Issue 16 • Fall 2024

The Learning Forest

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

From the Editorial Board

This issue of The Learning Forest examines how light detection and ranging (lidar) data, coupled with machine learning, can be utilized to analyze, identify, and map forested landscapes.

In the featured article, Robert McGaughey of the USDA Forest Service describes how a model built with lidar data can be trained to distinguish between Douglas-fir and western hemlock trees. Foresters walking on the ground can easily distinguish between these distinctive species. However, it is more challenging to identify species remotely using a model, in particular at larger spatial scales. Machine learning and statistical metrics were key to this approach. This innovative technique could open new possibilities for lidar data in forest planning, monitoring, and habitat assessments.

In the guest article, Anthony Stewart of the University of Washington describes using lidar data and machine learning to build a tool for identifying and mapping forested wetlands. Lead by Dr. Meghan Halabisky and Dr. Dan Miller, the team applied the tool to the Hoh River watershed on the Olympic Peninsula and found that wetlands covered significantly more area in this watershed than previously thought. Based on their mapping and soil analysis, they increased the current estimate of soil carbon stocks in this watershed by almost 500 percent. This research underscores the importance of wetlands to climate mitigation.

This issue also includes important project updates on the Type 3 Watershed Experiment, recent publications, and upcoming evening talks at the Olympic Natural Resource Center. We hope you enjoy this issue of The Learning Forest.

What's Inside?

Featured Article

Guest Article


Miles Micheletti, DNR

Photo of the forest captured by a UAS.

Featured Article

The View from Above:

Using UAS Lidar to Recognize Tree Species

By Robert J. McGaughey, USDA Forest Service, Pacific Northwest Research Station and Cathy Chauvin, DNR

Whether planning timber sales, meeting ecological objectives, or both, managing a forest requires a profusion of data.

Data collection is often the job of foresters and other field personnel, who go out in good weather and bad to set up field plots and survey what they find. These data are used to summarize species, basal area, volume, stem density, biomass, and other variables.

As much as foresters enjoy being outside, field data collection can be time consuming and expensive, especially in remote areas with limited road access. So foresters augment traditional data-gathering methods with remote sensing technology such as light detection and ranging (lidar). With this technology, large areas can be surveyed from above using sensors mounted on an airplane or an uncrewed aircraft system (UAS, commonly called a drone).

Unfortunately, it can be difficult to recognize tree species at this scale using lidar data. It has been done, but usually with a limited number of species and a small geographic area.

A team of researchers from the Pacific Northwest Research Station and University of Washington set out to meet this challenge in the experimental watersheds of the Type 3 (T3) Watershed Experiment in the Olympic Experimental State Forest (OESF). Their goal was to train a classification model to distinguish between Douglas-fir and western hemlock using UAS-collected lidar data from multiple harvest units. Hemlock and Douglas-fir are both common on the Olympic Peninsula but have different stumpage values as well as ecological significance. Being able to distinguish one species from the other using lidar data would be a significant boon to planning and management.

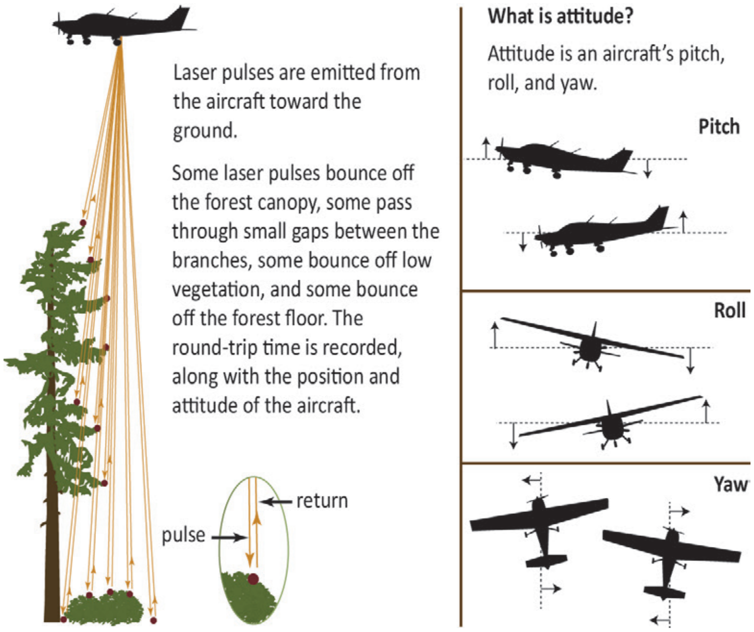
Training a Model

Although it sounds like science fiction, lidar is widely used today, even in cars and cell phones.

During a data-gathering flight, the lidar sensor mounted on the aircraft emits pulses of laser energy downward, then measures the travel time from the sensor to an object on the ground and back (Figure 1). These measurements are combined with information describing the precise position and attitude of the aircraft (its pitch, roll, and yaw) to create points that describe the forest in detail. An additional usable attribute for each point, called intensity, is a measure of the amount of energy reflected from the object.

