Snake River Basin
Adult Chinook Salmon and Steelhead Monitoring
2021 Annual Report

Trapped steelhead, Camp Creek Oregon

Nez Perce Tribe

Department of Fisheries Resources Management

Research Division

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Snake River Basin Adult Chinook Salmon and Steelhead Monitoring – 2021 Annual Report

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Abstract

The Nez Perce Tribe Department of Fisheries Resources Management, Research Division, monitors and evaluates the status of adult Chinook Salmon (*Oncorhynchus tshawytscha*) and summer steelhead (*O. mykiss*) returns throughout Nez Perce tribal project areas in the Snake River basin. In spawn year 2021, we calculated abundance, life history, and productivity performance measures using data collected from returning adults at Lower Granite Dam (LGD), picket and floating weirs, spawning ground surveys, and in-stream passive integrated transponder tag detection systems. When available, we reported 2021 adult metrics and data from the previous 10 years to provide context for the 2021 results. In 2021, the abundance of returning adult Chinook Salmon and steelhead at most monitoring locations and scales (i.e., basin, population, and tributary) remained below the 10-year average. Although below the 10-year average, fall Chinook Salmon escapement to LGD increased from 33,618 fish in 2020 to 37,982 in 2021. While there were no PIT tag based escapement estimates for adult spring/summer Chinook Salmon returns to the Snake River basin in 2020, population escapment estimates show an observable increase across the basin. The adult spring/summer Chinook Salmon escapement to LGDincreased from 27,539 in 2019 to 45,720 in 2021. Total summer steelhead escapement past LGD also increased from 36,541 in 2020 to 61,564 in 2021. Indicators of productivity remain low across species and life histories in the region. Specifically, progeny-per-parent estimates appear to indicate Snake River natural-origin spring/summer Chinook Salmon and natural-origin steelhead populations are not replacing themselves.

Introduction

Persistence of the Nez Perce Tribe (Tribe) is largely attributed to the vast abundance and accessibility of anadromous fish returning to the Snake River basin (basin). Annual returns served the Tribe as a primary food source, trade item, and cultural resource for thousands of years (Landeen and Pinkham 1999). The Tribe's reliance upon anadromous species influenced their historic occupation in the Pacific Northwest, which included over 13 million acres of present-day north-central Idaho, southeastern Washington, and northeastern Oregon, considered the Tribe's usual and accustomed area. The degree to which the Tribe is physically and spiritually coupled to returning salmon and other anadromous fish for sustenance was recognized and protected in the Treaty of 1855[1] (Landeen and Pinkham 1999). Subsequent modifications to the Treaty of 1855 confined the Tribe to a fraction of the initially identified territory while maintaining their rights to access usual and accustomed fishing areas and conferring co-management responsibilities. These treaty rights provide a framework for the Tribe's involvement in fish protection and management actions, population recovery efforts, and habitat restoration throughout Nez Perce Tribe territory.

Significant declines in adult Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), Sockeye Salmon (*O. nerka*), steelhead (*O. mykiss*), and Pacific Lamprey (*Entosphenus tridentatus*) returning to the basin have affected the Tribe's ability to preserve its culture, identity, and subsistence way of life. Reductions in Chinook Salmon and steelhead abundance have been significant over the past five decades (Nehlsen et al. 1991; McClure et al. 2003; NWFSC 2015). Similar declines occurred in most anadromous fish stocks across the United States Pacific Northwest (Heard et al. 2007). Many runs are now listed as either threatened or endangered under the Endangered Species Act (ESA). Because of historical declines and future threats to survival, two Chinook Salmon Evolutionary Significant Units (ESUs; Snake River spring/summer-run and Snake River fall-run) and one steelhead Distinct Population Segment (DPS; Snake River basin steelhead) in the basin are listed as threatened under the ESA (NMFS 1997).

The Tribe honors its cultural duty and obligation to protect and recover Snake River basin fish stocks. In part, they carry out their legal responsibility to co-manage these resources through the work of their Department of Fisheries Resources Management (DFRM). The DFRM focuses on protecting and restoring all aquatic resources and habitats in a manner consistent with the Tribe's way of life (NPT 2013). The Research Division assists in completing DFRM goals by monitoring and evaluating fish hatchery production programs and the naturally-spawning fish populations occurring throughout the basin and other usual and accustomed areas. The Research Division implements their adult Chinook Salmon and steelhead monitoring with funding from five Bonneville Power Administration (BPA) Fish and Wildlife projects, one Lower Snake River Compensation Plan project, and through collaboration with co-managers. Research Division projects gather, summarize, and analyze data collected annually across basin tributaries and the National Oceanic Atmospheric Administration's (NOAA) Interior Columbia River Technical Review Team (ICTRT)-defined populations and management areas (ICTRT 2003). The scale at which we summarize and present data in this report includes tributaries, ICTRT populations (hereafter, "population(s)"), and the Snake River basin (using Lower Granite Dam (LGD) information). Reported metrics differ across species and run depending on the specific project, DFRM, and regional management objectives.

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[1] Treaty with the Nez Perces, 12 Stat. 957 (June 11, 1855)

Fall Chinook Salmon returning to the Snake River population are monitored throughout available spawning areas by the Research Division's Nez Perce Tribal Hatchery (NPTH) Monitoring and Evaluations (BPA Project 1983-350-03) project and the Idaho Power Company. The Snake River fall Chinook Salmon population consists of four major spawning aggregates: Lower Hells Canyon, Upper Hells Canyon, Lower Clearwater, and the South Fork Clearwater/Selway reaches (ICTRT 2005). The Idaho Power Company are responsible for monitoring spawning in the Lower Hells Canyon and Upper Hells canyon spawning aggregates. The tribe monitors adult returns to the lower Snake River, Clearwater River, and Salmon River mainstem transects and their tributaries and report the success of hatchery production releases, abundance trends, and life history characteristic shifts for each spawning aggregate.

Adult spring/summer Chinook Salmon monitoring is conducted at the tributary- and population-scale by five Research Division projects. Tributary-scale reporting is for hatchery program effectiveness monitoring and evaluations. In contrast, population-scale reporting contributes to regional monitoring and status assessments for seven major population groups (MPG) representing 31 individual populations (ICTRT 2005). Research Division projects conducting hatchery program effectiveness monitoring include Grande Ronde Supplementation Monitoring and Evaluations (GRSME BPA Project 1998-007-02), Johnson Creek Artificial Propagation and Enhancement (BPA Project 1996-043-00), Lower Snake River Compensation Plan (LSRCP Grant F22AC00016-00), and NPTH Monitoring and Evaluations (BPA Project 1983-350-03). The Snake Basin Steelhead Assessments project (SBSA; BPA Project 2010-057-00) completes population monitoring and estimates natural-origin (hereafter, "natural") Chinook Salmon and natural steelhead adult return metrics for NOAA's status assessments.

Summer steelhead metrics also reported at the tributary- and population-scale comprises data collected and summarized by three Research Division projects. The Grande Ronde Supplementation Monitoring and Evaluations and the Imnaha River Steelhead Status and Smolt Monitoring (IRSSSM BPA Project 1997-015-01) projects collect and report adult steelhead data in the Grand Ronde / Imnaha River MPG. The Snake Basin Steelhead Assessments project, in conjunction with data collected by the GRSME and the IRSSSM projects, conducted steelhead population monitoring in 22 populations for NOAA's status assessments.

This report includes a subset of standardized fish metrics developed by the Ad Hoc Supplementation Workgroup (Beasley et al. 2008) that describe the current status of anadromous fish returning to basin populations and tributaries contained within the Tribe's usual and accustomed areas. Reported metrics include key abundance and life history performance measures for adult returns through spawn year 2021 (hereafter, "2021") and productivity metrics through either brood year 2016 or brood year 2018. Reported metrics facilitate project evaluations, adaptive management, and NOAA's status and trends monitoring. Metrics reported do not include all data collected or summarized annually for project-specific objectives and may differ across fall Chinook Salmon, spring/summer Chinook Salmon, and summer steelhead due to differences in monitoring strategies and species and run life history characteristics. Non-reported metrics and supporting data are available from report authors or the Research Division's centralized data repositories, available online at https://nptfisheries.shinyapps.io/kus-data/.

This report was prepared by the Research Division's Adult Technical Team to satisfy funding conditions and to describe annual work completed and data collected under BPA Fish and Wildlife program contracts 86723, 74017 REL 72, 74017 REL 74, 86929, 74017 REL 73, and LSRCP grant F22AC00016-00. The Adult Technical Team consists of fisheries biologists representing each of the Research Division’s projects responsible for collecting, summarizing, and analyzing returning adult fish data.

Methods

The Research Division calculated tributary and population abundance, life history, and productivity performance measures (e.g., Beasley et al. 2008) using data collected at LGD, picket and floating weirs, spawning ground surveys, and in-stream passive integrated transponder tag detection systems (IPTDS). We used different combinations of these datasets for fall Chinook Salmon, spring/summer Chinook Salmon, and summer steelhead to meet specific geographic and project objectives. Within each species and run, we used consistent definitions of performance measures, estimation methods when possible, and levels of biological organization.

Data Collection

Adult Trapping The Research Division collects broodstock and adult return data from the LGD adult trap and uses picket and floating weirs installed on certain tributaries within the basin.

In 2021, NOAA, with assistance from Idaho Department of Fish and Game (IDFG) employees, operated and captured returning Snake River Chinook Salmon and steelhead at the LGD adult trap. Trapping operations started March 1 and ended December 30 (Fish Passage Center, 2022). Trap personnel marked a portion of all spring/summer Chinook Salmon and steelhead captured at LGD with passive integrated transponder (PIT) tags. They also collected tissue and scale samples which were later analyzed to determine the origin (e.g., parentage-based tagging and sex), hatchery release group, and age of sampled fish. Similarly, personnel subsampled fall Chinook Salmon, collected tissue and scales, and retained a subset of fish for broodstock. After processing, fall Chinook Salmon broodstock were hauled to either Lyons Ferry Hatchery or Nez Perce Tribal Hatchery. LGD adult trap operational details are available in Harmon (2003). LGD adult trap metadata descriptions are available on the Fish Passage Center website at https://www.fpc.org/111_sharedfiles/adultmetadata.pdf.

Tributary specific adult spring/summer Chinook Salmon and summer steelhead traps followed similar operational protocols across all locations; however, periods of operation differed according to the target species’ run-timing, location, elevation, and annual environmental conditions. Weir data was collected electronically or on paper datasheets and later uploaded to www.finsnet.org. Interested parties can find data and additional details regarding DFRM weir protocols and methods at https://nptfisheries.shinyapps.io/kus-data/, https://www.finsnet.org, and https://www.monitoringresources.org/Document/Protocol/Details/2247.

In 2021, we collected adult spring/summer Chinook Salmon data at weirs on Johnson Creek and the Lostine River. Production and Research Division staff installed the Johnson Creek weir on June 14 and operated the weir until September 15. Production staff operated the Lostine River weir from February 15 to November 10, capturing spring/summer Chinook Salmon between June 10 and September 11. Outside of spring/summer Chinook season the Lostine River weir operates to target returning adult steelhead and Coho Salmon, while the Johnson Creek weir does not, resulting in a longer operating season for the Lostine River weir. The Johnson Creek weir operated continuously throughout the season without any missed trapping periods. The Lostine River weir experienced 220 hours and 45 minutes of non-operation throughout the year, with the majority of that downtime occurring between May 31 and June 16. Staff collected broodstock at each weir for local hatchery production and supplementation programs. In 2021, we transferred Johnson Creek spring/summer Chinook Salmon to IDFG's Rapid River Hatchery facility rather than the standard holding location on the South Fork Salmon River. Comanagers (IDFG and NPT) made the decision to hold and spawn adults at Rapid River due to the abnormally high regional water temperatures observed during the adult return and the concern that the South Fork facility was less equipped to temper the holding ponds with cool water. We transferred Lostine River broodstock to the Oregon Department of Fish and Wildlife's (ODFW) Lookingglass Fish Hatchery. Returning spring/summer Chinook Salmon not collected for broodstock were either marked and released upstream for abundance estimation and allowed to spawn naturally, transported downstream and released for potential harvest in their respective fisheries, out-planted to other rivers for natural spawning in underseeded habitat, or harvested for ceremonial and subsistence use. In addition, out-of-population strays were identified at the Johnson Creek trap based on the absence of an adipose fin; these strays were euthanized. Specific details for the operation of Johnson Creek and Lostine River weirs are available in Robbins et al. (2022), IDFG et al. (2021), and ODFW et al. (2021).

Research Division staff installed and operated adult summer steelhead weirs in Camp Creek (Imnaha River) and Jacks Creek (lower Clearwater River). Production Division staff operated a permanent hydraulic weir in the Lostine River to monitor steelhead returns (and spring/summer Chinook Salmon as described above). Before their upstream release, fish were marked and biological samples collected to enable estimates of abundance, sex, and age of returning fish. Jacks Creek tissue samples were analyzed by the Idaho Department of Fish and Game (IDFG) Genetic Monitoring of Snake River Steelhead and Chinook Salmon project This project creates a parental baseline of genotypes from all steelhead spawned in the Snake River basin that is used to determine hatchery of origin, and brood year spawned (age determination). All unmarked/untagged steelhead without matching hatchery parents were considered natural adults.

Although we attempted to operate steelhead weirs continuously, short periods of high spring flows caused periods of non-operation. The Camp Creek weir operated from February 23 to May 21, with panels submerged for some time after 1700 hours on March 19 to 0930 hours on March 20. The Lostine River weir operated from February 15 to November 10, except for 220 hours and 45 minutes of non-operation occurring between April and June due to high flow and debris. Further details regarding summer steelhead weirs are available in Harbeck et al. (2016), Harbeck and Espinosa (2012), and ODFW et al. (2020). The Jacks Creek weir was installed on January 28, and operated until June 3. The weir was functional throughout the season except for the morning of February 23, when the weir panels were down for a short period due to high water and debris. The weir was cleaned and was fishing again by 1000 hours the same morning. No other periods of downtime occurred during the 2021 trapping season.

Spawning Ground Surveys The Research Division conducted spawning ground surveys throughout the Snake River basin to monitor adult Chinook Salmon and steelhead spawning in 2021. We conducted surveys to obtain an index of spawner abundance, contribute to mark-recapture escapement estimates, collect life history data, and monitor the spatial distribution of spawning. We surveyed fall Chinook Salmon in four major spawning areas within the Snake River MPG: Clearwater River, Grande Ronde River, Imnaha River, and Salmon River. Surveyed areas for spring/summer Chinook Salmon included portions of the Dry and Wet Clearwater

River, Grande Ronde/Imnaha Rivers, South Fork Salmon River, and Middle Fork Salmon River MPGs. We also surveyed summer steelhead in 13 Imnaha River MPG tributaries.

Spawning ground surveys consisted of multiple-pass aerial surveys (i.e., small, unmanned aerial systems or helicopters) for fall Chinook Salmon and single- or multiple-pass ground surveys for spring/summer Chinook Salmon and summer steelhead. Multiple-pass ground surveys provided a count of (new) redds constructed since the previous pass(es). Multiple-pass surveys also provided additional carcass-based life history data that may otherwise be unavailable through a single-pass survey. Surveyors geospatially referenced redds (and in some cases carcasses) and sampled all observed carcasses for biological characteristics and distinguishing marks or tags. Surveyors recorded data electronically or on field datasheets and subsequently transferred information to a standardized collection repository: https://npt-cdms.nezperce.org. Survey data and additional details about methods and protocols are available at https://nptfisheries.shinyapps.io/kus-data/ and https://www.monitoringresources.org/Document/Protocol/Details/2255. Joseph Field Office staff conducted spring/summer Chinook Salmon spawning ground surveys jointly with ODFW in northeastern Oregon; refer to Feldhaus et al. (2020) for details on survey methods used in the Grande Ronde/Imnaha basin.

The Nez Perce Tribal Hatchery (NPTH) M&E Project staff completed fall Chinook Salmon spawning ground surveys between September 29 and December 2, 2021. We conducted aerial helicopter surveys in the Upper Clearwater River, Middle Fork Clearwater River, South Fork Clearwater River, Selway River, Grande Ronde River, Imnaha River, and Salmon River. This was the third year for small, unmanned aircraft system (sUAS) surveys in the lower Clearwater River below the North Fork Clearwater River confluence, including a successful pilot study initiated in 2019. We postponed a helicopter survey to compare sUAS counts due to inclement weather and turbid water. However, we later conducted a helicopter survey at the end of spawning on December 2. We also conducted an sUAS survey in the lower Potlatch River. In 2021, instead of having ten census 1-km high use transects and selecting ten 1-km lower use transects by a stratified random sampling approach as in 2019 and 2020, we selected 30 1-km census transects in the highest use spawning habitat. These 30 transects represented 96.3% of the total redds counted since redd surveys began in the entire lower Clearwater River (1988 – 2018).

We conducted spawning ground surveys to monitor spring/summer Chinook Salmon throughout tributaries located within 5 Snake River Basin MPGs representing 15 discrete populations. Elevated water temperatures led McCall and Joseph Field office staff to conduct supplementary carcass surveys in July to gather prespawn mortality data before the conventional survey schedule. Traditional surveys began on August 2 and continued until September 23. Surveyed populations included Big Creek (MFBIG), Big Sheep Creek (IRBSH), East Fork South Fork Salmon River (SFEFS), Imnaha River mainstem (IRMAI), Little Salmon River (SRLSR), Lochsa River (CRLOC), Lolo Creek (CRLOL), Meadow Creek (SEMEA), Minam River (GRMIN), Secesh River (SFSEC), South Fork Salmon River mainstem (SFSMA), Upper Selway River (SEUMA), Upper South Fork Clearwater (SCUMA), Wallowa/Lostine Rivers (GRLOS), and Wenaha River (GRWEN). We used the spring/summer Chinook Salmon spawning ground survey data to inform abundance, life history, distribution, genetic, and productivity metrics for project evaluations and NOAA status assessments (NWFSC 2015). However, we only reported spawning ground survey data for population areas surveyed by the Tribe and co-produced with ODFW for northeast Oregon survey reaches.

Imnaha River Steelhead Status and Smolt Monitoring project staff conducted spawning ground surveys for summer steelhead in the Imnaha River (IRMAI) MPG tributaries from March 7 through June 16. Tributaries surveyed included Bear Gulch Creek, Camp Creek, Carrol Creek, Crazyman Creek, Dry Creek, Freezeout Creek, Grouse Creek, Gumboot Creek, Imnaha River, Lick Creek, Little Sheep Creek, Mahogany Creek, Morgan Creek, and North Fork Gumboot Creek. Unlike Chinook Salmon redd survey data, we only used steelhead redd data to monitor spawning locations and spawner distribution, not as an index of abundance.

In-stream Passive Integrated Transponder Tag Detection Systems The Tribe performed research and monitoring to track the abundance, distribution, and diversity of spring/summer Chinook Salmon and summer steelhead in the Snake River Basin through PIT tag observations. This work was in collaboration with a large number of state, federal, and tribal agencies including, LGD trap operations (NOAA Fisheries; BPA Project 2005-002-00; Harmon 2003; Ogden no date); adult biological sampling at LGD IDFG; BPA Project 1990-055-00, BPA Project 1991-073-00; hatchery parental based tagging (PBT) baselines for Chinook and steelhead BPA Project 2010-031-00) and; population abundance using Genetic Stock Identification (BPA Project 2010-026-00).

In addition, the Integrated Status and Effectiveness Monitoring Project developed two critical run decomposition models to (1) estimate the number of natural adults at LGD with uncertainty (See et al. 2021) and (2) partition the LGD abundance into tributary- and population-level abundances with uncertainty based on PIT tag observations (See et al. 2021; Waterhouse et al. 2020). For many summer steelhead populations above LGD, the PIT tag-based run decomposition methodology was the only way to estimate population-level escapement because high spring flows precluded other methods.

The number of PIT tag observation sites varied between individual populations. Many of the annual IPTDS sites used in this study were initially installed and operated by the Integrated Status and Effectiveness Monitoring Project; however, in 2021, these sites switched to BPA Project 2018-002-00 (Orme and Albee 2012; Orme and Albee 2013; QCI 2013). In 2021, annual IPTDS sites in the basin operated with minimal to no downtime (Meier 2020), thus providing valid population estimates for spring/summer Chinook Salmon and steelhead.

We pooled PIT tag observations at the most downstream IPTDS location within each population area to generate population scale estimates because detection sites do not always align with established population boundaries (IPTDSW 2020). In addition to population-level estimates, we generated site-specific estimates providing tributary- or spawning aggregate-level abundance that provided an estimate of spawner distribution within some subbasins. Specific details for IPTDS operation, maintenance, data collection, and analysis are available in IPTDSW (2020), Orme and Kinzer (2018), Orme et al. (2019), https://nptfisheries.shinyapps.io/kus-data/, and https://www.monitoringresources.org/Document/Protocol/Details/2262.

Data Analysis

Specific details regarding data summary methods and estimation methods for each Chinook Salmon and summer steelhead performance metric are available in Kinzer et al. (2021) and Young et al. (2021). When possible, we used consistent methods annually and among projects, species, and geographic locations, but differences in management strategies, population complexity, or changing environmental conditions often necessitated the use of multiple methods to accurately estimate performance measures. Kinzer et al. (2021) provides alternative methods when conditions necessitate. Periodically, project datasets fluctuate, and preferred statistical approaches change, requiring updates to our calculations. Metric calculations are also available as a dynamic web page to capture Kinzer et al. (2021) changes and provide a source for the most recent methodology updates https://ryankinzer.github.io/NPT_Standardized_Methods/.

We used data collected from adult traps, spawning ground surveys, and IPTDS collectively to generate estimates of performance metrics for adult Chinook Salmon and steelhead. Adult metrics, as reported in this document, adhered to the definitions of the Ad Hoc Supplementation Workgroup performance measures (Beasley et al. 2008) and cover abundance, life history, and productivity metrics for 2021 returns. Reported productivity metrics for smolt-to-adult return rates and progeny-per-parent ratios were through brood year 2016 and included age-5 adult returns in 2021. Juvenile recruits-per-spawner was estimated through brood year 2018, when the most recent juvenile emigrant data was available for the reporting tributaries. We reported metrics calculated from IPTDS data for spring/summer Chinook Salmon and steelhead at the Snake River basin (e.g., abundance at LGD) and the population-level using the state space adult dam escapement model (STADEM) and the dam adult branch occupancy model (DABOM) as a single unified method to support comparisons across geographic locations, provide key information for DFRM and regional fish managers, and contribute to status and trends monitoring for NOAA's species status assessments. Additionally, we report metrics at the tributary level when weir and spawning ground data were available to support localized management decisions, hatchery evaluations, and project-specific objectives. The performance metrics in this report are typically reported on a 10-year scale, presented with associated confidence intervals, and a 10-year arithmetic mean (average) unless specifically stated otherwise. The 10-year geometric mean is reported in some cases and specifically stated in reference to set recovery thresholds.

Fall Chinook Salmon performance measures in this report include abundance, life history, and productivity metrics. Abundance metrics include Snake River basin escapement, as estimated by the Fall Chinook Salmon Run-reconstruction Group (Young et al. 2022), and an index of spawner abundance (i.e., redd counts) for each surveyed stream reach. Life history metrics included female and age proportions estimated from run-reconstruction efforts and the hatchery fraction observed at LGD (Young et al. 2022). Since 2016, PBT-based proportion hatchery-origin spawners (pHOS) estimates, which we derived by assigning fish to their hatchery-of-origin, were compared to run reconstruction-based pHOS estimation methods to examine the latter estimate's accuracy. Reported productivity metrics include pre-spawn mortality, progeny-per-parent ratios, and smolt-to-adult return (SAR) ratios. NPTH M&E staff calculated (SAR) ratios for fall Chinook Salmon from NPTH and associated acclimation sites, and the Fall Chinook Salmon Acclimation Project (FCAP) sites (Table 2). They generated estimates from coded wire-tagged jack and adult returns to LGD from 2017 to 2021 developed through run-reconstruction efforts (Young et al. 2022).

Spring/summer Chinook Salmon performance measures included abundance, life history, and productivity metrics. Abundance metrics include Snake River basin escapement at LGD, population escapement, tributary escapement and fish disposition, index of spawner abundance (i.e., redd counts), the proportion of hatchery returns to weirs (i.e., hatchery fraction) and spawning grounds (i.e., [pHOS]). Life history metrics included female proportion, returning age composition (i.e., age-at-return), and adult size-at-return. Reported productivity metrics include prespawn mortality, progeny-per-parent ratios (e.g., adult and jack return per adult and jack spawner), SAR's, and recruit-per-spawner (e.g., juvenile abundance at tributary per female spawner) Smolt-to-adult return rates for this report were calculated as returning natural adults at the tributary per juvenile emigrant estimate, and returning hatchery adults per hatchery juvenile release group estimate. Juvenile recruits for recruits-per-spawner estimates, are estimates of juvenile abundace at the tributary or the hatchery release group size estimate.

Summer steelhead performance measures included abundance, life history, and productivity metrics. Abundance metrics include an aggregated Snake River basin escapement at LGD, population escapement, tributary escapement, and the proportion of hatchery returns to weirs. Life history metrics include female proportion, returning age composition (i.e., age-at-return), spawner spatial distribution, adult size-at-return, and adult run timing. Reported productivity metrics include progeny-per-parent ratios and smolt-to-adult return rates. Imnaha River steelhead SAR's were calculated for two different release groups that were designated in the separation by code tag list (in-river and run-at-large). In-river/bypassed steelhead only includes fish bypassed back to the river to avoid the hydropower facility to assess juvenile steelhead survival for fish remaining in-river through emigration. Run-at-large fish may be barged or bypassed depending on daily management actions at each hydropower facility using the separation by code tag list.

Results and Discussion

Fall Chinook Salmon

Abundance

Snake Basin Abundance In 2021, the abundance of hatchery fall Chinook Salmon increased from 2020 levels, but natural abundances decreased for the same period (Figure 1). Total return of 37,982 also remained below the 10-year average (Young et al. 2022). Estimated abundance of natural adult and jack fall Chinook Salmon in 2021 appeared similar to 2020, whereas the estimated number of hatchery fish to LGD increased by around 4,000 fish. The natural adult 10-year geometric mean escapement was 9,840 (Young et al. 2022), which was higher than NOAA's minimum viability abundance threshold of 4,500 (NOAA 2017).

Index of Abundance – Redd Counts The Nez Perce Tribe completed multiple-pass aerial spawning ground surveys during the 2021 fall Chinook Salmon spawning period (Table 1). In the lower Clearwater River, total redds decreased by 434 redds from 2020 and remained below than the 10-year average (Figure 2). The Middle Fork Clearwater River, South Fork Clearwater River, Potlatch River, Imnaha River, and Grande Ronde River redd counts were slightly higher than in 2020 (Figure 3). It was not possible to compare Salmon River counts counts with previous years because turbid water prevented the observation of deepwater redds.

Using sUAS to survey fall Chinook Salmon redds in the lower Clearwater River, expanded using a probabilistic survey design, we estimated 1,235 total redds compared to 1,669 estimated in 2020. Similar to 2020, we assume sUAS counts are more accurate than helicopter surveys because three experienced staff reviewed high-definition video multiple times to quantify the presence of individual redd pockets more clearly. Video review is especially beneficial in high-density spawning transects or where redd superimposition occurred. A traditional helicopter survey was conducted at the end of spawning in 2021 for comparison against sUAS counts. However, turbid conditions did not allow for a direct comparison to be made.

Life History Characteristics

Female Proportion The female proportion of natural and hatchery fall Chinook Salmon upstream of LGD was 0.37 and 0.38, respectively, for the 2021 return year (Figure 4). Since

2012, the female proportion ranged from 0.10 for natural fish in 2021 to 0.48 for hatchery fish in 2017 (Figure 4).

Proportion Hatchery-Origin Spawners Young et al. (2022) run-reconstruction methods for fall Chinook Salmon enable precise estimates of pHOS in the population escaping past LGD. In 2021, the run reconstruction pHOS estimate (0.79; Figure 5) was slightly higher than in previous years. Estimated pHOS across years was variable with no observable trend. In 2021, the run reconstruction method was 2.9% lower than the PBT method (Young et al. 2022). With five years of data, a pattern emerged where the pHOS estimates from PBT were consistently higher than those from the run-reconstruction, with differences ranging from -0.3% to 11.8%. The six-year average difference was 5.8% (Young et al. 2022).

Age Composition Age-3 and age-4 fish dominated the composition of fall Chinook Salmon in 2021 (Figure 6). Hatchery fish also appear to have a slightly higher proportion of returning age-2 and age-4 fish than the natural fish. Differences in cohort strength may be responsible for the apparent variability and pattern shifts in age composition over time.

Progeny-per-Parent Productivity of brood year 2016 fall Chinook Salmon, measured by progeny-per-parent ratios, was below replacement levels for natural fish and >5.0 for hatchery fish (Figure 7). Since brood year 2006, the natural fall Chinook Salmon progeny-per-parent ratios continue to remain below replacement levels of 1.0. In contrast, the hatchery fall Chinook Salmon progeny-per-parent ratios exceeded 3.0 for all years during the same period (Figure 7).

Smolt-to-Adult Ratio SAR estimates for brood year 2016 ranged from a low of 0.18% for the FCAP Pittsburg Landing yearling releases to 0.72% for the Cedar Flats subyearling releases (Table 2). The SARs for brood year 2016 were lower than we observed over the past five years. The decreased SAR rates are likely due to less favorable ocean conditions in recent years.

Spring/Summer Chinook Salmon

Abundance

Snake Basin Abundance The 2021 abundance estimate for adult spring/summer Chinook Salmon to LGD increased marginally from 27,539 in 2019 to 45,720 in 2021, but remained below the 10-year average and near a historic low (Figure 8; Appendix A). Returns of adipose fin-clipped hatchery Chinook Salmon dominated the escapement at LGD, followed by natural, then unclipped hatchery returns.

Population Abundance ICTRT population abundance estimates generated by IPTDS in 2021 showed an observable increase from 2019 to 2021, but were again lower than the 10-year average in most populations and underscore an observable decline in spring/summer Chinook Salmon across a broad landscape starting in 2010 (Figure 9; Appendix B).

Tributary Escapement Weir-based tributary escapement in Johnson Creek continued to increase in 2021 from a 10-year low in 2019 (Figure 10). However, tributary escapement in the Lostine River decreased relative to 2020. The observable downward trend in abundance for these streams over the last 10 years is evident with the estimates remaining below the 10-year average and recovery thresholds for the last 5 years, including 2021 (NPT 2013; NOAA 2017; NMFS 2020).

