Winter Lake Restoration Effectiveness Monitoring

Report: Year 1

December 26, 2019

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Funded through OWEB grant #218-2042-15946

Acknowledgments

This project is the culmination of the need to assess the performance of a large-scale tidelands floodplain restoration project within the Coquille River valley. Numerous individuals have provided input into the various aspects of the monitoring design, funding, and implementation. There are a number of relationships that have provided the pathway for the China Camp Creek Project (C3P) Tide gate Replacement and Winter Lake Restoration Project (WLRP) to be accomplished and the monitoring to be possible. There is a need to express sincere gratitude to a number of individuals and organizations including:

Beaver Slough Drainage District - *John Knutson and Fred Messerle*

The Coquille Tribe - *Special thanks to the natural resources staff and cultural resources department – Don Ivy, Helena Linnell and Kassandra Rippee*

National Marine Fisheries Service – *Chuck Wheeler, Ken Phippen, Jim Muck*

The Nature Conservancy - *Jason Nuckols (Eugene) and Steve Denney (Roseburg)*

Oregon Watershed Enhancement Board – *Ken Fetcho, Mark Grenbemer and Meta Loftsgarden*

Oregon Department of Environmental Quality - *Pam Blake, Bryan Duggan and Kendra Girard*

Oregon Department of Fish and Wildlife - *Mike Gray, Stuart Love, Dominic Rocco, Christopher Claire, Gary Vonderohe*

Oregon Department of State Lands - *Bob Lobdell*

U.S. Fish and Wildlife Service – *James Duffy, Heidi Nelson providing federal Programmatic permitting coverage*

U.S. Army Corps of Engineers - *Tyler Krug*

Winter Lake Landowners – *The Chisholm, Isenhart, Messerle, and Smith Families*

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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
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 first year results (Oct. 1, 2018 – Sept. 30, 2019) 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 Coquille Working Landscapes 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 Coquille Working Landscapes Project's Monitoring and Adaptive Management Plan (MAMP), created as part of the National Marine Fisheries Service (NMFS) permit.

The main objectives of the Coquille Working Landscapes 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. 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 and within the water column there was little if any macrophytic vegetation and no established aquatic or benthic communities. In addition, the water levels in the winter of 2019 were predominantly managed to ensure protection of berm infrastructure as the newly planted vegetation needed protection from heavy wavelap scouring. Therefore, results of data obtained from nearly all categories from the first year post-restoration should not be used to judge the success of the project as a whole to meet the restoration goals.

Overall, the Coquille Working Landscapes Project exceeded many of the performance standards of monitoring parameters set by the MAMP. The total footage 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. The overall survival of planted trees and shrubs in the restoration unit was 70% which exceeded 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. In the first year of operation, no fish have been observed stranded or trapped in locations where there might be a connectivity issue.

Therefore, the restoration unit is considered to pass the stranding and trapping performance standard of the MAMP.

The winter 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, although performance standards will be determined in 2020 and presented in the second year report. Monitoring indicated that dissolved oxygen (DO) levels are below the performance standard (9mg/L) at the interior location of 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. From completion of restoration in Unit 2, mid-October 2018, through the winter months the water levels were managed with the specific goal of keeping water levels in Unit 2 below elevation 1.2 m in order to reduce the potential for erosion of the newly reconstructed berms. Thus, water levels were often below the 1.4-1.7 m elevation as specified in the MAMP. In the summer of 2019, water levels were again held below MAMP threshold goals to allow for construction of additional channels that would provide access to low-lying areas where fish stranding was likely during winter months. In the upcoming 2019-2020 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 Coquille Working Landscapes Project area were smaller than that at the reference site (Beaver Creek), the average fork length and weight were greater in the Coquille Working Landscapes Project area, producing an average Body Condition Index (BCI) of 1.15 compared to a BCI of 1.03 at Beaver Creek.

After one year in operation, the Coquille Working Landscapes 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 first year results (Oct. 1, 2018 – Sept. 30, 2019) 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 and tide gate upgrades (www.tnc.org/tide gates). 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 to encompass water quality and quantity, the site's physical and landscape attributes, and the response of salmonids to the restoration.

This report fulfills the requirements of the Coquille Working Landscapes Project's Monitoring and Adaptive Management Plan (MAMP), created as part of the National Marine Fisheries Service (NMFS) permit. (See Appendix A for the full MAMP.)

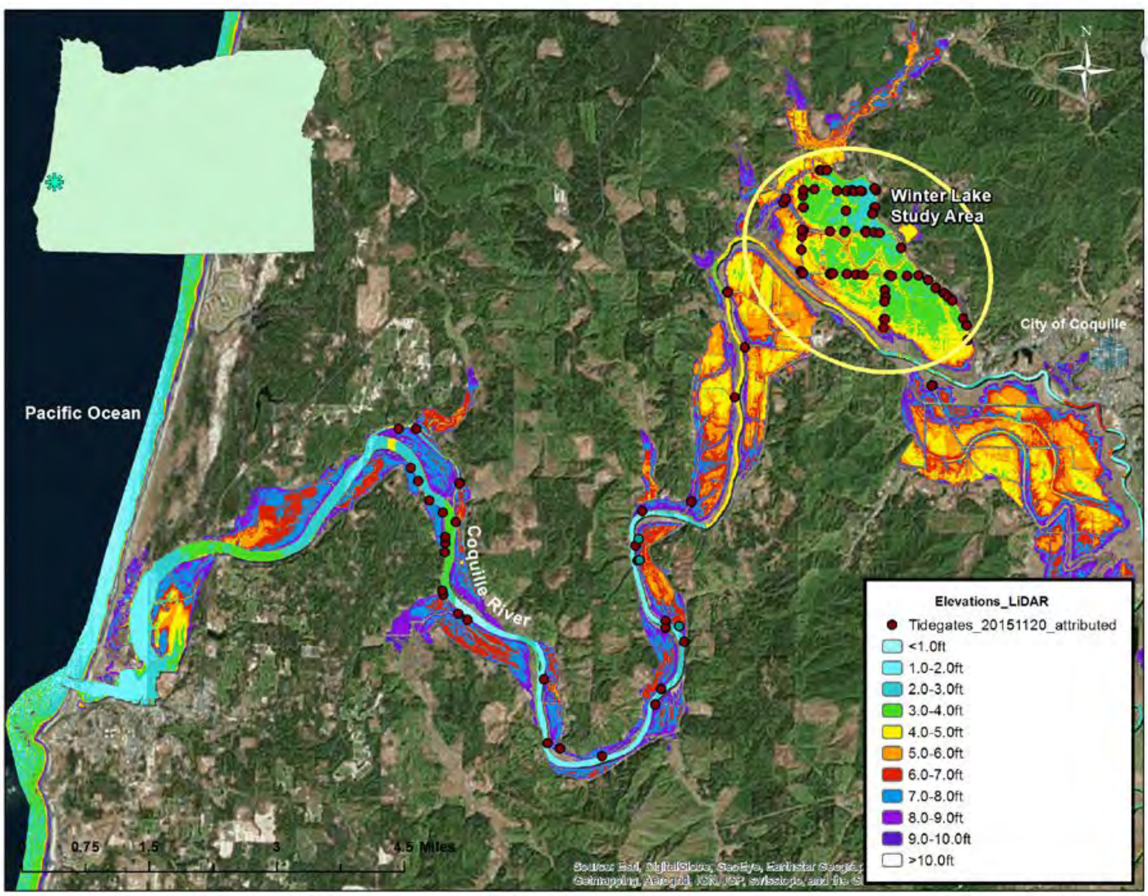

Figure 1. Coquille River Valley and Winter Lake study area.

2. Background

The Coquille River Valley 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 2004-2016 period when OC coho abundance averaged 20,835 annually, ranging from a low of 3,357 to a high of 55,667 (OASIS, 2017). 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 Coquille Working Landscapes 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 8.5ft NAVDD 88 and was historically subject to tidal influence (Figure 1). The Coquille Working Landscapes 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, which is considered the Winter Lake Restoration Project (WLRP), 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.

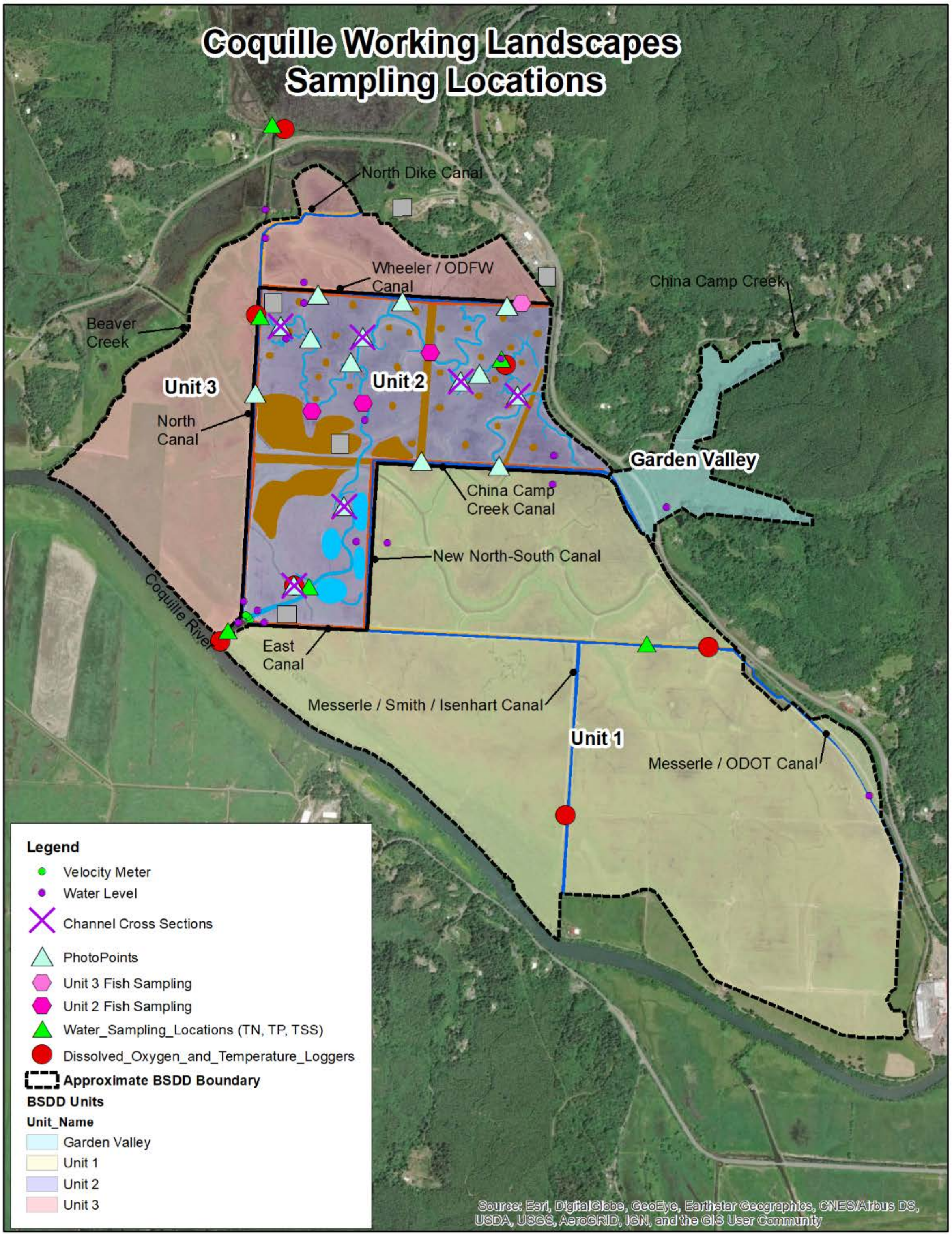

Figure 2. Winter Lake Restoration Effectiveness Monitoring project area with monitoring locations.

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. This tide gate replacement portion of the project is also referred to as the China Camp Creek Project (C3P). The existing corrugated metal 8.0ft diameter culverts and associated tide gates were removed and infrastructure consisting of seven new concrete box culverts 10ft in width x 8ft in height (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. C3P also constructed or reinforced berms surrounding the individual Units, effectively isolating Unit 2 from the other Units to achieve each unit's objectives.

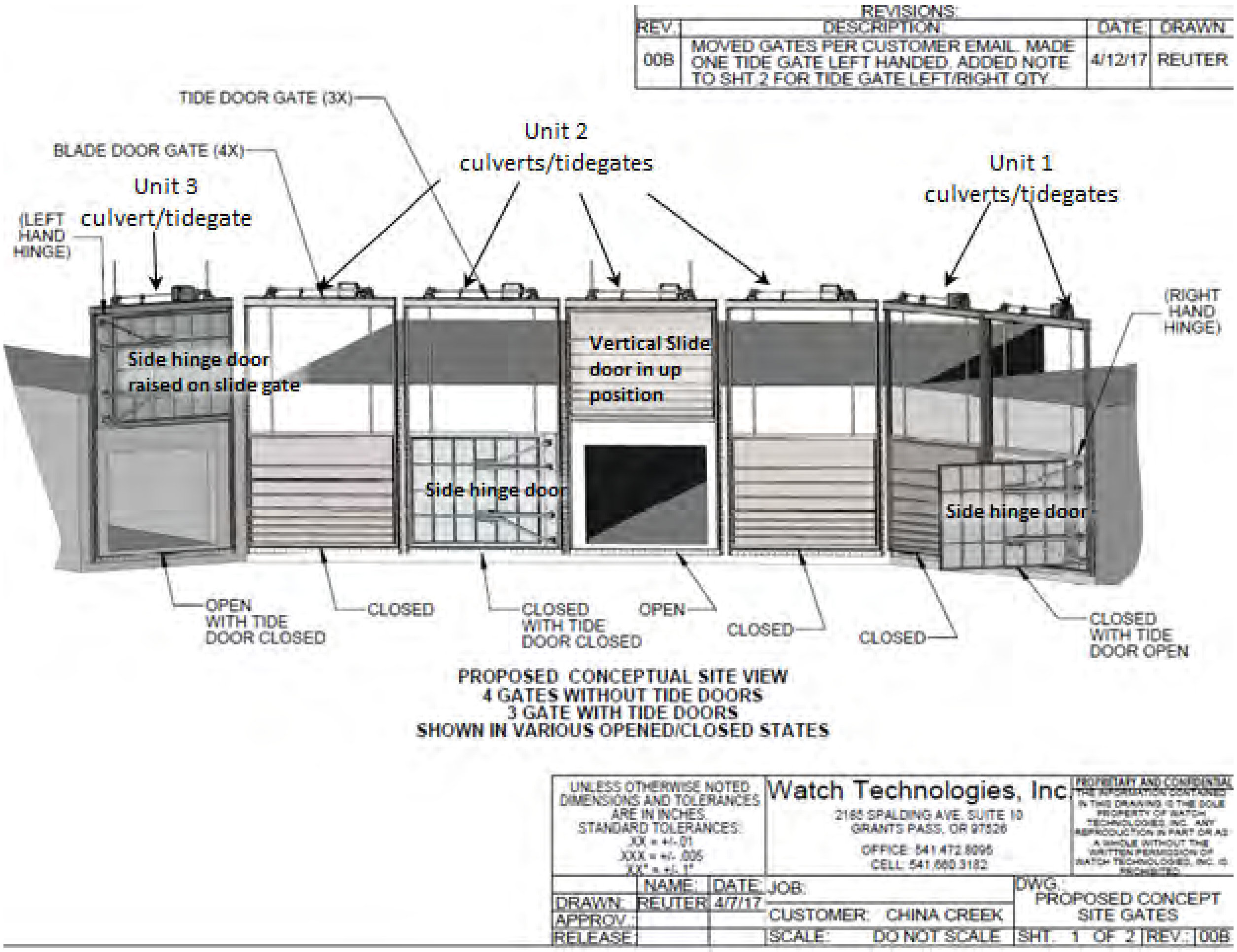

Figure 3. Coquille Working Landscapes Project tide gate reconstruction design drawing for C3P box culverts and tide gates. Each Unit has one side-hinged tide gate door.

Tidal wetland restoration was implemented in Unit 2 of the Coquille Working Landscapes Project (Figure 2) to increase overwinter, 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 Coquille Working Landscapes 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 Coquille Working Landscapes 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 Coquille Working Landscapes 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.

