Emigration of Chinook Salmon and Steelhead

Nez Perce Tribe
Department of Fisheries Resources Management
Research Division

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Emigration of Natural and Hatchery Juvenile Chinook Salmon (Nacó'x in Nez Perce) and Steelhead (Héeyey in Nez Perce) During Migration Year 2019

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Acronyms

BPA: Bonneville Power Administration

cfs: cubic feet per second

CI: confidence interval

DFRM: Department of Fisheries Resources Management

g: grams

HUC: Hydrologic unit code

IRSMP: Imnaha River Smolt Monitoring Program

JCAPE: Johnson Creek Artificial Propagation and Enhancement

K: Fulton's condition factor

LGR: Lower Granite Dam

LSRCP: Lower Snake River Compensation Plan

mm: millimeter

MY2019: migration year 2019

M&E: Monitoring and Evaluation

NPT: Nez Perce Tribe

NPTH: Nez Perce Tribal Hatchery

ODFW: Oregon Department of Fish and Wildlife

PIT tag: passive integrated transponder tag

PTAGIS: PIT Tag Information System Database

rkm: river kilometer

SBSA: Snake Basin Steelhead Assessments

SD: Standard Deviation

SURPH: Survival Under Proportional Hazards

Introduction

The Nez Perce people historically fished throughout the Snake River basin and the main stem Columbia River. Native fishes have long-standing cultural significance to the Nez Perce Tribe (hereafter referred to as the Tribe) including subsistence, ceremonial, spiritual, medicinal, economic, commercial, and intrinsic value. Sharp declines in the once robust runs of salmon and steelhead can largely be attributed to hydroelectric power developments, habitat degradation, poor water quality and quantity, and over-harvesting. The Nez Perce Tribe strives to recover all species and populations of anadromous and resident fish to healthy and harvestable levels within usual and accustomed areas in manners consistent with treaty-reserved rights (Department of Fisheries Resources Management [DFRM] Strategic Plan Ad Hoc Team 2013).

The Research Division of the DFRM is tasked with monitoring anadromous fish runs held sacred by the Tribe, which include Snake River basin spring/summer Chinook Salmon *Oncorhynchus tshawytscha*, fall Chinook Salmon *O. tshawytscha*, and summer steelhead *O. mykiss*. The juvenile life-history stage of these anadromous species provides researchers important information regarding the status of the population and is thus closely monitored by the Tribes' various programs. Juvenile Chinook Salmon (spring/summer and fall life-history strategies) and summer steelhead are monitored in the Clearwater River subbasin in Idaho by the Nez Perce Tribal Hatchery Monitoring and Evaluation (NPTH M&E) Project and the Snake Basin Steelhead Assessments (SBSA) Project. Juvenile spring/summer Chinook Salmon and summer steelhead are monitored by the Imnaha River Smolt Monitoring Project (IRSMP) and the Lower Snake River Compensation Plan (LSRCP) Hatchery Evaluation Project in the Imnaha River subbasin located in northeast Oregon, and by the Johnson Creek Artificial Propagation and Enhancement Monitoring and Evaluation (JCAPE M&E) Project in the South Fork Salmon River subbasin located in west-central Idaho.

The following report was prepared by the Research Division Juvenile Technical Team (JTT). The JTT is tasked with analyzing and reporting standardized juvenile metrics for monitored species. Standardized metrics are consistent across division projects and geographic location, and follow regional definition outlined by the Ad-Hoc Supplementation Workgroup (Beasley et al. 2008). This report details the juvenile life stage of natural- and hatchery-origin Chinook Salmon and steelhead during migration year 2019 (MY2019) from all the projects charged with monitoring juvenile life stages. Past project reports were written and submitted individually to funding agencies, sometimes in concert with adult metrics. The data presented here were collected by the Tribe's fisheries offices located in Joseph, Oregon, and McCall and Orofino, Idaho. This report satisfies contract obligations for Bonneville Power Administration project and contract numbers: 1983-350-003, contract: 75398 (NPTH M&E); 2010-057-00, contract: 00074017 REL 34 (SBSA); 1997-015-01, contract: 74666 (IRSMP); 1996-043-00, contract 74017 REL 53 (JCAPE); and, Lower Snake River Compensation Plan contract: F16AC00029 (LSRCP).

Project areas

The Clearwater River subbasin (Hydrologic Unit Code [HUC] 17060306) is located in north-central Idaho and encompasses about 25,000 km^2. The basin extends from its headwaters in the Bitterroot Mountains along the Idaho-Montana border to its mouth on the Idaho-Washington border. The Clearwater River subbasin ranges in elevation from nearly 2,750 m at its headwaters to 225 m at its confluence with the Snake River. Lolo Creek drains into the Clearwater River about 13.5 km upstream from Orofino, Idaho after passing through a steep canyon with limited access. The South Fork (SF) Clearwater River starts at the confluence of the American River and Red River and flows 100 km to join the Clearwater River at Kooskia, Idaho. The Lolo Creek and SF Clearwater rotary screw traps are located at river kilometer (rkm) 21.0 and 9.0, respectively (Figure 1).

The Imnaha River subbasin (HUC 17060102) is located in northeast Oregon and encompasses an area of about 2,538 km^2. The main stem Imnaha River flows north for 103 km from its headwaters in the Eagle Cap Wilderness Area to its confluence with the Snake River at rkm 309.0. Elevations in the watershed vary from 3,048 m at the headwaters to about 290 m at its confluence with the Snake River. The Imnaha River rotary screw trap is located at rkm 7.0 (Figure 1).

The South Fork Salmon River (SFSR) subbasin (HUC 17060208) is located in the Boise and Payette National Forests in central Idaho and encompasses an area of about 3,400 km^2. Johnson Creek flows north for 62 km until it joins the East Fork South Fork Salmon River (EFSFSR) near the town of Yellow Pine, located 23 km above its mouth. The Secesh River flows 43 km to join with the SFSR less than two kilometers downstream of where the EFSFSR empties into the SFSR. Elevations in the subbasin vary from 2,841 m at the headwaters of the Secesh River to 609 m at the confluence with the Salmon River. The Johnson Creek and Secesh River rotary screw traps are located at rkm 6.0 and 7.0, respectively (Figure 1).

Emigrating smolts travel about 700 kilometers from the headwaters of the Snake River basin through eight reservoirs and hydropower facilities before reaching the Pacific Ocean. Moving downstream in the Snake River, smolts from the project areas first arrive at Lower Granite Dam (LGR; Figure 1) before reaching Little Goose Dam, Lower Monumental Dam, and Ice Harbor Dam. The Snake River then enters the Columbia River where the smolts encounter McNary Dam, John Day Dam, The Dalles Dam, and Bonneville Dam.

Methods

The Tribe monitored anadromous juveniles migrating from the Snake River basin using rotary screw traps and beach seining methods during MY2019. The two methods are commonly used in the Pacific Northwest to safely capture emigrating juvenile salmonids (Johnson et al. 2007). Data collected during the Tribe's juvenile sampling, in conjunction with other environmental data, are used to estimate salmon and steelhead abundance, survival, emigration timing, and condition, which in turn, informs the management of these important tribal resources.

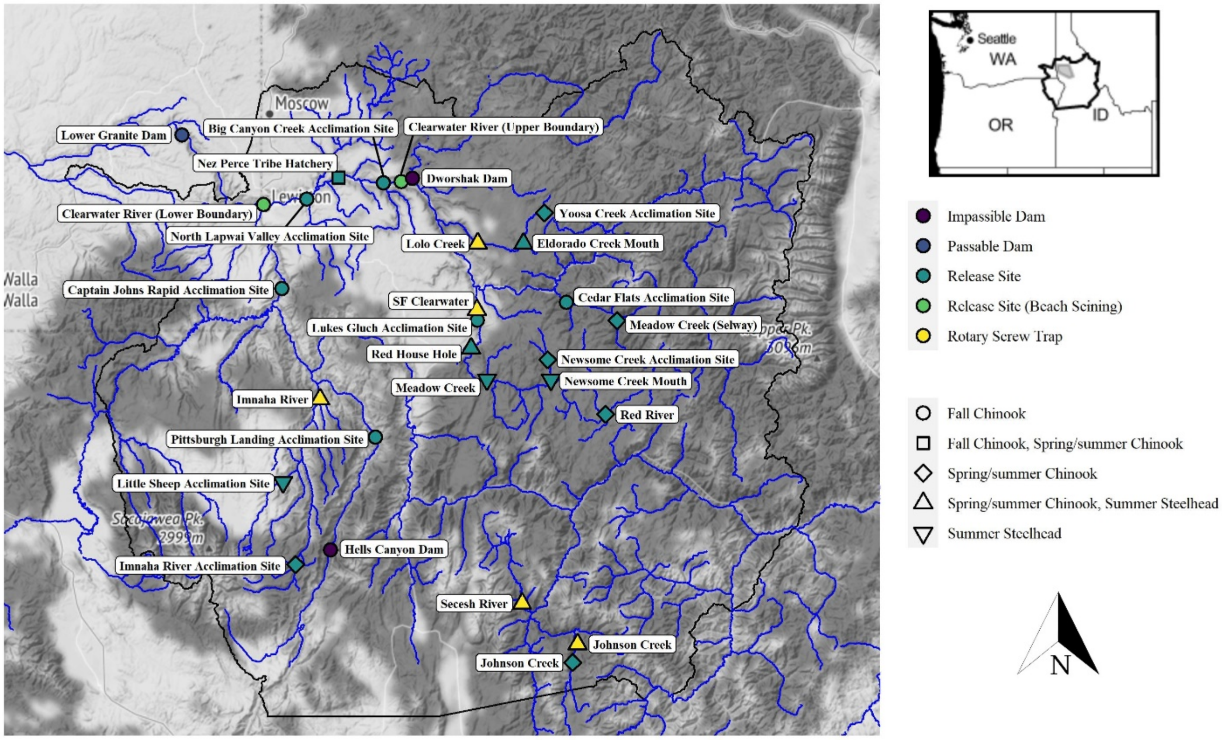

Figure 1. Map of rotary screw traps, hatchery release locations, and major dams. The black line is the perimeter of the original 1855 Treaty area.

Field sampling

Rotary screw trapping

We deployed a rotary screw trap (hereafter referred to as the trap or traps) to capture juvenile spring/summer Chinook Salmon and summer steelhead emigrants at each of the five trapping locations in the Snake River basin (Table 1). Natural-origin and hatchery-origin (hereafter referred to as natural or hatchery, respectively) emigrants were distinguished by the presence (natural) or absence (hatchery) of an adipose fin. We enumerated all captured fish, sampled a portion of the daily catch for biotic characteristics (i.e., length, weight), and marked them with PIT tags to conduct trap efficiency trials and survival studies. The proportion of catch sampled differed by trap and season, and depended on the number of fish crews could safely handle during the day. We attempted to operate traps seven days per week and processed catch daily throughout the sampling season. Trapping operations were occasionally suspended due to high water events, excessive water temperatures, icing, equipment malfunction, times of hatchery releases, and/or when staff were unavailable. For details regarding the basic operation and maintenance of the Tribe's rotary screw traps, the equipment needed to process and record the catch, sub-sampling proportions, and the safe capture, handling, tagging, and release of fish see: https://www.monitoringresources.org/Document/Protocol/Details/2242.

Table 1. Rotary screw trap cone size (m) and location in decimal degrees (DD).

Trap site	Cone size (m)	Latitude (DD)	Longitude (DD)
Imnaha River[1]	1.5	45.76381	-116.74802
Imnaha River[2]	2.1	45.76381	-116.74802
Johnson Creek	1.5	44.91764	-115.48336
Lolo Creek	1.5	46.29386	-115.97494
Secesh River	1.5	45.05952	-115.75691
SF Clearwater River	1.5	46.06790	-115.97792

[1] operated from early fall to early spring
[2] operated from early spring to early summer

During spring hatchery smolt releases at the Imnaha River trap, capture rates exceeded the number of fish that could be safely held in the trap box and processed by field staff. When this occurred, subsampling procedures were implemented to ensure the safety of field staff and catch. Subsampling allowed for estimating the number of fish that passed the trap by species and life stage (i.e., by emigrant group). For details regarding subsampling protocols see: https://www.monitoringresources.org/Document/Method/Details/6635.

Trapping operations were summarized by the number of days operated and not operated for each trap site and trapping period. We summarized target catch (i.e., spring/summer Chinook Salmon and summer steelhead juveniles) by trap site and emigrant group. Natural spring/summer Chinook Salmon emigrants were partitioned into parr (<60 mm in fork length and captured from July – August), presmolts (>60 mm fork length and captured from September – December), and smolts (>60 mm fork length and captured from January – June). Natural summer steelhead emigrants were partitioned by trapping season: summer/fall (July – December) and winter/spring (January – June). We summarized incidental catch (i.e., non-target catch), including Pacific lamprey *Entosphenus tridentatus*, by trap site, species, and life stage (if known).

Beach seining

Beach seining occurred on the lower Clearwater River to capture and PIT tag natural subyearling fall Chinook Salmon. We initiated beach seining activities when the Clearwater River discharge fell below 30,000 cubic feet per second (cfs) and continued to decline (U.S. Geological Survey [USGS] gauging station at Spalding, ID; Appendix A). We enumerated and measured biotic characteristics from all captured natural subyearling fall Chinook Salmon. We PIT-tagged all subyearlings with a fork length $\geq$ 50 mm that were not identified as hatchery-origin for survival and migration timing studies. Hatchery juveniles were identified by the presence of an adipose fin clip and/or a coded wire tag. For additional details regarding the Tribe's beach seining protocols see: https://www.monitoringresources.org/Document/Protocol/Details/2243.

Hatchery releases

Data on hatchery released Chinook Salmon and steelhead were provided by the hatcheries that released juveniles within the project areas or by the NPT projects associated with the project area. Release group information includes species and life stage (i.e., emigrant group), release site, release type, release date(s), number of fish released, and the number of PIT-tagged fish within the release group.

Hatchery spring/summer Chinook Salmon were released at three locations in the Snake River basin (Figure 1). Direct and acclimated releases of smolts reared at Lookingglass Fish Hatchery occurred at the Imnaha River Acclimation Facility upstream of the Imnaha River trap. Direct releases of Johnson Creek smolts reared at McCall Fish Hatchery occurred upstream of the trap. Acclimated release of presmolts reared at the Nez Perce Tribal Hatchery occurred at the Yoosa Creek Acclimation Facility upstream of the Lolo Creek trap.

Hatchery summer steelhead were released at several locations in the Snake River basin within the Imnaha River and SF Clearwater River subbasins (Figure 1). Acclimated release of smolts reared at Irrigon Fish Hatchery occurred at the Little Sheep Acclimation Facility upstream of the Imnaha River trap. The SF Clearwater River received direct releases at three different locations: smolts reared at Dworshak National Fish Hatchery (Lolo Creek and SF Clearwater broodstock) were released at Red House Hole along the lower SF Clearwater River; and, smolts reared at Clearwater Fish Hatchery (SF Clearwater broodstock) were released at Meadow and Newsome creeks, tributaries to the SF Clearwater River.

Snake River fall Chinook Salmon hatchery releases occurred throughout the Snake River basin (Figure 1). Acclimated releases of subyearlings and yearlings reared at Lyons Ferry Hatchery occurred at Captain John Rapids and Pittsburg Landing on the Snake River, and Big Canyon on the Clearwater River. Acclimated releases of subyearlings reared at the Nez Perce Tribal Hatchery occurred at North Lapwai Valley on the lower Clearwater River, Luke's Gulch on the SF Clearwater River, and Cedar Flats on the Selway River. Additionally, fall Chinook Salmon subyearlings were directly released into the lower Clearwater River from the Nez Perce Tribal Hatchery.

Environmental data

Temperature (°C) data were collected using in-stream temperature loggers installed near traps, (Imnaha River, Johnson Creek), in-stream PIT tag arrays (Lolo Creek, Secesh River, SF Clearwater River), and USGS gauging stations (Clearwater River; Appendix A). Discharge data were obtained from Idaho Power (Imnaha River) and USGS gauging stations (Clearwater River, Johnson Creek, Lolo Creek, SF Clearwater River; Appendix A). Discharge data for the Secesh River were unavailable for MY2019. Mean daily temperature and discharge were calculated for the duration of fish collection operations. Daily means were calculated and plotted for winter months even when trapping ceased due to unfavorable conditions.

Performance measures

Emigrant abundance at the trap site

We estimated life stage emigrant abundance for natural spring/summer Chinook Salmon and steelhead emigrant groups at each trap site. Daily trap data, sharing similar trap efficiencies, were grouped into periods, each of which was defined by at least seven recaptured fish (Steinhorst et al. 2004). Abundance estimates were calculated using a Bailey adjusted Lincoln-Petersen population estimator. Confidence intervals were estimated using a 95% parametric bootstrap of 1,000 iterations (Steinhorst et al. 2004). Data analysis was performed using package cuyem (Version 0.1.0) in Program R (Version 3.5.1) or Gauss statistical software. A census count was made for each hatchery Chinook Salmon and steelhead release group. When a trap was not operating the number of emigrants passing that trap was not estimated; therefore, the estimates of natural emigrant abundance during MY2019 should be considered minimum estimates of abundance.

