Lower Coquille Tide Gate and Fish Passage Monitoring Project, 2023-24

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1. Introduction

The Lower Coquille Tide Gate and Fish Passage Monitoring Program (LCM) leverages the close proximity both temporally and spatially of three tide gate upgrade and tidal floodplain habitat restoration projects within the lower Coquille River and a non-tide gated site at River Mile (RM) 4. The overarching program goal is a multi-partner collaboration to examine not only the functionality of individual tide gate projects to provide critical juvenile and adult fish access to habitats but also how their proximal and potentially compounded uplift promotes recovery of the Oregon Coast coho ESU. It is important to complete this effectiveness monitoring and document fish life-history linkages to these types of projects that are at the forefront of the tide gate replacement movement growing along the Oregon Coast, to ensure we are maximizing ecological benefits and return on investment. The three tide gated projects in the freshwater ecotone are well situated to examine the individual and cumulative benefits provided to overwintering juvenile salmonids within the Coquille River Basin.

The LCM began as a three-year monitoring project but has received additional funding to extend the project; therefore, monitoring will occur for a total of six years. The LCM is led by the Coquille Watershed Association (CoqWA) in collaboration with multiple branches of the Oregon Department of Fish and Wildlife (ODFW) and a burgeoning partnership with the US Fish and Wildlife Service (USFWS) facilitated by multiple individual grants. For detail on the collaboration and grant structure of the LCM program, please refer to the LCM Plan[1]. The LCM relies on Passive Integrated Transponder (PIT) technology and an expansive fish sampling effort to track juvenile coho movements and residency throughout the freshwater estuary and passage through tide gates. A combination of passive and active capture techniques (e.g., hoop trap nets, beach seines) are used to sample juvenile coho throughout the winter and spring in the restored project sites of Winter Lake, Seestrom and Lower Coquille River Wetland and Stream Enhancement (Cochran) (Figure 1), sampling also occurs at Beaver Slough (reference site) and in the lower Coquille River. Additionally, sampling structure and locations have been adjusted as need be, such as, the tagging of juvenile fall Chinook and fall sampling in the headwaters of the East Fork Coquille River at Laverne Park. In mid-December 2023, early winter high flows protruded into perched floodplain locations that were visually noted by the Team in the East Fork (EF) and North Fork (NF) sub-watersheds (Figure 1). In January through April several off-channel ponded water areas in pastures (Figure 1) were sampled in the EF and NF Coquille floodplains using seining methods. High numbers of fish were documented using these locations and these efforts contributed notable numbers of tagged fish to the monitoring project.

2. Background

Since the mid-1800s, land-use practices have substantially decreased the amount and quality of tidal floodplain complexes in the Coquille basin and anadromous fish returns, including ESA listed Oregon Coast coho, have decreased to an estimated 8% of historical abundance. The Coquille River has the second longest tidally influenced estuary in Oregon at 41 miles, with only the Columbia River being longer. Tidal floodplains and associated wetlands provide critical rearing habitat and slow water refugia for salmonids. Functional fish passage to fully tidal, un-tide gated habitats in the Coquille Valley has been reduced to ~1,000 acres, or <8% of historical acreage, by the use of levees, ditches and tide gates. Historic tide gate styles are largely top-hinged wood or steel and restrict juvenile fish rheotaxis movements from the mainstem Coquille River into locations that would historically have provided high quality off-channel

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[1] The Lower Coquille Tide Gate and Fish Passage Monitoring Plan, 2021.

winter and spring rearing. The National Marine Fisheries Service (NMFS) ESA Recovery Plan for Oregon Coast Coho Salmon (2016), Oregon Department of Fish and Wildlife (ODFW) Oregon Coast Coho Conservation Plan (2014), and Coquille Indian Tribe (CIT) Coquille Subbasin Plan (2007) have all identified the depletion of slow-water refugia as one of the key limiting factors affecting the recovery of Oregon Coast coho salmon. Although these habitats are now a restoration priority, there is limited published science on the migratory habits of juvenile coho into and within the tidally influenced estuaries of the Oregon Coast and specifically entry into tide gated habitats. Additionally, there is a wide opportunity to more fully understand juvenile coho use of floodplain habitats that are upstream of tidally influenced segments of river.

In the Coquille Basin, the life-history of juvenile coho exhibits a pattern where roughly 40% of the parr/pre-smolts (based on estimates of ODFW, Unpublished file data 2023) will migrate from natal headwaters down to the tidal and nontidal floodplain habitats of the river valley to rear from January-May. This pattern is similar to the life-history of spring Chinook in the Columbia River system (Jonasson et al. 2013, Keefe et al. 1995). Coquille coho seek off-channel rearing locations (ODFW Unpublished 2017; Anthony et. al 2022) to escape higher velocity, often turbid, mainstem river flows and lower quantity food item habitats in winter months. Estimates derived from back calculation of surveyed adult returns and Oregon Coast (OC) coho Smolt to Adult (SAR's) rate averages from ODFW Life-Cycle Monitoring sites from 2000-2022 suggest a range of 80,000-500,000 smolts may be migrating from the Coquille annually. This abridged estimation, dependent on in-basin production factors (precipitation, drought, summer temperatures, land use effects), suggests that large numbers of parr/pre-smolt coho are seeking overwinter habitats within the tidal and nontidal floodplain habitats.

Furthermore, James et al (2023) and Quinn and Peterson (1996) evaluation of juvenile coho life-history illuminated that smolt ocean survival was correlated to smolt body size and condition. ODFW unpublished data and Anthony et al. 2022 indicate that juvenile coho growth rates in freshwater tidal wetlands are capable of 150% of the growth rate of fish with a more riverine life-history. Nickelson (2012), estimated that the loss of nontidal and tidal wetland habitats and decreased access to these habitats were a large causation for coho declines since 1880. His analysis, calculated based on 16 studies, determined that wetland channel habitats could produce 180-270 smolts/acre or 11-17 adults per acre of restored wetland with typical OC coho SAR (Smolt to Adult) survival rates. There continues to be a strong need to more fully understand how restoration projects incorporating technologically advanced tide gate infrastructure can increase late fall, winter and spring access to tidal floodplains for the coho and Chinook parr and pre-smolts who are seeking these habitats. Projects that provide for improved access are considered to induce strong beneficial effects for the recovery of the Oregon Coast coho population.

Since 1890, the systematic installation of 133 tide gates in the estuary of the Coquille River Basin has facilitated the draining of >12,000 acres of tidal floodplain forest followed by clearing, conversion to pastureland, and filling of most larger tidal channels. Initial tide gates consisted of heavy top-hinged wooden doors and were installed on wooden culverts. As time progressed the culverts were constructed of steel and are now constructed of corrugated metal pipe (CMP) and high-density polyethylene (HDPE) with wooden, steel, or rubber top-hinged doors. These top-hinged gates are driven by gravitational head pressure differential exerted on the gate door. Top-hinged gates rarely open greater than 20° in angle, with only single direction outflow, most often at high velocity for fish attempting to enter, followed by immediate closing when upstream and downstream water levels reach equilibrium. During the rising limb of the tide, when downstream head pressure elevation exceeds the upstream elevation, the tide gate doors remain strongly closed. The resultant condition is that fish passage into critically important wetland habitats is at best difficult but often impossible.

Several investigations (Bass 2010; Souder 2007; Giannico and Souder 2005 and Green et al. 2012) have shown that traditional tide gates without Muted Tidal capability and associated Water Management Plans (WMP) can have substantive effects on hydrology, restrict or delay fish passage, incur effects to water chemistry, and alter the ecology of the ecotone between the receiving water and tidal channel network. Wright et al. 2016 found that brown trout required 600% more time to pass through a tide gate reach compared to reference segments of stream. Of the 128 tide gates in the Coquille basin, 129 remain old style top-hinged structures. Winter Lake (new 2017), Seestrom (new 2019), Cochran (new 2017), the Soil and Water Conservation District (SWCD) shepherded North Bank Working Lands tidal restoration project (2023) at River Mile 7.5, (Note: the Project does not monitor fish use of the SWCD North Bank Working Lands project completed in 2023) and Coaledo (new 2024, post-reporting period) are the sum of tide gates that have Muted Tidal Regulator (MTR) technology that enables adaptive water management by holding the tide gate open to allow for tidal inflow. The existing Coaledo tide gate has three 6.0ft CMP's that are heavily and actively deteriorating. Tidal inflow is moving through voids in the culvert overfill or through rusted sections of the existing culverts, as is visible during higher tides. However, our monitoring shows that large numbers of juvenile coho are moving from the mainstem Coquille River, upstream into Beaver Slough, navigating through the Coaledo gates and subsequently being captured upstream at the Beaver Slough trap site. It is thought that the primary route of passage is through those voids. This structure is scheduled to be replaced in 2024 after the sampling season associated with this report. The structure will house three 8.0ft (h) x 10ft (w) concrete box culverts and associated new MTR infrastructure. The new tide gate will permit water levels as defined in the WMP resulting in partially restored fish passage that is more similar to historical conditions with regular tidal passage windows.

Tide gate technology and WMPs have evolved substantively in the past 20 yrs with the hopes of improving fish passage while maintaining the ability to keep pastureland dry. Muted Tidal Regulator devices now allow for controlled tidal inflow into channel and floodplain habitats to a set elevation level, with levels being adjusted seasonally. For example, pasture grazing operations are dependent on dewatering of these floodplains following increasing day length and temperatures in May and June to promote grass growth therefore late spring water levels reflect this in the WMP. Conflictingly, the life-history of juvenile coho and fall Chinook in the Coquille Basin is currently linked to use of tidal floodplain networks during similar timing, in the winter and spring (coho) and late spring (Chinook). This same period is when yearling coho are smolting and migrating to the ocean while Fall Chinook linger into June until increasing temperatures exclude them from tidal channels. The new technologically advanced tide gates with MTR's can allow for tidal inflow to a set level with greatly increased fish passage during critical fish use periods, while maintaining sufficient pasture grass protections. Monitoring for fish use in these "Working Lands" projects, where traditional wetland pasture grazing use is anticipated to continue in perpetuity is critical for understanding 1). How the updated tide gate infrastructure and technology improve access for native fish to remaining and restored tidal floodplain habitats; 2). How management strategies of tide gate infrastructure can be used to provide this access; and 3). How Water Management Plan parameters affect the fish use of the floodplain.

There are a number of habitat attributes that affect fish movements into wetland channels and duration of use, including, but not limited to: channel depth (invert), design of channel morphology, and wetland hydrological features within tidal channel networks. It has been identified for example, that juvenile coho entry onto floodplain pastures is facilitated by channel networks serving those areas with a minimum depth of ~1.5ft of standing water on floodplain pastures with coho leaving flooded pastures as water levels recede below ~1.5ft in depth. Monitoring is critically needed to more fully understand a number of these relationships in addition to fish passage into and from tide gated channel networks.

3. Project Area and Overview

The Lower Coquille Tide Gate and Fish Passage Monitoring (LCM) study area focuses on the Lower Coquille River (Coquille Estuary) in the Coquille watershed. The Coquille watershed encompasses approximately 1,000 sq. mi. predominately located in Coos County, OR. The Coquille watershed is the largest watershed to originate from the Coast Range and has the second longest tidally influenced estuary on the Oregon Coast at 41 miles. The Coquille Estuary has the potential to provide high quality winter and spring rearing habitat for juvenile coho, Chinook, steelhead, and Pacific lamprey in addition to many other species of fish and wildlife. Predominate land uses in the Coquille Estuary include private and public forested lands, agriculture, and urban areas.

The beginning of a significant ecological uplift to winter and spring salmonid rearing habitat in the Coquille Valley began in 2017 with four working lands tide gate upgrade and habitat restoration projects (Figure 1). *(Note: the Project does not monitor fish use of the SWCD North Bank Working Lands project completed in 2023).* Traditional lumber, steel, rough cut lumber, and plywood tide gates were nearly all top-hinged heavy designs. Gate door openness times were limited and angle of door opening most often reflected outflow head pressures, which rarely developed more than 20˚ gate door angle of openness. Generally, the gravitational pull on the heavy doors pushed down against water outflow resulting in high outflow velocities and poor fish passage. This was combined with no ability to allow for tidal inflow. As a result, fish passage into tidal habitats was restricted to inadequate conditions on drain out cycles at low tide. All three of the monitored tide gate upgrades encompass technological advancements that enhance fish passage relative to traditional top-hinge gates. Specifically, two of the sites (Seestrom and Cochran) incorporate a fully mechanical Muted Tidal Regulator (MTR), a device that allows for tidal inflow with the level set to a desired water elevation, whereupon the door closes. A third site (Winter Lake) incorporates electrically operated slide gates, which allows for fine-tuned gate door adjustments to provide for fish passage and water management. The Winter Lake structure has also included duplicate side-hinged aluminum tide gate doors hung on three of the seven vertical slide gates (one Unit 1, Unit 2, and Unit 3 respectively). Side-hinged gates open with very limited head differential and open to an angle of around 80˚. These combined advanced technologies allow for greater capacity of fish movement, since the duration and angle of door opening is substantially increased compared to the replaced structures. Furthermore, all three projects included habitat restoration actions that enhanced habitat connectivity to wetlands and productivity upstream of the new tide gates whether that be on the ODFW Coquille Valley Wildlife Management Area or on working ranch parcels. All Restoration consisted of newly constructed stream channels, riparian plantings and livestock exclusion fencing. A fourth tide gate upgrade project, Coaledo Tide Gate & Fish Passage Project, is scheduled to be completed in the summer of 2024. This tide gate services Beaver Creek and Beaver Slough and has been used, to this date, as a reference site.

The first tide gate upgrade and habitat restoration project, completed in 2017, the Cochran project is at River Mile (RM) 13.5. Cochran is relatively small in size with respect to both tide gate upgrade and habitat restoration; a 6.0' diameter culvert and side-hinged tide gate was installed with MTR technology and 3,500' of tidal channel was created, Figure 2. The second project, Winter Lake Restoration, located at RM 20.4 was completed in 2018 and is unprecedented in size and complexity on the Oregon Coast. A structure containing seven new 8'x10' concrete box culverts and aluminum vertical slide style, electrically driven tide gates replaced the three failing old style vertical hinged wooden tide gates, Figure 3 - 4. The seven tide gates drain 1,761 acres and a berm network separates the floodplain into 3 hydrologically independent units up to elevation 6.5ft (Figure 1). Agriculture is the management focus of two units (Units 1 and 3; Figure 1) while fish and wildlife habitat is the management focus of Unit 2 owned mostly by ODFW. Construction developed 6.3 miles of new channel that was connected to historically present networks resulting in a total of 8.1 miles of channel. In addition, five tidal depressions, creating additional fish rearing area, were constructed in Unit 2 and are connected with new channels. The third project, Seestrom Tidelands Restoration (Seestrom), is a moderate-sized project completed in the summer of 2019 located at RM 14.3. The upgraded side-hinged MTR aluminum side-hinged tide gate drains 135 acres of land, which includes 11,500' of newly constructed tidal channel and 1.4 acres of tidal depressions, Figure 5).

The above three restoration projects are the core LCM restoration sites in the study. There are four other linked fish sampling locations in the study. The fourth sampling site, Beaver Slough (also referred to as Beaver Creek), is the reference site for LCM. Although Beaver Slough contains a tide gate, it is an old top-hinged wooden, leaky structure. There is a relatively, high degree of fish passage at this tide gate that apparently is facilitated by either an eroded pathway through the earthen fill surrounding the three corrugated metal 6.0ft culverts or rust degradation of the pipes. The relatively high density of juvenile coho captured upstream reflects the numbers of coho moving from downstream to upstream through the site. As discussed above, this tide gate is scheduled to be replaced in 2024 after the reporting period of this project. The fifth sampling area encompasses the reaches of the mainstem of the Coquille River upstream of the LCM sites to the head of tide at RM 41.0. The Coquille River reach tagging is important as it provides: 1) The opportunity to illuminate if coho juveniles migrating downstream are moving into only an individual wetland where the team captured them or multiple wetlands, and 2) the capture of riverine reared fish exhibiting differing body conditions prior to entering floodplain tidal wetlands. During the second year of monitoring a sixth sampling site was added to the project, Laverne Park, situated in the headwaters of the East Fork of the Coquille River. This site was added to increase the number of tagged juvenile coho in the Coquille River due to the difficulties of capturing sufficient numbers of coho in the mainstem Coquille River. To even further increase the number of tagged juvenile coho in the Coquille River, tagged coho were transferred from Beaver Slough to the mainstem Coquille River at Myrtle Point (Figure 1, RM 37.5). In 2024, during year 4, floodplain sampling upstream of RM 41.0 was introduced to further increase the number of tagged juvenile coho in the system. These additional sampling sites lead to a substantive expansion of knowledge pertaining to coho use of off-channel habitat. Sampling in those floodplain wetlands was supported by the annual hydrologic variability of the 2023-2024 winter where relatively long-duration floodwaters were retained on up to several hundred acres of pastureland at ~RM 6.6 the NF and RM 1.2 upstream of the NF on the EF Coquille River floodplain. High numbers of juvenile coho were found to be using these locations.

The additional funding to extend this project to 6 years in length also allowed the physical expansion of the project to include a non-tide gated site low in the estuary and a new partnership with the USFWS Bandon Marsh National Wildlife Refuge. The Bandon Marsh site is at the outflow of Fahy Creek tidal channel within the Ni-les'tun Unit (Ni-les'tun as named by the Coquille Indian Tribe means "small fish dam in the river" reflecting historical use by native peoples for fishing). The site has been affected by Pacific Plate tectonics twelve times in the last 6,700yrs. In 1700 the most recent earthquake lowered the marsh plane at least one-half foot. The Ni-les'tun Unit was diked, tide gated, and drained in the late 1800's or early 1900's by Euro-settlers seeking to increase pasturelands. The site was purchased by the USFWS in the early 2000's. Restoration of the 408 acre former dairy pastureland was initiated in 2009 and fully completed in 2015. Over one mile of dike and three tide gates were removed and just over five miles of tidal channel were installed. In Phase II (2014-2015) another 20 miles of much smaller width channel network was installed. The site is currently fully tidal without obstruction. The outflow channel where the PIT tag monitoring occurs is roughly 45ft in width and several hundred meters upstream from the confluence of the Coquille River. Although the installation occurred in summer of 2023 there was extensive troubleshooting to get the system functional. The troubleshooting was a long arduous process that was exasperated by working around the tide schedule and other field duties. Unfortunately, the antenna was not functional until the summer of 2024 therefore results will be incorporated into the fifth year's report.

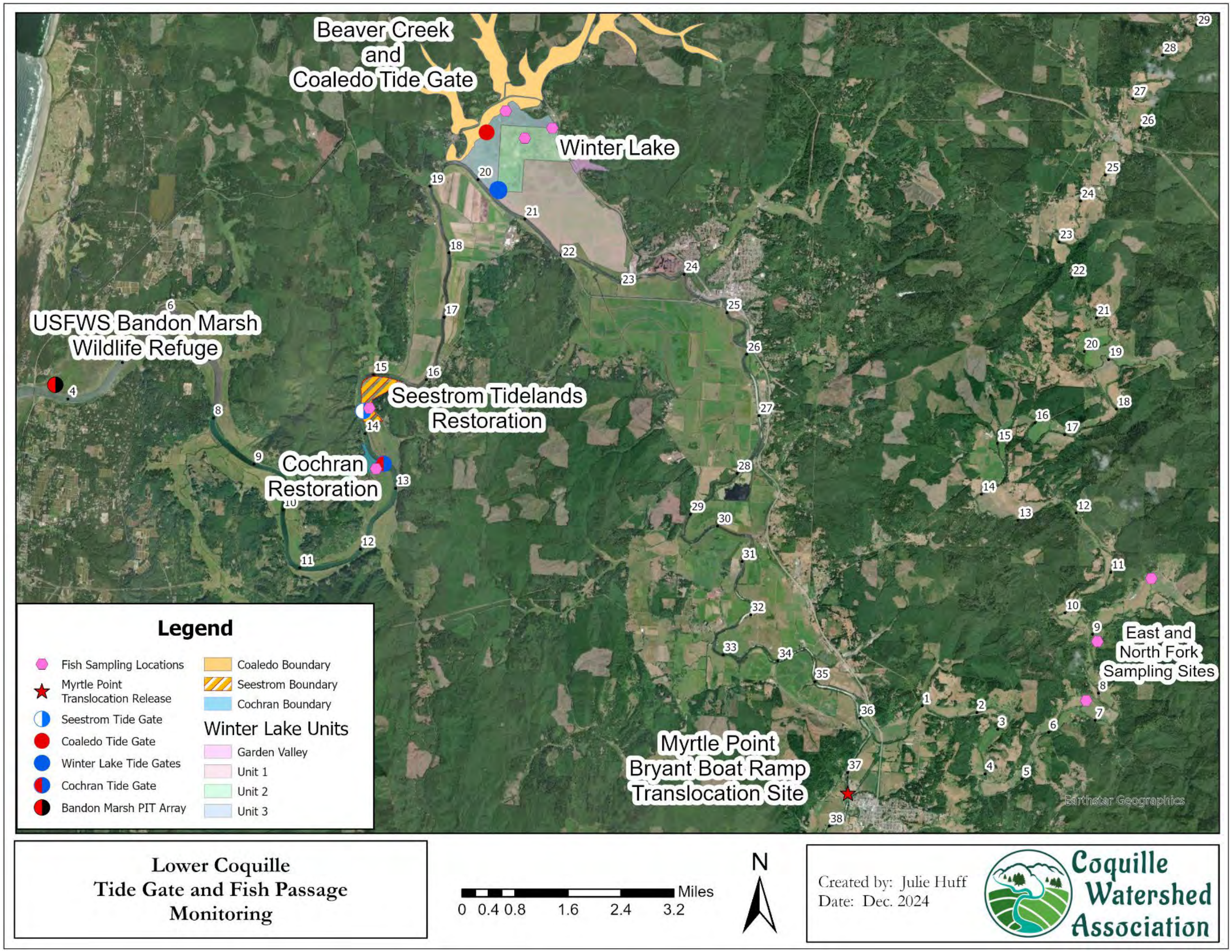

Figure 1. Lower Coquille Tide Gate and Fish Passage Monitoring location map.

Figure 2. A 6' diameter aluminum side-hinged MTR tide gate was installed at the Cochran project in 2017. The tide gate door is installed on the riverside of the culvert.

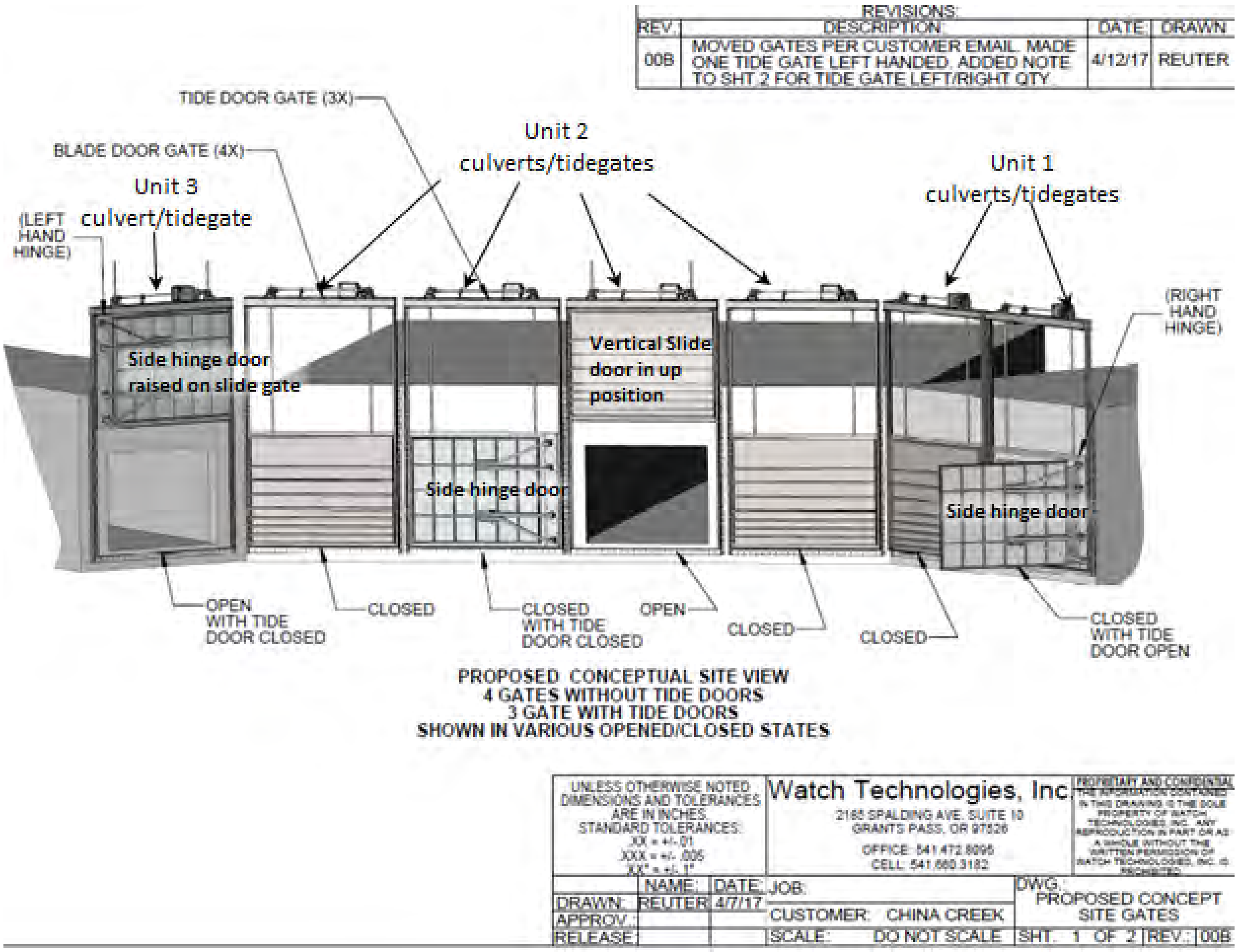

Figure 3. Winter Lake Project tide gate construction design drawing for box culverts and tide gates. Each Unit has one side-hinged tide gate door. Drawing depicts the river-side view of the tide gate structure.

Figure 4. Aerial view of the landward side of the Winter Lake tide gate structures during construction phase.

Figure 5. An 8'x8' aluminum side-hinged MTR tide gate was installed at the Seestrom project in 2019. The landward side of the MTR structure uses a counter weight to keep the tide gate door open during rising tides (left photo). The tide gate door is installed on the riverside of the concrete culvert (photo right).

4. Monitoring Questions

This monitoring project was designed to examine the effectiveness of several tide gate replacement projects at meeting their objectives and to assess how the collective uplift provided by these projects can promote recovery of coho salmon within the Oregon Coast Coho Salmon Evolutionarily Significant Unit. The primary goals for the project include improving understanding of juvenile coho use of tidal floodplains, understanding coho salmon response to the sizes, design, and operation of new tide gates and overall use of the restored habitats. The monitoring is intended to inform adaptive management of the sites while providing information to help improve effectiveness of future tide gate replacements and tidal habitat enhancement projects. To these ends, fish monitoring is focused on several questions related to the condition, growth, survival, and movement of juvenile coho salmon in off-channel tidally influenced habitats following tide gate replacement.

Condition

- Is overall body condition of juvenile coho reared in the tide gate project areas greater than riverine-reared coho?

Growth

- Are growth rates of juvenile coho reared in tide gate project areas greater than riverine-reared coho? Does overall size of restored habitat affect growth rate?

Survival

- Does survival increase for juvenile coho residing in tide gate projects compared to riverine-reared coho? Does survival vary with overall size of restored habitat?

Abundance & Density

- Are rearing densities dependent on overall size of restored habitat behind an upgraded tide gate?

Movement & Passage

- What is the residence time of juvenile coho in floodplain habitats upstream of redesigned, technologically advanced tide gates? Does residence time vary with overall size of restored habitat?
- What percentage of juvenile coho residing in the Coquille Estuary enter the restored project areas?
- Do juvenile coho enter more than one wetland restoration area during winter/spring downstream movements prior to entering the ocean?
- What are the water level and tide gate door operation preferences of juvenile coho for movement through tide gates?

5. Methods

The LCM program relies on Passive Integrated Transponder (PIT) technology and an expansive fish sampling effort to track juvenile coho throughout the freshwater estuary. The installation and operation of PIT antenna arrays are at the core of this study as they allow greater resolution of juvenile coho movement in both space and time due to the ability of PIT tagged fish to be individually identified. The arrays are attached directly to the landward (upstream) side of the tide gate culvert (Figure 6) whereas the tide gate door is installed on the river (downstream) side of the tide gate culvert. Each antenna has been designed with site-specific nuances in mind, some are of the pass thru style where fish swim through the antenna and some are of the pass over style where the fish swim over the antenna. The 2020 Winter Lake PIT pass thru antennas are 8ft wide x 4ft double rectangle, fiberglass tubing (2"x5") with the active wiring inside. These were mounted in Unit 1 (door 1B only of two doors in Unit 1), Unit 2 (doors 2B and 2C of four doors in Unit 2), with a single antenna on Unit 3 where there is only a single concrete box culvert. These double loop rectangle antennas were mounted in Units 1, 2, and 3 ~50ft upstream from tide gate doors on the upstream entrance of concrete box culverts. Single sail style antennas were originally installed upstream of Unit 1, 2, and 3 rectangle antennas. These sail antennas were installed with the hope they would assist with providing directionality for fish movements and additional detections. Unfortunately, the sail antennas have all since failed from the time of installation. Furthermore, the rectangular pass thru antennas of Unit 2 failed and were replaced in March 2022 with antenna wire housed in PEX pipe that were secured to the old rectangular pass thru antennas. At Seestrom, there is a single concrete box culvert with a double rectangle fiberglass tubing pass thru antenna (2020). At the Cochran site, there is a pass thru antenna constructed of a double loop of pex pipe around the end of the 6ft culvert pipe (2020). In Beaver Slough, there is a double loop pass over antenna within pex pipe anchored to the Beaver Slough channel ~150ft upstream of the Coaledo tide gate and two pass thru antennas attached to existing pilings ~100ft upstream of the tide gate on the westerly tributary (2021), (Figure 7). At Ni-les'tun five pass over antennas, constructed of pex pipe, were anchored to the main Fahy tidal channel ~200yds upstream from the confluence with the Coquille River (June 2024). As PIT antenna design and durability technology has advanced and with destruction of the Unit 1 antenna in winter of 2023, the Team has now moved to a new double blade antenna design at Winter Lake, installed in October of 2023 (Figure 8). In Unit 2, twin blade antennas were installed inside the concrete box culvert on the upstream end, about ~40' from the tide gate doors in bays 2B and 2C. In Unit 3, a single blade antenna was installed one foot upstream of the tide gate doors and will augment the original functioning double rectangle fiberglass encased antenna on the upstream of the concrete box culvert, 50ft from the tide gate. Due to funding constraints, the Team has mounted a single blade antenna in Unit 1. Antennas at Seestrom, Cochran, and the Coaledo site have remained fully functional as there are lower hydrologic forces and no changes to PIT antenna arrays have been made.

The tide gate culverts range in length from 50 feet at Winter Lake to 24 feet at Seestrom. PIT detections will denote when a juvenile coho is moving throughout the estuary but it will also identify approximately when passage of the tide gate has occurred. Prior to the third sampling season a total of 8 PIT antenna arrays have been installed; 4 on the Winter Lake tide gates, one on each of the Seestrom and Cochran tide gates and 2 on Beaver Slough 200 ft upstream of the tide gate. The PIT antennas are operated continuously throughout the 5-year project[2].

Figure 6. Winter Lake Unit 2 PIT antenna array on tide gate culvert 2B and 2C. The pass thru (gray fiberglass structure) and sail (white sail in water) antenna are installed on the landward (upstream) side of the tide gate culvert whereas the tide gate doors are installed on the river (downstream) side of the tide gate culvert.

[2] During the fourth year of monitoring there were multiple instances of PIT array outages or extremely poor detection efficiencies. A table of operating dates during the 2023-24 sampling season can be found in Appendix A.

Figure 7. Double pass thru antennas installed on existing pilings of the westerly channel of Beaver Slough 100' above the tide gate.

Figure 8. New blade style antennas installed on Gates 2B and 2C of Winter Lake Unit 2 in October of 2023.

A. *Fish Sampling*

The LCM fish sampling occurs behind the tide gates in the restored habitat of all project sites and in the mainstem Coquille River. The main objective for fish sampling in the restored habitat behind the tide gates is to get data on species abundance, growth estimates and site density and residence times. The fish sampling season at project sites begins in December and runs through until water temperatures rise above 18℃ in May. A minimum of 6 sampling events will happen each season at Cochran and Seestrom with 10 events at each site in the 2022-2023 season. Weekly fish sampling occurs at Beaver Slough and was proposed for Winter Lake Unit 2 but high water levels in Unit 2 caused inefficient trapping events. Therefore, Winter Lake Unit 2 tactics were altered and sampling events occur at dawn and dusk during peak abundance (as determined by coho caught at Beaver Slough) typically in March and April. With sampling not occurring in Winter Lake Unit 2 until mid-season there are low numbers of tagged coho on site. To counteract this, tagged coho were translocated from Beaver Slough to Winter Lake Unit 2 throughout the season.

The main objective for fish sampling in the mainstem Coquille River is to collect data on body condition of riverine reared coho for comparison with fish that have been rearing and captured within wetland habitats. It is important to note that all sampled wetland sites, with the exception of Beaver Creek, do not have juveniles produced from tributaries within the individual wetland land areas. Furthermore, there is spawning of adults in Beaver Creek but it is limited. Accordingly, coho captured upstream of tide gates are all or predominantly all juvenile coho that entered from the mainstem Coquille River. Capture of coho within the mainstem Coquille was developed as a tactic to determine how many coho migrating down the Coquille River enter tide gated sites. It was proposed to beach seine the mainstem river throughout December and April, but the 2021 and 2022 effort produced low numbers of captured coho. In order to achieve tagging targets, juvenile coho may be captured a) in the Coquille River downstream from the tide gate structures and translocated upstream for release post-tagging, b) in the headwaters or mid-river, higher up in the watershed (East Fork, North Fork, Laverne Park) or c) in Beaver Slough and translocated upstream for release post-tagging.

The primary method of capture for fish at Seestrom, Cochran and Beaver Slough are three or four foot diameter nylon hoop traps (Figure 9) with 25ft or 30ft fyke style leads. Traps were set using land or boat based methods in the thalweg of new and previously existing channels or canals with leads staked to both banks. Traps were mostly installed in sets of two. At Winter Lake, hoop traps were inefficient at capturing coho due to deeper channels allowing the coho to easily swim over the traps (Figure 10). Through trial and error, beach seining at dusk or dawn was deemed the most successful capture method and was utilized at Winter Lake in spring of 2022 through 2024 (Figure 11). Sampling in the mainstem Coquille River is accomplished using an 18.5ft North River boat and 126ft beach seine while a small hand seine (6ft in height x 25ft in length) is used while wading in the small streams of the headwaters.

Ideally, fish sampling locations would be randomly selected throughout the entire project area. However, the specific monitoring questions involve to a substantive degree, the determination of fish moving from outside of a tide gated area through infrastructure into a rearing site, the time spent within that site, benefits of rearing within the site, and identification of return to the river through tide gate infrastructure. Thus, direct capture of fish within specific land areas was of utmost importance versus randomly on the landscape. The Coquille River floodplain habitats are nuanced and winter access to trapping locations is often extremely limited. Resultantly, a lot of consideration on capture sites and effective tactics has been implemented with the project. Water levels can increase up to 10ft overnight with heavy rain. Protection of fish from trap laydown mortality and the ineffectiveness of some tactics (seining) when the valley floor is fully flooded has dictated that capture sites be fishable at the greatest number of days possible and with special consideration to fish well-being (velocities within trapping locations can increase mortality risk). Each site has been chosen with specific criteria including: 1) the ability of the trap site to represent the habitat area in the immediate and general vicinity. The ability of known equipment to capture fish repeatedly throughout the sampling season. 3) The capacity to limit mortality of fish due to lay down or detachment of traps or high water levels preventing recovery of traps. 4) The capacity to conduct trapping and seining operations safely. For these reasons, sampling locations were mostly stationary. At Seestrom, Cochran, Winter Lake Unit 3 and Beaver Slough sampling sites were constant throughout the season (Figure 12 - 13). When seining methods are used at Winter Lake, there are only a few locations able to be sampled due to access and riparian forest vegetation, due to dry ground and riparian vegetation, are limited to just a few locations (Figure 12). Likewise, seining locations in the mainstem Coquille River are limited to locations where water levels, tide cycles and sandy bank exposure are available on the date of effort; therefore, each seining event is unique.

