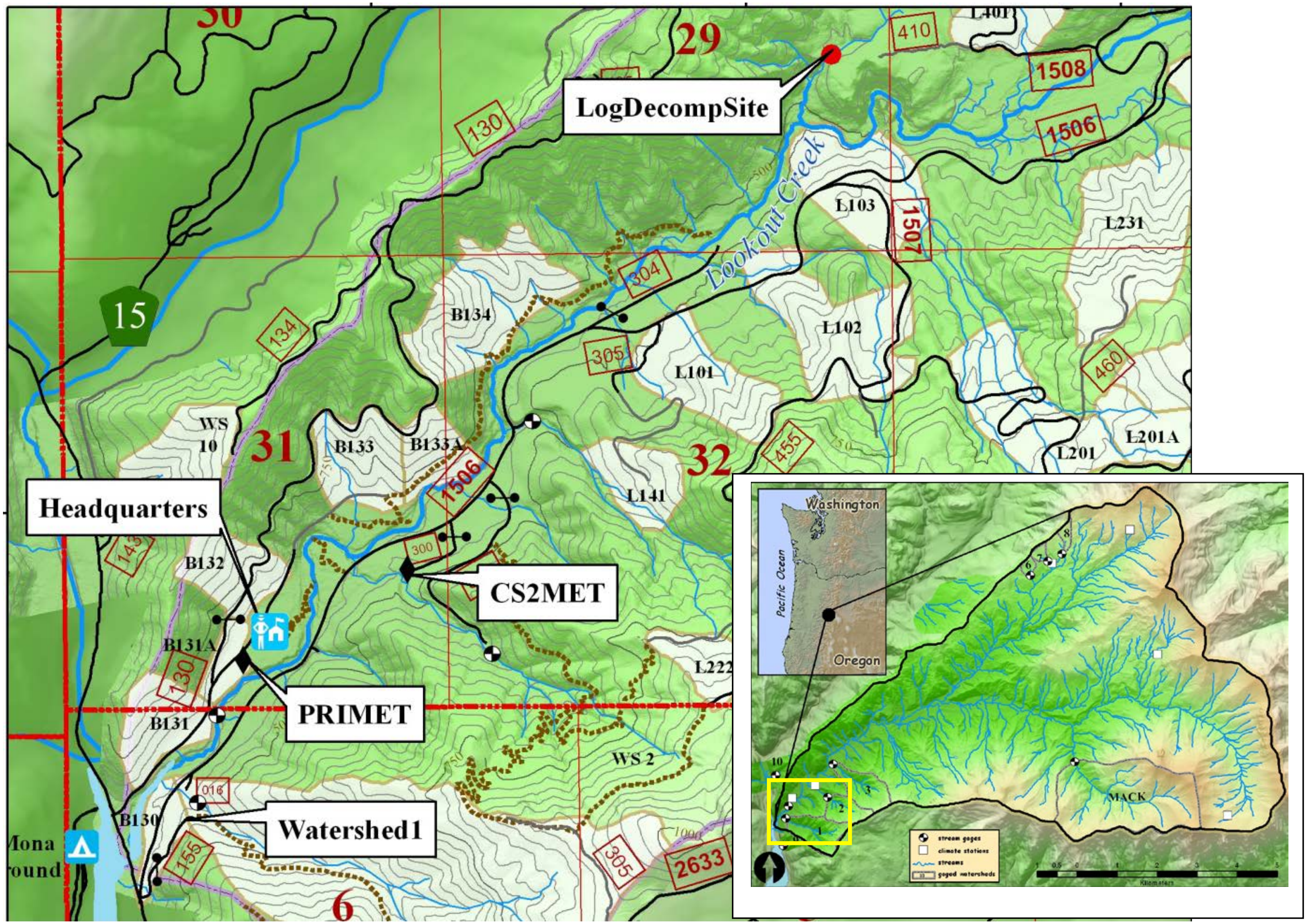
# Andrews Forest LTER

## Field Trip Briefing Booklet

**Prepared for the National Science Foundation Site Review Team**
**August 2-3, 2011**

HJA
HJ ANDREWS EXPERIMENTAL FOREST

# Map of the field trip sites at the Andrews Forest



# Field Trip Schedule

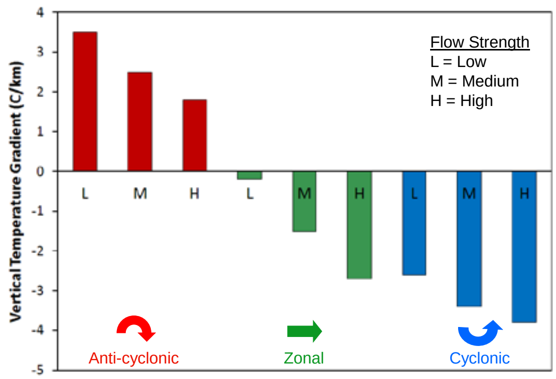
Tuesday, August 2, 2011

| Time | Site Location | Topic (and presenters) |
|---|---|---|
| 9:30 AM - 10:00 AM | PriMet | **Climate** (Chris Daly, Anne Nolin, Eric Sproles) |
| 10:00 AM - 10:15 AM | *transit* | drive to Log Decomp |
| 10:15 AM - 10:30 AM | Log Decomp | **Introduction to the Forest** (Tom Spies) |
| 10:30 AM - 10:45 AM | | **Humanities** (Fred Swanson, Nathaniel Brodie) with a short reading. |
| 10:45 AM - 11:00 AM | | **Carbon** (Mark Harmon). Carbon calculator, carbon sequestration and climate change and management |
| 11:00 AM - 11:20 AM | | **Research-Management Partnership** (Cheryl Friesen, Dave Kretzing, Sherri Johnson) |
| 11:20 AM - 11:35 AM | *transit* | drive to CS2 Met |
| 11:35 AM - 12:05 PM | CS2Met | **Phenology** (Matthew Betts, Sarah Frey, Kevin Briggs) |
| 12:05 PM - 12:20 PM | | **Streams, fish and cross-site nutrient studies** (Stan Gregory) |
| 12:20 PM - 12:50 PM | | Picnic **Lunch** |
| 12:50 PM - 1:05 PM | *transit* | drive to WS01 |
| 1:05 PM - 2:05 PM | WS01 | **Water and Carbon Cycling.** Intro (Barbara Bond), Cyberforest (Chris Thomas), Veg & NPP (Kristin Peterson), Soil carbon and DOC (Kate Lajtha), Interception Losses (Scott Allen), Stream metabolism(Alba Argerich). |
| 2:05 PM - 2:20 PM | *transit* | drive back to HQ |

