The Learning Forest

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

Issue 2 • October 2017

Editorial Board Message

Welcome to the second issue of *The Learning Forest*, a collaboration between the Washington State Department of Natural Resources (DNR) and the University of Washington's Olympic Natural Resources Center (ONRC).

In this issue, we travel to the open spaces in the forest to explore a study called "Mind the Gap," through which DNR is learning whether gaps created in the forest canopy through thinning are similar to those created naturally through fire, wind, disease, or other forces. DNR prioritized this study as part of its adaptive management process in the Olympic Experimental State forest (OESF). Why? Because the canopy gap concept is foundational to how DNR is balancing revenue production (through timber harvest) and habitat creation in the OESF. Results are expected to improve thinning techniques in the OESF and elsewhere. (Refer to the **forest land plan** for the OESF to learn more about the adaptive management process.)

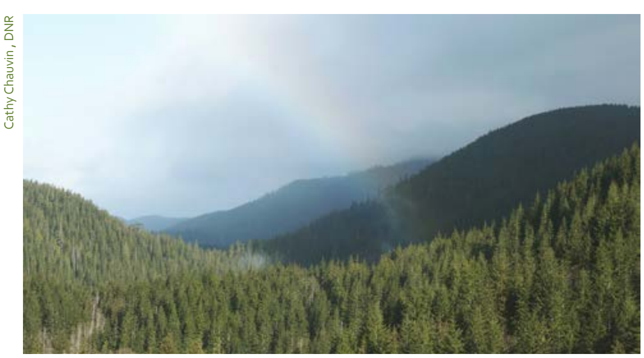
In our guest article, we look at the reintroduction of a little-known carnivore called the fisher. Reintroduction efforts on the Olympic Peninsula began in 2008. Nine years later, fishers are roaming across the area, and monitoring indicates that there are second and third generation descendants of the original 90 animals released. How does the reintroduction of fishers relate to forestry? Check out the link between fishers, porcupines, and merchantable timber described in the article.

In this Issue

The lessons learned on the Olympic Peninsula are now being used in a similar fisher reintroduction effort in the Cascades Range.

Thank you to those who sent encouraging emails and gave us constructive feedback on the inaugural issue. The editorial board is looking forward to more comments and suggestions on how to improve this newsletter.

Cathy Chauvin, DNR



A hazy spring morning in the OESF

Featured Article

Mind the Gap

Mimicking Nature in the Managed Forest

by Cathy Chauvin and Daniel Donato, DNR

Allen Estep, DNR

Photo 1. Gap created by a fallen old growth tree Note people standing on the far end of the tree.

Maybe it was disease, or insects, or wind, but the day finally came for the old-growth tree.

First came the pops and creaks as the wood fibers began to stretch and break on one side of the trunk and collapse on the other. Then the weight of the trunk began to shift in earnest. As momentum built, the sound gathered and rushed into a roar that culminated in a thud that shook the forest floor.

In its downward progress, the tree ripped branches from neighboring trees or toppled them completely, creating a long, jagged gap in the forest's canopy. As the sounds faded and the leaves came drifting down, the forest floor was illuminated with sunlight (Photo 1) that eventually will bring plants, young trees, and wildlife eager to colonize this new largess of energy and space.

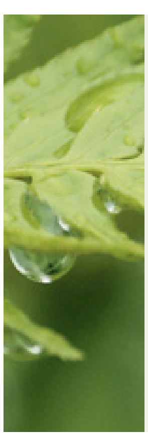
Multiply these gaps across the forest, add the effects of growth, decay, and renewal across the entire forest over many years, and the result is the complex world of the older forest. Snags, downed wood, multiple canopy layers, gaps, and places of dense growth provide a range of habitat for plants and wildlife.

By contrast, nature has not yet run this course in the younger, managed forest. Trees often are closely spaced, with a single canopy layer and no gaps.

To diversify the structure of these young stands and to increase revenue from thinning operations, forest managers may deliberately create gaps in the canopy by removing trees. Yet how close do these gaps come to mimicking nature? In 2015, the Washington State Department of Natural Resources (DNR) decided to find out.

