots of water exchange between low lying areas and the channel. The Coquille River contains the least amount of TKN therefore as water exchange between the different units and the river increases greater quantities of nutrients will be added to the river. Duplicate samples were also taken for TKN, all duplicates were within 12 % of the original sample passing accuracy standards.

Nitrogen is not often the primary limiting factor in aquatic systems for production of vegetation and macroinvertebrates. Mueller and Spahr (2005) noted that half of the streams sampled in the EPA study had total nitrogen concentrations in the 2-6 mg/L range, with 78 percent having a concentration of 2 mg/L or higher. The levels that have been observed at Winter Lake are considered reasonable levels at this point and are within the range common for agricultural watersheds. That said, there is a benefit to developing a further understanding of the levels and effects TKN has on fish and wildlife production in the project area. At this time algae growth is present in waterways of all Units in late summer, however, not at a level that is negatively impacting fish production. It is important to keep in mind that juvenile coho, which are a target species for the restoration project, usually don't arrive on the site until after cooler fall weather arrives when reduced levels of sunlight result in a lower aquatic plant density.

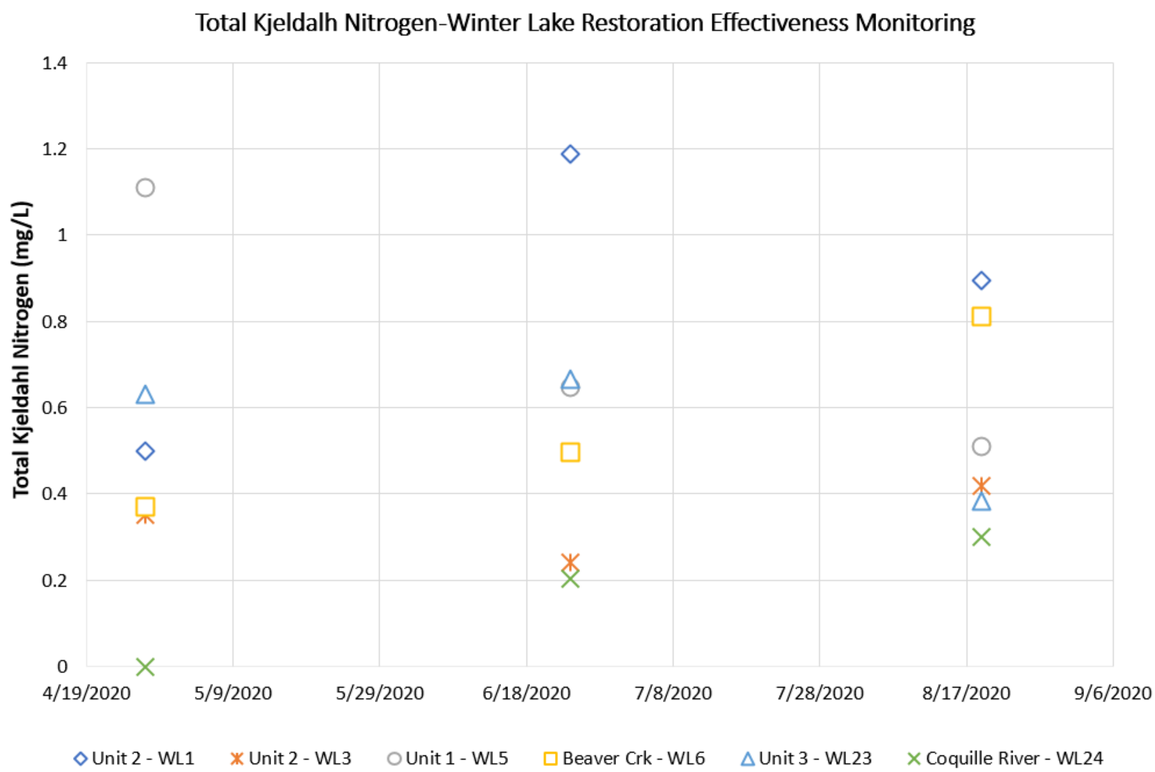

Figure 7. Total Kjeldahl Nitrogen sampling results of the Winter Lake Restoration Effectiveness Monitoring project, Coquille Oregon.

Total Suspended Solids

TSS are the material found in the water column that can be filtered out such as silt, decaying organic matter and waste or sewage. TSS is an important water quality parameter because it indicates the extent of turbidity in the water body. High turbidity can lead to lower levels of light reaching aquatic vegetation, increased temperature due to additional heat absorbed from sunlight and decreased visibility of fish to see and catch prey. High levels of TSS can also indicate higher concentrations of bacteria, nutrients, pesticides, algae and metals in the water column. TSS levels tend to increase with higher flows due to erosion and run-off from flooding and the ability of the faster moving water to hold more suspended solids.

Similar to TKN results, TSS levels are highest during the June sampling event and ranged from non-detectable to 17 mg/L through the sampling season (Figure 8). 2020 sampling results show a decreased amount of TSS detected during the April sampling event, this could be resulting from a drier spring than in 2019. Additionally, TSS is highest in the Coquille River during the April and June sampling events suggesting Winter Lake units do not contribute suspended sediments to the river.

Turbid flows in coastal streams are common during spring and winter. These waters enter wetlands and provide nutrient rich deposition. Levels of soil deposition on the Coquille floodplain have been truncated since installation of tide gates in the late 1800's and early 1900's. The installation of the tide gates has enabled inflow during flood events that more closely mimic historical conditions. Late summer TSS levels were within a range that when visually assessed the conditions allowed fish to feed and move in most channel and canal segments in all Units.

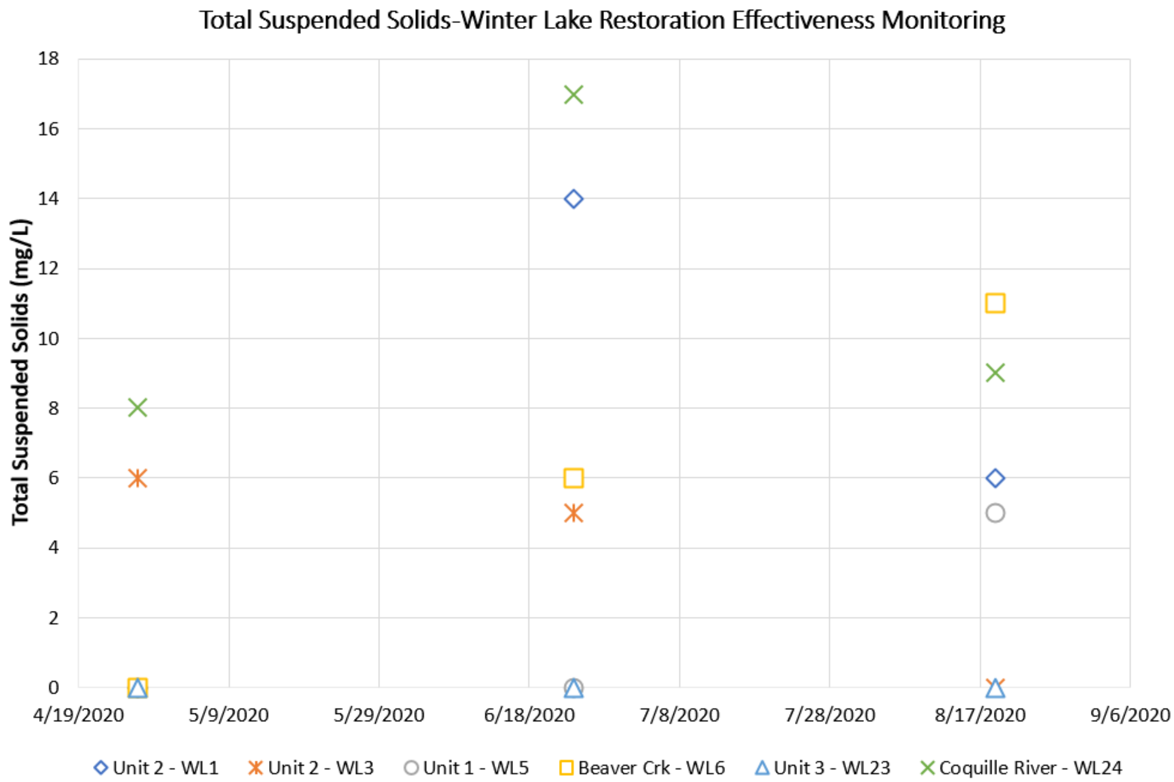

Figure 8. Total Suspended Solids sampling results of the Winter Lake Restoration Effectiveness Monitoring project, Coquille Oregon.

MAMP Table 2 Thresholds: The monitoring team will continue to collect TKN, TP and TSS samples and learn how the sites maturity effects these nutrient levels. *See report section 6.*

B. *Channel Complexity and Stability*

Background and Methods

The Winter Lake Unit 2 monitoring includes channel complexity, stability and depth. A relatively stable channel network is beneficial to fish populations because it promotes long-term vegetative growth and results in low-levels of erosion, which contributes to TSS within the water column. In addition to the stability of the channel banks, adequate depth is necessary to maintain fish passage in the newly constructed channels, prevent stranding of fish, and reduce the potential for disconnected ponded water which can present mosquito production risk.

Channel Complexity

Channel complexity is captured through two methods: 1) via Unmanned Aircraft System (UAS) flights; and 2) on the ground visual surveys, which are both compared to original design specifications. ODFW has staff that are authorized to operate an UAS for work. There several types of UAS that staff operate, one is located at the Charleston Field Office which will can follow a flight pattern and take simple pictures or videos. The second UAS is located in Corvallis, which will also follow flight patterns but is able to take georeferenced photos.

Channel Stability

Channel stability and depth is monitored through the annual measurement of 6 channel cross-sections and photo points throughout Unit 2 (Figure 9). Procedures described in *Protocols for Monitoring Habitat Restoration Projects in the Lower Columbia River and Estuary* (Roegner et al., 2008) were followed. Permanent metal t-post location markers were installed on the transect endpoints of each channel cross-section and are used as points of reference. A measuring tape was attached to the endpoints and a stadia rod and survey level were used to record height and distance from the t-post transect endpoints (Figure 10). Unfortunately, due to equipment malfunctions multiple different styles of survey equipment were used for channel cross-sections, such as a hand level, laser level and survey level. Measurement intervals varied from site to site and heights are referenced to the permanent end point markers. The 2018 surveys were done on foot while the channels were still dewatered, the 2019 surveys were completed using a kayak while the 2020 surveys used a combination of kayak and on foot. Analysis of channel cross-sections compared surveys from post construction in 2018 to present to determine if scouring has occurred and ensuring channel water levels are sufficient for fish passage.

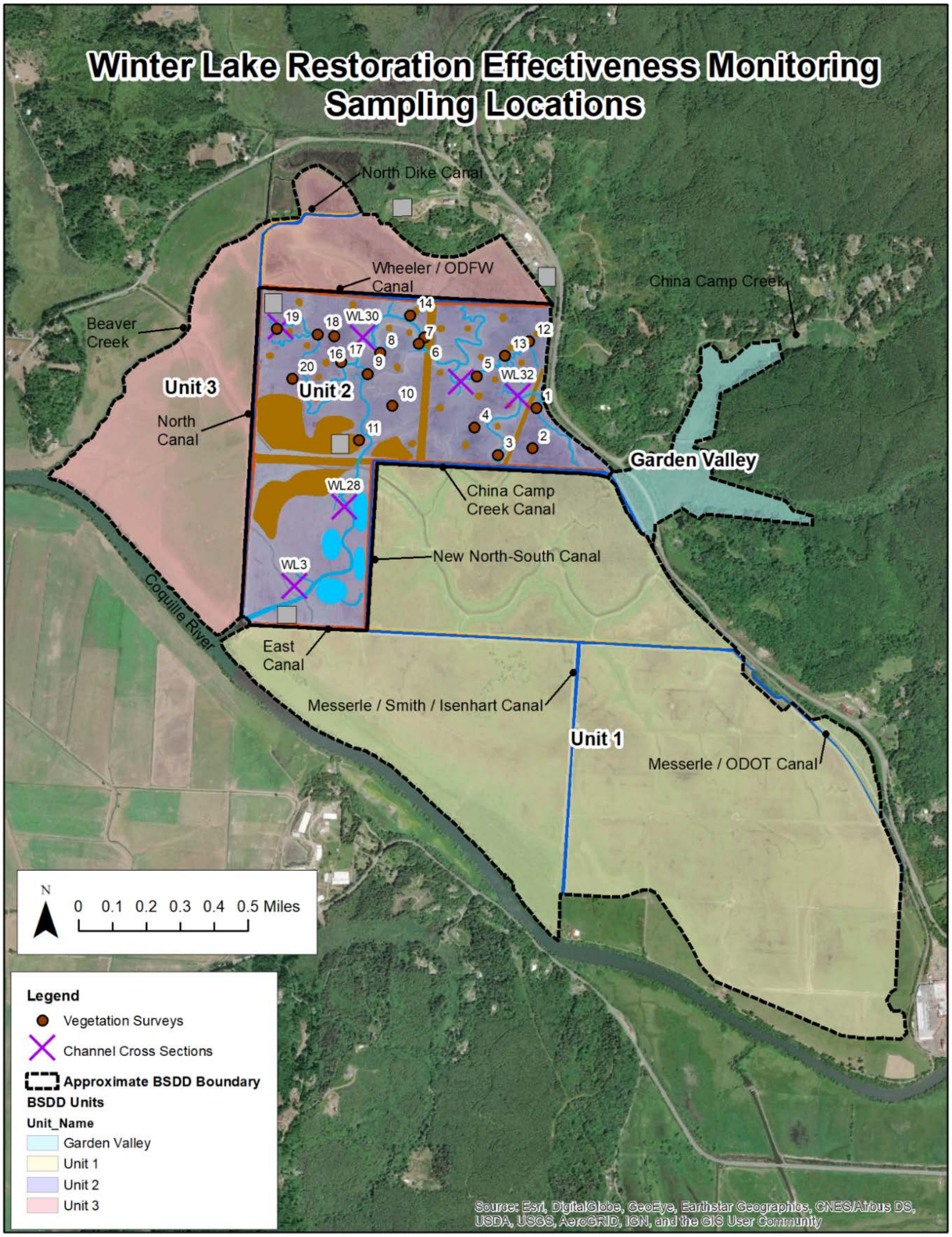

Figure 9. Sampling locations for the Winter Lake Restoration Effectiveness Monitoring Project. Vegetation composition and survival survey plots (19 total) are brown circles and channel cross-sections are purple crosses.

Figure 10. A laser level was used to complete some channel cross-sections in 2020 (left). If water depth allowed, 2020 channel cross-sections were completed on foot to maximize accuracy.

Results and Discussion

Channel Complexity, Length and Connectivity

Channel complexity is captured through aerial photographs taken by an UAS on an annual basis. As seen in the 2020 aerial photographs of the Restoration Unit (Unit 2) (Figure 11 and Figure 12), the channels are highly complex in both sinuosity and size. Post-construction channel configuration was at least as sinuous as the original engineered designs. Several additional channels were constructed in 2019 that were not on the original final design. This additional 3,700 ft of shallow channel was constructed in order to further the ability of fish to immigrate and emigrate from low level ponded water areas in Unit 2. These new channels will also assist with addressing mosquito production concerns.

In October 2020, ODFW staff from the Corvallis Research office conducted an UAS flight over Unit 2. This flight produced a georeferenced photo that can be used to measure channel lengths and widths that can be compared with photos in future flights. With these georeferenced photos we will be able to mark channel locations and over time observe if these channels are remaining stable or moving.

MAMP Thresholds (Table 2): The final Restoration design that was implemented resulted in construction of just over 27,000 ft of channel based on post-built engineering surveys. Sinuosity and other complexity features such as depth variation were visually assessed when the channel was dry just prior to introduction of water. The complexity was equal to or exceeded engineered design features and the MAMP thresholds. All segments of channel provided for fish passage at a level that was considered optimal (as assessed through visual inspection by ODFW and CoqWA staff) and exceeded the threshold in the MAMP (Table 2).

Figure 11. Aerial photo looking towards the Northeast corner of the Winter Lake Restoration Unit (Unit 2), photo taken July 27, 2020.

Figure 12. Aerial photo of the Winter Lake Restoration Unit (Unit 2) from the northwest corner looking southeast, photo taken Aug. 3, 2020.

Channel Stability and Depth

To evaluate channel stability and depth, six channel cross-sections are measured and photo points are taken annually. During both 2019 and 2020 surveys depth was adequate for fish passage at all sites surveyed. In 2019, all of the six cross-sections but one remained stable. Location WL32 had slight scouring on the left side (facing downstream) (Figure 13 and Figure 14). Again in 2020, all of the six-cross sections but one remained stable. In 2020, the cross-section that showed a change was WL3 (Figure 15 and Figure 16) and it experienced deposition and not scour, unlike WL32 in 2019. It is likely that the scour and deposition at these two locations are an artifact of measurement error due to the fact they were both completed with a kayak. The Winter Lake site experiences strong winds and currents during tidal exchanges creating difficult conditions while measuring channels. To improve accuracy, in 2020 all channels that were shallow enough (all except WL3 and WL28) were completed on foot using waders or dry suits. Cross-sections of WL28, 29, 30 and 31 can be found in Appendix C and a subset of photo points can be found in Appendix D.

MAMP Thresholds (Table 2): No threshold was set for this parameter.