# Understanding the Spatial and Temporal Variability of Climate within the Andrews Forest Landscape

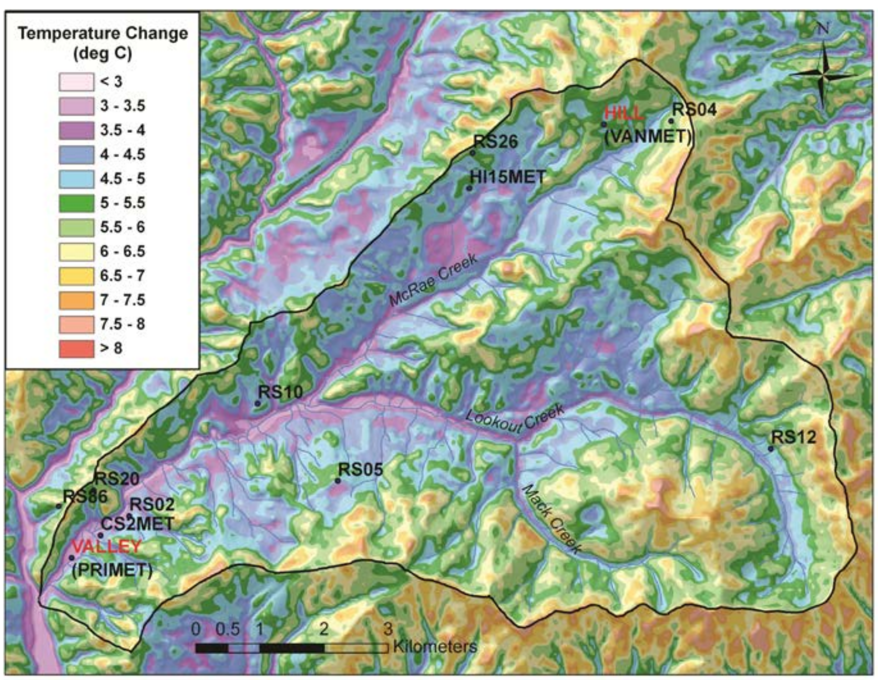
**Chris Daly, Dave Conklin, Mike Unsworth, John Moreau**

Temperature lapse rates at HJA are dependent on atmospheric flow patterns




Relationship between 700-hPa (~3000-m) flow strength and curvature and VANMET (1273m) - PRIMET (430m) daily minimum temperature difference for all days in the period 1987-2005. Cyclonic, or troughing, curvature days with high flow strength are often cloudy and wet, with good atmospheric mixing. In contrast, anti-cyclonic or ridging, curvature days with low flow strength are generally clear and dry, with poor atmospheric mixing, which promotes cold air pooling and inversion formation in valleys

The spatial patterns of future temperature change across HJA will be dependent on future shifts in the frequency of atmospheric flow patterns




Estimated spatial distribution of December daily maximum temperature response to a 2.5 °C regional temperature increase and a 10-day increase in the number of anti-cyclonic days across the HJA. Intricate patterns of elevation and topographic position create steep response gradients across the landscape.

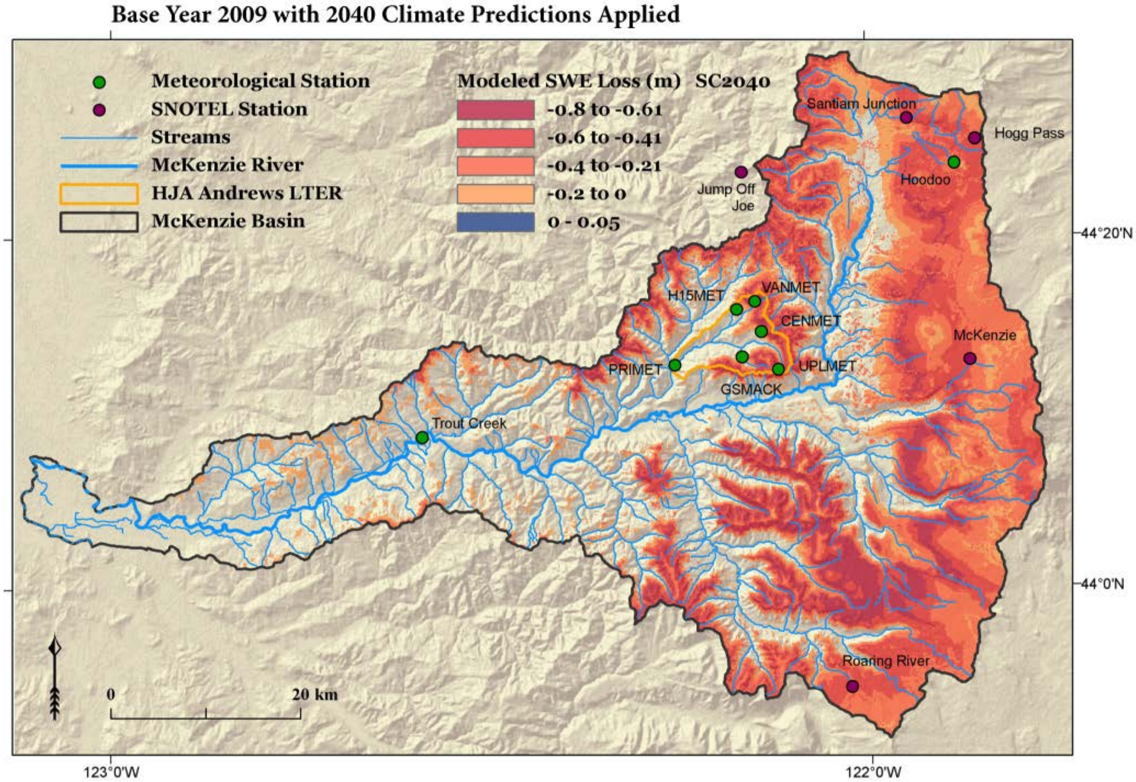
# Understanding Snowpack at the Watershed Scale in Present and Projected Future Climate

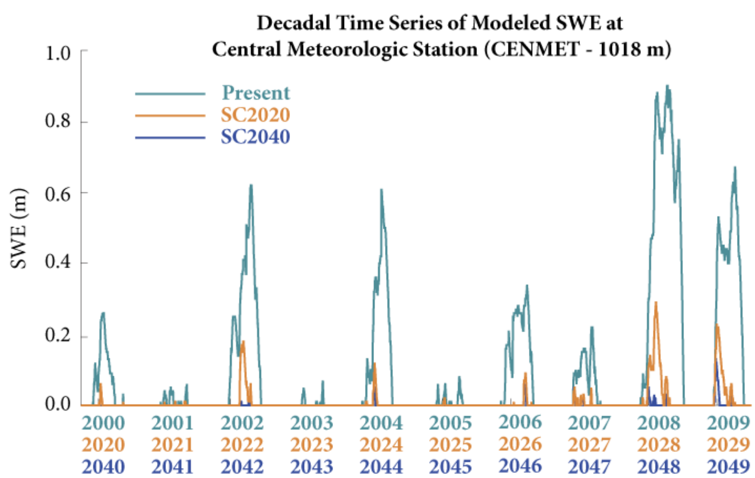
**Eric Sproles and Dr. Anne Nolin**

Snowmelt from the Cascade Mountains provide critical water supply for agriculture, ecosystems, and municipalities. Throughout the Pacific Northwest, current analyses and those of projected climate change impacts show rising temperatures resulting in diminished snowpacks, leading to declines in summertime instream flow. While snowpack has been measured at the local scale for decades, accurate basin-wide measurements of snowpack do not exist. This project examines and quantifies the effects of projected climate change on the distribution and storing capacity of snowpack at the basin scale.

**Modeled Loss of Snow Water Equivalent (SWE) with Perturbed Climate**

**Base Year 2009 with 2040 Climate Predictions Applied**




Changes in Simulated Snow Water Equivalent and Snow Covered Area

Volume of Snow Water

| | Total ($km^3$) | Loss ($km^3$) | % Loss |
|---|---|---|---|
| 2009 | 0.78 | - | - |
| SC2020 | 0.42 | 0.36 | 46 |
| SC2040 | 0.21 | 0.57 | 74 |

Snow Covered Area

| | Total ($km^3$) | Loss ($km^2$) | % Loss |
|---|---|---|---|
| 2009 | 1576 | - | - |
| SC2020 | 1089 | 487 | 31 |
| SC2040 | 756 | 820 | 52 |

# Humanities

**Fred Swanson, Charles Goodrich, Kathleen Dean Moore, Nathaniel Brodie**

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.