Although juvenile coho are the target species for monitoring, all fish species, native and non-native, are counted and recorded. The captured juvenile coho are weighed to the nearest 0.1g and measured fork length to the nearest 1.0mm. A sample of juvenile coho captured (measuring over 70mm) were tagged with Passive Integrated Transponders (PIT tagged) during trapping events, with the total number tagged varying as a subset of the number captured during each trapping event. Records of each individual PIT tagged coho were kept to ensure analysis accounted for the transfer of fish from Beaver Slough to both Winter Lake Unit 2 and the Coquille River at Myrtle Point. In addition, body condition including parasite loading and PIT data was recorded for individual tagged fish in a digital form on Survey123. Length, weight, and overall body condition was also noted for lamprey and salmonids other than coho. All coho were scanned with a Biomark HPR Plus or Lite hand held PIT tag reader in order to detect recaptured fish that had been tagged during a trapping event on a previous day. Recaptures were measured, weighed and recorded in Survey123 for further analysis of body condition changes and mobility from where they were originally tagged. PIT tag data was scanned directly into Survey123 using a field tablet and the BluePiano app[3].

Often in Unit 2 of Winter Lake water levels exceed the elevation where trapping or seining can occur. As an additional measure of monitoring, general abundance of juvenile coho has been documented on an intermittent basis by use of visual surveys of coho surface feeding in tidal ponds and on pasture areas when water is sufficiently deep (>1.5ft). Juvenile coho presence as indicated by feeding in floodplain pasture areas which generally initiates when water depth reaches 1.5ft and fish overcome instinctive resistance to leaving channel networks where water depths are more conducive to predator avoidance. In the winter and early spring it has been observed that juvenile coho are exclusively the only fish that are regularly surface feeding. This behavioral trait has been used as a framework for surveys, as few, if any, other species are observed in this manner. A low level of visual surveys were randomly conducted in 2020-21, 2021-22 and 2022-23 coinciding with the Chironomid midge hatch in March and April which provides surface water food. In addition, surveys were dependent on ODFW staff time and water levels that allowed foot access on dikes. The data is considered a loose measure of coho presence and general abundance. This information was not reported in 2020-21 and 2021-22.

[3] Instructions on how to replicate this can be found at the 35 minute mark of the PNAMP ETIS Webinar from 2021.

Figure 9. A 4' hoop trap with 25ft leads installed at the Cochran site. Hoop traps were used at most sampling sites in the 2020-21 field season (left) but only at Cochran, Seestrom and Beaver Slough in the following seasons.

Figure 10. High water levels at Winter Lake decreased trapping efficiencies when using the hoop traps due to juvenile coho swimming overtop the traps. The left photo shows Ivy Metzgus (CoqWA) and Morgan Davies (ODFW) in knee-deep water on the bank next to a sampling location during the 2021-22 sampling season. The right photo shows a marker buoy (circled in red) where the hoop trap leads are staked into the ground.

Figure 11. Dawn and dusk beach seining replaced hoop traps as the primary method of capturing juvenile coho at Winter Lake in the spring of 2022, 2023 and 2024.

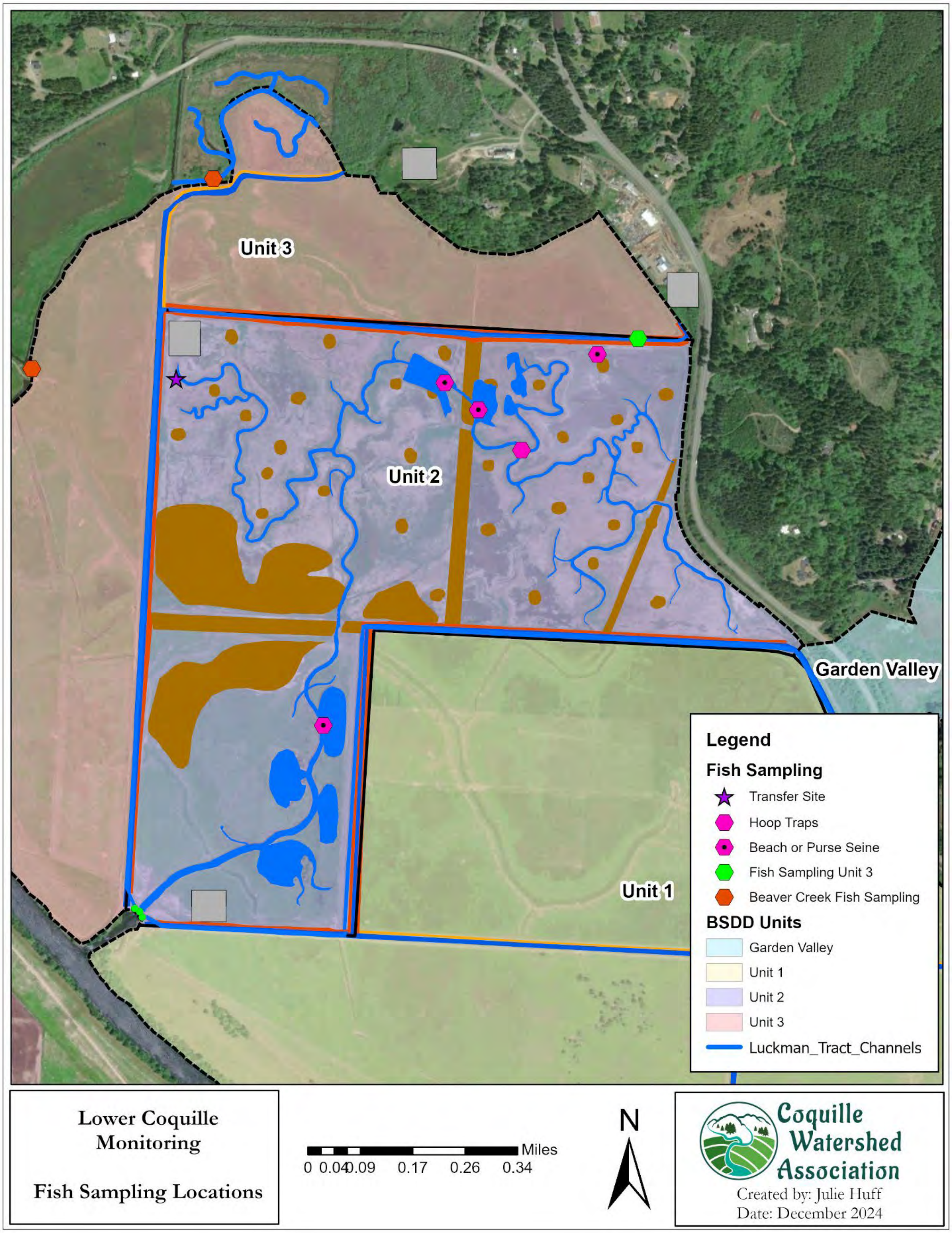

Figure 12. Sampling locations for the LCM site Winter Lake and Beaver Creek (Slough). Fish sampling in Unit 3 is a light pink hexagon, sampling in Beaver Slough is an orange hexagon and both stayed constant throughout the season. Fish sampling in Unit 2 are dark pink hexagons with the solid pink hexagon denoting hoop trap sites and the pink hexagon with a black dot denotes beach or purse seining sites. Due to the difficulties with sampling in the deep water of Unit 2, locations were chosen that had slightly higher ground.

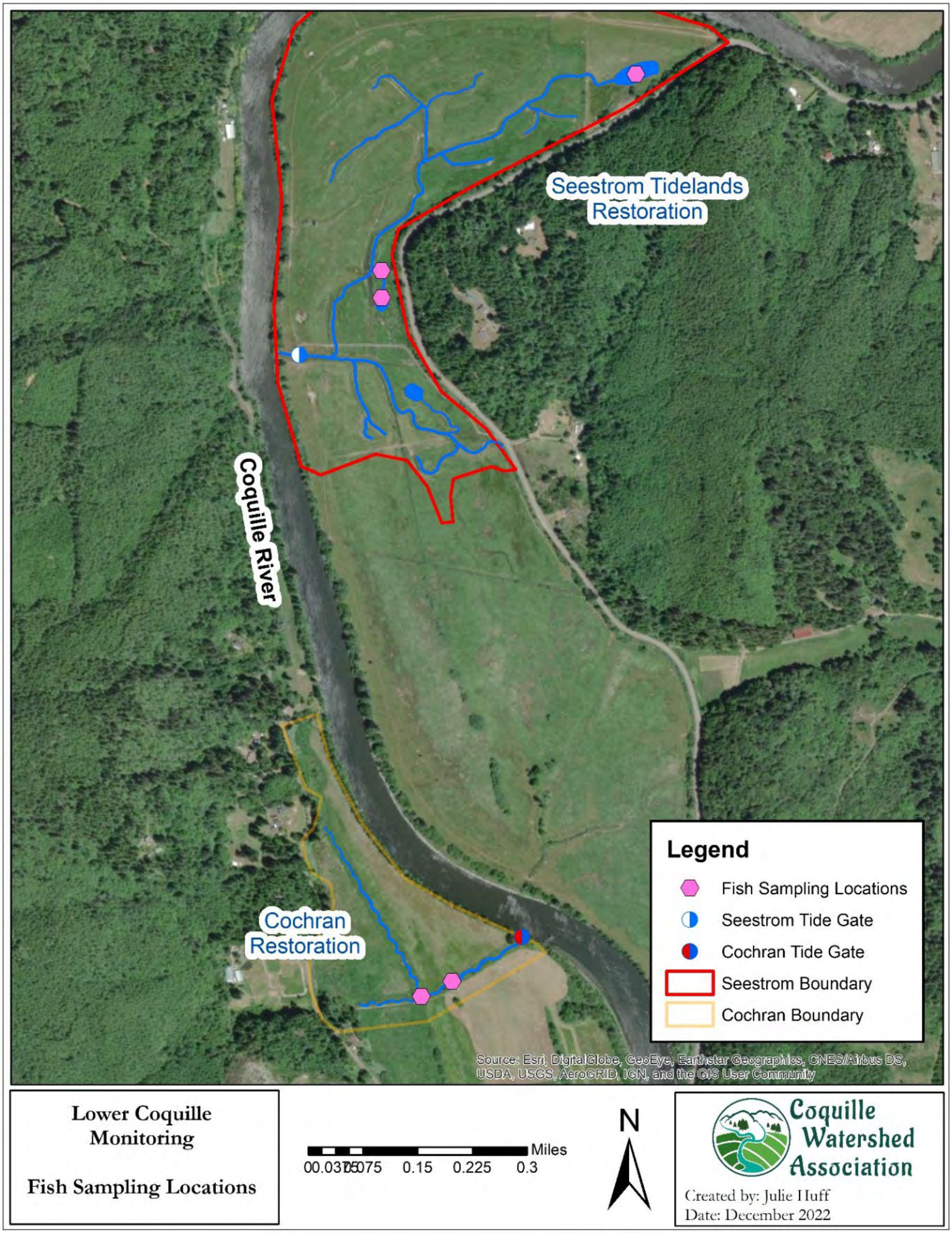

Figure 13. Sampling locations for LCM sites Seestrom and Cochran. At both locations, hoop traps were used throughout the season except near the end of the sampling season when a beach seine was used.

B. *Mid-River Basin Life History*

A proportion of juvenile coho in the Coquille River basin initiate mobilization from natal summer rearing areas migrating to downstream overwinter locations in the Coquille River basin in approximately early November. This downstream movement likely is in pulses with flow events, however, the exact pattern is not fully studied, but, is known to continue throughout the subsequent winter months. Knowledge of this pattern is based partially on multiple years of sampling in the Winter Lake area from early November to May by ODFW originally and now CoqWA/ODFW. The Cochran site outflow enters the Coquille River at RM 15.0, Seestrom at RM 15.5, Beaver Creek, at RM 19.5, and Winter Lake at RM 20.5. The NF Coquille River enters the SF at RM 36.3 to form the mainstem. The NF and EF Coquille Rivers conjoin at NF RM 9.1, which is a total of 45.4 river miles upstream from the Pacific Ocean at Bandon, OR.

On December 2nd and 3rd 2023 there were a large rain events in the Coquille Basin as reflected by the NF Coquille River U.S. Geological Survey Guage ##14327000 located at RM 3.8 (Figure 1). This resulted in a large extrusion of water into floodplain habitats of the NF, EF, and to a lesser degree lower SF Coquille River. The Project Team recognized that this flooding event made habitats available in floodplain where pastures developed ponded water areas deeper than1.5ft. Monitoring of juvenile coho through various efforts over the past 10yrs in the Coquille Basin, by ODFW staff has determined that pasture ponded water areas reaching or exceeding >1.5ft in depth facilitate use for rearing/feeding.

A number of these off-channel floodplain swales were noted during visual surveys by road, to have outflow channel connections for juvenile fish to enter from the Coquille River, primarily in the NF and EF Coquille River subbasins. LiDAR modeling evaluation was completed and further demarcated numerous floodplain locations that although previously known to exist, had not been evaluated on their potential to provide rearing habitat (Figure 2). In January-April of 2024 repeated relatively regular interval rainfall events resulted in subsequent recharge of floodplain habitat swale areas. LiDAR modeling denoted that outflow channels from pasture swales are currently in predominantly channelized pathways. Despite altered alignment since pre-colonial settlement, topographic assessment revealed that outflow channels at most locations provided fish access to internal lower elevation pasture swale locations at a much lower elevation than riverbank overflow elevation. In most cases 7-10ft lower.

The LCM Team implemented sampling with seining methods at a RM 1.2 EF Coquille River floodplain swale on January 23, 2024 and another on the NF Coquille River thereafter at NF RM 6.6 (Figure 2). Fish captured were assessed to species, measured, weighed and PIT tagged if over ~70mm. Another site on the SF Coquille River floodplain 1.2 east of Myrtle Point was also seined for capture of fish and PIT tagging.

6. Analytical Approach

A. *Site Parameters*

As part of the study, it is important to obtain information on water clarity, temperature, and water levels. Tide gate door management is just one of the factors that influence juvenile coho residence and movement throughout the estuary and affect these parameters due to the quantity of water exchanged. The site specific Water Management Plans specify interior water levels and tidal exchange of water at each site and are dependent on not only the tide gate operations, but also tidal and precipitation cycles, which in turn affect water quantity and quality factors. We monitored these influential site parameters such as temperature, conductivity and water level at all of the sites the first two years but have ceased measuring conductivity due to the freshwater nature of the sites. Velocity meters are installed at Winter Lake but, unfortunately, only Unit 2 was functioning during the sampling season.

A suite of Onset aquatic data loggers were used for monitoring the site parameters, specifically, U22 Pro v2 temperature loggers and U20 water level loggers. Each logger was set to 15-minute intervals and followed DEQ procedures for pre and post deployment calibration verifications. Furthermore, the data followed QA/QC standards as described in the Winter Lake Sampling and Analysis Plan approved by DEQ.

B. Species Abundance

Relative abundance of fish species in the four monitoring sites was determined by total individual counts of each species. Due to only seining and no hoop trapping at Winter Lake relative abundance was not fully representative of the monitoring across sites, thus we analyzed data accordingly with acknowledgement of this weakness.

Catch per unit effort (CPUE) was calculated for the Beaver Creek site to assess annual variation of the Coquille smolt population. CPUE was calculated by dividing the total number of coho captured by the soak time (hrs) of the hoop traps.

The Team is investigating methodology for developing numerical quantification of visual surveys. To date no enumerative calculation of juvenile coho observed feeding has been attempted. During the colder water months of the year (November through May), juvenile salmonids, primarily coho, surface feed in the channels, tidal ponds, and open-water pastures (when water depths are >1.5ft) of all sampling sites. Fish are feeding on a variety of flying insects, however, largely Chironomid midge larvae. These hatches can be dense in February, March, and April, however, vary from year to year.

C. Condition

Juvenile coho salmon were measured for length (fork length, mm) and weight (whole-body wet weight, g). A dimensionless body condition index was calculated from length and weight measurements as:

$$K = 10^5 \cdot (W/L^3) \qquad \text{(Eqn. 1)},$$

where K is Fulton's Condition Factor, W is whole-body wet weight (g), L is fork length (mm), and 10^5 is a scaling factor (Ricker 1975).

Weight-Length Relationships (WLR) at each location were assumed to follow:

$$W = aL^b \qquad \text{(Eqn. 2)},$$

where W is whole-body wet weight (g), L is fork length (cm), a is a constant intercept representing initial conditions, and b is the growth coefficient. The constants a and b were fit using least squares regression on the $\log_{10}$ transformed length and weight data as:

$$\log(W) = \log(a) + b \cdot \log(L) \qquad \text{(Eqn. 3)}.$$

WLRs were calculated for each location with sufficient captures (Beaver Slough, Cochran, and Seestrom in 2021-22 and 2022-23) with length and weight data pooled across all sampling dates. Data from sampling sites within locations were aggregated together; sites within locations were not analyzed separately. During the 2021-22 and 2022-23 seasons, WLRs were not calculated for Winter Lake Units 1, 2 and 3 or the mainstem Coquille River due to low or zero captures.

During the 2020-21 season, length, weight, and condition factor data were evaluated for normality using the Shapiro-Wilk normality test (Shapiro & Wilk 1965) and for homogenous error variance using Bartlett's

Test (Bartlett 1937a; 1937b). Logarithmic transformation failed to normalize distributions or to homogenize error variance for all locations in all months, so comparisons among locations were evaluated using the non-parametric one-way Kruskal-Wallis test (Kruskal & Wallis 1952). We continued to use the Kruskall-Wallis test to analyze data in the 2021-22 and 2022-23 seasons. Significant results were followed by Dunn's method for post-hoc pairwise comparisons (Dunn 1964) with Bonferroni-adjusted p-values.[4] Regression coefficients for WLRs were compared using Analysis of Covariance (ANCOVA).

D. Growth

Instantaneous growth rates of recaptured PIT tagged fish were calculated assuming exponential growth as (Busacker et al. 1990):

$g_L = [\mathrm{Log_e}(L_2)\text{-}\mathrm{Log_e}(L_1)]/\Delta t$ (Eqn. 4), and

$g_W = [\mathrm{Log_e}(w_2)\text{-}\mathrm{Log_e}(w_1)]/\Delta t$ (Eqn. 5)

Where:

G_L = Growth Rate (Length), mm·d^{-1}
G_W = Growth Rate (Weight), g·d^{-1}
L_1 = Length at initial capture, mm
L_2 = Length at recapture, mm
w_1 = Weight at initial capture, g
w_2 = Weight at recapture, g
Δt = Time between capture and recapture, days

Specific growth rates, as a daily percent change in weight (G_w) or length (G_L), were calculated as:

$G = 100(e^g\text{-}1)$ (Eqn. 6),

Where e is the base of natural logarithms and g is g_L or g_w for length and weight, respectively (Crane et al. 2019). These calculations were done for single site coho, which were assumed to have been resident at their tagging locations for the duration of their time at large.

Instantaneous growth rates were also calculated as the slope of the linear regression of mean $\log_e$-transformed lengths and weights of captured fish across sampling events. We then calculated specific growth rates using equation 6. This approach assumes that captured fish were residents of their respective capture locations for the duration of the season (December – April). In all sampling seasons to-date, some PIT tagged fish were detected at antenna arrays in locations different than where they were tagged, and locations are not closed to immigration/emigration through the study's seasonal monitoring periods.

Furthermore, variation in growth rates between Coastal Coho migratory life histories provides a qualitative reference for historical productivity as well as current and future habitat restoration (Hall et al 2023, Nickelson 2012). As tidal habitat restoration projects across the region are implemented and become mature, further examination of off channel and tidal habitats productivity between neighboring Basins can inform realized benefits for Coho salmon populations. For this analysis Coho smolts, defined as juveniles

[4] The Bonferroni method is a means of reducing the probability of a Type I error (false positive significant result) when performing multiple comparisons. In this approach, the α threshold for significance is reduced as $\alpha^* = \alpha$ divided by the number of comparisons. The implication is that, for the suite of all comparisons, the significance threshold remains α.

with Fork Length >=89mm, were aggregated by concurrent week of the year across 3 years (2021-23) in three South Coast Basins. Umpqua and Coos data are from 3 LCM Rotary Screw Trap locations: one operated by ODFW in the West Fork Smith River, a tidal tributary to the lower Umpqua and two by Coos Watershed Association in Palouse and Willanch Creeks, both Coos Bay tributaries. Coquille Basin hoop trap sampling was divided into two categories of Location: Valley and Tributary. Valley locations include; Winter Lake Unit 2 with 7 sites and Beaver Creek with 3 sites. Coquille Tributaries includes 2 sites that are Coquille River Valley tributaries Seestrom and Cochran.

E. Survival

Detection of tagged fish at a PIT antenna array reflects the joint probability of survival from tagging to detection and the probability of detection by the antenna array. Fish that are not detected at the antennas may be mortalities or fish that the antennas failed to detect. To separate those two "losses" of tagged fish, we intended to calculate detection efficiency of each antenna in the array as:

$$P_1 = N_1/(N_1+M_1) \qquad \text{(Eqn. 7),}$$

Where P_1 = Detection probability of antenna 1
N_1= Number of fish detected by antenna 1
M_1 = Number of fish missed by antenna 1 (number of fish that were detected at antenna 2 but not at antenna 1)

Equation 7 would also be used to calculate the detection efficiency of both antennas in the array, and the overall detection efficiency of the array, P, would be calculated as:

$$P = 1 - [(1-P_1) \cdot (1-P_2)] \qquad \text{(Eqn. 8).}$$

However, juvenile coho frequently staged near the antenna arrays making it unclear which fish-detection events should be considered fish-passage events (i.e., directional movement rather than milling near the array) for calculation of detection efficiency. To account for this, the antenna signal strength was examined as a marker for detection efficiency. As a rule of thumb, when the signal strength is below 200mV detection efficiency is severely reduced. In the present analysis, actual losses to mortality are not separated from apparent losses that are due to failure of the antenna arrays to detect tagged fish.

F. Movement and Passage Conditions

Assessment of movement and passage conditions is based on single site coho (detected only detected at their tagging location), multi-site coho (detected at locations different from their tagging location, and translocated coho (fish intentionally transferred from their tagging location to a different location). During the 2021-22 and 2022-23 seasons, PIT-tagged juvenile coho were translocated from Beaver Slough into Winter Lake Unit 2 and into the mainstem Coquille River at Bryant Boat Ramp in Myrtle Point, Oregon (~17 river miles upstream from Winter Lake). Translocations from Beaver Slough into Winter Lake Unit 2 continued in the 2023-24 seasons, but no fish were translocated from Beaver Slough into the mainstem Coquille River. However, tagged fish were translocated from off-channel seasonal wetlands into the mainstem Coquille River in 2023-24.

Residence times were assessed as post-tagging or post-arrival residence times at locations with PIT antenna arrays at the tide gates. For single-site coho that were only detected at the location of tagging, the period of residence was calculated as the number of days between tagging and final detection at the tide gates. This calculation of residence time requires the assumption that these fish resided at their location of tagging prior to final detection at the tide gate. This calculation was also used at Winter Lake Unit 2 for fish that were translocated there from Beaver Slough. For fish that were translocated to the mainstem Coquille River and fish that were detected other locations prior to detection at a given antenna array, the period of residence was calculated as the time between the first and last detections at the tide gate antenna array. This calculation requires the assumption that these fish did not leave and re-enter the location undetected between the first and last detections.

Assessment of conditions during passage required several assumptions to align detections at PIT arrays with measurements of potential covariates. First, we considered the time of entry into a location to be the first detection for fish that were previously tagged or detected at a different location. Entrance data are derived from multi-site coho or translocated coho, assuming the fish did not enter locations undetected by the arrays. Second, we considered an exit time from a location to be the last detection at an array, assuming fish did not exit the system undetected and that failure to detect a fish after the last detection was due to exit rather than mortality. Data on exit events are derived from single site coho, multi-site coho, and translocated coho.

In the 2020-21 and 2021-22 seasons, we centered our analytical approach on assessing whether conditions used by tagged juvenile coho salmon to enter or leave off-channel habitats were drawn from the same distribution as the conditions potentially available for use (i.e., when the tide gate doors were open). That is, do juvenile coho salmon non-randomly sub-sample a set of conditions for passage? In the 2022-23 assessment, we adjusted our analysis to include the substantial number of detections that are not classified as entry or exit events. These detections, which reflect transient occurrences or milling behavior, represent most tag detection data, and considering this data allows us to better define potentially available conditions for passage as requiring both the presence of tagged fish near the gates and open gates.

During the 2023-24 season, we did not attempt to differentiate conditions used for entry due to limited detections of mobile or translocated fish. Instead, we focused on timing of all detections relative to three parameters: whether the gate was open, the hour of day, and the change in water level upstream (landward) from the gate. Open gates are required for passage, and previous years' analyses indicated that the hour of the day appears to play an important role in the likelihood that juvenile coho will occur near the gates, with juvenile coho appearing to favor times around dawn and dusk at most sites. There also appeared to be some over-selection of negative rates of upstream (landward) water level change at some sites.

7. Results

A. Site Parameters

Mean daily water temperature for all sites are provided in Figure 14. Similar to previous years, temperatures were similar until March when site temperatures diverged. Conductivity is a good measure for the salinity of water therefore conductivity is monitored throughout the winter and spring months. During both the 2021 and 2022 field seasons salinity stayed within the freshwater range and will not be monitored in future years.The velocity meters at Winter Lake are in operable, therefore no data is available for the 2023-2024 sampling period.

Although all project sites are situated in the Coquille Estuary, the river behaves differently whether high in the estuary at Winter Lake or lower in the estuary at Cochran. The Coquille River upstream of river mile 16.0 is slower to drainout following high water events than below river mile 16.0 due to streambank resistance and a geological feature. For these reasons, the Winter Lake tide gates behave as floodgates during short to moderately long periods in the winter and spring when storms cause the Coquille River to rise significantly and riverbank friction eliminates tidal signal (Figure 15-16). Snowpack contribution to flows also have the effect of lengthening floodwater periods prior to when river levels drop and tidal effects reestablish. Even during typical tidal behavior, the dynamics of the Coquille River are different at each project site (Figure 15). Winter Lake is the site highest in the estuary and has a dampened tidal amplitude with minimal storm events (e.g. May 5) causing the river to rise significantly compared to the Cochran and Seestrom sites. Due to streambank resistance and a large point of bedrock intruding into the mainstem Coquille at Riverton, OR, as noted above, river elevations at low tide are also significantly higher above river mile 16.0 at Winter Lake than Seestrom and Cochran. The water management plan, these river dynamics and the elevation of the project site play a significant role in the duration that a tide gate door is open, as discussed below.

Fish passage through a tide gate is dependent on acceptable flow conditions but also the amount (% open) and duration that tide gate doors are open. The Cochran and Seestrom sites have side-hinge doors with a mechanical MTR that provides both inflow and outflow. The Winter Lake tide gates are electrical vertical slide gates with one gate per unit (Gate 1A, 2C and 3A) that has a second, side-hinged tide gate mounted on the outside of the vertical slide gate. These gates, with both vertical slide and side hinged secondary tide gates, are able to provide manual outflow through the side hinged gate and inflow through the vertical slide gate. If the slide gate is not open on the dual function gates then the side-hinge gates provide outflow only[5]. Water management plans dictate what water levels can be on the project sites behind tide gates and are agreed upon with the landowner before projects are implemented. Tide gate doors are adjusted so that water levels stay within the limits of the water management plans. Therefore, gate openness is highly dependent on water management plans and river levels. The Cochran site is the lowest site in the estuary and has one of the highest elevations; therefore, the tide gate door is open for significant periods throughout the winter and spring (Table 1). The Winter Lake project has large swaths of low elevation ground and is the highest site in the estuary, thus experiences higher river elevations at low tide. These factors result in both default and management actions that result in significant periods of time when tide gate doors are closed during the winter and spring (Table 1), as stated above. A monthly summary of gate openness of the side hinge gates at all sites show the range in gate openness (Table 1). The Winter Lake tide gates, as noted previously, rely on a motor driven adjustment of the electrical slide gates to allow incoming tide waters onto the project sites and are operated as summarized in Figure 17. In previous years gate openness at Winter Lake was calculated using water levels, in the 2023-2024 season magnetic compass data loggers were installed on the side-hinge gates. The compass data loggers are more accurate than the previous method due to the distance from water level measurements to the tide gate (150'). Additionally, the stilling well at the Seestrom site was compromised during the December-March months resulting in gate openness values that are likely lower than actual.

[5] For greater detail into how these gates function and are operated please refer to the Winter Lake Restoration Effectiveness Monitoring Report Year 3, 2021. https://drive.google.com/file/d/1EWPnLf34eEuXnEi22tH1vRCuN4BQP3Y7/view?usp=sharing

Table 1. Monthly duration of side-hinge tide gate door openness for Cochran, Seestrom, Winter Lake – Unit 1, Winter Lake – Unit 2 and Winter Lake – Unit 3. Both Cochran and Seestrom are manual mechanical MTR style tide gates that allow inflow and outflow. Inflow at Winter Lake is managed using the vertical slide gates (Figure 17). The side-hinged gates at Winter Lake are duplicative and only allow outflow. The Seestrom stilling wells used to calculate gate openness were compromised in the December-March months, reflecting lower values than the likely actual values.

Tide Gate Door Openness (side-hinge)	Cochran	Seestrom	Winter Lake, Unit 1	Winter Lake, Unit 2	Winter Lake, Unit 3
December	91%	35%	N/A	N/A	N/A
January	70%	29%	41%	34%	38%
February	93%	35%	38%	33%	34%
March	89%	32%	25%	19%	21%
April	100%	64%	27%	16%	23%
May	98%	64%	13%	9%	15%
June	66%	44%	8%	13%	11%

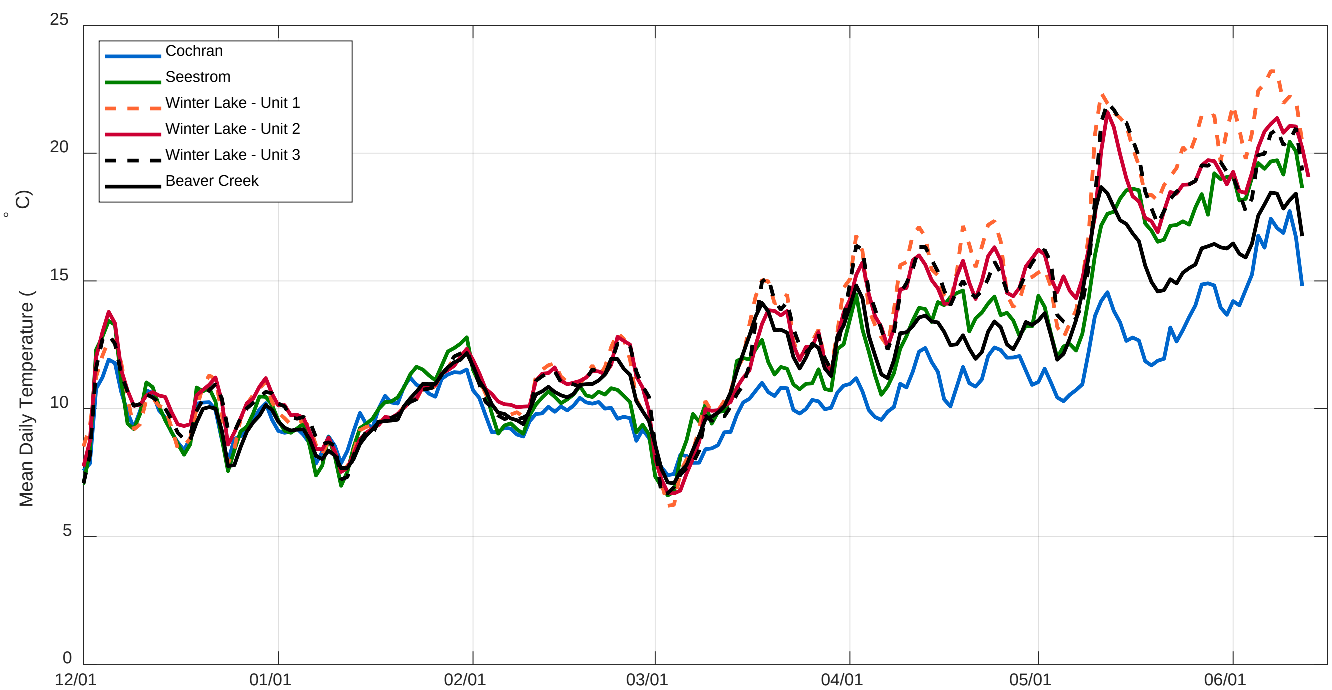

Figure 14. Mean daily water temperature at Cochran (blue), Seestrom (green), Winter Lake – Unit 1 (dashed orange), Winter Lake – Unit 2 (red), Winter Lake – Unit 3 (dashed black), Beaver Creek (black).

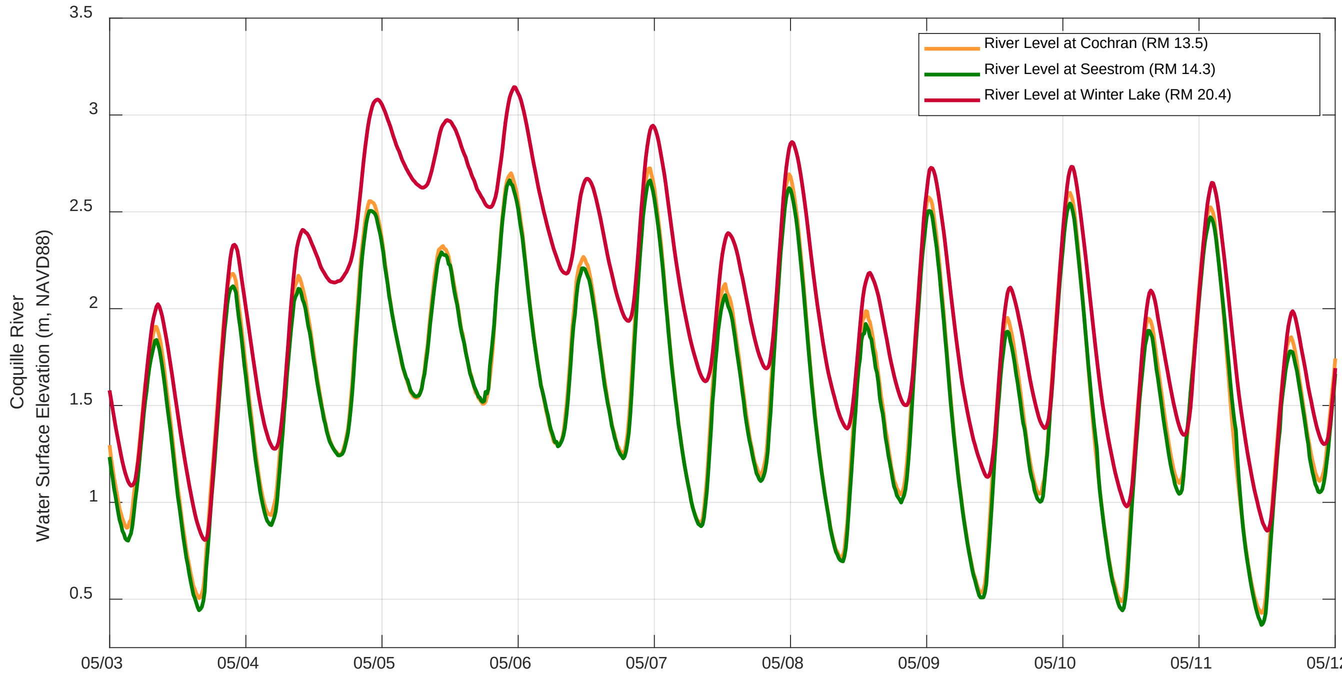

Figure 15. Water surface elevation of the Coquille River at the three project sites, Cochran (yellow), Seestrom (green) and Winter Lake (red). These sites are spread throughout the Coquille Estuary and have different tidal signals.

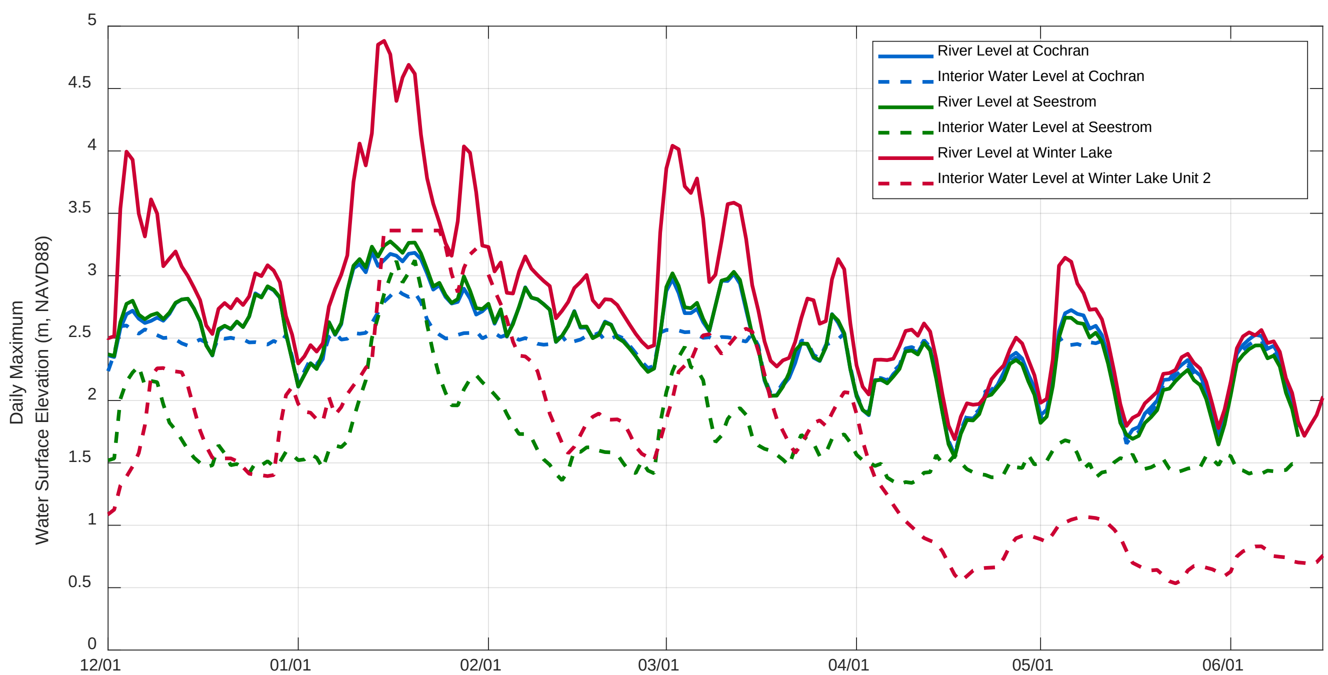

Figure 16. Daily maximum water surface elevations (m NAVD88) of the Coquille River at Cochran (blue), Seestrom (green), and Winter Lake (red) with their respect interior water levels represented as dashed lines. Winter Lake is positioned highest in the estuary and is influenced more by winter storm events than the other project sites.