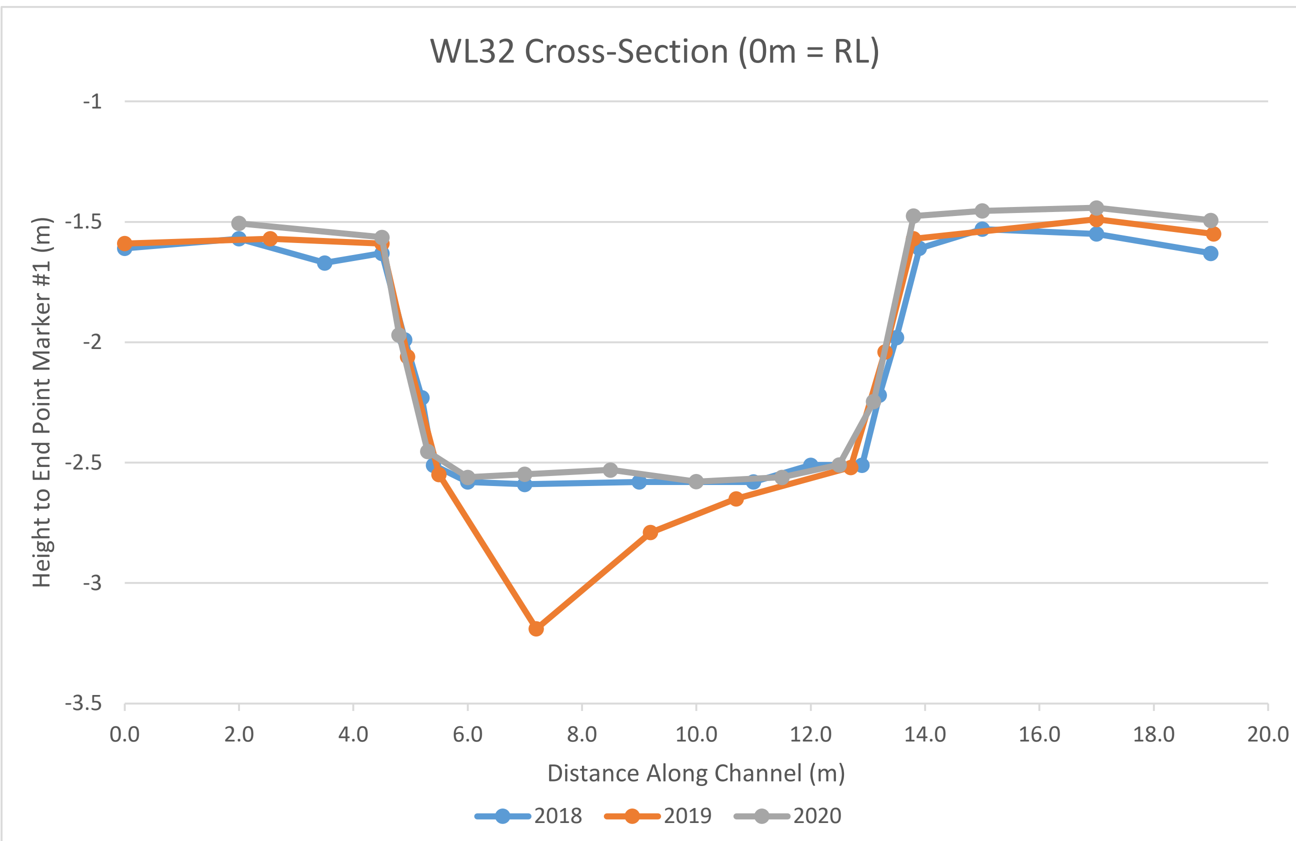

Figure 13. Cross-Sectional measurements of channel at location WL32 in Unit 2, Winter Lake Restoration Effectiveness Monitoring. All measurements are based on the distance from the end point marker on the river left bank (when looking downstream), therefore river left end point marker is distance 0.0m.

Figure 14. Upstream facing photo of location WL32 of the Winter Lake Restoration Effectiveness Monitoring, August 2020 (taken on river right).

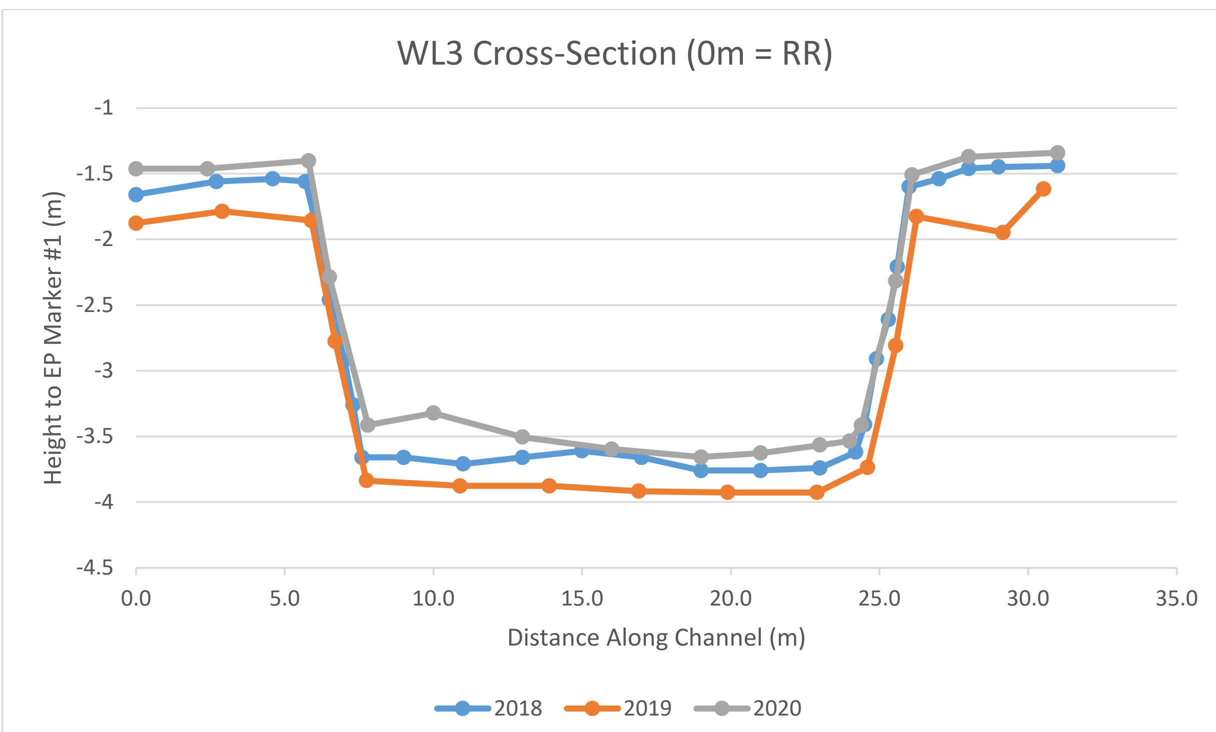

Figure 15. 2018-2020 cross-Sectional measurements of channel at location WL3 in Unit 2, Winter Lake Restoration Effectiveness Monitoring. All measurements are based on the distance from the end point marker on the river right bank (when looking downstream), therefore river right endpoint marker is distance 0.0m.

Figure 16. Upstream facing photo of location WL3 of the Winter Lake Restoration Effectiveness Monitoring, August 2020 (taken on river left).

C. *Vegetation Survival*

Background and Methods

A well-established riparian zone is an important objective for the Winter Lake project. Riparian vegetation plays an important role during both summer and winter seasons. During the high flows experienced in the winter season, riparian vegetation helps reduce water velocity which in turn decreases channel bed scour and enables sediment deposition to occur on the floodplain rather than in the mainstem Coquille River or the mouth. Slower water velocities are also beneficial to juvenile coho and other salmonid species residing in the Winter Lake project area during times of flooding. Furthermore, during the summer season a dense riparian canopy can block solar radiation that would otherwise be absorbed by the water column. The long-term goal of the Winter Lake project is to have a sufficiently dense riparian canopy to keep the channels cool enough to be used as a summer-time thermal refugia by salmonids as the mainstem Coquille River temperatures reach levels above salmonid tolerance.

To aid in the establishment of a robust riparian zone, Unit 2 of the Winter Lake Project was heavily planted with trees and shrubs. In the late fall of 2018, Winter Lake (Unit 2) was planted with 8,137 native trees and shrubs and over 70,000 Hooker's *(Salix hookeri)* and Scouler's *(Salix scouleriana)* willows. An additional 6,500 trees and shrubs and 35,000 willows were planted within Unit 2 in the fall of 2019. Vegetation composition and survival surveys are completed on an annual basis. A total of 19 plots were surveyed following the procedures outlined in Coos Watershed Association's

Riparian Silviculture Guideline (2003). The plot locations were chosen to be representative of the different landscape features (wildlife mounds vs riparian areas) or channel size (8-20m wide) of the Restoration Unit (above, Figure 9). The plots are established in the 2018 planting areas, situated in either riparian areas or wildlife mounds and the boundaries have been marked with wooden stakes. All living trees and shrubs were identified to species and counted, all dead trees and shrubs were counted and identified, if possible (Figure 17). A simple analysis of percent survival of all standing trees and shrubs was completed.


Figure 17. Thriving willows in the foreground and wild rice growing in tidal pools in the background (left). An alive Ash from plot 20 of the vegetation survival and composition survey, October 2020 (right).

Results and Discussion

In 2019, 20 plots were surveyed and the survival rate varied from a low of 16% to a high of 100%. In 2020, only 19 plots were surveyed due to missing GPS data of Plot 15. Plot survival rate ranges from 5% to 100% in 2020 and does not appear to be spatially dependent (Table 3 and Figure 18). The survival rate at plot 13 is artificially low because the trees were removed for mitigation work completed by Oregon Department of Transportation. No other plots showed signs of tree removal. Species specific survival rates were not calculated for 2020 as many of the dead trees and shrubs identified in 2019 were no longer present and the remaining dead trees were difficult to identify. Additionally, the 2019 and 2020 survival surveys only included trees and shrubs that were present and did not include 'missing' trees (a location that looked like there should be or had been a tree), due to uncertainty of whether it was pulled out by beavers or not planted. The overall survival rate decreased from 70% to 62% from 2019 to 2020. Over time the planted trees and shrubs will see variable mortality due to flooding and other natural causes, resulting in a natural mosaic of vegetation for fish and wildlife benefit.

MAMP Thresholds (Table 2): The overall vegetation survival of the tree and shrub planting of Unit 2 was 62% and exceeded the MAMP threshold of 60%.

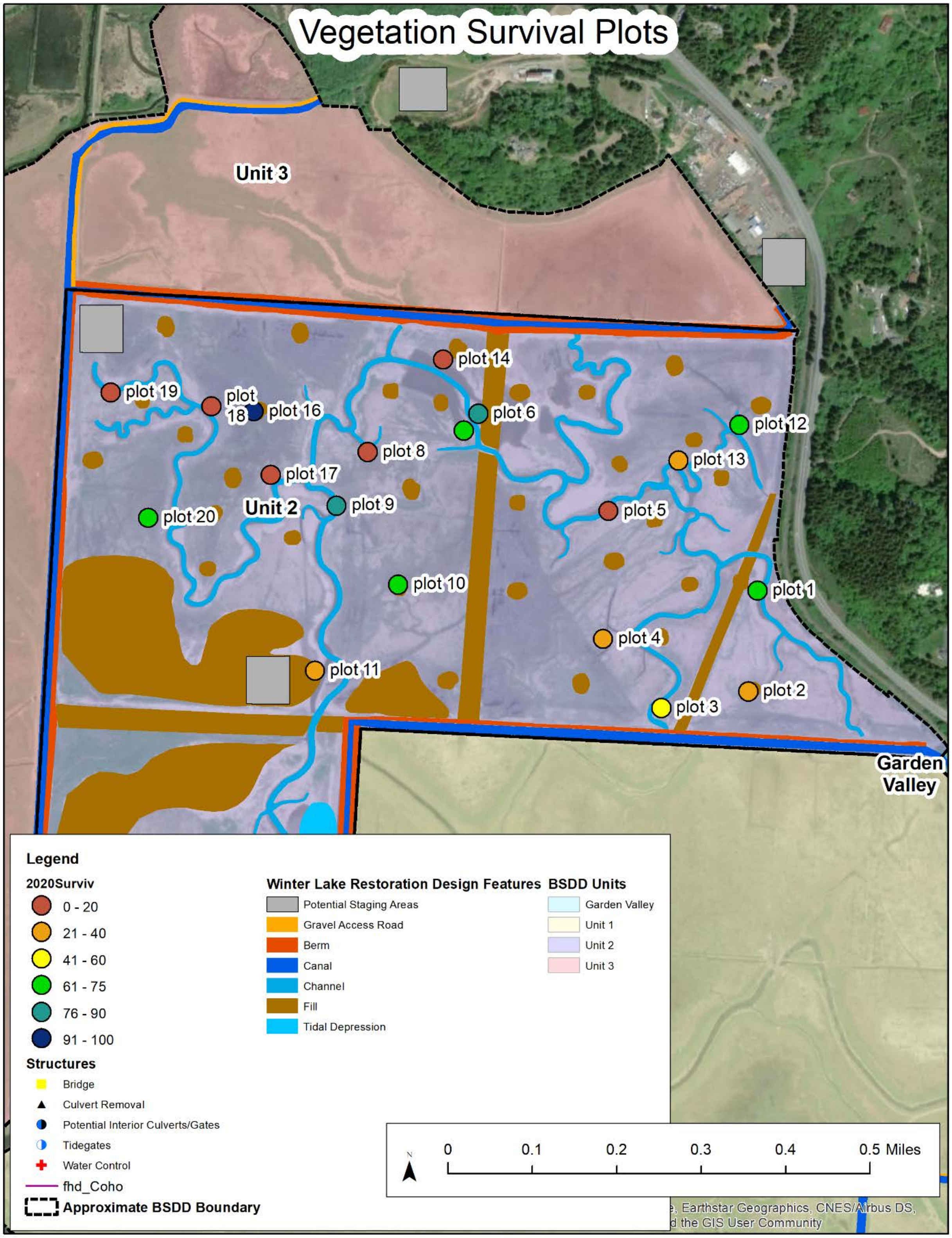

Figure 18. Vegetation survival of Winter Lake Restoration Project, Unit 2. 2020 Survival ranged from 5% to 100% and plot habitat type varied from wildlife mounds to riparian corridors.

Table 3. Vegetation Survival Survey of Winter Lake Restoration Project - Unit 2.

2020 Vegetation Survival Summary - Overall Survival Rate 62%

Plot #	% Plot Survival
1	71
2	33
3	50
4	27
5	13
6	89
7	74
8	18
9	83
10	70
11	32
12	70
13	33
14	5
16	100
17	11
18	18
19	8
20	62

D. *Surface and Groundwater Level*

Background and Methods

Surface water levels are important to monitor within the Winter Lake area because they are an indication of quantity and quality of habitat available and tide gate operations. When the tide gate doors are opened during incoming tides the water moves into the different Units creating deeper channels and tidal pools. When the tide water recedes, water flushes out of the Winter Lake Units and this exchange and mixing contributes to improved water quality.

Surface and groundwater levels are measured with both In-Situ's Rugged Troll 100 and ONSET U20L data loggers and are corrected with barometric pressure from a Rugged BaroTroll data logger located at the tide gate structures. Surface water level loggers (5 total) are installed in stilling wells attached to wooden posts driven into the stream or canal channel (Figure 19). Paired groundwater wells (3 pairs total) were installed by BSDD staff and followed protocols set by Northwest Hydraulic Consultants (NHC). Each paired well set includes a groundwater well in Unit 2 and one in an agricultural unit (Unit 1 or 3). Both groundwater wells and surface water stilling wells have been surveyed to establish elevations for each logger. Water level loggers are downloaded on a quarterly basis (pending field conditions) and field audits are performed at each download to assess data quality. In addition to the data loggers there are six permanent water level sensors installed in stilling wells throughout the Winter Lake area (Figure 19). Data from these water level sensors are sent via remote terminal unit (RTU) to the network computer in the tide gate control house and uploaded to the online portal supported by NHC. CoqWA downloads the portal data on a monthly basis for local use and storage. Groundwater analysis compares water level in the paired wells in a qualitative manner to see how management of each unit has an effect on localized groundwater levels. Surface water levels are analyzed through comparison of water levels with the thresholds set by the MAMP (Table 2).

As mentioned, groundwater monitoring is structured in a paired well arrangement, of the 3 pairs one well is located in Unit 2 while the other is located in Unit 1 or 3 to assess how water management alters groundwater levels (above, Figure 4). Surface water monitoring locations were distributed across the Winter Lake area with 3 situated just upstream and one downstream of the tide gate structure, these aid in management of the tide gate doors and water levels within the 3 units (above, Figure 4). There are an additional eight surface water monitoring locations in Units 1-3, Garden Valley area and the reference site (Beaver Slough). These water level monitoring locations help determine how water level management at the tide gates affect channels and canals far upstream from the structure.

Figure 19. Permanent wooden posts with PVC stilling wells attached to house water level loggers within (left), temperature is collected by water level loggers. Permanent steel stilling wells house water level loggers installed by Northwest Hydraulic Consulting (NHC), right. Data is transmitted via RTU to the network computer on-site every 15 minutes.

Results and Discussion

Surface Water Level

Note: *Unit 2 Restoration main channels have been designed such that the invert elevation is below the lowest level that minus tides subside. Thus, these main channels are able to provide ~1.0-2.0ft of water at the lowest tide elevations for fish habitat.*

The MAMP has set separate water level thresholds for the agricultural units and the Restoration Unit (Table 2).

Water levels are examined during two different time periods: the wet season (Oct 1-Apr 30) and the dry season (May 1- Sep 30) (Figure 20 and Figure 21). During construction the Unit 2 berms were increased in height to elevation 2.3 m (7.5ft). Above that elevation, water is able to move between all 3 units. Additionally, river levels can be restricted from entering the lands upstream of the tide gates to an elevation of 4.3 m, thus water elevation within Units 1, 2, and 3 is dependent on tide gate operations and river elevation. During the second winter post-construction there was one flood event, which we define as water levels greater than 2.3 m, thus the berms that keep each unit hydrologically separate were over-topped by flood waters just once, Figure 20. The single flood event that occurred in the second year was an extended period of very high water where river levels reached just under elevation 4.0 m. During this flood event, the tide gates were closed and the water elevation upstream of the tide gates remained under elevation 2.5 m out of caution to protect infrastructure (ie. dikes) within the drainage district.

During the summer water levels remained low for all Units except during irrigation periods in Units 1 and 3, (Figure 21). Water levels in Unit 2 were intentionally kept low due to ODOT earthwork being completed in the low lying northeast corner. Overall, there is natural variation in water levels due to rain or the absence of rain and the influence on river levels and pasture accumulation of water. The Winter Lake project is a complex system and as BSDD, ODFW and CoqWA navigate water levels and tide gate operations the goal is for future water level management to be closer to the MAMP thresholds.

