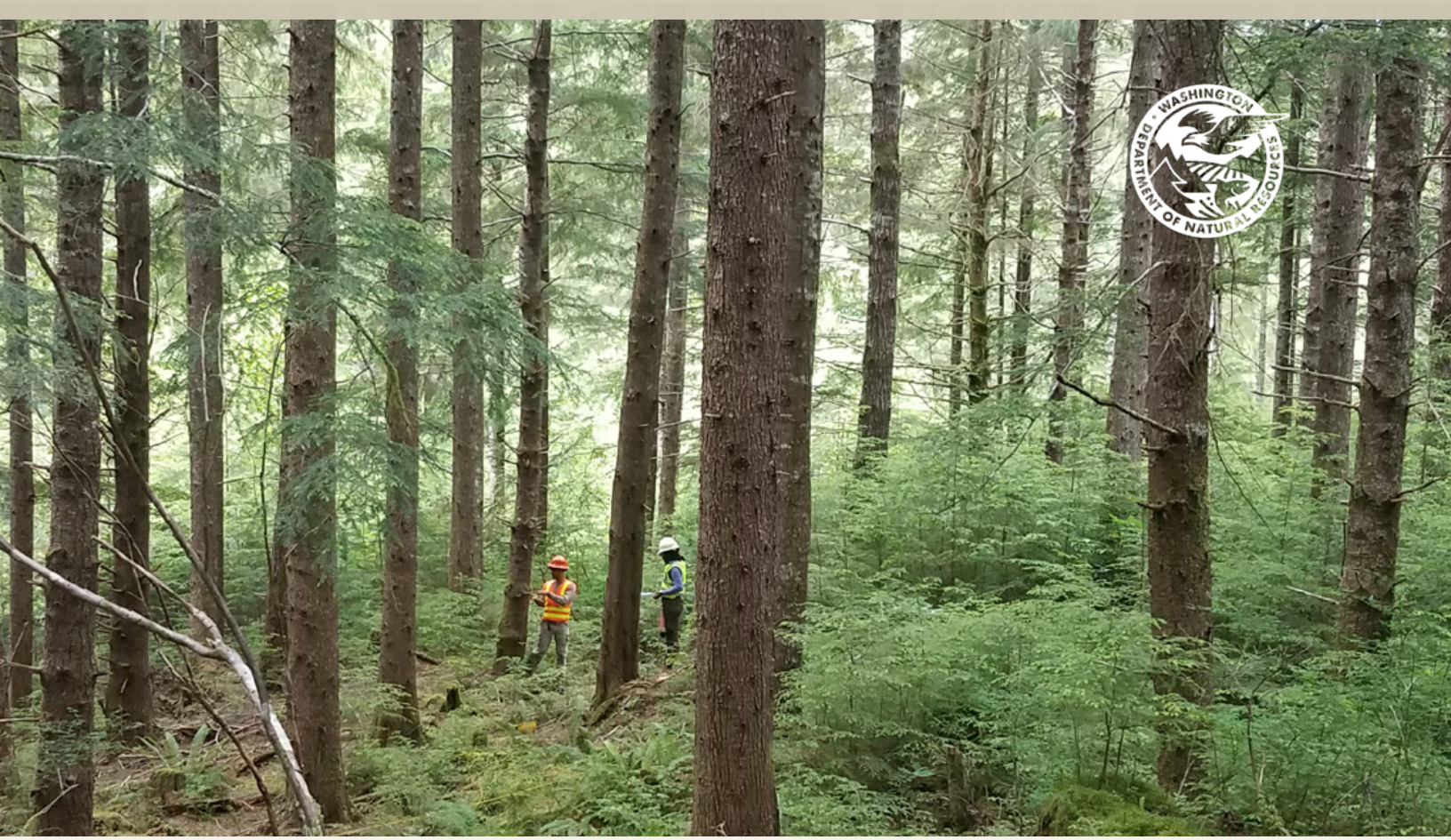


2023 Olympic Experimental State Forest

Science Conference

Linking Science to Natural Resource Management




May 3, 2023, 8:30 a.m. to 4:30 p.m. | Rainforest Arts Center, Forks, WA

Contents

About This Conference

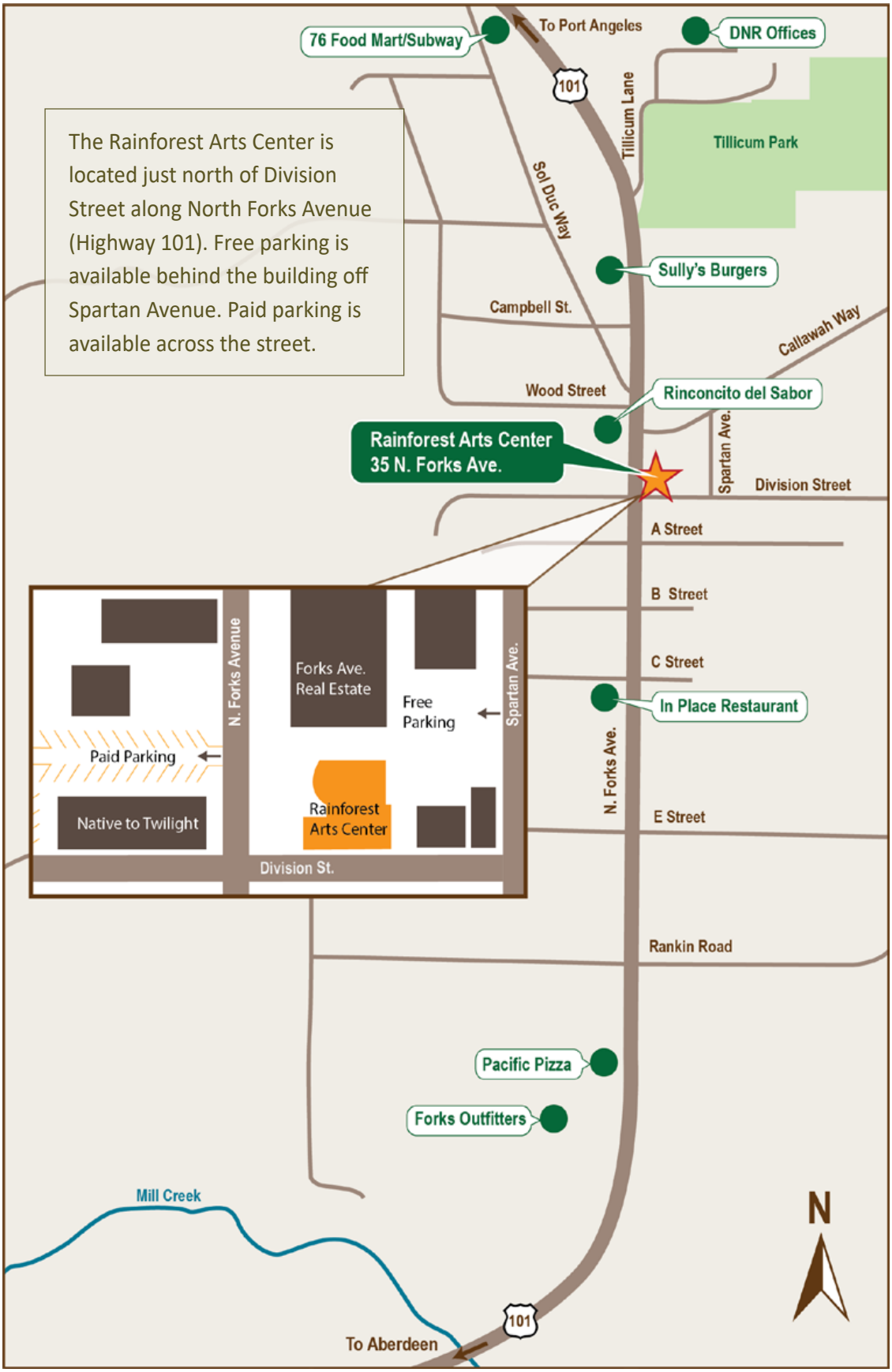
Welcome to the sixth annual Olympic Experimental State Forest (OESF) science conference. The 2023 OESF Science Conference is sponsored and hosted by the Washington State Department of Natural Resources (DNR).

The purpose of this conference is to communicate the results of research and monitoring activities taking place in the OESF and their relevance to land management uncertainties faced by DNR and other land managers. We hope the conference will encourage dialog among researchers, natural resource specialists, managers, and the public about the scientific foundations of land management.

2023 DNR Conference Committee:

Teodora Minkova
Tracy Petroske
Cathy Chauvin
Mark Enty
Emily Gardner

Forks Map


The Rainforest Arts Center is located just north of Division Street along North Forks Avenue (Highway 101). Free parking is available behind the building off Spartan Avenue. Paid parking is available across the street.
