Assessment of Bull Trout and Spring Chinook Salmon Passage during Operation of the Tucannon River Adult Weir/Trap

2018 and 2019 Annual Progress Report

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On the cover: *Fluvial Bull Trout from the Tucannon River. Photograph by WDFW*

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Abstract – Bull Trout are listed across their entire range in the U.S. (conterminously) under the Endangered Species Act (ESA) as a threatened species. Spring Chinook salmon are also listed under the ESA (Snake River spring/summer Chinook ESU). A potential threat to both species that has recently received considerable attention is the operation of weirs/traps and the resulting influence on each species' migration. Both species are captured annually at the Washington Department of Fish and Wildlife's (WDFW) Tucannon River adult weir/trap, with all Bull Trout passed upstream following capture, while a portion, or all, of the annual spring Chinook salmon run are held for broodstock for the Lower Snake River Compensation Plan (LSRCP) hatchery program. A team of biologists investigated whether the operation of the Tucannon River adult weir/trap impacted Bull Trout or spring Chinook salmon during their spawning migration. Bull Trout and spring Chinook salmon tagged with Passive Integrated Transponders (PIT) were used to monitor migratory behavior at instream PIT arrays in the Tucannon River, and more specifically around the adult weir/trap when in operation.

The percentage of Bull Trout that converted through the adult weir/trap in 2018 and 2019 was estimated to be 94.0% and 92.9%, respectively, which is below the established benchmark (95.0%). Overall, the median time it took Bull Trout to move through the adult weir/trap area was 3.5 and 3.9 days in 2018 and 2019, respectively. Bull Trout entering, escaping, and re-entering the trap many times (57% of the Bull Trout which entered the trap in 2019) has likely been the greatest influence in the overall delay of Bull Trout through the trap area.

The percentage of spring Chinook salmon that converted through the adult trap in 2018 and 2019 was estimated to be 81.5% and 65.6%, respectively. Overall, the median time it took spring Chinook salmon to move through the adult weir/trap area was 3.5 and 4 days in 2018 and 2019, respectively. Similar to Bull Trout, spring Chinook salmon were also determined to enter, escape, and re-enter the trap multiple times (41% of the spring Chinook salmon – includes both adults and jacks).

Due to the confirmation that fish are escaping the trap, modifications to the trap entrance have been discussed and the trap entrance will be modified for better capture/conversion of all species through the trap prior to 2020 trapping.

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Preface

This report is intended to document annual work and activities associated with Bull Trout and spring Chinook salmon passing the Tucannon River adult weir/trap, in the Tucannon River (Washington), which is operated for both the capture, collection and propagation of summer steelhead and spring Chinook salmon under the Lower Snake River Compensation Program hatchery mitigation program. This report primarily focuses on activities/monitoring in calendar year 2018 and 2019, but also includes information gathered on Bull Trout and spring Chinook salmon migration/passage from 2015-2017 run years where available.

This report is generally technical in nature and, for context, references and discusses operations and benchmarks that were previously established by co-managers. This report is not a policy document and, while its contents may inform the process, is not for the direct purpose of establishing final policy.

Introduction

Bull Trout (*Salvelinus confluentus*) are listed under the Endangered Species Act (ESA) as a threatened species. Bull Trout were listed across their entire range in the U.S. (coterminously) on November 1, 1999 (see USFWS 2015a). Factors contributing to the listing of Bull Trout included range-wide declines in distribution, abundance and habitat quality. Land and water uses that alter or disrupt the habitat requirements of Bull Trout can be a threat to the persistence of Bull Trout. Commonly considered examples of such threats include dams and timber harvest (USFWS 2015a). A potential threat from the operation of weirs/traps and the resulting influence on Bull Trout migrations has recently received considerable attention (Kelly Ringel 2014). The operation of weirs/traps are prevalent throughout the part of the Columbia River basin that is accessible to anadromous fish and where anadromous fish management occurs.

The Mid-Columbia Recovery Unit (MCRU) is one component of the coterminous Distinct Population Segment (DPS). The MCRU has numerous core areas, one of which is the Tucannon Core Area (Figure 1). Bull Trout still occupy most of their historic range in the Tucannon River watershed, and prior to 2000 the population of the core area was considered relatively large (USFWS 2010). Genetic analyses indicate that there are currently five local populations of Bull Trout, and possibly a sixth, within the core area of the Tucannon River watershed (USFWS 2008; Kassler et al. 2013). Both resident and migratory forms of Bull Trout still occur in the Tucannon River watershed (Martin et al. 1992; WDFW 1997) and recent data indicate that migratory Bull Trout regularly use the mainstem of the Snake River on a seasonal basis (Underwood et al. 1995; WDFW 1997; Faler et al. 2008; Bretz 2010; D. Wills, pers. comm. 2014). Spawning and early rearing for the Tucannon population is focused in the upper Tucannon River (generally considered above its confluence with Panjab Creek [rkm 75], ~16 rkm upstream from the Tucannon adult weir/trap), small tributaries to the upper mainstem, and in Panjab Creek and its tributaries.

Spring Chinook (*Oncorhynchus tshawytscha*) salmon are also present in the Tucannon River and include both natural- and hatchery- origin spawners from a hatchery program which began in 1985 (Bugert et al, 1986) under the Lower Snake River Compensation Plan (LSRCP) and has been operated by the Washington Department of Fish and Wildlife (WDFW). The Tucannon spring Chinook salmon population was listed as threatened in 1993 under the ESA and is part of the Snake River spring/summer Chinook ESU.

Both ESA-listed Bull Trout and Tucannon River spring Chinook salmon are routinely handled during annual operations of the Tucannon adult weir/trap. A “new” fish ladder/trap was constructed in 1998 adjacent to the existing Tucannon FH water intake facility. The water intake facility uses a sheet pile dam placed in the river as a backwater for the hatchery water supply. The fish ladder and trap allows passage upstream of the sheet pile dam (i.e. now considered or referred to as the “weir”) and selective capture of upstream migrants when the trap is operated.

The majority of the upstream migration at the adult weir/trap for both species occurs between May and July. Generally, Bull Trout that move from the lower Tucannon River to their spawning area are believed to pass through the entire area where spring Chinook salmon spawn. Overall, the Tucannon adult weir/trap generally operates from late February each year (for summer steelhead broodstock collection – also part of the LSRCP program) and is generally shut down in early October.

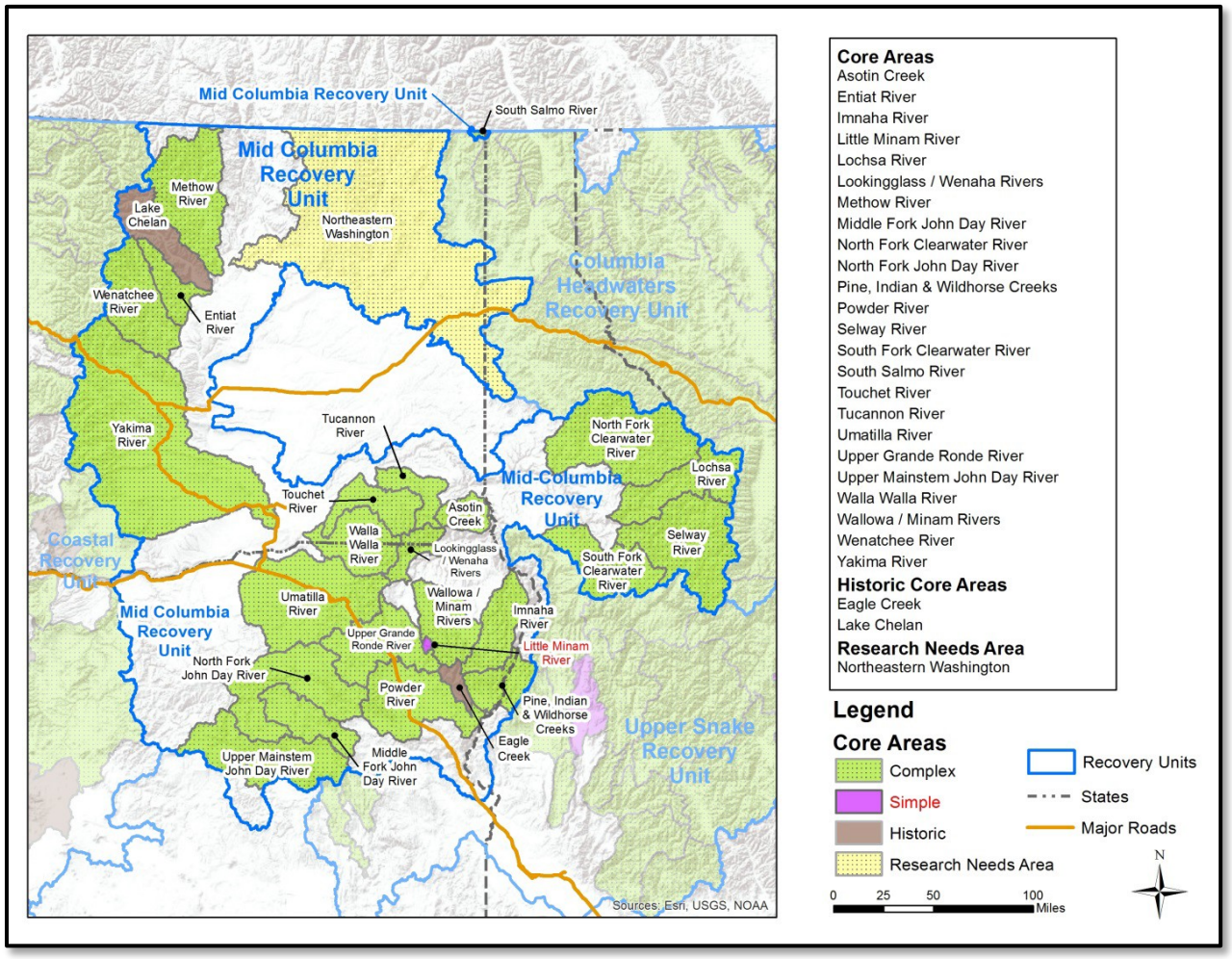

Figure 1. Populations of Bull Trout in the Mid-Columbia Recovery Unit are numerous and provided above. In the Tucannon River Bull Trout can be found primarily in the upper Tucannon River in the mainstem and the following small tributaries: Bear Creek, Cold Creek and Sheep Creek, Panjab Creek, Meadow Creek, Turkey Creek and Turkey Tail Creek. Bull trout are also known to exist in Cummings Creek, a small tributary that enters the Tucannon River mainstem about 1.6 km below Tucannon FH.

Endangered Species Act Consultation

Starting in 2015, the USFWS-LSRCP and its cooperators initiated consultation with NOAA-Fisheries on continued operation of spring/summer Chinook salmon, steelhead and rainbow trout programs in NE Oregon and SE Washington. In 2016, a Biological Opinion was issued (USFWS 2016) that identified with the following Terms and Conditions (Section 8.4.1c-d) for the Tucannon River spring Chinook salmon program:

c. Upon signature of this Opinion, the LSRCP and WDFW will continue to develop an evaluation of Bull Trout passage and delay at the Tucannon River Hatchery fish ladder/trap during periods of operation; initial discussions have already been initiated. As with the Imnaha study, it is understood that the Tucannon study design will use existing and improved PIT tag arrays and opportunistic PIT tagging efforts for completion. A monitoring group will be established to address Bull Trout passage and delay issues similar to that already described for the Imnaha weir (see T&C 1b of this Opinion and T&Cs in the associated Imnaha Weir Biological Opinion, incorporated here by reference) such that information from both the Tucannon and Imnaha studies may be used to more broadly answer the extent of passage and delay impacts in the action area. Progress reports will be submitted by WDFW and LSRCP after the second full year of data collection, and annual meetings will be convened between the monitoring group, co-managers, and cooperators to review the data and discuss potential operational changes to minimize adverse effects and reduce take associated with Tucannon facility operations. If proposed weir modifications are identified within the study period, those modifications must be implemented within a timeframe agreed to by the Service, LSRCP, and the co-managers in the Tucannon basin; follow-up actions, if needed, will be included in a final report following the study. If study results indicate that passage delays are not significantly impacting Bull Trout migration, co-managers and the Eastern Washington Field Office will determine whether continued PIT tagging and data collection are desired as a means of better understanding Bull Trout life history within the Tucannon River system; continuation of agreed upon aspects of the study will not be the responsibility of the LSRCP.

d. Include the Service (Ecological Services Field Office or Fisheries Office staff) in meetings to deal with weir issues and lessening impacts to Bull Trout.

Starting in late 2016, a monitoring workgroup including program staff from WDFW, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation and the USFWS was formed, held meetings, analyzed and reviewed existing data for the Tucannon River Bull Trout population. The workgroup developed an initial project goal and project objectives that specifically addressed the Tucannon adult weir/trap facility operations and potential passage and delay issues similar to the operations of the Imnaha River adult weir/trap in NE Oregon. Project implementation was initially attempted in run year 2017 but due to spring flooding events in the Tucannon River was delayed until 2018. This document meets the stated Term and Condition obligation for WDFW and LSRCP to provide a report after the second full year of data collection (2018 and 2019).

Tucannon River Project Goal

To provide information that can be used to minimize the incidental "take" of ESA-listed Bull Trout, spring Chinook salmon, and other ESA or sensitive species in the Tucannon River during operation and management of the Tucannon River adult weir/trap for broodstock collection of spring Chinook salmon and summer steelhead.

Tucannon River Project Objectives

1. From 2018-2022, assess the passage rate (conversion) of Bull Trout that is associated with the operation of the Tucannon River adult weir/trap for collection and enumeration of spring Chinook salmon for the hatchery program. Target benchmarks for Bull Trout conversions are an average across the five study years of at least 95%, with no less than 75% in any given year (point estimates). This criterion will be re-examined annually by the workgroup.

2. From 2018-2022, assess the migration delay (delay) of Bull Trout that is associated with the operation of the Tucannon River adult weir/trap for collection and enumeration of spring Chinook salmon for the hatchery program. Target benchmarks for delay (of Bull Trout that pass the adult weir/trap) are median passage times (between lower [TC1] and upper [TC3 and/or TC4] antenna arrays) of no longer than 8 days for May, 6 days for June, 4 days for July and 2 days for August and September, with no individual taking longer than 8 days in any month.

3. From 2018-2022, assess the passage rate (conversion) of spring Chinook salmon during standard broodstock collection and enumeration of the spring Chinook salmon run in the Tucannon River. Target conversion benchmarks for spring Chinook salmon have not been set, but will be determined prior to 2020 operations.

4. From 2018-2022, assess the migration delay (delay) of spring Chinook salmon during standard broodstock collection and enumeration of the spring Chinook salmon run in the Tucannon River. Target migration delay benchmarks for spring Chinook salmon have also not been set at this time, and will be determined prior to 2020 operations.

5. Minimize and standardize impacts to Bull Trout and spring Chinook salmon during operation of the Tucannon River adult weir/trap through adaptive management during planned monitoring activities of passage and delay. This will be done through ongoing and continued discussions and coordination between the USFWS, NOAA-Fisheries, co-managers, and cooperators, and may involve revising benchmarks, implementing operational changes or modification of structures.

Study Area and Adult Weir/Trap Operation

The Tucannon River adult weir/trap is located at approximately rkm 59. The facility is located on WDFW property within the W.T. Wooten Wildlife Area, and serves as the adult collection facility for the Tucannon River spring Chinook salmon and Tucannon River summer steelhead hatchery programs under the USFWS-LSRCP Program. From 1985 to 1996, a floating weir attached to a sheet pile dam adjacent to the Tucannon FH (rkm 58) was installed for broodstock collection with a target installation period in late-April or early-May. After major floods

destroyed this adult weir/trap location in 1996, a new fish ladder and trap was placed around the current Tucannon FH water intake facility and sheet pile dam (Photo 1). The original water intake sheet pile dam had a center 3-step ladder section which allowed unimpeded fish passage through the dam. In 1998, when the new facility was completed, the 3-step ladder section had to be closed off for broodstock collections for each of the hatchery programs. Hanging vinyl picket panels (first installed in 2008) are installed manually prior to the summer steelhead return each year, and kept in place throughout the spring Chinook salmon run. The objective of the panels are to prevent or lessen the number of fish that could jump over the dam (Photo 1), which during certain flow conditions many fish can pass unimpeded.

The adult weir/trap is operated by WDFW, with spawning, incubation and early rearing for spring Chinook salmon and steelhead hatchery programs occurring at Lyons Ferry FH, also operated by WDFW. Lead management entities identified in the current 2018 – 2027 U.S. v. Oregon Management Agreement include WDFW, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation.

Methods

Per the USFWS Biological Opinion (2016), and as part of ongoing investigations by co-managers and cooperating agencies, Bull Trout have been PIT-tagged annually at the Tucannon River adult weir/trap for several years. Upon capture, and determining a Bull Trout doesn't contain a PIT tag, a new PIT tag is inserted into the dorsal sinus (anterior edge of the dorsal fin) per Bouwens and Jakubowski (2015). Bull Trout which have been previously PIT tagged in other monitoring efforts within or outside the Tucannon River are opportunistically included in the analysis if they are detected in the Tucannon River and attempt passage at the Tucannon River adult weir/trap. In addition, spring Chinook salmon adults/jacks returning with PIT tags, either from juvenile tagging in the Tucannon River (hatchery or natural origin), or from adult tagging efforts at Bonneville or Lower Granite dams, were used to address the objectives for spring Chinook salmon. Documentation of PIT-tagged Bull Trout and spring Chinook salmon that move throughout the entire Tucannon River is possible through a series of instream PIT tag detection arrays (Figure 2) in the Tucannon River. Detection data can be queried from these PIT-detection arrays through the PIT tag information system (www.ptagis.org).

In most of our analyses we examined the PIT tag detections from the PIT antennas located just downstream (TC1), in the fish ladder (TC2), in the adult trap (TC3), and upstream (TC4) of the Tucannon River adult weir/trap (Photo 2) to achieve the objectives of the study. In addition to the standard instream PIT tag antennas that have been in place around the adult weir/trap since 2017, additional temporary PIT antennas were added in the fish ladder immediately in front of the trap entrance and to the floor of the trap (Photo 3) in 2019. These additional antennas were added to determine if migrating Bull Trout and Chinook salmon were avoiding the upper ladder and/or trap entrance, further delaying the passage of fish.

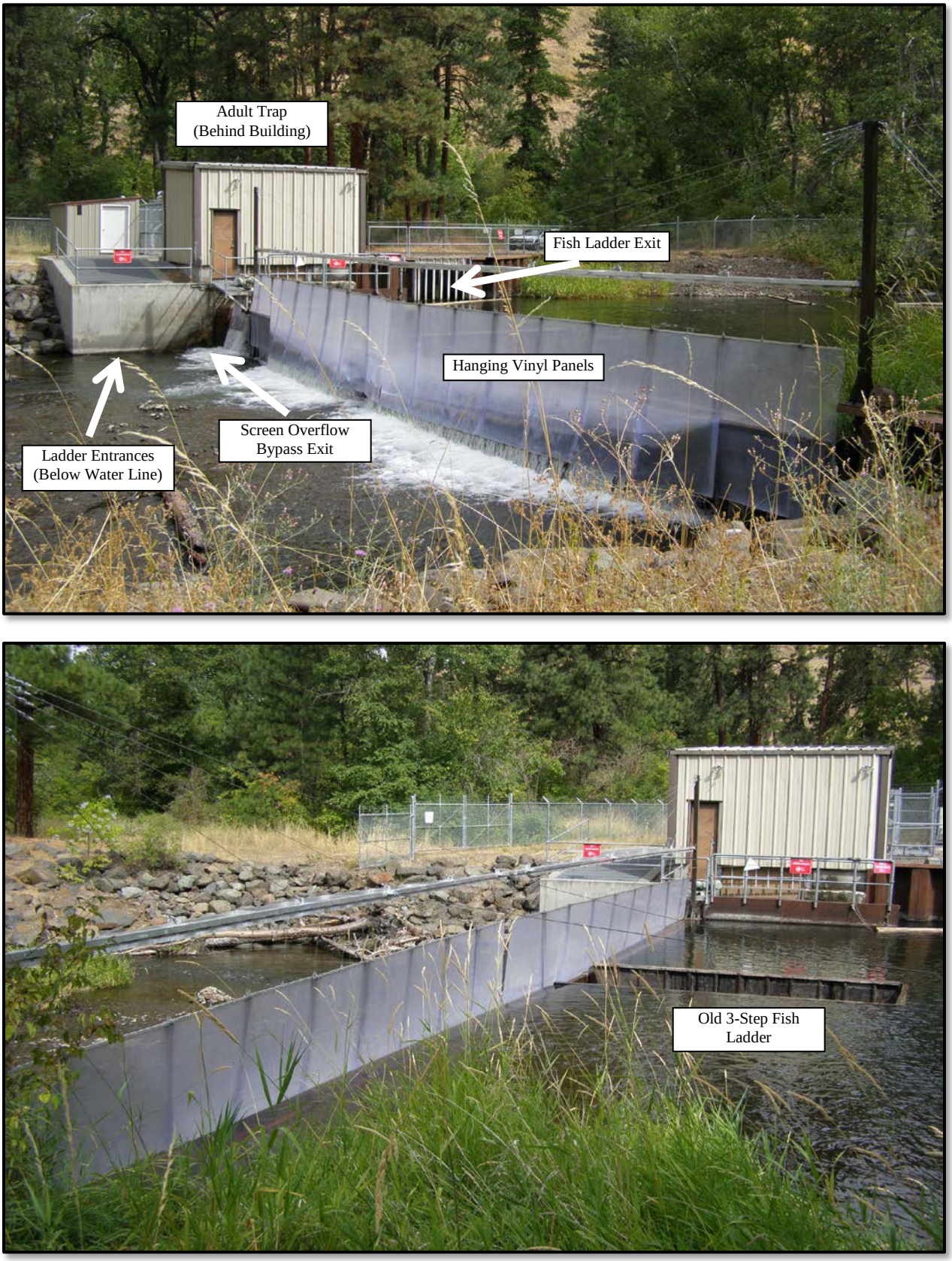

Photo 1. Photos of the Tucannon River adult weir/trap. Photos by WDFW hatchery evaluation staff.

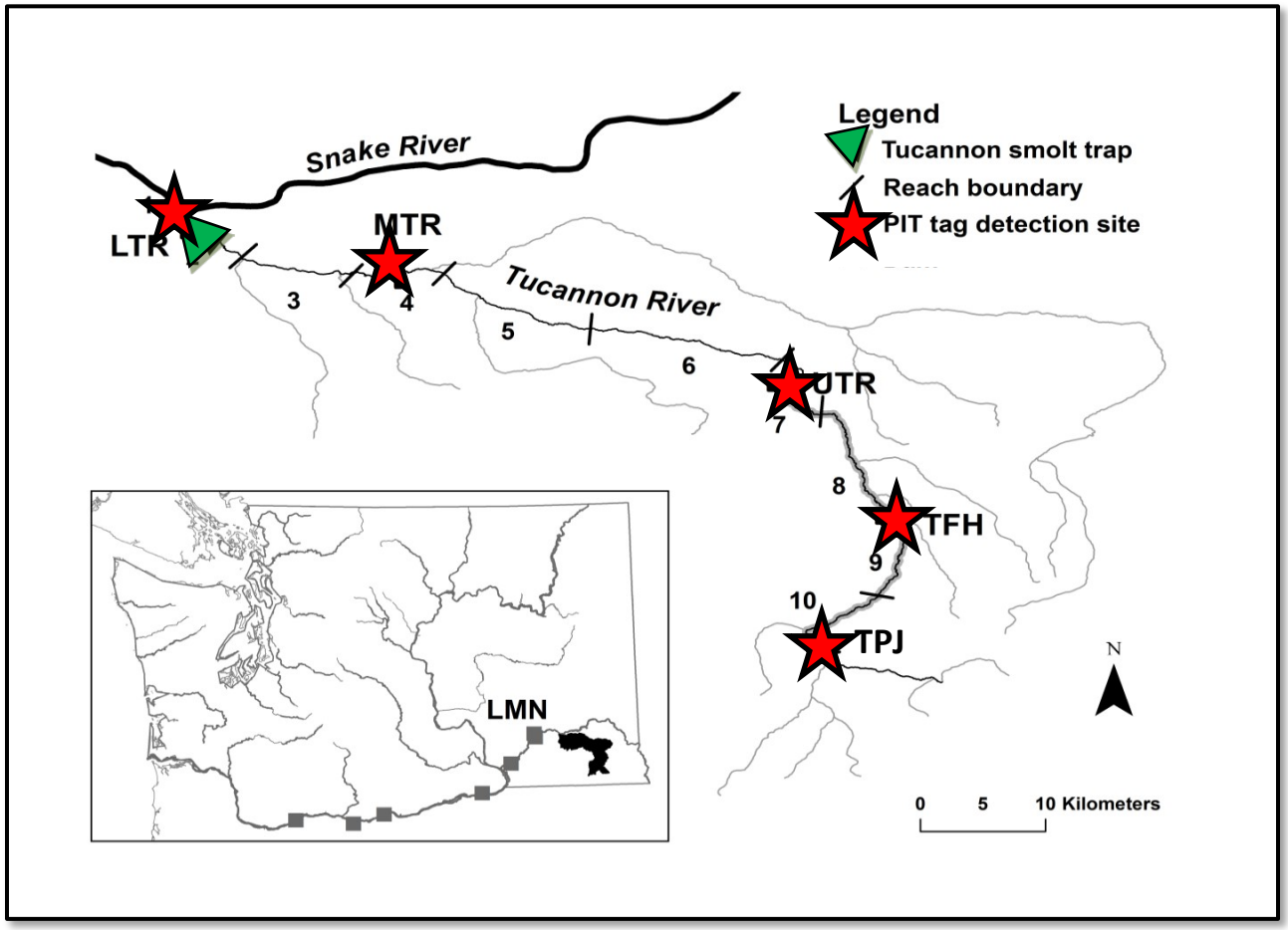

Figure 2. Tucannon River Basin and location of the adult trap/weir, PIT Tag Arrays, and smolt trap. Lower Monunmental Dam (LMN), 2nd of the lower four Snake River Dams, is identified in the inset of Washington.

Photo 2. Location of the Passive Integrated Transponder (PIT) tag detection arrays around the Tucannon River adult weir/trap site. The TC1 (4 antennas) and TC4 (6 antennas) are within the bankfull area of the Tucannon River, while TC2 (2 permanent antennas) are in the fish ladder. In 2019, two additional temporary antennas were installed, one at the top of the ladder immediately in front of the trap entrance (included in TC2), and one in the trap itself (included in TC3). All locations are approximations.

Photo 3. Photos of temporary antennas installed in 2019. (A) is the antenna placed immediately in front of the trap entrance, and (B) was mounted on the trap floor immediately in front of the trap throat. Note: the normal water level when the trap is in operation in both photos can be visually seen by the wetted walls.

Detection histories for the PIT- tagged Bull Trout and spring Chinook salmon were compiled to determine whether they exhibited a pattern reflective of the behavior of interest, specifically:

1) Detections occurred during adult weir/trap operation, not pre- or post-operation
2) Detections moving upstream rather than only downstream.
3) Detections tagged prior to year of capture at the adult weir/trap.

Detection histories for both species of interest from 2015-2017 were also added to some analyses to provide additional background on movement and detection patterns. The first year temporary PIT tag detection equipment was installed below the adult trap was 2015.

Objectives 1 and 3. From 2018-2022, assess the passage rate (conversion) of Bull Trout and spring Chinook salmon that is associated with the operation of the Tucannon River adult weir/trap for broodstock collection and enumeration of spring Chinook salmon for the hatchery program.

In 2018, adult weir/trap operations were similar to previous years and detections of PIT-tagged Bull Trout and Chinook salmon were summarized and analyzed as outlined in the Methods section. In 2019, all antennas at TC4 (upstream of the adult weir/trap) were inoperable during the first part of the season due to damaged antennas, cables, or antenna pods from high stream flows

experienced during the early spring. High stream flows, or lack of repair parts, prevented staff from making the necessary repairs before the spring Chinook salmon or Bull Trout runs arrived. As such, the calculations to assess passage rate (conversion) were slightly modified for 2019, where we used capture in the adult trap as the upper most detection location at the adult weir/trap, but also added in detections at the Panjab Array (TPJ) site in the upper Tucannon River. A small percentage of the Bull Trout and spring Chinook salmon can jump over the sheet pile dam under certain flow conditions, even with the hanging vinyl panels in place based on historical data. The addition of the Panjab PIT Array detections provided some data integrity that was lost in 2019 with TC4 inoperable.

Relative to Objectives 1 and 3, the *observed percent* of Bull Trout and spring Chinook salmon that passed the adult weir/trap was calculated as:

(TC3 + TC4)/TC1 x 100 ***[2018]*** ***or*** *(TC3 + TPJ)/TC1 x 100* ***[2019]***

Where:

TC1 = the number of PIT-tagged Bull Trout or spring Chinook salmon that were detected at the set of antennas below the trap,

TC3 = the number of PIT-tagged Bull Trout or spring Chinook salmon that were captured/handled in the adult trap (with confirmation from the temporary trap antenna),

TC4 = the number of PIT-tagged Bull Trout or spring Chinook salmon that were detected at the set of antennas above the trap, but weren't captured in the adult trap,

TPJ = the number of PIT-tagged Bull Trout or spring Chinook salmon that were detected at the Panjab Array, but weren't captured in the adult trap.

This analysis, as well as issues with the 2019 detections at TC4, was disseminated to the subject matter experts from coordinating agencies and discussed during working group coordination calls early in the 2019 season.

Objectives 2 and 4. During 2018-2022, assess the migration delay (delay) of Bull Trout and spring Chinook salmon associated with the operation of the Tucannon River adult weir/trap for brood stock collection and enumeration of spring Chinook salmon for the hatchery program.

