Science Council Committee, Andrews Forest, May, 2012

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AN INTRODUCTION TO THE

H.J. ANDREWS EXPERIMENTAL FOREST

Prepared for the
2012 LTER Executive Board and Science Council Meeting
May 14-18, 2012

HJ Andrews Experimental Forest
Long-Term Ecological Research Program
Broadly representative of the partially-logged, rugged mountainous landscape of the Pacific Northwest, the Andrews Forest contains excellent examples of the region’s conifer forests and associated wildlife and stream ecosystems (Fig 1). Situated in the 15,800-acre (6400-ha) drainage basin of Lookout Creek, the Andrews is more than just a place to study old-growth conifer forests in steep terrain. It is also place to understand how forests of all ages, managed landscapes (Fig. 2), road networks, streams, and mountain ecosystems function and change as a result of natural processes and human activities.

The Andrews has a maritime climate of wet, mild winters and dry, cool summers. Precipitation falls primarily from November through March, and varies with elevation, averaging 91 inches (230 cm) at low elevations to over 140 inches (355 cm) at higher elevations. In the wintertime, rain is mixed with snow in the lower portion of Lookout Basin and snow is more persistent at higher elevations (above 1000 m) (Fig 3). Highest streamflows usually occur in November through February during warm-rain-on-snow events.

Forest composition varies from Douglas-fir, western hemlock, and western red cedar at low elevations to Pacific silver fir, noble fir, and mountain hemlock at higher elevations. The Douglas-fir/western hemlock forests in this area are among the tallest and most productive in the world. Average tree heights are in excess of 75 meters and a typical stand stores in excess
of 600 megagrams of carbon per ha. These forests and streams are also noteworthy for the large amounts of fine and coarse woody debris they contain. Rapidly flowing mountain streams are the primary type of aquatic ecosystem with seasonal trends in streamflow following the precipitation pattern. Small first and second-order streams under natural conditions are dominated by coarse woody debris and receive large annual inputs of litter which provides the energy base for the aquatic organisms. Larger streams have a higher proportion of the energy base provided by in-stream photosynthesis, but litter inputs and coarse debris remain important components of all stream ecosystems.

The Andrews Forest supports a rich flora and fauna for a north temperate ecosystem. More than 500 vascular plant species are known to occur. Typical half-hectare plots in the uplands include 35 to 40 species of vascular plants and riparian sites have twice that number. Over 3,400 arthropod species have been reported, which probably represents slightly more than half the actual total. About 20 species of reptiles and amphibians, seven species of fish, and 50 species of mammals occur here. Over 70 species of birds are known to nest in the watershed. Plant and animal species associated with old-growth forests of the Pacific Northwest, including Vaux’s swift, northern flying squirrel, red-backed tree vole, Pacific yew and the northern spotted owl (Fig. 4), are especially well represented.

Major themes of Andrews research include conifer forest structure, function, and dynamics; watershed hydrology; carbon dynamics and sequestration; ecology of the fast, cold streams; landscape dynamics resulting from wildfire, flood, and land use. This research has lead to major discoveries including the high ecological value of old growth forests and its importance to the northern spotted owl, the ecological functions of dead wood in forest and stream ecosystems, and the long-term legacies of clearcutting on timing and yield of waterflow from watersheds. All of this research has occurred and continues to occur in within a dynamic social and policy environment regarding the purpose and use of forest lands.

When it was established in 1948, the Andrews Experimental Forest was covered with virgin forest. Before timber cutting began in 1950, about 65% of the Andrews Forest was in old-growth forest (~500 years old) and the remainder was largely in mature stands.
developed after wildfires in the mid-1800's to early 1900's. Clearcutting and shelterwood cuttings over about 30% of the Andrews Forest have created young plantation forests varying in composition, stocking level, and age that continue to be studied (Fig 5.). A series of experimental small watersheds had various forest harvest treatments applied as part of a long-term study of impacts of forest management on watershed processes. Wildfire had been the primary disturbance in the natural forest and windthrow, landslides, and lateral stream channel erosion were secondary disturbances.

