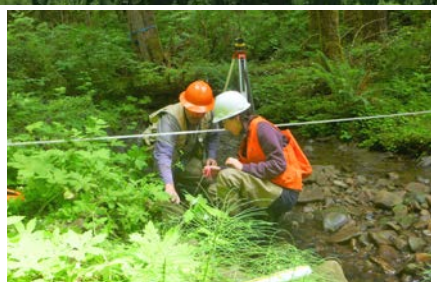
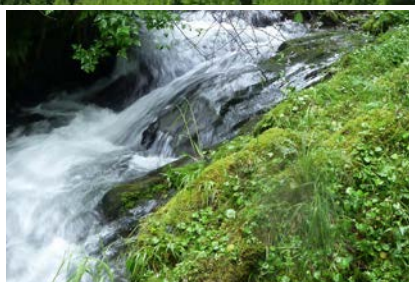
2019 Olympic Experimental State Forest Science Conference

Linking Science to Natural Resource Management


April 24, 2019, 8:30 am to 4 pm

Rainforest Arts Center

Forks, WA

Contents

About This Conference

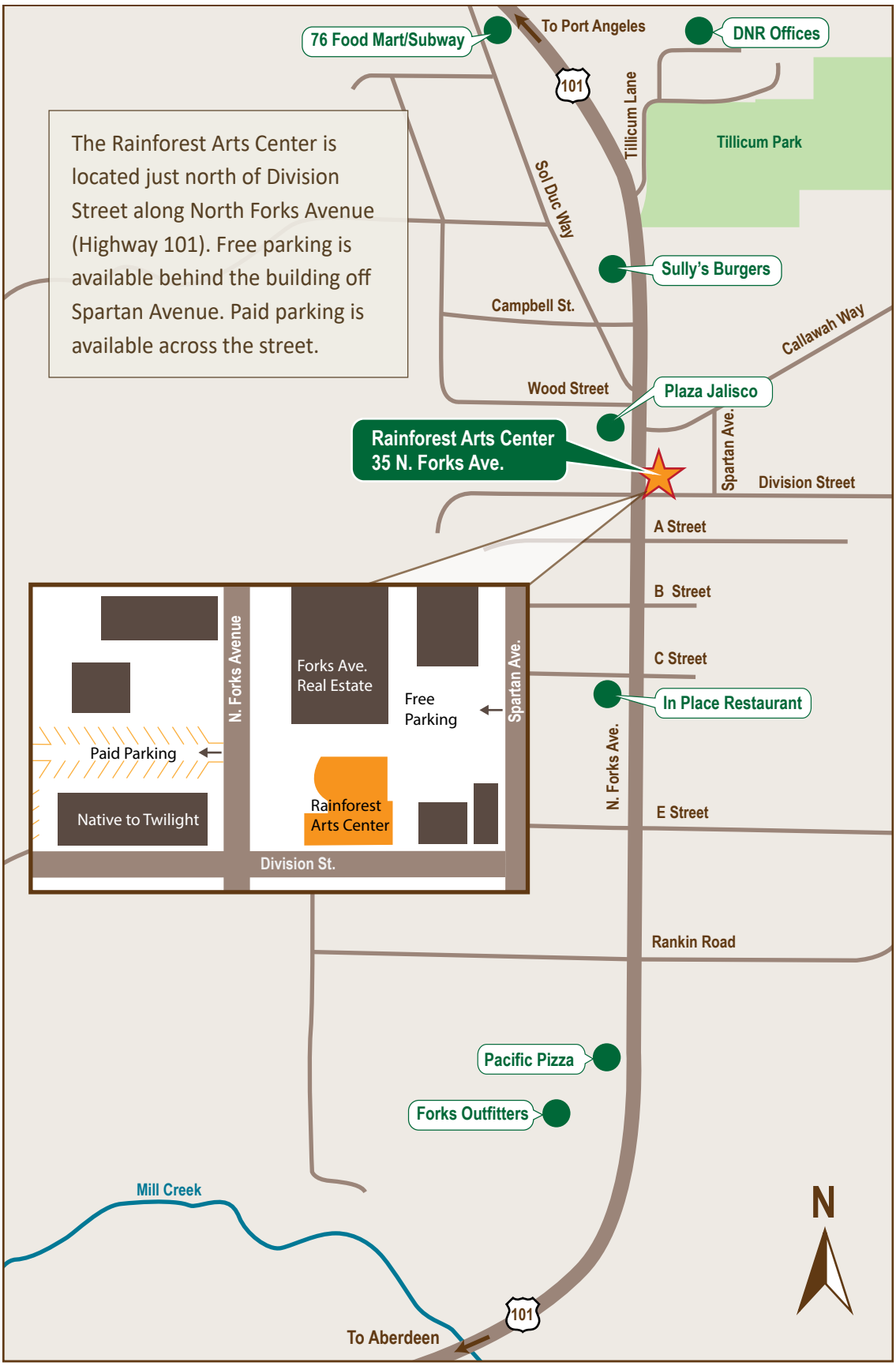
Welcome to the third annual Olympic Experimental State Forest (OESF) science conference, hosted by the Washington State Department of Natural Resources (DNR). Its purpose is to communicate the results of research and monitoring activities taking place in the OESF and their relevance to land management 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.