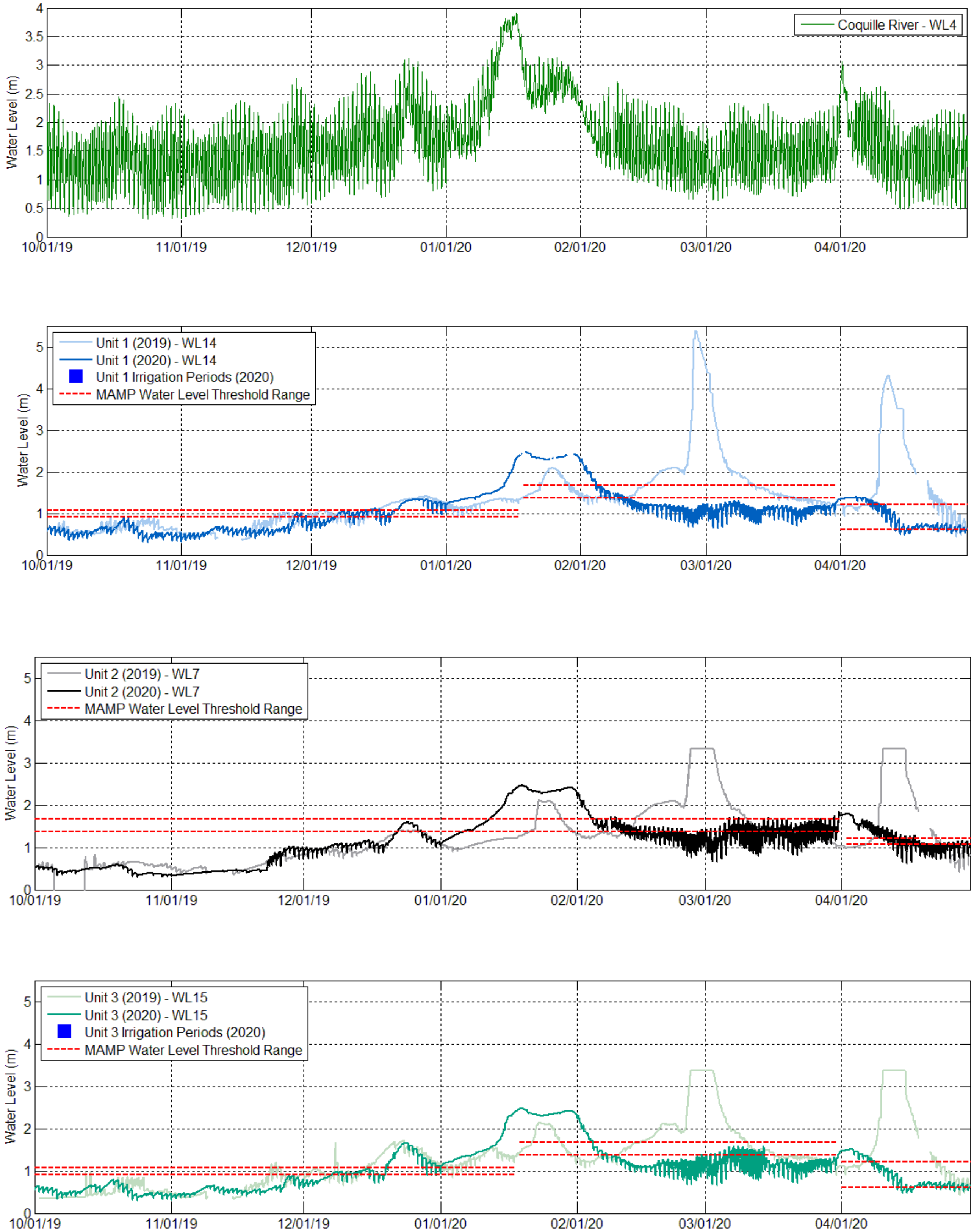

Figure 20. Water levels during the wet season, Oct 1 – Apr 30. There was one extended minor flood in mid-January. The MAMP threshold range is depicted by two red dashed lines and varies depending on season and Unit. The MAMP threshold is based on the daily high water level.

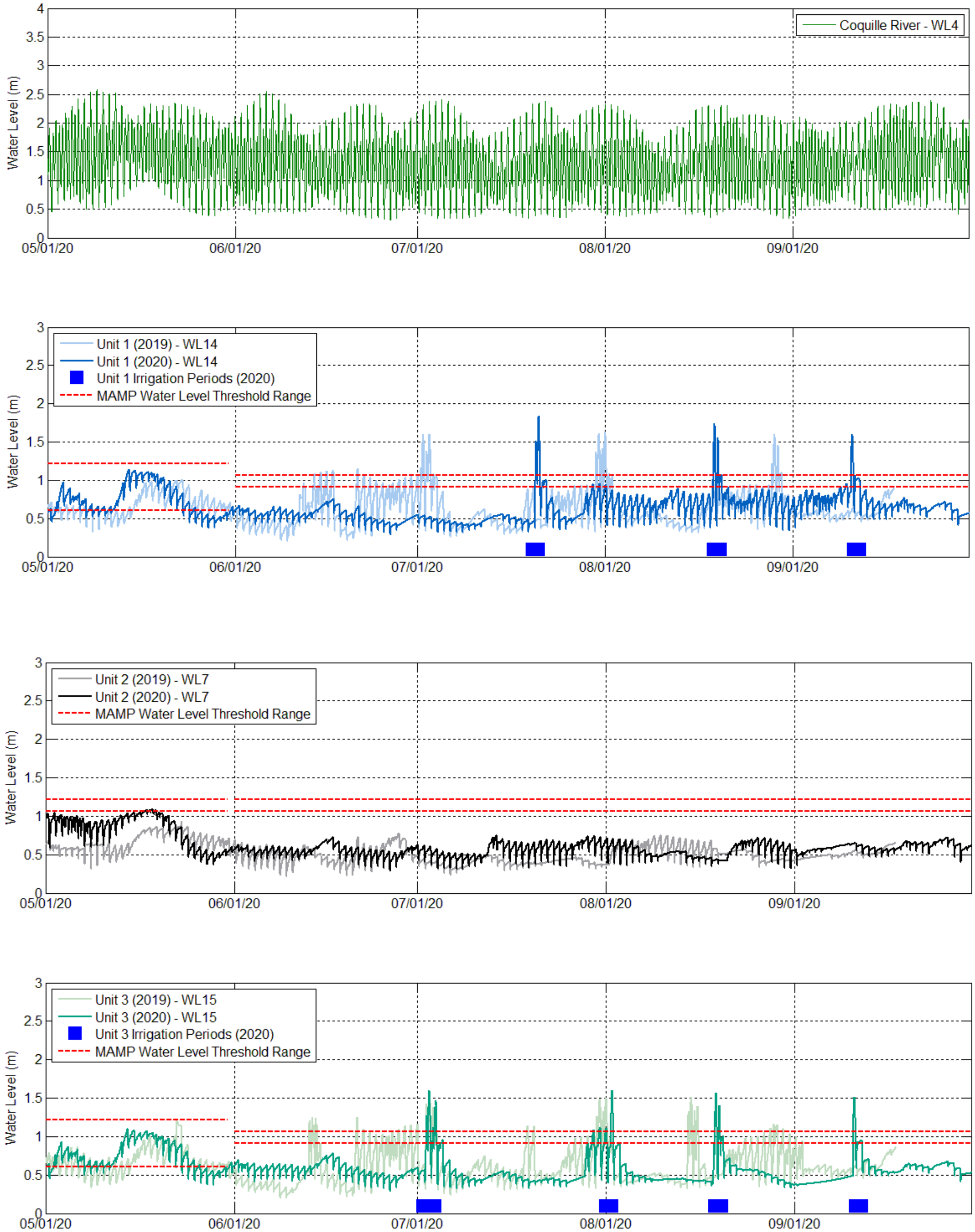

Figure 21. Water levels during the dry season, May 1 – Sep 30. Note the three irrigation events (blue lines) during the summer months in the agricultural units (Unit 1 and 3). The MAMP threshold range is depicted by two red dashed lines and varies depending on season and Unit. The MAMP threshold is based on the daily high water level.

Water levels of the reference site, Beaver Creek, are depicted in Figure 22. The one flood in January of 2020 is less extreme at Beaver Creek than the Winter Lake area. This is due to the location of Beaver Creek in the floodplain, natural river levees, berm isolation of Beaver Creek from Winter Lake area, the location where the logger is deployed, and a restrictive tide gate downstream of the logger. Low water levels similar to Units 1, 2, and 3 are seen during the summer months at the Beaver Creek site.

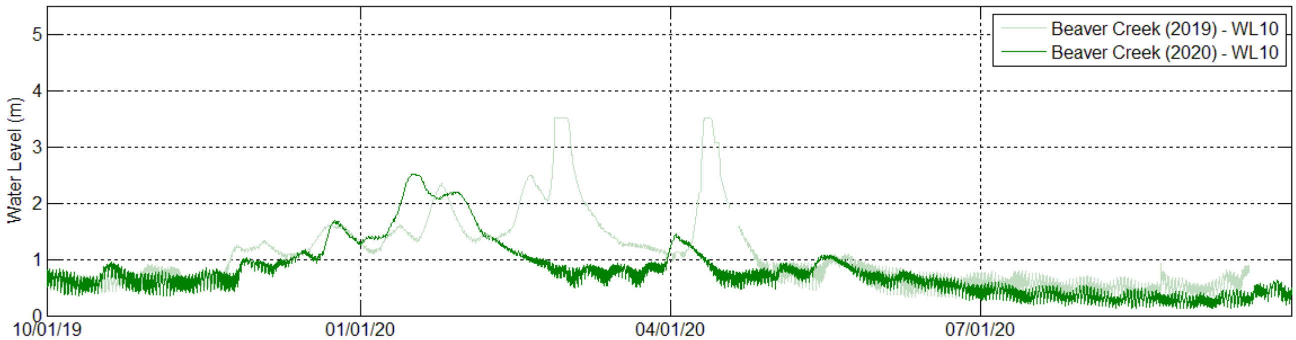

Figure 22. Water levels at Beaver Creek, reference site, from Oct 1 2019 - Sep 30, 2020.

MAMP Thresholds (Table 2): Water levels set as thresholds for Unit 2 were not consistently met on average for all Units in 2018-2019.

Groundwater Level

There are no MAMP thresholds set for groundwater levels. There are two well pairs in Unit 1 and 2 and one pair in Unit 2 and 3 (Figure 23). Groundwater wells in Unit 1 (WL17 and WL19) and Unit 3 (WL8) exhibit influence from the summer irrigation periods unlike their paired wells in Unit 2.

Since the groundwater wells are located in the floodplain, they all record the flood waters that occurred during the winter months (Figure 23). Overall, the groundwater levels show that periodic irrigation increases groundwater levels, which is beneficial to the survival and health of grasses, forbs, shrubs, and trees of the project area.

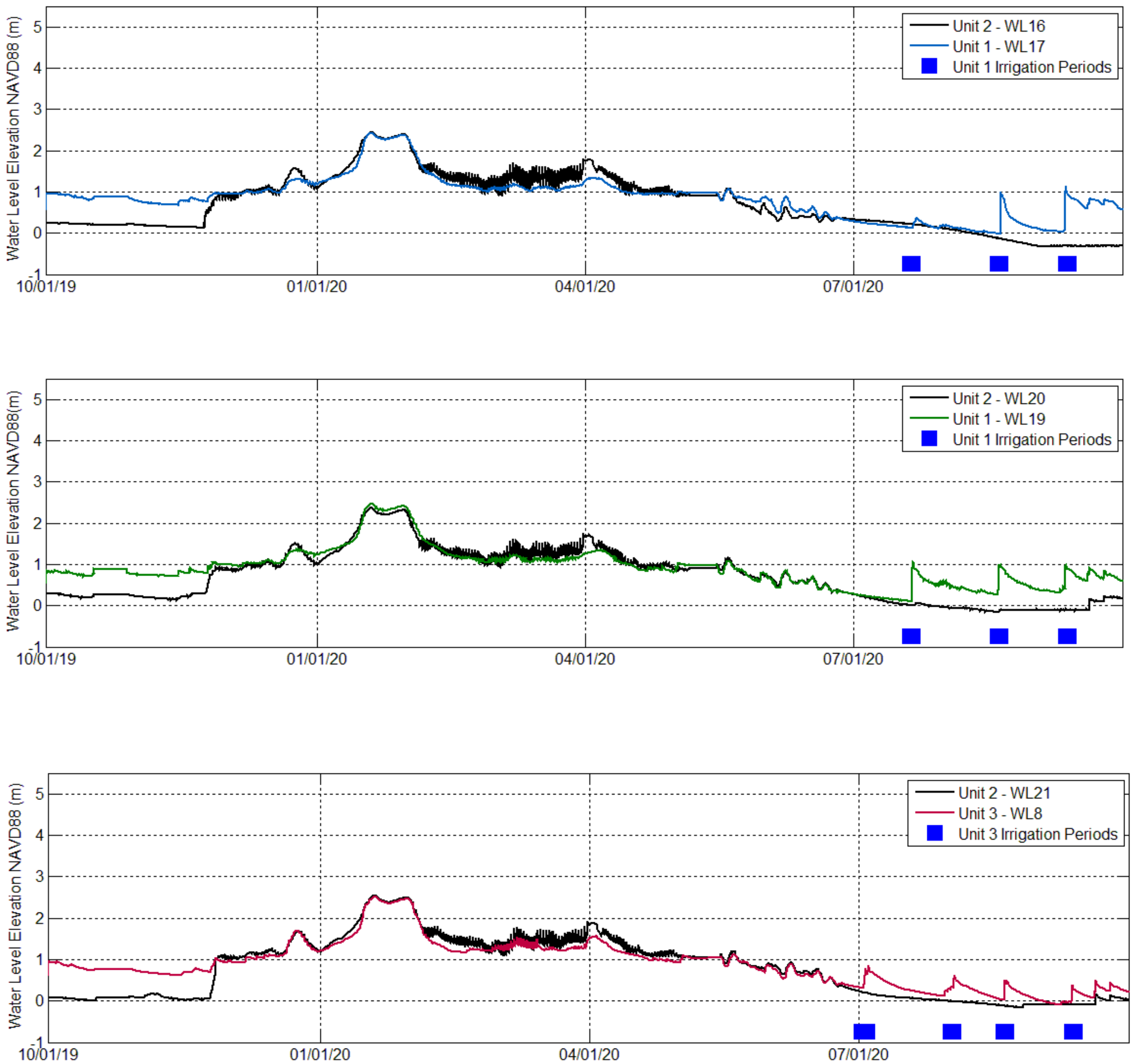

Figure 23. Groundwater levels of paired wells in Winter Lake project area. The top two figures show paired wells in Unit 1 and 2, with irrigation (blue bars) playing a significant role in summertime groundwater levels. The bottom figure shows the paired wells in Unit 2 and 3. During the winter months the water levels correspond to surface water levels since the wells are located in a floodplain.

E. *Dissolved Oxygen*

Background and Methods

Dissolved Oxygen (DO) is an important water quality parameter to monitor because aquatic organisms need it to survive such as fish and invertebrates. These organisms use oxygen during respiration therefore inadequate levels are harmful to their health. DO enters the water column in two main ways: 1) through the atmosphere by diffusion or aeration (wind or riffles) and 2) it is produced by plants and algae during photosynthesis. Water temperature also plays a role in DO levels as colder water can hold more oxygen. In general, DO levels vary on a daily basis due to water inflow-outflow mixing, wind patterns, photosynthesis and on a seasonal basis due to temperature.

Dissolved oxygen is measured continuously at seven locations throughout the Winter Lake area with Onset U26 Dissolved Oxygen Data Loggers (above, Figure 4). The Onset U26 data loggers measure dissolved oxygen via an optical sensor and are secured to the outside of the stilling well to allow for better flow around the optical sensor (Figure 19). To ensure accurate measurements the optical sensor needs to be cleaned of biofouling on a regular basis with frequency increasing during the warm summer months. The Onset U26 data loggers need to be laboratory calibrated and audited pre- and post- sensor cap replacement which occurs on a semi-annual basis. In addition, field audits are performed during each optical sensor cleaning. The calibration and audit procedures were followed according to DEQ protocol with the results used to assess data quality.

These DO monitoring locations assessed how increased tidal exchange effects dissolved oxygen content and compare to the nearby tidal wetland of Beaver Slough that has a dampened tidal signal. Temperature monitoring occurred at all DO monitoring locations. Where appropriate and workable with river flows, sampling occurred in the mainstem Coquille River to assess the water quality or DO conditions in the project area. The DO levels are analyzed through comparison of observed levels with the thresholds level set by the MAMP, of 9.0 mg/L (Table 2). The DO data is split into two separate timeframes for analysis, Oct 1- Mar 31 and Apr 1- Sep 30 to account for their naturally different thermal dynamics. The total number of days each logger recorded DEQ quality A or B data is listed as Day Count. Basic statistics were calculated such as mean, median, minimum, and maximum DO levels for the two time periods. In addition, the number of days each site failed the DO threshold (Daily Mean < 9.0 mg/L) is included along with the number of days the daily minimum and maximum were below the threshold.

Figure 24. The stilling well at dissolved oxygen monitoring location WL22. The logger is hung off the cap of the stilling well to allow for better flow around the optical sensor.

Results and Discussion

The fish species caught at Winter Lake (Section 5.I) require a wide-range of DO levels. Bottom feeders such as brown bullheads require very little DO while salmonids such as coho require much higher levels. The MAMP threshold for DO levels at Winter Lake is set at 9.0 mg/L, presented as the daily mean DO level. Between October and March, the mean DO levels in the Winter Lake area ranged from a low of 6.5 mg/L (WL22) to a high of 10.5 mg/L (WL3) (Table 4). Site WL3 in Unit 2 had the fewest number of days (8 days) where daily mean DO was below the threshold due likely to the proximity to the Coquille River and experiencing more exchange with the oxygenated river. The other 4 Winter Lake sites ranged between 92-131 days below the threshold. Although these DO levels are lower than the threshold, they are still higher when compared to the reference site, Beaver Creek – WL6, which has high numbers of juvenile coho during winter rearing. There are other studies around the state and in Northern California where what appear to be healthy juvenile coho are being observed in habitats with low levels of DO and cold water temperatures, therefore, the DO levels observed at this point are not of high concern. *See Section 7 of report for MAMP discussion*.

DO levels during the summer period are lower, as expected. The summertime mean DO levels in the Winter Lake area ranged from a low of 2.8 mg/L (WL22) to a high of 8.6 mg/L (WL3) (Table 4). The monitoring location, WL22 in Unit 1, is at the end of a canal in shallow and highly stagnant water with lots of vegetative growth therefore the DO levels seen at this site tend to be low during the summer and highly variable. All monitoring sites dropped below the 9.0 mg/L threshold set by the MAMP during the summer period but when compared to the DO levels of Beaver Creek (reference site) the Winter Lake sites on average have higher levels of DO.

During the first year of monitoring there were difficulties keeping the Coquille River (WL24) DO logger suspended during the winter months due to the high flows, large quantities of sediment being deposited and accessibility concerns, therefore WL24 was only deployed for part of the winter during the second year of monitoring. Additionally, the bi-annual DO sensor cap replacement and calibration happened in late November and early December and due to holidays and scheduling conflicts the redeployment of WL3 and WL6 were delayed, then high water levels caused further delay leading to low total day counts for these two sites. Likewise, during the summer months, the logger at WL5 failed the field audits numerous times leading to fewer days of high quality data (Table 4).