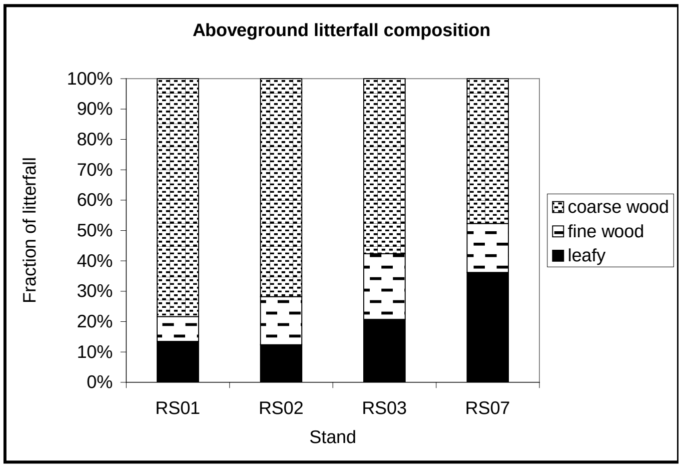
Color drawing by Elizabeth Farnsworth, a Visiting Scholar at the Andrews Forest in 2010. In describing her artwork, Farnsworth writes "I laid radial conduits that feed the ray and disk flowers of *Asteraceae* species against a backdrop of the topographic map of the Andrews Forest"

*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."*

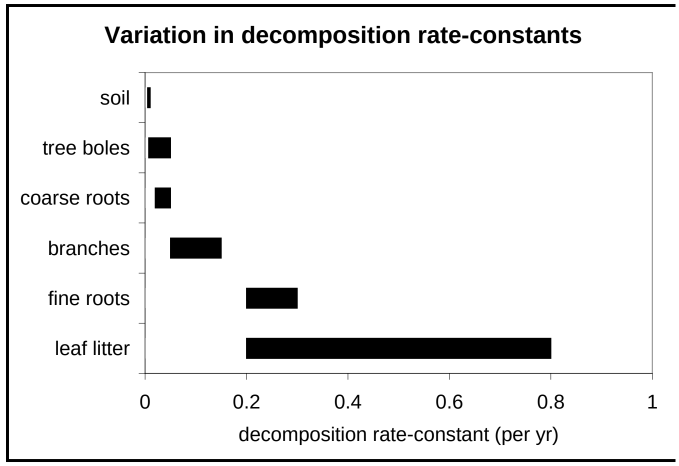
—excerpt from Poet Alison Hawthorne Deming's "Fear and Trembling in the Experimental Forest" written based on her Long Term Ecological Reflections Residency at the Andrews Forest.

# Carbon Dynamics at H. J. Andrews

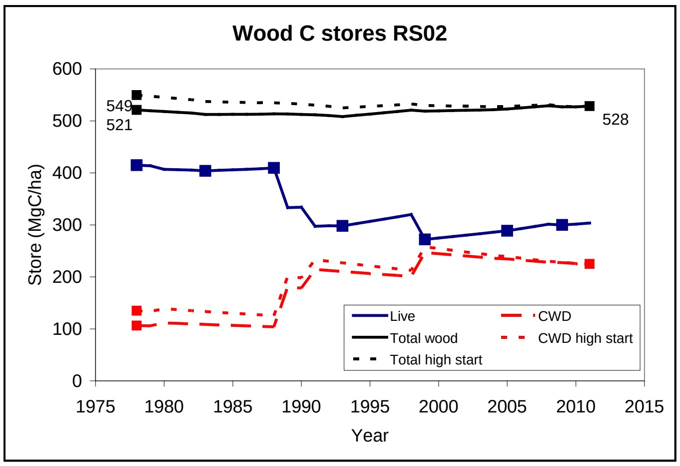
**M. E Harmon, R. Pabst, O N. Krankina, J. Sexton, B. Fasth**



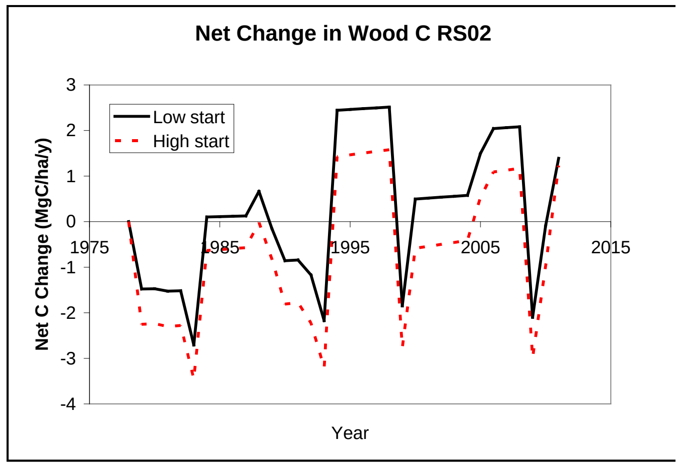

A distinctive feature of Cascade forests is the **high proportion of wood litter** formed.




LTER studies have estimated **decomposition rates** of many forms of detritus which **vary 2 orders of magnitude**.




A preliminary reconstruction of large wood C stores and net changes indicates that large **mortality events change the form, but not the total amount of wood C**.



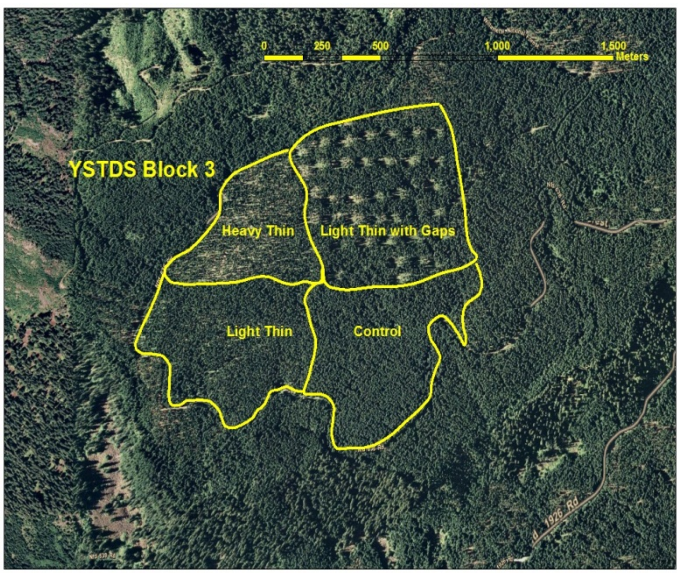

These events cause old-growth forests to rapidly shift from a possible **carbon source to a sink within a few years** and vice versa.

# Research – Management Partnership

**Presented by Cheryl Friesen, Dave Kretzing, Sherri Johnson**

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.

# The Effect of Complex Terrain on Springtime Insect Phenology at H.J. Andrews Experimental Forest: Adult Emergence and Flight Activity

**Judy Li, Bill Gerth, Sherri Johnson, Jay Sexton, Ari DeMarco, Kailan Mackereth, Mark Schulze**

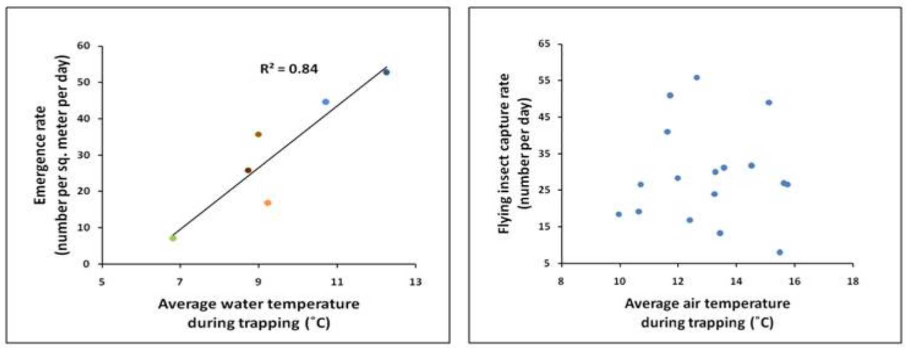
Background: Because insects are cold-blooded, developmental rates and activity levels are affected by temperatures in their surroundings. We expected that timing of adult emergence and flight activity could be predicted by temperatures which are in turn affected by elevation and microclimate gradients in this mountainous landscape.