The 2019 OESF Science Conference is sponsored by DNR.

2019 DNR Conference Committee:

Teodora Minkova
Cathy Chauvin
Jessica Huggins
Ralph Johnson
Mark Enty
Miles Micheletti
Jeff Ricklefs
Chris Snyder

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.

Conference Agenda

8:30 – 9:00 am: Registration, refreshments, and socializing

9:00 – 9:20 am: Welcome and annual updates of the OESF Research Program from Teodora Minkova, Program Manager

9:20 – 10:40 am: Morning Session 1

- **Minding the Gap: Developing Guideposts for Implementing Gap Treatments in the Olympic Experimental State Forest** | **Dan Donato,** DNR
- **Alternative Pre-commercial Thinning Treatments: Stand Structure 16 Years Later** | **Warren Devine,** DNR
- **How are we Doing? Assessing the Effectiveness of DNR's *State Trust Lands Habitat Conservation Plan* in Fostering Complex Forest Structure** | **Joshua Halofsky**, DNR
- **Rural Ecosystem Sustainability: Integrating Natural and Social Sciences to Achieve Community Wellbeing** | **Bryan Pelach**, University of Washington

10:40 – 11:10 am: Break with refreshments and poster session

- **Stream Conditions After 18 Years of Passive Riparian Restoration in Small Fish-Bearing Watersheds** | **Kyle Martens**, DNR
- **Preliminary Flow Records From Small, Mountainous Channels in the Olympic Experimental State Forest** | **Jeff Keck**, DNR
- **Monitoring the Performance of Alternative Pavement Design and Reinforcement of Roads in the Olympic Experimental State Forest** | **Justin Long**, DNR
- **Ethnoforestry: Applying Traditional Ecological Knowledge for Ecosystem Sustainability on the Olympic Peninsula** | **Courtney Bobsin,** University of Washington

11:10 – 12:10 pm: Morning Session 2

- **Riparian Microclimate Spatial and Temporal Variability on the Olympic Peninsula of Washington State** | **Katrina Keleher,** The Evergreen State College
- **Spatial and Temporal Trends in Dissolved Organic Carbon in Small, Fish-bearing Watersheds** | **Roxana Rautu,** University of Washington
- **Assessment of the Linkages Between Forests and Fish: Implications for Management and Monitoring on the Olympic Experimental State Forest** | **Kyle Martens,** DNR

12:10 – 12:20 pm: Closing remarks, Teodora Minkova

12:20 – 1:45 pm: Lunch (on your own)

1:45 – 4:00 pm: Afternoon session on use of remote sensing in natural resources management

4:00 pm: Adjourn

About the OESF

Located on the western Olympic Peninsula, the OESF was established to learn how to integrate revenue production (primarily through timber harvest) and ecological values (primarily habitat conservation) in a working forest.