A three-year effectiveness monitoring project, WLREM, has been funded by OWEB to ensure the Coquille Working Landscapes 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 Coquille Working Landscapes 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 U.S. Fish and Wildlife Service programmatic permit, 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	See Project Design: Photo Points and Channel Monitoring	Roegner et al. 2008.
a	Connectivity	Aerial drone flight	Annually in Sept. 2018-2021	Video and imagery of entire site	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	See Maps: Project Site for tide gate location	BSDD and Coos Watershed, personal communication
a	Velocity in tide gates	3 SonTek loggers in sub sample of tide gates	Continually, 15-min interval 2018-2021	See Maps: Project Site for tide gate location	Coos Watershed Association, personal communication
b	Channel complexity	Aerial drone flight	Annually in Sept. 2018-2021	Video and imagery of entire site	Smith et al. 2016, Peterson et al. 2015, Roegner et al. 2008.
b	Channel stability	Aerial drone flight and 9 on the ground photo points	Annually in Sept. 2018-2021	Video and imagery of entire site. See Project Design: Photo Points and Channel Monitoring.	Smith et al. 2016, Peterson et al. 2015, Roegner et al. 2008.

Table 1. Continued

c	Surface water and ground water level	17 water level loggers throughout the site	Continually, 15-min interval 2018-21	See Project Design: Water Quality and Level	Roegner et al. 2008.
d	Water Quality (TN)	6 water samples, TkN+Nitrate +Nitrite, Lab Analysis	April, June, Aug. 2018-2021	See Project Design: Water Quality and Level, one reference, one in Unit 1 and 3, two in Unit 2	DEQ 2009, USDA 2003
d	Water Quality (TP)	6 water samples, Lab Analysis	April, June, Aug. 2018-2021	See Project Design: Water Quality and Level, one reference, one in Unit 1 and 3, two in Unit 2	DEQ 2009, USDA 2003
d	Water Quality (TSS)	6 water samples, Lab Analysis	April, June, Aug. 2018-2021	See Project Design: Water Quality and Level, one reference, one in Unit 1 and 3, two in Unit 2	DEQ 2009, USDA 2003
d	Dissolved Oxygen and Temperature	7 HOBO Dissolved oxygen and temperature loggers	Continually, 15-min interval 2018-21	See Project Design: Water Quality and Level, one reference, one in Unit 1, two in Unit 2 and 3	Roegner et al. 2008.
e	Vegetation Composition and Survival	Vegetation survival plots	Annually in Sept. 2019-2021	Stratified random sampling	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	See Project Design: Photo Points and Channel Monitoring	Coos Watershed Association 2003, USDA 1999
f	Relative fish abundance	Trapping with hoop nets	Seasonally from Nov – April, weekly basis, 2018-2021	See Project Design: Juvenile Salmon Monitoring Proposal	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	See Project Design: Juvenile Salmon Monitoring Proposal	ODFW 2015, Lebreton et al. 2009

4. Methods and Analysis

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).

A. *Water Quality Grab Samples*

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. 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.

B. *Site Data*

WLREM Unit 2 data includes channel complexity, stability and depth and vegetation composition and survival. Channel complexity is captured through two methods: 1) via aerial drone flights; and 2) on the ground visual surveys, which are both compared to original design specifications. Channel stability and depth is monitored through the annual measurement of 6 channel cross-sections and photo points throughout Unit 2. 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 4). 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 and the 2019 surveys were completed using a kayak. Analysis of channel cross-sections compared surveys from post construction in 2018 to determine if scouring has occurred and ensuring channel water levels are sufficient for fish passage.

Vegetation composition and survival surveys are completed on an annual basis. A total of 20 plots were surveyed following the procedures outlined in Coos Watershed Association's Riparian Silviculture Guideline (2003). The plots are 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 4). A simple analysis of percent survival of all standing trees and shrubs was completed.


Figure 4. Channel cross section surveys post restoration completion, September 2018 (left). Vegetation survival and composition, September 2019 (right).

C. *Continuous Data*

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.

Surface and groundwater levels are measured with In-Situ's Rugged Troll 100 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 5). 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 Rugged Troll data loggers there are six permanent water level sensors installed in stilling wells throughout the WLREM area (Figure 6). 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. NHC is responsible for annual audits, calibrations and elevation accuracy checks of the permanent water level loggers. 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).

Table 2. Monitoring metrics and thresholds set by the MAMP

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Applicability
Aerial photo/drone-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
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

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Applicability
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

Dissolved oxygen is measured continuously at seven locations throughout the WLREM area with Onset U26 Dissolved Oxygen Data Loggers. 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 5). 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. Dissolved Oxygen (DO) levels are analyzed through comparison of DO levels observed with the thresholds level set by the MAMP, of 9.0 mg/L (Table 2). In addition, basic statistics were calculated for each DO logger such as mean, median, minimum, maximum, and the number of days the logger daily minimum, maximum and mean was below 9.0 mg/L. These statistics were calculated separately for the spring and summer months and the fall and winter months since naturally these seasons have different thermal dynamics.

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 daily temperature (WMT) below 22.2 °C (Table 2). Due to the quantity of temperature sensing instruments installed only temperature from DO loggers is analyzed and presented in this report. In addition to the above analysis, basic statistics were calculated for temperature data such as mean, median, minimum, maximum, number of days the WMT was above 22.2 °C and mean daily temperature fluctuations. These statistics were calculated separately for the spring and summer months and the fall and winter months, similarly to DO levels, since inherently these seasons have naturally different dynamics.

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. Annual audits are planned but have not been performed yet due to performance and maintenance issues with the SL3000's.

Figure 5. Permanent wooden posts with PVC stilling wells attached to house water level loggers within (left) and hang DO loggers from the cap (right). Temperature is collected by both water level and DO loggers.

Figure 6. Permanent steel stilling wells house water level loggers maintained by Northwest Hydraulic Consulting (NHC), left. Data is transmitted via RTU to the network computer on-site every 15 minutes.

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

The water levels within the BSDD and Units 1, 2, and 3 are managed with dual goals of allowing for pastureland grazing and increased production of fish and wildlife. Beaver Slough Drainage District (BSDD) staff serve as the overarching entity for water control in the Coquille Working Landscapes Project area. Water level is managed in all three units of the Coquille Working Landscapes 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; 3) Spring drainout; water levels are at or above bankfull in early spring with managed elevation decreases towards April grazing season. Because of 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. 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 elevation 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 the river mile 21.5 (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. 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

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 the CoqWA and as needed by ODFW. Door openness is quantified by calculating the average number of hours per week that the vertical slide-gates were open (minimum 5 cm) for each season (spring, summer, fall and winter).

> *Note: In the fall and winter of 2018-2019 the vertical slide-gates were often managed to maintain water levels below levels stated in the MAMP. Due to the restoration construction efforts being completed in October 2018 many of the berms were still bare dirt therefore they were negatively impacted by storm wave-lap and or overflow between Units during flood events and efforts were made to minimize these negative impacts by keeping water levels low.*

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 degree and amount of time the vertical slide-gate tide gates have been open allowing water levels on the upstream in Units 1, 2, and 3 to rise with the tidal or floodflow input from levels in the river. There are no devices on the side-hinged aluminum gates to directly monitor the duration and degree of openness of the side-hinged 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 mean number of hours per day by season (spring, summer, fall and winter) that the side-hinged gates were open was calculated using the upstream and downstream differential calculation method.

E. *Fish Sampling*

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 mostly during the wet months with minimal sampling in the summer months to assess relative fish abundance. Typically, four foot diameter nylon hoop traps (Figure 7 – 3ft shown) 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 1.0g and measured fork length to the nearest 1.0mm. All juvenile coho captured (measuring over 65mm) within the Coquille Working Landscapes 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 Destron Fearing hand held PIT tag reader in order to detect recaptured fish that had been tagged during a trapping event on a previous day.

Figure 7. During flood stage 3 ft hoop traps are deployed in flooded pasture (only lead floats are visible).

The mean fork length and mean weight by week was calculated for juvenile coho captured and assessed for trend through time. The mean fork length and weight by week was compared within trapping sites in the WLREM area and fish captured at the reference site in Beaver Slough. Additionally, juvenile coho length and weight was compared to fish captured at the West Fork Smith River ODFW Life-Cycle monitoring site on two selected weeks. Fish captured at the West Fork Smith River site are considered largely to have reared in riverine and stream conditions compared to fish in the WLREM area, rearing in tidal floodplain wetland habitat.

Although 4.0ft hoop traps were the primary method of fish capture in the 2018-2019 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. No seining was employed in 2018-2019 although this method will likely be deployed in the 2019-2020 sampling period.

F. *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 within normal scientific methodologies. 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 housed on the CoqWA server following field collection. Data is proofed for errors upon entry into the database.

Data is assessed for errors, which can be from a number of effects including sensor malfunction, power outages/surges, 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).

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G. *Sampling Locations*

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.

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 8) and capture if there are effects to these parameters due to tidal exchange. Site data sampling 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 (Figure 9). 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 velocity meters are located on all culverts that contain side-hinged tide gate doors (Figure 10).

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 (Figure 8). Surface water monitoring locations were distributed across the WLREM area with 4 situated just upstream and downstream of the tide gate structure in each unit, these aid in understanding tidal and river levels that are assessed in regards to levels upstream in Units 1, 2, and 3 (Figure 8). In turn this information facilitates tide gate door management. 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.

Dissolved oxygen (DO) monitoring locations are distributed along channels and canals in Units 1-3 and Beaver Slough (Figure 8). 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 water levels and DO monitoring locations. Where appropriate and workable with river flows, sampling occurred in the mainstem Coquille River to assess the water quality or DO level entering the project area.

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. Two primary sites were chosen to sample within Unit 2 (WL 43, WL 44), one location in Unit 3 (WL46), and a control site in Beaver Slough (Figure 10). 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. Overall, sampling locations throughout the season varied due to the constantly changing water levels but priority went to the primary sampling locations listed above.

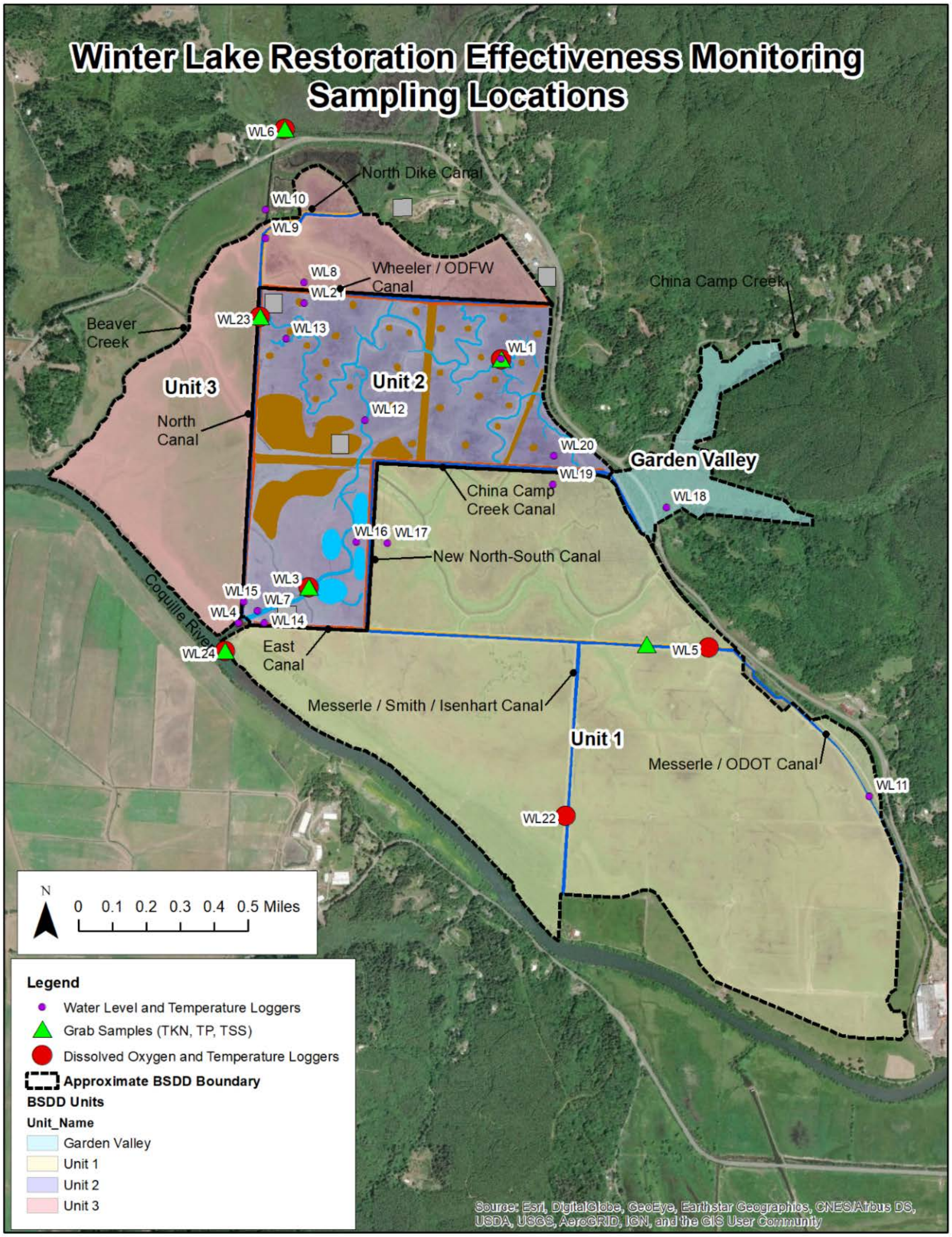

Figure 8. Sampling locations for the Winter Lake Restoration Effectiveness Monitoring Project. Grab samples (TKN, TP, TSS) are green triangles, dissolved oxygen (DO) continuous data loggers are red circles and both groundwater and surface water continuous data loggers are small purple circles. Temperature is monitored at all DO and water level logger locations.

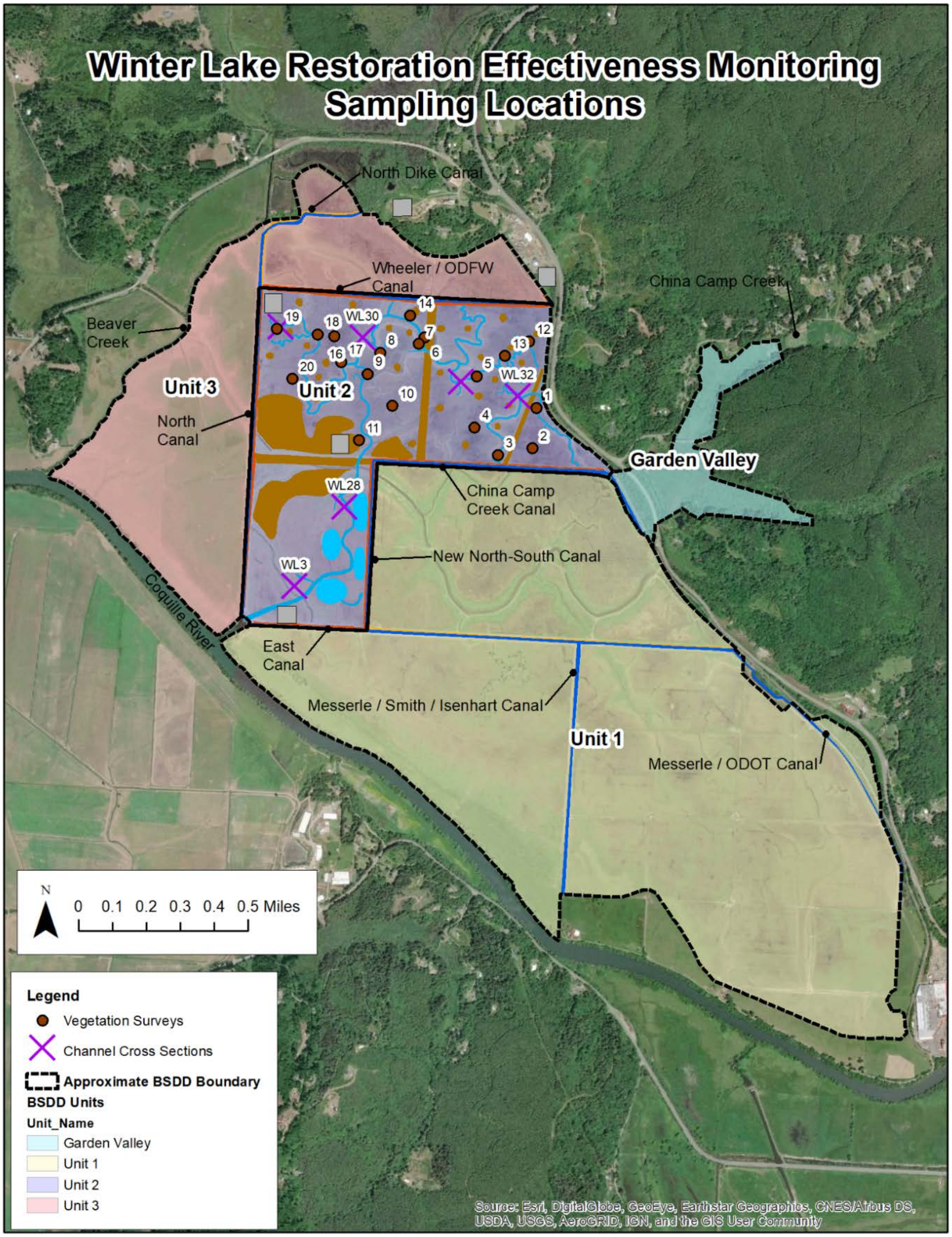

Figure 9. Sampling locations for the Winter Lake Restoration Effectiveness Monitoring Project. Vegetation composition and survival survey plots (20 total) are brown circles and channel cross-sections are purple crosses.

