Issue 8 • Fall 2020

The Learning Forest

Sharing scientific knowledge on sustainable land management in the Olympic Experimental State Forest and beyond

Editorial Board Message

We never knew how creative and resilient we could be until research and monitoring field season in the Olympic Experimental State Forest (OESF) collided with a global pandemic.

The challenges we faced were many and ever-changing: How many people can ride in one vehicle? How do we hire seasonal field technicians with limited access to Washington State Department of Natural Resources (DNR) offices? How do we compensate for canceled volunteer groups who were scheduled to sample all season? How do we mesh multiple organizations' safety protocols into one for collaborative teams? The season started with a shortage of personal protective equipment and ended with wildfires and a dense plume of smoke that limited outdoor activities.

Project leads got creative in reshuffling schedules, budgets, and shared resources. The research partners—DNR, University of Washington, Washington State University, and U.S. Forest Service Pacific Northwest Research Station—provided safety guidance and management support. Colleagues stepped up to help with fieldwork and equipment. Most importantly, the intrepid field technicians and interns kept a cheerful and caring attitude throughout the season. Thanks to these efforts, flexibility, and calculated risk-taking, all planned fieldwork was completed with no COVID-19 infections.

Other work continues as well, pandemic notwithstanding. Our featured article is about a study completed in April 2020 to confirm that Crowberry Bog in the OESF is a raised, ombrotrophic (rain-fed) bog, the first ever found in the western U.S. Our guest article is about a major effort to restore fish passage through culverts under roads on the Olympic Peninsula.

Whatever happens in the coming year, it is heartening to know that motivation, teamwork, and an ongoing commitment to science can see us through.

In this Issue

Teodora Minkova, DNR

DNR field technician Kayla Owen measures stream channel substrate (pebble size) this summer in the OESF.

Featured Article

Crowberry Bog

A Step Above the Rest

by F. Joseph Rocchio[1] *with* David J. Cooper[2], Edward Gage[2], Tynan Ramm-Granberg[1], and Andrea K. Borkenhagen[2,3]

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[2]Department of Forest and Rangeland Stewardship, Colorado State University, Fort Collins, Colorado

[3]Current address: Advisian, Calgary, Alberta, Canada.

A primary responsibility I had as a Washington Natural Heritage Program ecologist was to identify the best examples of Washington's ecosystems. Over the years, I have visited countless occurrences of rare and high-quality plant communities. But on a quiet August morning in 2011, I walked into an ecosystem I never expected to find in this state.

As part of an effort to survey wetlands on the western Olympic peninsula, Crowberry Bog was on my list of sites to visit (Figure 1). On the morning of my visit, I stood on the bog's edge planning my trek and noticed what appeared to be a tall thicket of shrubs. Yet when I got closer to them, it became clear that I had been fooled: Those shrubs were knee-high, dwarf versions of the shrubs I had just walked through. How was that possible? What optical illusion had my eyes played on me? As I looked back toward where I started, it hit me—no, floored me: I had just walked uphill!

It seemed I had just stepped onto a raised, ombrotrophic (precipitation-fed) bog (Text Box 1 on page 3). If true, it would be a significant find because no raised bogs are known to exist in the conterminous western U.S.

Joe Rocchio, DNR

Figure 1. Crowberry Bog and location

When I got back to the office, I checked the topographic maps generated from the Washington State Department of Natural Resources' (DNR) remote sensing data. The maps suggested the bog was indeed raised. So I immediately contacted peatland expert Dr. David Cooper at Colorado State University. Understandably skeptical, he replied with a simple message: "I need to see this site."

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Editor: Cathy Chauvin, Environmental Planner, DNR

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In April of 2016, Dr. Cooper and his colleagues joined DNR staff to examine Crowberry Bog. We agreed that the site seemed raised; however, many indicators of ombrotrophy can be misleading on their own. For example, the bog could be raised due to underlying topography rather than peat accumulation, and many bog vegetation species also occur in related peatland types called acidic fens (Text Box 1).

In short, determining if this is a raised bog would require multiple lines of evidence. So we designed a three-year study to gather it. The study began in April 2016 and was completed in partnership with Colorado State University.

Study Design

Our study focused on whether Crowberry Bog has the following indicators of ombrotrophy: (1) a distinctly raised surface; (2) water table levels that fluctuate with daily and seasonal precipitation; (3) downward and lateral movement of groundwater (indicating that water filters through the peat and drains out the sides of the bog); (4) very low calcium concentrations, similar to rainfall; and (5) vegetation patterns and composition indicative of ombrotrophic bogs. We also estimated moss growth and short-term peat accumulation (40 to 70 years) as a gauge of the bog's ecological integrity.