As in Objectives 1 and 3, for both 2018 and 2019 we specifically used previously PIT-tagged fish detected at the lower array (TC1), the capture date in the adult trap (TC3), or detected at the upper array (TC4). Target days of delay benchmarks used in this evaluation are identical to those developed for the Imnaha River (as data to inform benchmarks for the Tucannon River was lacking). Relative to Objective 2 and 4, the time (in days) for an individual Bull Trout or spring Chinook salmon to pass the adult weir/trap site was calculated by either:

a) $Capture\ date_{[TC3]} - 1^{st}\ detection\ date_{[TC1]}$ ***or***

b) $1^{st}\ detection\ date_{[TC4]} - 1^{st}\ detection\ date_{[TC1]}$

Where:

$1^{st}\ detection\ date_{[TC1]}$ = the date and time a PIT-tagged Bull Trout or spring Chinook salmon was first detected at the row of antennas immediately below the adult trap;

$Capture\ date_{[TC3]}$ = the date and time a PIT-tagged Bull Trout or spring Chinook salmon was captured in the adult trap by hatchery staff; and

$1^{st}\ detection\ date\ [TC4]$ = the date and time a PIT-tagged Bull Trout or spring Chinook salmon was first detected at the row of antennas immediately above the adult trap.

Due to confirmation of both species entering, and escaping the adult trap in 2019, we also estimated *hypothetical* delay times based on detections at $1^{st}\ detection\ date_{[TC1]}$ and $1^{st}\ detection\ date_{[TC3Temp]}$, where $1^{st}\ detection\ date_{[TC3Temp]}$ is the estimated date/time that fish would have been handled and released by hatchery staff during daily trap operations had those fish been retained in the trap upon their first entry into the trap. This analysis is to show what passage delay could look like once the adult trap entrance is modified and prevents fish from escaping. Trap checks were normally performed around 10:00 AM each day by Tucannon Fish Hatchery staff.

Results and Discussion

General Findings and Operations

Run timing of Bull Trout and spring Chinook salmon to the Tucannon adult weir/trap has varied since 2015 but individual years illustrating patterns between the species that are generally very similar, with the Bull Trout generally lagging slightly behind the spring Chinook salmon run (Figure 3). In most years, 50% of each run has been complete between June 5^{th}-20^{th}, and >90% of each run at the trap is generally completed by 10 July. In 2015, high temperatures and low stream flows likely resulted in the earlier run timing of both species to the adult weir/trap that year (Figure 3).

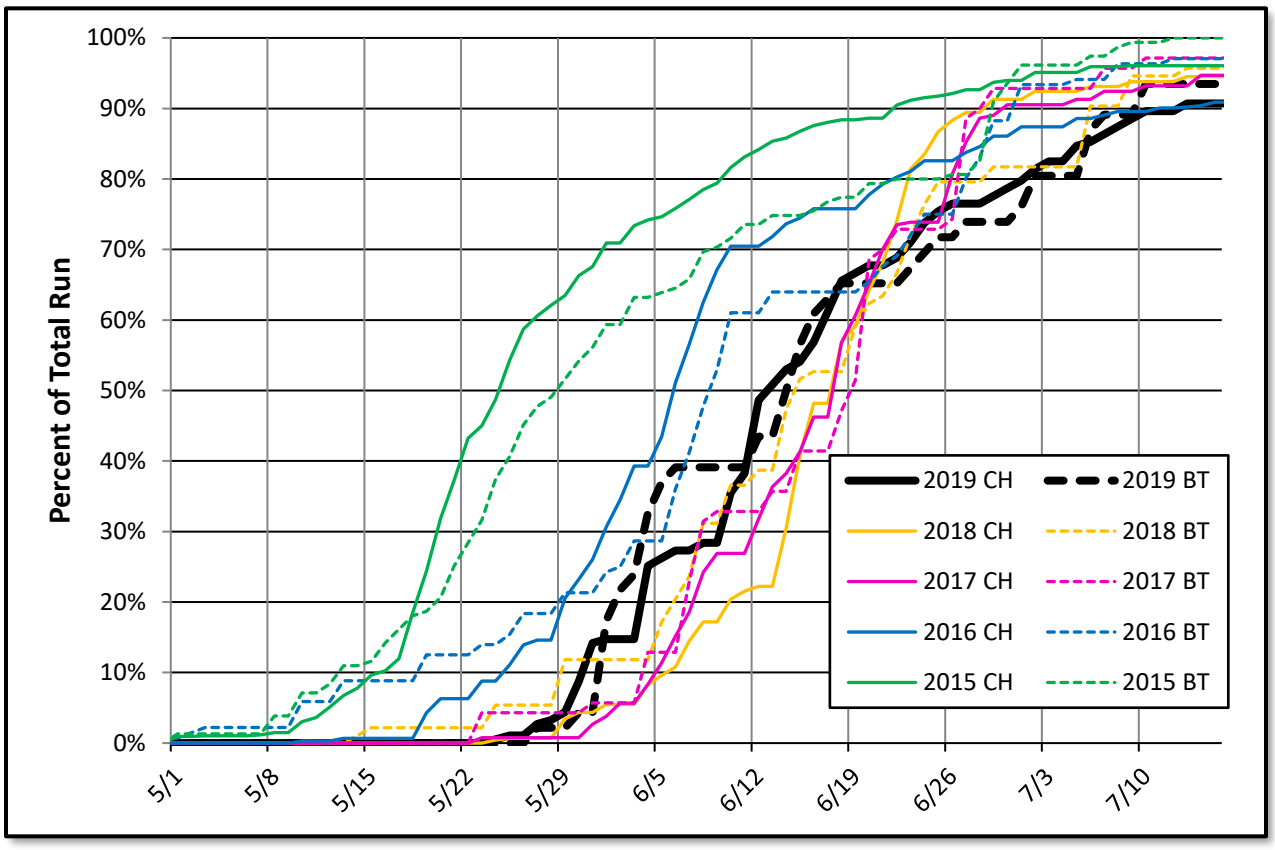

Figure 3. Run Timing of Bull Trout and spring Chinook salmon at the Tucannon adult weir/trap. Timing is based on capture of fish in the trap and does not indicate first arrival to the area. Sample size for each run year and by species are as follows (Bull Trout: 2015=155, 2016=136, 2017=70, 2018=93, and 2019=46; Spring Chinook: 2015=860, 2016=603, 2017=264, 2018=436, and 2019=183).

For many years, local biologists suspected that fish (all species) were being delayed due to false attraction water coming from the intake screen overflow/bypass which enters the river adjacent to the fish ladder entrance (Photo 1), or from the overflow of the river over the sheet pile dam (next to the intake building or across the face of the dam). Since the addition of PIT tag antennas below the trap and in the fish ladder in 2017, data collected from 2017-2019 for both spring Chinook salmon and Bull Trout suggests that this false attraction water is not as much of a problem as once believed, with over 90% of PIT-tagged spring Chinook salmon and ~75% Bull Trout determined to have entered the fish ladder less than one day after being detected downstream (Figure 4). An explanation for why 15-20% of the Bull Trout taking longer than two days to find the fish ladder entrance is not known but was a consistent trend among the three years of data examined. Further, the speed at which Bull Trout convert into the fish ladder based on size (fork length) appears uniform across the data collected (Figure 5).

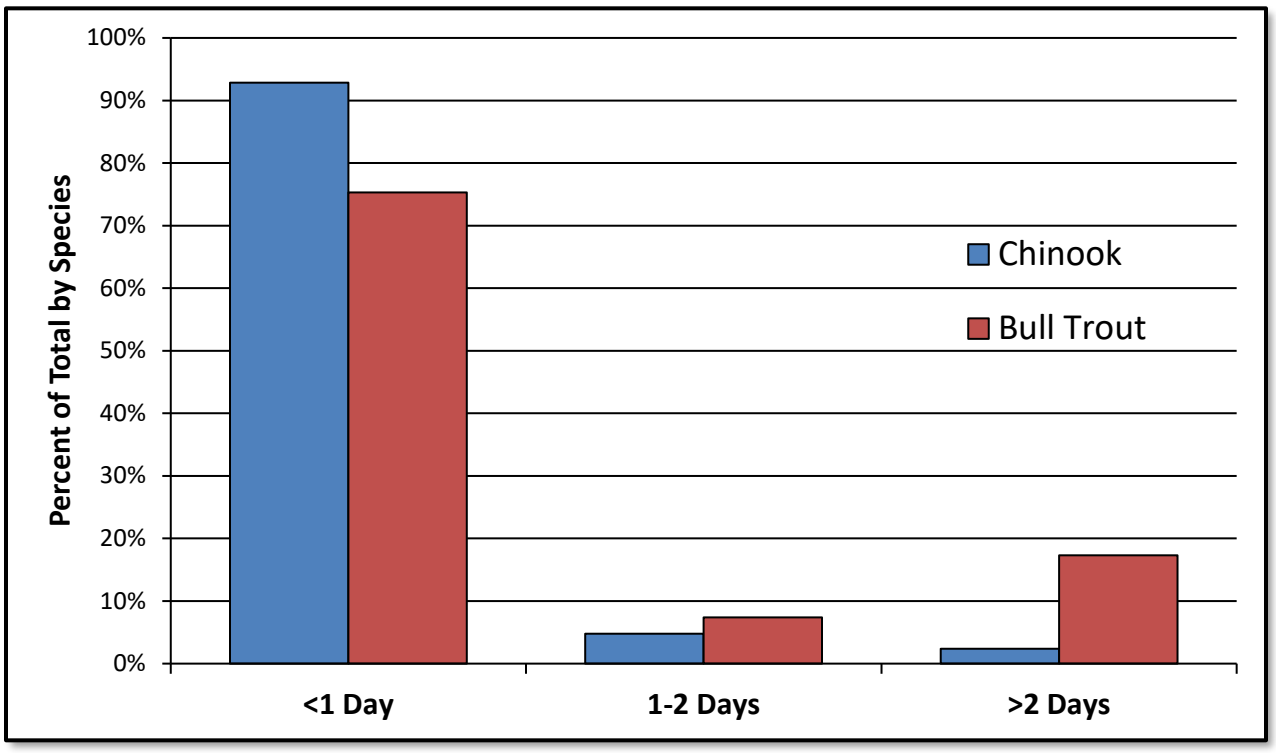

Figure 4. Travel days of spring Chinook salmon and Bull Trout from 1st detection downstream to fish ladder entrance, 2017-2019. Sample sizes for data presented are as follows (Bull Trout = 81, Spring Chinook = 126).

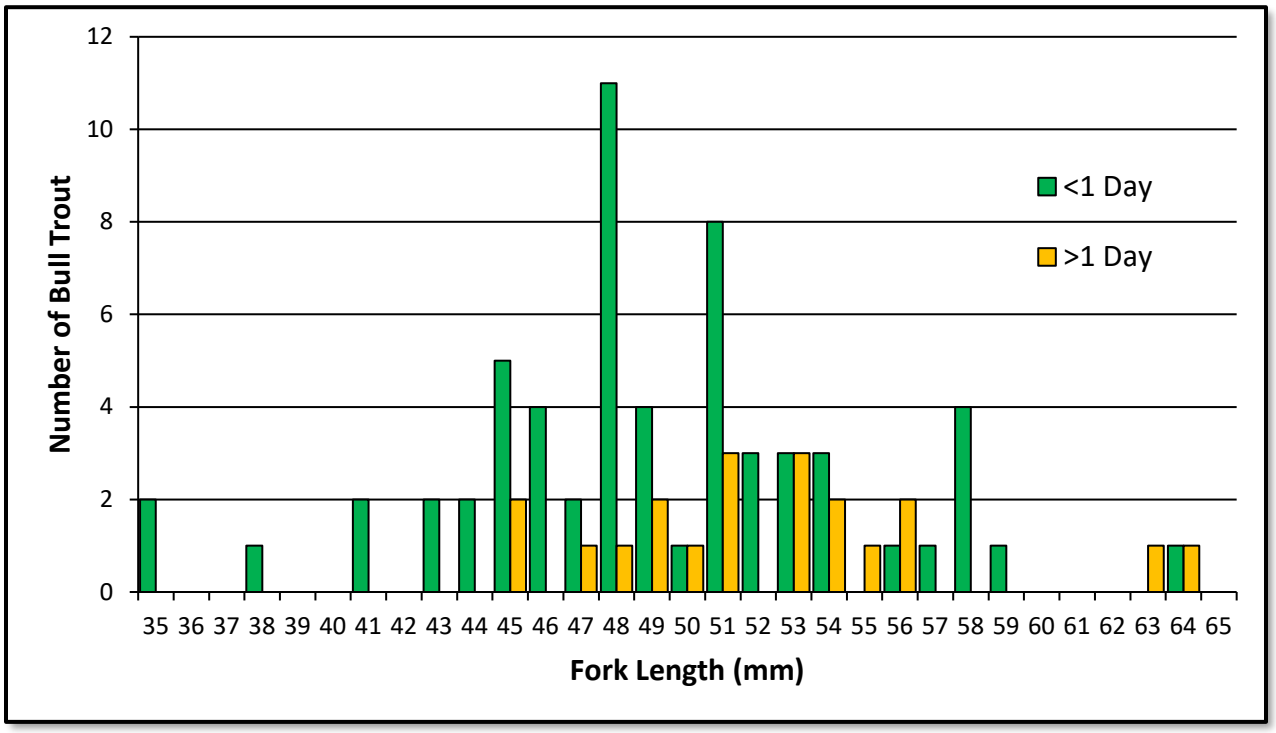

Figure 5. Size of Bull Trout from 2017-2019 and the time it took from 1st detection downstream to be detected within the fish ladder.

Infrastructure and Specific Adult Weir/Trap Operations in 2018 and 2019

In 2018, adult weir/trap operations were identical to prior years. The instream PIT tag array system and antennas (downstream, ladder, and upstream) were all functioning properly during the migration period. However, in 2019, due to higher river flows and unforeseen impacts, the antennas on the upstream side of the trap were not fully operational until 28 June. All other antennas were operational throughout the migration period. All previously PIT-tagged Bull Trout and spring Chinook salmon arriving below the adult weir/trap in 2018 and 2019 were included in this evaluation. In 2018 and 2019, 33 and 14, respectively, uniquely PIT-tagged Bull Trout, and 54 and 32, respectively, uniquely PIT-tagged spring Chinook salmon were detected moving upstream at TC1 based on detection history (Appendix A).

In 2018 and 2019, no spring Chinook salmon were intentionally passed upstream of the adult weir/trap upon initial capture. This was in agreement with co-management decision to retain all spring Chinook salmon due the anticipated low returns of spring Chinook salmon in both years, the likely shortage of broodstock for the hatchery program, and the high pre-spawn loss over the summer months of spring Chinook salmon that has been observed in the Tucannon River in more recent years (WDFW 2015, Gallinat and Ross 2018).

Bull Trout Conversion Rates and Delay (Objectives 1 and 2)

Objective 1 – Conversion

For the 2018 migration period, the first official year of the assessment period, 33 uniquely PIT-tagged Bull Trout were detected moving upstream at TC1 (Appendix B). To calculate conversion rates for 2018, we considered all previously PIT tagged Bull Trout detected at TC1, captured in the adult trap, and/or detected at TC4. During the 2018 trapping season, 29 Bull Trout were captured in the trap, and two (not already captured in the adult trap) were detected on the upstream antennas (jumped the weir). Thus, the conversion rate from below the adult weir/trap to eventual passage was 94%. Based on detection histories, two (6%) of the 33 Bull Trout that were detected at TC1 remained below the adult weir/trap after being detected.

During the 2019 migration, 14 previously PIT-tagged Bull Trout were detected moving upstream at TC1. To calculate conversion rates for 2019, we considered all previously PIT tagged Bull Trout detected at TC1, captured in the adult trap, and those detected at the TPJ array for the entire season. One (7.1%) of the 14 Bull Trout appears to have remained below the adult weir/trap throughout the study period, but with antennas above the trap disabled until the middle of June, it cannot be clearly ascertained. For the trapping season, 13 Bull Trout were captured in the trap, and zero of the 14 Bull Trout (not already captured in the adult trap) were detected on the TPJ array upstream. Thus, the conversion rate from below the adult weir/trap to eventual passage was 92.9%. The running average passage rate based on data from 2015, 2016, 2018 and 2019 is

95.6%. Overall conversion of Bull Trout through the adult weir/trap in both 2018 and 2019 was similar to previous years (Figure 6).

An added component to the 2019 analysis was the ability to determine trap retention/delay by placement of two temporary antennas; inside the ladder prior to the trap entrance and within the trap area (Photo 3). Avoidance/escapement of fish into the trap had been suspected based on data obtained in 2018, but couldn't be confirmed without the addition of these two antennas. Results from 2019 determined that 57% of the previously PIT tagged Bull Trout escaped the trap after entry (Appendix D).

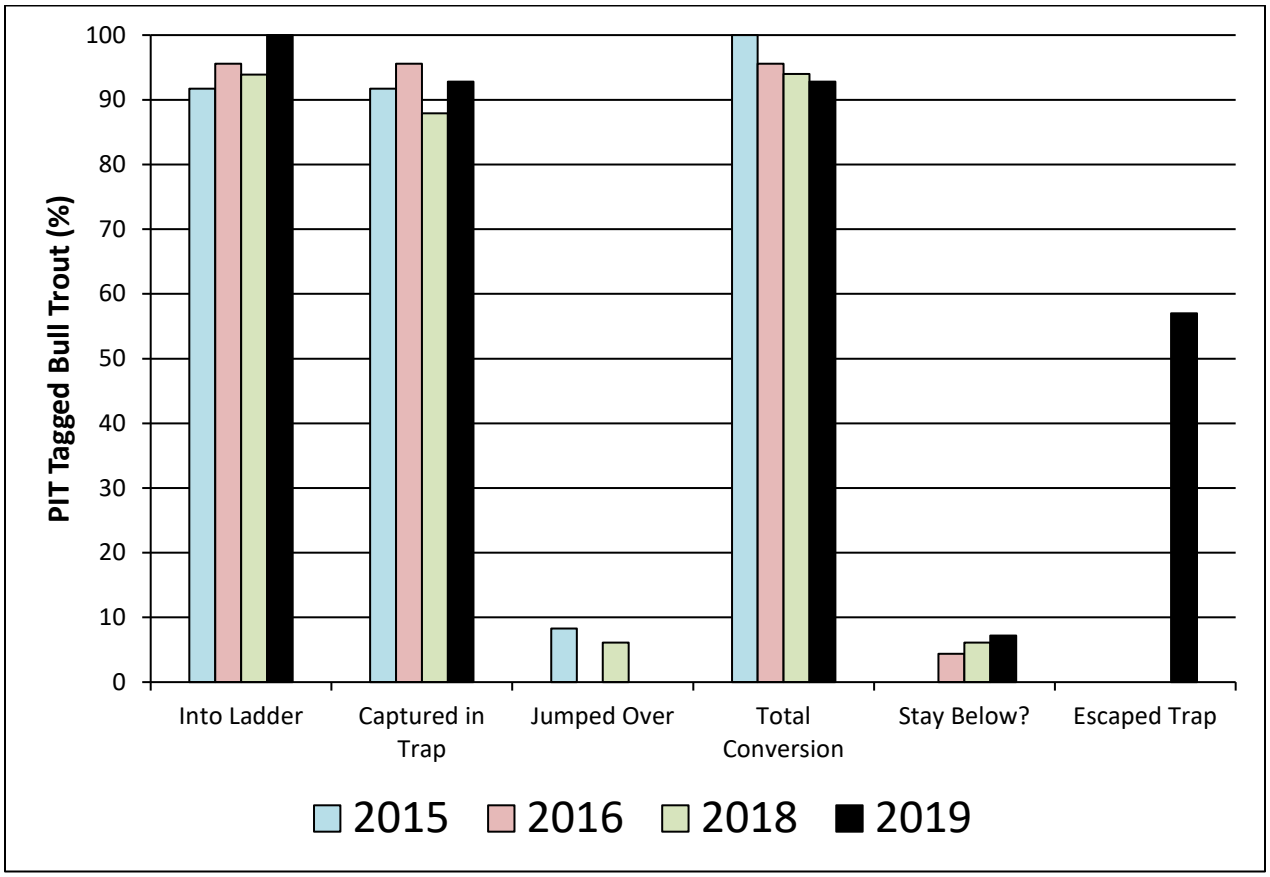

Figure 6. Tucannon River Bull Trout passage (conversion) through the Tucannon adult weir/trap, 2015, 2016, 2018 and 2019.

Objective 2. Delay

In order to assess migration delay we provide context by determining how quickly fish are migrating upstream before they reach the adult weir/trap area. This concept has been discussed in the Imnaha River basin with Bull Trout migration past an instream weir (USFWS, unpublished data) during workgroup meetings and separate follow up discussions with USFWS workgroup members. Based on multiple years of Bull Trout detections in the Tucannon River, median migration speeds (rkm/day) at detection sites below the adult weir/trap range from about 0.8-1.7

rkm/day (Figure 7). Median migration speeds around the adult weir/trap area (when starting from the antennas immediately downstream of the trap) have been estimated at <0.1 rkm/day. Following release from the trap after capture, migration speeds once again increase as indicated by the PIT arrays immediately upstream of the trap (~0.2 rkm/day), and the TPJ PIT array (1.1 rkm/day). Based on this information, the adult weir/trap area does appear to influence the migration rate of Bull Trout in the Tucannon River.

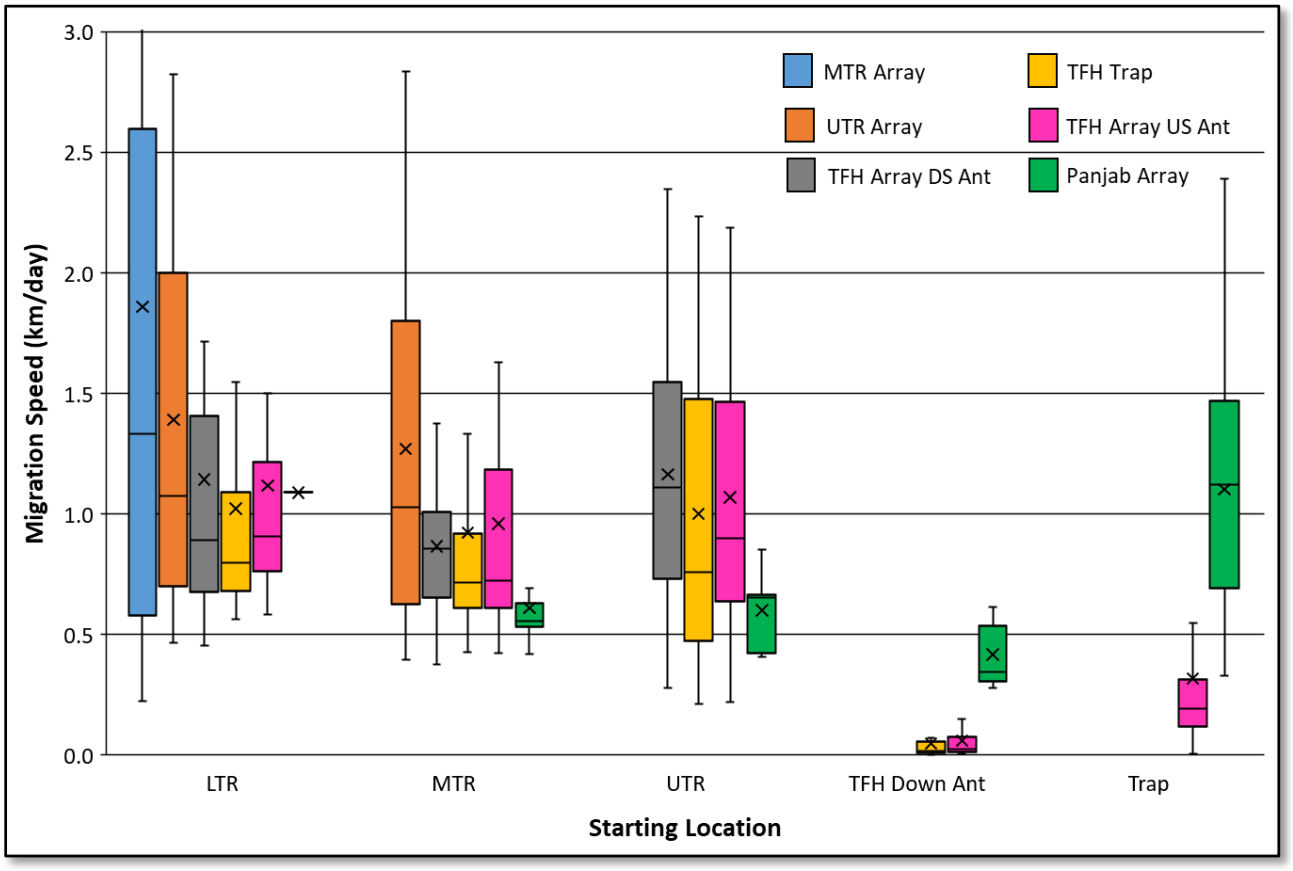

Figure 7. Box and Whisker plot for migration speed (km/day) of Bull Trout in the Tucannon River at various detection sites (data from 2006-2019). High and low lines represent minimum and maximum values, shaded boxes represent the 25th-75th percent quartiles, solid line in the shaded box represents the median, and the "X" in the shaded box represents the mean. Starting location represents where the migration speed calculation was initiated, and the shaded bars as keyed in the legend represent individual sites upstream.

2018 Specific Delay at the TFH Adult Weir/Trap

Thirty-one unique, previously PIT tagged Bull Trout were detected at both TC1, TC3, and/or TC4 and had detection histories indicating they were suitable for calculating days of delay specifically in the adult weir/trap area. Overall delay from first detection through the trap or above ranged from 0-31 days with a median of 3.5 days (Figure 8).

Delay in May (based on 9 Bull Trout) ranged from 2-30 days with a median of ~6 days, with 3

fish delayed more than 8 days. Delay in June (based on 19 Bull Trout) ranged from 0-25 days with a median of ~5 days, with 7 fish delayed more than 8 days. Delay in July (based on 3 Bull Trout) ranged from 1-3 days with a median of 1.5 days, with no fish delayed more than 8 days. The benchmarks for median days of delay in May, June, and July (8, 6, and 4 days, respectively) were met in all months. Maximum days of delay in May (4 days) and June (24 days) exceeded the benchmark for maximum days of delay (8 days) for just the month of June.

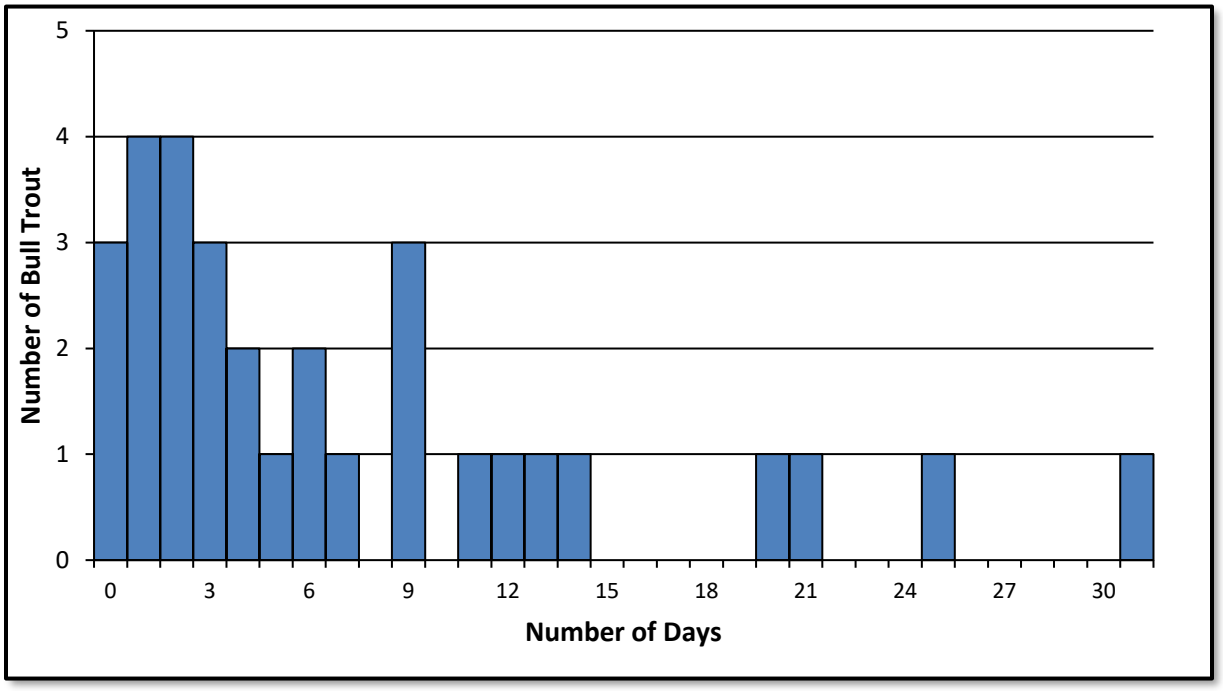

Figure 8. The actual number of days in 2018 it took Bull Trout to move from TC1 to TC3 (adult trap detection/passage by hatchery staff) or TC4.

2019 Specific Delay at the TFH Adult Weir/Trap

Thirteen unique, previously PIT tagged Bull Trout were detected at both TC1 and TC3 and had detection histories indicating they were suitable for calculating days of delay specifically in the adult weir/trap area. Overall delay from first detection to trap capture and release ranged from 1-24 days with a median of 3.9 days (Figure 9-A). With fish escaping the trap, we provide a hypothetical graph (Figure 9-B) which shows what delay would have been had the fish been captured the first time they entered the trap. Overall delay in this hypothetical situation would have been reduced to a range of 0-21 days with a median of 1.5 days.

Delay in May (based on 3 Bull Trout) ranged from 2-4 days with a median of 1.9 days, with no fish delayed more than 8 days. Delay in June (based on 10 Bull Trout) ranged from 0-24 days with a median of 9.5 days, with five fish delayed more than 8 days. No previously PIT tagged Bull Trout arrived below the adult trap after June 24th. The benchmarks for median days of delay

in May and June (8 and 6 days, respectively) were met in May, but not in June. Maximum days of delay in May (4 days) and June (24 days) exceeded the benchmark for maximum days of delay (8 days) for just the month of June.

