

FISH IN/OUT: SMOLT PRODUCTION

Study Goals and Objectives

The goals of the smolt trapping study are to provide annual abundance estimates for natural-origin juvenile salmon and steelhead originating from the upper Chehalis and Newaukum rivers. These two focal sub-basins have been identified by the ASRP as areas for near-term implementation and by measuring smolt production, we should be able to test the effectiveness of stream restoration activities for increasing the freshwater production of juveniles. Annual measurements include juvenile abundance and life history diversity (size, age, and run timing).

Methods / Study Design

The smolt trapping study utilizes two 1.5 m (5-foot) rotary screw traps located in the Newaukum and upper Chehalis rivers to conduct single trap, mark-recapture studies stratified by week to estimate natural-origin juvenile salmon and steelhead abundance. The mark-recapture design consists of counting maiden-caught fish and marking a known number of captured fish for release at an upstream location. Marks used in the studies include Passive Integrated Transponder (PIT) tags, Micro-Ject, and Visible Implant Elastomer (VIE) marks. Total maiden, marked, and recaptured fish are enumerated weekly and evaluated using Bayesian Time-Stratified Population Analysis System (BTSPAS, Bonner and Schwartz 2011). This method uses Bayesian P-splines and hierarchical modeling of trap efficiencies to determine abundance with known precision through time, which allows for estimation during missed trapping days and for time strata with minimal efficiency data. Targeted life stages are subyearling Chinook, yearling coho, and yearling (+) steelhead (age 1+). In addition, weekly data are collected to assess variation in fish size, age structure, origin, and outmigration timing.

Summary of Results

Abundance estimates from the 2022 smolt trapping study are presented in Table 1 and Figure 1. Of note was the low abundance of subyearling Chinook during the 2022 outmigration year from the upper Chehalis River (19,870, CV = 7.2%) and the Newaukum River (40,639, CV = 6.7%) relative to the previous year. The number of outmigrating subyearling Chinook decreased from 2021 to 2022 by 83.3% in the upper Chehalis River and by 75.1% in the Newaukum River (Table 2). Contrary to Chinook, the number of yearling coho smolts in 2022 increased by 88.9% compared to coho that out-migrated in 2021.

Juvenile steelhead from the upper Chehalis River, a productive area in the basin for this species, slightly increased between 2021 (9,736, CV = 27.6%) and 2022 (10,204, CV = 19.6%). A 2022 estimate of steelhead juvenile production in the Newaukum River is unavailable as the Newaukum River smolt trap was installed after the start of the steelhead migration. Installing the trap earlier in

the year may resolve this issue, although flashy river conditions in January and February have prevented safe trap installation until March in each year of operation (2019 - 2022).

An unusual observation in 2021 was the proportion of juvenile steelhead that out-migrated as one-year-olds (71.4% Age-1, 26.5% Age-2, and 2.1% Age-3). Throughout their range, most steelhead out-migrate as two-year-olds. It was unclear whether the one-year-olds originating from the upper Chehalis River were redistributing to areas lower in the basin or heading to sea. Field staff reported that the steelhead outmigrants had undergone smoltification, indicating they were physiologically preparing for life in saltwater, however, it would have been unusual for so many age-1 steelhead to emigrate from freshwater. Steelhead smolt age data from 2022 identified a higher proportion of two-year old fish compared to 2021 (34.9% Age-1, 60.1% Age-2, and 5.0% Age-3), indicating that the observations in 2021 may have been anomalous.

Table 1. Estimates of juvenile salmon and steelhead production in 2022 above the upper Chehalis River and Newaukum River smolt traps.

2022 Results	Upper Chehalis		Newaukum	
	Estimate	CV	Estimate	CV
Chinook	19,870	7.2%	40,639	6.7%
Coho	24,434	7.6%	51,031	20.2%
Steelhead	10,204	19.6%	NA	

Table 2. Percent change in juvenile salmon and steelhead production estimates between 2021 and 2022 for the upper Chehalis River and Newaukum River smolt traps.

% Change	Upper Chehalis	Newaukum
Chinook	-83.3%	-75.1%
Coho	88.9%	-11.6%
Steelhead	4.8%	NA