To determine the peatland's topography, we used LiDAR data. (LiDAR is technology that uses pulses of light from aircraft to generate extremely accurate topographic data.) To measure water table dynamics, we installed 15 well nests along a transect bisecting the site. Each nest consists of a single, slotted well with data loggers to measure hourly water table depth and three or four piezometers to measure water movement. Water samples were collected from all slotted wells and sent to the University of Washington for chemical analysis. Vegetation patterns were characterized by establishing 100-square-meter plots around each well nest. Within the plots, all vascular plants and bryophytes (non-vascular plants such as mosses and liverworts) were identified and their areal cover and height estimated. We also measured moss growth seasonally at three of the wells using vertical, stainless steel wires.

To estimate short-term peat accumulation, we excavated five shore pine trees (*Pinus contorta ssp. contorta*) and measured peat thickness from their germination point to the top of the moss surface on the tree bole. We then divided the peat depth by the tree's stem age to determine the peat accumulation rate.

Text Box 1. Definitions

- **Peatlands** are wetlands that accumulate peat (dead plant material).
- **Bogs** are peatlands solely dependent on precipitation (ombrotrophic), resulting in distinct hydrologic patterns and very low ion concentrations (being precipitation-fed, water in the bog is acidic and low in nutrients). This definition is used by peatland experts and is narrower than the definition commonly applied to Washington wetlands.

  In a **raised bog**, peat accumulation over thousands of years elevates the surface peat above the surrounding landscape and the influence of ground and surface water. In **flat bogs,** surface peat is above ground and surface water but is slightly or not raised.
- **Fens** are peatlands supported by surface and groundwater (minerotrophic), resulting in different hydrological patterns and higher concentration of ions than bogs. Water is alkaline to acidic and has higher levels of dissolved minerals due to groundwater contact with bedrock, surface deposits, and local soils.

What Did we Learn?

We concluded that the bog was raised, and that the cause was not underlying topography. Why? First, LiDAR data showed that the bog is elevated nearly 3 meters above the surrounding landscape, confirming what seemed conspicuous in the field (figures 2 and 3 on page 4). Second, a peat core from a pollen study in 1970 by Carl Heusser showed that the depth of peat from the bog surface was nearly 4 meters, followed by another 2 meters of organic-rich lake sediments. Heusser concluded the site was formed in a lake basin that was nearly 16,000 years old. Third, we used an avalanche probe to determine peat depth across the bog, and found that peat depth decreased toward the bog edge. All of this information suggests that a lake basin

