The Water Center's
Watershed Review
information on water and watersheds

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Director's message

Greetings to you all! The Water Center continues to be a vital link between the community and the University of Washington. Our goal is to provide interdisciplinary research, education, and outreach to address regional water issues. For example, our 18th Annual Review of Research, held on February 14, 2008, presented UW research to more than 400 representatives from government agencies, businesses, tribes, nonprofits, universities, and the public. Our weekly seminar series, held on Tuesday mornings, features an impressive line-up of water experts, and brings in more than 100 attendees each week. A final example is our Watershed Review.

This edition proudly features an article on the new National Ecological Observatory Network, a project led by Professor Jerry F. Franklin, College of Forest Resources. Next, Professor Richard G. Keil, School of Oceanography, explains his "spice research" in Puget Sound waters. We also highlight work of three of our students: Jonathan Miller, with the Engineers Without Borders UW Student Chapter, writes on Chapter activities; Cindy Flint and Jessica Taylor, both recent graduates of the College of Forest Resources, write on stream water quality and headwater stream riparian zones, respectively.

Finally, some news. The Water Center is pleased to announce that Professor Robert Edmonds, Associate Dean for Research in the College of Forest Resources, will be the Center's new Interim Director, as of September 24, 2008. Bob has been actively involved with the Center since its beginning, nearly 20 years ago, and we are fortunate to have his dedication and vision in leading the Center. I look forward to continuing involvement with the Center as a faculty member, and have appreciated greatly my time as Director, especially getting to know and work with all of you. Although the Center will be scaling down its operations, we plan to continue the seminar series, e-mail lists, the annual research review, and other outreach activities. We are also investigating new funding models and research opportunities to enhance the future contributions of the Center. Debbie Livingstone will continue to manage the daily operations of the Center. If you have any questions, please feel free to e-mail us at cwws@u.washington.edu.

I wish you all a safe and healthy year! ♦

—Anne C. Steinemann

The National Ecological Observatory Network (NEON)

Some incredible new resources in support of environmental research are coming to the Pacific Northwest—NEON!

Jerry F. Franklin, Professor, College of Forest Resources

What is Neon?

The National Ecological Observatory Network (NEON) is a major initiative to provide 21st century environmental scientists with the research platforms—infrastructure and data sets—that are needed to scientifically explore the impacts of climate change, land-use change, and invasive species on ecosystems and ecological processes. NEON is a major new initiative of the Biological Sciences Division of the National Science Foundation (NSF) and represents the first time that biological scientists have been able to tap into the special NSF account used in building major scientific facilities—the Major Research Equipment and Facilities Construction (MREFC) fund.

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In this issue

NEON is being created and will be operated as a national observatory, not a collection of regional observatories, even though (as will be seen) it will consist of highly-distributed sensor networks dispersed throughout the United States and its territories. An advanced cyberinfrastructure will link this distributed network and record, transmit, and archive the ecological data, making them openly available for at least 30 years. Comparability will be assured since the data are collected using standardized sensors and protocols. Placement is designed specifically to allow observation of ecological responses to changes in land use and climate and of the feedbacks with the geosphere, hydrosphere, and atmosphere.

About the Author: *Jerry F. Franklin is Professor of Ecosystem Analysis at the College of Forest Resources, University of Washington. He is also Director of the Wind River Canopy Crane Research Facility, and in 2004 was appointed Co-Principal Investigator in charge of planning the National Ecological Observatory Network (NEON) through the National Science Foundation Grant ($6 million/2 years). His areas of specialization include: 1) Structure and function of natural forest ecosystems, especially old-growth forests; 2) Successional processes and ecosystem recovery following catastrophic disturbances; 3) Effects of changing environmental conditions, such as global change, on forest processes; 4) Application of ecological principles to management of natural resources ("New Forestry," ecosystem management); and 5) Theory and practice of landscape ecology.*

NEON is specifically designed to help address two overarching questions:

- How are ecosystems across the United States affected by changes in climate, land use, and invasive species over time? How do they respond and at what rates?
- How do biogeochemistry, biodiversity, hydroecology, and biotic structure and function interact with changes in climate, land use, and invasive species across the nation? How do these feedbacks vary with ecological context and scale over time?