Sampling: April through June beginning in 2009. Emerging aquatic insect adults collected with emergence traps at 6 first to second order streams varying in water temperature. Flying insect activity levels monitored with malaise traps at 16 forested sites with varying air temperatures.

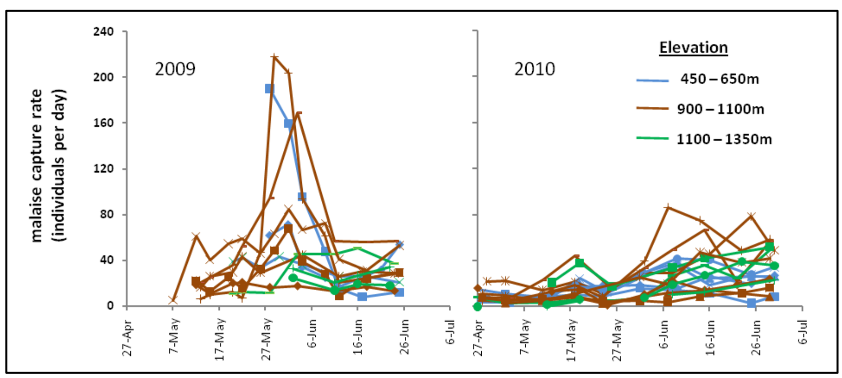
**Results**

- Adult aquatic insect emergence rate related to water temperature, but insect flight activity not related to air temperature.

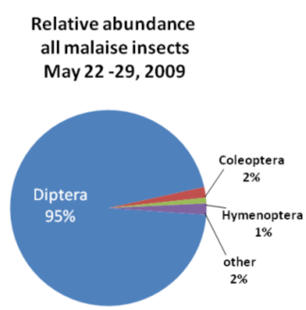
Mid-June 2009

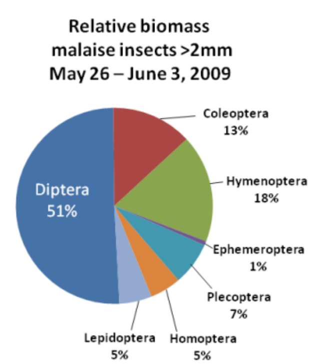



- High degree of year to year variation. 2010 was cooler than 2009. Lower malaise trap captures in 2010, but in each year, contrary to expectations, some of the mid-elevation (intermediate temperature) sites had the highest capture rates (i.e. activity levels).




- Preliminary analysis indicates abundance and biomass measurements provide different information. Numerically, malaise and emergence trap captures are dominated by Diptera. However, other insect orders with larger individuals contribute to biomass and may be important as prey for higher trophic levels.



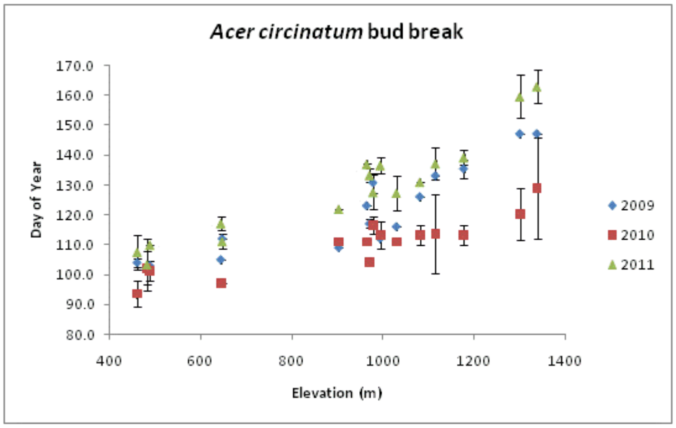



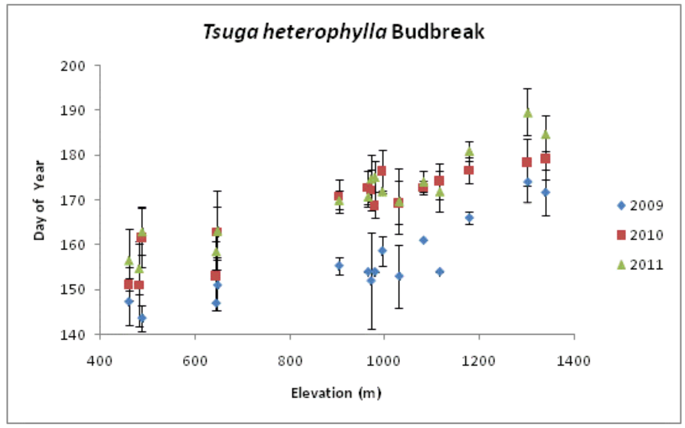

**Additional value:** Documenting biodiversity at the HJ Andrews. We have identified several taxa not noted in the Andrews Invertebrate Taxa List (Parsons et al. 1991). 27 Diptera genera, 1 stonefly genus, 2 stonefly species and 2 caddisfly species have been found so far.

# Influence of climate variability across space and time on plant phenology in a mountainous landscape

**Kevin Briggs, Warren Cohen, Ari DeMarco, Sarah Perez-Sanz, Mark Schulze, Jay Sexton**

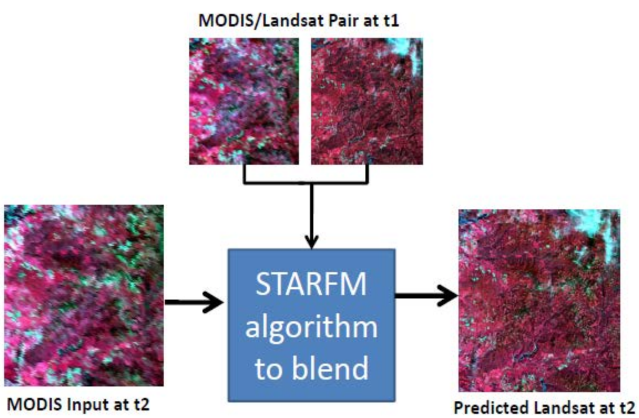
A. Observations of marked plants of 18 species at sites spanning elevation and microclimate gradients

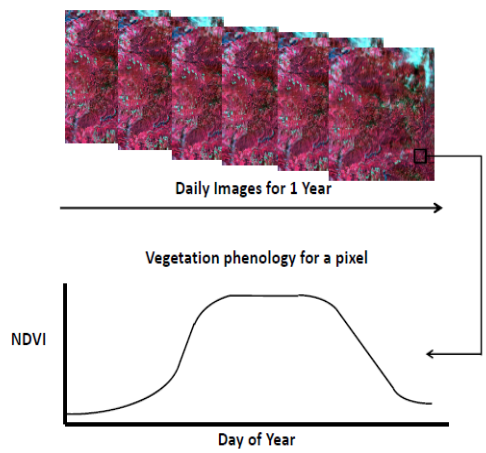



Elevation and microclimate in relation to complex terrain result in differences in spring plant phenology. Winter and spring conditions differ sharply among years, as does timing of bud break and leaf development. Climate variability among years does not result in uniform shifts in timing across sites.