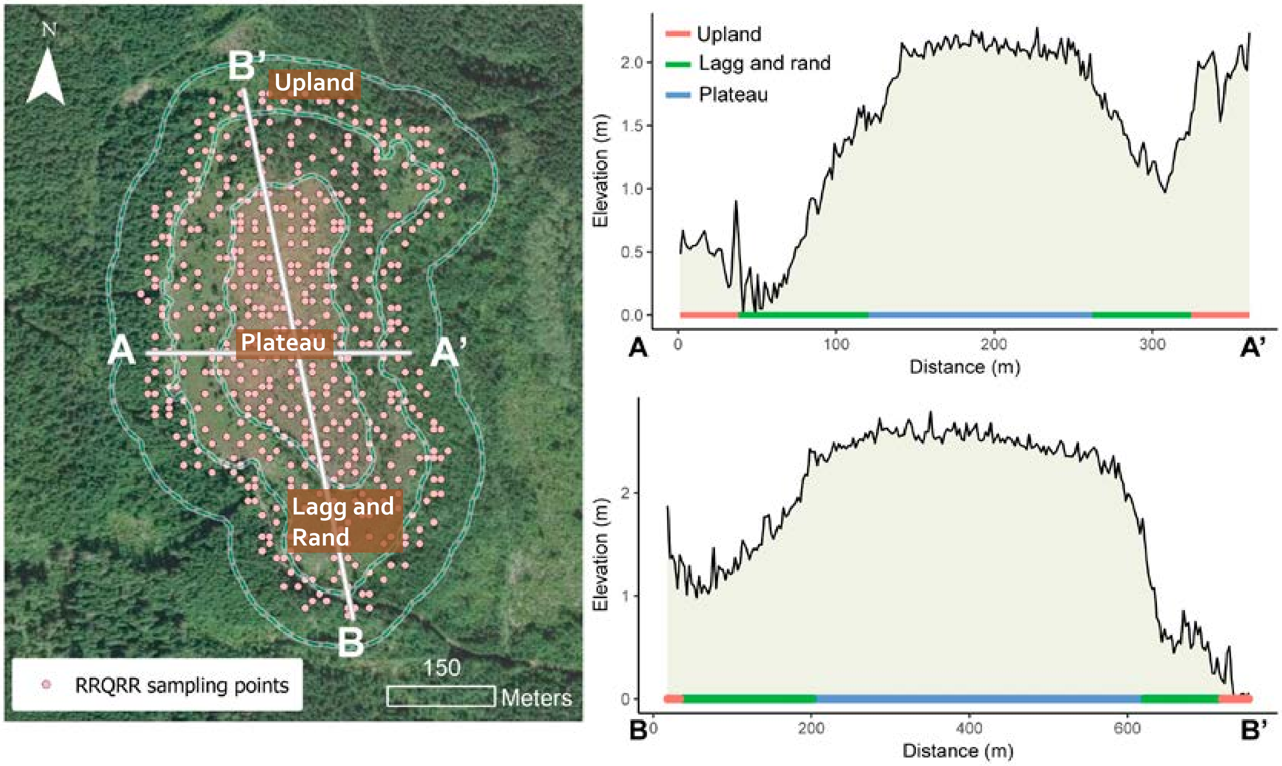

Figure 2. Sampling points and cross-sections used in analysis of LiDAR data. Elevation cross-sections A-A' and B-B' were extracted from a LiDAR-derived, digital terrain model of the bog. The cross-sections show the plateau, which is the flat-topped expanse; the rand, which is the upward-sloping bog margin; and the lagg, which is the wetland perimeter. RRQRR stands for reverse randomized quadrant-recursive raster, which is an algorithm used to generate sample points.

slowly filled with sediment and decaying plant material that built up layers of peat. Because of the very wet local climate, peat accumulation was able to continue even when the surface of the bog was above the influence of groundwater.

Our hydrologic investigations show that the bog is supported solely by precipitation. Water tables in all three landforms were near the surface during wet months but dropped to over 40 cm. deep during dry summer months (Figure 4 on page 5). In addition, water tables rose immediately following precipitation events and declined sharply if precipitation did not occur for more than a few days (Figure 4). Also, hydraulic gradients indicated that for most of the year, water percolated vertically into deeper peat layers in the plateau and then drained horizontally through the rand to the lagg, indicating that precipitation was the primary source of water into the bog.

Chemical analysis showed that like precipitation, the groundwater at Crowberry Bog has very low concentrations of calcium and magnesium ions (0.1-0.2 mg./L).

Figure 3. Oblique view of an aerial image that was draped over a LiDAR-derived, digital terrain model of Crowberry Bog. Note the abrupt change in tree height where the plateau begins. The plateau surface is approximately 450 meters long in the north-to-south direction.

Sodium and chlorid concentrations were high and indicated the importance of precipitation recharged by Pacific Ocean salt spray. Like the hydrological data, these results suggest that precipitation is the primary input of ions into the bog.

Regarding vegetation, the plateau was dominated by species common in ombrotrophic settings, especially

