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WILLAMETTE VALLEY DOWNSTREAM FISH PASSAGE MONITORING

Biannual Report Summary

March through June 2023

Prepared for:

U.S. Army Corps of Engineers

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Prepared by:

Cramer Fish Sciences

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INTRODUCTION

For over 50 years, the U.S. Army Corps of Engineers' (USACE) has managed and operated 13 dams in the Willamette River basin as part of the Willamette Valley Project (WVP). Each of these dams contributes to a system that provides flood control, power generation, and recreation. Management of the WVP is a complex process and presents challenges in meeting competing demands such as instream flows, fish passage, flood control, and recreation. Adding to the complexities are the listings of three fish species under the Endangered Species Act (ESA), spring Chinook salmon, *Oncorhynchus tshawytscha*, steelhead, *Oncorhynchus mykiss*, and bull trout *Salvelinus confluentus* (NMFS 2008; USFWS 2008). In 2008, the USACE, the U.S. Bureau of Reclamation, and the Bonneville Power Administration (BPA) (jointly known as the Action Agencies) consulted with the National Marine Fisheries Service (NMFS) to evaluate the impact of the WVP on the ESA-listed salmon and trout, which resulted in NMFS issuing the 2008 Willamette River Biological Opinion (BiOp; NMFS, 2008). In the BiOp, NMFS identified a Reasonable and Prudent Alternative (RPA) that set forth specific actions the Action Agencies could implement to satisfy their legal obligations under the ESA to "…avoid the likelihood of jeopardizing the continued existence of the ESA listed species or the destruction or adverse modification of their designated critical habitat (NMFS, 2008)."

On September 2021, the U.S. District Court for the District of Oregon issued an Interim Injunction Order directing the USACE to implement certain interim injunctive measures to improve fish passage and water quality at several WVP dam sites to benefit UWR spring Chinook salmon and winter steelhead while a reinitiated ESA consultation was completed. In the interim, the Court approved an Expert Panel to define the implementation plans of specific measures, which were required to "provide meaningful research, monitoring, and evaluation ("RM&E") of the interim injunctive measures." On February 28, 2022, the Expert Panel submitted its proposed "long term" plan for the RM&E to accompany the interim injunction measures for the remainder of the duration of the injunction. This study is a component of the RM&E measures identified by the Expert Panel.

The purpose of this project is to contribute to the Corps understanding of downstream passage of juvenile Chinook salmon and winter steelhead in the Willamette Valley Project. Monitoring includes the North Santiam, South/Middle Santiam, South Fork McKenzie, and Middle Fork Willamette River subbasins, including Fall Creek (Figure 1). This project consists of bulk marking juvenile Chinook salmon with PIT (Passive Integrated Transponder) tags to understand migration timing and survival within the WVP and interim management measures hypothesized to contribute to greater survival of juvenile and adult salmonids. To aid in the recapture of tagged fish, rotary screw traps (RSTs) are used at multiple locations across the WVP, and sampling within Green Peter and Lookout Point Reservoirs to understand how water management strategies may influence migration patterns and survival.

This report summarizes the work conducted through 30 June 2023 under contract with the U.S. Army Corps of Engineers for bulk marking and reservoir sampling. The summary of rotary screw trap results has been submitted separately.

Figure 1. Location of Willamette River Basin in Northwestern Oregon

SCHEDULE

The contract was awarded for this work in early March 2023, and anticipated it would take approximately two months to initiate activities associated with the bulk marking and reservoir distribution studies. This initially anticipated schedule for 2023 was to begin bulk marking in early April and reservoir studies in the first week in May. Due to permitting process, availability of equipment due to continued supply chain issues, coordination with hatcheries and training of field staff, a significant amount of advance work was necessary resulting in initial field activities ultimately beginning later than Cramer Fish Sciences originally envisioned. Bulk marking of Chinook fry began in mid-May and reservoir sampling officially began in mid-June. Project reporting occurs bi-weekly, monthly, and bi-annually (July and January) to summarize work to reporting to date.

Table 1. Summary of the anticipated field sampling effort, schedule and life stage targeted as part of this project.

Activity	**Timing**	**Target Life stage (Chinook)**
Bulk Marking (PIT tagging)	Winter/Spring and Fall	Fry, parr, and yearlings
Rotary Screw Trapping*	Year-round	Fry, parr, and yearlings
Reservoir Sampling (littoral and limnetic)	February through November	Fry, parr, and yearlings

*Results from rotary screw trap sampling is contained in a separate report.

BULK MARKING

Bulk marking of juvenile Chinook with PIT tags offers the opportunity to evaluate how an individual behaves, survives, grows, and out-migrates to saltwater as long as the individual is recaptured and survives. The purpose of bulk marking juvenile Chinook for this project is to determine how water management actions (e.g., drawdowns) influence the survival of juvenile Chinook. All of the Chinook used in the bulk marking portion of the project originated from hatcheries operated by the Oregon Department of Fish and Wildlife.

Methods

The following protocol provides detailed procedures for work done to marking, holding, fish transport, and release of juvenile Chinook salmon in the Willamette River basin during the spring of 2023.

Government Supplied Hatchery Fish

- Juvenile Chinook salmon used for bulk/batch marking in 2023 used for marking were raised and held at Willamette Valley ODFW hatchery facilities. Approximately 4,000 juvenile Chinook from Brood Year 2022 will originate from the Surrogate Program at OSU Wild Fish Surrogate Program, to be released in September 2023.

- For the spring 2022 period, fish were reared as follows:

- Fish to be released in the North Santiam basin were reared at the ODFW Marion Forks hatchery in Idanha, OR.
- Fish to be released in the South/Middle Santiam and Middle Fork Willamette basins were reared at the ODFW Willamette Hatchery in Oakridge, OR.
- Fry to be released in the South Fork McKenzie Basin were reared at the ODFW Leaburg and McKenzie Hatcheries in Leaburg, OR,

Holding and Tagging Sites

All Chinook salmon bulk/batch marked during the spring of 2023 were held and marked at the ODFW hatchery facility where they were raised. CFS coordinated with hatchery managers to ensure adequate space and water supplies for holding fish pre and post tagging at each site were available.

North Santiam Basin – Marion Forks Hatchery

Chinook salmon released in the North Santiam Basin were held pre and post tagging in indoor flow through ("Canadian") troughs (21 ft x 1.67 ft x 1.75 ft). After observation, they were moved to outdoor raceways (80 ft x 20 ft x 2.5 ft) at ODFW's Marion Forks Hatchery. Hatchery management set aside 16 troughs and two raceways for CFS use for tagging operations.

South/Middle Santiam & Middle Fork Willamette Basins – Willamette Hatchery

Fish to be released in the South/Middle Santiam and Middle Fork Willamette basins were held pre and post tagging at the ODFW Willamette Hatchery. Fry were held pre and post tagging in indoor troughs (20 ft x 4 ft x 4 ft). Yearlings and subyearlings are held pre-tagging in large raceways (75 ft x 20.5 ft x 4 ft). Post-tagging, subyearling and yearling release groups were held in net pens (6 ft x 6 ft x 3 ft) constructed of 1/8-inch mesh placed in the outdoor raceways.

South Fork McKenzie – McKenzie and Leaburg Hatcheries

Fry to be released in the South Fork McKenzie basin were held pre and post tagging at ODFW's McKenzie Hatchery indoors in flow through troughs (20 ft x 2.67 ft x 1.67 ft). Yearlings tagged in spring (starting 2024) and subyearlings tagged in fall are held at Leaburg Hatchery in net pens placed within the hatchery's large outdoor ponds. Hatchery management made six outdoor ponds/cement circulars at Leaburg or McKenzie hatchery available for use by this project (20ft diameter x 3.66ft deep). Net pens were constructed (6 ft x 6 ft x 3 ft) to enable separation and containment of hatchery release groups within the large outdoor ponds. Pens are made of 1/8-inch mesh and will have solid bottoms to collect any shed tags.

Fish Holding Conditions and Husbandry following delivery to CFS

Fish holding conditions were consistent with ODFW hatchery management practices and each hatchery's existing protocols were followed. ODFW hatchery staff supported the project by daily feedings, water quality monitoring, observation of abnormalities, and removal of mortalities at hatchery sites. Fish were under daily observation for abnormalities including poor swimming performance, fungus, unusual feeding behavior, direct mortalities, or any unusual marks.

Bulk/Batch Marking

To date, all release groups were uniquely marked with a passive integrated transponder (PIT) tag (Biomark, Inc.). An additional 3% of fish were marked for each release group to account for tagging mortality and ensure sufficient tag numbers of fish are achieved for each release group (Table 3). Fish have been tagged within the Cramer Fish Sciences fish marking trailer, which is disinfected then moved to each basin's holding site for bulk marking events. The marking trailer is equipped with 110V electricity and flow-through fish holding tanks. Additionally, it is equipped with a system to recirculate, aerate, and chill anesthetic water. During tagging, temperature, dissolved oxygen, and water chemistry are monitored for fish tagging tanks, and the recirculated anesthetization water is aerated and cooled with ice packs when necessary. Tagging ceases if the temperature of tanks exceeds 17 degrees Celsius or deviates more than 2 deg C from source/return water (Table 3). In an instance of a delay, tagging activities resume once water temperatures return to within thresholds safe for fish handling and tagging activities.