Johnson Creek The 2021 tributary escapement estimate to Johnson Creek was 699 spring/summer Chinook Salmon (Table 3). This estimate includes 614 fish upstream of the weir, 81 fish removed at the weir, an estimated four fish downstream and 0 fish harvested by Nez Perce Tribe fishers. The 2021 escapement estimate to Johnson Creek was 2.6 times higher than the escapement in 2019 and was the highest observed escapement in the past five years (Figure 10). Of the 555 unique fish captured and handled at the weir, 75 were removed for broodstock, 474 were released upstream for natural spawning, and six were euthanized and removed from the system according to management practices (Table 4).

Lostine River The 2021 tributary escapement estimate to the Lostine River was 914 spring/summer Chinook Salmon (Table 3). This estimate includes 432 fish upstream of the weir, 341 fish removed at the weir, an estimated 82 fish downstream, and 59 fish harvested by Nez Perce Tribe fishers. The 2021 Lostine River escapement estimate decreased from 1085 in 2020. Of the 728 unique fish captured and handled at the weir, 168 were removed for broodstock, the first arriving fish was removed for ceremonial and subsistence as is the custom, 288 were released upstream for natural spawning, 99 were transported and released downstream to recycle to the fishery, and 172 were outplanted to the Wallowa River for natural spawning (Table 4).

IPTDS Tributaries We report escapement estimates at all IPTDS locations in Appendix C. Site-specific estimates provide abundance at the tributary or spawning aggregate scale and a measure of spawner distribution within some basins. The location and distribution of IPTDS sites are available in Kinzer (2022). In addition, we report site-specific PIT tag detection probabilities used for abundance estimation in Appendix D.

Index of Abundance - Redd Counts In 2021, surveyors completed multiple-pass spawning ground surveys in five major population groups and 15 individual populations, observing a total of 1,794 spring/summer Chinook Salmon redds (Table 5; Figure *11*). Despite the total number of redds observed increasing from 1,453 in 2020, the index of spawner abundance for most populations appear to be in a general decline when observed over the past 10 years. Hatchery outplants into the Wet and Dry Clearwater MPGs increased in 2021, resulting in more redds than in 2020. Conversely, in areas where hatchery outplants didn't occur, such as in the Wet Clearwater's Upper Selway River, the number of redds observed were substantially lower. The largest increase occurred in the Upper South Fork Clearwater River, where surveyors observed 491 redds, an increase of 473 redds from 2020. In 2021, surveyors also observed more redds in the Lochsa River and Lolo Creek than in 2020. Redd numbers observed in 2021 remained relatively static or decreased across populations where management was relatively unchanged and there were no adult outplants or similar adult outplant practices compared to 2020. The number of redds observed was similar to 2020 in Big Creek, South Fork Salmon River mainstem, Big Sheep Creek, and the Wenaha River. The remaining population within the South Fork Salmon River MPG, in addition to the Grande Ronde/Imnaha MPG, had fewer redds observed in 2021 than in 2020. The total aggregated increase in redds across all populations was 341, or 1.2 times the number of redds observed in 2020. However, this appears to be a result of hatchery outplant practices and not an increase in adult spring/summer Chinook escapement.

Life History Characteristics

Female Proportion The female proportion (including jacks) of combined natural and hatchery Chinook Salmon returning to the Johnson Creek weir decreased from 0.36 in 2020 to 0.30 in 2020 and increased slightly at the Lostine River weir from 0.41 in 2021 to 0.42 in 2021 (Table 6; Figure 12). Female proportions over the past 10 years for Johnson Creek and Lostine River averaged 0.36 and 0.40, respectively. The 2021 female proportion (0.30) in Johnson Creek was slightly below the 10-year average, and the 2021 female proportion (0.42) in the Lostine River was slightly above its 10-year average.

The 2021 estimated female proportion of in-river spawners monitored by the Tribe via spawning ground surveys varied across populations (Table 5). In populations with greater than 20 individuals of known sex, the highest female proportion was in the Upper South Fork Clearwater (0.75, *n* = 819) and the lowest female proportion (0.33, *n* = 147) occurring in the East Fork South Fork Salmon River. The variations we observe in sex structures could be due to hatchery production programs (Knudsen et al. 2006), size-selective fishing regulations (Kendall and Quinn 2012), and natural variability due to the strengths and weaknesses of cohort classes.

Proportion Hatchery Origin Spawners The proportion of hatchery fish (e.g., hatchery fraction) returning to the Johnson Creek weir and Lostine River weirs during 2021 was 0.51 and 0.75, respectively (Table 6). The size of the hatchery release in the Lostine River is 2.5 times higher than that in Johnson Creek and this was reflected in the observed hatchery fraction at the Johnson Creek weir that was consistently lower than at the Lostine River weir for the past 10 years (Figure 14). In 2021, Johnson Creek returned the largest fraction of hatchery fish observed in the past 10 years. Notably, this increase occurred after the 10-year low in 2020. However, the 2020 low was confirmed by PBT analysis to be from a failed age-4 hatchery cohort return (BY2016) and the misclassification of origin of age-3 (BY17) hatchery fish at the weir (Kinzer et al. 2021).

We estimated the proportion of hatchery fish observed on spawning grounds (i.e., pHOS) in 2021 from the recovery of 1511 carcass in 11 of the 15 populations monitored by the Tribe (Table 5). No carcasses were found in the remaining five populations, or it was impossible to identify the origin of those collected. The populations with the highest pHOS were Big Sheep Creek (1.00, *n* = 22) and the upper South Fork Clearwater River (0.96, *n* = 818). We attributed these high pHOS estimates to outplants of hatchery fish for natural spawning and low natural returns. The Big Creek (0.0, *n* = 3), Secesh River (0.03, *n* = 94), and Wenaha River (0.0, *n* = 2) populations observed hatchery fish at 0.04 or less. Despite the small sample size in two of those three populations, they are wilderness systems, not supplemented with hatchery fish, or both. Therefore a low pHOS is expected. For populations with complete 10-year datasets, we observed the highest average pHOS in the Upper South Fork Clearwater and the Imnaha River mainstem populations, with the lowest average pHOS observed in the Big Creek and Secesh River populations (Figure 15).

Age Composition In 2021, the age-at-return for natural Chinook Salmon detected at in-stream PIT tag detection sites spanned three age classes: age-3 through age-5 for return years 2012-2021 (Figure 16). Like the age composition estimates from carcass data, most returning natural Chinook Salmon past LGD were classified as age-3 through age-5, with the majority of fish estimated as age-4 for most years and populations.

We estimated age composition in 7 of 15 monitored populations using dorsal fin ray samples, scale samples, genetic samples, coded wire tags, and PIT tags recovered from carcasses on the spawning grounds (Table 7). Like past years, our carcass-based age proportion estimates spanned three age classes: age-3 through age-5. Age-4 fish were the most abundant (Figure 17). In three populations (Minam River, Wenaha River and Little Salmon River) we were unable to estimate age composition due to a lack of samples. In the remaining five populations (Lochsa River, Lolo Creek, Meadow Creek, Upper Selway River, and Upper South Fork Clearwater) age structures were not analyzed for age composition analysis.

Size-at-Return Similar to previous years, spring/summer Chinook Salmon captured at the Johnson Creek and the Lostine River weirs had a bimodal size distribution. The smaller fish ranged from 300 to 650 mm FL and were primarily age-3. The mode of larger fish ranged from 651 to 1,200 mm FL and consisted of age-4 to age-5 individuals (Figure 18). The Johnson Creek weir captured a noticeably higher proportion of smaller fish than the ten-year average. This was also observed for natural Chinook Salmon captured at the Lostine River weir, but not for hatchery Chinook Salmon captured at the Lostine River weir (Figure 18).

The FL size distribution of natural and hatchery carcasses recovered in 2021 appeared similar to the 10-year average with a few exceptions (Figure 19). The East Fork South Fork Salmon River, Secesh River, South Fork Salmon River, and Wallowa/Lostine River populations appeared to have a greater proportion of shorter FL carcasses relative to the 10-year FL size distribution. Lengths were collected on few or no carcasses in the Wenaha River (*n* = 2), Little Salmon River (*n* = 0), Lochsa River (*n* = 0), Meadow Creek (*n* = 0), and Upper Selway River (*n* = 0) populations. A range-wide pattern of reduced body size has been observed for Pacific Salmon in recent decades (Lewis et al. 2015; Ohlberger et al. 2019; Oke 2020). A rigorous assessment of trend in the size (and age) of spring/summer Chinook Salmon in the Snake River basin is warranted, for size (and age) can have significant effects on the ecology and management of these fish.

Productivity

Prespawn Mortality In 2021, we estimated percent prespawn mortality in 12 of 15 monitored populations (Table 5). Prespawn mortality varied over time and across populations. The 2021 average prespawn mortality across all populations was approximately 5.6 %, and the 10-year average across all populations was approximately 13% (Figure 20). In populations with complete 10-year datasets, the highest 10-year average prespawn mortality occurred in the Wallowa/Lostine (19%), and the lowest prespawn mortality occurred in the Secesh River (2%). I In 2021 we observed the highest prespawn mortality in the Lolo Creek (33%, *n* = 9) population. We observed no prespawn mortality in the Big Creek (*n* = 5), Big Sheep Creek (*n* = 16), East Fork South Fork Salmon River (*n* = 48), Minam River (*n* = 6), and Wenaha River (*n* = 1) populations. However, the small sample size renders some of these estimates unreliable. In populations with sample sizes greater than 20 females, we observed the highest prespawn mortality in the Imnaha River mainstem (11%, *n* = 97) and the lowest in the East Fork South Fork Salmon River (0%, *n* = 48). Variation in prespawn mortality could be due to changes in stream temperature, fish size (Bowerman et al. 2021), or pressure from sport fisheries (Bendock and Alexandersdottir, 1990, Vincent-Lang et al. 1993).

Progeny-per-Parent Productivity for brood year 2016 spring/summer Chinook Salmon, measured by progeny-per-parent ratios, was below replacement levels for hatchery and natural fish in Johnson Creek and natural fish in the Lostine River with only hatchery fish in the Lostine River being above replacement (Table 8). However, over the past 10-years the typically higher progeny-per-parent rates observed for our hatchery fish in Johnson Creek and the Lostine River (Figure 21) have buffered the decreased return abundance of natural fish (Janowitz-Koch et al. 2018).

Progeny-per-parent ratios calculated at IPTDS sites are derived from 2012 through 2021 age-specific natural abundance estimates and exclude any hatchery "parent" spawners. Thus, we should view IPTDS productivity estimates as a "maximum" estimate of natural spawning productivity. As such, populations with more hatchery spawners are likely to exhibit a more positive bias, and populations with no hatchery spawners should remain unbiased. Regardless of the hatchery spawner contribution, progeny-per-parent ratios of natural spring/summer Chinook Salmon populations estimated using IPTDS observations and LGD sampling also show below replacement productivity levels across most Snake River Basin Populations (Figure 22).

Smolt-to-Adult Return We estimated SAR rates for brood year 2016 spring/summer Chinook Salmon in Johnson Creek and the Lostine River (Table 8). These estimates are calculated as the juvenile emigrant abundance or hatchery smolt release at the tributary to adult returns. These tributary-to-tributary abundance-based SAR estimates have remained below 2.0% and generally declined over the past 10-years (Figure 23).

Recruit-per-Spawner Estimates of hatchery juvenile recruits-per-female-spawner exceeded estimates of natural juvenile recruits-per-female-spawner in 2021 (Table 9). Over the past 10-years, the average recruits-per-female-spawner for Johnson Creek hatchery broodstock was approximately 5.3 times higher than their natural spawning counterparts. In the Lostine River population, the 10-year average recruits-per-female-spawner for hatchery broodstock was approximately 28.5 times higher than their natural spawning counterparts (Figure 24). These results demonstrate the sizeable demographic boost and survival advantage provided to fish spawned and reared in a hatchery environment during the early stages of their life cycle (Janowitz-Koch et al. 2018).

Summer Steelhead

Abundance

Snake Basin Abundance From July 1, 2020, to June 30, 2021, window count observations of all natural and hatchery steelhead at LGD totaled 59,126 fish, of which 20,679 were natural and/or unclipped adult steelhead (Columbia River DART, 2022). Using the State Space Adult Dam Escapement Model (STADEM) model (See et al. 2021), we estimated a total steelhead abundance at LGD of 61,564 fish in 2021 (Figure 25). We estimated natural escapement at 15,629 adult steelhead, representing 25.4% of the total return (Appendix A). The natural steelhead return for 2021 was the fifth-lowest within the past 10 years (Figure 25; Appendix A). Total natural steelhead abundance at LGD averaged nearly 38,300 adults from 2010 through 2016 but decreased to an average of 12,300 individuals from 2017 through 2021 (IPTDSW 2020). Since 2017, steelhead abundance estimates declined by 35% and remain below the 10-year average.

Population Abundance Although most of the natural ICTRT steelhead populations experienced a slight increase in abundance from 2020 to 2021, the 10-average continues to exhibit a downward trend (Figure 26; IPTDSW 2020). The Lemhi River and Clearwater River lower mainstem populations were an exception in 2021, where the abundance estimate decreased relative to 2020. Populations with the highest returns in 2021 included the Wallowa River (*n* = 963), Selway River (*n* = 915), and the Imnaha River (*n* = 892).

Tributary Escapement Similar to the population abundance estimates, tributary escapement estimates were somewhat higher in 2021.

Camp Creek In 2021, the Camp Creek weir captured eight natural and one hatchery adult steelhead with a 0.80 weir efficiency (Table 10; Figure 27). Using the Lincoln-Petersen mark-recapture estimator, the above-weir escapement estimate was 10 fish. Including an estimate of fish below the weir the total estimated escapement of summer steelhead into Camp Creek was 48 fish (Table 10). The weir trapped the first steelhead on March 26 and its last on April 17, 2021. The median trap date was March 29, 2021. In comparison, the 2021 IPTDS escapement estimate for Camp Creek was 34 natural fish (Appendix C). The site detected no previously PIT-tagged hatchery adult steelhead in 2021.

Lostine River In 2021, the Lostine River weir captured 134 natural adult summer steelhead with a weir efficiency of 0.25 (Table 10; Figure 27). The weir trapped the first and last steelhead on March 18 and June 2, 2021, respectively. The median date of capture was May 13, 2021. The weir-based escapement estimate was 404 adults using the Lincoln–Petersen mark-recapture estimator, while the IPTDS estimate was 8 (Figure 27, Appendix C). Factors for the wide-ranging estimates was due to the low number of recaptures in the Lincoln-Peterson mark-recapture estimator and only one natural adult steelhead was a recaptured LGD PIT-tagged adult steelhead used in the IPTDS estimate. No hatchery steelhead were trapped at the Lostine River weir in 2021. Eight natural-origin steelhead were natural post spawned mortalities that were disposed (Table 10) for nutrient enhancement in 2021.

Crazyman Creek The Crazyman Creek IPTDS site only detected four natural adult steelhead in 2021 which yielded a population estimate of 18 natural adult steelhead (Appendix C). The first detection was on April 23, and the last detection occurred on May 17. The median detection date was May 4, 2021. No hatchery steelhead were detected at the Crazyman Creek IPTDS site in 2021.

Grouse Creek The Grouse Creek IPTDS site population estimate was 66 natural adult steelhead (Appendix C) based on 23 unique detections. The first detection was on March 24, and the last detection occurred on May 29, 2021. The median detection date was April 28, 2021. No hatchery steelhead were detected at the Grouse Creek IPTDS site in 2021.

Jacks Creek In 2021, the Jacks Creek summer steelhead escapement to the weir was a census of 16 adults with a weir efficiency of 1.00 (Table 10; Figure 27). The IPTDS estimate was 15 (Appendix C) and based on two detections of adult steelhead previously tagged at LGD. Additionally, there were six fish that we designated as resident rainbow trout captured ranging in size from 360 to 460 mm FL. The weir trapped the first and last steelhead on February 25 and May 3, respectively. Five natural-origin and one hatchery-origin steelhead were post spawn mortalities that were disposed (Table 10) for nutrient enhancement in 2021.

White Bird Creek The White Bird Creek IPTDS population estimate was 89 natural adult steelhead in 2021 (Appendix C). The first detection was on March 8, and the last detection occurred on May 3, 2021. The median detection date was March 22, 2021

IPTDS Tributaries In addition to the tributaries specifically listed above, we reported escapement estimates from the Lower Granite dam adult branch occupancy model (DABOM) for many other Snake River basin IPTDS site locations (See et al. 2021; Appendix C). Site-specific estimates provided abundance estimates at the tributary or spawning aggregate scale and measured spawning distribution within some basins. Additionally, site-specific PIT tag detection probabilities were estimated and reported in Appendix D. See Orme and Kinzer (2018) for a description of the relative location and distribution of IPTDS sites.

Life History Characteristics

Female Proportion Across the Snake River basin, sex ratios of returning steelhead observed at IPTDS locations in 2021 ranged from 0.77 to 0.79 female (Figure 28). Proportions remain skewed towards females across all monitored populations. The female proportions for Jacks Creek, Lostine River, and Camp Creek were; 0.75, 0.72 and 0.67 respectively (Table 10).

Hatchery Fraction In general, we trap few hatchery steelhead at our weirs (Table 10). In 2021, we did not capture any hatchery adult steelhead at the Lostine River Weir. The Camp Creek weir captured one adult hatchery steelhead resulting in a hatchery fraction of 0.11 (Table 10). The Jacks Creek weir captured two adipose fin-clipped hatchery steelhead for a hatchery fraction of 0.13. Parentage analysis of all genetic samples collected from Jacks Creek was applied to determine hatchery of origin and age. One of the two tissue samples collected from adipose fin-clipped steelhead at Jacks Creek was genotyped successfully, showing that fish was the progeny of the 2017 spawn at Dworshak National Fish Hatchery. Genotyping and parentage analysis of steelhead with intact adipose fins successfully determined that 12 of 14 tissue samples collected at Jacks Creek had no hatchery parents. Those results validated our assumption that the steelhead with intact adipose fins captured at the Jacks Creek were natural-origin.

Age Composition PIT tag detections at IPTDS sites indicated annual returns of summer steelhead consisted of six “total” age groups (i.e., cohorts) ranging from age-3 to age-7. In 2021, age-5 and age-6 fish represented the dominant cohorts (Figure 31).

Freshwater ages of these natural steelhead varied from 1 to 4 years, with most fish spending 2 or 3 years in freshwater before smolting (Figure 32). Natural steelhead primarily returned as 2-ocean fish. One-ocean aged adult steelhead were nearly absent from the Snake River return, accounting for only 8% of the run and likely a cohort failure (similar to spawn year 2017). Furthermore, only six adult steelhead were 3-ocean aged fish above LGD (Figure 33).

Scale analysis of Imnaha River steelhead revealed a variety of stream- and ocean-age combinations. Adult steelhead spent 1 to 3 years in freshwater with 78% of the sample having emigrated as two year old smolts. Two thirds (66.8%) of the returning Imnaha steelhead were 2-ocean aged adults. No resident rainbow trout or repeat spawning steelhead were evident in the scale sample based on our analysis (data not shown).

Based on the scale analysis of Jacks Creek natural steelhead, we determined that ocean ages comprised three 1-ocean and 10 2-ocean adult returns, with the age of one natural adult undetermined. We identified the two hatchery steelhead adults captured at the Jacks Creek weir as 2-ocean adults (data not shown).

Size at Return Length distributions illustrate the size structure of a population. The FL distribution plots for summer steelhead measured at Camp Creek and Lostine River weirs depict fish in two prominent size classes, which also follow the trend line for the period of record (Figure 35).

The mean size of Imnaha steelhead returning to Camp Creek was 652 mm FL and ranged from 560 to 745 mm. Steelhead that spent one year in saltwater averaged 580 mm FL and steelhead that spent two years in saltwater averaged 690 mm FL. The average size of steelhead returning to the Lostine River was 688 mm FL and ranged from 405 to 820 mm.

The average size of Jacks Creek natural 1-ocean and 2-ocean adult steelhead was 610 mm FL and 743 mm FL, respectively. Only one of the 2-ocean natural adults captured at Jacks Creek was equal to or greater than 780 mm FL suggesting that this population doesn’t exhibit the B-run life history. Both of the hatchery steelhead captured at the Jacks Creek weir were greater than or equal to 780 mm FL suggesting a B-run life history.

Spatial Distribution in the Imnaha Population

We conducted multiple-pass spawning ground surveys in Camp and Mahogany creeks, single-pass surveys in thirteen upper Imnaha River tributaries (Table 11), and a float survey in the Imnaha River mainstem in 2021. During our surveys, we observed the first redd on March 28 and the last new redd on June 16. We found no redds in Dry, Lick, Mahogany Creek, Morgan Creek, or North Fork Gumboot Creek. Summaries of redd totals, redds per kilometer, and survey lengths are available in Table 11. Spawner distribution patterns in 2021 appeared similar to previous survey years (Figure 34).

Productivity

Progeny-per-Parent In-stream PIT tag detection estimates of progeny-per-parent natural steelhead ratios calculated from age-specific abundance estimates (spawn years 2010 through 2019) showed a decline for brood years 2010 through 2016 (Figure 36). Productivity estimates excluded hatchery “parent” spawners from the calculation, resulting in “maximum” estimates (i.e., positively biased). As such, populations with a greater number of hatchery spawners were likely to contain a larger positive bias, and populations with no hatchery spawners remained unbiased. Regardless of the hatchery spawner contribution, IPTDS results showed productivity decreased during the last few years (Figure 36).

Smolt-to-Adult Return We determined SARs for the Imnaha population using LGD-to-LGD estimates and SARs using Imnaha River-to-Imnaha River estimates for an actual rate back to the river of origin. We quantified SARs for both in-river / bypassed and run-at-large PIT tag groups according to juvenile steelhead segregation through the hydrosystem.

In 2021, sufficiently adequate adult returns allowed for the analyses of SARs for Imnaha River summer steelhead for juvenile migration year 2017 back through migration year 2009; a nine-year downward trend. Generally, the LGD-to-LGD Imnaha River SAR estimates paralleled the adult escapement trend. In-river groups had lower SAR estimates than run-at-large groups. The mean for the run-at-large was 2.12% compared with the in-river group was 1.37%. The run-at-large steelhead group ranged from a high of 4.16% in 2009 to a low of 0.19% in 2015. The in-river group ranged from 2.49% in 2013 to 0.10% in 2015 (Table 12).

Likewise, the tributary-to-tributary SARs were also variable and tracked the LGD-to-LGD downward trending rates, with the average SAR for the run-at-large tag group of 1.30% compared to the 0.78% average for the in-river tag group. Run-at-large tag group SAR estimates for steelhead ranged from 2.88% in migration year 2009 to 0.06 % in 2015. The in-river steelhead group ranged from a high of 1.62% in 2009 to 0.03% in 2015 (Table 13).

Conclusions and Recommendations

In recent years, Chinook Salmon and steelhead returns to the Snake River basin decreased, and models project they will continue declining into the future (Isaak et al. 2018). In the last 10-years, the observed rate of decline appeared to be similar across species and runs. Annually observed abundances for all stocks started to decline around 2010 and 2011 after a brief period of growth. Since then, reduced abundance and productivity severely limited treaty-reserved tribal and recreational fisheries. The returning abundance of Snake River anadromous fish was likely correlated negatively with out-of-basin factors including mainstem flows and temperatures (Crozier et al. 2020), with the most recent decline attributed to the additional stress of poor ocean conditions (Crozier et al. 2021). In 2021, most Snake River salmon and steelhead populations experienced higher returns than those observed from 2017 to 2019. Although this could indicate a shift from a downward trend towards a positive trend and future increases in abundance, it is likely short-term. Intensive population modeling suggests that a continued reduction in ocean survival, primarily driven by climate change, will perpetuate the decline of Snake River anadromous abundance. Given the declines in fish abundance observed in the last 10-years and any future decreases caused by poor ocean survival, the DFRM calls for immediate actions to offset current limiting factors and prevent Snake River salmon and steelhead extinction.

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References

Beasley, C. A., B. A., Berejikian, R. W. Carmichael, D. E. Fast, M. J. Ford, P. F. Galbreath, and D. A. Venditti. 2008. Recommendations for broad scale monitoring to evaluate the effects of hatchery supplementation on the fitness of natural salmon and steelhead populations. Final Draft Report of the Ad Hoc Supplementation Monitoring and Evaluation Workgroup.

Bendock, T. and M. Alexandersdottir. 1990. Hook and release mortality of Chinook salmon in the Kenai River recreational fishery. Alaska Department of Fish and Game. Fishery Data Series No. 90-16.

Bjornn, T. C. and N. Horner. 1980. Biological criteria for classification of Pacific salmon and steelhead as threatened or endangered under the Endangered Species Act. (SS/X.A.4.)

Bowerman, T. E., M. L., Keefer, and C. C. Caudill. 2021. Elevated stream temperature, origin, and individual size influence Chinook salmon prespawn mortality across the Columbia River Basin. Fisheries Research, Volume 237, Article 105874.

Carmichael, R.W., L.R. Clark, M Flesher, D. Eddy, S. Warren, H. Stanton. 2011. Imnaha River Summer Steelhead Hatchery Program Review. Oregon Department of Fish and Wildlife, LaGrande, Oregon.

Columbia River DART, Columbia Basin Research, University of Washington. 2021. PIT Tag Adult Returns Graphics & Text. Available from: https://www.cbr.washington.edu/dart/query/adult_graph_text.

Copeland, T., M. W. Ackerman, K. K. Wright, and A. Byrne. 2017. Life History Diversity of Snake River Steelhead Populations between and within Management Categories. North American Journal of Fisheries Management. 37:395-404

Crozier, L. G., B. J. Burke, B. E. Chasco, D. L. Widener, R. W. Zabel. 2021. Climate change threatens Chinook salmon throughout their life cycle. Communications Biology. 4:222(2021).

Crozier L. G., Siegel J.E., Wiesebron L.E., Trujillo E.M., Burke B.J., Sandford B.P., and D.L. Widener. 2020. Snake River sockeye and Chinook salmon in a changing climate: Implications for upstream migration survival during recent extreme and future climates. PLoS ONE 15(9): e0238886.

Feldhaus, J. W., D. L. Eddy, and J. R. Ruzycki. 2020. Lower Snake River Compensation Plan: Oregon Spring Chinook Salmon Evaluation Studies 2018 Annual Progress Report. Oregon Department of Fish and Wildlife, LaGrande, Oregon.

Fish Passage Center. 2022. Adult fish passage at Columbia and Snake River dams available at https://www.fpc.org/adults/Q_adults_passagedata.php.

Harbeck, J. R. and N. P. Espinosa. 2012. Imnaha river steelhead *Oncorhyncus mykiss* adult monitoring project. 2011 Annual Report, Project Number 212-032-00. Contract 48061, Bonneville Power Administration, Portland, Oregon.

Harbeck, J. R., N. P. Espinosa, A. Johnson and R. Rumelhart. 2016. Imnaha river steelhead *Oncorhyncus mykiss* adult monitoring project. 2012 Annual Report, Project Number 212-032-00. Contract 71016, Bonneville Power Administration, Portland, Oregon.

Harmon, J.R. 2003. A trap for handling adult anadromous salmonids at Lower Granite Dam on the Snake River, Washington. North American Journal of Fisheries Management. 23:989-992.

Heard, W. R., E. Shevlyakov, O. V. Zikunova, and R. E. McNicol. 2007. Chinook Salmon – Trends in abundance and biological characteristics. North Pacific Anadromous Fish Commission Bulletin. 4:77-91.

IDFG (Idaho Department of Fish and Game. 1992). Lower Snake River Compensation Plan Evaluation FY 1987- FY1991.

IDFG, NPT, SBT, USFWS and IPC (Idaho Department of Fish and Game, Nez Perce Tribe, Shoshone-Bannock Tribes, U.S. Fish and Wildlife Service and Idaho Power Company). 2021. Standard Operating Procedures for Salmon and Steelhead Production Programs in the Salmon and Snake River Basins. Available: https://fws.gov/media/annual-operations-plan-salmon.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2003. Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionary Significant Units Within the Interior Columbia River Domain. National Oceanographic and Atmospheric Administration.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2005. Population Maps. National Oceanographic and Atmospheric Administration.

Isaak, Daniel & Luce, Charles & Horan, Dona & Chandler, Gwynne & Wollrab, Sherry and David, Nagel. 2018. Global Warming of Salmon and Trout Rivers in the Northwestern U.S.: Road to Ruin or Path Through Purgatory?. Transactions of the American Fisheries Society. 147. 566-585. 10.1002/tafs.10059.

IPTDSW (In-stream PIT tag detection systems workgroup). 2020. Report to NOAA Fisheries for 5-Year ESA Status Review: Snake Basin Steelhead and Chinook Salmon Population Abundance, Life History, and Diversity Metrics Calculated from In-stream PIT Tag Observations (SY2010-SY2019). January 2020

Janowitz-Koch I., C. Rabe, R. Kinzer, D. Nelson, M. A. Hess, and S. R. Narum. 2018. Long-term evaluation of fitness and demographic effects of a Chinook Salmon supplementation program. Evolutionary Applications. 2019 Mar;12(3):456-469.

Kendall N. W. and T. P. Quinn. 2012. Size-selective fishing affects sex ratios and the opportunity for sexual selection in Alaskan sockeye salmon *Onchorhynchus nerka*, Oikos, Volume 122, Issue 3, 411-420.

Kinzer, R.N. 2022. Integrated In-stream PIT Tag Detection System Operations and Maintenance; PIT Tag Based Adult Escapement Estimates for Spawn Year 2021. [Manuscript in preparation]

Kinzer, R. N., Arnsberg, B., Harbeck, J., Maxwell, A., Orme, R., Rabe, C., Vatland, S. 2021. Snake River Basin Adult Chinook Salmon and Steelhead Monitoring. 2020 Annual Report. Nez Perce Tribe, Department of Fisheries Resources Management, Research Division. Lapwai, ID.

Kinzer, R. N., C. B. Watry, and T. T. Stright. 2021. Standardized Calculations for Snake River Basin Chinook Salmon and Steelhead High Level Indicators and Metrics. Nez Perce Tribe. https://ryankinzer.github.io/NPT_Standardized_Methods/.

Knudsen, C. M., S. L. Schroder, C. A. Busack, M. V. Johnston, T. N. Pearson, W. J. Bosch and D. E. Fast. 2006. Comparison of Life History Traits between First-Generation Hatchery and Wild Upper Yakima River Spring Chinook Salmon, Transactions of the American Fisheries Society, 135:4, 1130-1144, DOI: 10.1577/T05-121.1

Landeen, D., and A. Pinkham. 1999. Salmon and His People; Fish and Fishing in Nez Perce Culture. A Nez Perce Nature Guide. Confluence Press, Lewiston ID.