A New Concept in Thinning

When the Olympic Experimental State Forest (OESF) was established on the western Olympic Peninsula in 1992, DNR was faced with a different kind of gap: between vision and reality. The vision was a forested landscape with openings and young, mature, and old-growth stands arranged in an irregular pattern, capable of supporting northern spotted owls and other native species. The reality was the second growth forest. Because of extensive clearcutting in the previous three



The Learning Forest is an electronic, biannual newsletter published jointly by the **Washington State Department of Natural Resources** (DNR) and the **Olympic Natural Resources Center** (ONRC).

Editor: Cathy Chauvin, Environmental Planner, DNR

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decades, over half of the forests DNR managed in the OESF were structurally simple and less than 40 years old.

One way to address this challenge was to use variable density thinning. With this type of thinning, trees are removed in an irregular pattern: some areas are not thinned at all, some areas are gaps, and others are thinned to different densities. The idea is to put a single-canopy stand on the fast track to becoming habitat while also supporting healthy tree growth for revenue production.

Variable density thinning in the OESF was based in part on practical experience in how forests grow, and in part on the recommendations of forest scientists such as Andrew Carey from the US Forest Service Pacific Northwest Research Station. Carey recommended variable density thinning of second growth to better support populations of northern flying squirrels, a major prey species of northern spotted owls. He also incorporated this technique into "biodiversity pathways," a landscape-level management approach for meeting multiple objectives that DNR later adopted as part of its agency-wide silvicultural approach.

The challenge for DNR was writing variable density thinning prescriptions for large areas. DNR instructed loggers to create half-acre gaps for every 10 acres of thinning. Loggers were asked to avoid thinning in sensitive areas (called "skips" because loggers skip those areas) and to retain certain species of trees. They also were given a target relative density that ranged between 35 and 50. The result was a stand that was thinned more heavily in some places than others. Techniques have been refined over the years, but the basic concepts have remained the same.

For patterning the gaps, DNR had little to go on. How common are they? What shape do they tend to be? Despite decades of forest research, the scientific literature was curiously silent on gap geometry in the old-growth forests of the Pacific Northwest. Without those answers, DNR's success was hard to gauge. So DNR began a study appropriately named "Mind the Gap."

The Study

For this study, DNR wanted to understand how the managed forest responds to gaps and how to make the gaps (size, shape, and frequency) resemble those found in older forests. The study was done in three parts: a look at the half- acre gaps created at least 10 years ago in western hemlock and Douglas fir stands, an analysis of gaps in mature and old-growth forests, and a test of a common gap shape and size in a timber sale. The end product would be refined prescriptions for creating gaps.

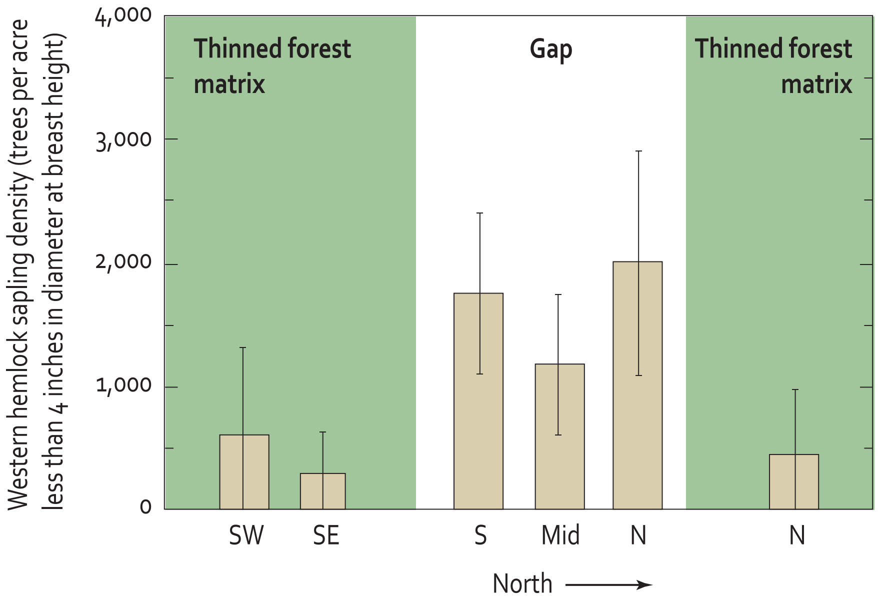
For the first part of the study, DNR compared aerial photos taken before thinning to those taken recently and took detailed field measurements. Results are still preliminary. But generally speaking, and despite a lack of site preparation and planting, the forest had surged into the gaps. Nearly 90 percent of the gaps measured were occupied by trees. Western hemlock averaged 1,400 to 2,100 stems per acre. One gap had as many as 3,600 stems per acre, which is many more than the surrounding forest (Photo 2 below and Graph 1 on page 4). Gaps also saw recruitment (establishment) of Douglas fir, Sitka spruce, western redcedar, and Pacific silver fir, albeit in lower numbers. Height growth in the gaps ranged from 16 inches per year for silver fir, hemlock, and redcedar to a robust 30 inches per year for Douglas fir. Shrubs were seldom dominant, easing fears that gaps would create "brush holes" in the forest.