Working in small batches (30-50 fish), fish were anesthetized using 50 mg/L tricaine methanesulfonate (MS-222) buffered with sodium bicarbonate. To minimize fish stress, fish anesthetic exposure did not exceed five minutes (PIT Tag Steering Committee 2014). Fish are then tagged based on fish fork length (FL). Fry greater than 45 mm but less than 65 mm were marked with 8 mm PIT tags and fry greater than 65 mm were marked with a 12 mm PIT tag. All fish >45 mm are adipose fin clipped, either by ODFW or by CFS staff with surgical scissors. All subyearlings have been and yearlings will be marked with 12 mm PIT tags. Fork length to the nearest millimeter and weight to the nearest 0.01 g were recorded for the first 3% of fish tagged for each release group. For each fish, the tag code is recorded before fish are transferred to a flow-through tank for a 30-minute recovery and observation period. Any mortalities during this period were documented. After fish have recovered, the bulk of each release group (95%) were held for a minimum of 48 hours prior to release with each uniquely tagged release group held in a separate tank or holding pen where feeding commenced. The remaining 5% were held separately to be used for tag retention/mortality holding trials, as described below under "Tag Retention and Mortality Holding Trials."

VIE Batch Marking

Prior to the initiation of the spring tagging season in 2023, we had planned to use VIE (Visual Implant Elastomer) tags for fry. However, due to the timing of marking activities following contract award and setup (i.e., 'fry' were >45mm at time of marking) and after consulting experienced elastomer taggers, and reviewing how marks change ontogenetically, we worked with the Corps to find a solution utilizing 8 mm PIT tags instead of VIE tags on fish down to 45 mm to increase survival and maximize the value of data by having individually marked fish available for subsequent recapture. First, handling fry smaller than 45 mm is difficult. Second, the VIE tags on small fry are very difficult to read after a fish has grown, and if the VIE tag cannot be visually identified (i.e., read) upon recapture in a rotary screw trap after extended rearing, provide no information for fish that rear for an extended period in reservoirs or streams. While published literature suggests that VIE marking may be suitable for this type of project (e.g., Leblanc, C.A., and Noakes, D.L., 2012), it is recommended that more discussion is needed before tagging of fry occurs in 2024.

PIT Tag Bulk Marking

PIT tagging procedures followed the methods detailed in the PIT Tag Marking Procedures Manual (PIT Tag Steering Committee 2014). Prior to tagging, feeding was ceased 24-48 hours in advance of tagging and resumed 24-28 hours post tagging, in order to reduce the risk of shed tags and lower the chance of hitting vital organs when injecting the PIT tags into the peritoneal cavity (PIT Tag Steering Committee 2014). Bulk mark group fish were tagged using single-use pre-loaded injector needles, pulled from trays holding sequentially numbered PIT tags. Tags were inserted using a MK25 PIT tag implanter (Biomark, Inc.). A new needle was loaded on the implanter for each fish. Fish were held in the hand with the belly of the fish facing up with the tail oriented toward the thumb, and the insertion point lined up with the middle finger. The middle finger was used to exert a slight pressure on the side of the fish's belly to ease needle penetration. The injector was laid in the hand so that the needle bevel faced toward the body of the fish. Tags were injected into the peritoneal cavity between the posterior tip of the pectoral fin and the anterior point of the pelvic girdle 1 to 2 mm from the mid-ventral line. Care was taken to keep the needle as parallel to the body axis as possible to keep the tag against the body wall, with minimal needle penetration (approximately 1-2 mm of the needle tip for small fish). Once the needle penetrated the abdominal wall, the tag was injected by pressing the trigger. After insertion, the used needle tip was ejected, and the fish scanned to read the tag code before transfer to the recovery tank.

A tag record includes information about the tagging session (i.e., date and location of tagging event, date and location of release) and tagged fish (i.e., species, run, rearing type, PIT tag code, fork length, and weight for the 3% subsample). Data during tagging were recorded using P4 software put out by PTAGIS[1]. Prior to release, holding tanks and the fish transport truck were examined to remove mortalities and scanned with a magnet to collect any shed PIT tags. PIT tag codes from sheds and mortalities were removed from the tag record. The PIT tag data has been inspected for data quality before being uploaded to PTAGIS at the time of release.

Fish Transport

Fish were transported in a 400-gallon insulated fish transport tank (Reiff Manufacturing). The tank was placed and secured in the bed of a Ford F350 truck. The tank is equipped with a water pump to circulate oxygenated water within the tank, and an oxygen tank was secured vertically in the bed of the truck and used to supply oxygen to the tank. Transport fish densities have been between 20 – 50 g/L (equivalent to 0.17 – 0.42 lbs/gallon) and dissolved oxygen was monitored and maintained between 80-120%, following the juvenile Chinook transport methods applied by the USGS (Kock et al. 2019). Temperature and dissolved oxygen are monitored during transport by using a water quality meter with a cable that extends to the truck cab. Prior to transport, the temperature of the release location was measured and if necessary, the temperature of tank water was manipulated during transport so that fish experience at most a 1.0 ºC change in temperature at release. Water temperature manipulations during transport were made by adding either ice or warm water to the tank at a rate that ensures fish experience a targeted less than 0.5 ºC change in temperature per 15 minutes (Kock et al. 2019) to stay in compliance with NMFS criteria.

[1] https://www.ptagis.org/Software/P4/P4

The fish transport tank is disinfected when switching between basins to prevent disease transmission. The inside of the tank was disinfected through exposure to 200 ppm chlorine for 30 minutes, after which it was thoroughly flushed with clean water (IHOT 1994).

Release

Release Methods

Maps of intended release locations are provided in Figures 2-6. The method of release from the transport truck will depend on the release location and reservoir elevation. When release locations are at boat ramps, the truck were backed down to the water's edge, where fish will then be volitionally released from the tank by attaching 6" collapsible tube, 6" semi-rigid tube, or 3" semi-rigid tube to the sluice gate at the bottom of the tank. Prior to fish release, the tubes were filled with water to prevent fish injury. To ensure fish are fully flushed from the tube at the end of the release, buckets of release location water were used to flush the tube after the tank empties. A generator and trashpump are also used occasionally be available to pump river water into the tank to assist in flushing fish from the tank. At roadside release locations, the same method were used, however the truck were parked at the nearest road shoulder.

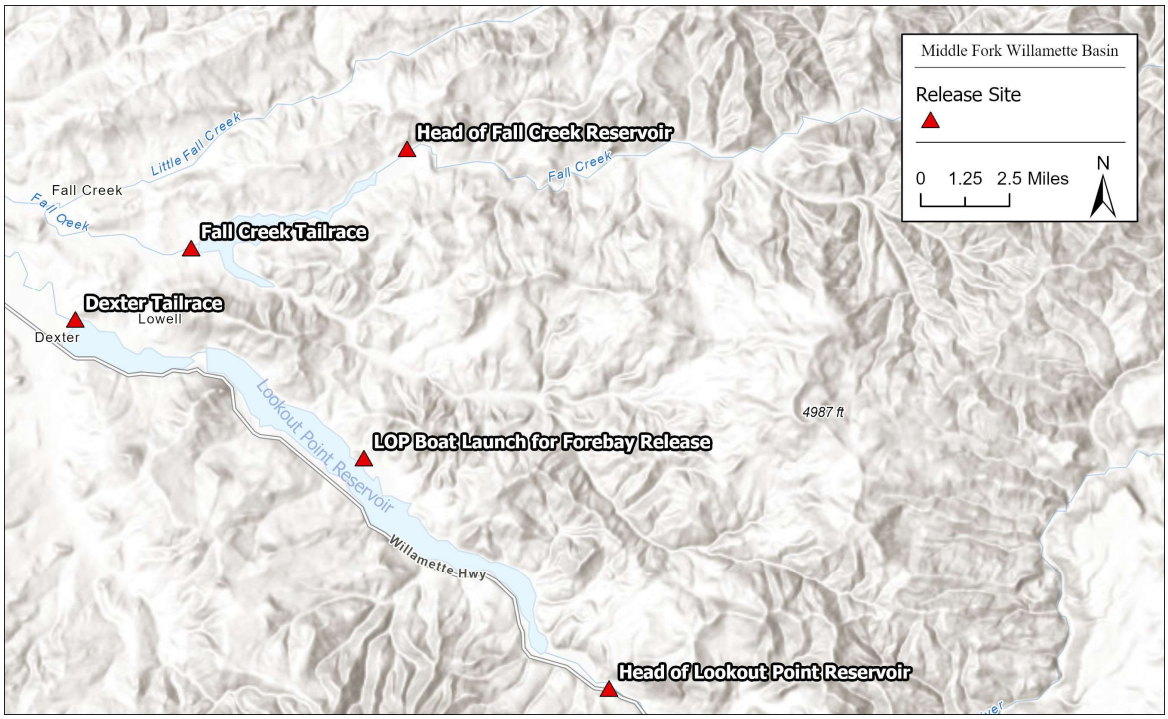

Figure 2. Map of Lookout Point, Dexter tailrace and Fall Creek release locations within the Middle Fork Willamette Basin. Head of Lookout Pt reservoir at Hampton Boat Launch (Black Canyon Campground as backup). Head of Fall Creek reservoir is at the location of the decommissioned boatramp approximately 800 meters below Dolly Varden Campground.