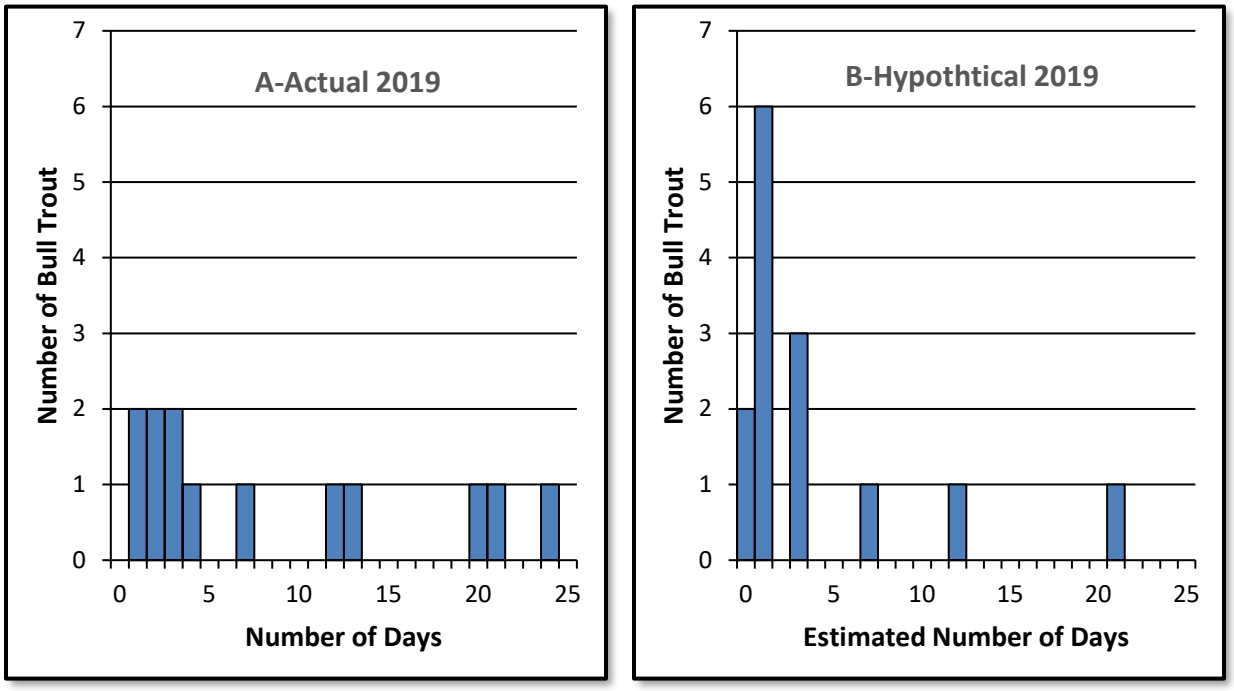

Figure 9. (A) The actual number of days in 2019 it took Bull Trout to move from TC1 to TC3 (adult trap detection/passage by hatchery staff). (B) The hypothetical number of days in 2019 it took Bull Trout to move from TC1 to TC3 (temporary adult trap antenna detection - not actual capture).

Figure 10 was developed to understand the amount of delay between all the years of Bull Trout detection information (2015-2019) on the Tucannon River. In an ideal situation of delay, all points should be on, or very close to, the diagonal line, representing little to no impact in migration delay by Bull Trout through the Tucannon River adult weir/trap structure. Based on data from 2015-2019, the degree of delay has been relatively consistent (Figure 10). In 2015, a drought and warm temperature year, migration delay was minimal (all points close to the diagonal line) because of the harsher conditions and fish likely had a greater desire to move upstream (Figure 10). Delay does not appear to be influenced by the size of Bull Trout (Figure 11). With the additional information obtained in 2019 about Bull Trout escaping the trap, and the consistent pattern of delay as observed in most previous years, we believe that Bull Trout have been escaping the trap for many years.

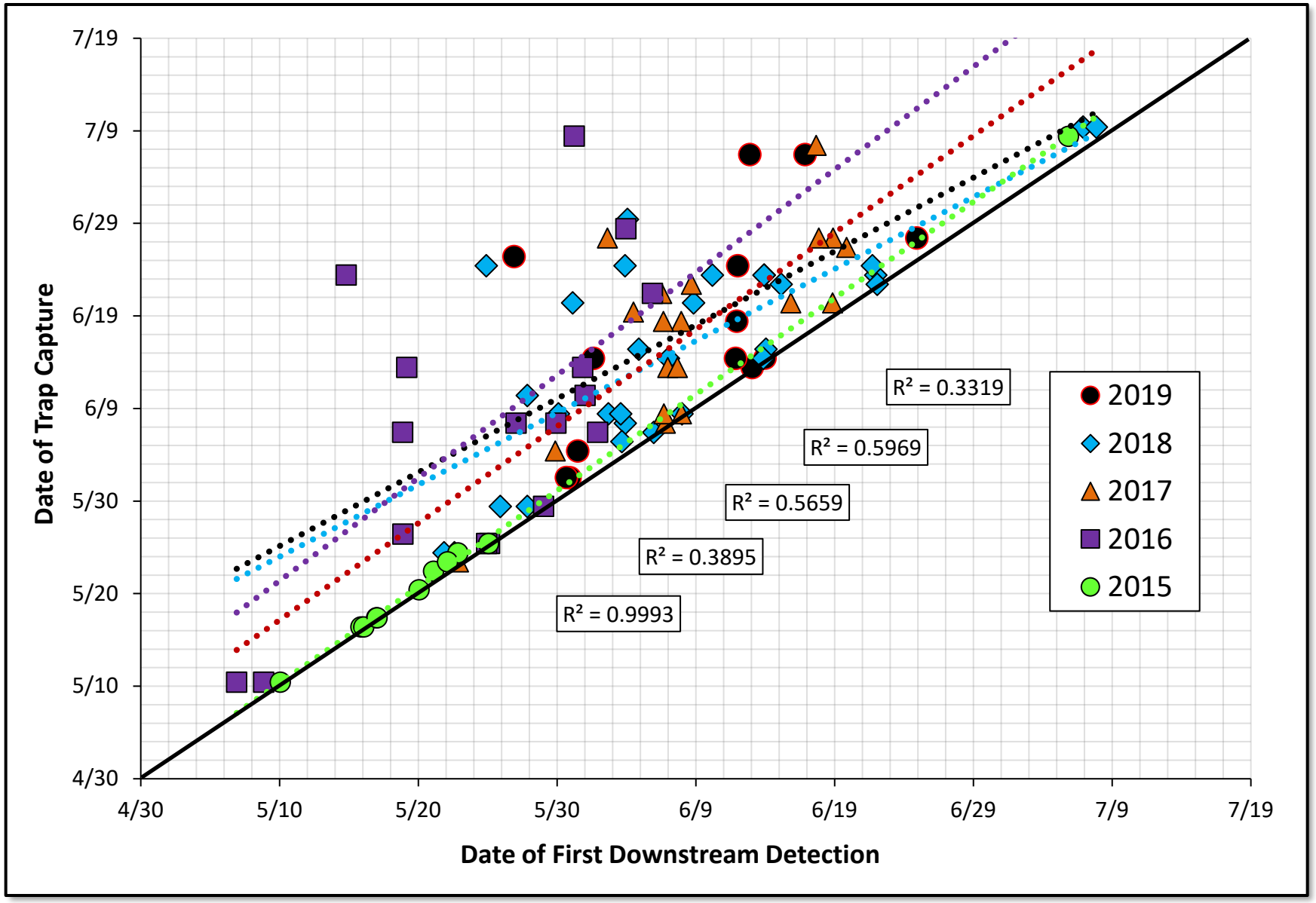

Figure 10. Migration delay of Bull Trout from 1st detection downstream to adult trap capture, 2015-2019. A square represents 2 days of time.

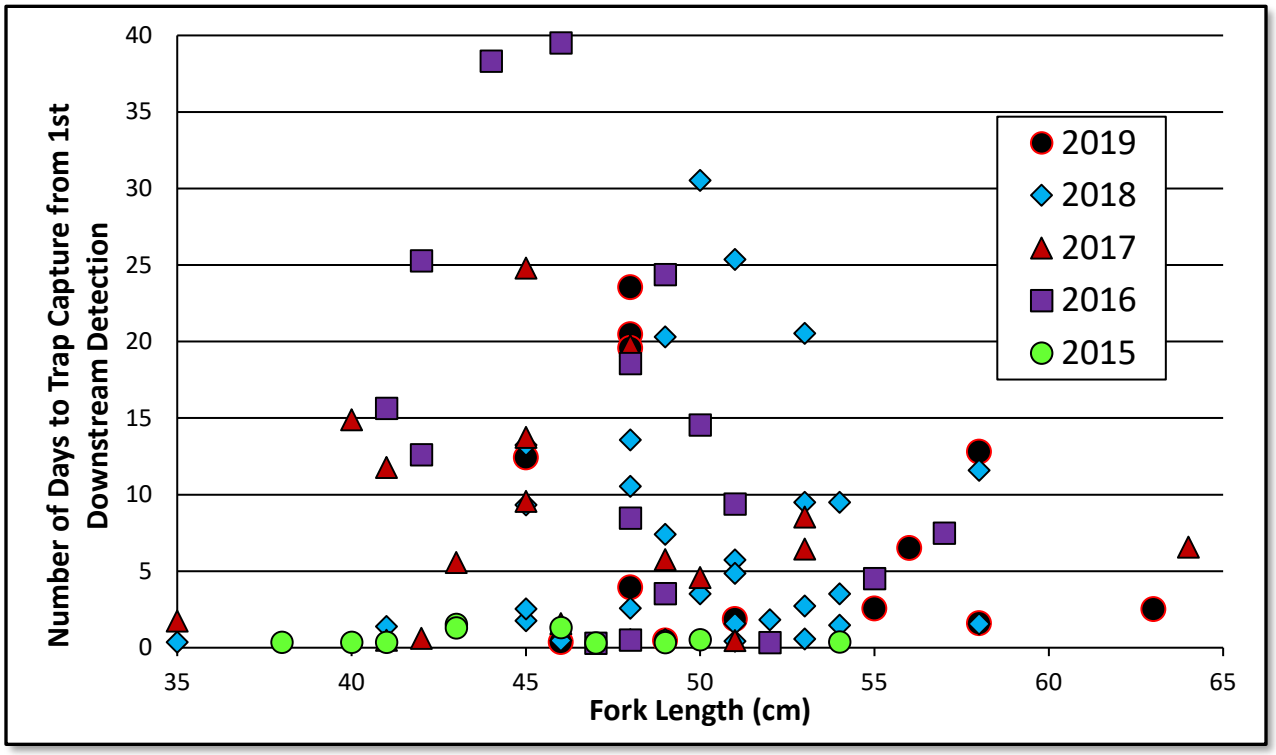

Figure 11. Migration delay of Bull Trout (by fork length) by the number of days to adult trap capture from 1st downstream detection, 2015-2019.

Migration and Conversion of Bull Trout into the Upper Tucannon River

As described previously, an additional instream PIT tag array was installed by WDFW and the U.S. Forest Service at the confluence of Panjab Creek and the mainstem Tucannon River in the late fall of 2018. The array consists of five antennas, with two below the mouth of Panjab Creek, one antenna in Panjab Creek, and two antennas upstream of Panjab Creek. The primary purpose of this array was to gain additional information primarily from Bull Trout (but could include other species as well) on their migration timing and migration speed (rkm/day) into the upper basin, but also to determine the proportion of Bull Trout entering each of these drainages.

In 2019, 13 previously PIT tagged, and 26 newly PIT tagged Bull Trout were passed upstream of the adult weir/trap (Appendix F). Of those, 7 (54%) of the previously PIT tagged, and 26 (84%) of the newly PIT tagged Bull Trout were detected on the Panjab PIT Array. Of the 33 total, 32 (97%) continued up the mainstem Tucannon River, and only one (3%) went up Panjab Creek.

Timing of the 33 PIT tagged Bull Trout to the upper watershed was highly variable (Figure 18), and migration speed doesn't appear to depend on size (Figure 19) or when they were passed at the adult trap/weir (Figure 20). WDFW plans to continue the operation of the Panjab PIT Array through the duration of this study.

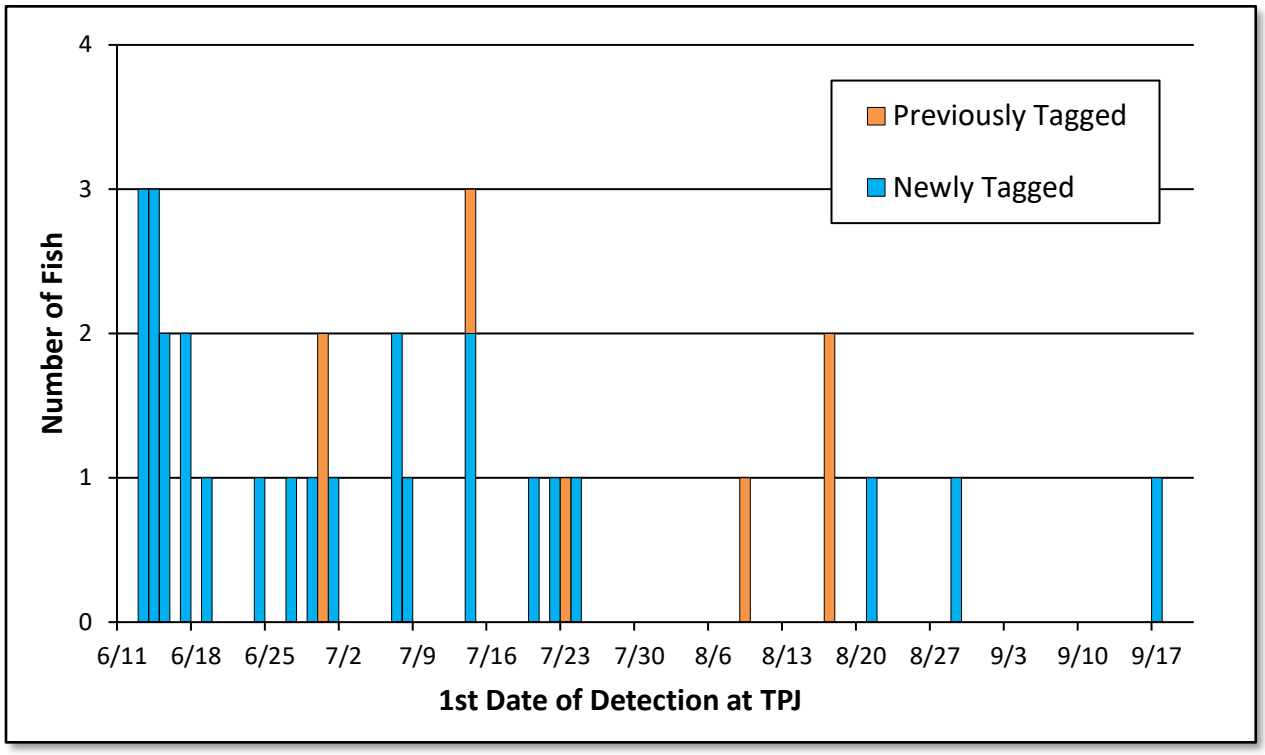

Figure 12. Timing of PIT tagged Bull Trout to the Panjab PIT Array, 2019

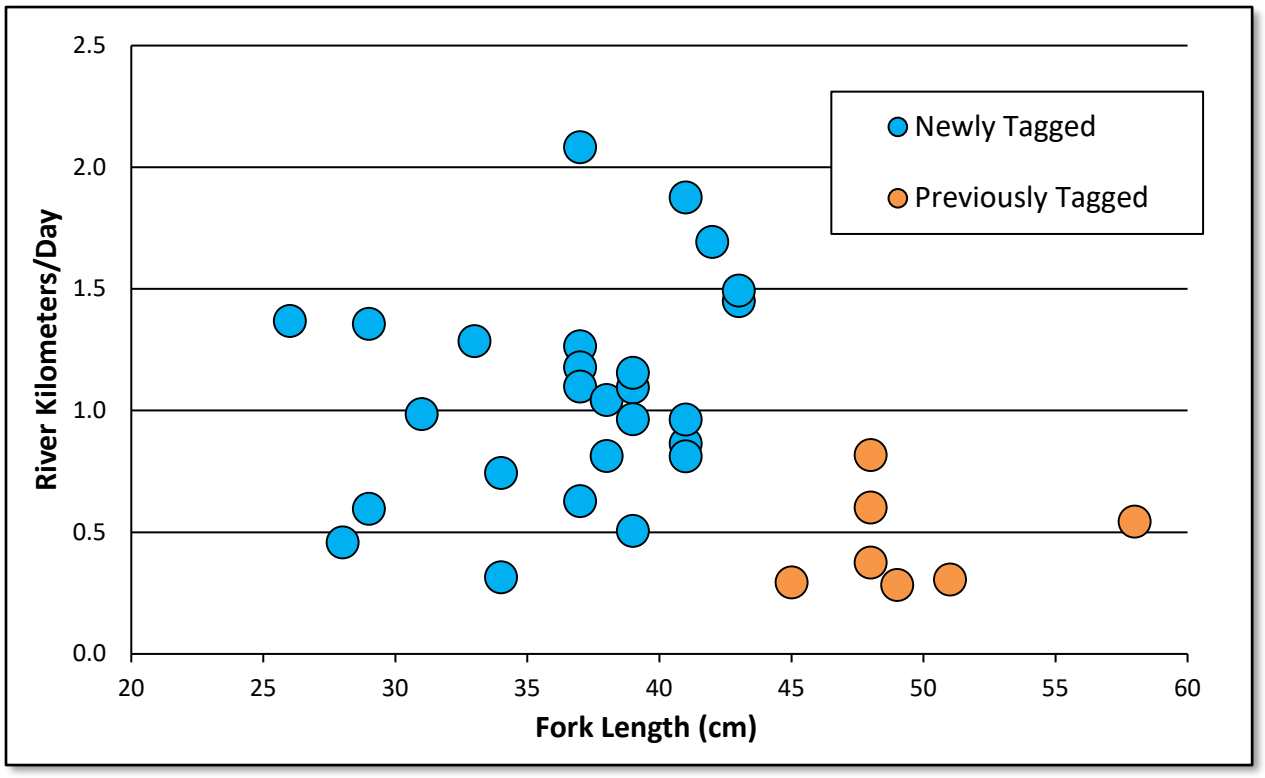

Figure 13. Migration speed of PIT Tagged Bull Trout following release at the adult weir/trap to the Panjab PIT Array by fork length, 2019

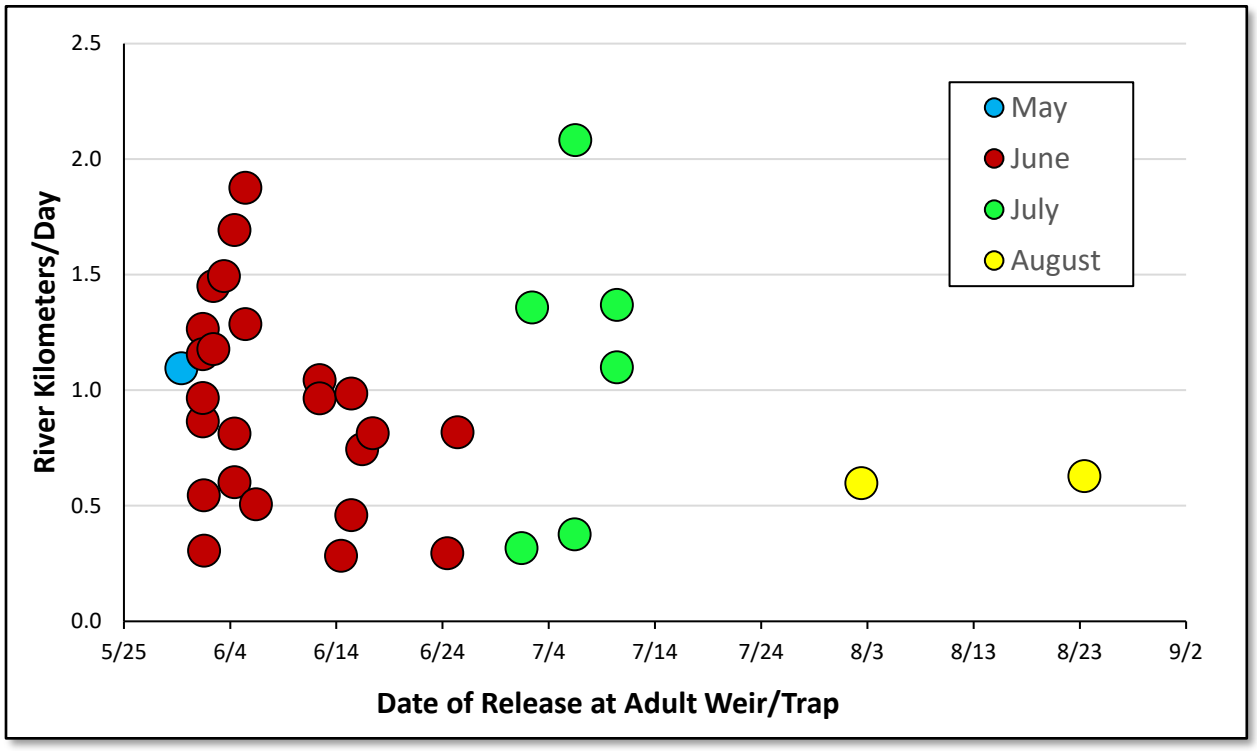

Figure 14. Migration speed of PIT Tagged Bull Trout following release at the adult weir/trap to the Panjab PIT Array by month, 2019

Spring Chinook Salmon Conversion Rates and Delay (Objectives 3 and 4).

Objective 3: Conversion

During the 2018 migration, the first official year of the assessment, 54 unique, previously PIT-tagged spring Chinook salmon were detected moving upstream at TC1 (Appendix C). A total of 34 spring Chinook salmon were captured in the trap, and 9 were detected on the upstream antennas (jumped the weir without capture). Eleven (~20%) of the 54 previously tagged spring Chinook salmon remained below the adult weir/trap based on detection history. Thus, the conversion rate from below the adult weir/trap to capture/passage was 79.6% (Figure 12).

In 2019, 32 spring Chinook salmon had appropriate upstream detection histories at TC1. Eleven (34%) appear to have remained below the adult weir/trap throughout the study period, although it's possible some of these passed above the adult weir/trap by jumping, but with antennas above the trap disabled until the middle of June, it's not entirely clear. We know some fish passed above the weir as staff spotted live spring Chinook salmon above the weir prior to spawning, and three redds were eventually found above the adult weir/trap. For the trapping season, 21 spring Chinook salmon were captured in the trap, and zero spring Chinook salmon (not already captured in the adult trap) were detected on the TPJ array upstream. Thus, the conversion rate from below the adult weir/trap to eventual trap capture was 65.6% (Figure 12).

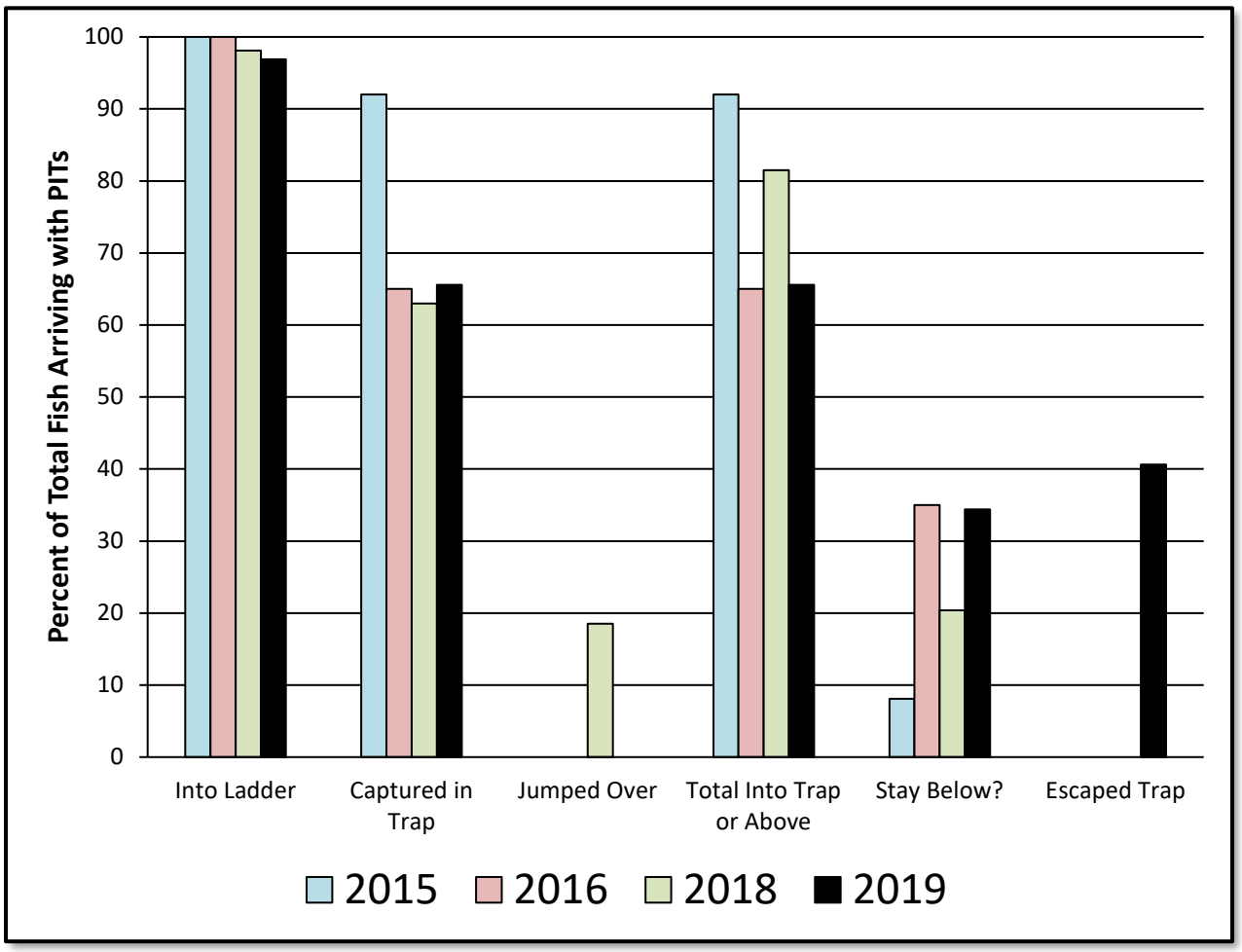

Figure 15. Tucannon River spring Chinook salmon passage (conversion) through the Tucannon adult weir/trap, 2015, 2016, 2018 and 2019.

Similar to the Bull Trout retention/delay analysis by placement of two temporary antennas; inside the ladder prior to the trap entrance and within the trap area, we preformed the same type of analysis with spring Chinook salmon. Avoidance/escapement of spring Chinook salmon into the trap had also been suspected based on data obtained in 2018, but couldn't be confirmed without the additional antennas. Results from 2019 determined that 41% of the spring Chinook salmon escaped the trap after entry (Appendix E).

Objective 4. Delay

Similar to the Bull Trout, in order to assess migration delay of spring Chinook salmon we provide context by determining how quickly fish are migrating upstream before they reach the adult weir/trap area. Based on data from 2016-2019 spring Chinook salmon detections in the Tucannon River, median migration speeds (rkm/day) at detection sites below the adult weir/trap range from about 2-8 rkm/day (Figure 13). Median migration speeds around the adult weir/trap area (when starting from the antennas immediately downstream of the trap) have been estimated at <0.05 rkm/day. Following release from the trap after capture, migration speeds once again increase as indicated by the PIT arrays immediately upstream of the trap (~0.2 rkm/day), and the TPJ PIT array (1.1 rkm/day). Based on this information, the adult weir/trap area does appear to influence the migration rate of spring Chinook salmon in the Tucannon River.

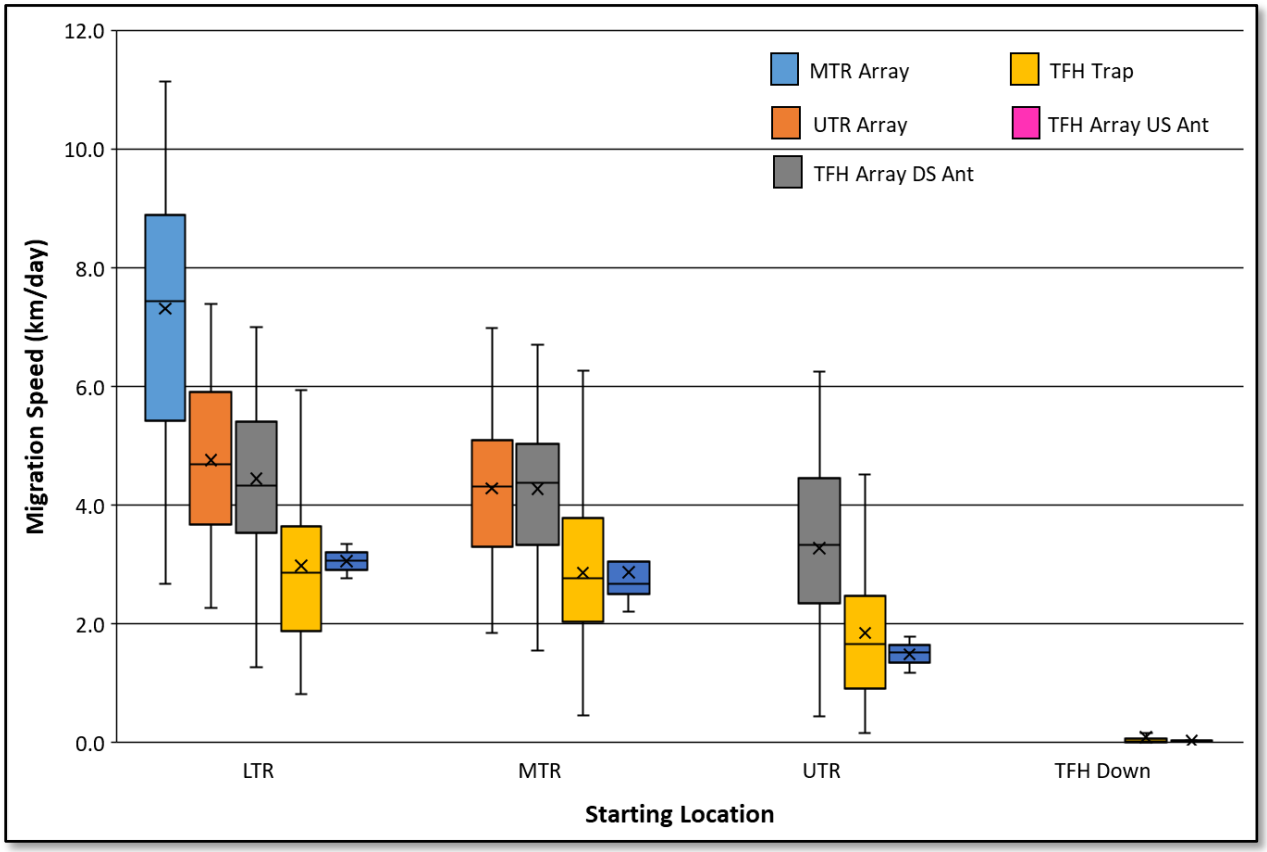

Figure 16. Box and Whisker plot for migration speed (km/day) of spring Chinook salmon in the Tucannon River at various detection sites (data from 2016-2019). High and low lines represent minimum and maximum values, shaded boxes represent the 25th-75th percent quartiles, solid line in the shaded box represents the median, and the "X" in the shaded box represents the mean. Starting location represents where the migration speed calculation was initiated, and the shaded bars as keyed in the legend represent individual sites upstream.