Despite a lack of site preparation and planting, the forest had surged into the gaps.

John Stanek, DNR

Photo 2. Young western hemlock trees growing in a gap

What about gap shape? When gaps were first created, DNR feared that wind would gather speed across the opening and slam into the trees on the windward side, pushing them to the ground. It did happen. But it happened only in a quarter to a third of the gaps, and gaps only expanded a tenth to a quarter of an acre. And some tree crowns along the edge widened into the gap by as much as three feet, seemingly in response to increased sunlight.



Graph 1 . Western hemlock regeneration within the gaps

To study the naturally-created gaps in older forests, DNR analyzed light detection and range (LiDAR) data and followed up with field verification. With LiDAR, lasers mounted on a small airplane are used to take measurements of the forest and ground. From these measurements, DNR creates a canopy surface model, which is essentially a topographic map of the top of the tree canopy, and a digital elevation model, which provides the contours of the ground. Between the two, one can determine the location, size, and shapes of gaps.

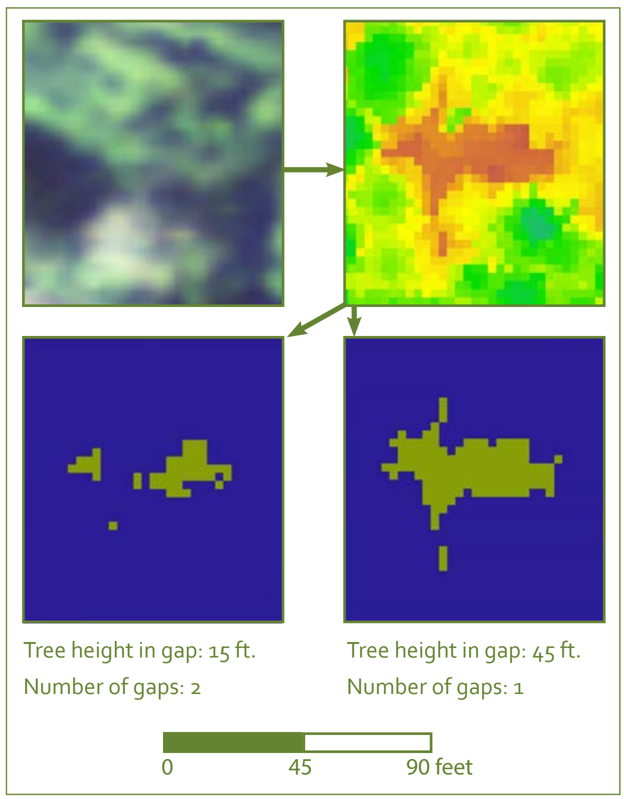


Figure 1. Delineating a canopy gap in an old-growth forest in the OESF

The size, shape, and number of gaps varies depending on the lower height threshold.

But what is a gap? Is it a place where one tree fell or several? Is it bare ground or can it be filled with young trees? If several gaps seem to be connected by thin spaces between trees, is that actually one gap? And how do you quantify the shape of gaps? Nature is messy and seldom obliges with something as straightforward as a square.

To solve the first problem, DNR applied filters to the data. For example, the gap had be a certain size and the difference in height between young trees in the gap and the overstory (Figure 1) had to fall within a defined range.

The second problem was tricky. Consider the shape in Figure 2 on page 5. How long is it? One could measure across the points that seem the farthest apart, but which two points?