Emigration timing at the trap site and Lower Granite Dam

The cumulative proportion of emigrants arriving at a trap site was calculated for natural and hatchery spring/summer Chinook Salmon and summer steelhead emigrant groups. The cumulative proportion of emigrants arriving at LGR was calculated for PIT-tagged natural and hatchery emigrant groups using interrogated PIT tag data queried from PTAGIS (www.ptagis.org). The proportion of emigrants passing LGR before the initiation of collections for transportation (April 23, 2019) was calculated for each trap site and emigrant group.

Emigration timing and the age of captured fish (i.e., age-at-emigration) at a trap site is closely related to the understanding of steelhead life-histories, brood year survivals, and full life-cycle productivity. Although we do not formally discuss steelhead age-at-emigration in this report; data for Clearwater juvenile steelhead is presented in Appendix B. We will include a more complete and thorough evaluation of age-at-emigration data in the migration year 2020 report.

Travel time from the trap site to Lower Granite Dam

Travel time (days) was calculated for all PIT-tagged natural and hatchery emigrants interrogated at both the trap site and LGR. Travel time was summarized by detection week at LGR by trap site and emigrant group. Mean weekly travel time was calculated by trap site for each emigrant group.

Survival to Lower Granite Dam

Emigrant group survival estimates used detections of PIT-tagged natural and hatchery Chinook

Salmon and steelhead emigrants collected during trapping and beach seining and subsequent downstream juvenile interrogation antennas at the hydroelectric dams in the lower Snake and Columbia rivers. Survival and associated standard error was estimated with the Cormack-Jolly-Seber model (Cormack, 1964; Jolly, 1965; Seber, 1965) in program PITPRO (version 4.19.8; Westhagen and Skalski 2009). Program SURPH (version 3.5.2; Lady et al. 2013) was used to calculate 95% confidence intervals around the survival estimates. Interrogation data for PITPRO were obtained from PTAGIS (www.ptagis.org).

Smolt equivalents at Lower Granite Dam

Smolt equivalents at LGR were estimated for each natural and hatchery emigrant group by multiplying the abundance estimate at the trap site by the estimated survival from the trap site to LGR. The calculation of variance associated with the smolt equivalent estimate was slightly different for natural and hatchery emigrant groups. Variance was calculated using an abundance estimate and its associated standard error (natural emigrant groups) or a census count with no associated standard error (hatchery emigrant groups). The standard deviation was calculated the same for both natural and hatchery emigrant groups. The standard deviation was used to construct 95% confidence intervals around the smolt equivalent estimate.

Variance (Var) for natural smolt equivalents were calculated using the estimate (E) and standard error (SE) for abundance (X) and survival (Y):

$$Var(X * Y) = E(X)^2 * SE(Y)^2 + E(Y)^2 * SE(X)^2 + SE(X)^2 * SE(Y)^2$$

Variance for hatchery smolt equivalents were calculated using the count from the census (X) and the standard error for survival (Y):

$$\mathrm{Var}(X * Y) = X^2 * SE(Y)^2$$

Standard deviation (SD) for both natural and hatchery emigrant groups:

$$\mathrm{SD}(X * Y) = \sqrt{Var(X * Y)}$$

Size and condition

Captured Chinook Salmon and steelhead emigrants were measured for fork length (nearest mm) and weight (nearest 0.1 g). Condition factor (K) was calculated for each emigrant group using Fulton's condition factor: $K = (weight/fork\ length^3)*100{,}000$ (Anderson and Neumann 1996).

Results and Discussion

Field sampling

Rotary screw trapping

We operated traps continuously during MY2019 unless precluded by environmental conditions, equipment damage/malfunction, or staffing shortages (Table 2). The traps were operated during the migration year, which is loosely defined as July – June, with some traps commencing migration year operations in mid- to late June (Johnson Creek and Secesh River; Table 2). Four of the five traps were removed in mid to late November due to unsuitable winter conditions and were reinstalled in mid to late March, except the Imnaha River trap, which was fished through the winter months when conditions allowed (Table 2). Trapping periods can generally be partitioned into two trapping seasons: summer/fall (July – December) and winter/spring (January – June). Operational days outnumbered non-operational days at all trapping sites during all trapping periods and environmental conditions were often the reason for non-operational days (Table 2).

Table 2. Trapping period, the number of days operated, and the number of days not operated by trap site for migration year 2019.

			# days not operated	
Trap site	Trapping period	# days operated	Environment	Equipment/ Staffing
Imnaha River	10/04/18 – 06/18/19	208	34	14
Johnson Creek	06/18/18 – 11/20/18	147	8	0
Johnson Creek	03/07/19 – 06/24/19	84	26	0
Lolo Creek	09/28/18 – 11/19/18	50	1	0
Lolo Creek	03/28/19 – 06/24/19	76.5	7	0
Secesh River	06/19/18 – 11/11/18	141	3	0
Secesh River	03/25/19 – 06/23/19	54	36	0
SF Clearwater River	08/28/18 – 11/15/18	70	1	1
SF Clearwater River	03/14/19 – 06/19/19	58	40	0

Target catch at trapping sites included natural spring/summer Chinook Salmon and summer steelhead emigrants. Hatchery-reared smolts were not considered target catch but were included to allow for comparison with natural smolts in each system. Target catch was highly variable among trap sites (Table 3). The majority of the catch at the Johnson Creek and Secesh River traps was comprised of natural spring/summer Chinook Salmon captured as parr and presmolts emigrating during the summer/fall trapping season (Table 2 and 3).

Table 3. Target catch (i.e., non-expanded) by trap site and emigrant group for migration year 2019. Locations with no hatchery releases are indicated by N/A.

Trap site	Natural Chinook Salmon			Hatchery Chinook Salmon smolts	Natural steelhead emigrants	Hatchery steelhead smolts
	parr	presmolts	smolts			
Imnaha River	0	1,788	2,204*	21,341*	4,299*	11,802*
Johnson Creek	2,538	4,222	768	86	671	N/A
Lolo Creek	0	1,187	487	174	689	N/A
Secesh River	5,110	15,528	185	N/A	845	N/A
SF Clearwater River	0	98	119	58	227	4,682

*Target catch includes estimates from subsampling: 62 natural Chinook Salmon smolts, 5,911 hatchery Chinook Salmon smolts, 45 natural steelhead smolts, 78 hatchery steelhead smolts

Mortalities for target species were summarized by trap site, emigrant group, and source of mortality, including: handling; tagging; predation; or, dead on arrival (Appendix C). Trapping and tagging mortality was low across trap sites (≤ 1.70%), with several trap sites reporting 0.00% mortality for many emigrant groups (Appendix C).

Incidental (non-target) catch during MY2019 included six families of freshwater fish: Catostomidae, Centrarchidae, Cottidae, Cyprinidae, Ictaluridae, and Salmonidae (Table 4). Incidental catch varied widely among trap sites (Table 4). Non-native species comprised some of the incidental catch including Smallmouth Bass *Micropterus dolomieu*, Bullhead Catfish *Ameiurus sp.*, and Channel Catfish *Ictalurus punctatus* (Table 4). Pacific Lamprey ammocoetes and macropthalmia were captured at all trap sites except the Secesh River (Table 5).

Table 4. Incidental catch by family, common name, scientific name, and trap site for migration year 2019.

Family	Common name *Scientific name*	Imnaha River	Johnson Creek	Lolo Creek	Secesh River	SF Clearwater River
Catostomidae	sucker *Catostomus sp.*	510	0	51	0	178
Centrarchidae	Smallmouth Bass *Micropterus dolomieu*	95	0	0	0	12
Cottidae	sculpin *Cottus sp.*	34	5	12	12	21
Cyprinidae	Chiselmouth *Acrocheilus alutaceus*	21	0	1	0	11
	dace *Rhinichthys sp.*	0	0	201	0	0
	Longnose Dace *R. cataractae*	71	14	0	142	0
	Northern Pikeminnow *Ptychocheilus oregonensis*	8	0	13	0	41
	Peamouth *Mylocheilus caurinus*	11	0	0	0	0
	Redside Shiner *Richardsonius balteatus*	29	0	48	0	106
Ictaluridae	Bullhead *Ameiurus sp.*	0	0	2	0	0
	Channel Catfish *Ictalurus punctatus*	0	0	2	0	0
Salmonidae	Brook Trout *Salvelinus fontinalis*	0	0	4	0	0
	Bull Trout *S. confluentus*	9	8	0	8	0
	Chinook Salmon – fall *Oncorhynchus tshawytscha*	0	0	0	0	369
	Coho Salmon *O. kisutch*	0	0	997	0	0
	Mountain Whitefish *Prosopium williamsoni*	42	123	7	122	6
	Rainbow Trout *O. mykiss*	0	0	0	0	2
	steelhead - adult *O. mykiss*	20	0	0	0	0
	Westslope Cutthroat Trout *O. clarkii lewisi*	0	17	1	15	1
Unknown	fry – unknown species	0	0	68	0	644
Total Catch		162	167	1,407	299	1,495

Table 5. Pacific Lamprey *Entosphenus tridentatus* catch by trap site and life stage for migration year 2019.

	Life stage		
Trap site	Ammocoete	Macropthalmia	Adult
Imnaha River	61	6	0
Johnson Creek	8	0	0
Lolo Creek	392	360	0
Secesh River	0	0	0
SF Clearwater River	16	1	0

Beach seining

In 2019, we conducted beach seining for fall Chinook Salmon on the Clearwater River for nine weeks. The first week of operation was June 9th and continued until August 11th (Table 6). During the seining season, Clearwater River flows and temperatures remained within safe operational levels for staff to safely handle fish. We captured a total of 2,837 fall Chinook Salmon subyearlings, of which we PIT-tagged 1,709 for survival and migration studies. Weekly catch varied from a high of 1,370 during the second week of operation to a low of 65 fish caught during the fifth week (Table 6).

Table 6. Week of sampling, average (avg) temp and average flow (Spalding, ID), total number captured, number PIT (passive integrated transponder) tagged, average FL (fork length), average K (condition factor), and CPUE (catch per unit effort; fish per seine haul) during natural subyearling fall Chinook Salmon beach seining on the lower Clearwater River. H/L = hook and line sampling

Week of sampling	Avg temp (ºC)	Avg flow (cfs)	Total # captured	# PIT tagged	Avg FL (mm)	Avg K	CPUE
9-Jun	13.8	23,150	545	140	72.3	1.08	54.5
16-Jun	13.5	18,800	1,370	696	59.3	1.16	342.5
23-Jun	13.2	14,000	265*	203*	56.0	1.11	58.8
30-Jun	16.8	9,020	174	162	65.7	1.12	19.3
7-Jul	12.3	15,267	65	64	66.0	1.14	3.3
14-Jul	12.4	13,750	140	128	113.9	1.20	H/L
21-Jul	11.4	13,433	228	216	100.8	1.17	H/L
28-Jul	11.9	11,600	138	131	101.9	1.16	H/L
11-Aug	12.7	11,225	177	172	105.3	1.16	H/L
Totals			2,837	1,709			

* Included in total are 30 fall Chinook Salmon seined and PIT-tagged on the lower SF Clearwater River.

Hatchery releases

Hatchery releases occurred within each project area, except for the Secesh River (Table 7), in collaboration with project partners including the Idaho Department of Fish and Game (SF Clearwater steelhead and Johnson Creek spring/summer Chinook Salmon), the Oregon Department of Fish and Wildlife (Imnaha River spring/summer Chinook Salmon), the Washington Department of Fish and Wildlife (Clearwater River fall Chinook Salmon) and the U.S. Fish and Wildlife Service (Imnaha River and SF Clearwater River steelhead). A portion of each hatchery release group were PIT-tagged to allow comparisons between natural and hatchery emigrant group performance metrics. Lolo Creek was the only trap site that had a presmolt spring/summer Chinook Salmon hatchery release in the fall, all other hatchery smolt releases occurred in the spring (Table 7). Brood year 2017 yearling and brood year 2018 subyearling fall Chinook Salmon releases occurred in the spring of 2019 (Table 8). The earliest release was March 12th from Pittsburg Landing and the latest release was June 11th from NPTH (Table 8).

Table 7. Hatchery spring/summer Chinook Salmon and steelhead juvenile releases by trap site, emigrant group, release site, release type, release date(s), number released, and the number of fish released with a passive integrated transponder (PIT) tag for migration year 2019.

Trap site	Emigrant group	Release site	Release type	Release date(s)	Number released	PIT tags released
Imnaha River	Chinook smolts	Imnaha Facility	Acclimated	04/10/19 – 04/15/19	292,412	9,976
Imnaha River	Chinook smolts	Imnaha River	Direct	04/15/19 – 04/17/19	219,114	9,037
Imnaha River	Steelhead smolts	Little Sheep Facility	Acclimated	04/01/19 – 04/09/19	211,269	14,913
Johnson Creek	Chinook smolts	Johnson Creek	Direct	03/27/19 - 03/29/19	127,829	2,011
Lolo Creek	Chinook presmolts	Lolo Creek	Acclimated	10/23/18	155,534	6,171
Lolo Creek	Chinook smolts	Lolo Creek	No hatchery Chinook smolt release occurred in migration year 2019 due to harsh winter conditions			
Lolo Creek	Steelhead smolts	Lolo Creek	246,859 (3,368 PIT tags) smolts for Lolo Creek were released at Red House in the SF Clearwater River			
Secesh River	N/A	N/A	N/A	N/A	N/A	N/A
SF Clearwater River	Steelhead smolts	Meadow Creek	Direct	04/03/19 – 04/09/19	472,942	10,590
SF Clearwater River	Steelhead smolts	Newsome Creek	Direct	03/27/19 – 03/29/19	123,860	2,535
SF Clearwater River	Steelhead smolts	Red House	Direct	03/25/19 – 03/26/19; 04/01/19 – 04/08/19	827,067*	13,413*

* Includes the hatchery steelhead smolts intended for Lolo Creek but release at Red House on the SF Clearwater River.

Table 8. Hatchery fall Chinook Salmon yearlings and subyearlings released by emigrant group, brood year, release site, release type, release date, number released, and the number of fish released with a passive integrated transponder (PIT) tag for migration year 2019.

Emigrant group	Brood year	Release site	Release type	Release date	Number released	PIT tags released
Yearling	2017	Captain John Rapids[1]	Acclimated	4/4/19	143,181	1,497
		Pittsburg Landing[1]	Acclimated	3/12/19	168,037	0
		Big Canyon Creek[1]	Acclimated	4/3/19	136,103	1,470
Subyearling	2018	Captain John Rapids	Acclimated	5/9/19	463,818	25,979
		Pittsburg Landing	Acclimated	5/10/19	402,946	25,959
		Big Canyon Creek	Acclimated	5/8/19	467,878	11,086
		Captain John Rapids II	Acclimated	5/31/19	208,323	4,499
		Pittsburg Landing II	Acclimated	5/24/19	208,540	4,295
		Big Canyon Creek II	Acclimated	6/2/19	209,128	4,490
		NPTH On-Station	Direct	6/11/19	423,057	4,500
		NPTH-Cherrylane[2]	Direct	3/27/19	70,125	0
		North Lapwai Valley	Acclimated	5/6/19	231,632	0
		Cedar Flats	Acclimated	6/10/19	259,752	4,496
		Lukes Gulch	Acclimated	5/30/19	277,238	4,500

[1] Due to a pipeline leak at Lyons Ferry Hatchery and an effort to conserve water, all Fall Chinook Acclimation Project yearlings were combined in one lake. Fish were already coded-wire-tagged and ad-clipped. As a result, evaluation of CWT codes for these yearlings were not specific to release site.

[2] Not a normal release, released early because of high enzyme-linked immunosorbent assay values.

Environmental data

Water temperature and discharge data were reported for trapping and beach seining project areas for the duration of fish collection operations. These data were also included for winter months when trapping operations were discontinued due to unsuitable conditions (Table 2; Figures 2 – 7). The Clearwater River experiences intentional cold water releases from Dworshak Dam to keep river temperatures below 15ºC until late August (Figure 2). Beach seining operations were conducted in temperatures ranging from about 12ºC to 17ºC. The Secesh River (Figure 6) and SF Clearwater River (Figure 7) trap sites had water temperatures approaching 20ºC during summer months, and during winter months freezing water temperatures occurred at all trap sites (0ºC; Figures 2 – 7). In the snowmelt-driven systems where traps were operated, spring runoff during MY2019 began in mid-March to early April and continued through May before discharge started to taper in June (Figures 3 – 5 and 7). Discharge data were unavailable for the ungauged Secesh River trap site (Figure 6).