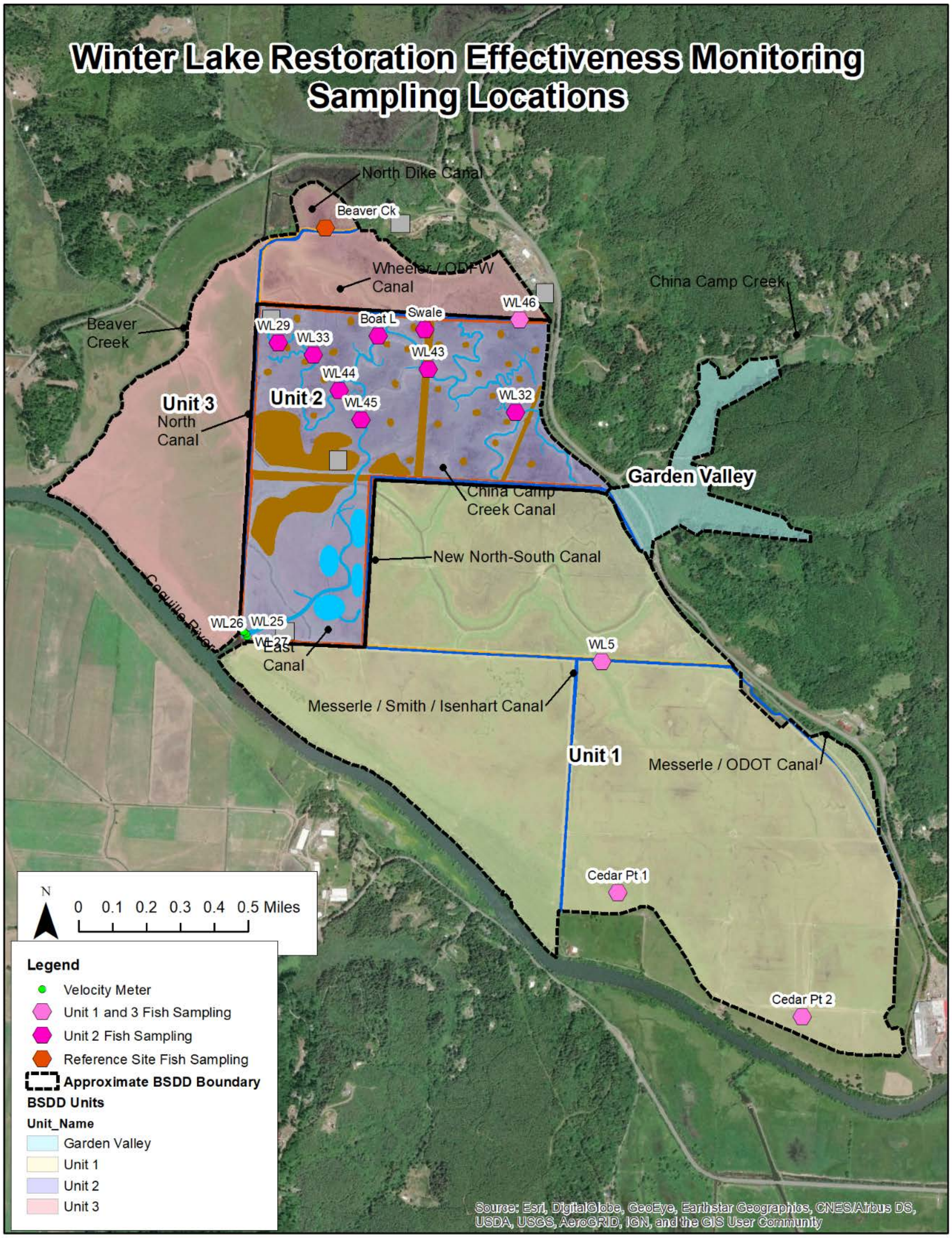

Figure 10. Sampling locations for the Winter Lake Restoration Effectiveness Monitoring Project. Continuous velocity meters are installed on 3 of the 7 tide gate culverts with all 3 being side-hinged tide gates, green circles (WL 25-27). Fish sampling in Units 1 and 3 are light pink hexagons, fish sampling in Unit 2 are dark pink hexagons and sampling in Beaver Slough is an orange hexagon.

5. Results and Discussion

The results of the first year of monitoring the Coquille Working Landscapes Project will be compared to the thresholds set by the MAMP to determine the effectiveness of the project. As with most large restoration and construction projects, the WLRP 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. Therefore, results of data obtained from nearly all categories from the first 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 WLRP 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.

A. *Water Quality Grab Samples*

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 is currently working towards determining these and will keep the Regional Review Team informed of new thresholds.

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 dies the bacteria breaking it down consume copious amounts of oxygen and decreases the water body’s dissolved oxygen levels.

Levels of TP at the WLREM site varied from non-detectable to 0.287 mg/L (Figure 11), with the highest levels seen in the agricultural units (Units 1 & 3) during the April 22nd sampling date. The Coquille River experienced a large flood in mid-April which likely attributed to these high levels when flood waters were receding and increasing run-off. During the August sampling event TP was only detected in Unit 1 (0.10 mg/L) and the reference site, Beaver Creek (0.15 mg/L). The June sampling was omitted from the results due to a shipping error which resulted in the samples not meeting QA/QC criteria.

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 12). 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 0.287mg/L in Unit 1 in April, which is sufficient supply for heavy aquatic plant growth. Aquatic plant growth in older canal networks of Units 1 and 3 is dense in late summer comprised largely of Brazilian elodea (*Egeria densa*). Despite these high levels of vegetative growth there has not been evidence that bacterial digestion of aquatic vegetation has resulted in oxygen demand levels contributing to fish kills. The Unit 2 restoration channels have as of yet to develop any substantive aquatic macrophytic vegetation since construction in 2018. We will continue to monitor aquatic vegetation growth on the study area, both for benefits and potential issues associated with project goals.

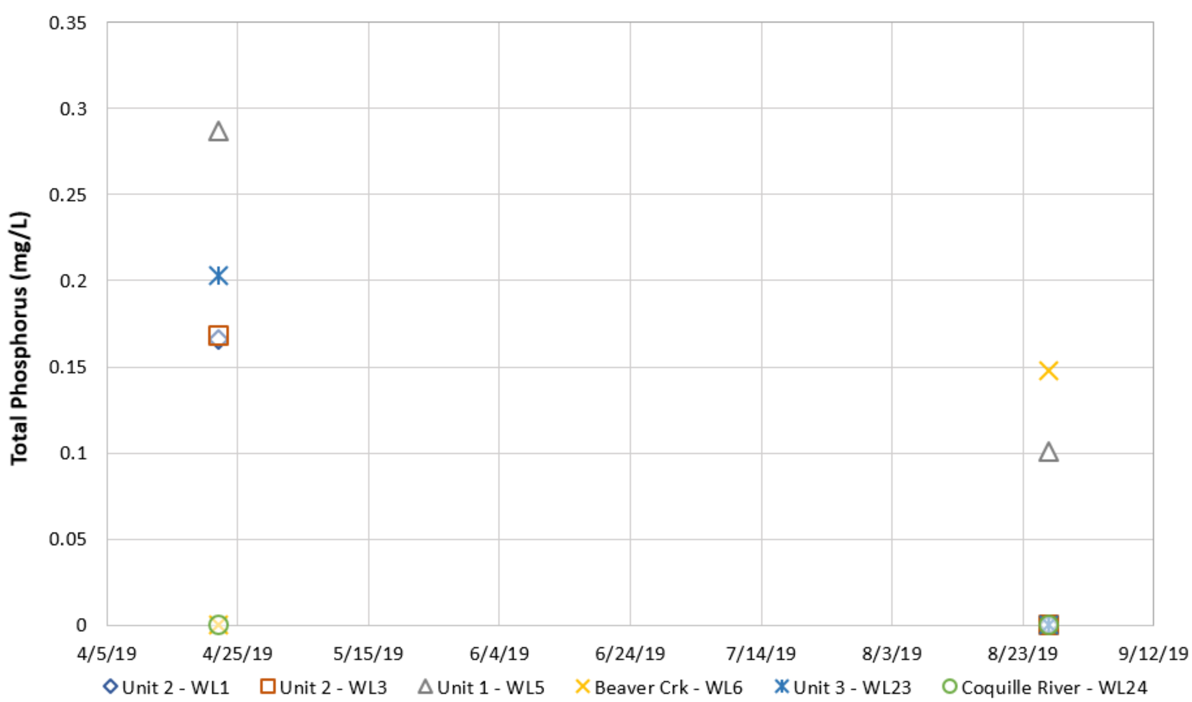

Figure 11. Total Phosphorus sampling results of the Winter Lake Restoration Effectiveness Monitoring project, Coquille Oregon.

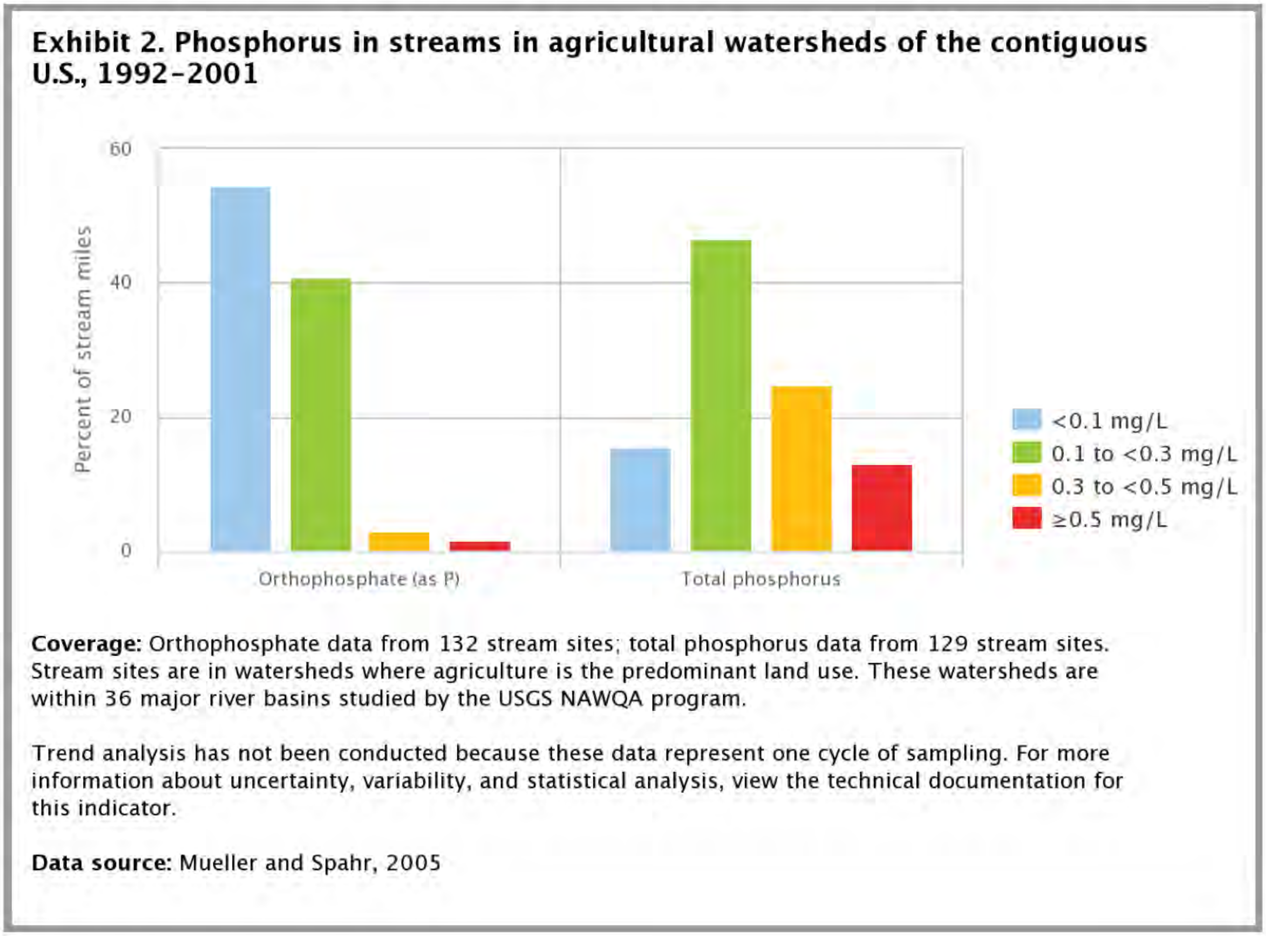

Figure 12. Results of the U.S. Environmental Protection Agency (EPA) study of Phosphorus levels in U.S. streams. Chart from Mueller and Spahr, 2005.

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 0.98 mg/L, Figure 13. As noted above in the TP results, a late spring flood probably encouraged higher TKN levels in the April sampling. The Coquille watershed typically sees very little rain in the summer months but 2019 had a wet late August with a storm event adding 0.44 in of rain on August 22nd which perhaps had an effect on TKN levels during the August 27th sampling event. The June sampling was omitted from the results due to a shipping error which resulted in the samples not meeting QA/QC criteria.

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 WLREM 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..

MAMP Table 2 Thresholds: The monitoring team will continue to assess and more thoroughly understand how the levels of phosphorus and nitrogen effect the ecology of the project area in order to develop recommended threshold levels. *See report section 6.*

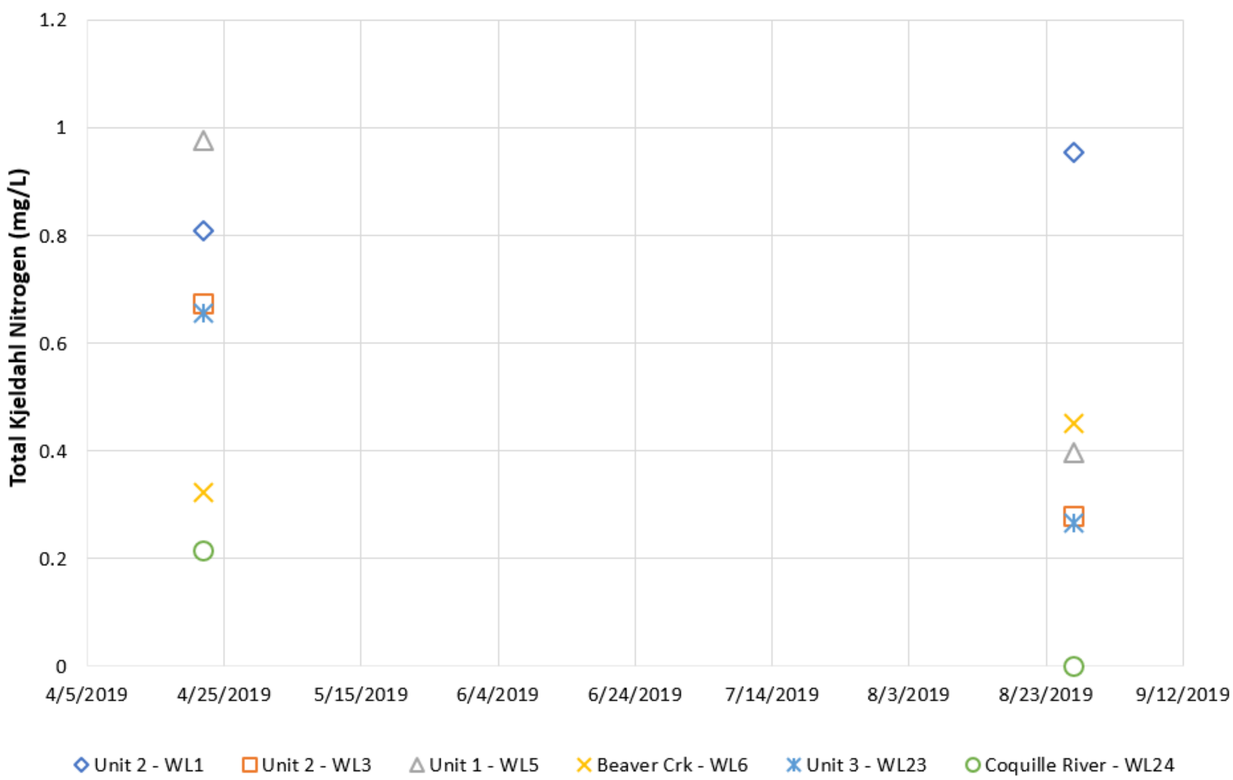

Figure 13. Total Kjeldahl Nitrogen sampling results of the Winter Lake Restoration Effectiveness Monitoring project, Coquille Oregon.