2018 Specific Delay at the TFH Adult Weir/Trap

Forty-three unique spring Chinook salmon were detected at both TC1, TC3, and/or TC4 and had detection histories indicating they were suitable for calculating delay. Overall delay from TC1 to TC3 or TC4 ranged from 0-31 days with a median of 3.8 days (Figure 14).

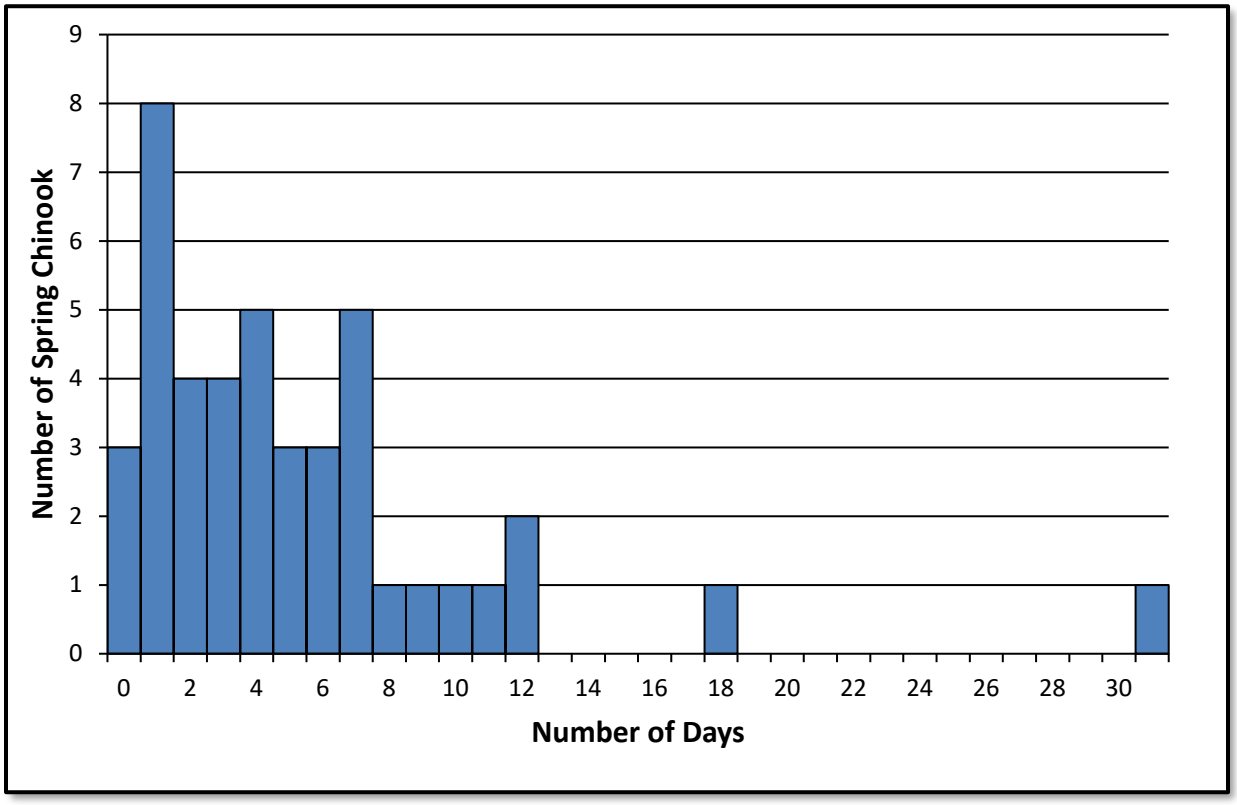

Figure 17. The actual number of days in 2018 it took spring Chinook salmon to move from TC1 to TC3 (adult trap detection/passage by hatchery staff) or TC4 (upstream antennas).

2019 Specific Delay at the TFH Adult Trap

Twenty-one unique spring Chinook salmon were detected at both TC1 and TC3 and had detection histories indicating they were suitable for calculating delay. Overall delay from first detection to trap capture ranged from 0-60 days with a median of 4 days (Figure 15-A). With fish escaping the trap, we provide an alternative graph (Figure 15-B) which shows what delay would have been had the fish been captured the first time they entered the trap. Overall delay (hypothetically) would have been reduced to 0-47 days with a median of 1.7 days.

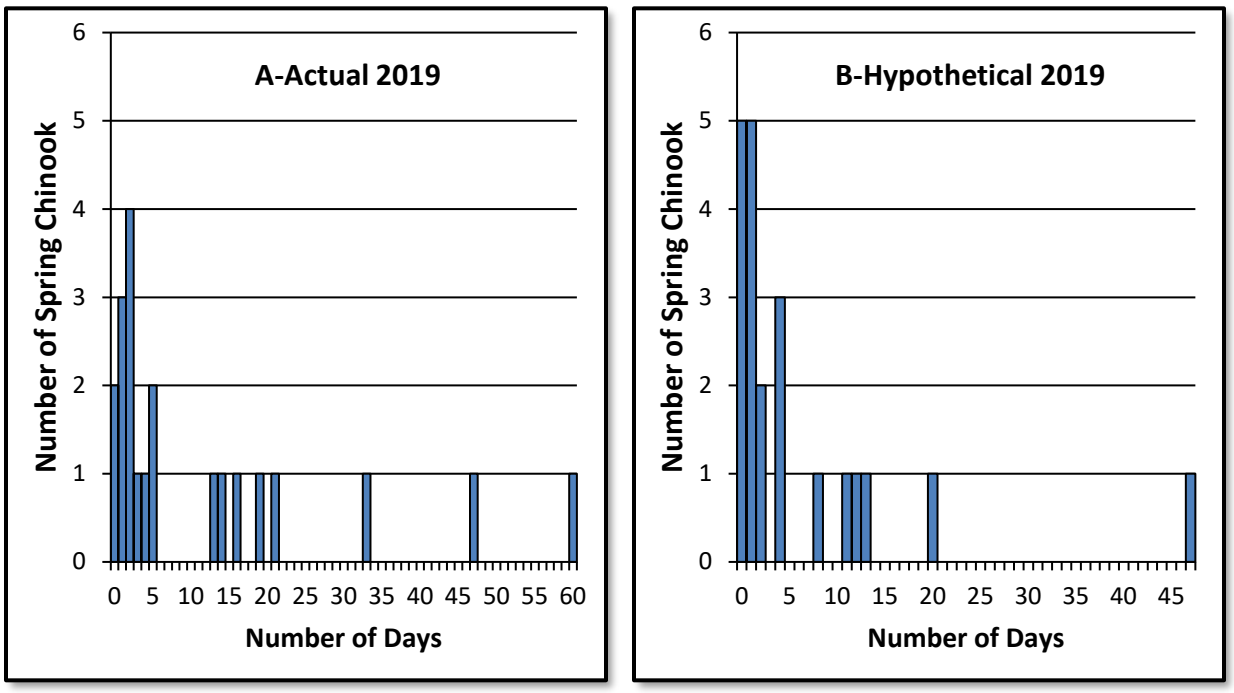

Figure 18. (A) The actual number of days in 2019 it took spring Chinook salmon to move from TC1 to TC3 (adult trap detection/passage by hatchery staff). (B) The hypothetical number of days in 2019 it took spring Chinook salmon to move from TC1 to TC3 (temporary adult trap antenna detection - not actual capture).

Figure 16 was developed to understand the amount of delay between all the years of spring Chinook salmon detection information (2015-2019) on the Tucannon River. In an ideal situation of delay, all points should be on, or very close to, the diagonal line, representing little to no impact in migration delay by spring Chinook salmon through the Tucannon River adult weir/trap structure. Based on data from 2015-2019, the degree of delay has been somewhat consistent (Figure 16). As with the Bull Trout in 2015, migration delay was minimal, likely because of the harsher environmental conditions and fish likely had a greater desire to move upstream (Figure 16). Similar to the Bull Trout, delay does not appear to be influenced by the size of fish either (Figure 17). With the additional information obtained in 2019 about spring Chinook salmon escaping the trap, and the somewhat consistent pattern of delay with previous years, we believe that spring Chinook salmon have been escaping the trap for many years also.

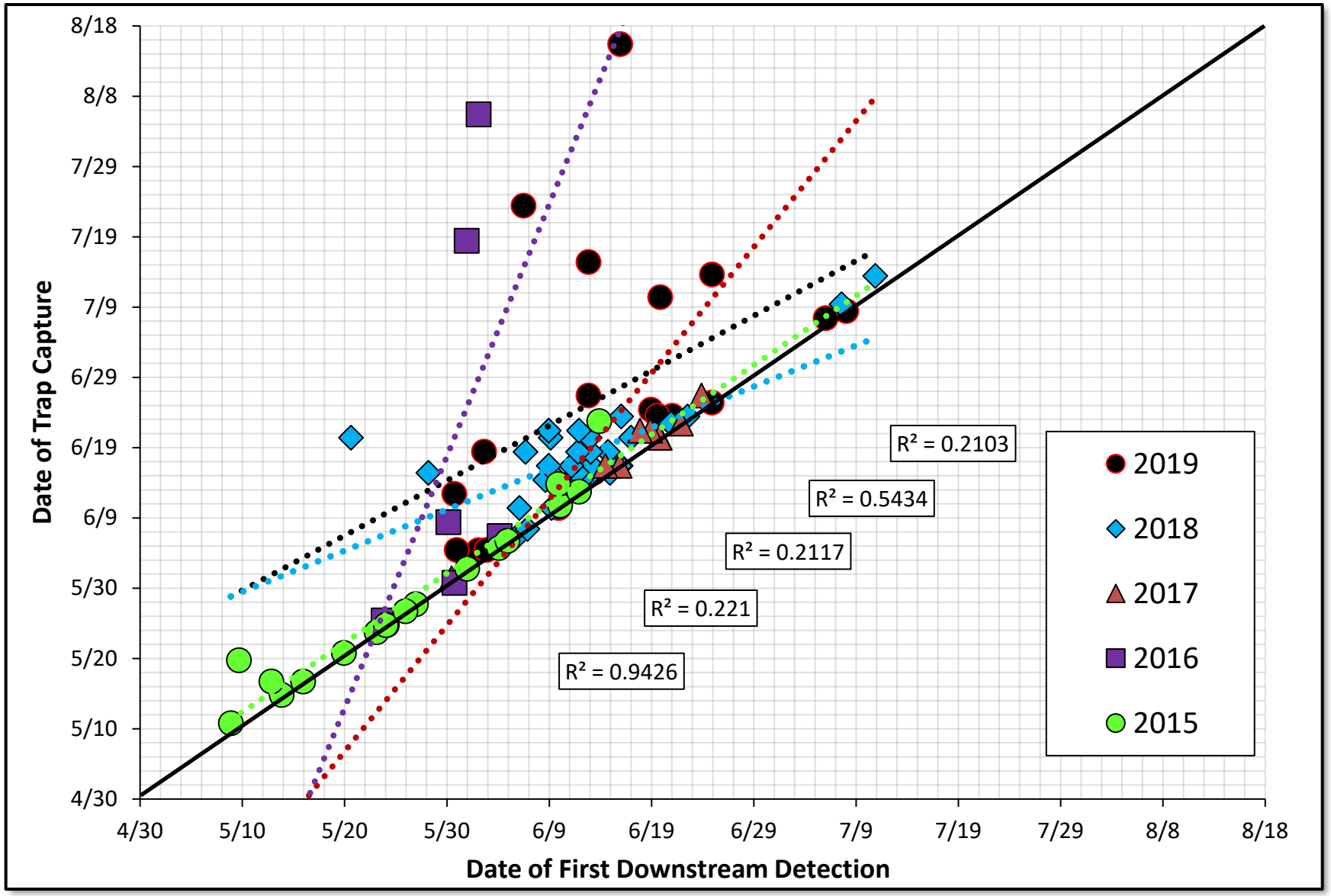

Figure 19. Migration delay of spring Chinook salmon from 1st detection downstream to adult trap capture, 2015-2019. A square represents 2 days of time

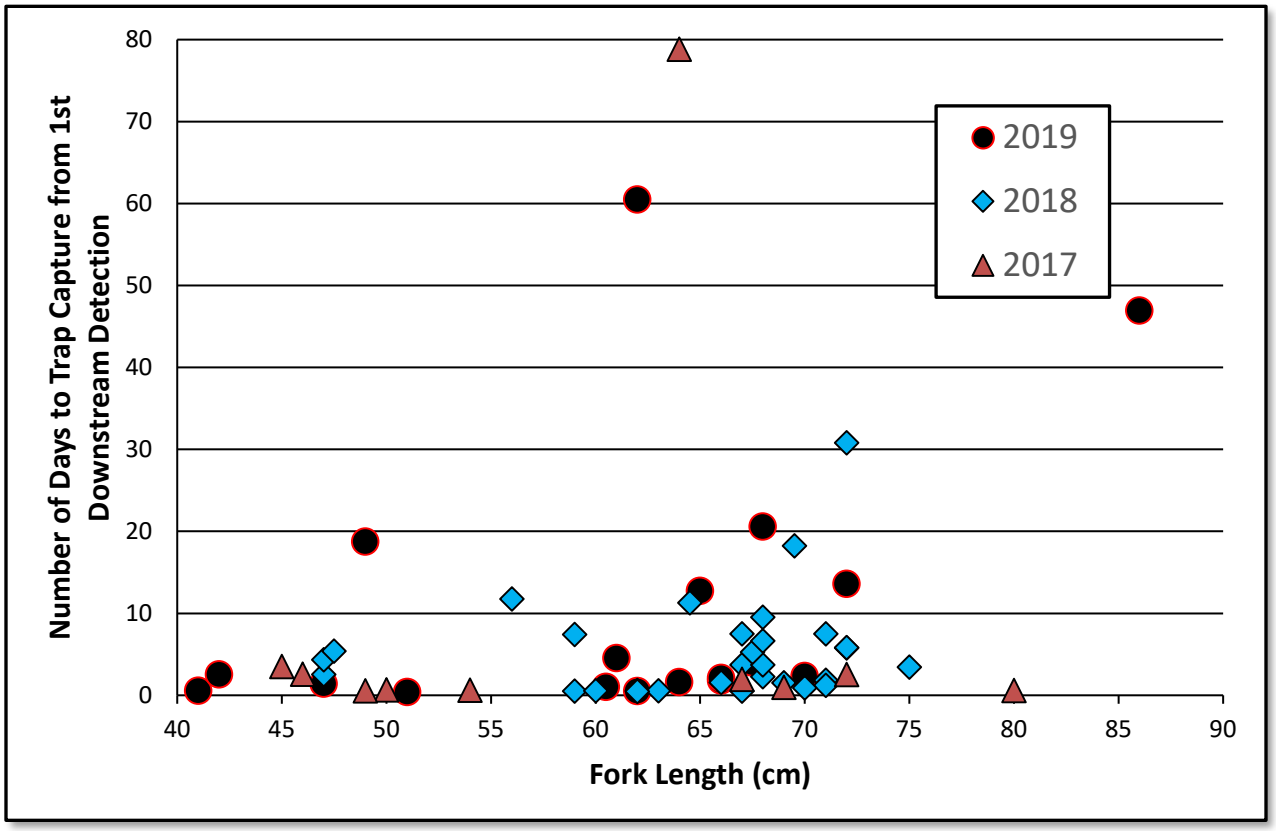

Figure 20. Migration delay of spring Chinook salmon (by fork length) by the number of days to adult trap capture from 1st downstream detection, 2015-2019.

Conclusions

This is the first report of a multi-year effort into the effects of the adult weir/trap operated for the LSRCP Tucannon River spring Chinook salmon program and its potential impacts to Bull Trout migration and delay. While not the main focus of the study, identical metrics for spring Chinook salmon migration and delay have also been summarized. This progress report presents specific findings in both the 2018 and 2019 migration years, but prior year's information (2015-2017) have been included where useful to better describe what has been observed for both Bull Trout and spring Chinook salmon migration and delay.

In 2018 and 2019, the Bull Trout conversion rate was 94.0 and 92.9%, respectively, (benchmark >95%) through the weir/trap area. For spring Chinook salmon, conversion through the trap area was 81.5% and 65.6% in 2018 and 2019, respectively.

Migration rate of Bull Trout from the lower Tucannon River upstream to the adult weir/trap is generally about 0.5-2.0 rkm/day. Migration rate of Bull Trout once they arrive in the trap area slows considerably. Similar results have been observed for the spring Chinook salmon migrating up the river as well, with migration speeds in the 0.5-2.0 rkm/day in the lower river until they

reach the adult trap site. Median delay of both species to navigate past the weir/trap in 2018 was 3.5 days, and in 2019 was slightly higher with 3.9 days for Bull Trout, and 4.0 days for spring Chinook salmon.

The ability of Bull Trout and spring Chinook salmon to negotiate the Tucannon River adult weir/trap area in 2018 and 2019, and in previous years, may reflect a number of variables that are not entirely clear at this point (e.g., the influence of environmental conditions). However, based on the information obtained in 2019 with the additional two antennas installed just in front of and in the adult trap, many of the questions from prior years' data have been explained by the ability of fish to escape the adult trap. A challenge prior to 2020 weir and trap operations will be to modify the trap entrance to prevent fish escaping, not hinder their ability to enter, while accommodating the full range and size of species captured. Trap modifications will be discussed within the Tucannon River workgroup during spring of 2020 for implementation during the year.

Acknowledgements

We thank the Lower Snake River Compensation Plan Office for funding the analysis of this work. We thank all those who improved this report through their review of earlier drafts. We thank the Tucannon FH staff (Doug Maxey, Daniel Pounds, Chris Highley, and Daniel Byington) for the daily operation of the adult trap, scanning and PIT tagging the Bull Trout and Spring Chinook salmon captured in the trap. We are also grateful to co-managers (the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation) for their support of and participation in this work as well as the U.S. Fish and Wildlife staff contributions to the Tucannon River workgroup.

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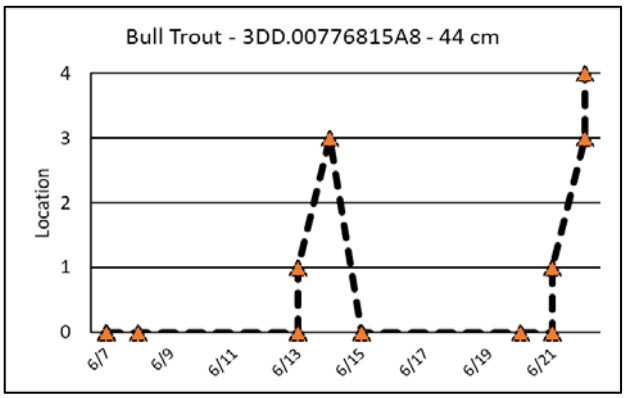
Appendix A

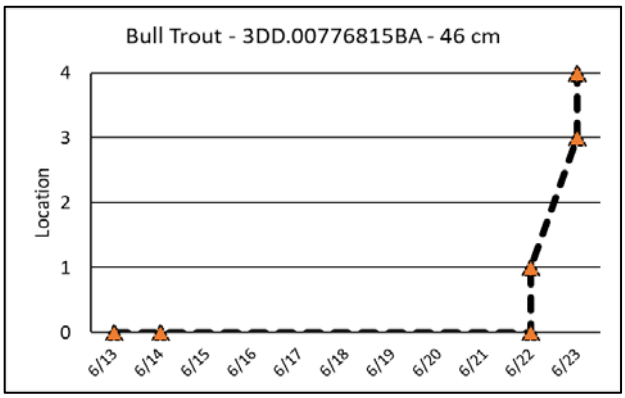
Previously PIT-tagged Bull Trout and Spring Chinook salmon used in this analysis for the 2018 and 2019 run years.

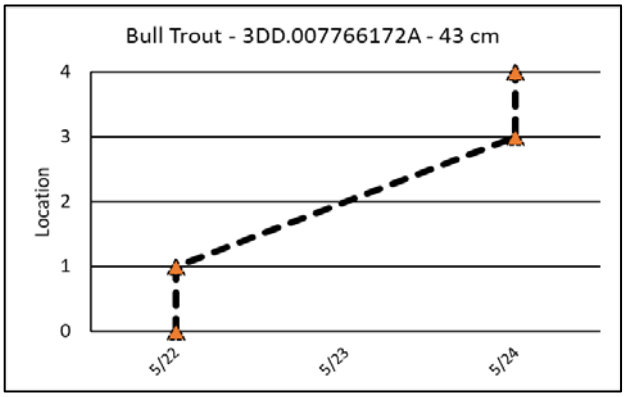
2018 – Bull Trout					
384.3B23976BBB	3D9.1C2D08CCD4	3DD.00776638F1	3DD.007766AE04	3DD.007767B8B7	3DD.00776815A8
384.3B23983DEF	3D9.1C2DCBC147	3DD.0077666A5B	3DD.007766B7D6	3DD.007767B8E3	3DD.00776815BA
384.3B239D41B4	3D9.1C2DCBCA38	3DD.00776675BA	3DD.007766C975	3DD.007767C2D2	3DD.0077682D87
384.3B23AA5ABE	3DD.007765CEB3	3DD.007766949C	3DD.00776761A0	3DD.007767D02A	
384.3B23AD1A13	3DD.007766172A	3DD.0077669C12	3DD.007767B495	3DD.007767DACF	
3D9.1C2D05A5AE	3DD.0077661C14	3DD.007766A1FA	3DD.007767B854	3DD.007767EE3A	
2018 – Spring Chinook Salmon					
3DD.003BDB4DA9	3DD.00775EB0A0	3DD.0077721C1E	3DD.007775E060	3DD.0077B6E3B1	3DD.0077BA58C8
3DD.003BDB4DAD	3DD.00775F5135	3DD.007772D04C	3DD.007775E19A	3DD.0077B744B7	3DD.0077BA5915
3DD.003BDB4DBA	3DD.00775FED7A	3DD.007774B9D1	3DD.007775F701	3DD.0077B8765A	3DD.0077BA5AFD
3DD.003BDB4E20	3DD.00775FF831	3DD.007774DAB6	3DD.007780FEA9	3DD.0077B8B2F3	3DD.0077BA6209
3DD.003BDB4E84	3DD.00776F6554	3DD.007775295C	3DD.0077813299	3DD.0077B8C14A	3DD.0077BA834F
3DD.0077510CED	3DD.00777169D1	3DD.0077756BB3	3DD.00778C2417	3DD.0077B90D27	3DD.0077BA9B4E
3DD.007751E527	3DD.0077719998	3DD.00777583DD	3DD.0077ADE47C	3DD.0077BA4354	3DD.0077BA9C31
3DD.00775E4B92	3DD.007771ADFE	3DD.007775AB57	3DD.0077B5E4B2	3DD.0077BA4925	3DD.0077BAC11F
3DD.00775E8C6B	3DD.007771FE88	3DD.007775AB97	3DD.0077B601FF	3DD.0077BA581B	3DD.0077BAC79F
2019 – Bull Trout					
384.3B23983DEF	3DD.003BF77371	384.3B23A83E41	3DD.007766172A	384.3B23A7EA97	3DD.003BF77360
384.3B23A82E47	3DD.007767B8E3	3DD.003BF77322	3DD.00776815BA	384.3B23AD1A13	3DD.007766B7D6
3D9.1C2DDAB58C	384.3B23A5843C				
2019 – Spring Chinook Salmon					
3DD.0077C077DF	3DD.00775EC381	3DD.00775F852B	3DD.007774F3D6	3DD.0077A5D971	3DD.0077B64FED
3DD.0077C0A0AD	3DD.00775EC3EE	3DD.00775F9A4A	3DD.0077758E24	3DD.0077A637B7	3DD.0077B68776
3DD.0077C0D9E3	3DD.00775EEBCF	3DD.00775FFF04	3DD.00778C9423	3DD.0077AE2FFB	3DD.0077B90306
3DD.0077C24CA9	3DD.00775F3271	3DD.007761C0A3	3DD.00778EDD6A	3DD.0077B5EF67	3DD.0077B92203
3DD.00775E4D5F	3DD.00775F49C3	3DD.003BF7725C	3DD.00778F01BD	3DD.0077B63DEF	3DD.0077B972B0
3DD.00775E6DD8	3DD.00775F5E27				

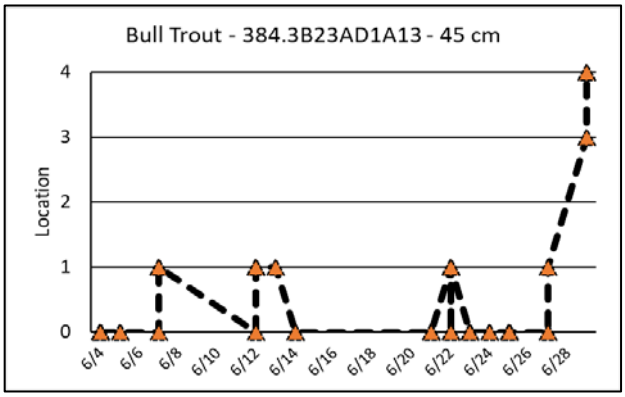
Appendix B

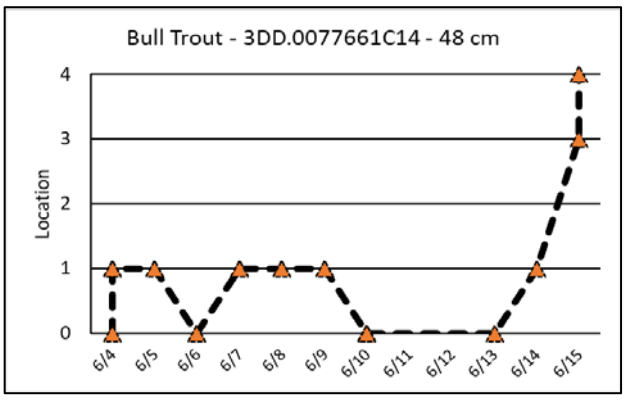
Movement histories of previously PIT tagged Bull Trout at the Tucannon River adult weir/trap, ***2018***. Location Key: 0 – Antennas below adult weir/trap; 1 – Antennas in the fish ladder; 2 – Antenna in the adult trap box (not available in 2018); 3 – Adult trap capture; 4 – Antennas above adult weir/trap.