Table 4. Dissolved Oxygen statistics for the winter period, Dec 1-Mar 31 2020 (top table) and summer periods, Apr 1-Sep 30 2020 (bottom table).

Oct-Mar Dissolved Oxygen	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	155	167	107	181	181	85	108
Mean	6.5	8.0	10.5	6.9	8.7	9.5	6.0
Median	7.0	8.0	10.8	7.2	8.9	9.6	6.3
Min	0.0	2.7	1.5	0.0	3.0	4.9	0.0
Max	14.5	17.0	13.8	14.0	15.1	12.5	9.5
Days Min < 9.0 mg/L	147	149	63	151	143	38	108
Days Max < 9.0 mg/L	85	79	0	100	56	21	89
Days Mean < 9.0 mg/L	116	120	8	131	92	30	108

Apr - Sep Dissolved Oxygen	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	132	176	176	176	176	143	176
Mean	2.8	5.6	8.6	6.5	5.1	8.1	3.0
Median	1.7	5.5	8.7	7.1	4.8	7.9	2.0
Min	0.0	0.2	1.5	0.0	0.0	3.0	0.0
Max	18.1	12.6	15.5	15.8	14.8	11.2	9.4
Days Min < 9.0 mg/L	132	173	169	172	154	137	176
Days Max < 9.0 mg/L	101	133	29	126	111	85	172
Days Mean < 9.0 mg/L	131	168	118	168	134	115	176

The daily mean DO levels at each site for both the first and second year of monitoring are plotted with the DO threshold and daily mean water levels of each unit (Figure 25 -Figure 31). The daily means are highest at WL3 in the restoration unit. Unfortunately, due to the nature of the DO logger deployment in the Coquille River much of the data was unusable due to high flows and sediment loading, Figure 31.

It was difficult to understand the correlating factors for data obtained in 2020 with regards to DO levels. For July-August in WL3, photosynthetic production of oxygen during daylight hours and bacterial demand in non-daylight hours appears to be a factor (Figure 28). Water inflow-outflow through the tide gate would be anticipated to have a mixing effect, however, flow has been visually assessed as laminar, thus there is less ability for the water to obtain oxygen from the air than if velocities were higher and there was turbulence. In Unit 2, the tide gates were closed from early June through September 30th, 2020. This was in order for ODOT to mechanically treat non-native plants in 18 acres of Unit 2 that have been designated as a mitigation site. This tide gate operation pattern resulted in very limited opportunity to assess DO concentrations in relation to tidal influence during the warmer months. Within Unit 2, the two sites, WL1 and WL3, behaved oppositely. DO levels varied greatly throughout the year at WL1 and did not follow similar patterns from 2019. DO levels in WL3, located near the tide gate, were more consistent possibly due to the exchange with the river because of its proximity to the tide gate.

In Units 1 and 3, the agricultural units, site WL22 was more variable in the winter than WL5 or WL23 which is likely due to being located at the end of a shallow canal. All three sites showed lowered DO levels during the warm summer months even though there were large aquatic plant communities at each site.

MAMP Thresholds (Table 2): DO level thresholds for Unit 2 were met at one of two sites (Table 4) for the winter and summer period.

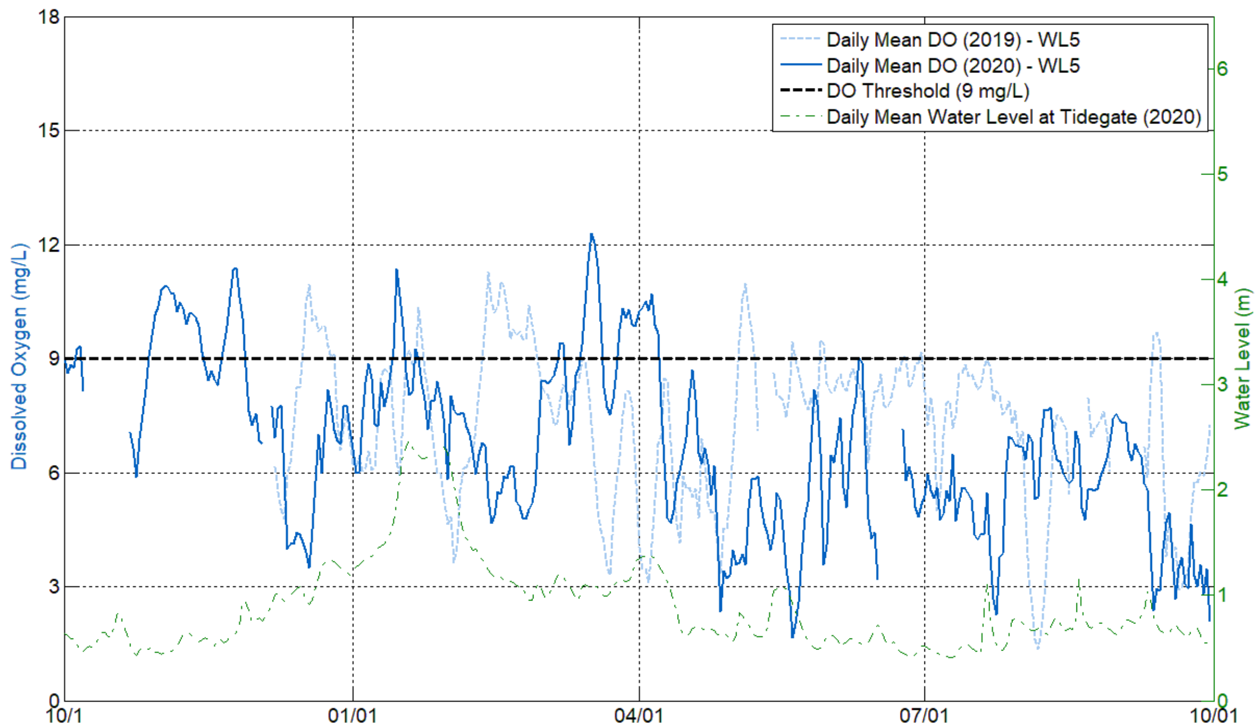

Figure 25. Dissolved oxygen trends and water level for Unit 1 at WL5 in 2019 (light blue) and 2020 (dark blue).

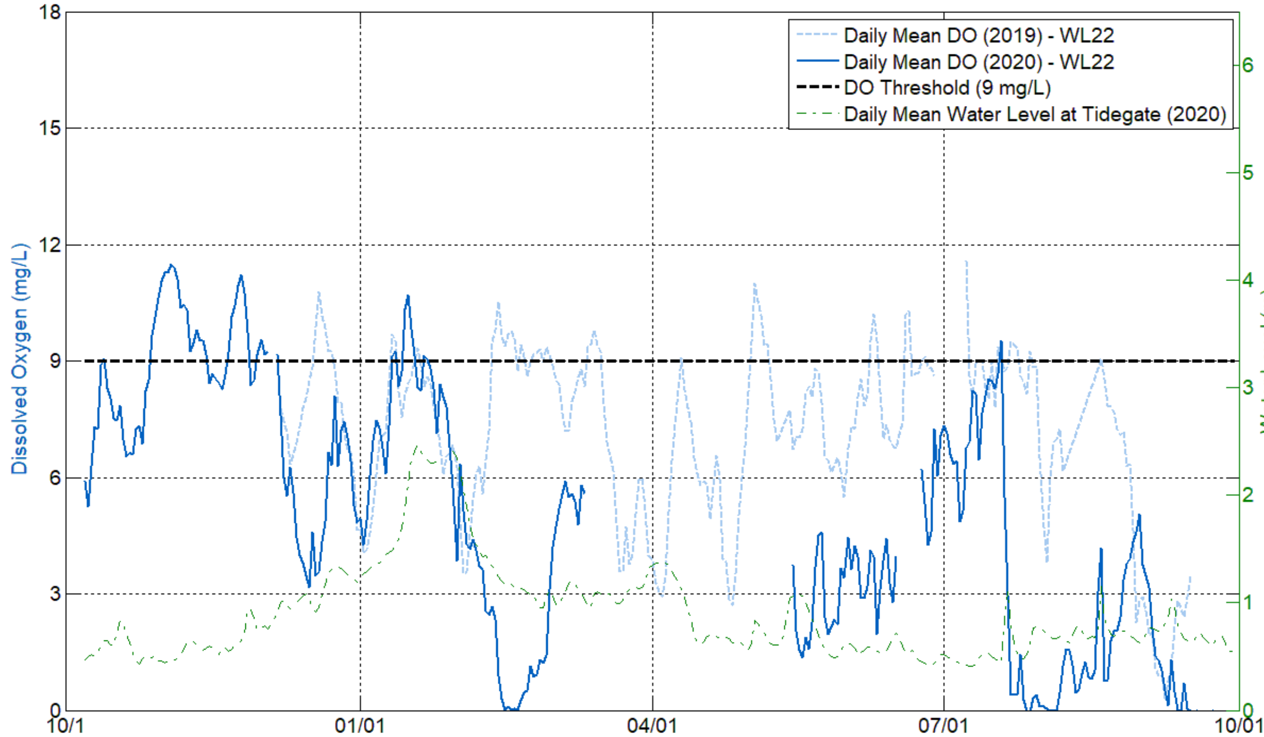

Figure 26. Dissolved oxygen trends and water level for Unit 1 at WL22 in 2019 (light blue) and 2020 (dark blue).

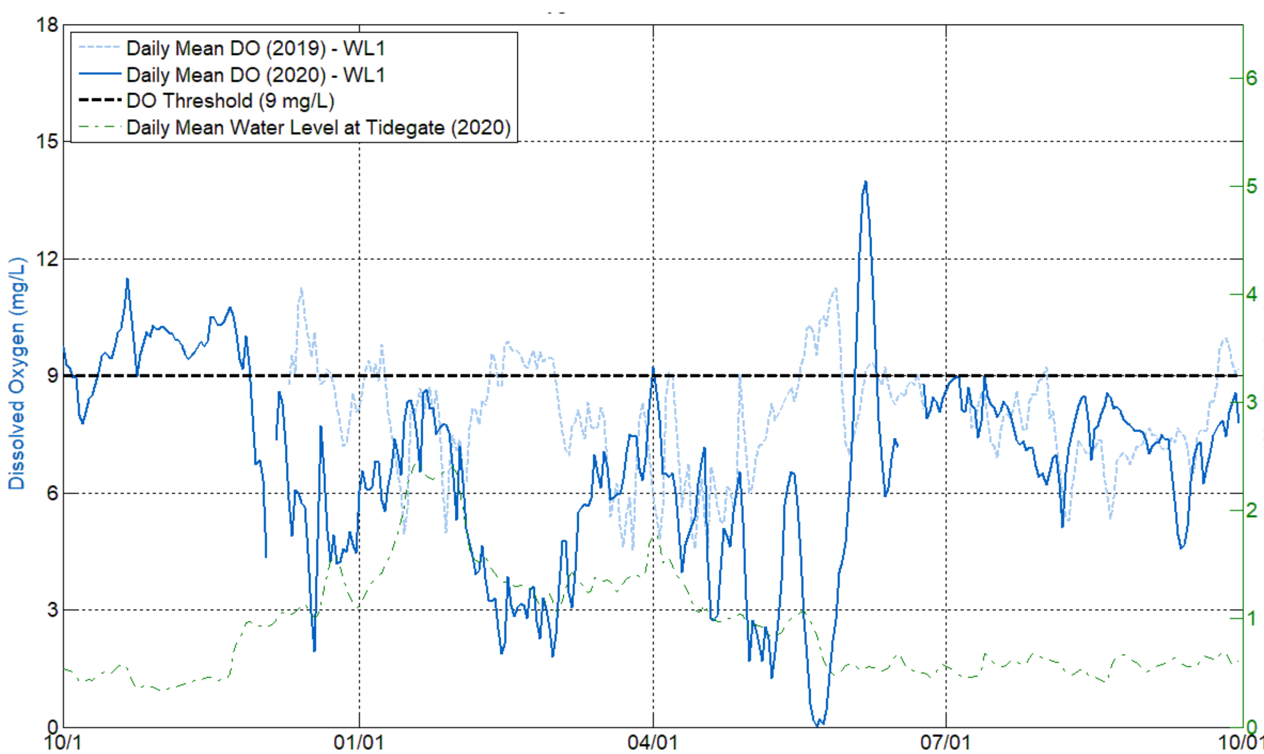

Figure 27. Dissolved oxygen trends and water level for Unit 2 at WL1 in 2019 (light blue) and 2020 (dark blue).

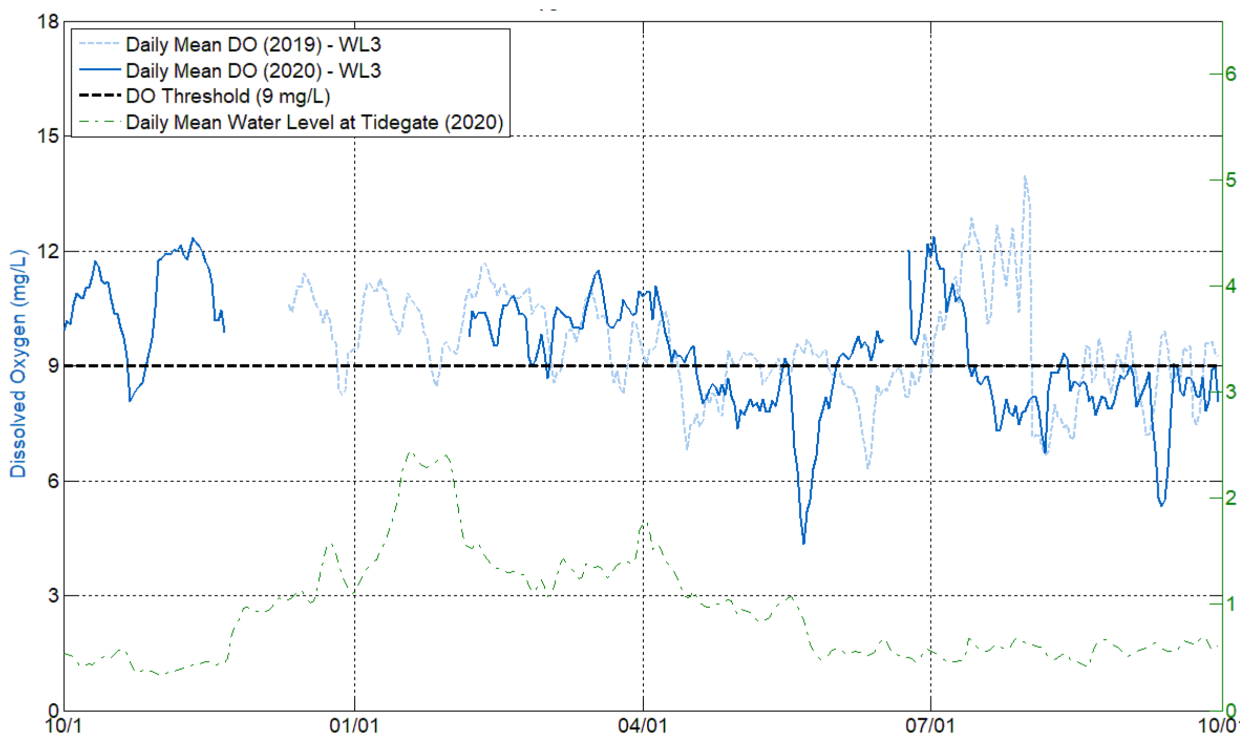

Figure 28. Dissolved oxygen trends and water level in Unit 2 at WL3 for 2019 (light blue) and 2020 (dark blue).

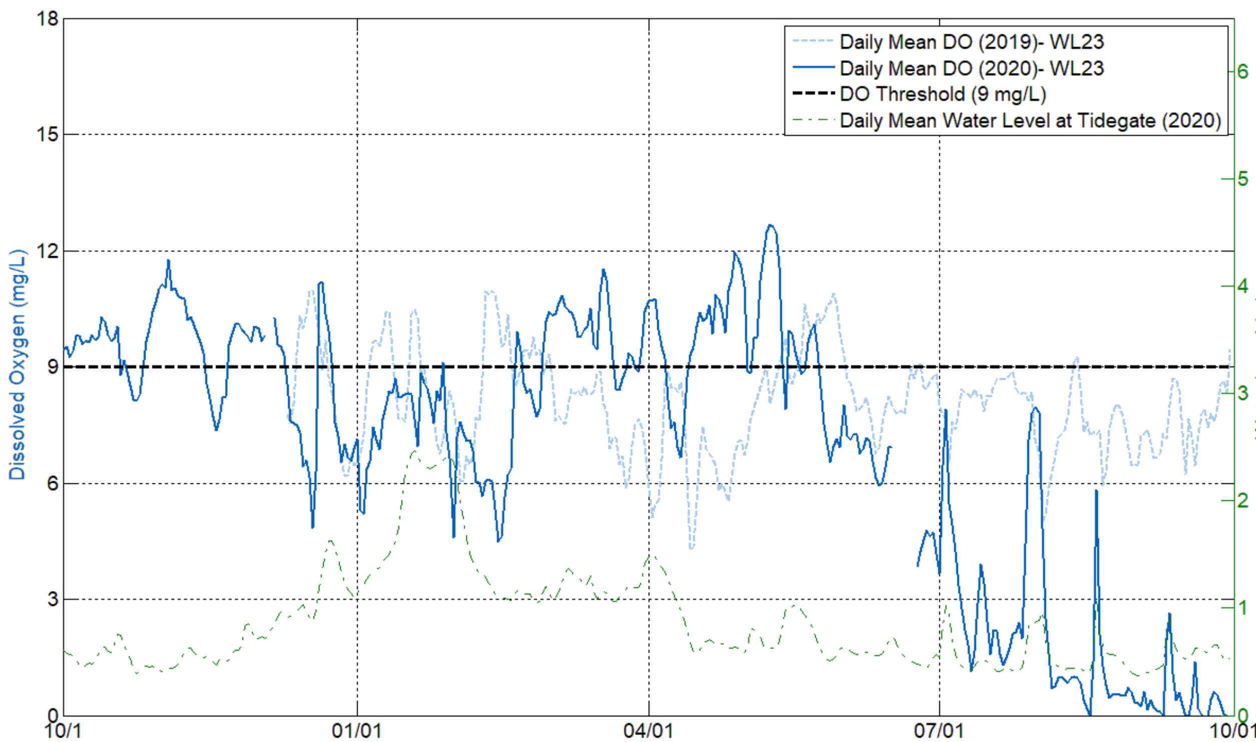

Figure 29. Dissolved oxygen trends for Unit 3 WL 23 in 2019 (light blue) and 2020 (dark blue).

