Riparian Validation Monitoring Program (RVMP)

2020 Annual Report

Washington State Department of Natural Resources, Forest Resources Division

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Olympia, WA 98504

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

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Executive summary

The Riparian Validation Monitoring Program (RVMP) was designed to meet the Washington State Department of Natural Resources' (DNR) commitment to the state trust lands Habitat Conservation Plan (HCP). This effort, beginning in 2016, combined with the Status and Trends Monitoring of Riparian and Aquatic Habitat (STRAH) program, represents DNR's largest systematic riparian and salmonid monitoring program and the best indication of riparian forest, stream, and salmonid conditions on DNR-managed lands. In 2020, the RVMP joined the T3 Watershed Experiment to add experimentation to its existing observational monitoring approach as envisioned in the 2016 RVMP study plan. Adding this experimentation component increases our ability to assess the cause-and-effect relationships between DNR management and salmonids under both current riparian management and alternative forest management prescriptions.

In 2020, DNR conducted population surveys to estimate juvenile salmonid densities (fish/meter) and biomass (grams/meter^2) in 40 watersheds from the annual panel (n=20) and the even-year rotating panel (n=21) of 62 RVMP monitored watersheds. An additional 31 fish and habitat surveys at the reach (n=20) and pour point (n=11) were conducted as part of the T3 Watershed Experiment. Monitoring also continued on the Bear Creek culvert removal with a reach sampled both above and below the site of the removed culvert. Finally, adult coho salmon redd surveys were conducted in 12 watersheds, and snorkel and habitat surveys were partially completed in the Clearwater River. Almost all planned fieldwork was completed despite the unprecedented challenges of the COVID-19 pandemic.

Monitoring has shown that salmonid populations have been relatively high within our annual panel of watersheds, primarily driven by age-0 trout. However, the average juvenile coho salmon density in 2020 was the lowest since sampling began in 2016. The low density of coho should be monitored further to understand if it is the result of yearly variations or a sustained decrease. Overall, there have been large yearly and between-site variations in juvenile salmonid populations highlighting the need for continuous (both annual and long-term) sampling. Longer records of fish density and biomass are needed in order to separate the effects of forest management from both spatial and temporal variability.

Since its implementation in 2016, the RVMP has published four peer-review journal articles with one assessing the relationship between riparian forests and instream wood published in 2020. The findings described in these publications and in the 2019 status report helped to develop riparian treatments for the T3 Watershed Experiment and continue to improve our knowledge on potential connections between salmonids and DNR management.

Acknowledgements

Jacob Portnoy, Katrina Campbell, Ruud Mengers, DNR Scientific Technicians and University of Washington interns for conducting fieldwork in 2020. 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. Andy Hayes and Allen Estep of DNR for providing managerial support. Luke Kelly of Trout Unlimited and Noelle Nordstrom of the DNR for conducting snorkel surveys.

Suggested Citation:

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

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Acronyms and Abbreviations

COH – Coho Salmon

CTT – Cutthroat Trout

DNR – Washington Department of Natural Resources

HCP – Habitat Conservation Plan

MS222 – Tricaine mesylate

OESF – Olympic Experimental State Forest

ONP – Olympic National Park

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

VRH – Variable Retention Harvest

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2020 Annual report for the Riparian Validation Monitoring Program (RVMP)

Kyle D. Martens

Introduction

The Riparian Validation Monitoring Program (RVMP) was designed to meet the Department of Natural Resources' (DNR) commitment for Riparian Validation Monitoring as described 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 state trust lands (state lands). The HCP Riparian Conservation Strategy aims to protect, maintain and restore habitat capable of supporting viable populations of salmonids and other species dependent on in-stream and riparian environments. Validation Monitoring, as described in the HCP, is meant "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). It is the most complex and difficult of the three types of monitoring (implementation, effectiveness, and validation) within the HCP and aims to test the hypothesis that forest management practices implemented under the HCP will restore and maintain habitat capable of supporting viable salmonid populations.

The RVMP uses an observational approach to monitor 62 Type-3 watersheds with 22 annually sampled watersheds and 40 watersheds sampled on a two-year rotation, and a 12 km stretch of the Clearwater River. 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 will then be developed to evaluate the cause-and-effect relationships between DNR management activities, riparian habitat, and salmonids. Once the underlying mechanisms are understood, DNR will use this information to affirm or adapt its management practices.

The Olympic Experimental State Forest (OESF) is a working forest designated by DNR for research and monitoring to better integrate revenue production (primarily through timber harvesting) and ecological values (primarily habitat conservation; WADNR 2016). The HCP designated the OESF as the place for Riparian Validation Monitoring. DNR's Status and Trends Monitoring of Riparian and Aquatic Habitat program (STRAH), which also takes place in the OESF, serves as a complementary study to the RVMP, utilizing the same sites and sharing data to improve efficiency and avoid collecting redundant information. While the RVMP was primarily designed to meet the department's commitment to the HCP, this program has many other uses (documented below) including its role as the only continuous field-based monitoring and assessment of riparian forests, fish, and stream habitat conditions on DNR-managed lands.

This monitoring provides evidence on whether DNR riparian management is working as intended.

Benefits to DNR from Riparian Validation Monitoring Program:

- Increases knowledge, confidence, and flexibility in DNR land management practices.
- Increases the ecological knowledge on the relationships between salmonids, habitat, and land management.
- Provides current information on salmonid conditions in the OESF that may alleviate the perception that practices on DNR-managed lands are negatively affecting salmonids on the Olympic Peninsula (Smith 2000; WRIA 21 Lead entity 2011).
- Supplies information for predictive models of future habitat conditions and impacts on fish under different management alternatives. DNR uses these models in planning documents such as the OESF Forest Land Plan and Sustainable Harvest Calculation.
- Monitors for the potential effects of climate change on salmonids or habitat in the Pacific Northwest.
- Complies with the HCP monitoring commitments and research priorities.
- Establishes stronger relationships with other natural resource agencies, research organizations, academia, and tribal nations.
- Informs DNR stakeholders about the state of natural resources and builds trust.

As recommended in the RVMP study plan (Martens 2016), an experimental study was added to the RVMP in 2020 as part of DNR's collaboration with the University of Washington on the T3 Watershed Experiment. The riparian component of the study was designed to assess both current DNR riparian management and three alternative management strategies adjacent to variable retention harvests (VRH; Martens 2016). One of the alternative riparian management prescriptions (active habitat restoration) was designed to reduce some of the hypothesized limiting habitat factors identified through STRAH and RVMP monitoring (i.e., 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 should ultimately provide the most comprehensive evaluation of DNR's current riparian management as well as provide information on potential management alternatives. More information on the T3 Watershed Experiment can be found at the University of Washington's Olympic Natural Resource Centers website (T3 Watershed Experiment | Olympic Natural Resources Center (washington.edu)) or in the experiment's riparian study plan (Riparian Study Plan final.pdf - Google Drive).

This report covers activities performed under the RVMP for the 2020 calendar year (January through December). More in-depth analyses from this program will come from peer-reviewed journal articles and the six-year (three watershed sampling rotations) status report currently scheduled for 2025. During 2020, DNR conducted 1) population surveys to determine juvenile salmonid densities (fish/meter) and biomass (grams/meter^2) estimates in 40 watersheds from the annual panel (n=21) and the even-year rotating panel (n=19) of 62 monitored watersheds; 2) 31 fish and habitat surveys at the reach (n=20) and pour point (n=11) of the T3 Watershed Experiment watersheds; 3) surveys above and below a removed culvert in Bear Creek; 4) adult coho salmon (*Oncorhynchus kisutch*) redd surveys in 10 streams; and 5) snorkel and habitat surveys in Reach 3 of the Clearwater River.

Study Area

The OESF includes approximately 110,000 ha of state lands on the western Olympic Peninsula (Figure 1). 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 forests within the OESF mostly consist of second- and third-growth forests resulting from prior timber harvests, with less than 10% of the forests being older than 140 years (WADNR 2016). The current sustainable harvest level for the OESF for the 2014-2025 decade is 739 mmbf. About 0.2% of the land base is projected to be harvested through thinning and about 0.7% harvested through VRH annually (WADNR 2019).

DNR-managed lands in the OESF contain over 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 spp.*) and/or sculpins (*Cottus spp.*). Coastal cutthroat trout are the most commonly found salmonid species within these smaller streams (Martens 2016).