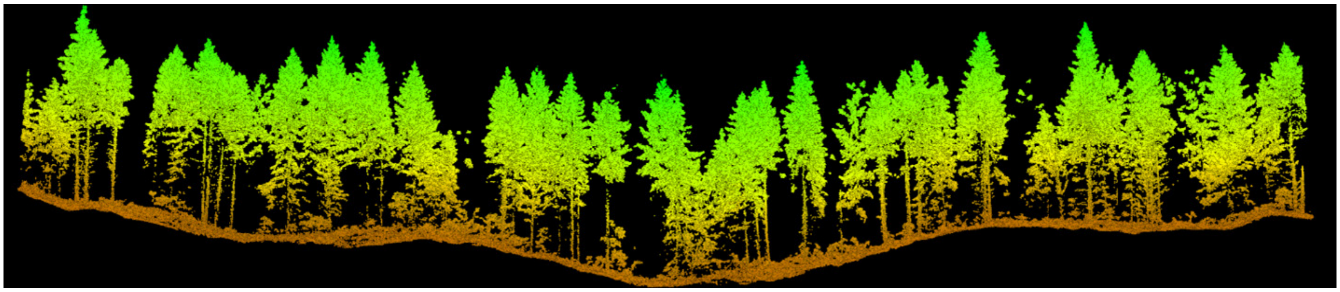
The most basic data produced by lidar sensors is the three-dimensional point cloud, which can capture the tree canopy and the ground surface, even in areas with dense tree cover (Figure 2). Point clouds can also be used to develop a digital elevation model, which represents the ground surface, and a canopy height model, which is a direct measurement of vegetation height for the entire area covered by the data.

The choice of aircraft matters. Many plane-based lidar sensors produce data with densities of 8 to 15 points per square meter. By contrast, UAS-mounted lidar sensors have much higher point density and smaller beam size, enabling them to capture fine-scale differences in foliage



Cathy Chauvin, DNR

Figure 1. Lidar measurements.



Bob McGauhey,USFS

Figure 2. Cross section of UAS lidar point data showing points from trees, understory vegetation, and the ground.

and branch patterns. This level of detail is helpful for tree species identification.

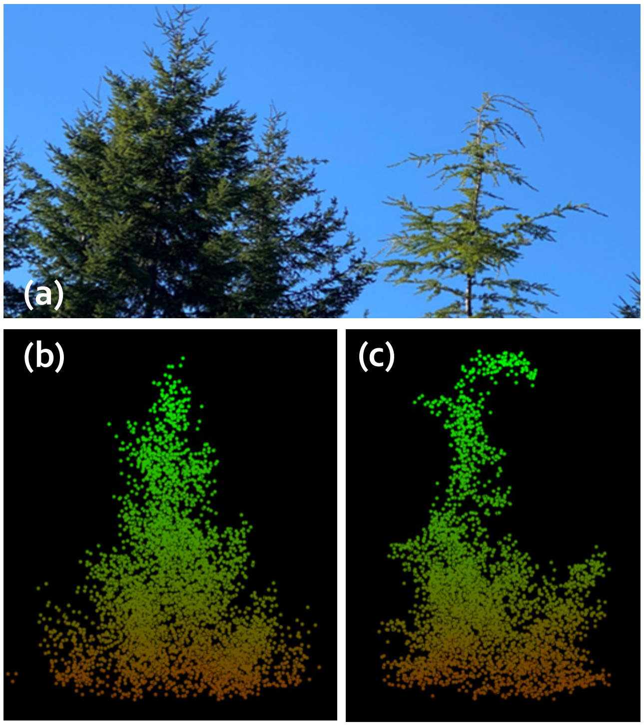
For this project, the team used UAS lidar data that were collected in 2021 from multiple harvest units in watersheds that are part of the T3 Experiment. Data were collected from a height of 50 to 80 meters, depending on the height of the trees, to produce final densities averaging over 1,000 points per square meter.

The team's approach involves using machine learning to "train" a species classification model to distinguish between western hemlock and Douglas-fir based on the shape of the tree's upper crown. Western hemlock has a distinctive crown shape with a "droopy leader" captured by the lidar point cloud (Figure 3).

Machine learning is a technique that mimics the way our brains organize and process information. When it comes to identifying plants, humans utilize a variety of visual cues including bark color and texture; foliage type (leaf or needle), color, arrangement, and shape; growth form; and environment (where the tree or plant is growing). Machine learning is similar, but for this study, the model does not use visual cues to determine tree species. Instead, it uses statistical metrics computed from the lidar point cloud.

Researchers measured 575 trees on 27 field plots located in the same area from which the lidar data were collected. Measurements included diameter, species, azimuth, distance between trees, and observations such as bear damage and broken tops. Plot and stem locations were determined using GPS positions for the plots and measurements from the center of the plot to every tree.

