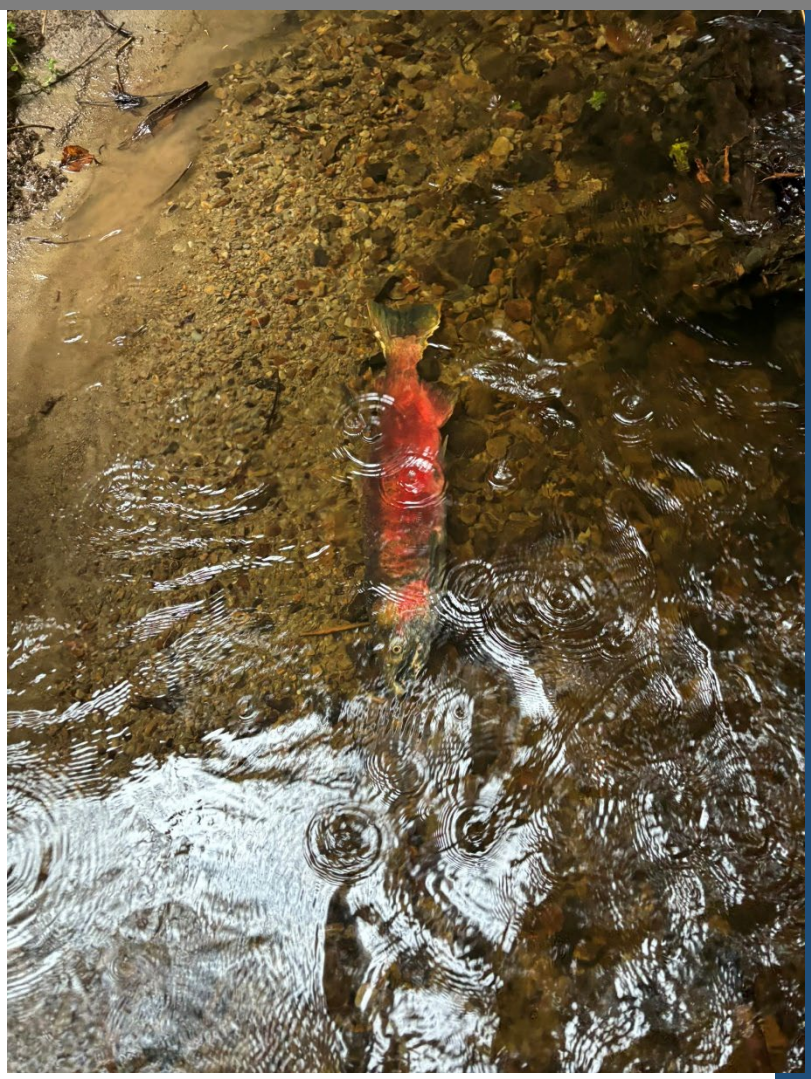
Riparian Validation Monitoring Program (RVMP)

2023 Annual Report



WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES
HILARY S. FRANZ | COMMISSIONER OF PUBLIC LANDS

This page was intentionally left blank.

Acknowledgements

We would like to thank Emily Gardner, Tristan Ward, Griffin Hammelgarn, Annika Thompson, Max Randals, Kyle Desumma, and Bree Belardinelli, and several University of Washington interns for conducting fieldwork in 2022, Dr. Teodora Minkova of DNR for providing supervising and managerial support, Dr. Warren Devine of DNR for providing data management and field support of the project, Allen Estep of DNR for providing managerial support, and Luke Kelly of Trout Unlimited, Alex Foster of the USDA Forest Service, Noelle Nordstrom of DNR, and Mara Zimmerman and Ned Pittman of the Coast Salmon Partnership for conducting snorkel surveys. All photos in this report were provided by DNR staff.

Suggested Citation:
Martens, K. D. 2024. Riparian Validation Monitoring Program (RVMP) 2023 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. Make space to provide a link here

Washington State Department of Natural Resources
Forest Resources Division
1111 Washington St. SE
Mailstop 47014
Olympia, WA 98504
www.dnr.wa.gov

Acronyms and Abbreviations

COH – Coho Salmon

CTT – Cutthroat Trout

DNR – Washington State Department of Natural Resources

HCP – Habitat Conservation Plan

MS222 – Tricaine mesylate

OESF – Olympic Experimental State Forest

ONP – Olympic National Park

RKM – River kilometer

RVMP – Riparian Validation Monitoring Program

STH – Steelhead/rainbow trout

STRAH – Status and Trends Monitoring of Riparian and Aquatic Habitat in the Olympic Experimental State Forest Program

T3 – Type 3 stream; the smallest fish-bearing stream, according to the Washington Forest Practices classification

VRH – Variable retention harvest

Executive Summary

The Washington State Department of Natural Resources designed its Riparian Validation Monitoring Program to fulfill the agency's commitment to the State Trust Lands Habitat Conservation Plan. Commencing in 2016, this program, in conjunction with the Status and Trends Monitoring of Riparian and Aquatic Habitat program, represents DNR's largest systematic habitat and salmonid monitoring program and provides the best indication of riparian forest, stream, and salmonid conditions on DNR-managed lands.

The 2016 RVMP study plan was designed to first use an observational monitoring approach and then add more complex experimental studies as necessary. This flexible approach allows DNR to continually adapt sampling strategies based upon an increasing understanding of management impacts on fish and stream habitat and the conditions of DNR-managed lands. In 2020, RVMP researchers joined the T3 Watershed Experiment to introduce experimentation, enhancing DNR's ability to assess cause-and-effect relationships between DNR land management and salmonid populations. This assessment encompasses both current riparian management practices and alternative forest management prescriptions.

In 2023, DNR crews conducted population surveys to estimate juvenile salmonid densities (fish/100 meters) and biomass (grams/100 meters^2) in 35 RVMP watersheds. These surveys covered the annual panel (n=20) and the even-year rotating panel (n=15) of 50 watersheds. Additionally, 31 fish and habitat surveys were carried out in the 16 watersheds of the T3 Watershed Experiment, with 20 at the reach (prescription site) and 11 at the pour point (the most downstream point in a watershed). Adult coho salmon redd surveys were conducted in 22 RVMP watersheds, with 12 of these sites sampled annually. Snorkel and habitat surveys were also completed in three monitored reaches, spanning more than 12 km of the Clearwater River.

Since the implementation of the RVMP in 2016, DNR has published six peer-reviewed journal articles. The findings presented in these publications, along with the 2019 status report, informed the development of riparian treatments for the T3 Watershed Experiment and continue to enhance our understanding of potential connections between salmonids and DNR management. Moreover, collaborations with other natural resource agencies have expanded our knowledge of fish distributions, species interactions, and steelhead and habitat conditions, providing valuable information to federal regulating agencies.

Table of Contents

Introduction

The Washington State Department of Natural Resources established the Riparian Validation Monitoring Program (RVMP) in 2016 to fulfill DNR's commitment for validation monitoring outlined in the State Trust Lands Habitat Conservation Plan (HCP; WADNR 1997). The HCP allows for long-term certainty of forest management (primarily timber harvest) by allowing incidental take of federally listed species in exchange for mitigation and minimization of environmental impacts on DNR-managed state trust lands (DNR-managed lands). The HCP Riparian Conservation Strategy aims to protect, maintain, and restore habitat that can sustain viable populations of salmonids and other species dependent on in-stream and riparian environments.

Validation monitoring, as described in the HCP, is the most complex and challenging of the three types of monitoring (the others being implementation and effectiveness) within the plan. Its purpose is "to evaluate cause-and-effect relationships between habitat conditions resulting from implementation of the conservation strategies and the animal populations these strategies are intended to benefit" (WADNR 1997). The RVMP is designed to test the hypothesis that forest management practices implemented under the HCP will restore and maintain habitat capable of supporting viable salmonid populations.

Following the RVMP study plan (Martens 2016), we employ an observational approach to monitor 50 Type-3[1] watersheds: 44 managed watersheds and 6 reference (unmanaged) watersheds. This monitoring includes annual sampling of 20 watersheds and a two-year rotation of 30 additional watersheds. We also monitor a 12-km stretch of the Clearwater River within DNR-managed lands, into which a number of these watersheds drain.

If negative trends are detected or suspected in salmonids (density, biomass, species composition, age structure, and number of redds) or in their habitat, experimental studies, similar to the ongoing T3 Watershed Experiment, will be developed. These studies will evaluate the cause-and-effect relationships between DNR management activities, riparian habitat, and salmonids. Understanding the underlying mechanisms will allow DNR to affirm or adapt its management practices accordingly.

[1] Type 3 water – "segments of natural waters that are not classified as Type 1 or 2 Water and have a moderate to slight fish, wildlife, and human use. (A) Stream segments having a defined channel of 2 feet or greater in width between the ordinary high-water marks in western Washington and having a gradient 16 percent or less; (B) Stream segments having a defined channel of 2 feet or greater in width between the ordinary high-water marks in Western Washington and having a gradient greater than 16 percent and less than or equal to 20 percent; and having greater than 50 acres in contributing basin size in western Washington."

The Olympic Experimental State Forest (OESF), designated by DNR for research and monitoring, integrates revenue production — primarily through timber harvesting — with ecological values, primarily habitat conservation (WADNR 2016). The HCP designates the OESF as the location for riparian validation monitoring. DNR's Status and Trends Monitoring of Riparian and Aquatic Habitat program (STRAH)[2], which also takes place in the OESF, is a complementary study to the RVMP. Both programs study the same reaches and share data to improve efficiency and avoid redundancy. Although the primary purpose of the RVMP is to meet the DNR's commitment to the HCP, it provides additional benefits and serves as the only continuous field-based monitoring and assessment of riparian forests, fish, and stream habitat conditions on DNR-managed lands.

The Riparian Validation Monitoring Program offers numerous benefits to the DNR, including:

- Increasing knowledge, confidence, and flexibility in DNR land management practices.
- Enhancing ecological understanding of the relationships between salmonid populations, habitat, and land management.
- Providing current information on salmonid population conditions in the OESF, which helps address concerns that DNR-managed lands negatively affect salmonid populations on the Olympic Peninsula (Smith 2000; WRIA 21 Lead entity 2011).
- Supplying information for predictive models of future habitat conditions and their effects on fish under different management alternatives. These models are used in planning documents such as the OESF Forest Land Plan.
- Monitoring the potential effects of climate change on salmonid populations or habitat in the Pacific Northwest.
- Fulfilling monitoring commitments and advancing research priorities outlined in the DNR State Trust Lands HCP.
- Establishing stronger relationships with other natural resource agencies, research organizations, academia, and tribal nations.
- Informing DNR stakeholders about the state of natural resources and fostering trust.