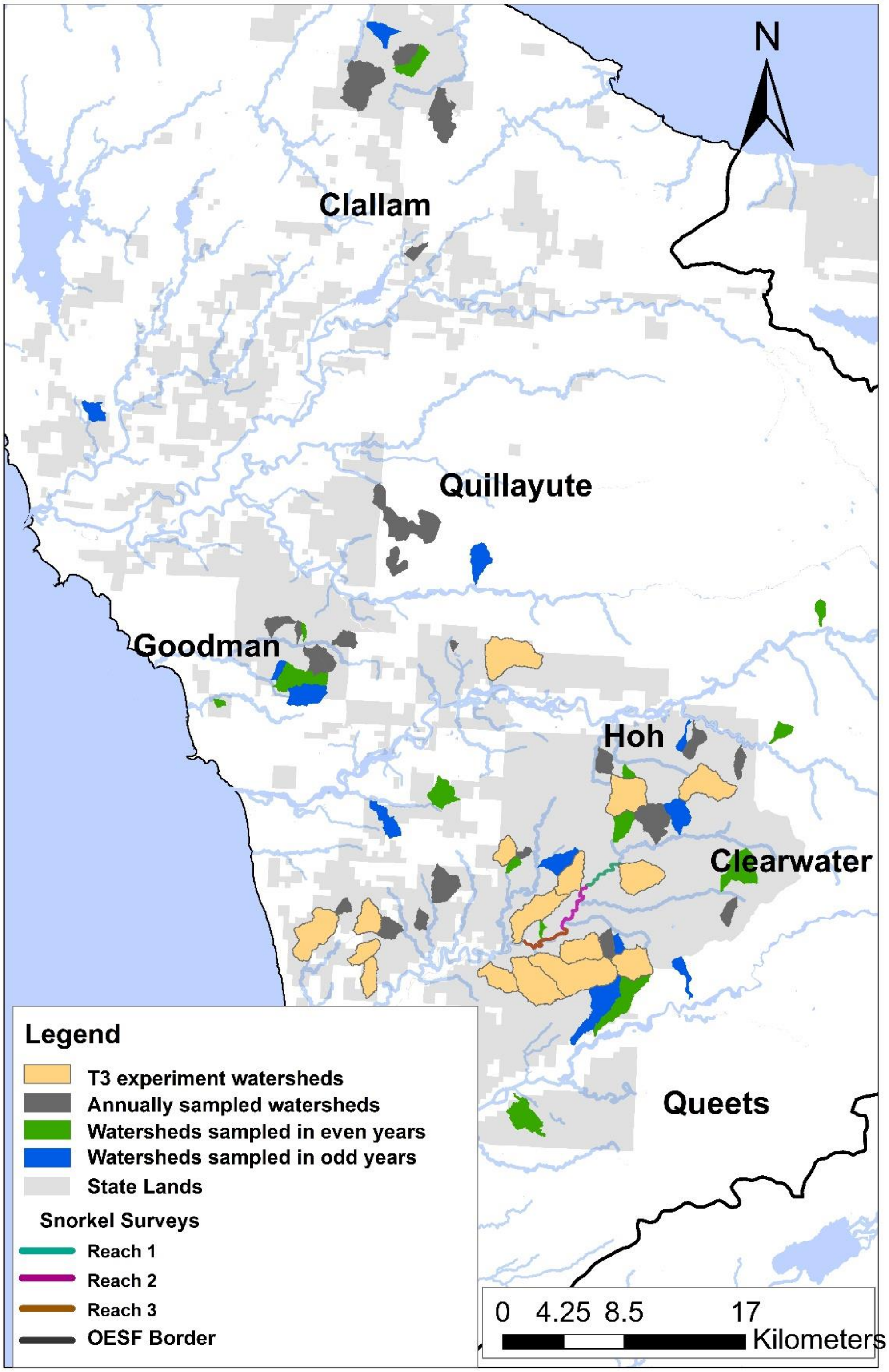

Figure 1. Map of OESF state managed lands and sample watersheds.

Methods

Study Design

The RVMP uses observational monitoring in 50 Type-3 watersheds[a] on state lands managed by DNR and 12 reference watersheds located on state lands (n=2), Olympic National Park (n=4), and Olympic National Forest (n=6; Martens 2016). The 50 managed watersheds were selected through a stratified random design under the STRAH program (Minkova et al. 2012). Reference watersheds (n=12) were selected based on their environmental condition (similar to the 50 managed watersheds), management history (> 95% of the watershed area never harvested), and location (reasonably easy access). As not all of the 62 watersheds could be sampled within a field season (summer), the RVMP calls for 22 watersheds to be sampled annually (annual panel), and an additional 40 watersheds per year to be sampled on a two-year rotation (even and odd years; Martens 2016). Sampling reaches for juvenile fish and stream habitat surveys are located near the watershed outlet just above the floodplain of its confluencing stream and are 20 times the bankfull width or a minimum of 100 meters in length. A section of the Clearwater River, a Type-1 stream[a], 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 62 monitored watersheds with a known coho salmon presence. In addition, starting in 2020, the T3 Watershed Experiment monitors two stream reaches in each of the study's 16 experimental watersheds. One of the sampled reaches is next to a planned timber harvest implementing the experiment and the other is at the pour point of the watershed (except for in Alterative 2 watersheds which have two prescriptions and monitoring only takes place at the reaches).

[a]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".

Juvenile Fish Sampling in Type-3 streams

Juvenile fish surveys for both the RVMP, T3 Watershed Experiment, and Bear Creek watersheds are conducted using multiple-pass removal electrofishing. Sample reaches in T3 watersheds and Bear Creek are 100 meters while sample reaches in watersheds in the RVMP (these reaches are the larger of 100 meters or 20 times the bankfull width by the STRAH program) over 120 meters were reduced to 100 meters or less to ensure all sampling could be completed within a day. 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 (https://www.smith-root.com) is used to collect fish with a forward and backward pass through the reach. Electrofishing is typically conducted using a frequency of 20 hertz with 10% duty cycle and voltage ranging from 300 to 600 volts. Fish sampling uses a variable pass (3 to 6 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 State Department of Fish and Wildlife (permit # 21-179) 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, additional sampling in the T3 Watershed Experiment watersheds includes stream shade (using hemispherical photos), bankfull width, pebble counts, and stream gradient.

Bear creek culvert removal monitoring

During reviews of 2016 annual report, the Olympic Regional Office requested that we monitor the effectiveness of the region's culvert replacement program. The evaluation of the Bear Creek culvert removal began in 2017 with the culvert removed after the 2018 sampling period. Sampling consists of two years of pre-removal monitoring followed by at least three years of post-removal monitoring following a BACI design. Sampling includes juvenile population estimates (as described above) directly above the culvert (treatment) and directly below the culvert (control). A BACI design improves the ability to detect effects since a portion of the inter-annual variation is accounted for by the correlation between treatment and control sites (Zimmerman et al. 2012). For a BACI design to be effective, treatments must have sufficient contrast in order to detect changes in fish abundance (Crawford and Rumsey 2011). A more in-depth look into this addition to the program can be found in Chapter 2 of the 2019 annual report (Howell and Martens 2020).

Redd Surveys in Type-3 streams

DNR redd 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). Surveys identify the presence of redds, any adult fish present, and mark locations with GPS. 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).

Snorkel Surveys on the Clearwater River

Snorkeling surveys are used to help understand the distribution of larger resident, anadromous adult, and juvenile salmonids in larger streams. The 12 km sampled section (starting near river kilometer 46 [downstream of Kunamakst Creek] and ending near river kilometer 33 [upstream of Bull Creek]) of the Clearwater River was chosen because it is fully contained within DNR managed lands and any impacts 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 pool, glides, and riffles measured with a laser rangefinder. Instream wood pieces are 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.

Results

Seventy-one stream reaches were sampled for juvenile salmon (including the RVMP [n =40] watersheds, T3 Watershed Experiment reaches [n=31] and Bear Creek [n=2]). Additionally, 12 RVMP watersheds were surveyed for coho salmon redds and Reach 3 (approximately rkm 37 [C-1005 road crossing] to rkm 33 [upstream of Bull creek]) of the mainstem Clearwater River was snorkeled. Reach 1 and 2 in the Clearwater River were not surveyed due to heavy rains and difficulties in scheduling make-up days during the COVID pandemic.