B. Remote Sensing of Vegetation Phenology




Blending of MODIS (daily, 1km resolution) with Landsat (2-3wks, 30 m resolution) satellite images to create daily, fine-grain images.

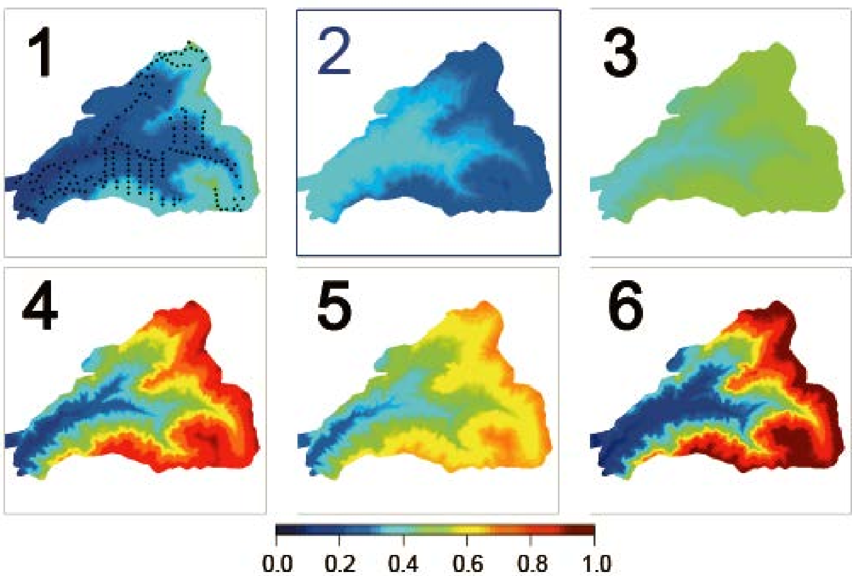

Phenocams link ground observations with remote sensing and provide daily observations of canopy ‘green-up’.

# Microclimate driven by complex terrain predicts within-season movement by a migrant songbird

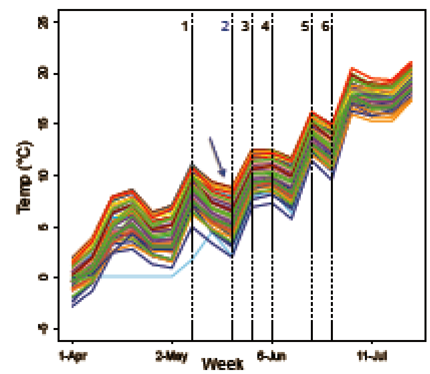
**Sarah Frey and Matthew Betts**

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.

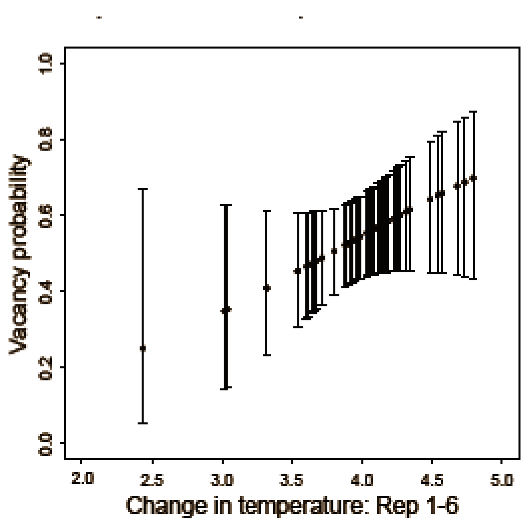
Distribution maps of Hermit Warbler occupancy probability as a function of elevation by sampling period for the 2010 breeding season.



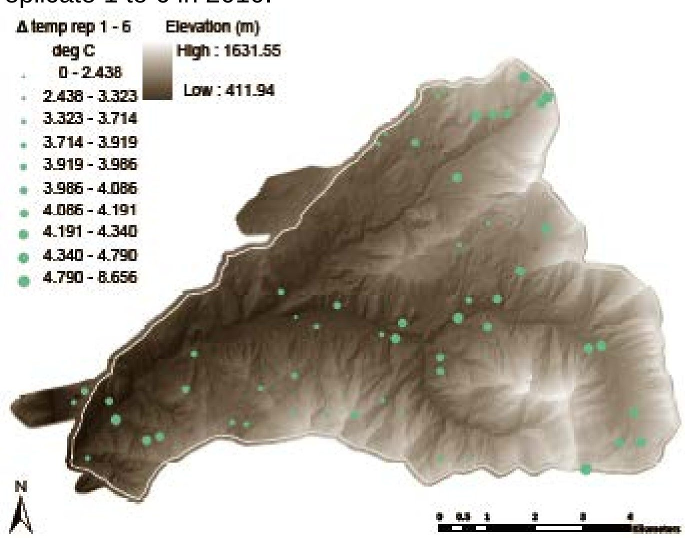

Mean weekly temperature (°C) for the 56 sites with temperature loggers from April – July 2010. Dotted lines represent bird sampling periods 1-6.




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.



# Population Responses to Pulse Disturbances Coastal Cutthroat Trout in Mack Creek

**Stan Gregory, Linda Ashkenas, Randy Wildman**

The LTER aquatic research program has estimated the population of coastal cutthroat trout (*Oncorhynchus clarkii*) in Mack Creek annually since 1987. A major flood occurred in February 1996. Maximum annual stream flow was two to three-fold greater than majority of other years during this period. Pulse disturbances often are assumed to have negative effects on fish populations, and the LTER long-term population study provides an opportunity to quantify the responses to episodic disturbances. In the summer after the flood, fish populations in reaches through old growth and young forest did not decline. Adult trout survived and young-of-the-year trout dramatically increased (Figure 1), resulting in substantial population increase rather than an abrupt reduction in abundance (Figure 2). Compared across the 23-yr record of fish populations, trout population densities in both reaches after the flood were the highest measured and young fish showed especially high densities post flood. Fish densities continued to be high for several years; the especially high densities of young fish successfully translated into increased numbers of adult fish the following years, and the population persisted through another flood of almost equal magnitude in 2000.

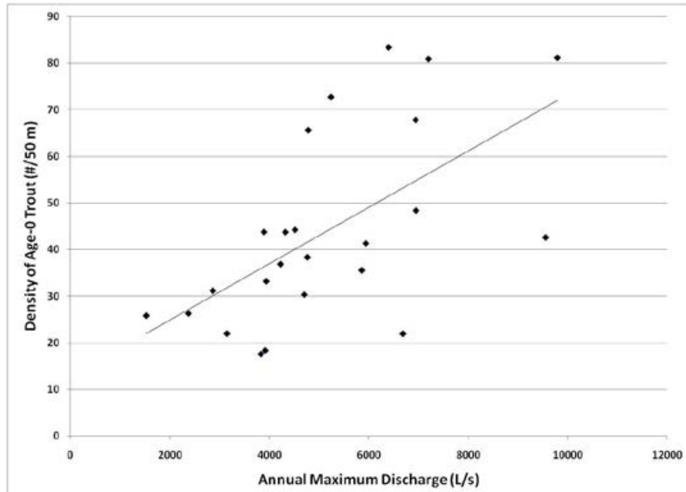



**Figure 1**. Relationship between population abundance of age-0 cutthroat trout and maximum annual discharge in the old-growth reach of Mack Creek (1987-2010).