Across approximately 270,000 acres (110,000 hectares) of state trust lands in the OESF, DNR generates a sustainable flow of revenue to its trust beneficiaries and restores and maintains habitat for native species, including the federally protected northern spotted owl and marbled murrelet. DNR balances these objectives through an experimental approach called "integrated management." Under this approach, DNR does not divide the land base into fixed, permanent areas to be managed primarily for revenue or ecological values. Instead, DNR manages the entire land base for both. DNR achieves integration through landscape-level planning and a combination of passive and active management. Active management involves silvicultural techniques designed to create and maintain a variety of forest stand structures.

Key components of this approach include research and monitoring and application of new information to management through a formal adaptive management process. Through its OESF research and monitoring program, DNR implements and coordinates projects; establishes and maintains research partnerships with universities, colleges, federal agencies, and other organizations; collaborates with local land managers, tribes, environmental organizations, and regulators; facilitates adaptive management; and provides educational opportunities such as internships and field trips.

DNR's management strategies 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/.

Presentation Abstracts

Session 1

Mind the Gap: Developing Guideposts for Implementing Gap Treatments in the Olympic Experimental State Forest.

Daniel C. Donato[1, 2], Joshua S. Halofsky,[1] Richard Bigley[1]

[1]DNR, Forest Resources Division

[2]University of Washington, School of Environmental and Forest Sciences

In the Olympic Experimental State Forest (OESF) and similar landscapes, commercial thinnings often include a habitat objective, specifically to accelerate the development of late-successional structure. One key structural feature is canopy gaps, which diversify overstory structure and can encourage understory development. To date, intentionally created gaps in thinning treatments have been conducted largely without a reference (target) condition, making success difficult to define or measure. In this study, we are combining remote sensing (LiDAR) and field data to better link silvicultural gap treatments with the late-successional forests they aim to emulate.

The study consists of three phases: A retrospective study of ½-acre gaps created more than 10 years ago, an observational study of natural gap structures in primary older forests (in other words, reference conditions), and a replicated silvicultural experiment to test novel gap treatments.

Preliminary results show that past ½-acre gaps have experienced dense natural tree regeneration (mean 2000 trees per acre, 90 percent occupancy) and moderate to rapid tree growth (16 to 30 inches per year), despite abundant shrub cover (approximately 90 percent). In primary older forests, most gaps are less than 1/4 acre with complex, sinuous shapes (analysis ongoing). The experimental gap treatments have been implemented in the Tacoma Select timber sale and monitoring of stand responses has begun.

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Alternative Pre-Commercial Thinning Treatments: Stand Structure 16 Years Later.

Warren D. Devine[1], Richard Bigley[1]

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In the Olympic Experimental State Forest (OESF), DNR manages forested state trust lands for both timber production and wildlife habitat through an integrated management approach. Among the silvicultural techniques used to manage these forests, pre-commercial thinning (PCT) is used to reduce intense competition in dense, young stands, promoting future development of selected trees. This study explores the use of alternative PCT treatments to not only reduce competition in young stands, but also to diversify the overstory structure, promoting development of understory vegetation and wildlife habitat. In

1998, five treatments were applied to five 20-year-old Douglas-fir/western hemlock stands near Forks: an unthinned control treatment, a standard PCT leaving 300 trees per acre, a standard PCT with the addition of 30- and 60-foot-wide gaps, a PCT leaving 200 trees per acre, and a PCT leaving 200 trees per acre with gaps. Sixteen years post-treatment, stand basal area per acre (a measure of overstory density) was 14 percent lower in the 200 trees per acre PCT than in the 300 trees per acre PCT. The addition of gaps reduced stand basal area by 19 percent and 11 percent in the 200 and 300 trees per acre treatments, respectively. However, when evaluating only the larger conifers (12+ inches in diameter), stand basal area was 8 percent greater at 200 trees per acre than at 300 trees per acre, and the addition of gaps had a smaller negative effect. Thus, alternative PCT treatments may offer potential for diversifying the structure of young stands without compromising timber production.