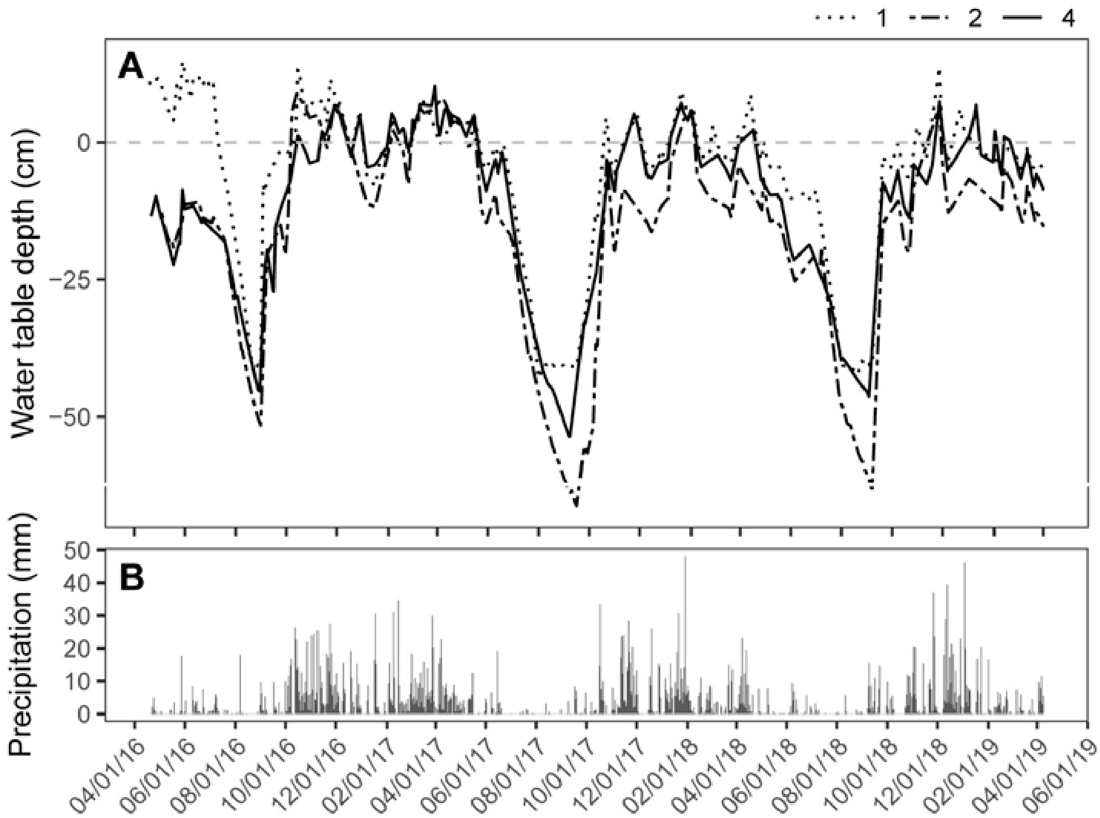

Figure 4. (A) Continuous depth-to-groundwater in wells 1 (lagg), 2 (rand), and 4 (plateau) for the entire study period (April 2016 to April 2019). (B) Daily precipitation from Forks, WA. Note the correspondence of water table depth to periods of low precipitation.

short stature Labrador-tea (*Rhododendron groenlandicum*) and western bog laurel (*Kalmia microphylla*); and rusty peat moss (*Sphagnum fuscum*), red peat moss (*S. rubellum*), cranberry (*Vaccinium oxycoccos*), and crowberry (*Empetrum nigrum*) (Figure 5). Stunted shore pine (*Pinus contorta var. contorta*) and western hemlock (T*suga heterophylla*) were common in portions of the plateau. The rand includes many of the same species, except their height and abundance conspicuously increased. The degree to which the rand dries out in the summer, resulting in more soil aeration and increased nutrients from peat decomposition, may explain the shift in vegetation structure. Vegetation in the lagg, which is minerotrophic, includes species more common in forested and shrub swamps, such as western red cedar (*Thuja plicata*), western crabapple (*Malus fusca*), and coastal rush (*Juncus hesperius*).

Figure 5. Plateau of Crowberry Bog. Red peat moss (*Sphagnum rubellum*) dominates the surface while western bog laurel (*Kalmia microphylla*) (showing off in bloom), crowberry (*Empetrum nigrum*), and Labrador-tea (*Rhododendron groenlandicum*) are the common shrubs.

Moss growth, which was highest on the plateau (average of 1 cm. per year), was concentrated in the winter and spring months while growth stagnation or height loss occurred during dry summer months. Estimates of short-term peat accumulation from the excavated shore pine trees ranged from 0.64 to 1.1 cm. per year. Together, these results suggest the bog is still accumulating peat.

Significance and Conservation

Evidence strongly indicates that Crowberry Bog is an ombrotrophic peatland, the first ecosystem of its type identified in the conterminous western U.S. and the most southern example in western North America. As such, it is of national and continental significance. The bog supports significant biodiversity features, including state imperiled plant communities, a globally rare butterfly, a state rare plant, and two state rare mosses. Because it is tied so closely to climatic factors, the bog's location at the southern extent of where raised bogs occur make it an ideal location for climate change research.

All of these factors led the Washington Natural Heritage Program to propose the site be designated a state natural area. In October, 2019 the Board of Natural Resources voted to protect Crowberry Bog as Washington's newest natural area preserve. Our research will help guide management and future research needed to maintain the site's ecological integrity.

Looking for exemplary examples of Washington's natural heritage is similar to embarking on a treasure hunt. Each rare species or rare ecosystem encountered is a thrilling experience. However, the day I set foot into Crowberry Bog will always be a step above the rest. ☙

For more information

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About the Author

Joe Rocchio is the Program Manager for DNR's Natural Heritage Program (WNHP) He also served as the WNHP's vegetation ecologist from 2007 to 2019. In that role, he developed a statewide classification of Washington's bogs and fens, conducted statewide inventories of high-quality peatlands, and researched the effects of surrounding land use on the vegetation, hydrological regime, and water chemistry of western Washington bogs. Joe has a B.S. in Environmental Science from Indiana University and an M.S. in Ecosystem Analysis from the University of Washington. He can be reached at **joe.rocchio@dnr.wa.gov**.