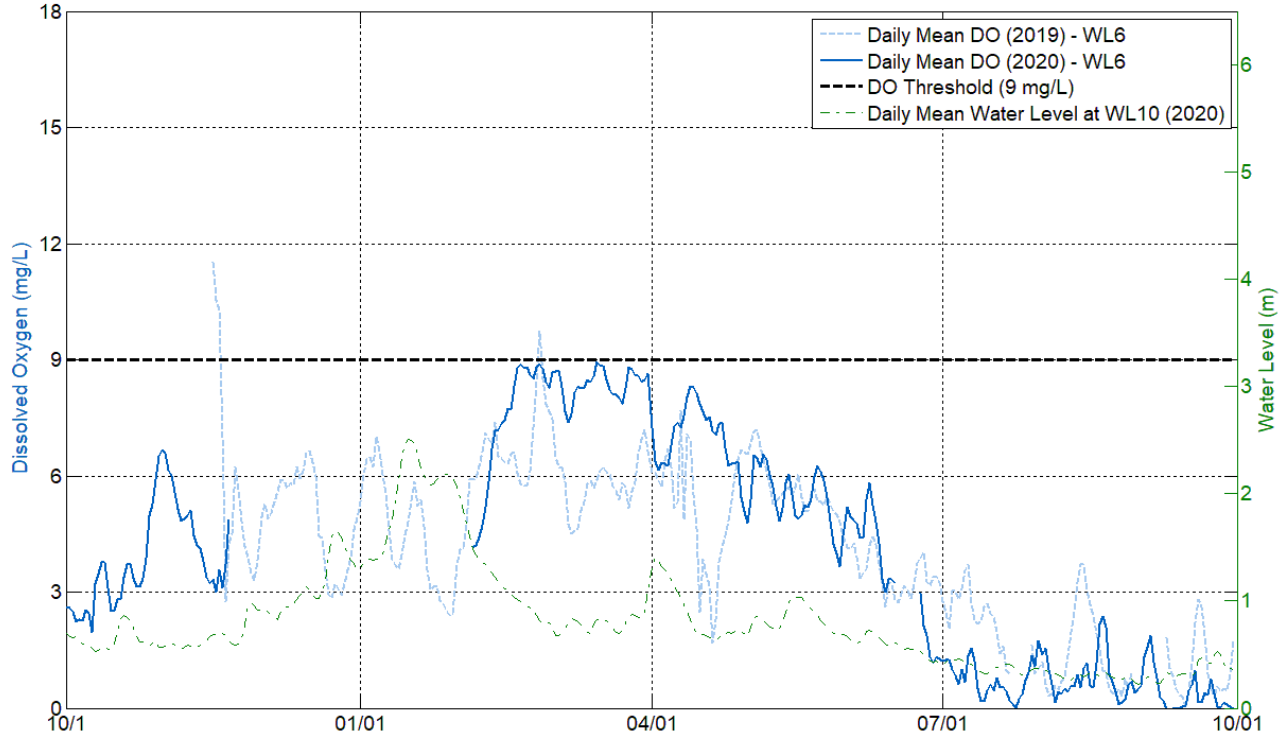

Figure 30. Dissolved oxygen trends for Beaver Creek WL6 in 2019 (light blue) and 2020 (dark blue).

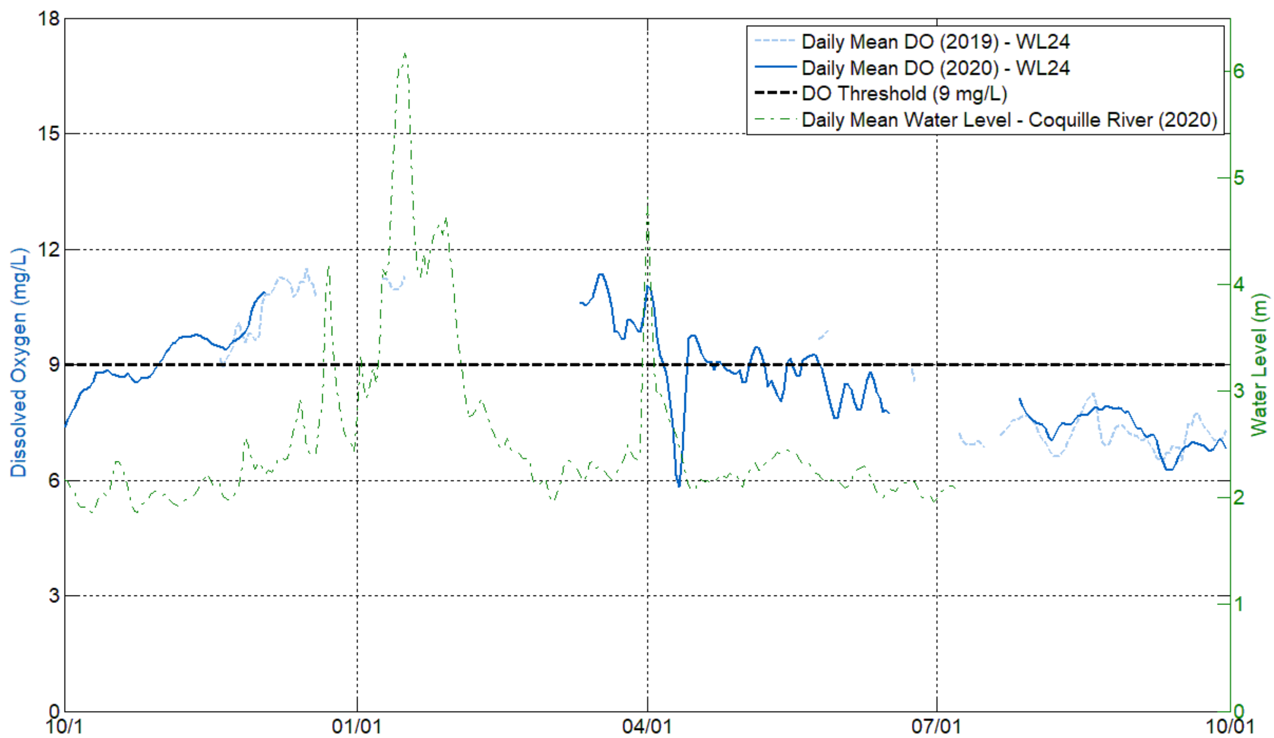

Figure 31. Dissolved oxygen trends for the Coquille River in 2019 (light blue) and 2020 (dark blue).

F. *Temperature*

Background and Methods

Salmon and steelhead are considered cold-water fish species and their health and survival are dependent on spawning and rearing in cool waters. One of the Winter Lake Project's primary objectives is to improve habitat to encourage recovery of the ESA-listed Oregon Coast coho therefore, temperature is an important parameter to monitor. In addition to keeping cold-water fish species healthy, it is desired and anticipated that cool water temperatures may reduce the abundance of non-native fish species that have warmer thermal preferences. These combined two factors are linked to the site's future potential of being used during summer periods by coho and for increased over winter survival due to juvenile coho with better body condition and decreased predation.

Water temperature is dependent on the energy budget of the stream channel. During summer months the main energy inputs that heat the water column are longwave radiation and convection, with the primary source of energy delivered as solar radiation. Furthermore, the main energy inputs that cool the water column are stream bed conduction, groundwater inflows, evaporation, and hyporheic exchange. Of all the energy inputs, solar radiation has the greatest influence on water temperature of the channels at Winter Lake, due to the young age of newly-planted riparian vegetation. As the riparian vegetation matures and the canopy shades the stream channels, solar radiation should drastically decrease. Additionally, any areas with groundwater inputs will eventually provide cold water refugia as shading develops and protects these zones during the warm summer months.

Both Rugged Troll water level loggers and Onset U26 DO loggers include temperature sensors. Laboratory calibration and audits are performed annually and field audits are performed at every download or cleaning event. Surface water temperatures are analyzed through comparison of temperatures with the thresholds set by the MAMP, Weekly Maximum Temperature (WMT), which we interpreted to be Weekly Maximum Daily Temperature, and averages the maximum daily temperature over a week period. The MAMP set a threshold for WMT to be below 22.2 °C (Table 2). Due to the quantity of temperature sensing instruments installed only temperature from DO loggers are analyzed and presented in this report. The temperature data collected at the Winter Lake area has been split into two separate time periods for analysis, Oct 1- Mar 31 and Apr 1- Sep 30 to account for naturally different thermal dynamics. The total number of days each logger recorded DEQ quality A or B data is listed as Day Count. As a note, the MAMP temperature threshold is to be reached by year 4 post-project completion.

Results and Discussion

During the Oct 2019 – Mar 2020 period all Winter Lake sites passed the temperature threshold set by the MAMP, with means ranging from a low of 9.7˚C (WL22) to a high of 11.3˚C (WL3). The mean daily change in temperature is similar for all sites ranging from 1.4 - 1.8 ˚C. The influence of the Coquille River water inflow and outflow largely drives temperatures near the tide gates. For example, WL22 and WL3 had similar mean daily temperature change but for two separate reasons. Site WL22 is in a narrow and shallow area of the canal and therefore heats up and cools down easily due to a smaller thermal mass. Yet, site WL3 is a very large and wide channel but experiences similar temperature swings due to its proximity to the tide gate structure (80m) and the exchange of Coquille River water.

All Winter Lake sites, including the Coquille River (WL24), exceeded the MAMP threshold of 22.2 ˚C for a period of time from Apr – Sept 2020. Although there is no riparian vegetation, Unit 3 (WL23) has the coolest temperatures of all Winter Lake sites. Although the Unit 2 sites (WL1 and 3) exceeded the MAMP threshold for the greatest number of days the channel of Unit 2 also has the greatest surface area for solar loading. As riparian vegetation matures the sites should become cooler. Site WL22 had the greatest mean daily change in temperature due to receding water levels while two sites (WL3 and WL23) had mean daily change in temperatures lower than that of the reference site, Beaver Creek (WL6).

During the first year of monitoring there were difficulties keeping the Coquille River (WL24) logger suspended during the winter months due to the high flows, large quantities of sediment being deposited and accessibility concerns, therefore WL24 was only deployed for part of the winter during the second year of monitoring. Additionally, the sensor cap replacement and calibration (for DO) happened in late November and early December and due to holidays and scheduling conflicts the redeployment of WL3 and WL6 were delayed, then high water levels caused further delay leading to low total day counts for these two sites. Likewise, during the summer months, the logger at WL5 failed the field audits numerous times leading to fewer days of high quality data (Table 5).

Table 5. Summary table of water temperatures of the Winter Lake Restoration Effectiveness Monitoring project. Temperature was split into two time periods for analysis, Dec 1- Mar 31 (cooler period) and Apr 1- Sep 30 (warmer period).

Temperature	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
10/1-3/31/20	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	155	181	107	181	181	85	108
Mean	9.7	10.5	11.3	10.6	10.3	11.7	9.6
Median	9.6	10.3	10.8	10.2	10.0	10.9	9.4
Min	4.1	5.0	6.6	5.1	5.4	5.8	4.9
Max	19.1	17.3	17.1	18.7	16.8	17.9	14.5
MWMT>22.2℃	0	0	0	0	0	0	0
Mean Daily ΔT	1.9	1.4	1.8	1.8	1.4	0.8	1.5

	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
4/1-9/30/20	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	132	176	176	176	176	143	176
Mean	19.1	19.5	18.9	20.1	17.6	18.0	16.1
Median	18.9	19.8	19.7	20.5	17.3	18.1	16.6
Min	14.7	10.4	8.2	10.5	10.2	8.0	8.4
Max	27.5	26.7	24.8	27.1	29.7	24.3	22.9
MWMT>22.2℃	51	61	63	78	11	32	0
Mean Daily ΔT	3.1	2.6	2.5	3.0	1.4	0.9	1.7

The first two years of temperature monitoring data are presented in Figure 32 as Weekly maximum Temperature. The WMT exceeds the MAMP threshold mainly during the months of June, July, and August. In Unit 2, the WL1 site warms more quickly than WL3 due to its distance from the tide gate structure (2.4 km) and smaller channel size. In Unit 1, temperatures follow similar patterns to Unit 2 and the irrigation periods with large inflow of water, specified by the blue bars in Figure 32 do not correspond with cooling at the temperature logger sites. At both Unit 3 and Beaver Creek (WL6) the 2020 summer temperatures stay significantly cooler than the 2019 temperatures with Unit 3 warming up during irrigation periods when the warm water is draining off fields. Unfortunately, until riparian vegetation matures and there is a greater level of Unit 2 channel shading, summer use by salmonids will be limited to a couple locations where there are groundwater inputs.

MAMP Thresholds (Table 2): All sites met the threshold set by the MAMP with means ranging from a low of 9.7˚C (WL22) to a high of 11.3˚C (WL3) during Dec-1 to March 31. However, they generally exceeded the threshold in the months of July and August.

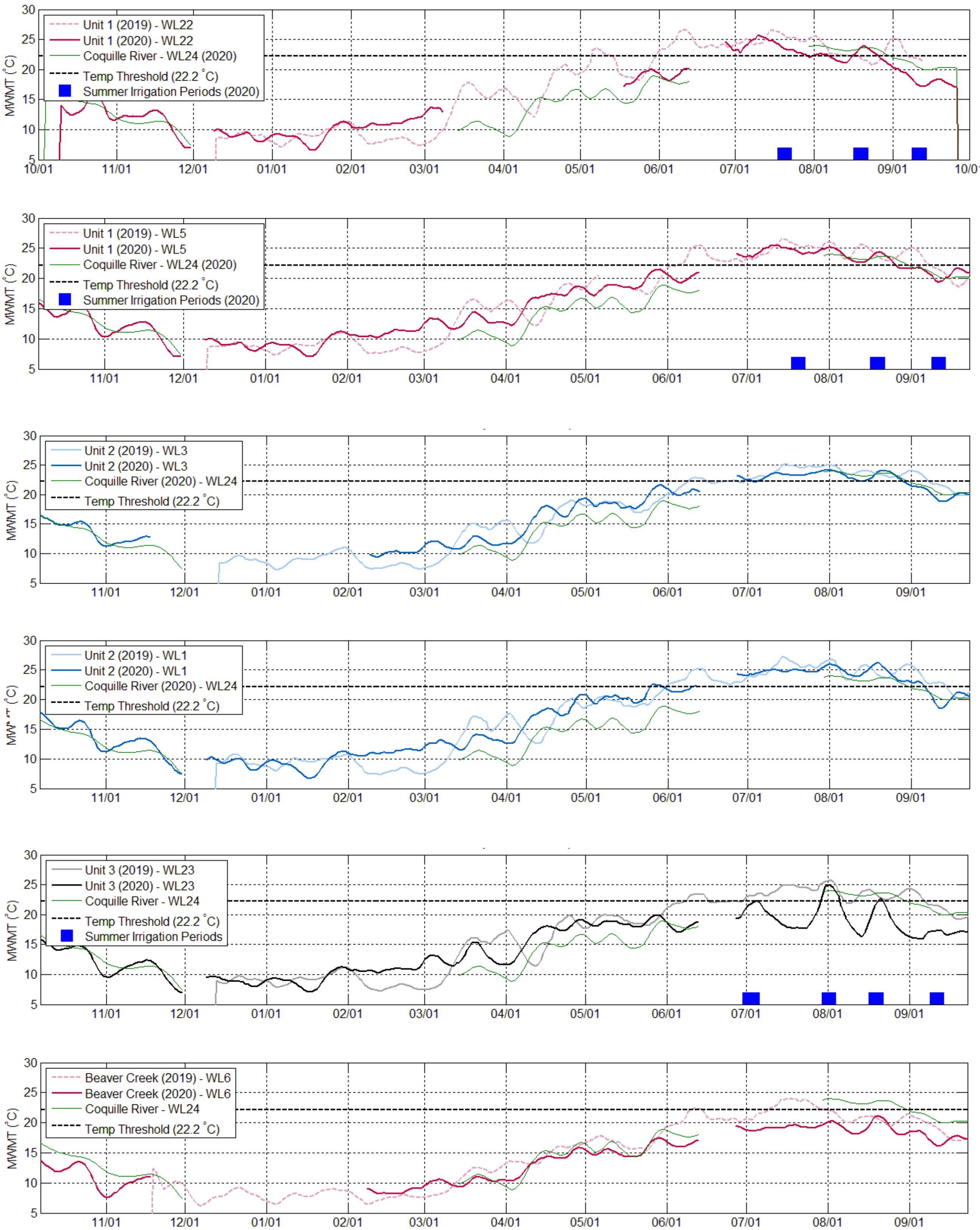

Figure 32. Weekly Maximum Daily Temperatures (WMT) of the 7 sites of the Winter Lake Restoration Effectiveness Monitoring project.

G. *Velocity in Tide Gate Culverts*

Background and Methods

Velocity of the inflow-outflow of water through the seven concrete box culverts may be important for fish passage assurance. Therefore, three of the seven tide gate culverts are equipped with Sontek's SL3000 Side-Looking Doppler Current Meter to measure water velocity. The SL3000's are mounted on an aluminum frame and attached to the culvert sidewall, the data is fed via hard-wired cables to the network computer located in the tide gate control house. A subset of the tide gate culverts (culverts 1A, 2C, and 3) were chosen for installation of the Sontek SL3000 to monitor velocity due to the high costs of instrumentation. The velocimeters are located on all culverts that contain side-hinged tide gate doors (Figure 38). Annual audits are planned but have not been performed yet due to performance and maintenance issues with the SL3000's.

Results and Discussion

To date, the project team has installed three velocimeters in culverts 1A, 2C, and 3 but has continued to experience difficulties with continuous operation. There has been continuous trouble shooting from power source interference to network communication failure. Little data was obtained for the second year of monitoring but the data that was obtained showed higher velocities than expected. Although the time period corresponding to the velocity readings was during high tidally influenced river levels that are not typical of the winter months and induce high velocities at the tide gate culverts. High velocities were observed throughout the channel network in Unit 2 during this same time period.

Velocity measurements are an important aspect of tide gate monitoring as it is uncertain what velocities prohibit juvenile fish passage which is crucial for future project designs. Therefore, we have contracted Derrek Faber, an ODFW expert in technical systems, to ensure the velocimeters are functioning for the third year of monitoring.

MAMP Thresholds (Table 2): No thresholds for velocity.