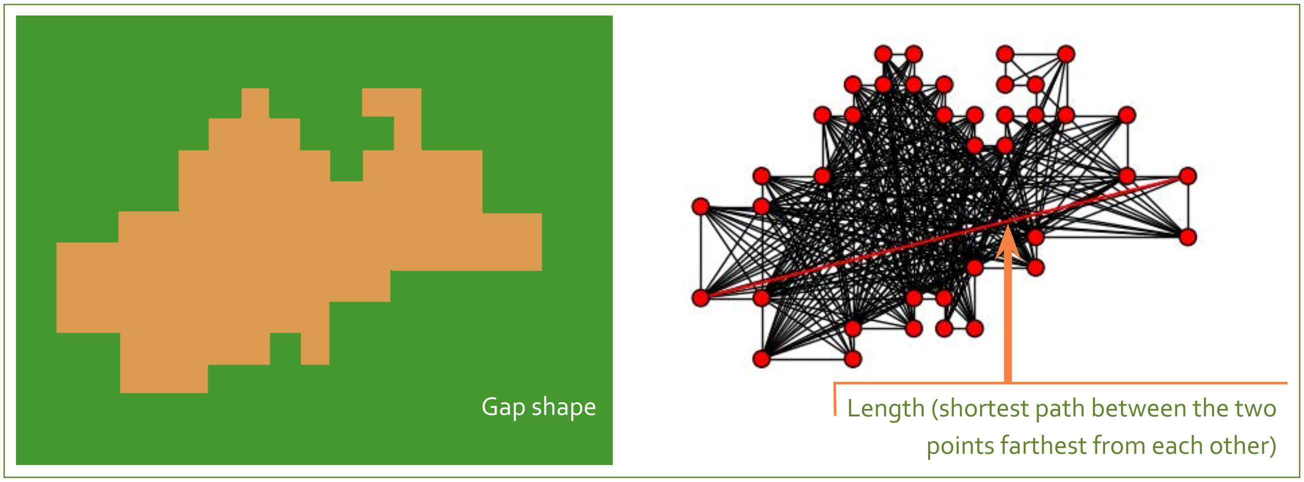


Figure 2. Determining gap length

To solve this challenge, project researchers wrote a computer program to determine gap length. The program measures the distance between every point that describes the outer edge of the shape. That exercise creates a dense spider web of lines. Then, the program uses those measurements to find the shortest path between the two points farthest from each other (Figure 2).

Analysis of the older forest continues. In the meantime, the team took advantage of a planned variable density thinning in a 40-year-old western hemlock stand to test the most prevalent gap shape seen so far in the older forest: long and skinny. The team instructed loggers to create 20 rectangular gaps and, for comparison, 20 circular gaps ranging in size between one eighth and one quarter acre and randomly distributed across the stand. Growth in and along the edges of the rectangular gaps will be compared to growth in the round gaps and a thinned area with no gaps. The first post-treatment measurements will be taken later this year.

Mind the Gap

So far, canopy gaps have been an ingenious way to balance revenue production and ecological values in the OESF, also called the learning forest. The trees removed to create the gap generate revenue and the gap itself supports ecological values by enriching the structure of the stand. And although the gap will eventually fill in with trees, chances are other gaps will be created through thinning or natural forces as DNR works toward a more complex forest.

Can the gaps be more effective? This study will continue to probe that question. More complete results will be shared as DNR continues to mind the gap in the OESF.

About the Authors

Cathy Chauvin is a writer, editor, planner, and graphic designer for DNR. She was part of the team completing the forest land plan and related environmental documents for the OESF.

Daniel Donato, Ph.D. is a natural resource scientist in DNR's Forest Resources Division, and an affiliate assistant professor at the University of Washington's School of Environmental and Forest Science. He conducts research and monitoring for upland forest habitats in support of DNR's *State Trust Lands Habitat Conservation Plan.* Dan is leading the Mind the Gap study. For questions about this study, contact him at daniel.donato@dnr.wa.gov.

Guest Article

Fishers on the Olympic Peninsula

Once Again, and Hopefully Here to Stay

by Jeffrey C. Lewis, Washington Department of Fish and Wildlife; Patti J. Happe, Olympic National Park; and Kurt Jenkins, US Geological Survey

Paul Bannick, Conservation Northwest

Photo 1. A female fisher picking up speed after being released

Lewis and Clark and the Corps of Discovery gave us a sense of what the Northwest looked like, felt like, and really was like about 213 years ago. Their perspective is valuable because the landscapes, forests, water, fish, wildlife, and people are now different in many ways. Unfortunately, in some ways, different means gone. For example, gray wolves, California condors, and an almost unknown carnivore known as the fisher (Photo 1) were lost from much of the Northwest, including Washington State. Progress toward the recovery of condors and wolves is well known; however, the fisher is a species that most Northwesterners have never even heard of, so it is no surprise that most do not know it was lost.