As envisioned in the study plan (Martens 2016), an experimental study was added in 2020 as a part of DNR's collaboration with the University of Washington and other research partners on the T3 Watershed Experiment[3]. The riparian component of this study aims to assess current DNR riparian management and three alternative forest management prescriptions adjacent to variable retention harvests (VRH; Martens 2016).

One of the three alternative riparian management prescriptions (active habitat restoration) was designed to reduce hypothesized limiting habitat factors identified through STRAH and RVMP

[2] Refer to the DNR website at https://www.dnr.wa.gov/programs-and-services/forest-resources/olympic-experimental-state-forest/research-projects for study plan, sampling protocols and annual reports of the STRAH program.

[3] Refer to the UW website at https://www.onrc.washington.edu/t3-watershed-experiment for study plans and other information on T3 Watershed Experiment.

monitoring: insufficient instream wood and excessive stream shading. Another alternative prescription will use variable-width, site-specific buffers designed to increase revenue while maintaining ecological protections. The final alternative will use heavy thinning and alder under-planting to allow for short-rotation alder crops designed to provide both economic and environmental benefits. Monitored watersheds will follow a Before-After, Control-Impact (BACI) design, with two to three years of pre-treatment monitoring followed by at least four years of post-treatment monitoring. This study will provide a comprehensive evaluation of DNR's current riparian management and information on potential management alternatives.

This report covers the RVMP activities performed in the 2023 calendar year. More in-depth analyses from this program will come from peer-reviewed journal articles and the six-year (three sampling rotations) status report currently scheduled for 2025[4] and will cover the sampling period 2016-2024.

During 2023, DNR crews conducted:

- Population surveys to determine juvenile salmonid densities (fish/100 meters) and biomass (grams/100 meter^2) estimates in 35 watersheds from the annual panel (n=20) and the even-year rotating panel (n=15) of the 50 RVMP watersheds;
- 31 fish and habitat surveys at the prescription sites (n=20) and at the pour points (the lowest point in a watershed; n=11) of the 16 watersheds where the T3 Watershed Experiment is implemented;
- Coho salmon (*Oncorhynchus kisutch*) redd surveys in 22 RVMP watersheds, 12 of which are sampled annually; and
- Snorkel and habitat surveys in 12 kilometers of the Clearwater River.

Study Area

The OESF includes approximately 110,000 ha of DNR-managed lands on the western Olympic Peninsula (Figure 1) within the boundaries of three Water Resource Inventory Areas (19, 20, and 21). The boundaries follow the Olympic Mountain crest, the West Twin Creek and Lake Crescent watersheds to the east, the Strait of Juan de Fuca to the north, the Pacific Ocean to the west, and the Quinault River watershed to the south. Elevations within the OESF range from sea level to 1,155 m.

The OESF is a coastal rain forest that receives heavy precipitation (203 to 355 cm per year) with the majority falling in the winter. It contains a diversity of forests within three vegetation zones (Franklin and Dyrness 1988). The majority of the OESF is within the western hemlock zone (*Tsuga heterophylla*; 150 to 550 m elevation), while the lower elevations (0 to 150 m) are in the Sitka spruce zone (*Picea sitchensis*) and the upper elevations (550 to 1,155 m) are in the Pacific silver fir zone (*Abies amabilis*). DNR-managed lands within the OESF mostly consist of second-

[4] Previous RVMP annual reports are available on the DNR website at https://www.dnr.wa.gov/programs-and-services/forest-resources/olympic-experimental-state-forest/research-projects.

and third-growth forest resulting from prior timber harvests, with less than 10 percent of the forest being older than 140 years (WADNR 2016).

DNR-managed lands in the OESF contain more than 4,300 km of streams, including portions of several major rivers, such as the Queets, Clearwater, Hoh, Bogachiel, Calawah, Sol Duc, Dickey, Hoko, and Clallam (WADNR 2013). The smallest fish-bearing streams (stream order 1-3; Strahler 1957) typically have some combination of juvenile coho salmon, rainbow trout/steelhead (*O. mykiss*), coastal cutthroat trout (*O. clarkii clarkia*), lampreys (*Lampetra or Entosphenus spp.*) and/or sculpins (*Cottus spp.*). Coastal cutthroat trout are the most commonly found salmonid species within this size of stream (Martens 2016).

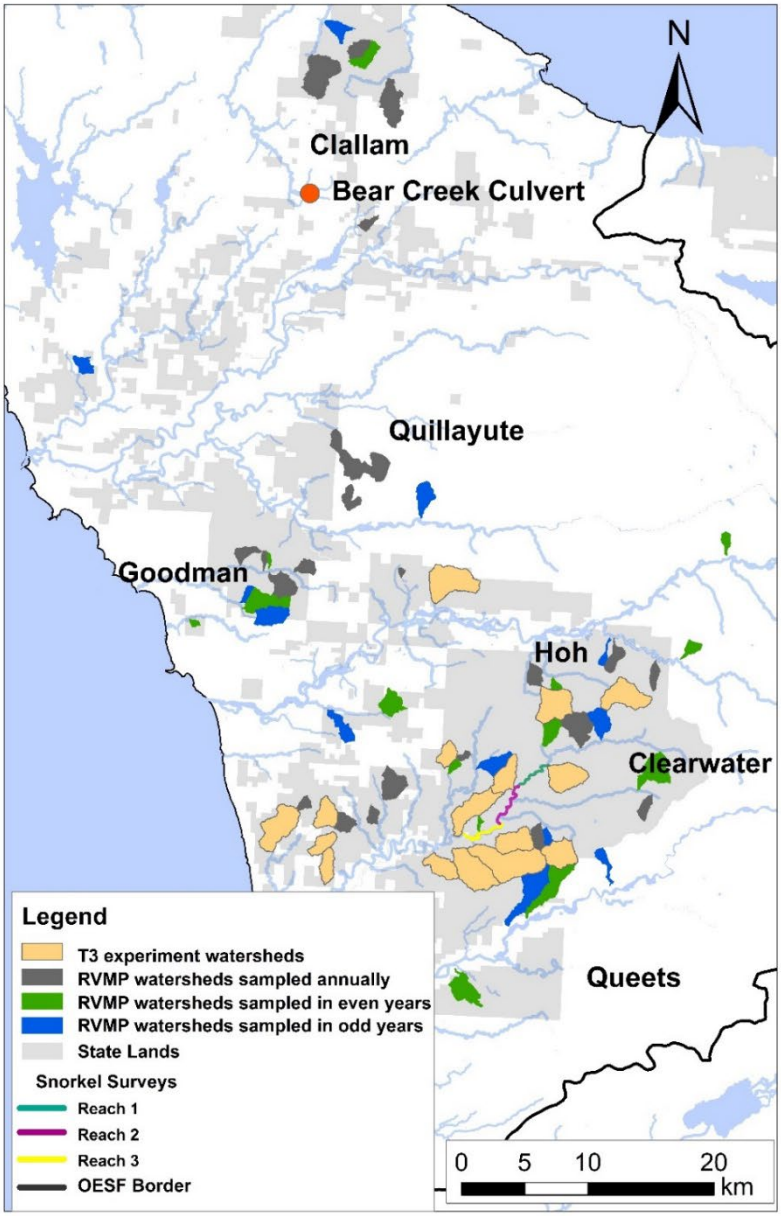


Figure 1. Map of OESF DNR-managed lands and sample watersheds.

Methods

Study Design

We use observational monitoring in 44 managed, Type-3 watersheds[5] on DNR-managed lands and six reference watersheds, two of which are located on DNR-managed lands and four in the Olympic National Park (Figure 1; Martens 2016). Six reference watersheds within the Olympic National Forest that were sampled between 2018-2021 are no longer being sampled due to a lack of resources. Six managed watersheds were removed from an original set of 50 watersheds on DNR-managed lands due to either absence of fish or an inability to properly sample (mostly due to excessive vegetation limiting the crew's ability to continuously move within the reach).

The 44 managed watersheds were selected through a stratified random design under the STRAH program (Minkova et al. 2012). Reference watersheds (n=6) were selected to have environmental conditions similar to the 44 managed watersheds, to have no or minimal management history (> 95 percent of the watershed area never harvested), and to have reasonably easy access. As not all of the 50 watersheds could be sampled within the summer field season (mid-July through mid-October), the RVMP calls for 20 watersheds to be sampled annually (annual panel), and an additional 30 watersheds to be sampled on a two-year rotation (even and odd years; Martens 2016). In addition to the 20 annual watersheds, we are now sampling two additional watersheds (730 and 760) annually because portions of the watersheds were recently harvested. Reference watersheds were split among the rotating watersheds.

[5] Type 1 water – "all waters, within their ordinary high-water mark, inventoried as "shorelines of the state" under Chapter 90.58 RCW and the rules promulgated pursuant to Chapter 90.58 RCW, but not including those waters' associated wetlands as defined in Chapter 90.58 RCW."

Type 2 water – "segments of natural waters that are not classified as Type 1 Water and have a high fish, wildlife, or human use. (i) Stream segments having a defined channel 20 feet or greater in width between the ordinary high-water marks and having a gradient of less than 4 percent."

Type 3 water – "segments of natural waters that are not classified as Type 1 or 2 Water and have a moderate to slight fish, wildlife, and human use. (A) Stream segments having a defined channel of 2 feet or greater in width between the ordinary high-water marks in western Washington and having a gradient 16 percent or less; (B) Stream segments having a defined channel of 2 feet or greater in width between the ordinary high-water marks in Western Washington and having a gradient greater than 16 percent and less than or equal to 20 percent; and having greater than 50 acres in contributing basin size in western Washington."

Type 4 water – "segments of natural waters which are not classified as Type 1, 2 or 3, and for the purpose of protecting water quality downstream are classified as Type 4 Water upstream until the channel width becomes less than 2 feet in width between the ordinary high-water marks."

Type 5 water – "natural waters not classified as Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks and drainage ways having short periods of spring or storm runoff."

RVMP sampling reaches for juvenile fish and stream habitat surveys are located near the watershed outlet, just above the floodplain of its confluencing stream. A section of the Clearwater River, a Type-1 stream[4], is also snorkel-surveyed to assess the effects of DNR management on larger streams of the OESF. Redd surveys are conducted over the lower 1,000 meters of streams in the 50 monitored watersheds with a known coho salmon presence.