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 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 and TP results, TSS levels are highest during the April sampling event and ranged from non-detectable to 16 mg/L through the sampling (Figure 14). As stated above, there was a late spring flood that likely elevated TSS levels during the April sampling event. The June sampling was omitted from the results due to a shipping error which resulted in the samples not meeting QA/QC criteria.

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 C3P 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, was considered a "good" range for fish to feed and move in most channel and canal segments in all Units. The ability of the tide gates to allow for summer inflow of tidal irrigation waters has resulted in a strong improvement of water quality, when assessed visually, compared to prior to 2019. In late fall and winter, natural tea colored vegetative water conditions are common and considered natural for coastal floodplain wetlands.

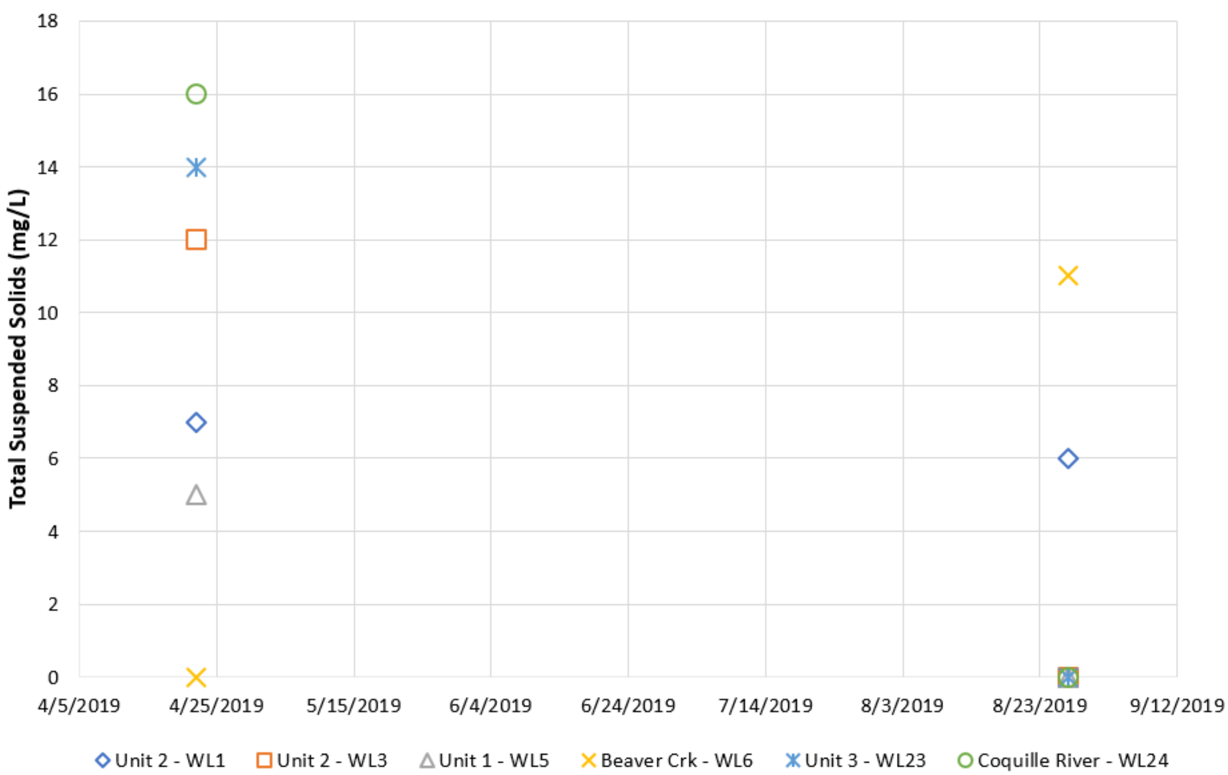

Figure 14. Total Suspended Solids sampling results of the Winter Lake Restoration Effectiveness Monitoring project, Coquille Oregon.

B. *Site Data*

Channel Complexity, Length and Connectivity

Channel complexity is captured through aerial photographs taken by a drone on an annual basis. As seen in the 2018 and 2019 aerial photographs of the Restoration Unit (Unit 2) (Figure 15 and 16), 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.

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 15. Aerial photo of the Northeast corner of the Winter Lake Restoration Unit (Unit 2), photo taken Aug. 16, 2019.

Figure 16. Aerial photo of the Winter Lake Restoration Unit (Unit 2) from the northwest corner looking south, photo taken Aug. 16, 2019.

Channel 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. To evaluate channel stability and depth, six channel cross-sections are measured and photo points are taken annually. Of the six cross-sections all but one remained stable. Location WL32 had slight scouring on the left side (facing downstream) (Figure 17 and 18). However, the cross-sectional surveys were completed in a kayak due to depth of water and it is uncertain as to whether this location experienced scour or the measurements observed were a result of measurement error. Cross-sections of WL3, 28, 29, 30 and 31 can be found in Appendix C and a subset of photo points can be found in Appendix D. Overall, depth was adequate for fish passage at all sites surveyed.

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

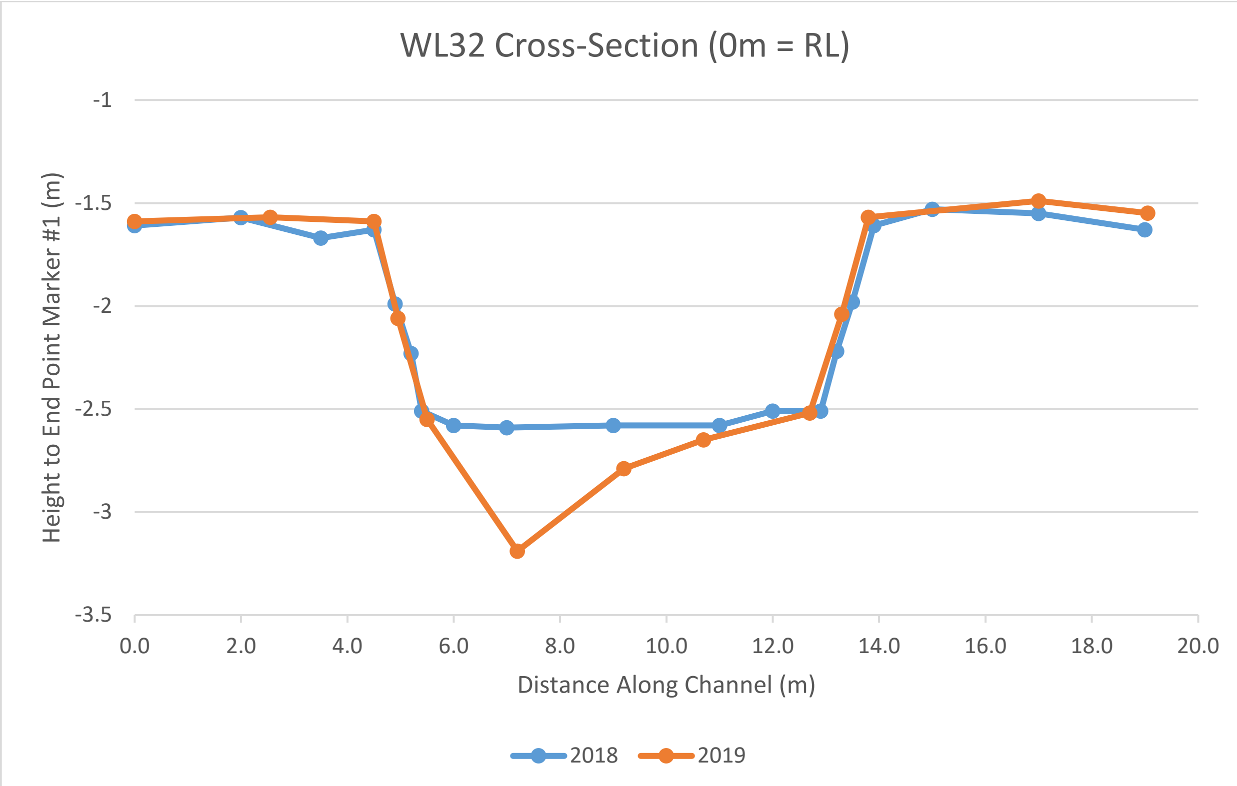

Figure 17. Cross-Sectional measurements of channel at location WL32 in Unit 2, Winter Lake Restoration Effectiveness Monitoring. All measurements are based on the distance from the end point marker on the river left bank (when looking downstream), therefore river left end point marker is distance 0.0m.

Figure 18. Upstream facing photo of location WL32 of the Winter Lake Restoration Effectiveness Monitoring.

Vegetation Survival

A well-established riparian zone is an important objective for the WLRP. 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 bay. Slower water velocities are also beneficial to juvenile coho and other salmonid species residing in the WLRP 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 WLRP 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

In the late fall of 2018, WLRP (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. Of the 20 plots surveyed, survival rate varied from a low of 16% to a high of 100% (Figure 19 and Table 3). Plot survival rate does not appear to be spatially dependent. Ash and willow had the highest survival rates, 77% and 79%, respectively. The spruce obtained for the planting had poor vigor when it was planted and as a result had the lowest survival rate (19%) of all species. Unfortunately, many trees showed signs of mortality from the early April flood, (e.g. dead trees at the leaf out stage). The survival survey 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. An additional 6,500 trees and shrubs and 35,000 willows were planted within Unit 2 in the fall of 2019 and will be included in future vegetation survival surveys. There will be variable mortality of the trees and shrubs planted due to flooding that will occur through time, 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 70% and exceeded the MAMP threshold of 60%.

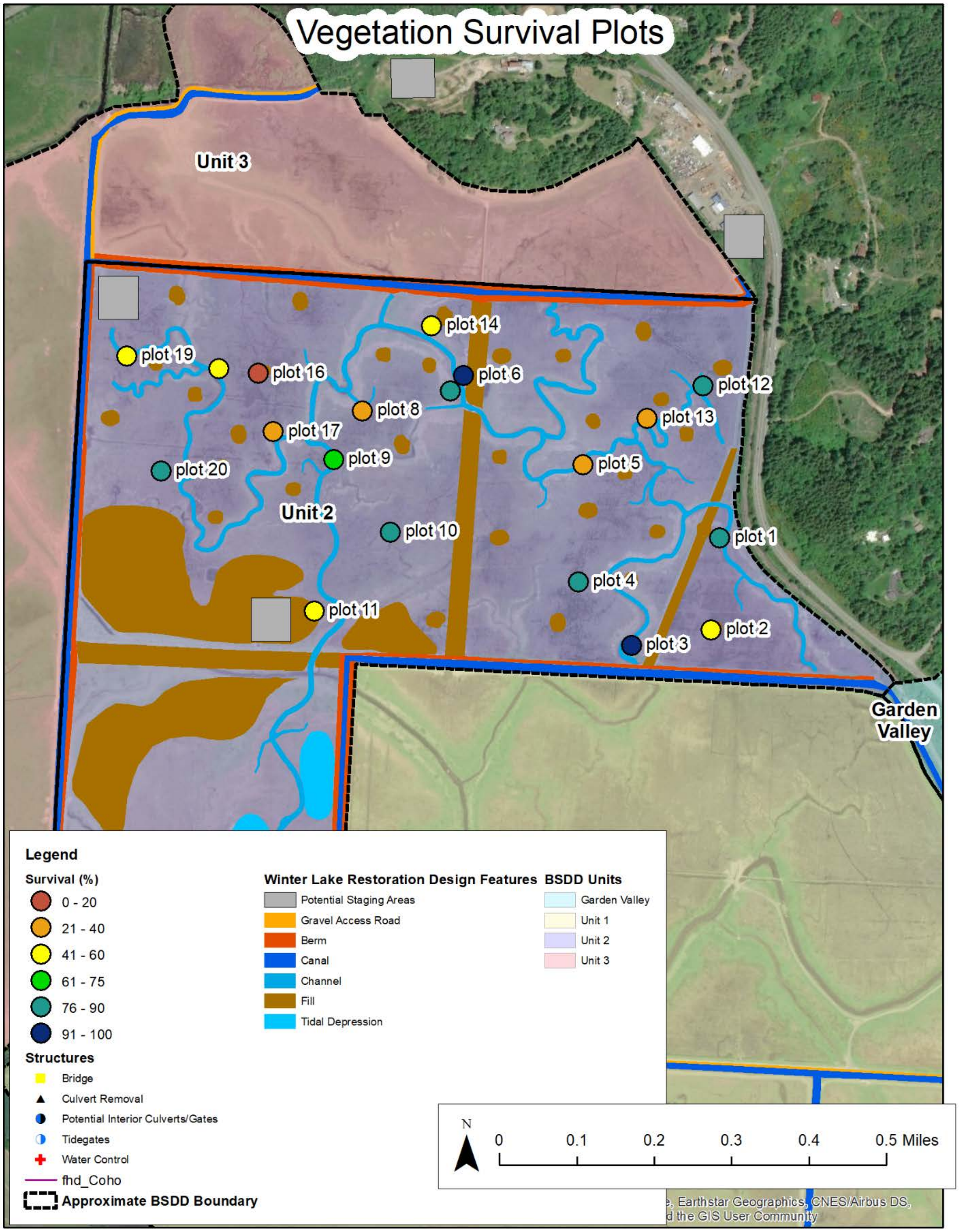

Figure 19. Vegetation survival of Winter Lake Restoration Project, Unit 2. Survival ranged from 16% to 100% and plot habitat type varied from wildlife mounds to riparian corridors.

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

2019 Vegetation Survival Summary - Overall Survival Rate 70.2%

Plot #	% Plot Survival
1	79
2	48
3	100
4	88
5	25
6	100
7	82
8	36
9	75
10	80
11	54
12	78
13	38
14	47
15	67
16	16
17	33
18	41
19	42
20	85

Species	% Survival	# Live
Ash	77.2	132
Willow	78.8	663
Crabapple	63.6	14
Alder	28	7
Cottonwood	56	51
Spruce	19.2	5

C. *Continuous Data*

Velocity in Tide gate Culverts

Velocity of the inflow-outflow of water through the seven concrete box culverts is important for fish passage assurance. To date, the project team has installed three velocity meters in culverts 1A, 2C, and 3. Some velocity data was obtained in 2018-2019, however, due to the complexity of the wiring and upload network to the computer control, data transfer discontinuity, and difficulty sorting through gaps in the data, no velocity data was analyzed for 2018-2019.

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

Temperature

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 WLRP'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 temperatures of the channels at the WLRP, 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. There are areas of significant groundwater inputs from springs in the project area (Claire, C., ODFW, personal communications February 2019), and eventually these areas will provide cold water refugia as shading develops and protects these zones during the warm summer months.

The temperature thresholds set by the MAMP are based on Maximum Weekly Temperature which we interpreted to be Weekly Maximum Daily Temperature (WMT), which averages the maximum daily temperature over a week period. The temperature data collected at the WLREM area has been split into two separate time periods for analysis, Dec 1- Mar 31 (cooler period) and Apr 1- Sep 30 (warmer period). 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.

During the cooler period all WLREM sites passed the temperature threshold set by the MAMP, with means ranging from a low of 8.8˚C (WL3) to a high of 9.4˚C (WL1). The mean daily change in temperature reflects the size of the channel, which relates to the total volume of water affected by solar radiation or how close the site is to the tide gate structure. The influence of 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 sites, including the Coquille River (WL24) and Beaver Creek (reference – WL6), exceeded the MAMP threshold of 22.2 ˚C during the summer period. 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).

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 the total day count is very low. Likewise, during the summer months, the logger at WL5 in Unit 1 became dry many times due to low water levels. This is reflected in the total day count and high daily change in temperatures (Table 4). Both of these issues will be addressed for year 2 of monitoring.