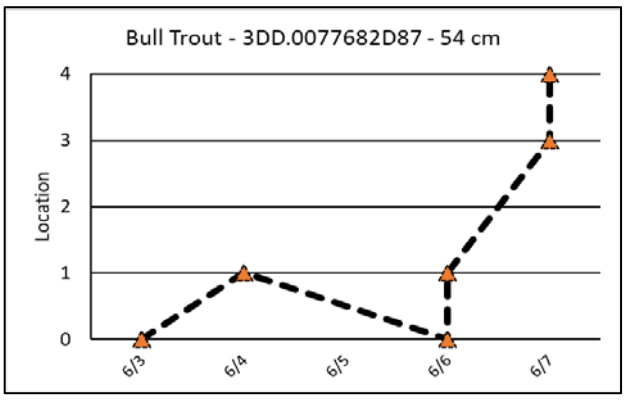


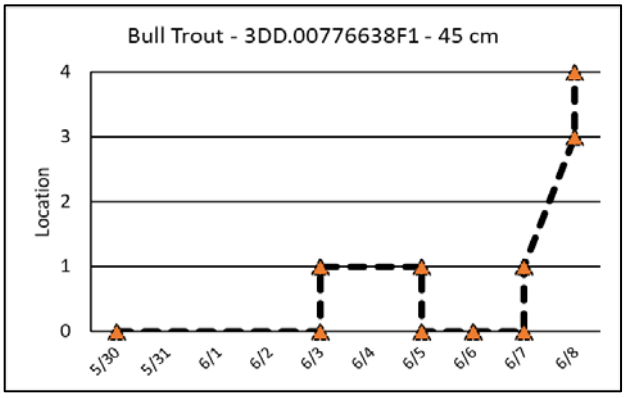











Bull Trout - 3DD.00776638F1 - 45 cm
Location
0
1
2
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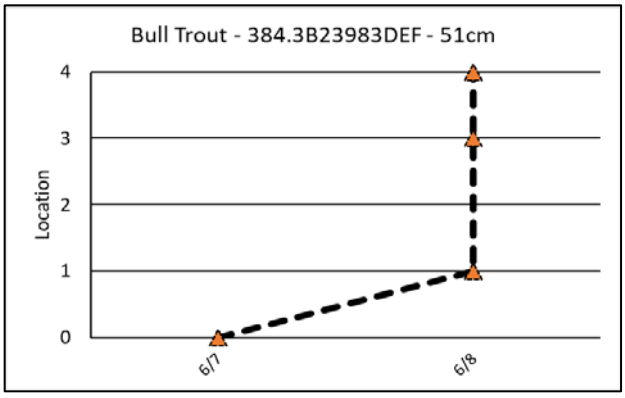
5/30
5/31
6/1
6/2
6/3
6/4
6/5
6/6
6/7
6/8


Bull Trout - 384.3B23983DEF - 51cm
Location
0
1
2
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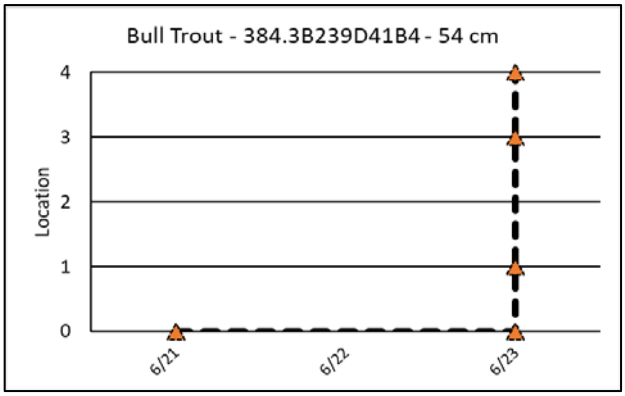
6/7
6/8


Bull Trout - 384.3B239D41B4 - 54 cm
Location
0
1
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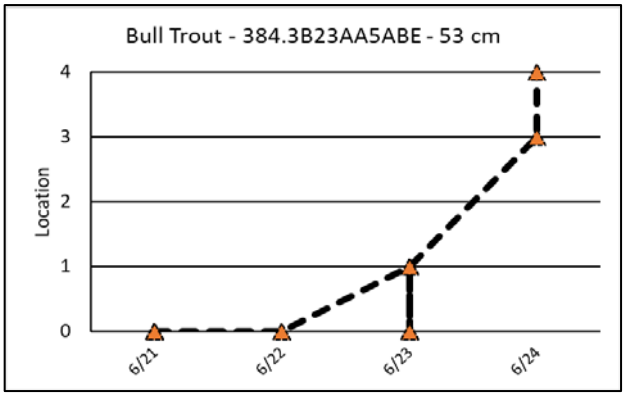
6/21
6/22
6/23


Bull Trout - 384.3B23AA5ABE - 53 cm
Location
0
1
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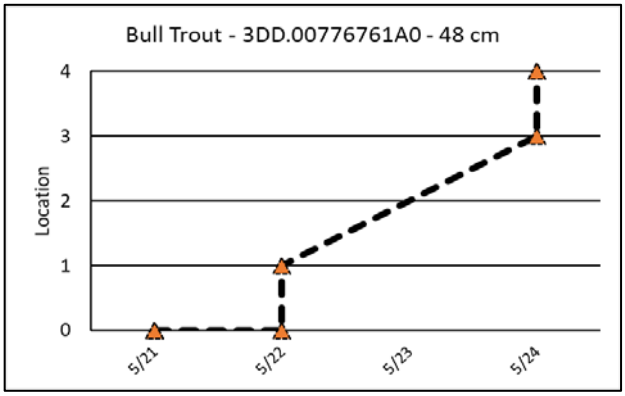
4
6/21
6/22
6/23
6/24


Bull Trout - 3DD.00776761A0 - 48 cm
Location
0
1
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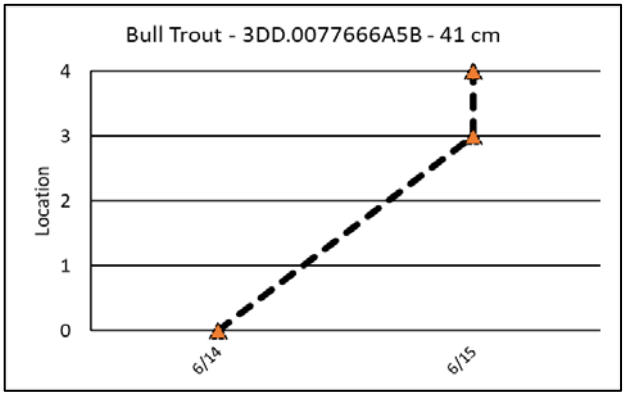
5/21
5/22
5/23
5/24


Bull Trout - 3DD.0077666A5B - 41 cm
Location
0
1
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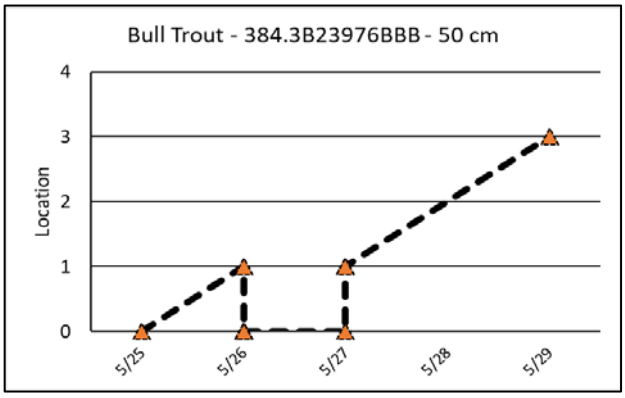
6/14
6/15


Bull Trout - 384.3B23976BBB - 50 cm
Location
0
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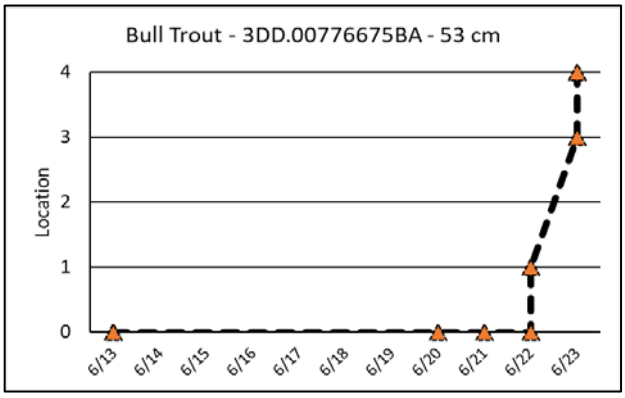
5/25
5/26
5/27
5/28
5/29


Bull Trout - 3DD.00776675BA - 53 cm
Location
0
1
2
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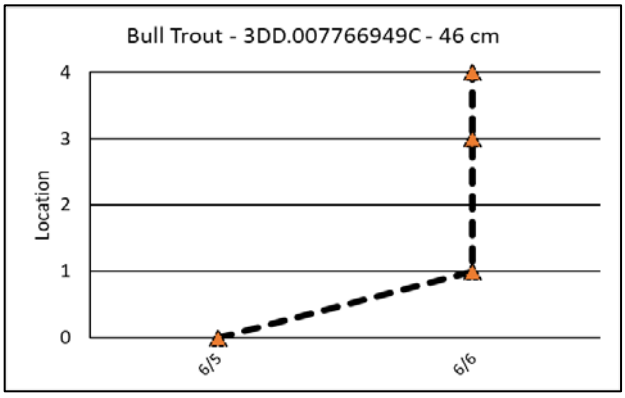
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20
6/21
6/22
6/23


Bull Trout - 3DD.007766949C - 46 cm
Location
0
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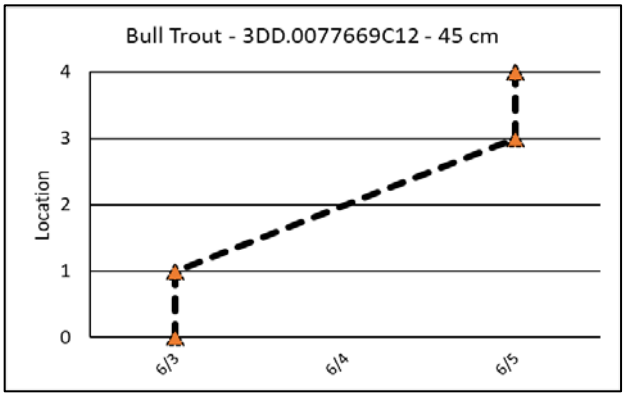
6/5
6/6


Bull Trout - 3DD.0077669C12 - 45 cm
Location
0
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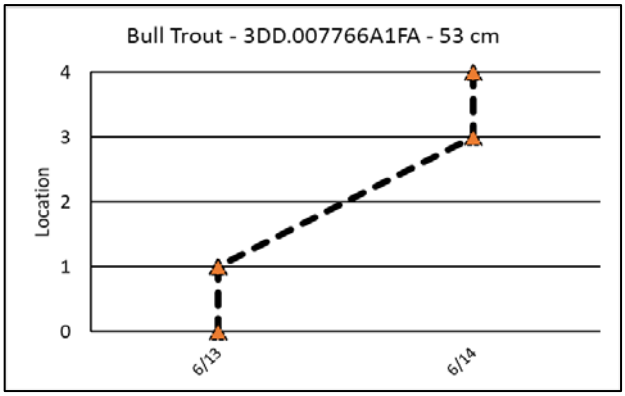
4
6/3
6/4
6/5


Bull Trout - 3DD.007766A1FA - 53 cm
Location
0
1
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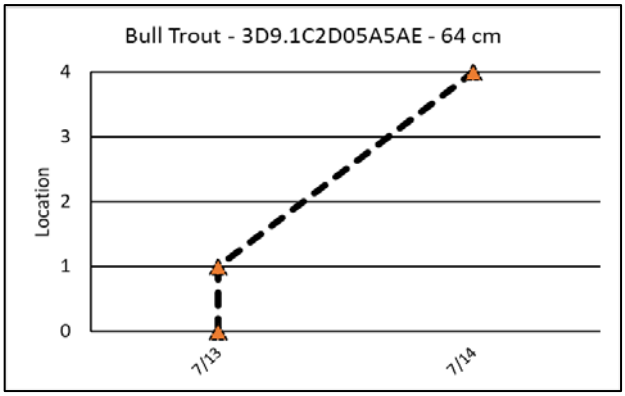
4
6/13
6/14


Bull Trout - 3D9.1C2D05A5AE - 64 cm
Location
0
1
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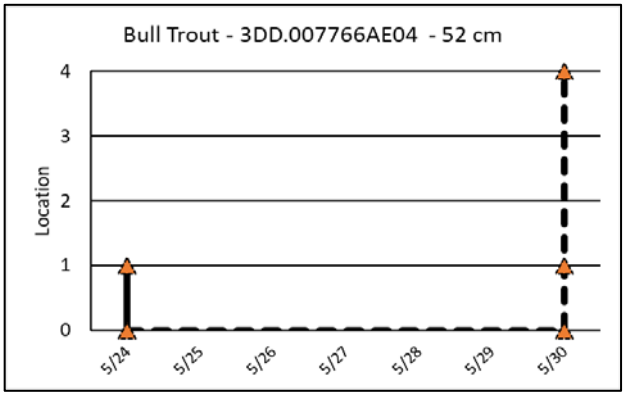
7/13
7/14


Bull Trout - 3DD.007766AE04 - 52 cm
Location
0
1
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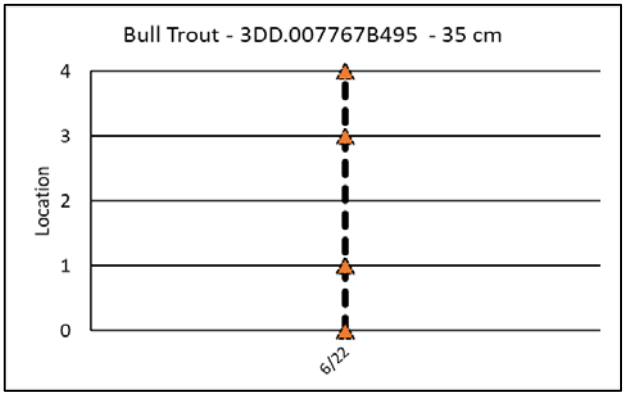
5/24
5/25
5/26
5/27
5/28
5/29
5/30


Bull Trout - 3DD.007767B495 - 35 cm
Location
0
1
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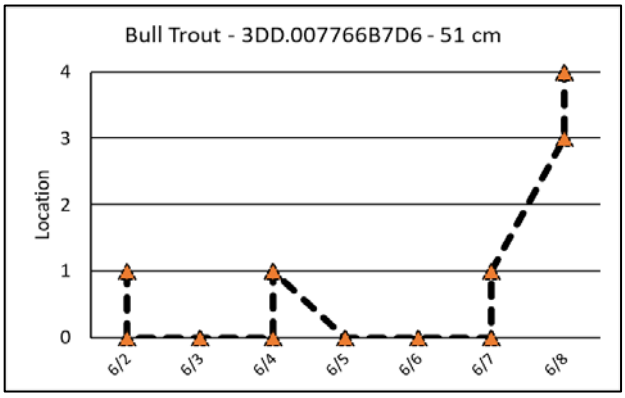
4
6/22


Bull Trout - 3DD.007766B7D6 - 51 cm
Location
0
1
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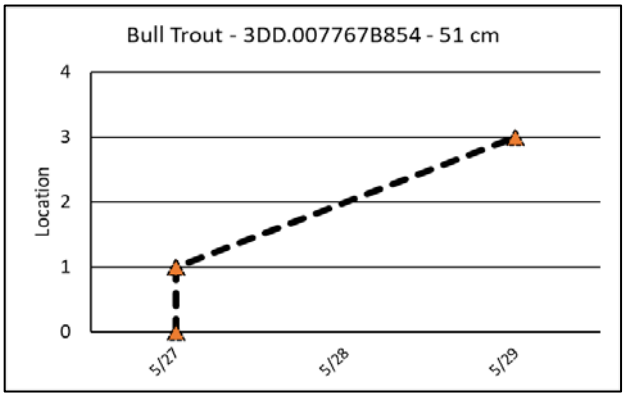
6/2
6/3
6/4
6/5
6/6
6/7
6/8


Bull Trout - 3DD.007767B854 - 51 cm
Location
0
1
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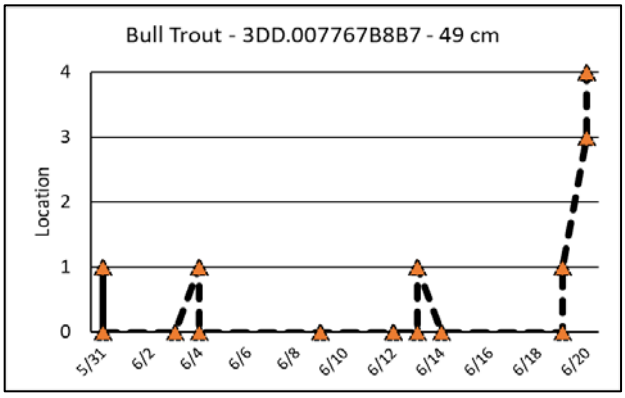
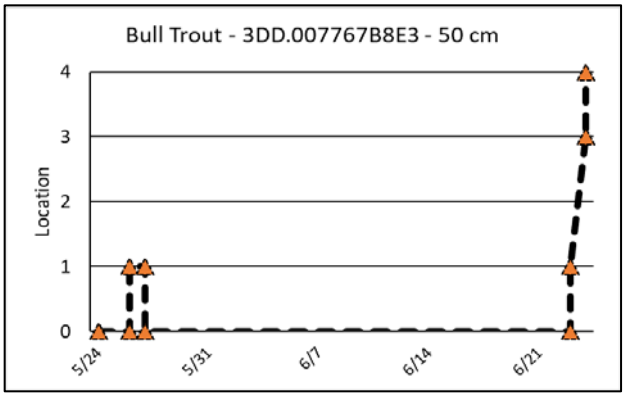
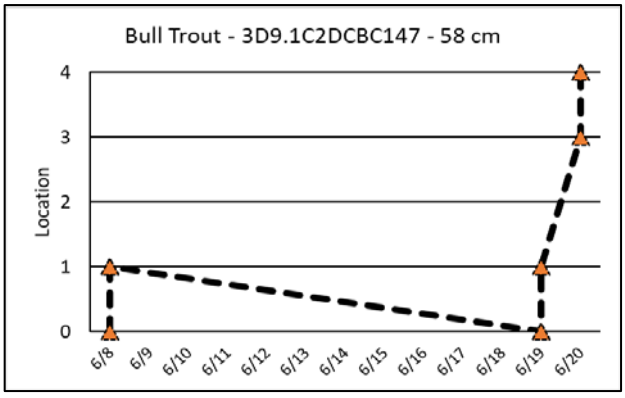
3
4
5/27
5/28
5/29


Bull Trout - 3DD.007767B8B7 - 49 cm
Location
0
1
2
3
4
5/31
6/2
6/4
6/6
6/8
6/10
6/12
6/14
6/16
6/18
6/20


Bull Trout - 3DD.007767B8E3 - 50 cm
Location
0
1
2
3
4
5/24
5/31
6/7
6/14
6/21


Bull Trout - 3D9.1C2DCBC147 - 58 cm
Location
0
1
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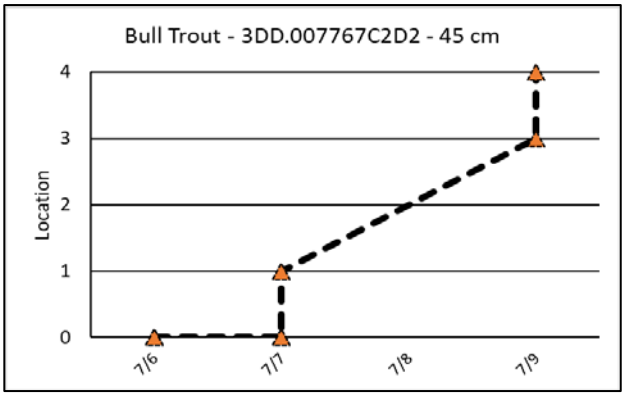
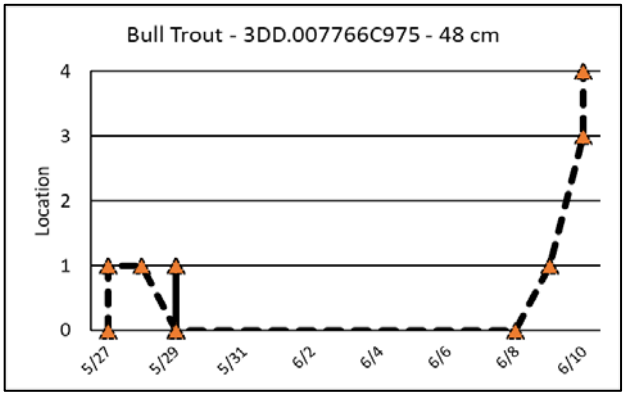
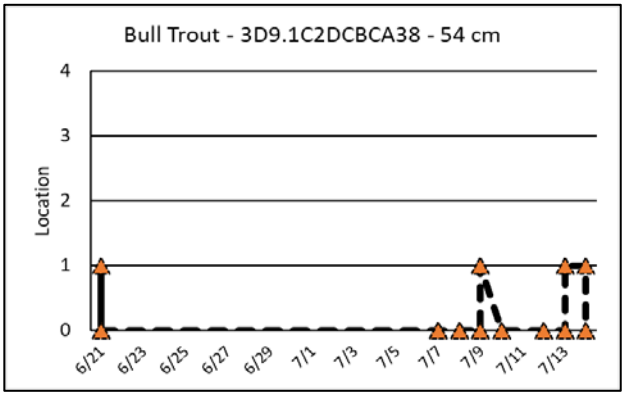
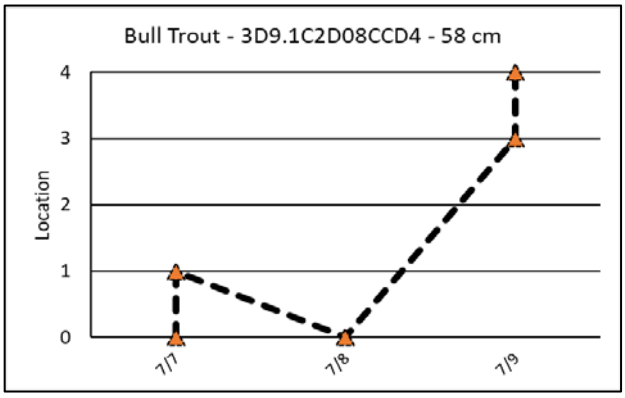
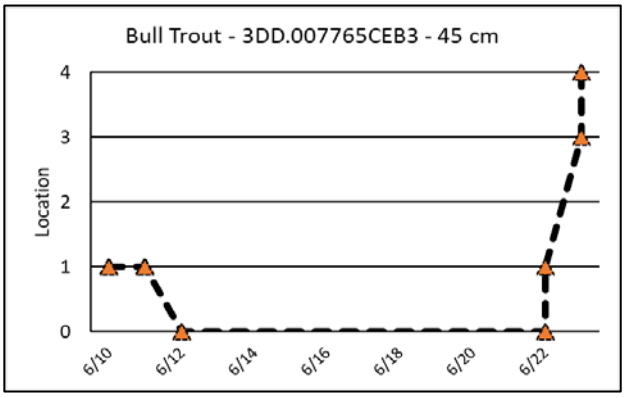
6/8
6/9
6/10
6/11
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20

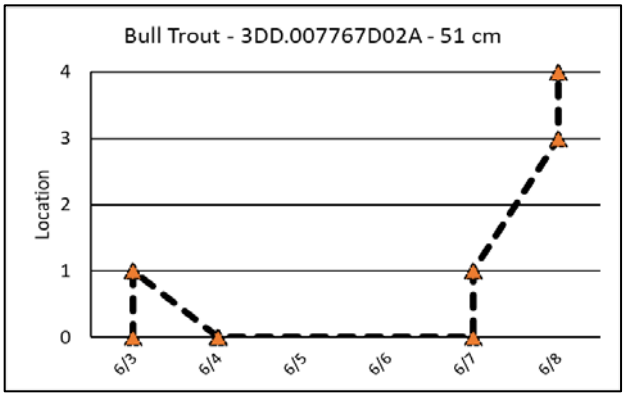

Bull Trout - 3DD.007767C2D2 - 45 cm
Location
0
1
2
3
4
7/6
7/7
7/8
7/9

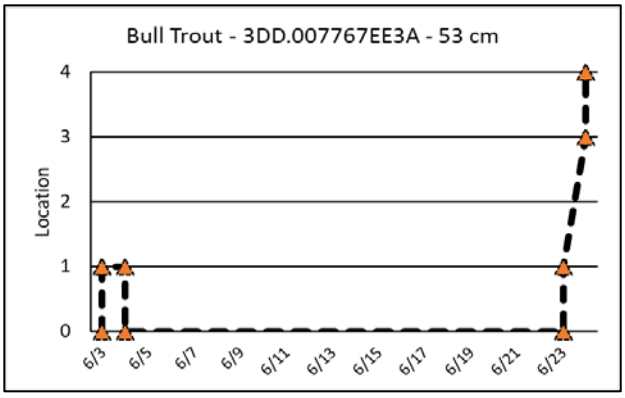

Bull Trout - 3DD.007766C975 - 48 cm
Location
0
1
2
3
4
5/27
5/29
5/31
6/2
6/4
6/6
6/8
6/10

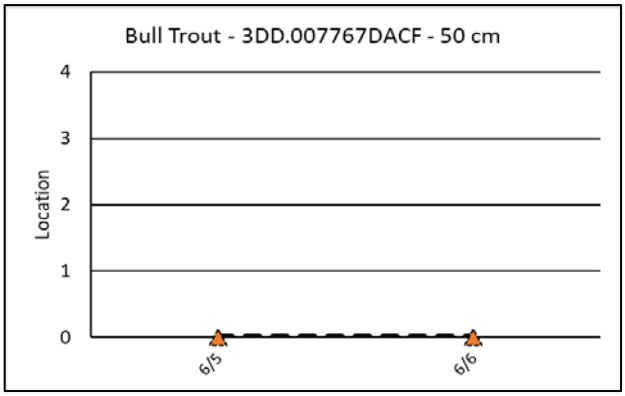

Bull Trout - 3D9.1C2DCBCA38 - 54 cm
Location
0
1
2
3
4
6/21
6/23
6/25
6/27
6/29
7/1
7/3
7/5
7/7
7/9
7/11
7/13


Bull Trout - 3D9.1C2D08CCD4 - 58 cm
Location
0
1
2
3
4
7/7
7/8
7/9


Bull Trout - 3DD.007765CEB3 - 45 cm
Location
0
1
2
3
4
6/10
6/12
6/14
6/16
6/18
6/20
6/22

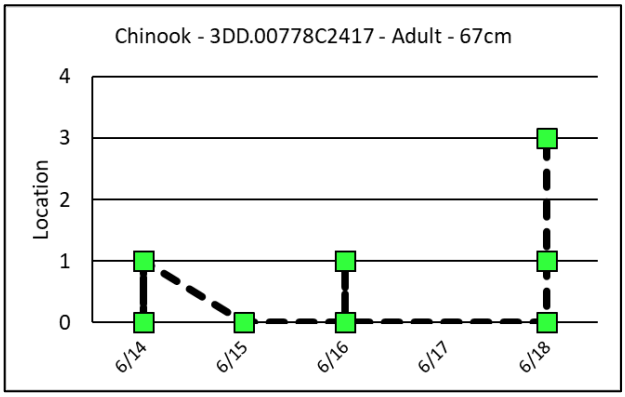

Bull Trout - 3DD.007767D02A - 51 cm
Location
4
3
2
1
0
6/3
6/4
6/5
6/6
6/7
6/8

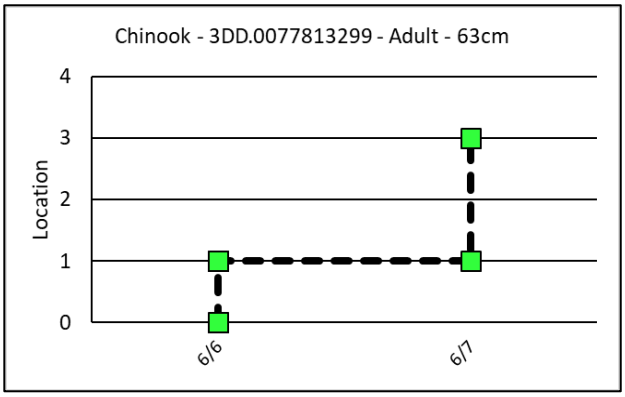

Bull Trout - 3DD.007767EE3A - 53 cm
Location
4
3
2
1
0
6/3
6/5
6/7
6/9
6/11
6/13
6/15
6/17
6/19
6/21
6/23

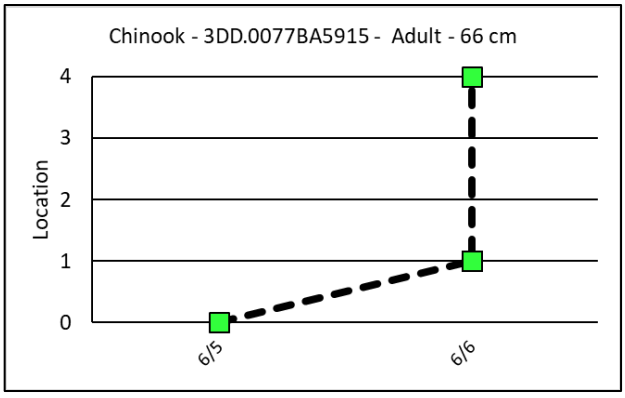

Bull Trout - 3DD.007767DACF - 50 cm
Location
4
3
2
1
0
6/5
6/6

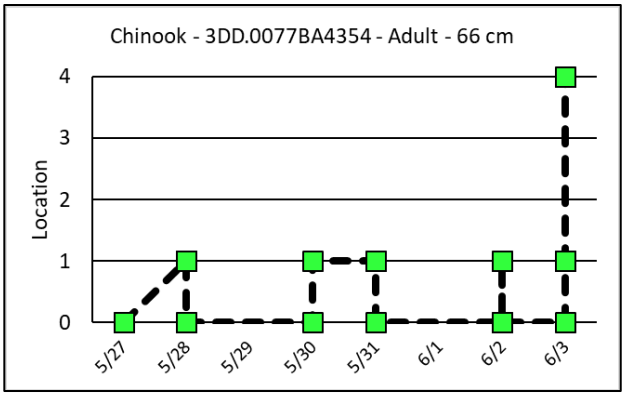
Appendix C

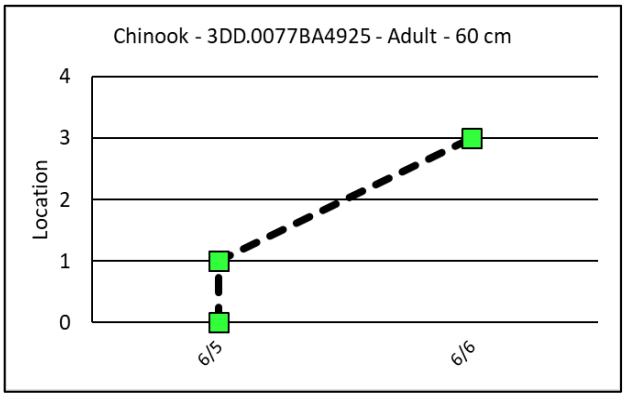
Movement histories of previously PIT tagged spring Chinook salmon at the Tucannon River adult weir/trap, ***2018***. Location Key: 0 – Antennas below adult weir/trap; 1 – Antennas in the fish ladder; 2 – Antenna in the adult trap box (not available in 2018); 3 – Adult trap capture; 4 – Antennas above adult weir/trap.