The Andrews has been a dynamic research-management partnership (Fig. 6) for over 50 years. Early research focused on ways to log old-growth forests but over the last 20 years the focus has been on how to conserve and restore forests and landscapes while providing a variety of ecosystem services. Societal conflict over the future of the vast tracts of federal forest lands in the region have been profoundly affected by science findings from the Andrews Forest and, in turn, have strongly influenced the course of science in the Andrews and more broadly. This partnership involves the research community centered on the Andrews Forest LTER site and land managers of the Willamette National Forest. The partnership has made substantial impacts on forest management and policy on topics such as characteristics of and conservation strategies for old-growth forest ecosystems; ecological roles and management implications of dead wood on land and in streams; ecology and population dynamics of northern spotted owl, effects of forest cutting and roads on streamflow, including floods; interactions of road and stream networks; and interactions of climate change with management and policy.
Andrews Forest Headquarters Information (also see map, back of page)

Phones: Cell phone coverage is not available at Headquarters and on most of the Andrews Forest site. Depending on your provider, you may get cell coverage at some point along the Blue River Reservoir. A telephone, which works for long distance with calling cards, is available in the main Headquarters office building.

Internet: All buildings at the Headquarters have wireless internet access. A computer lab is available in the office building. Our internet access is provided by a single T1 line, which can easily be overwhe med by heavy use. We also depend on this connection to transfer large amounts of data to Corvallis. Please refrain from downloading very large video and other files unless absolutely necessary for meeting needs.

Safety/Emergencies: First aid supplies are available in the office building. Please exercise basic safety while on site, particularly when driving on mountain roads or walking on steep forest trails. Emergencies should be reported immediately to Kathy Keable or Mark Schulze.

Local Activities
(also see the insets in the HJ Andrews Experimental (HJA) Forest map provided)

Lookout Creek Old-Growth Trail
3.5 mile hike through a classic old-growth forest along upper Lookout Creek. Maps are available at the Headquarters front office or a brochure can be downloaded in a printable format online: Lookout Creek Old-Growth Trail brochure (PDF).

Delta Old-Growth Trail (off site)
The one-half mile Delta Nature Trail takes visitors into the Delta Old Growth Grove. Experience majestic old growth Douglas firs and Western red cedars – some over 180 feet tall – from an accessible interpretive nature trail. The trail is located at the west end of Delta Campground, and is open all year. A brochure is available at the trailhead. http://www.fs.usda.gov/recarea/willamette/recreation/recarea/?recid=4365

McKenzie River Trail (off site)
The McKenzie River Trail closely follows the McKenzie River, a scenic whitewater river originating in the high Cascade Mountains. The trail crosses over several tributaries of the McKenzie River via log bridges. The lower sections of the trail pass through 600 year old Douglas-fir forests. While upper sections of the trail pass spectacular waterfalls and lava flows. Map and additional information available at the McKenzie River Ranger Station. http://www.mckenzierivertrail.com/

Other Activities
Fishing, biking, rafting, kayaking, hot springs. More information on any of these activities can be found at the McKenzie River Ranger Station. 57600 McKenzie Hwy, McKenzie Bridge, OR 97413. 541-822-3381. Many high Cascades trails and the McKenzie Pass Scenic Highway (242) will not be accessible at this time of year due to snow. Highway 126 is maintained for year round access to the Cascade crest and points east.
Field trip at the Andrews Forest LTER
For the LTER Science Council Meeting, May 16, 2012
(A). **Goal I**: Complex terrain and canopy cover moderate interactions between drivers and responders

Multiple processes at micro-, meso-, and regional scales affect relationships between microclimate and regional climate.

Cold air drainage transiently decouples low elevation microclimates from regional climate; hence low elevation is less sensitive than high elevation to climate variability.

Heterogeneity and multiple flow paths of C, N and water cycle processes at small scales reduce sensitivity of fluxes and flows at larger scales to variability in drivers.

Complex terrain alters the sensitivity of trophic interactions to drivers.

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(B). **Goal II - Complex terrain moderates ecosystem responses to future change**

High elevation will be more sensitive than low elevation to climate change due to tighter atmospheric coupling and rain/snow threshold

Climate-induced changes in disturbance (fire, pests) will have greater impact on future ecosystem structure and function than will the direct effects of climate change.

Complex terrain will mitigate potential trophic responses to climate change, such as asynchrony in phenology.

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(C). **Goal III - Shared understanding of roles and capacities among environmental scientists, social scientists and local communities and institutions promotes adaptive management for future change.**

Social networks and research-management partnerships are required to develop policies for forest management for future climate change.