Starting in 2020, the T3 Watershed Experiment monitors two stream reaches in each of the study's 16 experimental watersheds (Figure 1). Within each watershed, one sampled reach is next to a planned experimental timber harvest and the other is at the pour point of the watershed (except for in Alternative 2 watersheds, which have two prescriptions and where monitoring only takes place at the reaches).

Juvenile Fish Sampling in Type-3 Streams

Juvenile fish surveys for the RVMP watersheds and T3 Watershed Experiment are conducted using multiple-pass removal electrofishing. Sample reaches in the T3 Watershed Experiment watersheds are 100 meters long, while sample reaches in the RVMP watersheds are twenty times bankfull width and range from 100 to 120 m long. Before sampling, seine nets are placed at the top and bottom of a reach to block fish movement. After a reach is blocked, a Smith-Root model 24b backpack electrofisher is used to collect fish with a forward and backward pass through the reach (Figure 2). Electrofishing is typically conducted using a frequency of 60 hertz with 25 percent duty cycle and voltage ranging from 300 to 600 volts.

Figure 2. DNR field crew conducting juvenile population surveys using a backpack electrofisher.

Fish sampling uses a variable pass (three to six passes) form of multiple pass-removal electrofishing. The number of passes is determined through the charts of Connolly (1996) and used as described in Martens and Connolly (2014).

After electrofishing, all salmonids are anesthetized with MS-222, visually inspected, measured and weighed, and released. Fish collection activities were permitted through Washington Department of Fish and Wildlife (permit #23-156) and the U.S. Fish and Wildlife Service (permit #TE64608B-1). Fish population estimates are calculated using the program CAPTURE (Cooch and White

2012) and extrapolated over the length and area of the reaches.

After all passes are completed, stream habitat surveys are conducted. The habitat survey identifies habitat units based on the field guide of Minkova and Vorwerk (2015), counts the number of instream wood pieces, identifies pool-forming mechanisms, measures the lengths and widths of habitat units, and measures the depths of habitat units and pool-tail crests. In addition to the habitat unit surveys, sampling in the T3 Watershed Experiment watersheds includes stream shade (using hemispherical photos), bankfull width, pebble counts, stream gradient, leaf litter sampling, and riparian vegetation.

Redd Surveys in Type-3 Streams

Redd (spawning nests) surveys are conducted over the first 1,000 meters or to the end of anadromous fish for each RVMP watershed with known coho salmon occurrences. Coho salmon were found in 62 percent of the basins during initial sampling in 2015 (Martens 2016). Twelve of the 20 annual watersheds have previously contained coho salmon and are sampled every year. Surveyors identify the presence of redds, any adult fish present, and mark locations with GPS (Figure 3). All scheduled watersheds are sampled three times over the sampling season. Surveys begin in November and end in mid-January, following the methods of Gallagher et al. (2007).

Figure 3. Adult coho salmon creating a redd, or spawning nest.

Snorkel Surveys on the Clearwater River

Snorkeling surveys help to understand the distribution of larger resident, anadromous adults, and juvenile salmonids in larger streams of the OESF (Figure 4). They also provide insights on possible movements between Type-3 and larger streams.

The 12-km sampled section of the Clearwater River starts near river km 46 (downstream of Kunamakst Creek) and ends near river km 33 (upstream of Bull Creek). This section was chosen because it is fully contained within DNR-managed lands, and any impacts related to land management could be attributed to DNR management practices. This section was subsequently separated into three reaches based on the distribution of mountain whitefish (which were absent in the middle section in 2017; Martens 2018). This middle reach is dominated by bedrock with steep banks, creating a canyon stretch of river.

Methods closely follow the protocols of Thurow (1994), with a two- to three-person crew snorkeling in a downstream direction counting fish of each species per habitat unit (e.g. pools, riffles, and glides). Habitat surveys are conducted simultaneously with the snorkel surveys. This survey collects information on habitat units, instream wood, and substrate. Habitat units are separated into pools, glides, and riffles and unit length and width are measured with a laser rangefinder. Instream wood pieces were segregated into two groups: pieces 10-45 cm diameter and >2 m length, and "key pieces" >45 cm diameter and >2 m length. The percentage of channel substrate by categories (sand, gravel, cobble, boulder, and bedrock) are also visually estimated within each habitat unit.

Figure 4. Snorkelers counting fish in the Clearwater River.

Results

Sixty-six stream reaches were sampled for juvenile salmon (including the RVMP watersheds [n=35], T3 Watershed Experiment reaches [n=31]) in 2023. Additionally, 22 RVMP watersheds

were surveyed for coho salmon redds, and three reaches within the 12 km of the mainstem Clearwater River were snorkeled.

DNR crews identified and measured 1,298 age-1 or older coastal cutthroat trout, 3,115 coho salmon, 2,328 juvenile trout (a combination of age-0 coastal cutthroat trout and steelhead/rainbow trout), and 162 age-1 or older steelhead/rainbow trout during juvenile surveys. Sculpin were often found but were not collected because 1) sculpin lack a swim bladder and are not as easily collected as juvenile salmon, and 2) the HCP only calls for salmonid monitoring. Juvenile lampreys were found in 15 of the 66 watersheds.

In addition to the species found in Type-3 watersheds, mountain whitefish (*Prosopium williamsoni*) and longnose dace (*Rhinichthys cataractae*) were found during snorkel surveys in the mainstem Clearwater River. Bull trout (*Salvelinus confluentus*), the only ESA-listed salmonid species that has potential to be found within our sampling area, have never been found during our sampling efforts (a bull trout-specific report is prepared annually for the U.S. Fish and Wildlife Service; Appendix 1). In addition, aquatic amphibians including tailed frogs (*Ascaphus sp.*) and Cope's giant salamanders (*Dicamptodon copei*) were often encountered. However, amphibians were not counted because the project emphasis is salmonid fishes.

Figures 5 and 6 show the salmonid density and biomass of fish collected in 2023. Salmonid variability remains high among the watersheds as was found in previous years (Martens 2021). Watershed 690 had the highest density and biomass of fish, which was primarily driven by age-0 trout and coho salmon. Although age-0 trout and juvenile coho salmon make up the majority of fish, the streams with the most biomass typically have larger numbers of age-1 or older cutthroat trout or steelhead.

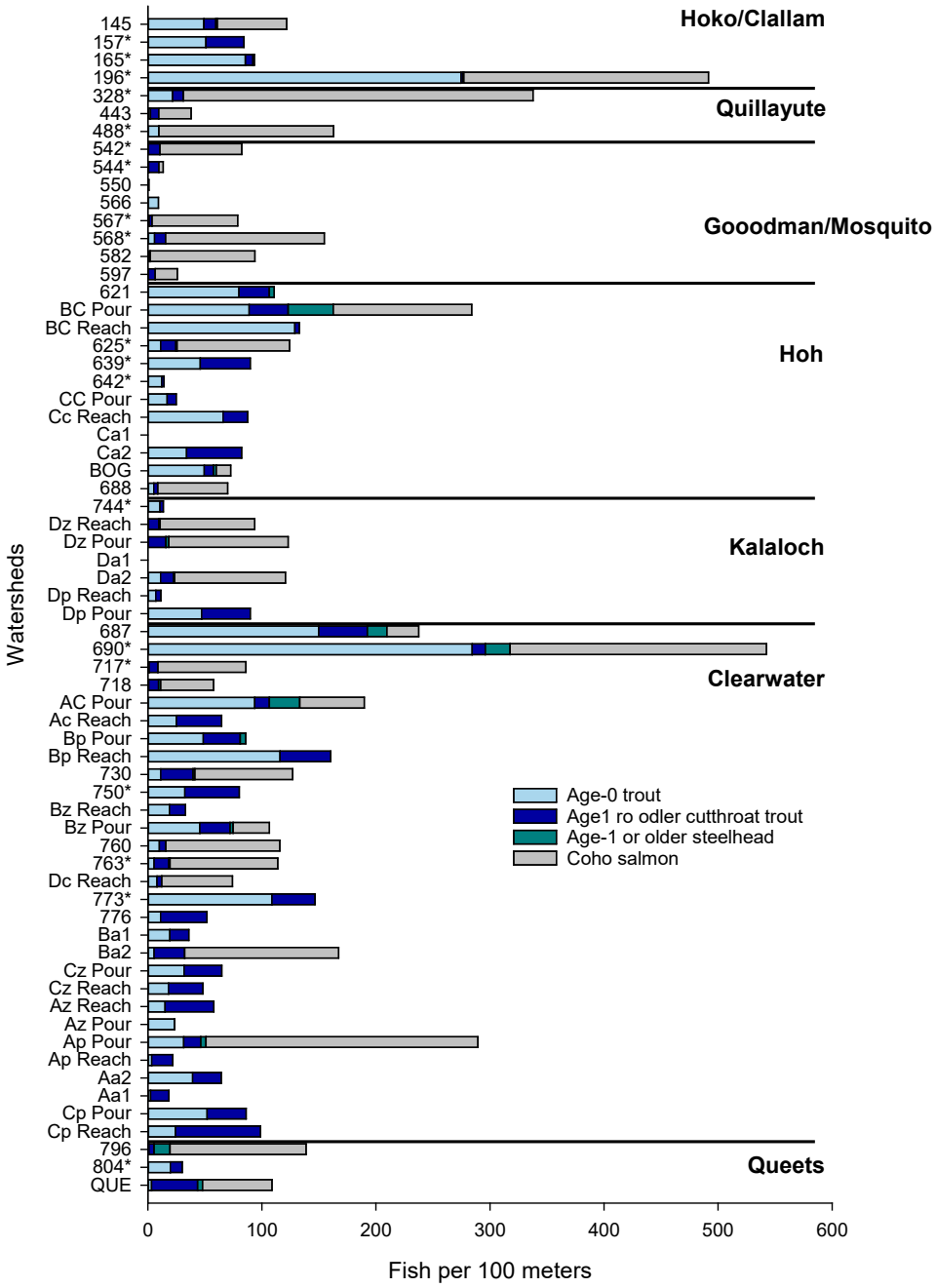


Figure 5. Density of juvenile salmonids (number per 100 meters), separated into larger watershed areas, collected during the summer 2023 field season (mid-July to mid-October) in the Olympic Experimental State Forest. The RVMP watersheds on DNR-managed lands are labeled with a 3-digit number; the RVMP watersheds in Olympic National Park are labeled with three capital letters; the T3 Watershed Experiment reaches are labeled with uppercase and lowercase letters. The asterisks identify the annually sampled watersheds.