A mid-sized member of the weasel family (the Mustelidae family, which also includes mink, martens, skunks, otters, badgers, and wolverines), fishers commonly occupy landscapes characterized by a mosaic of forest developmental stages. These mosaics tend to be dominated by old-growth and mature forests because these forests contain an abundance of prey and the large cavity trees, snags, and downed logs that fishers require for den and rest sites.

Fishers once occurred throughout the vast conifer forests of Washington and Oregon, including Washington's Olympic Peninsula. But by the mid-1900s, the fisher had disappeared from much of this area. Because the fisher is the bearer of a beautiful fur coat, it was sought by many trappers in the mid-and late-1800s and early 1900s, well before there was a wildlife agency to protect it from over-exploitation. The extremely high value of a fisher pelt (as much as $150 in the early 1900s, the equivalent of roughly $3,700 in 2017), a lack of fisher harvest regulations, and a growing number of trappers were the major causes for the fisher's decline and eventual disappearance from Washington. While this is an unfortunate history, it shows us that we did not lose fishers because we lost the habitats required by a self-sustaining fisher population; we lost fishers because we did not protect fisher populations adequately. Fortunately, that is a problem we can fix.

The loss of fishers to over-trapping is not unique to Washington, and neither is restoration. Fisher restoration efforts have occurred across the northern US with support from trappers, conservationists, wildlife managers, and foresters alike. The reasons for restoring fishers ranges from restoring ecosystem integrity to porcupines. For example, one of the fisher's ecological roles and fascinating life history traits is its ability to efficiently and effectively prey upon porcupines. This particular trait endears fishers to foresters, who take exception to the damage porcupines do to merchantable timber. Innovative foresters and wildlife managers discovered that restoration of fisher populations can succeed and also reduce porcupine damage to commercial timber. In fact, the fisher is one of the most successfully restored carnivores, which demonstrates that restoration works when large expanses of habitat remain within a species' historical range.

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The fisher has been listed as a state endangered species in Washington since 1998. We began fisher restoration activities in Washington with a 2004 reintroduction feasibility study, which indicated that self-sustaining fisher populations could be restored in three areas of the fisher's historical range in Washington: the Olympic Peninsula, the southwestern Cascade Range, and the northwestern Cascade Range. Because Olympic National Park on the Olympic Peninsula contained the largest amount of well-connected habitat, we initiated fisher reintroductions there. From 2008 to 2010, we captured and translocated a total of 90 fishers (50 females and 40 males) from central British Columbia and released them in the park (Photo 2). The release was a cooperative effort of the Washington Department of Fish and Wildlife, the National Park Service, Conservation Northwest, the US Geological Survey, and many other partners.

Because each released fisher had a radio transmitter, we learned a great deal about their movements, survival, and home-range establishment. Many fishers moved extensively across the Olympic Peninsula after being released, whereas a smaller number established home ranges near the release site and shortly after being released. While males established home ranges broadly across the Peninsula, the majority of females (79 percent) established home ranges within Olympic National Park and Olympic National Forest. We found that survival rates varied significantly among the cohorts released over the three release years, and that survival rates varied between the sexes (males had higher survival rates than females) and between the age classes (juveniles had higher survival rates than adults).

We also completed a monitoring project involving the use of remote cameras and hair-snare cubbies across the Olympic Peninsula from 2013 to 2016 to evaluate the reintroduction's success (Photo 3 and Figure 1 on page 8). We learned that fishers are widely distributed and consistently occupy a considerable portion of the Peninsula, and that this population is dominated by 2nd and 3rd generation descendants of the original 90 we released.

Although we have learned a great deal, the end of the story is not yet told. We and other state, federal, tribal, and non-governmental organizations are now updating information on the current distribution of fishers by using data acquired during the 2013 to 2016 monitoring project. Our goal is to learn more about the specific mosaics that support fishers on the Peninsula to better understand where fishers currently live and thrive. Number crunching should be completed soon.