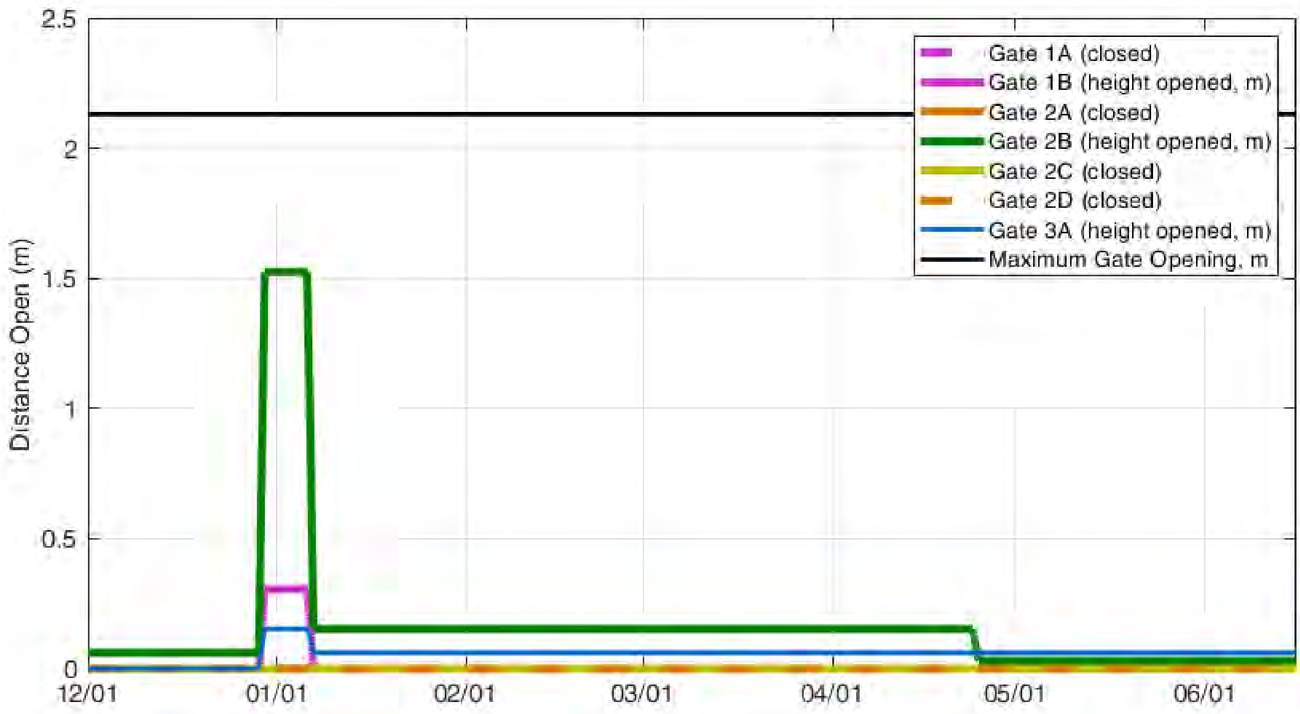

Figure 17. Distance open of vertical slide gates at the Winter Lake site for Unit 2 and 3. Gate 1B, 2C and 3A are dual function slide and side-hinge gates. The slide gate function of Gate 1B, 2A, 2C and 2D was not used during the monitoring season.

B. Species Abundance

Fish sampling in the Coquille Estuary was initiated in late-December of 2023 and concluded for the season in mid-May of 2024 due to rising water temperatures and the need to meet NMFS PIT tagging and fish handling guidelines. A total of 1,558 pre-smolt coho juveniles were captured across all sites during the sampling season over a total of 68 sampling events with some days consisting of 2+ sampling events. There were 1,165 fewer coho captured in 2024 than 2023 even though there were 11 more sampling events in 2024. Throughout the project, the actual coho abundance at the project sites in the Coquille follows the same trend as the Oregon Coast Coho salmon ESU Mid-South Coast stratum pre-smolt abundance estimates; 2023 pre-smolts, which correspond to LCM 2024 coho, are estimated to be 78% of the 2022 pre-smolt abundance (Figure 18). Typically the largest coho captures are at the reference site, Beaver Slough, but the 2023-2024 captures were very low, a mere 12% of coho captured in the 2022-2023 season (Table 2). The LCM tam had used Beaver Slough captures as an understanding of how many coho were in the system, 2023-2024 CPUE at Beaver Slough show the lowest abundance in Beaver Slough of the LCM timeline (Figure 19). The greatest number of coho were captured in upstream sites and is discussed below (Mid-River Basin Life History). 33 juvenile coho were caught at Beaver Slough, PIT tagged and then translocated into the northwest corner of Winter Lake - Unit 2, while no juvenile coho were translocated upstream into the mainstem Coquille River at Myrtle Point unlike previous years (Table 2). The last salmonid to be detected was a YOY Coho at the Seestrom site on March 31st, the last smolt was detected on May 12th at Beaver Creek.

A total of 22 other species of fish and aquatic organisms were captured in addition to coho, listed in Table 3 The most common non-native fish species captured at the LCM project sites are bullhead catfish *(Ameiurus nebulosus)*, bullfrog tadpoles (*Lithobates catesbeianus*), and bluegill *(Lepomis macrochirus)*, which is the same as previous years. All are competing for food with coho juveniles while the large non-native fish are considered a potential predator on coho juveniles. Pacific lamprey *(Entosphenus tridentata)* were captured only at the Cochran and Beaver Slough project sites (Table 3).

Visual monitoring of juvenile coho surface feeding was conducted randomly and intermittently based on Chironomid midge hatches and water levels in 2019-20 (during the final year of the Winter Lake Monitoring Project), in 2020-21, 2021-22, and 2022-23. In 2020-21 water levels were conducive to weekly monitoring from March-May. High numbers of juvenile coho were observed feeding in the pastures of NE Unit 2 and tidal ponds in spring of 2020 on a minimum of four occasions (Figure 20-21). Lower levels of surface feeding activity were observed in 2021-22, however, fish were observed feeding on April 11, 2022 in NE Unit 2 within one of the tidal wetland ponds (Figure 22). In spring 2023 midge hatches were of minor magnitude for much of the January to May period and high water levels precluded regular surveys from dike pathways during much of March-April. Accordingly, no visual data was recorded (photos) for 2023 in Unit 2, although ODFW staff viewed some fish feeding on several occasions. High levels of surface feeding fish considered to be coho pre-smolts were, however, documented in the main Beaver Creek canal at the ODFW Coquille Valley Wildlife Area entry, 200yds upstream from the trapping location on April 13th, 2023 (Figure 23). Few observations were made of coho feeding in the Winter Lake Unit 2 channels in 2023-2024, this is attributed to a wet hydrologic year and high river levels that left the tide gate doors closed more frequently.

Table 2. Fish sampling summary from the Dec 19, 2023 - May 15, 2024 sampling season.

						Beaver Creek			Winter Lake	
	Total	Mainstem Sampling	Mid-River Sampling (East, North and South Fork Ponds)	Cochran	Seestrom	Released to site	Translocated to Unit 2	Translocated to Coquille River	Unit 2[1,2]	Unit 3
# of Sampling Events[3]	65	-	13	11	10	16	2	0	15	1
Total coho caught[4]	1558	-	1192	114	69	163	33	-	0	8
Total coho tagged[5]	1275	-	930	96	57	152	32	0	0	8
Total Chinook caught	110	-	108	0	2	0	-	-	0	0

1 - No trapping was completed in Unit 1.

2 – trapping events consisted of 6 seine, 8 crayfish trap and 1 dip net events

3 - Cochran had net damage due to Nutria at one sampling event

4 - Includes recaptures

5 - Does not include recaptures

Table 3. Total species abundance for the Dec 19, 2023 - May 15, 2024 fish-sampling season not including mainstem Coquille River sampling.

	Yearly Total	Winter Lake, Unit 2	Winter Lake, Unit 3	Cochran	Seestrom	Mid-River Sampling (East, North and South Fork Ponds)	Beaver Slough, Reference
Total Sampling Events	65	15	1	11	10	13	16
Species (native)							
Coho	1579	-	8	114	69	1192	196
Chinook	110	-	-	-	2	108	-
Cutthroat Trout	9	-	1	4	-	1	3
Dace	8	-	-	-	-	8	-
Lamprey (Western Brook)	0	-	-	-	-	-	-
Newts	1229	2	-	25	21	1177	4
Northwest Salamander	6	-	-	2	2	-	2
Pacific Lamprey	3	-	-	1	-	-	2
Red legged Frog	11	-	-	6	4	-	1
Sculpin sp.	242	-	-	209	33	-	-
Steelhead	1	-	-	-	1	-	-
Sucker	35	-	-	-	1	29	5
Three Spine Stickleback	1757	12	7	261	287	220	970
Unknown tadpole	1528	6	-	32	4	1385	101
Species (non-native)							
Black Crappie	93	30		-	48	6	9
Bluegill	275	67	6	-	171	8	23
Brown Bullhead	663	73	-	2	63	72	453
Bullfrog Tadpole	701	15	-	46	96	364	180
Crayfish sp.	281	55	8	6	72	-	140
Gambusia	54	13	5	23	6	1	6
Goldfish	43	-	-	8	10	-	25
Largemouth Bass	61	29	9	-	9	10	4
Yellow Perch	29	28	-	-	-	-	1

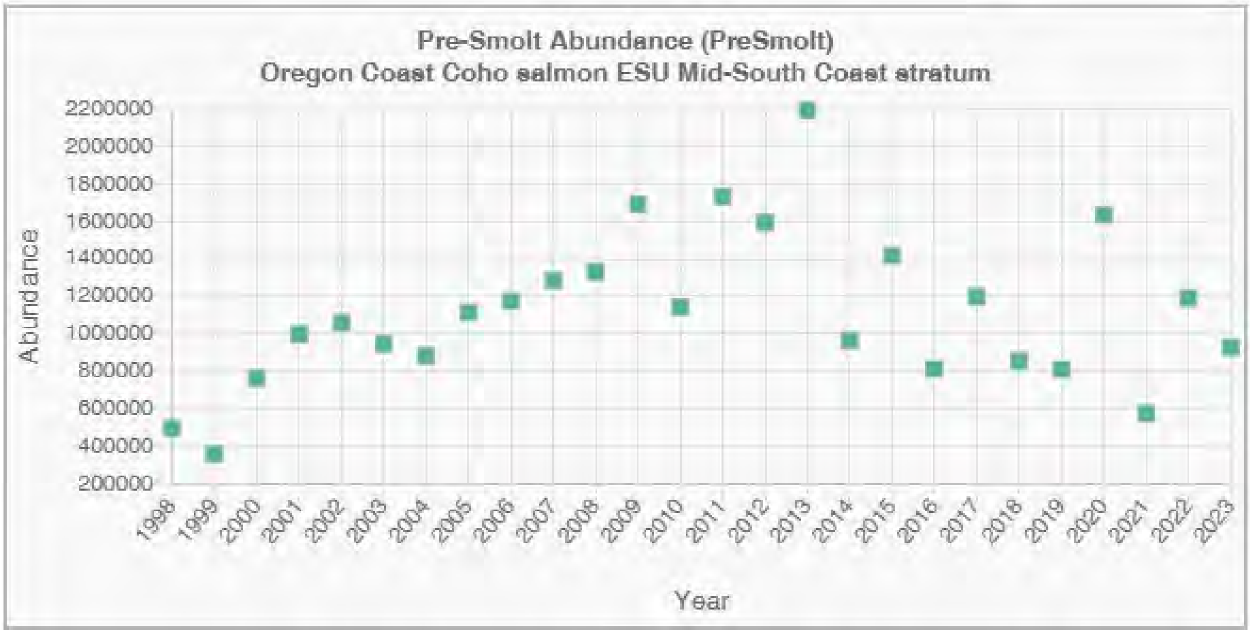

Figure 18. Pre-smolt abundance estimates for OR Coast Coho salmon ESU Mid-South Coast Stratum by year. Source: StreamNet. 2024. https://www.streamnet.org/data/hli/presmolt/?hli-id=30.

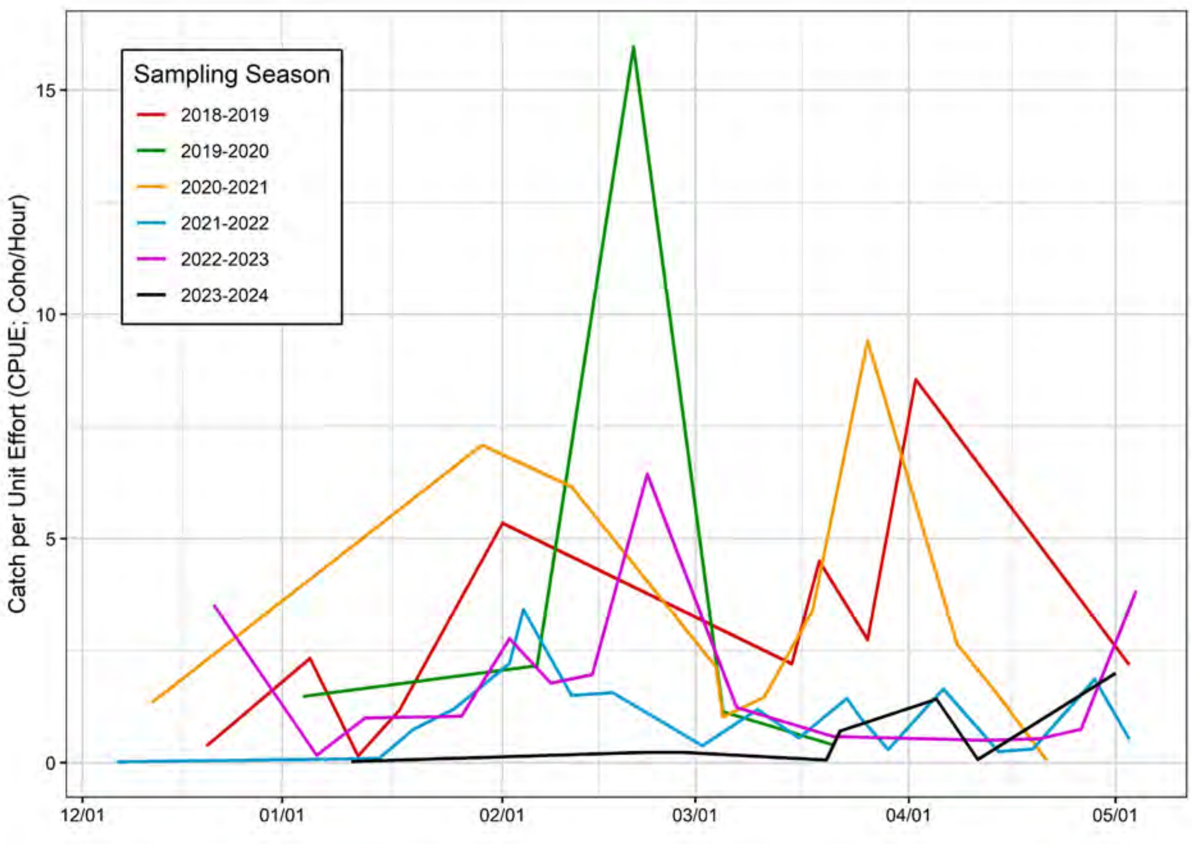

Figure 19. Catch per unit effort (CPUE) of coho salmon at the Beaver Slough site for the past 6 years.

Figure 20. Juvenile coho feeding in the Unit 2 NE tidal wetland pond, April 11th, 2020. Arrows point at single fish surface feeding tension rings.

Figure 21. Juvenile coho feeding in the Unit 2, NE wetland floodplain March 31, 2020. Arrows point at single fish surface feeding tension rings.

Figure 22. Juvenile coho feeding in the Unit 2 NE tidal wetland pond, April 11th, 2022. Arrows point at single fish surface feeding tension rings.

Figure 23. Juvenile coho feeding in main Beaver Slough at the ODFW Coquille Valley Wildlife Area entry, April 13th, 2023. Arrows point at single fish surface feeding tension rings.

C. *Mid-River Basin Life History*

In January of 2024, the Project Team initiated sampling in a floodplain pasture at RM 1.2 upstream from the NF Coquille EF confluence. There was greater intensity rainfall in 2023-2024 earlier than 2021-2022 and 2022-2023 and the ten year average (Figure 24) and at regular return intervals. This early high level of precipitation inundated and repeatedly maintained connectivity throughout the winter, (Figure 25) for a number of locations with water depth >1.5ft for juvenile coho to rear. Visual surveys by road and LiDAR elevation modeling were used to estimate that 100+ acres of river adjacent floodplain pasture locations in the NF and EF Coquille River subbasins (Figure 25) were potentially suitable in size and depth for rearing, although many have poor connectivity for fish ingress/egress predominantly due to historical attempts to drain them. Outflow channelization was historically aimed at multiplying the number of outflow channels and shortening their length. As a result, the grade slope of connection with the river has steepened substantively.

On January 23 a total of 63 coho (Table 4) were captured using seining methods at the EF RM 1.2 location. This site was repeatedly sampled generally every other week until April 24th, 2024. From January 23rd through April 24th, 2024 a total of 811 juvenile coho were captured (Table 4) and 104 young of the year (YOY) fall Chinook. Of the total captured 595 coho were PIT tagged from this location (Table 4). Of those PIT tagged, 423 were released during the multiple sampling events to the mainstem EF Coquille River channel and 358 were released back into the wetland pasture ponded water area. Of the 595 PIT tagged fish released to both the site and the EF Coquille River, none were detected at downstream tidal restoration PIT tag monitoring sites.

Growth rates for fish within the NF RM 1.2 site were assessed based on recapture of 186 fish at the EF RM 1.2 location from January 23 to April 24, 2024. The average length and weight by month was calculated to be 107.4mm and 16.5g respectively (Table 5-6). The body condition of fish as visually assessed was high and with low metacercaria parasite loading on most fish. BCI for fish averaged 1.21 in the January through February period and 1.22 from March through April.

On February 13, 2024 sampling was conducted at RM 6.6 upstream of the mainstem Coquille River within a floodplain pasture ponded area adjacent to the NF Coquille River. This 1.4 acre location had very high density rearing of juvenile coho. A total of 493 juvenile coho were captured and 264 tagged at this site on February 13, 2024. A total of 217 fish were released to the main NF Coquille River and 47 fish were returned to the pasture floodplain following tagging. Of the total of 264 PIT tagged 8 were interrogated at the Beaver Creek site downstream. Based on capture of 493 fish in the 1.4 acres of ponded water and the two seine haul lack of ability to result in depletion, an estimated 1,400+ juvenile coho were assessed to be rearing at the time of sampling within the wetted area. Size range of fish was within the range for other riverine floodplain wetland reared fish with an average length of 112.1mm (Table 5) and body condition was generally high with a BCI of 1.15.

River Stage and Access to NF/EF Floodplain Habitats

Historical deposition of sediments through time in the river adjacent riparian forest, has resulted in development of a natural river levee along the NF, EF, and mainstem Coquille River floodplains. Floodplain habitats in a direction outward from the river, are often lower with distance from the river and in many cases substantially lower in elevation than the river banks (7ft+) in the EF and NF Coquille watersheds. At Winter Lake Coquille, RM 20.5, the differential elevation of the floodplain reaches up to 15 feet. Figure 25, which illustrates the topographical elevation of the lower reaches of the NF and EF floodplains, clearly highlights this variation in elevation. Consequently, the ingress and egress of floodwaters from these areas are constrained to the channel networks, which have been primarily modified by human activities, until floodwaters attain a critical threshold and flow over the riverbanks for a brief period at the peak of the hydrograph. Fish entry into these floodplain swale locations is restricted to one of two routes and more likely dominated by 1). Migration into floodplain habitats through outflow connecting channels; and or 2). Migration overbank through flow pathways into the floodplain at intermittent high flow intervals.

Hydrological conditions vary accordingly with precipitation intensity and timing year to year. In December of 2023 large precipitation events on December 2nd and 3rd resulted in flows averaging over a gauge height of 20.0ft for 10 days until December 12th (Figure 24). In 2022 an event with flow levels above stage 20.0ft did not occur until December 28th and only persisted with an average above elevation 20.0ft for five days (Figure 24). In 2021 the first event averaging 20.0ft stage height or higher was December 24-27th or four days (Figure 24). Elevation of river flows and duration of peak flows directly link to the fish passage connectivity of floodplain adjacent habitats.

Largely due to channelization and shortened flow paths, most outflow channels from these pasture floodplain ponded water areas tend to exhibit steep gradients with cascades in the initial 100-200ft segments from confluence with the river moving inward to the swales. This likely affects the ability of juveniles to migrate inland into the off-channel ponded areas due to high velocities at mid and lower river levels. With higher river stage, the outflow channels from many of these floodplain habitats become "Swim In" conditions as the rise in river elevation floods the cascade/steepened segments. The potential effects to juvenile salmonid and other native fish species access to these locations as affected by river water elevations and floodplain habitat areas was assessed as depicted in Figure 24, 25 and 26. River level analysis was completed specifically for the EF Coquille RM 1.2 floodplain swale pond. This assessment included calculation of the duration (# of days) of level elevation "Swim In" water conditions for the outflow channel, whereas maximum ability for juvenile salmonids to enter the site was assumed to be when river levels were at the invert elevation of the pond or higher.

Based on field observations in November 2024 at the EF RM 1.2 location correlation to the NF Coquille River USGS gauge downstream at RM 4.2, conditions were assessed that for the EF RM 1.2 site in correlation to the stage at the NF gauge that would develop level water elevation for fish to swim in without resistance to the swale (Figure 26). At the EF RM 1.2 location it was determined that a NF Coquille River stage of 21.5ft would result in water elevations of 43ft, which provides for ponded water "Swim In" conditions to the floodplain pasture swale. A total of 10 days from December to April in 2021-2022, 10 days in 2022-2023, and 27 days 2023-2024 were found to be above stage 21.5ft/elevation 43ft at the EF RM 1.2, which was considered to be "highly accessible" water elevation for juvenile salmonids to enter floodplain ponded water area Figure 26 and 27. Assessment of flow stage conditions from November through May from 2013-2024 was completed and demarcated that peak flow events and duration varies not only monthly and daily, but annually. For the assessment there are a number of years the duration of high flows above stage of 21.5 is limited (Figure 28).

The Project Team closely visually monitored a number of locations where juvenile coho were identified to be feeding during the winter months in the NF and EF floodplain. As river flows declined, the pasture floodplain pool depths subsided. Once they were very shallow (<1.5ft in depth) during drier periods between major rain events, few juvenile fish were seen feeding and subsequent seining events at the EF

RM 1.2 captured fewer fish per seine haul perhaps suggested declining abundance with later date in the spring sampled.

At the EF RM 1.2 location a total of 358 juvenile coho were released to the river between 02/23 and 04/24/2024. Of these fish two were recaptured in the wetland pond area, which is ~1,837ft upstream from the EF Coquille River release site. The fish were recaptured following a flow event where "Swim In" connectivity would have occurred with water stage above 21.5 or elevation 43.0ft at the site (Figure 29).

Table 4. E. F. Coquille River off-channel wetland ponded water area sampled, number of juvenile coho captured, PIT tagged, and release disposition, January through April 2024.

Date	GPS_station	Captured	Sum of PIT Tagged	Sum of Recapture	Sum Released to River	Sum Released to Pond	Marked "at large"
1/23/2024	EF Coq. RM 1.2 Wtlnd Pond	64	61	0	0	61	0
1/30/2024	EF Coq. RM 1.2 Wtlnd Pond	122	108	9	0	117	61
2/6/2024	EF Coq. RM 1.2 Wtlnd Pond	124	88	32	0	120	169
2/23/2024	EF Coq. RM 1.2 Wtlnd Pond	222	140	80	**141**	79	257
3/7/2024	EF Coq. RM 1.2 Wtlnd Pond	131	74	55	**83**	46	256
4/2/2024	EF Coq. RM 1.2 Wtlnd Pond	34	26	7	**33**	0	247
4/24/2024	EF Coq. RM 1.2 Wtlnd Pond	114	98	3	**101**	0	240

Table 5. Mean fork lengths (mm, ±95% CI) of juvenile coho salmon sampled in the Mid-River Basin of the East, South and North forks from January – April. 'NA' indicates Not Applicable, where no juvenile coho salmon were sampled in the applicable month.

Year	Month	EF RM 1.2		NF		SF		CoC	
		n	Fork Length (mm)	n	Fork Length (mm)	n	Fork Length (mm)	n	Fork Length (mm)
2024	Jan	186	96.2 (± 1.5)	0	NA	0	NA	0	NA
2024	Feb	346	109.2 (± 1.2)	264	112.4 (± 1.1)	0	NA	0	NA
2024	Mar	131	120.9 (± 1.7)	0	NA	34	130.3 (± 2.6)	49	112.1 (± 11.3)
2024	Apr	148	105.4 (± 5.3)	0	NA	0	NA	0	NA
2024	All	811	107.4 (± 1.3)	264	112.4 (± 1.1)	34	130.3 (± 2.6)	49	112.1 (± 11.3)

Table 6. Mean whole-body wet weight (grams, ±95% CI) of juvenile coho salmon sampled in the Mid-River Basin of the East, South and North forks from January – April. 'NA' indicates Not Applicable, where no juvenile coho salmon were sampled in the applicable month.

Year	Month	EF RM 1.2		NF		SF		CoC	
		n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)
2024	Jan	186	11.7 (± 0.5)	0	NA	0	NA	0	NA
2024	Feb	346	16.0 (± 0.5)	264	16.7 (± 0.5)	0	NA	0	NA
2024	Mar	131	22.5 (± 0.9)	0	NA	34	24.5 (± 1.3)	49	23.5 (± 4.4)
2024	Apr	148	18.6 (± 2.4)	0	NA	0	NA	0	NA
2024	All	811	16.5 (± 0.6)	264	16.7 (± 0.5)	34	24.5 (± 1.3)	49	23.5 (± 4.4)

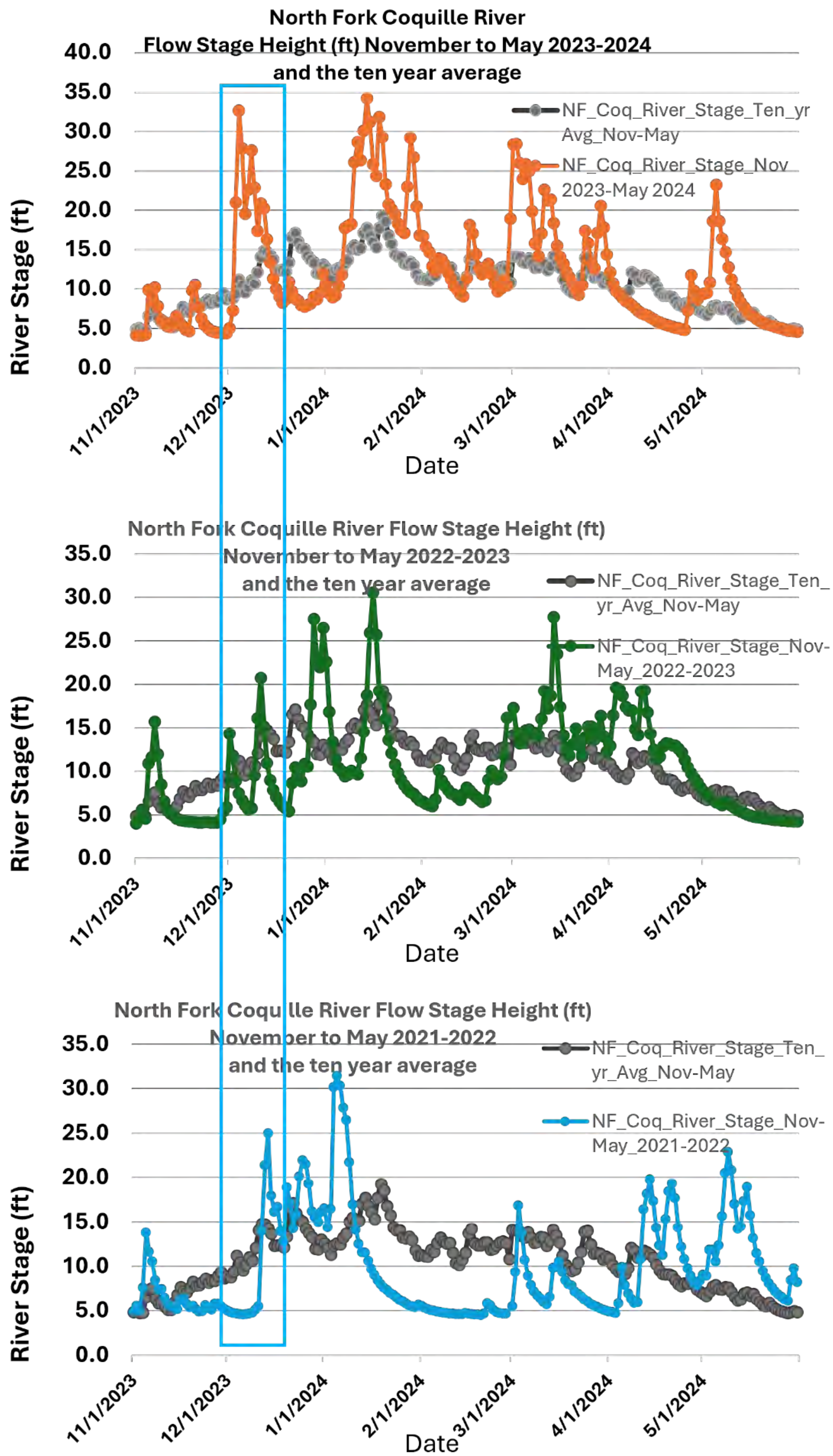

Figure 24. North Fork Coquille Flow Stage as Recorded at the USGS Gauge #14327000 for 2021-2024 and the Ten Year Average.

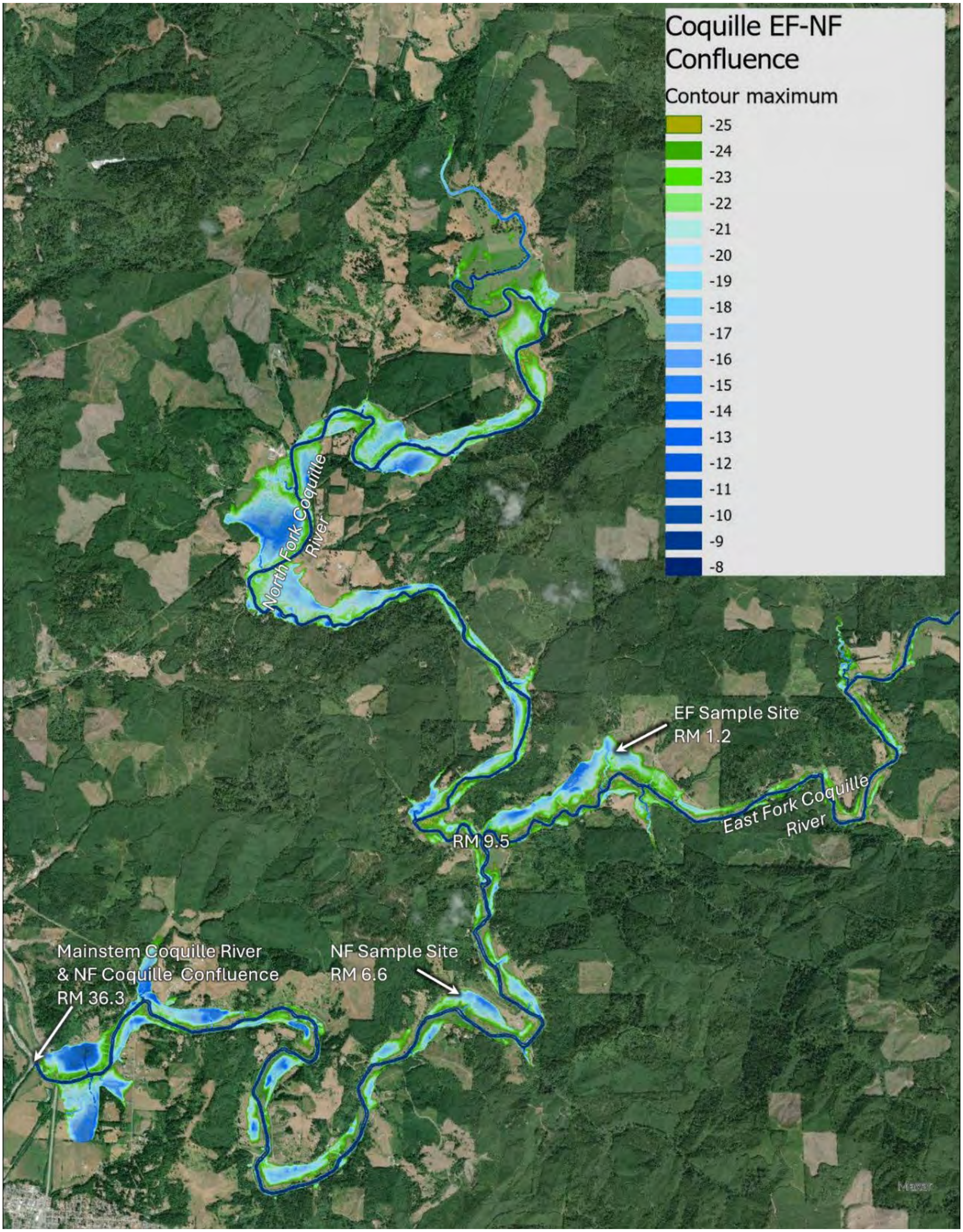

Figure 25. Floodplain pasture floodplain land area relative elevations to the river channel, specifically adjusted by river reach. Figure also denotes NF Coquille RM 6.6 and EF Coquille RM 1.2 capture/tagging sites.