Table 4. 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
12/1/18-3/31/19	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	115	115	111	112	112	59	136
Mean	9.2	9.3	8.8	9.4	9.3	8.0	8.2
Median	8.4	8.5	8.4	8.9	8.7	7.9	8.0
Min	4.3	5.5	5.7	4.7	6.0	5.3	4.3
Max	19.9	17.3	17.8	22.0	18.9	15.9	16.2
WMT>22.2 °C	0	0	0	0	0	0	0
Mean Daily ΔT	1.8	1.1	1.7	1.5	1.2	0.7	1.0

Temperature	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
4/1/19-9/30/19	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	155	179	179	179	179	140	179
Mean	19.3	20.1	19.6	20.4	19.8	21.1	17.5
Median	20.1	20.8	20.7	21.0	20.5	22.0	17.9
Min	5.5	10.4	9.8	11.2	10.2	12.8	11.2
Max	34.4	29.8	26.3	28.3	30.0	24.9	26.1
WMT>22.2 °C	84	95	83	107	77	74	24
Mean Daily ΔT	5.1	2.8	2.3	3.1	2.2	0.8	2.6

The WMT exceeds the MAMP threshold mainly during the months of June, July, and August as seen in Figure 20. 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 the agricultural units (Units 1 and 3), temperatures follow similar patterns to Unit 2 and the irrigation periods with large inflow of water, specified by the blue bars in Figure 20, do not correspond with cooling at the temperature logger sites. The reference site, Beaver Creek - WL6, stays cooler than all other sites but still exceeds the MAMP thresholds during mid-July, however, for a much shorter period and to a lesser degree, which is important for production of salmonids. Although temperatures surpassed MAMP thresholds in Beaver Creek, this location is still able to support salmonids yearlong. 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 8.8˚C (WL3) to a high of 9.4˚C (WL1) during Dec-1 to March 31. However, they generally exceeded the threshold June 1-August 31st.

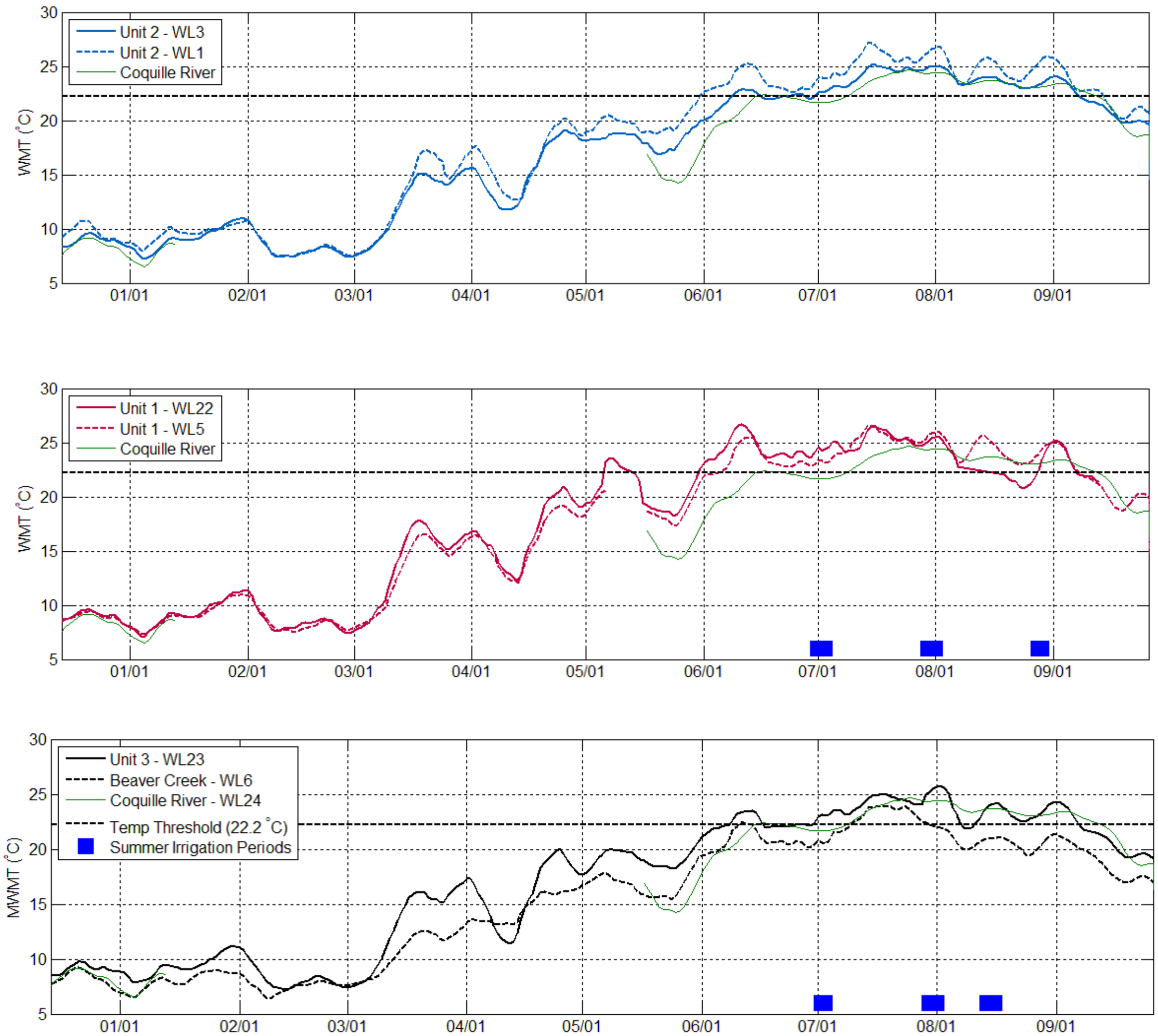

Figure 20. Weekly Maximum Daily Temperatures (WMT) of the 7 sites of the Winter Lake Restoration Effectiveness Monitoring project.

Dissolved Oxygen

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.

The fish species caught at WLRP (Results - Fish Sampling, 5.E) 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 the WLRP is set at 9.0 mg/L, presented as the daily mean DO level. The DO data is split into two separate timeframes for analysis, similar to the temperature analysis above: Dec 1- Mar 31 and Apr 1- Sep 30. 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. During the winter period, the mean DO levels in the Coquille Working Landscapes area ranged from a low of 7.5 mg/L (WL22) to a high of 10.2 mg/L (WL3) (Table 5, and Figures 21- 27). Site WL3 in Unit 2 had the fewest number of days (14 days) where daily mean DO was below the threshold while the other 4 Coquille Working Landscape sites ranged between 76-86 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. Furthermore, there are other studies around the state (K. Fetcho, OWEB, personal communications, June 14 2019) that are seeing similarly low levels of DO with large, healthy juvenile coho populations, therefore the DO levels observed at this point are not of high concern. *See Section 6 of report for MAMP discussion*.

DO levels during the summer period are lower, as expected. The summertime mean DO levels in the Coquille Working Landscapes area ranged from a low of 6.7 mg/L (WL22) to a high of 9.1 mg/L (WL3) (Table 5). WL3 experienced very high and variable levels of DO in July and we suspect it was caused by high levels of vegetation surrounding the DO logger, Figure 24. 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 Coquille Working Landscapes sites on average have higher levels of DO.

Table 5. Dissolved Oxygen statistics for the winter period, Dec 1-Mar 31 (top table) and summer periods, Apr 1-Sep 30 (bottom table).

Dissolved Oxygen	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
12/1/18-3/31/19	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	115	115	111	112	112	39	136
Mean	7.5	7.7	10.2	8.1	8.4	10.6	5.4
Median	7.8	7.9	10.4	8.3	8.4	10.9	5.6
Min	1.8	1.7	6.8	2.4	3.7	6.7	1.6
Max	12.8	11.5	13.3	12.1	11.2	12.6	12.3
Days Min < 9.0 mg/L	113	96	37	98	91	12	133
Days Max < 9.0 mg/L	61	66	0	42	43	0	129
Days Mean < 9.0 mg/L	86	82	14	80	76	1	132

Dissolved Oxygen	Unit 1		Unit 2		Unit 3	Coq Riv	Bvr Crk
4/1/19-9/30/19	WL22	WL5	WL3	WL1	WL23	WL24	WL6
Day Count	146	164	179	166	179	87	163
Mean	6.7	7.0	9.1	7.7	7.8	7.3	3.3
Median	7.1	7.2	9.0	7.5	7.8	7.2	3.2
Min	0.0	0.0	2.9	2.1	2.2	4.0	0.0
Max	14.2	13.7	19.1	14.5	12.5	10.0	8.6
Days Min < 9.0 mg/L	145	164	149	160	170	83	163
Days Max < 9.0 mg/L	65	64	15	90	55	82	163
Days Mean < 9.0 mg/L	122	150	92	136	158	83	163

The daily minimum and maximum DO levels at each site are plotted with the DO threshold and daily mean water levels of each unit (Figures 21 - 27). The daily minimums are lowest in Unit 1 (WL5 and WL22) and Beaver Creek (WL6) while the daily maximums are highest at WL3 in the restoration unit. The DO logger deployment in the Coquille River was continually being buried by sediment and much of the data was unusable, which is evident in Figure 27. In addition, WL22 experienced very low water levels which exposed the logger to air and resulted in unusable data (Figure 22).

It was difficult to understand the correlating factors for data obtained in 2019 in regards to DO levels. In Unit 2, average DO levels were perhaps slightly higher (Figure 23) and detectibly higher (Figure 24) during winter and early spring (March-April) than after water temperature reached levels where ecologic processes were more robust in early summer. 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 21). Water inflow-outflow through the tide gate would be anticipated to have a mixing effect, however, flow velocities are sufficiently low (<3.0ft/sec; based on anecdotal observations) and flow is 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 for the most part from June 1 to September 15th in 2019. This was in order for ODOT to chemically 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. In upcoming years, more stochasticity will be incorporated into the summer tidal management for Unit 2, which may allow for more analysis of DO and inflow-outflow.

In Units 1 and 3 there appears to be a relationship between strong inflow in the winter-spring periods and DO concentrations. That said there would need to be a more in-depth analysis completed for individual flood flow events. During summer months, there appears to be a pattern reflecting substantive variability of DO levels from May through August. We considered this to be related to daylight hour photosynthetic production within the strongly established macrophyte communities of older canals and subsequent reductions in DO at night through bacterial consumption. Further analysis of individual time periods might show correlative effects with inflow-outflow and DO for Units 1 and 3, however, we were unable to visually determine a readily apparent pattern (Figures 21, 22 and 25).

MAMP Thresholds (Table 2): DO level thresholds for Unit 2 were met at one of two sites (Table 5) for the winter and summer period.

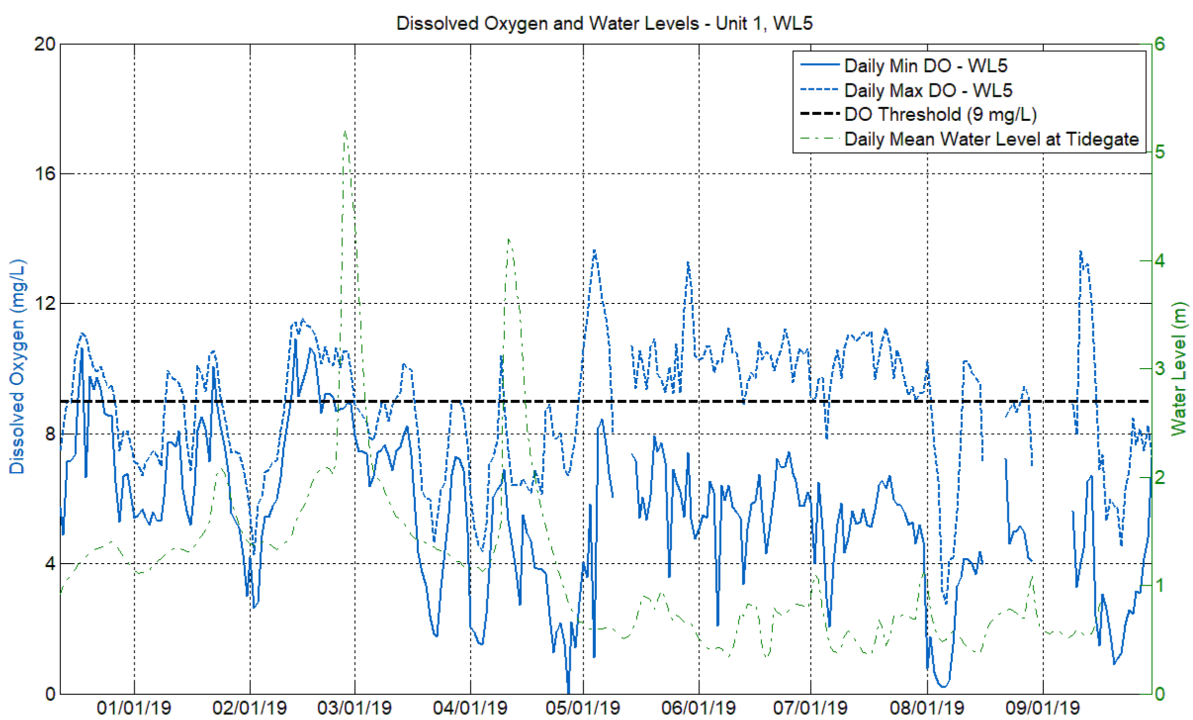

Figure 21. Dissolved oxygen trends and water level for Unit 1 at WL5 in 2019.

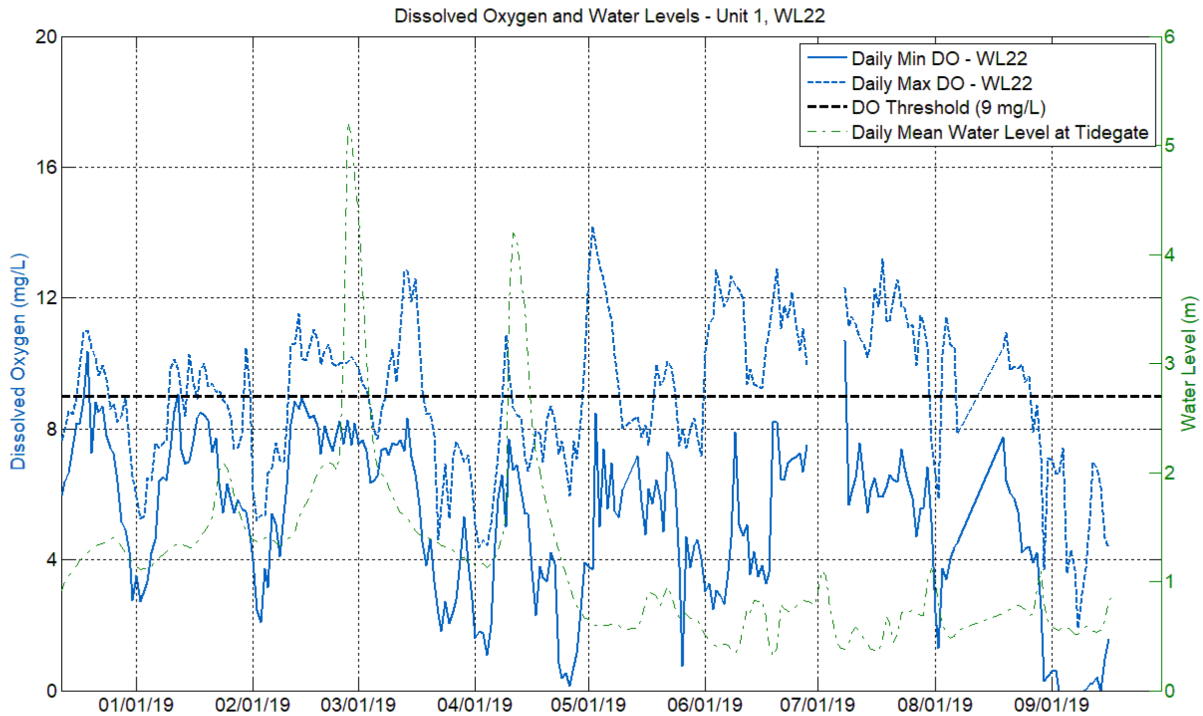

Figure 22. Dissolved oxygen trends and water level for Unit 1 at WL22 in 2019.