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How are we Doing? Assessing the Effectiveness of DNR's *State Trust Lands Habitat Conservation Plan* in Fostering Complex Forest Structure.

Joshua S. Halofsky[1], Daniel C. Donato[1, 2], Thomas Laxton[1], Richard Bigley[1]

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To date, DNR has been assuming that the *State Trust Lands Habitat Conservation Plan* (HCP) is effective in meeting habitat objectives, such as fostering structurally complex forest. While this assumption can be tested through aerial photography and examining individual stands, these observations tend to be qualitative in nature and only reflect recent conditions at fine scales. To truly examine HCP effectiveness, trends in forest structure on DNR-managed lands should be quantitatively examined pre- (1984 through 1998) and post-HCP (1998 through 2016) implementation across the entire landscape. Using an independent data source, we sought to quantitatively determine if positive changes in structurally complex forest abundance are occurring following HCP implementation.

Across all lands in western Washington included in the analysis, we find that DNR-managed forests have become more structurally complex since the signing of the HCP, a marked change from the flat or declining trends before the HCP. Consistent with HCP objectives, this increase is occurring on lands managed under a harvest constraint (in other words, riparian and uplands), while lands managed under shorter rotations primarily for economic revenue show no increase in structural complexity. Our approach offers an avenue to continuously monitor HCP lands through time using an independent data source, and provides a quantitative pre-HCP baseline against which future changes on these lands can be assessed.

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Rural Ecosystem Sustainability: Integrating Natural and Social Sciences to Achieve Community Wellbeing

Bryan Pelach[1], Courtney Bobsin[2], Bernard Bormann[2], Chelsea Midgett[3], Marc L. Miller[4]

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[2] University of Washington, School of Environmental and Forest Sciences, Olympic Natural Resources Center

[3]University of Washington, School of Environmental and Forest Sciences

[4]University of Washington, School of Marine and Environmental Affairs

The long-standing public forestlands debate—timber economy versus environmental protections on public forest lands—has not produced many winners. Most rural communities, northern spotted owls, murrelets, and salmon all appear to have suffered despite decades of actions trying to support them. Better outcomes may be achieved by reframing the debate around ecosystem sustainability, in which both community and environment wellbeing are equally valued. This holistic, systems approach addresses social and cultural matters beyond economics, and environmental issues beyond species listed under the Endangered Species Act. Avoiding historical, repeated policy crashes and achieving real, long-term sustainability also requires the singularly human capacity to learn and adapt quickly. To realize this capacity, the inertia of current practice needs to be balanced with formal science-based, socially connected forms of adaptive management. We present some examples from the Olympic Peninsula to illustrate this framework.

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Session 2

Riparian Microclimate Spatial and Temporal Variability on the Olympic Peninsula of Washington State.

Katrina Keleher[1], Warren D. Devine[2], Richard Bigley[2]

[1]The Evergreen State College

[2] DNR, Forest Resources Division

Riparian microclimate variables, which include moisture, temperature, wind speed, and light, impact habitats and species in and near streams. Microclimate maintains in-stream temperatures while providing cool, moist conditions alongside streams which amphibians, small mammals, and invertebrates require. Despite a significant regulatory emphasis on riparian zones, few studies have examined the factors that determine riparian microclimate. For this study, we examined the spatial and temporal variability of a three-year microclimate dataset from ten different watersheds throughout DNR-managed forests in the Olympic Experimental State Forest (OESF). We developed mixed multivariate models with both fixed and random effects to examine the relationships between microclimate variables (vapor pressure deficit and air temperature) and a number of discrete predictor variables including distance from stream, height

above stream, percent shade, and solar radiation. In this presentation, I will share key findings from this study and offer potential management implications from the results. These findings will advance the understanding of microclimate gradients and may help to refine future designations of riparian management areas.

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Spatial and Temporal Trends in Dissolved Organic Carbon in Small, Fish-bearing Watersheds.