Researchers computed 86 statistical metrics that described the distribution of point heights and intensity values associated with those 575 trees. Then, researchers trained the model using a general-purpose, machine-learning technique called "random forest." In this technique, the model uses the statistical metrics to build a set of hierarchical classification rules for tree identification.



Bernard Bormann,ONRC

Bob McGauhey,USFS

Figure 3. Photograph (a) and cross section of point clouds showing the upper portions of crowns for Douglas-fir (b) and western hemlock (c). The trees in the photograph are not the same trees shown in the point clouds.

Modeling results showed that point cloud metrics for the upper three meters of a one-meter radius cylinder centered on each treetop produced information the model needed to distinguish between Douglas-fir and western hemlock trees. Overall accuracy using metrics derived from point heights and intensity values was as high as 91.8 percent.

Careful examination of the small, cylindrical point samples confirmed that western hemlock had a higher proportion of points near the top of the crown due in part to the droopy leader. Of the metrics used in the classification model, the one that best represents the proportion of points near the top of the crown, the 99th percentile height (meaning 99 percent of the points are lower than this height) was the most important metric when training the classification model.

To demonstrate the utility of the model, researchers mapped Douglas-fir and western hemlock across a 28-hectare (69-acre) harvest unit in the Clearwater River watershed of the OESF. First, researchers used a canopy elevation model to delineate individual tree crowns in the lidar point cloud, then computed metrics describing the distribution of points for each of these trees. Once this was complete, they applied the model to the unit using the point height and intensity metrics computed for each of the isolated trees.

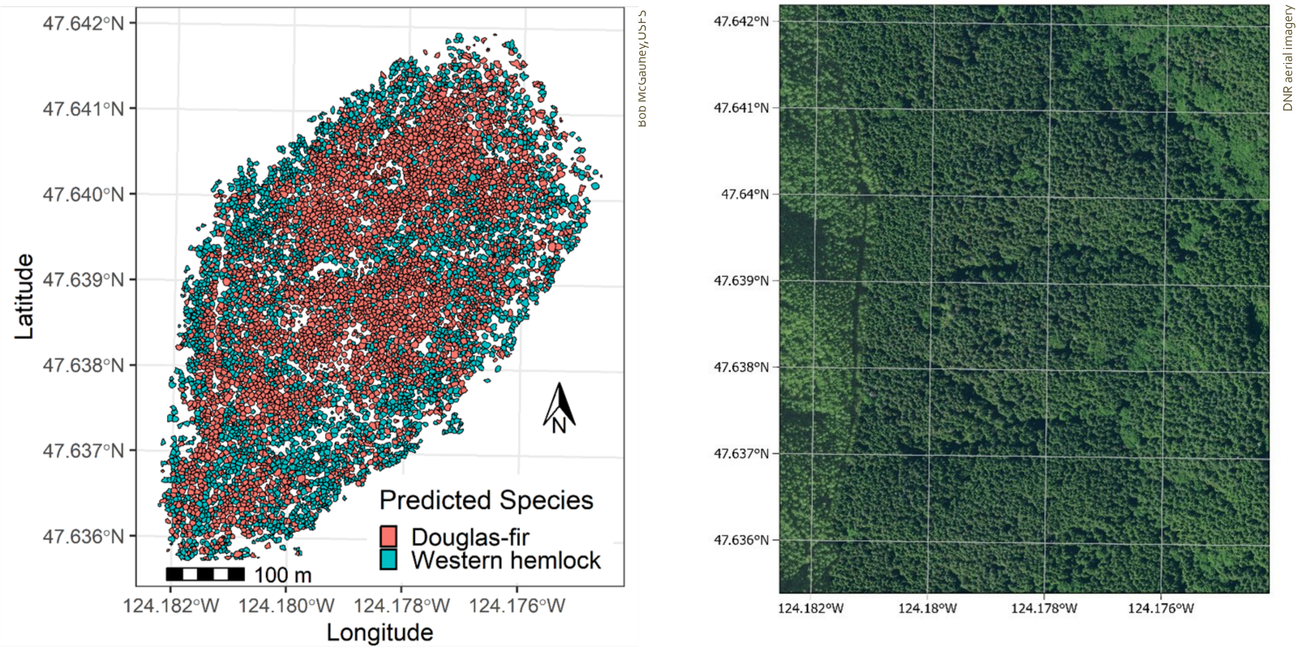
Results are shown in Figure 4. This unit is relatively even-aged and dominated by Douglas-fir and western hemlock. Because the model is limited to Douglas-fir and western hemlock, any other species in the unit will be misidentified. These other species are not shown in the graphic.

Although the map in Figure 4 covers only 69 acres, the model could be applied to larger areas or multiple harvest units. The only true spatial limitation for this technique is related to the data collection process. The UAS can only fly so long before the batteries need to be changed, and the more flights that are needed to cover an area, the more complex the data processing becomes. Practically speaking, the aircraft and sensor used for this study can collect data for areas up to about 500 acres.