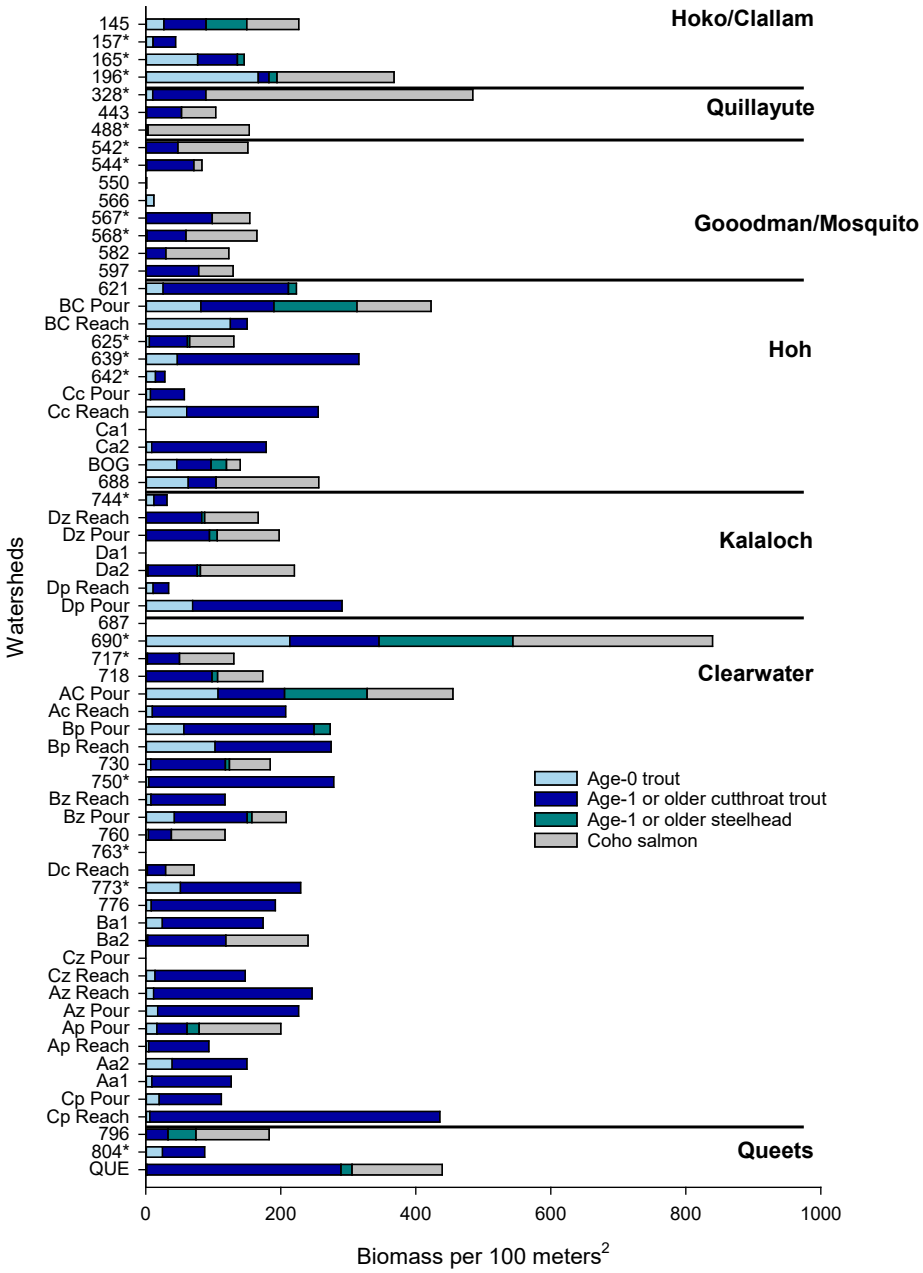


Figure 6. Biomass of juvenile salmonids (grams per 100 meters^2), separated into larger watershed areas, collected during the Riparian Validation Monitoring Program's summer 2023 field season (mid-July to mid-October) in the Olympic Experimental State Forest. The RVMP watersheds on DNR-managed lands are labeled with a 3-digit number; the RVMP watersheds in Olympic National Park are labeled with three capital letters; the T3 Watershed Experiment reaches are labeled with uppercase and lowercase letters. The asterisks identify the annually sampled watersheds.

The average density and biomass of salmonids within annually sampled RVMP managed watersheds are shown in Figures 7 and 8. Salmonid densities in the annually sampled watersheds continue to remain high when compared to the first few years of sampling in 2016 and 2017. However, age-1 or older cutthroat trout and rainbow trout/steelhead densities remained consistent with prior years despite the high densities of age-0 fish in 2022.

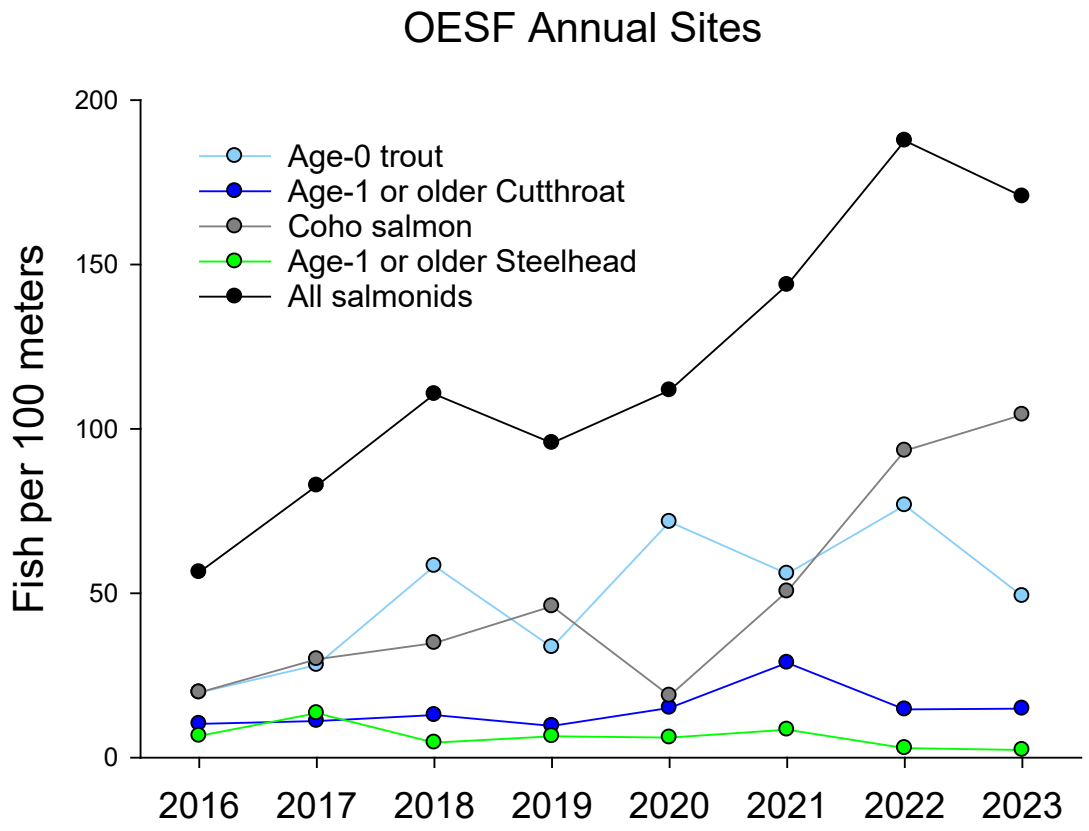


Figure 7. The average fish density (number per 100 meters) of juvenile salmonids collected from the 20 annual sampled sites during the Riparian Validation Monitoring Program's summer 2023 field season (mid-July to mid-October) in the Olympic Experimental State Forest (OESF).

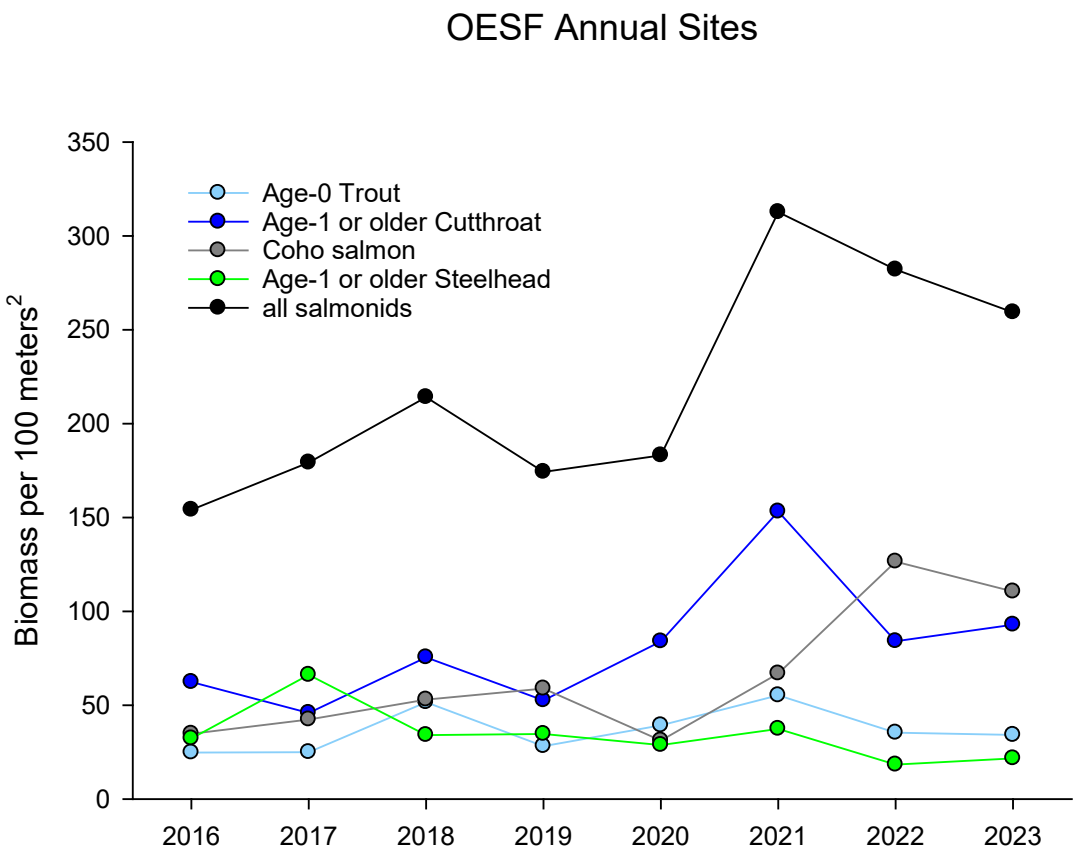


Figure 8. The average fish biomass (grams per 100 meters^2) of juvenile salmonids collected from 20 annual sampled sites during the Riparian Validation Monitoring Program's summer 2023 field season (mid-July to mid-October) in the Olympic Experimental State Forest (OESF).