Exploration of alternative futures helps communities and institutions make choices, openly and adaptively.

Societal decisions about natural resource use depend on awareness of ecological services.
### Field Trip Schedule

**Wednesday, May 16, 2012**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30 PM – 12:50 PM</td>
<td>Introductions</td>
</tr>
<tr>
<td></td>
<td>(Barbara Bond, Julia Jones, Mark Schulze)</td>
</tr>
<tr>
<td>12:50 PM – 1:00 PM</td>
<td>Load vans</td>
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<tr>
<td>1:00 PM – 1:25 PM</td>
<td>Transportation to first stop</td>
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<tr>
<td>1:25 PM – 1:55 PM</td>
<td><strong>Talks at first stop</strong></td>
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<tr>
<td>1:55 PM – 2:20 PM</td>
<td>Transportation to second stop</td>
</tr>
<tr>
<td>2:20 PM – 2:50 PM</td>
<td><strong>Talks at second stop</strong></td>
</tr>
<tr>
<td>2:50 PM – 3:15 PM</td>
<td>Transportation to third stop</td>
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<tr>
<td>3:15 PM – 3:45 PM</td>
<td><strong>Talks at third stop</strong></td>
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<tr>
<td>3:45 PM – 4:15 PM</td>
<td>Transportation to fourth stop</td>
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<tr>
<td>4:15 PM – 4:45 PM</td>
<td><strong>Talks at fourth stop</strong></td>
</tr>
<tr>
<td>4:45 PM – 5:00 PM</td>
<td>Transportation to headquarters</td>
</tr>
<tr>
<td>5:00 PM – 6:00 PM</td>
<td><strong>Poster Session.</strong> Conference Room. Snacks and beverages provided.</td>
</tr>
<tr>
<td>6:00 PM – 7:00 PM</td>
<td><strong>Dinner. Cafeteria.</strong></td>
</tr>
</tbody>
</table>

*Group will divide into four sections and rotate around four stops:*

**Watershed 1.** Barbara Bond, moderator. LTER6 integrated research, airsheds, watersheds

**Blue River Reservoir.** Hannah Gosnell, moderator. Social science context of LTER6 work: human use of the landscape (MALs), ecosystem services, research-management partnership.

**Riparian Forest** (concrete bridge stop). Sherri Johnson, moderator. Phenology, birds, bioacoustics, streams.

**Log Decomposition site** (old-growth forest). Fred Swanson, moderator. Old-growth forest, LTEReflections, arts and humanities, education
Integrated Research at Watershed 1

Moderated by Barbara Bond, Andrews LTER

Background: Experimental watersheds are a cornerstone of research at many LTER (and USFS EFR) sites – Andrews is significant part of very active groups doing inter-site climate/hydro/stream chem IM infrastructure and synthesis (some of this work is described in the poster session). WS1 was instrumented in 1952 along with WS2 (control) and WS3; logged in 1962-66; planted; wood removed. More than 100 permanent vegetation plots in the watershed, established after the harvest, provide a rich picture of growth and development after harvest.

Dozens of research projects have taken place in WS1, many of them ongoing; today we’ll focus primarily on projects that are specifically tied to LTER6. Airshed/carbonshed work in WS1 began in the 1990s (funded by independent grants from the NSF) and provides significant infrastructure, including a 37m tower at the base of WS1 along with two smaller towers, one at the top WS1 and one at the base of WS2.

LTER6 studies in WS1:

In LTER6 we are investigating fine-scale spatial and temporal variability in carbon and water cycle processes, specifically in response to topographic variability. We will be testing the hypothesis (primarily through the use of models) that heterogeneity in edaphic and climate drivers of these processes at fine temporal and spatial scales confers reduces sensitivity to potential climate change at the whole-basin scale.

We are working to develop a comprehensive budget of carbon cycle stores and fluxes (as a “snapshot” for the current stage of forest development), including above and belowground terrestrial processes as well as aquatic processes and attempting to describe spatial and temporal variability as well as uncertainty of measurements and estimates. We’re also working to establish connections and feedbacks between carbon and water cycle processes at fine spatial and temporal granularity. The three presentations you will hear at this stop represent just a few of several studies that are each strong “stand-alone” research projects, and collectively will help us achieve these broader goals.