Figure

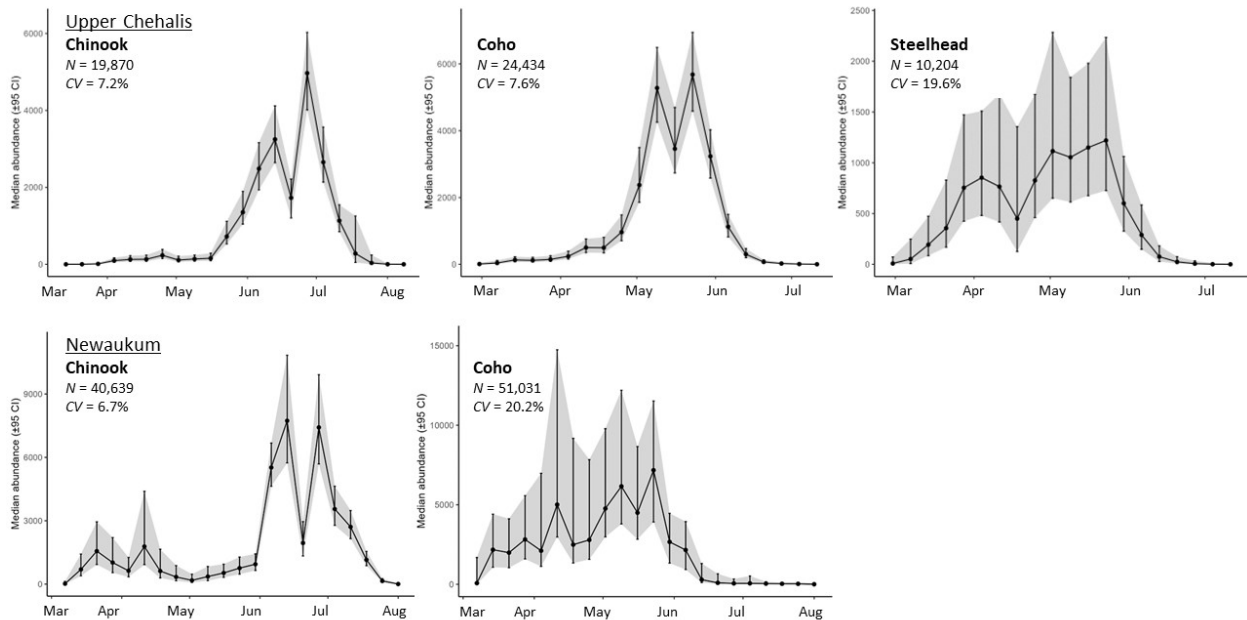


Figure 1. Abundance (\pm 95% CI) estimates for juvenile Chinook, coho, and steelhead in 2022 originating upstream of rotary screw traps operated in the upper Chehalis River and Newaukum River. Estimates are stratified by week and based on partial-capture rotary screw trap mark-recapture studies.

Discussion

We generated estimates of abundance for juvenile salmon and steelhead in 2022 and noted that juvenile Chinook production decreased substantially in 2022 compared to 2021. Adult spawner abundance of Chinook in the Chehalis River Basin was 42.7% higher in 2020 (2,828 spring Chinook and 15,924 fall Chinook) than 2021 (2,575 spring Chinook and 8,176 fall Chinook), but probably not enough to account for the 83.3% decrease in juvenile production from 2021 to 2022. Therefore, we attribute the lower juvenile production in 2022 to variations in stream conditions between 2021 and 2022. Late fall 2021 and early winter 2022 were characterized by several high flow events above action stage that likely disrupted Chinook redds and affected emerging fry. Emergent fry may have been washed downstream during the high-water events, leaving fewer juveniles to rear in freshwater to the parr/smolt stage. Restoration actions designed to reduce impacts of high flow events (e.g., flooding, scouring) will likely have a positive impact on the survival of juvenile Chinook salmon.

We also noted that juvenile coho production increased by 88.9% in the upper Chehalis in 2022 compared to 2021. Juvenile coho over-winter in side-channel and floodplain habitats and may have been less impacted by high water events in the mainstem in late fall/early winter 2021/2022

than Chinook. Restoration actions that increase stream complexity and improve floodplain connectivity could have a positive impact on juvenile coho production by increasing access to high quality rearing habitat, especially if production is density dependent.

Adaptive Management

Juvenile monitoring informs Steering Committee decisions about the location and type of habitat projects to fund for the ASRP and helps determine whether those projects are performing as intended. Therefore, this work is crucial to both the adaptive management science and policy feedback loops. Decreased juvenile Chinook production in 2022 relative to 2021 in both the Newaukum and upper Chehalis rivers was likely due to instream conditions during the egg incubation and fry emergence periods of late fall 2021 and early winter 2022. There were two atmospheric river events in November 2021 and January 2022 that produced rain that was concentrated in western Washington. Restoration actions that could help armor rivers from high precipitation and high flow events would likely improve survival during these extreme events by reducing redd scouring and fry transport downstream. Other actions targeting floodplain reconnection might also benefit rearing juveniles by mitigating the effects of flood stage flow on vulnerable life stages. In addition, floodplain reconnection and the availability of additional rearing habitat should increase rearing capacity for species such as coho, whose overall productivity may be limited by density dependence, especially if rearing habitat is a limiting factor. Further monitoring of juvenile abundance through time will help make these assessments and will be important for evaluating whether restoration actions are having the desired impact of improving freshwater rearing habitat.

Reference

Bonner, S.J., and C.J. Schwarz. 2011. Smoothing population size estimates for time-stratified mark-recapture experiments using Bayesian P-splines. *Biometrics* 67(4):1498-1507.