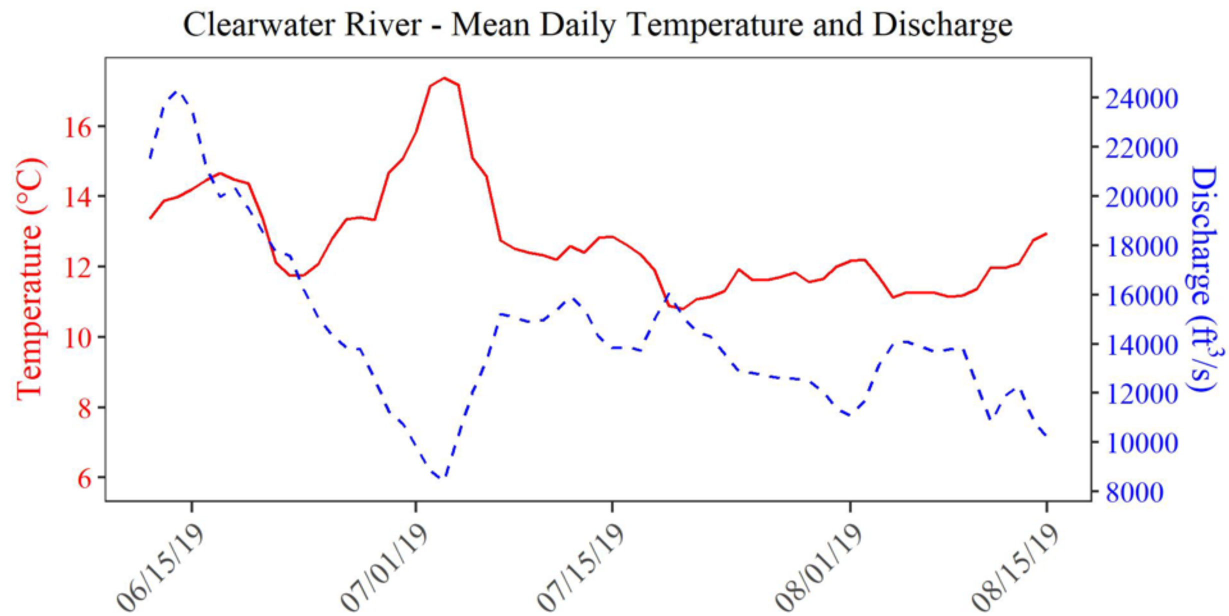

Figure 2. Mean daily temperature (℃, red solid) and discharge (ft^3/sec, blue dash) for the Clearwater River at Spalding, ID during migration year 2019 fall Chinook Salmon beach seining operations.

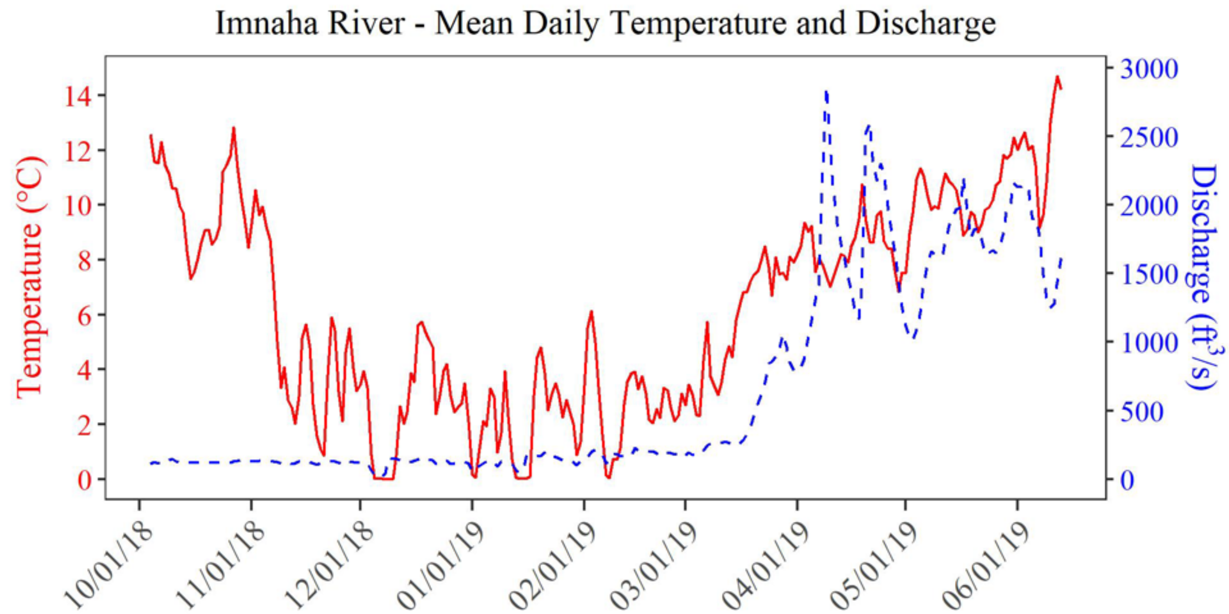

Figure 3. Mean daily temperature (°C, red solid) and discharge (ft^3/sec, blue dash) for the Imnaha River during migration year 2019 spring/summer Chinook Salmon and steelhead rotary screw trapping.

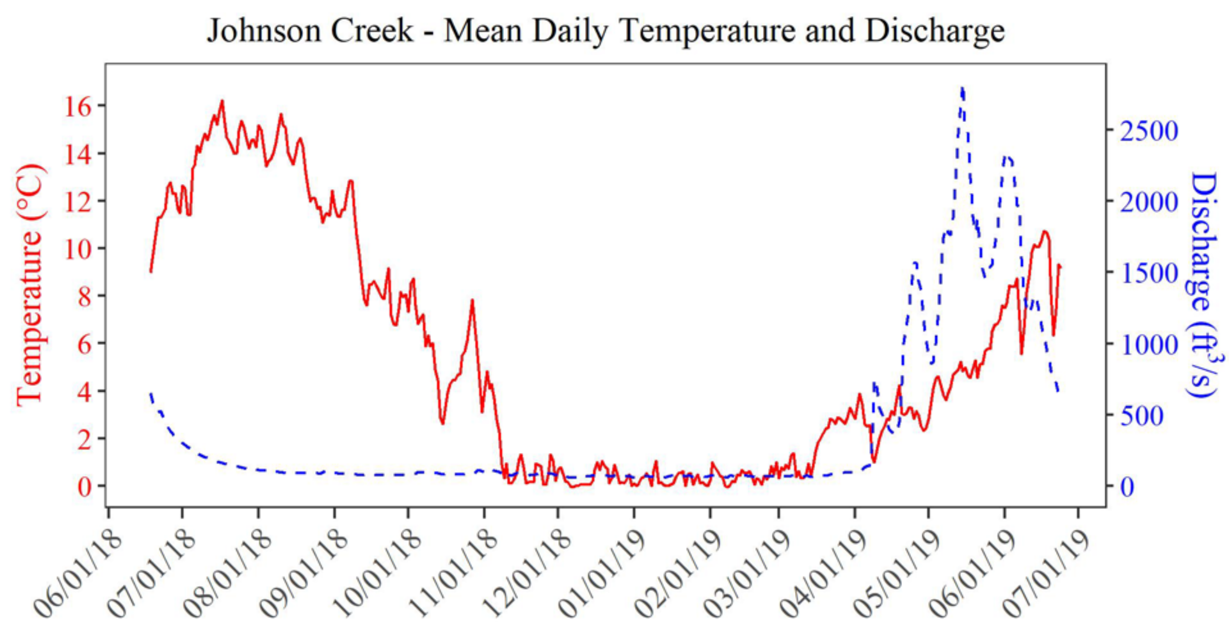

Figure 4. Mean daily temperature (°C, red solid) and discharge (ft^3/sec, blue dash) for Johnson Creek during migration year 2019 spring/summer Chinook Salmon and steelhead rotary screw trapping.

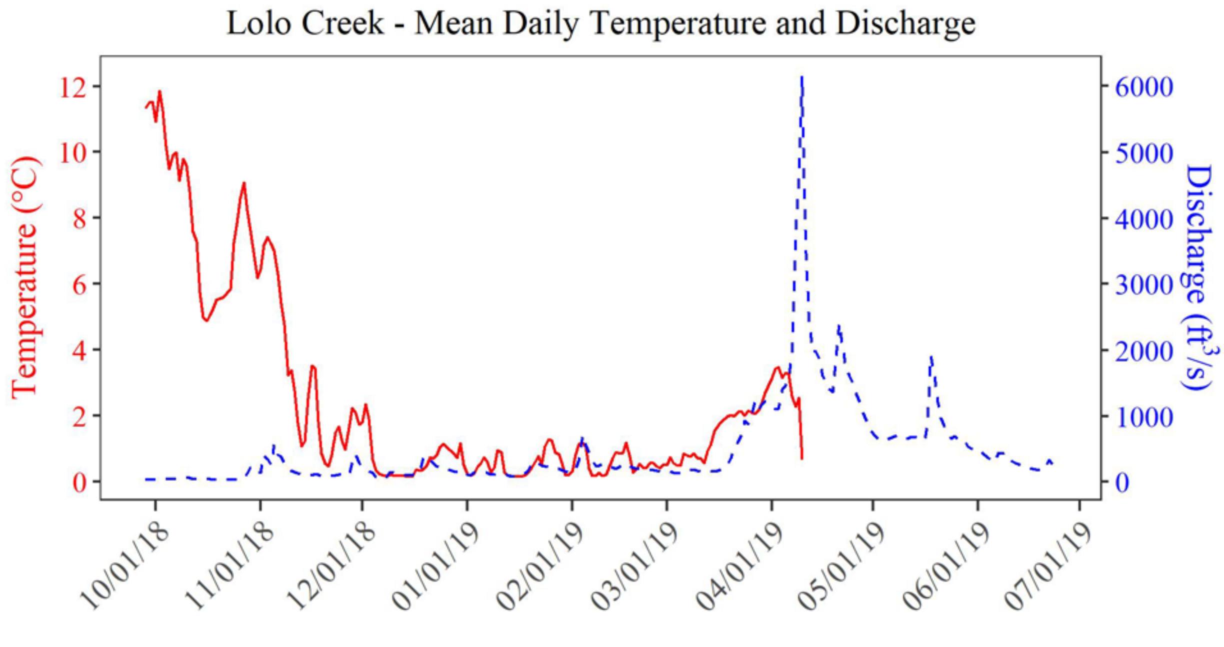

Figure 5. Mean daily temperature (℃, red solid) and discharge (ft^3/sec, blue dash) for Lolo Creek during migration year 2019 spring/summer Chinook Salmon and steelhead rotary screw trapping.

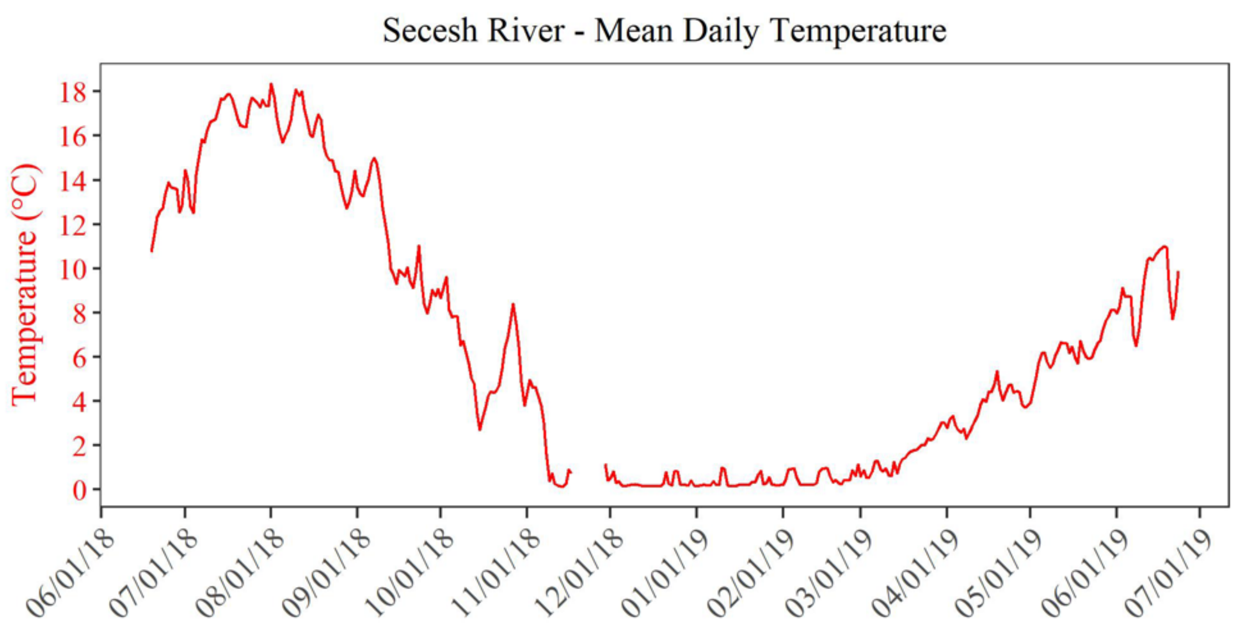

Figure 6. Mean daily temperature (℃, red solid) for Secesh River during migration year 2019 spring/summer Chinook Salmon and steelhead rotary screw trapping.

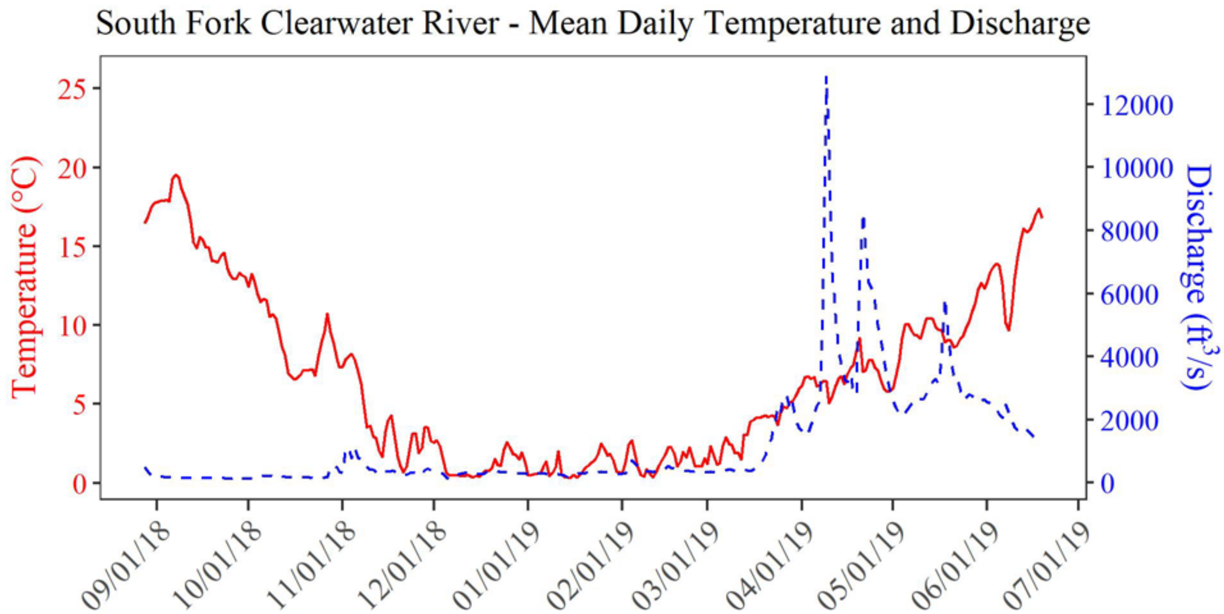

Figure 7. Mean daily temperature (℃, red solid) and discharge (ft^3/sec, blue dash) for the South Fork Clearwater River trap site for migration year 2019.

Performance measures

Emigrant abundance at the trap site

Abundance estimates varied by trap site and emigrant group. Natural spring/summer Chinook Salmon parr and presmolt emigrants comprised the majority of the Johnson Creek and Secesh River emigrant abundance (Figure 8). Abundance estimates for Imnaha River and Lolo Creek natural steelhead emigrants were not partitioned into seasonal catch but rather estimates for the entire migration year (Figure 8). An abundance estimate for natural steelhead emigrants from Johnson Creek, Secesh River, and SF Clearwater River was unavailable for MY2019 because of environmental conditions that precluded adequate trap efficiency trials necessary to estimate emigrant abundance.