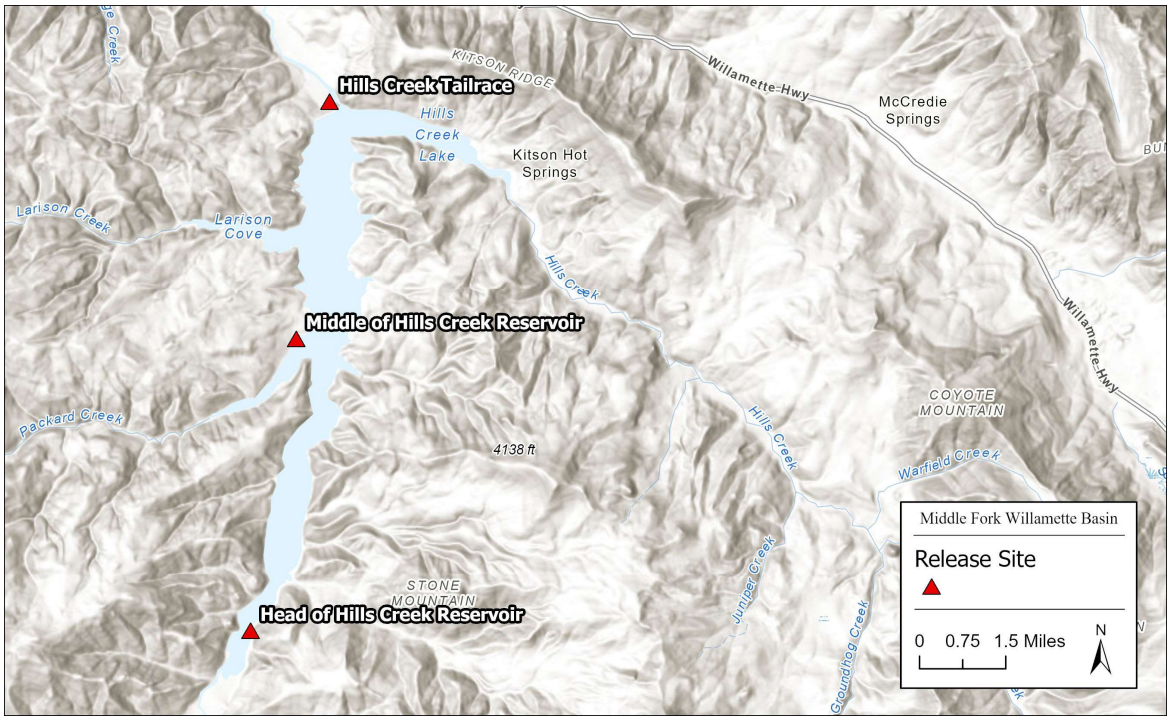

Figure 3. Map of Hills Creek Reservoir release locations within the Middle Fork Willamette Basin. The mid-reservoir release location occurs at Packard boat ramp. The head of reservoir release location occurs at the upper reservoir bridge crossing.

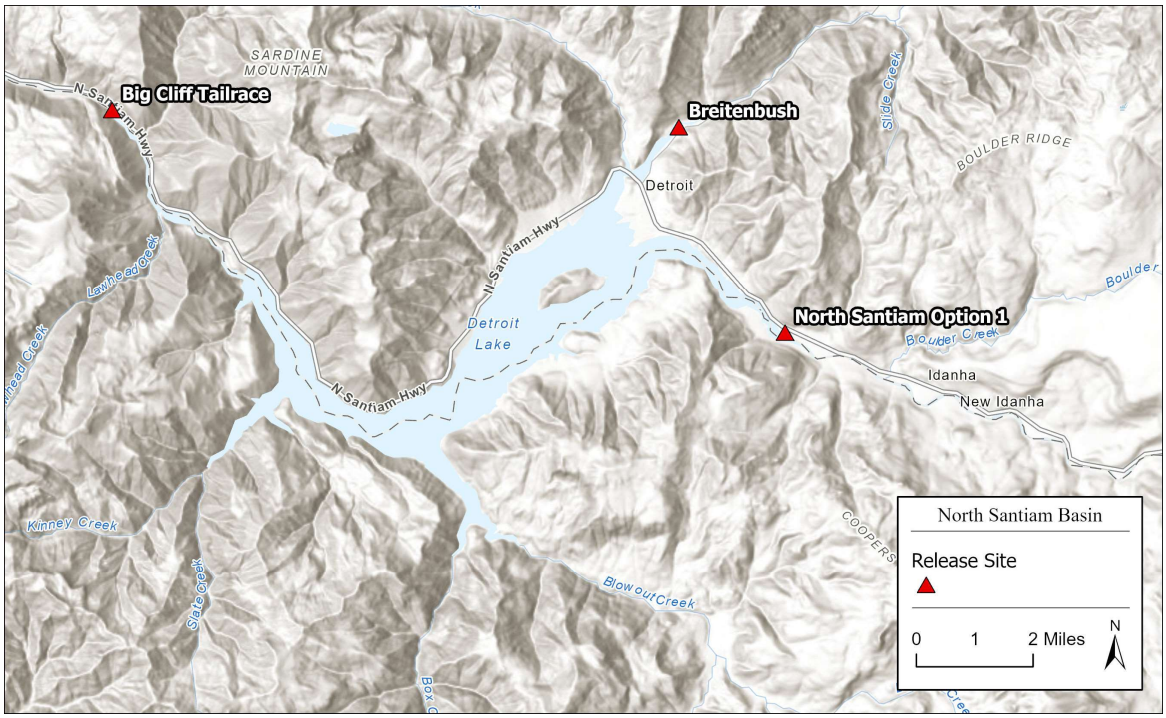

Figure 4. Map of release locations within the North Santiam Basin. The North Santiam head of reservoir release site is the Santiam Falls Campground or Hoover Campground. The Breitenbush release site is at the USGS gaging station.

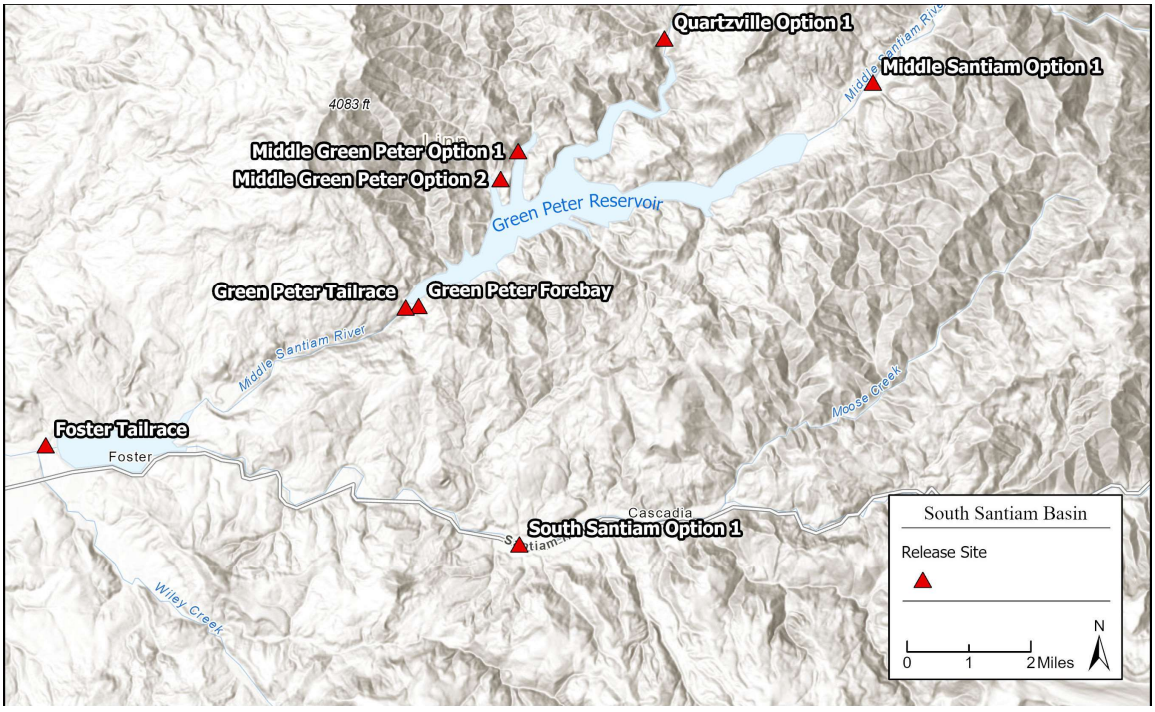

Figure 5. Map of release locations in the Middle/South Santiam basin including Green Peter Reservoir. Green Peter forebay releases are at Billings Park. Middle Santiam head of reservoir releases are anticipated occur at the bridge crossing at the top of the reservoir. Quartzville head of

reservoir releases are occur at one of the multiple river access sites along the Quartzville Dr depending on conditions at the time of release. Whitcomb County Park and Thistle Creek boat ramp are alternate release locations that may be used, if needed, depending on reservoir conditions during the deep drawdown.