Samples repeated for eight years in all the RVMP watersheds are starting to reveal patterns among the watersheds (Figure 9). Some streams, such as 196, 690, and 796, consistently contain high densities of salmonids with high inter-annual variability. Another group of streams (544, 545, 550, 566, 567, 605, 642, 658, 688, 744, 804, HOH) have maintained low densities of salmonids with low inter-annual variability.

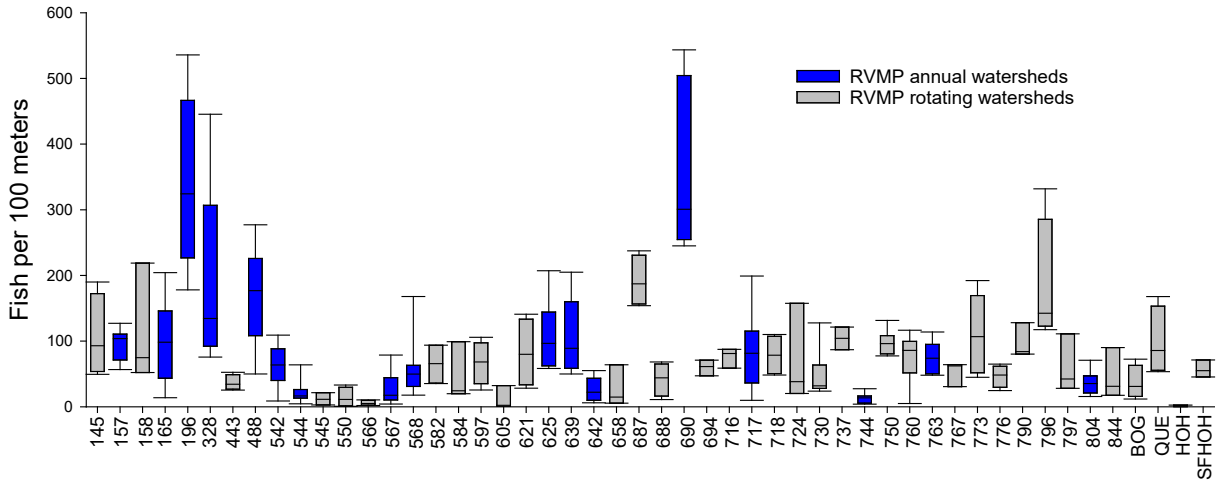


Figure 9. The fish density (number per 100 meters) of all juvenile salmonids sampled at all monitoring sites from 2016 through 2023 (annually sampled watersheds were typically sampled for 6 years while rotating watersheds were sampled 3 years) in the Olympic Experimental State Forest. The line in the bars represent the median, the boxes outline the 25th and 75th percentile and the bars represent the 10th and 90th percentile.

A portion of Watershed 488 adjacent to our monitoring reach was harvested using Variable Retention Harvest in 2022. Since this was an annually sampled watershed, we were able to assess both the pre-harvest and post-harvest fish populations within this watershed (Figure 10). Fish densities and biomass after harvest have remained within the range of fish densities and biomass of the pre-harvest data. The average fish density after harvest (210.28 fish per 100 m) is currently higher than the average fish density before harvest (169.34 fish per 100 m). However, fish biomass had a higher average before harvest (240.44 g per 100 m^2) than after harvest (214.20 g per 100 m^2).

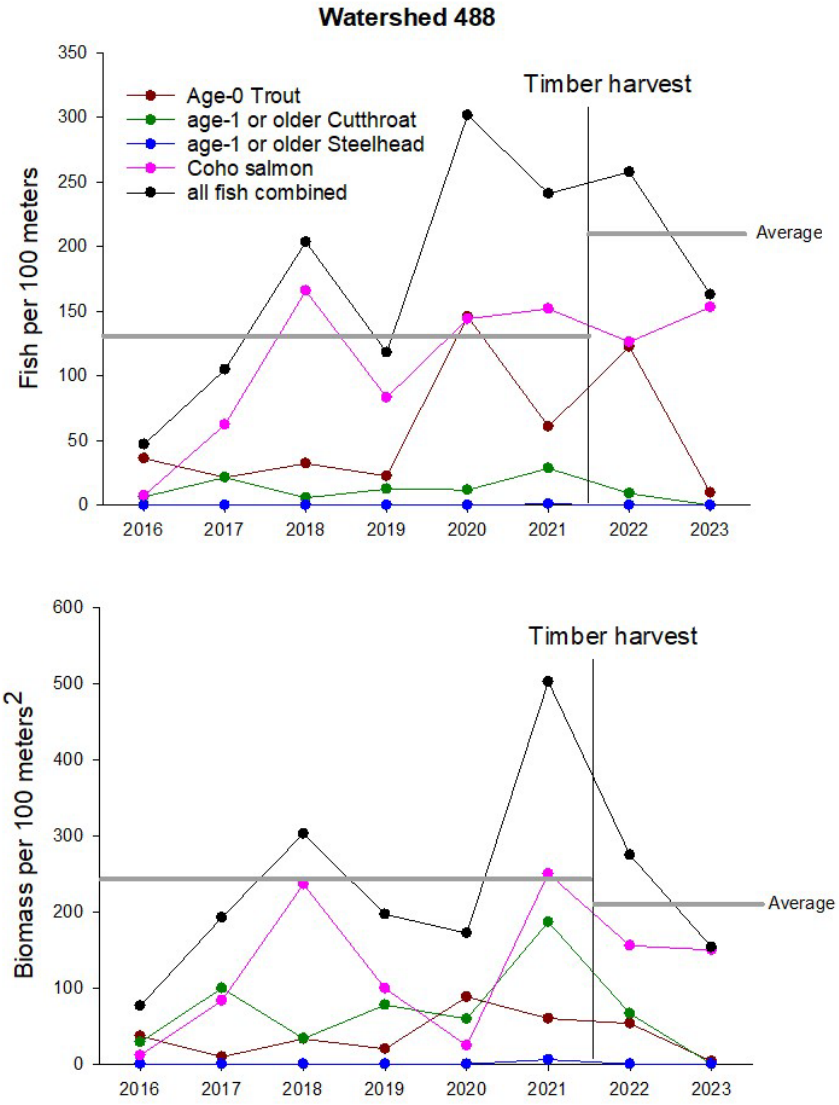


Figure 10. Fish density and Biomass of Watershed 488 before and after timber harvest prior to the 2022 field season. The average density and biomass for all fish before and after harvest are noted by the gray bars.

Redd Surveys in Type-3 Streams

Redd surveys were conducted in 12 annually sampled streams from 2016 through 2023. Annual numbers of coho salmon redds are presented in Figure 11. Watershed 328 continues to have the highest number of redds with 8 redds in 2023. Most streams have contained a limited number (<5) or no redds despite a consistent juvenile coho salmon presence.

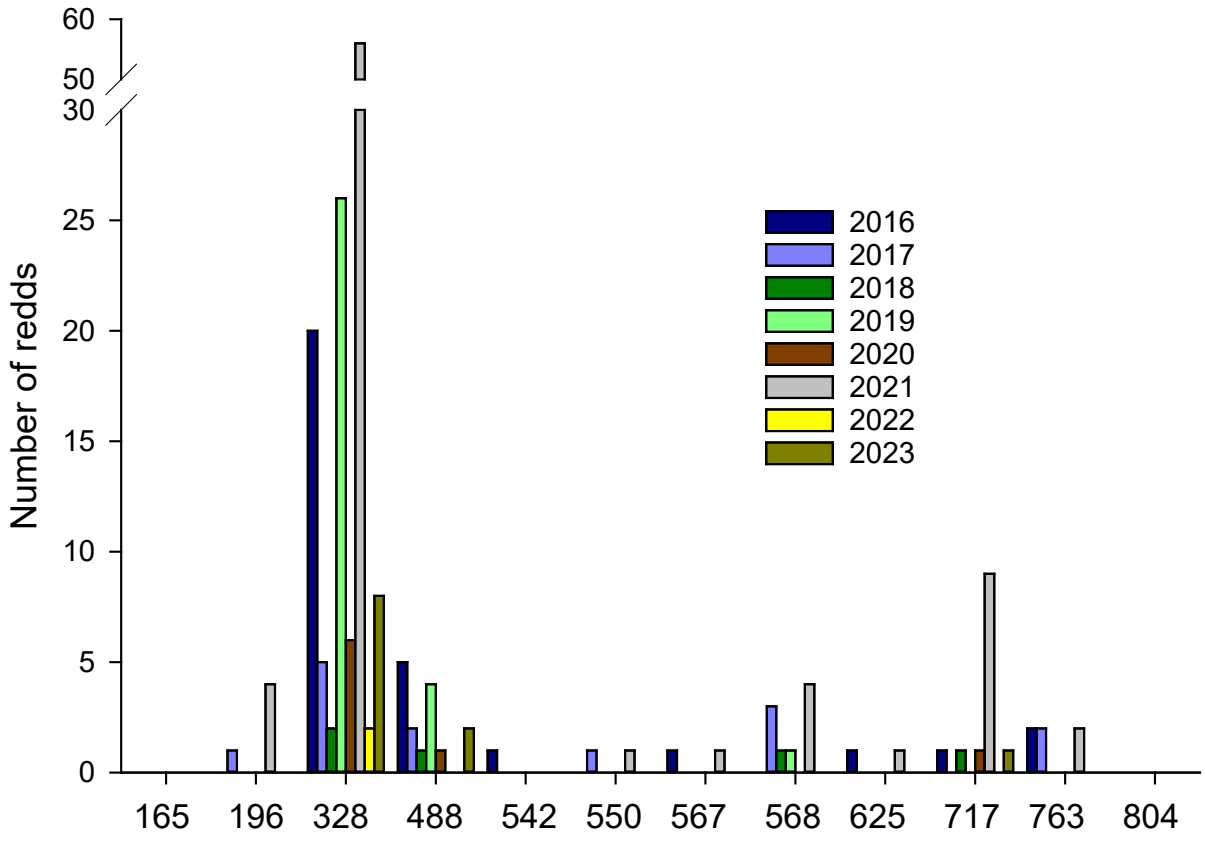


Figure 11. Coho salmon redd surveys conducted in the annual panel of watersheds from 2016 through 2023.