WS1 is also a primary focus for our “cyber-forest” research in LTER6 – i.e., the development of new technology to measure and study ecosystem processes.
Spatial Patterns of Interception Loss in Complex Terrain

Scott T. Allen\textsuperscript{1}, Barbara J. Bond, Jeffrey J. McDonnell
\textsuperscript{1}Oregon State University, Water Resources Graduate Program

Interception loss, the evaporation of moisture intercepted by plant canopies, comprises a large component of the annual water budget. However, the spatial heterogeneity of throughfall and interception loss is typically addressed either by averaging, or it is left unaddressed. Thus, the potential dramatic effects of interception loss heterogeneity on ecohydrological processes have been largely ignored.

We applied a spatially-explicit approach to interception loss modeling at 50 m resolution across Watershed 1 to account for spatial heterogeneity in solar radiation, vegetation, and precipitation. Using the model, we conducted virtual experiments to elucidate the primary controls over the interception loss heterogeneity to work towards answering the questions: Why does interception loss vary and does its variability matter? We found the spatial variability of interception loss during large storms is fairly small, and is insignificant compared to heterogeneity in net precipitation caused by topography-induced precipitation variability. Interception loss was most variable during summer rain events of less than 10 mm, which could be a critical moisture input to plants during water-stressed conditions.

Total interception loss for winter, and summer from the 2006-2008 water years. Gross precipitation (P\textsubscript{g}) depth and interception loss (IL, in \%) are the averages of the two year period with mean ± standard deviation. The summer interception loss pattern is almost entirely determined by vegetation patterns. The winter IL pattern is determined by both solar radiation and vegetation heterogeneity.

Individual events’ ranges of spatial variation in interception loss. Each bar is one event. F, W, Sp. and Su. indicate the season of the events. The shade of grey indicates increasing number of standard deviations from the mean as the shade becomes lighter.
Cyberforest—using light, sound, and fog to study effects and feedbacks of terrain on local climate, airflow, and carbon and water transport

Christoph Thomas, College of Earth, Ocean, and Atmospheric Sciences (CEOAS), Biomicrometeorology Group, OSU
Collaborators: John Selker, Department of Biological and Ecological Engineering, OSU
Michael Unsworth, College of Earth, Ocean, and Atmospheric Sciences (CEOAS), OSU
Barbara Bond, Department of Forest Ecosystems & Society, OSU

The complex interactions between drivers and responders in mountainous terrain require spatial information to identify the pathways for these interactions and to allow for quantitative estimates of water and carbon budgets. Watershed 1 (WS1) continues to be the test bed for new emerging technologies that can provide spatial information about air and soil temperature, water, carbon isotopes, and wind by using sensor networks that combine many observational techniques in a unique fashion (Figs. 1, 2). The ‘cyberforest’ concept uses light (laser-based instruments including distributed temperature sensing, DTS, and stable isotope cavity ringdown-spectrometers), sound (ground-based acoustic remote sensing), and machine-generated, laser-illuminated fog to study how air, heat, water, and carbon communicate in this complex landscape. Observations from experiments at WS1 carried out over multiple years in connection with data from the larger HJA climate network provide the basis for the investigations. The analysis of wind flow patterns and air temperatures from the historic climate record at the HJA showed that the frequency of occurrence and timing of nocturnal cold-air drainage in the HJA valley has shifted considerably. This shift impacts the thermal microclimate of the valley leading, e.g., to an earlier arrival of spring by one month over the period 1958 through 2008 (Fig. 3). This finding suggests that, contrary to common belief, mountain valleys can be hot spots of climate change and may not be able to provide a cold refuge for species in a warming world.

Figure 1: Schematic of the 'Disco in the Forest'

Figure 2: Temperature cross-section using fiber optics

Figure 3: Spring arrives earlier by one month at some of the HJA climate stations.
Understanding Stream Metabolic Activity by Using Tracers

Alba Argerich, Postdoc researcher, Forest Ecosystems and Society Dept., OSU

Respiration and nutrient uptake show high temporal and spatial variability not only related to hydraulic parameters but to environmental factors (e.g. stream nutrient concentrations, water temperature, light, etc.)