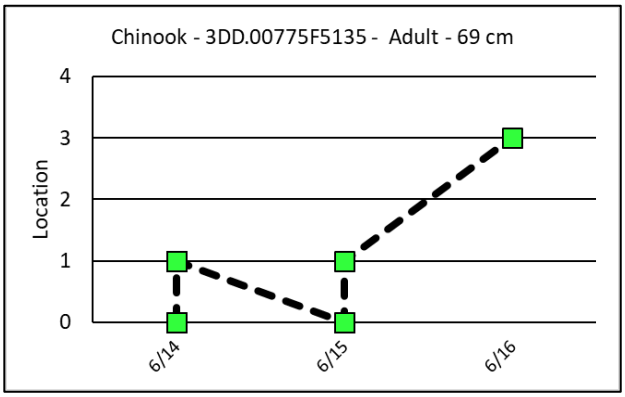


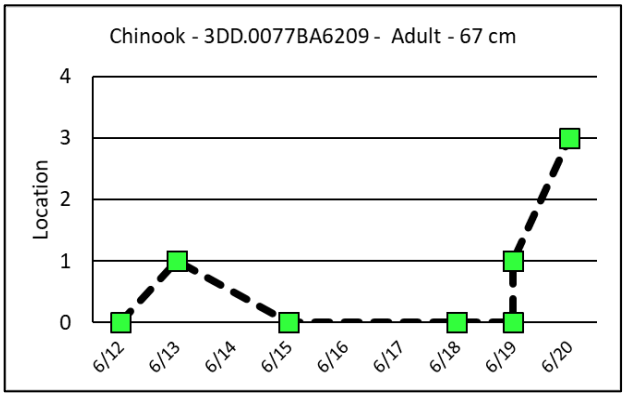











Chinook - 3DD.0077BA6209 - Adult - 67 cm
Location
0
1
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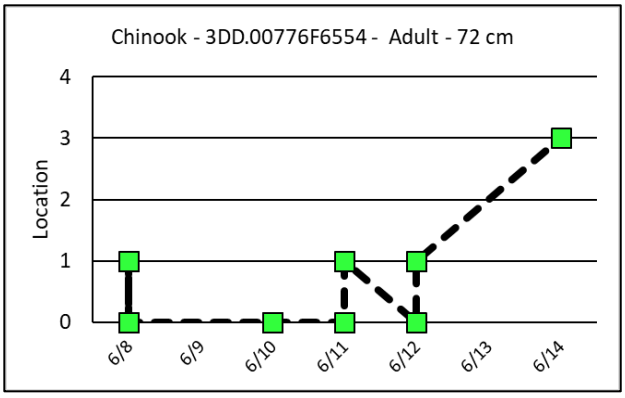
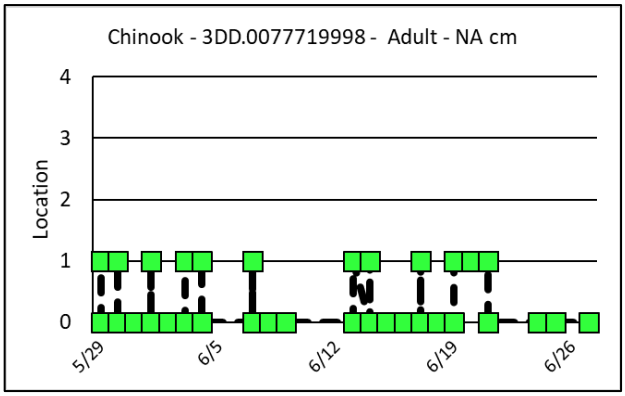
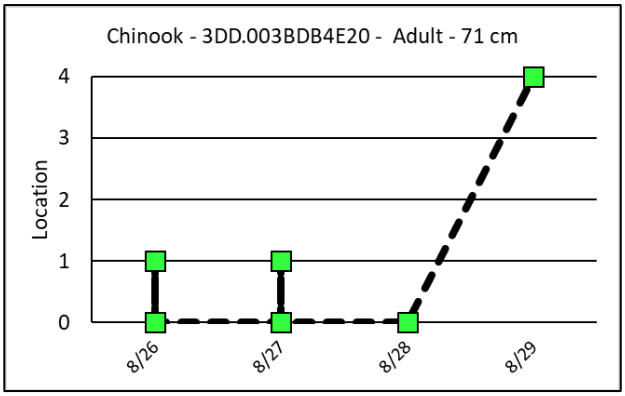
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20


Chinook - 3DD.00776F6554 - Adult - 72 cm
Location
0
1
2
3
4
6/8
6/9
6/10
6/11
6/12
6/13
6/14


Chinook - 3DD.0077719998 - Adult - NA cm
Location
0
1
2
3
4
5/29
6/5
6/12
6/19
6/26


Chinook - 3DD.003BDB4E20 - Adult - 71 cm
Location
0
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8/26
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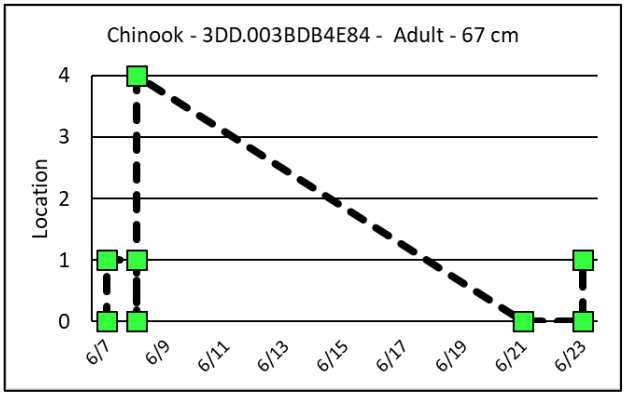
8/29


Chinook - 3DD.003BDB4E84 - Adult - 67 cm
Location
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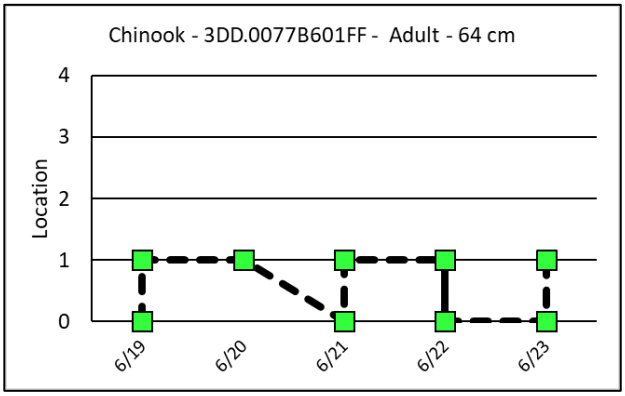
6/23


Chinook - 3DD.0077B601FF - Adult - 64 cm
Location
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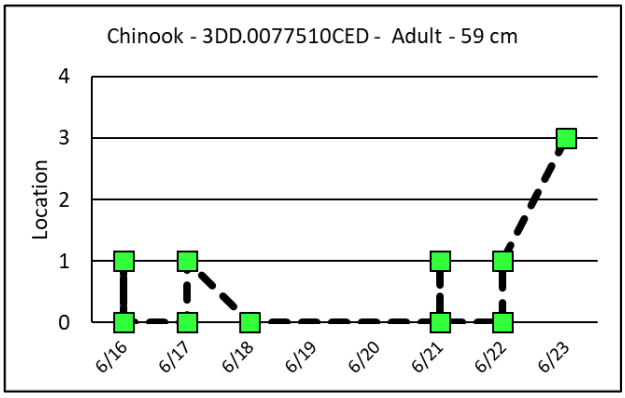
Chinook - 3DD.0077510CED - Adult - 59 cm
Location
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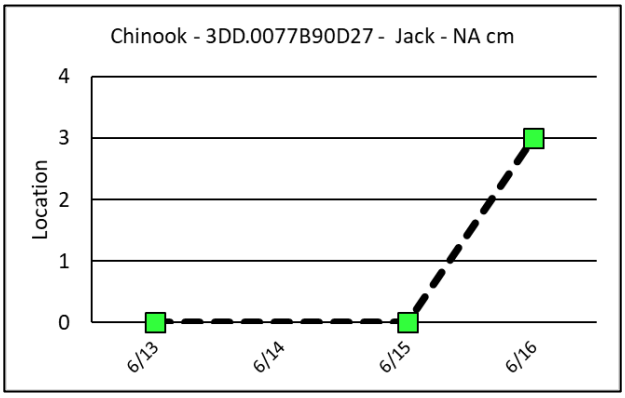
Chinook - 3DD.0077B90D27 - Jack - NA cm
Location
0
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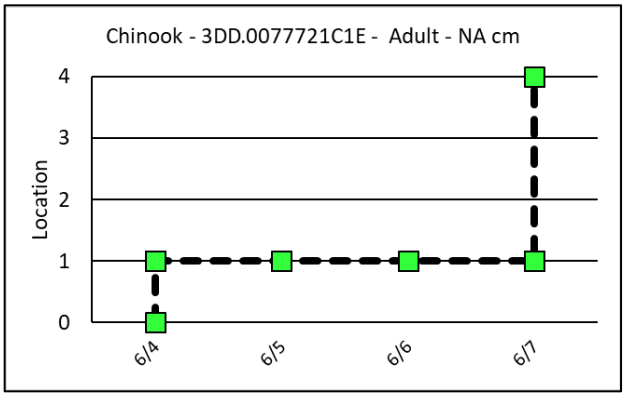
6/16


Chinook - 3DD.0077721C1E - Adult - NA cm
Location
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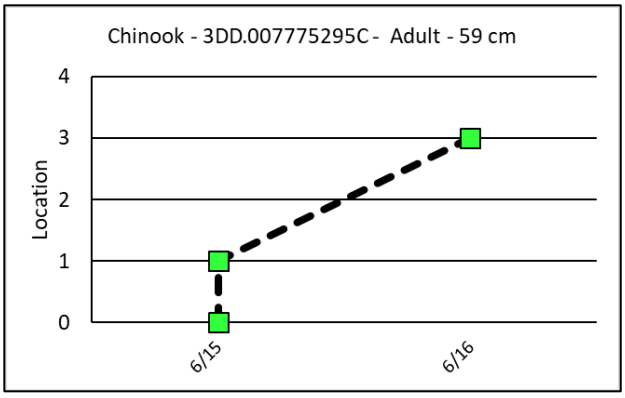
Chinook - 3DD.007775295C - Adult - 59 cm
Location
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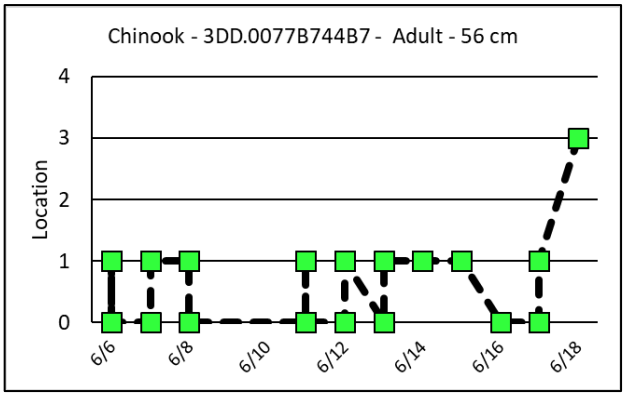
Chinook - 3DD.0077B744B7 - Adult - 56 cm
Location
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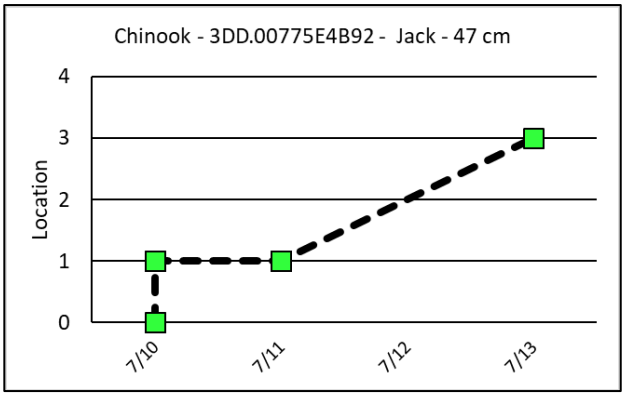
Chinook - 3DD.00775E4B92 - Jack - 47 cm
Location
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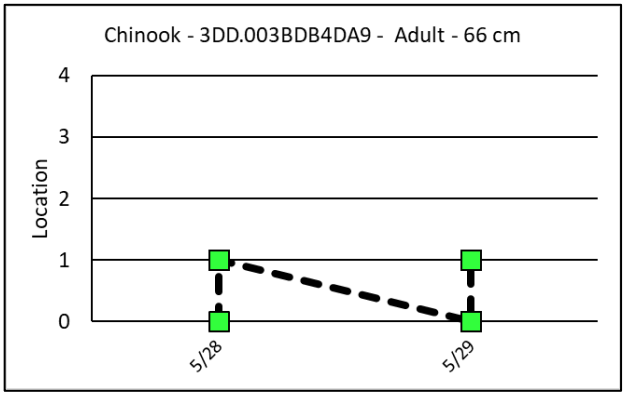
Chinook - 3DD.003BDB4DA9 - Adult - 66 cm
Location
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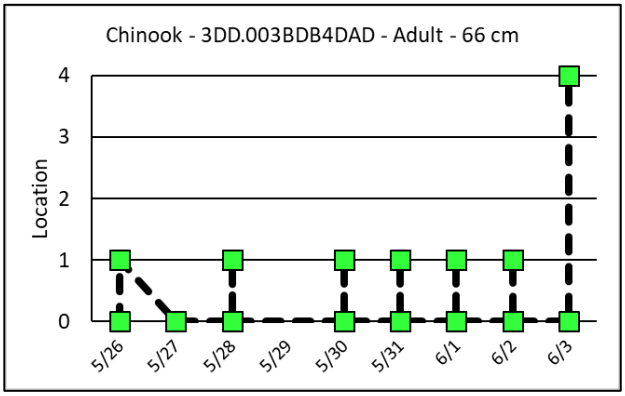
5/29


Chinook - 3DD.003BDB4DAD - Adult - 66 cm
Location
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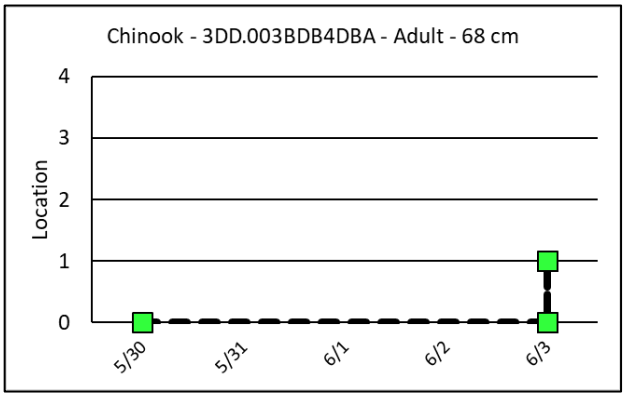
6/3


Chinook - 3DD.003BDB4DBA - Adult - 68 cm
Location
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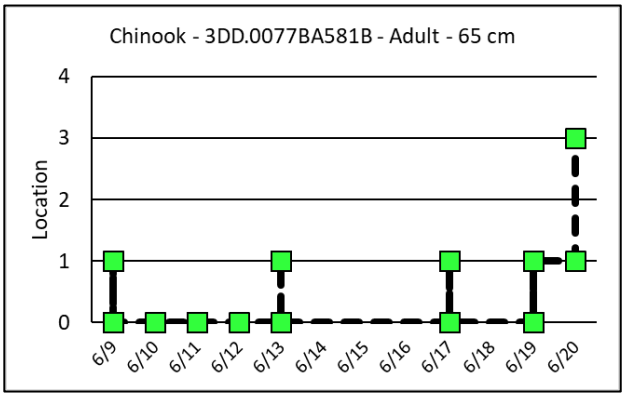
6/3


Chinook - 3DD.0077BA581B - Adult - 65 cm
Location
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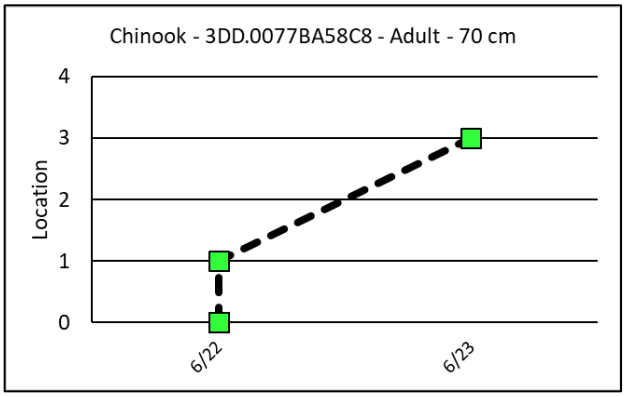
6/19
6/20


Chinook - 3DD.0077BA58C8 - Adult - 70 cm
Location
4
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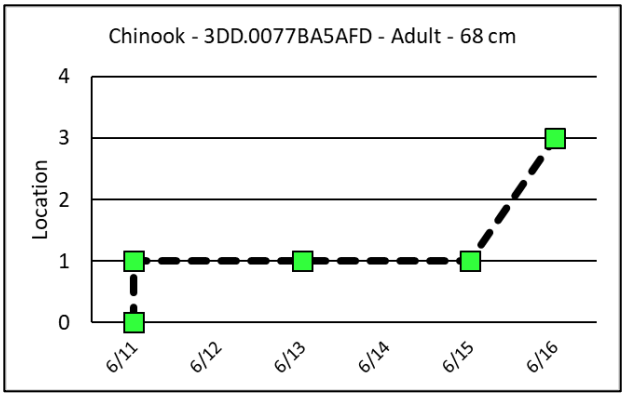
6/22
6/23


Chinook - 3DD.0077BA5AFD - Adult - 68 cm
Location
4
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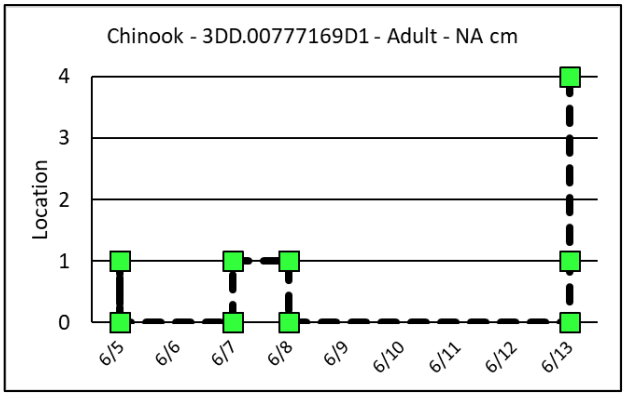
6/16


Chinook - 3DD.00777169D1 - Adult - NA cm
Location
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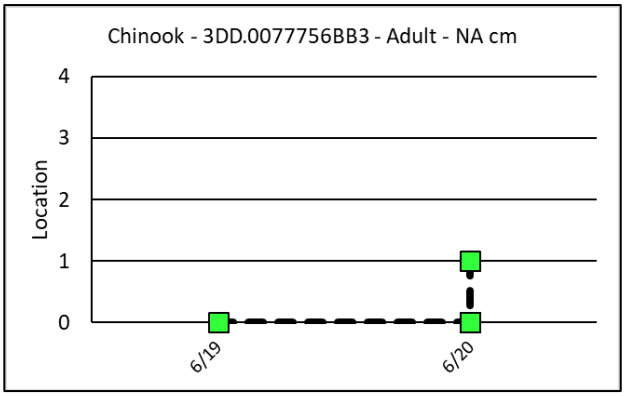
6/13


Chinook - 3DD.0077756BB3 - Adult - NA cm
Location
4
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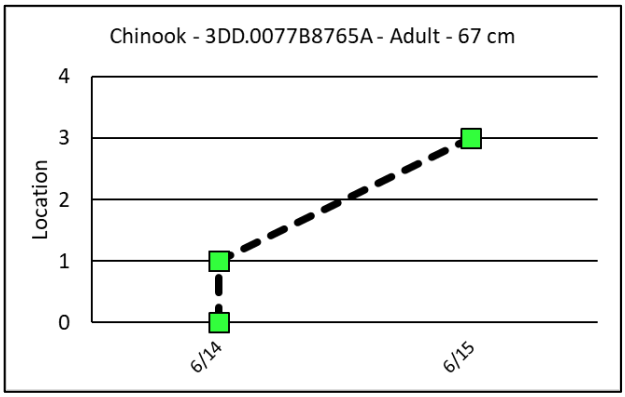
6/19
6/20


Chinook - 3DD.0077B8765A - Adult - 67 cm
Location
4
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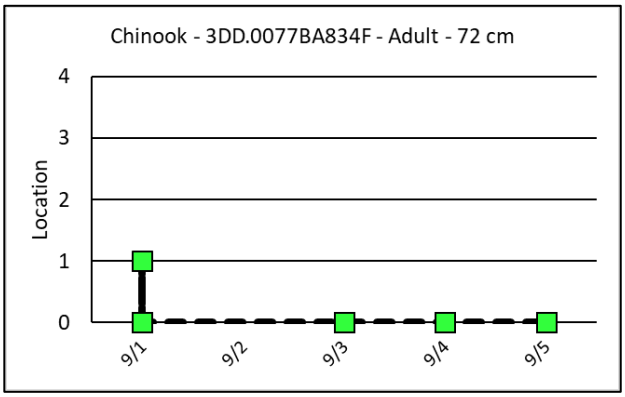
6/14
6/15


Chinook - 3DD.0077BA834F - Adult - 72 cm
Location
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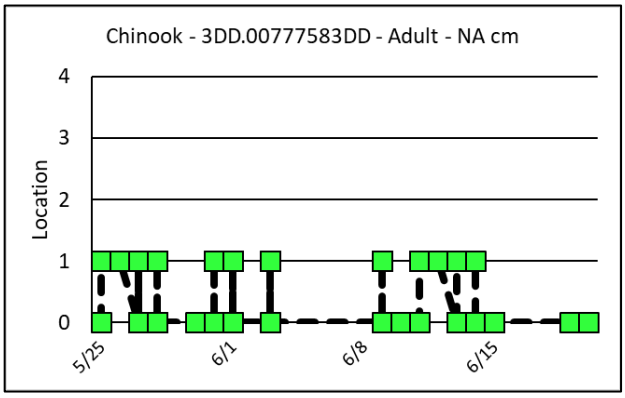
9/5


Chinook - 3DD.00777583DD - Adult - NA cm
Location
4
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6/1
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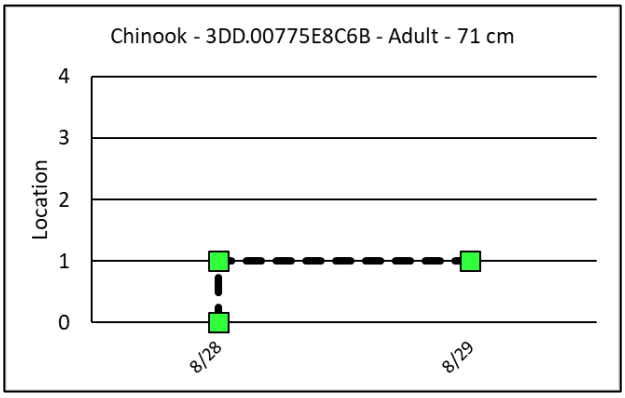
6/15


Chinook - 3DD.00775E8C6B - Adult - 71 cm
Location
4
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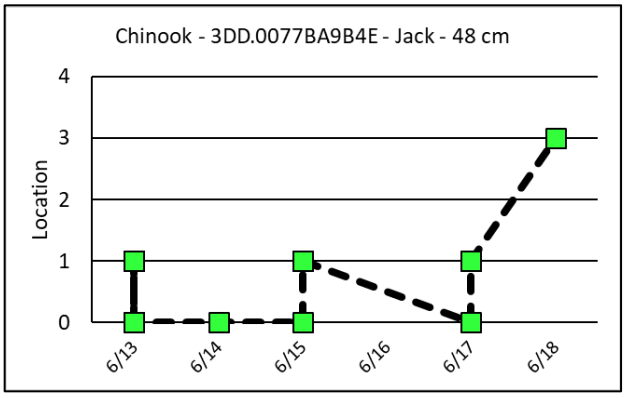
8/28
8/29


Chinook - 3DD.0077BA9B4E - Jack - 48 cm
Location
0
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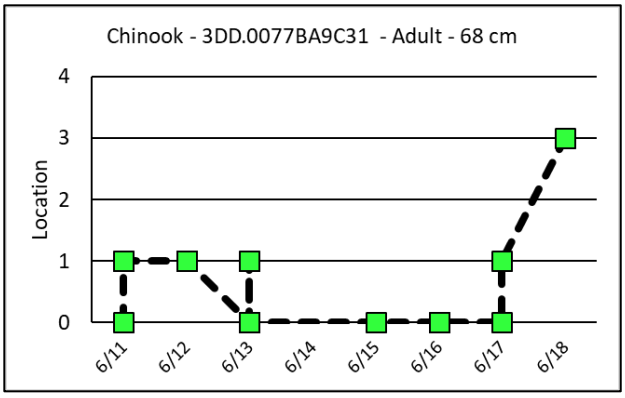
6/18


Chinook - 3DD.0077BA9C31 - Adult - 68 cm
Location
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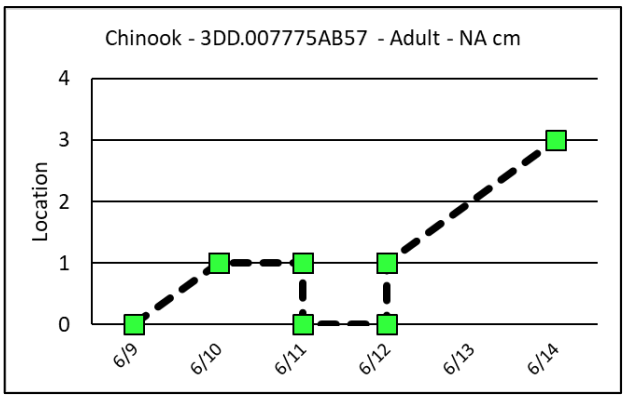
6/18


Chinook - 3DD.007775AB57 - Adult - NA cm
Location
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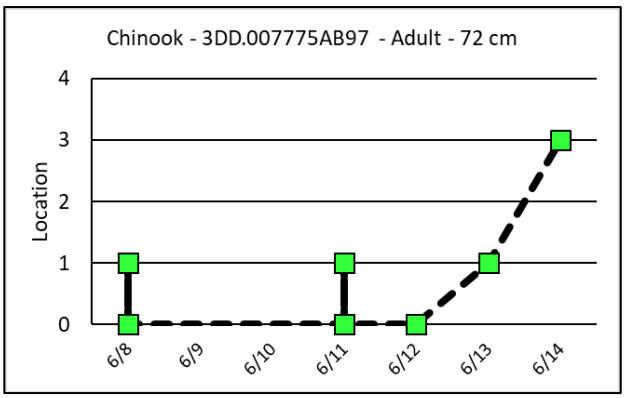
6/14


Chinook - 3DD.007775AB97 - Adult - 72 cm
Location
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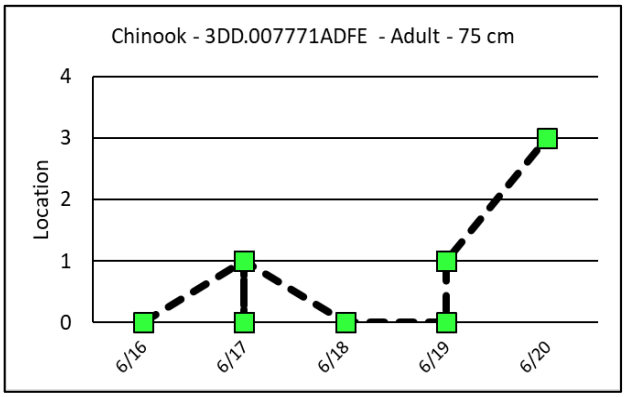
6/14


Chinook - 3DD.007771ADFE - Adult - 75 cm
Location
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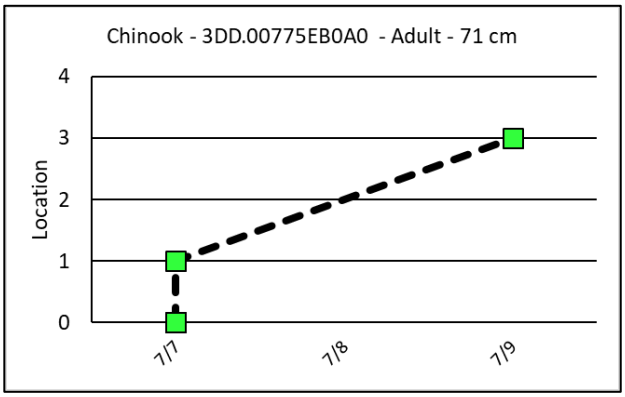
6/20


Chinook - 3DD.00775EB0A0 - Adult - 71 cm
Location
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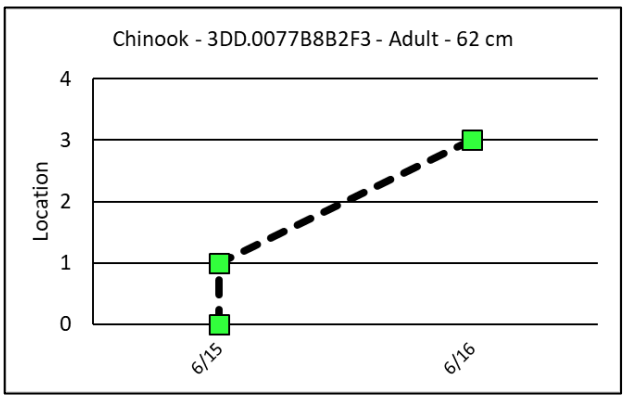
Chinook - 3DD.0077B8B2F3 - Adult - 62 cm
Location
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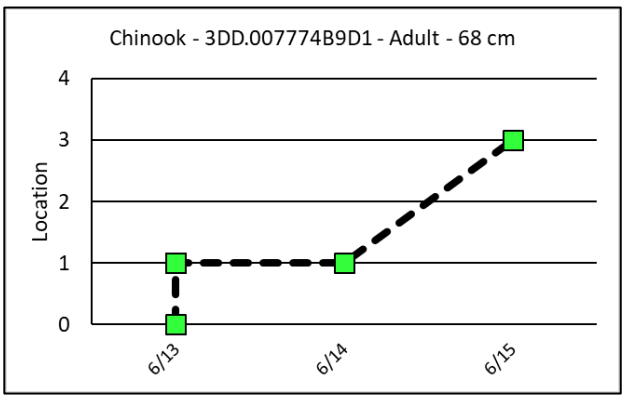
6/16