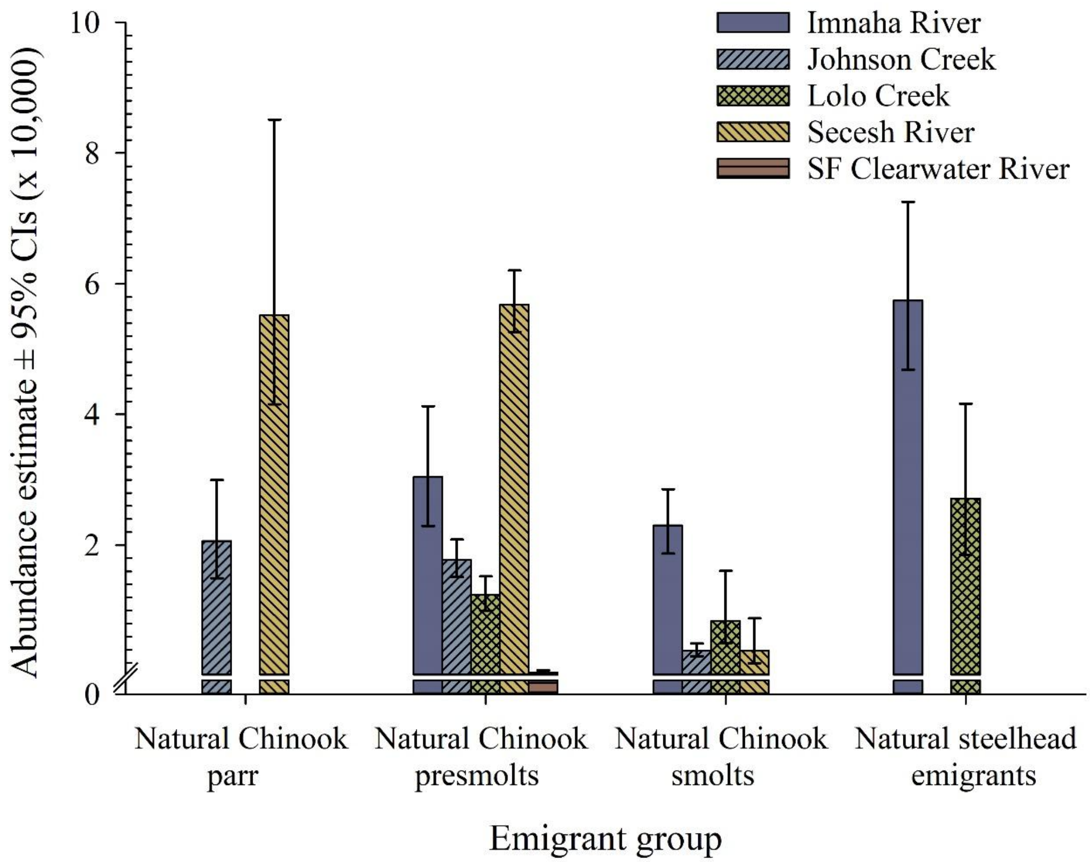

Figure 8. Natural Chinook salmon and steelhead abundance estimates and 95% confidence intervals by trap site and emigrant group for migration year 2019.

Emigration timing at trap sites

Cumulative proportion curves summarized emigrant arrival timing at the trap sites. Trapping periods likely captured the majority of emigration at the trap sites, as suggested by the rate of catch (i.e., catch per trap day) at the start and end of a trapping period. However, traps often began capturing fish soon after the initial deployment, suggesting some emigration occurred prior to the start of trapping; therefore, it is reasonable to assume that some emigration also continued after the cessation of trapping (Table 2 and Figures 9 – 13). Additionally, reductions in cumulative proportion curves represent a decline in catch, which can be caused by natural fluctuations in emigrant arrival at the trap or by environmental conditions that precluded trap operation.

Summer/fall season

The cumulative proportions for spring/summer Chinook Salmon parr and presmolts were bound by the dates associated with the periods used to define the life stage except for a small number of parr captured in late June by the Johnson Creek trap (Figure 9). Natural spring/summer Chinook

Salmon parr at the Johnson Creek and Secesh River traps had similar cumulative proportion patterns, but arrival timing at the Secesh River trap was slightly delayed relative to the Johnson Creek trap (Figure 9). A large proportion (~0.4) of Imnaha River natural spring/summer Chinook Salmon presmolts arrived at the trap in December (Figure 10), whereas only a small proportion (<0.1) of Imnaha River natural summer steelhead emigrants arrived during that same time period (Figure 11).

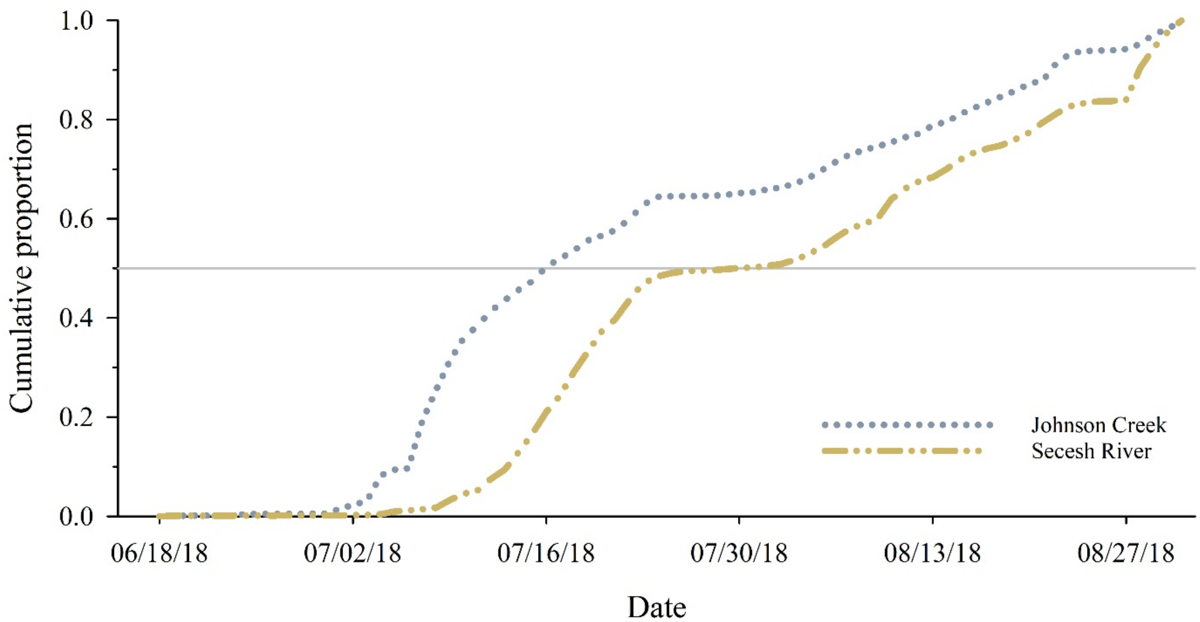

Figure 9. Cumulative proportion and arrival date of natural spring/summer Chinook Salmon parr by trap site for migration year 2019. The solid grey horizontal line represents a cumulative proportion of 0.5 arrival.

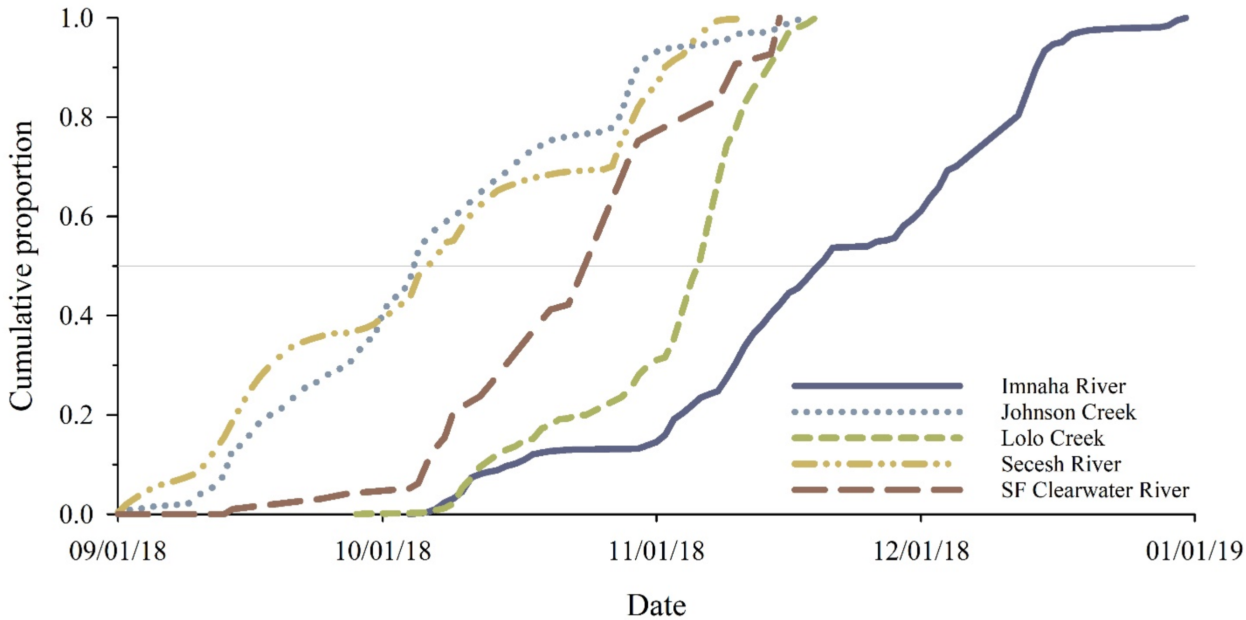

Figure 10. Cumulative proportion and arrival date at the trap site of natural spring/summer Chinook Salmon presmolts for migration year 2019. The solid grey horizontal line represents a cumulative proportion of 0.5 arrival.

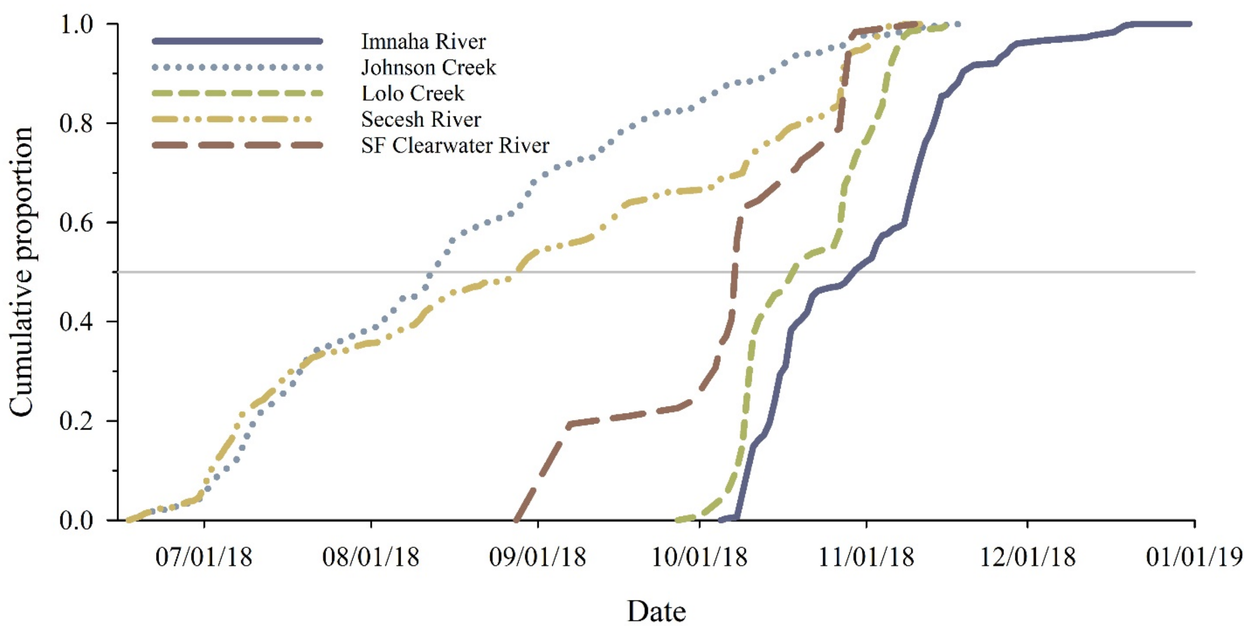

Figure 11. Cumulative proportion and arrival date at the trap site of natural summer steelhead emigrants tagged in the summer/fall season for migration year 2019. The solid grey horizontal line represents a cumulative proportion of 0.5 arrival.

Winter/spring season

The winter/spring emigration included both natural and hatchery emigrant groups. Johnson Creek, Secesh River, and SF Clearwater River traps experienced a rapid increase in the cumulative proportion (> 0.5) of natural spring/summer Chinook Salmon smolts from mid-March through early April (Figure 12a). Natural summer steelhead smolt arrival timing and cumulative proportion was similar at the Imnaha River, Lolo Creek, and SF Clearwater traps (Figure 13a). The start of hatchery spring/summer Chinook Salmon smolt emigration was influenced by hatchery release date (Table 7 and Figure 12b); however, hatchery release dates were chosen to occur during the period when natural emigration occurs. The majority of Imnaha River hatchery spring/summer Chinook Salmon smolts and SF Clearwater River hatchery summer steelhead smolts emigrated past the respective trap sites within a few days (Figure 12b and Figure 13b, respectively).

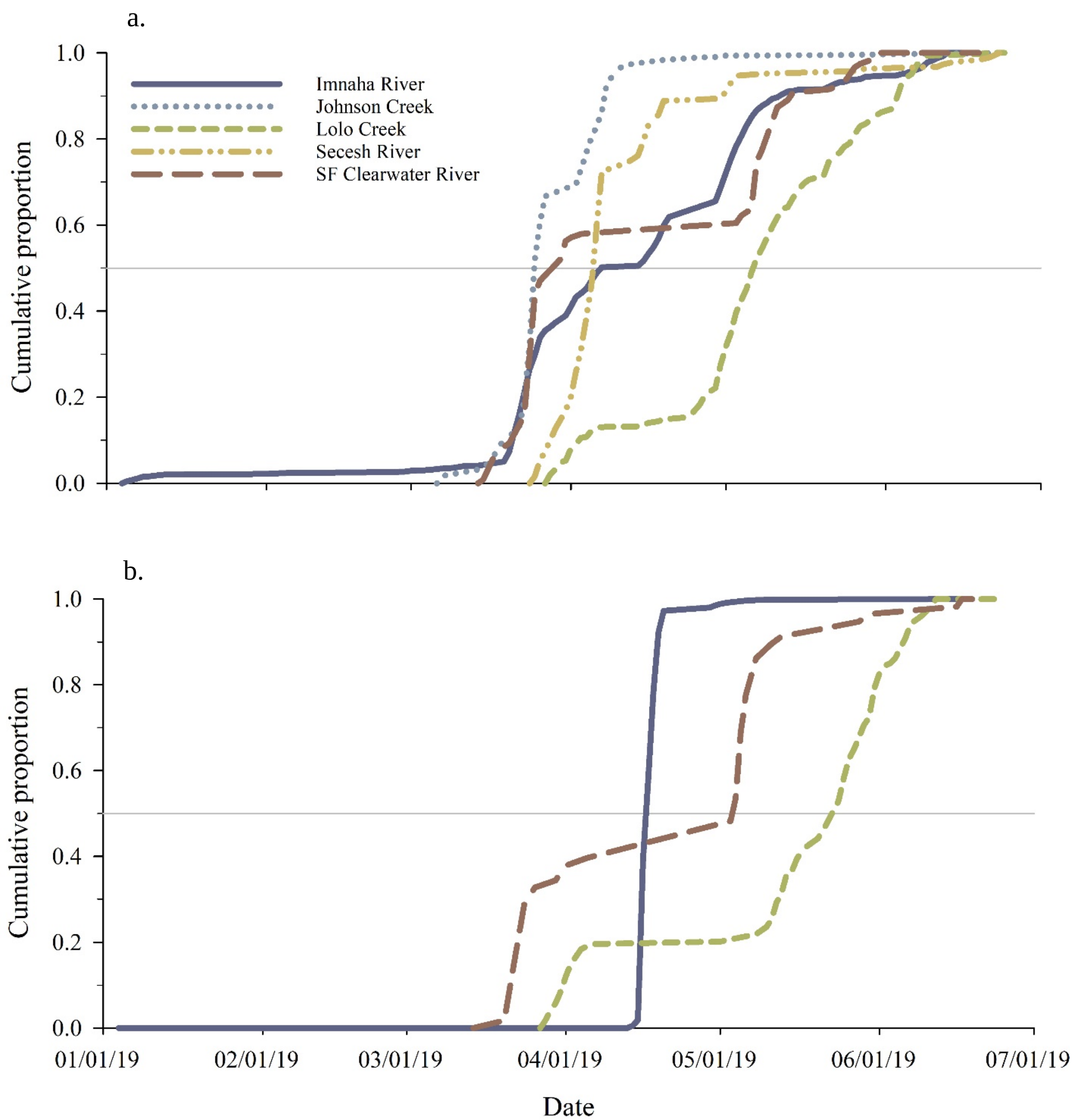

Figure 12. Cumulative proportion by arrival date at the trap site for: a) natural spring/summer Chinook Salmon smolts and, b) hatchery spring/summer Chinook Salmon smolts for migration year 2019. The solid grey horizontal line represents a cumulative proportion of 0.5 arrival.