Winter: low metabolic activity, main controlling factors: streamflow and temperature

Summer: higher metabolic activity, hyporheic processes gain importance

![Resazurin](image1.png)

Aerobic respiration

![Resorufin](image2.png)

![Graph SUMMER](image3.png)

![Graph WINTER](image4.png)
Log Decomposition Experiment Field Trip Stop—
A Venue for Many Forms of Inquiry

Moderated by Fred Swanson, US Forest Service, Pacific Northwest Research Station (geologist, retired); Oregon State University (courtesy professor)

DIRT. We walk by the DIRT (Detrital Input and Redistribution Treatments) experiment site (in old-growth forest below the road) led by Kate Lajtha and part of an international network of sites to examine how litterfall and root turnover affect long-term C and N dynamics in soil. Treatments include: control, double litter, no AG litter, no roots, no inputs, etc. Established here in 1997, early findings include: root detritus appears to have a stronger contribution to ecosystem dynamics than does aboveground litter; increases in high-quality litter appear to cause priming of soil organic matter such that increased litter deposition paradoxically serves to increase the respiration of old soil organic matter and thus reduce stores of soil organic matter in the soil. The reduction of inputs of detritus to the soil has led to decreased stores of labile organic content of soil, but after 10 years, no decreases in stabilized C have been observed.

Douglas-fir Plantation. As we head up the trail (abandoned logging road) we pass through an area clearcut (1952), broadcast burned, and planted to Douglas-fir. Note tree mortality due to suppression (smaller, standing dead trees) and physical processes (larger trees toppled by wet snow canopy loading and other processes). Elsewhere on the Andrews we have silviculture experiments to assess tradeoffs among carbon sequestration, wildlife habitat characteristics, wood production, etc.

Log Decomposition Experiment. Established by Mark Harmon and Jerry Franklin in 1985 with a 200-year design life, this site has become a focal point for studies of log decomposition, observations by visiting writers in the Long-Term Ecological Reflections program, and discussions of carbon dynamics at the full range of scales, management of dead wood in forest systems, old-growth forests, and much more. The log decomposition work examines decay processes, log hydrology, changes in log properties over time, etc. for four species (Pacific silver fir Abies amabilis, western hemlock Tsuga heterophylla, Douglas-fir Pseudotsuga menziesii, western redcedar Thuja plicata – increasing order of decay resistance) set out at 6 sites across the forest representing a range of environments. Periodically a subset of logs is sampled destructively by cutting of cookies, which are sectioned vertically and horizontally for measurement of bulk density, nutrient concentrations, and other properties. Key findings to date include: a substantial fraction of many nutrients, including N is exported initial via leaching and fungal fruiting bodies even when C/N ratios are high (400-500); decomposition rates vary by roughly an order of magnitude (A. amabilis=0.06 per year versus T. plicata=0.007 per year) for the same size and environment; decay resistant species have a large response to increases in diameter than non-resistant species; and decomposition rate differences between T. heterophylla (0.023 per year) and P. menziesii (0.020 per year) are not as large as originally thought. The latter was likely do to a confounding of species and average size (P. menziesii is typically twice the diameter of T. heterophylla). The PNW experience gives important perspective in modeling of C dynamics in science, management, and policy as is the importance of dead wood as a C store in natural and managed systems.

Sampling the larger landscape. The Andrews group samples the larger Pacific Northwest landscape in various ways, including remote sensing (many sensors used to detect many forest characteristics) and an extensive system of vegetation plots (generally 1 ha, live and dead trees stem mapped, ca. 5-yr measurement cycle, plots as old as 100 yrs, mainly since 1970s, in natural and managed stands). We also examine regional spatial patterns of fire regimes, elements of biodiversity, and other themes.
Long-Term Ecological Reflections is a collaboration among the Andrews Forest Long-Term Ecological Research group; the USDA Forest Service; and the Spring Creek Project, a privately-endowed program in the Department of Philosophy, Oregon State University. Like the National Science Foundation's Long-Term Ecological Research program on which it is modeled, the Long-Term Ecological Reflections program gathers reflections for generations, assembling a long-term record of changing creative responses to an ever-changing landscape and its societal context.

The Spring Creek Project Mission: The challenge of the Spring Creek Project is to bring together the practical wisdom of the environmental sciences, the clarity of philosophical analysis, and the creative, expressive power of the written word, to find new ways to understand and re-imagine our relation to the natural world.