McClure, M. M., E. E. Holmes, B. L. Sanderson, and C. E. Jordan. 2003. A large-scale, multispecies status assessment: anadromous salmonids in the Columbia River basin. Ecological Applications, *13*(4), 964-989.

Meier, K. 2020. Integrated In-stream PIT tag Detection System Operations and Maintenance, Operations and Maintenance Annual Report. Biomark Inc. Boise Idaho. BPA Project 2018-002-00, BPA contract #80535.

Nehlsen W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16(2):4-21.

NPT (Nez Perce Tribe). 2013. Nez Perce Tribe Department of Fisheries Resources Management: Management Plan 2013-2028. Prepared by the Department of Fisheries Resources Management Strategic Plan Ad Hoc Team. Available: https://nezperce.org/wp-content/uploads/2020/09/DFRM-Management-Plan-2013-2028.pdf

NMFS (National Marine Fisheries Service). 1992. Endangered and threatened species; threatened status for Snake River spring/summer Chinook Salmon, threatened status for Snake River Fall Chinook Salmon Federal Register [Docket No. 910647-2043, 22 April 1992] 57 (78): 14,653-14,662.

NMFS (National Marine Fisheries Service). 1997. Endangered and Threatened Species: Listing of Several Evolutionary Significant Units (ESUs) of West Coast Steelhead Federal Register [Docket No. 960730210–7193–02, 18 August 1997] 62 (159): 43937-43954.

NMFS (National Marine Fisheries Service). 2020. A Vision for Salmon and Steelhead: Goals to Restore Thriving Salmon and Steelhead to the Columbia River Basin. Phase 2 Report of the Columbia River Partnership Task Force of the Marine Fisheries Advisory Committee. October 2020. Portland, OR. Available: https://www.fisheries.noaa.gov/vision-salmon-and-steelhead-goals-restore-thriving-salmon-and-steelhead-columbia-river-basin.

NOAA (National Oceanic and Atmospheric Administration) (NOAA). 2017. ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon (Oncorhynchus tshawytscha) & Snake River Basin Steelhead (Oncorhynchus mykiss). Available: https://www.fisheries.noaa.gov/resource/document/recovery-plan-snake-river-spring-summer-chinook-salmon-and-snake-river-basin.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

Ogden, D. no date. Operation of the Adult Trap at Lower Granite Dam, 2020. For the Period of January 1 to December 31, 2020., BPA project 2005-002-00.

ODFW, CTUIR and NPT (Oregon Department of Fish & Wildlife, Confederated Tribes of the Umatilla Reservation and Nez Perce Tribe). 2020. Steelhead Annual Operation Plan for Lower Snake River Fish and Wildlife Compensation Plan. Grande Ronde and Imnaha Basin. For the Period of January 1 to December 31, 2021.Available: https://fws.gov/media/annual-operations-plan-grande-ronde

ODFW, CTUIR and NPT (Oregon Department of Fish & Wildlife, Confederated Tribes of the Umatilla Reservation and Nez Perce Tribe). 2021. Annual Operating Plan for Lower Snake River Fish and Wildlife Compensation Programs. Grande Ronde and Imnaha Basins, Oregon. Spring Chinook, Fall Chinook, Coho Salmon and Pacific Lamprey. For the Period of January 1 to December 31, 2021. Available: https://fws.gov/media/annual-operations-plan-grande-ronde

Orme, R., and C. Albee. 2012. Integrated Status and Effectiveness Monitoring Project: Salmon Subbasin Instream PIT Tag Array Site Profiles and Detection Efficiencies. Prepared for Quantitative Consultants, Inc. under BPA Project #2003-017-00.

Orme, R., and C. Albee. 2013. Integrated Status and Effectiveness Monitoring Project: Salmon Subbasin In-stream PIT Tag Array Site Descriptions and Data Collection. Prepared for Quantitative Consultants, Inc. under BPA Project #2003-017-00.

Orme, R., and R. Kinzer. 2018. Integrated in-stream PIT tag detection system operations and maintenance; PIT tag based adult escapement estimates for spawn years 2016 and 2017. Nez Perce Tribe Department of Fisheries Resources Management. Prepared for Quantitative Consultants, Inc. Annual Report 2018, BPA Project 2018-002-00.

Orme, R., R. N. Kinzer, and C. Albee. 2019. Population and Tributary Level Escapement Estimates of Snake River Natural-origin Spring/Summer Chinook Salmon and Steelhead form In-stream PIT Tag Detection Systems – 2019 Annual Report. BPA Project 2018-002-00.

QCI (Quantitative Consultants, Inc). 2013. Integrated status and effectiveness monitoring project: Salmon Subbasin cumulative analysis report. Quantitative Consultants, Inc. Annual report, 2012, BPA Project 2003-017-00

Robbins, J., D. Brown, and J. Gebhards. 2022. Johnson Creek Adult Chinook Salmon Run Report. 2021 Annual Report. Project Number 1996-043-00. Contract 74017 Rel 74. Prepared for U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

See, K. E., Kinzer, R. N., & Ackerman, M. W. 2021. State-Space Model to Estimate Salmon Escapement Using Multiple Data Sources. North American Journal of Fisheries Management. https://doi.org/10.1002/nafm.10649

Sontag, D. M. 2013. Predation, turbidity, and other factors influencing juvenile Salmonid survival in the lower Snake River.

Tiffan, K. F., T. J. Kock, C. A. Haskell, W. P. Connor, and R. K. Steinhorst. 2009. Water velocity, turbulence, and migration rate of subyearling fall Chinook salmon in the free-flowing and impounded Snake River. Transactions of the American Fisheries Society, 138(2), 373-384.

Vincent-Lang, D., M. Alexandersdottir, and D. McBride. 1993. Mortality of coho salmon caught and released using sport tackle in the Little Susitna River, Alaska. Fisheries Research 15 : 339-356.

Waterhouse, L., White, J., See, K., Murdoch, A., & Semmens, B. X. 2020. A Bayesian nested patch occupancy model to estimate steelhead movement and abundance. Ecological Applications, *0*(0), 17. https://doi.org/10.1002/eap.2202.

WDF (Washington Department of Fisheries). 1993. Stock composition of fall chinook at Lower Granite Dam in 1992. Columbia River laboratory progress report 93-5. Battleground, WA. (F/X.A.2.c.)

WDFW and ODFW (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife). 2000. Status Report: Columbia River runs and fisheries 1938-2000. Joint Columbia River Management Staff. Vancouver, Washington/Clackamas, Oregon.

Young, W., S. Rosenberger, D. Milks, and B. Sanford. 2014. Preliminary 2013 Snake River Fall Chinook salmon returns to Lower Granite Dam. February 3, 2014 memo to US v Oregon Technical Advisory Committee (TAC). 5 pages.

Young, W., S. Rosenberger, J. Bumgarner, J. Fortier, B. Sandford, and A. Harris. 2022. Snake River fall Chinook salmon Lower Granite Dam run reconstruction report; return year 2021. Prepared for U.S. Fish and Wildlife Service, Lower Snake River Compensation Plan United States Department of Interior Grant No. F21AP00406-00. Boise, Idaho.

Tables

Table 1. Fall Chinook Salmon redds observed during 2021 aerial spawning ground surveys. We expanded redds observed in the surveyed Lower Clearwater River reaches with a probabilistic survey design to estimate the total number of redds in the entire river section; the total estimated redd count is in the parentheses.

Stream	Transect	Pass 1	Pass 2	Pass 3	Total
Selway River	Lower Selway River	3	27	14	44
South Fork Clearwater River	SF1	1	60	23	84
Middle Fork Clearwater River	M.F. Clearwater River	2	30	31	63
Clearwater River	Upper Clearwater River	1	58	39	98
	Lower Clearwater River	172	747	0	919 (1,235)
Grande Ronde River	Lower Grande Ronde River	3	209	172	384
Imnaha River	Lower Imnaha River	0	31	15	46
Salmon River	Lower Salmon River	247	0	0	247
Potlatch River	Lower Potlatch River	2	0	0	2
North Fork Clearwater River	Lower North Fork Clearwater	0	0	0	0

Table 2. Fall Chinook Salmon smolt-to-adult (SAR) for brood year 2016 hatchery-origin releases.

Release Site/Life Stage	CWTs Released	Jacks	2-Ocean	3-Ocean	4-Ocean	Total	SAR%
NPTH Subyearling	606,612	350	847	2,385	181	3,763	0.62
Cedar Flats Subyearling	209,131	10	331	1,076	97	1,514	0.72
Lukes Gulch Subyearling	210,346	78	191	1,113	56	1,438	0.68
Big Canyon Subyearling	215,828	280	276	542	0	1,098	0.51
Captain Johns Subyearling	214,610	377	373	322	0	1,072	0.50
Pittsburg Landing Subyearling	217,049	216	250	165	0	631	0.29
Big Canyon Yearling	156,561	121	250	33	0	404	0.26
Captain Johns Yearling	155,866	128	151	61	0	340	0.22
Pittsburg Landing Yearling	157,011	98	146	35	0	279	0.18

Table 3. Tributary escapement of natural- and hatchery-origin spring/summer Chinook Salmon returning to Johnson Creek and the Lostine River during spawn year 2021 (95% CIs in parentheses).

Stream Name	Above Weir Escapement	Below Weir Escapement	Weir Removal	NPT Harvest	Tributary Escapement
Johnson Creek	614 (565, 664)	4 (4, 4)	81	0	699 (650, 749)
Lostine River	432 (283, 653)	82 (63, 111)	341	59	914 (746, 1164)

Table 4. Final disposition of spring/summer Chinook Salmon trapped and handled at Nez Perce Tribe operated weirs during spawn year 2021.

Weir	Disposition	Natural		Hatchery		Sub-total
		Female	Male	Female	Male	
Johnson Creek	Brood Stock	41	34	0	0	75
	Natural Spawning	55	140	69	210	474
	Stray Removal	0	0	3	3	6
Lostine River	Brood Stock	15	19	65	69	168
	Distribution	0	0	1	0	1
	Natural Spawning	49	101	84	54	288
	Outplant	0	0	34	138	172
	Recycled	0	0	36	63	99

Table 5. Total redds counted and estimated life history metrics from combined natural- and hatchery-origin spring/summer Chinook Salmon carcasses collected during 2021 spawning ground surveys (MPG = major population group, pHOS = proportion of hatchery-origin spawners, 95% CIs in parentheses).

MPG	Population	Total Redds	pHOS	Female Proportion	Prespawn Mortality
Dry Clearwater	Upper South Fork Clearwater	491	0.96 (0.92, 0.98)	0.75 (0.67, 0.81)	0.02 (0.01, 0.07)
Grande Ronde / Imnaha	Big Sheep Creek	35	1.00 (0.85, 1.00)	0.73 (0.52, 0.87)	0.00 (0.00, 0.19)
	Imnaha River mainstem	311	0.77 (0.70, 0.83)	0.57 (0.50, 0.64)	0.11 (0.06, 0.19)
	Minam River	103	0.14 (0.03, 0.51)	0.67 (0.35, 0.88)	0.00 (0.00, 0.39)
	Wallowa/Lostine River	182	0.69 (0.61, 0.75)	0.41 (0.33, 0.48)	0.09 (0.04, 0.18)
	Wenaha River	101	0.00 (0.00, 0.66)	0.50 (0.09, 0.91)	0.00 (0.00, 0.79)
Middle Fork Salmon River	Big Creek	26	0.00 (0.00, 0.56)	1.00 (0.65, 1.00)	0.00 (0.00, 0.43)
South Fork Salmon River	East Fork South Fork Salmon River	123	0.53 (0.45, 0.61)	0.33 (0.26, 0.41)	0.00 (0.00, 0.07)
	Little Salmon River	0	-	-	-
	Secesh River	99	0.04 (0.02, 0.11)	0.42 (0.33, 0.53)	0.03 (0.00, 0.14)
	South Fork Salmon River mainstem	115	0.75 (0.63, 0.84)	0.51 (0.39, 0.63)	0.03 (0.01, 0.16)
Wet Clearwater	Lochsa River	6	-	-	-
	Lolo Creek	146	0.94 (0.72, 0.99)	0.56 (0.33, 0.77)	0.33 (0.12, 0.65)
	Meadow Creek	50	-	-	-
	Upper Selway River	6	-	-	-

Table 6. Hatchery fraction and female proportion of combined natural- and hatchery-origin spring/summer Chinook Salmon returning to Johnson Creek and Lostine River weirs during spawn year 2021 (95% CIs in parentheses).

Weir	Hatchery Fraction	Female Proportion
Johnson Creek	0.51 (0.47, 0.55)	0.30 (0.27, 0.34)
Lostine River	0.75 (0.71, 0.78)	0.42 (0.39, 0.45)

Table 7. Estimated age composition of natural- and hatchery-origin spring/summer Chinook Salmon carcasses collected during 2021 spawning ground surveys (MPG = major population group, 95% CIs in parentheses).

MPG	Population	Age 3	Age 4	Age 5
Grande Ronde / Imnaha	Big Sheep Creek	0.00 (0.00, 0.28)	1.00 (0.72, 1.00)	0.00 (0.00, 0.28)
	Imnaha River mainstem	0.03 (0.01, 0.11)	0.93 (0.84, 0.97)	0.03 (0.01, 0.11)
	Minam River	-	-	-
	Wallowa/Lostine River	0.16 (0.09, 0.26)	0.83 (0.72, 0.90)	0.01 (0.00, 0.08)
	Wenaha River	-	-	-
Middle Fork Salmon River	Big Creek	0.00 (0.00, 0.39)	0.67 (0.30, 0.90)	0.33 (0.10, 0.70)
South Fork Salmon River	East Fork South Fork Salmon River	0.41 (0.34, 0.49)	0.56 (0.48, 0.64)	0.03 (0.01, 0.07)
	Little Salmon River	-	-	-
	Secesh River	0.18 (0.11, 0.27)	0.78 (0.68, 0.85)	0.04 (0.02, 0.11)
	South Fork Salmon River mainstem	0.12 (0.06, 0.24)	0.84 (0.72, 0.91)	0.04 (0.01, 0.12)

Table 8. Spring/summer Chinook Salmon performance measures including adult progeny-per-parent and smolt-to-adult return (SAR) productivity estimates for Johnson Creek and Lostine River natural and hatchery spawning during brood year 2016.

Stream	Origin	Tributary Spawners	Juvenile Recruits	Adult Progeny	SAR%	Progeny-per-Parent
Johnson Creek	Hatchery	56	103,919	2	0.00	0.03
	Natural	630	304,180	387	0.13	0.61
Lostine River	Hatchery	172	245,784	713	0.29	4.15
	Natural	895	73,477	340	0.46	0.38

Table 9. Spring/summer Chinook Salmon juvenile recruits-per-female-spawner for Johnson Creek and Lostine River natural and hatchery spawning during brood year 2018. We calculated natural-origin recruits-per-spawner as juvenile emigrants for the tributary per female spawner and hatchery-origin as juvenile smolts released per female collected for broodstock.

Stream	Origin	Female Spawners	Juvenile Recruits	Recruits-per-Spawner
Johnson Creek	Hatchery	45	120,556	2,679
	Natural	257	115,680	449
Lostine River	Hatchery	88	260,820	2,964
	Natural	328	49,637	151

Table 10. Escapement of summer steelhead above DFRM weirs in spawn year 2021 and the estimated hatchery and female proportions of fish returning to the weir (95% CIs in parentheses). Estimates for the Lostine River and Jacks Creek are only upstream of the weir, while Camp Creek estimates are for the entire tributary.

Weir	Unique Fish Handled	Disposed	Escapement	Female Proportion	Hatchery Fraction
Camp Creek Weir	9	0	48 (38, 55)	0.67 (0.35, 0.88)	0.11 (0.02, 0.43)
Lostine River Weir	134	8	404 (84, 724)	0.72 (0.64, 0.79)	0.00 (0.00, 0.03)
Jacks Creek Weir	16	6	16 (16, 16)	0.75 (0.54, 0.96)	0.13 (0.00, 0.29)

Table 11. Summer steelhead redd density observed during 2021 spawning ground surveys in the Imnaha River subbasin.

Stream	Total Redds	km Surveyed	Redds/km
Bear Gulch	28	4.2	6.7
Big Sheep Creek	21	4.9	4.3
Camp Creek	19	7.6	2.5
Carrol Creek	1	2.0	0.5
Crazyman Creek	11	5.9	1.9
Dry Creek	0	1.9	0.0
Freezeout Creek	13	3.3	3.9
Grouse Creek	48	16.3	2.9
Gumboot Creek	20	5.6	3.6
Imnaha River	6	16.0	0.4
Lick Creek	0	5.3	0.0
Mahogany Creek	0	0.9	0.0
Morgan Creek	0	0.8	0.0
North Fork Gumboot Creek	0	1.0	0.0

Table 12. Imnaha River smolt-to-adult return (SAR) rates from Lower Granite Dam (LGR) to LGR for in-river and run-at-large tagged natural-origin steelhead for migration years 2009 – 2017.

Migration year	Smolts detections at LGR	Adult Detections at LGR	Ocean Age at Return			SAR
			I	II	III	
In-river steelhead						
2009	1,903	45	25	20	0	2.36%
2010	1,645	39	22	16	1	2.37%
2011	866	6	5	1	0	0.69%
2012	1,604	35	24	11	0	2.18%
2013	1,924	48	19	28	1	2.49%
2014	2,314	25	17	8	0	1.08%
2015	1,050	1	1	0	0	0.10%
2016	1,476	7	5	2	0	0.47%
2017	832	5	4	1	0	0.60%
Run-at-large steelhead						
2009	1,970	82	42	39	1	4.16%
2010	1,645	49	25	24	0	2.98%
2011	1,185	12	5	7	0	1.01%
2012	2,067	63	28	35	0	3.05%
2013	1,966	55	24	31	0	2.80%
2014	2,341	49	28	21	0	2.09%
2015	1,065	2	2	0	0	0.19%
2016	1,435	19	15	4	0	1.32%
2017	695	10	4	6	0	1.44%

Table 13. Imnaha River natural-origin steelhead Tributary-to-Tributary smolt-to-adult return (SAR) rates in-river and run-at-large tagged natural-origin steelhead for migration years 2009 – 2017.

Migration Year	Imnaha River smolts	Adults detected Imnaha River	Ocean age					SAR
			0.5	1	2	3	Repeat Spawner (Spawn years)	
In-river steelhead								
2009	2591	42	0	24	18	0	0	1.62%
2010	3068	33	0	20	12	0	1 (2012, 2014)	1.08%
2011	1268	6	0	6	0	0	0	0.47%
2012	2467	29	0	19	10	0	0	1.18%
2013	3516	40	0	18	21	1	0	1.14%
2014	3340	24	0	16	8	0	0	0.72%
2015	3088	1	0	1	0	0	0	0.03%
2016	2354	11	1	8	2	0	0	0.47%
2017	1427	5	0	3	2	0	0	0.35%
Run-at-large steelhead								
2009	2567	74	0	39	34	1	0	2.88%
2010	3080	47	0	23	24	0	0	1.53%
2011	1361	12	0	7	5	0	0	0.88%
2012	2991	57	0	28	28	0	1 (2014, 2015)	1.91%
2013	3483	46	0	21	25	0	0	1.32%
2014	3357	46	0	28	18	0	0	1.37%
2015	3090	2	0	2	0	0	0	0.06%
2016	2412	21	0	17	4	0	0	0.87%
2017	1234	11	0	7	4	0	0	0.89%

Figures

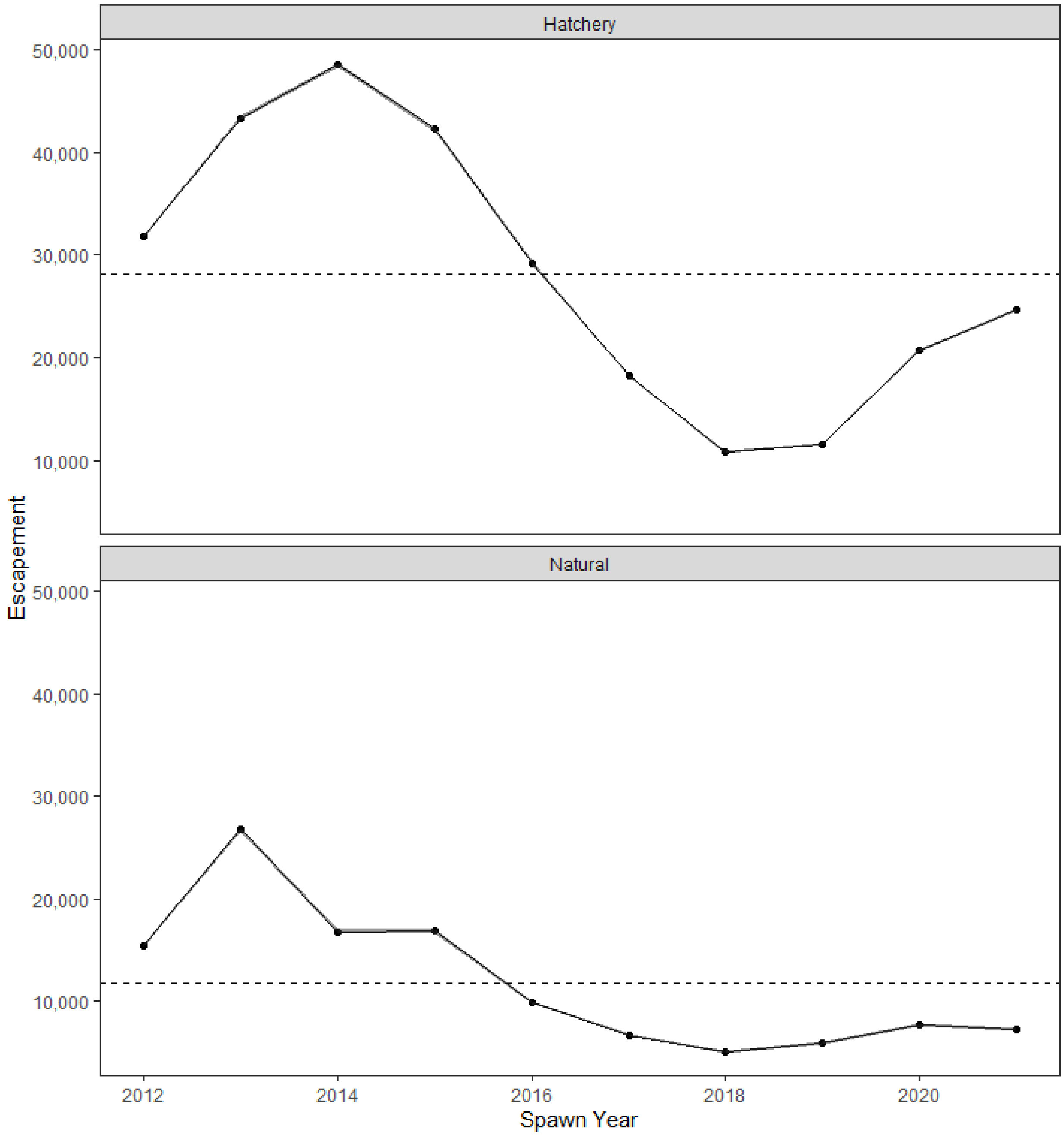

Figure 1. Natural- and hatchery-origin Snake River fall Chinook Salmon returns to Lower Granite Dam (Young et al. 2022*;* grey band represent 95% CI; dashed lines represents the 10-year average).

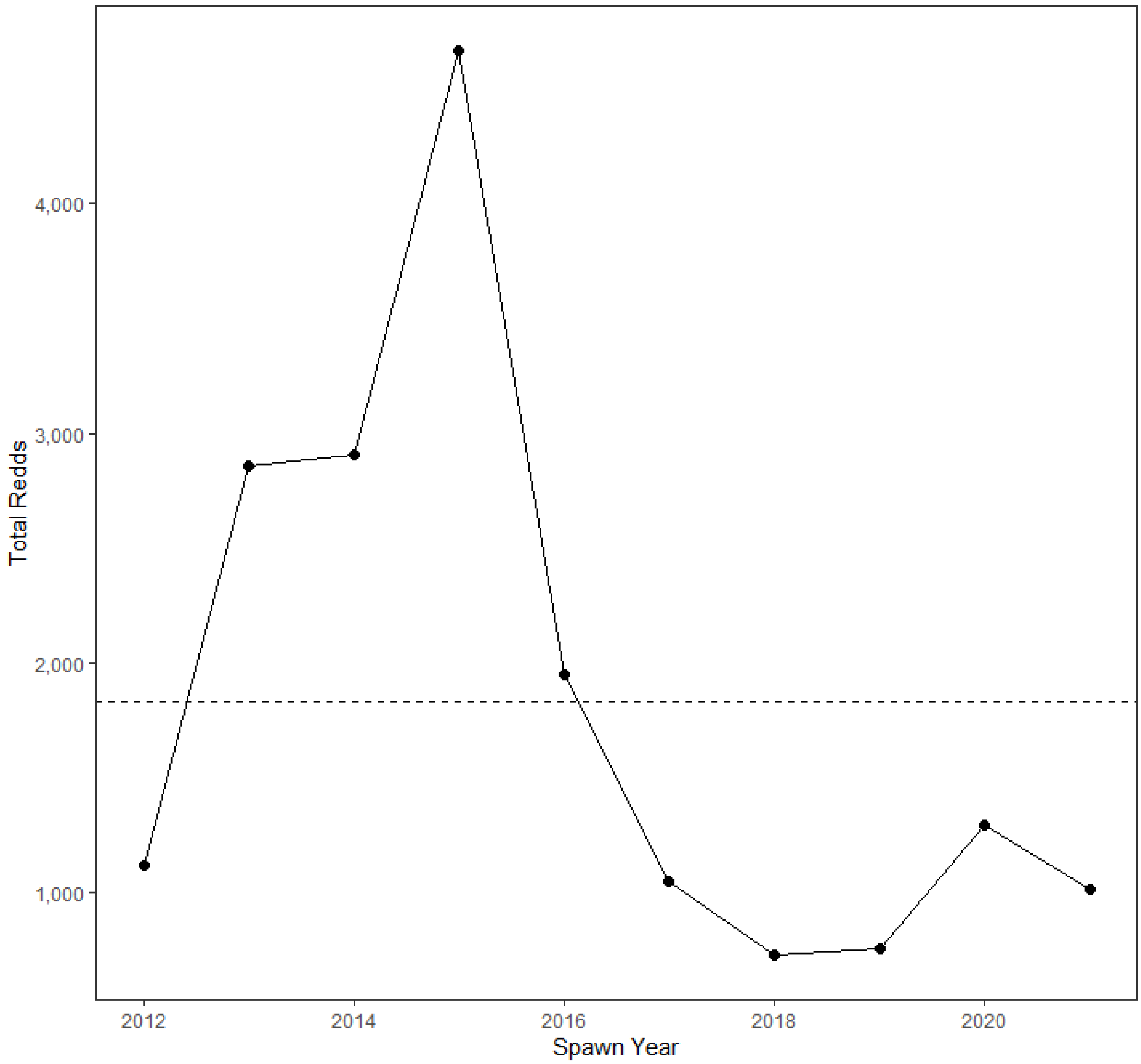

Figure 2. Fall Chinook Salmon redds counted during aerial spawning ground surveys in the lower Clearwater River from 2012 to 2021 (dashed line represents the 10-year average).

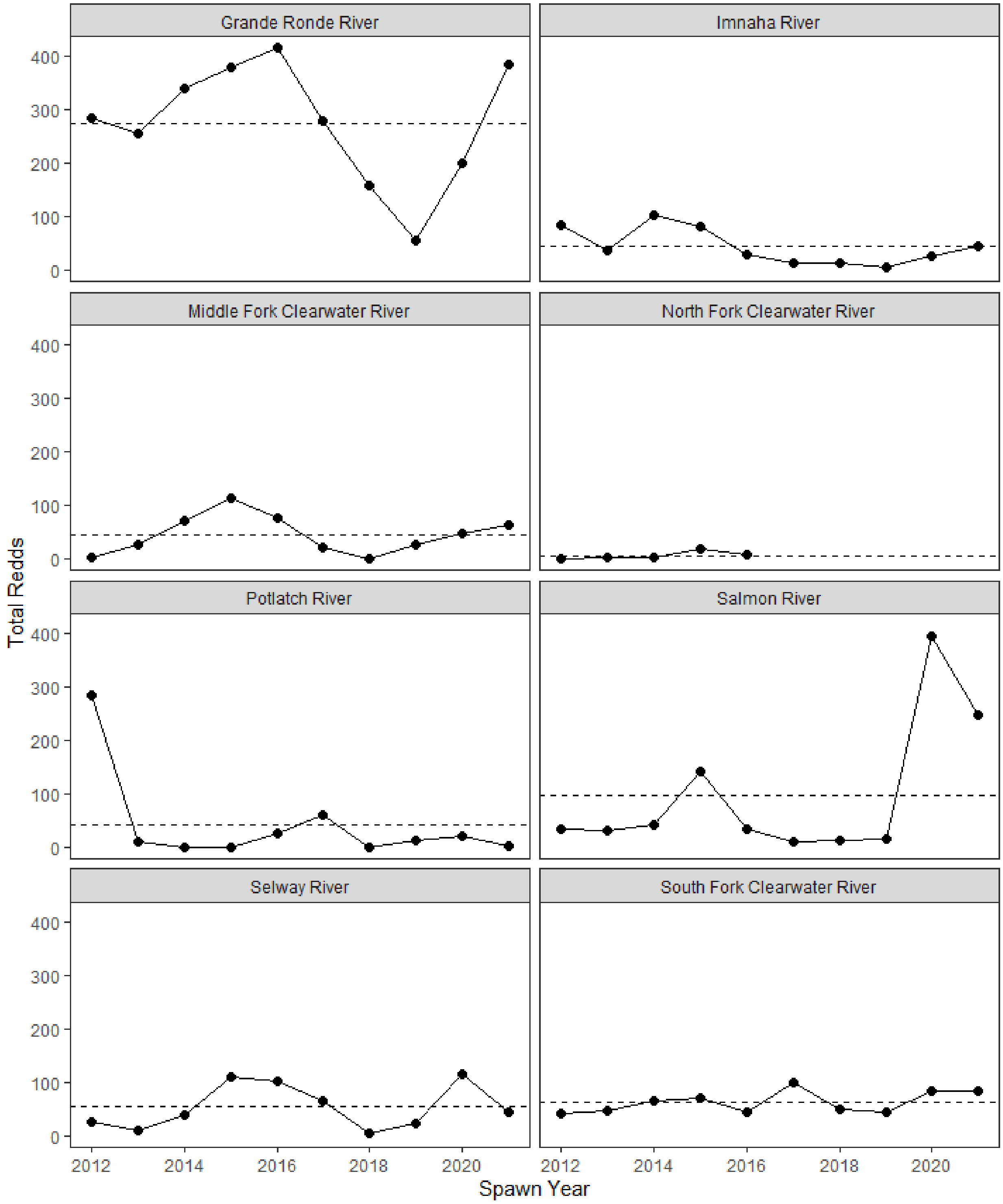

Figure 3. Fall Chinook Salmon redds counted throughout the Snake River basin during aerial spawning ground surveys from 2012 to 2021 (dashed lines represents the 10-year average).