You are Invited to Participate

The Washington Department of Natural Resources (DNR) and the Olympic Natural Resources Center (ONRC) invite researchers and stakeholders to participate in research, monitoring, and other learning activities in the Olympic Experimental State Forest (OESF). Contact Teodora Minkova at teodora.minkova@dnr.wa.gov or Franklin Hanson at fsh2@uw.edu. Information on past and current projects in the OESF can be found at this **link**.

Guest Article

Coldwater Connections
That Bring Salmon Home

by Mara Zimmerman, Coast Salmon Partnership

Forests and salmon habitat are integrally linked. Nowhere is this more evident than the temperate rainforest of the Olympic Peninsula, with its massive trees, free-flowing rivers, and cool streams.

Salmon move continually along the river network, seeking habitat to spawn, rear, and adapt to changing seasonal conditions. And yet, many tributary streams have been cut off from the river network by road systems that were not designed with fish passage in mind. The bridge and culvert structures built at each road crossing give continuity to both road and stream. Yet stream conditions deteriorate and fish passage becomes impeded when these structures are too narrow or steep. This problem is especially an issue for narrow culvert pipes across the Olympic Peninsula that divert smaller streams under roadways.

Road systems on the Olympic Peninsula are under multiple jurisdictions, each with different capacities and mandates to address the fish passage problem. On roads managed by private and state forestland owners such as the Washington State Department of Natural Resources, the Washington State Forest & Fish Law requires fish passage barriers to be identified and corrected by 2021. The majority of these culverts have been addressed. On roads managed by other state agencies, culverts that have the greatest impact on fish habitat must be corrected by 2030. The Northwest Forest Plan also recognizes the need to provide and maintain fish passage at road crossings of existing and potential fish-bearing streams on lands managed by the U.S. Forest Service.

What is needed is a watershed-scale solution that addresses all road systems together. Barriers that are corrected in one area of the watershed are only useful to salmon if the downstream and upstream culverts also are passable. A strategic approach, formulated by river networks and across road ownerships, is needed.

A Future of Coldwater Connections

In 2017, the **Coast Salmon Partnership** and its restoration partners on the Olympic Peninsula launched the Coldwater Connection Campaign. Spearheaded through a collaboration with the **Wild Salmon Center** and **Trout Unlimited**, this campaign will reconnect salmon to streams needed for cold-water refuge during the summer heat and high-flow refuge during the winter floods.

We are focused on river systems flowing west from the Olympic Mountains to the Pacific Ocean, complementing others' work on culvert issues in the Strait of Juan de Fuca streams to the east and the Chehalis River basin to the south. We are laying the foundation to find the greatest gains for salmon and to increase cost effectiveness through geographically bundled projects.

The first phase of our work was to update information on county road culverts in western Jefferson and Clallam counties. Previous inventories on these road systems were nearly two decades old or had never been completed. Our team walked the entirety of the county road system and assessed the fish passage status of ninety-eight culverts on known fish-bearing streams (Figure 1). Of these, 61 culverts (62 percent) were a barrier to fish passage and an additional 27 culverts of unknown status (28 percent) will require further hydraulic modeling (Figure 2 on Page 8). Although we had hoped that the majority of the impact might be limited to a few culverts, we instead found there were

Luke Kelly, Trout Unlimited

Figure 1. Culvert evaluation. A surveyor measures the dimensions of a culvert pipe to determine fish passage status at this location on the western Olympic Peninsula.

many culverts blocking small amounts (less than 1 mile) of upstream habitat and that cumulatively these barriers resulted in at least 42 miles of disconnected salmon habitat (Figure 3). County roads, however, are one of several ownerships on the Olympic Peninsula, and these results need a broader context to understand their impacts on salmon.

In the second phase, we are working with nearly 900 fish passage barriers across multiple jurisdictions on the western Olympic Peninsula. This long list of barriers come from the seven different county, state, tribal, and federal databases that we consolidated for this project.