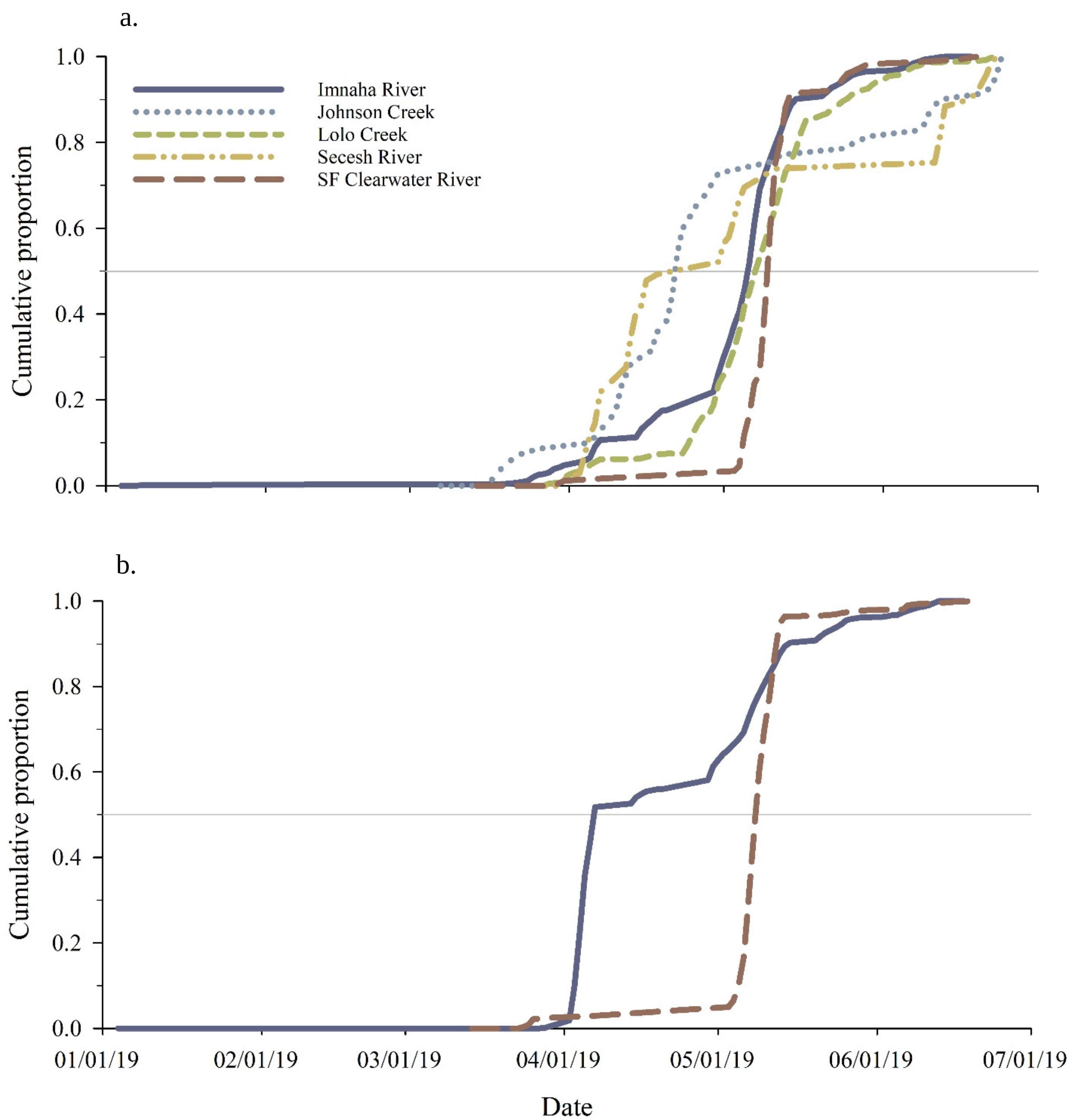

Figure 13. Cumulative proportion by arrival date at the trap site for: a) natural summer steelhead smolts and, b) hatchery summer steelhead smolts for migration year 2019. The solid grey horizontal line represents a cumulative proportion of 0.5 arrival.

Emigration timing at Lower Granite Dam

Detection antennas at LGR were fully operable starting March 25, 2019 with detections of fish PIT-tagged at the trap sites beginning shortly thereafter (Figures 14-16). Emigrant cumulative proportion and arrival timing at LGR varied widely among trap sites and emigrant groups (Figures 14-16). Emigrant groups tagged and released in the summer/fall season (including natural summer steelhead emigrants) generally arrived earlier and completed emigration past

LGR sooner than those tagged in the winter/spring season (Figures 14-16). The cumulative proportion of Lolo Creek natural spring/summer Chinook Salmon smolts lagged several days behind Chinook Salmon smolts from other trap sites (Figure 15b). Hatchery smolt emigration timing was similar to their natural conspecifics when comparing duration of emigration, with the exception of SF Clearwater River summer steelhead smolts (Figure 15b and Figure 15c).

The collection of emigrants at LGR for general transportation began April 23, 2019. The proportion of each emigrant group by trap site that passed LGR before the initiation of collection for transportation varied (Figures 14-16 and Table 9). Parr and presmolt emigrant groups generally had a higher cumulative proportion passage before transportation collection when compared to smolt emigrant groups (Table 9). Among the five trap sites, the Imnaha River emigrant groups had relatively higher cumulative proportion passage before the start of transportation and Johnson Creek emigrant groups had relatively lower cumulative proportion passage before the start of transportation (Table 9).

Detections of Clearwater River basin natural summer steelhead smolts at LGR often included tagged fish from previous migration years but emigrated one to two years later. For example, during MY2019, detections at LGR included 20 Lolo Creek individuals tagged in MY2017, 9 Lolo Creek individuals tagged in MY2018, and 14 Newsome Creek individuals tagged in MY2018 (data not included in figures).

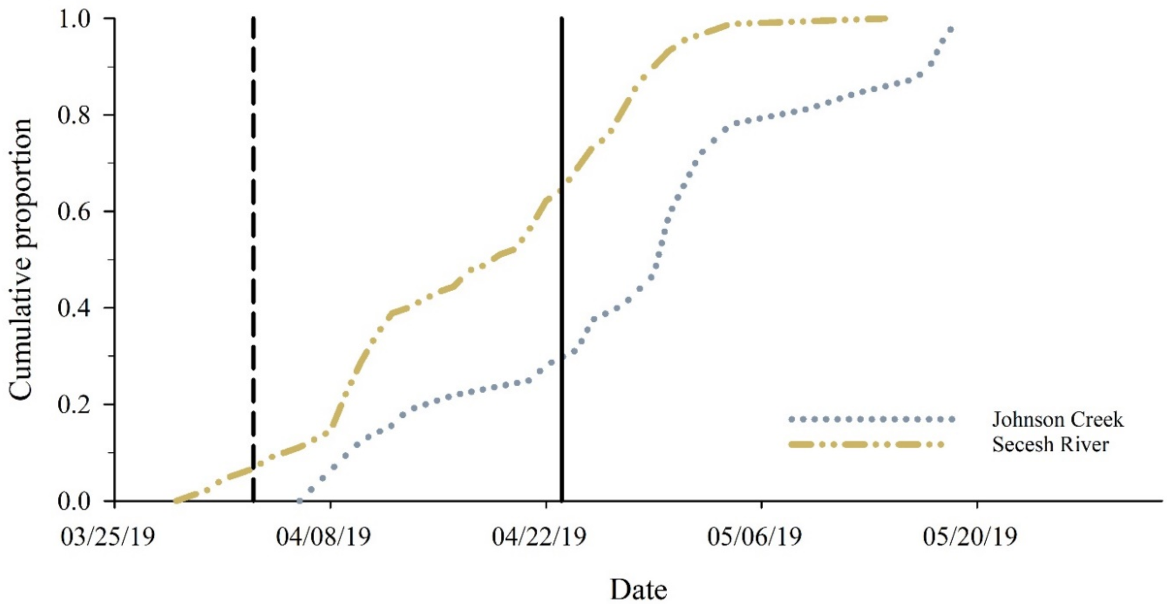

Figure 14. Cumulative proportion by arrival date for natural spring/summer Chinook Salmon parr by trap site at Lower Granite Dam for migration year 2019. The dashed vertical line represents the start of spring spill while the solid vertical line represents the start of transportation collections at Lower Granite Dam.

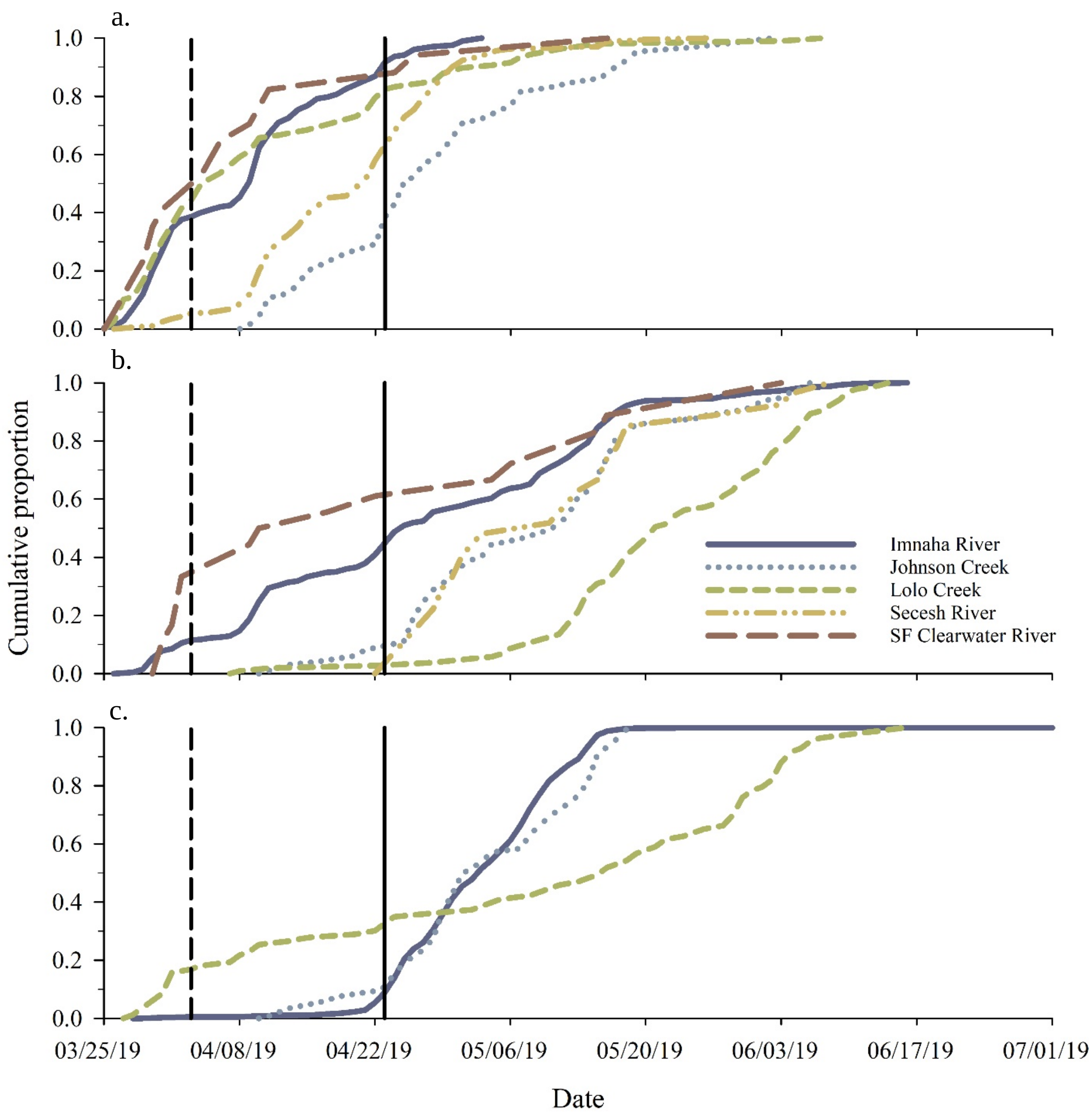

Figure 15. Cumulative proportion by arrival date for: a) natural spring/summer Chinook Salmon presmolts, b) natural spring/summer Chinook Salmon smolts and, c) hatchery spring/summer Chinook Salmon smolts by trap site at Lower Granite Dam for migration year 2019. The dashed vertical line represents the start of spring spill while the solid vertical line represents the start of transportation collections at Lower Granite Dam. *Not shown: three Imnaha River hatchery smolts detected emigrating past Lower Granite Dam in August 2019.

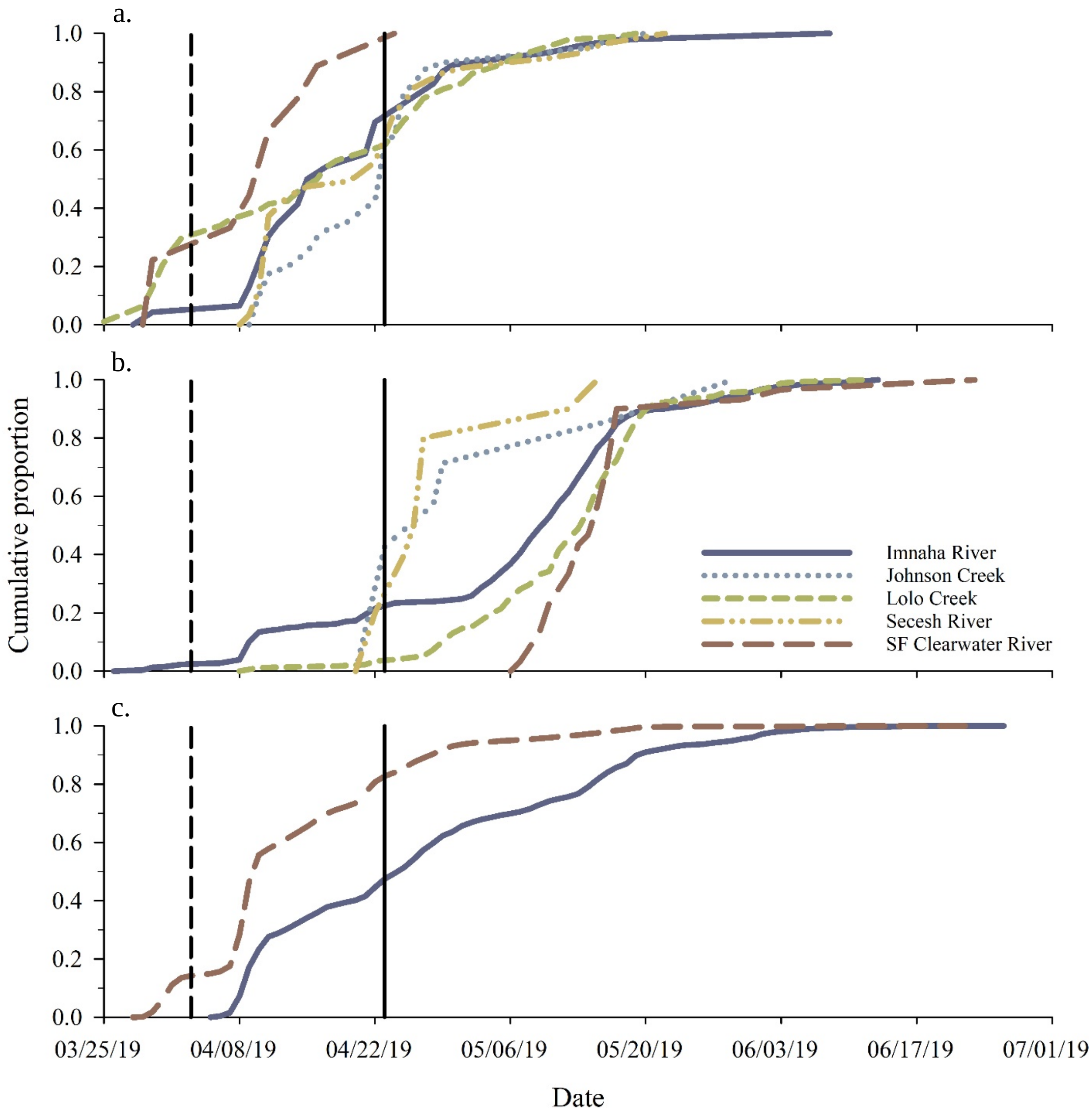

Figure 16. Cumulative proportion by arrival date for: a) natural summer steelhead fall emigrants, b) natural summer steelhead smolts, and c) hatchery summer steelhead smolts by trap site at Lower Granite Dam for migration year 2019. The dashed vertical line represents the start of spring spill while the solid vertical line represents the start of transportation collections at Lower Granite Dam.

Table 9. Proportion of emigrants detected at Lower Granite Dam before April 23, 2019, when collections for transportation began and the number of individuals detected throughout the entire emigration (in parentheses) at Lower Granite Dam for each emigrant group for migration year 2019.