Snorkel Surveys on the Clearwater River

Annual fish densities collected in the three sampled reaches of Clearwater River, are presented separately for each of the three most commonly found species – coho salmon, juvenile trout (rainbow trout/steelhead or coastal cutthroat trout) and mountain whitefish (Figure 12). In 2023, most fish densities were in range with previous years (Figure 12). One exception was the relatively higher density of coho salmon found in Reach 3 when compared with the other reaches in 2023. Though, it should be noted that 58% of coho salmon in this reach were found within two habitat units. One habitat unit alone was estimated to contain 800 coho salmon. Excluding this one outlier habitat unit (287 meter) for the reach would decrease fish densities from 30.8 fish per 100 meters to 17.7 fish per 100 meters for the almost six-kilometer reach.

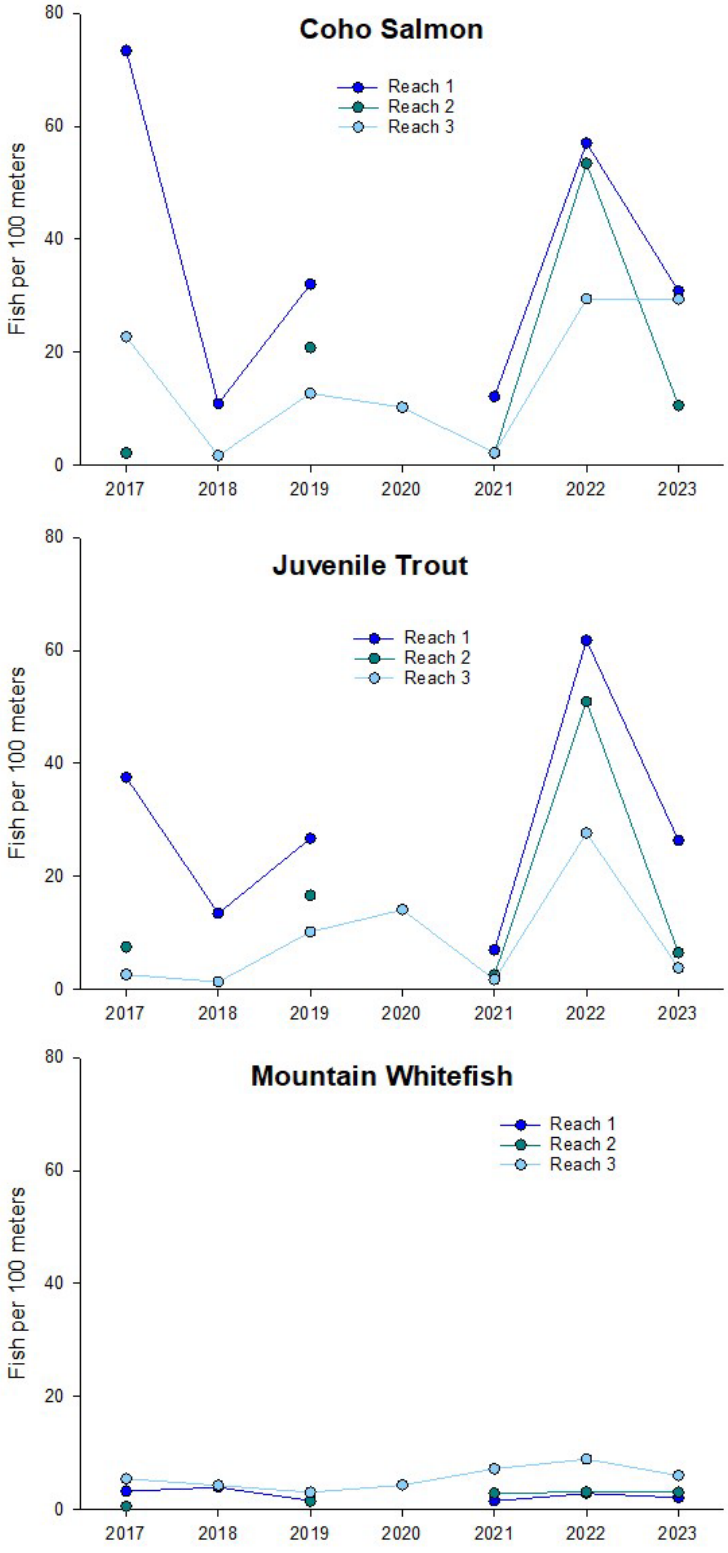


Figure 12. Annual densities of coho salmon, juvenile trout (rainbow trout/steelhead or coastal cutthroat trout), and mountain whitefish density in the Clearwater River.

Discussion

Riparian Validation Monitoring

Although the RVMP is still in the early stages of monitoring, we are gradually improving our ability to identify changes in salmonids populations over time and across different areas. Detecting trends and patterns is challenging due to the slow rate of long-term habitat development following extensive harvests preceding the 1997 HCP. Recovery from the impacts of historic logging practices is expected to take hundreds of years (Martens et al. 2020), resulting in gradual habitat changes and corresponding effects on salmonids. The high variability between watersheds and years further complicates the detection of these changes. The time required to detect any changes will depend on factors such as the magnitude of change resulting from DNR management activities, year-to-year variation, and site differences (Martens 2016). Consequently, many years of monitoring and a relatively high number of sites are necessary to differentiate spatial and temporal variation from potential impacts of DNR management on salmonid populations (Kershner et al. 2004; Liermann and Roni 2008).

The high density and biomass estimates of salmonids across the OESF that were found over the last three years (2020-2022) continued in 2023. This is primarily driven by an increase in juvenile coho salmon and age-0 trout. However, we are not seeing a corresponding increase in age-1 or older cutthroat trout densities or biomass. This trend may indicate increased recruitment into OESF streams. However, the lack of response in older fish warrants continued monitoring. An increase in age-0 fish (trout and coho salmon) without a corresponding increase in older fish could indicate limited rearing habitat.

Reduced juvenile rearing habitat capacity could result in mortality or movement. Although movement poses risks for younger fish such as increased predation, it could also lead to enhanced fitness by utilizing under-seeded or higher-quality habitat (Cooke et al 2022). It remains unclear whether it would be more impactful to increase juvenile rearing capacity in natal streams (habitat improvement) or to focus on downstream locations with potentially superior habitat (such as off-channel habitat), but increased risks (predation) would have the greatest overall benefit on these populations. It is also possible that populations that utilize both strategies, with some fish staying in natal streams and others moving to better habitat, will have the greatest resilience (Shrimpton et al. 2014).

The VRH harvest conducted in watershed 488 provides the first look at how an individual DNR management activity (logging of second growth upland forest with retained riparian buffer) could potentially impact salmonids. While post-harvest monitoring is still in the early stages, the data collected so far indicate that post-harvest densities and biomass are within the ranges observed prior to harvest. Figure 10. highlights the high degree of variability between years that could obscure potential positive or negative responses from forest harvest and DNR riparian

conservation measures. Additional sites and years of monitoring are required to better understand the impacts, if any, from current DNR management practices.

It was interesting to see similar densities of coho salmon in reaches 1 and 3 of the Clearwater River. Previous years have shown a greater separation in densities between the two reaches, leading to the identification of Reach 3 as a potential site for restoration. However, we believe the call for restoration in Reach 3 is still valid for a couple of reasons. One, 800 coho salmon were found within a single habitat unit and counting that number of fish within a small area is more of an estimate than an exact count, which could result in an over estimation of coho salmon. Second, there remains a difference in age-0 trout densities between the two reaches. Finally, the fact that two habitat units, which also contained significant amounts of instream wood, contained over 57% of all coho salmon over a 6-kilometer reach highlights the potential for restoration to be impactful within the reach. As a result, Reach 3 remains a site with a high potential for increasing juvenile rearing capacity and habitat connectivity through restoration.

Products and Publications

The RVMP has continuously expanded our knowledge of salmonids and their habitat across the OESF, resulting in a growing number of publications. Peer-reviewed journal publications based on RVMP data collected to date include:

Martens, K. D., W. D. Devine, T. V. Minkova, and A. D. Foster. 2019. Stream conditions after 18 years of passive riparian restoration in small fish-bearing watersheds. Environmental Management 63(5):673-690.

Martens, K. D., D. C. Donato, J. S. Halofsky, W. D. Devine, and T. V. Minkova. 2020. Linking instream wood recruitment to adjacent forest development in landscapes driven by stand-replacing disturbances: a conceptual model to inform riparian and stream management. Environmental Reviews 28(4):517-527.

Devine, W. D., E. A. Steel, A. D. Foster, T. V. Minkova, and K. D. Martens. 2021. Watershed characteristics influence winter stream temperature in a forested landscape. Aquatic Sciences 83(3):1-17.

Martens, K. D. and J. Dunham. 2021. Evaluating coexistence of fish species with coastal cutthroat trout in low order streams of western Oregon and Washington, USA. Fishes 6(4) doi.org/10.3390/fishes6010004

Martens, K. D. and W. D. Devine. 2022. Pool Formation and The Role of Instream Wood in Small Streams In Predominantly Second-growth Forests. Environmental Management 1-13.

Toskey, E. K., S. M. Bollens, G. Rollwagen-Bollens, P. M. Kiffney, K. D. Martens, and B. T. Bormann. 2024. Stream Algal Biomass Associations with Environmental Variables in a Temperate Rainforest. Water 16(11): p.1533.

In addition to these publications, the RVMP produces popular science materials and conducts presentations, field tours, and other outreach activities. Between March 2023 and June 2024, we delivered four presentations, led one field tour, and were featured in a popular journal article. The presentations included:

- A presentation on steelhead within the OESF to a panel of NOAA Fisheries Scientists determining if Olympic Peninsula steelhead should be listed under the Endangered Species Act (March 17, 2023).
- A presentation on current stream and riparian forest conditions in the OESF to a group of stream restoration practitioners organized by Natural Systems Designs (November 11, 2023).
- A presentation to Olympic Region foresters on the implementation of the T3 Watershed Experiment (March 27, 2024).
- A presentation to the Natural Resource program at Peninsula College on the history of DNR management and resulting conditions (June 5, 2024).