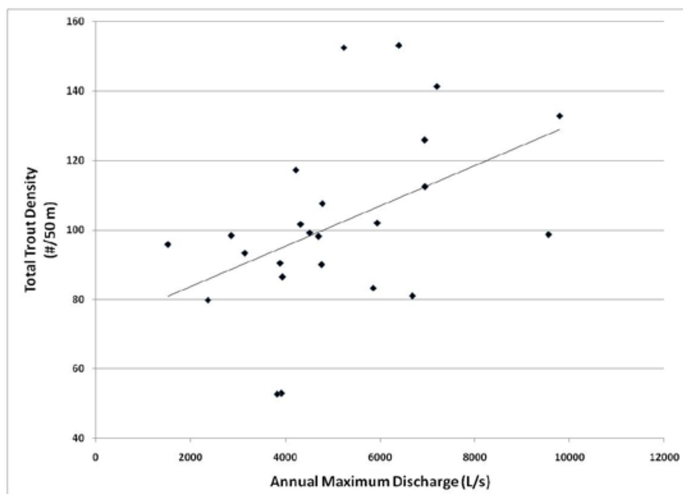



**Figure 2**. Relationship between total population abundance of cutthroat trout and maximum annual discharge in the old-growth reach of Mack Creek (1987-2010).

Floods in this region occur from December through March, trout spawn in April and May, and young-of-the-year trout growth during the summer low flow period allows the fish to reach sizes that can survive the flowing winter floods, reflecting the influence of disturbance regimes on life history traits of aquatic organisms. If adult trout survive the winter floods, they potentially provide new recruits to the population. In these streams, small gravel suitable for constructing redds is scarce. Floods can have negative effects on trout populations by direct mortality, eliminating or filling pool habitat, and scouring spawning substrates. On the other hand, floods can have a positive effect on trout populations if they deposit spawning gravel, remove silt from spawning gravels, create deep pools, and create complex wood accumulations. Our long-term studies of large wood dynamics have demonstrated that more than 95% of the wood in Mack Creek does not move in most years. Even in the 1996 flood, only 13% of the pieces of large wood were mobilized and most were retained within 1 km. Our long-term studies of interactions between riparian forests, geomorphology, and aquatic populations demonstrates that life history traits are closely linked with the physical dynamics of stream ecosystems and their association riparian networks.

# Temporal Trends In Stream N Concentrations In EFR Reference Basins

**A. Argerich[1], S.L. Johnson[2], S.D. Sebestyen[2], C.C. Rhoades[2], J.D. Knoepp[2], E.A. Greathouse[1], G.E. Likens[4], J. Campbell[2], W.H. McDowell[3], M.B. Adams[2], J. B. Jones[5], P.M.Wohlgemuth[2], D.M. Amatya[2], W. McCaughey, and G. Ice[6]**

[1]Oregon State University, [2]USDA Forest Service, [3]University of New Hampshire, [4]Cary Institute of Ecosystem Studies, [5]University of Fairbanks, [6]National Council for Air and Stream Improvement

To increase our understanding of stream chemistry trends in reference basins we synthesized **stream nitrate data collected over 12 to 43 years from 22 forested reference basins from 7 USFS Experimental Forest Research sites**. Results show:

**Highlights:**

a) **Great temporal and spatial variability in N concentrations and trends.** Nearby reference basins may present opposite temporal trends.

b) **Changes in trends when considering different windows of time –** pointing to relevance and importance of long-term studies.

c) **Trends in atmospheric deposition or discharge do not coincide with observed trends in stream N concentrations**.

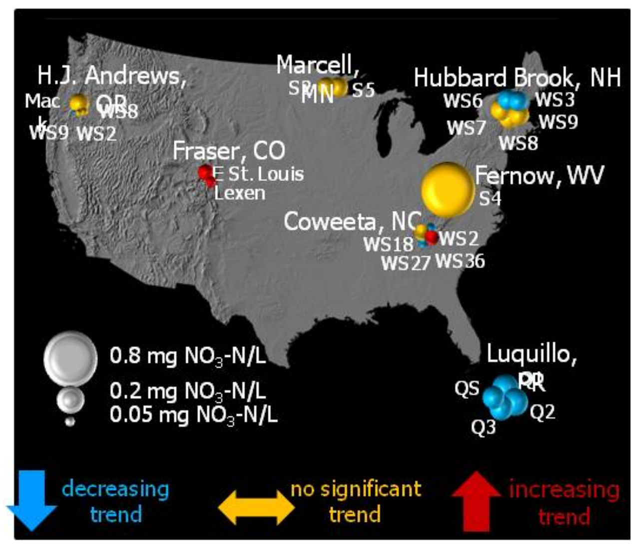



**Figure 1**. Study sites. Size of the circles represent the monthly average flow-weighted nitrate concentration of the basin between 1996-2007. Color of the circles represent the observed trend.