NEON is a critical step toward forecasting how ecosystems and organisms interact with changes in climate and land use, and what the impact of these changes might be on people and their enterprises. NEON data will be made readily available to researchers, teachers, students, and all citizens with an interest in ecological science and environmental processes.

How is NEON geographically distributed?

Since NEON is specifically intended to address continental-level questions, the components of the observatory will be widely distributed geographically and in a pattern that encompasses important climatic and ecologic variability. NEON has partitioned the US and its territories into 20 ecoclimatic **domains** based on a statistical analysis of climatic state variables and wind vectors. Washington is partitioned between two domains—the Pacific Northwest ecoclimatic domain from the Cascade Range west to the Pacific Ocean and the Great Basin domain.

Each ecoclimatic domain will be equipped with identical infrastructure, beginning with a fully instrumented NEON **Core Site** located within a wildland area broadly representative of the domain. Candidate sites have been selected for these core sites, based on a competitive and objective selection process but final decisions await the NSF approval of the final Project Execution Plan, which is currently in the process of development. The candidate core site location selected for the Pacific Northwest domain is the Wind River Experimental Forest in the southern Washington Cascade Range, where the University of Washington's College of Forest Resources and US Forest Service's Pacific Northwest Research Station jointly operate the Wind River Canopy Crane Research Facility.

What is included in the NEON infrastructure?

Core sites are locations where a substantial portion of the standard set of instruments and observations are permanently located to collect long-term biological, biophysical, and biogeochemical data within and adjacent to a highly instrumented small wildland watershed. The **Fundamental Instrument Unit** (FIU) will consist of fixed towers supporting sensor arrays that will collect comprehensive data on climate and canopy microclimate, air pollution and air quality, the carbon cycle, soil characteristics, and water quality. The **Fundamental Sentinel Unit** (FSU) will provide measurements of soil and aquatic biochemistry and track patterns and changes in organisms, including small mammals, insects, birds, soil microbes, plants, and algae. Since the planned life of the NEON

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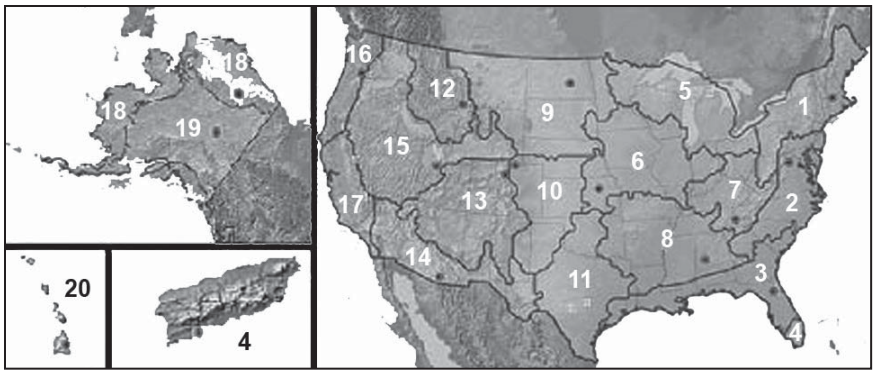


There are 20 NEON ecoclimatic domains. Each domain hosts one fully instrumented NEON Core Site located in a wildland area.

program is at least 30 years, the long-term measurements using identical protocols at the 20 permanently located core sites will provide extraordinary data sets for assessing climatic change and its consequences at the continental scale.

NEON needed additional capability for detailed examinations of variability and changes in organisms, ecosystems, and ecological processes along environmental and land-use gradients, however. It also needed the capacity to take advantage of opportunities provided by site-specific events, such as disturbances (e.g., storms, volcanic eruptions, and wildfires), invasions of exotic organisms, or outbreaks of disease. So, additional instrumentation will be available in the form of **Relocatable Tower Systems** and mobile or **Rapid Deployment Systems**.

The Relocatable Tower Systems consist of a suite of instruments that can be moved to collect data outside the fixed Core Sites. They will be deployed for extended and periodic campaigns to provide measurements of environmental variability and to gather ecological data along gradients of elevation, precipitation, and land use. The towers with their associated instruments would be located at hardened sites for periods of several months to several years, then relocated to other sites. An example of one possible gradient relevant to the Pacific Northwest would be a gradient of forest land use.