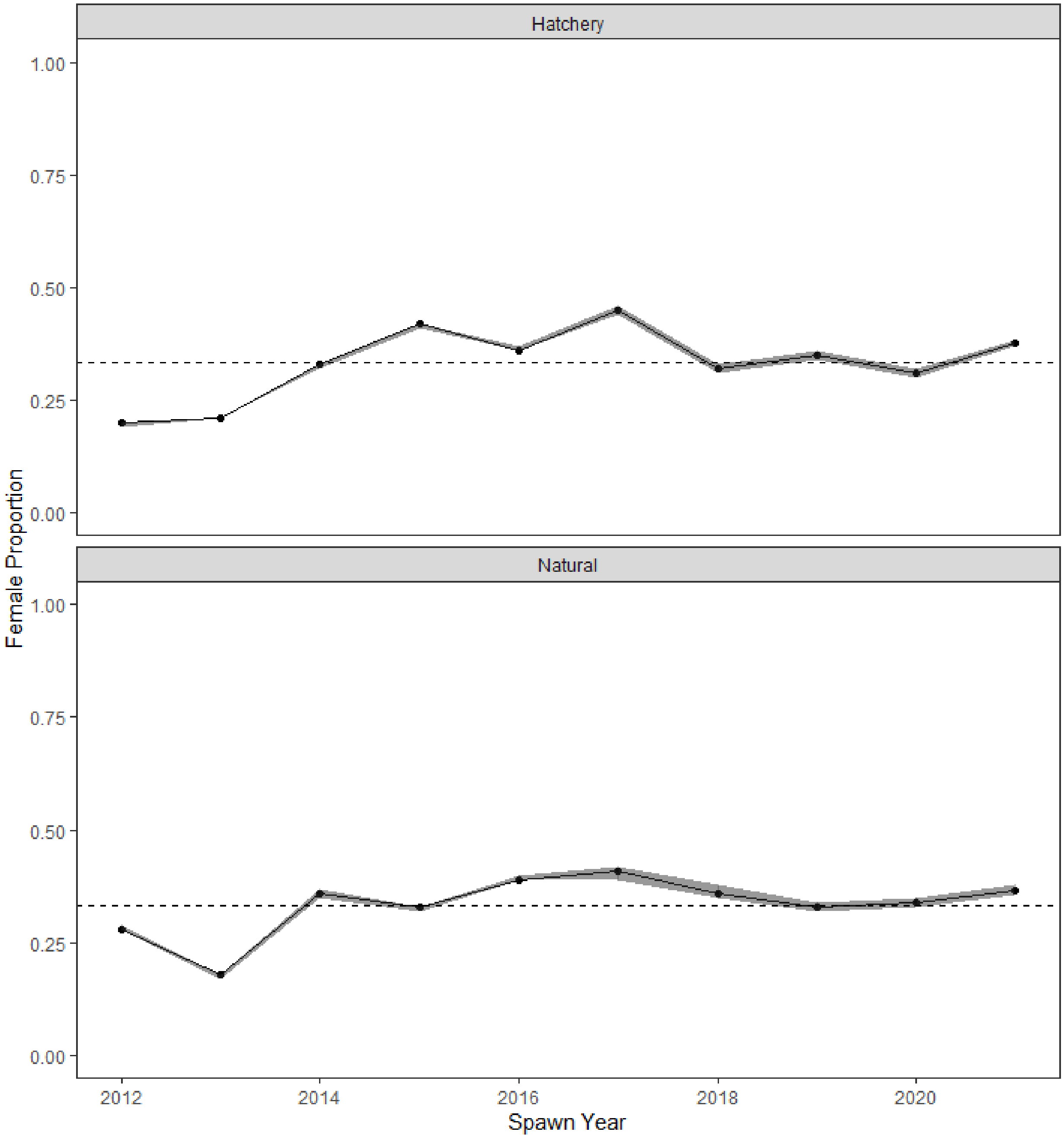

Figure 4. Fall Chinook Salmon female proportion of hatchery- and natural-origin fish escaping upstream of Lower Granite Dam. We calculated female proportion using run-reconstruction data (Young et al. 2022; grey bands represent 95% CI; dashed lines represents the 10-year average).

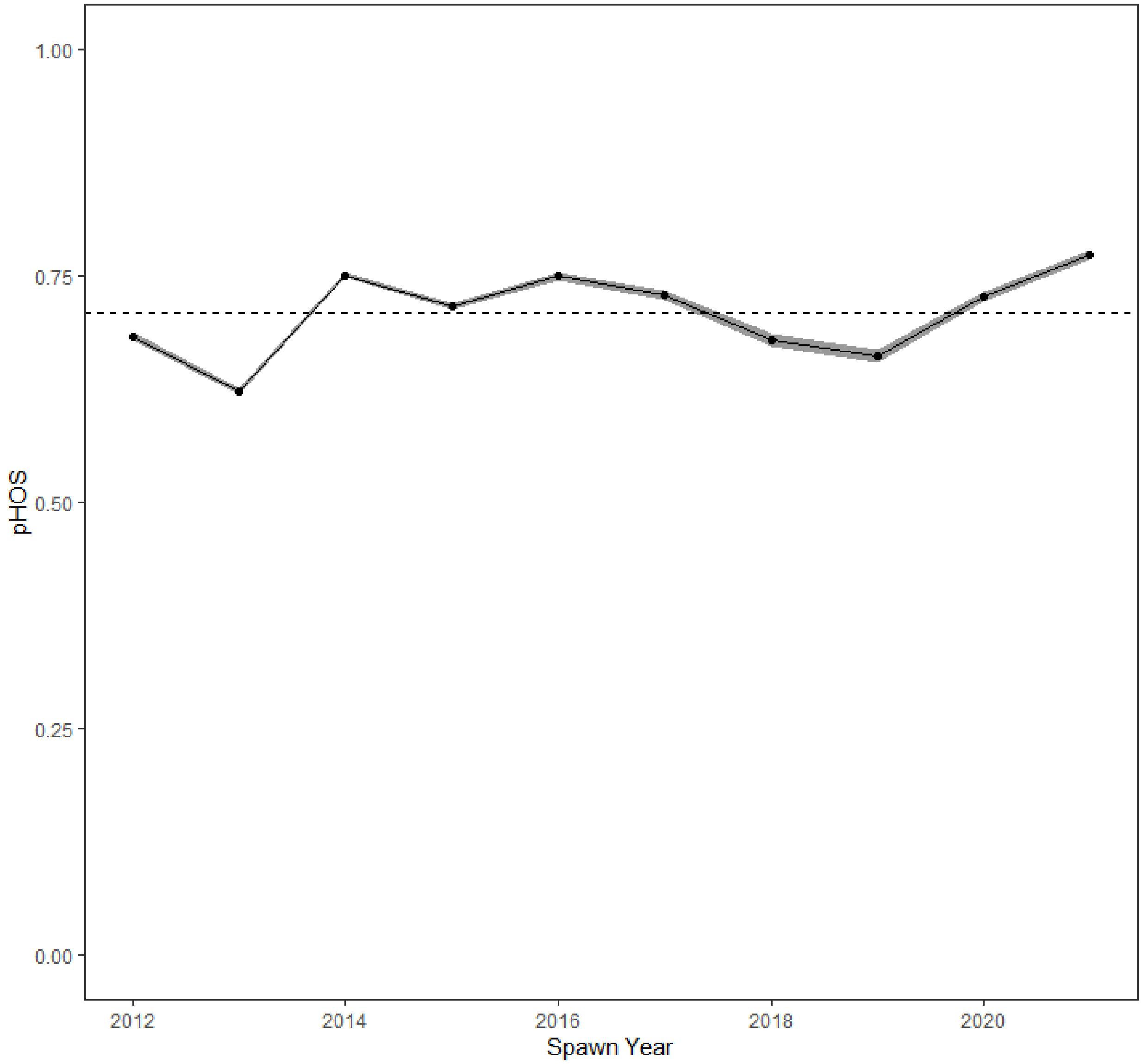

Figure 5. Fall Chinook Salmon proportion of hatchery-origin spawners (pHOS) calculated from fish released upstream of Lower Granite Dam (Young et al. 2022; grey band represent 95% CI; dashed line represents the 10-year average).

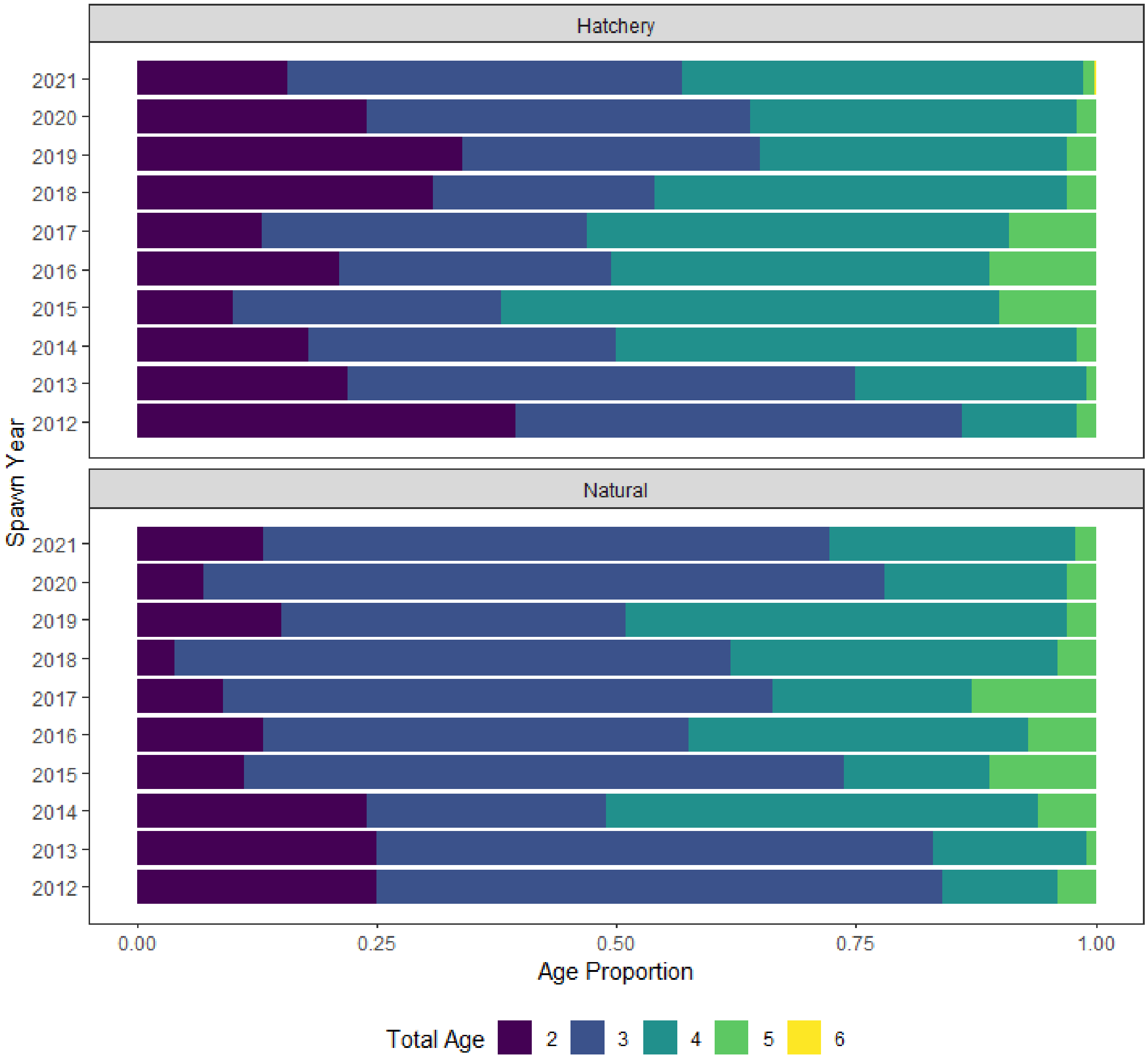

Figure 6. Fall Chinook Salmon age proportion of fish released upstream of Lower Granite Dam (Young et al. 2022).

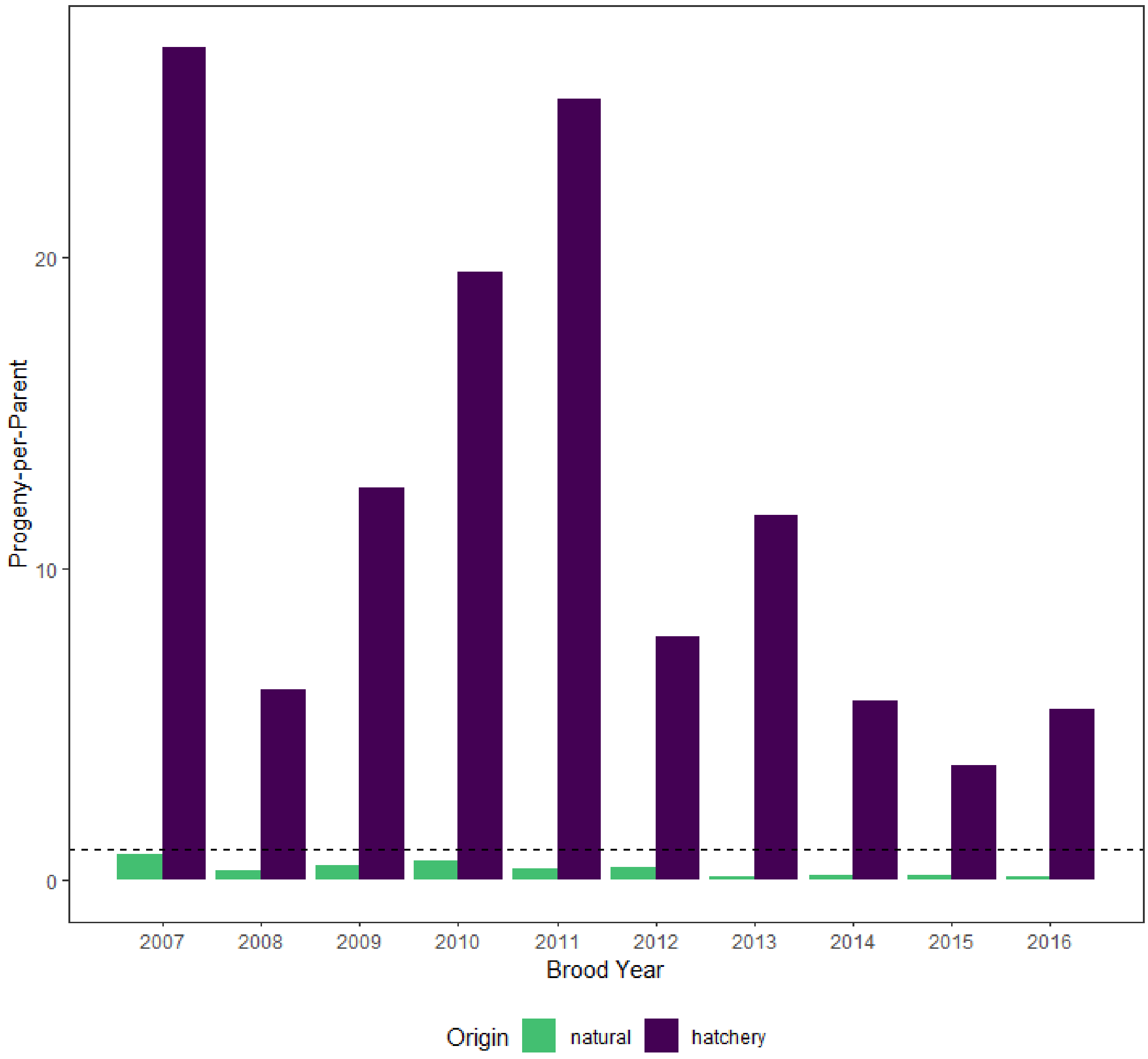

Figure 7. Natural and hatchery fall Chinook Salmon progeny-per-parent ratios to Lower Granite Dam from brood year 2007-2016 (dashed line represents replacement).

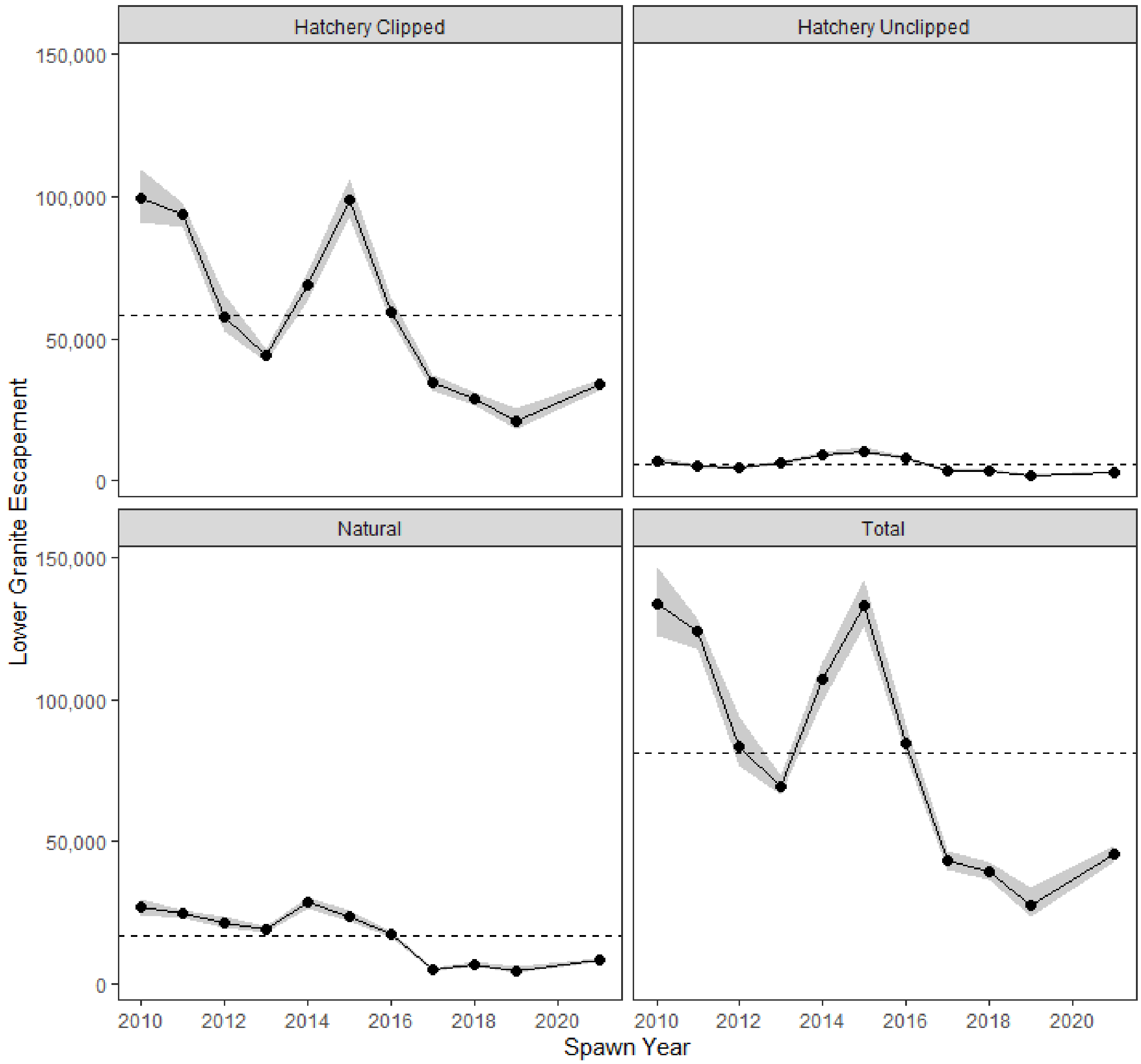

Figure 8. Spring/summer Chinook Salmon escapement past Lower Granite Dam (grey bands represent 95% CI; dashed lines indicates the 10-year average). No data is available for spawn year 2020 returns.

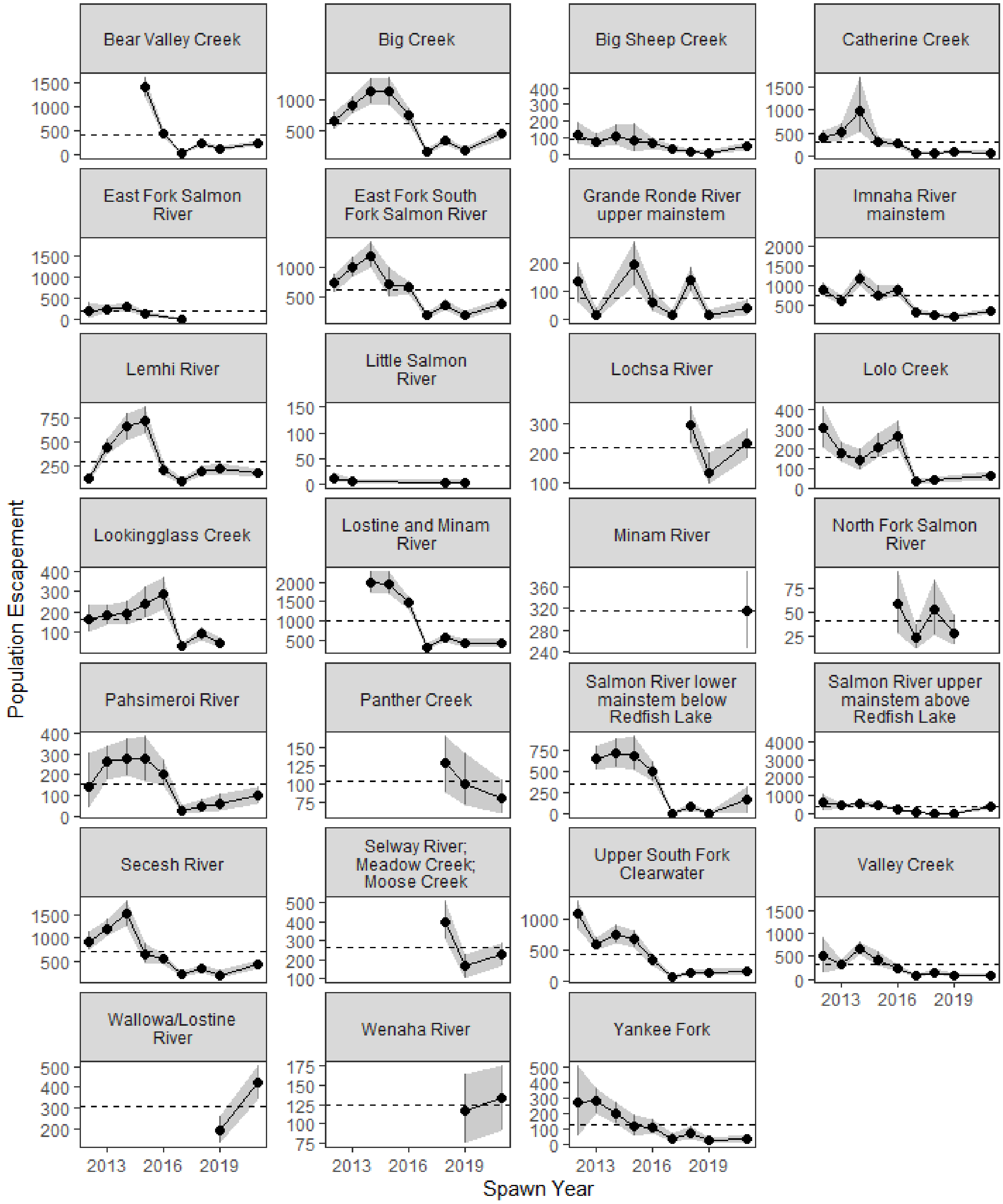

Figure 9. Natural-origin spring/summer Chinook Salmon escapement into several ICTRT populations (grey bands represent 95% CI; dashed lines indicates the 10-year average). No data is available for spawn year 2020 returns.

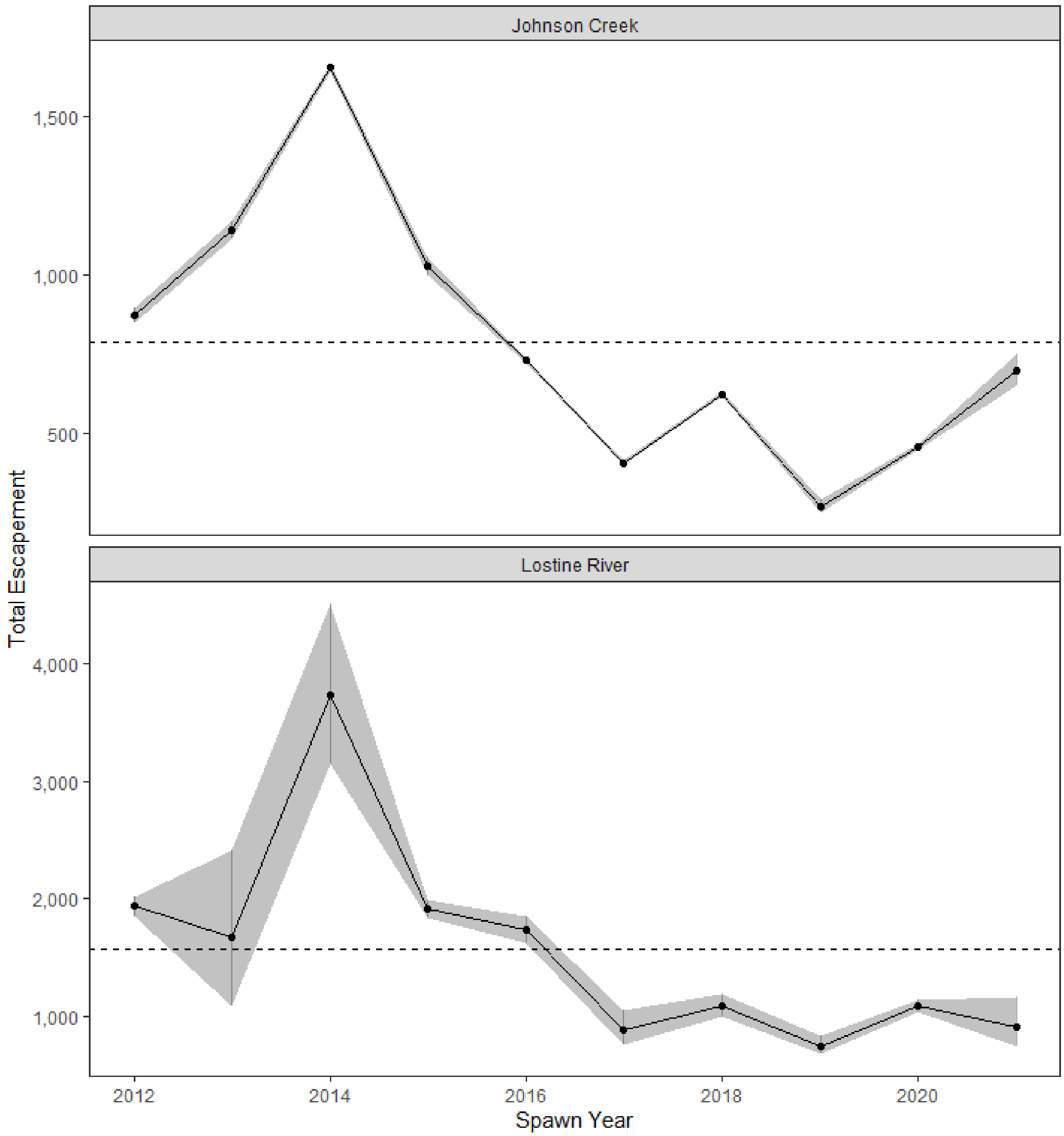

Figure 10. Total spring/summer Chinook Salmon tributary escapement to Johnson Creek and the Lostine River for the last 10-years (2012-2021; grey bands represent 95% CI; dashed lines represents the 10-year average.

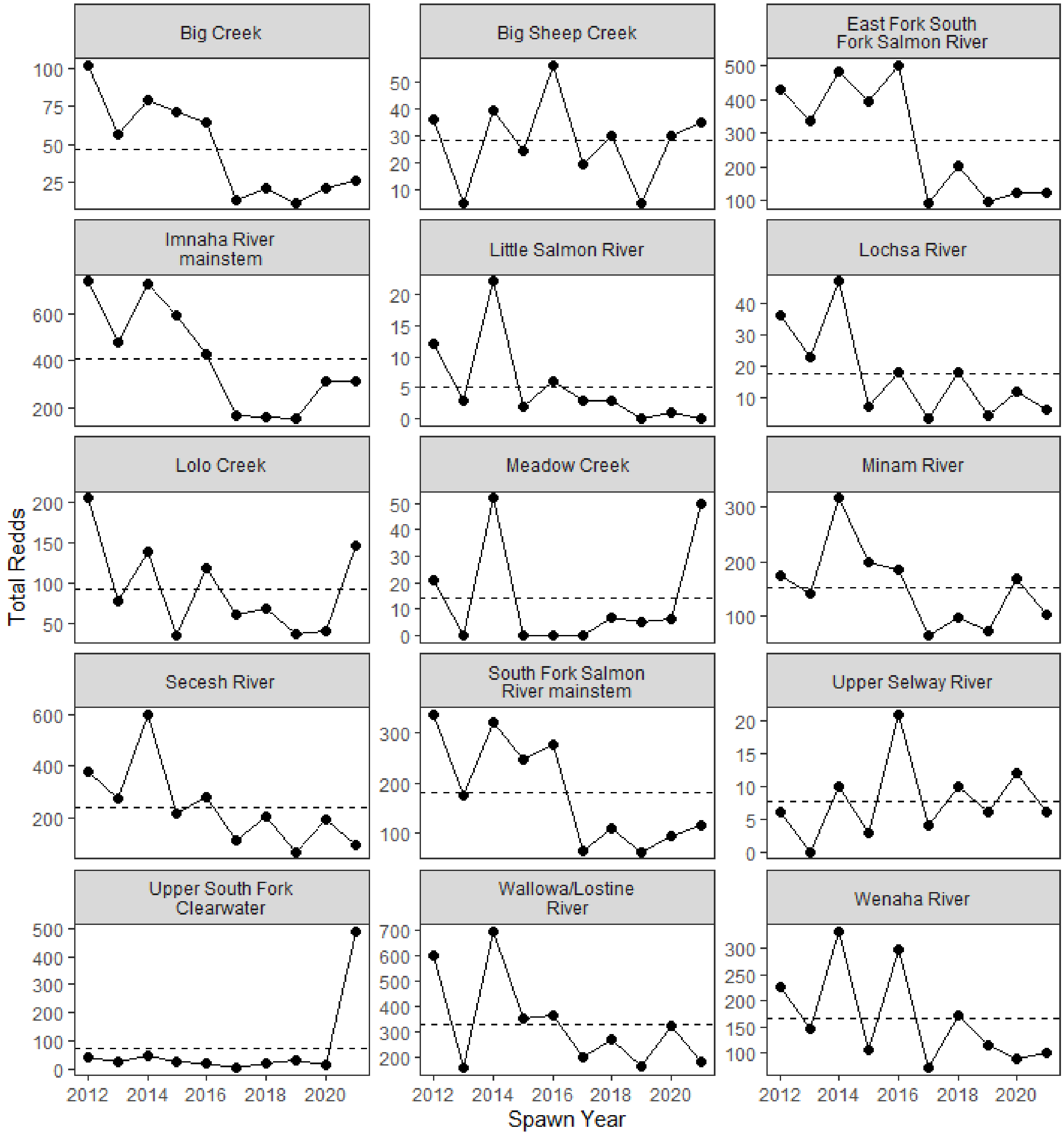

Figure 11. Total spring/summer Chinook Salmon redds observed by Nez Perce Tribe personnel in Snake River Basin ICTRT populations by spawn year (dashed lines represents the 10-year average).