This number can seem overwhelming to those working on the ground. Where do we start? Certainly, the severity of the barrier is important to consider as are linear upstream habitat and proximity to other fish

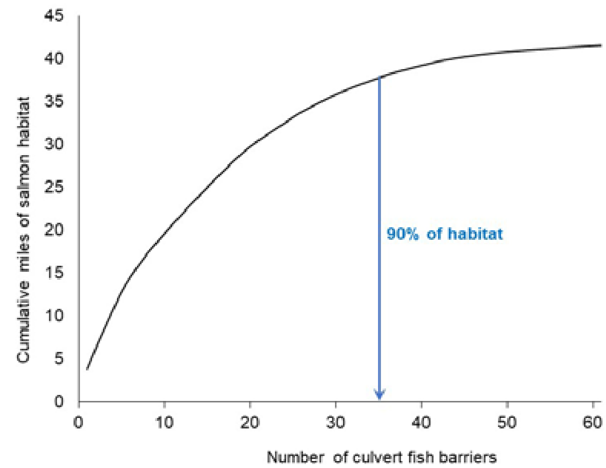

Figure 3. Improvements needed to open habitat. Replacement or repair of at least 40 culvert fish barriers will be required to open 95 percent of the salmon and steelhead habitat currently blocked by county roads in western Jefferson and Clallam counties.

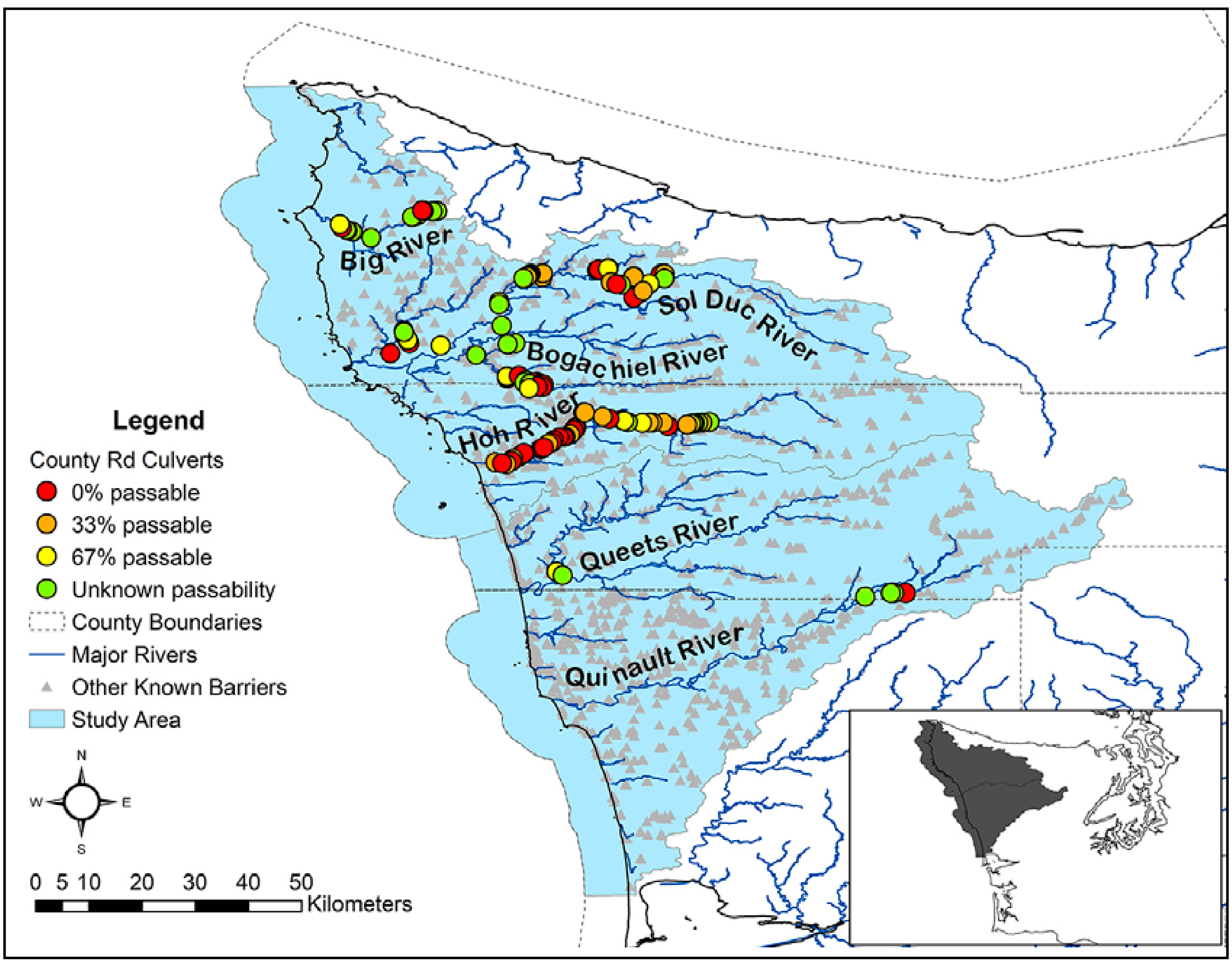

Figure 2. County road culvert fish barriers. Our team inventoried culverts on the county road systems in western Jefferson and Clallam counties and assessed these sites for fish passage. We used our field measurements to calculate the severity of the barrier status (percent passability).