76 Food Mart/Subway
To Port Angeles
101
DNR Offices
Tillicum Lane
Tillicum Park
Sol Duc Way
Sully's Burgers
Campbell St.
Callawah Way
Wood Street
Rinconcito del Sabor
Rainforest Arts Center
35 N. Forks Ave.
Spartan Ave.
Division Street
A Street
B Street
C Street
In Place Restaurant
N. Forks Ave.
E Street
Rankin Road
Pacific Pizza
Forks Outfitters
Mill Creek
To Aberdeen
N
N. Forks Avenue
Forks Ave. Real Estate
Free Parking
Spartan Ave.
Paid Parking
Native to Twilight
Rainforest Arts Center
Division St.

Conference Agenda

8:00 – 8:30 am: Registration, information tables, refreshments, and socializing

8:30 – 8:40 am: Welcome from Teodora Minkova, OESF Research Program Manager

8:40 – 9:50 am: Oral Presentation Session 1

- **Status and Trends of Riparian and Aquatic Habitat in the OESF: Recent Findings | Warren Devine,** DNR
- **Steelhead and Salmonid Habitat Within the Olympic Experimental State Forest | Kyle Martens**, DNR
- **The Aquatic Trophic Productivity Model: Modeling Stream Food Web Response to Riparian Treatments | Emily Whitney,** University of Alaska Southeast

9:50 – 10:50 am: Break with student and DNR posters, information tables, and refreshments