A Look Ahead

Being able to completely map species provides valuable information for foresters as they plan forest management activities. This technique could be used to improve forest inventories and may also prove useful for monitoring, timber valuations, and habitat assessments in remote areas. Uses will likely continue to evolve along with the technology. Encouraged by this success of this project, researchers are expanding this work to cover more tree species, specifically western redcedar, to make this work even more useful.

With a UAS, the data needed for this work can be captured at specific times or when conditions are "just right." This advantage, coupled with streamlined logistics, automated flight planning, and efficient data pro-



Bob McGaughey, USFS

DNR aerial imagery

Figure 4. Map showing the classification model applied to data representing individual trees identified using a CHM to map species over a 28-hectare harvest (left). The photo on the right shows the same area and highlights the difficulty of distinguishing species using aerial photos alone.

cessing workflows, means that a UAS is well suited for frequent collection over small areas such as harvest units or watersheds to facilitate management planning and monitoring.

But fear not. Even advanced technology like UAS and lidar still require some field work. There will always be opportunities to don cork boots for a day in the rainy wilds of Washington.

For More Information

[Learn more about tree classification using lidar data at this link.]

About the Author

Robert (Bob) McGaughey is a research forester with the USDA Forest Service, Pacific Northwest Research Station and an affiliate instructor at the University of Washington. His research focuses on using lidar data to inform forest inventory and management and developing lidar software tools. He is the developer of the FUSION/LDV lidar data processing and visualization software suite. He can be reached at Robert.Mcgaughey@usda.gov.

Recent Publications

Toskey, E. K., S. M. Bollens, G. Rollwagen-Bollens, P. M. Kiffney, K. D. Martens, B. Bormann. 2024. Stream Algal Biomass Associations with Environmental Variables in a Temperate Rainforest. Water, 16, 1533.

This study explored how benthic algae (algae attached to the stream bed substrate) and seston (algae suspended in the water) 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 experimental watersheds of the Type 3 (T3) Watershed Experiment. Stream algae are important bases of stream food webs and therefore a key environmental indicator for the T3 Experiment.

The study found that benthic algae's chlorophyll-a concentration, which is used as a proxy for algal biomass, increased with stream temperature and decreased with water velocity. The seston's chlorophyll-a concentration increased with benthic macroinvertebrate predator abundance and stream temperature.

Learning about these relationships will help interpret the algae response to the riparian treatments in the T3 Experiment and help distinguish between management effects and environmental variation.

Kyle Martens. 2024. Riparian Validation Monitoring Program 2023 Annual Report. Forest Resources Division, Washington Department of Natural Resources, Olympia, WA, 40 p.

The 2023 Riparian Validation Monitoring Annual Report includes results from 67 fish population surveys across 36 validation and 31 T3 Watershed Experiment reaches, 22 coho redd (nest) surveys, and 12 kilometers of snorkel surveys in the Clearwater River performed during summer 2023. The team observed continued increases in juvenile coho and age-0 trout populations, but did not observe similar increases in age-1 or cutthroat trout. The report presents initial findings from watershed 488, which underwent a variable retention harvest two years ago. Findings show that fish density and biomass maintained similar levels before and after harvest. The report also includes findings from snorkel efforts on the Clearwater River and reiterates recommendation to promote fish habitat restoration in the lowest stream reach.

Miles Micheletti, DNR

Snorkel survey in the Clearwater River.

Guest Article

Using Advanced Mapping to Uncover Hidden Carbon Stocks in Forested Wetlands

By Anthony Stewart, Meghan Halabisky, David V. D'Amore, David Butman, Chad Babcock, and L. Monika Moskal, University of Washington

In Washington state, forested wetlands are unique ecosystems that blend the characteristics of both forests and wetlands, creating environments rich in biodiversity and ecological functions. Often characterized by waterlogged soils and a dense canopy of trees, these wetlands are scattered across the state's diverse landscapes, from lowland forests to mountainous regions (Photo 1).

Despite their elusive nature, forested wetlands play a crucial role in the carbon cycle. They are significant carbon reservoirs, storing large amounts of soil carbon. Carbon accumulates in wetlands due to the lack of oxygen in their waterlogged soils, which reduces microbial activity that breaks down organic matter. By accumulating carbon, forested wetlands help mitigate climate change.

Traditional wetland and carbon mapping techniques have often overlooked these hidden carbon stocks, leading to an underestimation of their extent and true value and importance in carbon budgeting and conservation efforts. These issues motivated our team at the University of Washington to develop a new approach to identifying and mapping wetlands and wetland carbon stocks. The team was led by Dr. Meghan Halabisky, along with Dr. Dan Miller.

Mapping Wetland Potential

Our approach involved the development of the Wetland Intrinsic Potential (WIP) tool. The WIP tool uses remote sensing to map forested wetlands, the key to which is aerial light detection and ranging (lidar) technology. Lidar uses lasers mounted on a small airplane or uncrewed aircraft system (UAS, also called a drone) to create detailed maps of the earth's surface. Aerial lidar is especially useful for mapping areas with a lot of vegetation, as the laser pulses can penetrate through leaves and branches to reach the ground and capture the fine details of the topography.