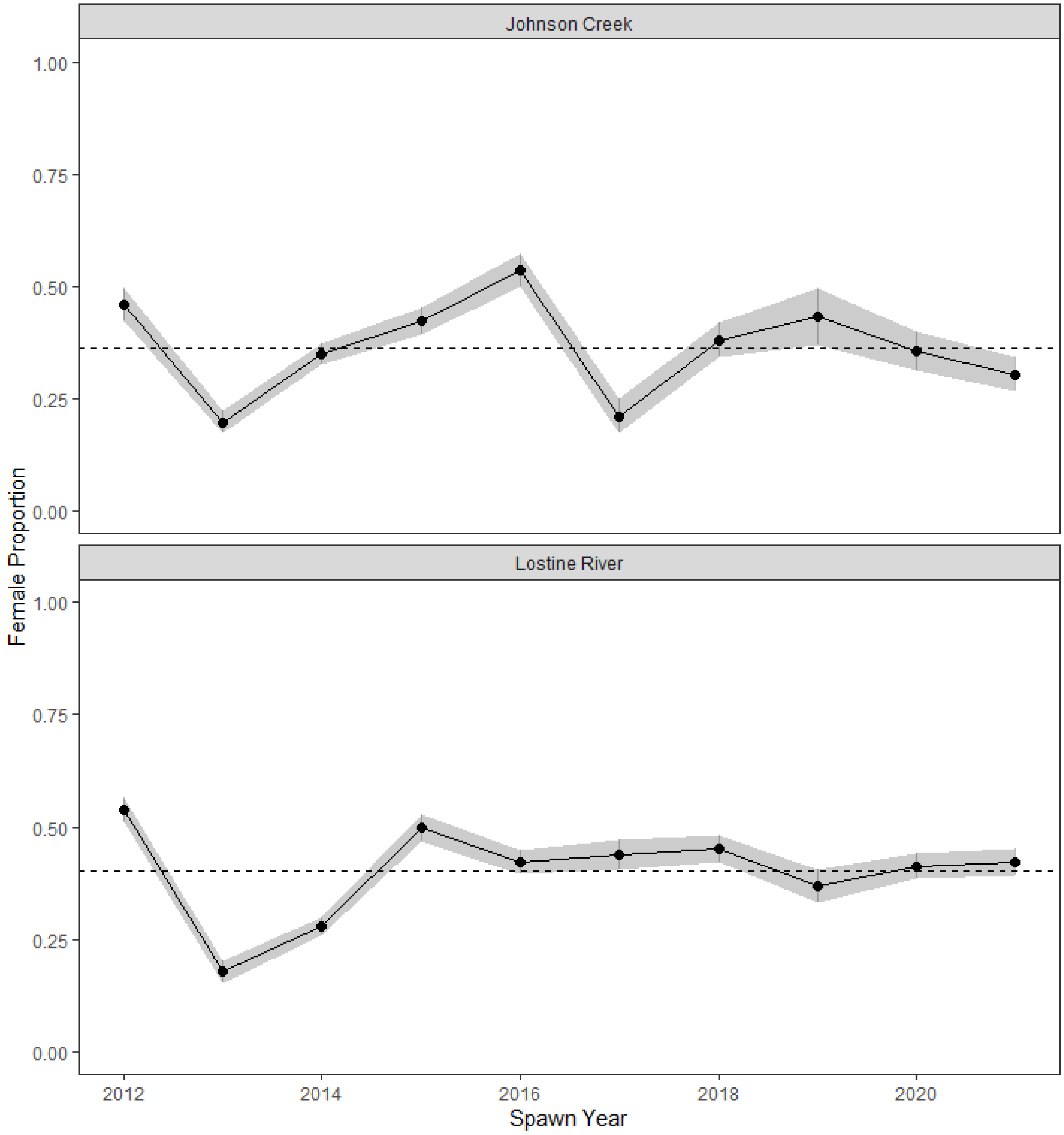

Figure 12. Female proportion of combined natural- and hatchery-origin spring/summer Chinook Salmon escaping to Johnson Creek and Lostine River weirs over the last 10-years (2012-2021; grey bands represent 95% CI; dashed lines represents the 10-year average).

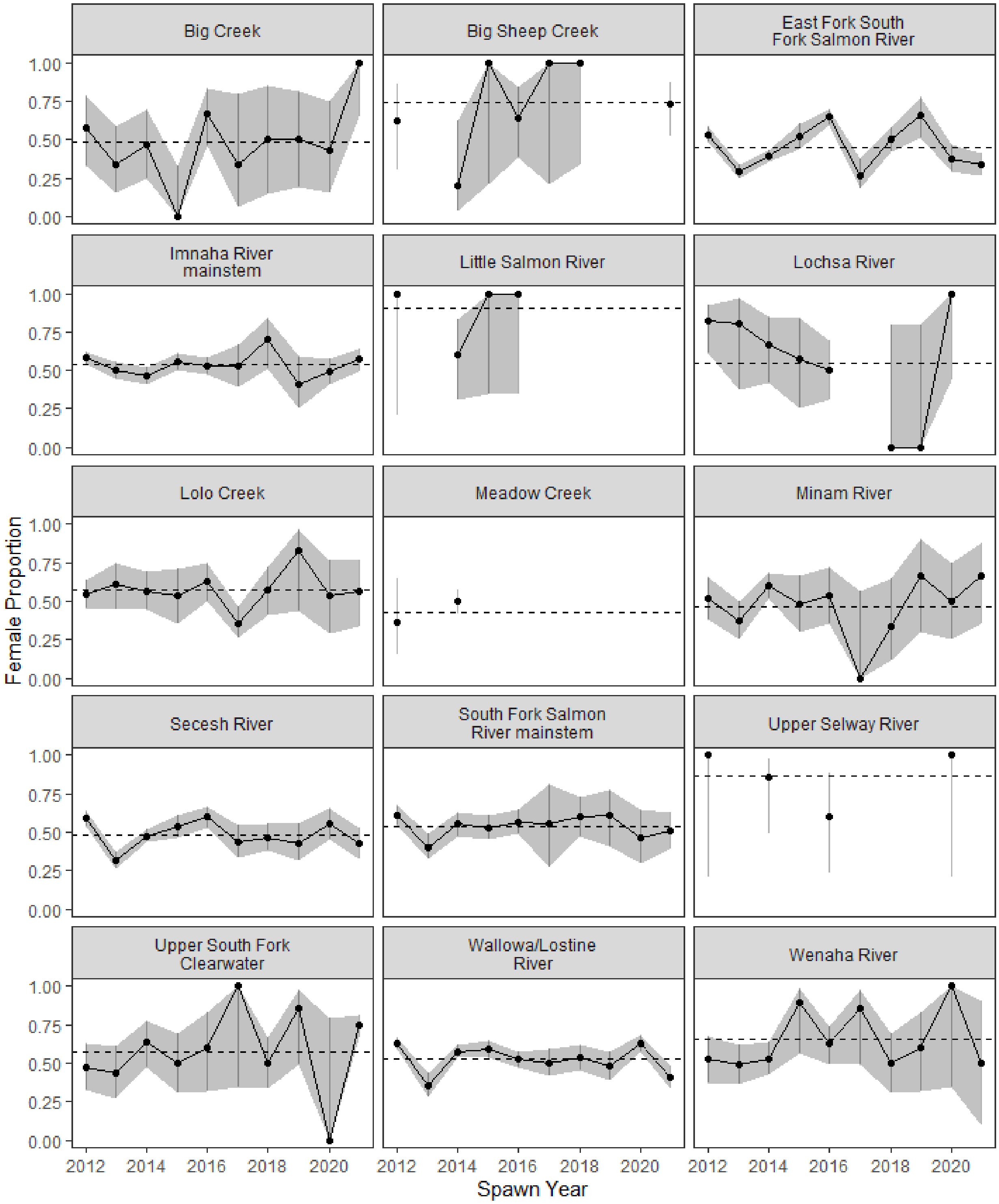

Figure 13. Combined natural- and hatchery-origin spring/summer Chinook Salmon female proportion calculated from carcasses collected during spawning ground surveys within NPT monitored ICTRT populations during the past 10 spawn years (2012-2021; grey bands represent 95% CI; dashed lines represents the 10-year average).

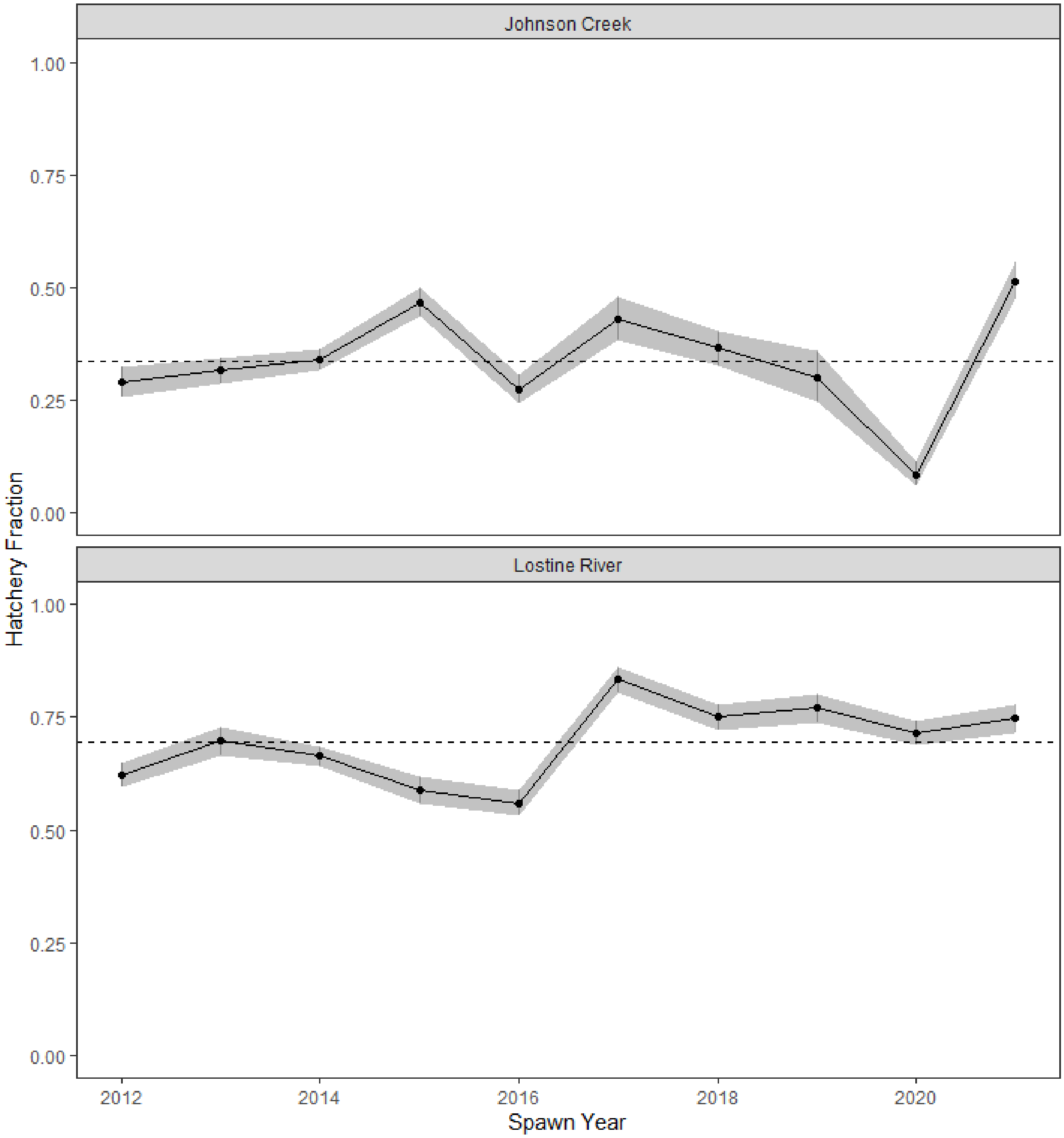

Figure 14. Hatchery fraction of spring/summer Chinook Salmon escaping to Johnson Creek and Lostine River weirs by spawn year (2012-2021; grey bands represent 95% CI; dashed lines represents the 10-year average).

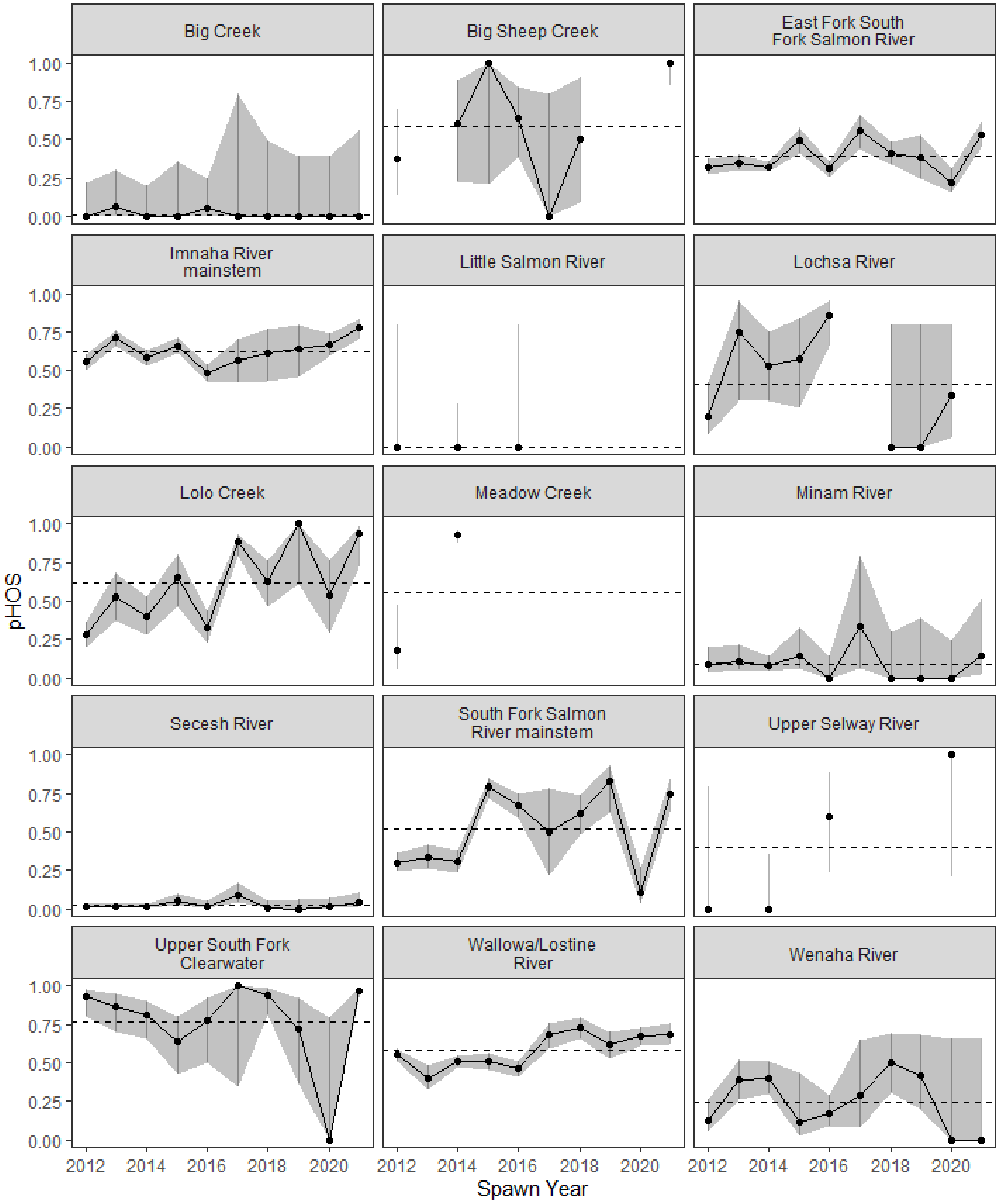

Figure 15. Proportion of hatchery-origin spring/summer Chinook Salmon spawners (pHOS) in each Nez Perce Tribe surveyed ICTRT population estimated from carcasses collected during spawning ground surveys over the last 10-years (2012- 2021; grey bands represent 95% CI; dashed lines represents the 10-year average).

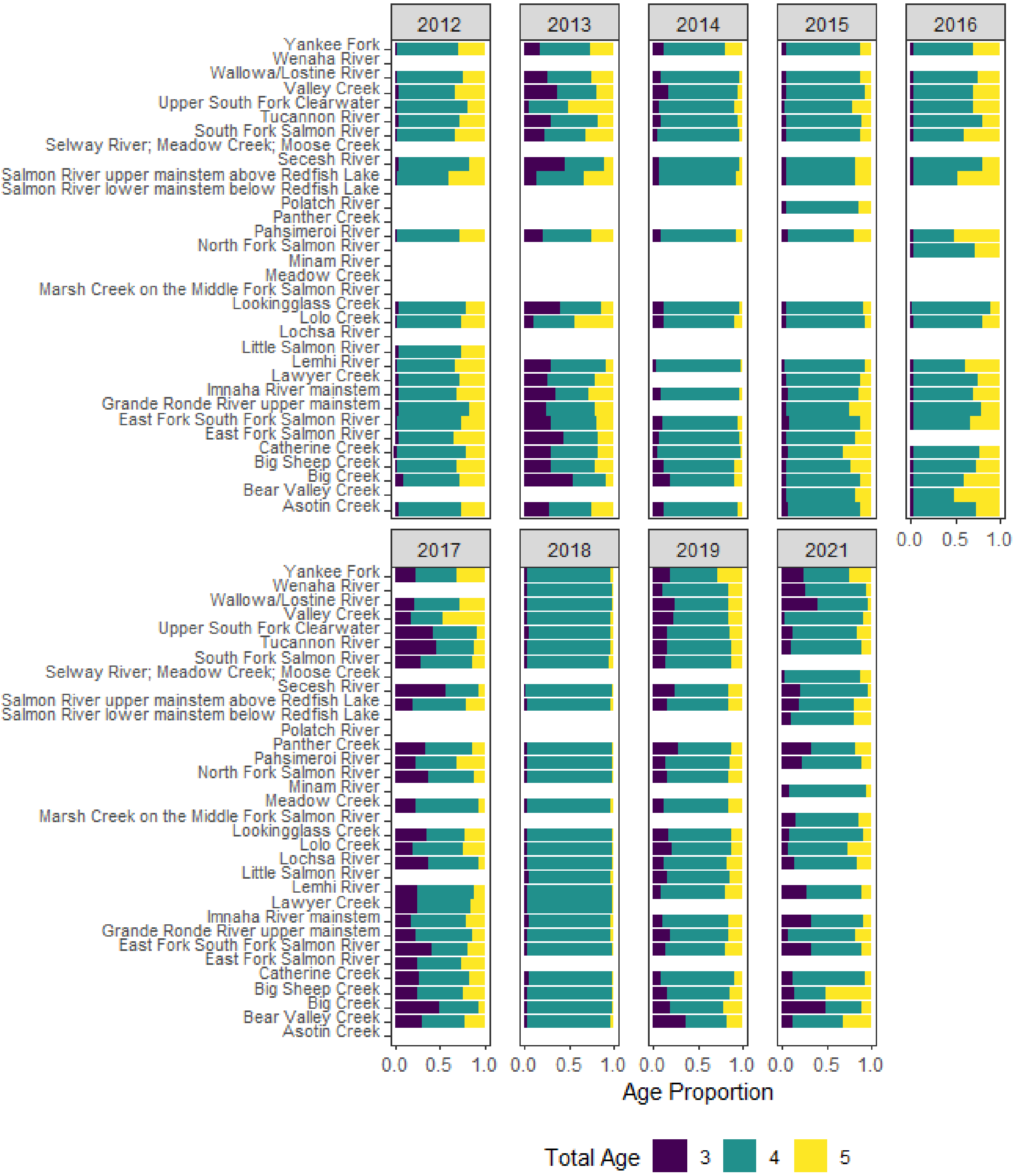

Figure 16. Age proportions of natural-origin spring/summer Chinook Salmon throughout ICTRT populations using PIT tag detections at in-stream arrays. We could not calculate age proportions for the survey year 2020 without PIT tagging and age sample collection at Lower Granite Dam.

Figure 17. Combined natural- and hatchery-origin age proportions of spring/summer Chinook Salmon spawners in each Nez Perce Tribe surveyed ICTRT population as estimated from carcasses collected during the last 10-years (2012-2021) of spawning ground surveys. We derived age estimates from coded wire tags, passive integrated transponder tags, visual implant elastomer tags, genetic samples, fin ray samples, and scale samples.

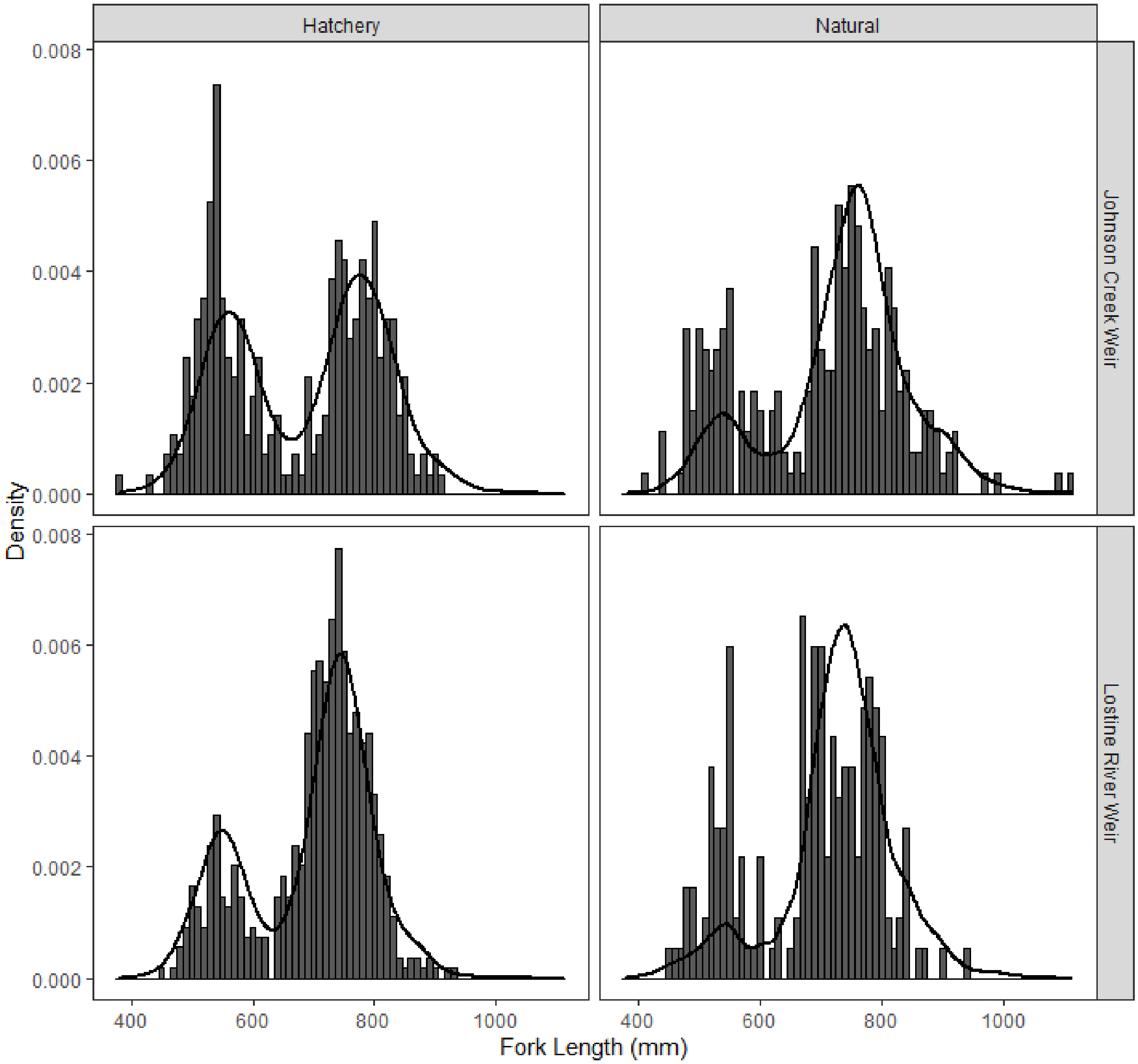

Figure 18. Fork length distributions of natural- and hatchery-origin spring/summer Chinook Salmon trapped at Johnson Creek and Lostine River weirs during spawn year 2021 (bars) compared to all fish collected over the past 10-years (line).

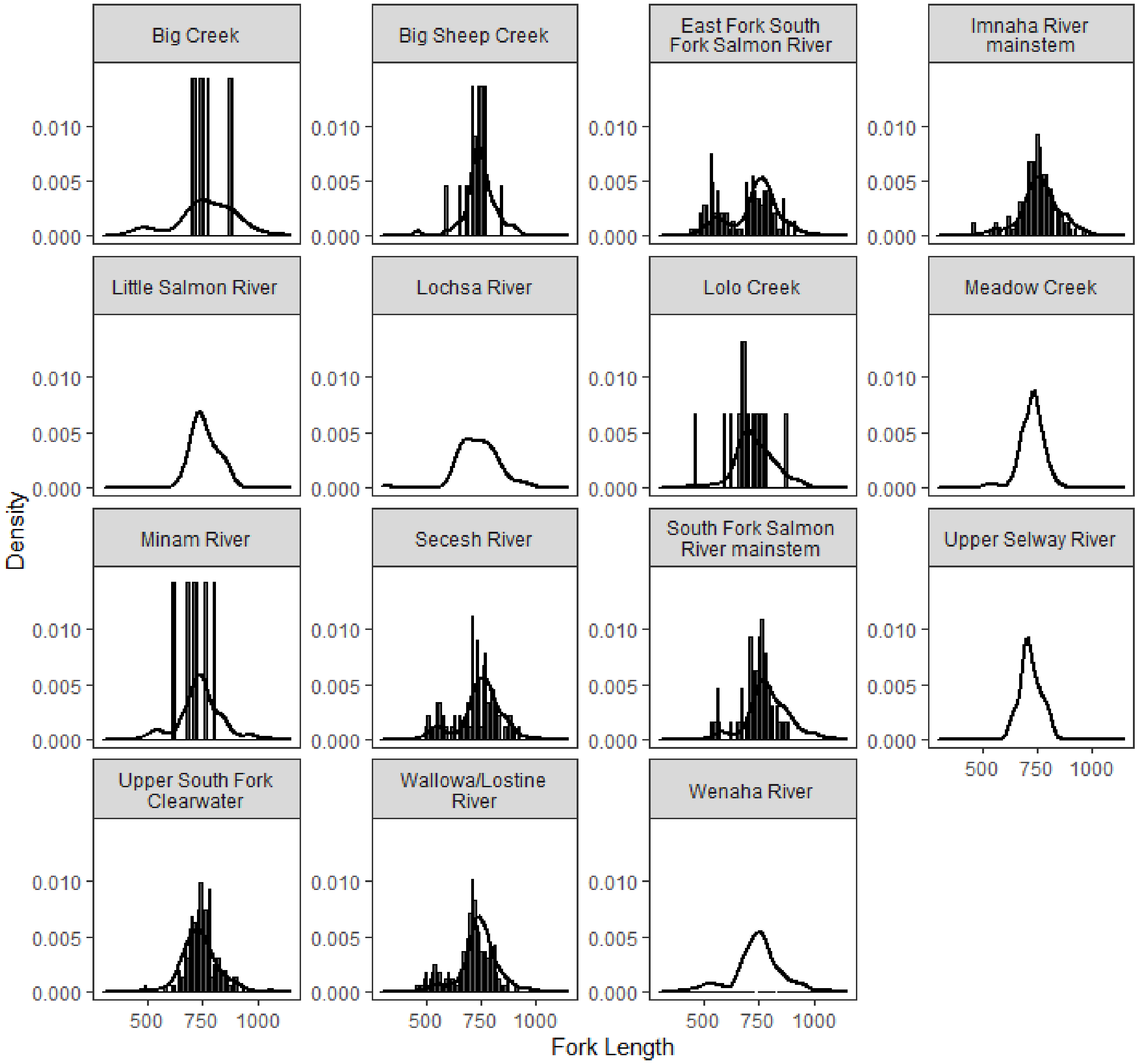

Figure 19. Fork length distributions of natural- and hatchery-origin spring/summer Chinook Salmon carcasses collected from Nez Perce Tribe monitored ICTRT populations during 2021 spawning ground surveys (bar) and for the last 10-years (2012-2021) (line).