- **Addressing the Challenge of Regenerating Western Redcedar | Rose Cornwell,** University of Washington
- **Baseline Analysis of *Salmonidae* Diet as it Relates to Ecosystem Conditions Within the Type 3 Watershed Experiment | Olivia Eickerman,** Whitman College
- **Determination of Optimal and Suitable Habitat Criteria for Coho Salmon on the Olympic Peninsula | Emily Anderson,** University of Washington
- **Juvenile Coho and Redd Density Across the Olympic Experimental State Forest | Emily Gardner,** DNR
- **A History of Heavy Harvesting: Logging through the Decades in the Type 3 Watersheds | Karena Iliakis**, University of Washington
- **Acoustic Indices Characterize Avian Community Biodiversity and Activity | Gio Jacuzzi,** University of Washington
- **Comparing Harvesting Costs of Two Machine Settings: A Cost Analysis Study | Puspa Raj Joshi**, Oregon State University
- **Simulating Cash Flows From Forest Management Regimes: A Web Application for Easily Comparing the Financial Trade-offs Between Different Management Activities and Scenarios | Matthew Schmidt,** University of Washington
- **Stream Algae Biomass Associations with Environmental Variables in a Temperate Rainforest | Elsa Toskey**, Washington State University

10:50 – 12:30 pm: Oral Presentation Session 2

- **Using Drone LIDAR to Characterize Stand Structure and Species Composition | Robert McGaughey,** US Forest Service
- **Challenges to Predict Forest Growth for the Type 3 Prescriptions | Jeffrey Comnick,** University of Washington
- **Overstory Growth and Understory Regeneration at the Long-term Ecosystem Productivity Study in Sappho, WA | Courtney Bobsin,** University of Washington
- **Red Alder as an Agent of Change on the Olympic Peninsula | Bernard Bormann,** University of Washington

12:30 – 1:30 pm: Lunch (on your own) and information tables

1:30 – 2:40 pm: Panel discussion on planning and implementing the Type 3 Watershed Experiment

2:40 – 2:45 pm: Closing remarks, Teodora Minkova

2:45 – 3:00 pm: Travel to Calawah River Park

3:00 – 4:30 pm: Demonstration of less-familiar monitoring equipment at Calawah River Park

4:30 pm: Adjourn

About the Olympic Experimental State Forest (OESF) Research and Monitoring Program

Located on the western Olympic Peninsula, the Olympic Experimental State Forest (OESF) is a working forest and a living laboratory. Across 270,000 acres (110,000 hectares) of state trust lands, the Washington State Department of Natural Resources (DNR) produces revenue for trust beneficiaries such as counties and public schools, primarily through timber harvest. DNR also provides habitat for threatened and endangered species and healthy streams for salmon and other aquatic species.

OESF Mission

DNR's mission in the OESF is to learn how to integrate revenue production and ecological values across the landscape, and to deliver this knowledge to DNR managers for continuous improvement of land management practices. DNR achieves this mission through landscape-level planning, a variety of silvicultural techniques, research and monitoring, adaptive management, effective communication, and information management.

DNR's mission, vision, management strategies, and the activities and priorities of the research and monitoring program are described in the 2016 OESF Forest Land Plan and based on DNR's *State Trust Lands Habitat Conservation Plan (HCP)* adopted in 1997. For more information on the OESF, visit http://www.dnr.wa.gov/oesf/.

Research and Monitoring Projects

The majority of projects that DNR and its research partners undertake in the OESF are focused on silvicultural techniques, wildlife habitat development, and riparian and aquatic monitoring. Following are a few examples.

- **Status and Trends Monitoring of Riparian and Aquatic Habitat:** Evaluates habitat response to the OESF riparian conservation strategy and provides data for riparian validation monitoring.
- **Riparian Validation Monitoring:** Evaluates fish response to the OESF riparian conservation strategy. Assesses cause-effect relationships between land management, habitat, and salmonid populations.
- **Type 3 Watershed Experiment:** Operational-scale management experiment testing alternative upland and riparian silvicultural prescriptions. The goal is to expand the DNR forest management toolbox. Implemented through broad research partnerships and learning-based collaboration with stakeholders.

Information on these and other DNR-led and collaborative projects, as well as studies funded and implemented by external parties in the OESF, is available on DNR's website.

Field sampling stream habitat

Stakeholder field tour for the Type 3 Watershed Experiment

Research Partnerships and Information Management

Formal and informal research collaborations are maintained with universities, government agencies, and non-profit organizations. The program develops and maintains databases for DNR-funded research projects. All data and metadata are available upon request.

Adaptive Management Process

Adaptive management is a way to manage natural resources when knowledge is incomplete about ecosystem functions or how management affects those functions. DNR follows an administrative procedure for a formal, step-by-step process, by which DNR uses scientific information to improve land management.

Flowchart illustrating the OESF adaptive management process

Outreach and Communication

In addition to the annual OESF Science Conference, DNR's outreach efforts include The Learning Forest, which is a joint publication of DNR and University of Washington's Olympic Natural Resources Center. Its purpose is to share scientific knowledge on sustainable land management in the OESF and beyond. The newsletter has been published twice a year since 2017. All issues available on DNR's website.
Scientific publications in peer-reviewed journals and project reports are produced continuously. All are available on DNR's website. Program staff gives presentations, seminars, workshops and field tours.

Education

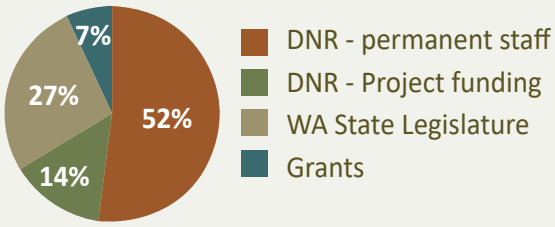
The program offers a variety of educational opportunities for students, educators, stakeholders, researchers, and volunteers. These opportunities include student capstone projects, internships, research advisory, lectures, seminars, and field tours.