Roxana Rautu[1], Bernard Bormann[2], David Butman[1], Teodora V. Minkova[3]

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One of the most poorly understood facets of terrestrial carbon cycling is carbon loss to aquatic systems. These solutes not only represent a carbon loss for terrestrial systems but also play an important role in carbon cycling and microbial loops, both in freshwater and marine ecosystems. Understanding the mechanisms of carbon export through freshwater is key to predicting how future climate change will affect carbon fluxes and to developing a modern carbon budget for the Olympic Peninsula. During the summer and fall of 2018, dissolved organic carbon (DOC) and water quality data were collected along the stream networks of four small, fish-bearing watersheds in the OESF. This presentation will discuss some preliminary results on how landscape characteristics in these watersheds affect the spatial and temporal variability in DOC concentration and quality. The goals of this study are not only to better understand a rarely studied component of carbon cycling, but also to inform future monitoring methodology of stream carbon. The watersheds chosen for this study are part of the Large-Scale Integrated Management Experiment (T3 Experiment), allowing for the unique opportunity to explore the impacts different harvesting techniques have on stream productivity and carbon dynamics in the future.

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Assessment of the Linkages Between Forests and Fish: Implications for Management and Monitoring on the Olympic Experimental State Forest.

Kyle D. Martens[1].

[1]DNR, Forest Resources Division

Understanding the causal links between riparian forests, streams, and salmonids is important for evaluating the likely impacts of forest management practices. Previous studies have identified three major

causal pathways (in-stream cover, light, and hydrology) that may be important for fish of the Olympic Experimental State Forest (OESF). I developed a conceptual model of these pathways and evaluated the evidence supporting each pathway and the role of density dependence on age-1 or older coastal cutthroat trout. Results of this evaluation provided some support for all three of the pathways as well as the presence of self-thinning (a density-dependent process in which fish reach an equilibrium between size and abundance) in age-1 and older cutthroat trout. Stream depth was one of the most important factors affecting age-1 or older cutthroat trout. In addition, the support for the light pathway and lower gradient streams in the in-stream cover pathway were less than expected. This result may be due to the limited range of conditions in canopy coverage and lack of overall cover in the lower gradient streams of the OESF.

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Poster Abstracts

Stream Conditions After 18 Years of Passive Riparian Restoration in Small Fish-bearing Watersheds.

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

[1]DNR, Forest Resources Division

[2]US Department of Agriculture Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory

Passive ecological restoration (using natural processes of succession and disturbance to alleviate anthropogenic impacts) is commonly used to manage riparian forests previously subjected to production forestry. Eighteen years after the implementation of passive riparian restoration in the OESF, we used four common stream health indicators (stream temperature, canopy closure, in-stream wood, and salmonid densities) to assess conditions in small fish-bearing streams. Summer stream temperatures have decreased below levels in unmanaged reference streams. Riparian forest canopy closure has increased beyond that in reference streams. In-stream wood and age-1 or older salmonids are either stable at reduced levels or declining, compared with production forestry and unmanaged reference watersheds. Second-growth riparian forests need more time to develop to allow more light into streams, while also allowing for continuous recruitment of larger pieces of in-stream wood. Passive restoration in second-growth forests alone is unlikely to increase salmonid production in the near future.

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Preliminary Flow Records From Small, Mountainous Channels in the Olympic Experimental State Forest.

Jeff Keck[1], Teodora V. Minkova[1], Warren D. Devine[1], Erkan Istanbulluoglu[2]

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[2]University of Washington, College of Engineering

In this poster, we present preliminary flow records from the Olympic Experimental State Forest (OESF). Through repeat flow measurements, channel surveys and the installation of pressure transducers and staff gages, we are developing long-term records of flow in small (2 to 20 km^2 basins) step-pool to cascade channels that transport pulses of sediment and violently swing between low and high flows.

From our first five years of flow observations, we have found that the geologic setting of the basin may play a large role in hydrograph characteristics. Not surprisingly, accurately measuring low and high flows is difficult. To improve accuracy of the flow records, we are using the BaRatin rating curve technique (Le Coz et al., 2013[a]) which incorporates both the hydraulic geometry and measured flow and water height measurements of the channel to determine the water height to flow relationship. As we refine our measurement techniques and improve accuracy, the long-term goal of these observations is to quantify flow trends and help humans (DNR) better understand how past and present tree harvests on the Olympic Peninsula may be altering natural hydrologic and geomorphic processes.