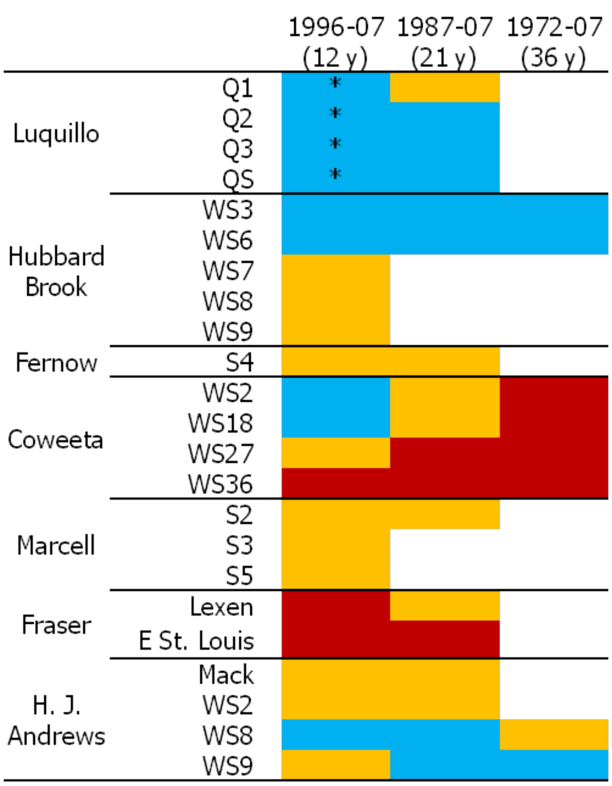



**Table 1**. Trends in monthly flow-weighted nitrate concentrations

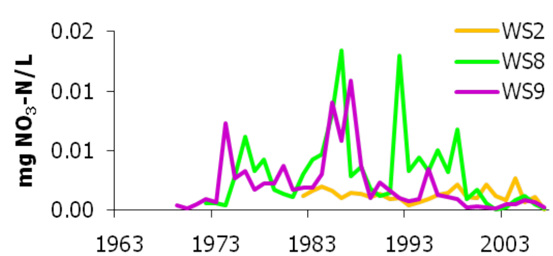


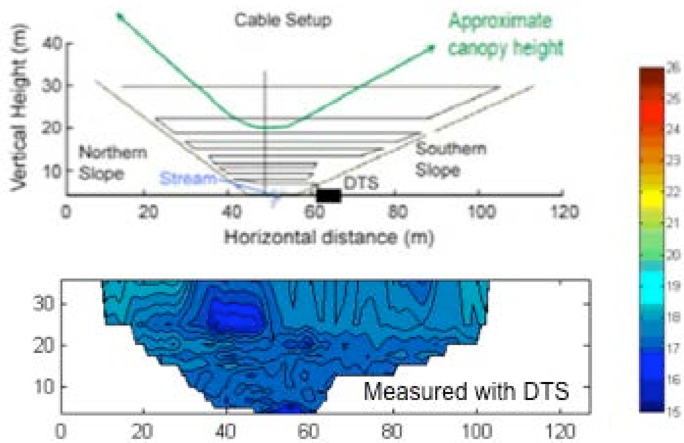

**Figure 2**. Monthly flow-weighted nitrate concetrations in 3 of the 4 HJA basins considered in this study.

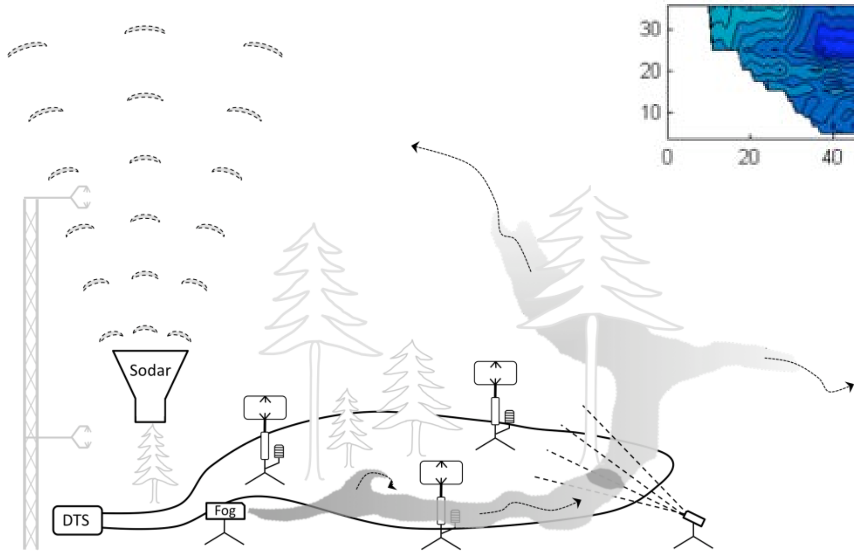
# Cyberforest — using light, sound, and fog to study effects and feedbacks of terrain on local climate and carbon and water transport

**Christoph Thomas[1], John Selker[2], Michael Unsworth[3], Barbara Bond[4]**

[1]College of Earth, Ocean, and Atmospheric Sciences (CEOAS), Biomicrometeorology Group, OSU, [2]Department of Biological and Ecological Engineering, OSU, [3]College of Earth, Ocean, and Atmospheric Sciences (CEOAS), OSU, [4]Department of Forest Ecosystems & Society, OSU

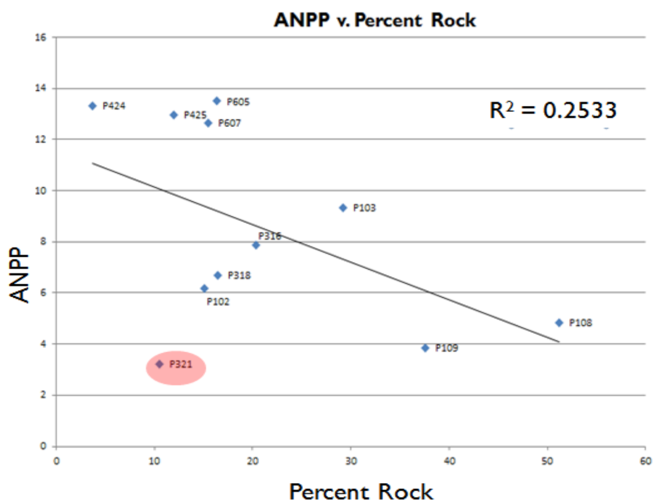
The complex interactions between drivers and responders in mountainous terrain require spatial information to identify the main pathways of these interactions and to allow for quantitative estimates of water and carbon budgets. Watershed 1 (WS1) continues to be the test bed for new emerging technologies that can provide spatial information about air and soil temperature, water, carbon isotopes, and wind by using sensor networks that combines many observational techniques in a unique fashion. 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 intensive experiments at WS1 carried out over multiple years in connection with data from the larger HJA climate network will also be one focus of the NSF Career award #0955444 entitled *A New Direction into Atmospheric Near-Surface Transport for Weak-Wind Conditions in Plant Canopies* (PI Thomas).