University of Washington students on an OESF field tour

Funding Sources

The program is funded primarily by DNR with additional funding for specific projects from the Washington State Legislature and from research grants. The program's capacity increases substantially through research partnerships with universities, federal and state research organizations, and others.

Fiscal years 2021 and 2022 funding sources:



In-kind contributions from research partners:

- Scientific expertise
- Equipment
- Fieldwork assistance
- Consultation and coordination

OESF Program Team

Teodora Minkova
Program Lead

Kyle Martens
Fish Biologist

Warren Devine
Research Scientist

Emily Gardner
Scientific Technician

Tracy Petroske
Research Coordinator

Cathy Chauvin
Newsletter Editor

Presentation Abstracts

Oral Presentations Session 1

Status and Trends of Riparian and Aquatic Habitat in the OESF: Recent Findings

Warren D. Devine[1], Teodora V. Minkova[1], Kyle D. Martens[1], Alex Foster[2]

[1]Washington State Department of Natural Resources

[2]U.S. Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory

In 2013, the Washington State Department of Natural Resources (DNR) initiated a program to monitor the status and trends of riparian and aquatic habitat in small fish-bearing streams in the Olympic Experimental State Forest (OESF). The program's purpose is to assess habitat conditions produced by DNR's riparian management under the OESF Forest Land Plan, which is in turn guided by the riparian conservation strategy of the *State Trust Lands Habitat Conservation Plan*. Monitoring is conducted in 50 DNR-managed watersheds and in 12 reference watersheds that have never been harvested. Nine aquatic and riparian habitat indicators are sampled at the reach level near the outlet of each watershed: stream temperature, stream shade, instream wood, channel morphology, channel substrate, habitat units, riparian forest vegetation, and—for 10 of the 62 streams—stream flow and riparian microclimate. Since the last major project report, additional analyses have been conducted on: (1) stream temperature response to the June 2021 heatwave, (2) factors influencing riparian microclimate, and (3) links between in-stream wood and pool formation. These new findings will be presented in the context of what we have already learned from this monitoring project.

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Steelhead and Salmonid Habitat Within the Olympic Experimental State Forest

Kyle D. Martens[1], Warren D. Devine[1], Teodora V. Minkova[1]

[1]Washington State Department of Natural Resources

In February 2023, NOAA Fisheries determined that a petition to list Olympic Peninsula Steelhead under the Endangered Species Act may be warranted and initiated a 90-day review. As part of the review, Washington Department of Natural Resources (DNR) was asked to present data from research and monitoring in the Olympic Experimental State Forest (OESF). DNR monitors steelhead habitat and populations within the OESF through three programs: Status and Trends Monitoring of Riparian and Aquatic Habitat; Riparian Validation Monitoring, which assesses the cause and effect relationships between land management under the *State Trust Lands Habitat Conservation Plan* (HCP) and salmonids; and the Type 3 Watershed Experiment, which compares current and alternative riparian management associated with forest harvests. In this presentation, we will first discuss the distribution and trends of steelhead within the OESF. Next, we will explore how historic forest harvests continue to impact salmonid habitat, providing exam-

ples from environmental indicators such as stream temperature, canopy cover, instream wood, and pools by comparing both recent trends and conditions prior to the adoption of the HCP. Finally, we will provide information on DNR's fish passage barrier removal efforts and recent findings from a study of salmonid populations before and after the removal of a partial fish passage barrier culvert (considered a 33 percent passable barrier under Washington Department of Fish and Wildlife guidelines).

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The Aquatic Trophic Productivity Model: Modeling Stream Food Web Response to Riparian Treatments

Emily Whitney[1], Ryan J. Bellmore[2], Joe Benjamin[3], Teodora V. Minkova[4], Kyle D. Martens[4], Warren D. Devine[4]

[1] University of Alaska Southeast, Alaska Coastal Rainforest Center

[2]U.S. Forest Service

[3]U.S. Geological Survey

[4]Washington State Department of Natural Resources

Alongside efforts to monitor the impacts of a harvest experiment within the Olympic Experimental State Forest, we are applying a stream food web model to assess potential impacts of different riparian treatments. The Aquatic Trophic Productivity (ATP) model is a stream food web model that links the dynamics of the food web to the physical and hydraulic conditions of the stream, as well as the composition of the riparian habitat. This modeling approach can provide insight about how changes to environmental conditions affect fish productivity, both in the short- and long-term, which can be challenging to measure directly. Using data collected by the Washington Department of Natural Resources and collaborators, we parameterized the ATP model for a site representative of the conditions within the experimental area. We then manipulated these inputs to simulate five different riparian treatments: no-action, a 30 meter buffer, light thinning with gaps and in-stream wood, variable buffer widths, and alder rotations under thinned conifers. The results of these simulations can generate hypotheses on the short and long-term responses to these management strategies and help identify conditions under which the stream food web may be sensitive to changes.

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Oral Presentations Session 2

Using Drone LIDAR to Characterize Stand Structure and Species Composition

Robert J. McGaughey[1]

[1]U.S. Forest Service, Pacific Northwest Research Station

Light detection and Ranging (LIDAR) data have revolutionized the way we study topographic and environmental processes. LIDAR sensors installed on remotely piloted or autonomous aircraft (UAS or drones) offer the ability to cost-effectively collect data over small areas at frequent intervals. The resulting high-density data facilitates the study of forest operations and ecological processes at the scale of individual trees, while still providing the ability to summarize conditions over hundreds of acres.