	Proportion passed before transportation				
Emigrant group	Imnaha River	Johnson Creek	Lolo Creek	Secesh River	SF Clearwater River
Natural Chinook parr	N/A	0.28 (32)	N/A	0.64 (90)	N/A
Natural Chinook presmolts	0.92 (207)	0.39 (65)	0.82 (108)	0.63 (277)	0.82 (17)
Natural Chinook smolts	0.45 (408)	0.08 (97)	0.03 (103)	0.04 (27)	0.06 (18)
Hatchery Chinook smolts	0.09 (2,773)	0.11 (149)	0.33 (83)	N/A	N/A
Natural steelhead fall emigrants	0.70 (46)	0.63 (40)	0.61 (94)	0.64 (59)	0.89 (9)
Natural steelhead smolts	0.22 (875)	0.43 (7)	0.03 (178)	0.20 (10)	0.00 (30)
Hatchery steelhead smolts	0.47 (3,238)	N/A	N/A	N/A	0.83 (4,466)

Travel time

Travel time between tagging (natural emigrants) or detection (hatchery emigrants) at the trap site and detection at LGR was plotted by emigrant group for each trap site. Summer/fall season tagged emigrant group travel times exceeded 90 days (Figures 17-23). Natural summer steelhead smolts, relative to other emigrant groups, took less time to travel from the trap site to LGR as suggested by low weekly means and compressed weekly box and whisker plots (Figures 17-23). Natural spring/summer Chinook Salmon smolts also traveled quickly between trap site and LGR, although not as rapidly as natural steelhead smolts (Figures 17-23). Imnaha River hatchery summer steelhead smolts took longer to travel between the trap site and LGR than their natural conspecifics (Figure 23). Travel time for hatchery summer steelhead smolts from the SF Clearwater River was represented by a single detection at LGR (Figure 23).

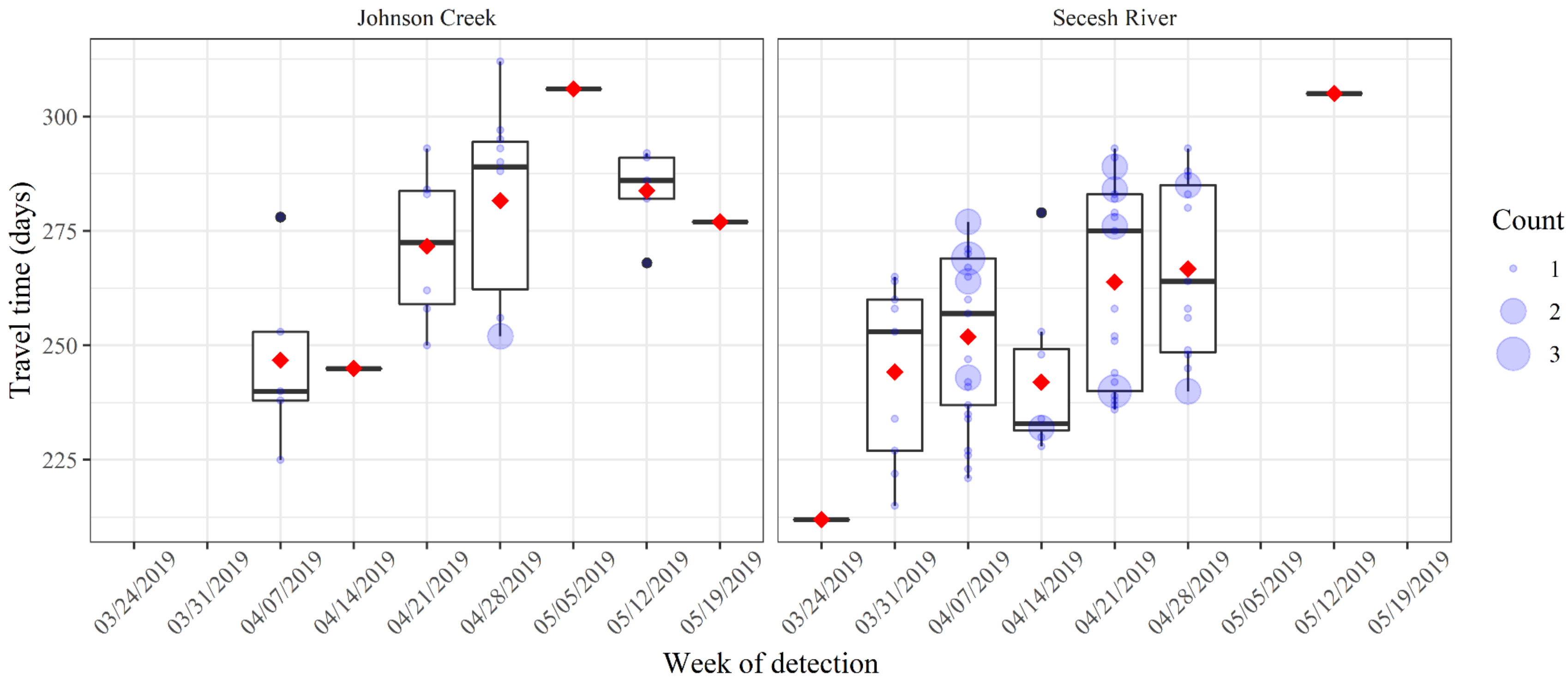

Figure 17. Travel time for natural spring/summer Chinook Salmon parr (size of blue circle corresponds to the count) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

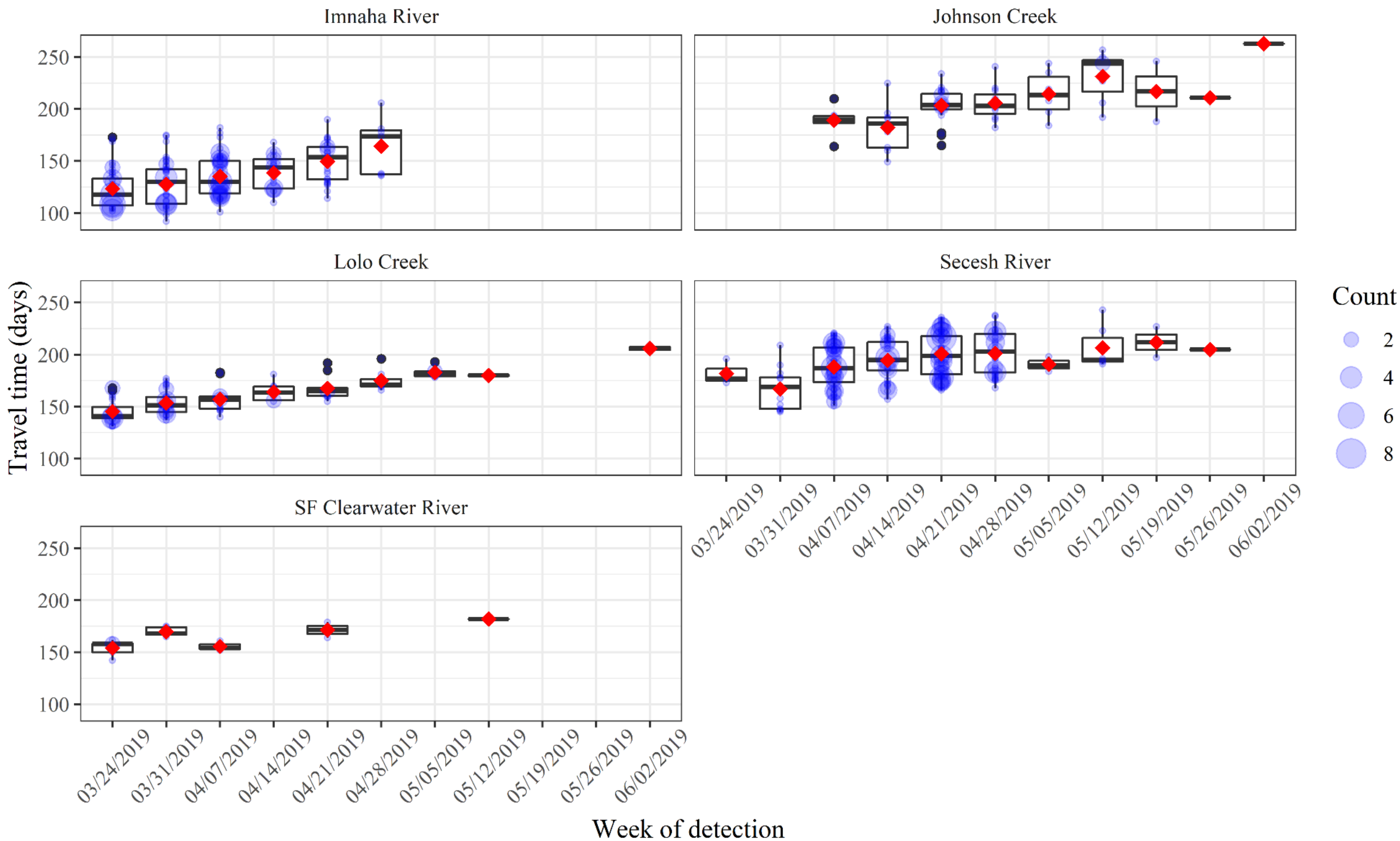

Figure 18. Travel time for natural spring/summer Chinook Salmon presmolts (size of blue circle corresponds to the count of presmolts) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

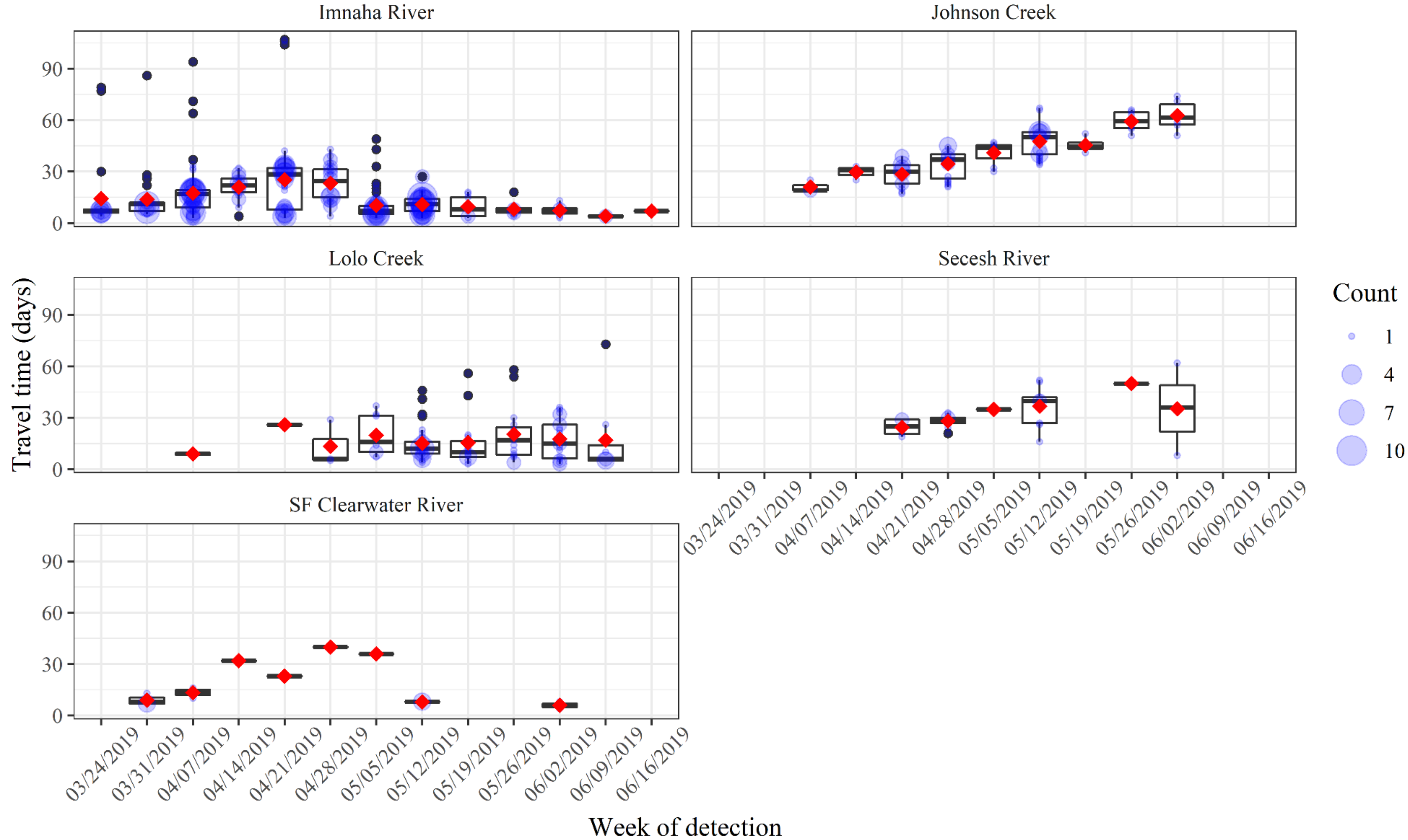

Figure 19. Travel time for natural spring/summer Chinook Salmon smolts (size of blue circle corresponds to the count) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

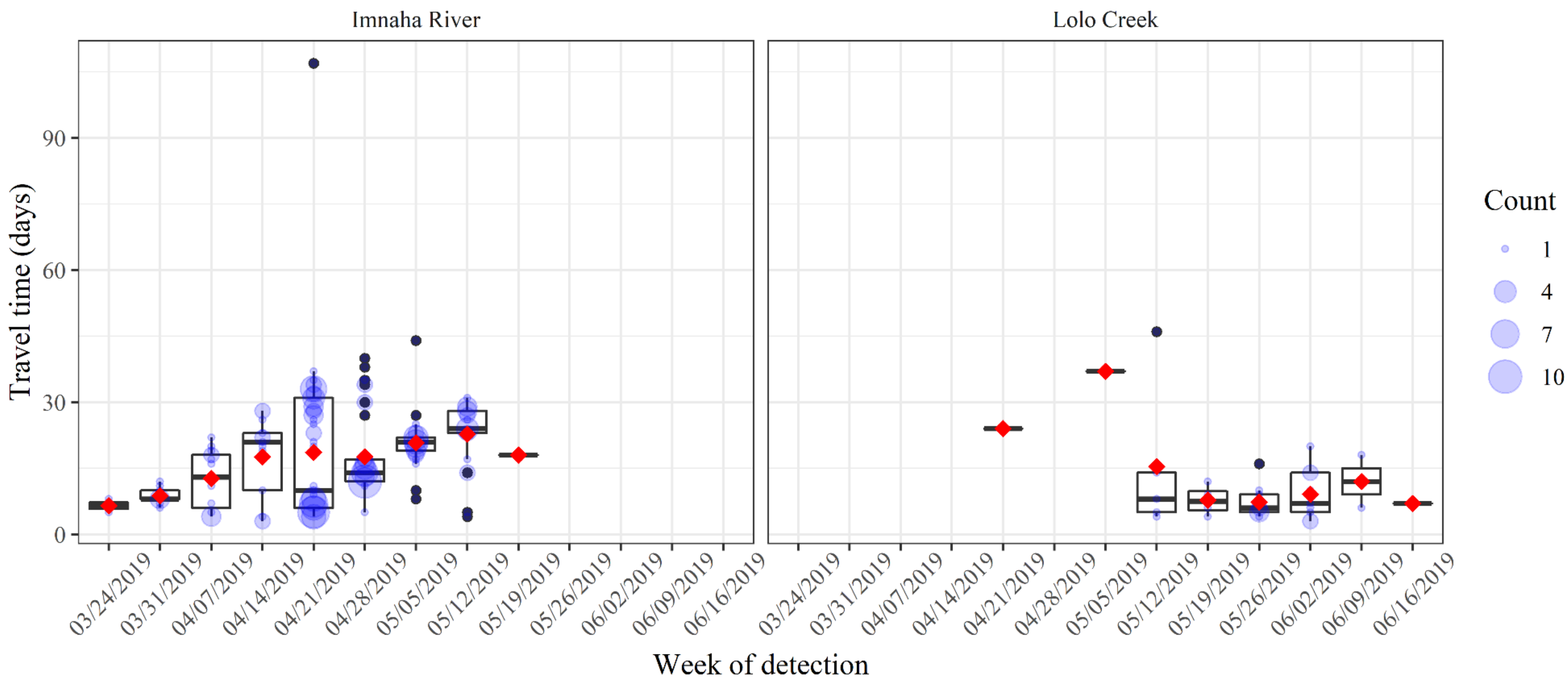

Figure 20. Travel time for hatchery spring/summer Chinook Salmon smolts (size of blue circle corresponds to the count) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