H. *Water Level Management, Tide gate Door Operations and Tide Gate Door Openness*

Background and Methods

The water levels within the Units 1, 2, and 3 are managed with dual goals of allowing for pastureland grazing and increased production of fish and wildlife. Coho juveniles are primarily thought to move downstream from natal areas to the Coquille River Valley in early November with subsequent demand of individual fish to enter floodplain tidal wetlands to over-winter. Waterfowl also arrive in the same period as they need to find over-winter flooded pastures and wetlands to feed and rest.

Beaver Slough Drainage District (BSDD) staff serve as the overarching entity for water control in the Winter Lake Project area. Water level is managed in all three units of the Winter Lake Project area, as specified in the MAMP, through adjustments in tide gate door operations (discussed below). In addition to the MAMP, The CVWA Management Plan (ODFW 2016) has a general Water Management Plan (WMP) for Unit 2 that is in collaboration with the MAMP, which calls for:

1) Summer; water levels upstream of the tide gate at or below channel bank elevation;
2) Fall and Winter; water levels up to bankfull height with exceedance and overfill into pasture floodplain on higher tides and flood events; Additionally, fall management is geared towards water fowl hunting then later managed for fish habitat.
3) Spring drainout; water levels are at or above bankfull in early spring with managed elevation decreases towards April grazing season.

Due to the objectives and hydrological isolation of the Restoration Unit (Unit 2) there is a greater need and ability to manage water inflow for slightly higher levels throughout the year to benefit fish access and wetland function. The management of water levels over and above the overarching MAMP is fluid and is based on a framework of landowner's needs, weather and water level variations and time of year. A tide gate operating matrix that aids in water level management above and beyond the MAMP guidelines is being finalized and will be included in Year 3's report. The operating matrix helps guide tide gate door operations during non-tidal periods when the river levels rise due to rain events. Overall, ODFW staff work closely with the BSDD to bring water levels to a desirable range without reaching a level that has impacts on grazing and pasture operations. Unit 2 berms have been elevated to 2.3m NAVDD 88, which allows for isolated water management in this Unit up to that level.

Individual landowners and ODFW have all been authorized with BSDD coordination to open or close tide gate doors using manual control methods at the tide gates into their individual Units and properties, however, due to the need to manage the computer hub intricacies all computer commands are implemented with BSDD staff.

Flood Inflow: Tidal inflow to the tide gate is relatively predictable from June through October. In months when the river flows rise or fall in relation to precipitation; the added volume of water in the river and the friction of this water on the riverbanks as it moves from river mile

20 (Winter Lake) towards the Pacific Ocean softens and often nullifies the tidal signal. This provides highly variable conditions in the winter for water management. The overall goals are to manage the tide gate doors during the fall and winter months in order to mimic, but soften tidal inflow and floodflow conditions into Units 1, 2, and 3 for fish passage. BSDD staff, ODFW, and landowners coordinate closely and often tide gate adjustments are based on daily communications when there are heavy rain events. Feedback from the water level loggers in the individual Units provides information for tide gate adjustment in relation to water levels goals.

Tidal and Flood Outflow: Tidal and flood water outflow from the individual Units into the Coquille River is through two pathways: 1) through the side-hinged manual tide gate doors; and 2) through slide-gates if they are open during drainout.

Summer and Irrigation: The agricultural landowners and ODFW within the restoration area have a demand for summer tidal inflow. The goals range from; the need to incur flushing flows in the canal and channel networks to improve water quality, irrigation for livestock, increasing water levels for waterfowl, and inducing current to move aquatic vegetation and sediments from canals. Water levels are able to be increased up to the extent of the tide in conjunction with individual landowner goals.

Time of Tide Gate Openness - Slide Gates

The ODFW WMP is very flexible during winter months and inflow is adjusted often in response to communications between BSDD and ODFW, with overarching priority for: 1) the protection of infrastructure, 2) providing for production of fish and wildlife with emphasis on coho salmon juveniles and 3) managing water levels for recreational use within ODFW and CCGC lands. The vertical slide gates are opened and closed via a motor driven gearbox with a worm drive shaft with both manual and automated control. The automated control is through the computer control panel onsite. The slide gates can be opened irrespective of tide levels or river levels upstream or downstream of the tide gates. This provides the Muted Tidal Regulator capacity and is highly important for water management, as it allows the gates to be opened when tide elevation downstream on the incoming tide would normally push against a side-hinged gate and force it closed.

Vertical slide-gates are managed in a manner to allow for tidal and flood inflow into Units 1, 2, and 3 up to a desired water level based on management goals. The vertical slide-gate degree of door openness is monitored by sensors on the individual gates and sent via RTU to the network computer. All data from the network computer is uploaded onto an online portal managed by NHC. Data is downloaded monthly from the NHC portal and stored locally by CoqWA and as needed by ODFW.

The vertical slide gates can open a varying amount from all the way shut to wide open (2.13m). To assess how frequently the Winter Lake Units were accessible from the Coquille River through the vertical slide gates the percentage of time the gates were open was calculated at differing heights. The slide gate heights were split into 11 ranges, from 0.05m to 2.13m and percent of time gate was open was calculated on an annual basis. The percent of time period was calculated cumulatively, for example, when the gate range is at 40% open this time period refers to when the gate height is between 2% and 40% open, **not** between 30% and 40% open. Therefore, summation of Table 6 is greater than 100%.

Table 6. The total percent of time the slide gate is open for the Oct 1, 2019-Sept. 30, 2020 time-period based on the distance open (slide gate height).

Percent of Time Period (Oct 1 - Sept 30) Slide Gate is Open

Distance Open (m)	Percent Open	Unit 1		Unit2				Unit3
		Gate 1A	Gate 1B	Gate 2A	Gate 2B	Gate 2C	Gate 2D	Gate 3A
0.05	2%	0	14%	10%	44%	0	0	14%
0.21	10%	0	5%	10%	22%	0	0	6%
0.43	20%	0	2%	9%	19%	0	0	4%
0.64	30%	0	2%	9%	19%	0	0	2%
0.85	40%	0	2%	5%	19%	0	0	2%
1.07	50%	0	2%	0%	14%	0	0	2%
1.28	60%	0	1%	0%	9%	0	0	2%
1.49	70%	0	1%	0%	9%	0	0	2%
1.71	80%	0	1%	0%	4%	0	0	2%
1.92	90%	0	0%	0%	3%	0	0	2%
2.13	100%	0	0%	0%	2%	0	0	2%

Time of Tide Gate Openness - Side-hinged Gates

The duration and degree that the side-hinged aluminum tide gates are open is largely dependent on two factors: 1) the amount of precipitation that has fallen daily and accumulates upstream; and 2) the amount of time the vertical slide-gates have been open allowing water levels upstream of the tide gates to rise and cannot be opened manually. There are no devices on the side-hinged aluminum gates to directly monitor the duration and degree of openness of these tide gates. However, the duration of openness is able to be assessed using water level data from the upstream and downstream data logger and calculating the time period that water levels fall on the outgoing tide. It is important to keep in mind that side-hinged gates only open when the elevation differential of water is higher on the upstream side than downstream. The average time per day (in hours) each side-hinged tide gate was open was calculated for 2 different time-periods using the upstream and downstream differential calculation method. Since gate openness is related to fish accessibility the average time per day the side hinge gates were open was calculated during the over-winter period (Oct 1-Mar 31) and then for the entire year (Oct 1 – Sept 30).

<u>Descriptions:</u>

1). If heavy precipitation falls, the pasture area water level upstream of the tide gates generally rises more rapidly than the Coquille River. Thus, for a day or two, as the Coquille is responding to precipitation that has fallen in the basin upstream, there will be head differential at the low tide which allows the side hinged tide gates to open. As the river rises then the side hinged gates often remain closed for a number of days until the river elevations fall.

2). Slide gates are able to allow inflow of tidal water as they can be opened irrespective of the elevation of the water downstream of the tide gate structure. Thus, if the slide gates have allowed water to inflow up to an elevation that is higher than the low cycle of the tide or as high as river levels and there is a subsequent drop in water elevation downstream of the tide gates, the side hinged tide gates will open in response to differing head potential.

3). One week a month the tide cycles have a higher amplitude due to stronger influence of the moon. This results in higher peak tides and lower ebb tides, which increase the potential water elevation differentials upstream of the tide gate structure in Units 1, 2, and 3 and downstream in the channel leading to the river, which can result in a longer period of door openness with very low tides.

Results and Discussion

Time of Tide Gate Openness - Slide Gates

Each Unit is operated under different management goals therefore slide gate door openness varies from Unit to Unit (Figure 33-Figure 35). Furthermore, slide gates are operated on a longer-term basis with changes in heights occurring days to weeks apart rather than from tide cycle to tide cycle. Slide gates are opened less frequently in Units 1 and 3 (Figure 33 and Figure 35) due to a difference in management objectives and limited interior culvert capacity as mentioned in Section 3. Even with a minimal amount of slide-door openness Units 1 and 3 see increases in the amount of time the side-hinge gates are open. The restoration unit (Unit 2) is still requiring lower water levels throughout the summer and fall for continued plantings and earth work by ODOT which requires slide gate doors to be closed (Figure 34). Slide gates are opened to a greater degree in Unit 2 than in Units 1 and 3 which reflects in the interior water levels of all units. The relationship between slide door openness and side-hinge door openness is complex but one innovative management strategy used frequently is to “crack” the slide door open from 0.05-0.2m which allows the Coquille River water to enter the site almost continuously through the incoming tide cycle. This in turn raises the interior water level during high tide so that during the following low tide the side-hinge door is open for an extended period of time.

Slide gate doors in Unit 1 and 3 are open at least 0.05m for 14% of the year while Unit 2 is open at least this high 44% of the year, Table 6. Again, slide gates in Unit 2 are open more frequently and for an extended period of time than Unit 1 and 3. The percent of time the slide gate is open is one parameter that determines fish accessibility into the Winter Lakes units.

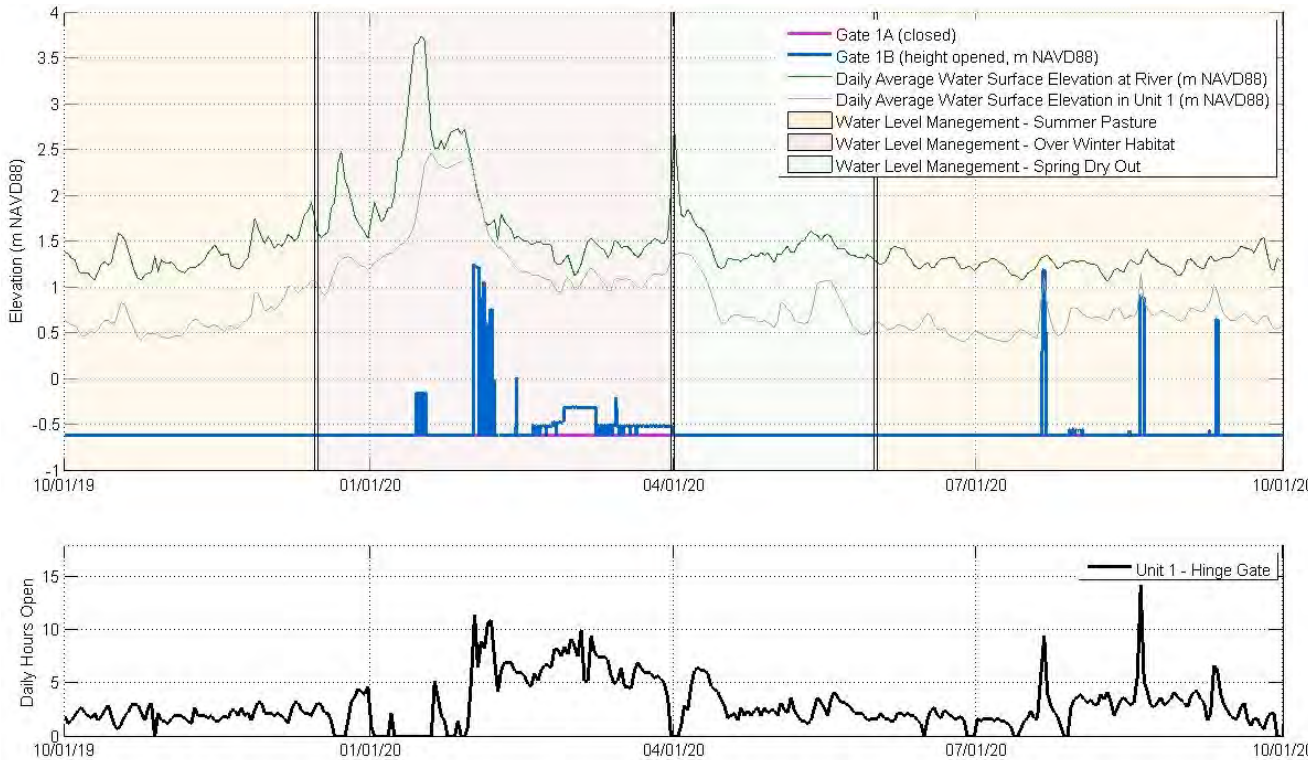

Figure 33. Slide-gate and hinge-gate door operations of Unit 1 for the 2nd year of monitoring at the Winter Lake Project. Unit 1 has 2 slide-gates, 1A and 1B, with 1A staying closed the whole year. The greater the slide-gates are opened the more frequently the side-hinge gates will open and reflect increases in interior water levels (light green). The management objectives for Unit 1 are broken into 3 time periods as depicted by the shaded areas.

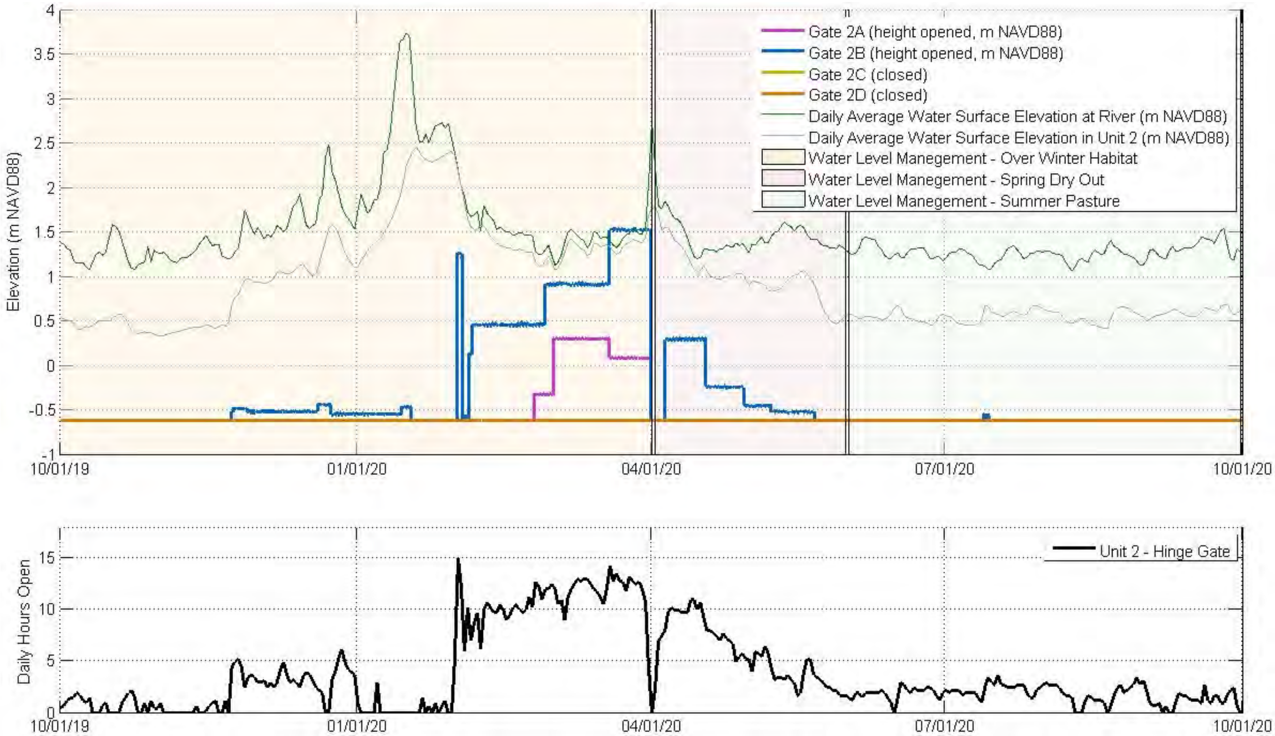

Figure 34. Slide-gate and hinge-gate door operations of Unit 2 for the 2nd year of monitoring at the Winter Lake Project. Unit 2 has 4 slide-gates, 2A, 2B, 2C and 2D, with 2C and 2D staying closed the whole year. The greater the slide-gates are opened the more frequently the side-hinge gates will open and reflect increases in interior water levels (light green). The management objectives for Unit 2 are broken into 3 time periods as depicted by the shaded areas.