DNR-led crews handled 877 coastal cutthroat trout, 490 coho salmon, 2,433 juvenile trout (a combination of age-0 coastal cutthroat trout and steelhead/rainbow trout), and 164 steelhead/rainbow trout during juvenile density surveys. Sculpin were often found but were not collected (sculpin lack a swim bladder and are not as easily collected as juvenile salmon, and the HCP only calls for salmonid monitoring). Juvenile lamprey were also found in 16 of the 71 watersheds. In addition to the species found in Type-3 watersheds, mountain whitefish and longnose dace were found during snorkel surveys in the mainstem Clearwater River.

Figures 2 and 3 show the salmonid density and biomass of fish collected in 2020. Salmonid variability remains high between the watersheds as was found in previous years (Martens 2021). Watershed 690 had the highest density of fish which was primarily driven by age-0 trout. This watershed also contained the highest density and biomass of age-1 or older rainbow trout/steelhead. When present, age-1 or older rainbow trout/steelhead made up a large portion of the biomass within streams.

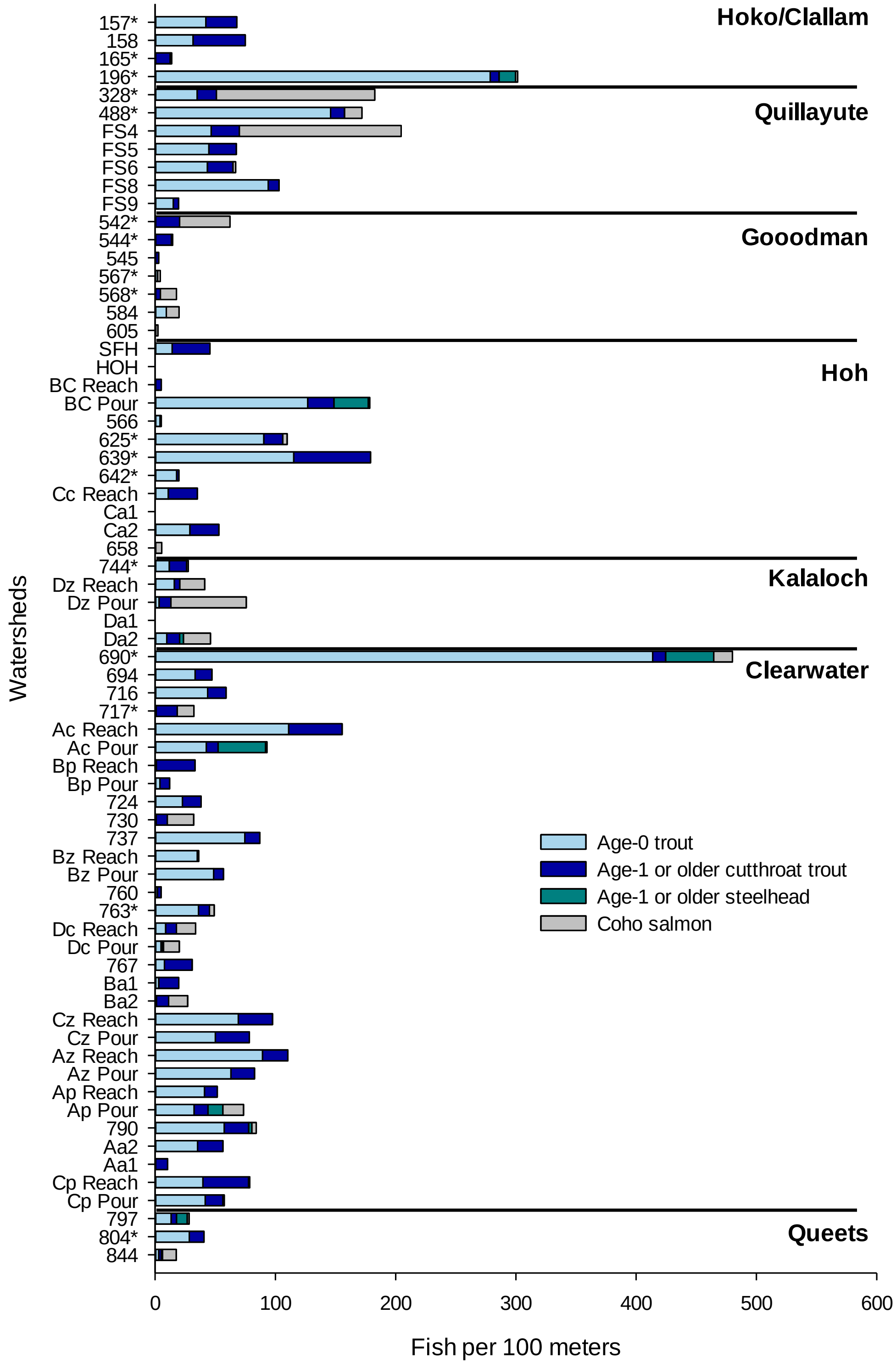

*Figure 2. Fish density (number of fish per 100 meters of stream reach) during the summer of 2020. *Annual sampling reaches*

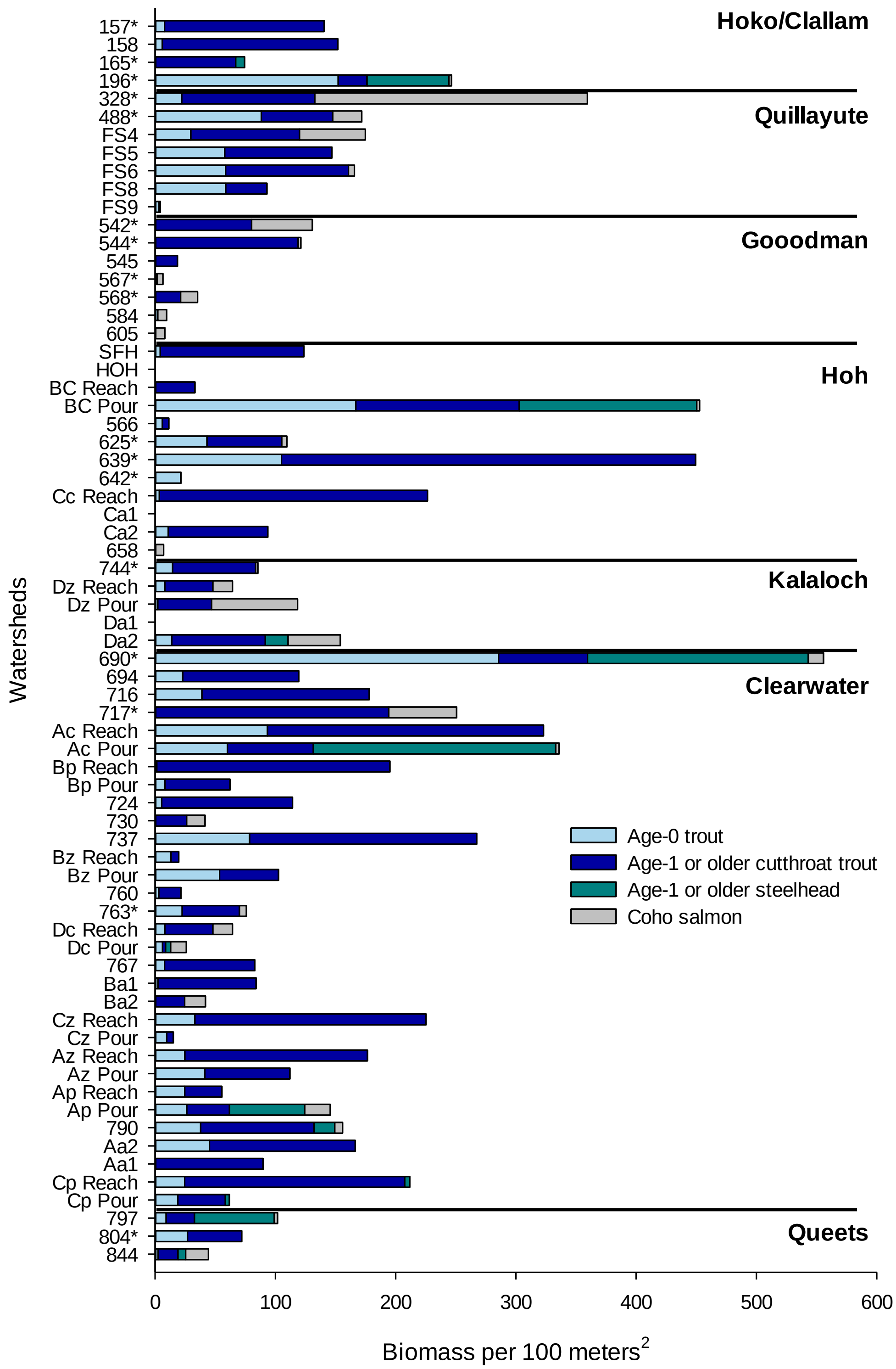

*Figure 3. Fish Biomass (grams per 100 meters² of stream reach) sampled during the summer of 2020. *Annual sampling reaches*

The average density and biomass of salmonids within annually sampled RVMP watersheds are in Figures 4 and 5. Salmonid densities in the annually sampled watersheds continue to remain high when compared to the first two years of sampling. In 2020, age-0 trout were the most numerous salmonid and has been responsible for most of the between year variability for all salmonids. Juvenile coho salmon numbers had the lowest levels found since sampling began in 2016. Age- 1 or older cutthroat trout and rainbow trout/steelhead have shown the least amount of variability between years. Fish biomass has remained more stable when compared with density.