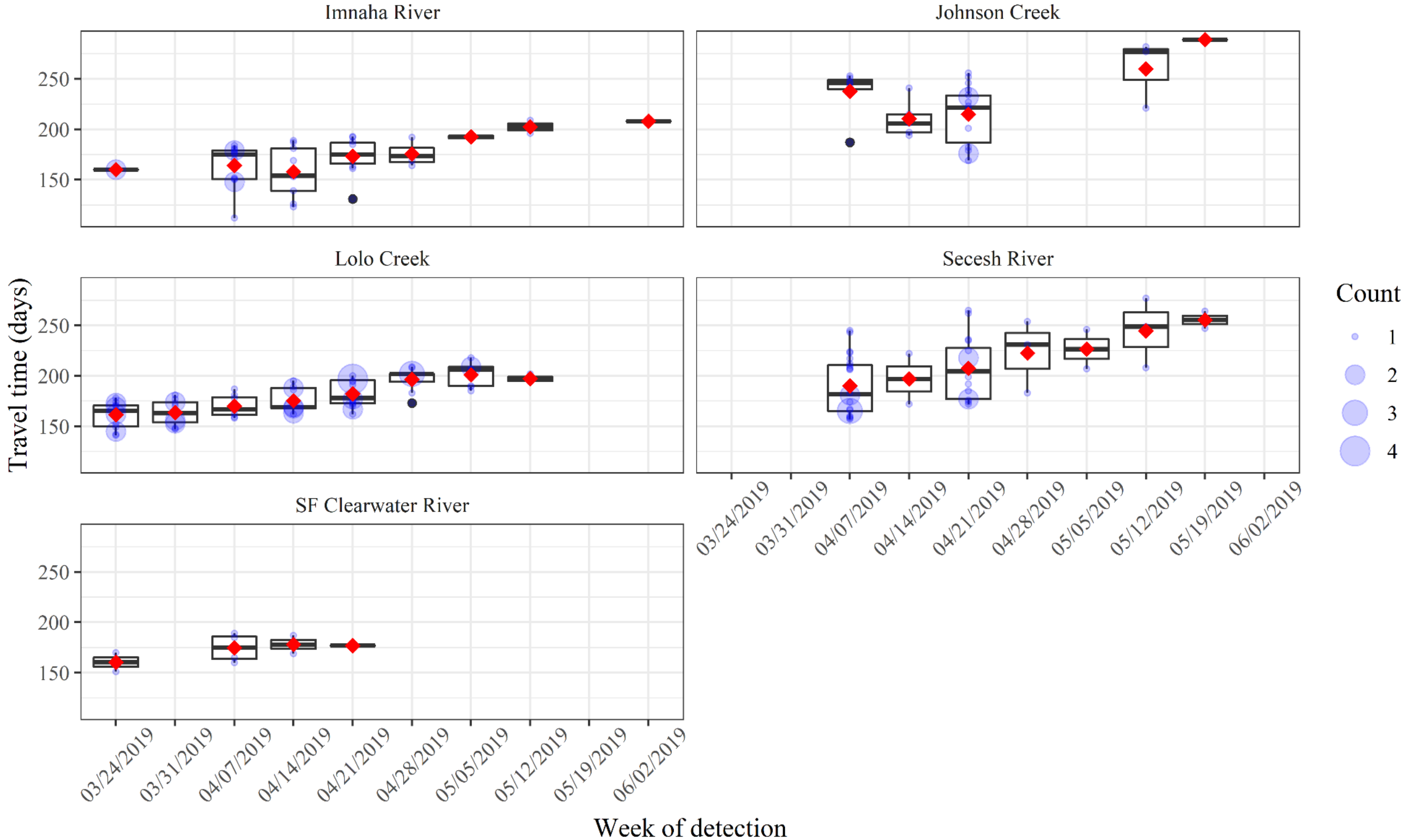

Figure 21. Travel time for natural summer steelhead summer/fall trapping season emigrants (size of blue circle size corresponds to the count) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

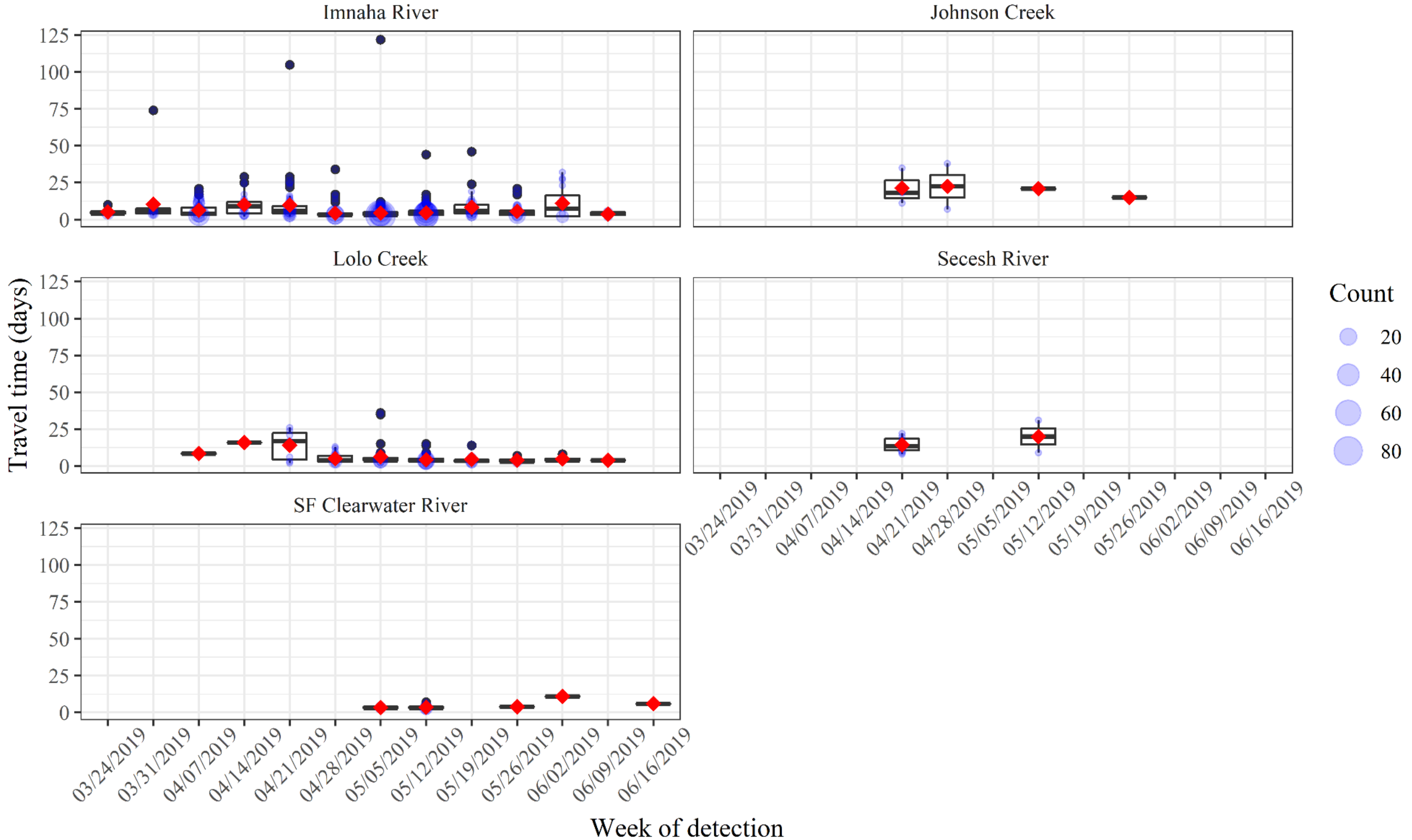

Figure 22. Travel time for natural summer steelhead smolts (size of blue circle corresponds to the count) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

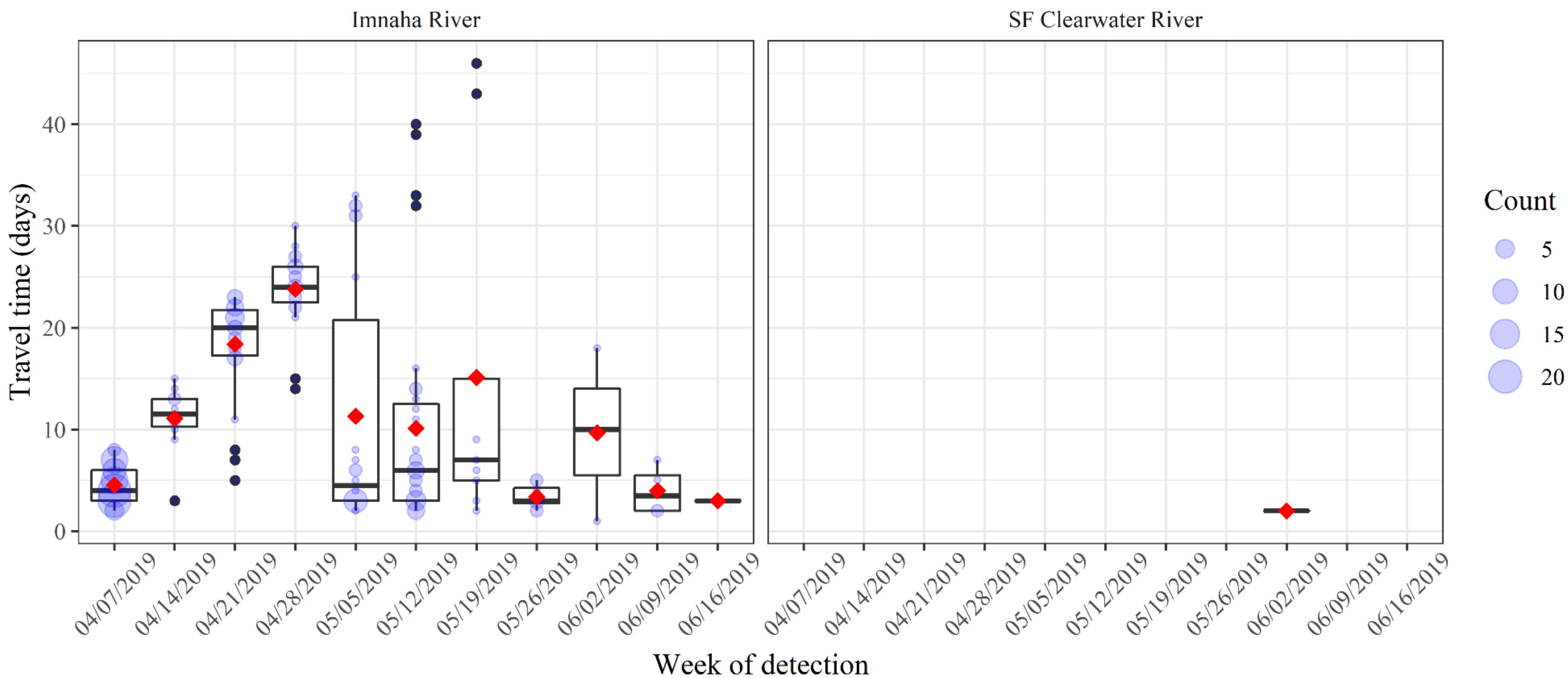

Figure 23. Travel time for hatchery summer steelhead smolts (size of blue circle corresponds to the count) from the trap site to Lower Granite Dam summarized by week of detection at Lower Granite Dam for migration year 2019. Mean travel time (red diamond) and box (25th percentile, median, 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for weekly travel time.

Survival and smolt equivalents

Survival for natural spring/summer Chinook Salmon and summer steelhead smolts from the trap site to LGR ranged from 0.50 – 0.81 and 0.63 – 0.80, respectively (Table 10). Natural summer steelhead smolt survival and smolt equivalents from the Imnaha River trap represent winter/spring emigrant estimates. Alternatively, Lolo Creek and SF Clearwater River steelhead smolt equivalents are the product of the survival estimate of steelhead captured in the spring between 120 mm and 300 mm and the abundance estimated from all juvenile steelhead captured during the fall and spring (Table 10). Survival estimates for parr and presmolts inherently include over-winter survival of the emigrant group and are often much lower than smolt survival, which does not account for over-winter survival (Table 10). The hatchery spring/summer Chinook Salmon smolts at Lolo Creek were released as presmolts in the fall above the trap site and estimates of survival to LGR were from emigrants in this group that were captured, tagged, and released at the trap site the following spring. Abundance for this group at the trap site was not estimated; therefore, smolt equivalents were also not estimated (Table 10).

Table 10. Estimated survival and 95% confidence intervals (95% CI) for natural and hatchery spring/summer Chinook Salmon and summer steelhead emigrants from trap site to Lower Granite Dam (LGR) and the estimated number of smolt equivalents and 95% confidence intervals at LGR for migration year 2019.

Emigrant group by trap site	Survival (95% CI) to LGR	Smolt equivalents (95% CI) at LGR
Imnaha River		
Natural Chinook presmolts	0.35 (0.31 – 0.38)	10,505 (7,160 – 13,850)
Natural Chinook smolts	0.81 (0.75 – 0.89)	18,674 (13,790 – 23,557)
Hatchery Chinook smolts	0.70 (0.52 – 1.06)	-
Hatchery Chinook smolts[1]	0.58 (0.54 – 0.62)	296,174 (274,618 – 317,729)
Natural steelhead smolts[2]	0.80 (0.76 – 0.86)	39,006 (28,684 – 49,328)
Hatchery steelhead smolts	0.98 (0.87 – 1.12)	-
Hatchery steelhead smolts[1]	0.74 (0.72 – 1.06)	155,705 (150,985 – 160,426)
Johnson Creek		
Natural Chinook parr	0.32 (0.26 – 0.40)	6,641 (3,003 – 10,279)
Natural Chinook presmolts	0.34 (0.30 – 0.40)	5,989 (4,293 – 7,686)
Natural Chinook smolts	0.58 (0.31 – 0.71)	2,252 (1,499 – 3,005)
Hatchery Chinook smolts[1]	0.51 (0.40 – 0.67)	65,193 (48,481 – 81,904)
Lolo Creek		
Natural Chinook presmolts	0.31 (0.27 – 0.36)	3,888 (2,843 – 4,933)
Natural Chinook smolts	0.55 (0.44 – 1.09)	4,577 (1,048 – 8,107)
Hatchery Chinook smolts	0.52 (0.32 – 2.53)	-
Natural steelhead smolts[2]	0.63 (0.55 – 0.84)	16,990 (8,546 – 25,433)
Secesh River		
Natural Chinook parr	0.27 (0.23 – 0.33)	15,127 (0 – 74,955)
Natural Chinook presmolts	0.43 (0.39 – 0.48)	24,659 (21,464 – 27,853)
Natural Chinook smolts	0.50 (0.45 – 0.55)	1,948 (0 – 3,972)
SF Clearwater River		
Natural Chinook smolts	-	-
Natural steelhead smolts[2]	0.68 (0.46 – 1.54)	-
Hatchery steelhead smolts		
Meadow Creek[3]	0.77 (0.76 – 0.79)	366,057 (357,436 – 374,678)
Newsome Creek[3]	0.67 (0.64 – 0.71)	83,482 (78,626 – 88,337)
Red House[3]	0.77 (0.76 – 0.78)	636,015 (625,478 – 646,551)

[1] Survival is estimated from the hatchery release site to Lower Granite Dam.
[2] Survival and smolt equivalent estimates are for winter/spring trapping season emigrants only.
[3] Hatchery steelhead smolts are released into the SF Clearwater River drainage at three separate locations. Survival is estimated from the hatchery release site to Lower Granite Dam.

Survival estimates of fall Chinook Salmon natural and hatchery yearlings and subyearlings to Lower Granite Dam were variable for migratory year 2019 (Table 11). Yearling hatchery releases had the highest survival and averaged 0.88. Natural subyearlings tagged during beach seining activities had the lowest survival at 0.20. Hatchery subyearling survival estimates from release to Lower Granite dam ranged from a low of 0.53 to a high of 0.85 (Table 11).

Table 11. Estimated survival and 95% confidence intervals (95% CI) for natural and hatchery fall Chinook Salmon from beach seining and hatchery releases to Lower Granite Dam (LGR) and the estimated number of smolt equivalents and 95% confidence intervals at LGR for migration year 2019 (brood year [BY] 2017 and 2018).

Emigrant group	Seine site/release site	Survival (95% CI) to LGR	Smolt equivalents (95% CI) at LGR
BY2017 Hatchery Yearlings	Big Canyon Creek	0.87 (0.80 - 0.94)	118,410 (109,420 – 127,400)
	Captain John Rapids	0.91 (0.86 - 0.96)	130,295 (123,251 – 137,339)
BY2018 Hatchery Subyearlings	Big Canyon Creek	0.53 (0.46 - 0.60)	247,975 (216,612 – 279,338)
	Big Canyon Creek II	0.65 (0.52 - 0.78)	135,933 (109,044 – 162,822)
	Captain John Rapids	0.64 (0.60 - 0.68)	296,844 (278,571 – 315,117)
	Captain John Rapids II	0.85 (0.73 - 0.97)	177,075 (151,800 – 202,350)
	Cedar Flats	0.56 (0.42 - 0.70)	145,461 (108,550 – 182,372)
	Lukes Gluch	0.65 (0.54 - 0.76)	180,205 (150,482 – 209,928)
	NPTH On-Station	0.53 (0.40 - 0.66)	224,220 (170,986 – 277,454)
	Pittsburgh Landing	0.65 (0.61 - 0.69)	261,915 (245,962 – 277,868)
	Pittsburgh Landing II	0.55 (0.49 - 0.61)	114,697 (102,026 – 127,368)
BY2018 Natural Subyearlings	Clearwater River	0.20 (0.13 - 0.27)	

Size and condition

Fork length was more variable within emigrant groups among trap sites in the winter/spring than the summer/fall trapping season (Figure 24, Figure 25). Natural spring/summer Chinook Salmon presmolts had similar median fork lengths among trap sites, except for the Imnaha River trap site which was likely related to fish captured later in the summer/fall trapping season (Figure 24). Hatchery emigrant groups had slightly longer fork lengths than their natural counterparts (Figure 25). Fulton’s condition factor was less variable within emigrant groups and among trap sites than fork length, suggesting similar condition at the time of emigration past the trap sites (Figure 26, Figure 27).