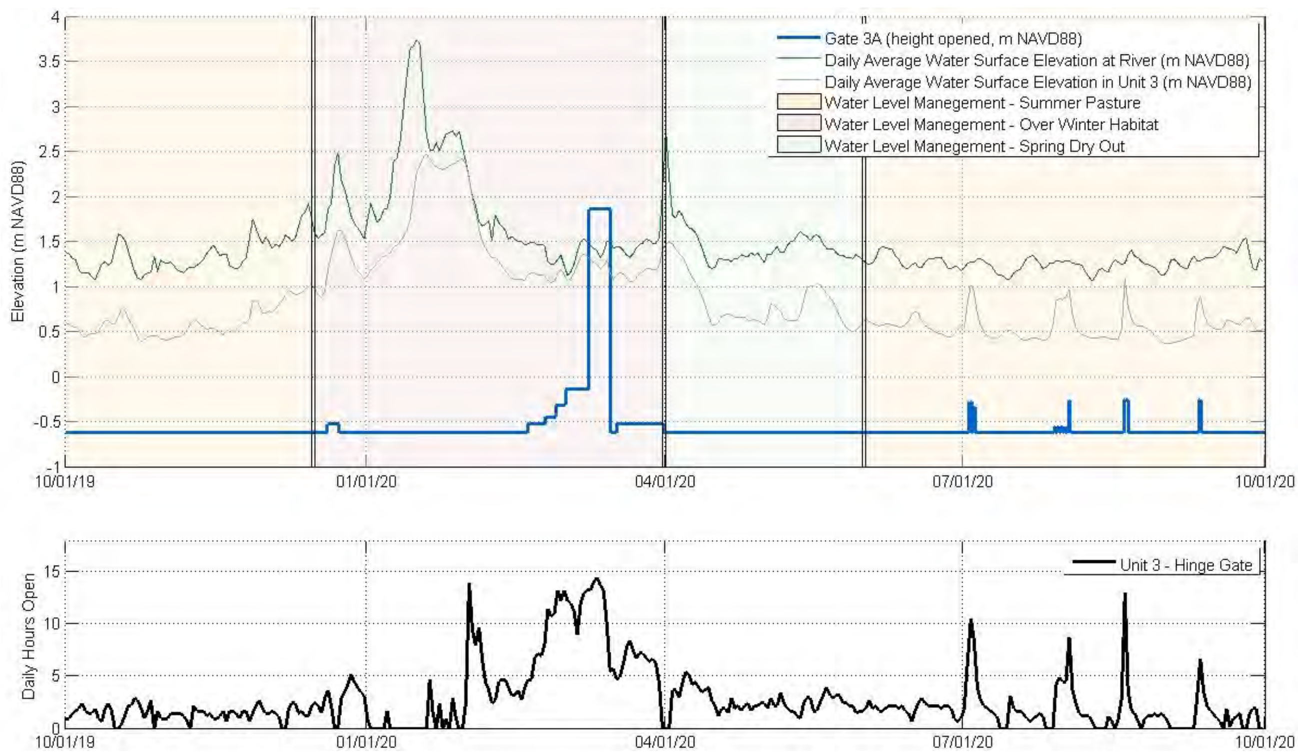

Figure 35. Slide-gate and hinge-gate door operations of Unit 3 for the 2nd year of monitoring at the Winter Lake Project. Unit 3 has 1 slide-gate, 3A. The greater the slide-gates are opened the more frequently the side-hinge gates will open and reflect increases in interior water levels (light green). The management objectives for Unit 3 are broken into 3 time periods as depicted by the shaded areas.

Time of Tide Gate Openness - Side-hinged Gates

The three side-hinged tide gate doors cannot be manually opened and only open when the hydraulic head is less on the downstream side. Side-hinge gate openness from unit to unit varies as seen in Figure 36, these variations reflect the different operating schemes to reach the individual units management goals. The percent of time each side-hinged tide gate was open during the over-winter period and the entire year are shown in Table 7. During the over-winter period, the side-hinge gate servicing Units 1 and 3 was open 14% and 15% of the time, respectively, while the side-hinge gate servicing Unit 2 was open 19% of the time. The same trend is seen when calculated over the entire year, Unit 1 and 3 are open less frequently than Unit 2. Although the amount of time that the side hinge-door is open at first glance is low, during the winter the river levels are raised and the tidal signal is dampened naturally having shorter periods of tides low enough to cause the side-hinge door to open. Additionally, in Unit 2 a slide gate is open during the second half of the winter management period, Figure 34, allowing 24 hour fish access even though the side-hinge gate might be closed.

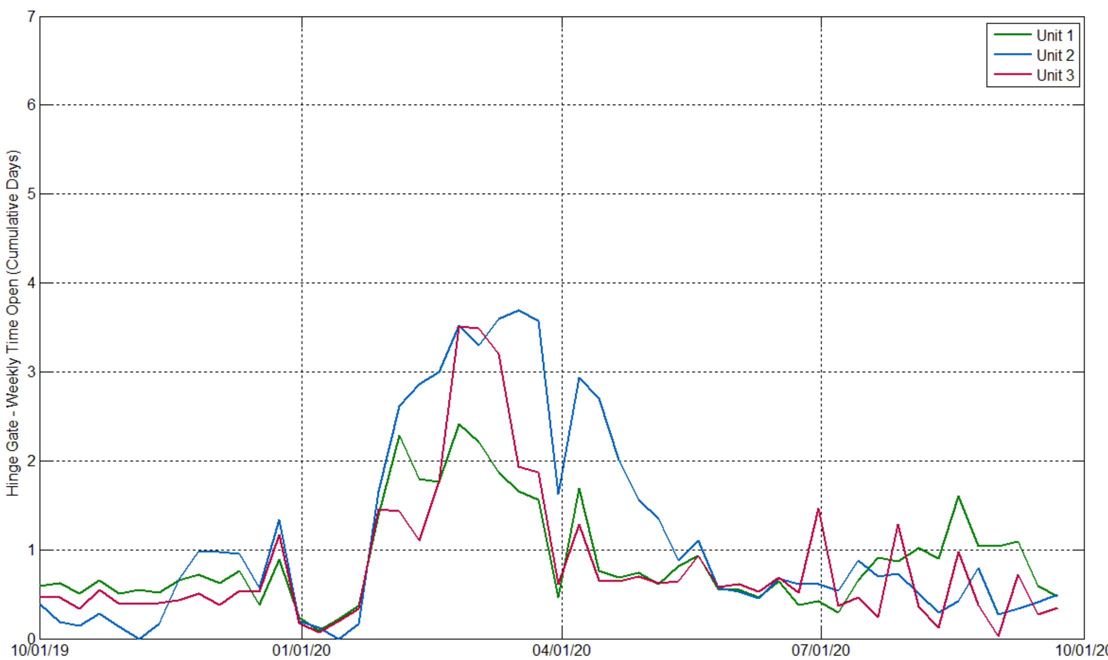

Figure 36. Amount of time open of the side-hinged tide gates every week for each unit of the Winter Lake Project.

Table 7. Percent of time the side-hinged tide gate is open during the over-winter period (Oct 1,2019- Mar 31, 2020) and the entire year (Oct 1, 2019 – Sept 30, 2020) for each management unit of the Winter Lake Project.

Percent of Time Side-Hinge Tide Gate is Open			
	Unit 1	Unit 2	Unit 3
	Gate 1A	Gate 2C	Gate 3A
Over Winter Period (Oct 1 - Mar 31)	14%	19%	15%
Entire Year (Oct 1 - Sept 30)	13%	16%	12%

MAMP Thresholds (Table 2): No thresholds for tide gate door openness.

I. *Fish Sampling*

Background and Methods

The goal of fish sampling is to monitor for 1) relative fish abundance and 2) body condition factor and survival of salmonids, with the primary focus on over wintering juvenile coho. Fish sampling occurs from December to May each year. Typically, four foot diameter nylon hoop traps (Figure 37) with 25ft or 30ft leads were the primary method of capture for fish. Traps were set using either land based or small boat transport methods in the thalweg of new and previously existing channels or canals with leads staked to the left and right banks. Traps were mostly installed in sets of two with data recorded on data sheets. Coho juveniles are a target species for specific monitoring and were weighed to the nearest 0.1g and measured fork length to the nearest 1.0mm. All juvenile coho captured (measuring over 65mm) within the Winter Lake Project boundaries were tagged with Passive Integrated Transponders (PIT tagged) while only a portion of the juvenile coho captured in the reference site (Beaver Slough) were PIT tagged. In addition, body condition including parasite loading and PIT data was recorded for individual tagged fish on the data sheets. Length, weight, and overall body condition was also noted for salmonids other than coho. All coho were scanned with a Biomark HPR Plus or Lite hand held PIT tag reader in order to detect recaptured fish that had been tagged during a trapping event on a previous day.

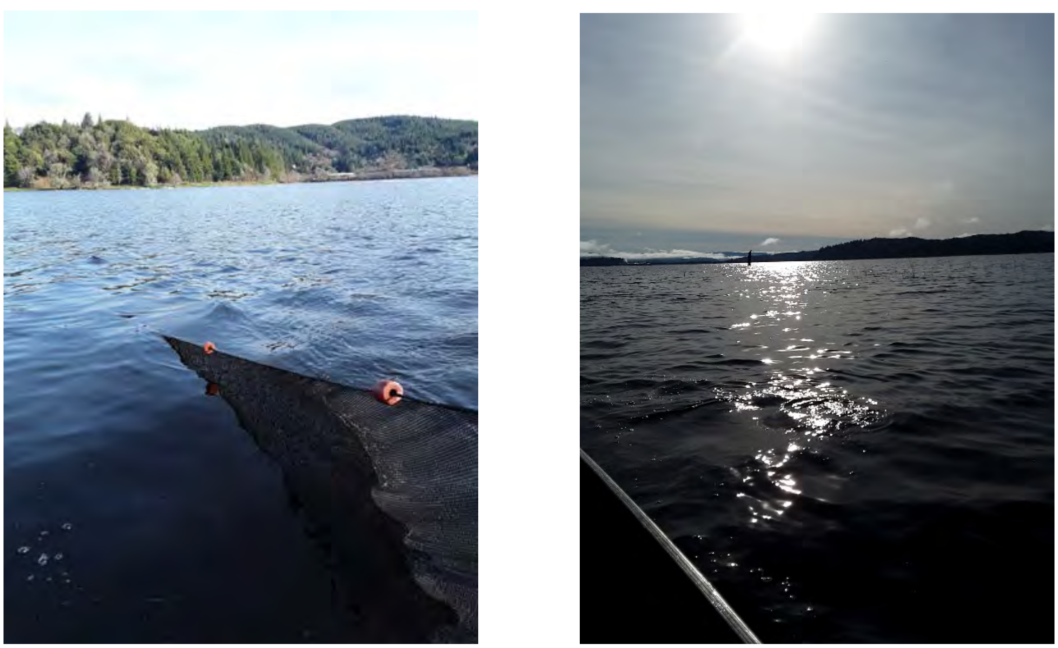

Figure 37. During flood stage 4 ft hoop traps are deployed in flooded Unit 2 (Hoops are submerged only the wings are visible).

Although 4.0ft hoop traps were the primary method of fish capture in the 2019-2020 fish sampling, 3.0ft hoop traps were also employed at a number of selected sites when high flows prevented sampling at primary locations. These sites were chosen as specific surrogates to identify fish movements from channels into pasture floodplain habitats. Seining can also be an effective method for sampling juvenile salmonids when flood flows prevent hoop trapping. Minimal seining was completed during the 2019-2020 sampling period using borrowed equipment but both a beach and purse seine were purchased to diversify the fish sampling methods for the 2020-2021 season.

Fish sampling locations are spread throughout Beaver Slough and Units 1, 2, and 3 based on: 1) previous sampling locations that would provide a baseline; 2) locations that would maximize fish captured (e.g. below confluences) and methods deployed and 3) accessibility based on water levels. Sampling sites were adjusted from the 2018-2019 season due to an increase in gate door openness resulting in higher velocities experienced in the channels. During the 2019-2020 season sample locations were primarily at two sites within Unit 2 (WL 43, WL 44), one location in Unit 3 (WL46), and a control site in Beaver Slough (Figure 38). Although due to varying water levels and difficulties with high velocity many other sites were sampled during the season. During flood stage these locations were inaccessible and hoop traps were instead deployed in flooded pasture land. When water elevations decreased below elevation 3.5ft there was accessibility to set traps in additional locations and were sampled with 3 ft hoop traps at the further reaches of Unit 2. Overall, sampling locations throughout the season varied due to the constantly changing water levels but priority went to the primary sampling locations listed above.

We used a standard Body Condition Index (BCI) factor, K, (Pess et al., 2011) defined as:

$$BCI(K) = \frac{10^5 \times W(g)}{L(mm)^3}$$

to calculate the numerical physical BCI and used the index as an assessment of size of fish captured by Unit. We then compared BCI factors by week and Unit to assess for trends through time.

Results and Discussion

Fish sampling was initiated in late November of 2019 and concluded for the season in March 2020 due to safety concerns of covid-19. A total of 976 pre-smolt coho juveniles were captured from December 2019 to March 2020 during 22 trapping nights. These 22 trap nights resulted in a total of 748 hrs trapped and a Catch Per Unit Effort (CPUE) of 1.37 coho captured per hour of trapping for the season (Table 8). Coho were captured at most in-channel trapping locations (Figure 38), with no coho captures in flooded pastures, however, this was due predominantly to the large amount of effort at in-channel sites. Variation over time of coho numbers captured is seen in Figure 39 with a maximum capture of 703 coho at Beaver Creek on Feb 20th, 2020.

Table 8. Winter Lake project area juvenile coho captured using 4′ hoop net trapping efforts from December 2019 to March 2020.

		Unit 2	Unit 3	Reference - Beaver Creek
	Total Count	Channel Sites (4' traps)	Channel Sites (4' traps)	Channel Sites (4' traps)
Total Sampling Events*	22	11	3	8
Coho	976	46	11	919
Catch per Unit Effort (CPUE)	1.37	0.09	0.12	6.47
Avg. Length (mm)	111	119	111	107
Avg. Weight (g)	14.9	17.9	14.9	13.8
Avg. Body Condition Factor, K, (BCI)	1.04	1.06	1.04	1.04
# PIT tagged	173	46	11	116
# Recaptured	2	0	0	2

* No coho were captured using 3' traps therefore these events were not included

A total of 19 other species of fish and aquatic organisms were captured in addition to coho. These are listed in Table 10 in Appendix E. A total of 1,371 bullhead catfish *(Ameiurus nebulosus)*, 739 yellow perch (*Perca flavescens*), 679 black crappie *(Pomoxis nigromaculatus)*, and 41 largemouth bass *(Micropterus salmoides)* were captured in the study area. All are competing for food with coho juveniles while the large non-native fish are considered a potential predator on coho juveniles. Further work will be done to assess their trend in the Restoration Unit in subsequent years. Pacific lamprey *(Entosphenus tridentata)* were captured in all Units of Winter Lake, including flooded pastures of southern Unit 1 (Cedar Pt 2). All Pacific lamprey caught, a total of 6, were ammocoetes.

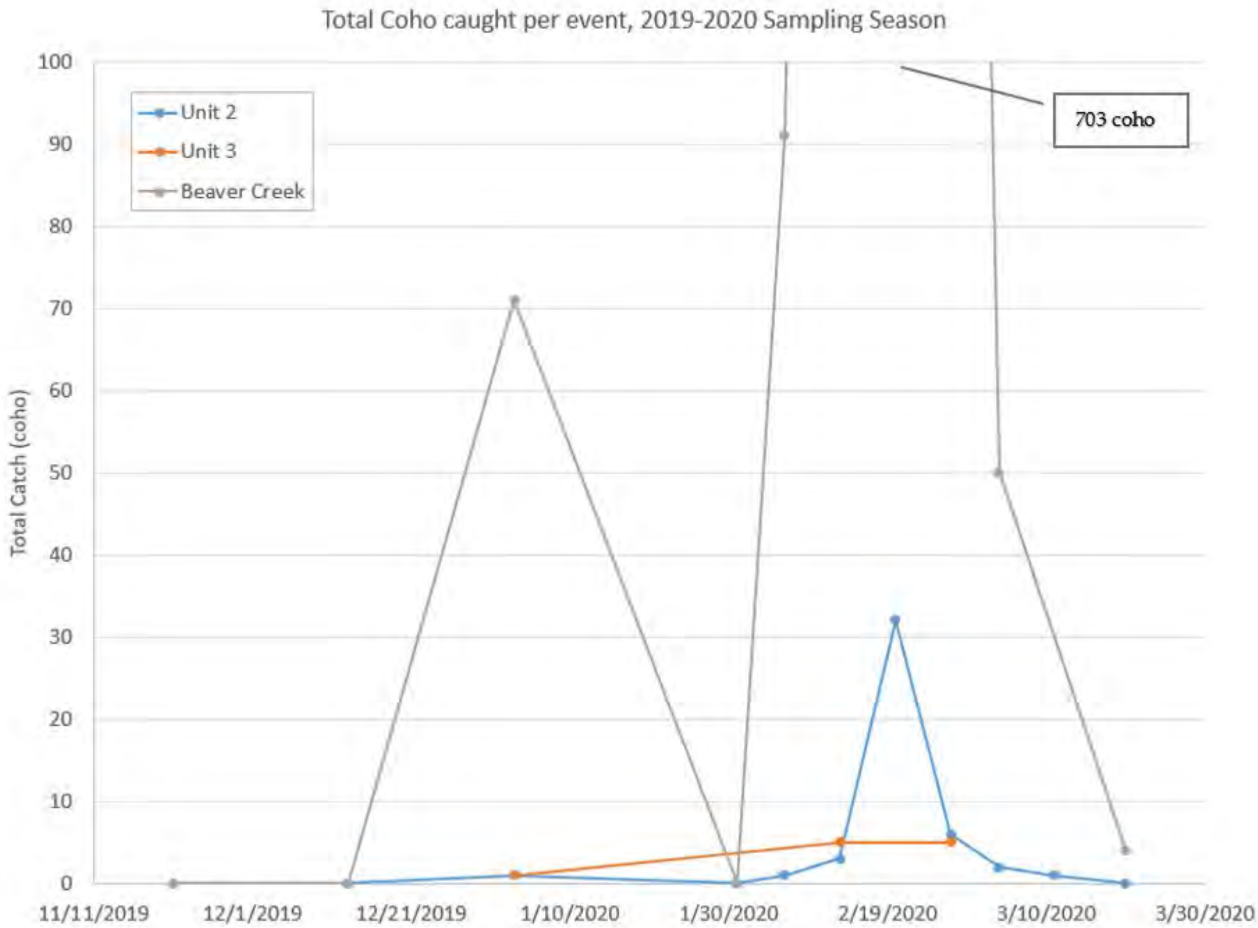

Figure 39. Coho captured during the second year of sampling.

Relative Fish Abundance

There was a strong propensity for coho to be captured at the Beaver Creek site (919 of the 976 total) as compared to Units 2 and 3, where a total of 57 coho were captured despite a higher trapping effort in Units 2 (Table 8). A total of 11, 3, and 8 trap days were completed in Units 2, 3, and Beaver Creek, respectively. The CPUE for 4' hoop traps for Unit 2 was 0.09 coho captured per hour, Unit 3 was 0.12 coho captured per hour, and Beaver Slough was 6.47 coho captured per hour. The 2019-2020 results are similar to 2018-2019 sampling results with Beaver Creek having a much higher CPUE than both Unit 2 and 3. Although fewer coho are captured in Unit 2 there were still more coho caught in Unit 2 during 2019-2020 than 2018-2019 even with a shortened sampling season.

There are likely several key reasons that a much higher number of coho and greater CPUE were noted at the Beaver Creek reference site: 1) the site is in a segment of new channel constructed in 2017, which was part of a larger restoration project and connected the new channel to existing high quality rearing habitat; 2) the Coaledo Drainage District tide gate was leaking on both the inflow and outflow of the tide cycles, which allowed access for juvenile coho; 3) the trap site is downstream from a known rearing area in the main Beaver Creek canal; 4) some coho spawning does occur in the upper watershed of Beaver Creek, whereas the Unit 2 and 3 canals and channels are not connected to upstream spawning habitat; and 5) the sampling Beaver Creek site has a greater trapping efficiency due to shallower water levels.