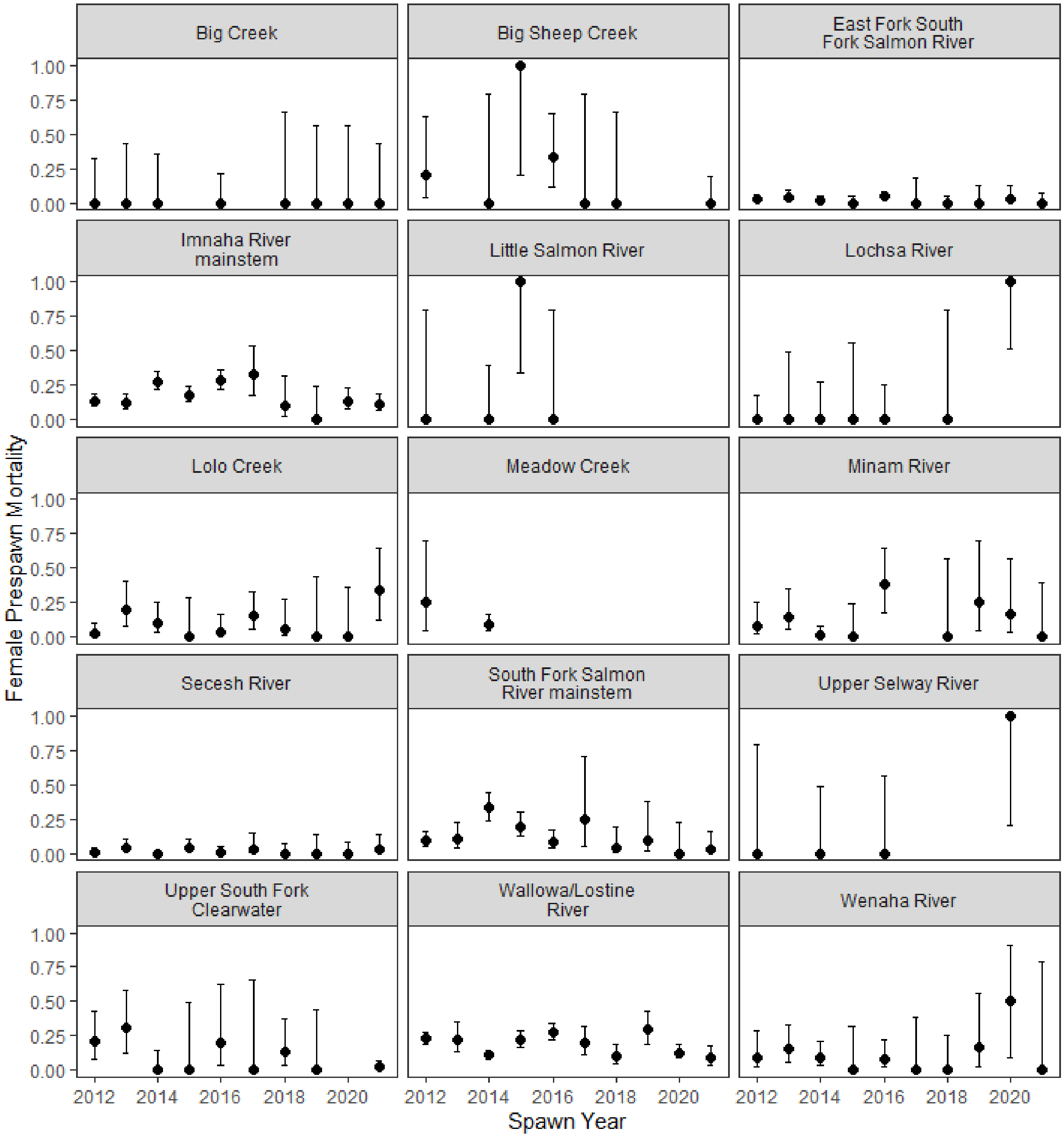

Figure 20. Prespawn mortality of combined natural- and hatchery-origin spring/summer Chinook Salmon collected during spawning ground surveys for the past 10 years (2012-2021) in each Nez Perce Tribe surveyed ICTRT population. Error bars show 95% CI’s.

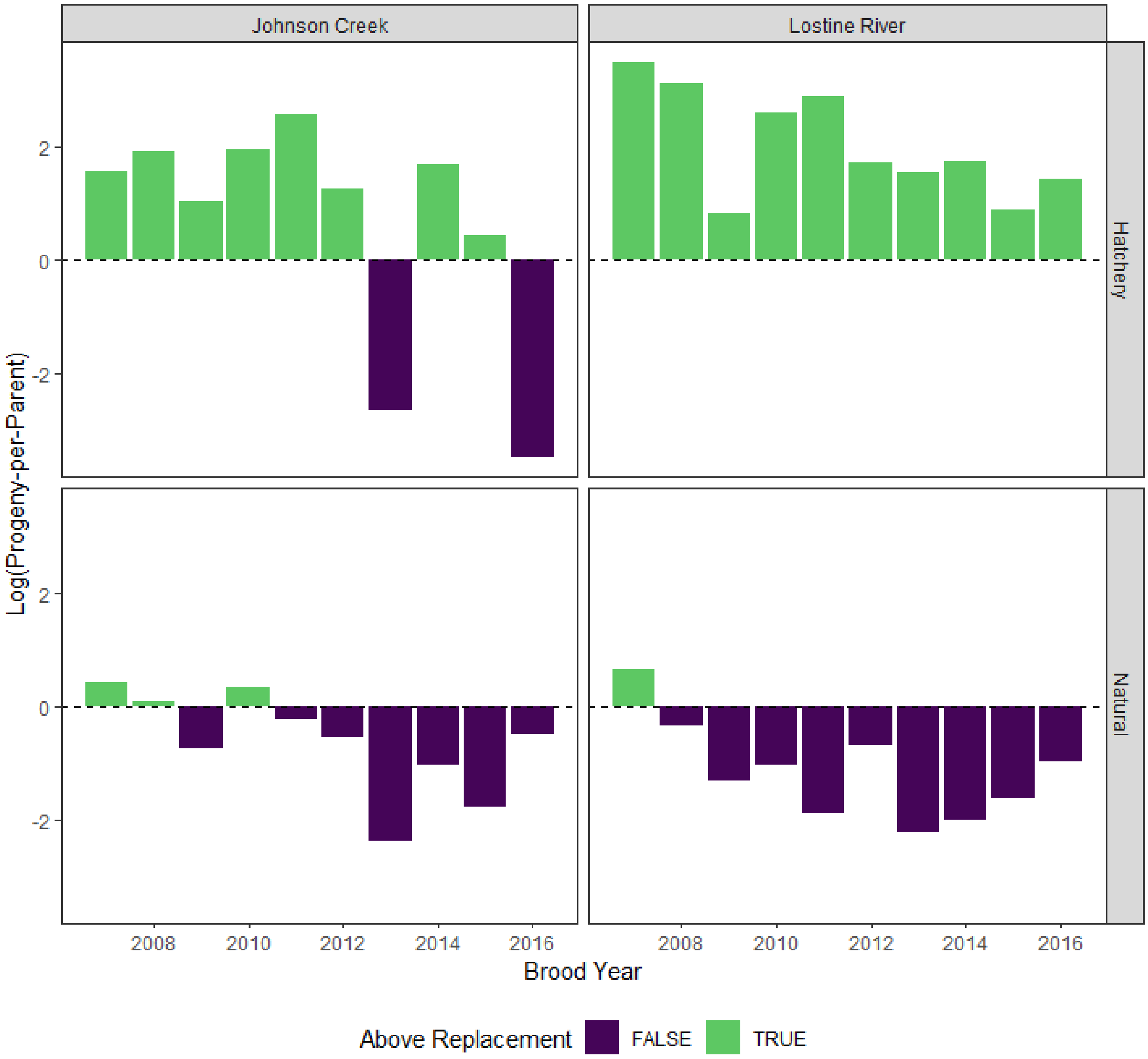

Figure 21. Spring/summer Chinook Salmon progeny-per-parent in Johnson Creek and Lostine River for brood years 2007-2016 presented on the log scale, where positive (green) bars indicate an annual estimate above replacement (dashed line), and negative (purple) bars indicate below replacement productivity. Progeny recruits include all age-3 jack and adult returns for the brood year.

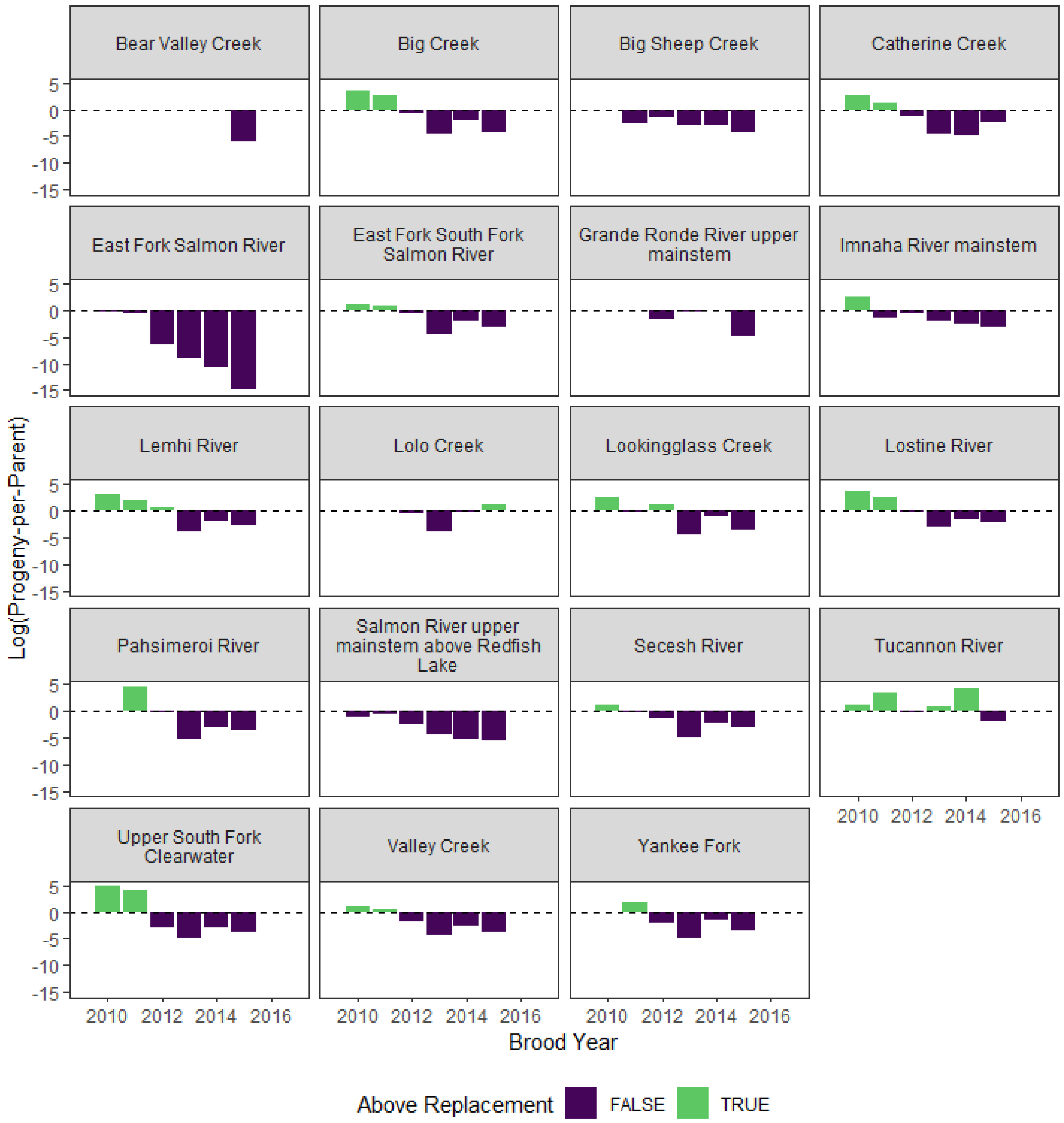

Figure 22. Natural-origin Chinook Salmon progeny-per-parent productivity estimates calculated from scales collected at Lower Granite Dam, PIT tag detections at in-stream arrays, and abundance estimate generated from the DABOM model. Here we present productivity estimates on the log scale where positive (green) bars indicate an annual estimate above replacement (dashed line), and negative (purple) bars indicate below replacement productivity. Productivity estimates do not include hatchery-origin spawners, resulting in proportionally biased estimates relative to the number of hatchery-origin spawners.

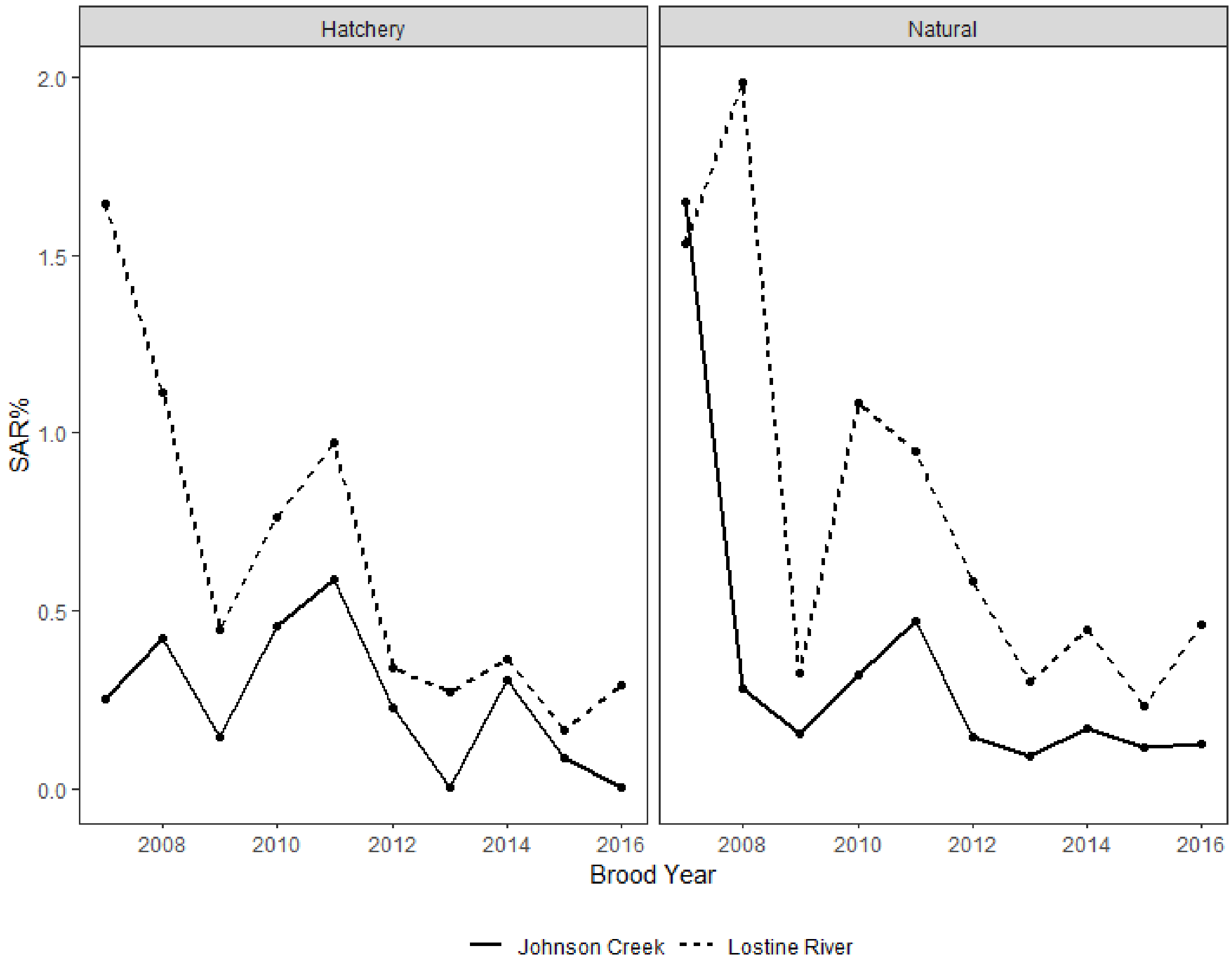

Figure 23. Spring/summer Chinook Salmon smolt-to-adult return (SAR) percentage in Johnson Creek and Lostine River for brood years 2007-2016.

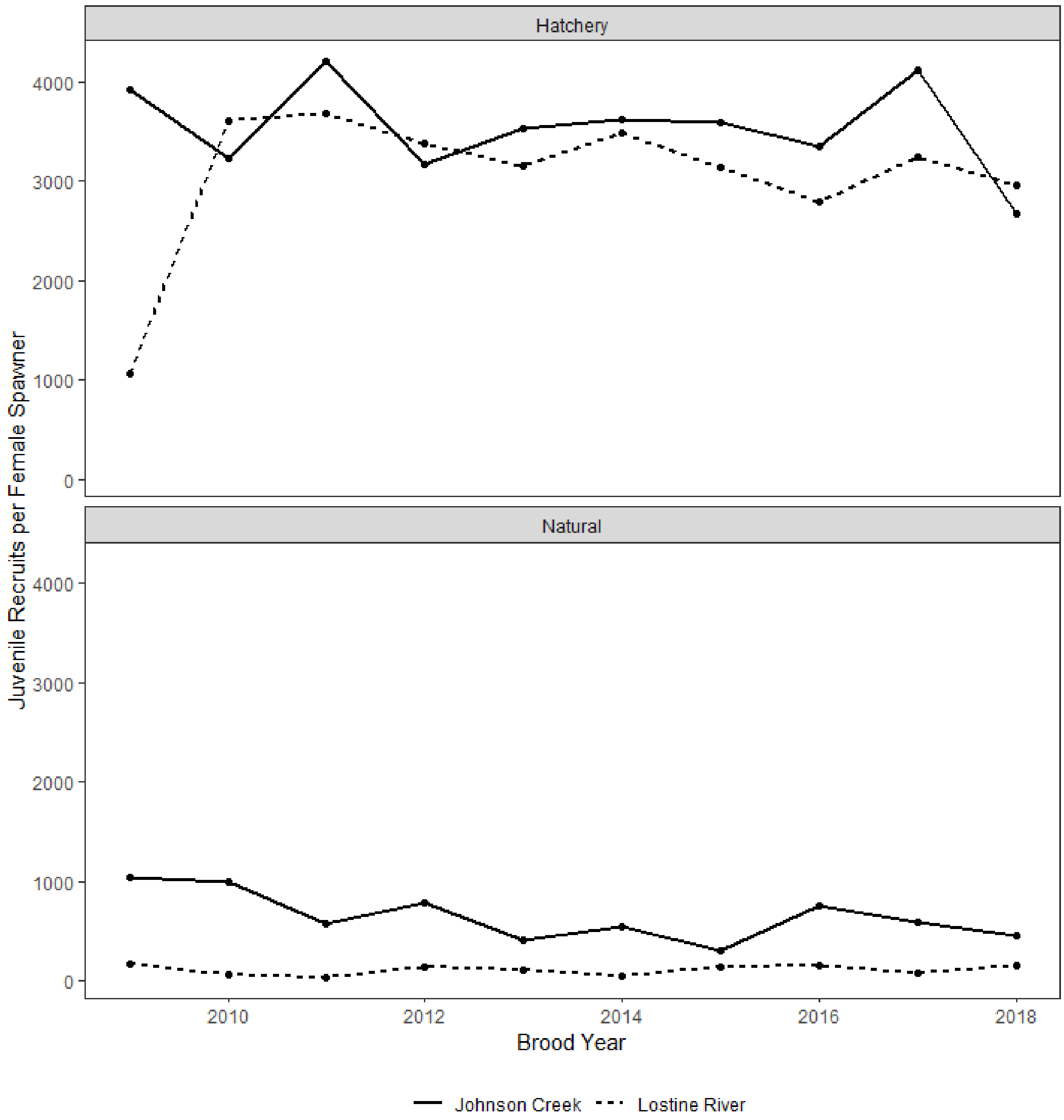

Figure 24. Spring/summer Chinook Salmon juvenile recruits per female spawner in Johnson Creek and Lostine River for brood years 2009-2018.

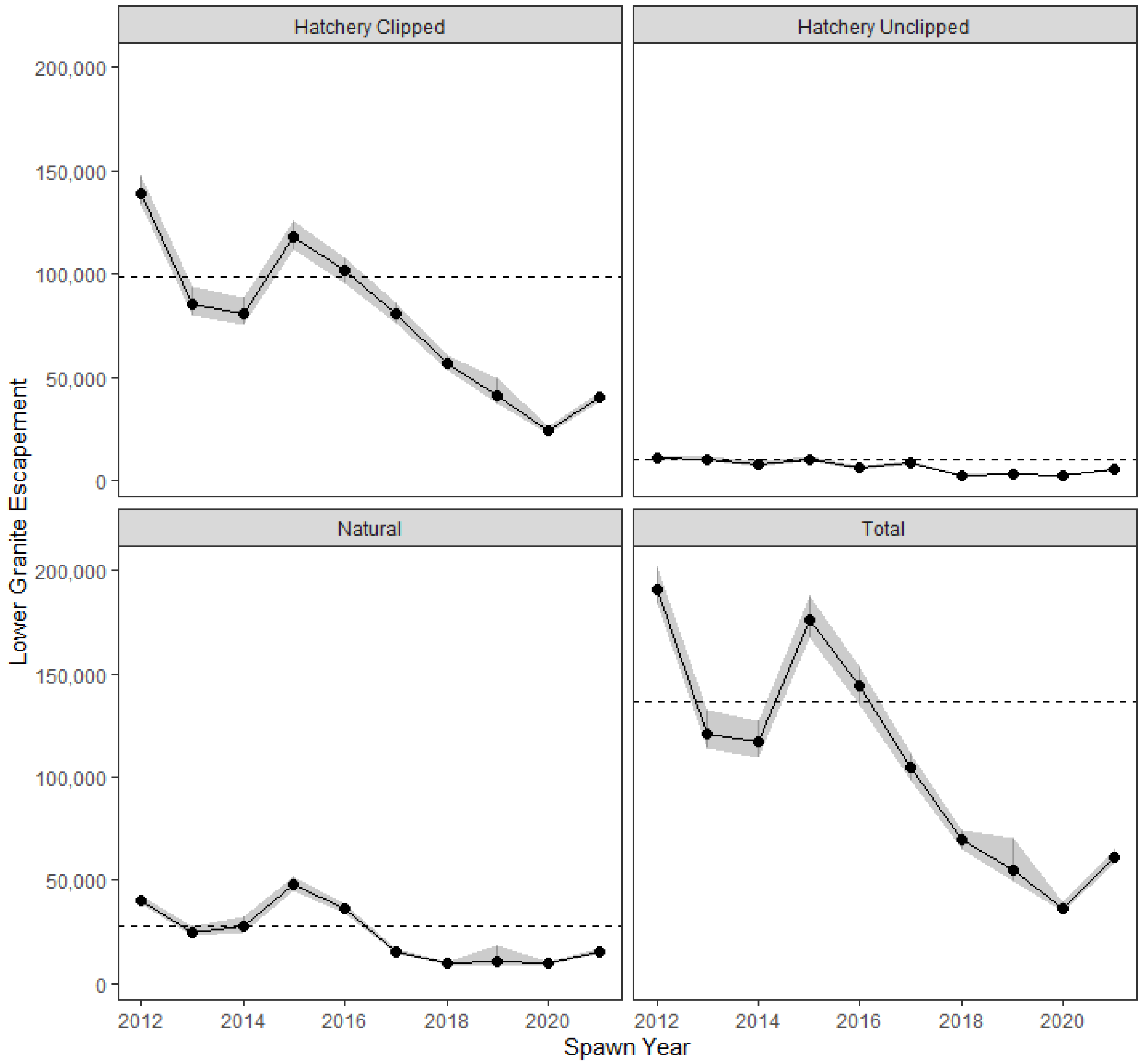

Figure 25. Escapement of unique summer steelhead passing Lower Granite Dam estimated by STADEM for spawn years 2012-2021 (grey bands represent 95% confidence intervals; dashed lines represents the 10-year average).

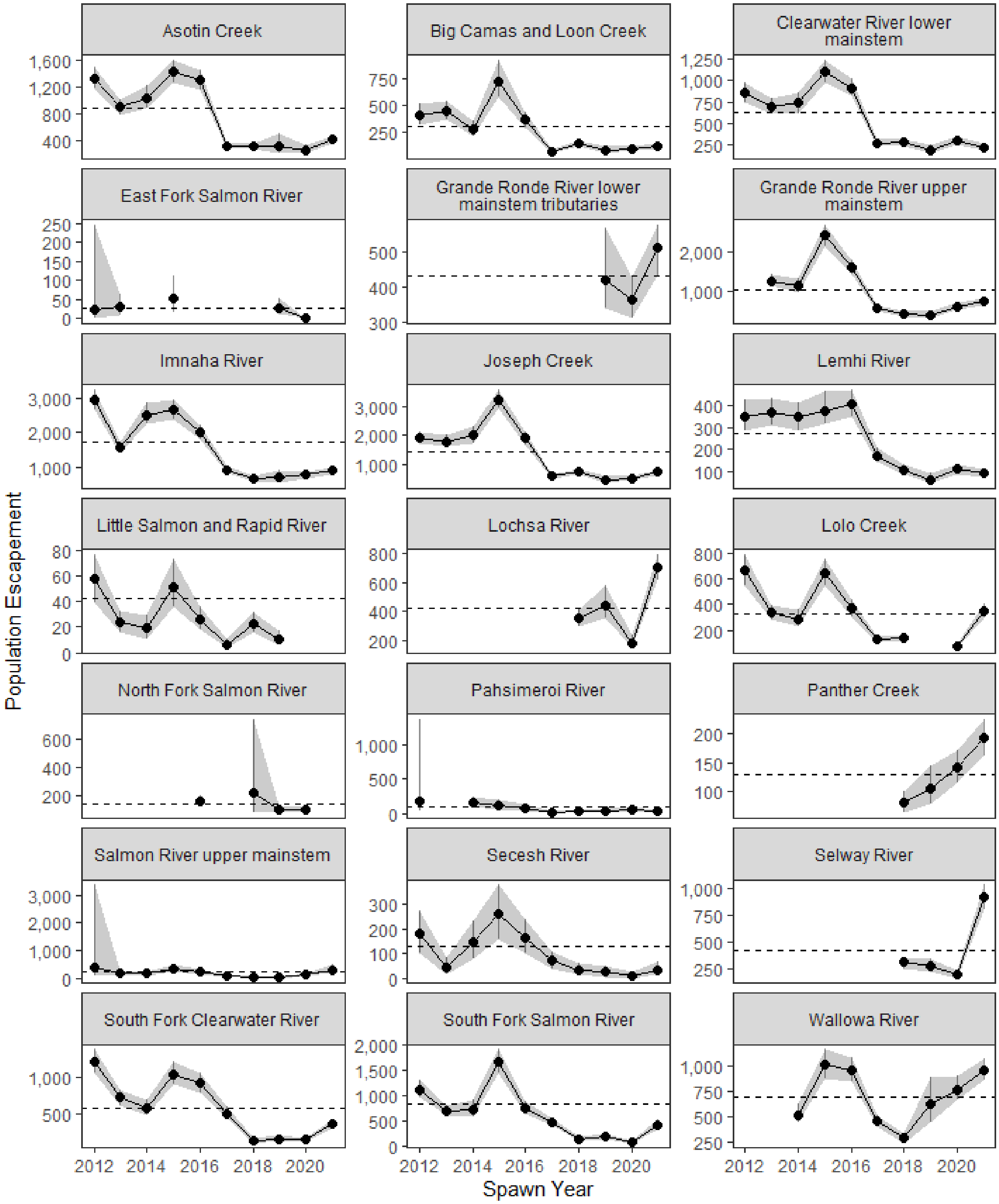

Figure 26. Escapement of natural-origin summer steelhead into ICTRT populations estimated by STADEM and DABOM models (grey bands represent 95% confidence intervals; dashed lines represents the 10-year average).

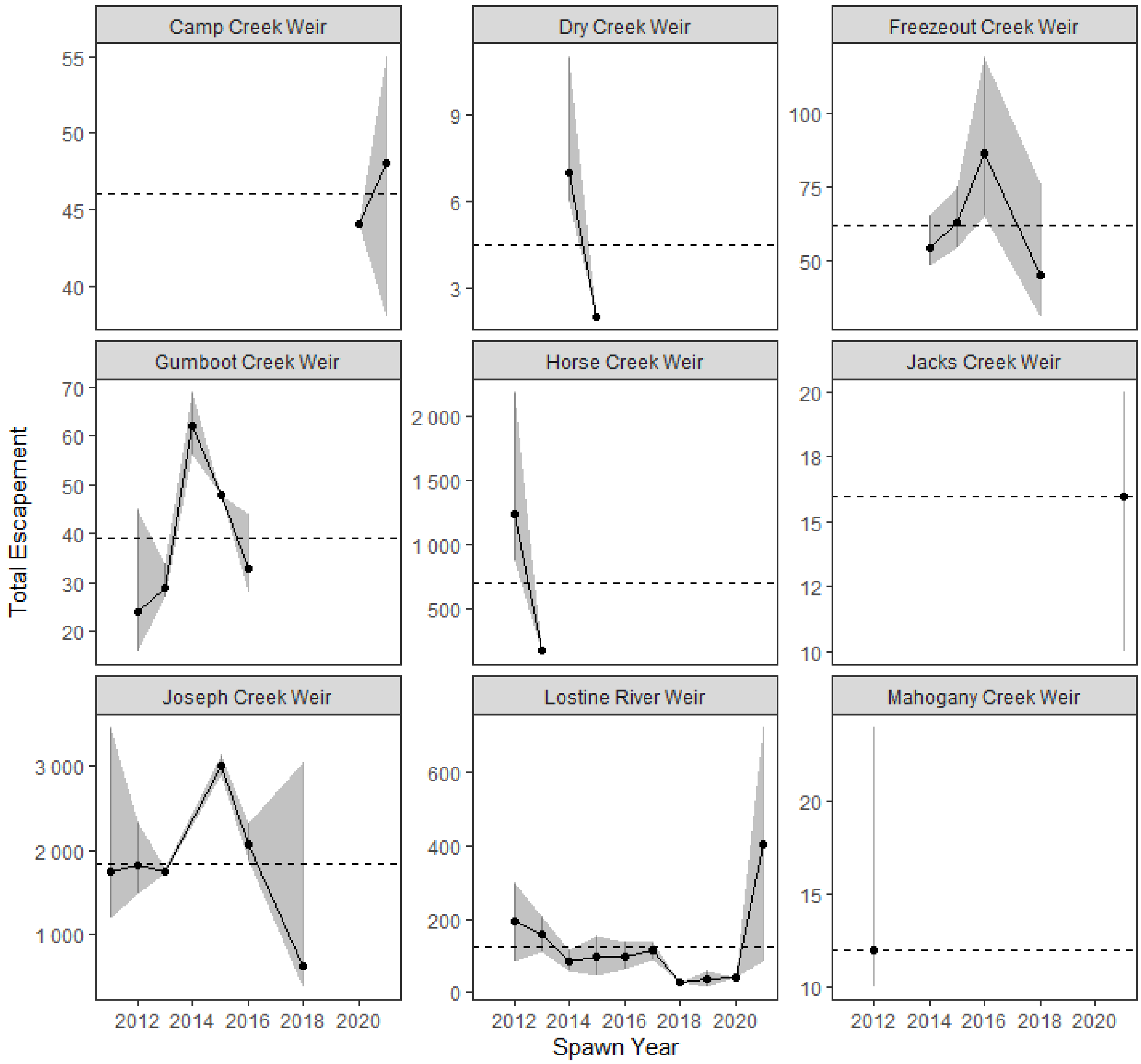

Figure 27. Total summer steelhead escapement to DFRM operated weirs (grey bands represent 95% confidence intervals; dashed lines represents the 10-year average).