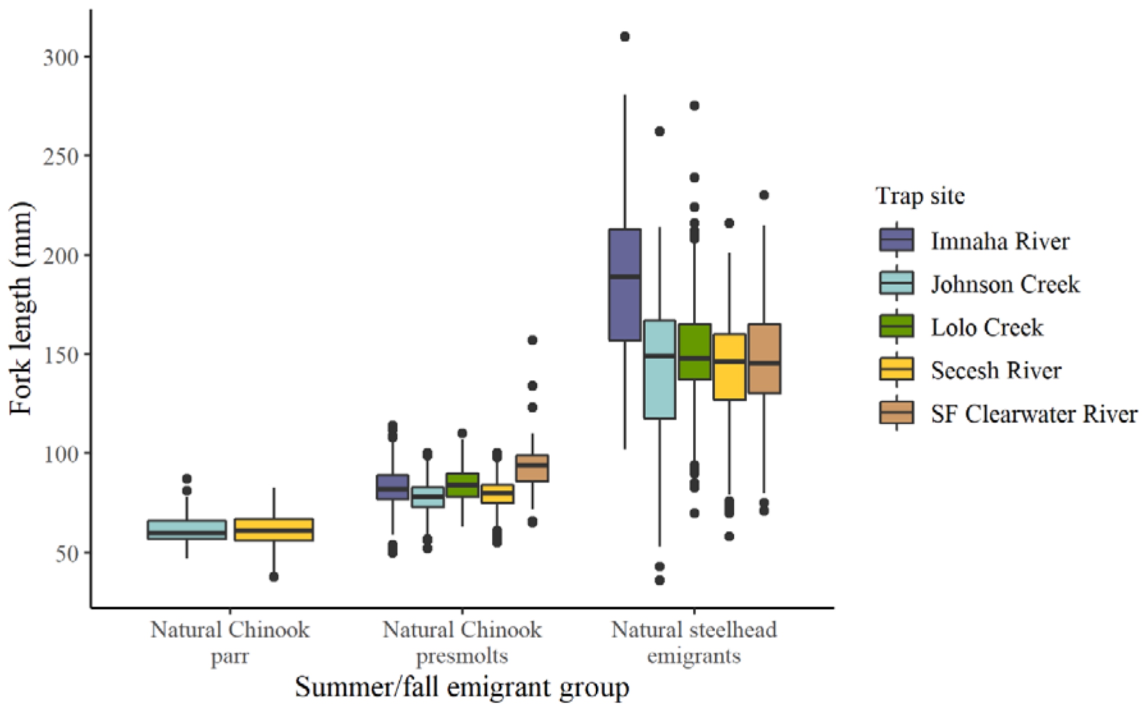

Figure 24. Fork length (mm) by emigrant group and trap site for summer/fall trapping season for migration year 2019. Box (25th percentile, median, and 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for fork length.

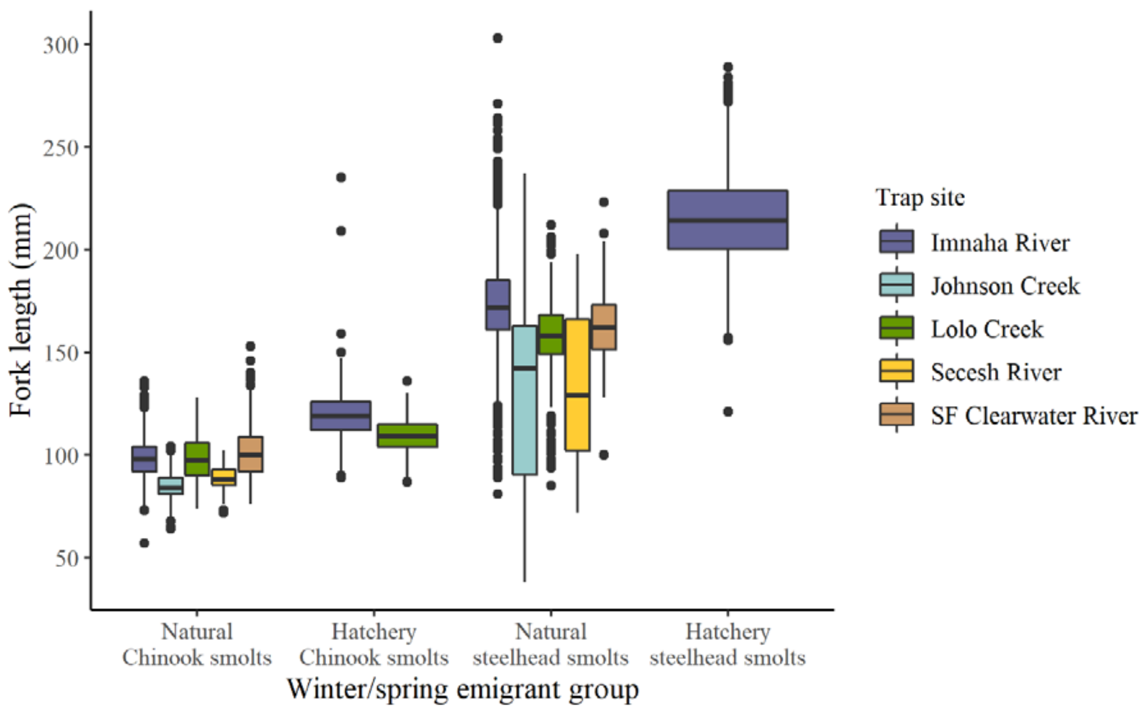

Figure 25. Fork length (mm) by emigrant group and trap site for winter/spring trapping season for migration year 2019. Box (25th percentile, median, and 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for fork length.

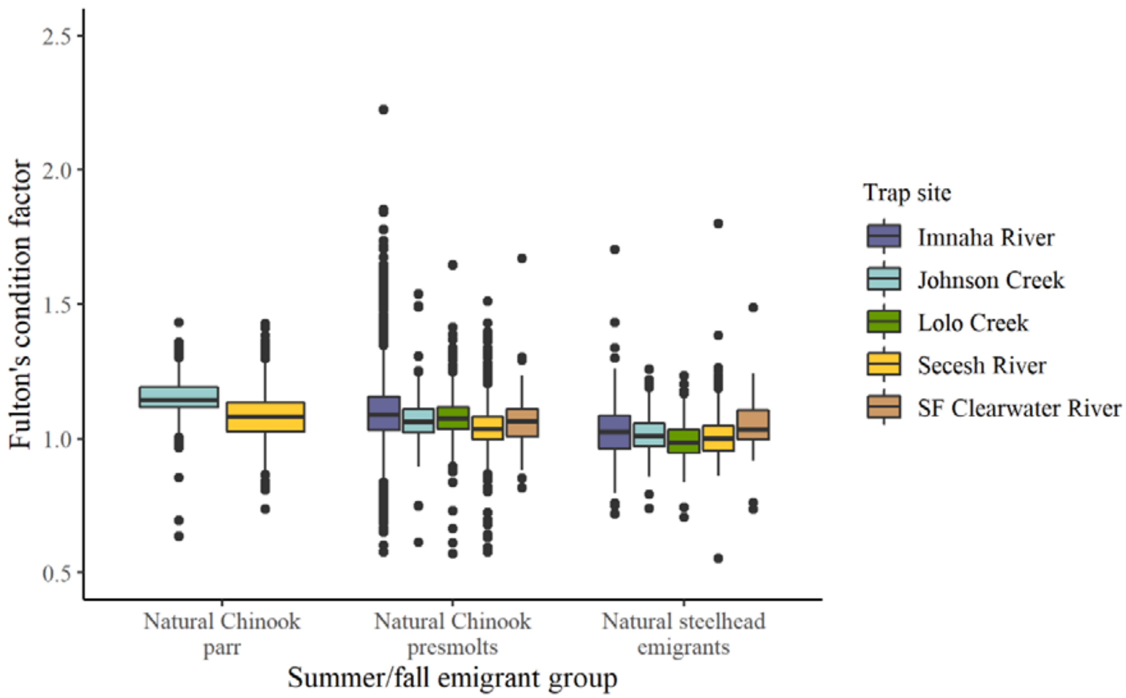

Figure 26. Fulton's condition factor by emigrant group and trap site for summer/fall trapping season for migration year 2019. Box (25th percentile, median, and 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for Fulton's condition factor.

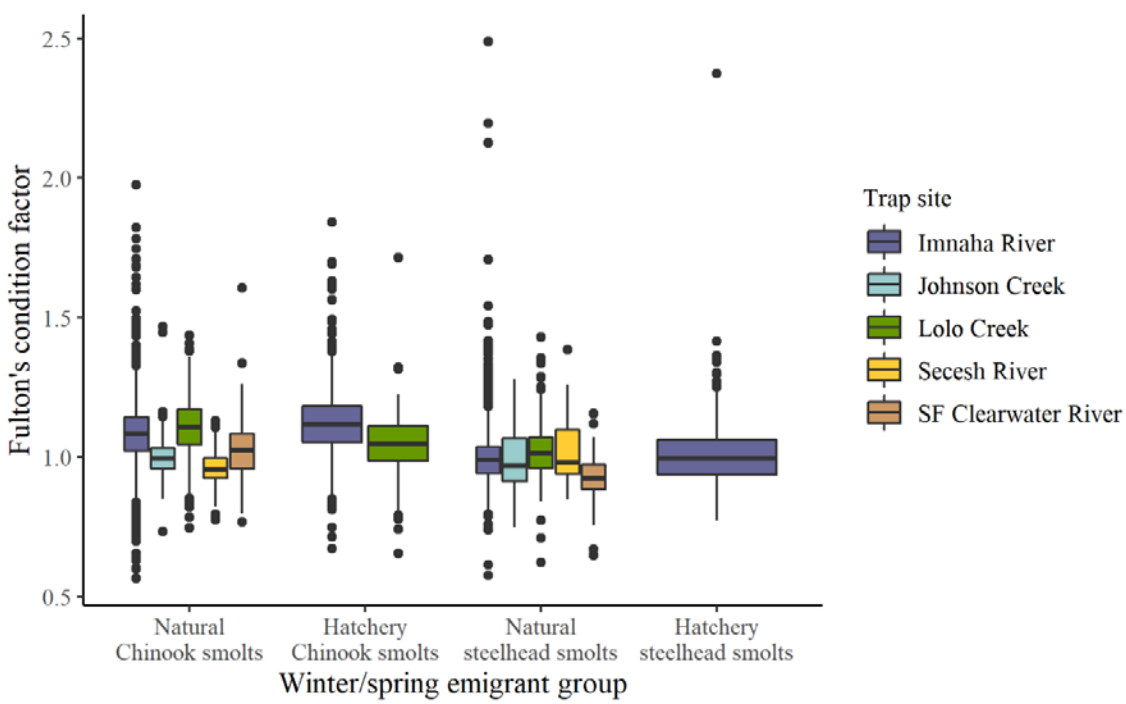

Figure 27. Fulton's condition factor by emigrant group and trap site for winter/spring trapping season for migration year 2019. Box (25th percentile, median, and 75th percentile) and whisker (95% confidence levels; outliers represented by black circles) plots for Fulton's condition factor.

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Appendices

Appendix A. Temperature recorders used to collect river and creek temperature data. Temperature data source, array ID, and location by trap site. Gauging station location and ID by trap site. PTAGIS = PIT Tag Information System, PIT = passive integrated transponder, DD decimal degrees.

Trap site	Temperature source	PTAGIS Array ID	Latitude (DD)	Longitude (DD)
Clearwater River	USGS Spaulding, ID	N/A	46.44833	-116.82750
Imnaha River	Onset® logger	N/A	45.76224	-116.74918
Johnson Creek	Onset® logger	N/A	44.91764	-115.48340
Lolo Creek	PIT array	LOLOC	46.29435	-115.97602
Secesh River	PIT array	ZEN	44.03338	-115.73291
SF Clearwater River	PIT array	SC1, SC2	46.12723	-115.97774

Gauging stations used to collect river and creek discharge data.

Trap site	Location	Gauge ID	Latitude (DD)	Longitude (DD)
Clearwater River	Spalding, ID	13342500	46.44833	-116.82750
Imnaha River	Imnaha, Oregon	13292000	45.56202	-116.83402
Johnson Creek	Yellow Pine, Idaho	13313000	44.96167	-115.50000
Lolo Creek	Greer, Idaho	13339500	46.37167	-116.16250
Secesh River	no gauge available	-	-	-
SF Clearwater River	Stites, Idaho	13338500	46.08667	-115.97556

Appendix B. The number of juvenile summer steelhead (n) that were captured at Clearwater River rotary screw traps during migration year 2019 from which scales were collected and the percentage of freshwater ages determined from analysis of the scales.

		Freshwater Age				
Trap	(n)	1	2	3	4	Unknown
Lolo Creek						
Fall 2018	104	80.8%	18.3%	0.0%	0.0%	1.0%
Spring 2019	176	10.8%	65.9%	18.8%	0.6%	4.0%
South Fork Clearwater River						
Fall 2018	31	64.5%	32.3%	3.2%	0%	0%
Spring 2019	51	13.7%	51.0%	31.4%	3.9%	0%
Newsome Creek						
Fall 2018	117	32.5%	60.7%	4.3%	0.0%	2.6%

Appendix C. Sources of mortality for spring/summer Chinook Salmon and summer steelhead emigrants due to trapping, handling, tagging, predation, and dead on arrival (DOA) at the trap sites during migration year 2019.

Imnaha River screw trap

Summer/Fall 2018

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	0	0	0	0.00	0	0.00	0	0.00
Handling	1	0.06	0	0.00	0	0.00	0	0.00
Tagging	3	0.18	0	0.00	0	0.00	0	0.00
Predation	0	0	0	0.00	0	0.00	0	0.00
DOA	0	0	0	0.00	0	0.00	0	0.00
Total	4	0.24	0	0.00	0	0.00	0	0.00

Winter/Spring 2019

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	11	0.54	13	0.06	3	0.08	1	0.01
Handling	5	0.24	1	0.00	0	0.00	4	0.03
Tagging	18	0.88	1	0.00	2	0.05	0	0.00
Predation	1	0.05	0	0.00	2	0.05	2	0.02
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	35	1.70	15	0.07	7	0.18	7	0.06

Johnson Creek screw trap

Summer/Fall 2018

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	6	0.08	0	0.00	1	0.16	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	1	0.01	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	7	0.10	0	0.00	1	0.16	0	0.00

Winter/Spring 2019

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	0	0.00	0	0.00	0	0.00	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	0	0.00	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	0	0.00	0	0.00	0	0.00	0	0.00

Lolo Creek screw trap

Summer/Fall 2018

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	1	0.20	0	0.00	0	0.00	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	0	0.00	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	1	0.20	0	0.00	0	0.00	0	0.00

Winter/Spring 2019

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	0	0.00	0	0.00	0	0.00	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	0	0.00	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	0	0.00	0	0.00	0	0.00	0	0.00

Secesh River screw trap

Summer/Fall 2018

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	12	0.05	0	0.00	0	0.00	0	0.00
Handling	2	0.01	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	3	0.01	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	17	0.08	0	0.00	0	0.00	0	0.00

Winter/Spring 2019

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	0	0.00	0	0.00	1	1.08	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	0	0.00	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	0	0.00	0	0.00	1	1.08	0	0.00

South Fork Clearwater River screw trap

Summer/Fall 2018

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	0	0.00	0	0.00	0	0.00	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	0	0.00	0	0.00	0	0.00	0	0.00
Predation	0	0.00	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	0	0.00	0	0.00	0	0.00	0	0.00

Winter/Spring 2019

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of mortality	N	% trapped	N	% trapped	N	% trapped	N	% trapped
Trapping	0	0.00	0	0.00	3	0.07	0	0.00
Handling	0	0.00	0	0.00	0	0.00	0	0.00
Tagging	1	0.00	0	0.00	0	0.00	0	0.00
Predation	0	0.00	0	0.00	0	0.00	0	0.00
DOA	0	0.00	0	0.00	0	0.00	0	0.00
Total	1	1.03	0	0.00	3	0.07	0	0.00