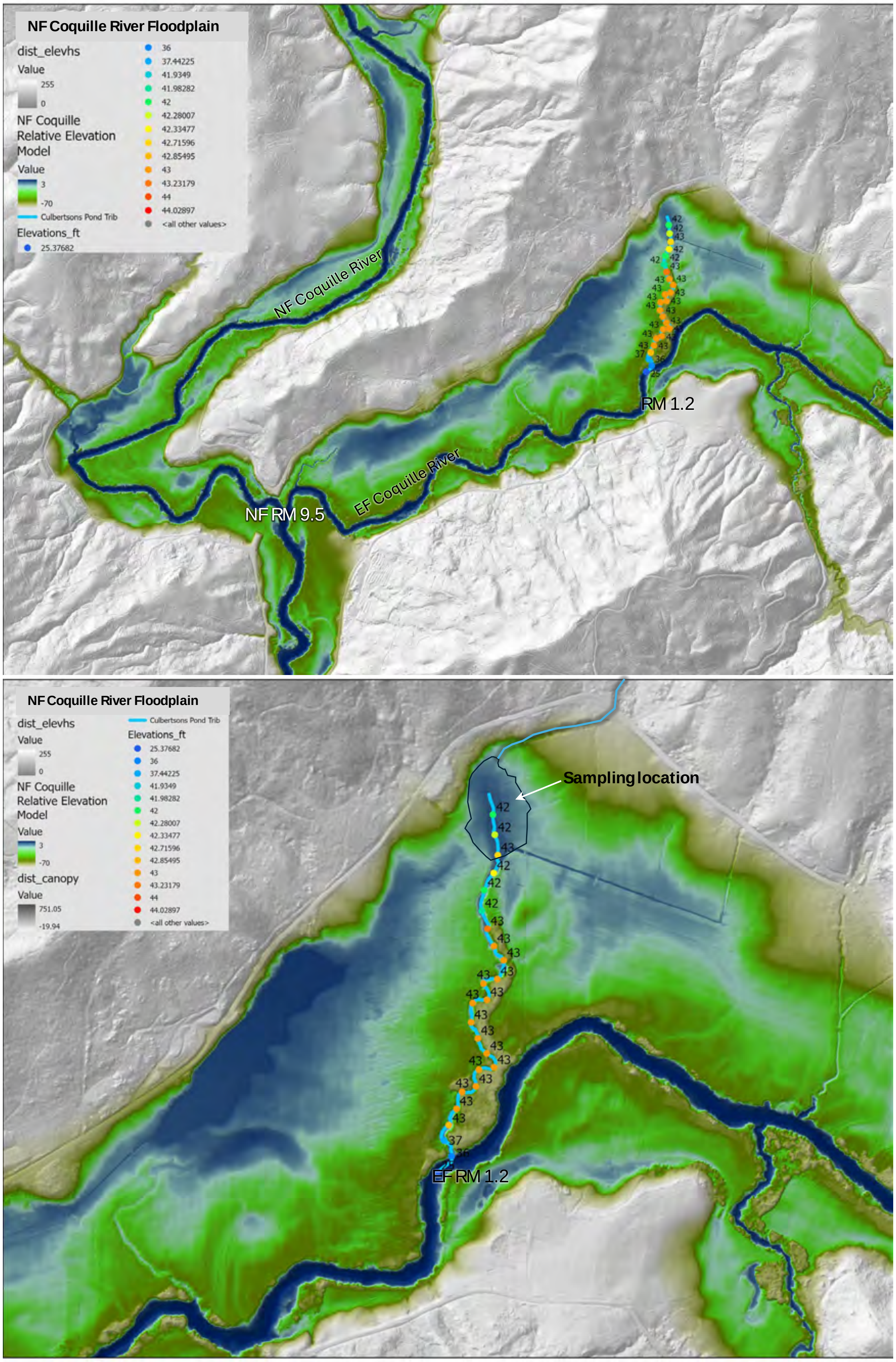

Figure 26. NF and EF Coquille River floodplain top, lower image EF RM 1.2 sampling location and elevations of the outflow channel from floodplain swale sampling area.

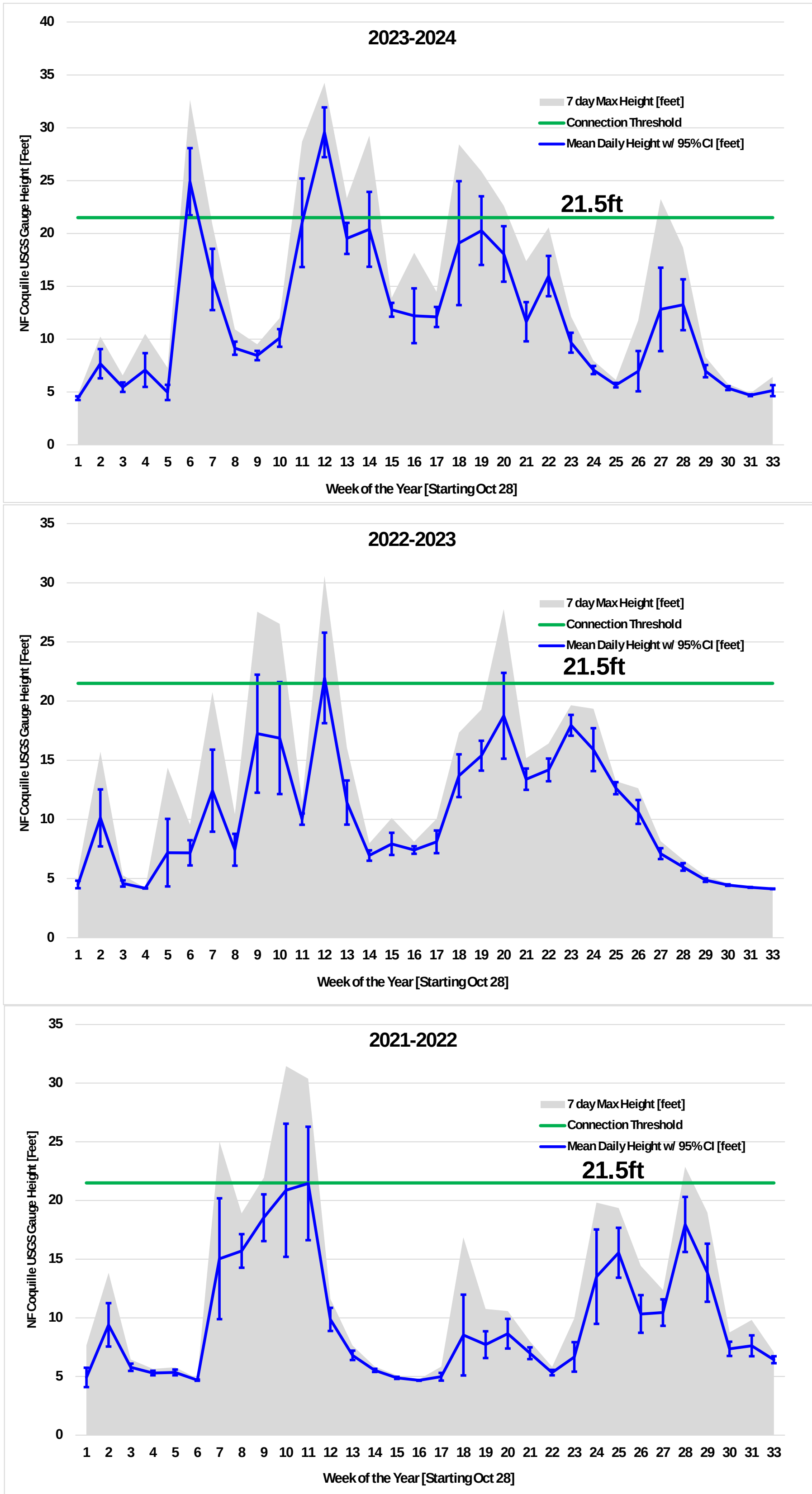

Figure 27. Coquille River stage height at NF Coquille River guage, with demarcation of 21.5ft demarcated as critical stage for water levels at EF RM 1.2 "Swim In" conditions for juvenile coho 2023-2024, 2022-2023, and 2021-2022.

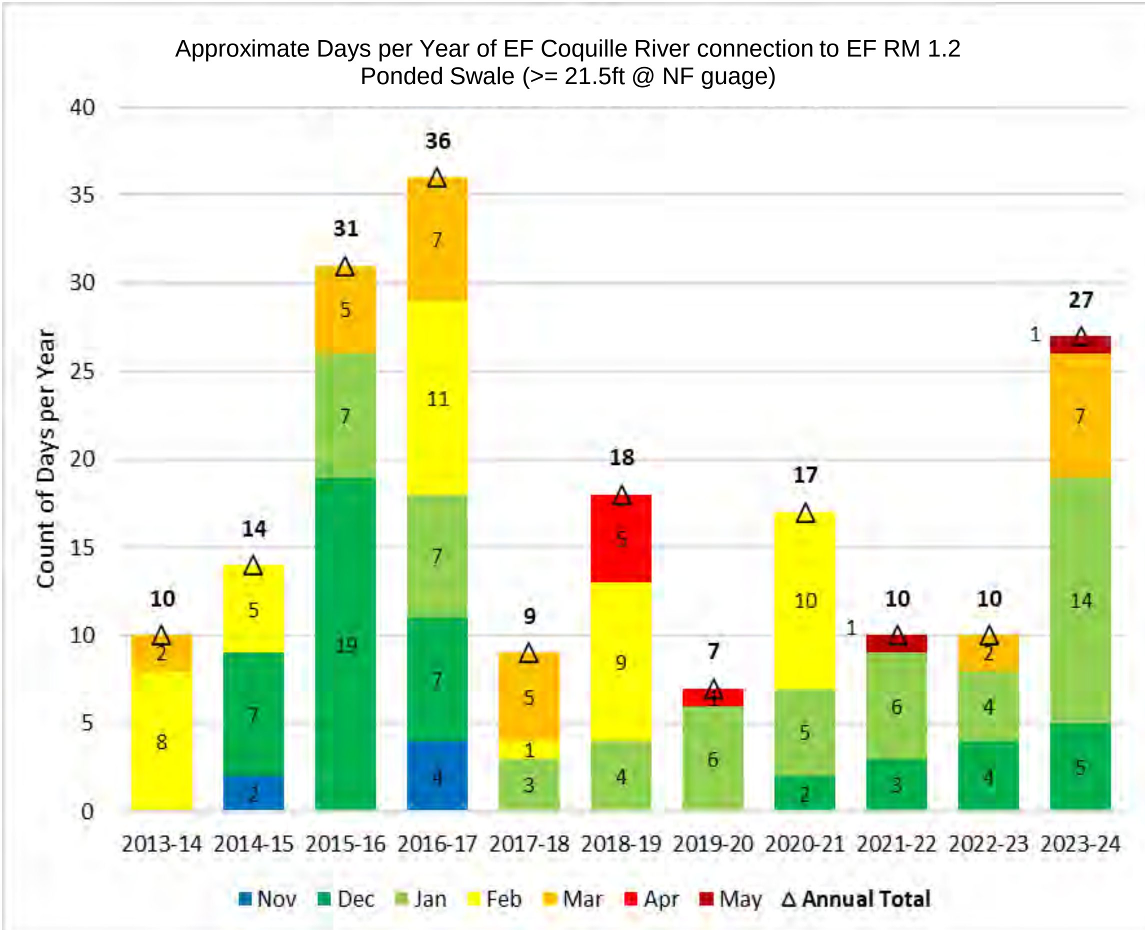

Figure 28. Assessment of days per year of EF Coquille River fish passage connectivity based on river stage of 21.5ft at NF Coquille River gauge for November through May 2013-2024.

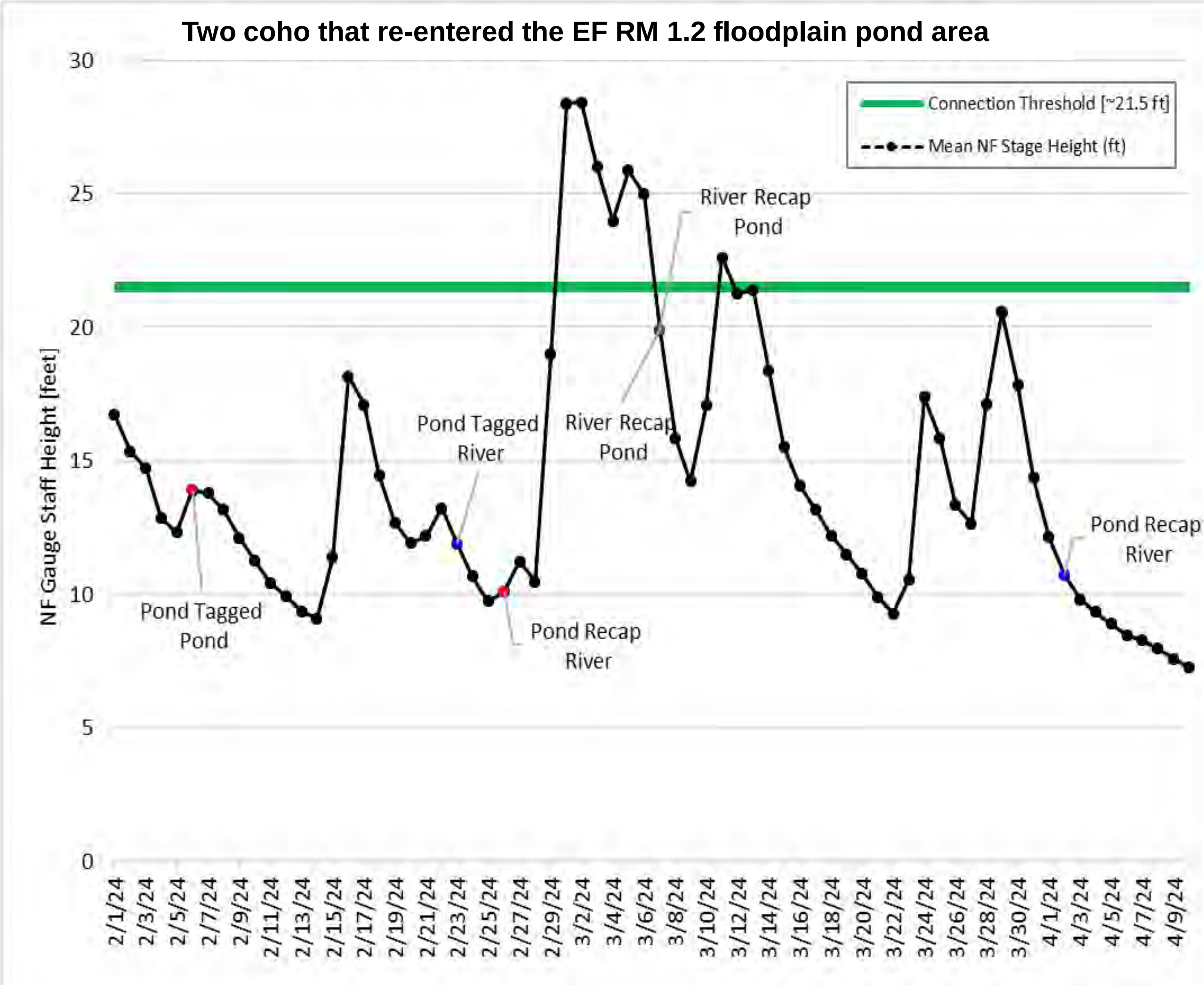

Figure 29. NF Coquille River stage height and subsequent recapture of two fish that reentered the wetland ponded water sampling location on the EF. Coquille River at RM 1.2 following release 1,837ft downstream in the mainstem EF Coquille River at outflow channel mouth.

D. Condition

Mean lengths, weights, and condition factors for juvenile coho salmon by location and month of capture are provided in Table 7-9, respectively. In 2020-21, Kruskal-Wallis tests indicated significant differences in mean lengths and weights among locations in each month and when data were pooled across all months (Table 10). Condition factor differed among locations in February, March, and April or when data were pooled across all months (Table 4). Pairwise comparisons in 2020-21 suggested that, after starting the monitoring period at similar lengths, by April juvenile coho salmon in Beaver Slough and Winter Lake Unit 2 had grown significantly longer than their counterparts at Cochran, Seestrom, or in the mainstem Coquille River (Figure 30). The pattern was similar for weight, though pairwise comparisons could not clearly identify homogeneous groupings in April (Figure 31). In April, pairwise comparisons indicated that juvenile coho at Winter Lake Unit 2 were significantly heavier than those at Cochran, Seestrom, and in the mainstem Coquille River. Patterns were less pronounced for condition factor, where by April pairwise comparisons indicate three homogenous but overlapping groupings (Group A = Winter Lake Unit 2, Cochran, and Seestrom; Group B = Cochran, Seestrom and Mainstem; Group C = Beaver Slough and Mainstem) (Figure 32).

In both 2021-22 and 2022-23, we were only able to compare the Beaver Slough, Cochran, and Seestrom locations due to insufficient captures in other locations. In 2021-22, Kruskall-Wallis tests indicated significant differences in mean lengths and weights among sites in January, March, and April or when data were pooled across all months (Table 11). Mean condition factor differed significantly among locations in January through February or when data were pooled across all months (Table 11). Sample sizes were low in some months at some locations (See Table 7-12). In 2022-23, there were significant differences in mean lengths and weights among sites in January through April, and condition factor differed significantly among locations in December-February and in April (Table 12). In both the seasons, comparisons between fish rearing in off-channel areas and those captured in the mainstem Coquille River were not possible due to a lack of data from the mainstem during concurrent months. Mainstem data were available only for fish captured at Laverne Park in late fall. In both seasons, juvenile coho captured at Cochran tended to be smaller in length and weight than those captured at Beaver and Seestrom (Figure 33-34; Figure 36-37). Patterns in both seasons were more variable and less pronounced for condition factor, but this metric was lower at Beaver Slough late in the season (Figure 35-38).

In the 2023-24 season, we compared length, weight, and condition of juvenile coho salmon at Beaver Slough, Cochran, Seestrom, Winter Lake Unit 3, and off-channel seasonal wetlands, but data were not available to include all sites in all months (Table 13; Figure 39-41). Kruskall-Wallis tests indicated significant differences in mean lengths and weights among sites in February, March, and April, and differences in mean condition factor in all months. Pairwise comparisons indicated that lengths and weights tended to be higher in Beaver Slough until April, when data were available for Winter Lake Unit 3 (Figure 39-41). While both lengths and weights in the off-channel seasonal wetlands tended to be lower than other locations, condition factor tended to be similar to or higher (Figure 39-41).

In 2020-21, there was little indication that slopes of WLRs differed among months within locations. Therefore, the 2021-22 and 2022-23 WLRs were compared across locations using data aggregated across all sampling events (Table 14; Figure 42). When data were pooled, there were significant differences in the slopes of the WLRs among locations in 2020-21 (ANCOVA, $F = 5.96$, $df = 4, 1216$, $p < 0.0001$) and 2023-24 (ANCOVA, $F = 19.42$, $df = 4, 1482$, $p < 0.0001$), marginally significant differences in 2021-22 (ANCOVA, $F = 2.90$, $df = 2, 1580$, $p = 0.0553$), and no significant differences in 2022-23 (ANCOVA, $F = 1.08$ $df = 2, 1760$, $p = 0.3395$) However, the analyses after 2020-21 did not include Winter Lake Unit 2 or the mainstem Coquille River due to low or zero captures in those locations.

Table 7. Mean fork lengths (millimeters, ±95% CI) of juvenile coho salmon sampled in Beaver Slough, Winter Lake Unit 2, Winter Lake Unit 3, Cochran, Seestrom, the mainstem Coquille River, and off-channel seasonal pothole wetlands from December - May. 'NA' indicates Not Applicable, where no juvenile coho salmon were sampled in the applicable month.

Year	Month	Beaver Slough		Winter Lake Unit 2		Winter Lake Unit 3		Cochran		Seestrom		Coquille R. (2020-21) Potholes (2023-24)	
		n	Fork Length (mm)	n	Fork Length (mm)	n	Fork Length (mm)	n	Fork Length (mm)	n	Fork Length (mm)	n	Fork Length (mm)
2020	Dec	22	72.6 (±2.7)	6	82.7 (±7.1)	0	NA	0	NA	58	82.2 (±3.5)	0	NA
2021	Jan	20	108.8 (±4.6)	6	106.5 (±10.1)	0	NA	70	87.6 (±2.4)	16	94.4 (±5.0)	0	NA
2021	Feb	23	112.2 (±4.4)	2	118.0 (±15. 7)	0	NA	88	99.1 (±2.2)	101	102.0 (±2.0)	0	NA
2021	Mar	411	130.5 (±0.9)	25	135.1 (±8.4)	1	185	0	NA	109	111.4 (±1.7)	0	NA
2021	Apr	137	131.8 (±1.7)	28	136.5 (±5.6)	0	NA	15	117.7 (±4.1)	59	117.1 (±3.5)	39	117.6 (±3.1)
2020-21	All	613	127.4 (±1.2)	67	127.9 (±5.7)	1	1.01	173	96.1 (±2.0)	343	103.9 (±1.7)	39	117.6 (±3.1)
2021	Dec	0	NA	0	NA	0	NA	2	87.5 (±10.8)	10	88.9 (±6.8)	0	NA
2022	Jan	180	108.6 (±1.7)	0	NA	0	NA	143	95.7 (±1.9)	25	103.7 (±2.7)	0	NA
2022	Feb	540	109.4 (±0.9)	0	NA	0	NA	5	97.6 (±14.7)	2	102.5 (±22.5)	0	NA
2022	Mar	366	122.4 (±1.2)	1	118	0	NA	17	114.9 (±8.4)	8	110.1 (±10.4)	0	NA
2022	Apr	182	141.7 (±2.2)	1	132	1	130	27	121.4 (±5.0)	34	137.9 (±5.5)	0	NA
2022	May	40	155.8 (±3.3)	0	NA	0	NA	0	NA	12	152.0 (±7.6)	0	NA
2021-22	All	1308	118.8 (±0.9)	2	125 (±13.7)	1	130	193	100.9 (±2.2)	91	121.7 (±5.1)	0	NA
2022	Dec	84	82.6 (±2.3)	0	NA	0	NA	0	NA	45	82.0 (±3.4)	0	NA
2023	Jan	130	104.3 (±2.0)	0	NA	0	NA	179	87.4 (±1.6)	123	91.0 (±1.7)	0	NA
2023	Feb	666	104.0 (±0.8)	0	NA	0	NA	12	87.4 (±6.3)	47	90.3 (±3.1)	0	NA
2023	Mar	173	115.0 (±1.7)	0	NA	0	NA	31	105.1 (±4.5)	59	108.2 (±3.0)	0	NA
2023	Apr	134	147.0 (±1.9)	1	166.0	0	NA	32	111.6 (±4.6)	48	129.8 (±2.9)	0	NA
2023	May	24	133.5 (±5.1)	0	NA	0	NA	0	NA	8	140.0 (±7.8)	0	NA
2022-23	All	1211	109.4 (±1.0)	1	166.0	0	NA	254	92.6 (±1.8)	330	99.6 (±2.1)	0	NA
2023	Dec	0	NA	0	NA	0	NA	14	94.6 (±7.0)	22	91.1 (±5.8)	0	NA
2024	Jan	1	108.0	0	NA	0	NA	46	100.4 (±4.0)	17	94.9 (±8.8)	186	96.2 (±1.5)
2024	Feb	24	127.3 (±4.4)	0	NA	0	NA	31	114.1 (±4.6)	14	122.4 (±6.6)	608	110.6 (±0.9)
2024	Mar	32	160.8 (±5.3)	0	NA	0	NA	48	137.5 (±4.4)	7	153.9 (±12.3)	165	122.9 (±1.5)
2024	Apr	137	160.9 (±2.2)	0	NA	8	165.5 (±10.7)	1	133.0	0	NA	148	105.5 (±5.3)*
2024	May	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
2023-24	All	194	156.4 (±2.5)	0	NA	8	165.5 (±10.7)	140	115.7 (±3.6)	60	106.8 (±6.5)	1107	109.4 (±1.0)*

Table 8. Mean whole-body wet weight (grams, ±95% CI) of juvenile coho salmon sampled in Beaver Slough, Winter Lake Unit 2, Winter Lake Unit 3, Cochran, Seestrom, the mainstem Coquille River, and off-channel seasonal pothole wetlands from December – May. 'NA' indicates Not Applicable, where no juvenile coho salmon were sampled in the applicable month.

Year	Month	Beaver Slough		Winter Lake Unit 2		Winter Lake Unit 3		Cochran		Seestrom		Coquille R. (2020-21) Potholes (2023-24)	
		n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)
2020	Dec	22	4.3 (±0.4)	4	6.0 (±1.0)	0	NA	0	NA	58	7.4 (±1.2)	0	NA
2021	Jan	20	14.1 (±1.8)	6	15.0 (±4.5)	0	NA	69	7.6 (±0.6)	16	9.7 (±1.8)	0	NA
2021	Feb	23	16.6 (±2.0)	2	18.9 (±9.0)	0	NA	86	11.2 (±0.8)	99	12.0 (±0.7)	0	NA
2021	Mar	412	24.1 (±0.5)	23	32.2 (±5.4)	1	64	0	NA	109	15.6 (±0.7)	0	NA
2021	Apr	137	23.7 (±0.9)	28	30.2 (±3.2)	0	NA	15	19.3 (±2.2)	59	19.4 (±1.7)	39	17.7 (±1.4)
2020-21	All	614	22.7 (±0.5)	63	27.6 (±3.1)	1	1.01	170	10.5 (±0.7)	341	13.5 (±0.6)	39	17.7 (±1.4)
2021	Dec	0	NA	0	NA	0	NA	2	7.9 (±3.8)	10	8.4 (±2.7)	0	NA
2022	Jan	180	14.7 (±0.7)	0	NA	0	NA	142	10.4 (±0.7)	25	13.1 (±1.1)	0	NA
2022	Feb	541	14.4 (±0.4)	0	NA	0	NA	5	11.5 (±5.0)	2	11.9 (±6.3)	0	NA
2022	Mar	366	20.2 (±0.6)	1	20.9	0	NA	17	17.3 (±4.0)	8	15.5 (±4.1)	0	NA
2022	Apr	179	31.8 (±1.5)	1	29.0	1	22.6	27	21.1 (±2.6)	34	32.8 (±3.4)	0	NA
2022	May	40	41.4 (±2.5)	0	NA	0	NA	0	NA	12	41.0 (±5.5)	0	NA
2021-22	All	1305	19.3 (±0.5)	2	25.0 (±7.9)	1	1.03	193	12.5 (±0.9)	91	23.8 (±2.9)	0	NA
2022	Dec	82	6.0 (±0.6)	0	NA	0	NA	0	NA	45	6.2 (±0.8)	0	NA
2023	Jan	126	13.3 (±0.8)	0	NA	0	NA	176	7.7 (±0.5)	113	8.4 (±0.5)	0	NA
2023	Feb	659	12.2 (±0.3)	0	NA	0	NA	12	7.2 (±1.3)	47	8.3 (±0.9)	0	NA
2023	Mar	172	16.9 (±0.9)	0	NA	0	NA	31	12.6 (±1.4)	58	14.1 (±1.1)	0	NA
2023	Apr	133	33.0 (±1.2)	1	60.1	0	NA	32	15.4 (±1.7)	48	23.9 (±1.5)	0	NA
2023	May	24	26.7 (±2.7)	0	NA	0	NA	0	NA	8	30.6 (±5.4)	0	NA
2022-23	All	1196	15.2 (±0.5)	1	60.1	0	NA	251	9.3 (±0.6)	319	12.0 (±0.8)	0	NA
2023	Dec	0	NA	0	NA	0	NA	13	10.3 (±2.8)	22	8.8 (±2.0)	0	NA
2024	Jan	1	14.0	0	NA	0	NA	46	12.2 (±1.6)	14	10.4 (±3.2)	186	11.7 (±0.5)
2024	Feb	23	25.8 (±3.0)	0	NA	0	NA	30	18.4 (±2.5)	14	23.1 (±3.8)	607	16.3 (±0.4)
2024	Mar	31	47.2 (±4.7)	0	NA	0	NA	48	32.3 (±3.0)	7	43.4 (±9.5)	157	22.9 (±0.8)
2024	Apr	137	47.7 (±1.8)	0	NA	8	57.9 (±9.6)	1	25.1	0	NA	148	18.6 (±2.4)*
2024	May	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
2023-24	All	192	44.82 (±1.8)	0	NA	8	57.9 (±9.6)	138	20.4 (±2.0)	57	17.0 (±3.5)	1098	16.8 (±0.5)*

Table 9. Mean condition factor, K (±95% CI), of juvenile coho salmon sampled in Beaver Slough, Winter Lake Unit 2, Cochran, Seestrom, the mainstem Coquille River, and off-channel seasonal pothole wetlands from December – May. 'NA' indicates Not Applicable, where no juvenile coho salmon were sampled in the applicable month.

Year	Month	Beaver Slough		Winter Lake Unit 2		Winter Lake Unit 3		Cochran		Seestrom		Coquille R. (2020-21) Potholes (2023-24)	
		n	K	n	K	n	K	n	K	n	K	n	K
2020	Dec	22	1.12 (±0.07)	4	0.96 (±0.28)	0	NA	0	NA	58	1.25 (±0.09)	0	NA
2021	Jan	20	1.08 (±0.03)	6	1.20 (±0.07)	0	NA	69	1.10 (±0.03)	16	1.11 (±0.06)	0	NA
2021	Feb	23	1.15 (±0.03)	2	1.12 (±0.10)	0	NA	86	1.11 (±0.02)	99	1.10 (±0.02)	0	NA
2021	Mar	411	1.07 (±0.01)	23	1.20 (±0.03)	1	1.01	0	NA	109	1.12 (±0.02)	0	NA
2021	Apr	137	1.02 (±0.01)	28	1.15 (±0.02)	0	NA	15	1.17 (±0.05)	59	1.15 (±0.02)	39	1.07 (±0.02)
2020-21	All	613	1.06 (±0.01)	63	1.16 (±0.03)	1	1.01	170	1.11 (±0.02)	341	1.14 (±0.02)	39	1.07 (±0.02)
2021	Dec	0	NA	0	NA	0	NA	2	1.14 (±0.15)	10	1.12 (±0.09)	0	NA
2022	Jan	179	1.11 (±0.01)	0	NA	0	NA	142	1.14 (±0.02)	25	1.16 (±0.03)	0	NA
2022	Feb	539	1.07 (±0.01)	0	NA	0	NA	5	1.17 (±0.04)	2	1.09 (±0.13)	0	NA
2022	Mar	366	1.07 (±0.01)	1	1.27	0	NA	16	1.09 (±0.05)	8	1.12 (±0.05)	0	NA
2022	Apr	179	1.08 (±0.01)	1	1.26	1	1.03	27	1.15 (±0.03)	34	1.23 (±0.04)	0	NA
2022	May	40	1.08 (±0.02)	0	NA	0	NA	0	NA	12	1.15 (±0.04)	0	NA
2021-22	All	1303	1.08 (±0.01)	2	1.27 (±0.01)	1	1.03	192	1.14 (±0.01)	91	1.17 (±0.02)	0	NA
2022	Dec	82	1.00 (±0.02)	0	NA	0	NA	0	NA	45	1.08 (±0.04)	0	NA
2023	Jan	126	1.11 (±0.01)	0	NA	0	NA	176	1.10 (±0.01)	113	1.07 (±0.01)	0	NA
2023	Feb	659	1.05 (±0.01)	0	NA	0	NA	12	1.06 (±0.07)	47	1.08 (±0.02)	0	NA
2023	Mar	172	1.07 (±0.01)	0	NA	0	NA	31	1.05 (±0.03)	58	1.06 (±0.02)	0	NA
2023	Apr	133	1.03 (±0.01)	1	1.31	0	NA	32	1.07 (±0.04)	48	1.07 (±0.02)	0	NA
2023	May	24	1.10 (±0.03)	0	NA	0	NA	0	NA	8	1.07 (±0.04)	0	NA
2022-23	All	1196	1.05 (±0.00)	1	1.31	0	NA	251	1.09(±0.01)	319	1.07 (±0.01)	0	NA
2023	Dec	0	NA	0	NA	0	NA	13	1.17 (±0.05)	22	1.08 (±0.03)	0	NA
2024	Jan	1	1.13	0	NA	0	NA	46	1.15 (±0.03)	14	1.10 (±0.04)	186	1.26 (±0.01)
2024	Feb	23	1.21 (±0.04)	0	NA	0	NA	30	1.18 (±0.03)	14	1.22 (±0.04)	606	1.17 (±0.01)
2024	Mar	31	1.11 (±0.02)	0	NA	0	NA	48	1.21 (±0.03)	7	1.17 (±0.04)	157	1.21 (±0.01)
2024	Apr	137	1.13 (±0.01)	0	NA	8	1.26 (±0.03)	1	1.17	0	NA	148	1.26 (±0.02)*
2024	May	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
2023-24	All	192	1.13 (±0.01)	0	NA	8	1.26 (±0.03)	138	1.18 (±0.02)	57	1.13 (±0.02)	1097	1.21 (±0.01)*

Table 10. Results of Kruskal-Wallis tests (Kruskal-Wallis H Statistic, degrees of freedom, p-value) comparing fork lengths, weights, and condition factor among locations (Beaver Slough, Winter Lake Unit 2, Cochran, Seestrom, and Mainstem) by month and with data pooled across months during the 2020-21 season. Critical values are Chi-squared approximated at a=0.05 with k-1 degrees of freedom. Significant results are shown in bold.

Parameter	Month	H	df	p-value
Length	December[i]	12.74	2	**0.0017**
	January[ii]	45.07	3	**<0.0001**
	February[iii]	20.91	2	**<0.0001**
	March[iv]	184.43	2	**<0.0001**
	April[v]	94.30	4	**<0.0001**
	All Months	558.13	4	**<0.0001**
Weight	December[i]	18.81	2	**0.0001**
	January[ii]	45.57	3	**<0.0001**
	February[iii]	23.61	2	**<0.0001**
	March[iv]	175.76	2	**<0.0001**
	April[v]	69.48	4	**<0.0001**
	All Months	517.31	4	**<0.0001**
Condition Factor	December[i]	3.42	2	0.1811
	January[ii]	6.30	3	0.0979
	February[iii]	6.82	2	**0.0330**
	March[iv]	62.96	2	**<0.0001**
	April[v]	120.10	4	**<0.0001**
	All Months	142.36	4	**<0.0001**

[i]December includes only Beaver Slough, Seestrom, and Winter Lake Unit 2; Winter Lake Unit 2 had low sample size (n = 6 & 4 for length and weight & condition, respectively)

[ii]January includes Beaver Slough, Seestrom, Cochran, and Winter Lake Unit 2; Winter Lake Unit 2 had low sample size (n = 6).

[iii]February includes Beaver Slough, Seestrom, and Cochran; Winter Lake Unit 2 was not included due to low sample size (n = 2).

[iv]December includes only Beaver Slough, Seestrom, and Winter Lake Unit 2

[v]April includes all locations.

Table 11. Results of Kruskal-Wallis tests (Kruskal-Wallis H Statistic, degrees of freedom, p-value) comparing fork lengths, weights, and condition factor among locations (Beaver Slough, Cochran, and Seestrom) by month and with data pooled across months during the 2021-22 season. Critical values are Chi-squared approximated at a=0.05 with k-1 degrees of freedom. Significant results are shown in bold.

Parameter	Month	H	df	p-value
Length	December[i]	0.01	1	0.9137
	January	88.51	2	**<0.0001**
	February	3.56	2	0.1684
	March	8.37	2	**0.0153**
	April	35.35	2	**<0.0001**
	May[i]	0.47	1	0.4934
	All Months	169.69	2	**<0.0001**
Weight	December[i]	0.19	1	0.9137
	January	81.40	2	**<0.0001**
	February	2.76	2	0.2525
	March	7.27	2	**0.0263**
	April	30.00	2	**<0.0001**
	May[i]	0.06	1	0.8026
	All Months	144.41	2	**<0.0001**
Condition Factor	December[i]	0.05	1	0.8299
	January	13.82	2	**0.0010**
	February	9.00	2	**0.0111**
	March	10.50	2	**0.0052**
	April	58.40	2	**<0.0001**
	May[i]	7.97	1	**0.0048**
	All Months	162.287	2	**<0.0001**

[i]December includes only Cochran and Seestrom, and May includes only Beaver Slough and Seestrom.

Table 12. Results of Kruskal-Wallis tests (Kruskal-Wallis H Statistic, degrees of freedom, p-value) comparing fork lengths, weights, and condition factor among locations (Beaver Slough, Cochran, and Seestrom) by month and with data pooled across months during the 2022-23 season. Critical values are Chi-squared approximated at α=0.05 with k-1 degrees of freedom. Significant results are shown in bold.

Parameter	Month	H	df	p-value
Length	December[i]	0.04	1	0.8479
	January	140.59	2	**<0.0001**
	February	70.47	2	**<0.0001**
	March	20.69	2	**<0.0001**
	April	116.60	2	**<0.0001**
	May[i]	1.60	1	0.2118
	All Months	238.05	2	**<0.0001**
Weight	December[i]	0.42	1	0.5208
	January	143.40	2	**<0.0001**
	February	67.77	2	**<0.0001**
	March	21.32	2	**<0.0001**
	April	113.04	2	**<0.0001**
	May[i]	1.76	1	0.1842
	All Months	211.04	2	**<0.0001**
Condition Factor	December[i]	14.39	1	**0.0001**
	January	20.27	2	**<0.0001**
	February	6.26	2	**0.0467**
	March	1.64	2	0.4432
	April	22.99	2	**<0.0001**
	May[i]	0.00	1	0.9826
	All Months	28.00	2	**<0.0001**

[i]December and May include only Beaver Slough and Seestrom.

Table 13. Results of Kruskal-Wallis tests (Kruskal-Wallis H Statistic, degrees of freedom, p-value) comparing fork lengths, weights, and condition factor among locations (Beaver Slough, Cochran, Seestrom, and off-channel pothole wetlands) by month and with data pooled across months during the 2023-24 season. Critical values are Chi-squared approximated at a=0.05 with k-1 degrees of freedom. Significant results are shown in bold. No samples were available in May at any sites.

Parameter	Month	H	df	p-value
Length	December[i]	1.18	1	0.2828
	January[ii]	1.72	2	0.4239
	February	49.13	3	**<0.0001**
	March	122.96	3	**<0.0001**
	April	179.68	2	**<0.0001**
	May	-	-	-
	All Months	455.22	4	**<0.0001**
Weight	December[i]	1.68	1	0.1988
	January	2.89	2	0.2363
	February	49.51	3	**<0.0001**
	March	116.92	3	**<0.0001**
	April	168.13	2	**<0.0001**
	May	-	-	-
	All Months	442.24	4	**<0.0001**
Condition Factor	December[i]	8.42	1	**0.0024**
	January	62.70	2	**<0.0001**
	February	11.06	3	**0.0112**
	March	39.86	3	**<0.0001**
	April	118.66	2	**<0.0001**
	May	-	-	-
	All Months	136.03	4	**<0.0001**

[i]December includes only Cochran and Seestrom.
[ii]Beaver Slough omitted from January due to low sample size (n = 1)

Table 14. Weight-length relationship parameters for juvenile coho salmon sampled in 2020-21, 2021-22, 2022-23, and 2023-24. Parameters were estimated from the linear relationship between log_{10} transformed values for weight (g) and length (cm). Young of year fish entering the sites late in the season (April/May) were excluded, but the off-channel pothole wetlands sampled in 2023-24 included a smaller size cohort in April sampling.