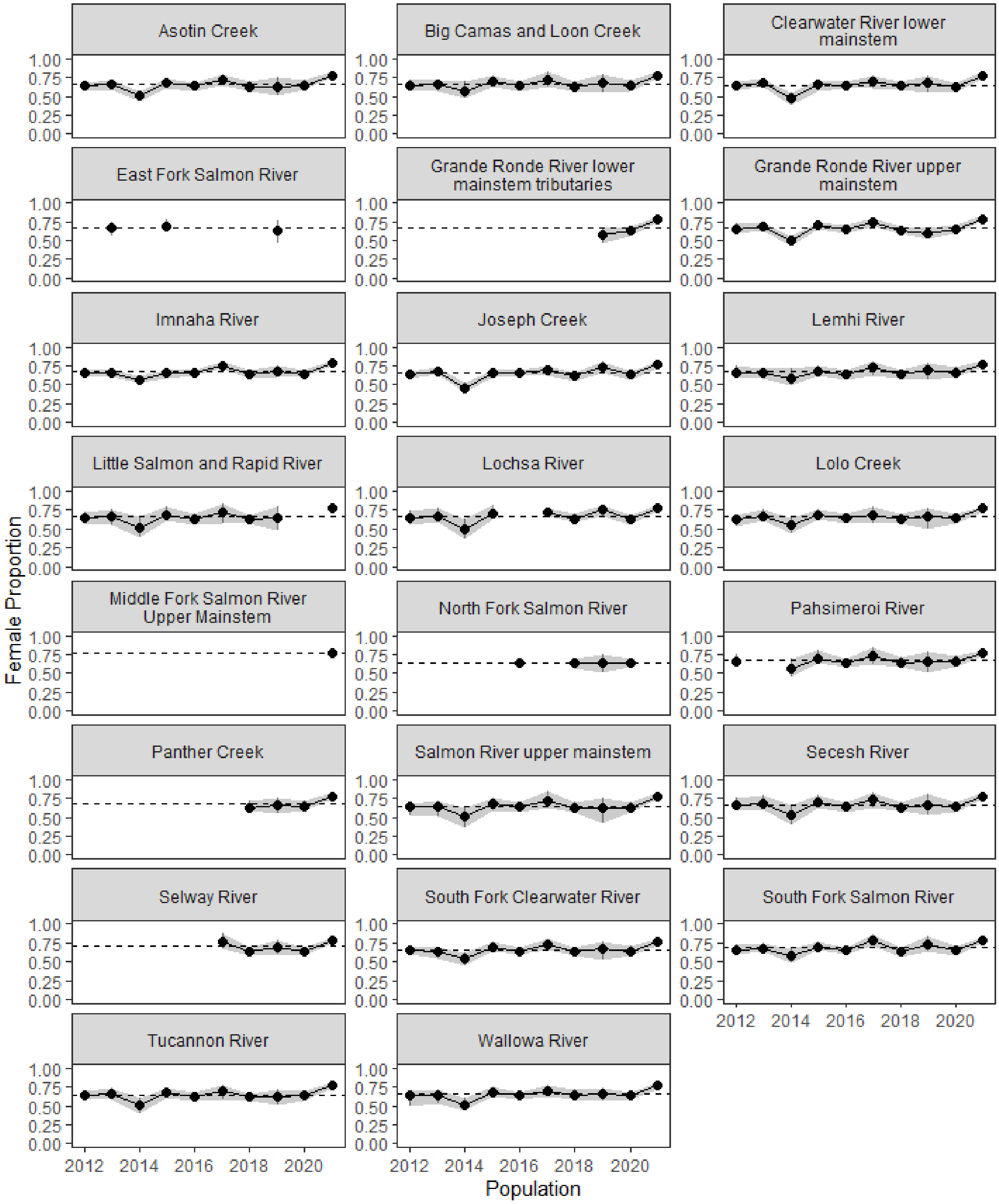

Figure 28. Female proportion of natural-origin summer steelhead in ICTRT populations estimated from PIT tag detections at instream arrays in spawn year 2021 (grey bands represent 95% confidence intervals; dashed lines represents the 10-year average).

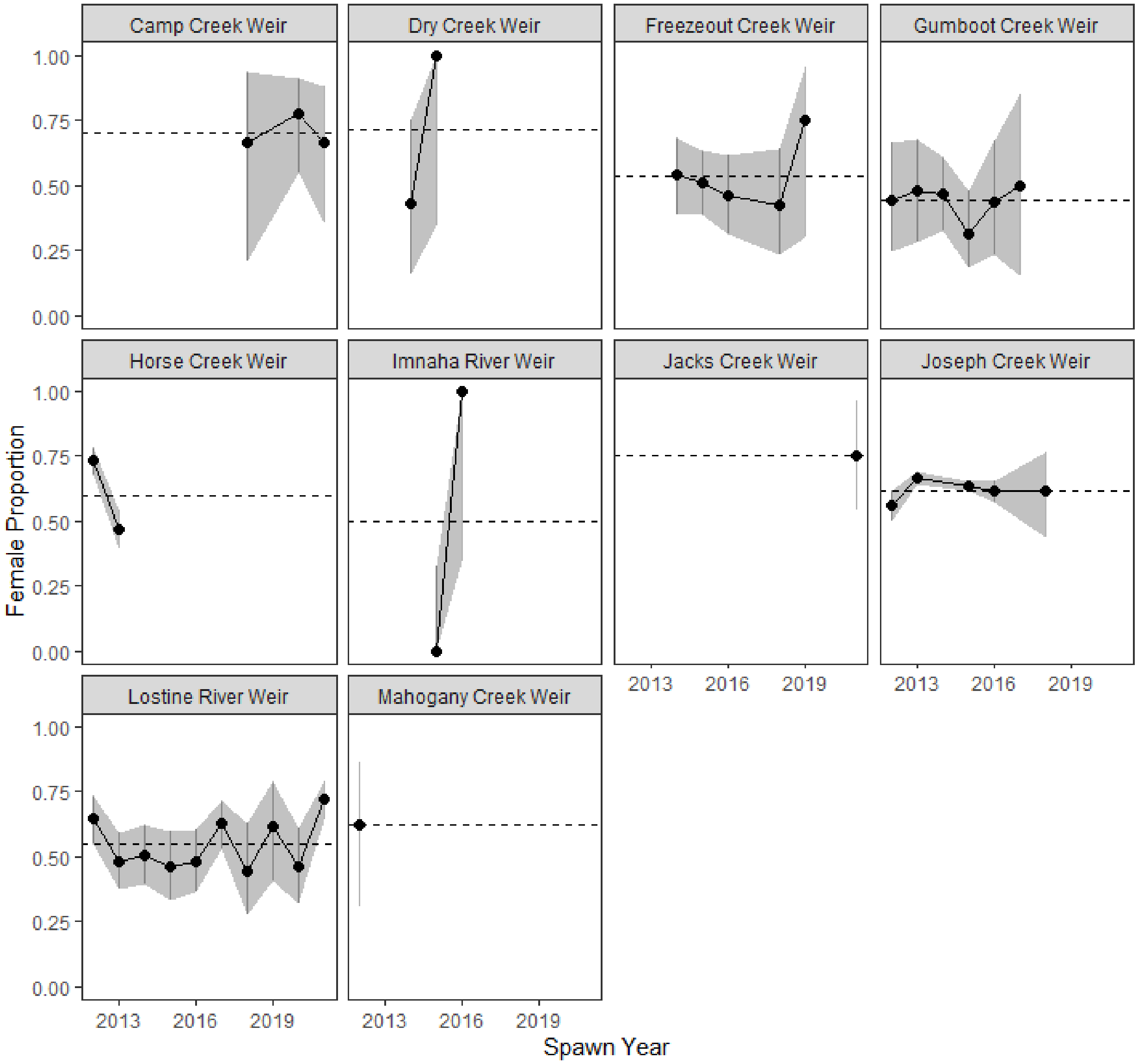

Figure 29. Female proportions of summer steelhead returning to DFRM operated weirs (grey bands represent 95% confidence intervals; dashed lines represents the 10-year average)..

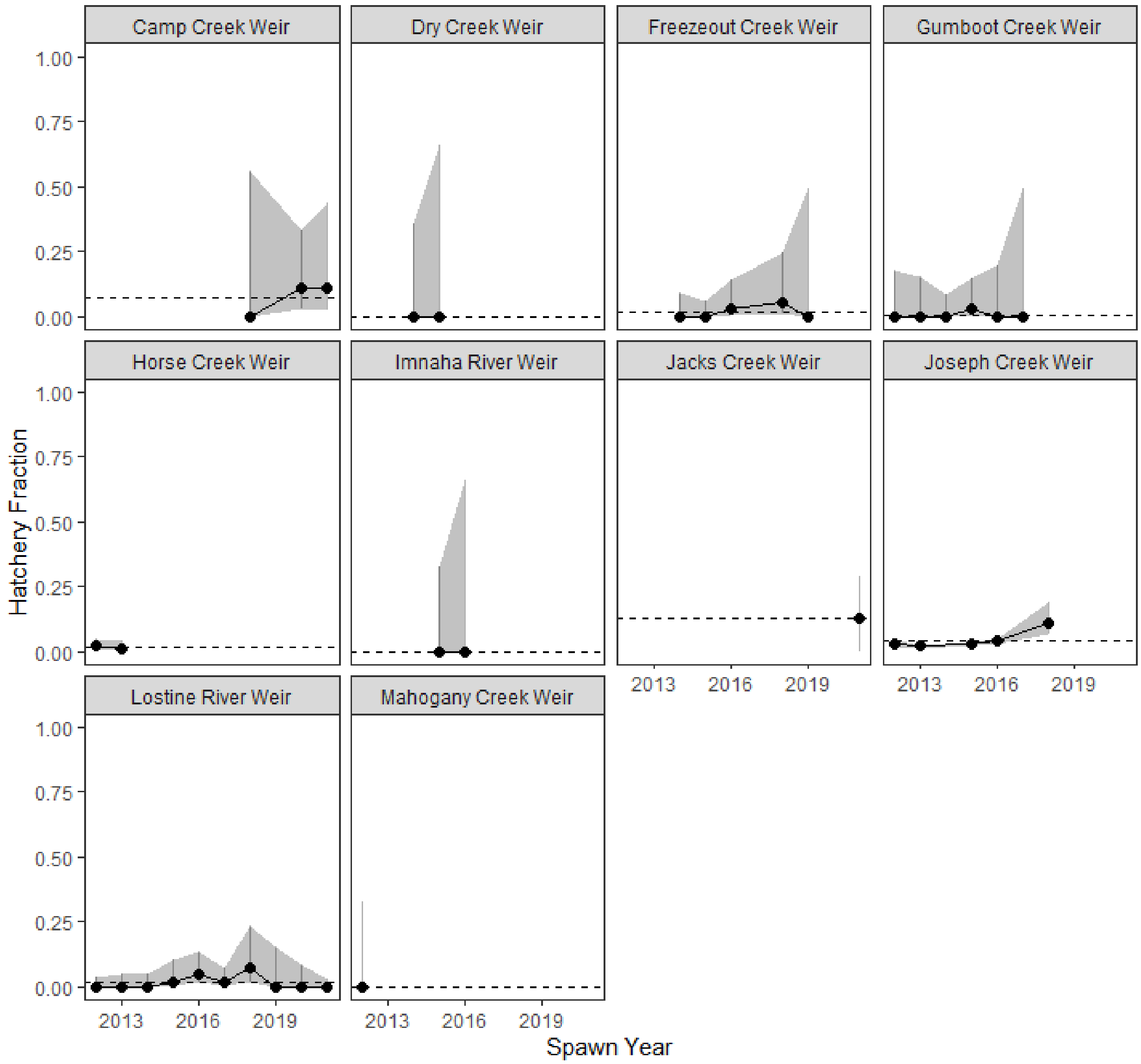

Figure 30. Hatchery fraction of summer steelhead returning to DFRM operated weirs with (grey bands represent 95% confidence intervals; dashed lines represents the 10-year average)..

Figure 31. Total age proportions of natural-origin summer steelhead in ICTRT populations estimated from PIT tag detections at instream arrays and scales collected at Lower Granite Dam.

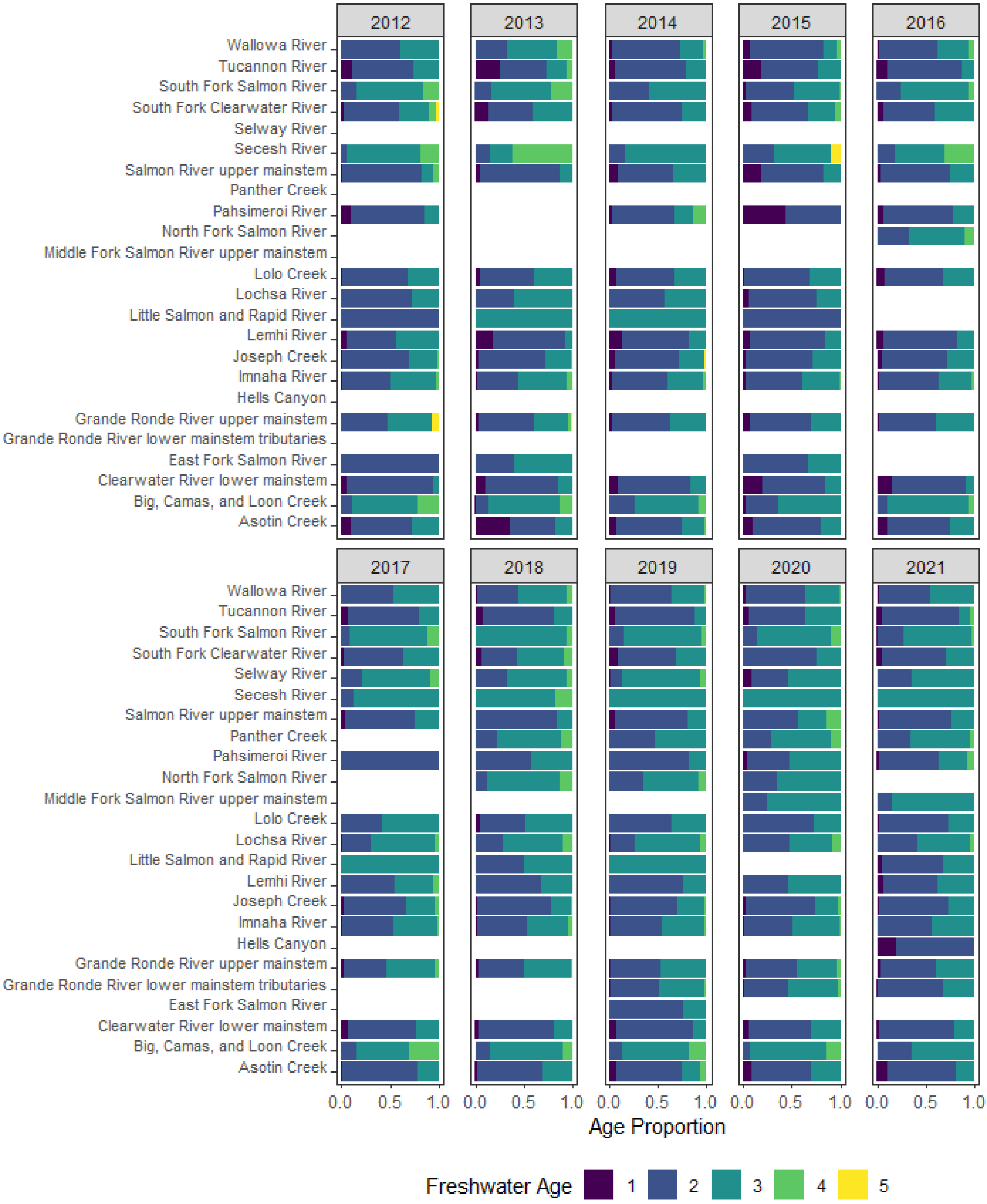

Figure 32. Freshwater age proportions of natural-origin summer steelhead in ICTRT populations estimated from PIT tag detections at instream arrays and scales collected at Lower Granite Dam.

Figure 33. Ocean age proportions of natural-origin summer steelhead in ICTRT populations estimated from PIT tag detections at instream arrays and scales collected at Lower Granite Dam.

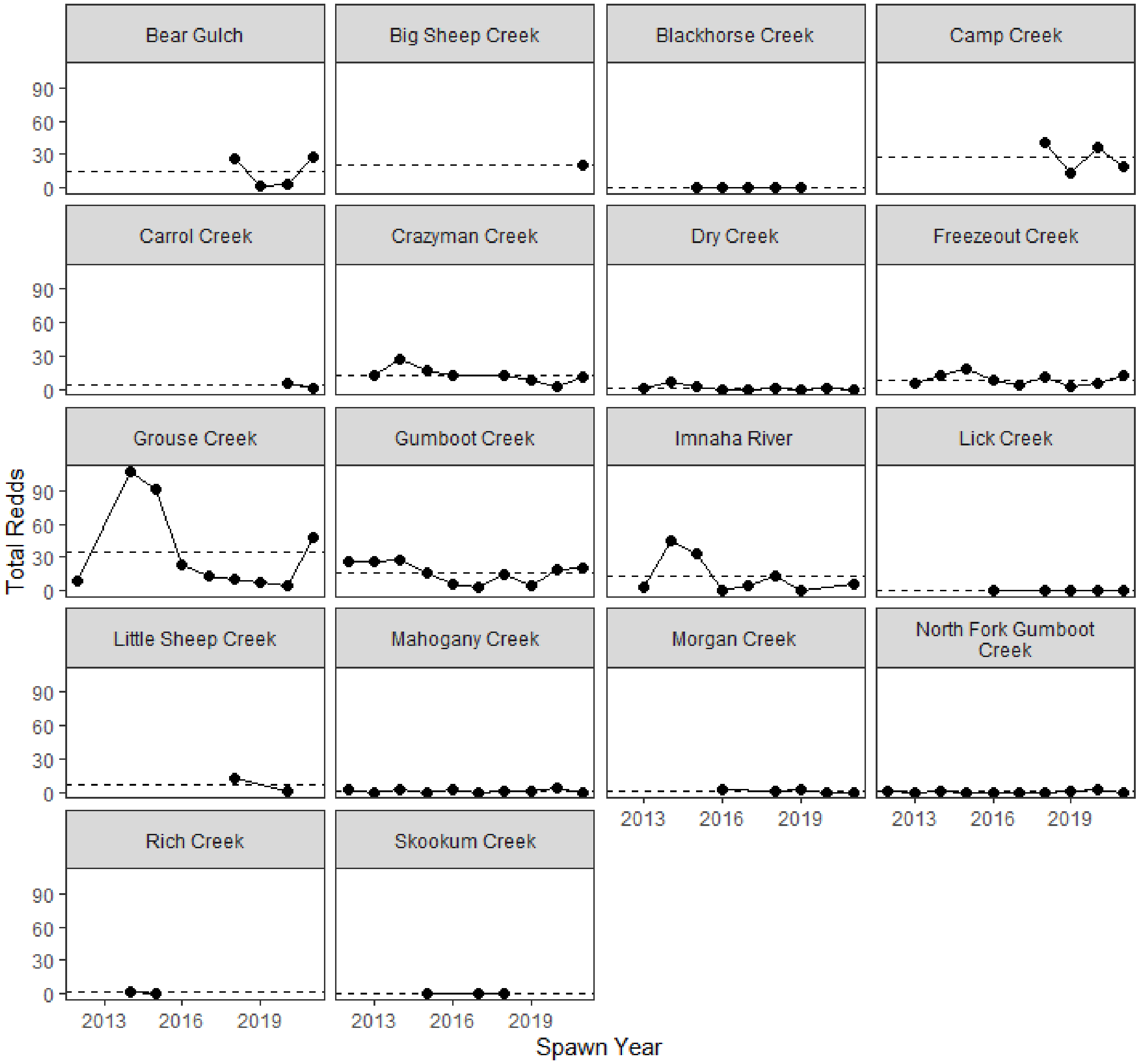

Figure 34. Total summer steelhead redds counted in the ICTRT Imanha River major population group during spawning ground surveys from 2012 to 2021 (dashed lines represents the 10-year average).

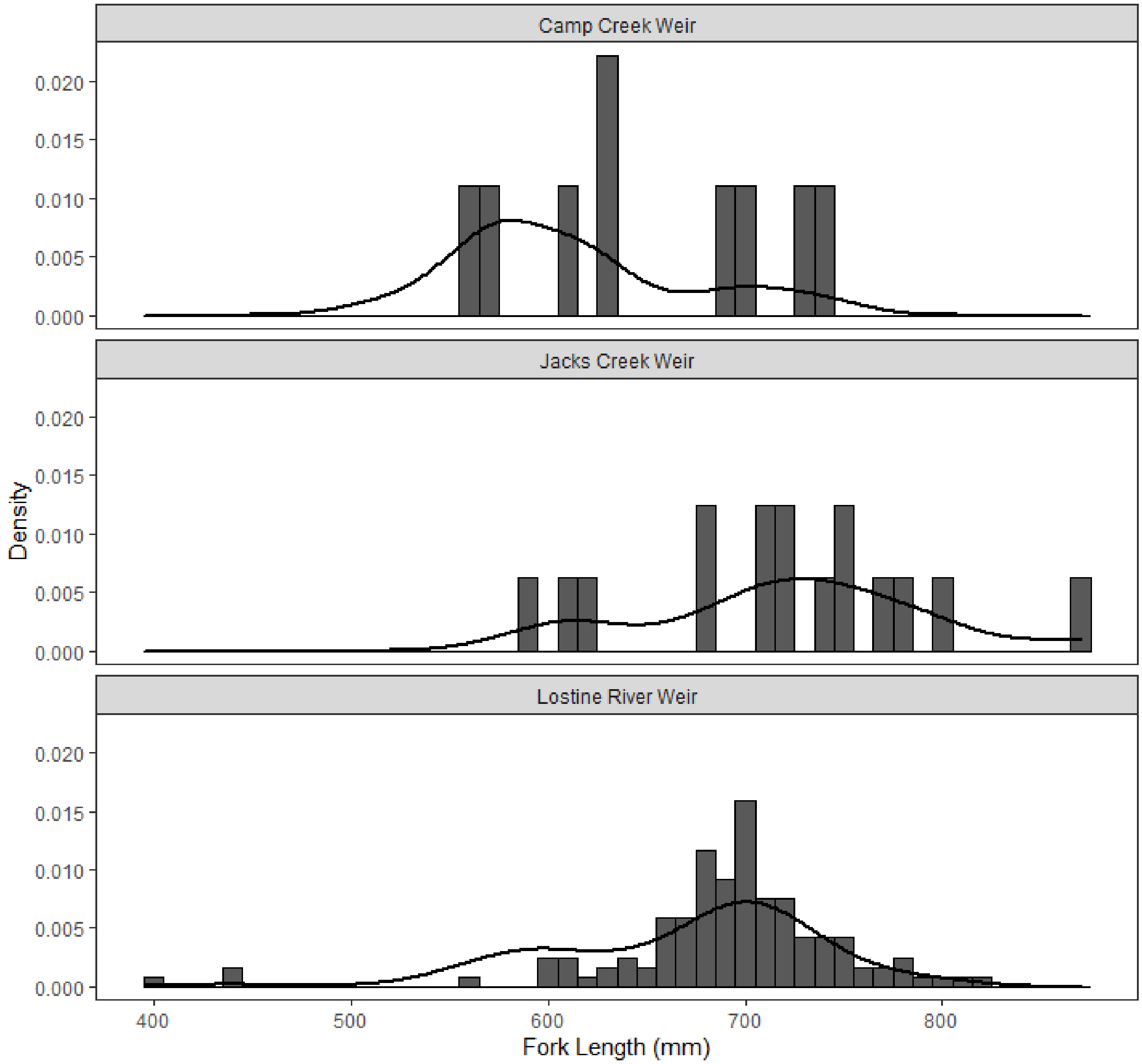

Figure 35. Fork length distribution of summer steelhead trapped at DFRM operated weirs during spawn year 2021 (bars) and the period of record (line).

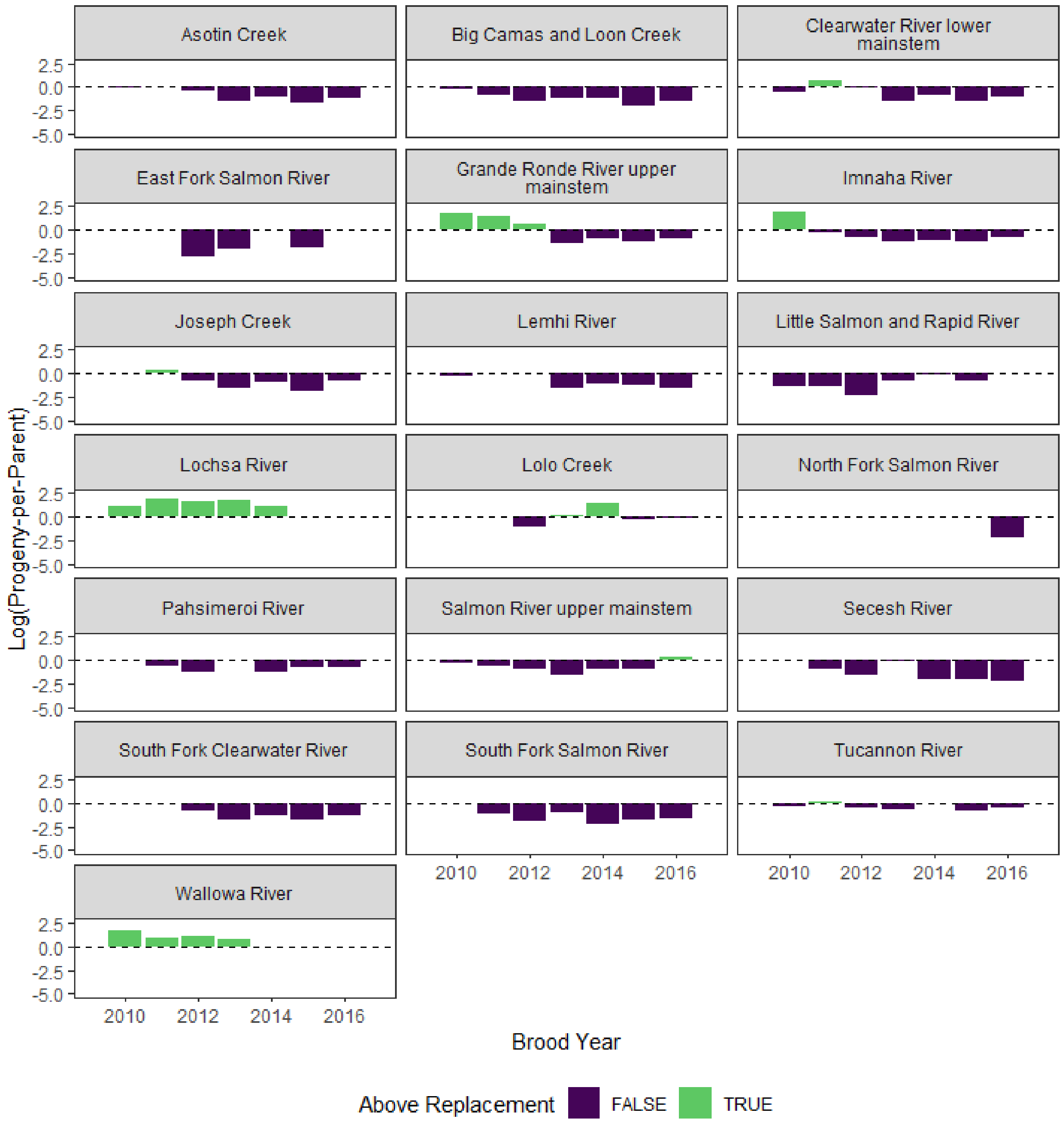

Figure 36. Natural-origin summer steelhead progeny-per-parent productivity estimates calculated from scales collected at Lower Granite Dam, PIT tag detections at in-stream arrays, and abundance estimates generated from the DABOM model. We present productivity estimates on the log scale where positive (green) bars indicate an annual estimate above replacement (dashed line), and negative (purple) bars indicate below replacement productivity. Productivity estimates do not include hatchery-origin spawners, resulting in proportionally biased estimates relative to the number of hatchery-origin spawners.

Appendix

Appendix A. Lower Granite Dam state space adult dam escapement model (STADEM) estimates for spring/summer Chinook Salmon and summer steelhead from 2012-2021.