Anthony Stewart, UW

Photo 1. Forested wetland in the Cascade Mountains.

For this project, we used a lidar-derived digital terrain model to calculate terrain metrics such as slope, curvature, and depressions. These metrics also were calculated for different scales to achieve a more comprehensive characterization of the topography. We then used machine learning to combine these terrain metrics with additional remote sensing data and known wetland locations to create new forested wetland maps of the Hoh River Watershed on the Olympic Peninsula (Figure 1.)

The new maps show continuous wetland probability ranging from 0 to 1.0, which corresponds to wetland development. Uplands with no wetland features such as saturated soils or standing water have a probability of less than 0.5. Areas with some wet soils have a probability of approximately 0.5, and wetlands with multiple wetland features such as saturated wet soils, standing water, or wetland specific vegetation have a probability between 0.5 and 1.0.

Next, we hypothesized that the WIP tool probability would help us predict wetland soil carbon stocks because soil carbon increases with soil water saturation. We addressed this hypothesis in our recent study, [Revealing Hidden Carbon in Forested Wetland Soils](), for which we investigated hidden carbon in forested wetland soils in the Hoh River Watershed.

Our approach included taking soil samples at random locations that corresponded to values evenly distributed along the 0.0 to 1.0 WIP gradient. At each location, we dug a soil pit down to at least 1 meter or to a restricting layer (such as bedrock) and characterized the soil horizons by color and texture (soil horizons are unique soil layers parallel to the surface) (Photo 2). We took a sample from each horizon for further analysis of the

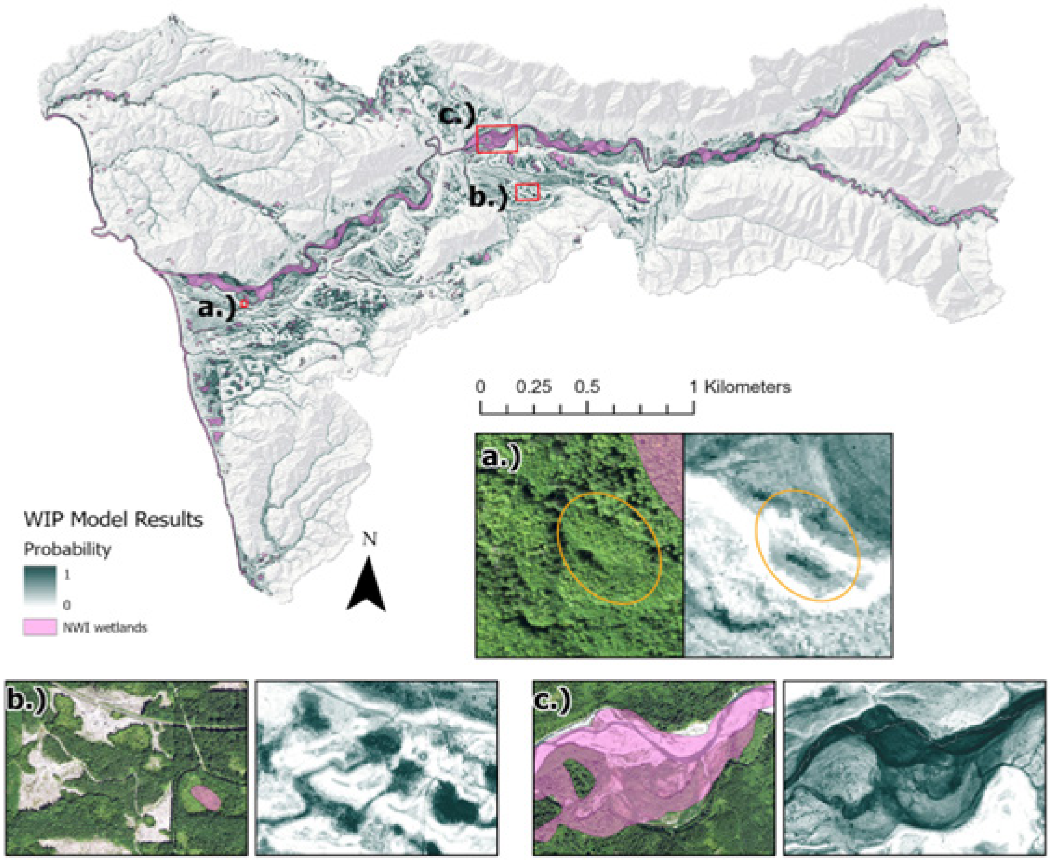


Figure 1. From Halabisky et al., 2023, Wetland Intrinsic Potential (WIP) map of the Hoh River Watershed with three examples: depressional wetland (a), peatland (b), and riverine wetland (c). Current mapping by the National Wetland Inventory (NWI) is shown in pink.