Location	Year	n	r^2	p-value	a	b
Beaver Slough	2020-21	613	0.96	<0.0001	0.0150	2.86
	2021-22	1303	0.97	<0.0001	0.0101	3.02
	2022-23	1196	0.98	<0.0001	0.0112	2.97
	2023-24	192	0.96	<0.0001	0.0192	2.81
Winter Lake Unit 2	2020-21	63	0.96	<0.0001	0.0095	3.08
	2021-22	2	NA	NA	NA	NA
	2022-23	1	NA	NA	NA	NA
	2023-24	0	NA	NA	NA	NA
Cochran	2020-21	170	0.93	<0.0001	0.0088	3.10
	2021-22	192	0.96	<0.0001	0.0133	2.93
	2022-23	251	0.96	<0.0001	0.0117	2.96
	2023-24	138	0.98	<0.0001	0.0089	3.11
Seestrom	2020-21	341	0.93	<0.0001	0.0162	2.84
	2021-22	91	0.98	<0.0001	0.0110	3.03
	2022-23	319	0.98	<0.0001	0.0105	3.01
	2023-24	57	0.99	<0.0001	0.0078	3.16
Mainstem Coquille R.	2020-21	39	0.93	<0.0001	0.0099	3.03
	2021-22	0	NA	NA	NA	NA
	2022-23	0	NA	NA	NA	NA
	2023-24	0	NA	NA	NA	NA
Off-Channel Potholes	2023-24	1097	0.98	<0.0001	0.0160	2.88

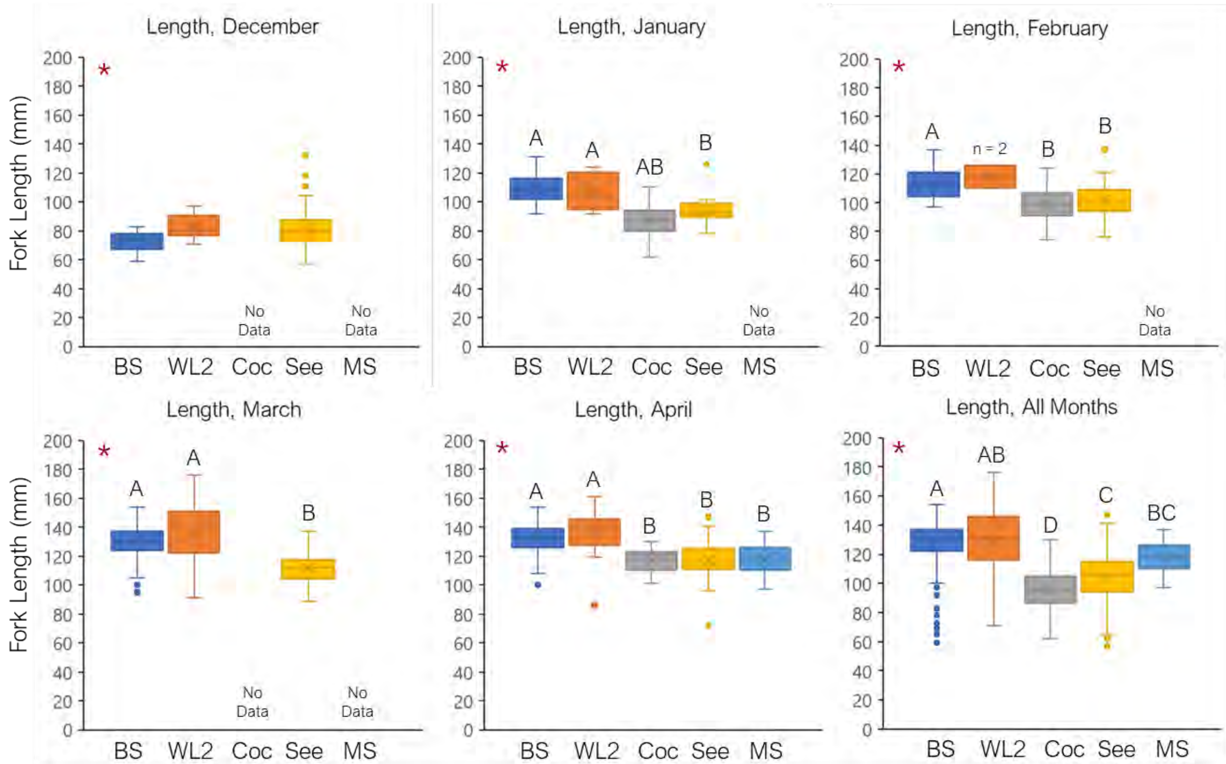

Figure 30. Box plots of fork length (mm) by month and pooled across months for Beaver Slough (BS), Winter Lake Unit 2 (WL2), Cochran (Coc), Seestrom (See) and the Mainstem Coquille River (MS) in the 2020-21 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.017 in Dec, Feb, Mar; 0.008 in Jan; 0.005 in Apr & All Months). Winter Lake Unit 2 was not included in statistical analyses in February due to low sample size (n = 2). Post-hoc comparisons could not identify homogeneous groupings in December.*

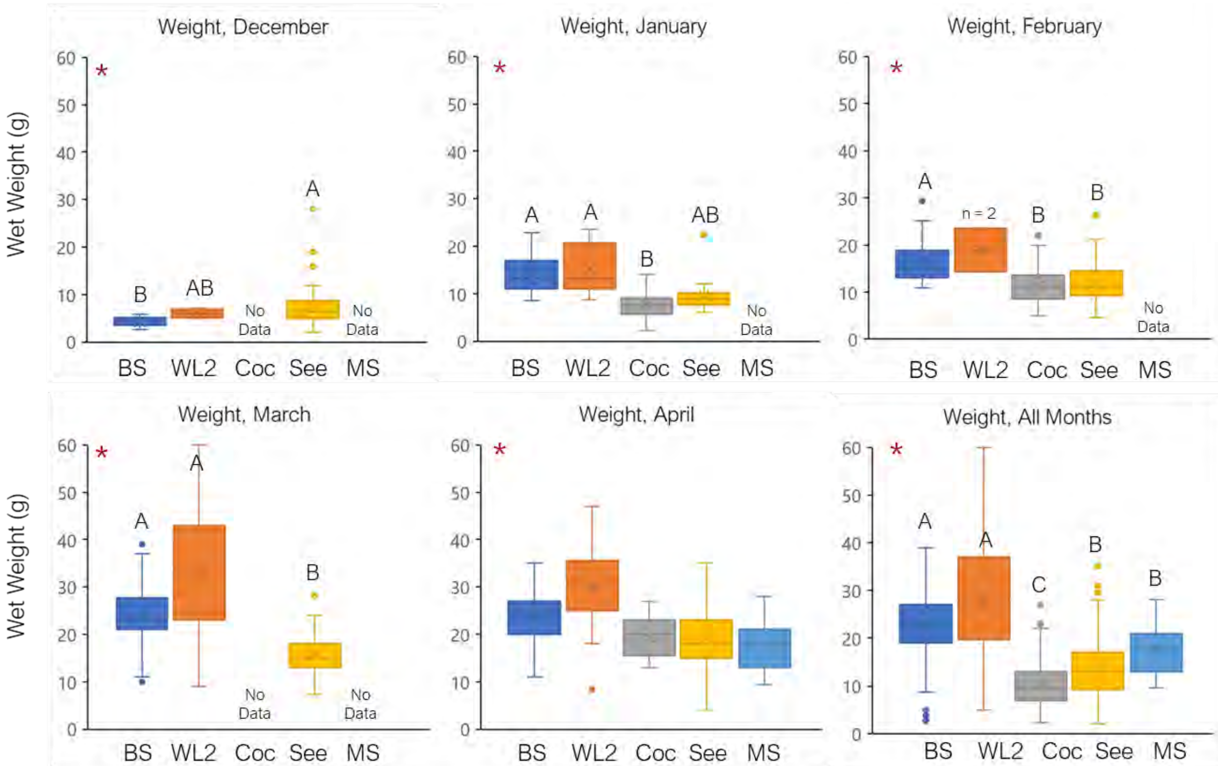

Figure 31. Box plots of whole-body wet weight (grams) by month and pooled across months for Beaver Slough (BS), Winter Lake Unit 2 (WL2), Cochran (Coc), Seestrom (See) and the Mainstem Coquille River (MS) in the 2020-21 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.017 in Dec, Feb, Mar; 0.008 in Jan, & 0.005 in Apr & All Months). Winter Lake Unit 2 was not included in statistical analyses in February due to low sample size (n = 2). April post-hoc comparisons could not identify homogeneous groupings at p* = 0.005).*

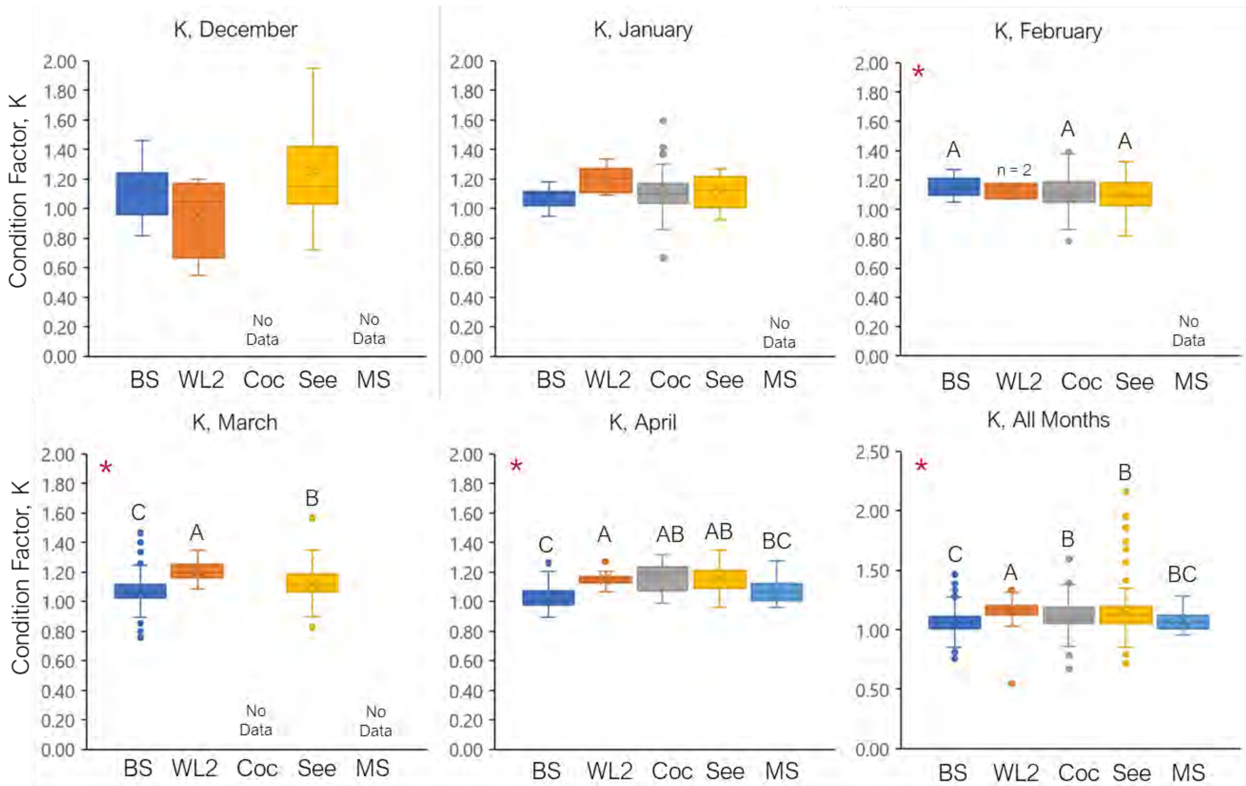

Figure 32. Box plots of Fulton's Condition Factor (K, nondimensional) by month and pooled across months for Beaver Slough (BS), Winter Lake Unit 2 (WL2), Cochran (Coc), Seestrom (See) and the Mainstem Coquille River (MS) in the 2020-21 season. An asterisk (*) indicates significant Kruskal-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.017 in Dec, Feb, Mar; 0.008 in Jan, & 0.005 in Apr & All Months). Winter Lake Unit 2 was not included in statistical analyses in February due to low sample size (n = 2); despite a significant Kruskal-Wallis Test in February, differences could not be identified with post-hoc comparisons at p* = 0.017.*

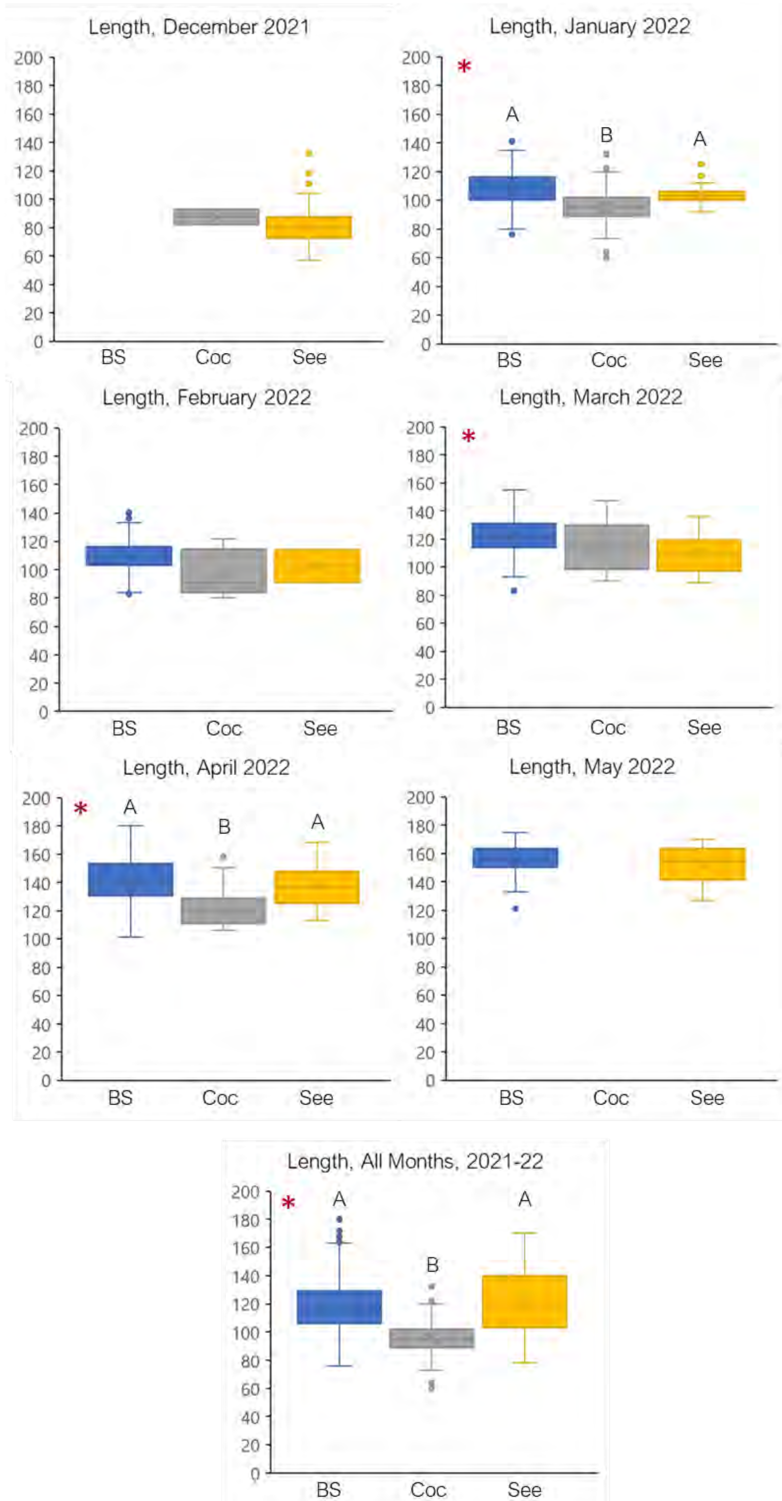

Figure 33. Box plots of fork length (mm) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See) in the 2021-22 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.05 in Dec, May; 0.017 in Jan-Apr & All Months). Post-hoc comparisons could not identify homogeneous groupings in March at p* = 0.017).*

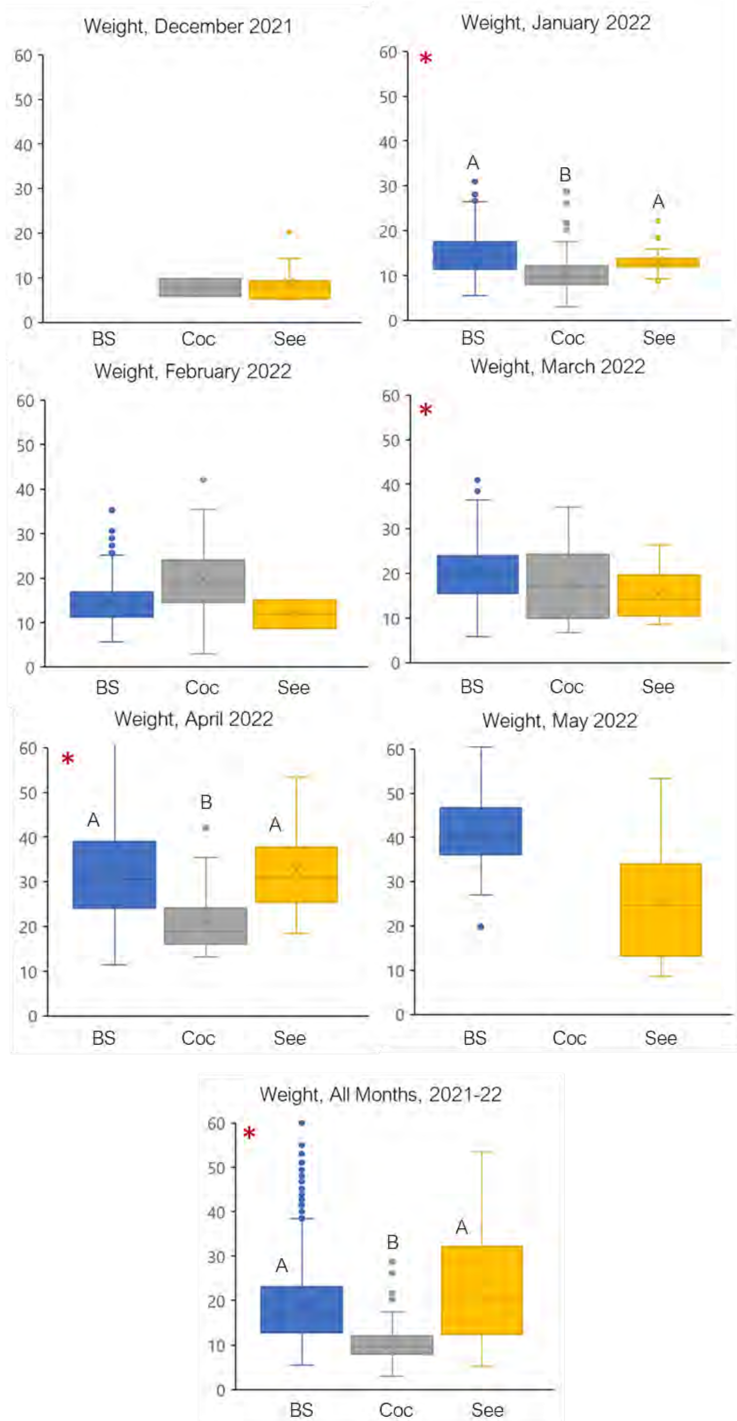

Figure 34. Box plots of whole-body wet weight (grams) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See) in the 2021-22 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.05 in Dec, May; 0.017 in Jan-Apr & All Months). Post-hoc comparisons could not identify homogeneous groupings in March at p* = 0.017).*

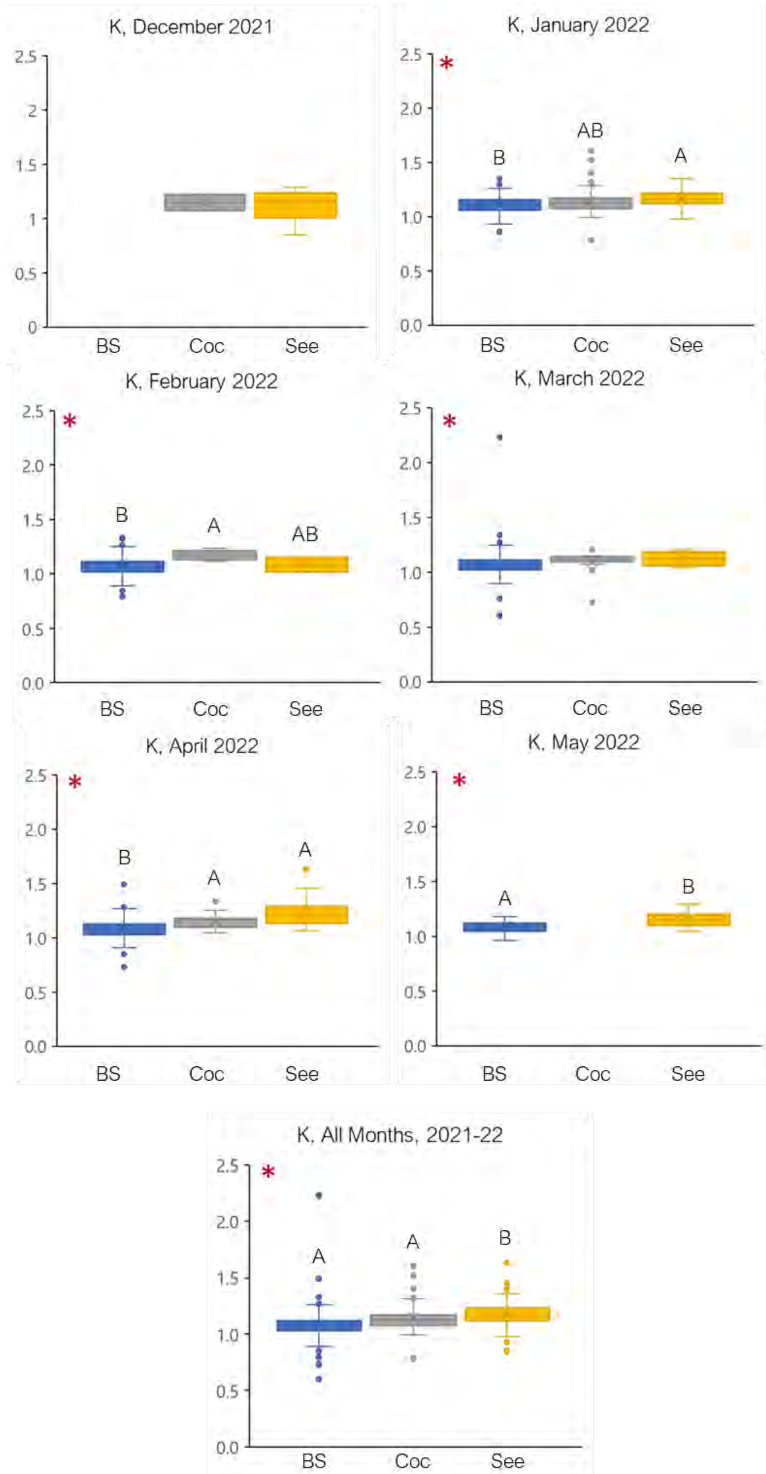

Figure 35. Box plots of Fulton's Condition Factor (K, nondimensional) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See) in the 2021-22 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.05 in Dec, May; 0.017 in Jan-Apr & All Months). Post-hoc comparisons could not identify homogeneous groupings in March at p* = 0.017.*

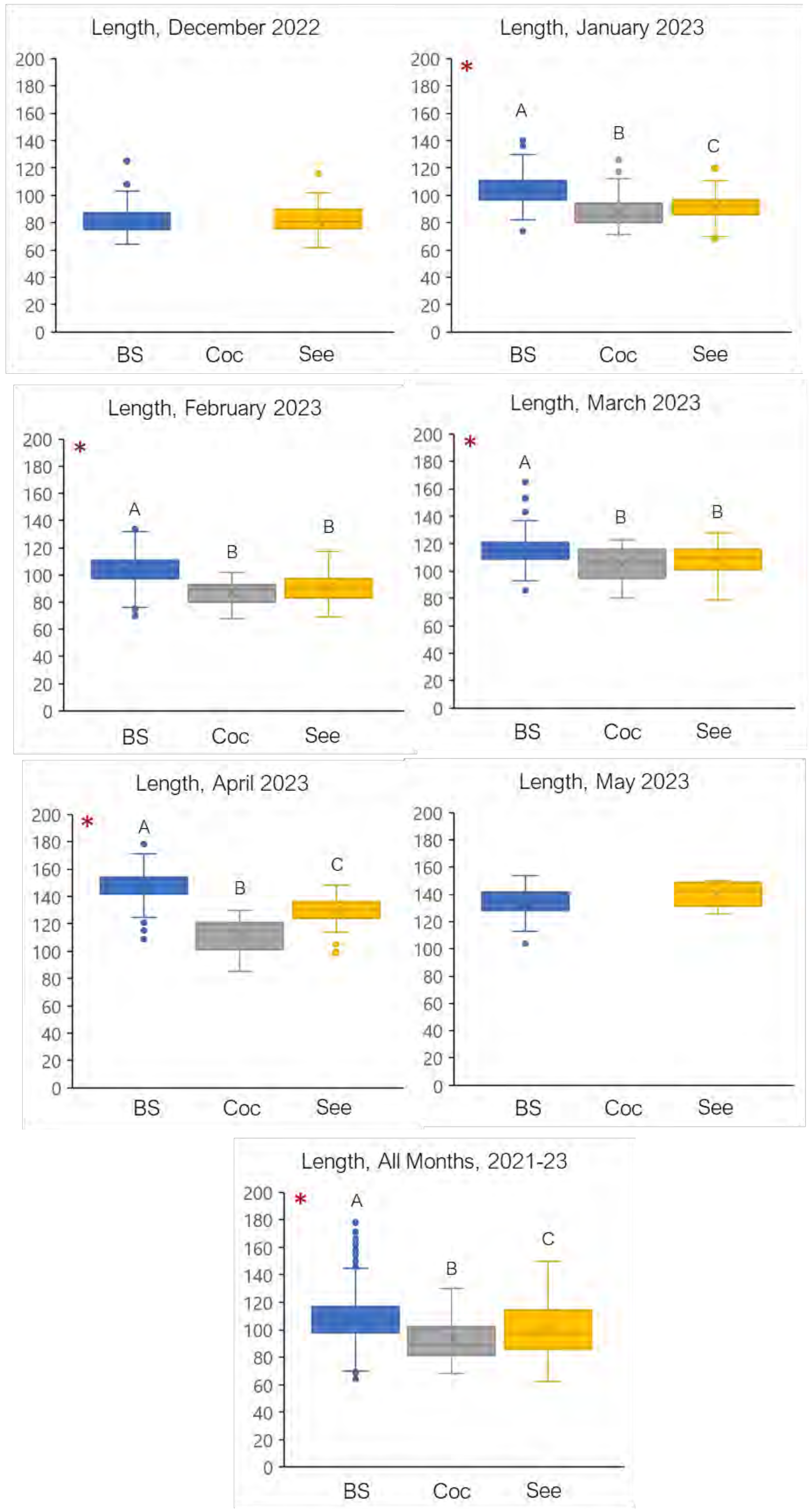

Figure 36. Box plots of fork length (mm) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See) in the 2022-23 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.05 in Dec, May; 0.017 in Jan-Apr & All Months).*

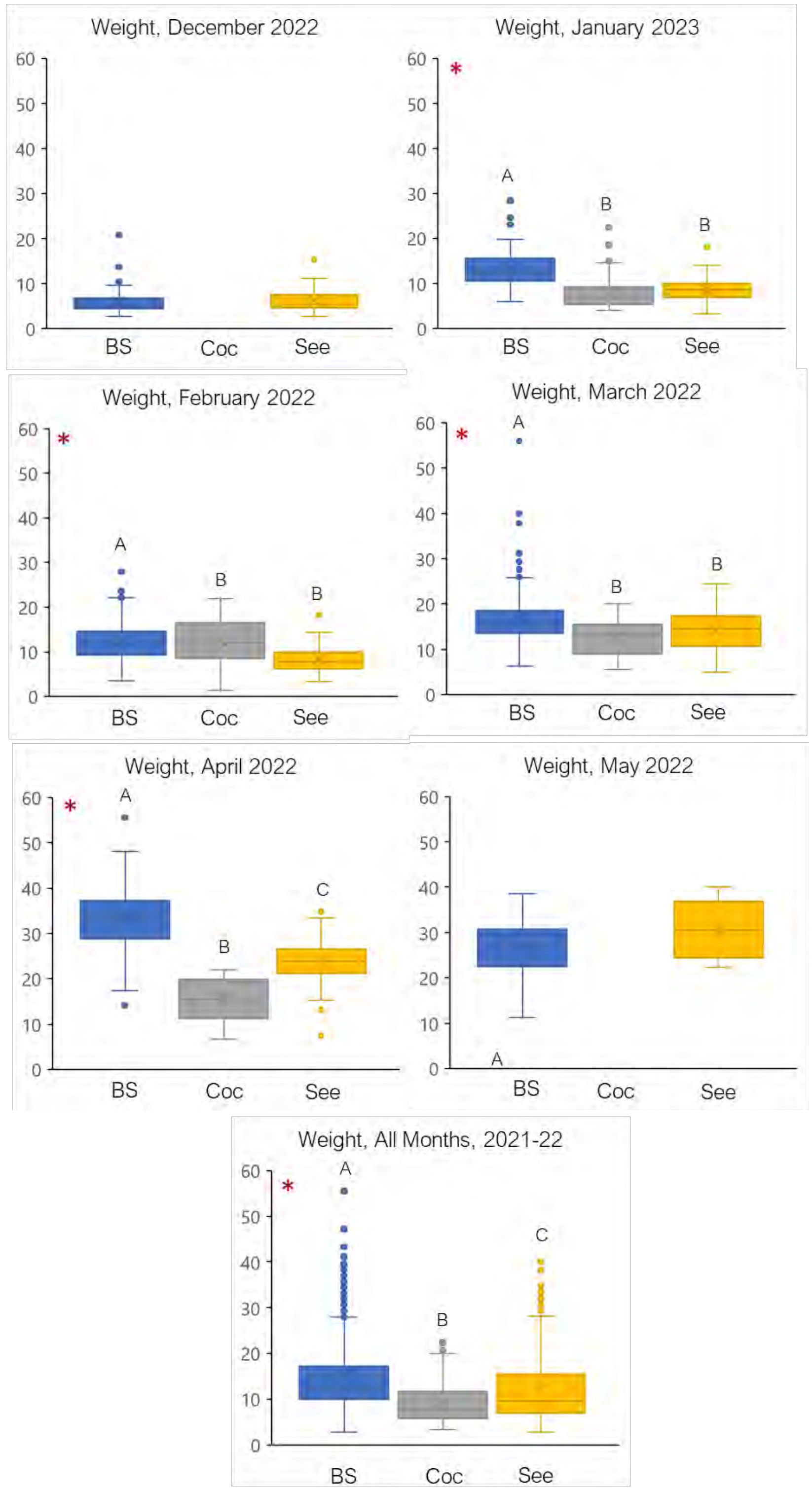

Figure 37. Box plots of whole-body wet weight (grams) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See) in the 2022-23 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.05 in Dec, May; 0.017 in Jan-Apr & All Months).*

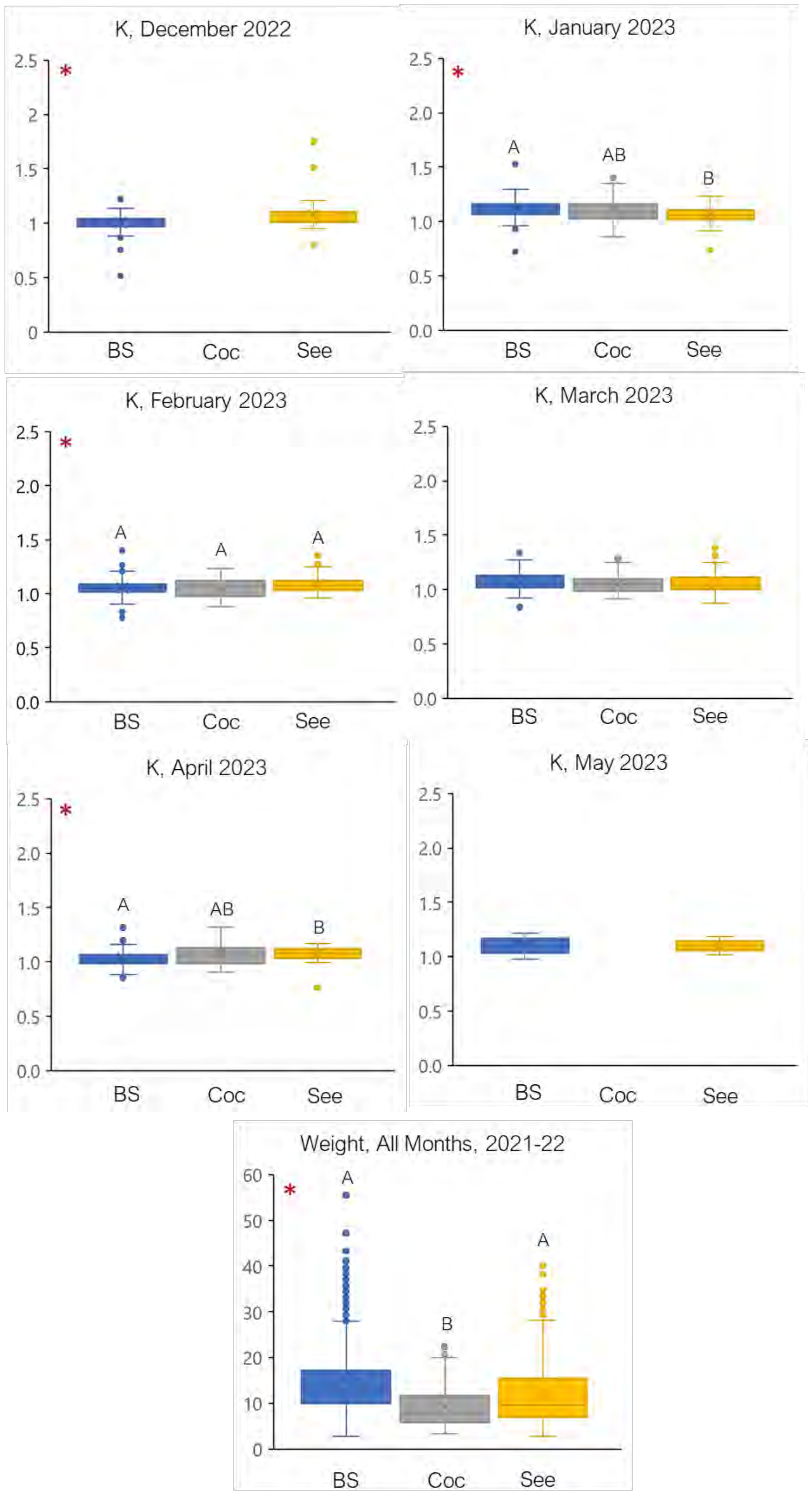

Figure 38. Box plots of Fulton's Condition Factor (K, nondimensional) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See) in the 2022-23 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.05 in Dec, May; 0.017 in Jan-Apr & All Months). Post-hoc comparisons could not identify homogeneous groupings in February at p* = 0.017.*