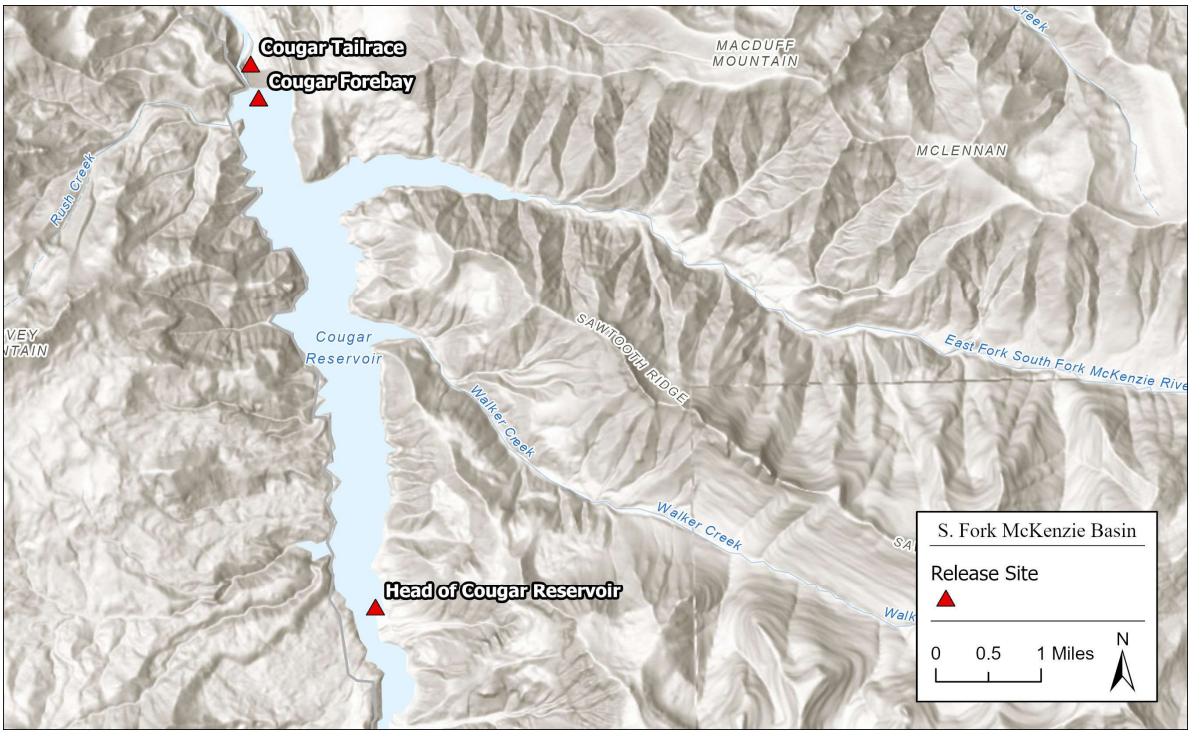

Figure 6. Map of release locations in Cougar Reservoir within the South Fork McKenzie basin. Cougar forebay releases will likely occur at the face of Cougar dam during drawdown periods as distances are anticipated to be too far for effective forebay releases elsewhere. Cougar head of reservoir releases are at Cougar Crossing or Slide Creek Day Use area.

Results: Bulk Marking Summary through 30 June 2023

Middle Fork Willamette

Hills Creek Dam

From May 22nd to June 1, 2023, a total of 10,117 juvenile Chinook salmon of the Willamette stock (22H) were marked with adipose clips and Passive Integrated Transponder (PIT) tags for the Hills Creek Head of Reservoir release group (Table 3). Following the initiation of tagging until the release of these fish on June 5, 2023, a tagging mortality rate of 0.22 percent and a tag shedding rate of 0.09 percent were recorded. For this release group, we reserved 300 individuals to be held for a minimum of two weeks to assess long-term mortality and tag shedding rates. Upon adjusting for the long-term mortality group, mortalities, and shed tags, we estimate that 9,817 PIT-tagged salmon were released into Hills Creek Head of Reservoir at approximately 10:35 AM on June 5, 2023 (Table 4; Figure 3). The fish were released at the Bingham boat ramp into water that was approximately 11.4 degrees Celsius.

Lookout Point and Dexter Dams

From May 22 to May 24, 2023, approximately 10,000 fish were tagged to be released at Lookout Point at head of reservoir from the Black Canyon Campground boat ramp. Before their release we measured average mass of 2.9 g, and approximately 63 mm fork length. Mortality estimates were very low at less than .39 percent. Tag losses (shed) were estimated at only a half of a percent (Table 3). Temperature at the time of release was favorable at approximately 13 degrees Celsius.

Fall Creek Dam

Between June 1, 2023, and June 7, 2023, we tagged a total of 10,040 juvenile Chinook salmon for the Fall Creek Head of Reservoir release group (Table 3). Before their release, we recorded a tagging mortality rate of 0.68 percent and a tag shed rate of 0.30 percent. For this release group, we designated 300 individuals to be retained for a minimum of two weeks for the assessment of long-term mortality and tag shedding rates. After accommodating the long-term mortality sub-sample, observed tagging mortality, and shed tags, we estimate that 9,642 PIT-tagged salmon were released into the head of Fall Creek Reservoir on June 12, 2023 (Table 3; Figure 2). The fish were released at the site of the decommissioned boat ramp that is approximately 800 meters downstream of Dolly Varden Campground (location of the historic rotary screw trap), where water temperatures were approximately 19 degrees Celsius.

South Santiam River

Green Peter Dam

Cramer Fish Sciences initiated the bulk marking of hatchery-reared juvenile Upper Willamette River Chinook salmon at Willamette Hatchery (Oakridge, OR) on May 15th, 2023. Under the direction of the Corps, Green Peter Head of Reservoir release groups were prioritized so that their release would coincide with spill operations at Green Peter Dam. During the period from May 15th to May 18th, 2023, a total of 10,274 South Santiam stock (24H) juvenile Chinook salmon were marked with adipose clips and Passive Integrated Transponder (PIT) tags. These marked fish were categorized into two release groups: those headed for the Middle Santiam arm (N = 5071) and those bound for the Quartzville Creek arm of Green Peter Reservoir (N = 5203; refer Table 2). Between the commencement of tagging and the release of these fish on May 22nd, 2023, mortality rates due to tagging were observed at 1.46 percent for the Middle Santiam group and 0.35 percent for the Quartzville Creek group. The tag shed rate mirrored the mortality rate, being higher for the Middle Santiam release group at 0.63 percent, compared to the Quartzville Creek group at 0.35 percent. After adjusting for these losses, we estimate that 4,965 PIT tagged salmon were released into the Middle Santiam arm at the upper bridge and 5,167 into the Quartzville Creek arm of the reservoir just downstream of the Moose Creek Day-Use Area (Table 3; Appendix A - Figure 4). It is noteworthy that at the time of release, water temperatures were approximately 18 degrees Celsius in both reservoir arms, and our teams observed piscivory by smallmouth bass. Additionally, there was a miscommunication between field staff that resulted in failing to retain a three percent subsample of this release group to evaluate long-term mortality and tag shed rate.

North Santiam River

Detroit and Big Cliff Dams

Bulk marking resumed on June 13th at Marion Forks Hatchery with the Detroit Head of Reservoir release groups. Two groups of “fry” have been tagged, but neither group has been released yet. First group of 15,058 juvenile Chinook salmon were tagged, of which 7,530 were earmarked for the Breitenbush arm of Detroit Reservoir, and the remaining 7,528 for the North Santiam River arm

(Table 5). The second group of 15,195 were adipose clipped and PIT tagged between June 26, 2023 and June 29, 2023, split into the same two release locations (Table 5). The reason for the delay was due to exposure of these fish to a bacteria in the hatchery. We expect these fish to be released pending further observation in in July.

Releases at Big Cliff will start in October (Table 5).

South Fork McKenzie

Cougar Dam

We started PIT tagging and adipose clipping juvenile Chinook salmon at Leaburg Hatchery on June 20, 2023, aiming to tag 10,000 fish. However, on the first day, we noted high mortality rates among both tagged fish and those waiting in the staging trough. Out of the 3,553 salmon tagged, 93 died by day's end, a rate of 2.3%. This was unusual, considering our average mortality rate during tagging is typically 0.62%. We also found 10 dead fish in the staging trough. While we don't usually record data for fish in raceways or staging troughs, mortalities in these groups are normally quite rare.

Despite maintaining water temperatures within two degrees Celsius of the fish's holding environment, which averaged a favorable 10.4 C, and using the same MS-222 stock solution as previously, mortality rates were high. The experienced crew ensured proper marking techniques were followed.

Of note, the group of 10,000 fish that we were tagging had been raised separately from the rest of the brood year 2022 McKenzie River Chinook salmon at the hatchery. This particular subgroup did not receive antibiotic feed treatment at the same time as the rest of the McKenzie stock, which took place in late April/early May as they were held separately for release in the near future. This knowledge raised some concern that fish may be battling a pathogen, and the additional stress of handling and marking was pushing them past the limit of what they could endure. We reached out to the state pathologist, Dr. Aimee Reed, and she agreed that there was a high possibility that these fish could be battling a pathogenic disease. The pathologist informed us that she was currently running tests on fish from Leaburg but that the results would not be available for several days. In the meantime, we were advised to halt all marking activities. We are still awaiting results from pathology at this time (30 June 2023).

After disinfecting our tagging trailer and working out the logistics of which hatchery could accommodate us next, we moved locations back to Marion Forks Hatchery, where we are tagging for release in the North Santiam.

Table 3. Bulk marking summary statistics. Total number of fish marked (N), mean fork length (FL), mean weight, start date of marking, end date of marking, total mortalities from start of tagging to release, mortality percentage, total shed tags from start of tagging to release, and shed tag percentage. For releases that occurred after 30 June (North Santiam), those data are not finalized, but will be available in the January 2024 biannual report.