The Rapid Deployment Systems or mobile laboratories consist of instruments transported by and, in some cases, housed in vehicles. The mobile laboratories can move rapidly to a location and be quickly installed to undertake an integrated set of measurements. They would be deployed to take advantage of unusual events, such as wildfires or outbreaks of disease or invasive species. They can also be used for additional measurements along gradients, for social research, or as an educational resource.

Some additional components complete the initial NEON plan. The **Airborne Observation Platform** will use remote sensing instruments to obtain regional information for scaling and extrapolation from the ground-based sites. The **Land Use Analysis Package** will provide for the information packages that are needed for comprehensive assessment and analysis of patterns, changes, and drivers of land use, land cover, and land management. Finally, experiments are planned that will operate at various time horizons, using coordinated measurements and standardized infrastructure (such as rainout shelters) so that differences in responses to experimental treatments can be assessed across the ecoclimatic domains.

Where is NEON currently in its development?

NEON seems to be taking a long time to become a reality—and it is—but that is to be expected with a program of this magnitude. NEON first became a basis for discussions and meetings over 7 years ago and got down to serious planning in 2005. The current conceptual plan emerged in 2006. Several planning and review hurdles were passed in 2007 but perhaps the biggest hurdle—completion, review, and approval of the Project Execution Plan—is expected to happen in 2009. Once that plan is approved by NSF, then construction can commence!

NEON itself was incorporated as a non-profit corporation—NEON, Inc.—at the end of 2006, a requirement stipulated by the National Science Foundation. NEON, Inc. will be the primary organization funded by NSF for construction, operation, and maintenance of the NEON assets, including the sensor systems and towers, the cyberinfrastructure, and the data sets. This is different than some other MREFC-created facilities, which are operated by one or two academic institutions. NEON is a member-based organization, however, and now has over 50 institutional members, including the University of Washington.

Much more information, including the current status of planning activities, can be found on the NEON, Inc. web site (www.neoninc.org). ♦

NATIONAL ECOLOGICAL OBSERVATORY NETWORK

Environmental Spices

Richard G. Keil, Associate Professor/Fleming Fellow, and Jaqui Neibauer, Research Scientist/Engineer, School of Oceanography

What do our local waters, aspirin, and chocolate chip cookies have in common? All contain cooking spices such as vanilla or cinnamon. In fact, the use of cooking spices (natural and artificial) is so prevalent in our society that, with the proper equipment, it is straightforward to trace the pathways delivering spices to the environment and their presence therein.

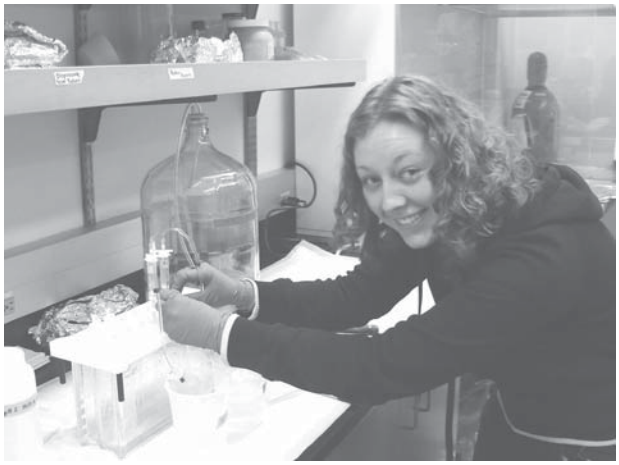
But why bother to do that? With the continued degradation of our urban waterways, timely research questions center around the point- and non-point paths that connect citizens to Puget Sound. In fact, one of the critical priorities identified in the Puget Sound Conservation and Recovery Plan (PSP 2007) is to identify linkages between consumer behavior and environmental impacts. In our lab, we believe that this can be approached both through 'traditional' analyses of pollutants as well as by tracing more 'friendly' compounds that do not pose a threat to society or the Sound. Thus, we use cooking spices to evaluate the time scale and magnitude of the connection between consumer shelf and Puget Sound.

It started during a student teaching cruise aboard the UW's ship Thomas G. Thompson, as a group of undergraduate students pondered the impact of man on the marine environment. I commented that our lab routinely measures some common spices because they are the building blocks of the lignin in wood. (For our 'real' research we use lignin to trace woody materials from forests to depositional sites in lakes and the ocean.) We decided to try and measure spices in sewage effluent and in Puget Sound to see if spice abundance mimics human consumption patterns.