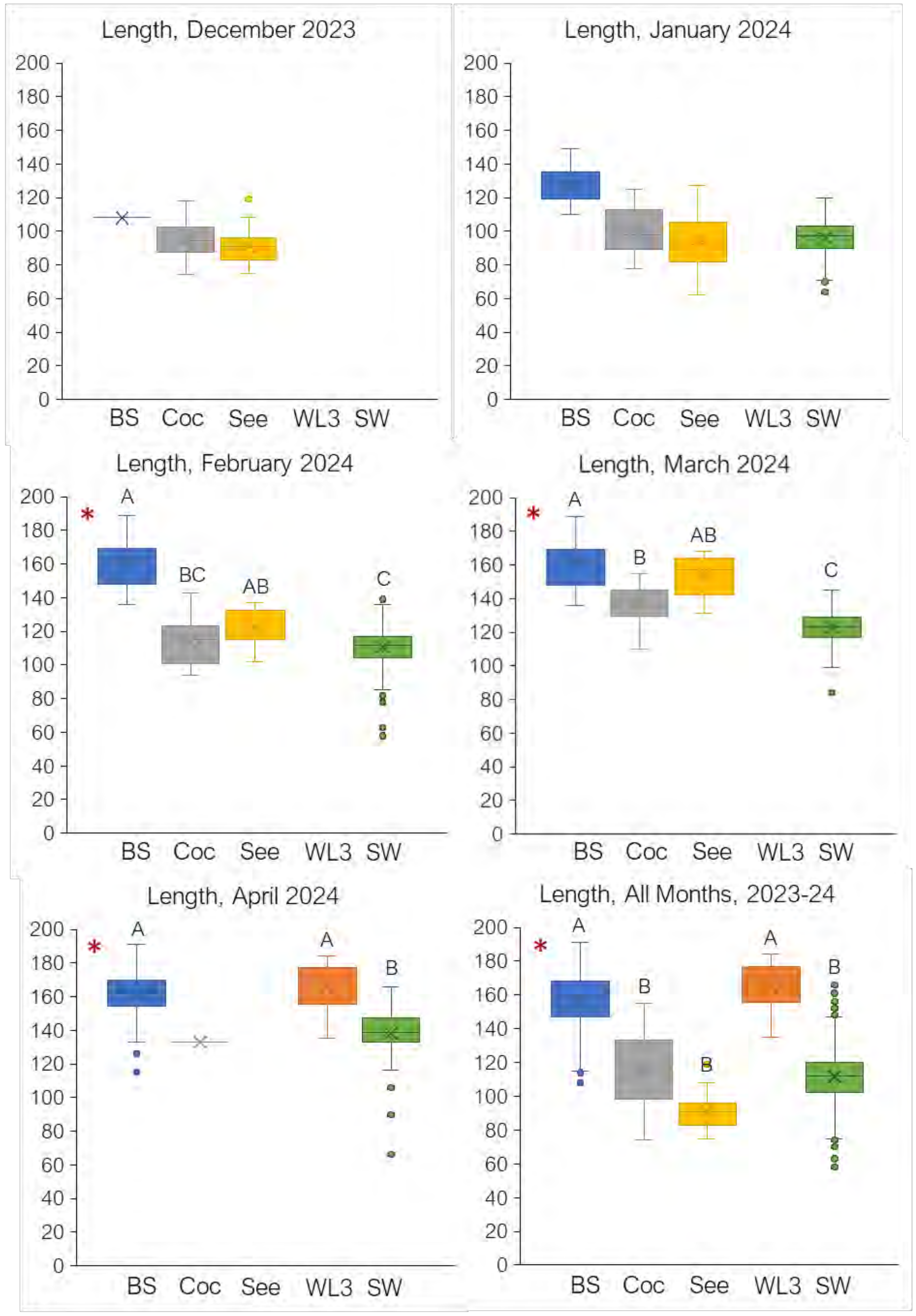

Figure 39. Box plots of fork length (mm) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See), Winter Lake Unit 3, and off-channel seasonal wetlands (SW) in the 2023-24 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, (p = 0.003 in Feb & Mar;, 0.017 in April, and 0.01 All Months)*

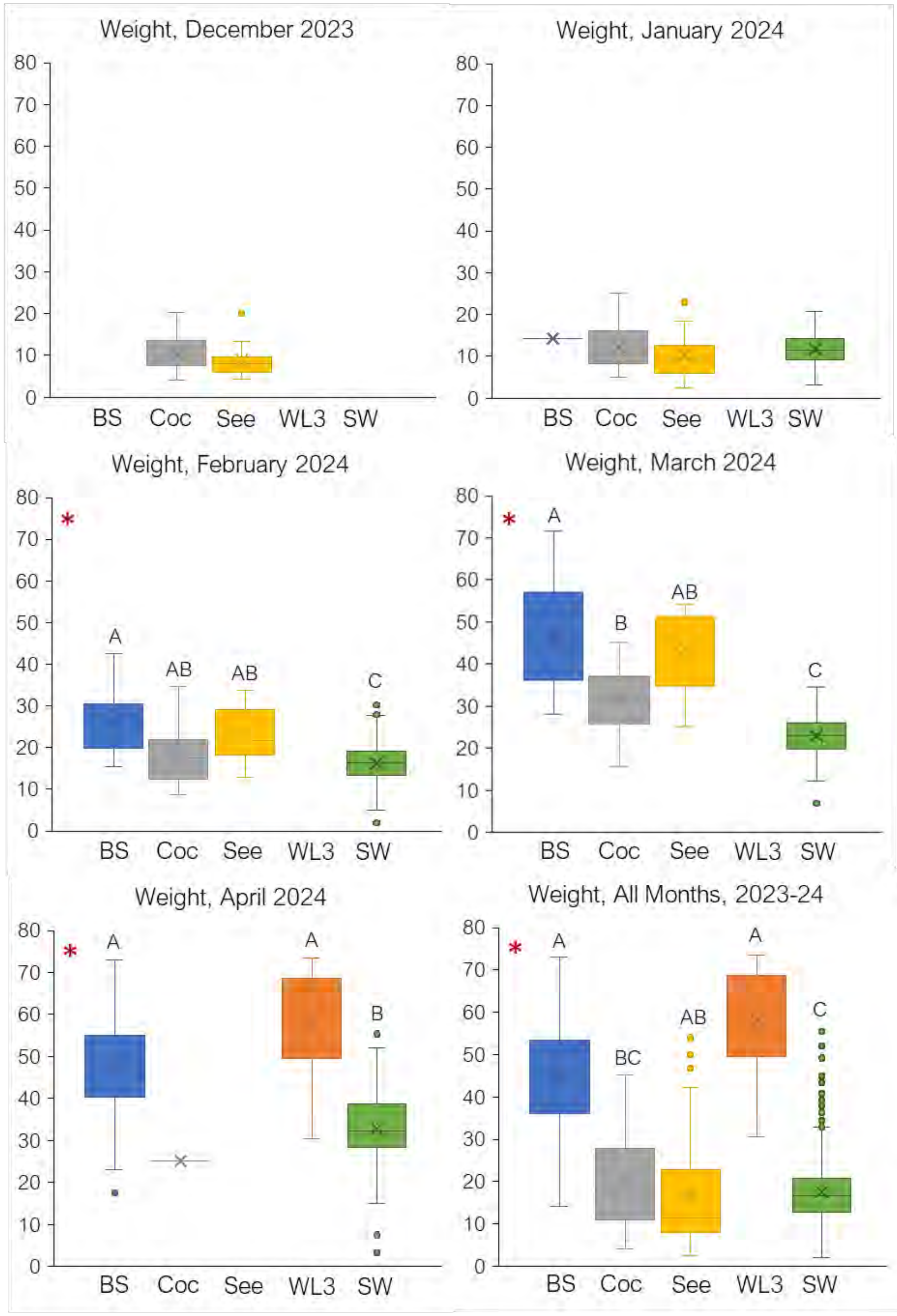

Figure 40. Box plots of whole-body wet weight (grams) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See), Winter Lake Unit 3, and off-channel seasonal wetlands (SW) in the 2023-24 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise

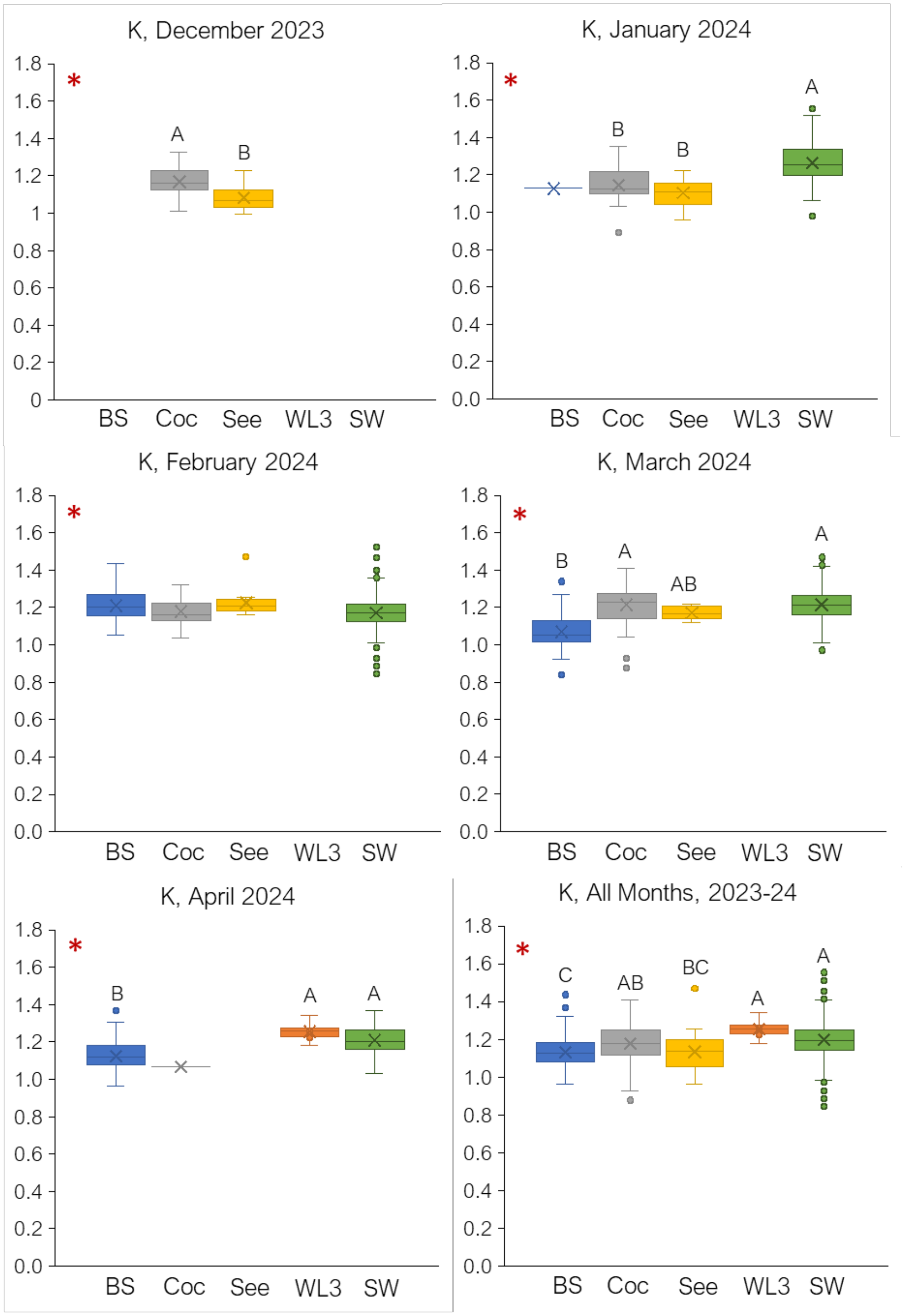

Figure 41. Box plots of Fulton's Condition Factor (K, nondimensional) by month and pooled across months for Beaver Slough (BS), Cochran (Coc), and Seestrom (See), Winter Lake Unit 3, and off-channel seasonal wetlands (SW) in the 2023-25 season. An asterisk (*) indicates significant Kruskall-Wallis tests. Letters (A, B, C) above boxes indicate homogenous groups identified through post-hoc pairwise comparisons with Bonferroni-adjusted p-values, p (p* = 0.013 in Feb & Mar; 0.017 in Apr; 0.01 All Months).*

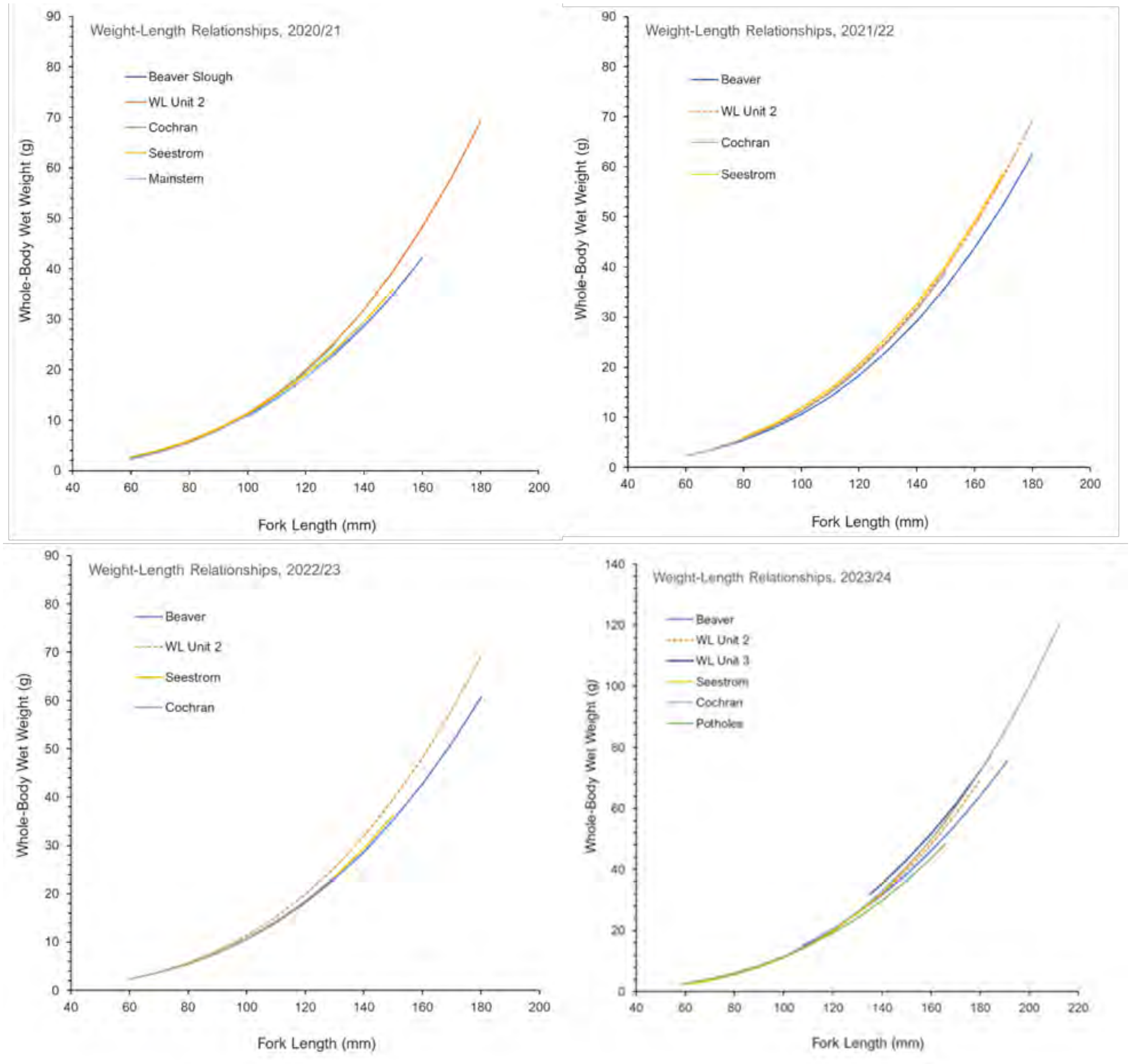

Figure 42. Weight-Length Relationships for juvenile coho salmon in Beaver Slough, Winter Lake Unit 2, Cochran, Seestrom, and the Mainstem Coquille River during the 2020-21 (upper left panel), 2021-22 (upper right panel), 2022-23 (lower left panel), and 2023-24 seasons. Data points are omitted for figure clarity. Curves span the length ranges observed at each site. The relationship was not generated for the mainstem or Winter Lake Unit 2 after the 2020-21 season due to insufficient captures. The 2020-21 curve for Unit 2 is shown as a dashed line for comparison other seasons.

E. Growth

In the 2020-21 season, 23 tagged fish were recaptured, and no fish were recaptured more than once. During the 2021-22 sampling season, 70 tagged fish were recaptured after their initial capture and tagging. Ten fish were recaptured twice after tagging and one was recaptured three times after tagging. In the 2022-23 season, 80 fish were recaptured after their initial tagging event. Five fish in Beaver Slough were recaptured twice. In previous years, most recaptures occurred at the location of tagging. However, in the 2023-24 season, no fish were recaptured at three fish were recaptured at locations different from their initial capture location. Only 7, 1, and 1 fish were recaptured in 2023-24 at Cochran, Beaver, and Seestrom, respectively. However, it is notable that one fish tagged at 162 mm in Beaver Slough in March, 2024 was caught as a jack (427 mm) by an ODFW district biologist in October, 2024.

Rates of growth calculated from single-site recaptured individuals at Winter Lake Unit 2, Beaver Slough, Seestrom, and Cochran were similar to those inferred by regression of mean lengths and weights across sampling events in the first season (2020-21; Table 15). However, small sample sizes for recaptured individuals and, in some cases, relatively few successful capture events or low captures in some events limited the precision of estimates (Table 15). After the 2021-22 season, rates of growth calculated from recaptured individuals have differed, sometimes substantially, from estimates inferred by regression of mean lengths and weights across sampling seasons (Table 15). These discrepancies likely arise from two potential causes. First, growth in length and weight tends to be very slow prior to mid-March, after which it accelerates rapidly. A bias in recaptures toward fish capture-recapture intervals late in the season may skew recapture-based averages higher than estimates determined from sampling intervals. Second, growth increments measured at a recapture interval of less than approximately 28-30 days appear to be subject to considerable variability, likely due to the substantial influence of measurement error on small growth increments, especially prior to the mid-March increase in growth rates.

Variation in growth rates between Coastal Coho migratory life histories provides a qualitative reference for historical productivity as well as current and future habitat restoration (Hall et al 2023, Nickelson 2012). As tidal habitat restoration projects across the region are implemented and mature, further examination of off channel and tidal habitats productivity between neighboring Basins can inform realized benefits for Coho salmon populations. For this analysis Coho smolts, defined as juveniles with Fork Length >=89mm, were aggregated by concurrent week of the year across 4 years (2021-24) in three South Coast Basins, Figure 43. Umpqua and Coos data are from 3 Life Cycle Monitoring rotary screw trap locations: one operated by ODFW in the West Fork Smith River, a tidal tributary to the lower Umpqua and two by Coos Watershed Association in Palouse and Willanch Creeks, both Coos Bay tributaries. Coquille Basin hoop trap and seine sampling was divided into three categories of Location: Valley, Tributary and EF-NF Off Channel. Valley locations include; Winter Lake Unit 2 with 7 sites and Beaver Creek with 3 sites. Coquille Tributaries includes 2 sites that are Coquille River Valley tributaries Seestrom and Cochran. EF-NF Off Channel sites, sampled only in 2024, are smaller pasture pond sites above and below the confluence of the East and North Forks of the Couquille River.

Table 15. Growth in length (Δ length, %·d^{-1}) and weight (Δ length, %·d^{-1}) determined from the growth of tagged and recaptured individuals and inferred from the mean length or weight of fish captured at fish sampling events at each location. Confidence intervals are shown in parentheses. Growth has not calculated Winter Lake Unit 2 since 2020-21 due to low or no captures.

Location	Season	Source	Δ length (%·d^{-1})	Δ weight (%·d^{-1})
Beaver Slough	2020-21	Inferred Growth (11 events)	0.41 (±0.16)	1.16 (±0.53)
		Recapture Growth (n = 3)	0.40 (±0.14)	1.25 (±0.39)
	2021-22	Inferred Growth (18 events)	0.31 (±0.08)	0.89 (±0.26)
		Recapture Growth (n = 68)	0.45 (±0.04)	1.77 (±0.21)
	2022-23	Inferred Growth (12 events)	0.41 (±0.07)	1.19 (±0.24)
		Recapture Growth (n = 64)[i]	0.45 (±0.04)	1.57 (±0.22)
	2023-24	Inferred Growth (8 events)	0.40 (±0.23)	1.12 (±0.68)
		Recapture Growth (n = 1)	0.94	2.76
Winter Lake Unit 2	2020-21	Inferred Growth (13 events)	0.38 (±0.11)	1.20 (±0.33)
		Recaptures (n = 4)[ii]	0.73 (±0.30)	2.67 (±1.43)
	2021-22	NA	NA	NA
		NA	NA	NA
	2022-23	NA	NA	NA
		NA	NA	NA
	2023-24	NA	NA	NA
		NA	NA	NA
Cochran	2020-21	Inferred Growth (4 events)	0.25 (±0.60)	0.78 (±0.14)
		Recaptures (n = 5)	0.51 (±0.04)	1.99 (±0.15)
	2021-22	Inferred Growth (8 events)	0.28 (±0.15)	0.82 (±0.41)
		Recaptures (n = 9)	0.71 (±0.13)	2.26 (±0.54)
	2022-23	Inferred Growth (7 events)	0.23 (±0.17)	0.64 (±0.61)
		Recaptures (n = 5)	0.41 (±0.08)	1.31 (±0.35)
	2023-24	Inferred Growth (7 events)	0.37 (±0.12)	1.09 (±0.45)
		Recapture Growth (n = 8)	0.69 (±0.16)	1.42 (±0.98)
Seestrom	2020-21	Inferred Growth (5 events)	0.29 (±0.14)	0.80 (±0.22)
		Recaptures (n = 8)	0.24 (±0.04)	1.64 (±0.51)
	2021-22	Inferred Growth (10 events)	0.31 (±0.12)	0.94 (±0.39)
		Recaptures (n = 4)[iii]	1.06 (±0.25)	2.90 (±0.95)
	2022-23	Inferred Growth (9 events)	0.39 (±0.08)	1.19 (±0.26)
		Recaptures (n = 10)	0.54 (±0.13)	1.84 (±0.52)
	2023-24	Inferred Growth (4 events)	0.60 (±0.25)	0.79 (±0.4)
		Recapture Growth (n = 1)	0.44	2.47
Wetlands	2023-24	Inferred Growth (9 events)[iv]	0.42 (±0.13)	1.23 (±0.30)
		Recapture Growth (n = 181)	0.67 (±0.03)	2.02 (±0.14)

[i] Includes 5, 2X recaptures; Excludes 2 fish recaptured within a day of initial capture.
[ii] 3 of 4 recaptures in WL Unit 2 were fish relocated from Beaver Slough.
[iii] 5 tagged coho were recaptured at Seestrom; one was not included in the analysis because it was recaptured after only one day at large.
[iv] Excludes a smaller-sized cohort that appeared late in the season.

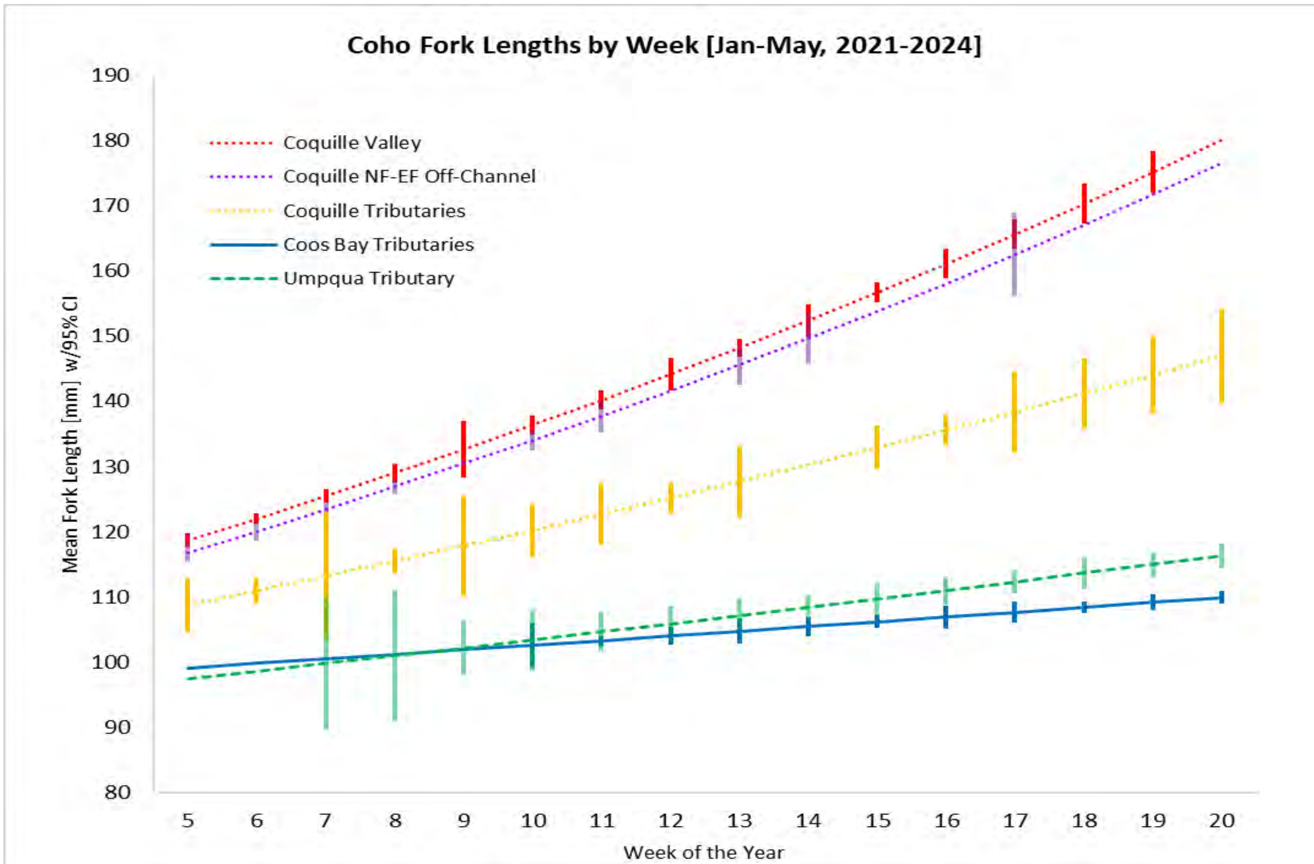

Figure 43. An exponential model to predict weekly juvenile salmonid growth at the four locations with different Coastal Coho migratory life histories. Umpqua and Coos data are from 3 Life Cycle Monitoring rotary screw trap locations: one operated by ODFW in the West Fork Smith River, a tidal tributary to the lower Umpqua and two by Coos Watershed Association in Palouse and Willanch Creeks, both Coos Bay tributaries. Coquille Basin hoop trap and seine sampling was divided into three categories of Location: Valley, Tributary and EF-NF Off Channel. Valley locations include; Winter Lake Unit 2 with 7 sites and Beaver Creek with 3 sites. Coquille Tributaries includes 2 sites that are Coquille River Valley tributaries Seestrom and Cochran. EF-NF Off Channel sites, sampled only in 2024, are smaller pasture pond sites above and below the confluence of the East and North Forks of the Couquille River.

F. Survival

Actual losses to mortality could not be separated from apparent losses due to the failure of the antenna arrays to detect some individuals. The percentage of tagged fish detected at antenna arrays will be considered minimum rates of survival until the detection efficiency of the antenna arrays can be determined. Regardless, a large proportion of tagged individuals were subsequently detected at the tide gates at Seestrom (2020-21 = 82%; 2021-22 = 88%; 2022-23 = 64%; 2023-24 = 95%), Cochran (2020-21 = 91%; 2021-22 = 88%; 2022-23 = 90%; 2023-24 = 88%), and Beaver Slough (2021-22[6] = 88%; 2022-23 = 64%; 2023-24 = 77%) (Table 16-19; Figure 44). The overall proportion of tagged fish subsequently detected at tide gate PIT antenna arrays was much lower at Winter Lake Unit 2 (2020-21 = 19%; 2021-22 = 17%; 2022-23 = 33%; 2023-24 = 34%) Unit 3 (2023-24 = 38%) than at the other locations (Table 16-19; Figure 44). This lower detection proportion may be attributable to higher mortality in the Winter Lake

[6] The 2021-22 season was the first season of operation for the Coaledo PIT antenna array at Beaver Slough.

units, lower detection efficiency at the Winter Lake PIT antenna arrays, or both. Estimates of detection probability will be necessary to further assess this persistent discrepancy in detection proportions at Winter Lake relative to the other locations. Likewise, lower proportional detections of fish at Seestrom and Beaver Slough relative to previous seasons may be due to higher mortality, lower detection efficiency, or both during the 2022-23 season.

Table 16. Time (days) elapsed from tagging to final detection (single site coho) and the percentage of tagged fish detected at the tide gate PIT tag antenna arrays by month and location in the 2020-21 sampling season.

	Month	Number Tagged	Time to Final Detection, Days		Percent of Tagged Fish Detected at Gate
			Avg ± 95% CI	Range	
Winter Lake Unit 2	December	5	NA	NA	0
	January	5	61 ± NA	NA	20
	February	2	NA	NA	0
	March	131[i]	22 ± 6	8 to 35	12
	April	77[i,ii]	10 ± 4	1 to 29	32
	May	0	NA	NA	NA
Cochran	December	0	NA	NA	NA
	January	48	11 ± 4	0 to 82	98
	February	76	4 ± 2	0 to 31	87
	March	0	NA	NA	NA
	April	15	4 ± 1	1 to 10	93
	May	0	NA	NA	NA
Seestrom	December	30	28 ± 10	0 to 74	67
	January	14	31 ± 11	12 to 57	79
	February	69	25 ± 5	1 to 70	90
	March	97	13 ± 3	1 to 47	76
	April	56	9 ± 2	1 to 31	89
	May	4[ii]	6 ± 7	1 to 15	100

[i]Fish tagged at Winter Lake in March and April include fish captured at Beaver Slough and relocated on the tagging date to Winter Lake Unit 2).
[ii]Fish tagged in May at Seestrom were juvenile Chinook salmon (n =4); fish tagged in April at Winter Lake Unit 2 include 21 Chinook salmon.

Table 17. Time (days) elapsed from tagging to final detection (single site coho) and the percentage of tagged fish detected at the tide gate PIT tag antenna arrays by month and location in the 2021-22 sampling season.

	Month	Number Tagged	Time to Final Detection, Days		Percent of Tagged Fish Detected at Gate
			Avg ± 95% CI	Range	
Winter Lake Unit 2[i]	December	0	NA	NA	NA
	January	53	7 ± 11	N/A	4
	February	109	30 ± 16	N/A	5
	March	50	12 ± 5	8 to 35	40
	April	45	11 ± 4	1 to 29	36
	May	0	NA	NA	NA
Beaver	December	0	NA	NA	NA
	January	47	65 ± 13	1 to 124	87
	February	298	48 ± 4	1 to 114	86
	March	108	41± 4	1 to 79	92
	April	64	28 ± 3	1 to 49	95
	May	13	7 ± 3	3 to 17	77
Cochran	December	2	5 ± 5	3 to 7	100
	January	138	7 ± 2	1 to 77	86
	February	4	11 ± 18	1 to 38	100
	March	15	18 ± 11	<1 to 56	100
	April	20	13 ± 7	1 to 45	95
	May	0	NA	NA	NA
Seestrom	December	9	58 ± 24	1 to 104	78
	January	21	24 ± 16	1 to 92	95
	February	2	39 ± 74	1 to 77	100
	March	8	33 ± 13	7 to 62	100
	April	32	9 ± 4	1 to 34	84
	May	11	2 ± 0.4	1 to 3	82

[i]Fish tagged at Winter Lake include fish captured at Beaver Slough and relocated on the tagging date to Winter Lake Unit 2.

Table 18. Time (days) elapsed from tagging to final detection (single site coho) and the percentage of tagged fish detected at the tide gate PIT tag antenna arrays by month and location in the 2022-23 sampling season.

	Month	Number Tagged	Time to Final Detection, Days		Percent of Tagged Fish Detected at Gate
			Avg ± 95% CI	Range	
Winter Lake Unit 2[i]	December	0	NA	NA	NA
	January	50	38 ± 16	1 to 91	40
	February	147	22 ± 9	0 to 74	29
	March	50	51 ± 3	37 to 53	25
	April	45	4 ± 1	1 to 7	43
	May	0	NA	NA	NA
Beaver	December	76	86 ± 15	0 to 149	47
	January	33	60 ± 15	7 to 107	61
	February	246	36 ± 5	0 to 109	70
	March	40	43 ± 5	2 to 55	57
	April	32	7 ± 2	2 to 11	50
	May	0	NA	NA	NA
Cochran	December	0	NA	NA	NA
	January	175	15 ± 5	0 to 127	88
	February	10	7 ± 16	3 to 59	80
	March	30	8 ± 5	1 to 42	93
	April	31	4 ± 3	0 to 27	90
	May	0	NA	NA	NA
Seestrom	December	34	77 ± 43	30 to 120	12
	January	116	46 ± 10	1 to 121	44
	February	42	18 ± 9	0 to 92	90
	March	56	28 ± 7	0 to 67	79
	April	48	11± 2	4 to 25	88
	May	20	4 ± 3	1 to 25	80

[i]Fish tagged at Winter Lake include fish captured at Beaver Slough and relocated on the tagging date to Winter Lake Unit 2.

Table 19. Time (days) elapsed from tagging to final detection (single site coho) and the percentage of tagged fish detected at the tide gate PIT tag antenna arrays by month and location in the 2023-24 sampling season.

	Month	Number Tagged	Time to Final Detection, Days		Percent of Tagged Fish Detected at Gate
			Avg ± 95% CI	Range	
Winter Lake Unit 2[i]	December	0	NA	NA	NA
	January	0	NA	NA	NA
	February	0	NA	NA	NA
	March	1	NA	NA	0
	April	31	8 ± 3	2 to 18	35
	May	0	NA	NA	NA
Winter Lake Unit 3	December	0	NA	NA	NA
	January	0	NA	NA	NA
	February	0	NA	NA	NA
	March	0	NA	NA	NA
	April	8	5 ± 1	4 to 6	38
	May	0	NA	NA	NA
Beaver	December	9	NA	NA	0
	January	1	75	75	100
	February	24	40 ± 5	22 to 53	88
	March	29	16 ± 4	1 to 37	90
	April	98	12 ± 2	1 to 39	78
	May	0	NA	NA	NA
Cochran	December	13	18 ± 12	1 to 53	85
	January	41	27 ± 8	1 to 93	88
	February	29	12 ± 3	1 to 34	90
	March	12	8 ± 5	1 to 23	83
	April	1	1	1	100
	May	0	NA	NA	NA
Seestrom	December	22	53 ± 16	1 to 110	95
	January	14	56 ± 13	21 to 85	100
	February	13	22 ± 8	1 to 43	92
	March	9	4 ± 1	3 to 5	89
	April	0	NA	NA	NA
	May	0	NA	NA	NA

[i]Fish tagged at Winter Lake Unit 2 were fish captured at Beaver Slough and relocated on the tagging date to Unit 2.

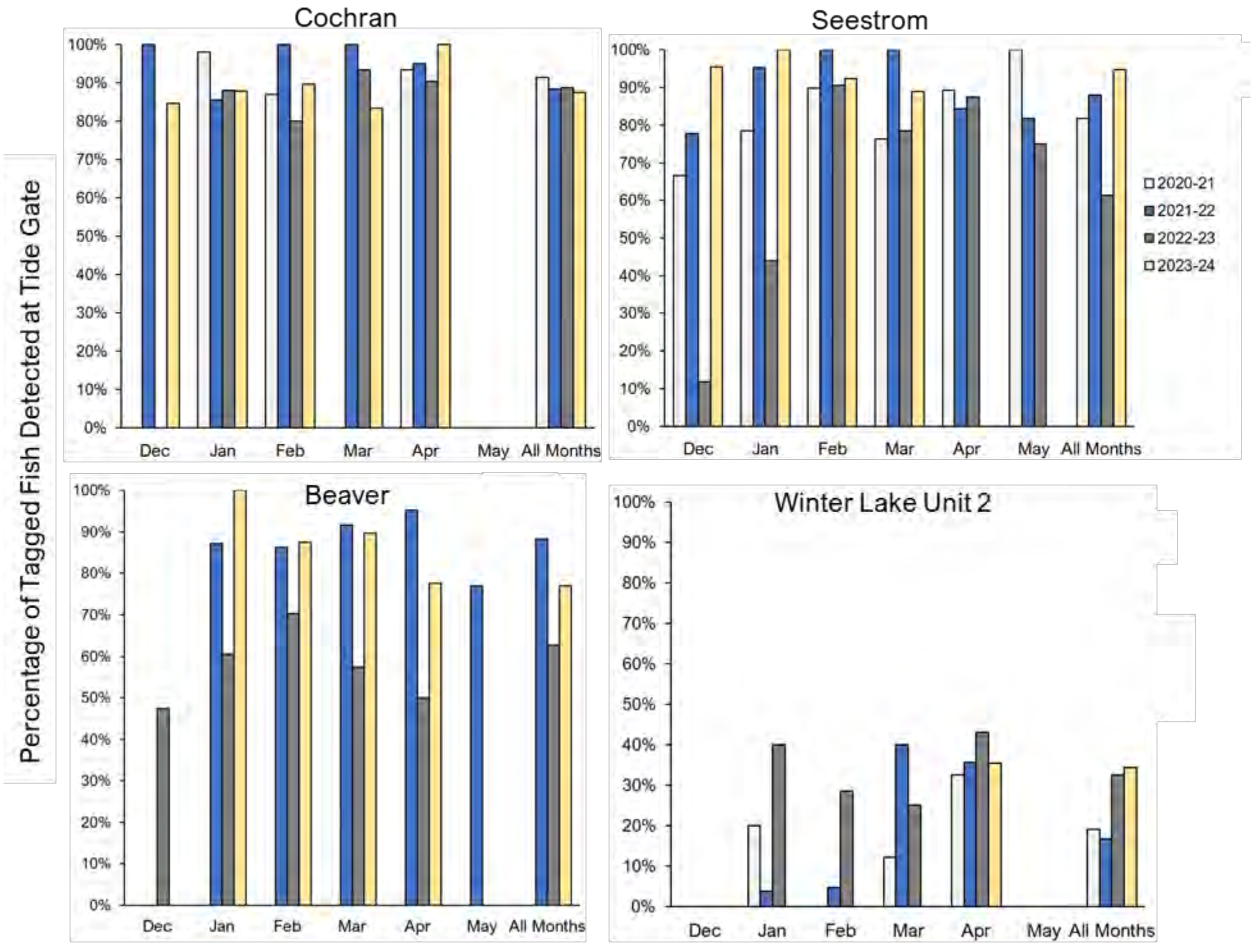

Figure 44. Percent of tagged single-site fish detected at tide-gate antenna arrays by tagging month for each location in 2020-21 (light gray bars), 2021-22 (blue bars), 2022-23 (dark gray bars), and 2023-24 (gold bars). The antenna array at Beaver Slough was first operated during the 2021-22 season. Figures include only single-site fish.