Paul Bannick, Conservation Northwest

Photo 2. A female fisher heads off into her new home after being released

National Park Service

Photo 3. A male fisher photographed at a fisher detection station on Olympic National Park in 2015

The triangular object on the right is a hair-snare cubby; the fisher enters to take the bait and leaves strands of hair behind on the gun brushes that are set into the sides.

We are not ready to shout from any rooftops that the restoration of fishers on the Olympic Peninsula is a resounding success; however, the signs so far are very encouraging. We hope you have the good fortune to see a fisher when you visit the Olympic Experimental State Forest, Olympic National Forest, or Olympic National Park, because we know, for a fact, that you could.

To learn more about fishers, fisher restoration, and fishers conservation in Washington, visit Washington Department of Fish and Wildlife's **fisher web page**.

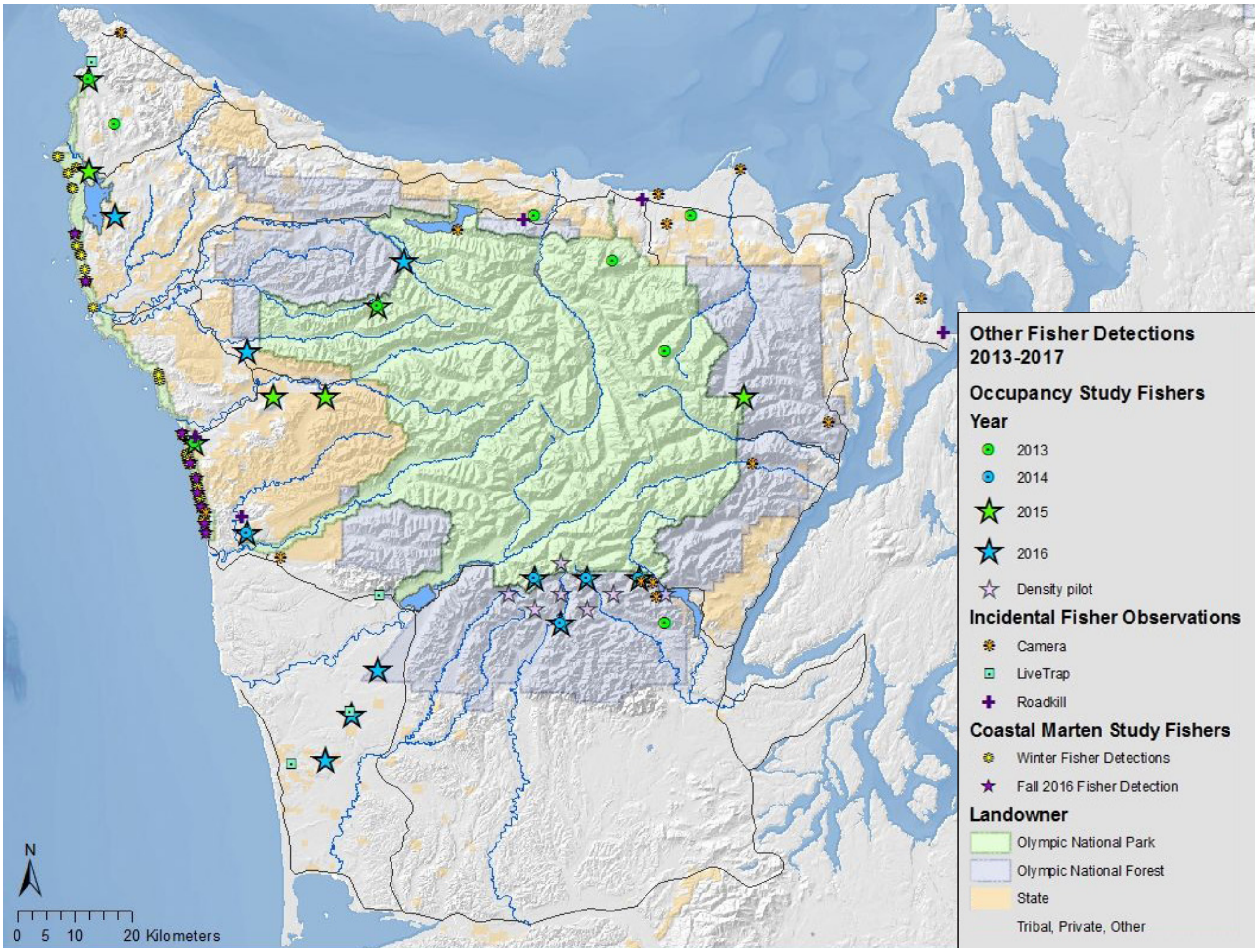
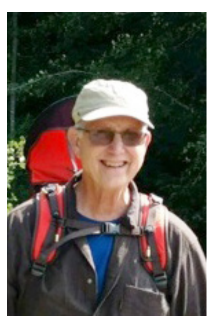