Reference: Le Coz, J., Chaleon C., Bonnifait, L., Le Boursicaud R., Renard, B., Branger, F., Diribarne, J., Valente, M. (2013). Bayesian analysis of rating curves and their uncertainties: The BaRatin method. Houille Blanche. 10.1051/lhb/2013048.

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Monitoring the Performance of Alternative Pavement Design and Reinforcement of Roads in the Olympic Experimental State Forest.

Justin Long[1]

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DNR's aggregate resources are dwindling and scarce in some regions. Costs of crushing, hauling and placing of aggregate often approaches 40 to 50 percent or more of the total road construction costs.

The Forest Roads program compared four treatment alternatives on an 890-foot logging spur constructed in March and hauled on in April, 2018 in the Pacific Cascade Region. The primary objective was to evaluate different aggregate treatments and depths on poor subgrade during wet weather timber hauling. The treatments applied were as follows:

- Treatment 1 - Geogrid reinforcement with 8-inch aggregate depth.
- Treatment 2 - Geofabric reinforcement with 12-inch aggregate depth.
- Treatment 3 - DNR Aggregate Depth Tool 16-inch aggregate depth.
- Treatment 4 - 16-inch as designated in the engineer's design in the road plan.

The geogrid section performed significantly better than the other sections, with an average rut of 2.3 inches. The average rut depths for the geofabric, DNR Aggregate Depth Design Tool, and engineer's design were 6.4 inches, 5.2 inches, and 5.2 inches, respectively. Subgrade reinforcement offers landowners the ability to haul in wet weather and on weak subgrades while using less aggregate and reducing road construction cost.

A secondary study will take place in the summer of 2019 in the Olympic Experimental State Forest (OESF). The study will look at the performance of reinforced crushed and round aggregate versus an unreinforced control section.

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Ethnoforestry: Applying Traditional Ecological Knowledge for Ecosystem Sustainability.

Courtney Bobsin[1]

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Across the Olympic Peninsula, widespread changes in forest management policy have altered rural communities over the last several decades. Many rural communities were hit hard by a decrease in available jobs due to a decline in timber supply, northern spotted owl protections, and mill modernization. Tribes have since suffered from a decline of some cultural keystone species adapted to early-seral conditions precluded by creation and focus of late-seral reserves. In the aftermath of this, rural communities are left to rebuild with their primary sources of work and culture degraded. We believe a key way to build community resilience and health is through ethnoforestry: using traditional ecological knowledge of local people and applying it to forest management on public lands. Applied ethnoforestry can utilize the space between naturally regenerating conifers to grow targeted plant species. Species that are culturally valuable to nearby communities will be planted, tended, and then harvested for personal or semi-commercial use. Experiments will be developed and implemented within the Olympic Experimental State Forest (OESF) Large Scale Integrated Management Experiment (T3 study) in the next year. This project is applying the Olympic Natural Resource Center's new model of ecosystem sustainability that gives equal weight to both community and environment wellbeing in order to achieve success.

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Afternoon Session on Use of Remote Sensing in Natural Resource Management

Instructors: Miles Micheletti, Jeff Ricklefs, and Chris Snyder, DNR

DNR Remotely-Sensed Forest Inventory

Jeff Ricklefs[1]

[1]DNR, Forest Resources Division

DNR manages approximately 2.3 million acres of forested state trust lands for the benefit of public trusts. Accurate and timely information on forest conditions is crucial for effective forest management. Since 2013, DNR has relied on remote-sensing technologies to report a suite of forest inventory parameters. In this presentation, I provide an overview of DNR's use of LiDAR and "phodar" (photogrammetrically derived point clouds). I will discuss the remote sensing technologies, the methods DNR employs to build predictive models, and our validation efforts.