G. Movement and Passage

The following is a summary of tagging and detection data from the 2023-24 season.

Early Season Tagging - Laverne Park

2021-22: 81 juvenile coho were tagged at Laverne Park in September and October 2021. Three of these fish (4%) were subsequently detected at antenna arrays at Winter Lake Unit 1 (n = 1) and Beaver Slough (n = 2).

2022-23: In September and October of 2022, 157 juvenile Coho were tagged at Laverne Park. Four of these fish (1%) were later detected at antenna arrays at Beaver Slough (n = 2) and Seestrom (n = 2).

2023-24: No fish were tagged at Laverne Park in the 2023-24 season.

Mainstem Translocations

2021-22: 399 juvenile coho were tagged and translocated from Beaver Slough to the mainstem Coquille River approximately 17 miles upstream from Winter Lake (Bryant Boat Ramp). Sixty-eight of these fish (17%) were eventually detected back at the Coaledo array at Beaver Slough. Nine of the returns to Beaver Slough also stopped at other sites prior to detection at Coaledo. Fourteen of the translocated fish were detected at Winter Lake Unit 1, two at Winter Lake Unit 2, 32 at Winter Lake Unit 3, and two at Seestrom. No fish translocated to the mainstem were detected at Cochran.

2022-23: 428 juvenile coho were tagged and translocated from Beaver Slough to the same location on the mainstem Coquille River. Sixty-eight of these fish (16%) were eventually detected back at the Coaledo array at Beaver Slough. Nineteen of the translocated fish were detected at Winter Lake Unit 2, 33 at Winter Lake Unit 3, nine at Seestrom, and two at Cochran. No fish translocated to the mainstem were detected at Winter Lake Unit 1.

2023-24: No juvenile coho salmon were translocated to the mainstem from Beaver Slough. However, 497 juvenile coho salmon were tagged and translocated from seasonal pothole wetlands to the mainstem Coquille River. Seven (1.4%) of these fish were subsequently detected at Beaver Slough. An additional 396 tagged juvenile coho were released back into the wetland locations. One (0.3%) of these fish was subsequently detected at Beaver Slough. All of these fish were tagged on the same date (2/13/24) but were first detected at Beaver Slough at dates ranging from 2/19/24 to 5/11/2024.

Winter Lake Unit 1

2021-22: Although no coho were tagged at Winter Lake Unit 1, 48 individuals (all coho) were detected at the Unit 1 PIT antenna array. None of these fish were tagged in Unit 1. Five were originally tagged and released at Cochran, five at Seestrom, four at Beaver Slough and one in the mainstem Coquille River at Laverne Park. Fourteen of the coho detected at Unit 1 were fish that had been captured at Beaver Slough and translocated to the mainstem, and 19 were fish that had been translocated from Beaver Slough into Winter Lake Unit 2. One fish was detected in Unit 1 on two separate events before and after detection at another location.

2022-23: No coho were tagged at Winter Lake Unit 1. However, one juvenile coho that was initially captured and tagged in Beaver Slough and released into Unit 2 was subsequently detected at the Unit 1 PIT antenna.

2023-24: No coho were tagged or detected in Winter Lake Unit 1.

Winter Lake Unit 2

2021-22: Only two coho were initially captured and tagged in Winter Lake Unit 2, but 255 juvenile coho were tagged and translocated from Beaver Slough to Unit 2. Fifty-three individuals, all coho, were detected at the Unit 2 PIT antenna array. One was originally tagged and released in Unit 2, while six were originally tagged and released back into Beaver Slough. Two of the coho detected at the Unit 2 antenna array were fish that had been captured at Beaver Slough and translocated to the mainstem, and 44 were fish that had been translocated from Beaver Slough into Unit 2.

2022-23: Only one juvenile coho salmon was captured and tagged in Winter Lake Unit 2, but 291 tagged juvenile coho were translocated from Beaver Slough to Unit 2. One hundred and twenty-nine coho were detected at the Unit 2 PIT antenna array. One was originally tagged and released in Cochran, four in Seestrom, and nine in Beaver Slough. Nineteen of the coho detected at the Unit 2 antenna array were fish that had been captured at Beaver Slough and translocated to the mainstem, and 96 were fish that had been translocated from Beaver Slough into Unit 2.

2023-24: No juvenile coho salmon were captured and tagged in Winter Lake Unit 2. However, 32 tagged juvenile coho were translocated from Beaver Slough to Unit 2. Eleven of these fish were subsequently detected at Unit 2 PIT arrays. No fish tagged at other sites were detected at Unit 2 arrays.

Winter Lake Unit 3

2021-22: Only one juvenile coho was initially captured and tagged in Winter Lake Unit 3, but 68 individuals, all coho, were detected at the Unit 3 PIT antenna array during the 2021-22 season. One was originally tagged and released in Unit 3, while three were originally tagged and released at Cochran, one at Seestrom, and eight in Beaver Slough. Thirty-two of the coho detected at Unit 3 were fish that had been captured at Beaver Slough and translocated to the mainstem, and 23 were fish that had been translocated from Beaver Slough into Unit 2.

2022-23: No juvenile coho salmon were tagged and released in Winter Lake Unit 3. However, 89 fish were detected at the Unit 3 PIT antenna array. Six were originally tagged and released at Cochran, eight at Seestrom, and 23 at Beaver Slough. Thirty-three of the coho detected at Unit 3 were fish that had been captured at Beaver Slough and translocated to the mainstem, and 19 were fish that had been translocated from Beaver Slough into Unit 2.

2023-24: Eight juvenile coho salmon were tagged and released in Winter Lake Unit 3 on a single date (4/4/2024). Three of these fish were subsequently detected at Unit 3 PIT arrays. No fish tagged at other sites were detected at Unit 3 arrays.

Cochran

2021-22: 168 juvenile coho were tagged at Cochran, and 162 individuals, all coho, were detected at the Cochran PIT antenna array. Of these, 158 were coho originally tagged and released at the Cochran location, while three were originally tagged and released at Seestrom and one at Beaver Slough. Two fish were detected at the Cochran array on two separate events before and after detection at another location. No fish that were translocated from Beaver Slough into the mainstem or Winter Lake Unit 2 were detected at the Cochran array.

2022-23: 241 juvenile coho were tagged at Cochran, and 229 individuals were detected at the Cochran PIT antenna array. Of these, 218 were coho originally tagged and released at the Cochran location, while eight were originally tagged and released at Seestrom and one at Beaver Slough. Two fish detected at the Cochran array had been translocated from Beaver Slough into the mainstem.

2023-24: 96 juvenile coho salmon were tagged and released back into the Cochran location. In all, 86 individuals were detected at the PIT array; 85 originated from Cochran and 1 from Seestrom.

Seestrom

2021-22: 83 juvenile coho were tagged at Seestrom, and 108 coho were detected at the antenna array. Of these, 73 were coho originally tagged and released at the Seestrom location, while 28 were originally tagged and released at Cochran, and three at Beaver Slough. Two were fish that had been translocated from Beaver Slough into the mainstem, and two were fish that had been translocated from Beaver Slough to Unit 2. Three fish were detected at the Seestrom array on two separate events before and after detection at another location.

2022-23: 304 juvenile coho were tagged at Seestrom, and 224 coho were detected at the antenna array. Of these, 195 were coho originally tagged and released at the Seestrom location, while sixteen were originally tagged and released at Cochran, and one at Beaver Slough. Nine were fish that had been translocated from Beaver Slough into the mainstem, and one was a fish that had been translocated from Beaver Slough to Unit 2.

2023-24: 57 juvenile coho salmon were tagged and released at Seestrom. In this season, 63 individuals were detected at the PIT array with 55 originating from Seestrom and 8 from Cochran.

Beaver Slough

2021-22: 526 juvenile coho were tagged and released at Beaver Slough, and 576 coho were detected at the antenna array. Of these, 469 had been originally tagged and released in Beaver Slough, while three were originally tagged and released at Seestrom, seven at Cochran, and two in the mainstem Coquille River at Laverne Park. Sixty-eight of the 428 juvenile coho (16%) translocated from Beaver Slough to the mainstem and 27 of the 255 juvenile coho (11%) translocated from Beaver Slough to Winter Lake Unit 2 were detected as returning to Beaver Slough. Four coho were detected at the Coaledo array on two separate events before and after detection at another location.

2022-23: 419 juvenile coho were tagged and released at Beaver Slough, and 370 coho were detected at the antenna array. Of these, 269 had been originally tagged and released in Beaver Slough, while eleven were originally tagged and released at Seestrom, seven at Cochran, and two in the mainstem Coquille River at Laverne Park. Sixty-eight of the 399 juvenile coho (17%) translocated from Beaver Slough to the mainstem and 13 of the 291 juvenile coho (4%) translocated from Beaver Slough to Winter Lake Unit 2 were detected returning to Beaver Slough.

2023-24: 161 juvenile coho salmon were tagged and released back into Beaver Slough. One hundred and thirty-two individuals were detected at the PIT arrays; 124 originated from fish tagged and released back into Beaver Slough, seven were fish captured in pothole wetlands and released in the mainstem Coquille River, and one fish had been tagged and released back into a seasonal wetland.

Post-tagging residence time for single site coho generally decreased through the season at Beaver Slough, Seestrom, and Winter Lake Unit 2 in all years. Short residence times at Winter Lake in January 2022 are likely attributable to low sample size (n = 2). Residence times at Cochran, the smallest location, tended to be brief throughout all years. Residence times for single site coho tended to be longer in larger, more complex habitats (Table 16-19; Figure 45).

In contrast to single-site fish, the juvenile coho that traveled among sites or were detected after translocation to the mainstem, tended to have variable and shorter residence times, on average during the past two seasons (Table 20-21). Many of these fish were detected for relatively brief events. Over the past two seasons (since we have had antenna arrays near the Coaledo tidegate), there has been a tendency for these mobile fish to reside longer at Beaver Slough than other locations (Table 20-21). Most detection events of mobile fish at Beaver Slough in the 2021-22 and 2022-23 seasons involved fish that had been initially captured in Beaver Slough but translocated to Winter Lake Unit 2 or the mainstem Coquille River. Low numbers of mobile juvenile coho make it difficult to interpret results in 2023-24 (Table 22)

Passage

Detections of juvenile coho were most prevalent from January through April. Below, we summarize conditions during which juvenile coho were present near the tidegates at Cochran, Seestrom, and Beaver Slough. Lower or no detections precluded comparisons of coho presence to conditions near the tidegates at the Winter Lake complex, but summaries of overall conditions are provided.

Cochran

Juvenile coho salmon at the Cochran location showed a clear preference to occupy habitat near the tidegates near sunrise and sunset. Monthly figures show the widening of the duration between peaks as the daylight period lengthens. The gate tended to be open >80% of the hours in each month, but high water led to more protracted closures in January. The presence of juvenile coho salmon at the gate typically coincided with declining upstream water levels (i.e., outflow) or low rates of increasing upstream water levels (Figure 46). Most (96%) detections and 99% of final detections (i.e., presumed exits) occurred when the gate was open.

Seestrom

Juvenile coho salmon at the Seestrom location also showed a clear propensity to be active near the gate near sunrise and sunset. In January and February, detections were more prevalent in the morning than in the evening. In the 2023-24 season, the gate was often closed during preferred morning periods and was closed approximately 50-60% of similar periods in the evening (Figure 47). Only 38% of detections occurred when the gate was open, but 81% of final detections coincided with an open gate.

Beaver

There were no detections at the Coaledo gate in January, but juvenile coho salmon showed a strengthening bimodal distribution of activity near the tidegate in February through April. Near the end of the season, the fish appeared to be the most active near the gate during late evening to early morning, a pattern observed in previous years. The gate was open approximately 50-80% of the time in January, with openness generally higher in February, and more variable in March and April. Detections near the gates tended to coincide with decreasing upstream water levels that are presumed to indicate outflow (Figure 48). At this location, 65% of detections occurred when the gate was open, but 92% of final detections (i.e., presumed exits) coincided with an open gate.

Winter Lake Complex

Detections at Winter Lake PIT arrays were insufficient to delineate a temporal distribution of fish activity in the 2023-24 season. Gates at Winter Lake units 1, 2, and 3, were closed >50 - 60% of time in January. In February, gates were closed more often for much of the day but peaked at approximately 70 – 80% open in late evening. Gate closures were more frequent throughout the day in March and April (Figure 49-51). It should be noted that passage through open slide gates may have been possible.

Table 20. Time (days) elapsed from first to last detection by event and month for mobile coho, including fish translocated to the mainstem in the 2021-22 sampling season. Month is the start of the detection event (assumed entrance to the off-channel habitat location).

	Month	Number of Events	Time to Final Detection, Days	
			Average	Range
Winter Lake Unit 1	December	0	NA	NA
	January	24	13	0 to 115
	February	23	8	0 to 83
	March	1	0	NA
	April	0	NA	NA
	May	1	1.1	NA
Winter Lake Unit 2	December	0	NA	NA
	January	2	0	NA
	February	0	NA	NA
	March	5	1	0 to 3
	April	2	<1	0 to 0.5
	May	0	NA	NA
Winter Lake Unit 3	December	0	NA	NA
	January	10	15	0 to 57
	February	46	12	0 to 62
	March	10	7	0 to 36
	April	2	41	40 to 41
	May	0	NA	NA
Beaver	December	0	NA	NA
	January	16	41	0.1 to 121
	February	45	35	0 to 105
	March	36	33	0 to 72
	April	1	0	NA
	May	6	2	0 to 9
Cochran	December	0	NA	NA
	January	2	0	NA
	February	3	16	<1 to 49
	March	1	NA	NA
	April	0	NA	NA
	May	0	NA	NA
Seestrom	December	0	NA	NA
	January	17	11	0 to 90
	February	15	9	0 to 48
	March	4	12	0 to 45
	April	1	<1	NA
	May	1	<1	NA

Table 21. Time (days) elapsed from first to last detection by event and month for mobile coho, including fish translocated to the mainstem in the 2022-23 sampling season. Month is the start of the detection event (assumed entrance to the off-channel habitat location).

	Month	Number of Events	Time to Final Detection, Days	
			Average	Range
Winter Lake Unit 1	December	0	NA	NA
	January	0	NA	NA
	February	0	NA	NA
	March	0	NA	NA
	April	1	0	NA
	May	0	NA	NA
Winter Lake Unit 2	December	0	NA	NA
	January	2	7	0 to 13
	February	20	10	0 to 76
	March	5	17	0 to 47
	April	2	0	0
	May	0	NA	NA
Winter Lake Unit 3	December	0	NA	NA
	January	8	21	0 to 81
	February	56	18	0 to 72
	March	15	22	0 to 49
	April	8	1	0 to 6
	May	2	0	0
Beaver	December	2	138	127 to 149
	January	6	35	0 to 96
	February	52	27	0 to 83
	March	34	24	0 to 70
	April	6	4	0 to 8
	May	1	0	NA
Cochran	December	1	0	NA
	January	2	<1	0 to 1
	February	2	0	0
	March	6	2	0 to 10
	April	0	NA	NA
	May	0	NA	NA
Seestrom	December	0	NA	NA
	January	3	52	10 to 98
	February	12	16	0 to 96
	March	9	14	0 to 52
	April	2	7	0 to 13
	May	3	2	0 to 6

Table 22. Time (days) elapsed from first to last detection by event and month for mobile coho, including fish translocated to the mainstem in the 2023-24 sampling season. Month is the start of the detection event (assumed entrance to the off-channel habitat location).

	Month	Number of Events	Time to Final Detection, Days	
			Average	Range
Winter Lake Unit 1	December	0	NA	NA
	January	0	NA	NA
	February	0	NA	NA
	March	0	NA	NA
	April	0	NA	NA
	May	0	NA	NA
Winter Lake Unit 2	December	0	NA	NA
	January	0	NA	NA
	February	0	NA	NA
	March	0	NA	NA
	April	0	NA	NA
	May	0	NA	NA
Winter Lake Unit 3	December	0	NA	NA
	January	0	NA	NA
	February	0	NA	NA
	March	0	NA	NA
	April	0	NA	NA
	May	0	NA	NA
Beaver	December	0	NA	NA
	January	0	NA	NA
	February	5	60	42 to 81
	March	1	36	NA
	April	0	NA	NA
	May	2	4	<1 to 8
Cochran	December	0	NA	NA
	January	1	<1	NA
	February	0	NA	NA
	March	0	NA	NA
	April	0	NA	NA
	May	0	NA	NA
Seestrom	December	0	NA	NA
	January	2	52	1 to 48
	February	4	<1	<1
	March	1	24	NA
	April	0	0	NA
	May	0	0	NA

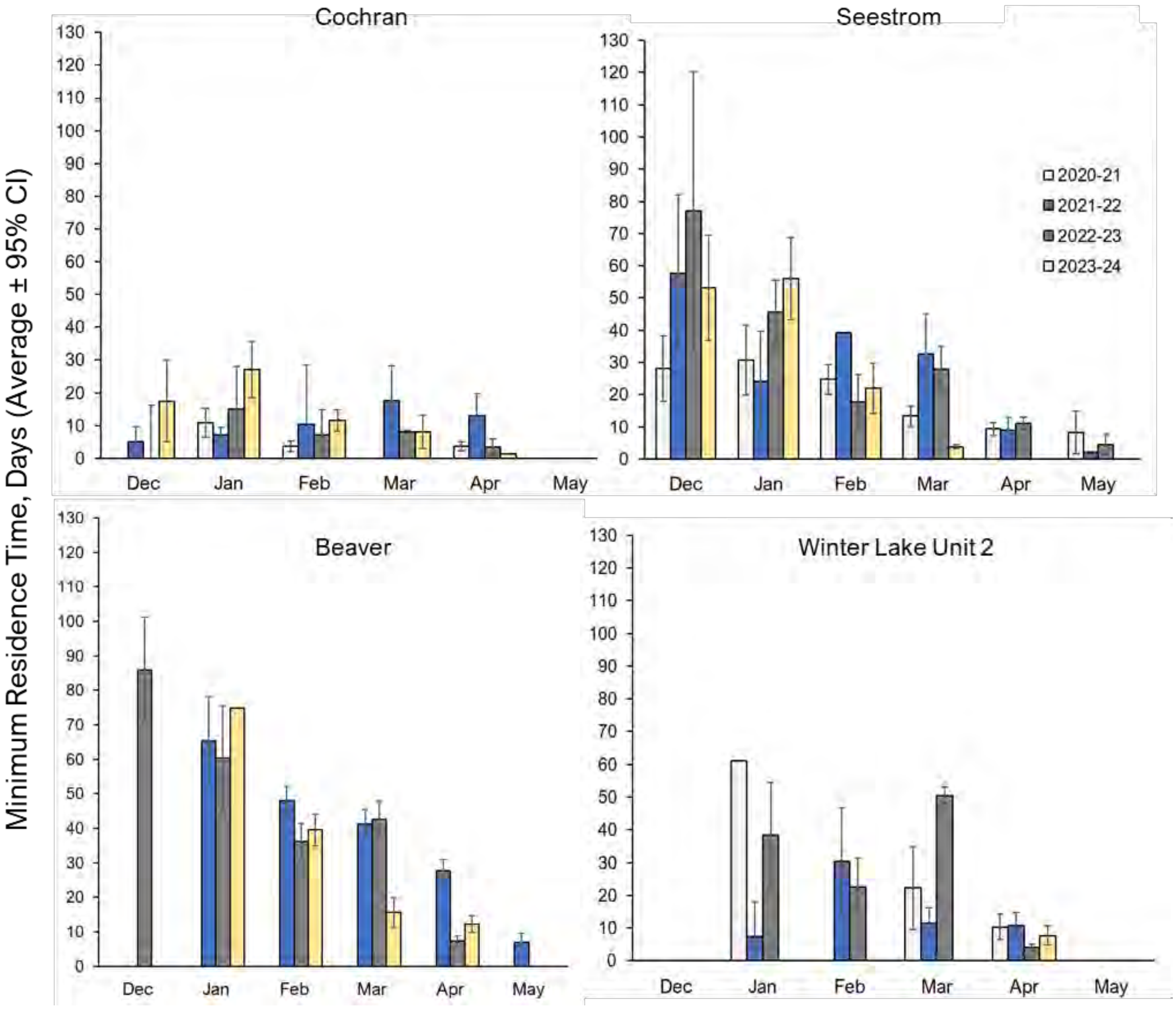

Figure 45. Minimum residence time (average days from tagging until final detection at tide gate arrays), Average ±95% Confidence Intervals in 2020-21 (gray bars), 2021-22 (blue bars), 2022-23 (dark gray bars;), and 2023-24 (gold bars). The antenna array at Beaver Slough was first operated during the 2021-22 season. Months indicate the month of initial capture and tagging. Figures include only single-site fish. Average residence times are considered "minimums" because dates of entry into off-channel sites are unknown for most single site fish.

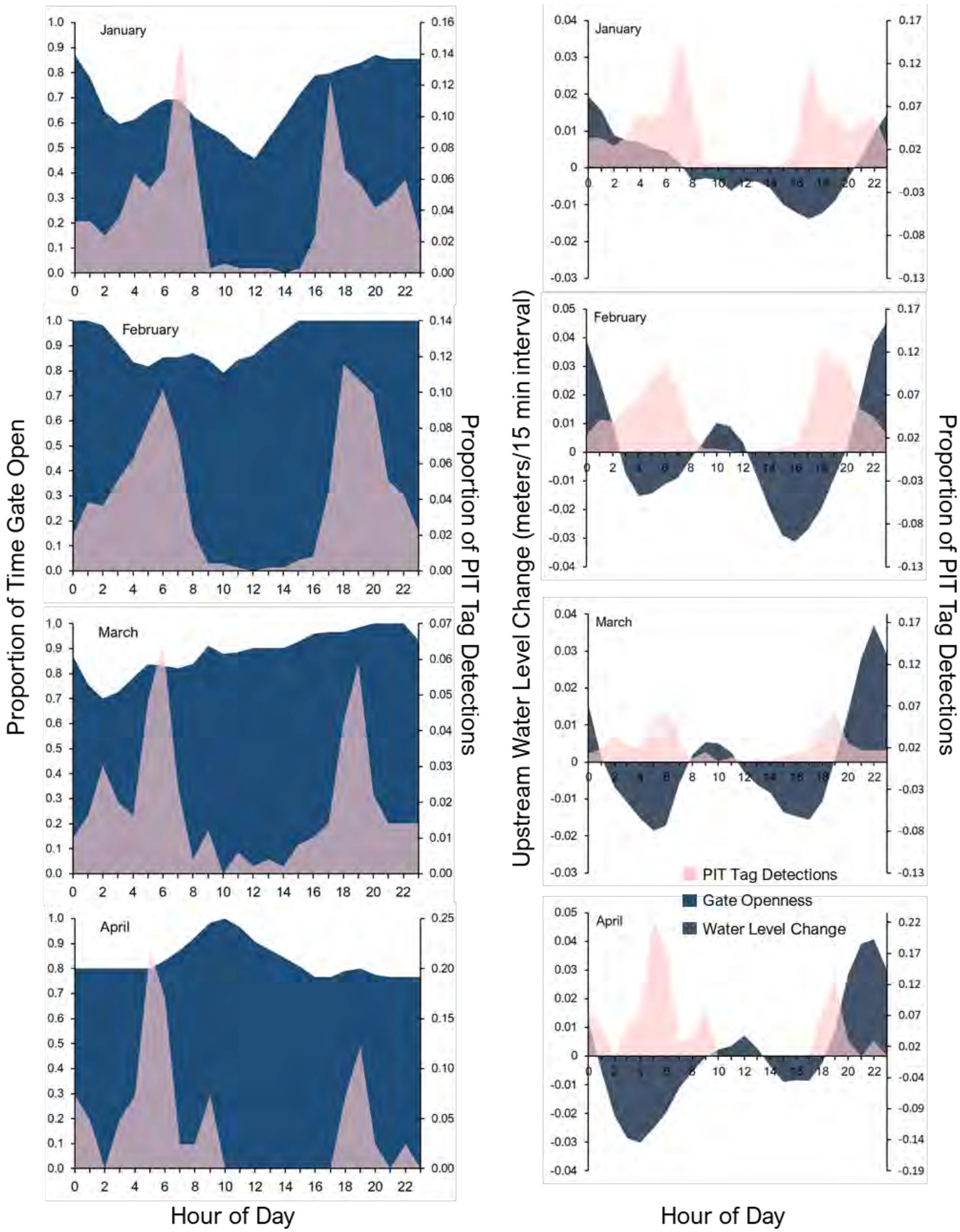

Figure 46. Proportion of monthly PIT tag detections by hour of day (pink shading), proportion of time the gate was open during each hour, by month (blue shading, left panels), and the average rate of upstream (landward) water level change during each hour, by month (gray shading, right panels) at the Cochran tidegate.

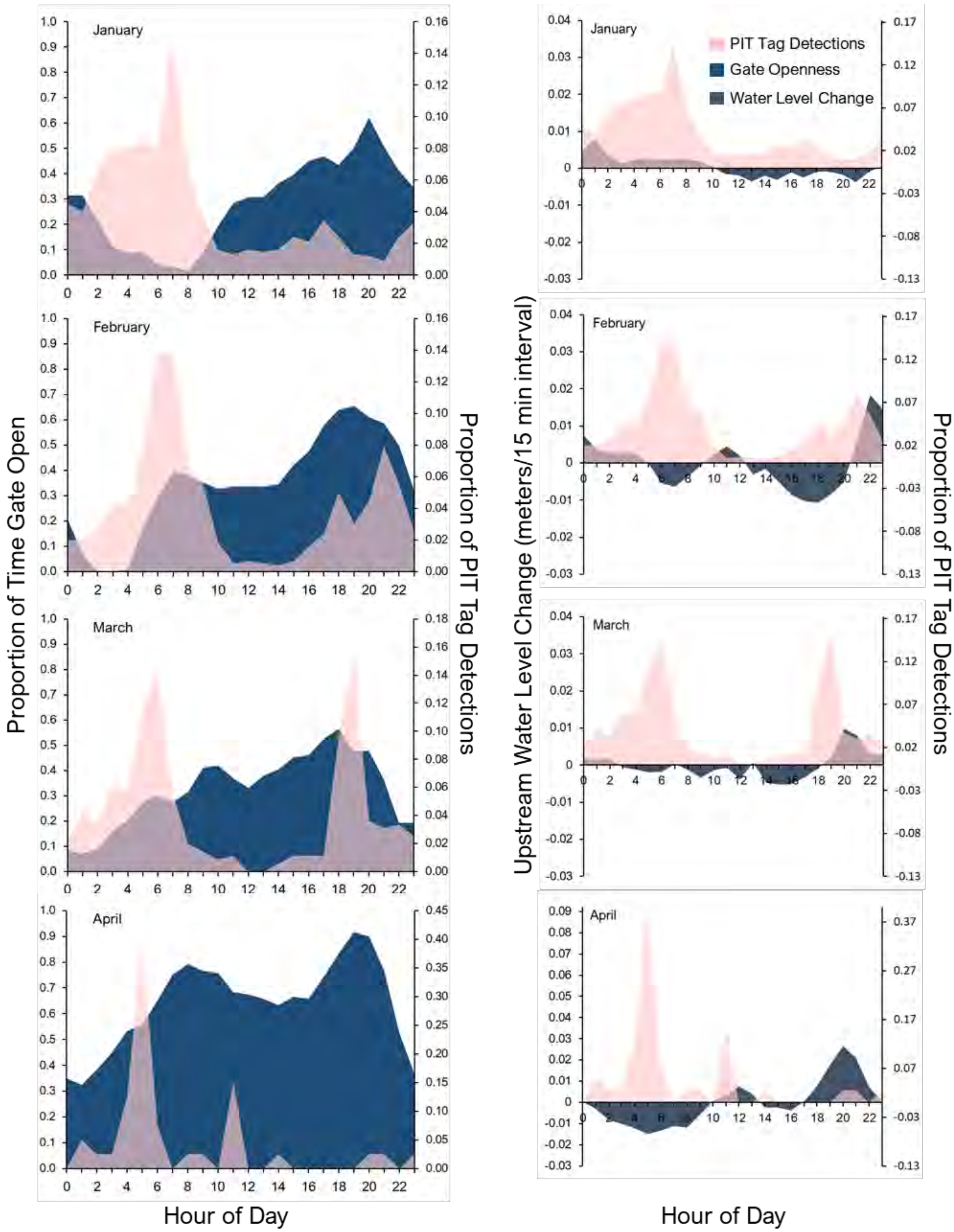

Figure 47. Proportion of monthly PIT tag detections by hour of day (pink shading), proportion of time the gate was open during each hour, by month (blue shading, left panels), and the average rate of upstream (landward) water level change during each hour, by month (gray shading, right panels) at the Seestrom tidegate.

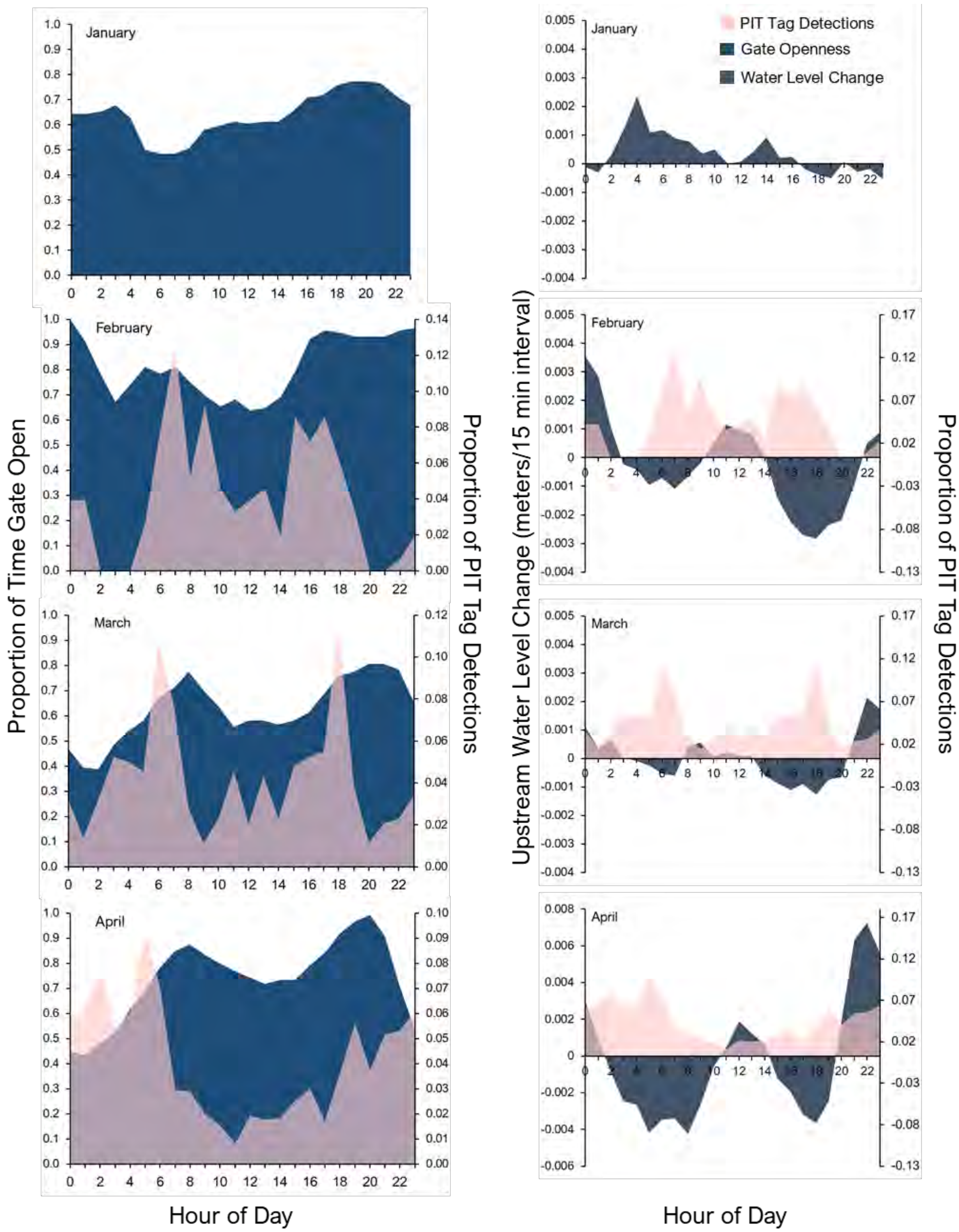

Figure 48. Proportion of monthly PIT tag detections by hour of day (pink shading), proportion of time the gate was open during each hour, by month (blue shading, left panels), and the average rate of upstream (landward) water level change during each hour, by month (gray shading, right panels) at the Coaledo tidegate (Beaver Slough).

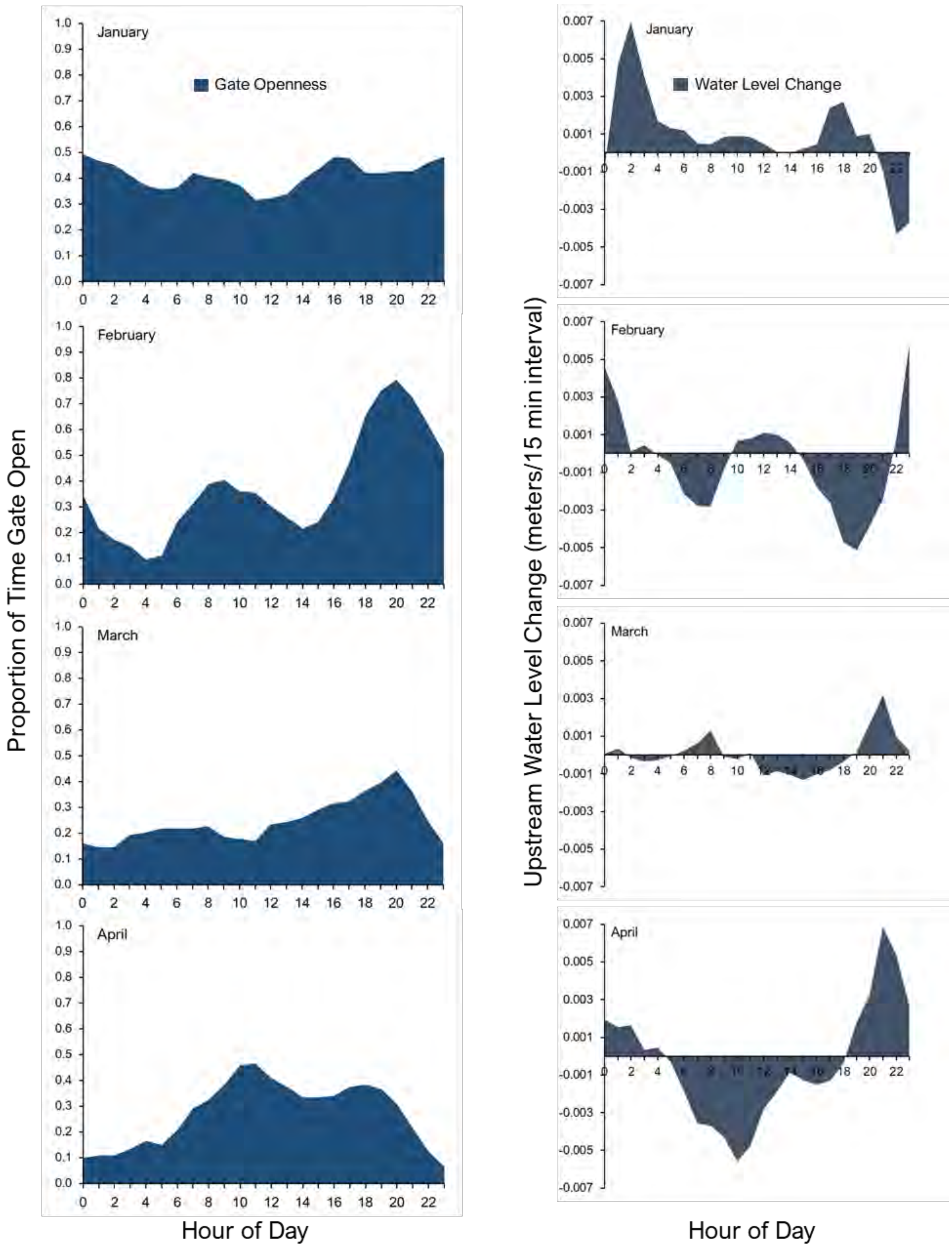

Figure 49. Proportion of time the gate was open during each hour, by month (blue shading, left panels), and the average rate of upstream (landward) water level change during each hour, by month, at Winter Lake Unit 1.