Mark Group	N	Mean FL (mm)	Mean Weight (g)	Date Start	Date End	Morts	Mort. %	Sheds	Shed %
Green Peter Head of Reservoir - Middle Santiam Arm	5,071	56.1		5/15/23	5/16/23	74	1.46	32	0.63
Green Peter Head of Reservoir - Quartzville Creek Arm	5,203	58.5		5/17/23	5/18/23	18	0.35	19	0.37
Lookout Point Head of Reservoir	10,041	63.1	2.9	5/22/23	5/24/23	39	0.39	53	0.53
Hills Creek Head of Reservoir	10,117	64.6	2.9	5/30/23	6/1/23	22	0.22	9	0.09
Fall Creek Head of Reservoir	10,040	67.3	3.2	6/1/23	6/7/23	68	0.68	30	0.30
Detroit Head of Reservoir Breitenbush Arm	7,530	66.9	3.6	6/13/23	6/14/23	TBD	TBD	TBD	TBD
Detroit Head of Reservoir - North Santiam Arm	7,528	66.9	3.6	6/14/23	6/15/23	TBD	TBD	TBD	TBD
Cougar Head of Reservoir	3,553	67.7	3.5	6/20/23	6/20/23	TBD	TBD	TBD	TBD
North Santiam Basin – Fall 2023 and Spring 2024	15,195	67.3	3.5	6/26/23	6/29/23	TBD	TBD	TBD	TBD

Table 4. Actual release summary statistics. Date of release, number of marked fish released, transport tank water temperature and the beginning and end of the transport, and water temperature at the release location. Releases at Detroit occurred in July and are not available for this report.

Release Location	Release Date	Fish	Trans. Temp Start	Trans. Temp End	Release Site Temp
Green Peter Head of Reservoir - Quartzville Creek Arm	5/22/2023	5,203	12	13.2	18
Green Peter Head of Reservoir - Middle Santiam Arm	5/22/2023	5,071	11.9	12.9	18.3
Lookout Point Head of Reservoir	5/30/2023	9,741	11.9	12.5	13.2
Hills Creek Head of Reservoir	6/5/2023	9,817	12.9	13.2	11.4
Fall Creek Head of Reservoir	6/12/2023	9,642	16.5	17.4	19.0

Schedule for Bulk Marking and Release

The following represents the bulk marking and release locations for the remainder of the study. In 2023 (Table 5) the opportunity to mark fry was missed due to a variety of factors as discussed above (i.e., permitting process, availability of equipment due to continued supply chain issues, coordination with hatcheries and training of field staff, and a significant amount of advance work).

Table 5. Tentative (target) release schedule for brood year 2022. Bold rows highlight the release groups that have been tagged and released during this reporting period. Italicized and underlined rows highlight release groups that have been tagged during this reporting period, but will be released at a later date. Release dates are approximate and depend upon operations and conditions such as reservoir elevation, road closures, etc. **See Table 3 and Table 4 for further details about tagging and releases conducted through 30 June 2023.**

Release Date	Release Basin	Release Area	Release Location	Lifestage	N
2/1/2023	*North Santiam*	*Detroit Reservoir*	*Breitenbush River*	*fry*	*3750*
2/1/2023	*North Santiam*	*Detroit Reservoir*	*North Santiam River*	*fry*	*3750*
3/1/2023	**MF Willamette**	**Fall Creek Dam**	**Fall Creek Head of Reservoir**	**fry**	**5000**
3/1/2023	**MF Willamette**	**Lookout Point and Dexter**	**Lookout Point Head of Reservoir**	**fry**	**5000**
3/1/2023	**MF Willamette**	**Hills Creek Dam**	**Hills Creek Head of Reservoir**	**fry**	**5000**
3/1/2023	*SF McKenzie*	*Cougar Dam*	*Cougar Head of Reservoir*	*fry*	*5000*
3/15/2023	*SF McKenzie*	*Cougar Dam*	*Cougar Head of Reservoir*	*fry*	*5000*
3/31/2023	**MF Willamette**	**Fall Creek Dam**	**Fall Creek Head of Reservoir**	**fry**	**5000**
4/1/2023	**MF Willamette**	**Lookout Point and Dexter**	**Lookout Point Head of Reservoir**	**fry**	**5000**
4/1/2023	*North Santiam*	*Detroit Reservoir*	*Breitenbush River*	*fry*	*3750*
4/1/2023	*North Santiam*	*Detroit Reservoir*	*North Santiam River*	*fry*	*3750*
4/1/2023	**South Santiam**	**Green Peter Reservoir**	**Green Peter Head of Reservoir - Middle Santiam Arm**	**fry**	**2500**
4/1/2023	**South Santiam**	**Green Peter Reservoir**	**Green Peter Head of Reservoir - Quartzville Creek Arm**	**fry**	**2500**
4/15/2023	**MF Willamette**	**Hills Creek Dam**	**Hills Creek Head of Reservoir**	**fry**	**5000**
4/15/2023	**South Santiam**	**Green Peter Reservoir**	**Green Peter Head of Reservoir - Middle Santiam Arm**	**fry**	**2500**
4/15/2023	**South Santiam**	**Green Peter Reservoir**	**Green Peter Head of Reservoir - Quartzville Creek Arm**	**fry**	**2500**
8/30/2023	South Santiam	Foster Reservoir	Foster Dam Tailrace	subyearling	1000
8/30/2023	South Santiam	Foster Reservoir	Foster Head of Reservoir	subyearling	2000

9/15/2023	MF Willamette	Lookout Point and Dexter	Dexter Dam Tailrace	subyearling	2000
9/15/2023	MF Willamette	Lookout Point and Dexter	Lookout Point Head of Reservoir	subyearling	5000
9/15/2023	MF Willamette	Lookout Point and Dexter	Lookout Point Dam Forebay	subyearling	5000
9/15/2023	SF McKenzie	Cougar Dam	Cougar Head of Reservoir	subyearling	3000
9/15/2023	South Santiam	Green Peter Reservoir	Green Peter Head of Reservoir - Middle Santiam Arm	subyearling	2500
9/15/2023	South Santiam	Green Peter Reservoir	Green Peter Head of Reservoir - Quartzville Creek Arm	subyearling	2500
10/1/2023	*North Santiam*	*Big Cliff Dam*	*Big Cliff Dam Tailrace*	*subyearling*	*8000*
10/1/2023	*North Santiam*	*Detroit Reservoir*	*Breitenbush River*	*subyearling*	*5000*
10/1/2023	*North Santiam*	*Detroit Reservoir*	*North Santiam River*	*subyearling*	*5000*
10/15/2023	MF Willamette	Fall Creek Dam	Fall Creek Head of Reservoir	subyearling	5000
10/15/2023	MF Willamette	Fall Creek Dam	Fall Creek Dam tailrace	subyearling	1000
10/15/2023	SF McKenzie	Cougar Dam	Cougar Dam Forebay	subyearling	5000
10/15/2023	SF McKenzie	Cougar Dam	Cougar Dam Tailrace	subyearling	4000
10/15/2023	SF McKenzie	Cougar Dam	Cougar Head of Reservoir	subyearling	4000
10/15/2023	South Santiam	Green Peter Reservoir	Green Peter Dam Tailrace	subyearling	4000
10/15/2023	South Santiam	Green Peter Reservoir	Green Peter Head of Reservoir - Middle Santiam Arm	subyearling	2500
10/15/2023	South Santiam	Green Peter Reservoir	Green Peter Head of Reservoir - Quartzville Creek Arm	subyearling	2500
10/15/2023	South Santiam	Foster Reservoir	Foster Dam Tailrace	subyearling	4000
10/15/2023	South Santiam	Foster Reservoir	Foster Head of Reservoir	subyearling	5000
11/15/2023	MF Willamette	Fall Creek Dam	Fall Creek Head of Reservoir	subyearling	5000
11/15/2023	MF Willamette	Fall Creek Dam	Fall Creek Dam tailrace	subyearling	1000
11/15/2023	North Santiam	Big Cliff Dam	Big Cliff Dam Tailrace	subyearling	6000
11/15/2023	SF McKenzie	Cougar Dam	Cougar Dam Forebay	subyearling	5000
11/15/2023	SF McKenzie	Cougar Dam	Cougar Dam Tailrace	subyearling	4000
11/15/2023	SF McKenzie	Cougar Dam	Cougar Head of Reservoir	subyearling	4000
11/16/2023	MF Willamette	Hills Creek Dam	Hills Creek Dam Head of Reservoir	subyearling	5000
11/16/2023	MF Willamette	Hills Creek Dam	Hills Creek Dam tailrace	subyearling	3000