We contacted King County and got permission to start sampling treated sewage from the West Point facility immediately prior to its discharge into Puget Sound. We also began rounding up samples from local streams and from Puget Sound itself. Sampling commenced right before Thanksgiving 2006. We currently measure several spices including cinnamon, vanilla and some vanilla derivatives. We like to joke that we can measure 'parsley, sage, rosemary, and thyme' but in fact parsley is a tricky one.

It turns out that the natural world does notice what you ate for dinner last night. At the sampled source (West Point) we observe pulses of certain cooking spices after major holidays. For example, thyme is only present right after Thanksgiving and methyl-vanilla (found in waffle cones and kettle corn) is only found in the summer during warm weather. Vanilla and cinnamic acid have distinct pulses associated with most major holidays (Christmas, Valentines, etc.). The natural cycle in Puget Sound is a little more muted—it is after all, a large body of water to dilute things within. Nonethe-less, we think we observe a seasonal pattern in spice distributions within the Sound, but more research is needed. One thing we do know for sure is that Puget Sound has a distinct spice composition relative to the more 'pristine' fjords on the west coast of Vancouver Island that serve as our control locations. Puget Sound has more artificial vanilla (ethyl-vanilla) than other marine locations or natural sources of water (local streams and rivers). Ethyl vanilla, a minor component of artificial vanilla, is a compound with few known natural sources, so seeing it dominating the spice composition of Puget Sound speaks to the power of urban activity in influencing the chemical composition of our local marine waterways.

In the winters of 2006 and 2007, on a whim we converted the amount of spice added to Puget Sound each day into the same amount of spice that would be found in holiday cookies such as chocolate chip, gingerbread persons, and snickerdoodles. The flux of 'home-baked cookie equivalents' during the holiday season averages about 250,000 cookies per day, roughly 2/3 butter or chocolate chip, and 1/3 snickerdoodle or similar cinnamon-containing cookies such as gingerbread. If accurate, and taking into account our digestion, this means that the average person in Seattle was eating at least two cookies per day during the holidays and that the bacteria of Puget Sound eat about two cookies a week. Maybe we and they need to go on a diet?!



Undergraduate student Britta Voss extracting spices from seawater using solid-phase extraction columns.

The study remains unfunded and largely staffed by volunteer undergraduates, but our student Britta Voss is the recipient of a Mary Gates Undergraduate Research Scholarship and fellow spice girl Kelsey Powers has a summer internship sponsored by the Joint Institute for the Study of the Atmosphere and Ocean. We have also received in-kind support from Puget Consumers Coop and Theo Chocolates. Student and community enthusiasm goes a long way,

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perhaps because spices are non-offensive and they cheerfully remind the general public how connected we are through our daily lives to the world we live in. ♦

Snapshots of current research

Does Forest Fertilization Negatively Impact Water Quality in Hood Canal?

Cindy Flint, College of Forest Resources, 2008 Graduate (MS)

Nitrogen (N) fertilization of our landscape can contribute to pollution of our water supply, nutrient depletion and acidification of our soils, and eutrophication of our waterways (Vitousek et al., 1997). Eutrophication is currently a problem in Hood Canal, Washington. Anthropogenic additions of N to the upper water column are contributing to large phytoplankton blooms and when the plankton biomass sinks to the bottom of the canal, oxygen is consumed during the process of decomposition. Due to the historically low rates of mixing and highly stratified water column, this deep water, low in dissolved oxygen, is often unable to replenish its oxygen content. As recent as 1986, mortality and stress of aquatic animals as a result of these low oxygen levels started to intensify (Curl and Paulson, 1991) and have continued to be a problem in current years.