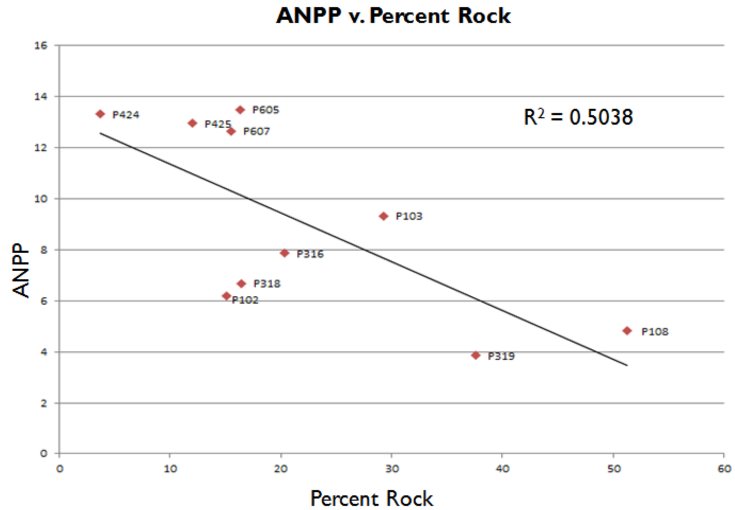


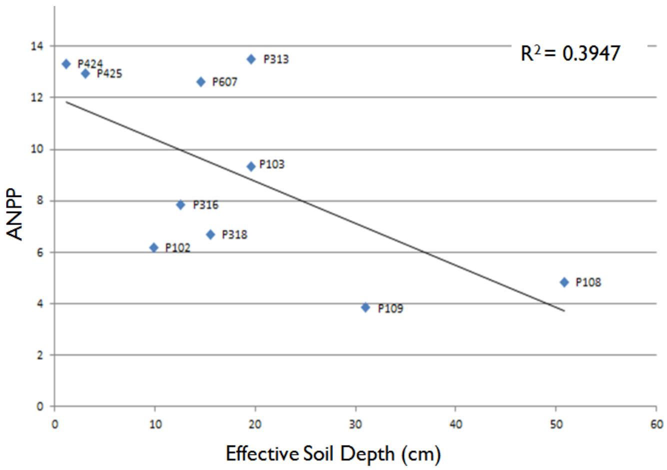



# Site History, Environment, and Stand Structure

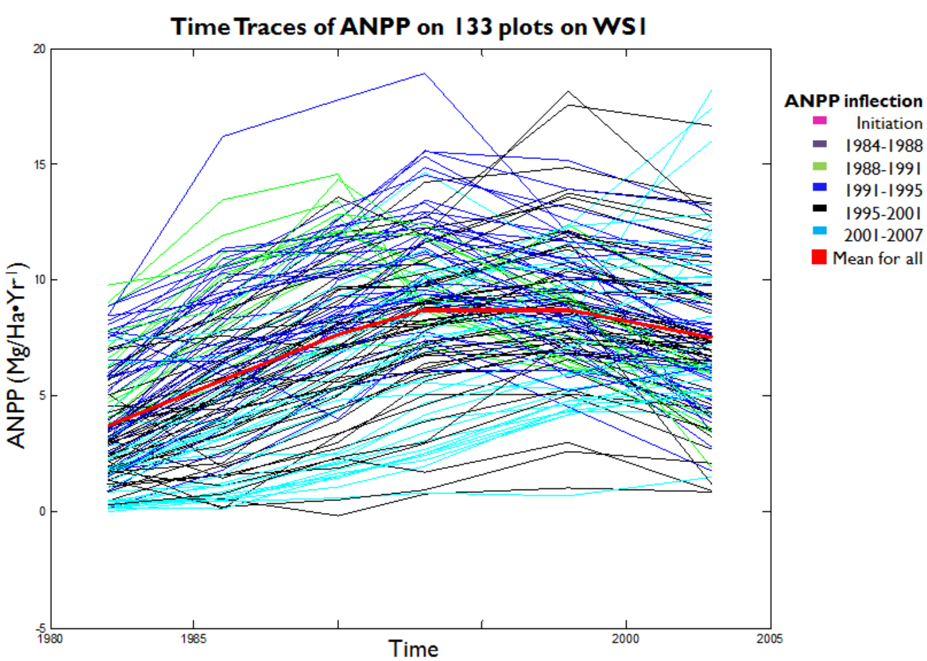
K.S. Peterson, K. Lajtha, D. Quandt, S. Sell, J. Wig, B. Bond



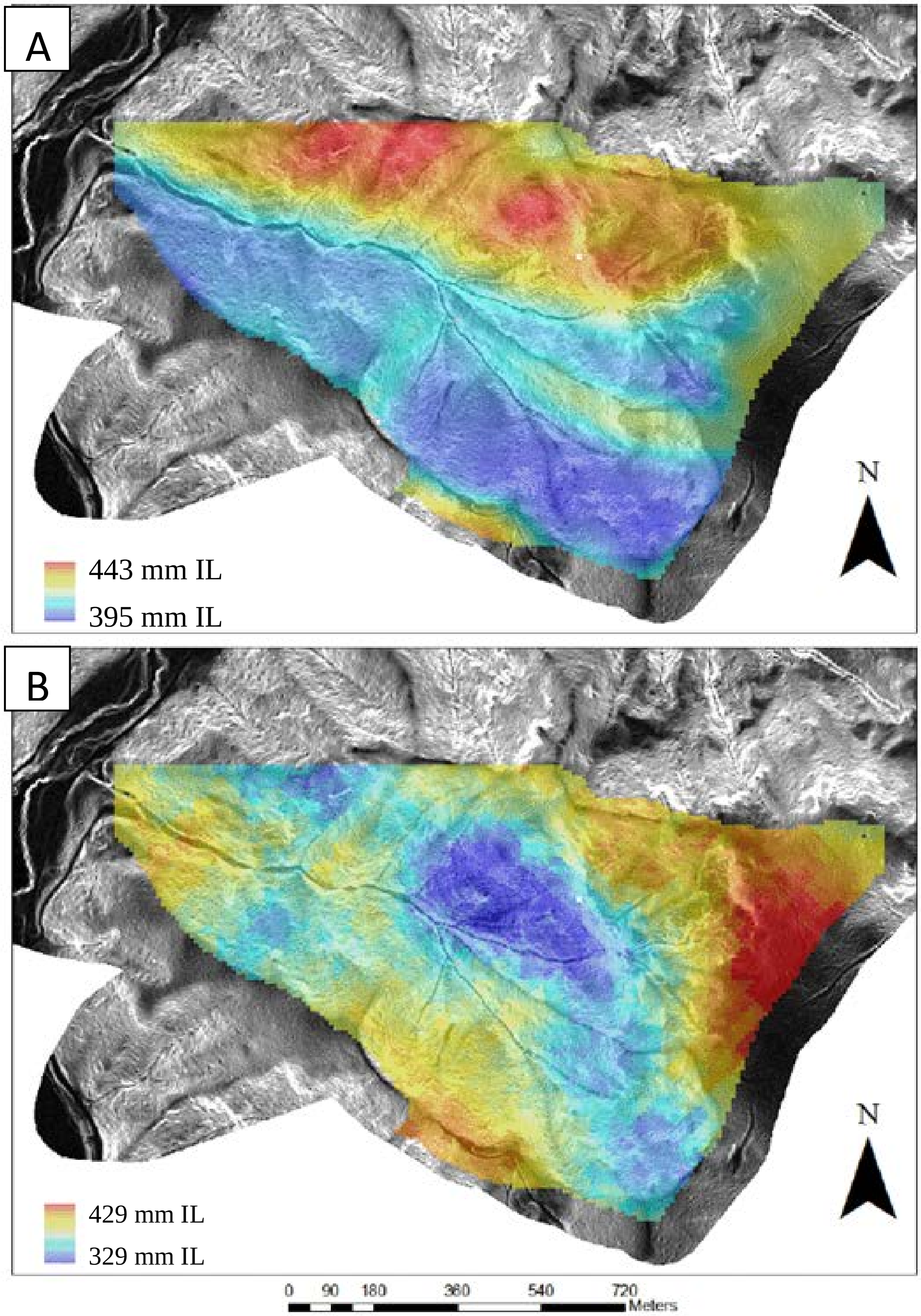




**Aboveground net primary productivity (ANPP)** should be negatively correlated with percent rock because rock presence limits plant available moisture. The weakness of this correlation (0.2533) can be improved when an outlier, P321 (plot 321) is removed (0.5038). **Why?** The productivity on this plot is exceptionally low because the plot is in a stage of canopy closure, although other plots are still highly productive. **Does site history affect other expected ANPP relationships?** Effective soil depth (depth to bedrock net of rocks by volume) is negatively related to ANPP (0.3947) although we expect a positive relationship. **Time traces** of ANPP on all 133 plots reveal that when a site reaches maximum productivity varies tremendously even in a small watershed. Stand structure at this scale is more heterogeneous than we initially expected.



# Modeled Interception Loss Variability induced by Vegetation and Topographic Complexity

**Scott T. Allen, Kristin S. Peterson, Barbara J. Bond**




Interception loss (IL) on Watershed 1 has been modeling using the Penman-Monteith model with inputs from distributed datasets (50x50m). Preliminary modeled data of IL (not including stem evaporation) is for the 2006-2008 water years with ~4000mm of precipitation. Radiation, relative humidity, temperature, wind speed and precipitation are measured at the tower at 15 minute intervals. Radiation is distributed with DEM-calculated clear-sky-radiation using the method described by Bristow et al. 1985. Temperature and precipitation are distributed using the PRISM Model (Daly et al. 1997). Figure A shows the IL variability caused by only the heterogeneity in potential evaporation (a constant vegetation is assumed). Figure B shows the distribution of IL caused by the combination of the variable energy (Fig. A) plus the vegetation heterogeneity as measured through LIDAR and vegetation surveys.

# Relating Hydromorphology and Stream Metabolism

**Alba Argerich[1], Ricardo González[2], Sherri Johnson[3], Roy Haggerty[2]**

[1]Forest Ecosystems and Society Dept., OSU; [2]Geosciences Dept., OSU; [3]Forest Service

Streams, even though a narrow strip through the landscape, are part of the carbon budget for a WS through respiration.

Transient storage zones (hyporheic or superficial) are hotspots for stream metabolism (i.e., nutrient uptake and respiration).

Stream metabolism show high temporal and spatial variability not only related to hydromorphological parameters but to environmental factors (e.g. stream nutrient concentrations, water temperature, insolation, etc.)

Its challenging to measure whole stream metabolism in steep mountain streams and the new tracer Resazurin is showing promise.