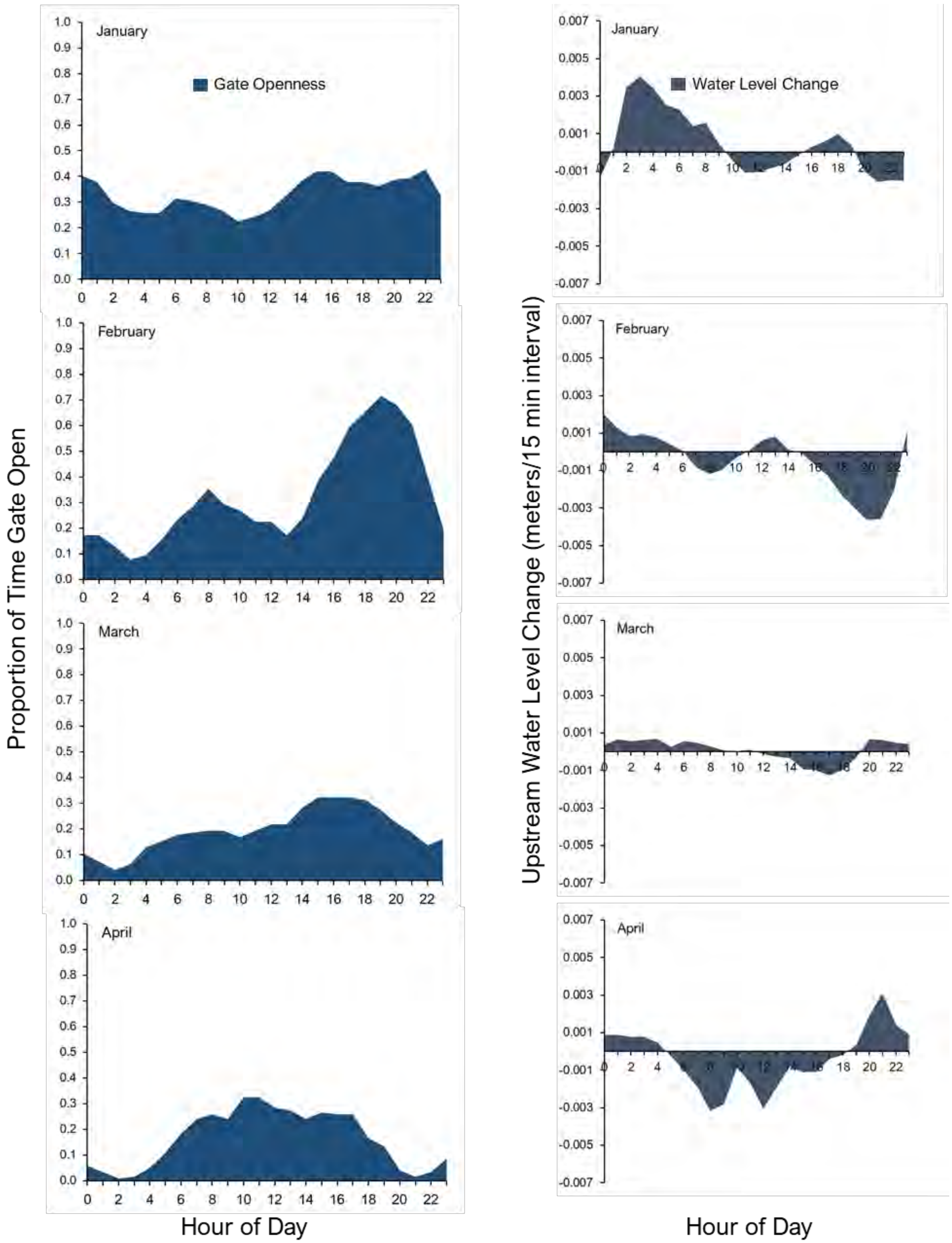

Figure 50. Proportion of time the gate was open during each hour, by month (blue shading, left panels), and the average rate of upstream (landward) water level change during each hour, by month, at Winter Lake Unit 2.

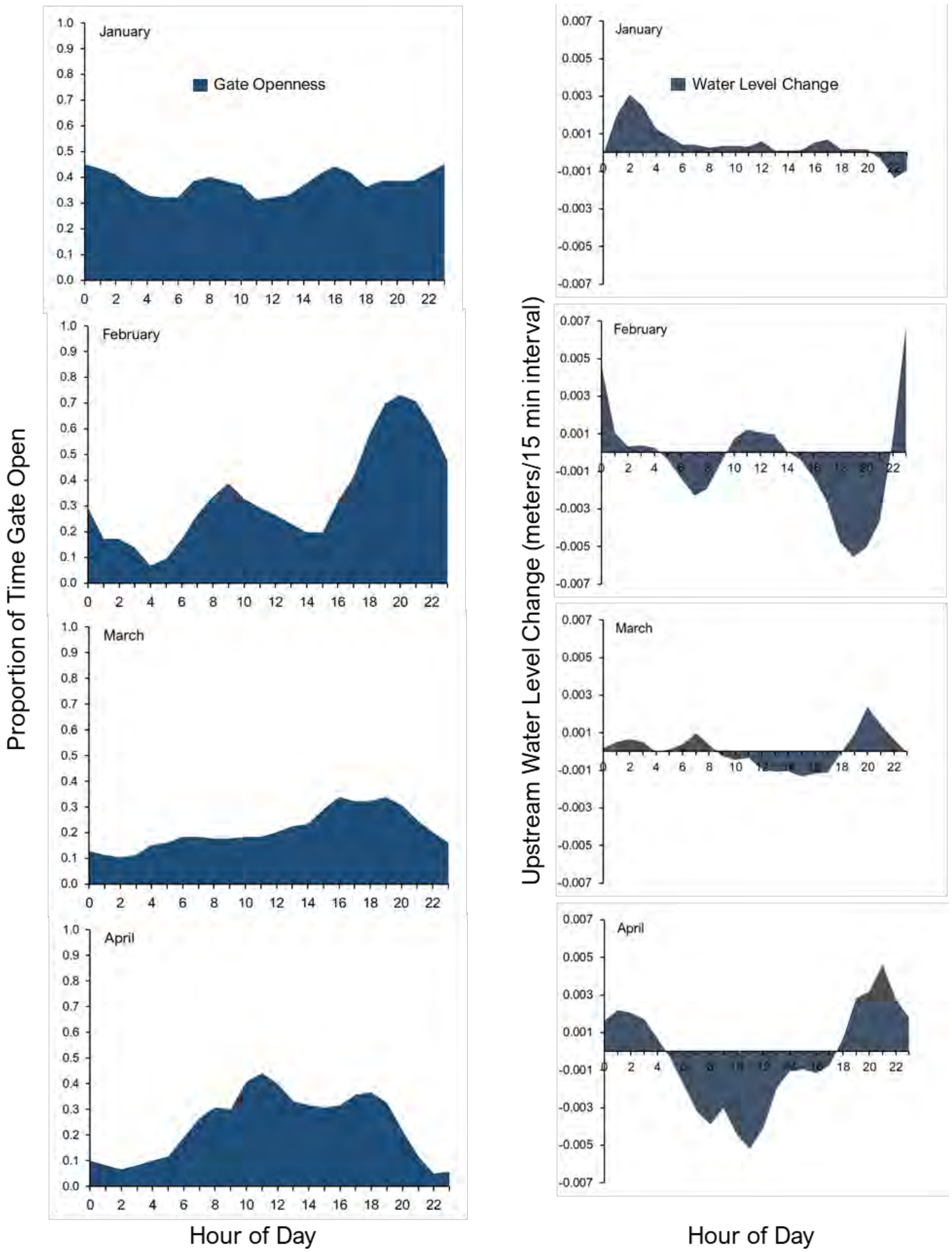

Figure 51. Proportion of time the gate was open during each hour, by month (blue shading, left panels), and the average rate of upstream (landward) water level change during each hour, by month, at Winter Lake Unit 3.

8. Discussion

A. Mid-River Basin Life History

Floodplain entry in the Coquille River basin off-channel wetland ponded water areas has been documented in 2023-2024 to not only be common for juvenile coho, but also appears to be highly advantageous for growth rates and overall body condition (Figure 43). Fish rearing at the EF RM 1.2 floodplain swale were statistically the same size by week throughout the winter (Figure 42) suggesting benefits are similar or identical compared to fish captured in known highly productive habitats at Winter Lake at RM 20.5 or Beaver Slough (Coaledo) at RM 19.5. Overall density of fish/acre in the EF RM 1.2 location appeared anecdotally to be slightly lower than the NF RM 6.6 location where a roughly 1,400+ juvenile coho were estimated to be present in a 1.4 acre floodplain ponded location when sampled on February 13. Overall the range of fish densities/acre were roughly considered to be similar to Nickelson 2012 estimates for fish rearing in floodplain habitats. That said extensive effort to determine density of fish at sample sites was not pursued.

Field observations and modeling suggest that river stage likely exhibits a strong influencing factor on the "Swim In" connectivity of off-channel floodplain habitats. Flow patterns vary year to year. In 2023-2024 there were 270% more days (27 days in 2023-2024 vs. 17 days in 2022-2023 and 2021-2022) when fish had river stage height of 21.5ft/equivalent to elevation 43ft at EF Coquille RM 1.2. Evaluation of flow stage patterns November through May from 2013-2024 indicate that "Swim In" connectivity varies substantially. In 2015-2016, 2016-2017, and 2023-2024 there were 31, 36, and 27 total days where water was above stage 21.5 at the NF Coquille River gauge. Over the 11 year period eight of those years had fewer than 20 days with river stage 21.5 or greater.

Based on known life-history patterns it is anticipated that connectivity for fish to enter wetland ponded areas in the early months of the winter (November through February), would be advantageous. Juvenile coho are smaller in those months due to younger age and have a strong need to encounter conditions where high quality food and rearing conditions allow for steady growth towards size needed to smolt in late winter/spring. Many fish at the EF Coquille RM 1.2 were found to be similar in length/weight for fish expected to smolt by April/May. Fish of a size range in late March or April close to terminal need for smolting might be hesitant to reenter wetland habitats after exit if their size and body condition allowed for highly successful smoltification. Thus a greater number of days where there was "Swim In" conditions in November through February likely would be of greater advantage for fish in the river seeking off-channel habitat. It is critically important to note that the current relationship for "Swim In" conditions to elevation 21.5ft at the EF RM 1.2 location and an unknown number of other sites, is considered to be directly and strongly related to historical channelization and bifurcation of prior to colonial-settlement outflow networks. On the ground assessment and LiDAR modeling indicates that pre-alteration many swale networks were fewer, collecting larger drainage area, and exiting over longer distances with lower gradient. This would have resulted in conditions where juvenile fish would have been much less dependent on high flow events to swim into sites as velocities in connecting channels would have been lower leading to more manageable energetics for navigating inward from the river to swale locations.

The flow stage patterns observed at the EF RM 1.2 location undoubtedly relates to the other 100+ acres of floodplain swale habitat within the NF and EF. If densities of juvenile coho were similar amongst all 100+ acres of EF/NF off-channel floodplain habitats to those observed in 2024, over 140,000 juvenile coho may have been present within those areas in 2023-2024. That said access (discussed below) varies between sites and water year for fish to enter. In addition water year regimes would affect duration of use year to year. The timing of the first high water may be critical to fish entry as well. If an early winter high water event provides "Swim In" conditions this may serve fish more adequately than mid or late winter when fish may have already moved downstream to other reaches. Additionally, high flow events above the 21.5ft stage threshold through the winter period when fish can and do choose to enter, can differ in the number of days and interval between events between years (Figure 24, 27 and 28). In 2023-2024 peak flow events exceeding stage of 21.5ft were relatively evenly spaced at roughly six week intervals.

It is ultimately important to recognize that tidally influenced wetlands downstream of Coquille experience a much more dependable extent and duration of wetted area habitat, which is likely to be more consistently present and accessible year to year. This is due to generally lower elevation of interior swales related to river level and tidal amplitude. EF and NF Coquille habitat wetted area acreages and access that relates directly to river high flow events and frequency interval are much more variable year to year as they are linked only to higher flows not having tidal influence.

Most of the connectivity and duration of suitability of off-channel floodplain habitat swale habitat in all of the Coquille River basin has been heavily altered since colonial settlement. This holds true for the NF and EF subbasins. The natural river levee along the NF and EF Coquille River results in long troughs of land that parallel the river channel as demarcated by the blue areas in Figure 25 and 26. These troughs historically were fed from multiple small upslope tributaries, with troughs reconnecting to the rivers on the downstream ends, predominantly at locations where the river meandered into bedrock hillslope forcing reentry of flow that was captured within these troughs. Since 1900 most of the floodplain troughs have had multiple outflow ditches constructed to drain them. As a result, the duration of water in swales that persists to >1.5ft of depth in the winter/spring has been diminished for most locations. Additionally, reduction in the number of upslope tributaries feeding into a given floodplain trough has resulted in earlier winter/spring dewatering of outflow channels, that provide outmigration fish passage. This is considered to have greatly increased SF the potential for fish stranding in these habitats. Most outflow channel installations also shortened the distance resulting in steeper gradient to the river elevation with serious implications for reduction in juvenile fish ability to swim in on low flows.

Trapping effort for the Beaver Creek, Cochran, and Seestrom sites in 2023-2024 exceeded effort of 2021-2022 and 2022-2023. Despite greater effort, fewer fish were captured in 2023-2024 compared to 2021-2022, and 2022-2023. Flow levels in 2021-2022 and 2022-2023 were generally lower overwinter (17 days above stage of 21.5 @ the NF Coquille River gauge compared to 27 days in 2023-2024; Figure 24 and 27). This could suggest that perhaps fewer coho entered NF and EF Coquille River subbasin wetland swale habitats in 2021-2022 and 2022-2023 compared to 2023-2024. It is unknown if the high levels of juvenile fish encountered in NF/EF swale locations in 2023-2024 and successful rearing of fish in those off-channel locations resulted in fewer fish moving to downstream locations to overwinter/rear, thus affecting trapping Catch Per Unit of Effort and total catch at Beaver Creek, Cochran, and Seestrom.

The understanding of the hydrology/ecology related to these EF/NF floodplain troughs brings strong restoration opportunity. Due to the high propensity of fish to enter and live in these locations, the Team is now incorporating information from 2023-2024 into restoration strategies that reestablish more natural hydrology into these habitats. The primary goal will be to recapture and retain all upslope tributaries within a trough by elimination of the altered multiple outflow ditches and recreate more natural outflow paths at historical locations. This will maximize fish entry and exit reestablishing solid production within these critically valuable habitats at lower hydrograph stage height and in a more continuous pattern.

B. Condition

Is overall body condition of juvenile coho reared in the tide gate project areas greater than riverine-reared coho?

In the 2020-21 sampling season, we were able to compare length, weight, and condition factor between off-channel locations and the mainstem river near the end of the winter rearing period. In that assessment, juvenile coho salmon captured at Winter Lake Unit 2 were significantly longer, heavier, and more robust in body condition than juvenile coho captured in the mainstem Coquille River. Juvenile coho salmon captured at Beaver Slough also approached the end of winter rearing longer and heavier than those captured in the mainstem, but condition factors were similar. Juvenile coho captured late in the season at the Cochran and Seestrom locations were similar in length, weight, and condition to fish captured in April in the mainstem (Table 7- 9; Figure 30-32). High weights relative to length at Winter Lake Unit 2 can also be seen in weight-length relationships from the 2020-21 season (Figure 39). Since the initial survey season, we have been unable to further address this question because no juvenile coho salmon have been captured in the mainstem, except for fish captured and tagged at Laverne Park early in the season (September & October of 2021 and 2022). However, there were similarities in the results for the sites with available data (Winter Lake Unit 2, Seestrom, Cochran, Beaver Slough) (*cf.* Figure 30-41).

The mean lengths of juvenile coho captured in April at Beaver Slough (2020-21 = 131.8 ± 1.7 mm; 2021-22 = 141.7 ± 2.2 mm; 2022-23 = 147 ± 1.9 mm; 2023-24[7] = 161 ± 2.2 mm) Winter Lake Unit 2 (2020-21 = 136.5 ± 5.6 mm; 2021-22 = 132 mm; 2022-23[8] = 166 mm; 2023-24 = no captures) and Winter Lake Unit 2 (2023-24 = 166 ± 11 mm) are similar to those observed for out-migrating coho salmon at the Mill Creek life cycle monitoring site in the Yaquina basin (Avg. = 130.7 mm from 1997 through 2014). This site tends to have larger out-migrants and often higher marine survival rates relative to other life cycle monitoring sites within the Oregon Coast Coho ESU (Suring et al. 2015). End-of-season lengths at Seestrom have also been relatively large since the 2021-22 season (Table 7).

The similarities in length, weight, and condition among the two smaller off-channel locations (Cochran and Seestrom) and the mainstem Coquille River may reflect greater exchange of fish in these locations with the mainstem (i.e., shorter residence times and higher mobility for juvenile coho using the smaller off-channel locations). However, it is notable that, since the 2021-22 season, fish at Seestrom have been substantially longer and heavier than Cochran fish (Table 7-9). The Seestrom site is larger and more complex than the Cochran site. Higher weights and condition in Winter Lake Units 2 and 3 may be attributable to differences in resource availability and/or fish densities between these locations. Across years, average lengths and weights are highest in the larger, more complex off-channel locations, and lowest in the smallest site (Cochran) and the mainstem (Figure 52).

In all sampling seasons, comparisons of condition-related metrics have been limited due differential capture success among locations. Continued adaptive adjustments to sampling approaches and the aggregation with data collected in future sampling years should continue to improve our ability to discriminate the size and condition of juvenile coho salmon in the various off-channel and mainstem locations. However, the analytical approach currently applied also may be overly conservative. The Bonferroni adjustment we applied to post-hoc pairwise comparisons can inflate Type II error rates, and the decision to apply the adjustment is neither straightforward nor routinely applied in a consistent manner

[7] No juvenile coho were captured in Beaver Slough in April 2024. The value shown is for March 2024, when data were available.
[8] Only one juvenile coho was captured in Winter Lake Unit 2 in April during the 2021-22 and 2022-23 seasons.

(Cabin & Mitchell 2000). As additional data are collected, the decision to apply this adjustment may be reconsidered.

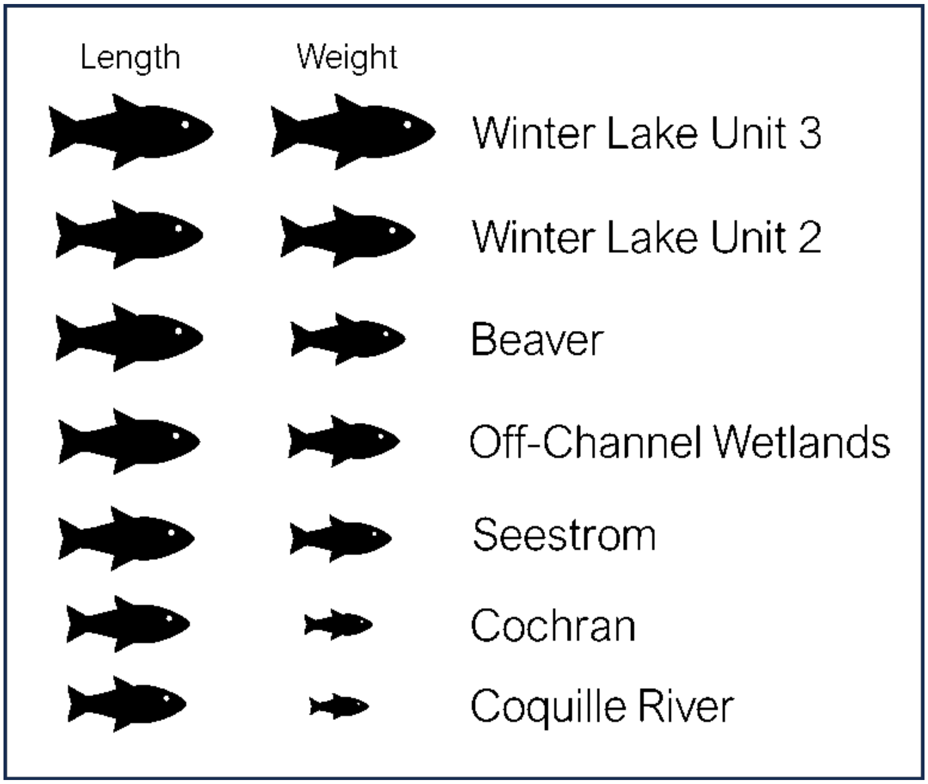

Figure 52. Average lengths and weights of juvenile coho salmon in April (across all study years) depicted with images sized to their proportion of the average length or weight observed at Winter Lake Unit 3. April is typically the last month in the survey season during which data exist at all sites; some sites do have length and weight data for May. Panel A depicts averages across years. Relatively few juvenile coho salmon were captured at Winter Lake Units 2 and 3, and this may bias results if those individuals were abnormally large. Data for the Coquille River mainstem are only available for 2021; off-channel seasonal wetlands were only surveyed in the 2023-24 season.

C. Growth

Are growth rates of juvenile coho reared in tide gate project areas greater than riverine-reared coho? Does overall size of restored habitat affect growth rate?

Through the course of this study, we have not recaptured any of the juvenile coho salmon tagged in the mainstem, and there have not been multiple successful capture events in the mainstem. Therefore, we have not been able to determine growth rates from recaptures or infer growth rates for juvenile coho salmon in the mainstem Coquille River. However, the larger sizes near the end of the winter rearing period at some of the off-channel locations suggest that juvenile coho rearing in these areas likely grow at faster rates assuming the fish enter the monitoring period (late December) at similar sizes.

In all seasons years, there have been no statistically significant differences in growth rates (length or weight) among off-channel locations when growth was inferred from successive capture events. Continued adaptation of capture effort/methods and continued data collection will help to identify the differences in growth rates among sites that seem apparent in the differential progression of lengths and weights through the winter period (Figure 30-41).

D. Survival

Does survival increase for juvenile coho residing in tide gate projects compared to riverine-reared coho? Does survival vary with overall size of restored habitat?

As with growth (above), we intended to approach these questions using mark-recapture methods that to-date have been precluded by low recaptures. Survival from tagging to final detection at the Seestrom and Cochran tide gates appears to be relatively high given that overall >80% of tagged individuals in all seasons were subsequently detected at the tide gates after some time at large (Table 16-19; Figure 44). Similarly, almost 90% of juvenile coho tagged at Beaver Slough were subsequently detected at the Beaver Slough PIT array in 2021-22, the first year of operation at that location (Table 16; Figure 44). Lower proportions of tagged fish detected at the tide gates in Winter Lake Unit 2 in all sampling seasons and lower proportions of tagged fish detected at Beaver Slough and Seestrom in 2022-23 relative to years before and after (Table 16-19; Figure 44) may be attributable to lower rates of survival, lower detection efficiency, or both. Survival to final detection will be further resolved as we determined detection efficiencies for each tide gate antenna array. Estimates of detection efficiency will allow us to account for apparent losses (losses attributable to a failure to detect, not realized losses due to mortality) in estimates of survival. We are continuing to develop a rule set to formalize the discrimination of fish-passage events from fish-detection events (e.g., Connolly et al. 2008).

E. Abundance/Density

Are rearing densities dependent on overall size of restored habitat behind an upgraded tide gate?

We intended to address questions of abundance and rearing densities using abundances estimated through mark-recapture approaches. Limited recaptures so far have precluded this approach. We will continue to pursue these methods as adaptation of capture effort and methods increases the number of fish tagged and recaptured.

F. Movement & Passage

What is the residence time of juvenile coho in floodplain habitats upstream of a fully redesigned and technologically advanced tide gate? Does residence time vary with overall size of restored habitat?

Residence times determined through this work are residence times from tagging to final detection at tide gate PIT antenna arrays for fish detected only at their tagging location (single site coho) or event residence times from first detection to last detection for fish detected at multiple locations. These are not comprehensive residence times because we do not know how long the fish resided at the tagging location prior to tagging. These estimates may be considered as minimum residence times that are specific to the time of tagging.

Despite these limitations, our current estimates of residence time do provide for comparisons among locations if they are compared at similar points during the winter rearing period. There appears to be a general trend of longer post-detection rearing earlier in the season progressing to shorter residence times later in the period, except for at the smallest site (Cochran) where residence times are typically brief (Table 16-19; Figure 45). In 2020-21, post-tagging residence seemed to be longer in the largest habitat (Winter Lake Unit 2) and shorter in the smallest habitat (Cochran) (Table 16; Figure 44). Results in the 2021-22, 2022-23, and 2023-24 seasons also seemed to indicate longer residence times in larger, more complex off channel locations, but low captures in some months led to high uncertainty in estimates in some months at some locations (e.g., Winter Lake Unit 2; Figure 44).

Since translocations were initiated in the 2021-22 season, we have also been able to evaluate residence times of mobile or translocated coho from entrance to exit of a location. Many of these fish were detected for relatively brief periods, particularly at some sites (e.g., Winter Lake Unit 2), but it is notable that residence times tended to be longer at Beaver Slough (Table 17). There appears to be a propensity for mobile and translocated fish to favor the larger, more complex locations (i.e., Winter Lake Units & Beaver Slough). In previous seasons, recapture histories of fish translocated from Beaver Slough suggested homing back to that rearing location, but it was not yet clear whether the tendency to return to Beaver Slough reflected a fidelity to that site or simply attraction to a favorable off-channel conditions. Although detections of translocated fish were limited in 2023-24, it is notable that, of the fish translocated to the mainstem from off-channel seasonal wetlands, all subsequent detections occurred at the Beaver Slough antennas.

What percentage of juvenile coho residing in the Coquille Estuary enter the restored project areas?

We did not capture juvenile coho in the mainstem Coquille River until late in the season in 2020-21, and no juvenile coho were captured in the mainstem in the following seasons except for early-season tagging at Laverne Park in fall of 2021 and 2022. We will continue to explore this question as we learn more about the proportion of juvenile coho in the mainstem that use restored project areas for winter rearing habitat. However, in the 2021-22 and 2022-23 sampling seasons, 3 of 81 (4 %) and 4 of 157 (1%) fish, respectively, tagged at Laverne Park (~49 miles upstream from Winter Lake) early in the season were subsequently detected at the Coaledo, Winter Lake Unit 1, or Seestrom PIT arrays later in the season. One hundred and three of 399 fish (26%) tagged at Beaver Slough and subsequently relocated to the mainstem approximately seventeen river miles upstream from Winter Lake were subsequently detected at tide gate PIT arrays at Seestrom, Coaledo, and Winter Lake Units 1, 2 and 3). In the 2022-23 season, 119 of 428 fish (28%) relocated to the mainstem Coquille River were subsequently detected at Seestrom, Cochran, Coaledo, and Winter Lake Units 2 and 3. In both seasons, over half of these fish were returning to their homesite at Beaver Slough (Coaledo).

In 2023-24, only 7 of 497 (1.4%) fish translocated from seasonal off-channel wetlands to the mainstem Coquille River were subsequently detected, all at the Coaledo antennas. An additional juvenile coho salmon tagged and released back into a seasonal wetland was also subsequently detected at Coaledo. Relatively low detections of translocated coho salmon during this season may reflect prevailing flow conditions that were not conducive to movement, high availability of alternative off-channel habitats due to high water, and/or lower availability of gated off-channel habitats due to more frequent closure under high water conditions.

What are the water level and tide gate door operation preferences of juvenile coho for movement through tide gates?

Given limited detections in 2023-24, we did not extensively analyze gate conditions coinciding with the entry and exit of juvenile coho salmon. Instead, we further examined key parameters identified in previous years to better define the timing window for fish activity near the tide gates. In previous years, juvenile coho salmon at all sites except Winter Lake favored presence at the tide gates near dawn and dusk. This could be related to foraging behavior and predator avoidance. While other covariates likely play a role in determining fish presence near the gates, none of those evaluated to-date have exhibited the strong pattern observed for the hour of day.

In prior years, we aggregated data across the sampling season. In the current analysis year, we evaluated time of day by month to allow for change through the season. This segregation of the data reveals that the crepuscular pattern of activity changes through time as day length changes (Figure 46-48). Peaks in activity (detections) tend to occur near, and shift with, timing of sunrise and sunset. The implication is that windows of peak activity near the tide gates may be narrower than indicated in previous analyses given the shift in timing of sunrise and sunset by up to two hours over the course of the season. Identifying potential windows for passage relative to the solar photoperiod may improve retrospective analysis of previous years' data.

During 2023-24, the tide gates at Seestrom were frequently closed during times of peak activity, particularly during the morning hours (Fig. 17). Gates were also frequently closed at the Winter Lake Complex (Figure 49-50) throughout the season, which may have contributed to failure to detect mobile or translocated coho at these gates. Slide gates may have allowed for some passage despite the closure of the main gates. Use of ungated off-channel habitat (e.g., seasonal wetlands) created by high flows may have provided an important rearing alternative to the gated habitats that may have been less available for passage in 2023-24.

We continued to consider the rate of change in landward water level as a proxy for velocity, but there are several important caveats. First, a given rate of change in landward water level when water levels are high could result in a higher velocity through the culvert than the same rate of change at a lower landward water level. This is because the change in elevation at higher water levels is likely to indicate the exchange of higher volume of water than would occur at lower water levels. Second, for a given discharge, velocity through the culvert will depend on the depth within the culvert. Third, increasing water levels when the gates are closed indicates increased depths due to runoff, not flow through the culvert. Despite these complications, detections of juvenile coho often coincided with negative landward water level change (i.e., presumed outflow) and lower rates of positive water level change (Figure 46-49). We will continue to explore methods to more closely relate these variables to velocities at the tidegates to improve their utility as surrogates for velocity.

9. Conclusion

The Lower Coquille Monitoring program has shown to date that two of the tide gate upgrade and habitat restoration projects are highly used by juvenile coho salmon during the winter and spring rearing period. Among the four years of monitoring, Winter Lake Unit 2 exhibits high juvenile coho use, as indicated by lower resolution observational data. Nevertheless, there still remains an unclarified understanding of the relationship between the acuity of observational data and the annual variability of parr/pre-smolts observed in Unit 2. Similar inferred growth rates were seen across all off-channel sites but residence times varied with longer residence times at the larger sites. Therefore it's understandable that across years, average lengths and weights are highest in the larger, more complex off-channel locations. These results should not diminish the need for smaller tide gate projects as over a quarter of all tagged coho were detected at 2 or more sites and although the residence times are shorter the inferred growth rates are still similar across all projects. Furthermore, coho are highly mobile in the Coquille estuary and access to all of these sites varies depending on the river dynamics. Off-channel floodplain swales in the NF and EF Coquille subbasins appear to be highly valuable for juvenile coho rearing, particularly in high-water years when greater connectivity to these habitats occur. Data collected during 2023-2024 suggest that these areas support significant juvenile coho densities, with growth rates comparable to known highly productive habitats at Winter Lake and Beaver Creek. The relationships of passage conditions and successful passage are complex and this project is still teasing out the intricacies but it's evident from the completed analysis that passage is preferred near dawn and dusk, during ebbing tides and the slack period before and after ebb tide. Future analysis will continue to examine what draws coho to be present at the tide gate to help management practices promote successful fish passage.

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11. Appendices

A. PIT Antenna Operation

Table 23. Table of dates for when the PIT antennas were inoperable for the 2022-23 field season.

Winter Lake								Seestrom		Cochran		Coaledo	
Unit 1		Unit 2				Unit 3							
Gate 1A pass thru	Gate 1AB Sail[1]	Gate 2B pass thru	Gate 2B pass thru	Gate 2C pass Thru	Gate 2C pass thru	Gate 3A sail[1]	Gate 3A pass thru	Antenna 1	Antenna 2	Antenna 1	Antenna 2	Antenna 1	Antenna 2
12/1	-	12/1	12/1	12/1	12/1	-	12/1	12/26-1/26	12/26-1/26	12/16	12/28-1/15	12/31-1/5	12/31-1/5
12/24-1/5		12/24-1/5	12/4-1/5	12/24-1/5	12/24-1/5	-	12/24-1/5	6/1-6/2		2/1	1/20	5/1-5/10	5/1-5/10
1/20-1/22		2/21	2/23-4/6	4/21-4/27	4/21-4/27		4/21-4/27			6/4	1/30-2/1	5/16-5/17	5/16-5/17
1/30-6/18		3/15	4/21-4/27							6/9-6/12	2/10	5/20	5/20
		3/16-3/18									4/6	5/25-6/2	5/25-6/2
		3/20-4/10									6/4	6/12-6/13	6/12-6/13
		4/17-4/27											
		4/28											
		4/30-5/3											
		5/5-5/8											
		5/9-6/18											

1 - The sail antennas of Unit 1 and 3 are not functional

B. Tidal Bin

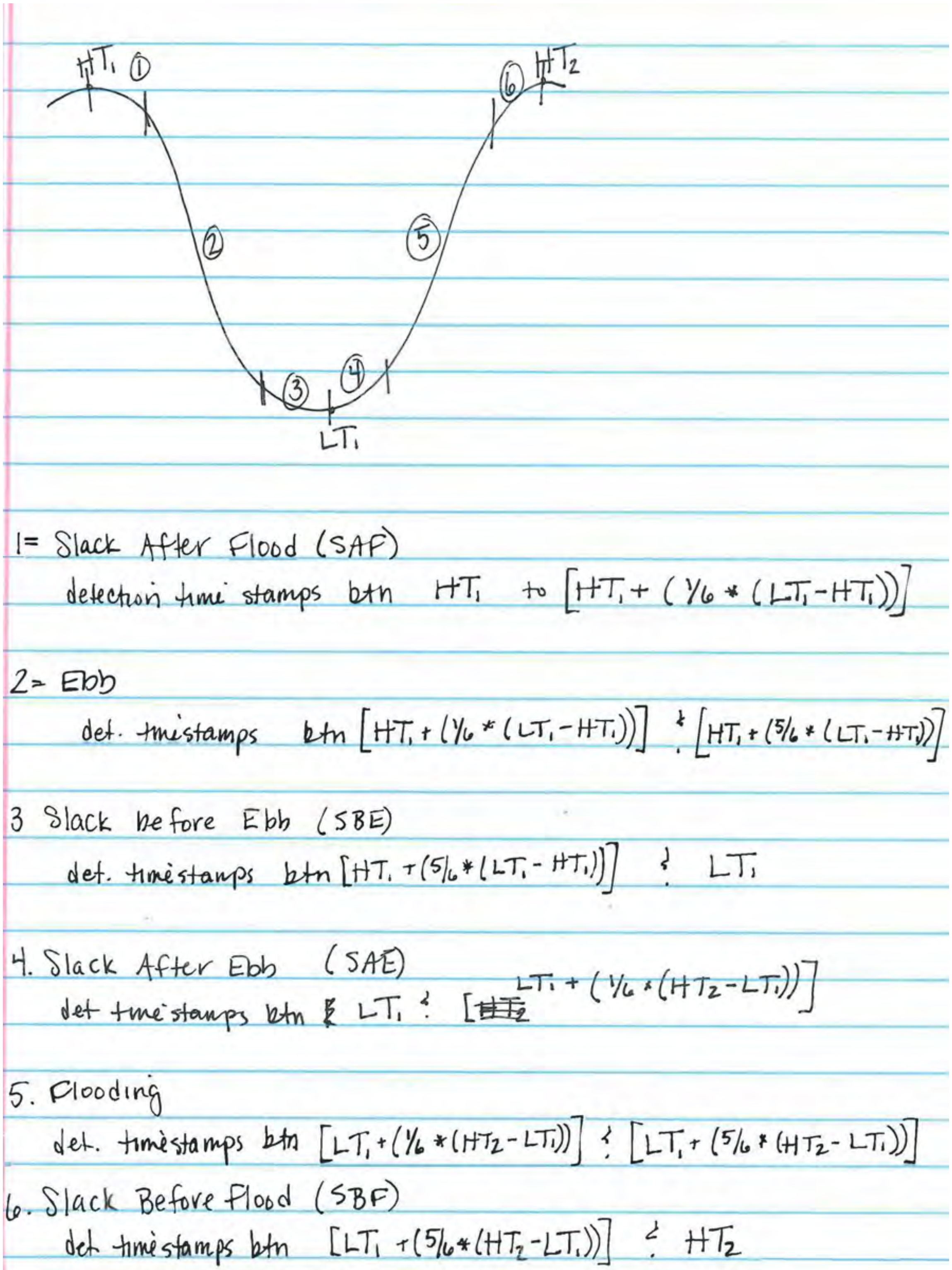

Figure 53. A schematic of how tidal bins were calculated for the Lower Coquille Monitoring project.