Several studies done in this region have shown increased levels of N in stream water immediately following fertilization with urea, at similar application rates to this study. Most of these increased levels of N were due to runoff and direct fertilizer application to streams. The Forest Practices Act requires a 25 ft unfertilized buffer along potential fish bearing streams. Direct application to streams can occur if streams are not large enough to fall under these protections, such as headwater streams, or if aerial application is not accurate and it occurs accidentally (Meehan et al., 1975; Malueg et al., 1972; Perrin et al., 1984; Hetherington, 1984; Cline, 1973; Bisson et al., 1992; McCall, 1970). There was, however, a need to explore the movement of N through the soil profile to see if it is leaching beyond the rooting zone and potentially contributing nutrients to Hood Canal. The purpose of this study was, therefore, to use lysimeters to collect the soil solution as it moved out of the rooting zone and analyze it for N.

After monitoring lysimeter solutions for 11 months following fertilization, the total amount of N that leached out of the rooting zone was 3 kg N ha^{-1} (see table 1). Of the total N applied as urea fertilizer (224 kg N ha^{-1}), this represents just 1%. Ninety one percent of this total N that leached from the soil profile did so during the month of November, when extremely intense precipitation occurred. It may be that if these record rains had not occurred and precipitation was spread more evenly throughout the winter months, we would have seen less leaching. With the onset of global warming, however, increasing frequency of high intensity rains are predicted to continue (Arnell et al., 2001) so these results could be an indicator of future leaching behavior.

Nitrate concentrations are also of concern because levels above the water quality standard of 10 mg NO_3^--N L^{-1} (US EPA, 1986) can lead to blue baby syndrome in infants. The peak nitrate concentration that leached out of the rooting zone (100cm) was 0.22 mg N L^{-1} which is well below the water quality standard. The peak concentration found at the 20cm depth, however, was 10.62 mg N L^{-1}. Whether or not these high nitrate concentrations in the shallow soil are causing adverse affects to the soil biota is not known.

In conclusion, it appears the amount of N leaching out of the rooting zone is small relative to the amount applied, however, calculations to determine the potential impact of this on Hood Canal are yet to be made. ♦

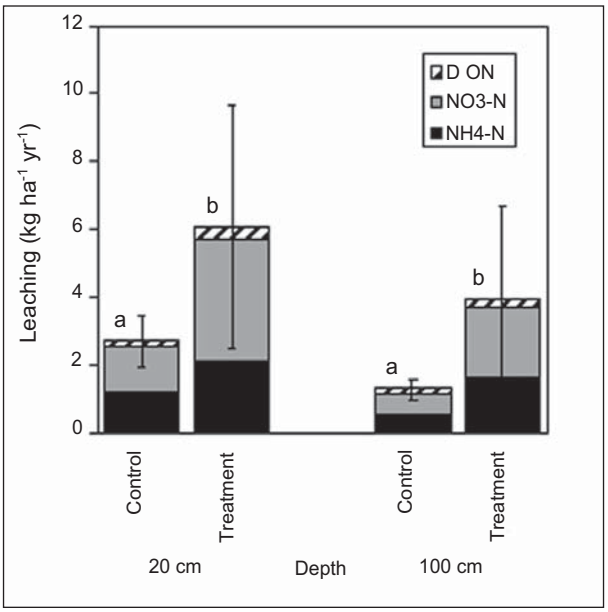

Table 1: Total N Flux. The amount of total N that moved beyond the 20cm and 100cm depths during the first year following fertilization are shown. Letters show significant differences by depth ($p < 0.10$). Error bars equal to one standard deviation.

Soil and Stream Nitrogen in Forested Headwater Stream Watersheds in Relation to Riparian Buffers

Jessica C. Taylor, College of Forest Resources, 2008 Graduate (MS-Forest Soils)

Historically, research concerning riparian area conservation and biogeochemical cycling in those areas has been performed on larger rivers and streams that are fish bearing. Research is increasingly becoming focused on the connection between these downstream reaches and the headwater streams that feed them. Headwater streams affect the ecological and economic viability of downstream rivers by regulating flood waters, by maintaining the quality of drinking water, and by preventing some types of pollution. Because of these functions, the job of protecting the larger streams and rivers begins with monitoring and evaluating their source: the headwater streams.

Headwater streams are defined as the creeks and streams that are the origins of most of the world's rivers. They are less than 1.5 m in width and non-fish bearing. In Washington State, these streams make up a large proportion of the total stream habitat. It is estimated that headwater streams make up 50% of all stream length in our state. These streams are usually found in areas with very steep terrain and are closely coupled with hillslope processes including sediment and debris transport as well as hyporheic exchange where there is a mixing of shallow groundwater and surface water. The dynamics of hyporheic flow interactions are recognized as being very important for nutrient cycling, sediment movement, and fish spawning. All these ecosystem processes can easily be affected by forest management practices and therefore influence the headwater streams.