An idea common to science and poetry is that an experiment is an act the outcome of which is unknown. In science the goal is to add to a body of knowledge. In poetry the goal is to add to a body of reflection, to share the innerness of human life in ways that help us to get the drift of how the world is working. Who can know what the outcome will be of such practices when poet and scientist attempt to engage in them side by side, not one in service to the other? This, finally, is the freedom we seek in our seeking: the promise of discovery, the flicker of enlightenment that by its nature opens up a little more intriguing darkness, the desire for unexpected connection. It is a freedom that feels particularly delicious when the small moment of an individual experiment is posed in the context of a 200-year collective one.”

—excerpt from Poet Alison Hawthorne Deming’s “Fear and Trembling in the Experimental Forest” written based on her Long Term Ecological Reflections Residency at the Andrews Forest.
LTER and Environmental Philosophy

Allen Thompson, Assistant Professor of Philosophy; Oregon State University

My work is addressing philosophical questions about the environment, including ethical and conceptual issues about anthropogenic global climate change. For example...

- Questions about the abatement of greenhouse gas emissions. “How do we justly distribute the costs of mitigation?” and “How do we understand and establish claims about moral responsibility for global climate change?”

- Questions about adaptation to climate change. “How is climate adaptation related to building resilience, reducing vulnerability, and advancing human development?”

- Questions about valuing and managing the non-historic, novel ecosystems that arise due to human activity. “Can novel ecosystems be valuable in conservation and restoration practices?” and “Do novel ecosystems enable evolutionary processes and exhibit wildness?”

Work at the Andrews LTER can be integral to thinking about land management beyond traditional goals set by historic conditions, including conservation, preservation, and restoration. To better understand emerging novel ecosystems we need careful, long-term study of historic systems.

“A novel ecosystem is a physical system of abiotic and biotic components (and their interactions) that, by virtue of human influence, differ from those that prevailed historically, having a tendency to self-organize and retain its novelty without future human involvement. Novel ecosystems are distinguished from hybrid ecosystems by practical limitations (thresholds) on the recovery of historical qualities.”


- “Origins of the Novel Ecosystem Concept,” by Joe Mascaro, Jim Harris, Lori Lach, Allen Thompson, Michael Perring, David Richardson, and Erle Ellis

- “Concerns About Novel Ecosystems,” by Rachel Standish, Allen Thompson, Eric Higgs, and Stephen Murphy

- “Valuing Novel Ecosystems,” by Andrew Light, Allen Thompson, and Eric Higgs


Ethical Adaptation to Climate Change. Eds. A. Thompson and J. Bendik-Keymer. 2012. MIT
Undergraduate Research and Education

Olivia Poblacion, Undergraduate Student, Department of Geosciences, Oregon State University

As a geography major, I am passionate about discovering a broad view of the Earth. This has led me to participate in two undergraduate research programs that utilize the unique offerings of a LTER forest. The experiences I have gained at the H.J. Andrews have included work on vegetation surveys, moth trapping and identification, climate data analysis, and leading a plant ID workshop and tour of the old growth forest for my peers.

In gaining a better understanding of Earth systems through my involvement with IDES and the EISI (see right column), I have become increasingly committed to communicating geosciences to diverse audiences. I am now minoring in writing, and working on a story for Terra, OSU’s research magazine, about the projects of undergraduate students in the Ecoinformatics Summer Institute.

It is apparent to me that research opportunities at the H.J. Andrews are invaluable for young scientists. The forest unwaveringly teaches students the essence of ecological research—that all systems are interconnected, and that there is so much remaining yet to be discovered.

EcoInformatics Summer Institute (EISI)

The NSF-funded EISI brings together students in math, computer science, and ecology to work on interdisciplinary research projects at the H.J. Andrews Experimental Forest. Students spend 5 weeks conducting fieldwork in the forest, and another 5 weeks at OSU analyzing data and building models of ecological processes. Their summer research projects help advance the large accumulations of data that are collected at the LTER site, and include topics such as ecohydrology, wood in streams, and moths and meadows.