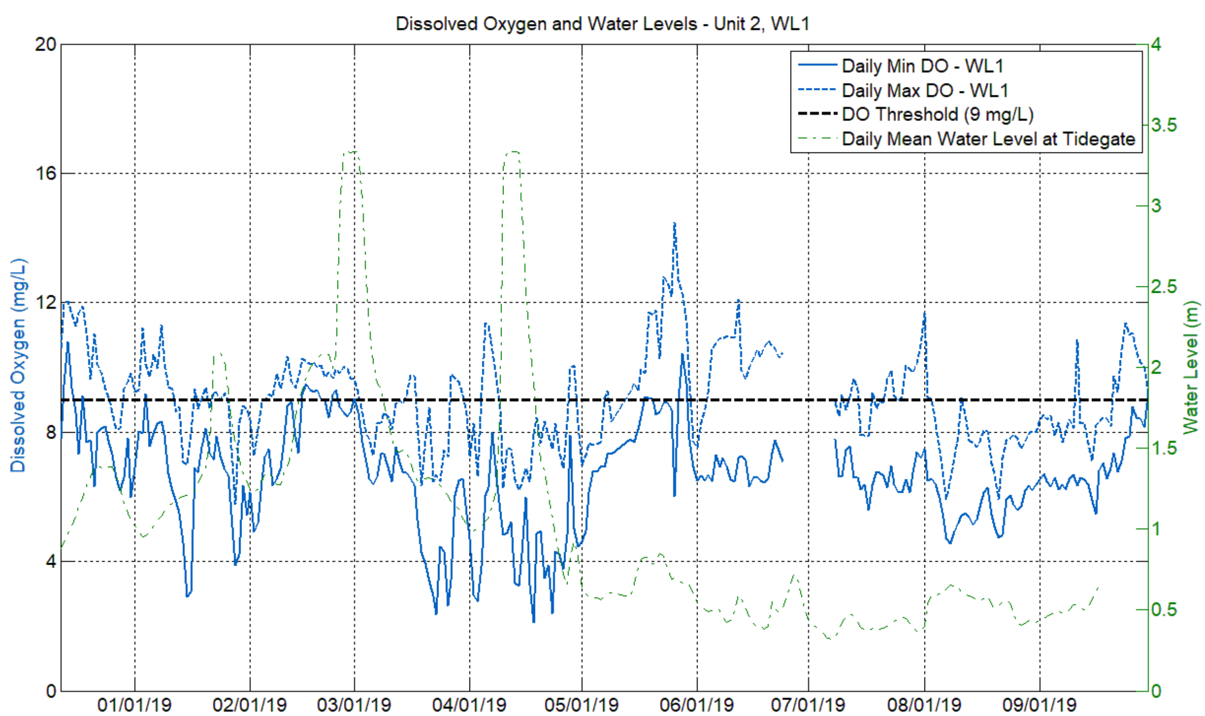

Figure 23. Dissolved oxygen trends and water level for Unit 2 at WL1 in 2019.

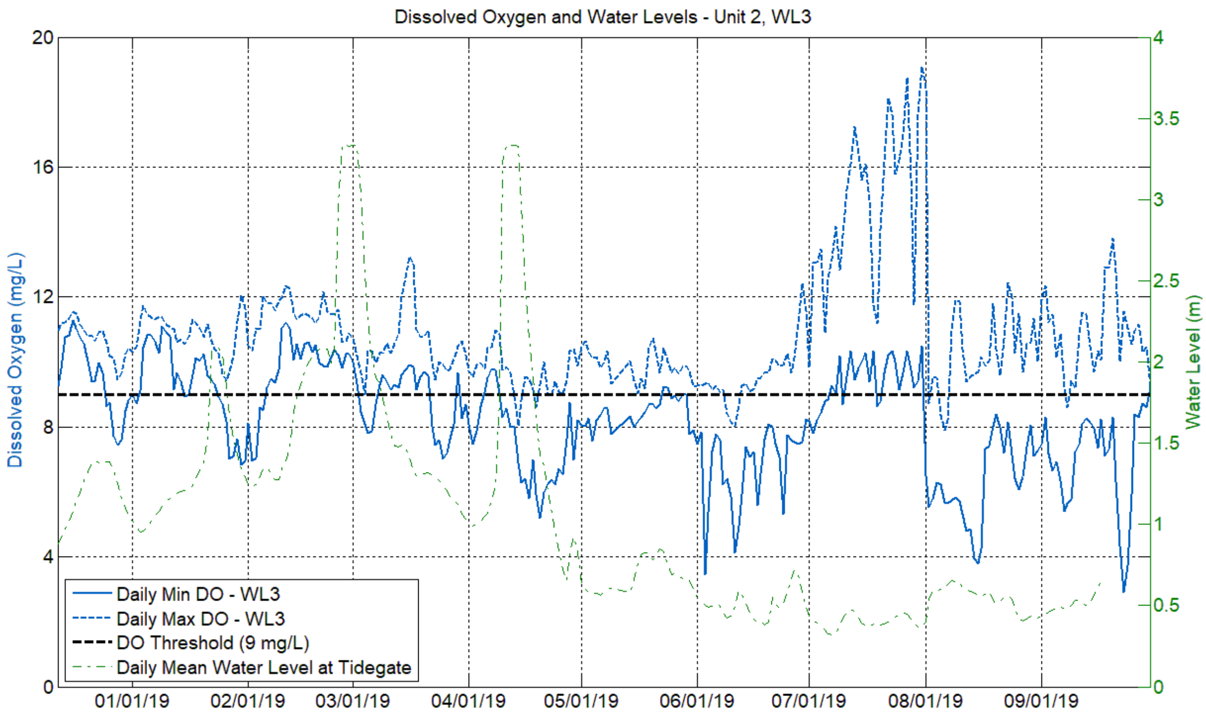

Figure 24. Dissolved oxygen trends and water level in Unit 2 at WL3 for 2019.

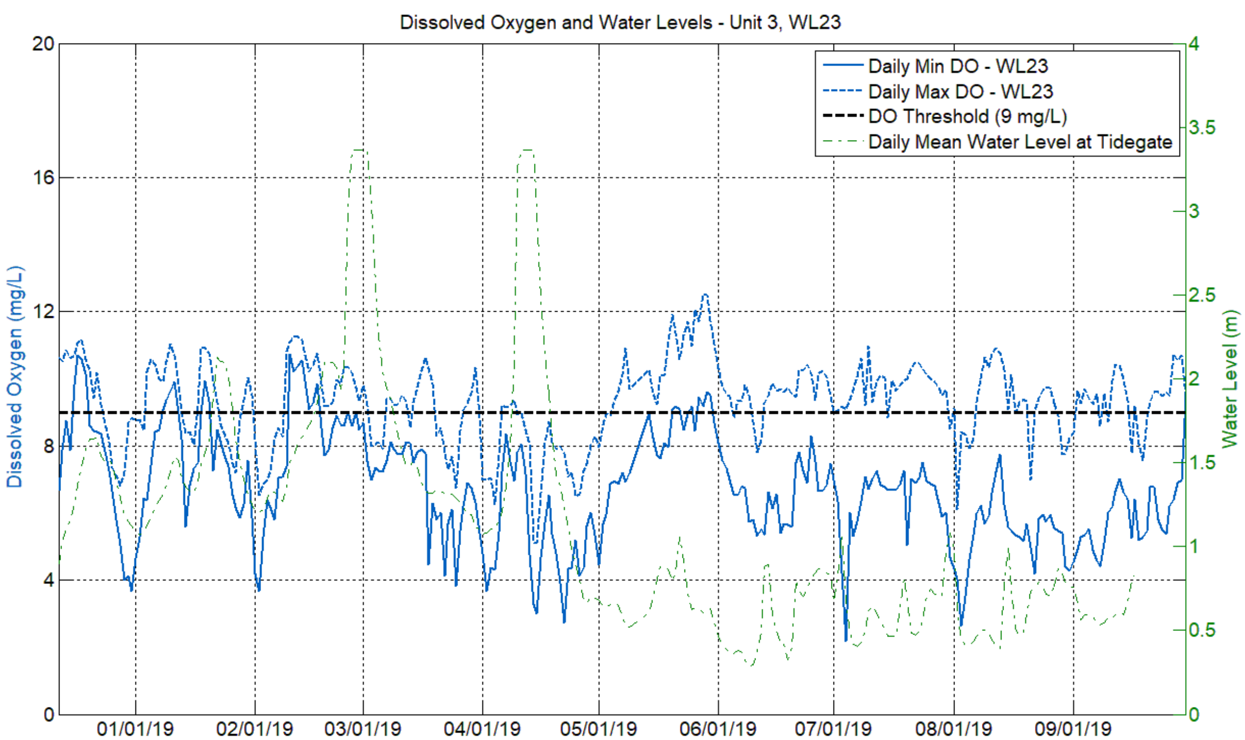

Figure 25. Dissolved oxygen trends for Unit 3 WL 23 in 2019.

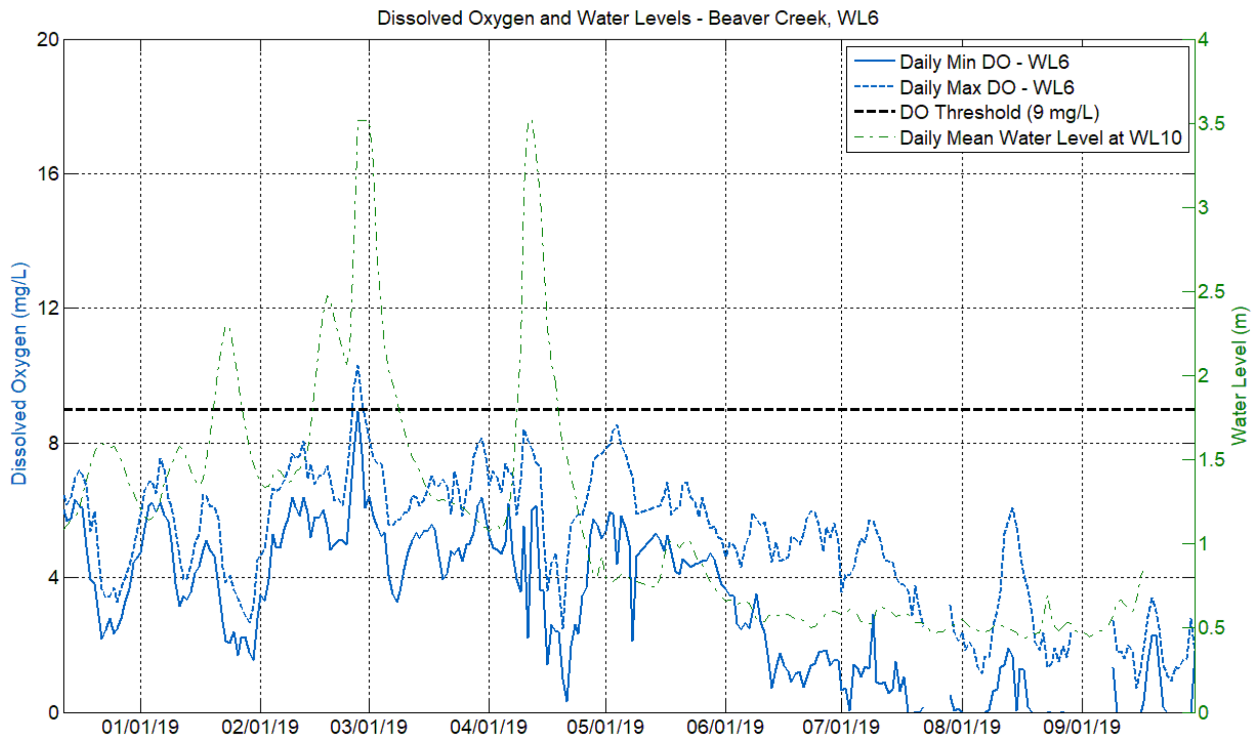

Figure 26. Dissolved oxygen trends for Beaver Creek WL6 in 2019.

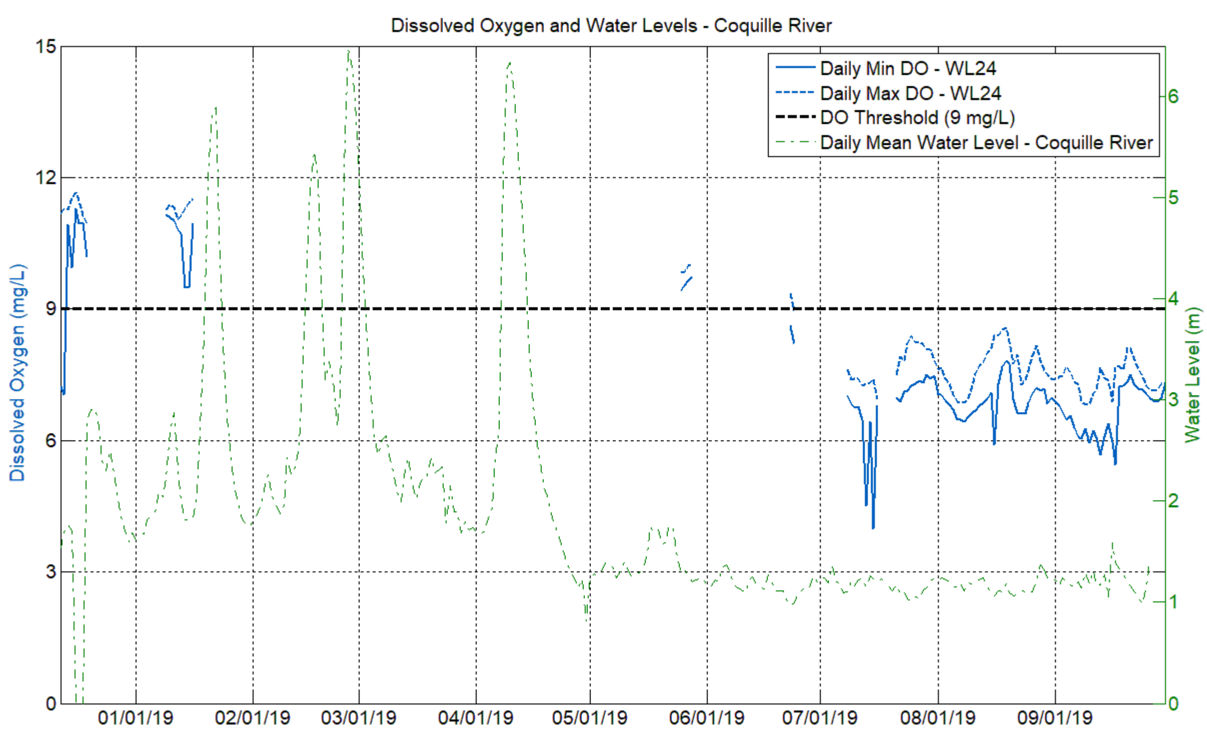

Figure 27. Dissolved oxygen trends for the Coquille River in 2019.

Surface Water Level

Surface water levels are important to monitor within the Coquille Working Landscapes 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 Coquille Working Landscapes Units and this exchange and mixing contributes to improved water quality. (***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). Discussion in the Water Level Management section (5.D) below describes the various reasoning for not meeting the water level management MAMP thresholds in the first year of operation.

Water levels are examined during two different time periods: the wet season (Oct 1-Apr 30) and the dry season (May 1- Sep 30) (Figures 28 and 29). The reconstructed berms were increased in height for Unit 2 to elevation 2.3 m (7.5ft). Above that elevation, water is able to move between 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 first winter post-construction there were three flood events, 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 three times, Figure 28. During the mid-January event, river levels reached a level over elevation 5.5 m, yet the water elevation upstream of the tide gates remained under elevation 3.0 m due to ODFW and BSDD tide gate management.

An added benefit of the new tide gate structure is the quantity of water that can flow through the tide gate. The seven 8ft x 10ft dimension tide gate culverts have a 300% greater capacity than the former tide gate infrastructure (three 8.0ft round culverts) that was removed. The new infrastructure allows the units to be drained faster after floods. During the flood events, water level loggers in Units 2 and 3 reached the maximum water level they can detect, 3.4 m (Figure 28) and for short periods data indicated water level was at or above that elevation.

During the summer water levels remained low for all Units except during irrigation periods in Units 1 and 3, (Figure 29). Water levels in Unit 2 were intentionally kept low due to the need to construct additional channels and other maintenance issues described below in Water Level Management (5.D). Water level data stops September 17, 2019 due to issues with the NHC Portal. Overall, there is much natural variation in water levels due to rain or the absence of rain and the influence on river levels and pasture accumulation of water. Future water level management will be closer to the MAMP thresholds.