11/16/2023	MF Willamette	Hills Creek Dam	Hills Creek forebay or mid-reservoir	subyearling	5000
2/1/2024	MF Willamette	Hills Creek Dam	Hills Creek Dam Head of Reservoir	yearling	5000
2/1/2024	MF Willamette	Hills Creek Dam	Hills Creek Dam tailrace	yearling	3000
2/1/2024	MF Willamette	Hills Creek Dam	Hills Creek forebay or mid-reservoir	yearling	5000
2/28/2024	MF Willamette	Fall Creek Dam	Fall Creek Dam Head of Reservoir	yearling	5000
2/28/2024	MF Willamette	Fall Creek Dam	Fall Creek Dam Tailrace	yearling	1000
2/28/2024	MF Willamette	Lookout Point & Dexter Dams	Head of Lookout Point Dam reservoir	yearling	5000
2/28/2024	MF Willamette	Lookout Point & Dexter Dams	Dexter Dam Tailrace	yearling	2000
2/28/2024	MF Willamette	Lookout Point & Dexter Dams	Lookout Point Dam Forebay	yearling	5000
2/28/2024	SF McKenzie	Cougar Dam	Cougar Dam Forebay	yearling	2000
2/28/2024	SF McKenzie	Cougar Dam	Cougar Dam Tailrace	yearling	1000
2/28/2024	SF McKenzie	Cougar Dam	Cougar Head of Reservoir	yearling	2000
3/30/2024	SF McKenzie	Cougar Dam	Cougar Dam Forebay	yearling	2000
3/30/2024	SF McKenzie	Cougar Dam	Cougar Dam Tailrace	yearling	1000
3/30/2024	SF McKenzie	Cougar Dam	Cougar Head of Reservoir	yearling	2000
3/31/2024	MF Willamette	Fall Creek Dam	Fall Creek Dam Head of Reservoir	yearling	5000
3/31/2024	MF Willamette	Fall Creek Dam	Fall Creek Dam Tailrace	yearling	1000
4/1/2024	MF Willamette	Lookout Point & Dexter Dams	Head of Lookout Point Dam reservoir	yearling	5000
4/1/2024	MF Willamette	Lookout Point & Dexter Dams	Dexter Dam Tailrace	yearling	2000
4/1/2024	MF Willamette	Lookout Point & Dexter Dams	Lookout Point Dam Forebay	yearling	5000
4/1/2024	North Santiam	Big Cliff Dam	Big Cliff Dam Tailrace	yearling	2000
4/1/2024	North Santiam	Detroit Dam	Breitenbush River	yearling	2000
4/1/2024	North Santiam	Detroit Dam	North Santiam River	yearling	2000

Recaptures

There have been two recaptures of PIT tagged fish so far this year (Table 6). One recapture occurred at the Green Peter Tailrace rotary screw trap and one fish was recaptured in an Oneida net in Lookout Point Reservoir. As the study progresses and fish reach the size for migration, it is expected that more fish will be recaptured at downstream locations such as screw traps, PIT tag antenna arrays, estuary trawls, etc. All data are entered into PTAGIS.

Table 6. PIT tag recoveries. GPR = Green Peter Reservoir, LOP = Lookout Point Reservoir.

PIT ID	Release Date	Release Location	Recapture Date	Recapture Location
3D6.15348025F1	5/22/2023	GPR of Reservoir - Middle Santiam Arm	5/28/2023	GPR Tailrace Rotary Screw Trap
3D6.15348010F9	5/30/2023	LOP Head of Reservoir	6/27/2023	LOP Trap Net

RESERVOIR DISTRIBUTION STUDIES

Methods

Reservoir distribution studies were conducted during 2023 and 2024 in Green Peter and Lookout Point reservoirs to characterize the life history characteristics and body condition of juvenile Chinook salmon and *O. mykiss* utilizing the reservoir environment, including nearshore juvenile distribution and longitudinal distribution of Chinook salmon in relation to dam operations.

Data Collection

Juvenile Chinook Longitudinal Distribution & Body Condition

Biological Data

Past research in Willamette reservoirs indicates that Chinook fry (<50 mm fork length [FL]) are closely associated with shallow nearshore habitat in spring before beginning to move offshore in June and shifting farther offshore and into deeper waters later in summer when water temperatures are at their maximum (Monzyk et al. 2015). Fish sampling methodology has been selected to be consistent with past efforts (e.g. Monzyk et al. 2015) and to account for seasonal habitat use by juvenile Chinook salmon. To capture nearshore migration, fry were be sampled in shallow nearshore environments primarily using floating box traps and Oneida Lake traps. In summer and fall, juvenile Chinook were sampled using gill nets, set in the pelagic zone at depths corresponding with typical Chinook thermal preferences as determined by past vertical distribution evaluations in Lookout Point Reservoir (Monzyk et al. 2013, Kock et al. 2019).

Nearshore trapping was conducted following the methods of Monzyk et al. 2015. A stratified random sampling design were used for daily trap locations. Each reservoir was stratified into three longitudinal zones (lower, middle and upper) where each zone represents approximately one third of the reservoir length (Figure 1; Figure 2). In Green Peter Reservoir, an additional zone was created to capture the Quartzille Creek arm of the reservoir (labeled "Quartzville" in Figure 2). Within each reservoir zone, the maximum conservation pool shoreline[2] was split into

[2] https://geospatialusace.opendata.arcgis.com/datasets/03e322d7e89b48a9b48e9c3f4bcaf29e_0/explore?location=34.797101%2C-97.473165%2C5.00

reaches of approximately 850 m. In Lookout Point Reservoir, nearshore shoreline reaches were altered slightly to be consistent with those used by ODFW in past studies (Brandt et al. 2016).

In Lookout Point Reservoir, three shoreline reaches within each longitudinal zone (lower, middle and upper) were randomly selected each sampling day for floating box trap placement (n = 9), and one location were randomly selected per zone for Oneida Lake trap placement (n = 3 total). These same trap allocations were used for Green Peter Reservoir, however, in addition, one Oneida trap and one floating box trap were placed in randomly selected shoreline reaches within the Quartzville zone, for a total of n=10 box traps and n=6 Oneida Lake traps per day.

Within each selected shoreline segment, trap placement is determined based on suitability of site access and tie off locations. Traps were fished for approximately 24 hours, before being checked and moved to a new random location.

During each daily trap check, the trap throat were closed and the time the trap is checked were recorded. All fish will then be removed from the trap using nylon mesh dip nets and transferred to buckets filled with well-oxygenated fresh reservoir water. Non-target fish (not Chinook salmon or *O. mykiss*) were identified to species and coarse size/age class, enumerated and the first 10 of each species and size class were measured for FL to the nearest mm and released. Non-target species will also be checked for presence/absence of the ectoparasitic copepod *Salmincola californiensis* and the number of fish with and without copepods were recorded. Size or age classes were estimated in the field based on physical characteristics and relative size differences between cohorts.

Captured Chinook and *O. mykiss* were examined for marks (adipose fin clips, PIT or VIE tags). All marked target species less than 300 mm were anesthetized in small batches using 50 mg/L MS-222 buffered with sodium bicarbonate. They will then have their mark/tag information recorded and were measured for FL to the nearest mm, weighed to the nearest 0.01 g, and assessed for physical condition. Chinook or *O. mykiss* marked with a VIE tag that are recaptured and greater than 45 mm FL will additionally be tagged with a PIT tag based on FL (8 mm PIT: 45 mm < FL < 65 mm; 12 mm PIT: FL > 65 mm). The physical condition assessment will include percent descaling, injuries, evidence of disease or pathogens, and parasite presence/intensity. Fish were examined systematically for *S. californiensis* infection intensity following methods used by Romer et al. (2017). Field crews will carefully examine the brachial cavity and fins for the presence of copepods. The number of copepods found and their location on the fish were recorded. Following physical assessment, fish were transferred to a bucket filled with well-oxygenated fresh reservoir water to fully recover before release. Marked target species greater than 300 mm will have their mark information recorded, were measured for FL, and were immediately released.

Unmarked Chinook and *O. mykiss* greater than 300 mm FL were measured for FL and then released. Unmarked target species less than 300 mm were anesthetized and tagged in the field with a PIT tag based on fork length. Fish over 45 mm were tagged with uniquely identifiable PIT tags. Fish tagged in the field will have their tag information recorded, fork length and weight measured, and they were given a physical condition assessment. After being processed, fish will recover in recovery buckets prior to release. Data on PIT tagged fish were uploaded to PTAGIS monthly.