Increasing Diversity in Earth Sciences (IDES)

The NSF-funded IDES brings together students in math, computer science, and ecology to work on interdisciplinary research projects at the H.J. Andrews Experimental Forest. Students spend 5 weeks conducting fieldwork in the forest, and another 5 weeks at OSU analyzing data and building models of ecological processes. Their summer research projects help advance the large accumulations of data that are collected at the LTER site, and include topics such as ecohydrology, wood in streams, and moths and meadows.
Microclimate driven by complex terrain predicts within-season movement by a migrant songbird

Sarah J. K. Hadley, PhD student, and Matthew Betts, Assistant Professor
Forest Ecosystems and Society, Oregon State University

Current predictions about species sensitivity to climate change are primarily based on ‘bioclimatic envelope models’. These models assume that species either shift their geographic ranges to match underlying macroclimate, or they go locally extinct where macroclimate is no longer suitable. The degree to which species’ behavior can mediate these possibilities is not well known. For instance, microclimate variability in complex terrain could buffer against climate changes by providing local options for short, adaptive movements and resource tracking.

Distribution maps of Hermit Warbler occupancy probability as a function of elevation by sampling period for the 2010 breeding season.

The probability of Hermit Warbler site vacancy as a function of the change in temperature from replicate 1 – 6 (ΔT)

A map of the 56 bird survey locations with temperature loggers displayed as a function of the change in temperature (ΔT) from replicate 1 to 6 in 2010.

Mean weekly temperature (°C) for the 56 sites with temperature loggers from April – July 2010. Dotted lines represent bird sampling periods 1-6.
Hyporheic Zones and Mountain Streams

Steve Wondzell, Research Riparian Ecologist, Pacific Northwest Research Station, US Forest Service

The hyporheic zone – areas of the streambed and near-stream aquifers through which stream water flows – has been identified as critically important in stream nutrient cycling, in moderating stream temperature regimes, and in creating unique habitats within streams. The overall objective of this research is to increase understanding of hyporheic zone processes in aquatic ecosystems, including (1) the geomorphic factors driving hyporheic exchange flows, (2) the effect of land-use activities on the hyporheic zone, (3) quantifying the amount of hyporheic exchange flow within stream networks, and (4) the role of the hyporheic zone in stream nitrogen cycling.

Movement of water through the hyporheic zone is very slow – taking hours to days to move distances of only a few meters. In this example, the effect of log steps on hyporheic exchange is clearly seen – with tracer labeled stream water (yellow) initially downwelling above log steps (7 & 26 hrs) and then spreading more extensively throughout the width of the valley floor.

The slow movement of stream water through the hyporheic zone exposes water and transported solutes to unique biogeochemical environments with subsequent impacts on whole stream metabolism and nutrient cycling. Water temperatures in the hyporheic zone are also typically buffered and lagged, with respect to diel changes in stream temperature. As a consequence, upwelling environments are of special interest, because upwelling water has the potential to be thermally or chemically distinct from stream water.

Figure 1. Tracer movement (yellow) through the hyporheic zone in lower WS01

Figure 2. Diel fluctuation between daily maximum and daily minimum temperatures is buffered with increasing residence time in the hyporheic zone with respect to the adjacent stream in WS03.
Maps and Locals (MALs): A Cross-Site LTER Comparative Study of Land-Cover and Land-Use Change with Spatial Analysis and Local Ecological Knowledge

Hannah Gosnell, Associate Professor, College of Earth, Ocean, and Atmospheric Sciences; Denise Lach, Professor, Public Policy Graduate Program; Tim Inman, MA Public Policy; Myrica McCune, Institute of Natural Resources

Participating LTER Sites:
AND, ARK, BNZ, CCE, CWT, GCB, JRN, KBS, KNZ, LUQ, NWT, SGS, BES, CAP, FCE, HBR, NTL, PIE, SBC

Maps and Locals (MALs) was a cross-site Long-Term Ecological Research (LTER) network project undertaken in 2009-2011 to utilize both local knowledge (LK) and spatial analysis to understand the drivers, issues, and dynamics of land use and land cover change (LULCC). MALs follows from and adds to the recent movement to develop and make operational the Integrative Science for Society and Environment (ISSE) initiative, which seeks to integrate social science into the LTER network by approaching LTER sites as coupled social-ecological systems (SES). In addition to substantive findings, MALs reveals epistemological and methodological challenges and opportunities in expanding the LTER program to include social science.