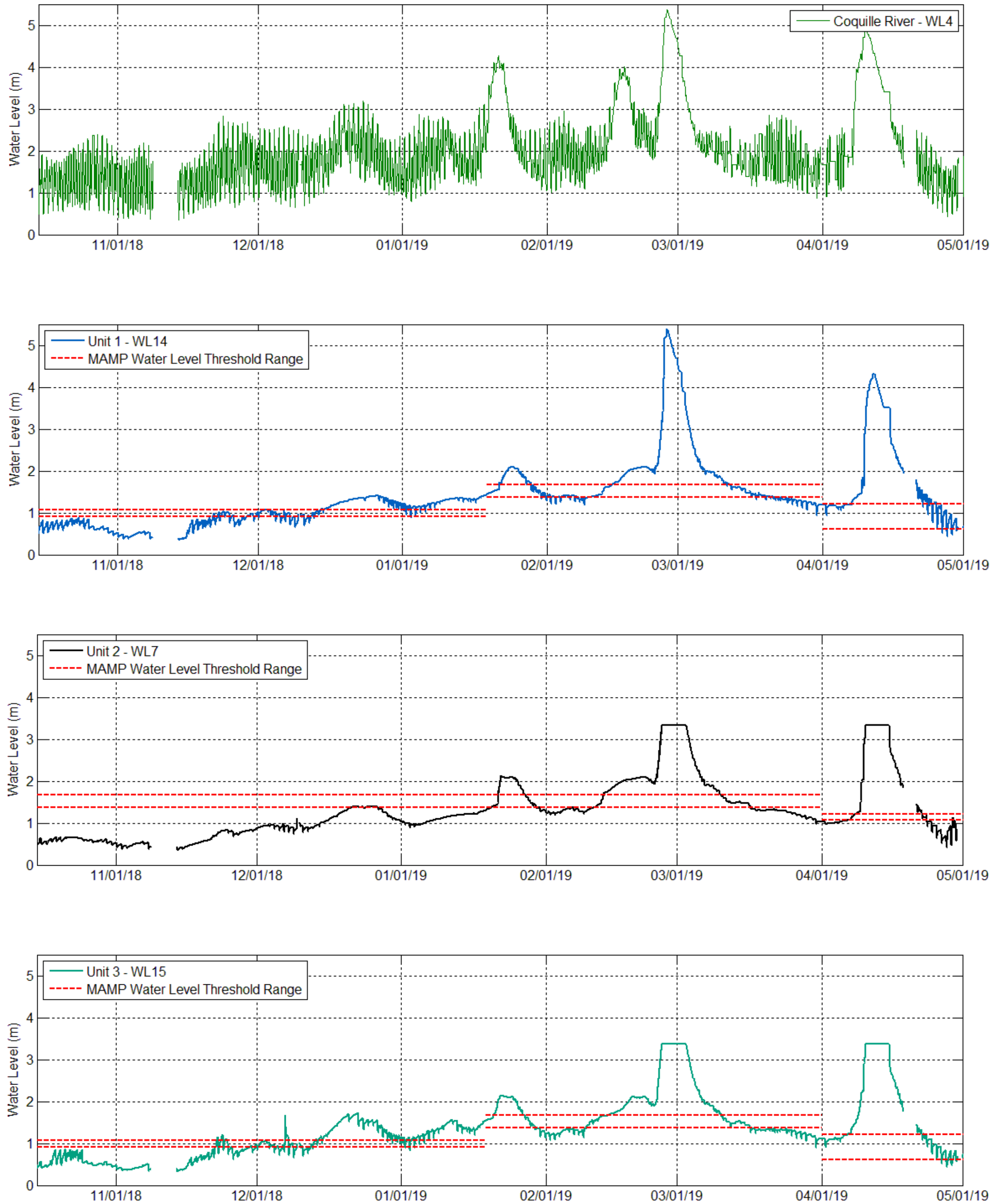

Figure 28. Water levels during the wet season, Oct 1 – Apr 30. Note the three flood events in the first months of 2019. The MAMP threshold range is depicted by two red dashed lines and varies depending on season and Unit.

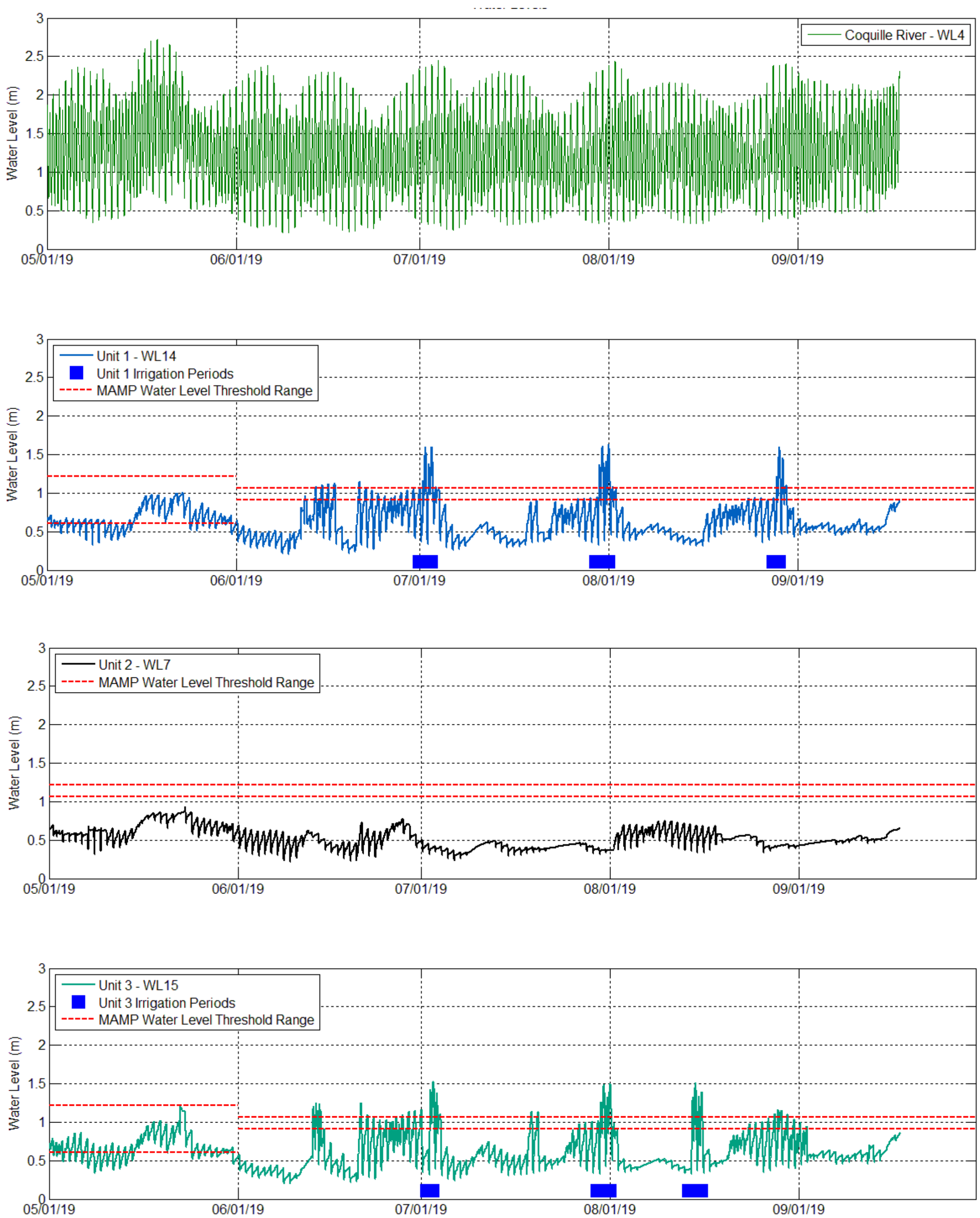

Figure 29. Water levels during the dry season, May 1 – Sep 17. Note the three irrigation events (blue lines) during the summer months in the agricultural units (Unit 1 and 3). The MAMP threshold range is depicted by two red dashed lines and varies depending on season and Unit.

Water levels of the reference site, Beaver Creek, are depicted in Figure 30. The three floods in the beginning of 2019 are less extreme at Beaver Creek than the Coquille Working Landscapes area. This is due to the location of Beaver Creek in the floodplain, natural river levees, berm isolation of Beaver Creek from Coquille Working Landscapes area, the distance water needs to travel from the river to reach 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.

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

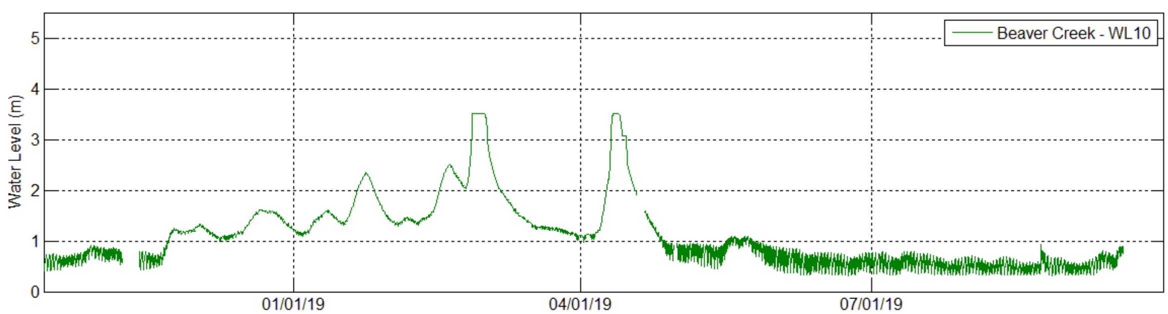

Figure 30. Water levels at Beaver Creek, reference site, from Oct 1 2018 - Sep 17, 2019.

Groundwater Level

There are no MAMP thresholds set for groundwater levels. There are two well pairs in Unit 1 (Figure 31). Both groundwater wells in Unit 1 (WL17 and WL19) exhibit influence from the summer irrigation periods unlike their paired wells in Unit 2. Groundwater well WL20 exhibits unusual behavior compared to the other two groundwater wells in Unit 2 (WL16 and WL21). On August 23rd, the day after an 11 mm rain event, the water level rose 0.77 m, suggesting this localized groundwater is highly dependent on rain.

Since the groundwater wells are located in the floodplain, they all record the flood waters that occurred during the winter months (Figure 31). 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. At this point it is unclear if the increase in groundwater levels, short and long-term, during irrigation periods reflect water overtopping the well casing and entering the well rather than water permeating through the soil complex.

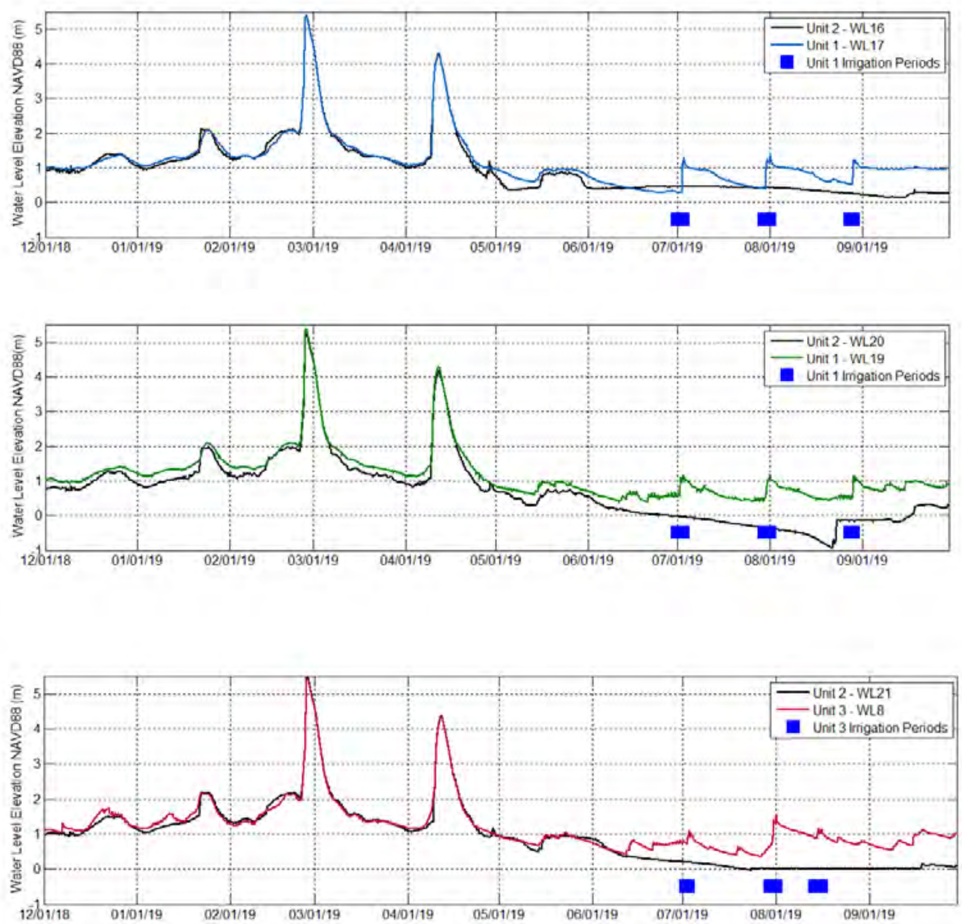

Figure 31. Groundwater levels of paired wells in WLREM project area. The top two figures show paired wells in Unit 1 and 2, with irrigation (blue bars) playing a significant role in summertime groundwater levels. The bottom figure shows the paired wells in Unit 2 and 3. During the winter months the water levels correspond to surface water levels since the wells are located in a floodplain.

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

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.

There is a strong effort to manage integrity of the berm infrastructure. This resultant need is addressed through close BSDD and landowner water level coordination. The objective is to manage water levels during winter months in a manner where the water levels rise consistently in the individual Units to prevent high volume overflow with hydraulically damaging effects for the vulnerable segments of berm. The ability of juvenile salmonids, including coho, to enter into the

Unit 2 Restoration habitats is linked to the time that the tide gate door is open throughout the period when fish are present and habitat conditions are suitable (e.g. temperature, water levels). Thus a high degree of importance has been placed on managing the tide gates servicing Unit 2 for maximum time of openness from October to March. This is reflected in the MAMP goals in Table 2.

Flood Inflow: Tidal inflow from the river to the tide gate is relatively predictable from June through October and strongly reflects the tidal levels. In months when the river flows rise or fall in relation to heavier precipitation, the added volume of water in the river and the friction of this water on the riverbanks as it moves from River Mile (RM) 21.5 (Winter Lake) towards the Pacific Ocean softens and often nullifies the tidal signal. This provides highly variable river elevation 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 allow inflow and outflow to mimic natural conditions, but soften volume and elevations to manageable levels within Units 1, 2, and 3. 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 level 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 include 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 can be increased up to the extent of the tide in conjunction with individual landowner goals.

The goals of the BSDD and ODFW in the winter of 2019 were predominantly to manage for protection of the newly rebuilt berm infrastructure that was in a state where planted erosion control grasses needed protection from heavy storm wavelap. Thus, water management and elevation were often based on the need to protect infrastructure. In the summer of 2019, berm infrastructure developed a protective rootmass layer that inhibits erosion, which will allow for more robust water management in upcoming years.

Vertical Slide Tide 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 berms, 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.

Side-hinged Tide gates

The duration and degree that the side-hinged aluminum tide gates are open is largely dependent on three factors: 1) the amount of precipitation that has fallen daily and accumulates upstream (vertical head pressure), 2) the degree and amount of time the vertical slide-gate tide gates have been open allowing water levels upstream in Units 1, 2, and 3 to rise with the tidal or floodflow input from the river and 3) the tidal amplitude.

<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.

Tide gate Door Openness

The seven tide gate doors that service the Coquille Working Landscapes area open in two different ways, as described above. The vertical slide gate opens through either manual operations or a remote controlled mechanism, the side-hinged gates open when the water level is lower on the downstream side of the gate. The vertical slide gates can open a varying amount from all the way shut to wide open (2.4m). To assess the amount of time the vertical gates were open the height was split into three ranges, 0.05-0.3m, 0.3-1.2m and greater than 1.2m. The time frame was also split into two ranges, the wet winter months (Oct-Apr) and the drier summer months (May- Sep). Slide gate doors are operated more frequently in the 0.05-0.3m and 1.2+ m ranges than the 0.3-1.2m range, Table 6.

Table 6. Length in days of each of the 7 vertical slide tide gate doors open at three different height ranges, 0.05-0.3m, 0.3 – 1.2m and over 1.2m. The year was split into 2 different periods, the winter period of October 12, 2018 – April 30, 2019 and the summer period May 1, 2019 – September 17, 2019.