During timber harvest, a large portion of the nitrogen within the ecosystem may be removed. This disruption of the local nitrogen cycle has several important repercussions. One effect is to reduce the amount of nitrogen available for new vegetative growth. Another repercussion of timber harvest is the increase in the levels of solar radiation that reach the soil. The removal of the vegetative cover can cause more of the soil surface to be exposed and it is possible that this exposure can cause greater fluctuations in the temperature of the surface of the soil, which in turn can affect microbial activity if water is not a limiting factor. Increased soil microbial activity typically increases nitrogen mineralization and nitrification, leading to increased production of both ammonium and nitrate. Consequently, it is possible that concentrations of these two biologically available forms of nitrogen could become greater than that which can be used by the remaining vegetation. This could lead to excess amounts of nitrate leaching out of the soil and into the groundwater which could be a potential problem downstream. Nevertheless, most studies of timber harvesting in the Pacific Northwest have not found high levels of nitrate leaching to the streams following harvest. The main concern in the Pacific Northwest is not upslope harvesting but harvesting effects in the riparian zone and across stream traffic. Riparian areas are commonly defined as the three-dimensional transitional zone between terrestrial and aquatic systems. These zones are ecologically important for wildlife habitat and as a location where significant nutrient cycling occurs linking plants, aquatic communities and wildlife.

In order to protect these streams and their banks from the harvesting effects to the riparian zones, management plans often mandate the leaving of vegetation along stream banks. My research addressed the question of whether or not this riparian buffer had a statistically significant effect on either soil nitrogen mineralization rates (the transformation from organic to inorganic nitrogen usually completed by microbial activities) or on stream nitrogen concentrations.

Three different harvest practices were monitored to determine their effects on soil and stream nitrogen biogeochemical cycling; 1) clearcut with no tree buffer left adjacent to the streams, 2) harvests that left a buffer next to the streams, and 3) control forests that

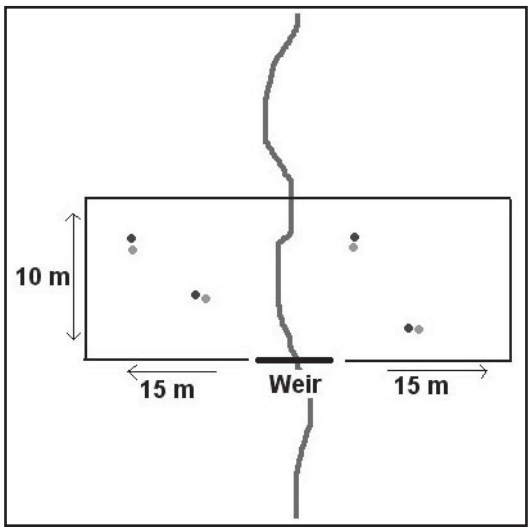

Diagram 1: Diagram of soil sample collection area in relation to weir installed in stream. Paired soil sample sites are marked by contrasting circles. Samples were collected within 15 m of the stream bank and within 10 m upstream of the weir.

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were not harvested. This research project was conducted in the Capitol Forest near Olympia, Washington. Within each watershed there were four sets of soil samples analyzed quarterly for nitrogen mineralization and a correlated water sample taken from the stream each month (see Diagram 1). Water samples were analyzed for total carbon, total nitrogen, nitrate, ammonium, and several trace minerals.

Statistical analyses show a "harvest" effect on soil nitrogen mineralization (N-min) rates between sites that had harvesting activity (buffer and no buffer) and the sites that were left unharvested (control). Overall, control sites had higher nitrogen mineralization rates and higher stream nitrogen concentrations. The buffered and non-buffered sites showed a trend of the buffered sites having regularly higher soil nitrogen mineralization rates and stream nitrogen concentrations.