Chinook - 3DD.007774B9D1 - Adult - 68 cm
Location
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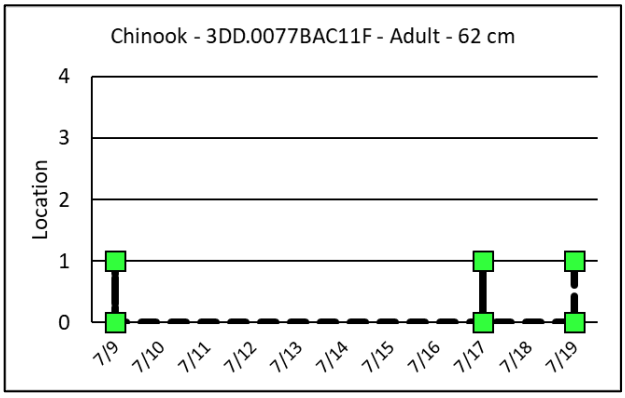
Chinook - 3DD.0077BAC11F - Adult - 62 cm
Location
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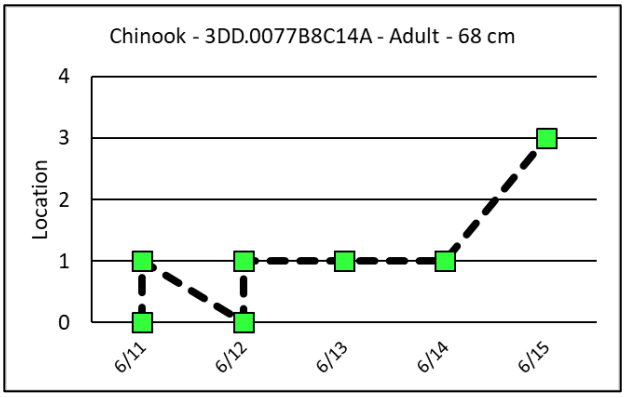
Chinook - 3DD.0077B8C14A - Adult - 68 cm
Location
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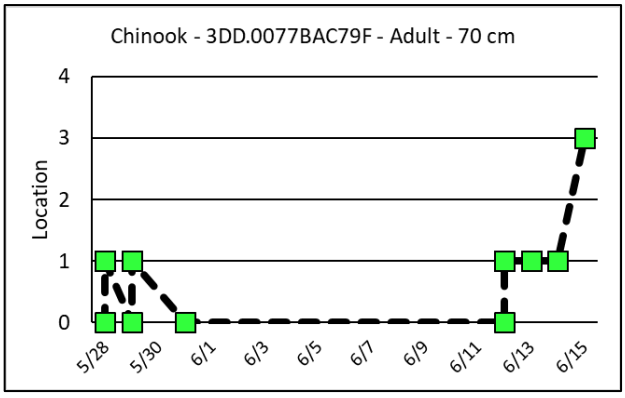
Chinook - 3DD.0077BAC79F - Adult - 70 cm
Location
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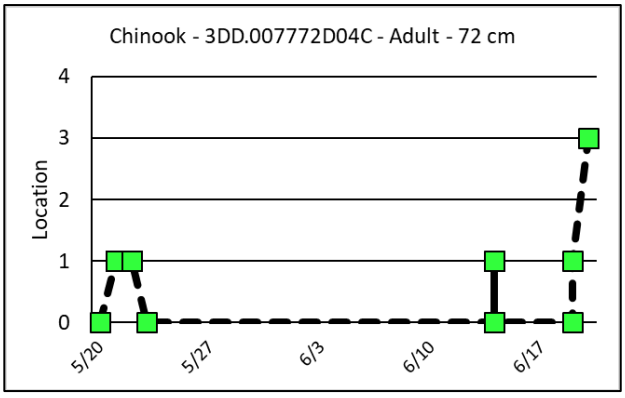
6/15


Chinook - 3DD.007772D04C - Adult - 72 cm
Location
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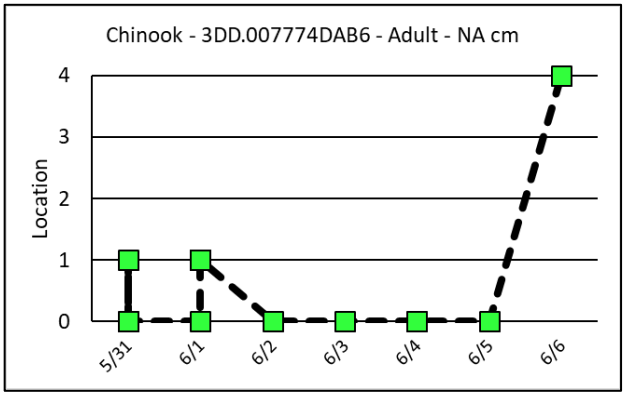
Chinook - 3DD.007774DAB6 - Adult - NA cm
Location
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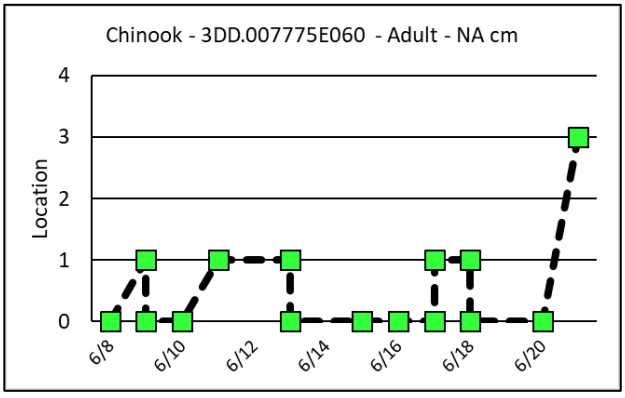
6/5
6/6


Chinook - 3DD.007775E060 - Adult - NA cm
Location
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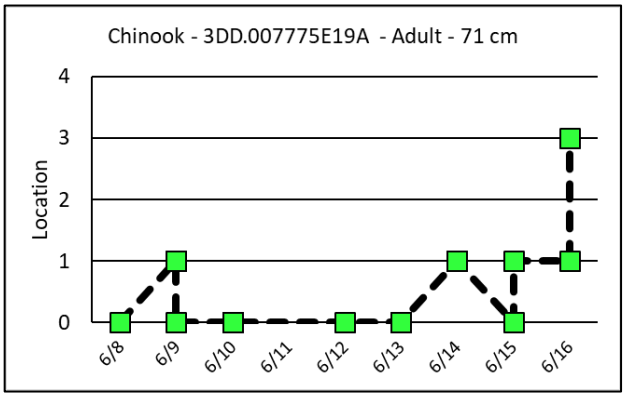
Chinook - 3DD.007775E19A - Adult - 71 cm
Location
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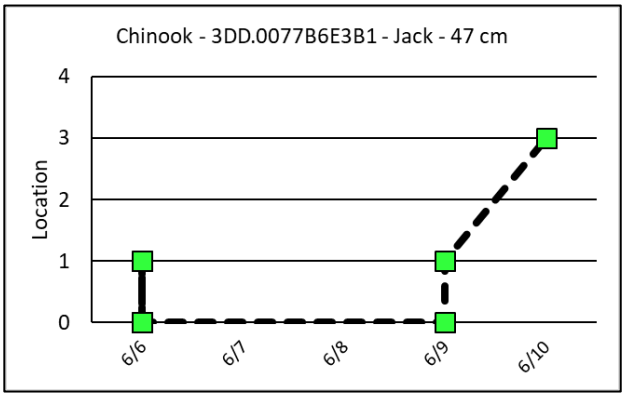
Chinook - 3DD.0077B6E3B1 - Jack - 47 cm
Location
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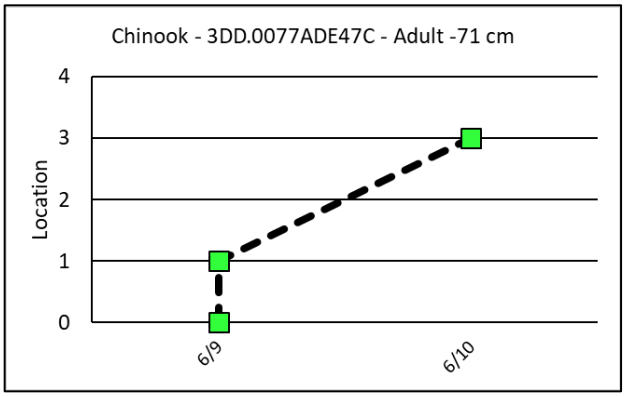
Chinook - 3DD.0077ADE47C - Adult -71 cm
Location
4
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6/9
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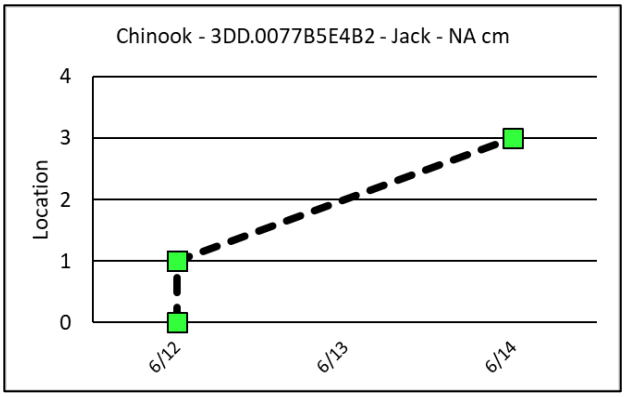
Chinook - 3DD.0077B5E4B2 - Jack - NA cm
Location
4
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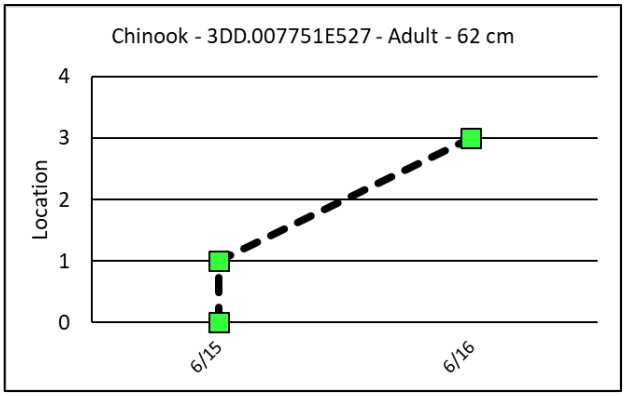
6/13
6/14


Chinook - 3DD.007751E527 - Adult - 62 cm
Location
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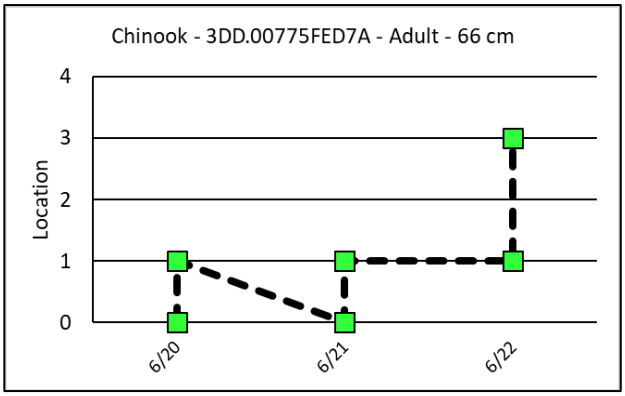
6/15
6/16


Chinook - 3DD.00775FED7A - Adult - 66 cm
Location
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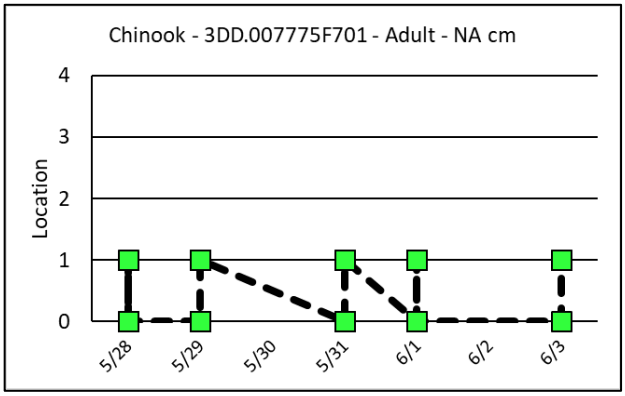
6/21
6/22


Chinook - 3DD.007775F701 - Adult - NA cm
Location
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5/29
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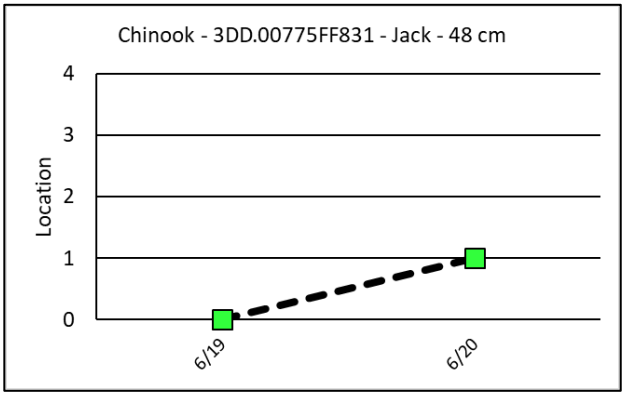
6/2
6/3


Chinook - 3DD.00775FF831 - Jack - 48 cm
Location
4
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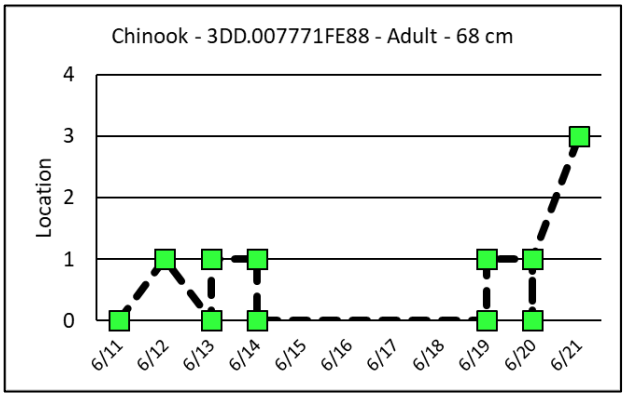
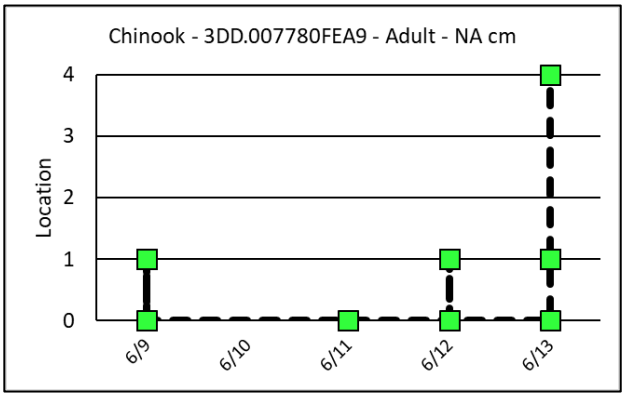
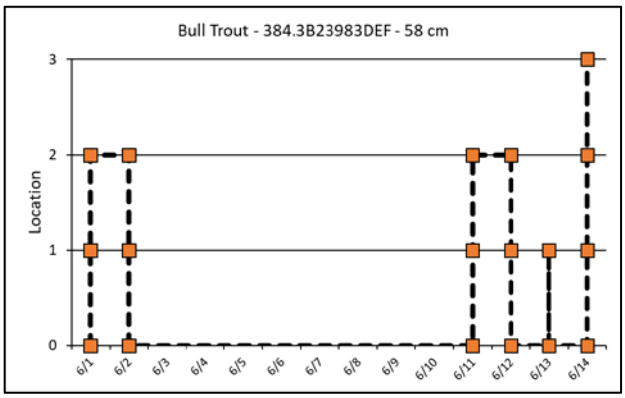
6/19
6/20

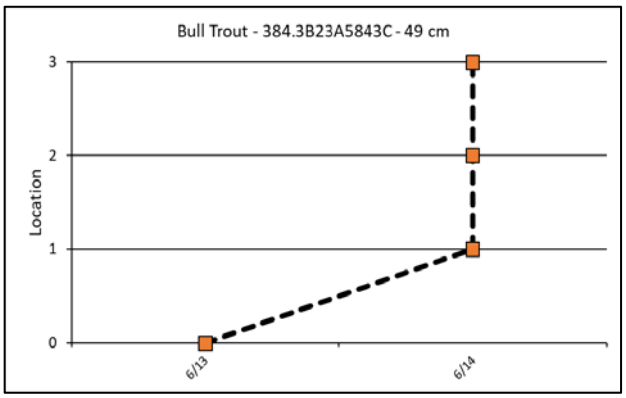

Chinook - 3DD.007771FE88 - Adult - 68 cm
Location
4
3
2
1
0
6/11
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20
6/21

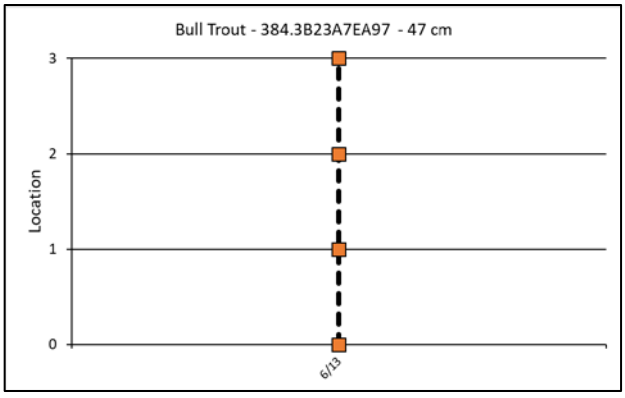

Chinook - 3DD.007780FEA9 - Adult - NA cm
Location
4
3
2
1
0
6/9
6/10
6/11
6/12
6/13

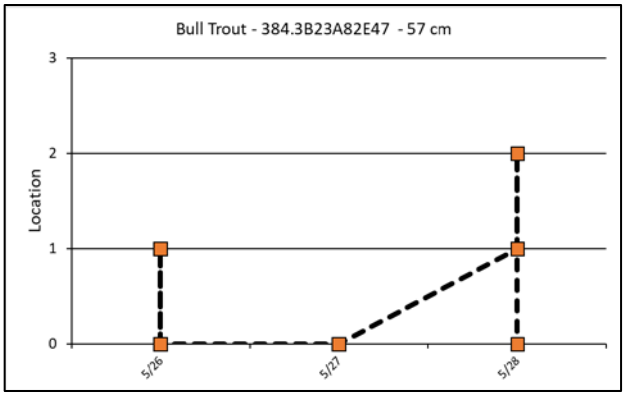
Appendix D

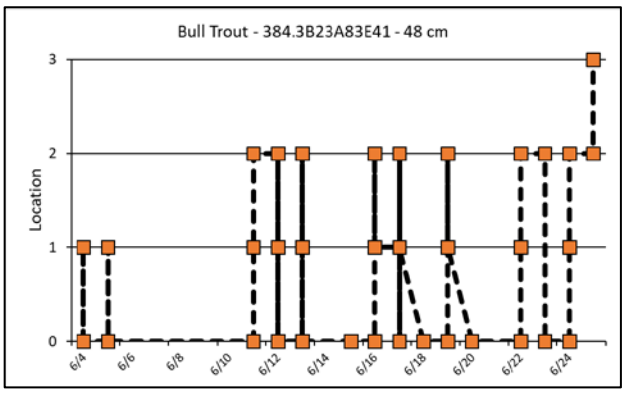
Movement histories of previously PIT tagged Bull Trout at the Tucannon River adult weir/trap, ***2019***. Location Key: 0 – Antennas below adult weir/trap; 1 – Antennas in the fish ladder; 2 – Antenna in the adult trap box; 3 – Adult trap capture. Movement of fish between location 1 and 2 indicate fish moving into and escaping the trapping area.

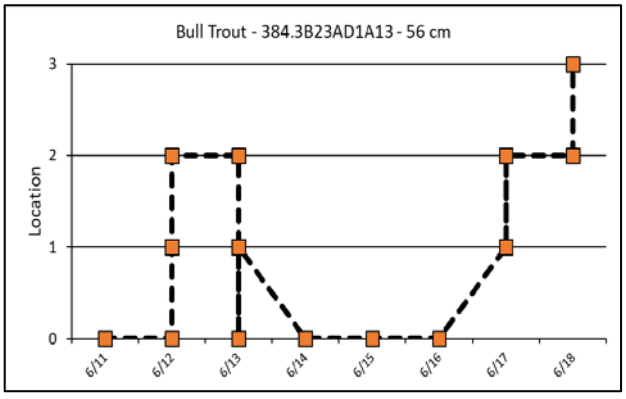


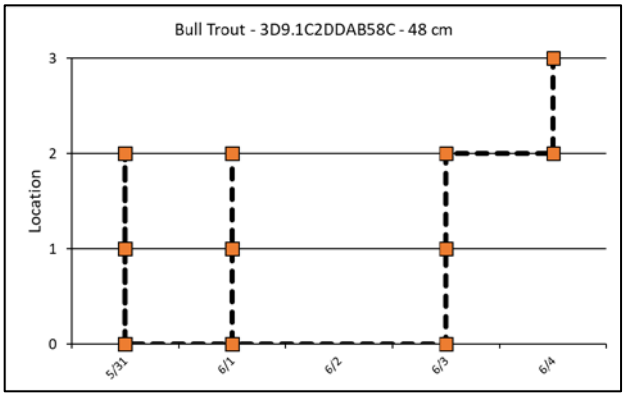


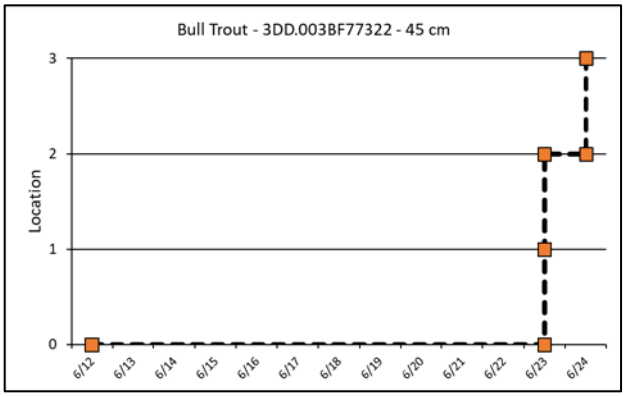


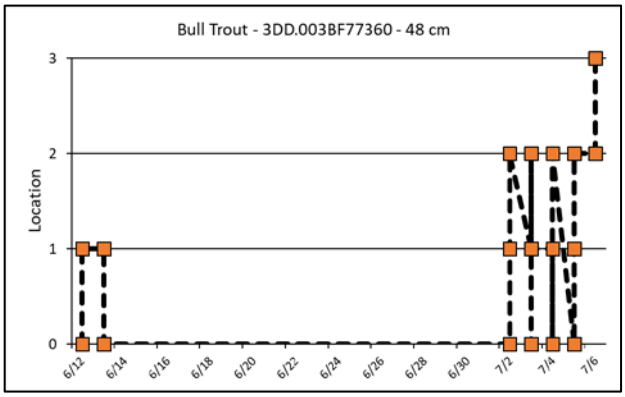


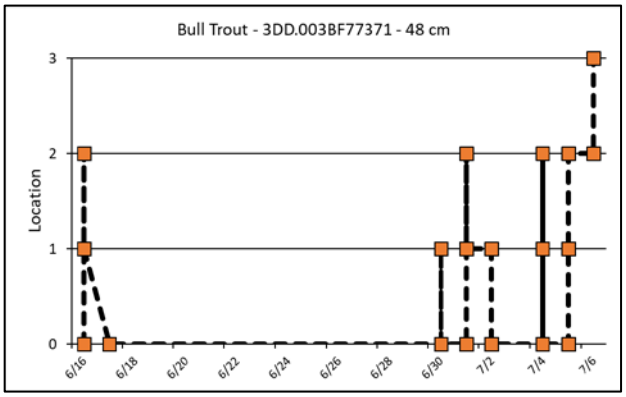


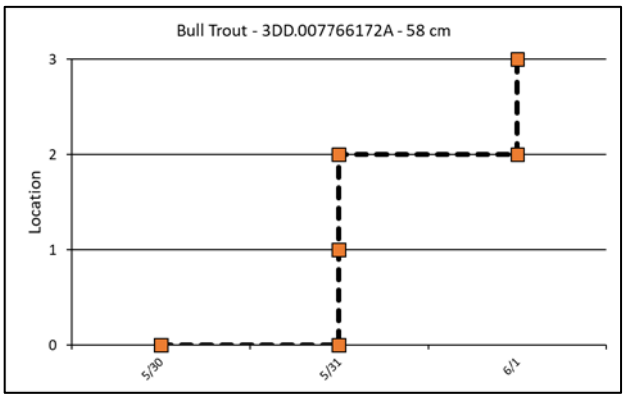


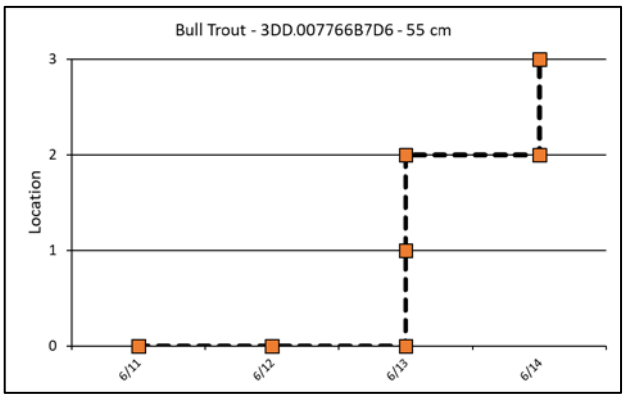

Bull Trout - 3D9.1C2DDAB58C - 48 cm
Location
0
1
2
3
5/31
6/1
6/2
6/3
6/4

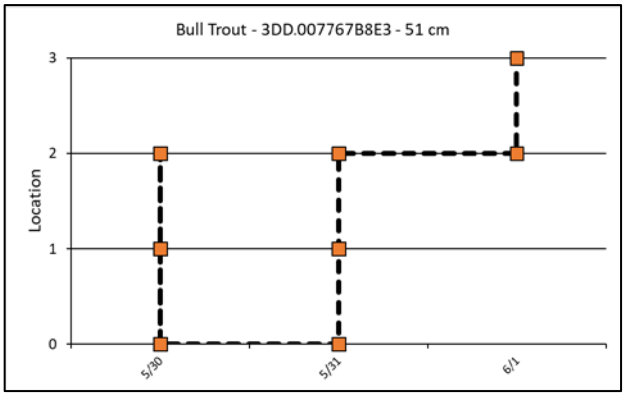

Bull Trout - 3DD.003BF77322 - 45 cm
Location
0
1
2
3
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20
6/21
6/22
6/23
6/24

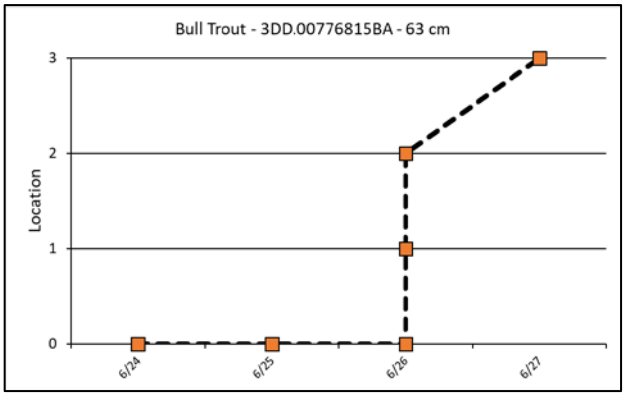

Bull Trout - 3DD.003BF77360 - 48 cm
Location
0
1
2
3
6/12
6/14
6/16
6/18
6/20
6/22
6/24
6/26
6/28
6/30
7/2
7/4
7/6


Bull Trout - 3DD.003BF77371 - 48 cm
Location
0
1
2
3
6/16
6/18
6/20
6/22
6/24
6/26
6/28
6/30
7/2
7/4
7/6


Bull Trout - 3DD.007766172A - 58 cm
Location
0
1
2
3
5/30
5/31
6/1

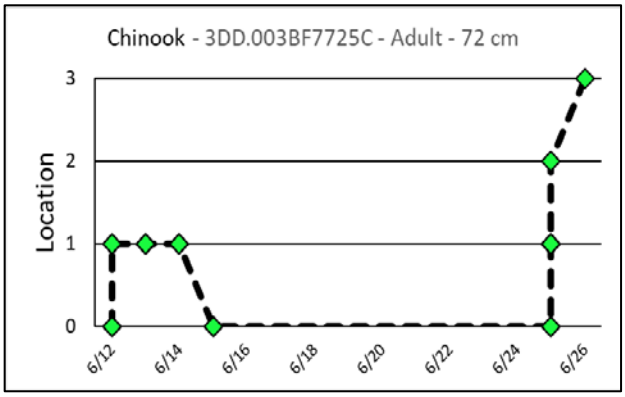

Bull Trout - 3DD.007766B7D6 - 55 cm
Location
0
1
2
3
6/11
6/12
6/13
6/14

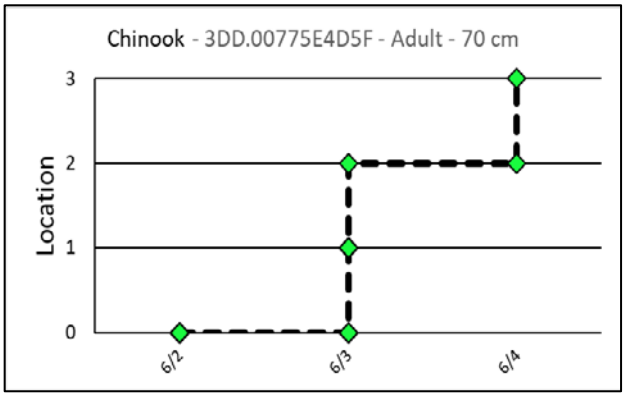

Bull Trout - 3DD.007767B8E3 - 51 cm
Location
0
1
2
3
5/30
5/31
6/1

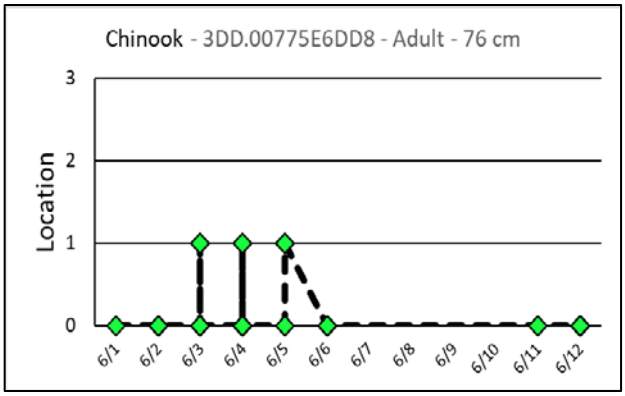

Bull Trout - 3DD.00776815BA - 63 cm
Location
0
1
2
3
6/24
6/25
6/26
6/27

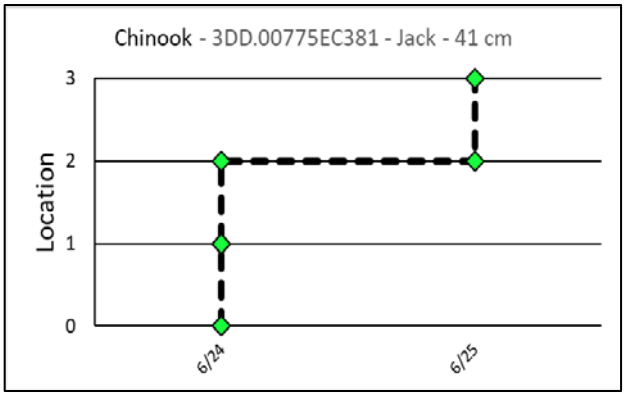
Appendix E

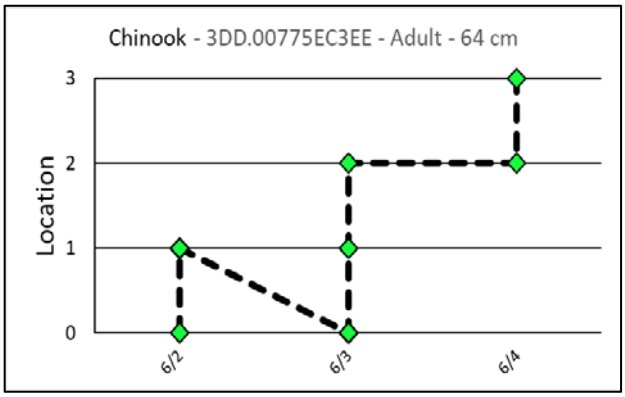
Movement histories of previously PIT tagged spring Chinook salmon at the Tucannon River adult weir/trap, ***2019***. Location Key: 0 – Antennas below adult weir/trap; 1 – Antennas in the fish ladder; 2 – Antenna in the adult trap box; 3 – Adult trap capture. Movement of fish between location 1 and 2 indicate fish moving into and escaping the trapping area.