In addition, we led a field tour of a recently completed timber harvest as part of the active habitat restoration prescription within the T3 Watershed Experiment on April 25, 2024, and were featured in an article of the Winter/Spring 2024 edition of American Forestry.

RVMP Future Directions

With the addition of four T3 Watershed Experiment watersheds managed under current DNR practices and several RVMP management watersheds with either recently completed VRH units (watersheds 488, 544, 568, 730, and 760) or units scheduled for VRH over the next few years (watersheds 157, 545, 625 and 642), the OESF is set up for a large muti-site BACI study that can assess potential impacts of VRH and the associated riparian conservation measures. These 12 monitored watersheds (watershed 545 is not sampled annually) with VRHs will be compared with the four control watersheds in the T3 Watershed Experiment and eight RVMP management watersheds with no planned harvest over the next four to 10 years to evaluate both treatment and controls across the OESF. This extensive monitoring effort should provide managers and stakeholders information on the effects of current DNR practices and whether the HCP riparian conservation strategy, as implemented in the OESF, is meeting expectations. The 2025 report comprehensive report will cover multiple-year analyses of the RVMP, evaluations of the current monitoring design, and recommendations for future monitoring.

References

Connolly, P. J. 1996. Resident cutthroat trout in the central coast range of Oregon: logging effects, habitat associations, and sampling protocols. Doctoral Dissertation. Oregon State University. Corvallis, Oregon.

Cooch, E. and G. White. 2012. A gentle introduction to Program Mark. Colorado State University, Fort Collins.

Cooke, S. J., J. N. Bergman, W. M. Twardek, M. L. Piczak, G. A. Casselberry,, K. Lutek, L. S. Dahlmo, K. Birnie-Gauvin, L. P. Griffin, J. W. Brownscombe, and G. D. Raby. 2022. The movement ecology of fishes. Journal of Fish Biology, 101(4):756-779.

Franklin, J. F. and C. T. Dyrness. 1988. Natural vegetation of Oregon and Washington. Corvallis, OR: Oregon State University Press.

Gallagher, S. P., P. K. Hahn, and D. H. Johnson. 2007. Redd counts. *In* Johnson, D. H., B. M. Shrier, J. S. O'Neil, J. A. Knutzen, X. Augerot, T. A. O'Neil, and T. N. Pearsons. Salmonid field protocols handbook: Techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

Halofsky, J. E., D. L. Peterson, K. A. O'Halloran, H. C. Hawkins, eds. 2011. Adapting to climate change at Olympic National Forest and Olympic National Park. Gen. Tech. Rep. PNW-GTR-844. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 130 p.

Kershner, J. L., M. Coles-Ritchie, E. Cowley, R. C. Henderson, K. Kratz, C. Quimby, D. M. Turner, L. C. Ulmer, and M. R. Vinson. 2004. A Plan to monitor the aquatic and riparian resources in the area of PACFISH/INFISH and the Biological Opinions for bull trout, salmon, and steelhead. Gen. Tech. Rep. RMRS-GTR-121. US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Liermann, M. and P. Roni., 2008. More sites or more years? Optimal study design for monitoring fish response to watershed restoration. North American Journal of Fisheries Management 28(3):935-943.

Martens, K. D., and P. J. Connolly. 2014. Juvenile anadromous salmonid production in upper Columbia River side channels with different levels of hydrological connection. Transactions of the American Fisheries Society 143(3):757-767.

Martens, K. D. 2016. Washington State Department of Natural Resources' Riparian Validation Monitoring Program for salmonids on the Olympic Experimental State Forest - Study Plan. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA.

Martens, K. D. 2018. Washington State Department of Natural Resources' Riparian Validation Monitoring Program (RVMP) for salmonids on the Olympic Experimental State Forest – 2017 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA.

Martens, K. D., W. D. Devine, T. V. Minkova, and A. D. Foster. 2019. Stream conditions after 18 years of passive riparian restoration in small fish-bearing watersheds. Environmental Management. doi.org/10.1007/s00267-019-01146-x

Martens, K. D. 2019. Assessment of the causal linkages between forests and fish: implications for management and monitoring on the Olympic Experimental State Forest – The 2016-2018 Riparian Validation Monitoring Program Status Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA.

Martens, K. D., D. C. Donato, J. S. Halofsky, W. D. Devine, and T. V. Minkova. 2020. Linking instream wood recruitment to adjacent forest development in landscapes driven by stand-replacing disturbances: a conceptual model to inform riparian and stream management. Environmental Reviews 28(4):517-527. doi.org/10.1139/er-2020-0035

Martens, K. D. 2021. Riparian Validation Monitoring Program (RVMP) 2020 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA.

Martens, K. D. 2022. Riparian Validation Monitoring Program (RVMP) 2020 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA.

Minkova T., J. Ricklefs, S. Horton, and R. Bigley. 2012. Riparian Status and Trends Monitoring for the Olympic Experimental State Forest. Draft Study Plan. DNR Forest Resources Division, Olympia, WA.

Minkova, T. and M. Vorwerk. 2015. Field Guide for identifying stream channel types and habitat units in Western Washington. Washington State Department of Natural Resources, Olympia WA.

Shrimpton, J. M., K. D. Warren, N. L. Todd, C. J. McRae, G. J. Glova, K. H. Telmer, and A. D. Clarke. 2014. Freshwater movement patterns by juvenile Pacific salmon Oncorhynchus spp. before they migrate to the ocean: Oh the places you'll go!. Journal of Fish Biology, 85(4):987-1004.

Smith, C. J. 2000. Salmon and steelhead habitat limiting factors in the north Washington coastal streams of WRIA 20. Washington State Conservation Commission, Lacey, Washington.

Strahler, A. N. 1957. Quantitative analysis of watershed geomorphology. Eos, Transactions of the American Geophysical Union 38(6):913-920.

Thurow, R. F. 1994. Underwater methods for study of salmonids in the intermountain west. General Technical Report (INT-GTR-307). U. S. Department of Agriculture, Forest Service, Intermountain Research Station.

Washington State Department of Natural Resources (WADNR), 1997. Final habitat conservation plan: Washington State Department of Natural Resources, Olympia, WA.

Washington State Department of Natural Resources (WADNR), 2013. Olympic Experimental State Forest HCP planning unit forest land plan revised draft Environmental Impact Statement. Olympia, WA.

Washington State Department of Natural Resources (WADNR), 2016. Olympic Experimental State Forest HCP Planning Unit Forest Land Plan: Washington State Department of Natural Resources, Olympia, WA.

Washington State Department of Natural Resources (WADNR), 2019. FINAL Environmental Impact Statement on alternatives for the establishment of a sustainable harvest level for forested state trust lands in western Washington. Washington State Department of Natural Resources, Olympia, WA.

WRIA 21 Lead Entity. 2011. WRIA 21 Queets/Quinault Salmon Habitat Recovery Strategy. http://www.onrc.washington.edu/MarinePrograms/NaturalResourceCommittees/QuinaultIndianNationLeadEntity/QINLE/OrganizingDocs/WRIA21SalmonHabRestorStrategyJune2011EditionFINAL.pdf

Appendix 1: USFWS Annual Bull Trout report for Permit #TE-64608B-1: Washington Department of Natural Resources' Salmonid Validation Monitoring Program for the Olympic Experimental State Forest - 2023 Annual Report.

Washington Department of Natural Resources
Kyle D. Martens, Fish Biologist, Olympia, WA

Introduction

Washington State Department of Natural Resources (DNR) conducted fish sampling throughout the Olympic Experimental State Forest (OESF) in 2023 under Section 10, Endangered Species Act Permit No. TE-64608B-1. Areas within the OESF are protected under Unit 1 of The U.S. Fish and Wildlife Services' Critical Habitat for bull trout (*Salvelinus confluentus*), although the extent of bull trout within the OESF is not well understood. Sampling was conducted under the DNR's salmonid validation monitoring program, described in the 2016 study plan, available at (http://file.dnr.wa.gov/publications/lm_oesf_riparian_monitor_salmonids_2016_plan.pdf). The monitoring program follows the direction of the state's habitat conservation plan (HCP) and is being utilized to determine the conservation strategy of the HCP within the OESF through assessing cause and effect relationships between DNR management activities, habitat, and salmonid populations. In addition, a new study assessing the use of current and alternative buffer configurations on DNR Type-3 streams within the OESF was initiated in 2020, adding 16 streams to our sampling schedule (http://depts.washington.edu/sefsonrc/index.php/oesf-t3-experiment/).

Methods

In 2023, sampling was completed in 51 watersheds within the OESF (Fig. 1), including 2 reference sites (Bogachiel and Queets, see appendix) in Olympic National Park. These sites were located in small, fish-bearing tributaries of the Hoko River, Clallam River, Quillayute River (including the Sol Duc River, Dickey River, and Calawah River), Goodman Creek, Mosquito Creek, Hoh River, and the Queets River (including the Clearwater River; http://file.dnr.wa.gov/publications/lm_oesf_long_term_monitoring_stations.pdf).

To estimate fish density, we conducted backpack electrofishing over 100 m reaches using multiple-pass removal electrofishing following methods outlined in Martens and Connolly (2014). Sampling took place from mid-July through October. In September, a snorkel survey was conducted in a 12 km section of the upper Clearwater River (Fig. 1)

Results

No bull trout were encountered during the 2023 field season.

Discussion

No bull trout have been encountered from 2015-2023 and may not be present in the smaller headwater streams of the OESF. Bull trout are thought to use the larger portions of the Clearwater River but have not been identified in the areas snorkeled from 2016-2023. This may be due to low abundances, detection efficiency, or survey timing. In 2024, we plan to resample the 20 annual watersheds, 20 watersheds in the odd-year rotation of watersheds, 32 reaches within the 16 watersheds reaches per watershed of the T3 watershed experiment, and the 12 km section of the upper Clearwater River. A list of the publications from this work can be found in the following section.

References and OESF Publications

Martens, K. D. and Connolly, P. J. 2014. Juvenile anadromous salmonid production in Upper Columbia River side channels with different levels of hydrological connection. Transactions of the American Fisheries Society, 143(3):757-767.