barriers. But how about the number of species in a stream? How about future suitability of stream temperatures and flows? How about invasive plant establishment or lack thereof? We assembled a work group of local restoration partners who are weighing in on the importance of these factors and using a Decision Support Tool, developed on the Geographic Information Systems platform, to calculate ecological gain associated with each fish passage barrier. This tool has been used in other areas of the state and we are refining its use for the Olympic Peninsula. Our goal is to equip our local partners with information needed to tackle culvert projects that will have the maximum benefit for salmon. Further, a comprehensive strategy for culverts in this region should increase the competitiveness of future proposals for state and federal fish passage funding.

Looking Ahead

Fish barrier culverts are not unique to the western Olympic Peninsula. However, the solutions for salmon are more straightforward here; very little of the land is developed, much of the floodplain and tributary habitat remains intact, and riparian areas set aside from harvest by forest practice rules and public agency policies continue to mature. Opening access to these intact habitats is an immediate win for the salmon. The biggest challenge is the sheer number of barriers to be addressed. The Coldwater Connection Campaign is equipping local restoration partners with a strategy to address this challenge, reconnect the stream network, and bring the salmon home. ☙

About the Author

Mara Zimmerman is the Executive Director of the Coast Salmon Partnership. She holds a Ph.D. in biology from the University of Michigan and has dedicated her career to understanding and conserving fishes and freshwater ecosystems. She has worked with fishes, both large and small, across the United States and Canada and even spent a few months on the tundra rivers of western Kamchatka, Russia. At the Coast Salmon Partnership, she is focused on the Washington Coast Salmon Recovery Region and river systems flowing to the Pacific Ocean from Cape Flattery to Cape Disappointment. She works with local restoration partners, agencies and tribes, and scientists to protect and restore some of the last remaining strongholds of wild salmon and steelhead in the contiguous United States. She can be reached at **mara@coastsalmonpartnership.org.**

Recent Publication

Linking Instream Wood Recruitment to Adjacent Forest Development in Landscapes Driven by Stand-Replacing Disturbances

A Conceptual Model to Inform Riparian and Stream Management

Martens, K.D., D.C. Donato, J.S. Halofsky, W.D. Devine, T.V. Minkova. **Environmental Reviews.**

Instream wood plays an important role in shaping stream channels and creating fish habitat in conifer forests, but many streams currently have reduced amounts of wood due to past timber harvest and wood removal. How much wood will be delivered to the streams from the adjacent riparian forests depends in part on their stage of development. In this paper, the authors combine literature on forest development and disturbance and the processes that drive the delivery of instream wood to explicitly connect the change in instream wood with the dynamics of adjacent riparian forests. The proposed conceptual model highlights a U-shaped pattern of instream wood recruitment, in which instream wood recruitment is highest after a stand-replacing disturbance and during the old-growth stage, and lowest through the middle stages of forest development (which currently are the most abundant stages in many landscapes). The reduced levels of instream wood are likely to persist until these forests reach the old-growth stage of development (less than 200 years old). This pattern suggests careful examination of the predominant riparian conservation strategy of passive restoration (for example, unharvested riparian reserves) and the alternative of active restoration (for example, wood additions or other riparian treatments).

Project Updates

Large- Scale Integrated Management Experiment (T3 Experiment)

Three field surveys started this summer as part of the multi-agency **T3 Experiment** on DNR-managed lands in the Olympic Experimental State Forest (OESF). (T3 refers to a Type 3 stream, which is the smallest of the fish-bearing streams.) The goal of this study is to assess the impacts of current and alternative forest management strategies on ecosystem wellbeing, including humans as part of the ecosystem. Four experimental upland and riparian treatments are planned in 16 Type 3 watersheds (494 to 1,976 acres [200-800 hectares] each) in the OESF. For questions, contact **Teodora.Minkova@dnr.wa.gov**.

Stream Macroinvertebrates

A research team from Washington State University sampled macroinvertebrates, phytoplankton (microscopic photosynthetic organisms that live suspended in water), and periphyton (a mixture of algae, cyanobacteria, microbes, and detritus that is attached to submerged surfaces) at 31 stream monitoring sites in the 16 experimental watersheds. Upon collection, the samples appear rich in Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa. EPT taxa tend to be very sensitive to various forms of pollution, so their high abundance in the samples suggests healthy streams. Laboratory work to identify the macroinvertebrate species and their abundance and the chemical analysis of phytoplankton and periphyton samples will take place over the winter. This fieldwork was assisted by UW interns and DNR field technicians.