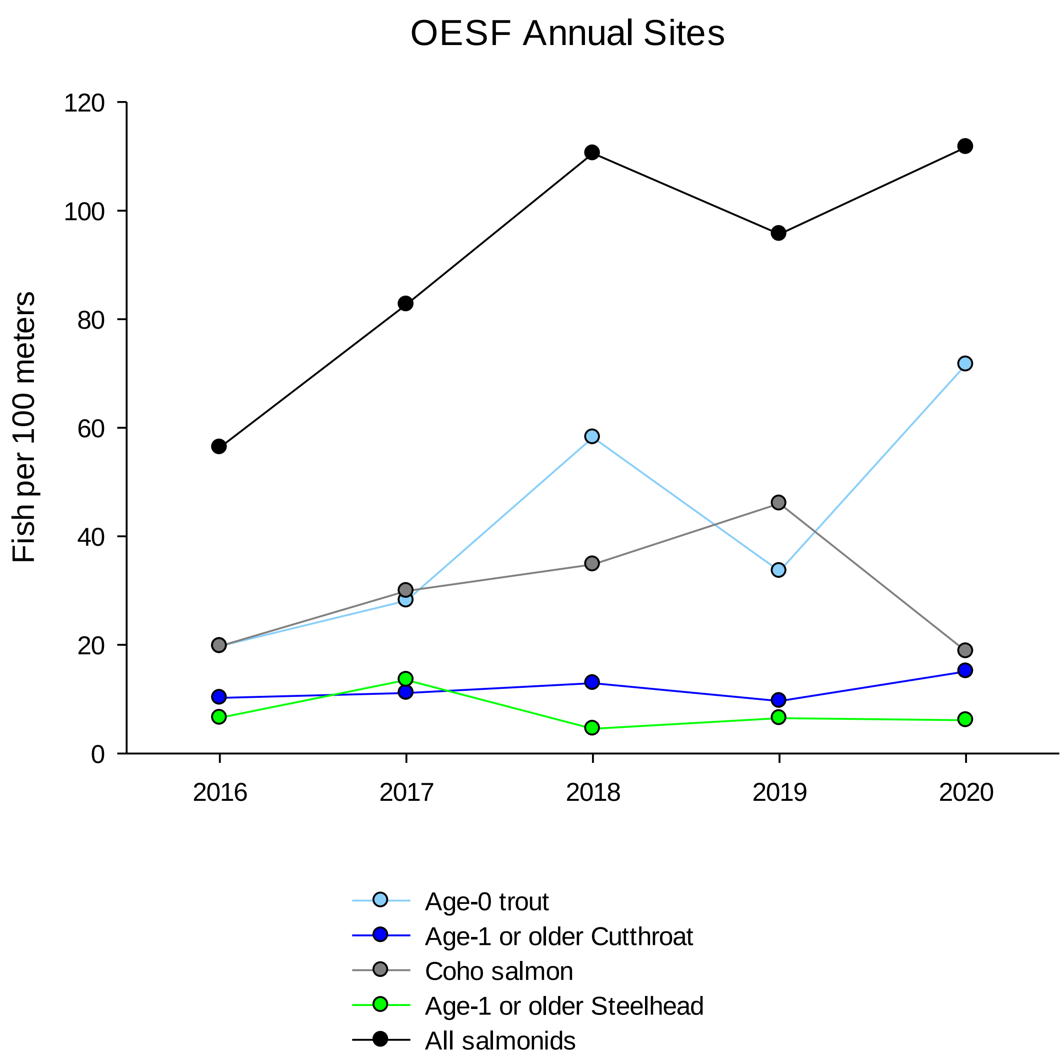

Figure 4. Average fish per 100 meters of stream for the annual panel of sampling sites (n=20) under the Riparian Validation Monitoring Program (RVMP) on the Olympic Experimental State Forest.

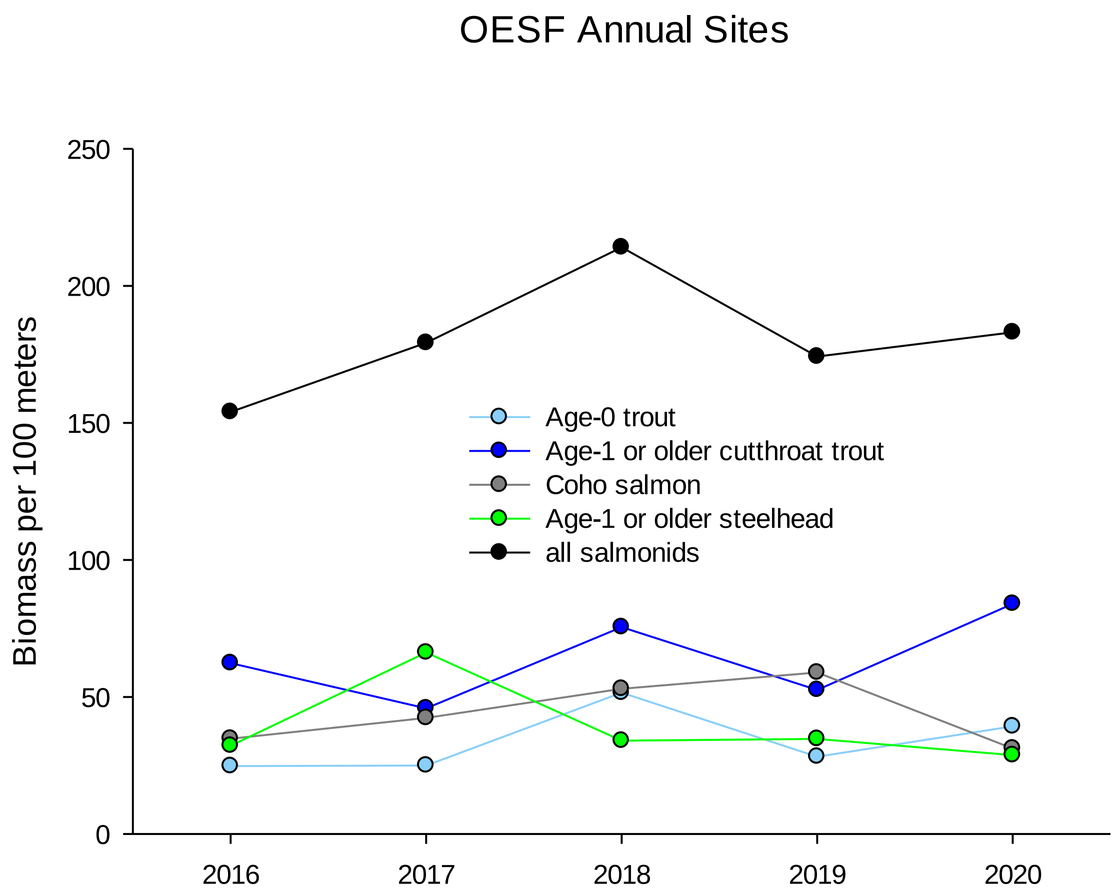

Figure 5. Average Biomass (g per 100 meters^2) for the annual panel of sampling sites (n=20).

Fish densities from 2017-2020 above and below the former culvert site in Bear Creek are in Figure 6. There has been no obvious change in age-1 or older cutthroat trout since removal of the culvert. However, the number of age-0 cutthroat trout both above and below the culvert has increased since removal.