Anthony Stewart, UW

Photo 2. An example of a wetland soil pit with marks for each horizon.

carbon content, which was used to calculate the carbon stocks for each point. Finally, we used GPS location data to build a spatial model and map of soil carbon stocks across the entire Hoh River Watershed.

The soil carbon map in our study revealed new patterns of wetland soil carbon that are significantly underestimated by current wetland and soil carbon maps (Figure 2). The current maps of wetland soil carbon and extent estimated that wetlands only covered approximately 2 percent of the surface area and 3 percent of the total soil carbon in the Hoh River Watershed. However, our estimates showed that wetlands covered 9 percent of the surface area and stored approximately 20 percent of the total soil carbon. This disparity was due in large part to the unmapped forested wetlands, which we termed “cryptic carbon.” By incorporating this newly identified cryptic carbon, we increased the estimated soil carbon stock of wetlands by nearly 500 percent, compared to previous soil carbon map estimates. These results highlight the dramatic underestimation of wetland soil carbon.

This research underscore the critical role forested wetlands play in carbon storage. These ecosystems are not only biodiversity hotspots, but also significant carbon reservoirs that are highly vulnerable to land-use changes. Understanding the distribution and magnitude of soil organic carbon in forested wetlands enables the creation of policies that restrict activities likely to degrade these essential ecosystems. Prioritizing the conservation of these areas is essential, especially in light of recent legislative rulings (such as Sackett vs. EPA in the U.S. Supreme Court) that may threaten wetland protections.