Figure 1. Fisher detections on the Olympic Peninsula of Washington from 2013 to 2017

About the Authors

Jeff Lewis, Ph.D. is a mesocarnivore conservation biologist with Washington Department of Fish and Wildlife in Olympia, WA. Jeff works to restore and protect at-risk populations of mid-sized carnivores (for example, fishers, wolverines, lynx, and Cascade red foxes) in Washington by coordinating and leading multi-agency teams of biologists in recovery, monitoring, and research projects.

Patti Happe, Ph.D. is the wildlife branch chief for Olympic National Park. She is the National Park Service lead for the Olympic fisher restoration project.



Kurt Jenkins, Ph.D. is a research wildlife biologist for the USGS Forest and Rangeland Ecosystem Science Center, Olympic field station and an affiliate professor at University of Washington's School of Environmental and Forest Sciences. He has worked with Jeff and Patti since 2008, monitoring restoration of Washington's Olympic Peninsula fisher population and providing a variety of scientific supports to national parks and tribes in the Pacific Northwest.

Project Updates

Ethnobotany

The Olympic Natural Resources Center (ONRC) has initiated a new program to learn about traditional use of plants by tribes in western Washington. ONRC will study the potential for growing and harvesting some of these plants for cultural and ecological purposes as part of forestry operations, specifically on Washington Department of Natural Resources (DNR) lands in the Olympic Experimental State Forest (OESF). Added to this, ONRC will explore commercial marketing and sales to defray costs and perhaps add jobs on the Olympic Peninsula.

ONRC will build relationships with tribal members, review primary literature, and learn from experts at the University of Washington and beyond. Students at the University of Washington's Native Plant Nursery will study propagation methods, bringing tribal history and culture back to main campus where students can learn and practice ethnobotany in a tangible way. Other satellite nurseries may be established on tribal lands to engage tribal youth, who also may help plant seedlings in the forest and track survival and growth. For more information, contact Bernard Bormann at bormann@uw.edu.

Influence of Repeated Alternative Biodiversity Thinning Treatments on Coastal Forests

DNR managers recognize the power of pre-commercial thinning (PCT) to influence how forest stands develop. For this study, DNR is exploring alternative approaches to PCT, including varying tree spacing and creating gaps, to increase forest structural diversity for wildlife habitat and the diversity of wood products produced. For this study, initiated in 1999 in cooperation with staff from DNR's Olympic Region, DNR is assessing the effects of these alternate approaches on both vegetation structure and timber production. DNR is quantifying treatment responses by field sampling a permanent plot network and analyzing canopy metrics using light detection and ranging (LiDAR)-derived data. Information gained from this project will inform DNR's decisions about the value of different treatment options in meeting multiple management objectives.

After the initial PCT, DNR completed a second thinning in the spring of 2017. The second thinning was more uniform; however, this thinning introduced gaps into the plots that did not receive them in 1999. DNR will begin post-thinning measurements in the fall of 2017. For more information, contact Richard Bigley at richard.bigley@dnr.wa.gov.

Impact of Military Flights on Olympic Soundscapes

Noise disturbance from military training over the Olympic Peninsula has been steadily increasing over the past decade. Concern is rising about how current and future noise could impact the unique biota in the region, the residents who live here, and the millions of visitors who arrive to enjoy wild and pristine areas.

In the spring and summer of 2017, University of Washington researchers installed sound recorders in several locations on the western Olympic Peninsula, including the OESF. Project objectives are to 1) assess the timing, frequency, duration, and magnitude of noise from military flyovers; and 2) characterize the impact of the disturbance on the overall biophony (the collective sounds that wildlife make in a given environment), as well as the activity of two focal bird species, the Pacific wren and varied thrush.