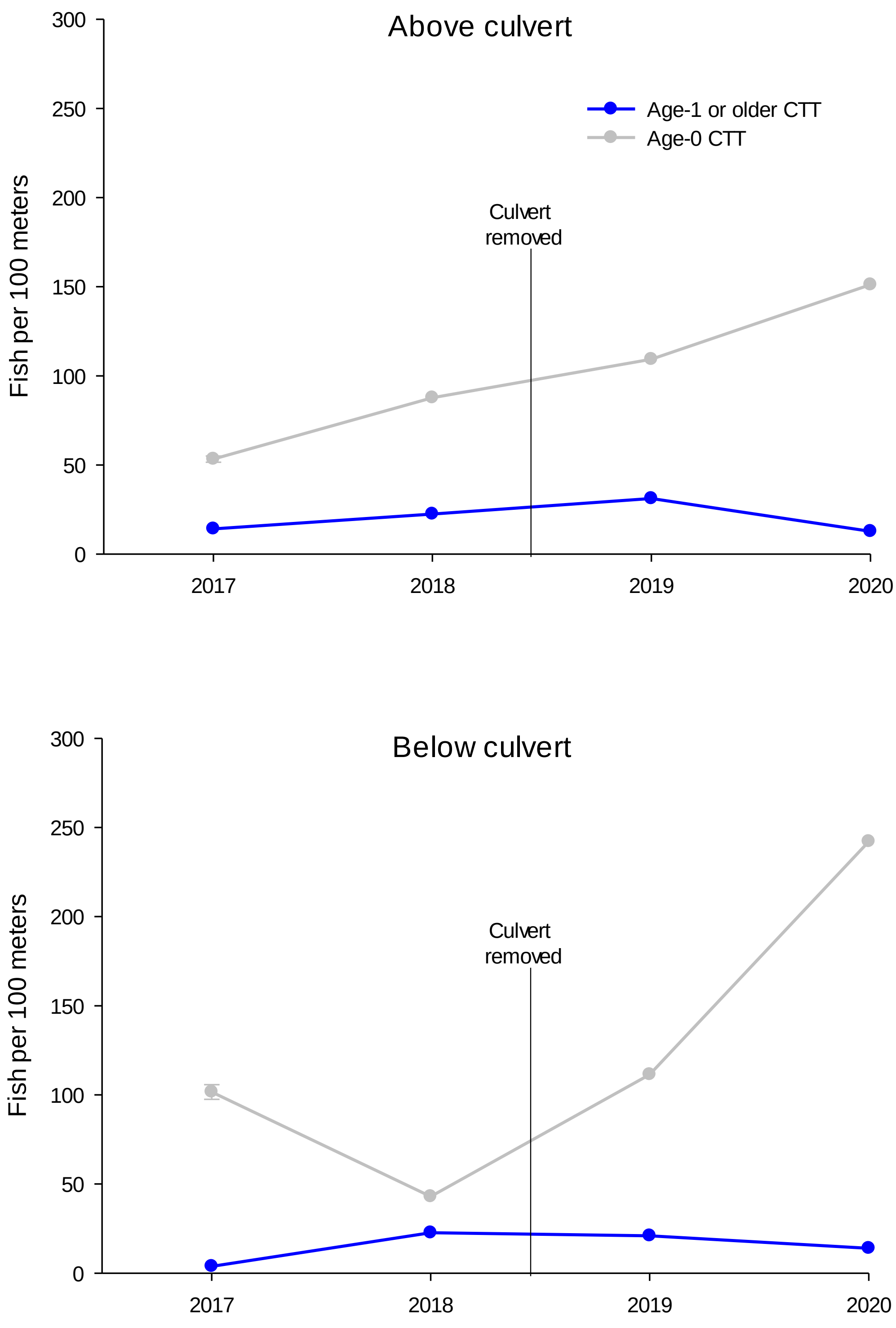

Figure 6. Fish density (number of fish per 100 meters of stream reach) above and below Bear Creek before (2017-2018) and after (2019-2020) culvert removal.

Annual numbers of coho salmon redds are in Figure 7. Redd surveys were conducted in 12 streams from 2016 through 2020. Watershed 328 continues to have the highest number of redds with 6 in 2020. This stream appears to be an anomaly as most streams have ranged from 0 to 5 redds. Overall, several of these streams have consistently had few to no redds.

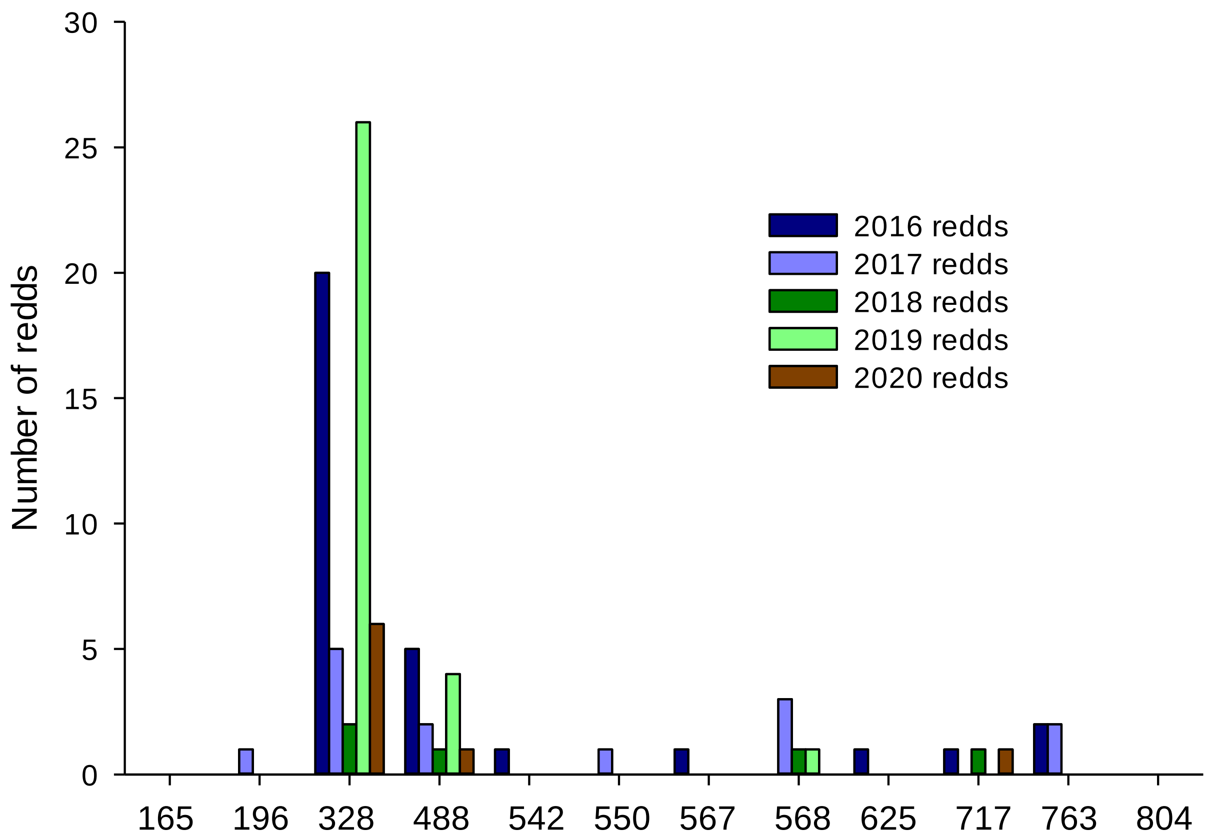

Figure 7. Coho salmon redd surveys conducted in the annual panel of watersheds from 2016 through 2020.

Annual fish density, calculated from snorkel data collected in the three sample reaches of Clearwater River, is presented separately for each of the three main species – coho salmon (Figure 8), age-0 trout (Figure 9) and mountain whitefish (Figure 10). Due to heavy rains (resulting in poor visibility in the water and cancelation of planned survey activities) and a limited amount of volunteers due to the COVID pandemic, only Reach 3 was sampled in 2020. Reach 3 was prioritized for sampling since it offers the most potential for stream restoration and could be used for pre-sampling monitoring for any future restoration activities. Coho salmon and mountain whitefish in Reach 3 were similar to previous years, however the number of age-0 trout were the highest recorded since sampling began in 2017.