Oct 12 - Apr 30 — Total Time Tide gate Door Open (in days)

Height of Slide Gate Door	Gate 1A	Gate 1B	Gate 2A	Gate 2B	Gate 2C	Gate 2D	Gate 3
0.05 - 0.3m	61.2	2.1	1.3	0.8	120.7	1.1	82.4
0.3 - 1.2m	3.2	7.3	7.9	1.3	3.9	1.3	0.0
1.2+ m	0.1	14.5	6.5	29.1	0.3	14.7	0.3

May 1 - Sep 17 — Total Time Tide gate Door Open (in days)

Height of Slide Gate Door	Gate 1A	Gate 1B	Gate 2A	Gate 2B	Gate 2C	Gate 2D	Gate 3
0.05 - 0.3m	4.1	33.0	1.1	9.4	0.1	0.1	27.6
0.3 - 1.2m	0.5	3.2	0.1	0.5	0.3	0.4	5.3
1.2+ m	0.8	4.6	1.1	2.4	1.7	2.4	0.5

The three side-hinged tide gate doors only open when the hydraulic head is less on the downstream side, as stated above. In addition, when the gate opens it is open the full amount (90° angle) and remains open until it closes. The side-hinged doors typically open due to the tide cycle or rain events, and cannot be opened manually. The cumulative number of days each side-hinged gate was open for both the wet winter months (Oct-Apr) and the drier summer months (May-Sep) are shown in Table 7. During the wet season, the side-hinge gate servicing Units 1 and 3 was open a total of 17 days while the side-hinge gate servicing Unit 2 was open only 9.8 days. Similarly, during the dry season, the side-hinge gate servicing Units 1 and 3 was open a total of 24.8 and 23 days, respectively, while the side-hinge gate servicing Unit 2 was open only 14.5 days.

Table 7. Length of time, in days, the three side-hinged tide gate doors were open at the Coquille Working Landscapes Project. The year was split into 2 different periods, the winter period of October 12, 2018 – April 30, 2019 and the summer period May 1, 2019 – September 17, 2019. The hinged tide gate doors are dependent on a negative hydraulic pressure to open the door i.e. lower water levels downstream of tide gate.

Oct 12 - Apr 30

Side-Hinge Gate Door	Gate 1A	Gate 2C	Gate 3
Total time open (in days)	17.4	9.8	17.5

May 1 - Sep 17

Side-Hinge Gate Door	Gate 1A	Gate 2C	Gate 3
Total time open (in days)	24.8	14.5	23

E. *Fish Sampling*

Fish sampling was initiated in early December of 2018 and concluded for the season in May 2019. In the summer of 2019 (mid-September) a single sampling event was completed to ascertain summer fish use of channels. A total of 1,460 pre-smolt coho juveniles were captured from December 2018 to

May 2019 during 44 trapping nights. These 44 trap nights resulted in a total of 1,130 hrs trapped and the number of coho captured per hour of trapping, Catch per Unit effort (CPUE), of 1.29 coho captured per hour for coho juveniles overall (Table 8). All coho were captured at the primary sites (Figure 10), which were in-channel trapping locations, however, this was due predominantly to the large amount of effort at these sites. Effort at off-channel and pasture locations was not sufficiently substantive in 2018-2019 to ascertain the density of fish on the general floodplain pastures adjacent to channels or determine if and how far juvenile coho will wander from the channels.

Table 8. WLREM project area juvenile coho captured using 4′ and 3′ hoop net trapping efforts from December 2018 to May 2019.

		Unit 2		Unit 3	Reference - Beaver Creek
	Total Count	Channel Sites (4' traps)	Channel Sites (3' traps)	Channel Sites (4' traps)	Channel Sites (4' traps)
Total Sampling Events	44	19	4	11	10
Coho	1460	30	4	28	1398
Hours Trapped	1130	534	98	259	239
Catch per Unit Effort (CPUE)	1.29	0.06	0.04	0.11	5.85
Avg. Fork Length, L, (mm)	107	111	156	99	107
Avg. Weight, W, (g)	17	23	48	16	16
Avg. Body Condition Factor, K, (BCI)	1.05	1.14	1.26	1.04	1.03
# PIT tagged	233	25	0	28	180
# Recaptured	2	0	0	0	2

A total of 23 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 2,431 bullhead catfish *(Ameiurus nebulosus)*, 1,868 black crappie *(Pomoxis nigromaculatus),* and 70 largemouth bass *(Micropterus salmoides)* were captured in the study area. All are considered a potential predatory influence on coho juveniles. Further work will be done to assess their trend in the Restoration Unit in subsequent years. Interestingly, a Pacific lamprey *(Entosphenus tridentata)* adult was captured at the Cedar Point 2 pasture trapping site following floodwater inflow to the project area.

Relative Fish Abundance

There was a strong propensity for coho to be captured at the Beaver Creek site (1,398 of the 1,460 total) as compared to Units 2 and 3, where a total of 62 coho were captured despite a higher trapping effort in Units 2 and 3 (Table 8). A total of 23, 11, and 10 trap days were completed in Units 2, 3, and Beaver Creek, respectively. The CPUE for Unit 2 was 0.06 and 0.04 coho captured per hour trapped respectively for 4′ and 3′ hoop traps. Unit 3 CPUE was 0.11 coho captured per hour with only 4′

hoop traps fished due to the depth of the canals. The CPUE was 5.85 coho captured per hour trapped for the Beaver Creek site.

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 on the site connecting to high quality rearing habitats that were previously inaccessible for fish to use; 2) the channels at this site were constructed in 2017, which allowed the ecological community within the new connecting channels a year to develop food items prior to 2018 initiation of trapping; 3) the Coaledo Drainage District tide gate was leaking heavily on both the inflow and outflow of the tide cycles late into the fall in 2018, which allowed access for juvenile coho (it was fixed late fall 2018, but still leaks substantially, providing some fish access); 4) the trap site is just upstream from a known rearing area in the main Beaver Creek canal; 5) 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; 6) perhaps the most relevant theory for the lower numbers of coho captured in Unit 2 is that the channel networks were new as of October 2018, with no macrophyte community, nor had a macroinvertebrate food community substantially colonized the new channels. It is possible that coho in the river approaching the tide gate noted the limited food availability through scent cues in water moving through the Unit 2 tide gates and moved to other preferable locations.

Juvenile coho captured were measured, weighed, assessed for overall parasite loading, and were injected with Passive Integrated Transponder (PIT) tags. A total of 25, 28, and 180 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.

During the 2018-2019 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. There are a couple of possibilities for the low recapture rate at all sites, and specifically the Beaver Creek reference site including: 1) some or most fish may move into and from the trapping areas during a short time period; 2) the number of fish within the Beaver Creek study site was very large during the 2018-2019 study period; 3) for Unit 2 the size of the restoration area (407) acres and channel network system is large at 27,000 ft during the 2018-2019 study period.

Additionally, Unit 2 is much larger than the acreage upstream of the trap site at Beaver Creek which is 30 acres and only 3,200 ft of channel. Thus there is a higher likelihood of being captured at the Beaver Creek site due to a higher density of fish. The Beaver Creek channel is also smaller and the trap leads have a somewhat higher capacity to prevent fish from swimming around.

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 111mm (Table 8). Comparatively, the average fork lengths of fish captured in Unit 3 and at the Beaver Creek site were 99mm 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, there are several potential reasons that fish were larger in Unit 2: 1) the density of fish was lower based on the CPUE compared to the Beaver Creek site, thus there was less competition for food; 2) juvenile coho in Unit 2 were heavier at an average of 23g and 48g compared to 16g for both Unit 3 and Beaver Creek (Table 8); 3) the juvenile coho caught at the 3' trap sites in Unit 2 are significantly larger due to sites being sampled in the spring time when juvenile coho at all sites were older and therefore larger in size.

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 for fish captured by Unit (Table 8). Fish in Unit 2 also had a higher BCI with an average of 1.14 and 1.26 for 4' and 3' trap sites, respectively, than fish in Unit 3 and Beaver Creek, 1.04 and 1.03, respectively (Table 8). We hypothesize the primary factor for lower BCI's of Beaver Creek fish is the higher density of fish in Beaver Creek, resulting in more competition for food resources.

We analyzed fish length and weight relationship as well for the fish captured at Coquille Working Landscapes rearing in floodplain wetland habitats compared to fish that were presumably reared under primarily riverine and stream conditions and captured at the West Fork Smith River ODFW Life Cycle Monitoring trap. Fish were obtained from the two sites during the same week in April and thus, in theory, are of similar age. Fish captured in the Coquille Working Landscapes sites were on average longer with greater weight (Figure 32).

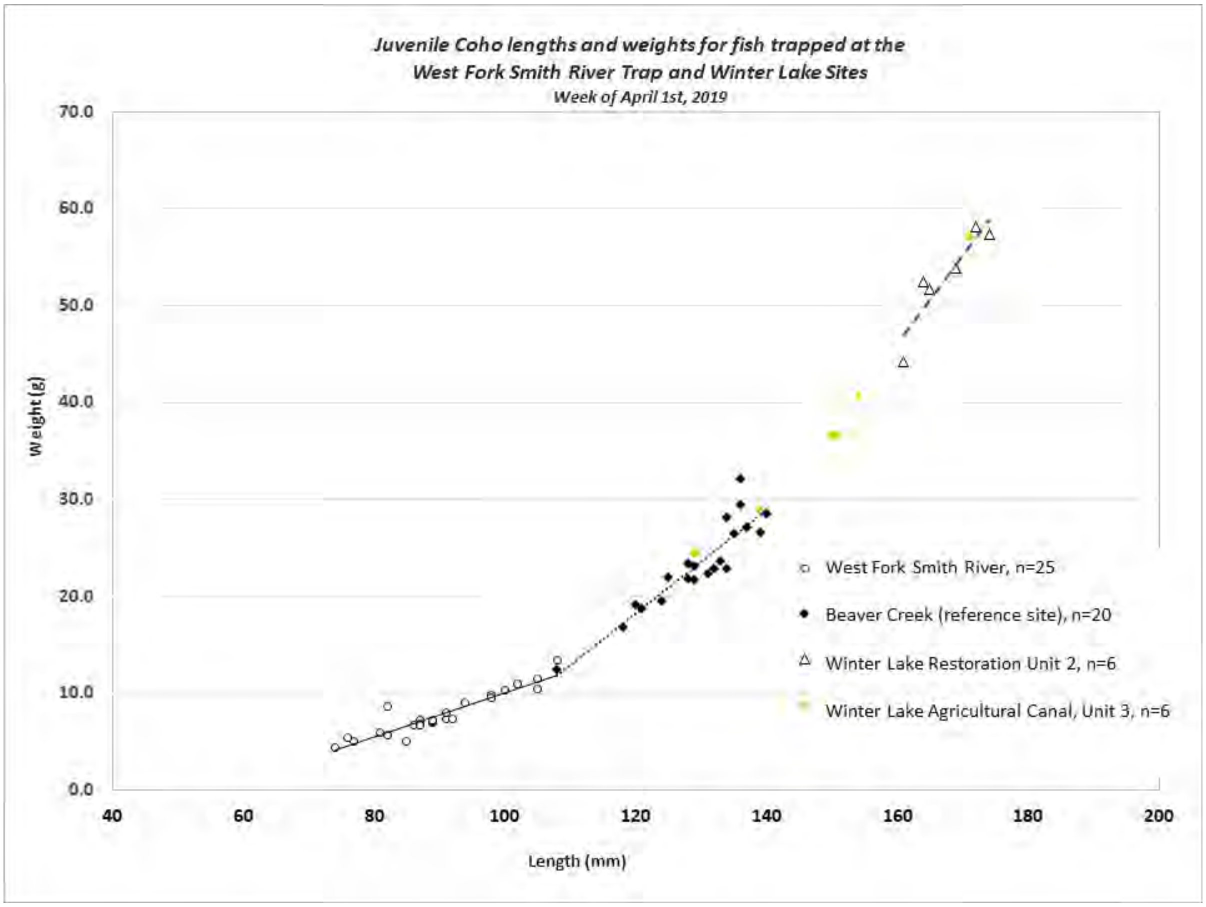

Figure 32. Comparative analysis of Coquille Basin floodplain reared coho juveniles captured in the Winter Lake project area, with coho juveniles considered to be of riverine rearing disposition captured in the W.F. Smith River basin. Fish were roughly presumed to be of the same age as they were captured with a seven day period in April, 2019 at both sites.

6. Summary for MAMP Metrics

A. *Monitoring Metric Conclusions*

The WLRP 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 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 Coquille Working Landscapes Project is meeting those performance standards. Table 9 documents the parameters and whether the performance standards were met or not met.

Channel Length: Over 27,000 ft of tidal channel was constructed in Unit 2 in 2018, with another ~3,700 ft of shallow connecting channels added in 2019 meeting the MAMP standard.

Temperature: Temperatures as measured at two locations in Unit 2 channels (WL 1 and WL3; Figure 8) documented that summer temperatures were above the 22°C threshold. Winter temperatures were within the performance threshold. Following construction, the channels were without vegetative shading and despite planting of ~110,000 trees and shrubs it is anticipated that roughly 4-6 years will be required for growth in order for sufficient cover to develop and bring temperatures within the desired range.

<u>Dissolved Oxygen:</u> 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; perhaps there is tolerance for lower DO when water temperatures are cold and in zones where there is preferential food availability.

<u>Nitrogen, Phosphorus and Total Suspended Solids:</u> 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: A total of 110,000 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. Spruce survival has been low as well, however, this species was planted with an expected poor survival due to the low elevation of Unit 2 and long duration of wet conditions. 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. 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. 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 2019, the Restoration area is considered to be within the MAMP threshold (Table 9).

Water Management: In 2018 the WLRP included reconstruction of over 2.4 km of berms. The majority was elevated 0.6-1.5 m in order to provide a uniform final construction height of 2.3 m. This design feature was incorporated to allow for water to be managed independently within the individual Units up to elevation 2.3 m. The un-vegetated earthen material was vulnerable to wavelap erosion until vegetated. The berm was seeded and mulched, however, there will be a lag of around two seasons prior to achieving full stability associated with vegetative root structure. From completion of the Unit 2 Restoration in mid-October 2018 through the winter months, ODFW and the BSDD coordinated and managed the tidal levels, with the specific goal of keeping water levels in Unit 2 below elevation 1.2 m in order to reduce the potential for erosion of the newly reconstructed berms. Accordingly, water levels were often below the 1.4-1.7 m elevation as specified in the MAMP (Table 2). In the summer of 2019, water levels were again held below MAMP threshold goals to allow for construction of additional channels that would provide access to low-lying areas where fish stranding was likely during winter months. Summer water levels were below MAMP goals in order to facilitate access for excavator equipment to construct channels connecting these locations. In the upcoming 2019-2020 year, BSDD and ODFW will be working to manage water more robustly.

Table 9. Winter Lake Restoration monitoring parameter metric table, year 1 2018-2019.

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Pass or Fail
Aerial photo/drone-video or ground based GPS	Channel Length	20,000 feet	1. > 20,000 feet (Pass) 2. < 20,000 feet (Fail)	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
Data loggers	Dissolved Oxygen	9 mg/L DO	1. >9 mg/L DO (Pass) 2. <9 mg/L DO (Fail)	Winter – Fail Summer - Fail
Grab Samples	Total Nitrogen	TBD*	TBD	N/A
Grab Samples	Total Phosphorous	TBD*	TBD	N/A
Grab Samples	Organic Matter	TBD*	TBD	N/A
Survival plots	Percent Survival	60% survival	1. > 60% survival required (Pass) 2. < 60% survival (Fail)	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
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

Table 9 continued

Monitoring Technique	Monitoring Metrics	Threshold	Decision Pathway	Pass or Fail
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
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
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
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
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
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
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
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
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
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

* 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 first year monitoring of the Unit 2 restoration, ODFW site inspections, and coordination with BSDD several items were identified for corrective action in 2019.

- Additional channels were constructed to provide ingress and egress of juvenile fish to low-lying areas where stranding was likely. The northeast corner of Unit 2 has roughly 60 acres that are under elevation 0.76m (2.5ft) NAVDD88. Several low-lying areas with potential to hold shallow ponded water were connected with hand excavated channels to reduce the risk of mosquito production.
- The new north and south berm that was constructed on the west side of the new China Camp Creek north and south canal in 2018 experienced some minor damage due to water flow during winter flow events. It was deemed necessary to increase the height of this berm by 0.15m (0.5ft). This will prevent future overflow and water impacts. Once water levels have equalized in all Units and water is above the west and north side of Unit 2, the risk of damage to the north and south berm on the southeast side is minimized.
- In October 2018, following construction, ~8.0 acres of disturbed soils in the northern floodplain of Unit 2 were planted with species that are highly desirable for waterfowl: wild rice (*Zizania palustris), wapato (Sagittaria latifolia),* shortawn foxtail *(Alopecurus aequalis)*, and American sloughgrass *(Beckmannia syzigachne)*. Another five acres were planted with American sloughgrass and shortawn foxtail in October 2019.

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 one year in operation, the Winter Lake tide gate replacement and restoration project is already meeting 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.

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