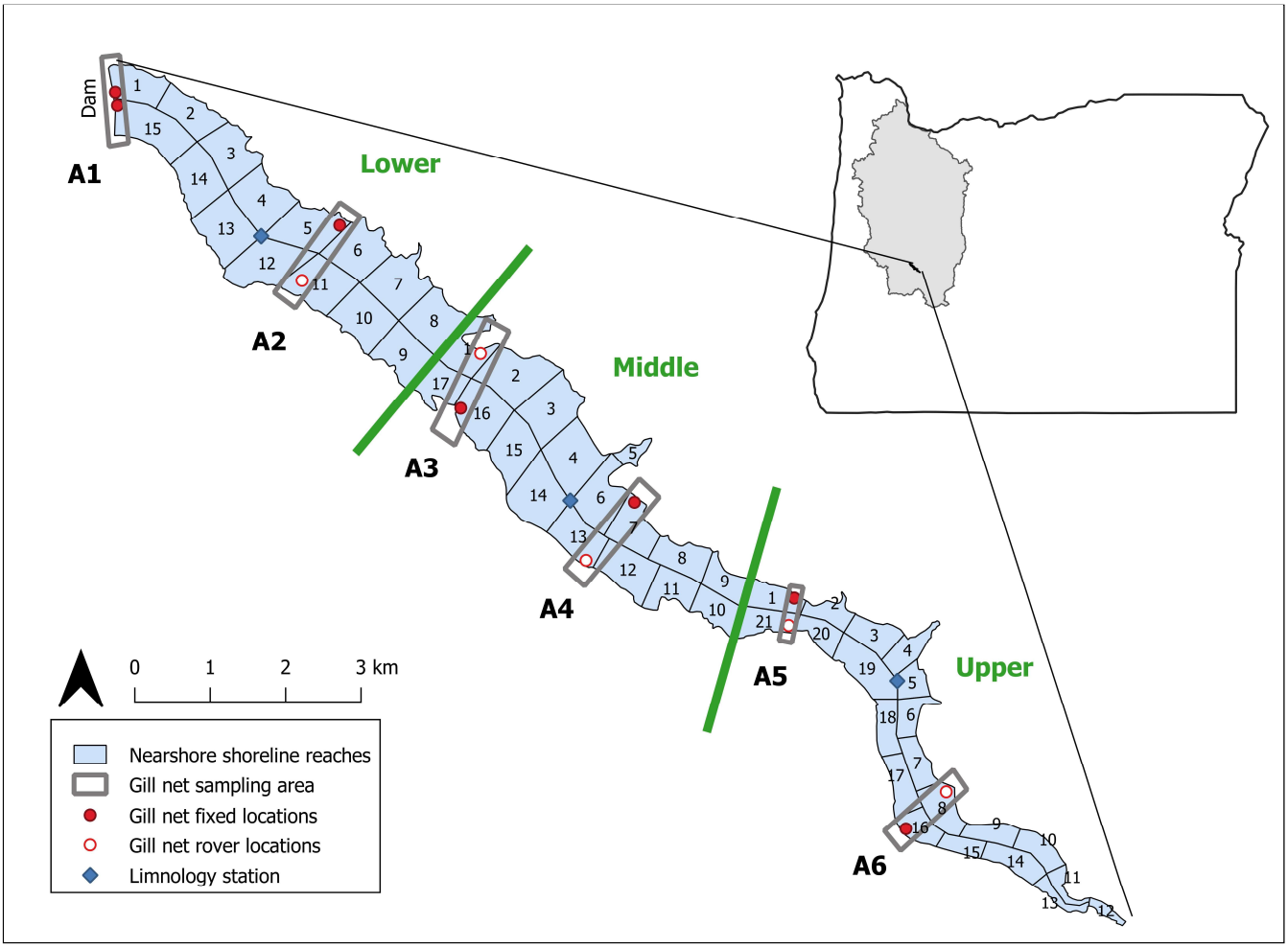

Figure 1. Map of Lookout Point Reservoir nearshore shoreline reaches, reservoir zones (lower, middle and upper), gill netting sampling areas and limnological stations.

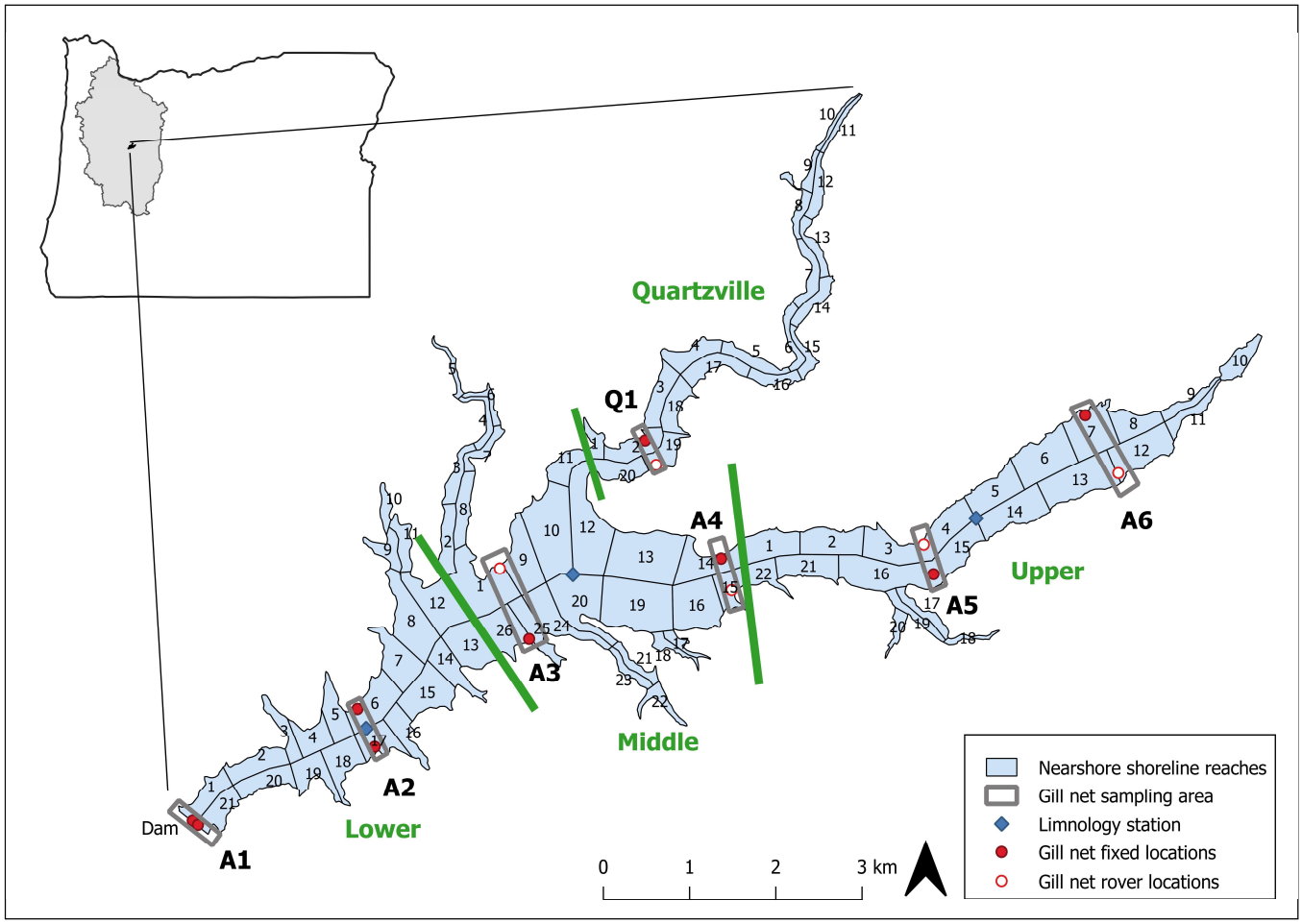

Figure 2. Map of Green Peter Reservoir nearshore shoreline reaches, reservoir zones (lower, middle and upper), gill netting sampling areas and limnological stations.

Parr longitudinal distribution

Biweekly gill netting were conducted between mid-June and the end of November to assess the longitudinal distribution of Chinook parr after they move offshore. Consistent with nearshore sampling, each sampling event will consist of four days of sampling effort on each reservoir, including one day of setting gill nets and three days of checking nets. Green Peter and Lookout Point reservoirs were sampled on alternate weeks for a total of two weeks of sampling effort on each reservoir per month. Gill netting may be suspended early (before the end of October) if conflicts with other studies arise (i.e., USGS and PNNL studies).

Gill netting were conducted following the methods of Monzyk et al. 2015. In each reservoir, floating gill nets were set at six fixed sampling locations evenly spaced from the head of the reservoir to the dam (Figure 1; Figure 2). A seventh fixed sampling location were used in Green Peter Reservoir within the Quartzville arm (site Q1). In total, 8 nets were set each day in Lookout Point, and 9 nets in Green Peter Reservoir. Two nets were set off the dam face (site A1), while one net were set at each of the remaining sites (sites A2-A6, site Q1 in Green Peter). Lastly, each day one "rover" net were set across the reservoir from a fixed site to increase sampling effort (gill net rover locations on Figure 2). The rover site were selected systematically each day to ensure as close as possible

to equal supplemental sampling effort among sites each month. Gill nets were 24.4 m long by 4.9 m deep[3] and comprised of four 6.1 m panels (square mesh sizes: 9.5, 12.7, 19.1 and 25.4 mm) (Research Nets, Inc.). Nets were set perpendicular to shore at depths corresponding to typical Chinook habitat use and thermal preferences (Monzyk et al. 2015, Kock et al. 2019, Monzyk et al. 2013). Each sampling event, reservoir vertical temperature profiles were collected (see "Limnological Sampling," below) to determine appropriate net depths. It is expected that depths were greatest during peak thermal stratification (top of net at approximately 9.1 m July and August, 15.2 m early September), before returning to near the surface by the end of October (Monzyk et al. 2015). Net suspension methods will follow Ingram and Korn (1969). For each net set, we will record site GPS, set and pull date and time, site depth, target net depth, and describe the weather (see data sheets in Appendix C). Nets were fished for approximately 24 hours between pulls.

All fish caught were identified to species and coarse size/age class and the mesh size where each fish was captured were recorded. The first 10 of each non-target species (not Chinook or *O. mykiss*) and age/size class were measured for FL before disposal/release. All mortalities were sunk after puncturing the swim bladder, while live non-target fish were immediately released. Chinook salmon and *O. mykiss* captured were examined for marks (fin clips, PIT or VIE tags). Marks and tag codes were recorded, and mortalities were measured for FL and weight and assessed for physical condition. Any live target species less than 300 mm FL were handled following the same procedures as for nearshore sampling and if unmarked, were tagged. Live Chinook and *O. mykiss* greater than 300 mm were examined for marks, measured for FL and released.

Limnological Sampling

In each reservoir, three limnological stations were established. One were located in the upper third of the reservoir, one in the middle, and one in the lower third along the longitudinal axis (Figure 1; Figure 2). On the first day of each biweekly sampling effort, crews will collect a vertical temperature and dissolved oxygen (DO) profile at each station using a YSI (model ProDSS, YSI Inc.) equipped with a 100 m cable and depth sensing multisonde. Starting at the surface, temperature and DO were recorded at one second intervals (approximately every 0.5 m) on the descent until the station depth is reached. Profile data were downloaded from the YSI and saved to an electronic cloud-based database daily. As the reservoir drawdown occurs in the fall, the stations will stay the same, but their conditions (e.g., depth) will be different.