A total of 46, 11, and 116 juvenile coho in Unit 2, Unit 3, and Beaver Creek, respectively, were tagged. The project is planning to use the standard Lincoln Peterson mark recapture methodology to estimate the number of fish within the individual Units. The Team recognizes there is a modest violation of the rules of the Lincoln Peterson formulation (The site must be a closed habitat with no immigration or emigration) as fish move into and out of the sample areas. However, the calculations will be predicated as minimum estimates.

For the 2019-2020 season we were only able to recapture two fish for all sites trapped, with both being at the Beaver Creek site. This result came despite tagging upwards of 25 fish per week at the site and following up with subsequent trapping events several times on a seven-day rotation. Because of the low number of recaptures, we did not make estimates of fish abundance using the Lincoln Peterson mark recapture methodology. There are a couple of possibilities for the low recapture rate at all sites: 1) some or most fish may move into and from the trapping areas during a short time period; 2) for Unit 2 the size of the channel network system is large at 27,000 ft and sampling occurred in a small area.

Body Condition Factor and Survival

Overall, fish captured were in excellent condition when visually inspected. Some fish did have external trematode metacercaria parasite loading that mostly ranged from low to moderate and was determined on a qualitative scale. The average fork lengths for fish captured at 4' trapping sites in Unit 2 were 119mm (Table 8). Comparatively, the average fork lengths of fish captured in Unit 3 and at the Beaver Creek site were 111mm and 107mm, respectively. Overall, the average fork length and weight of fish captured in Unit 2 was larger than other sites (Table 8). It is assumed that growth rate within the individual habitats contributed to the variability in fish size rather than larger fish moving from the Coquille River into Unit 2 as compared to the other habitats. In that context, the fish in Unit 2 may be larger because the density of fish was lower based on the CPUE compared to the Beaver Creek site, thus there was less competition for food.

Overall coho in Unit 2 had a higher BCI with an average of 1.06, than coho in Beaver Creek, 1.04 (Table 8). As seen in Figure 40 the season begins with Unit 2 and Beaver Creek exhibiting similar BCI factors and ends the season with Unit 2 having a BCI of 0.07 greater than Beaver Creek. We hypothesize the primary factor for lower BCI's of Beaver Creek fish at the end of the season is the higher density of fish in Beaver Creek, resulting in more competition for food resources.

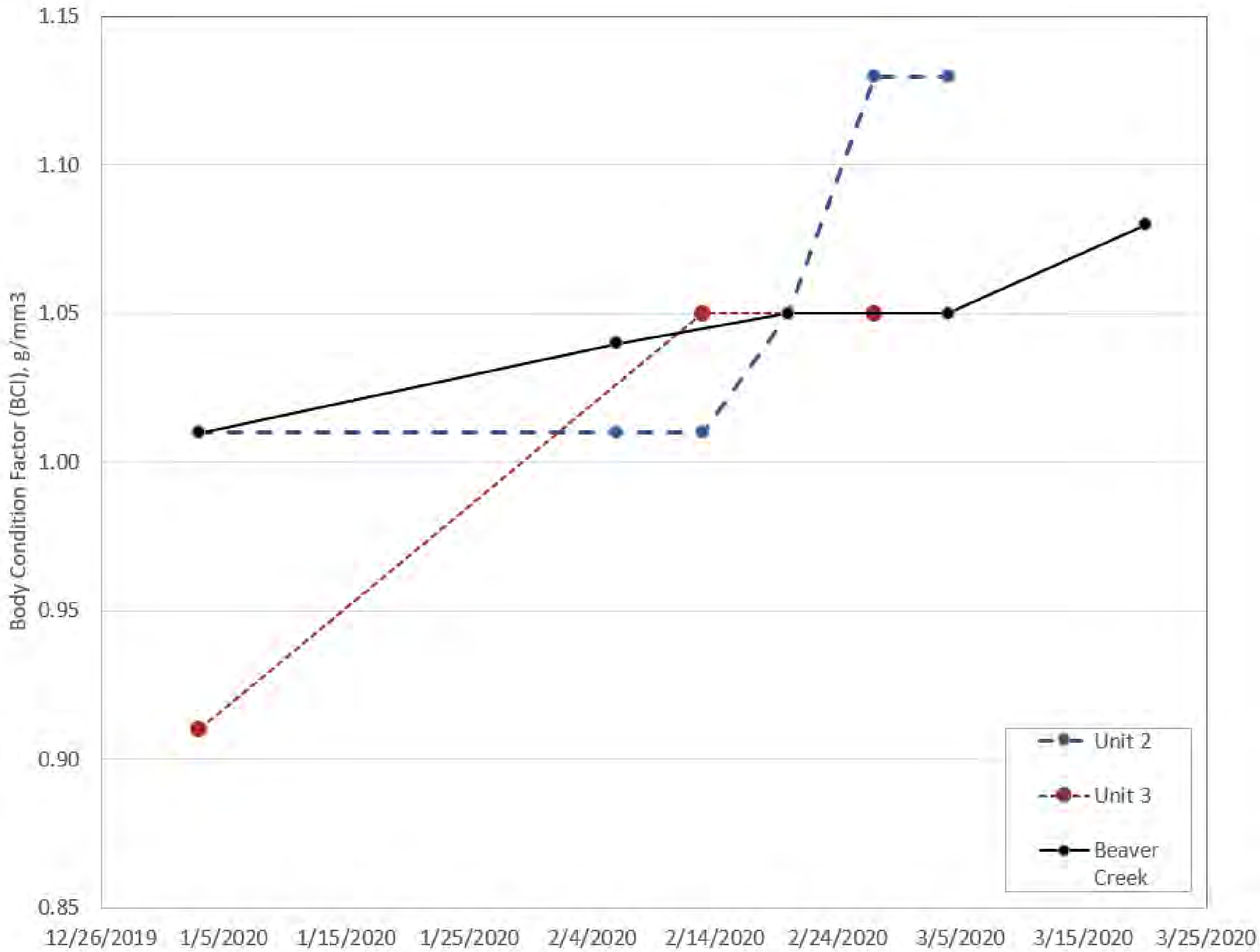

Figure 40. Calculated weekly BCI for coho captured during the second year of monitoring.

MAMP Thresholds (Table 2): No thresholds for fish abundance.

6. Data Quality Assurance

The monitoring team (CoqWA and ODFW) have endeavored to develop protocols that result in collection of information that is repeatable, transferable, and consistent with standard scientific methodologies. A DEQ approved Sampling and Analysis Plan (SAP) has been developed for the Winter Lake Monitoring project and includes many details of sampling and data quality assessment. It is available by request, please contact CoqWA for a copy. Additionally, CoqWA has supplied training for their field technicians under the team lead for the intricacies of data logger installation, DEQ Quality Assurance measures, proper cleaning of equipment, downloading and operations checks for loggers, and error checking. CoqWA and ODFW have implemented fish handling and data collection procedures that are standardized between crew members. Data for water quality monitoring, vegetation monitoring, and fish sampling is digitized and housed on the CoqWA server following field collection. Data is proofed for errors upon entry into the database. Handwritten data sheets from the field are also saved and will be kept following CoqWA's record retention policy.

Data is assessed for errors, which can be from a number of effects including sensor malfunction, power outages/surges, user error and other factors prior to analysis. Only data that passes the Data Quality Level A and B requirements set by DEQ have been included in the analysis and results section of this report, specifics on those requirements can be found in the Data Quality Matrix (Appendix B).

7. Summary for MAMP Metrics

A. *Monitoring Metric Conclusions*

The Winter Lake federal permitting for project implementation was under the USFWS Coastal Program Programmatic coverage. The Programmatic requires a robust level of reporting to ensure that actions not only follow best management practices (BMP's) and implementation design, but meet performance goals, which are outlined in Table 2. The monitoring efforts documented in this report provide the information to understand if the Winter Lake Project is meeting those performance standards. Table 9 documents the parameters and whether the performance standards were met or not met.

Channel Length: Over ~30,700 ft of tidal channel was constructed in Unit 2 in 2018 and 2019 meeting the MAMP standard.

Temperature: Temperatures as measured at two locations in Unit 2 channels (WL 1 and WL3; Figure 4) documented that summer temperatures were above the 22°C threshold. Winter temperatures were within the performance threshold. The channels experience minimal shading from the yearling trees and shrubs planted in 2018 and 2019 therefore it is anticipated that roughly 4-6 years will be required of growth in order for sufficient cover to develop and bring temperatures within the desired range.

Dissolved Oxygen: The project data is providing illumination of the ecological function of the Coquille River floodplain tidal wetland habitats. The Biological Oxygen Demand (BOD) appears to have a large role in the DO levels of these habitats. When the MAMP was developed, ODFW and USFWS coordinated on all thresholds and consulted with knowledgeable professionals on the various parameters. Oxygen saturation levels at sea level are at equilibrium at 9.03 mg/L. Plant growth in wetlands is a major component of the ecosystem processes. These constituent vegetative products are largely or fully retained on site as there is often little water velocity to carry them from the location where they are produced. Consequently, the processing of a large portion of the vegetative production is completed through decomposition done by bacteria, amoeboid organisms, and macroinvertebrates. The team is finding that DO levels are moderately below average at the interior location of Unit 2 (WL 1) (Table 9). This is primarily thought to be related to BOD at night. Temperature also plays a role in DO oxygen levels with cooler temperatures potentially allowing for greater saturation. It is anticipated that as shading increases, the summer DO levels will increase also. That said, communication with personnel from other wetland projects in Oregon has indicated that DO levels may commonly be lower than full saturation.

Salmonid fish are able to tolerate DO levels well below 9.03 mg/L. However, at levels below 5.0mg/L, fish are commonly displaying symptoms of stress in highly crowded conditions in hatcheries (ODFW, G. Vonderohe, personal communication, 2018). The average DO level during the spring-summer at the Beaver Creek site was 3.3 mg/L, which would be considered highly stressful under hatchery conditions and likely to result in fish mortality. Despite very low DO, the greatest number of coho were captured from the Beaver Creek location. Coho are not considered likely to be present at the trap site during summer months when stream temperatures are above preferred limits. The high densities of coho in the winter and spring indicate that food availability is desirable and perhaps there is tolerance for lower DO when water temperatures are cold and in zones where there is preferential food availability.

Nitrogen, Phosphorus and Total Suspended Solids: The MAMP coordination efforts between ODFW and USFWS in 2016 culminated in recognition that these parameters are highly important for understanding ecological function at a site. Nitrogen and phosphorus are keystone elements for production of muscle tissue in fish and exoskeletons in macroinvertebrate prey items. Thus, they are critical for production of fish and wildlife. Nevertheless, excessive levels can contribute to eutrophication and high levels of bacteria and plant growth that can induce lethal conditions for fish. The Winter Lake monitoring team has been visually monitoring plant communities in the study area. DO levels within Unit 2 suggest that nitrogen and phosphorus are within a tolerable range, with acknowledgement that the land area in Units 1 and 3 are used for pasture grazing. During winter flood events, nutrient laden waters move from both the river and adjoining Units into the Restoration Unit. CoqWA and ODFW will continue to work closely to monitor the levels of these constituents. At this time there do not appear to be any negative issues related to the levels detected.

Planting Survival: Over 120,000 willows, shrubs, and trees have been planted within the Restoration area. Survival has been low for shrubs which are short in stature and this has been predominantly due to flood suffocation during winter months. Rodent impacts on the site are very low as the winter flooding reduces overall rodent populations. Overall, survival of the plantings have met the MAMP threshold (Table 9).

Channel Connectivity: Visual inspection has indicated that the design and implementation of tidal channels in Unit 2 has met objectives. As previously reported, a few low-lying ponded areas were identified in the winter of 2018 and 3,700 ft of additional channels were installed in 2019 to alleviate fish stranding potential at these locations. Currently there are no additional areas that could potentially strand fish. The channel implementation layout has resulted in connectivity that meets the MAMP goal (Table 9).

Stranding and Trapping: Visual assessment has been completed for potential fish stranding on Unit 2 as ODFW staff have been on site during winter and spring when water levels are often variable and conditions for passage more visible. No fish have been observed stranded or trapped in locations where there might be a connectivity issue. Through 2020, the Restoration area is considered to be within the MAMP threshold (Table 9).

Water Management: In the summer of 2020, water levels were purposefully held below MAMP threshold goals to allow ODOT to mechanically re-work 18 acres of low-lying Unit 2. In the upcoming 2020-2021 year, BSDD and ODFW will be working to manage water more robustly through learning from previous years water management and through the creation of a tide gate operation matrix which helps strategize water levels during non-tidal flows.

Table 9. Winter Lake Restoration monitoring parameter metric table, Year 1 and 2

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Pass or Fail Year 1 (2018-2019)	Pass or Fail Year 2 (2019-2020)
Aerial photo/UAS-video or ground based GPS	Channel Length	20,000 feet	1. > 20,000 feet (Pass) 2. < 20,000 feet (Fail)	Pass	Pass
Data loggers	Maximum Weekly Temperature	22.2 °C by year four post project. 20 °C maximum during summer at year 10	1. < 22.2 °C (Pass) 2. > 22.2 °C (Fail)	Winter – Pass Summer - Fail	Winter – Pass Summer - Fail
Data loggers	Dissolved Oxygen	9 mg/L DO	1. >9 mg/L DO (Pass) 2. <9 mg/L DO (Fail)	Winter – Fail Summer - Fail	Winter – Fail Summer - Fail
Grab Samples	Total Nitrogen	TBD*	TBD	N/A	N/A
Grab Samples	Total Phosphorous	TBD*	TBD	N/A	N/A
Grab Samples	Organic Matter	TBD*	TBD	N/A	N/A
Survival plots	Percent Survival	60% survival	1. > 60% survival required (Pass) 2. < 60% survival (Fail)	Pass	Pass
Visual inspection	Connectivity	Surface connectivity	1. Side channel providing fish passage/flow between channel and pond (Pass) 2. Side channel not providing fish passage/flow between channel and pond (Fail)	Pass	Pass
Visual inspection	Stranding and Trapping	Depth of main channel thalweg of sufficient depth to allow passage of fish present / tidal depressions	1. Continuous flow (low- flow depth) of at least 2- 3" (Pass) 2. Discontinuous or very shallow flow depth (Fail)	Pass	Pass

Table 9 continued

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Pass or Fail Year 1 (2019-2020	Pass or Fail Year 2 (2019-2020
Water Level Data Logger	Water Depth – Unit 1-3 Oct.-March; Basic Flush Level until first flood event or cattle are pulled	0.9 to 1.1 meters NAVD88	1. >0.9 2and <1.1 m (Pass) 2. <0.9 or >1.1 m (Fail)	Pass	Fail
Water Level Data Logger	Water Depth – Unit 1-3 Oct.-March; After first flood event transition to Over Winter Habitat Level	1.4 to 1.7 meters NAVD88	1. >1.4 and <1.7 m (Pass) 2. <1.4 or >1.7 m (Fail)	Pass	Pass
Water Level Data Logger	Water Depth – Unit 2 Oct.-March; Complete transition to Over Winter Habitat Level	1.4 to 1.7 meters NAVD88	1. >1.4 and <1.7 m (Pass) 2. <1.4 or >1.7 m (Fail)	Fail	Pass
Water Level Data Logger	Water Depth – Unit 1-3 April to May; Maximum Dry Out – maximum elevation	0.6 to 1.2 meters NAVD88	1. >0.6 and <1.2 m (Pass) 2. <0.6 or >1.2 m (Fail)	Pass	Pass
Water Level Data Logger	Water Depth – Unit 1-3 April to May; Transition to Basic Flush Level as conditions allow	0.9 to 1.1 meters NAVD88	1. >0.9 and <1.1 m (Pass) 2. <0.9 or >1.1 m (Fail)	Pass	Pass
Water Level Data Logger	Water Depth – Unit 2 April to May; Transition back to Basic Flush Level	1.1 to 1.2 meters NAVD88	1. >1.1 and <1.2 m (Pass) 2. <1.1 or >1.2 m (Fail)	Fail	Pass
Water Level Data Logger	Water Depth – Unit 1-3 June to September;	0.9 to 1.1 meters NAVD88	1. >0.9 and <1.1 m (Pass) 2. <0.9 or >1.1 m (Fail)	Fail	Pass
Water Level Data Logger	Water Depth – Unit 1-3 June to September; Irrigation	1.2 to 1.4 meters NAVD88	1. >1.2and <1.4 m (Pass) 2. <1.2or >1.4 m (Fail)	Pass	Fail
Water Level Data Logger	Water Depth – Unit 2 June to September; Basic Flush Level	1.1 to 1.2 meters NAVD88	1. >1.1 and <1.2 m (Pass) 2. <1.1 or >1.2 m (Fail)	Fail	Fail
Water Level Data Logger	Water Depth – Unit 2 June to September; Sept to October begin transition to Over Winter Habitat Level	1.4 to 1.7 meters NAVD88	1. >1.4 or <1.7 m (Pass) 2. <1.4 or >1.7 m (Fail)	Fail	Fail

* ODFW will use the Beaver Slough as a reference site for to determine the desired conditions for N, P, and OM (C. Claire, ODFW, personal communication 2016).

B. *Recommended Maintenance or Corrective Actions*

Based on the second year monitoring of the Unit 2 restoration, ODFW site inspections, and coordination with BSDD several items were identified for corrective action in 2020 and beyond.

- In October 2019 five acres of north-eastern Unit 2 were planted with American sloughgrass and shortawn foxtail. These five acres are used as mitigation for ODOT and needed additional work throughout the summer of 2020 to ensure adequate plant densities.
- Additional plantings of cottonwood and Oregon ash were planted in the fall of 2020 and although they aren't included in vegetation survival counts they will increase vegetation density across the project.
- Lastly, water management of the 3 Units is a complex process and to aid in reaching water management goals a tide gate operating matrix has been drafted. A final copy will be included in the Year 3 report.

C. *Winter Lake Restoration Project Goals*

1). Reestablishment of the hydrology and connectivity that mimics a condition more similar to historical pre-settlement conditions in order to benefit native anadromous fish with emphasis on winter rearing juvenile coho salmon.

2). Enhancement of habitat features and plant communities to maximize overwinter conditions for waterfowl.

3). Provide an ecologically functional landscape that is fully accessible for public hunting, fishing and recreational use.

After two years in operation, the Winter Lake tide gate replacement and restoration project is working closer to meet its goals. As the landscape matures in the subsequent years, the habitat for juvenile coho, waterfowl, and other native species will improve as well as furthering the goal of a landscape for public use.