LOCAL KNOWLEDGE

"Do we have more log timber out there growing as a resource? I believe we do. Has it changed as far as what it looks like? Absolutely." — Local Logger

"A lot of those old clear cuts are 40 years old and are in pretty bad shape, heavy density, and need thinning badly." — Local Environmental Activist

"There's virtually no logging families on the river now and there's an awful lot of retired folks. It's become kind of a retirement community." — Local Logger
Impacts of climate and land cover change on tradeoffs in reservoir management for flood protection and irrigation benefits

Kathleen Moore, PhD Student, Geography, College of Earth, Ocean, and Atmospheric Sciences

In the Pacific Northwest, where the majority of precipitation falls during the winter, mountain snowpacks provide an important source of streamflow during the dry summer months when water demands are frequently highest. Increasing temperatures associated with climate change are expected to result in a decline in winter snowpacks, earlier snowmelt, and a shift in the timing of streamflows, with an increasing fraction of streamflows occurring earlier in the water year and drier conditions during the summer. Understanding the effects of climate and land cover change on streamflows is important for reservoir operations such that trade-offs between reservoir goals can be managed optimally. The Army Corps of Engineers has developed a water control diagram for each reservoir (Fig. 1), which reflects the anticipated uses of water as well as the Corps' limitations and responsibilities (U.S. Army Corps of Engineers, 2011). This research investigates how expected changes in streamflow due to climate or land cover change affects the optimization of social tradeoffs via the reservoir rule curve. The study will focus on the Blue River and Cougar reservoirs in the McKenzie basin with the possibility of expanding to the scale of the Willamette Basin. Future scenarios from the Willamette Water 2100 Project (http://water.oregonstate.edu/ww2100/) will be assessed. Figure 2 shows the reservoir rule curve for Blue River reservoir and deviations from it over the period 1975-2012.

![Reservoir water control diagram](image1)

Figure 1. Reservoir water control diagram.

![Reservoir operation curve](image2)

Figure 2. Reservoir operation curve for Blue River and deviations from it, 1975-2012.
Our Research-Management Partnership has its foundation in the Andrews Forest with impacts that extend regionally, nationally and internationally. These collaboration have a long history, dating back to earliest forest treatments at HJA in the 1950s.

Primary partners are researchers at PNW and OSU and natural resource managers for federal and state agencies as well as private forest lands.

Collaborations cover a wide range of topics including forest planning, future scenarios, forest dynamics from plot to landscape scales, role of disturbances, forest-stream interactions, water quality and quantity and societal perspectives.

Common elements include:

- Basic and applied research that is quickly translated and implemented by managers
- Collaborative exchanges to identify issues and raise questions
- Information sharing and outreach through tours, workshops and publications.
Utilities and Corporations as Ecosystem Services Buyers

Investigators: P1 - Sally Duncan (INR), co-PIs - Hannah Gosnell (OSU), Sue Lurie (INR), Anita Morzillo (OSU), Max Nielsen-Pincus (UO), Robert Parker (UO), Eric White (OSU),

GRA’s – Drew Bennett (OSU), Trish Hickson (UO)

INR - Institute for Natural Resources, OSU – Oregon State University, UO – University of Oregon

Funding Agency: USDA’s National Institute for Food and Agriculture (NIFA)

This research examines the potential to develop diverse funding streams for the provision of ecosystem services and focuses on current opportunities in the McKenzie River watershed. This concept emerged through a partnership with the Eugene Water and Electric Board (EWEB) as the utility began exploring new approaches to protecting water quality in the McKenzie, Eugene’s sole source of drinking water. The research envisions utilities as a logical nexus linking beneficiaries of ecosystem services (i.e. utility customers) and suppliers (e.g. upstream landowners) through the emerging concept of Payment for Ecosystem Services (PES). In a utility-based PES program, utility customers pay landowners for management practices that provide water filtration and other ecosystem services and may ultimately reduce downstream treatment costs. Our research is investigating existing PES programs and examining the institutional arrangements that facilitate and impede the development and delivery of these programs. Results will inform EWEB in the development of their PES program. Researchers are also examining ways to effectively engage the diversity of landowners and land managers in the watershed including farmers, residential owners, and the Willamette National Forest. The program is already receiving significant attention and may serve as a model for similar programs across the country.

Flow Chart of a Hypothetical Utility Based PES Program