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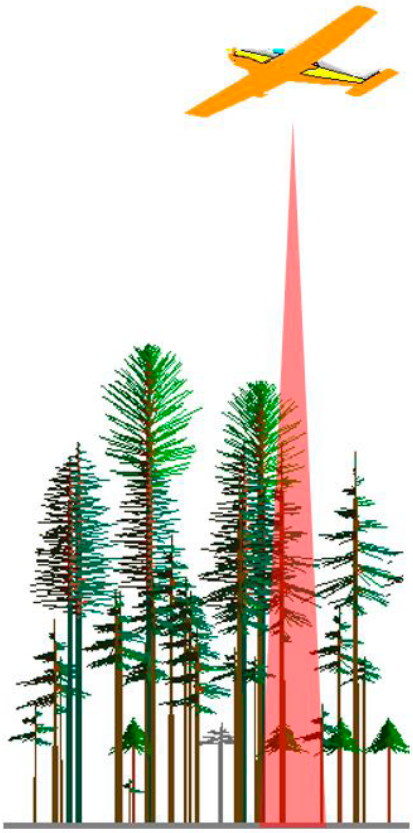
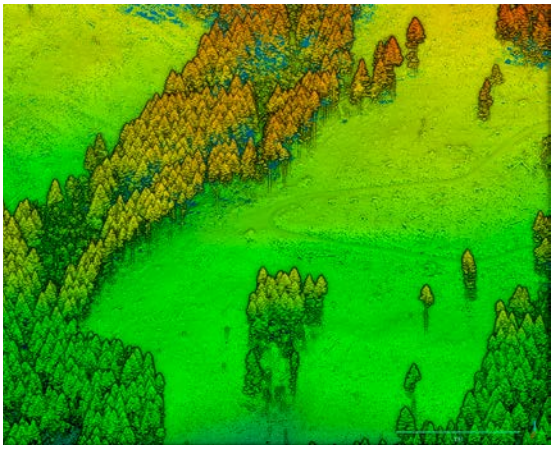
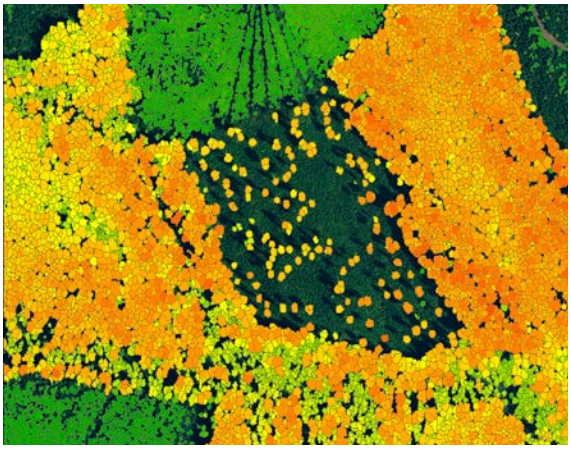


Collection of LiDAR data



Full return LiDAR point cloud



Individual tree segmentation using LiDAR

Applications of Unmanned Aircraft Systems (UAS) for Silvicultural Monitoring

Miles Micheletti[1]

[1]DNR, Forest Resources Division

I will discuss planned and operational uses of UAS, better known as drones, for silviculture at DNR. Drones are a relatively new addition to the world of remote sensing, and occupy a unique place in the hierarchy of cost and value. One focus is on young stand surveys, using sapling height and density to make informed decisions about thinning prescriptions, planting, herbicide application, and more. I will also discuss what it means to have an "operational" program, and how other forest managers might use drones to support their work.

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Miles Micheletti launching a drone

Stream images captured by drone

A LiDAR-based Approach for Mapping Streams and Riparian-Associated Wetlands

Chris Snyder[1]

[1]DNR, Forest Resources Division

Stream networks and associated riparian management zones in western Washington are extensive and represent a considerable portion of DNR-managed lands. Accurate mapping of these features is important for effective and efficient forest land management operations, environmental assessments, and strategic forest land planning. I present a summary of our efforts to develop a LiDAR-based model for mapping stream types and riparian-associated wetlands.