Martens, K. D. 2016. Washington State Department of Natural Resources' Riparian Validation Monitoring Program for salmonids on the Olympic Experimental State Forest - Study Plan. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. https://www.dnr.wa.gov/publications/lm_oesf_riparian_monitor_salmonids_2016_plan.pdf

Martens, K. D. 2017. Washington State Department of Natural Resources' Riparian Validation Monitoring Program for salmonids on the Olympic Experimental State Forest – 2016 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. https://www.dnr.wa.gov/publications/lm_oesf_rvmp_2016_annual_report.pdf

Martens, K. D. 2018. Washington State Department of Natural Resources' Riparian Validation Monitoring Program (RVMP) for salmonids on the Olympic Experimental State Forest – 2017 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. https://www.dnr.wa.gov/publications/lm_oesf_rvmp_2017_annual_report.pdf

Martens, K. D. 2019. Assessment of the causal linkages between forests and fish: implications for management and monitoring on the Olympic Experimental State Forest – The 2016-2018 Riparian Validation Monitoring Program Status Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. https://www.dnr.wa.gov/publications/lm_oesf_rvmp_2018_annual_report.pdf

Martens, K. D., Devine, W. D., Minkova, T. V. and Foster, A. D. 2019. Stream conditions after 18 years of passive riparian restoration in small fish-bearing watersheds. Environmental Management, 63(5):673-690.

Martens, K. D., Donato, D. C., Halofsky, J. S., Devine, W. D. and Minkova, T. V. 2020. Linking instream wood recruitment to adjacent forest development in landscapes driven by stand-

replacing disturbances: a conceptual model to inform riparian and stream management. Environmental Reviews, 28(4):517-527.

Martens K. D., Dunham J. 2001. Evaluating Coexistence of Fish Species with Coastal Cutthroat Trout in Low Order Streams of Western Oregon and Washington, USA. Fishes, 6(1):4. https://doi.org/10.3390/fishes6010004

Martens, K. D. 2022. Riparian Validation Monitoring Program (RVMP) 2020 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA.

Martens, K. D. 2022. Riparian Validation Monitoring Program (RVMP) 2021 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. Available at: https://www.dnr.wa.gov/sites/default/files/publications/lm_oesf_rmvp_2021_ar.pdf

Martens, K. D. and Devine, W. D. 2022. Pool Formation and The Role of Instream Wood in Small Streams in Predominantly Second-growth Forests. Environmental Management. https://doi.org/10.1007/s00267-022-01771-z

Martens, K. D. 2023. Riparian Validation Monitoring Program (RVMP) 2022 Annual Report. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. https://www.dnr.wa.gov/sites/default/files/publications/lm_oesf_rmvp_2022_ar.pdf

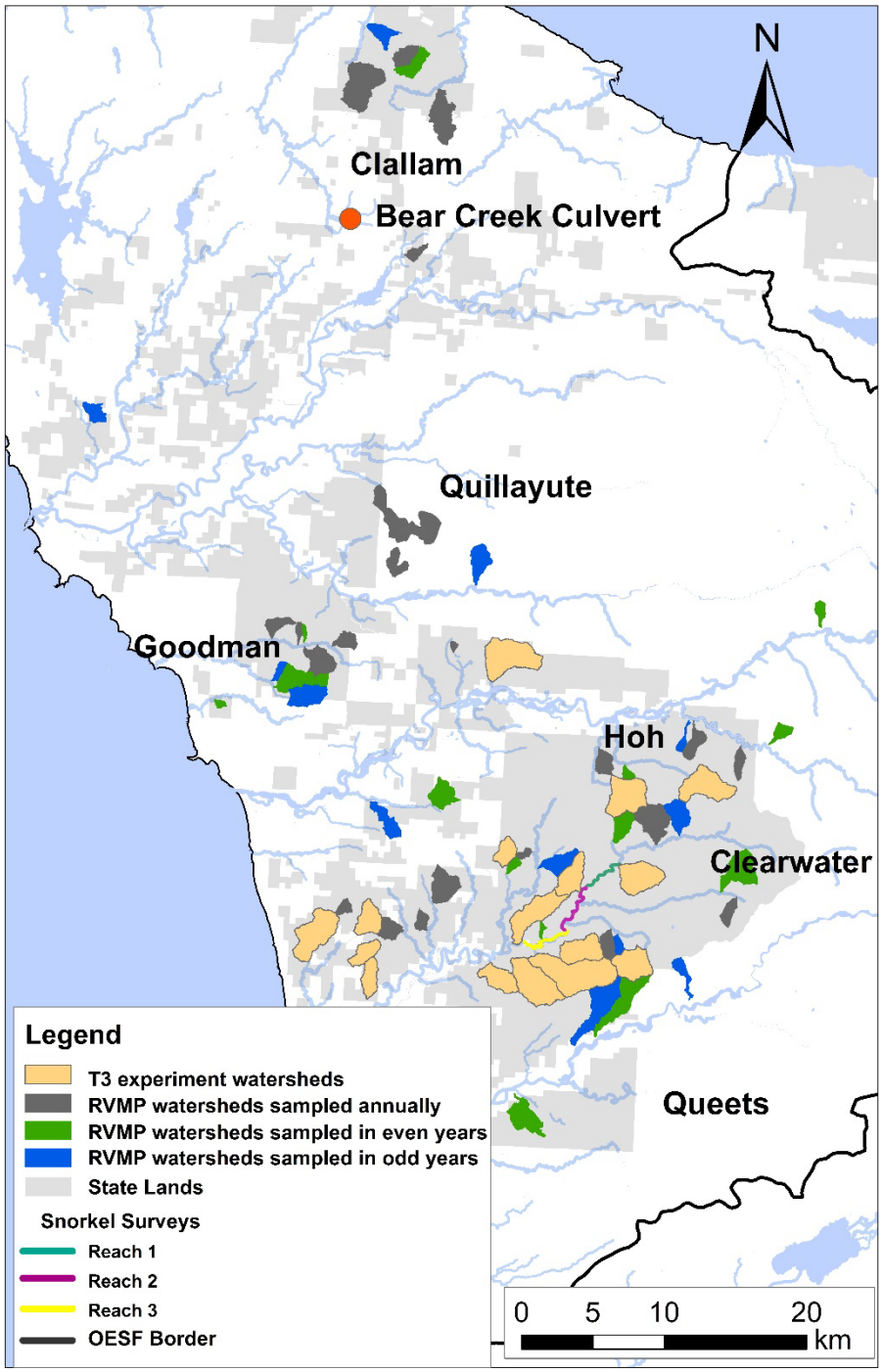


Figure 1. Map of watersheds and sites sampled in the 2023 field season across the Olympic Experimental State Forest.

Appendix Table 1. Watershed locations and fish species encountered during Washington Department of Natural Resources' fish sampling on the OESF in 2023. COH = coho; CTT = coastal cutthroat; RBT =

steelhead or rainbow trout; TRT = unknown juvenile trout species (CTT or RBT); SCP = Sculpin (Cottus species); LMP = juvenile lamprey; and None = no fish were collected at site.

Basin	Latitude	Longitude	Fish Species
145	48.230598	-124.330753	COH, CTT, RBT, TRT, SCP
157	48.22385192	-124.2948482	CTT, TRT, SCP
165	48.21168359	-124.3569823	CTT, RBT, TRT, SCP
196	48.19762618	-124.2741879	COH, CTT, RBT, TRT, SCP
328	48.091938	-124.2994254	COH, CTT, TRT, SCP
443	47.982793	-124.583603	COH, CTT, TRT, SCP, LMP
488	47.94543555	-124.311738	COH, CTT, TRT, SCP
542	47.84627504	-124.4061643	COH, CTT, TRT, SCP
544	47.8429896	-124.3812407	COH, CTT, TRT, SCP
550	47.843254	-124.349481	COH, SCP
566	47.846652	-124.233881	TRT, SCP, LMP
567	47.84378017	-124.3631071	COH, CTT, TRT, SCP, LMP
568	47.84201489	-124.3753559	COH, CTT, TRT, SCP, LMP
582	47.825944	-124.397975	COH, CTT, SCP, LMP
597	47.811372	-124.370912	COH, CTT, SCP LMP
621	47.79513	-124.017193	CTT, RBT, TRT
625	47.80673077	-124.0082626	COH, CTT, RBT, TRT, SCP
639	47.79260891	-123.9626384	CTT, TRT
642	47.78772853	-124.0953962	CTT, TRT, SCP
687	47.747204	-124.01884	COH, CTT, RBT, TRT
688	47.735903	-124.290812	COH, CTT, TRT, SCP
690	47.742588	-124.04108	COH, CTT, RBT, TRT
717	47.71952839	-124.1531565	COH, CTT, TRT, SCP, LMP
718	47.713129	-124.125936	COH, CTT, RBT, TRT, SCP, LMP
730	47.695933	-124.234346	COH, CTT, RBT TRT, SCP, LMP
744	47.676491	-124.319234	CTT, TRT, SCP
750	47.6970612	-123.9609047	CTT, TRT, SCP
760	47.672657	-124.252894	COH, CTT, TRT, SCP
763	47.66614737	-124.2697792	COH, CTT, RBT, TRT, SCP
773	47.673263	-124.076269	CTT, TRT
776	47.6638	-124.068889	CTT, TRT
796	47.62141	-124.086913	COH, CTT, RBT, TRT, SCP, LMP
804	47.63644366	-124.1426444	CTT, TRT, SCP
Bogachiel	47.901242	-124.214975	COH, CTT, RBT, TRT, SCP
Queets	47.643235	-124.004597	COH, CTT, RBT, TRT, SCP
Aa	47.643166	-124.183549	CTT, TRT, SCP

Ac	47.6616	-124.1152667	CTT, RBT, TRT
Ap	47.63793333	-124.1359333	COH, CTT, RBT, TRT, SCP, LMP
Az	47.64249	-124.122	CTT, TRT, SCP
Ba	47.67301667	-124.1655333	COH, CTT, TRT, SCP
Bc	47.830166	-124.1941	CTT, TRT
Bp	47.714	-124.179	CTT, TRT
Bz	47.41936	-124 06.838	COH, CTT, RBT, TRT, SCP
Ca	47.76421667	-124.0783167	CTT, TRT, SCP
Cc	47.769	-123.312	CTT, TRT
Cp	47.652	-124.0527833	CTT, TRT, SCP
Cz	47.709	-124.059	CTT, TRT, SCP
Da	47.64683	-124.31185	COH, CTT, RBT, TRT, SCP, LMP
Dc	47.66763	-124.3106333	COH, CTT, TRT, SCP, LMP
Dp	47.64298333	-124.2977833	CTT, TRT, SCP
Dz	47.648249	-124.3575	COH, CTT, RBT, TRT, SCP, LMP