High-density drone LIDAR data were collected over several study sites on the Olympic Peninsula. These data provide overall information such as canopy cover, the distribution of gap sizes and tree clumps, and the distribution of tree heights, along with information for individual trees including height, branch and crown details, overall crown size and shape, stem form, and potentially species. Initial evaluations of the drone LIDAR data have provided information that describes stand conditions and the attributes of individual, overstory trees. Additional work is focused on species identification using the point cloud data; determining more accurate stem locations; analyses of gap size; relationships between gap size, overstory species, and understory species composition; and using pre- and post-treatment data to measure treatment effects.

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Challenges to Predict Forest Growth for the Type 3 Prescriptions

Jeffrey Comnick[1]

[1]University of Washington, School of Environmental and Forest Sciences, Natural Resource Spatial Informatics Group

Novel silvicultural treatments proposed for the Type 3 Watershed Experiment pose challenges for existing forest growth and yield models. Treatments with a strong spatial component are difficult to project in commonly used distance-independent models, such as the Forest Vegetation Simulator. Uncommon species mixes not represented in datasets used to construct a growth model are also difficult to project with confidence. Despite these challenges, growth simulations are necessary for two reasons. First, the simulations represent quantitative hypotheses of how forest stands will develop following treatments. These hypotheses can be tested in future years by comparing projections against field measurements. Second, the simulations allow treatments to be compared to standard Washington State Department of Natural Resources (DNR) treatments within a landscape planning context. This requires growth model assumptions to be consistent with existing DNR simulations. We propose to model spatially heterogenous treatments in the Forest Vegetation Simulator by representing a stand as a grid of plots. Between growth cycles, a solar radiation model is run on a canopy surface raster derived from the grid. Custom calibra-

tions are developed using solar radiation for each grid cell to adjust growth and account for clumps and gaps within a stand. We also present key assumptions and compare results for polyculture treatments.

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Overstory Growth and Understory Regeneration at the Long-term Ecosystem Productivity Study in Sappho, WA

Courtney R. Bobsin[1], Bernard T. Bormann[1]

[1]University of Washington, Olympic Natural Resources Center

In the Pacific Northwest, short rotations of Douglas-fir monocultures is a common management approach on public and private timberlands. Other species, such as red alder, are often removed from stands to prevent competition. However, alder can have numerous benefits, in part due to its ability to fix atmospheric N_2. In a long-term ecosystem productivity study, an early seral treatment with mixed alder and Douglas-fir was compared to a pure Douglas-fir plantation treatment. This study evaluates the first 25 years of stand development, understory growth, seedling recruitment, and alder effects across silviculture treatments and site differences. Seven years after implementation, there was little difference between treatments. Site-specific differences were evident, with early seral units in one block having higher biomass, higher basal area, and lower mortality of Douglas-fir and red alder seedlings. These trends did not continue, and there was little difference in understory and overstory between treatments and blocks after this time. Salal, a dominating and recalcitrant understory species in the region, had a negative relationship with alder, where areas of high alder led to less salal cover. Future monitoring will allow us to have a longer-term picture of changes, treatment impacts, and potential site-specific effects going forward.

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Red Alder as an Agent of Change on the Olympic Peninsula

Bernard T. Bormann[1]

[1]University of Washington, Olympic Natural Resources Center

Forest management in western Washington has a distinct Douglas-fir bias. Stud mills prefer it, it grows well on many sites after regeneration harvests, and as a consequence, much is known about it relative to other northwest conifers and hardwoods. Less uncertainty is Douglas-fir's greatest virtue, but often, it seems to constrain the management toolbox. One way to expand that toolbox is to learn more by trying to grow other species like hemlock and alder (but also cedar, spruce, maple, …). The Type 3 Watershed Experiment chose to study alder in three of its experimental prescriptions: alder rotations in the ripar-

ian zone (under widely thinned conifers), upland plantings of mixed alder and cedar, and possibly natural alder regeneration in the complex early seral prescription. I will review some of the reasons why we did this, driven by our interest in both environment and community wellbeing. I will also present some preliminary findings about growing alder for two other purposes not considered in the Type 3 experiment: alder strips as fire breaks, and alder as a way to more quickly sequester carbon. Finding alternatives to wall-to-wall Douglas-fir might help expand the forest management toolbox—alder may be showing us the way.

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Poster Abstracts

Addressing the Challenge of Regenerating Western Redcedar

Rose Cornwell[1]

[1]University of Washington

Western redcedar (*Thuja Plicata*) is highly susceptible to ungulate browse compared to other conifer species, resulting in structural damage and low survivorship of seedlings. This sub-study was produced through learning-based collaboration with the Cedar Browse Learning Group (CBLG), a group organized to address concerns over regenerating western redcedar under browse pressure on the Olympic Peninsula. The CBLG played an integral role in defining research objectives, sharing knowledge, and designing silvicultural treatments to test the effectiveness of browse deterrent methods.

As defined by the CBLG, the objectives of this 33-acre substudy nestled within the Type 3 Watershed Experiment are: 1) Utilize learning based collaboration to better understand ways of regenerating western redcedar, and 2) Test different silvicultural treatments designed to prevent ungulate browsing and produce replicable, economically feasible results for regeneration at an operational scale. The treatments proposed by the CBLG include plastic mesh fencing; Trico PRO repellent; co-planting sitka spruce (*Picea sitchensis*) and western redcedar in the same hole; solid and mesh individual tubing at varying heights; and a no-action control. Treatments will be tested across four units in upland watersheds within the boundaries of the Type 3 Watershed Experiment in the Olympic Experimental State Forest.