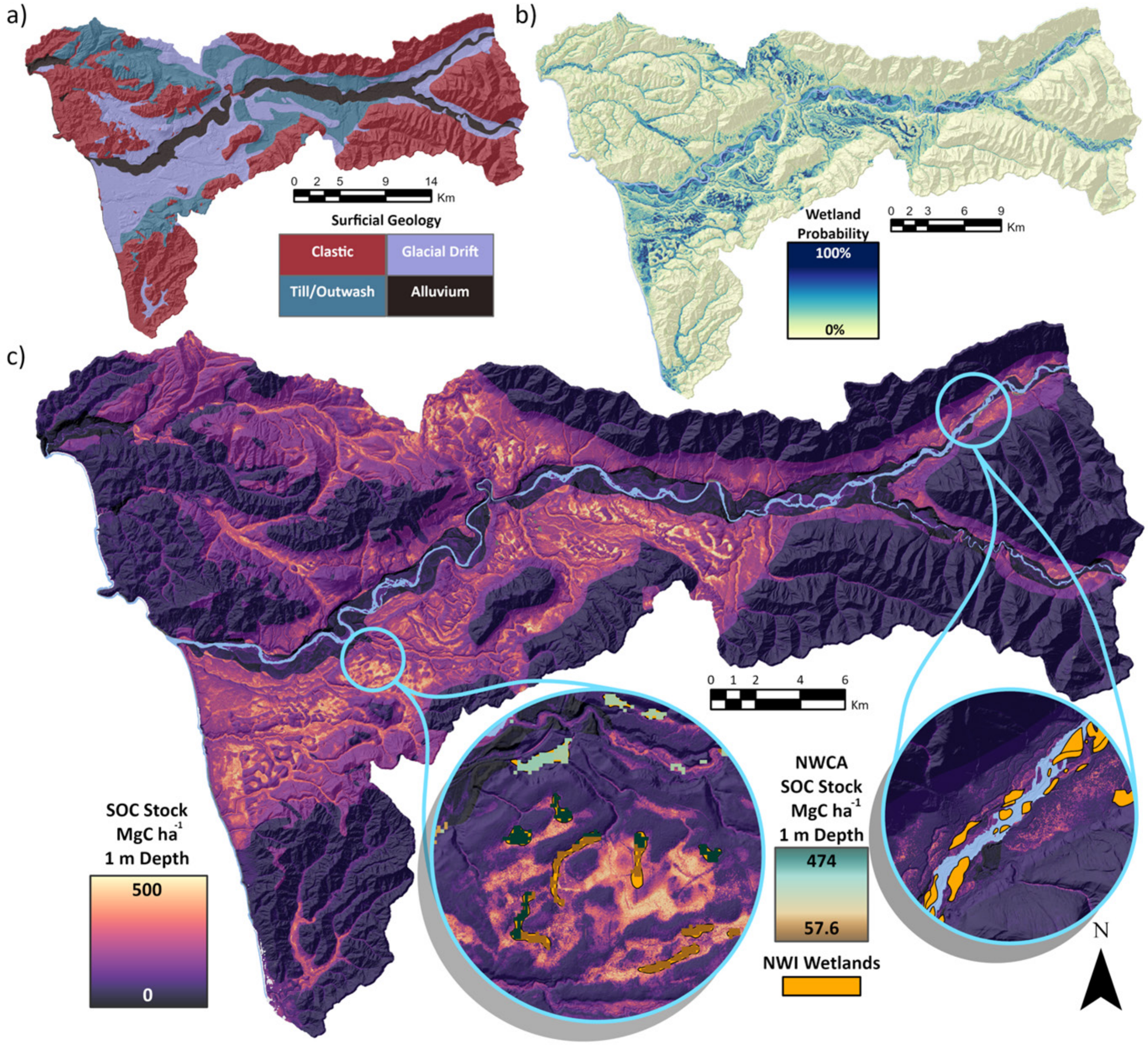


Figure 2. From Stewart et al., 2024, maps of the Hoh River Watershed showing a) the surficial geology, b) the wetland intrinsic potential (wetland probability on a percent scale), and c) the map of soil organic carbon. The circular, zoomed insets show comparisons to currently available, estimated wetland extent from the National Wetland Inventory (NWI) and wetland extent with soil organic carbon stocks from the National Wetland Condition Assessment (NWCA).

Our research provides a foundation for future studies on the carbon dynamics of forested wetlands and the refinement of mapping techniques, encouraging ongoing collaboration and research. Adopting advanced mapping techniques, such as the soil mapping and wetland identification metrics demonstrated in our study, can improve the accuracy of soil carbon maps, guiding more effective identification and protection of high-carbon areas.

In summary, our research offers vital insights that can significantly inform and enhance the work of foresters, biologists, and land managers in Washington state. By addressing the hidden carbon stocks in forested wetlands, we can improve conservation efforts, refine land management practices, and support climate change mitigation, ensuring the protection and sustainability of these critical ecosystems.

About the Author

Anthony Stewart is a PhD student at the University of Washington studying the carbon storage and geographic distribution of forested wetlands. He uses a combination of remote sensing, soil science, and machine learning to build detailed maps of carbon stored in wetlands. He can be reached at ajs0428@uw.edu.

T3 Watershed Experiment Updates

The Type 3 (T3) Watershed Experiment is a roughly 20,000-acre experiment that is being implemented across 16 watersheds in the Olympic Experimental State Forest (OESF). Its purpose is to test novel land management strategies that benefit both communities and forests. For background, visit DNR's website or the project webpage.

Timber Harvests

Of the 13 timber sales implementing the T3 Experiment, three have been logged, eight are being logged now, and two are nearly ready for logging, with the necessary roads built. Most of the timber sales are progressing faster than expected, and most logging should be completed by November 2025.

The T3 research team is working with DNR foresters to collect data on compliance with the logging contracts and research designs. Compliance looks at prescription elements such as leave trees, riparian buffer widths, and log jams in streams. To assess environmental conditions immediately after harvest and establish a baseline for windthrow and biomass monitoring, the research team is using an unmanned aerial system (UAS, referred to as a drone) with and without lidar (Photo 1).

Silviculture

After logging is complete, the T3 researchers will begin implementing the silvicultural prescriptions that are part of the experiment. Most site-preparation activities will take place in the summer of 2025 and most of the tree planting will take place in the winter of 2026. Researchers are preparing detailed silviculture implementation plans to guide marking of sites in the field, site preparation, and planting.

DNR is building an implementation costs database capturing the costs of T3 timber sales planning, layout, and compliance, as well as the costs of silviculture activities such as site preparation, planting and vegetation control for all T3 prescriptions. The data will be used in an economic model comparing novel to standard prescriptions.

Monitoring

Teodora Minkova, DNR

Photo 1. Miles Micheletti, DNR's UAS Data Manager, plans a UAS flight over a recently logged T3 harvest unit.

The environmental responses to T3 experimental prescriptions are being monitored through multiple biotic and abiotic indicators. Having completed four years of pre-harvest monitoring, T3 researchers are now conducting post-harvest monitoring in logged riparian and upland areas. Riparian and aquatic indicators include fish, macroinvertebrates, periphyton (organisms that live attached to underwater surfaces), leaf litter, light, in-stream wood, water temperature, and water chemistry. Upland indicators include forest birds, woodland salamanders, and vegetation. Researchers from the T3 Experiment and the U.S. Geological Survey are cooperating to develop a wildlife study in which the response of large and medium size mammals to the T3 prescriptions will be monitored by cameras, beginning in the fall of 2024.

Snorkel Survey Changes in the Riparian Validation Monitoring Project

This summer, a modification was made to the existing snorkel survey of the Clearwater River to monitor habitat and fish. While the team will continue to monitor the upper and lower reaches of the Clearwater River, they will no longer monitor the middle reach. A narrow bedrock canyon, the middle reach has limited potential to either serve as a control for the upper and lower reaches, or to exhibit drastic habitat changes from DNR management or restoration activities.

Instead of the middle reach of the Clearwater River, the team will conduct snorkel surveys on a stream reach of the Snahapish River. Located on DNR-managed land, the new stream reach has recently been identified for restoration by a cooperative group led by the Quinault Indian Nation and Trout Unlimited. This change provided an opportunity to enhance collaboration with local stakeholders and leverage existing data to better understand the effectiveness of stream restoration efforts.