Results: Reservoir Study Summary through 30 June 2023

We finally received our first shipment of nets during the 24th week of the year (June 11 – June 17, 2023), and immediately conducted test deployments in Green Peter to work out any issues with net configurations and logistics associated with the deployment and operation of the trap nets. Sampling began in earnest the following week when we were able to set a total of three Oneida and nine box minnow traps throughout Green Peter Reservoir. Table 5 provides the effort by trap type and reservoir for the reporting period.

Table 1. Start and end date by statistical week.

Week	Start	End	Reservoir	Net Type	Effort
24	6/11/2023	6/17/2023	Green Peter	oneida	47.7 hours
25	6/18/2023	6/24/2023	Green Peter	box minnow	746.5 hours
25	6/18/2023	6/24/2023	Green Peter	oneida	304.1 hours
26	6/25/2023	7/1/2023	Lookout Point	box minnow	682.7 hours
26	6/25/2023	7/1/2023	Lookout Point	oneida	217.1 hours

[3] Note, this is slightly larger than reported by Monzyk et al. 2015, which used 4.6 m deep nets. The net depth was increased to conform with the manufacturer's material specifications.

As expected, mean surface water temperatures exceeded 20 degrees Celsius in each reservoir (Table 6; Figure 9). With temperatures optimum for Chinook between 13 and 15 degrees Celsius, it would suggest that the juvenile Chinook would move down to depths in the metalimnion (12-15m). This movement coincides with efforts in July to set gill nets targeting deeper areas to capture Chinook movement in Green Peter and Lookout Point Reservoirs.

Table 2. Mean surface water temperature measure during each trap net deployment.

Week	Reservoir	Water Surface Temperature °C
24	Green Peter	20.5
25	Green Peter	21.1
26	Lookout Point	21.7

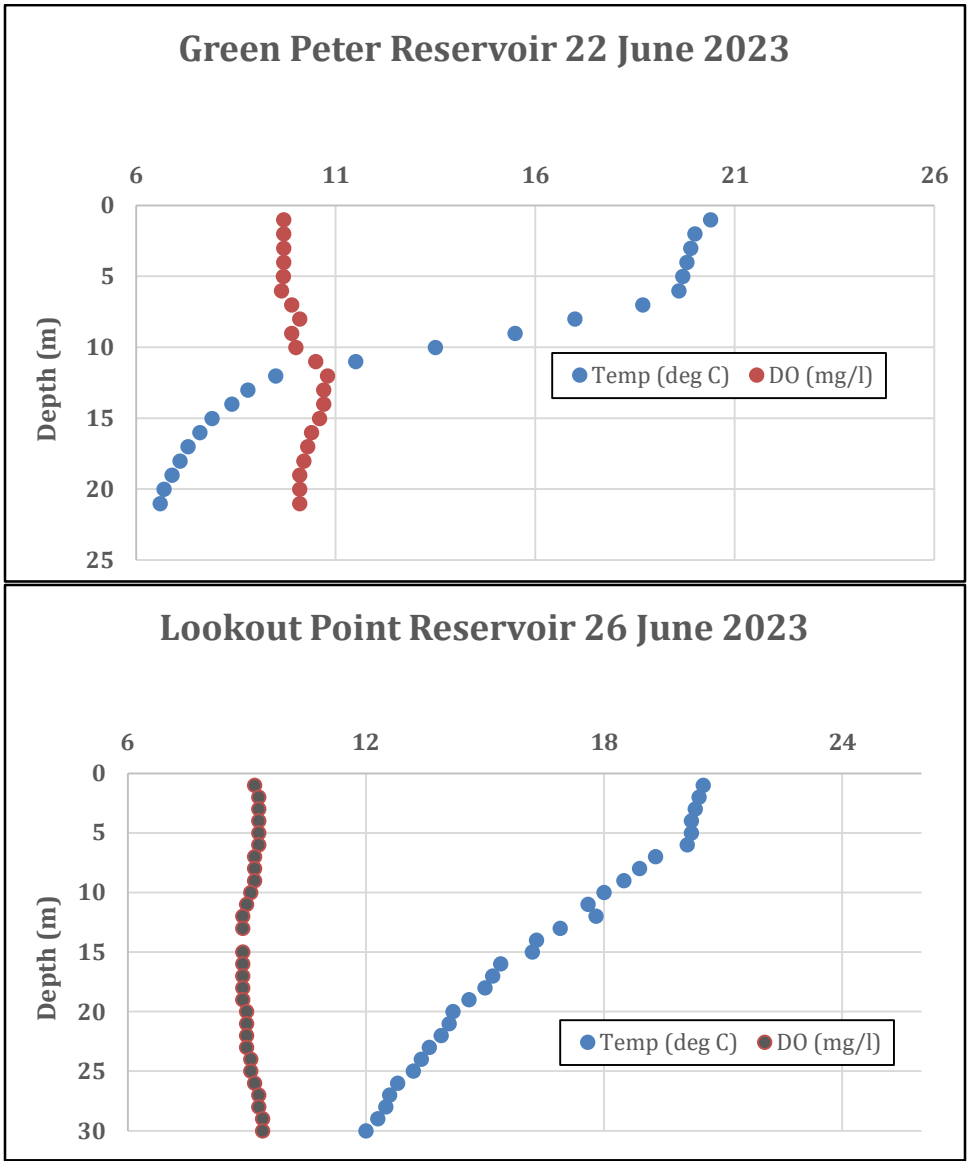

Figure 9. Temperature and dissolved oxygen profiles of Green Peter (top) and Lookout Point (bottom) Reservoirs during sampling. Note: surface temperature in both reservoirs is greater than 20 deg C.

Nearshore floating trap and Oneida netting in both reservoirs had some interesting results. The most abundant species in our catch were bluegill, followed by juvenile smallmouth bass, and juvenile largemouth bass. We captured a total of nine Chinook salmon, all of which were captured in Lookout Point Reservoir (Table 7).

Table 3. Summary of catch by reservoir. BLC - Black Crappie, BLG - Bluegill, CHS – Chinook salmon, CUT - Cutthroat trout, LMB - Largemouth bass, LSS - Large-scale sucker, NPM - Northern Pike Minnow, SMB - Smallmouth Bass, WAL - Walleye.

Week	Reservoir	Species	Catch
24	Green Peter	BLC	1
24	Green Peter	BLG	128
24	Green Peter	SMB	2
25	Green Peter	BLC	1
25	Green Peter	BLG	220
25	Green Peter	CUT	1
25	Green Peter	LMB	52
25	Green Peter	NPM	1
25	Green Peter	SMB	6
26	Lookout Point	BLG	8,587
26	Lookout Point	CHS	9
26	Lookout Point	LMB	1
26	Lookout Point	LSS	1
26	Lookout Point	SMB	283
26	Lookout Point	WAL	19

The nine Chinook salmon were all captured in either the upper (n = 5) or middle (n=4) zones of Lookout Point reservoir (Appendix B, Figure 6), and were released unharmed. The Chinook had a mean fork length of 87.2 mm and 83.6 mm in the middle and upper zones, respectively (Table 8). Moving forward, expected catches of marked Chinook should increase with methodologies changing to suspended gill nets.

Table 4. Detailed catch summary of CHS-Chinook salmon. Lengths are fork length measured in millimeters.

Week	Reservoir	Zone	Species	Catch	Min Length	Mean Length	Max Length
26	Lookout Point	MIDDLE	CHS	4	80	87.2	92
26	Lookout Point	UPPER	CHS	5	73	83.6	95

CONCLUSIONS

Due to the schedule constraints associated with contract award timing, preparation, and initiation of sampling activities, this reporting period represents approximately 6 weeks worth of sampling.

During this time we have learned that PIT tagging fry with 8 mm tags works very well if the fish are of sufficient size and can give more information than VIE tags on timing, migration, and offers the ability to determine survival at tagging stations within the Columbia River downstream. It is recommended that we continue to use the 8 mm

PIT tags on fry to meet the needs of the project if the fish are of sufficient size at the time of tagging and prior to release.

For bulk marking, we have refined the process to minimize stress in tagging and releases and are well poised for the larger tagging efforts this fall. We have had very few recoveries of PIT tagged Chinook in the reservoirs and rotary screw traps. This is likely due to two primary reasons. First, the releases of fish in the head of reservoir likely experience very high predation. Observations of bass in the immediate vicinity of the release location suggest their may be high mortality with daytime releases. Second, the sampling areas of the reservoir in the summer are relatively small compared to the volume of reservoir habitat available. To mitigate these effects, night time releases would likely reduce predations (we have observed that pattern in other systems) and more sampling effort next winter and spring would only help to increase catches.

For the reservoir work, surface waters warmed very quickly this spring and subsequent sampling needs to target depths of up to 15 m in the metalimnion in order to capture PIT tagged Chinook. After the autumn marking, trapping, and reservoir efforts, we will have collected data through fall operations including deep draw downs at Green Peter and Lookout Point reservoirs which will allow us to report further results in the next biannual summary. The expectation of moving from littoral to limnetic sampling earlier should also help with our capture efficiency of Chinook.

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