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Baseline Analysis of *Salmonidae* Diet as it Relates to Ecosystem Conditions Within the Type 3 Watershed Experiment

Olivia Eickerman[1], Peter Kiffney[2]

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[2]NOAA, National Marine Fisheries Service, Northwest Fisheries Science Center

This poster will present an analysis of pre-harvest data collected on stream fish diets (juvenile coho, salmon, trout, and sculpin) for the Type 3 Watershed Experiment. Our results show no among-logging treatment difference in abiotic variables, including percent riparian shading ($p = 0.58$), stream temperature ($p = 0.38$), nitrogen concentrations in stream water ($p = 0.27$), discharge ($p = 0.31$), and the amount of in-stream wood debris ($p = 0.88$). Our analysis of between-year differences in fish diet (corrected for number of invertebrates per fish) showed no significant difference ($p = 0.12$), allowing us to combine years before statistical analysis (coho n= 57; sculpin n =101; rainbow trout n= 9; cutthroat trout n=116; juvenile trout n= 102). An among-species comparison of diet (coho, sculpin, rainbow trout, cutthroat trout, and juvenile trout) showed significant differences ($p < 0.001$). Comparing diet to assigned logging treatment also showed a significant difference ($p < 0.001$). These diet data establish baseline conditions to compare with post-logging diets.

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Determination of Optimal and Suitable Habitat Criteria for Coho Salmon on the Olympic Peninsula

Emily Anderson[1], Kyle D. Martens[2]

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[2]Washington State Department of Natural Resources

Within the Olympic Experimental State Forest (OESF), Coho salmon (*Oncorhynchus kisutch*) and habitat data were collected from 74 sites: ≥100-meter long reaches of small fish-bearing streams . This data was utilized to develop criteria for optimal and suitable habitat of coho salmon. Habitat suitability criteria were determined for the following variables: in-stream wood, canopy closure, stream temperature, and stream gradient. Our analysis found that coho salmon will optimally occupy sites that have a stream gradient between 1.8 and 4.6 percent, water temperatures between 14.08 and 15.26 °C, canopy closure between 91.6 and 92.9 percent, and instream wood density between 0.18 and 0.36 pieces per meter of stream length. Suitable sites were found to have a gradient between 0.9 and 7.5 percent, temperatures between 12.97 and 16.42 °C, canopy closure between 88.5 and 93.8 percent, and wood density between 0.09 and 0.56 per meter of stream length. Following a chi-squared analysis, only the optimal canopy closure and the suitable stream gradient ranges were found to be statistically significant, indicating that all other ranges identified in my analysis may not represent optimal and suitable habitat for coho salmon.

Better defining these ranges and the relative importance of coho salmon habitat indicators could provide more meaningful results that would better inform potential management or restoration decisions.

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Juvenile Coho and Redd Density Across the Olympic Experimental State Forest

Emily Gardner[1], Kyle D. Martens[1]

[1]Washington State Department of Natural Resources

Redd surveys and summer juvenile counts for coho salmon have been conducted by the Washington State Department of Natural Resources across the Olympic Experimental State Forest (OESF) consistently since 2016. Relationships between redd density and juvenile numbers can be complex and are often influenced by many outside factors. Here, we examine juvenile coho counts in the OESF in relation to annual redd density. We also compare OESF annual redd counts to escapement numbers from 2016-2020 released by the Washington Department of Fish and Wildlife. Redd surveys were conducted by surveying during spawning (November – January) from the stream mouth to 1000 meters upstream. Juvenile counts were obtained through multiple-pass backpack electroshocking each summer season (July – October) within a designated 100-meter stream reach. One stream within the 21 monitored basins consistently showed high redd numbers and a relationship between redd density and juvenile numbers, suggesting high spawner return and limited juvenile migration from outside sources. Overall, juvenile numbers across monitored streams in the OESF are likely influenced by outside spawners and juvenile dispersal.

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A History of Heavy Harvesting: Logging through the Decades in the Type 3 Watersheds

Karena Illiakis[1], Teodora V. Minkova[2], Warren D. Devine[2]

[1]University of Washington, Program on the Environment

[2]Washington State Department of Natural Resources

Washington State's Olympic Peninsula is known for both its lush environment as well as its importance to the timber industry, so understanding how the pattern of logging has changed over time is imperative for understanding how ecosystems recover after such disturbances. The purpose of this research is to create a comprehensive spatial account of management disturbances in the 20,386-acre study area of the Type 3 Watershed Experiment, with a focus on creating a GIS layer of timber harvest polygons from the earliest harvests in the 1950s through 2022. Methods include an inventory of available data sources, such as timber auction notices and historical imagery; the georeferencing of aerial imagery; and a translation of the

data into GIS mapping software. Results from this work show that most harvests occurred in the 20-year period between 1970 and 1990, with the most active 5-year period being 1975 to 1979, when 4,242 acres were harvested. Results also show a sharp decline in harvests after 1995. By having this data available, researchers who are working to understand ecosystem dynamics post-harvest will be able to connect the current conditions and the Type 3 treatment responses to historical events, and thus better predict how the novel prescriptions of the Type 3 study may affect the environment.