Remembering Frank Hanson

A Message from the Editorial Board

Frank Hanson, former co-editor of the Learning Forest, passed away August 23, 2024 after a long illness. We will remember him with great fondness as a thoughtful and kind person. He is known to so many people, through his remarkable contributions to the Peninsula's west end as superintendent to the Quileute Tribal School and by helping the Olympic Natural Resources Center connect deeply to the local community and tribal members.


Photo courtesy of the Hanson Family

Education and Outreach

Type 3 (T3) Watershed Experiment Learning Groups Update

The last few months have been productive for T3 Experiment learning groups, which are a key part of the learning based collaboration process. [Find out more about learning groups at this link].

Cedar learning group members are adjusting site selections and making final decisions on equipment purchases, such as fencing and tubing to protect cedar seedlings for the [cedar browse sub-study]. This study will examine the impacts of deer and elk browse on forest ecosystems and plant communities, including western redcedar.

The Invasive Species learning group continues to explore the use of remote sensing to document the presence and mechanisms of spread of invasive plants, in particular Scotch broom, on the Olympic Peninsula. University of Washington student Paisley Blume completed a [Scotch Broom Sub-study plan] to examine four treatment combination approaches to mitigating Scotch broom growth.

Given the [success of student research through the Type 3 (T3) Watershed Experiment], all of the learning groups (including the history, carbon, tribal, and aquatics groups) have compiled a list of sub-projects that could be accomplished by university undergraduate and graduate students interested in completing capstone or theses projects. T3 staff have begun an outreach program to share project ideas with future, potential students. If interested, contact Tracy.Petroske@dnr.wa.gov.

2024 Summer Interns

This summer, the Olympic Natural Resources Center (ONRC) hosted five interns and one field technician to complete the first post-harvest vegetation monitoring in the T3 Experiment. For the cedar-alder polyculture prescription and the ethnoforestry variable-density planting prescription, the interns established 30 new understory plots. For each plot, they collected data on the total percent cover for each species, the number of naturally regenerating tree seedlings present, and the total biomass, as well as spatial data on where these plots are located. These data will be paired with uncrewed aircraft system (drone) lidar and multispectral imagery to assess the total understory biomass across all of the recently harvested units for these two prescriptions.

In addition, the interns established permanent tree plots in the T3 control units to track growth and mortality of trees over time. From these plots, they collected data on tree species, diameter, mortality, and spatial position within the plot for stem mapping and linking to lidar data.


2024 summer interns. From left to right: Olivia Anderson, Wyatt Mojo, Kate Giesen, Maggie Koontz, and Sophie Goodson. Photo was taken by crew leader Paisley Blume.

The crew also worked on other studies across Washington and Oregon, and gave an ONRC Evening Talk on the wide variety of projects they worked on. Read more about their talk on the ONRC website.

Rosemond Evening Talks

The ONRC has announced three Rosemond Evening Talks for this fall. All talks are held at 7 p.m. PST at the Olympic Natural Resources Center, located at 1455 S. Forks Avenue in Forks, Washington. Talks may also be attended remotely via Zoom at this link. Visit this link to learn about previous talks.

Thursday, October 24, 2024:

Where's Waldo, Western Redcedar Edition: Locating Cedar Using UAV Lidar and Multispectral Imagery

Presented by Ally Kruper, University of Washington.

Tuesday, November 12, 2024:

What Are Earthquakes, How Do We Monitor Them, and How Do We Receive Forewarning?

Presented by Mickey Cassar., Pacific Northwest Seismic Network.

Wednesday, December 11, 2024:

Coastal Watershed Assessment Project: eDNA as a Freshwater Habitat Assessment Tool and its Potential for Tribal Fisheries Management

Presented by John Hagan, Northwest Indian Fisheries Commission.

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
Editorial Board:

- Teodora Minkova, Ph.D., OESF Research and Monitoring Manager, DNR
- Bill Wells, Olympic Region Manager, DNR
- Bernard Bormann, Ph.D., ONRC Director, University of Washington
- Courtney Bobsin, Ph.D., ONRC Research Scientist, University of Washington

All newsletter issues are available online. To receive this publication or to be added to the distribution list, visit our sign-up page or contact the editor at Cathy.Chauvin@dnr.wa.gov.

Featured Photo

David Riley, DNR

DNR Olympic Region Biologist and project coordinator Emily Gardner congratulating Dick Larson, owner of Double L Timber, for winning the 2023 Washington Exceptional Logging Contractor Award. The award is from the Washington State Sustainable Forestry Initiative® (SFI®) Implementation Committee (WASIC). The mission of WASIC is to foster an understanding of SFI and promote sustainable forestry practices on all forestlands in Washington. Mike Potter, Coast District Manager for DNR's Olympic Region, is holding the award in the background.

Emily nominated Double L for their excellent work implementing a timber sale that is part of the Type 3 (T3) Watershed Experiment. The timber sale included novel treatments in riparian and upland areas, such as thinning with gaps in the riparian forest and creation of log jams in streams.