Erica Whitney, DNR

Graduate student Elsa Toskey. Smoke is from the September wildfires.

Stream Habitat and Fish Surveys

The first season of pre-treatment sampling was completed at 31 stream monitoring sites in the 16 experimental watersheds. Field teams of University of Washington (UW) interns and DNR technicians sampled channel morphology, instream wood, shade, and habitat units such as pools and conducted electrofishing at all sites to identify fish species and their abundance. The stomach content of salmonids was collected to evaluate their diets as part of a collaborative effort between DNR and NOAA. U.S. Forest Service Pacific Northwest Research Station staff installed water temperature loggers at all sites to record temperature at 60-minute intervals year round. Because of COVID-19, the four UW summer interns and their leader were tested prior to the season and formed a "family pod" that isolated and worked together for the duration of field season.

Acoustic Monitoring of Birds

DNR and an independent collaborator installed audio recorders at 214 monitoring stations in the upland portions of the 16 experimental watersheds. Four forest habitat types were covered: stand regeneration (0 to 15 years old), competitive exclusion (25 to 80 years old), mature forest (80 years old and older), and recently thinned forest stands. Ten days of continuous audio recording were collected at each station and habitat surveys were conducted at several stations. Over the winter, the audio files (11 terabytes of raw data!) will be screened for calls and songs of indicator bird species.

Species presence and absence, together with habitat and landscape characteristics, will be analyzed to understand what controls the occupancy of the indicator species before the harvest treatments. Later, post-treatment sampling and modeling will evaluate the effects of different harvesting and planting techniques. The project is partially funded by a grant from the **Earthwatch Institute** and is organized as a **citizen science project**. Since the six volunteer expeditions were canceled due to COVID-19, DNR and UW researchers and independent collaborators contributed additional personnel and funding this summer.

Downloading audio recorders.

Long-term Ecosystem Productivity Study (LTEP)

The LTEP project evaluates the effects of harvesting, woody debris retention levels, and plant species on tree and soil productivity; soil carbon, nutrients, and structure; and plant species diversity. The project is replicated in Sappho, Washington and three experimental units in Oregon.

Denise Wise, UW

The Sappho Unit.

Each 15-acre experimental unit includes five, 18-by-18 meter tree plots that contain about 40 trees. Each 15-acre experimental unit includes five, 18-by-18 meter tree plots that contain about 40 trees. The early-seral treatments involve adding alder trees to the typical conifer planting to promote a more diverse understory and extend the amount of time the forest is in this stage. The mid-seral treatments involve planting Douglas-fir seedlings only to advance the forest to the mid-seral stage more quickly.

This summer, interns from the UW Olympic Natural Resource Center (ONRC) tackled re-measurement of the tree plots in the early- and mid-seral experimental treatment units at the Sappho unit, which was established in 1995. The interns worked under the excellent supervision of Esaac Mazengia from the UW School of Environmental and Forest Sciences, with occasional assistance from graduate student Courtney Bobsin, ONRC Director Bernard Bormann, and ONRC Education and Outreach Coordinator Frank Hanson. Each tree was visited, given a new aluminum tag, and mapped relative to plot corners, and its species, diameter, and status were noted. That is roughly 5,000 trees. Contact Bernard Bormann at **bormann@uw.edu** with questions.

Washington Swiss Needlecast Working Group Meeting

The ONRC held its autumn Swiss needle cast working group meeting on October 29. Connie Okasaki of the UW's Quantitative Ecology and Resource Management program discussed the importance of random, spatially balanced ground sampling in estimating the various attributes of this potentially serious problem. Monika Moskal of the UW School of Environmental and Forest Sciences summarized her thoughts on the role that emerging remote sensing technologies could play in evaluating and monitoring Swiss needle cast and its impact on coastal Washington. Sándor Tóth, also of the UW, introduced a new tool he is developing for forest landowners to assess the financial impact of this problem. Lastly, Gabriela Ritokova gave an update on the various research activities that the Oregon State University Swiss Needle Cast Cooperative has most recently pursued. Contact Sándor Tóth at **toths@uw.edu** with questions.

Featured Photo

Teodora Minkova, DNR

DNR 2020 seasonal technicians protected and ready for another day of monitoring streams and electrofishing in the OESF. From left: Kayla Owen, Katrina Campbell, Jacob Portnoy, Rudd Mengers, Alexander Pavlinovic, Erika Whitney, and Keith Penn.