In addition to assessing the noise impacts from military jets, this study will inform future acoustic monitoring of wildlife in forested lands, for example monitoring of marbled murrelet calls. For more information, contact Lauren Kuehne at lkuehn@uw.edu.

Teodora Minkova, DNR

Sound recorder near Forks in the OESF

Large Scale Integrated Management Experiment

On September 14, 2017, DNR and ONRC officially launched this experiment with the selection of about 22,000 acres of state trust lands in the OESF. Researchers will compare three different management strategies, each of which represent a different intensity of integrated management: as described in the current **forest land plan**, with more integration of revenue production and ecological values than the forest land plan, and with less integration than the forest land plan. An unmanaged control watershed was designated for a 10-year period only, and each management strategy was randomly assigned to four replicate Type 3 watersheds (drainages around the smallest fish-bearing streams) that were approximately 1,400 acres each. In addition, approximately 10,700 acres of state trust lands in the OESF were selected for stand-level experimentation. Ecological, economic, social, and operational feasibility responses to experimental treatments will be monitored over the long term using field and remote sensing data.

DNR and ONRC developed the **study proposal** in 2016 with input from a diverse group of stakeholders, and will consider stakeholder input when developing the study plan. Researchers from the University of Washington, US Forest Service Pacific Northwest Research Station, NOAA Fisheries, DNR, and other organizations have been invited to collaborate in plan development. To see how the plan unfolds, check **this link** over the next several months. For more information, contact Bernard Bormann at bormann@uw.edu.

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.ed. Information on past and current projects in the OESF can be found at this **link**.

Upcoming Events

ONRC Evening Talks

Talks are held in the Hemlock conference room, ONRC, 1455 S. Forks Avenue in Forks, WA. For dates and times, contact Frank Hanson, ONRC Education and Outreach Coordinator, at fsh2@uw.edu.

Michael Pollock, a research fish biologist with NOAA Fisheries, will discuss a study to restore channelized streams by encouraging a local beaver population to build longer–lived dams.

Korena Mafune, a University of Washington Ph.D. candidate, will discuss her latest research on plant-fungal relationships in temperate old-growth rain forests, with a specific focus on canopy soils and host tree fungal interactions.

Recent Publications

Sampling Protocols for Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF

Editors Teodora Minkova (Washington Department of Natural Resources [DNR]) and Alex Foster (US Forest Service Pacific Northwest Research Station) published a compendium of stream and riparian monitoring protocols. One protocol describes field procedures for site establishment and nine protocols describe field sampling and data management procedures for the following habitat attributes: stream temperature, channel morphology, stream shade, channel substrate, in-stream large wood, habitat units and channel classification, stream discharge, riparian microclimate, and riparian vegetation. The protocols were written by the project's research and technical team.

Each protocol includes detailed sampling techniques, field forms, and robust quality assurance and control procedures, which are essential to ensuring the accuracy and repeatability of measurements for characterizing site conditions and temporal trends over the duration of this long-term project. The compendium is available on **DNR's website** as well as through the Forest Service Pacific Northwest Research Station **publications portal**.

Understory Development in Thinned Stands as Part of the Long-term Ecosystem Productivity Study (Masters Thesis)

Courtney Bobsin, a graduate student at the University of Washington, compared understory development in an untreated, 70-year-old Douglas fir stand to plots treated with three different silvicultural prescriptions: clearcut and replant with Douglas fir, clearcut and replant with a mix of conifer and red alder, and selective thinning. Analyses for the period from 1992 to 2016 showed that, particularly in the plots that were clearcut and replanted, the prolific growth of salal and bracken fern had negative impacts on the growth and establishment of other understory species. In the thinned plots, naturally-regenerated tree seedlings and saplings were more abundant than in the clearcut plots. In the plots clearcut and replanted with a mix of conifer and red alder, the red alder did not influence the understory but appear to have suppressed the regeneration of western hemlock, allowing greater establishment and survival of young Douglas fir trees.

Featured Photos

Cathy Chauvin, DNR

OESF Science Conference in Forks, Washington, April 2017

Over 80 people attended this year's conference, which included presentations about ongoing research and monitoring projects in the OESF and an afternoon field tour to DNR-managed lands.