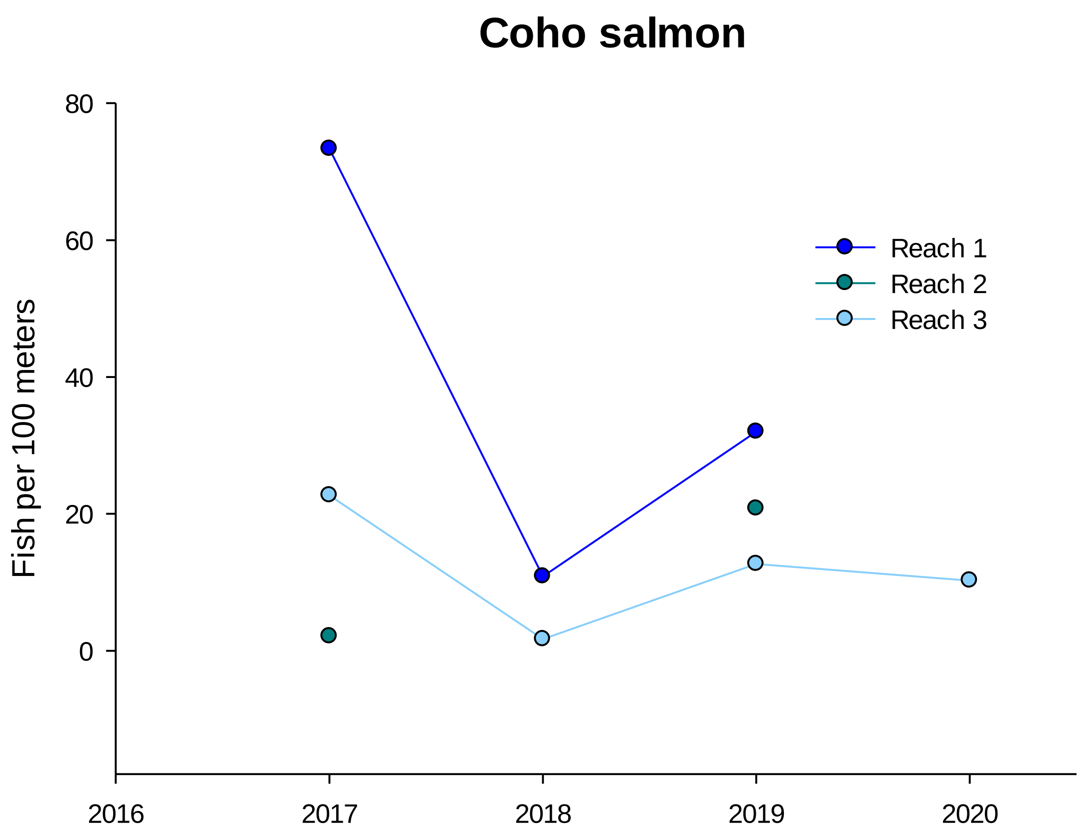

Figure 8. Coho salmon density in the Clearwater River from 2017 through 2020. Reach 2 was not snorkeled in 2018 and 2020; Reach 1 was snorkeled in 2020.

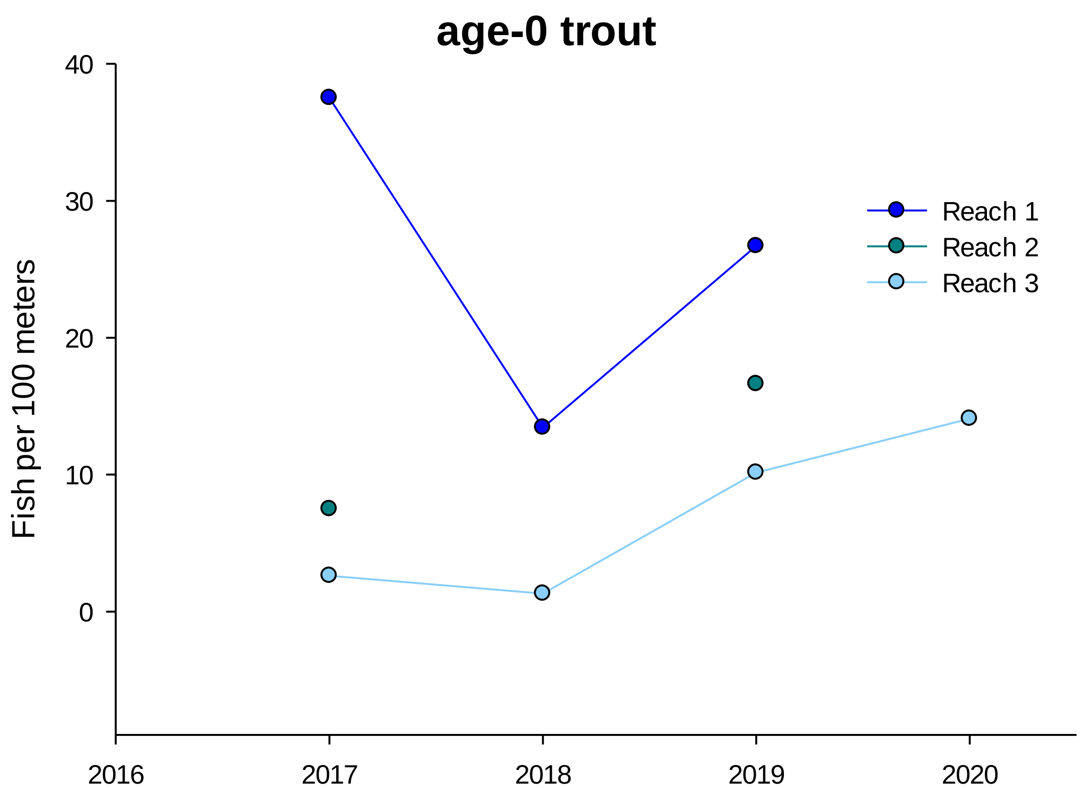

Figure 9. Age-0 trout density in the Clearwater River from 2017 through 2020. Reach 2 was not snorkeled in 2018 and 2020; Reach 1 was snorkeled in 2020.

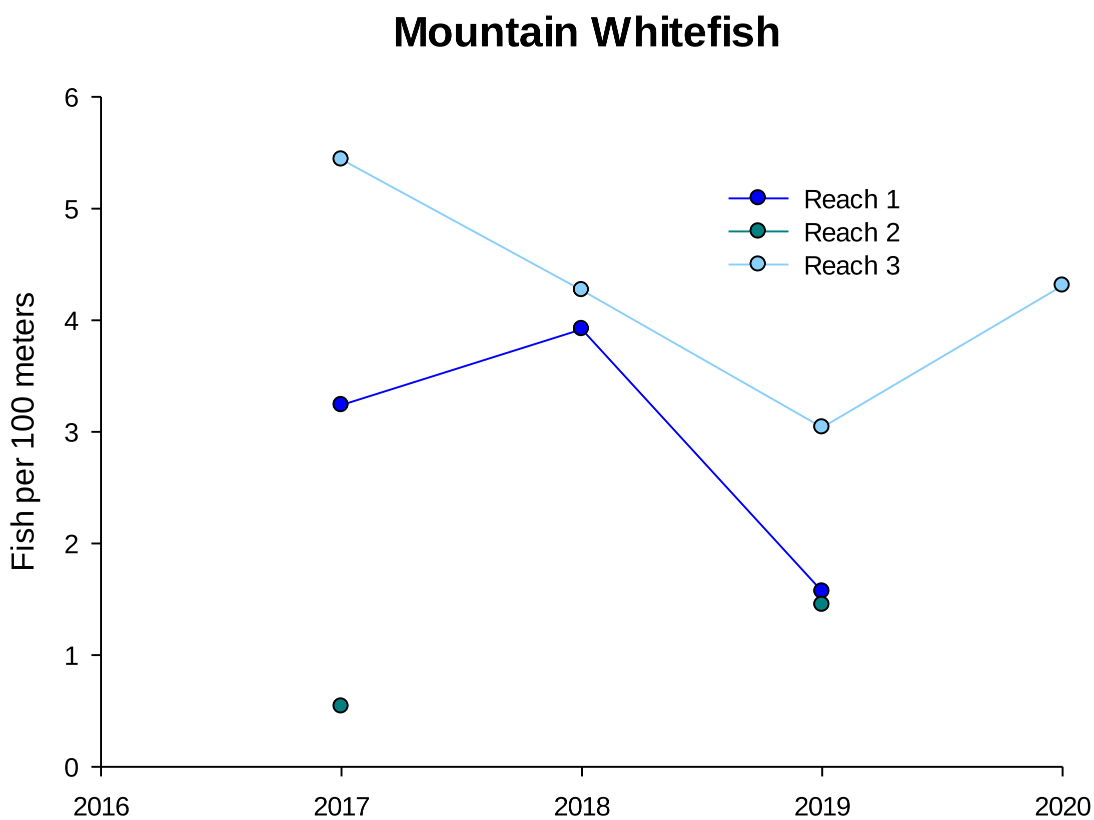

Figure 10. Mountain whitefish density in the Clearwater River from 2017 through 2020. Reach 2 was not snorkeled in 2018 and 2020; Reach 1 was snorkeled in 2020.