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Acoustic Indices Characterize Avian Community Biodiversity and Activity

Giordano Jacuzzi[1], Julian Olden[1], Teodora V. Minkova[2], Lauren Kuehne[3], Daniel Donato[2]

[1] University of Washington, College of the Environment, School of Aquatic and Fisheries Sciences

[2]Washington State Department of Natural Resources

[3]Omfishient Consulting

Forests around the world face unprecedented impacts from land-use conversion, creating an urgent need to rapidly evaluate the effects of forestry practices on wildlife. Acoustic monitoring is a powerful and cost-effective approach to assess the consequences of these impacts on sonant animals by revealing changes in community composition and activity across space and time. However, traditional methods for bio-acoustic species identification can be time and resource intensive, severely limiting this approach at scale.

Acoustic indices offer an efficient alternative to rapidly characterize communities by quantifying the "soundscape" with statistics that summarize particular aspects of the structure and distribution of acoustic energy, with the aim of extracting meaningful ecological information. Mirroring ecological diversity indices, alpha-acoustic indices are positively correlated with local biodiversity, while beta-acoustic indices reflect inter-site diversity.

Here we use acoustic indices to quantify and characterize vocalizations of avian species in the Olympic Experimental State Forest, providing insight into patterns of community composition and vocal activity along a gradient of developmental stages, including previously-logged stands. Preliminary results suggest that acoustic indices may facilitate the monitoring and evaluation of habitat function and biodiversity assessment at local, ecosystem, and landscape scales over long periods of time.

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Comparing Harvesting Costs of Two Machine Settings: A Cost Analysis Study

Puspa Raj Joshi[1], Woodam Chung[1]

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Yarding cost is a significant factor that impacts the overall harvesting cost of timber. In this study, conducted in Olympic Experimental State Forest, we compare the harvesting system cost for two different yarding systems: the Berger C-19 yarder, and the Komatsu PC 300 yarder. The system cost for the Berger C-19 yarder system is estimated to be $273.87/million board foot (MBF), whereas the system cost for the Komatsu PC 300 yarder system is $233.67/MBF. The findings suggest that the Komatsu PC 300 yarder system is more cost-effective than the Berger C-19 yarder system.

The yarding cost is affected by the number of choker setters employed in the harvesting process. The higher the number of choker setters, the higher the harvesting cost. Thus, it is crucial to optimize the number of choker setters to minimize the yarding cost. This study provides valuable insights into the optimal number of choker setters that can be employed in the harvesting process to achieve the lowest yarding cost.

The results of this study can be useful for forestry companies, timberland owners, and harvesting contractors in making informed decisions about the choice of yarding system and the number of choker setters to employ. By selecting the most cost-effective yarding system and optimizing the number of choker setters, forestry companies can significantly reduce their harvesting costs and improve their profitability.

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Simulating Cash Flows From Forest Management Regimes: A Web Application for Easily Comparing the Financial Trade-offs Between Different Management Activities and Scenarios

Matthew Schmidt[1], Sandor Toth[1]

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We developed a tool and accompanying web application to simulate cash flows from forest management activities, and to assist forest landowners in western Washington in determining the financial trade-offs between various management scenarios. We are using this tool to asses the financial trade-offs of the novel treatment regimes developed for the Type 3 Watershed Experiment in the Olympic Experimental State Forest. We seek to determine if, and under what economic and growth conditions, it would be optimal for trust beneficiaries to choose these novel treatment options over the Department of Natural Resources' standard harvest and silviculture activities. The web application remains under development and we are looking for potential beta testers to help us improve this product before we release it to the public.

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Stream Algae Biomass Associations with Environmental Variables in a Temperate Rainforest

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Stream algae, including benthic algae and autotrophic seston, are important bases of stream food webs, and several different environmental factors may influence their biomass. We explored how benthic algae and autotrophic seston biomass (using Chlorophyll-a as a proxy for algal biomass) were associated with stream temperature, channel width, canopy cover, stream cardinal orientation, benthic macroinvertebrate abundance, salmonid biomass, and water velocity in 16 small, fish-bearing streams in the temperate rainforest of the Olympic Peninsula in Washington State in the summer of 2020. We performed a mixed-effects regression analysis of extracted chlorophyll a (Chl-a) and then used model averaging to determine the most relevant algal-environmental associations for benthic algae and autotrophic seston separately. We found that benthic algae Chl-a concentration increased significantly with stream temperature and decreased significantly with water velocity. For autotrophic seston, we found that Chl-a concentration increased significantly with benthic macroinvertebrate abundance and stream temperature and decreased significantly with channel width and the interaction between benthic macroinvertebrate abundance and channel width. This study underscores the need to consider a broad range of environmental variables when making research and management decisions concerning stream ecology.