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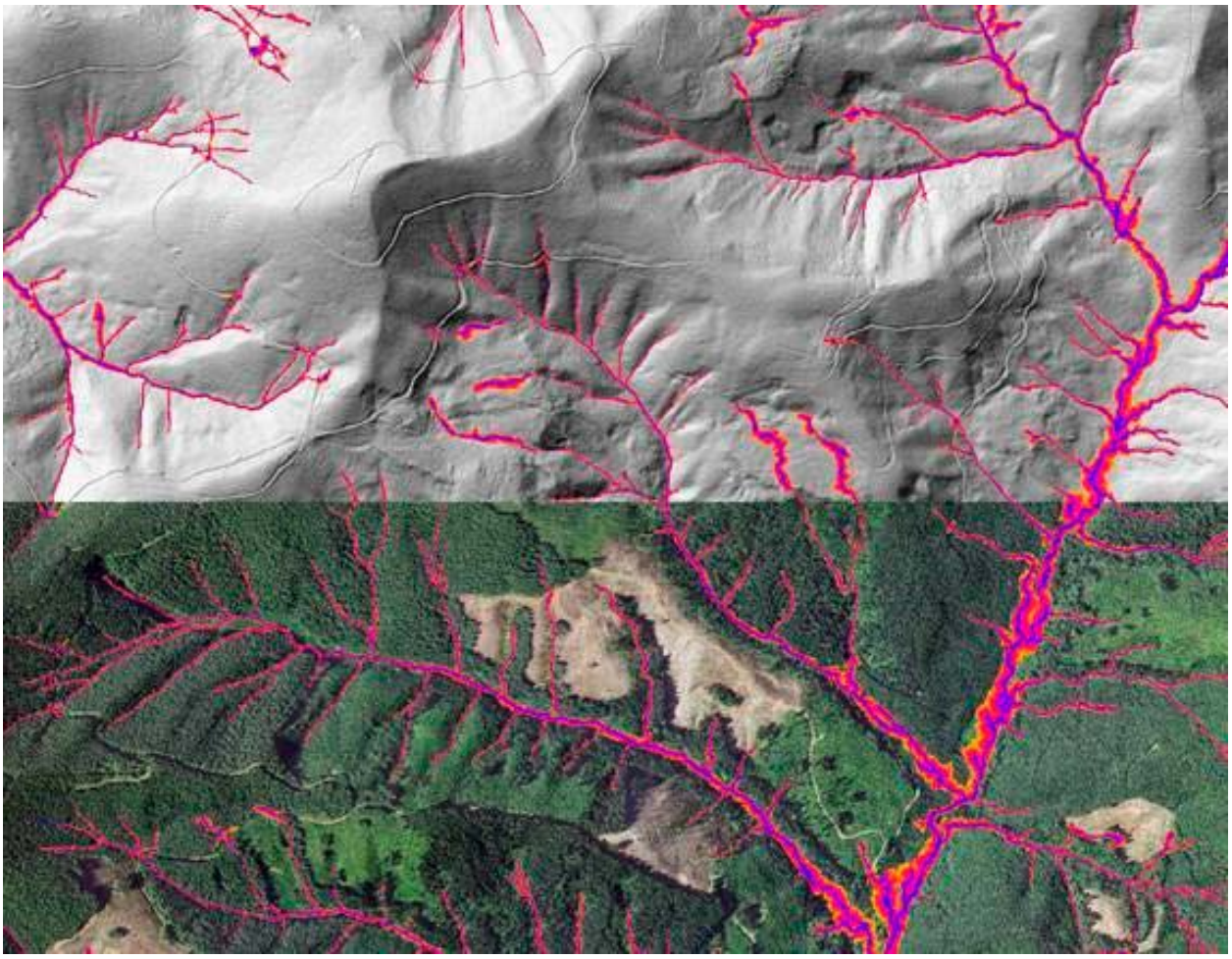

LiDAR-derived RS-Hydro "Wet Area Index" model

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
- Plaza Jalisco (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.