Discussion

The lack of obvious spatial patterns across the RVMP watersheds and between-year differences highlight the need to continue sampling a large number of watersheds at a relatively high frequency. The OESF contains biophysically diverse landscapes resulting in diverse fish communities and densities. Fish species typically live within a specific set of physical habitats, such as stream gradient and watershed size, that help to determine their range within a watershed. Martens and Dunham (2021) found that cutthroat trout and steelhead could be found within the widest range of gradients (0.3 to 21%) while coho salmon were found over a lower range of gradients (0.3 to 7.1%). Coho and cutthroat trout also tended to prefer smaller watersheds while steelhead were mostly found in larger watersheds. Salmonid populations also have high amounts of natural variability over time (Bayley 2002; Dunham et al. 2002). This year-to-year variability is common in salmonid populations and has been related to many factors including changes in ocean conditions, adult harvest, and local weather patterns (Hobday and Boehlert 2001; PFMC 2018; Sheldon and Richardson 2021). Given this high degree of variability, changes in fish populations resulting from habitat changes can be tough to separate from natural changes without repeated sampling of a large number of sites (George et al. 2021). Relatively stable juvenile coho salmon and age-1 or older populations of cutthroat trout, when averaged across watersheds, show that expected habitat changes resulting from the HCP and corresponding changes in salmonids may be identified. Basically, when numbers are stable between years and sites, there is an expectation that an increase or decrease from the established data is identifiable. If the numbers were more erratic, it would be difficult to separate any OESF wide increases in salmonids from yearly or site variations. The low juvenile coho salmonid densities in 2020 should continue to be monitored to determine if it is due to yearly variability or the start of a sustained decline. In addition, future analyses on streams with consistently high or low abundances (such as watershed 690) may provide important information for determining the factors causing both good and poor salmonid habitat.

The RVMP was first implemented in 2016 and is still in the early stages of monitoring. As monitoring continues we are better suited to distinguish changes in salmonid populations. However, this is made more difficult by the expected slow rate of long-term change. Modern forest management practices were developed to minimize the effects of forest harvest on streams and salmonids, and recovery from some of the impacts of historic logging practices are likely to take place over 100s of years (Martens et al. 2020). This means that any habitat and corresponding changes to salmonids are likely to be small amidst a background of naturally wide swings in salmonid numbers and a wide range of physical habitat among watersheds. The exact amount of time required to detect a change (if present) will be dependent on the combination of the amount of change in salmonid populations or habitat resulting from DNR management activities, the amount of year-to-year variation, and the amount of differences between the sites (Martens 2016). As a result, it was anticipated that many years of monitoring a relatively high number of sites would be required to separate both the spatial and temporal variation from any potential impacts of DNR management on salmonid populations.

To date the Bear Creek culvert removal has produced mixed results. First, there were no obvious changes in age-1 or older cutthroat trout after removal. However, there have been increases in age-0 cutthroat trout in reaches below and above the removed culvert. Since we are seeing this increase in both above and below the former culvert, we cannot say that this change is a result of the culvert removal. More data is needed to see if we will be able to identify a change relating to culvert removal. The last year of sampling is currently scheduled for 2021 and the potential for more sampling will be evaluated before sampling is scheduled to begin in 2022.

The lack of consistent coho salmon redd counts and relatively consistent numbers of juvenile coho salmon during summer electrofishing surveys could be attributed to two sources: 1) spawning above the 1,000 meter redd surveys and downstream movement after hatching or 2) upstream juvenile coho salmon movement from larger streams. In many of these streams, the 1,000 meter redd surveys make up all or the majority of anadromous coho salmon access. As such, most juvenile coho salmon in watersheds with low or no redds are more likely the result of juvenile fish moving upstream into these smaller watersheds from larger streams. This type of movement has been well documented and allows for habitat expansion beyond areas with coho salmon spawning (Kahler et al. 2001; Bramblett et al. 2002; Wigington et al 2006).

Clearwater River snorkel surveys have consistently found lower numbers of juvenile fish in Reach 3 (River kilometer 40 to 33) when compared to other reaches and has been identified as a potential place for steam restoration (Martens 2018). We are currently working with the Quinault Lead Entity to identify and prioritize restoration activities within the Clearwater Watershed and are promoting restoration within this reach. If habitat restoration occurs in this reach, the data collected from this program has potential to be used for evaluating the impact of restoration actions. This type of evaluation is uncommon but is needed to ensure that restoration actions are working and limited resources are not being wasted (Palmer et al. 2005).

As data from the RVMP continues to accumulate, we are constantly learning more about the status of salmonids and habitat across the OESF. This work has led to an ever-increasing number of publications. In 2020, the RVMP published a peer-reviewed paper that linked the age of riparian forests with levels of instream wood (which has been found to be important for salmonids; Martens et al. 2020). This paper hypothesized that instream wood levels and salmonids are not likely to recover until forest stands reach the old-growth stage of development (>200 years) or experience an increased amount of natural disturbance (e.g., windthrow, wildfire, landslides, stream erosion, or forest disease). In the paper we recommended that active restoration of riparian forest and stream be explored to speed up the development of old growth forest structure and provide relief against current low levels of instream wood. Publications from the RVMP include:

> 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), pp.673-690.
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> 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), pp.517-527.
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With the addition of four T3 Watershed Experiment watersheds using current DNR practices and several watersheds in the RVMP scheduled for VRH over the next few years (watersheds 157, 488, 544, 545, 568, 625, 642, 730, and 760), the OESF is set up for a large BACI study that can assess the impacts of DNR's riparian management. These 12 monitored VRH watersheds (watershed 545 is not sampled annually) can be compared with the four control watersheds in the T3 Watershed experiment and eight RVMP watersheds with no planned harvest over the next 4-10 years. This monitoring should give managers and stakeholders some of the most definitive information on the effects of current DNR practices and whether the HCP riparian conservation strategy, as implemented in the OESF, is meeting expectations.

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Appendix 1. USFWS 2020 Annual Bull Trout Permit Report

Washington Department of Natural Resources' Salmonid Validation Monitoring Program for the Olympic Experimental State Forest - 2020 Annual Report.

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

Introduction

Washington Department of Natural Resources (DNR) conducted fish sampling across the Olympic Experimental State Forest (OESF) in 2020 under Section 10, Endangered Species Act Permit No. TE-64608B-1. The OESF contains areas that are protected in Unit 1 of U.S. Fish and Wildlife Services' Critical Habitat for bull trout (*Salvelinus confluentus*), though the exact extent of bull trout across the OESF is largely unknown. Fish sampling was conducted under DNR's salmonid validation monitoring program. The salmonid validation monitoring program is described in the 2016 study plan (http://file.dnr.wa.gov/publications/lm_oesf_riparian_monitor_salmonids_2016_plan.pdf) and follows the guidance from the state's Habitat Conservation Plan (HCP). The validation monitoring program will be used to assess the HCP's riparian conservation strategy in the OESF by developing cause and effect relationships between DNR management activities, habitat, and salmonid populations. In 2020 a new study was in initiated to assess the use of current and alternative buffer configurations on streams. This study added 16 new streams to the existing sampling design (http://depts.washington.edu/sefsonrc/index.php/oesf-t3-experiment/).

Methods

In 2020, sampling was attempted 57 in smaller headwater watersheds of the OESF (Figure 1), which included 8 reference sites on the Olympic National Forest and Olympic National Park. The watersheds 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).

Backpack electrofishing was conducted to estimate fish densities at the reach level using multiple-pass removal electrofishing. Multiple-pass removal closely followed the methods of Martens and Connolly (2014) with all sampling occurring from mid-July through October. In addition, a snorkel survey was conducted over a 12 km section of the upper Clearwater River in September (Figure 1).