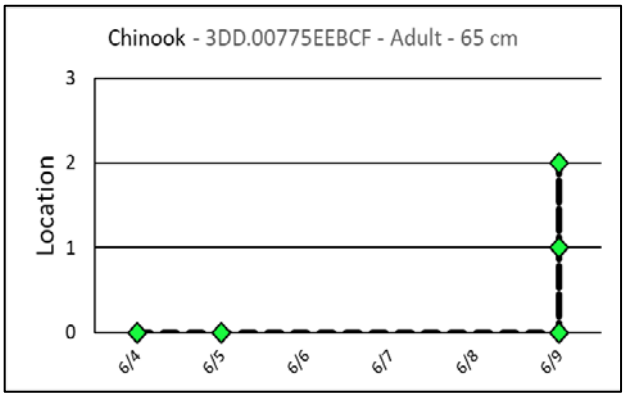


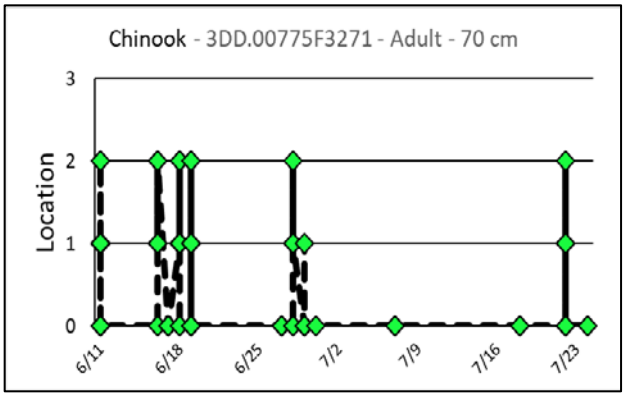


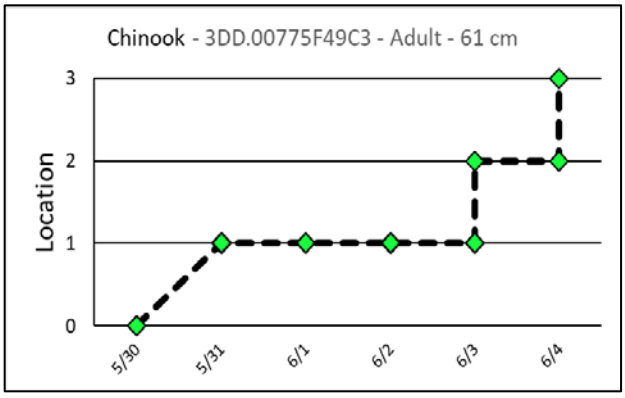


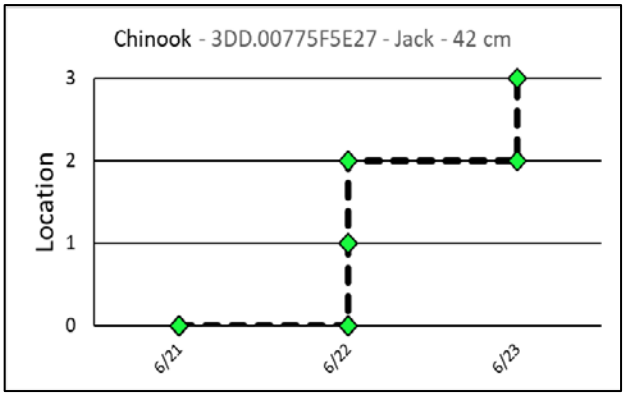


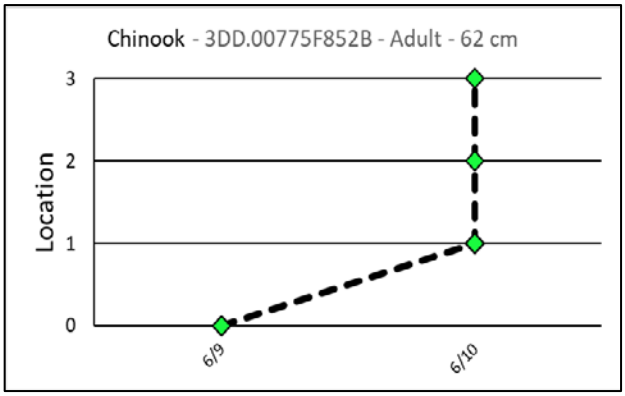


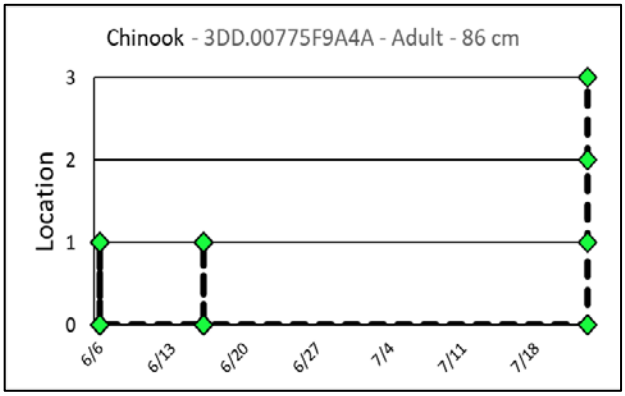


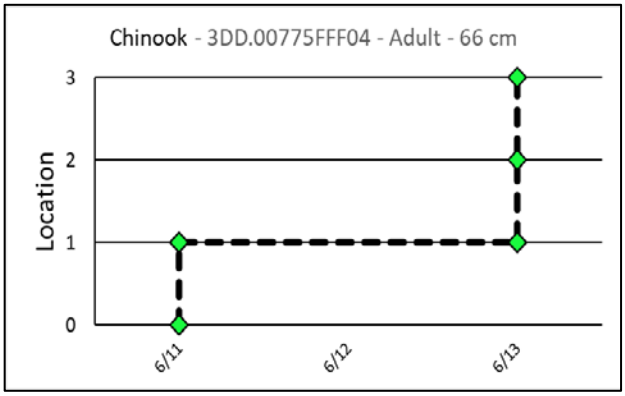

Chinook - 3DD.00775F3271 - Adult - 70 cm
Location
0
1
2
3
6/11
6/18
6/25
7/2
7/9
7/16
7/23

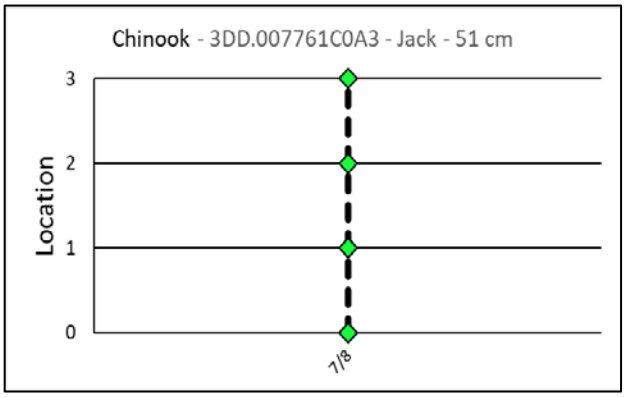

Chinook - 3DD.00775F49C3 - Adult - 61 cm
Location
0
1
2
3
5/30
5/31
6/1
6/2
6/3
6/4

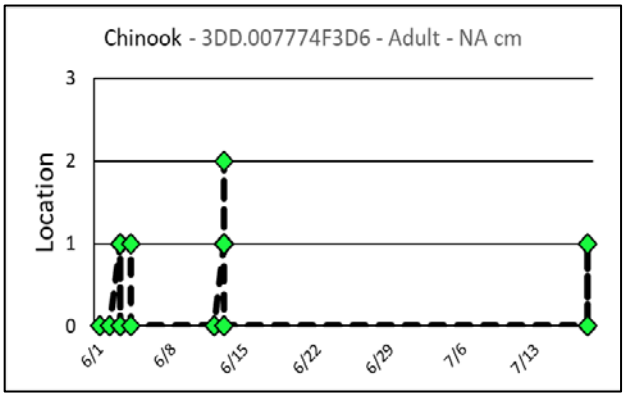

Chinook - 3DD.00775F5E27 - Jack - 42 cm
Location
0
1
2
3
6/21
6/22
6/23

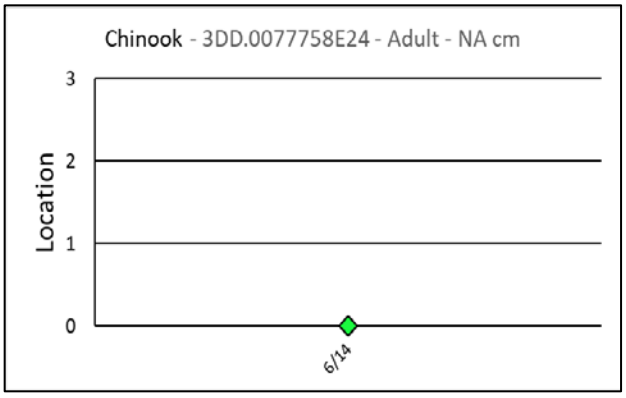

Chinook - 3DD.00775F852B - Adult - 62 cm
Location
0
1
2
3
6/9
6/10

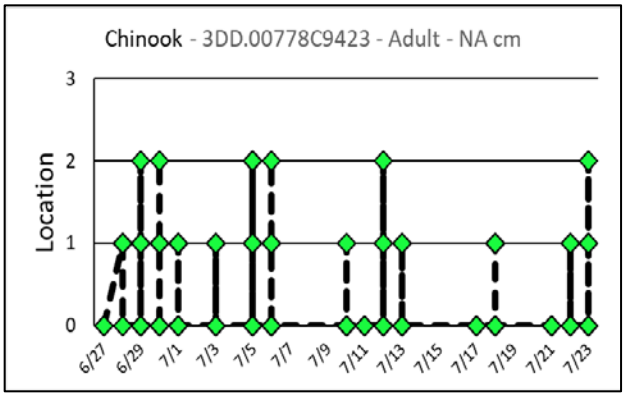

Chinook - 3DD.00775F9A4A - Adult - 86 cm
Location
0
1
2
3
6/6
6/13
6/20
6/27
7/4
7/11
7/18

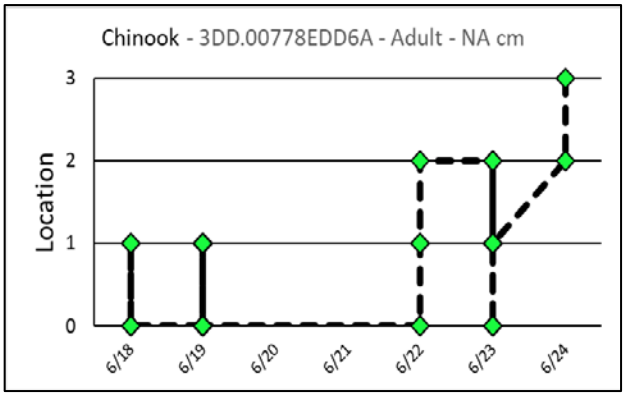

Chinook - 3DD.00775FFF04 - Adult - 66 cm
Location
0
1
2
3
6/11
6/12
6/13

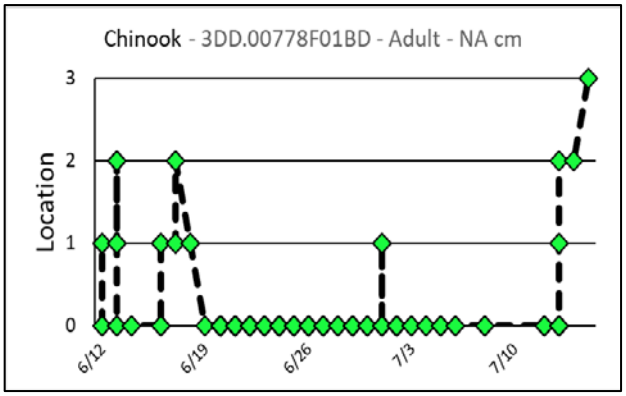

Chinook - 3DD.007761C0A3 - Jack - 51 cm
Location
0
1
2
3
7/8

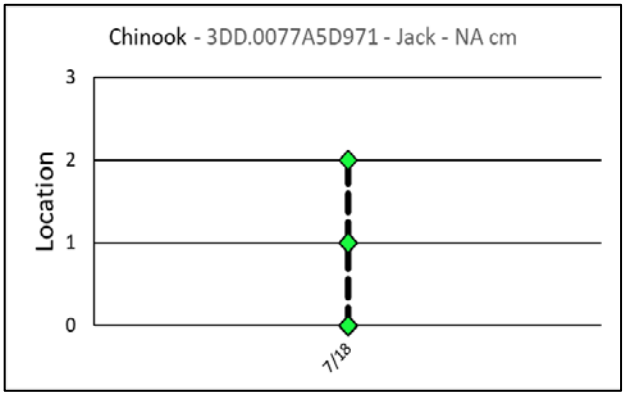

Chinook - 3DD.007774F3D6 - Adult - NA cm
Location
0
1
2
3
6/1
6/8
6/15
6/22
6/29
7/6
7/13

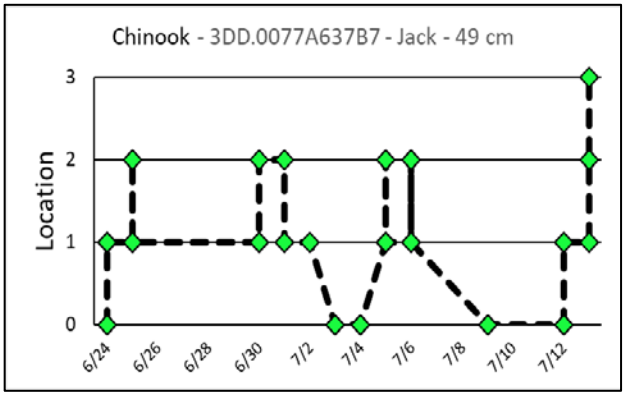

Chinook - 3DD.0077758E24 - Adult - NA cm
Location
3
2
1
0
6/14

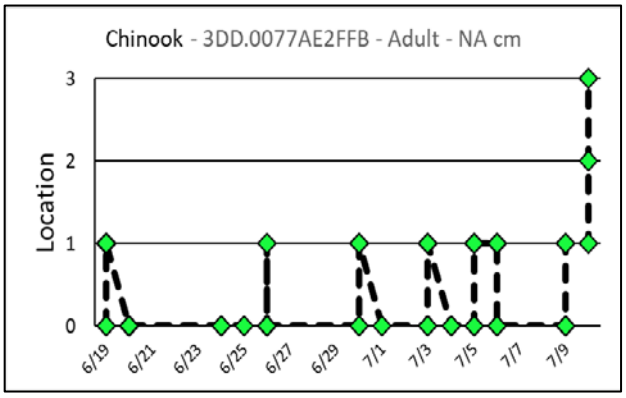

Chinook - 3DD.00778C9423 - Adult - NA cm
Location
3
2
1
0
6/27
6/29
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23

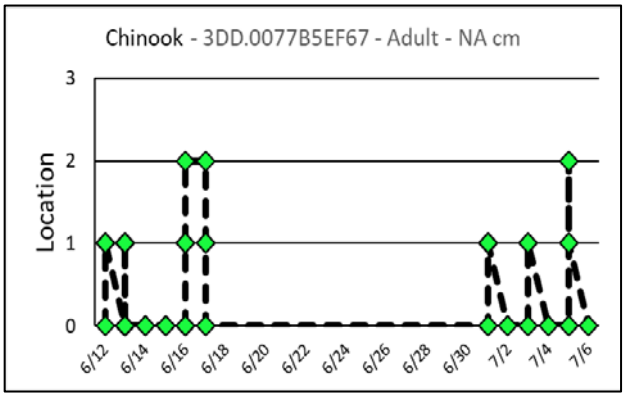

Chinook - 3DD.00778EDD6A - Adult - NA cm
Location
3
2
1
0
6/18
6/19
6/20
6/21
6/22
6/23
6/24

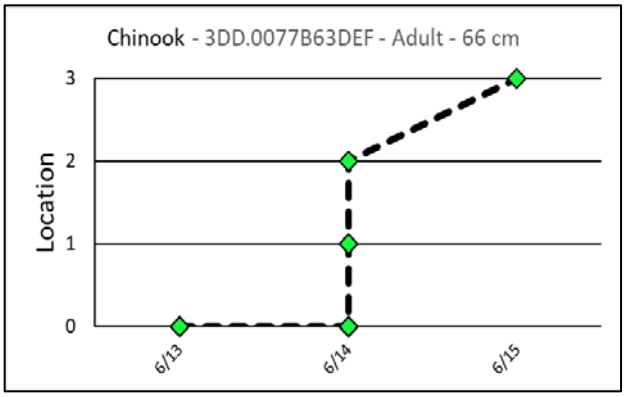

Chinook - 3DD.00778F01BD - Adult - NA cm
Location
3
2
1
0
6/12
6/19
6/26
7/3
7/10

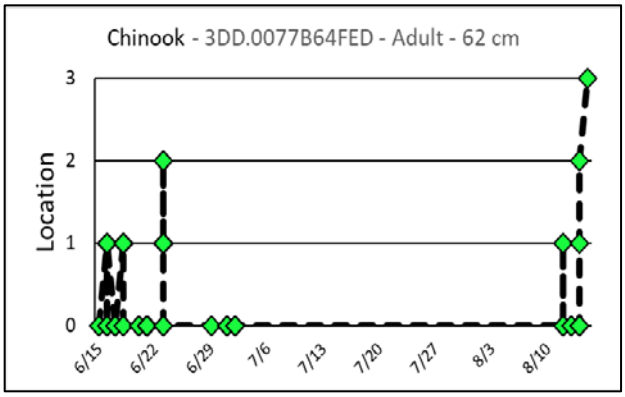

Chinook - 3DD.0077A5D971 - Jack - NA cm
Location
3
2
1
0
7/18

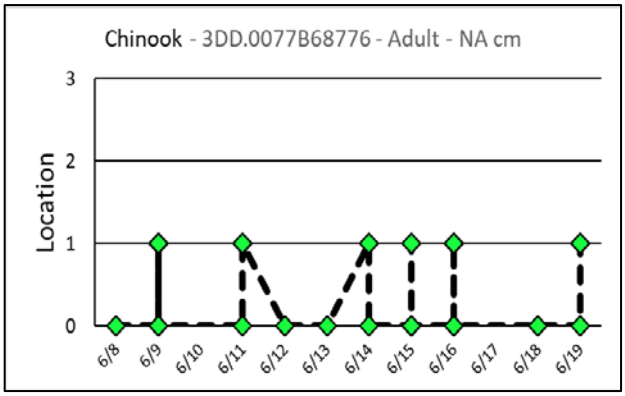

Chinook - 3DD.0077A637B7 - Jack - 49 cm
Location
3
2
1
0
6/24
6/26
6/28
6/30
7/2
7/4
7/6
7/8
7/10
7/12

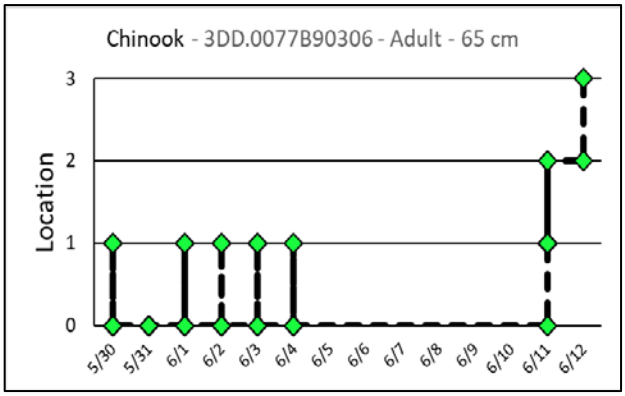

Chinook - 3DD.0077AE2FFB - Adult - NA cm
Location
3
2
1
0
6/19
6/21
6/23
6/25
6/27
6/29
7/1
7/3
7/5
7/7
7/9

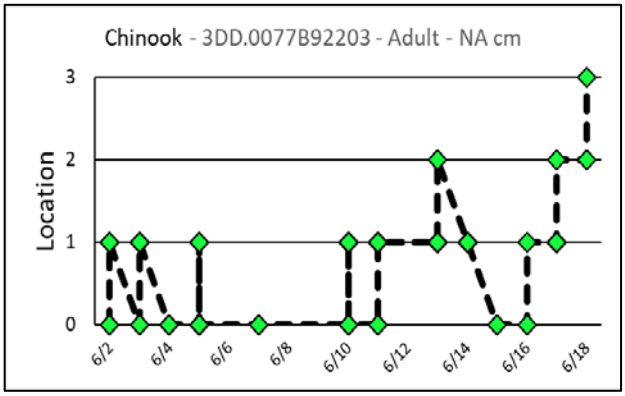

Chinook - 3DD.0077B5EF67 - Adult - NA cm
Location
3
2
1
0
6/12
6/14
6/16
6/18
6/20
6/22
6/24
6/26
6/28
6/30
7/2
7/4
7/6

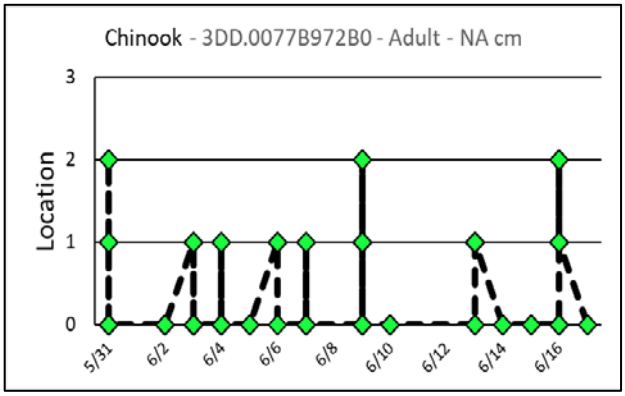

Chinook - 3DD.0077B63DEF - Adult - 66 cm
Location
0
1
2
3
6/13
6/14
6/15

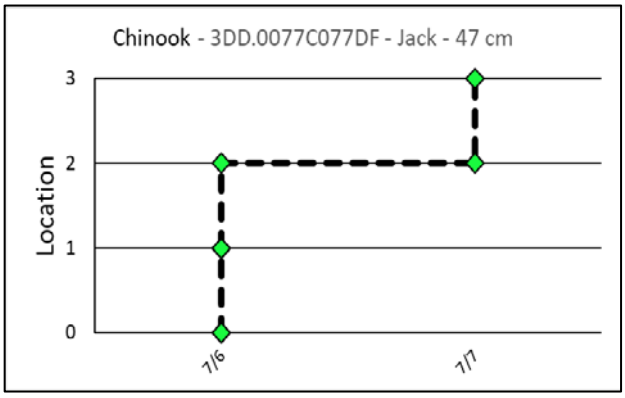

Chinook - 3DD.0077B64FED - Adult - 62 cm
Location
0
1
2
3
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10

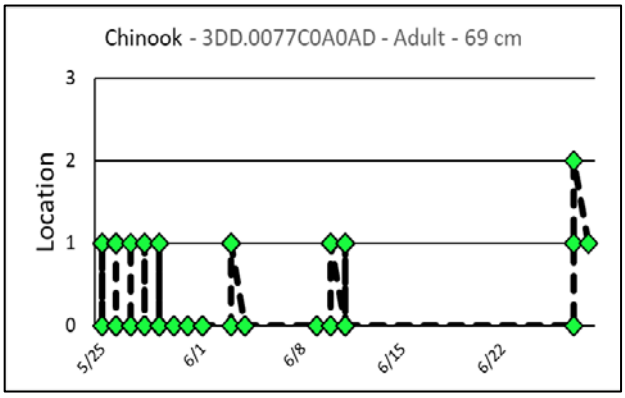

Chinook - 3DD.0077B68776 - Adult - NA cm
Location
0
1
2
3
6/8
6/9
6/10
6/11
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19

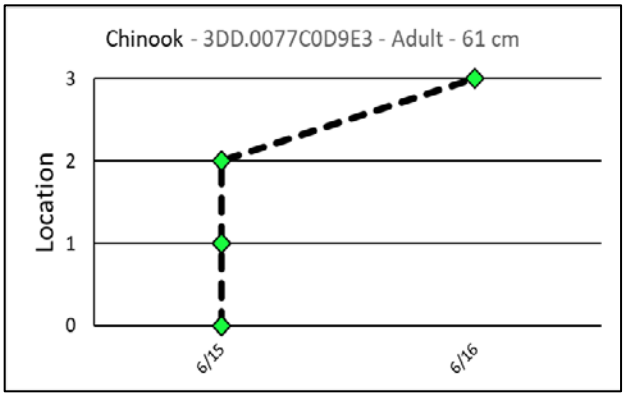

Chinook - 3DD.0077B90306 - Adult - 65 cm
Location
0
1
2
3
5/30
5/31
6/1
6/2
6/3
6/4
6/5
6/6
6/7
6/8
6/9
6/10
6/11
6/12

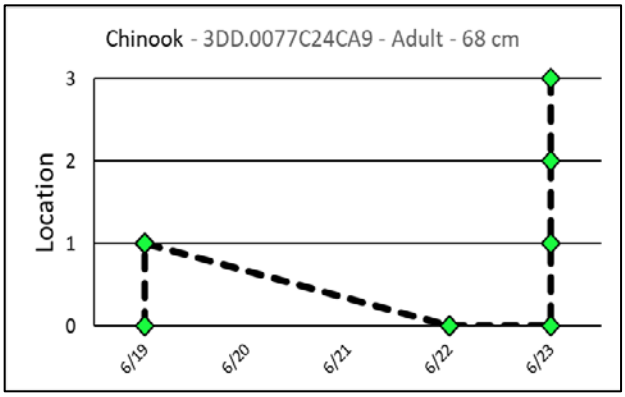

Chinook - 3DD.0077B92203 - Adult - NA cm
Location
0
1
2
3
6/2
6/4
6/6
6/8
6/10
6/12
6/14
6/16
6/18


Chinook - 3DD.0077B972B0 - Adult - NA cm
Location
0
1
2
3
5/31
6/2
6/4
6/6
6/8
6/10
6/12
6/14
6/16


Chinook - 3DD.0077C077DF - Jack - 47 cm
Location
0
1
2
3
7/6
7/7


Chinook - 3DD.0077C0A0AD - Adult - 69 cm
Location
0
1
2
3
5/25
6/1
6/8
6/15
6/22


Chinook - 3DD.0077C0D9E3 - Adult - 61 cm
Location
3
2
1
0
6/15
6/16


Chinook - 3DD.0077C24CA9 - Adult - 68 cm
Location
3
2
1
0
6/19
6/20
6/21
6/22
6/23

Appendix F

Newly PIT-tagged Bull Trout tagged at the Tucannon adult weir/trap in 2019 used to summarize movements/conversions into the upper watershed at the TPJ array for the 2019 run year only.

Bull Trout		
3D9.1C2DD9ED6E	3D9.1C2DD9EE64	3D9.1C2DDA082A
3D9.1C2DDA1683	3D9.1C2DDA643C	3D9.1C2DDA6AE6
3D9.1C2DDA6CA2	3D9.1C2DDA70F3	3D9.1C2DDA87EE
3D9.1C2DDA9047	3D9.1C2DDA97AC	3D9.1C2DDAB4DB
3D9.1C2DDAB4F0	3D9.1C2DDAB8E4	3D9.1C2DDAB908
3D9.1C2DDABADF	3D9.1C2DDABEEE	3D9.1C2DDAC367
3D9.1C2DDAC638	3D9.1C2DDAC6BF	3D9.1C2DDACBB1
3D9.1C2DDAD811	3D9.1C2DDADF6D	3D9.1C2DDAE5BA
3D9.1C2DDAE9A9	3D9.1C2DDAEC42	3D9.1C2DDAEC67
3D9.1C2DDAEF51	3D9.1C2DDAEF5D	3D9.1C2DDB2AA3
3D9.1C2DDB5465		

Previously PIT-tagged Bull Trout passed upstream of the Tucannon adult weir/trap in 2019 used to summarize movements/conversions into the upper watershed at the TPJ array for the 2019 run year only.

Bull Trout		
384.3B23983DEF	384.3B23A83E41	384.3B23A7EA97
384.3B23A82E47	3DD.003BF77322	384.3B23AD1A13
3D9.1C2DDAB58C	3DD.007766172A	3DD.003BF77360
3DD.003BF77371	3DD.00776815BA	3DD.007766B7D6
3DD.007767B8E3		

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Lower Snake River Compensation Plan Office
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Boise, ID 83709-1657

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