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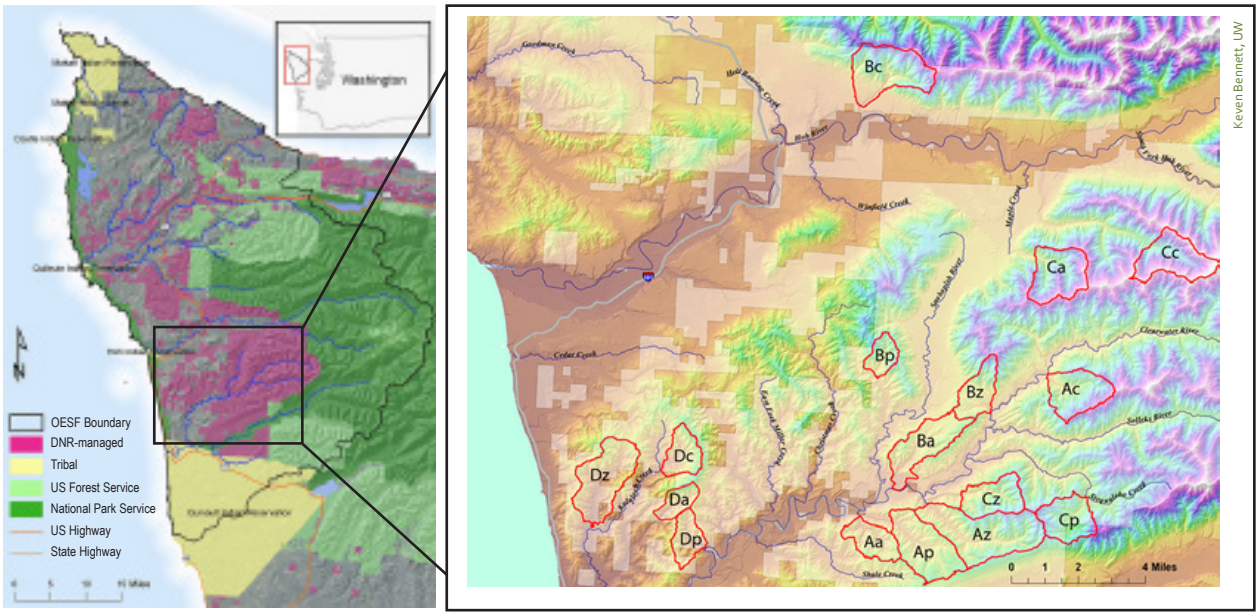
Panel Discussion: Sharing Perspectives on Type 3 Watershed Experiment Planning and Implementation

Location: Rainforest Arts Center
Facilitator: Teodora Minkova, DNR, OESF Research and Monitoring Manager
Panelists: **Bernard Bormann,** University of Washington, Director of the Olympic Natural Resources Center; **Kelly Lawrence**, U.S. Forest Service, Olympic National Forest Supervisor; **Bill Wells**, DNR, Forest Resources Division Manager (acting); **Kevin Alexander**, DNR, Forester

Panelists representing different groups participating in the Type 3 Watershed Experiment (researchers, foresters, DNR managers, stakeholders, and interested land managers) will share their views on the lessons learned so far, the value of the project, and ideas for improving it. The audience will have the opportunity to participate as a collective representative of the project stakeholders. A facilitator will guide the discussion, with questions about the challenges and value of bridging knowledge domains, professional experiences, and cultural perspectives, and the significance of learning-based collaboration. Given the adaptive management focus of the Type 3 Watershed Experiment, the panelists also will discuss whether and how the project is contributing to our collective capacity to adapt forest management practices and policies to rapidly changing environmental and social conditions in the Pacific Northwest.

The Type 3 Watershed Experiment is being implemented across 20,000 acres in 16 watersheds in the OESF. Experimental upland and riparian treatments will be implemented through 13 timber sales.



Information Tables

Location: Rainforest Arts Center

Local organizations doing ecological research, monitoring, and habitat restoration on the Olympic Peninsula will present their work through display of project reports, brochures, fact sheets, photos and other materials. Representatives of the organizations will be available to answer questions. The goal is to bolster collaboration and engagement with local natural resource practitioners, land managers, scientists, and the community.

The tables will be located in the back of the main hall and can be visited during the conference registration (8-8:30 am), the student and DNR poster session (9:50-10:50 am), and the lunch break (12:30-1:30 pm).

Field Activity: Demonstrations of Less-Familiar Field Equipment

Location: Calawah River Park (refer to map on page 21)

Researchers and field staff from DNR and the University of Washington's Olympic Natural Resources Center will demonstrate less-familiar field equipment for environmental research and monitoring, such as acoustic monitoring units, light sensors, and the latest models of laser range finders. Staff will be available to explain equipment specifications, its use in coastal forests, and how it compares to more traditional equipment and field techniques, such as point-count bird surveys, densitometers, and hemispherical photography.

Acoustic recording units

Getting to Calawah River Park

From the Rainforest Arts Center, turn right (north) on Highway 101 (North Forks Ave.). Travel 0.7 miles and look for a turn to the right. The park is located next to the Calawah River.

Parking is free and no permits are required.

Lunch Options

The fastest and easiest options for lunch are listed below. All of these restaurants are located along Forks Avenue North or South (Highway 101), which is the main road through town (refer to map on page 3).

- **Forks Outfitters Deli** (sandwiches, soup, chicken, hot case), 950 South Forks Avenue
- **Subway** (76 Food Mart and Subway sandwich shop), 490 North Forks Avenue
- **Sully's Drive In** (hamburgers, sandwiches, chicken, ice cream), 220 North Forks Avenue

The following options are good, but with the time allotted for lunch you may not make it back in time for the afternoon session.

- **Pacific Pizza** (pizza, pasta, sandwiches, soup, salad bar), 870 South Forks Avenue
- **In Place Restaurant** (sandwiches, burgers, soup, pasta), 320 South Forks Avenue
- **Rinconcito del Sabor** (Mexican food, full service restaurant), 90 North Forks Avenue

If you prefer to bring your own lunch, you may enjoy it at nearby Tillicum Park, which is located north of the Rainforest Arts Center along North Forks Avenue.