Results

During the 2020 field season, no bull trout were encountered.

Discussion

No bull trout were encountered from 2015-2020, 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 were not present in the areas snorkeled in 2016-2020. This may be due to low abundance, detection efficiency, or timing of our surveys. In 2021, we plan to resample the 20 annual watersheds, 20 watersheds in the even-year rotation of watersheds, 16 watersheds with 20 reach and 12 pour point locations in the T3 watershed experiment, and the 12 km section of the upper Clearwater River.

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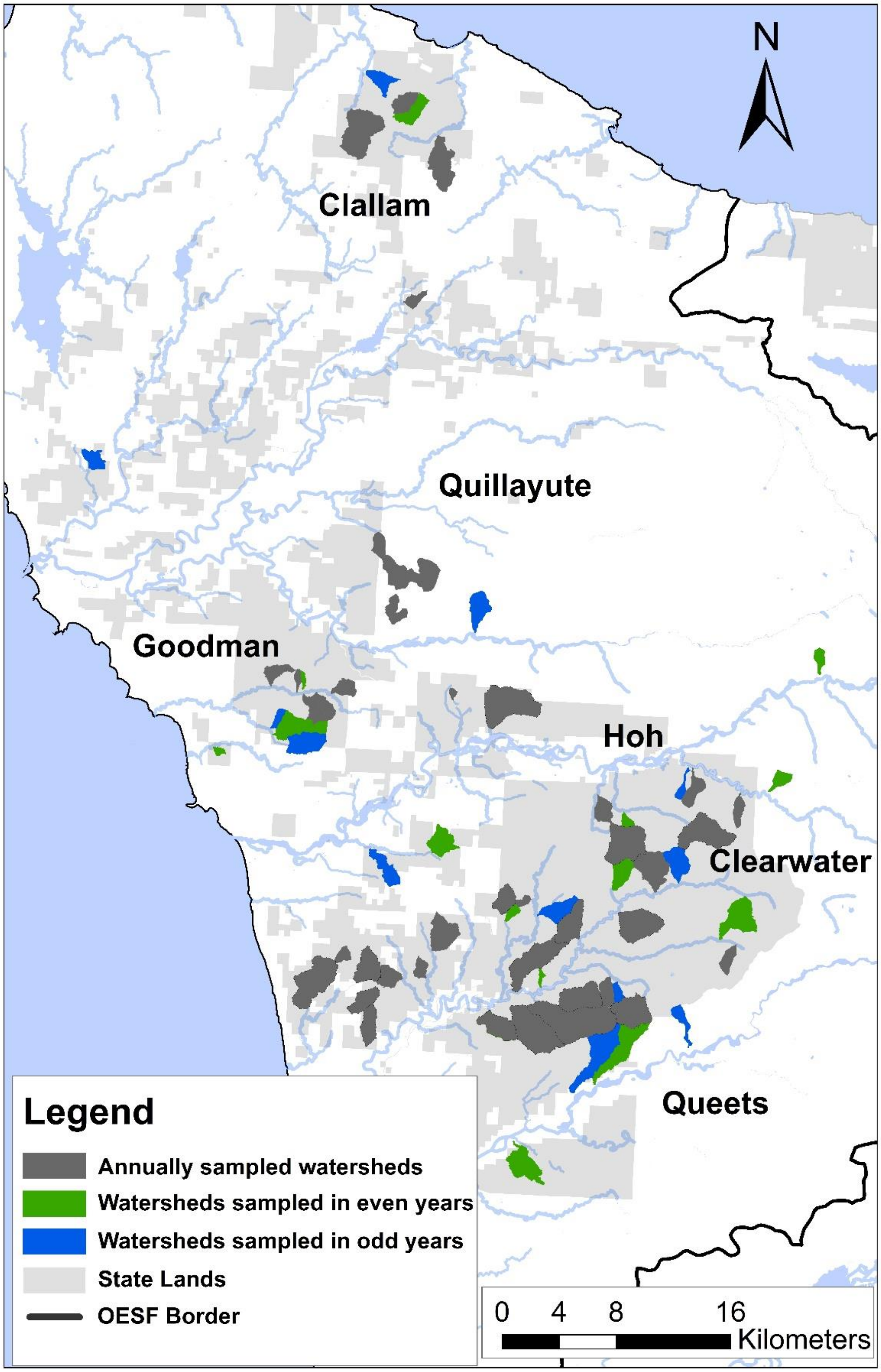

Figure 1. Map of snorkeling sites sampled in the 2020 field season across the Olympic Experimental State Forest.

Appendix Table 1. Watershed locations and fish species encountered during Washington Department of Natural Resources' fish sampling on the OESF in 2020. 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; UNK = DNR did not sample; and None = no fish were collected at site.

Basin	Latitude	Longitude	Fish Species
157	48.22385192	-124.2948482	CTT, TRT
158	48.223841	-124.29488	CTT, TRT
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
488	47.94543555	-124.311738	COH, CTT, TRT, LMP, SCP
542	47.84627504	-124.4061643	COH, CTT, SCP
544	47.8429896	-124.3812407	COH, CTT, SCP
545	47.844564	-124.376208	CTT, SCP
566	47.846652	-124.233881	TRT, SCP, LMP
567	47.84378017	-124.3631071	COH, CTT, TRT, LMP, SCP
568	47.84201489	-124.3753559	COH, CTT, TRT, LMP, SCP
584	47.815533	-124.402262	COH, TRT, LMP, SCP
605	47.79513	-124.017193	COH, SCP
625	47.80673077	-124.0082626	COH, CTT, RBT, TRT, SCP
639	47.79260891	-123.9626384	CTT, RBT, TRT
642	47.78772853	-124.0953962	TRT, LMP, SCP
658	47.746714	-124.248597	COH, LMP, SCP
690	47.742588	-124.04108	CTT, RBT, TRT
694	47.728741	-124.078429	CTT, TRT
716	47.727889	-123.953892	CTT, TRT
717	47.71952839	-124.1531565	COH, CTT, TRT, SCP
724	47.705386	-124.176911	CTT, TRT
730	47.695933	-124.234346	COH, CTT, RBT, TRT, LMP, SCP
737	47.6996	-123.975663	CTT, TRT
744	47.676491	-124.319234	CTT, TRT, SCP
760	47.672657	-124.252894	COH, CTT, TRT, SCP
763	47.66614737	-124.2697792	COH, CTT, TRT, SCP
767	47.66427	-124.140339	CTT, TRT
790	47.648024	-124.1871	COH, CTT, RBT, TRT, SCP
797	47.604905	-124.087034	COH, CTT, RBT, TRT, LMP, SCP
804	47.63644366	-124.1426444	COH, CTT, TRT, SCP

Bear Creek	48.142	-124.326	CTT, TRT, SCP
FS-4	47.913516	-124.301256	COH, CTT, RBT, TRT, SCP
FS-5	47.924546	-124.280198	CTT, TRT, SCP
FS-6	47.914691	-124.287959	COH, CTT, TRT, SCP
FS-7	47.907842	-124.292975	CTT, TRT
FS-8	47.898843	-124.282767	CTT, TRT, SCP
FS-9	47.924021	-124.252572	CTT, TRT, SCP
Hoh	47.869163	-123.892203	No Fish
SFHoh	47.794138	-123.937157	CTT, TRT
Aa	47.643166	-124.183549	CTT
Ac	47.6616	-124.1152667	CTT, TRT, SCP
Ap	47.63793333	-124.1359333	COH, CTT, RBT, TRT, SCP
Az	47.64249	-124.122	CTT, TRT, SCP
Ba	47.67301667	-124.1655333	COH, CTT, TRT, SCP
Bc	47.830166	-124.1941	COH, CTT, RBT, TRT, SCP
Bp	47.714	-124.179	CTT, TRT, SCP
Bz	47 41.936	124 06.838	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, RBT, TRT, SCP
Cz	47.709	-124.059	COH, CTT, RBT, TRT, SCP
Da	47.64683	-124.31185	COH, CTT, RBT, TRT, LMP, SCP
Dc	47.66763	-124.3106333	COH, CTT, RBT, TRT, LMP, SCP
Dp	47.64298333	-124.2977833	CTT, RBT, TRT, SCP
Dz	47.648249	-124.3575	COH, CTT, TRT, LMP, SCP