Species	Spawn Year	Origin-Clip	Escapement	SD	Lower 95% CI	Upper 95% CI
Chinook Salmon	2012	Total	83,360	4,351	76,696	94,058
		Natural	21,328	1,022	19,667	23,787
		Hatchery Clipped	57,542	3,249	52,584	65,509
		Hatchery No-Clipped	4,501	312	3,965	5,193
	2013	Total	69,406	1,607	66,360	72,984
		Natural	19,051	625	17,972	20,433
		Hatchery Clipped	44,145	1,175	41,904	46,574
		Hatchery No-Clipped	6,243	299	5,712	6,889
	2014	Total	106,940	3,638	99,419	113,469
		Natural	28,490	1,052	26,423	30,484
		Hatchery Clipped	69,048	2,651	63,423	73,624
		Hatchery No-Clipped	9,380	447	8,514	10,262
	2015	Total	133,016	4,010	125,645	142,147
		Natural	23,829	1,051	21,981	26,053
		Hatchery Clipped	98,684	3,240	92,623	106,212
		Hatchery No-Clipped	10,489	620	9,447	11,875
	2016	Total	84,426	2,609	80,501	91,051
		Natural	17,244	545	16,366	18,567
		Hatchery Clipped	59,190	1,999	56,082	64,149
		Hatchery No-Clipped	8,018	293	7,517	8,662

Species	Spawn Year	Origin-Clip	Escapement	SD	Lower 95% CI	Upper 95% CI
	2017	Total	43,130	1,677	39,888	46,666
		Natural	5,159	240	4,716	5,670
		Hatchery Clipped	34,468	1,400	31,793	37,471
		Hatchery No-Clipped	3,508	178	3,176	3,874
	2018	Total	39,604	1,470	36,782	42,671
		Natural	6,997	315	6,408	7,656
		Hatchery Clipped	28,980	1,123	26,849	31,316
		Hatchery No-Clipped	3,615	189	3,266	4,011
	2019	Total	27,539	2,899	23,767	33,684
		Natural	4,668	611	3,942	6,090
		Hatchery Clipped	20,936	2,223	18,056	25,569
		Hatchery No-Clipped	1,913	212	1,593	2,390
	2021	Total	45,720	1,338	42,797	48,191
		Natural	8,592	308	8,030	9,261
		Hatchery Clipped	33,989	1,084	31,592	35,882
		Hatchery No-Clipped	3,105	146	2,824	3,393
Steelhead	2012	Total	190,444	4,464	183,719	201,569
		Natural	40,373	1,073	38,613	42,879
		Hatchery Clipped	139,136	3,400	133,827	147,386
		Hatchery No-Clipped	10,984	421	10,223	11,885
	2013	Total	120,764	4,509	113,905	132,258
		Natural	25,048	1,059	23,416	27,511
		Hatchery Clipped	85,370	3,239	80,381	93,609
		Hatchery No-Clipped	10,328	602	9,455	11,823

Species	Spawn Year	Origin-Clip	Escapement	SD	Lower 95% CI	Upper 95% CI
	2014	Total	116,776	4,388	109,182	127,152
		Natural	28,106	1,878	24,760	32,228
		Hatchery Clipped	80,970	3,381	74,985	88,244
		Hatchery No-Clipped	7,723	635	6,840	9,274
	2015	Total	176,218	5,060	167,671	187,801
		Natural	47,816	1,710	45,058	51,592
		Hatchery Clipped	117,954	3,515	111,753	125,958
		Hatchery No-Clipped	10,437	567	9,493	11,704
	2016	Total	144,432	4,420	135,179	153,186
		Natural	36,082	1,330	33,829	38,642
		Hatchery Clipped	102,068	3,198	95,200	108,337
		Hatchery No-Clipped	6,225	350	5,641	6,966
	2017	Total	104,314	3,632	98,280	111,885
		Natural	15,432	607	14,470	16,716
		Hatchery Clipped	80,606	2,791	75,778	86,222
		Hatchery No-Clipped	8,245	509	7,529	9,395
	2018	Total	69,508	2,265	65,369	74,261
		Natural	10,096	380	9,376	10,888
		Hatchery Clipped	56,812	1,903	53,271	60,847
		Hatchery No-Clipped	2,604	144	2,353	2,923
	2019	Total	54,770	5,848	49,446	70,329
		Natural	10,388	2,746	8,366	18,348
		Hatchery Clipped	41,138	3,280	37,600	49,583
		Hatchery No-Clipped	3,186	296	2,821	3,879

Species	Spawn Year	Origin-Clip	Escapement	SD	Lower 95% CI	Upper 95% CI
	2020	Total	36,542	1,144	34,690	39,312
		Natural	9,941	371	9,288	10,759
		Hatchery Clipped	24,218	809	22,899	26,187
		Hatchery No-Clipped	2,381	141	2,129	2,685
	2021	Total	61,564	1,787	58,024	65,283
		Natural	15,628	516	14,645	16,666
		Hatchery Clipped	40,451	1,292	37,916	43,095
		Hatchery No-Clipped	5,456	288	4,945	6,087

Appendix B. Dam adult branch occupancy model (DABOM) population estimates for spawn year 2021.

Species	Location	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
Steelhead	CRLMA-s	218	20	0.09	182	258
	CRLOC-s	697	47	0.07	613	789
	CRLOL-s	346	30	0.09	291	406
	CRSEL-s	915	61	0.07	806	1,040
	CRSFC-s	351	31	0.09	296	416
	GRJOS-s	745	48	0.06	646	835
	GRLMT-s	513	38	0.07	431	577
	GRUMA-s	752	46	0.06	661	840
	GRWAL-s	963	54	0.06	871	1,074
	IRMAI-s	892	56	0.06	790	1,001
	MFBIG-s	114	15	0.13	88	143
	SFMAI-s	415	54	0.13	323	530
	SFSEC-s	36	14	0.37	16	68
	SNASO-s	407	28	0.07	356	463
	SRLEM-s	92	12	0.13	70	114
	SRPAH-s	26	11	0.41	8	50
	SRPAN-s	194	17	0.09	161	226
	SRUMA-s	313	80	0.25	205	495
Chinook salmon	CRLOC	231	26	0.11	178	278
	CRLOL	59	11	0.19	38	82
	GRCAT	73	18	0.23	43	113
	GRLOS	423	42	0.10	342	503
	GRLOS/GRMIN	426	43	0.10	343	509
	GRMIN	314	36	0.12	245	388
	GRUMA	43	14	0.31	18	70
	GRWEN	134	22	0.16	92	176

Species	Location	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	IRBSH	49	15	0.30	22	77
	IRMAI	342	36	0.10	285	425
	MFBEA	231	29	0.12	178	288
	MFBIG	439	42	0.09	362	520
	SCUMA	147	22	0.15	108	193
	SEUMA/SEMEA/SEMOO	225	29	0.13	169	285
	SFEFS	393	44	0.11	323	488
	SFSEC	429	43	0.10	362	529
	SRLEM	176	22	0.13	138	223
	SRLMA	172	92	0.56	6	311
	SRPAH	102	21	0.21	60	145
	SRPAN	81	12	0.15	60	106
	SRUMA	378	101	0.26	217	572
	SRVAL	87	20	0.22	51	125
	SRYFS	37	13	0.34	16	67

Appendix C. Dam adult branch occupancy model (DABOM) site estimates for spawn year 2021.

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
Steelhead	ACB	115	20	0.18	78	155
	ACB_bb	43	13	0.29	21	71
	ACM	265	23	0.09	224	313
	ACM_bb	83	20	0.24	48	123
	AFC	71	16	0.23	43	105
	ALPOWC	31	5	0.16	23	42
	ASOTIC	123	22	0.18	86	171
	BCANF	41	14	0.33	19	70
	BSC	270	35	0.13	206	340
	CAMP4C	7	6	0.75	0	19
	CATHEW	54	15	0.27	26	85
	CCU	92	30	0.31	51	160
	CCW	71	20	0.27	36	112
	CMP	34	58	0.99	0	185
	COC	22	4	0.18	14	30
	CZY	18	11	0.54	4	41
	DWL	29	4	0.15	22	38
	EFPW	3	2	0.60	0	6
	EPR	1	1	0.76	0	4
	ESS	167	27	0.16	119	224
	ESS_bb	152	27	0.17	102	202
	EVL	62	12	0.20	39	86
	EVL_bb	3	4	1.00	0	12
	EVU	57	12	0.21	36	81
	EVU_bb	9	7	0.70	0	23
	FISTRP	89	21	0.23	53	134

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	GCM	66	18	0.26	36	106
	GEORGC	57	16	0.27	29	90
	GOA	443	41	0.09	365	521
	GOA_bb	27	22	0.72	0	72
	GRA_bb	6,234	199	0.03	5,825	6,592
	GRANDW	37	25	0.63	0	82
	GRS	599	44	0.07	512	682
	GRS_bb	153	26	0.17	106	209
	HLM	4	2	0.47	1	8
	HLM_bb	1	1	0.89	0	4
	HYC	29	10	0.34	12	50
	IHR	77	19	0.25	42	116
	IHR_bb	3	4	1.04	0	12
	IML	55	16	0.28	27	87
	IMNAHW	51	15	0.29	24	82
	IR1	871	57	0.06	762	983
	IR2	852	57	0.07	744	960
	IR2_bb	180	62	0.37	12	258
	IR3	296	36	0.12	230	369
	IR3_bb	146	27	0.18	98	203
	IR4	60	17	0.27	32	96
	IR5	46	14	0.30	22	76
	IR5_bb	47	15	0.31	22	80
	JA1	15	4	0.26	9	23
	JOC	742	48	0.06	648	833
	JohnDay	19	9	0.45	4	38
	JOSEPC	379	223	0.59	2	724

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	JUL	6	2	0.28	3	10
	JUL_bb	2	2	0.78	0	6
	KEN	6	6	0.71	0	18
	KRS	184	30	0.16	132	249
	LAP	212	20	0.09	177	252
	LAP_bb	166	20	0.12	128	208
	LC1	346	30	0.09	289	407
	LC2	309	30	0.10	249	368
	LLR	92	12	0.13	71	116
	LMA	117	27	0.23	65	171
	LOOH	122	13	0.11	97	148
	LOSTIW	8	7	0.72	0	24
	LRL	699	49	0.07	611	798
	LRU	687	49	0.07	590	782
	LRW	10	6	0.54	1	21
	LRW_bb	9	6	0.56	1	21
	LSHEEF	55	17	0.29	27	90
	LTR	301	36	0.12	234	374
	MAR	63	9	0.14	46	81
	MCN	40	14	0.34	17	68
	MCN_bb	6	5	0.74	0	18
	MR1	367	41	0.11	290	449
	MTR	251	33	0.13	193	318
	OXBO	43	7	0.16	30	57
	PAHH	26	11	0.41	9	51
	PCA	194	17	0.09	161	227
	SALSFW	31	41	0.94	0	129

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	SAWT	88	21	0.24	53	134
	SC1	352	31	0.09	297	417
	SC2	303	39	0.13	230	380
	SC3	34	83	1.13	0	256
	SC4	3	5	1.12	0	14
	SC4_bb	3	5	1.11	0	15
	SFG	453	40	0.09	378	530
	SFG_bb	60	20	0.32	25	102
	STL	165	71	0.40	69	320
	STR	86	56	0.64	0	183
	SW1	915	60	0.07	806	1,040
	SW2	859	59	0.07	747	973
	SWT	45	14	0.29	23	75
	TAY	114	14	0.13	88	143
	TENMC2	109	12	0.11	85	133
	TFH	58	22	0.36	23	107
	TPJ	8	10	0.88	0	30
	UGR	752	48	0.06	665	851
	UGR_bb	581	50	0.09	490	684
	UGS	75	19	0.25	44	117
	Umatilla	12	7	0.50	2	26
	USE	785	59	0.07	680	910
	USI	500	56	0.11	385	598
	USI_bb	151	72	0.50	2	251
	UTR	95	22	0.23	57	144
	VC1	28	20	0.66	0	64
	VC2	58	18	0.29	29	95

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	WALH	8	7	0.73	1	22
	WallaWalla	19	9	0.44	5	38
	WB1	89	10	0.12	72	111
	WEB	25	10	0.40	7	45
	WEN	510	38	0.07	441	589
	WR1	961	55	0.06	846	1,061
	WR1_bb	29	16	0.53	1	59
	WR2	523	45	0.09	443	616
	WR2_bb	503	44	0.09	424	592
	Yakima	11	8	0.62	1	27
	YFK	87	21	0.23	49	127
	YPP	15	11	0.63	2	38
	ZEN	36	14	0.38	13	65
Chinook salmon	BRC	232	29	0.12	178	287
	BSC	49	14	0.29	23	77
	CATHEW	73	18	0.24	42	113
	CCU	132	27	0.20	86	188
	CCW	107	21	0.19	72	152
	DWL	61	11	0.18	42	85
	ESS	397	44	0.11	317	486
	ESS_bb	80	20	0.24	47	120
	EVL	155	21	0.14	114	196
	EVL_bb	7	6	0.68	0	19
	EVU	147	21	0.14	108	188
	EVU_bb	20	10	0.48	4	42
	FISTRP	96	62	0.62	0	205

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	GOA	28	8	0.27	14	44
	GOA_bb	8	6	0.62	0	20
	GRA_bb	2,337	106	0.04	2,144	2,560
	GRANDW	18	9	0.47	5	38
	GRS	42	8	0.18	28	59
	GRS_bb	13	6	0.44	3	26
	HYC	20	10	0.45	6	40
	IML	229	29	0.13	172	286
	IMNAHW	204	30	0.15	146	263
	IR1	402	37	0.09	338	480
	IR2	398	37	0.09	331	472
	IR2_bb	7	6	0.73	0	19
	IR3	340	35	0.10	277	412
	IR3_bb	59	16	0.26	31	92
	IR4	280	32	0.11	226	353
	IR5	99	19	0.19	63	138
	IR5_bb	99	20	0.20	66	140
	JOHNSC	304	37	0.12	234	377
	KRS	614	55	0.09	511	726
	LC1	59	12	0.20	38	82
	LC2	55	12	0.21	34	78
	LLR	175	22	0.12	136	220
	LOOH	33	8	0.24	20	51
	LOSTIW	166	26	0.16	120	220
	LRL	232	26	0.11	178	283
	LRU	198	31	0.15	139	258

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	LRW	104	18	0.17	69	141
	LRW_bb	104	18	0.17	72	139
	LTR	21	7	0.32	10	37
	MAR	200	26	0.13	150	252
	MR1	312	36	0.12	247	388
	MTR	16	6	0.38	6	29
	PAHH	102	22	0.21	63	148
	PCA	80	13	0.16	56	106
	RFL	16	8	0.48	3	32
	SALSFW	123	24	0.20	78	171
	SAWT	234	34	0.14	170	304
	SC1	147	22	0.15	109	193
	SC2	132	23	0.17	88	175
	SC3	37	32	0.69	4	116
	SC4	10	7	0.60	1	26
	SC4_bb	11	7	0.60	1	26
	SFG	1,499	90	0.06	1,321	1,677
	SFG_bb	53	16	0.30	20	82
	STL	369	102	0.27	217	582
	STR	286	154	0.48	98	603
	SW1	226	30	0.13	169	285
	SW2	193	29	0.15	141	252
	TAY	437	40	0.09	359	516
	TFH	8	5	0.57	1	18
	TPJ	3	4	0.85	0	11
	UGR	204	28	0.14	154	258

Species	Site	Escapement	SD	CV	Lower 95% CI	Upper 95% CI
	UGR_bb	25	17	0.65	0	59
	UGS	44	14	0.32	17	73
	USE	1,333	89	0.07	1,166	1,506
	USI	795	69	0.09	674	941
	USI_bb	179	94	0.55	0	317
	UTR	13	6	0.41	4	25
	VC1	40	28	0.63	0	91
	VC2	88	20	0.23	51	126
	WEN	135	22	0.16	95	180
	WR1	739	55	0.07	636	854
	WR1_bb	4	6	1.01	0	19
	WR2	420	42	0.10	340	503
	WR2_bb	252	33	0.13	187	314
	YFK	38	13	0.34	16	67
	YPP	12	10	0.66	1	32
	ZEN	430	44	0.10	347	521

Appendix D. Estimated dam adult branch occupancy model (DABOM) node detection probabilities for spawn year 2021.

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
Steelhead	ACB	ACB_D	24	0.97	0.04	0.04	0.88	1.00
		ACB_U	24	0.97	0.04	0.04	0.89	1.00
	ACM	ACM_D	31	0.60	0.07	0.11	0.46	0.72
		ACM_M	39	0.74	0.06	0.08	0.62	0.85
		ACM_U	46	0.88	0.05	0.05	0.78	0.95
	AFC	AFC_U	15	1.00	0.00	0.00	1.00	1.00
	ALPOWC	ALPOWC	6	1.00	0.00	0.00	1.00	1.00
	ASOTIC	ASOTIC	12	0.48	0.10	0.20	0.29	0.67
	BCANF	BCANF	8	1.00	0.00	0.00	1.00	1.00
	BSC	BSC_D	56	0.99	0.02	0.02	0.95	1.00
		BSC_U	56	0.99	0.02	0.02	0.95	1.00
	CAMP4C	CAMP4C	1	1.00	0.00	0.00	1.00	1.00
	CATHEW	CATHEW	12	1.00	0.00	0.00	1.00	1.00
	CCU	CCU_D	6	0.33	0.11	0.35	0.13	0.57
	CCW	CCW_D	6	0.41	0.12	0.29	0.20	0.64
		CCW_U	6	0.40	0.12	0.30	0.17	0.63
	COC	COC_D	4	0.85	0.15	0.18	0.52	1.00
		COC_U	4	0.85	0.16	0.18	0.49	1.00
	CZY	CZY_D	3	0.82	0.19	0.23	0.40	1.00
		CZY_U	3	0.81	0.18	0.22	0.41	1.00
	DWL	DWL	6	1.00	0.00	0.00	1.00	1.00
	EFPW	EFPW	1	0.72	0.24	0.33	0.23	1.00
	EPR	EPR_U	1	1.00	0.00	0.00	1.00	1.00
	ESS	ESS_D	32	0.95	0.04	0.04	0.87	1.00
		ESS_U	33	0.98	0.03	0.03	0.92	1.00
	EVL	EVL_D	13	0.95	0.06	0.07	0.80	1.00

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
		EVL_U	9	0.68	0.12	0.17	0.43	0.88
	EVU	EVU_D	12	0.88	0.09	0.10	0.69	0.99
		EVU_U	12	0.88	0.08	0.09	0.70	0.99
	FISTRP	FISTRP	17	1.00	0.00	0.00	1.00	1.00
	GCM	GCM_D	13	0.89	0.08	0.09	0.71	0.99
		GCM_U	14	0.95	0.07	0.07	0.79	1.00
	GEORGC	GEORGC	11	1.00	0.00	0.00	1.00	1.00
	GOA	GOA	17	0.20	0.04	0.22	0.12	0.29
	GRS	GRS	76	0.66	0.04	0.06	0.58	0.75
	HYC	HYC_D	7	0.84	0.14	0.16	0.55	1.00
		HYC_U	2	0.30	0.14	0.47	0.06	0.57
	IR1	IR1	174	0.98	0.01	0.01	0.96	1.00
	IR2	IR2	168	0.97	0.01	0.01	0.94	0.99
	IR3	IR3_D	47	0.76	0.05	0.07	0.66	0.87
		IR3_U	39	0.64	0.06	0.09	0.52	0.75
	IR4	IR4_U	11	0.85	0.11	0.13	0.60	0.98
	IR5	IR5_D	12	0.95	0.07	0.07	0.78	1.00
		IR5_U	12	0.95	0.07	0.07	0.80	1.00
	JA1	JA1_D	2	0.71	0.23	0.32	0.24	1.00
		JA1_U	1	0.43	0.23	0.53	0.06	0.86
	JOC	JOC_D	144	0.97	0.01	0.02	0.94	0.99
		JOC_U	148	1.00	0.01	0.01	0.98	1.00
	KEN	KEN_D	1	0.67	0.24	0.37	0.20	1.00
		KEN_U	1	0.65	0.24	0.38	0.18	1.00
	KRS	KRS_D	22	0.60	0.08	0.14	0.45	0.77
		KRS_U	34	0.93	0.06	0.06	0.80	1.00
	LAP	LAP_D	44	0.98	0.02	0.02	0.93	1.00
	LC1	LC1	57	0.93	0.03	0.03	0.87	0.99

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
	LC2	LC2	55	1.00	0.00	0.00	1.00	1.00
	LLR	LLR_D	18	0.91	0.06	0.07	0.79	1.00
		LLR_U	18	0.92	0.07	0.07	0.77	0.99
	LMA	LMA	3	0.15	0.08	0.49	0.03	0.31
	LOOH	LOOH	24	1.00	0.00	0.00	1.00	1.00
	LOSTIW	LOSTIW	1	1.00	0.00	0.00	1.00	1.00
	LRL	LRL	108	0.80	0.04	0.04	0.73	0.86
	LRU	LRU	126	0.94	0.02	0.03	0.89	0.98
	LRW	LRW_D	2	0.80	0.19	0.24	0.37	1.00
		LRW_U	2	0.79	0.19	0.24	0.36	1.00
	LSHEEF	LSHEEF	11	1.00	0.00	0.00	1.00	1.00
	LTR	LTR_D	3	0.06	0.03	0.52	0.01	0.13
		LTR_M	57	0.95	0.03	0.03	0.89	0.99
		LTR_U	43	0.72	0.06	0.08	0.61	0.83
	MAR	MAR_D	13	0.95	0.07	0.07	0.80	1.00
		MAR_U	13	0.95	0.06	0.07	0.80	1.00
	MCN	MCN	1	0.16	0.11	0.71	0.01	0.40
	MR1	MR1_D	52	0.68	0.05	0.08	0.56	0.77
		MR1_U	66	0.86	0.05	0.05	0.77	0.94
	MTR	MTR_M	42	0.83	0.05	0.07	0.72	0.93
		MTR_U	49	0.96	0.03	0.03	0.90	1.00
	OXBO	OXBO	9	1.00	0.00	0.00	1.00	1.00
	PAHH	PAHH	5	1.00	0.00	0.00	1.00	1.00
	PCA	PCA_D	50	0.99	0.02	0.02	0.94	1.00
		PCA_U	50	0.99	0.02	0.02	0.94	1.00
	SAWT	SAWT	19	1.00	0.00	0.00	1.00	1.00
	SC1	SC1	59	0.94	0.03	0.04	0.87	0.99
	SC2	SC2	47	0.87	0.08	0.09	0.72	1.00

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
	SFG	SFG	69	0.79	0.04	0.05	0.70	0.86
	SW1	SW1	149	0.88	0.03	0.03	0.83	0.93
	SW2	SW2	159	1.00	0.00	0.00	1.00	1.00
	SWT	SWT_D	9	0.93	0.09	0.10	0.73	1.00
		SWT_U	8	0.83	0.11	0.13	0.60	0.99
	TAY	TAY_D	16	0.70	0.10	0.15	0.49	0.88
		TAY_U	18	0.78	0.10	0.13	0.58	0.95
	TENMC2	TENMC2	22	1.00	0.00	0.00	1.00	1.00
	TFH	TFH_D	9	0.75	0.18	0.24	0.41	1.00
	TPJ	TPJ_D	1	0.63	0.25	0.40	0.16	1.00
		TPJ_U	1	0.63	0.26	0.42	0.14	1.00
	UGR	UGR	154	0.98	0.01	0.01	0.96	1.00
	UGS	UGS_D	12	0.77	0.10	0.13	0.56	0.94
		UGS_M	13	0.83	0.09	0.11	0.65	0.97
		UGS_U	12	0.77	0.10	0.13	0.55	0.94
	USE	USE	77	0.48	0.05	0.10	0.38	0.57
	USI	USI	69	0.67	0.05	0.07	0.57	0.75
	UTR	UTR_D	11	0.58	0.11	0.19	0.35	0.78
		UTR_U	15	0.76	0.10	0.13	0.56	0.93
	VC2	VC2_D	12	0.94	0.08	0.09	0.75	1.00
		VC2_U	10	0.78	0.11	0.14	0.57	0.98
	WALH	WALH	1	1.00	0.00	0.00	1.00	1.00
	WB1	WB1_D	17	0.96	0.05	0.05	0.85	1.00
		WB1_U	17	0.96	0.05	0.05	0.84	1.00
	WEB	WEB_D	5	0.87	0.14	0.16	0.55	1.00
		WEB_U	5	0.88	0.14	0.16	0.55	1.00
	WEN	WEN_D	61	0.56	0.06	0.10	0.45	0.67
		WEN_U	70	0.65	0.06	0.09	0.52	0.75

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
	WR1	WR1	114	0.57	0.04	0.06	0.50	0.64
	WR2	WR2_D	105	0.96	0.02	0.02	0.91	0.99
		WR2_U	105	0.96	0.02	0.02	0.92	0.99
	YFK	YFK_D	18	0.96	0.05	0.05	0.85	1.00
		YFK_U	17	0.91	0.07	0.08	0.77	1.00
	YPP	YPP_D	2	0.74	0.22	0.30	0.28	1.00
		YPP_U	2	0.75	0.22	0.30	0.28	1.00
	ZEN	ZEN_D	6	0.88	0.14	0.15	0.56	1.00
		ZEN_U	5	0.74	0.15	0.21	0.42	0.98
Chinook salmon	BRC	BRC	53	1.00	0.00	0.00	1.00	1.00
	BSC	BSC_D	11	0.94	0.08	0.08	0.76	1.00
		BSC_U	11	0.94	0.07	0.08	0.78	1.00
	CATHEW	CATHEW	17	1.00	0.00	0.00	1.00	1.00
	CCW	CCW_D	20	0.81	0.08	0.10	0.65	0.95
		CCW_U	21	0.85	0.07	0.08	0.71	0.96
	DWL	DWL	14	1.00	0.00	0.00	1.00	1.00
	ESS	ESS_D	93	0.99	0.01	0.01	0.97	1.00
		ESS_U	90	0.96	0.02	0.02	0.92	0.99
	EVL	EVL_D	36	0.98	0.03	0.03	0.92	1.00
		EVL_U	18	0.50	0.08	0.16	0.34	0.65
	EVU	EVU_D	30	0.85	0.06	0.07	0.73	0.95
		EVU_U	32	0.90	0.05	0.06	0.79	0.98
	GOA	GOA	2	0.33	0.15	0.45	0.06	0.61
	GRANDW	GRANDW	4	1.00	0.00	0.00	1.00	1.00
	GRS	GRS	7	0.67	0.13	0.19	0.41	0.90
	HYC	HYC_D	3	0.64	0.19	0.30	0.27	0.95

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
		HYC_U	4	0.82	0.17	0.21	0.44	1.00
	IML	IML_D	52	0.92	0.04	0.04	0.84	0.98
		IML_U	52	0.92	0.04	0.04	0.84	0.97
	IMNAHW	IMNAHW	24	0.47	0.07	0.16	0.33	0.62
	IR1	IR1	93	0.98	0.01	0.01	0.95	1.00
	IR2	IR2	87	0.92	0.03	0.03	0.86	0.97
	IR3	IR3_D	79	0.96	0.02	0.02	0.91	0.99
		IR3_U	68	0.82	0.04	0.05	0.74	0.90
	IR4	IR4_D	58	0.84	0.04	0.05	0.76	0.92
		IR4_U	65	0.95	0.03	0.03	0.89	0.99
	IR5	IR5_D	24	0.94	0.05	0.06	0.82	1.00
		IR5_U	25	0.97	0.04	0.04	0.89	1.00
	JOHNSC	JOHNSC	72	1.00	0.00	0.00	1.00	1.00
	KRS	KRS_D	85	0.59	0.04	0.07	0.50	0.66
		KRS_U	142	0.98	0.01	0.01	0.95	1.00
	LC1	LC1	12	0.95	0.07	0.07	0.79	1.00
	LC2	LC2	12	1.00	0.00	0.00	1.00	1.00
	LLR	LLR_D	40	0.98	0.02	0.02	0.93	1.00
		LLR_U	40	0.98	0.02	0.02	0.92	1.00
	LOOH	LOOH	7	1.00	0.00	0.00	1.00	1.00
	LOSTIW	LOSTIW	39	1.00	0.00	0.00	1.00	1.00
	LRL	LRL	44	0.79	0.06	0.08	0.66	0.89
	LRU	LRU	41	0.85	0.09	0.11	0.69	1.00
	LRW	LRW_D	24	0.90	0.06	0.06	0.78	0.99
		LRW_U	26	0.97	0.03	0.04	0.89	1.00

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
	LTR	LTR_D	1	0.22	0.14	0.65	0.02	0.53
		LTR_M	6	0.91	0.11	0.12	0.65	1.00
		LTR_U	5	0.77	0.15	0.19	0.46	0.99
	MAR	MAR_D	43	0.96	0.03	0.03	0.90	1.00
		MAR_U	44	0.98	0.02	0.02	0.93	1.00
	MR1	MR1_D	37	0.51	0.06	0.11	0.40	0.62
		MR1_U	49	0.67	0.06	0.09	0.56	0.79
	MTR	MTR_M	4	0.73	0.16	0.22	0.41	0.99
		MTR_U	4	0.73	0.16	0.22	0.39	0.98
	PAHH	PAHH	23	1.00	0.00	0.00	1.00	1.00
	PCA	PCA_D	18	0.96	0.05	0.05	0.85	1.00
		PCA_U	18	0.96	0.05	0.05	0.85	1.00
	RFL	RFL	3	1.00	0.00	0.00	1.00	1.00
	SALSFW	SALSFW	29	1.00	0.00	0.00	1.00	1.00
	SAWT	SAWT	54	1.00	0.00	0.00	1.00	1.00
	SC1	SC1	25	0.82	0.07	0.09	0.68	0.95
	SC2	SC2	26	0.92	0.07	0.07	0.78	1.00
	SC3	SC3	1	0.18	0.18	1.00	0.01	0.58
	SC4	SC4_D	1	0.51	0.23	0.45	0.10	0.91
		SC4_U	2	0.78	0.19	0.25	0.35	1.00
	SFG	SFG	256	0.73	0.02	0.03	0.68	0.78
	SW1	SW1	31	0.63	0.07	0.11	0.50	0.78
	SW2	SW2	42	1.00	0.00	0.00	1.00	1.00
	TAY	TAY_D	89	0.89	0.03	0.04	0.82	0.95
		TAY_U	85	0.85	0.04	0.04	0.77	0.91

Species	Site	Node	Obs. Tags	Det. p	SD	CV	Lower 95% CI	Upper 95% CI
	TFH	TFH_D	2	0.60	0.23	0.38	0.23	1.00
	UGR	UGR	42	0.96	0.03	0.03	0.89	1.00
	UGS	UGS_D	7	0.73	0.13	0.18	0.47	0.94
		UGS_M	8	0.83	0.12	0.14	0.57	0.99
		UGS_U	3	0.34	0.13	0.39	0.09	0.60
	USE	USE	193	0.65	0.03	0.05	0.59	0.72
	USI	USI	115	0.65	0.04	0.05	0.58	0.71
	UTR	UTR_D	5	0.90	0.12	0.13	0.63	1.00
		UTR_U	5	0.89	0.12	0.14	0.61	1.00
	VC2	VC2_D	17	0.86	0.08	0.09	0.70	0.98
		VC2_U	19	0.96	0.05	0.05	0.85	1.00
	WEN	WEN_D	17	0.58	0.10	0.18	0.37	0.77
		WEN_U	19	0.64	0.11	0.17	0.43	0.84
	WR1	WR1	102	0.60	0.04	0.06	0.52	0.67
	WR2	WR2_D	93	0.94	0.02	0.03	0.89	0.98
		WR2_U	68	0.69	0.05	0.07	0.60	0.78
	YFK	YFK_D	8	0.92	0.10	0.11	0.69	1.00
		YFK_U	8	0.92	0.09	0.10	0.70	1.00
	YPP	YPP_D	2	0.75	0.22	0.29	0.28	1.00
		YPP_U	2	0.73	0.22	0.31	0.26	1.00
	ZEN	ZEN_D	98	0.96	0.02	0.02	0.92	0.99
		ZEN_U	92	0.90	0.03	0.03	0.84	0.95