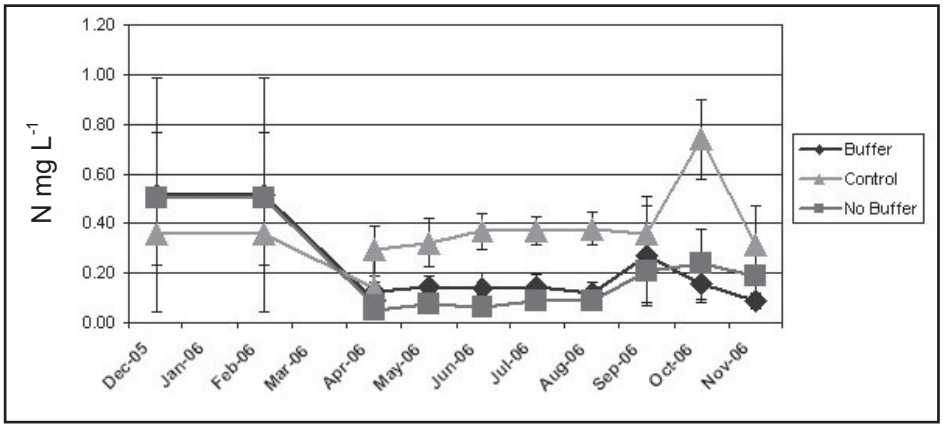

Table 1: Total inorganic nitrogen concentrations in stream water. Each line is an average of three replicates of each watershed type. Standard error bars are included for each treatment and time point.

The higher concentrations of stream nitrogen in the control sites may be tied to the greater quantities of decomposing leaf litter (not measured) in the control streams (see Table 1). However, overall measurements were low compared to the results of research done in other parts of the country. The highest individual measurement taken throughout the 12 month

Kg/ha to 15 cm depth (std. error)

Net N-Min	Winter	Spring	Summer	Autumn	Annual
Buffer	-0.2 (1.5)	7.4 (3.5)	1.0 (1.2)	-3.7 (1.4)	13.6 (2.3)
Control	8.0 (1.4)	34.9 (17.9)	5.5 (.08)	-20.5 (10.5)	83.7 (11.3)
No Buffer	0.9 (1.5)	7.4 (3.9)	-1.2 (1.0)	-4.6 (1.0)	7.4 (2.5)
TO NO3-N	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
Buffer	0.5 (0.5)	1.6 (0.2)	2.3 (1.0)	7.8 (4.4)	36.6 (20.7)
Control	0.6 (0.1)	2.1 (0.6)	11.5 (6.5)	29.7 (18.3)	131.6 (75.7)
No Buffer	0.5 (0.2)	0.5 (0.2)	0.3 (0.3)	3.4 (1.0)	13.9 (3.9)
T1 NO3-N	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
Buffer	0.4 (0.7)	10.3 (4.4)	4.1 (1.7)	5.3 (3.0)	60.5 (31.3)
Control	4.9 (2.5)	36.5 (19.57)	19.5 (10.7)	14.9 (9.3)	227.5 (116.0)
No Buffer	0.4 (0.5)	7.9 (1.0)	1.9 (1.2)	1.6 (0.6)	35.2 (7.0)
TO NH4-N	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
Buffer	2.5 (0.9)	3.9 (1.6)	4.4 (0.6)	2.7 (1.0)	40.6 (7.6)
Control	0.4 (0.8)	6.3 (2.8)	5.8 (2.3)	6.7 (1.7)	57.5 (16.5)
No Buffer	0.8 (0.5)	4.5 (1.6)	4.9 (0.9)	4.5 (0.6)	44.2 (8.8)
T1 NH4-N	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
Buffer	2.4 (0.6)	2.6 (1.0)	3.6 (0.7)	1.5 (0.1)	30.2 (6.5)
Control	4.1 (2.3)	6.7 (1.7)	3.2 (2.0)	1.0 (0.5)	45.3 (9.6)
No Buffer	1.8 (0.4)	4.5 (0.6)	2.1 (0.2)	1.7 (0.7)	30.3 (0.8)

Table 2: Mean nitrogen values taken from four replicates within each replicate of the treatment types (buffer, no buffer and control) (n=9). Soil samples were collected from the mineral A horizon. In situ incubation treatment periods were 30 days per season for net N-mineralization and T1 measurements. T0 N measurements are immediate with no incubation period.

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study period was 0.74 mg N L^{-1} on October 23, 2006; this is less than the mandatory minimum in Washington State of 10 mg NO_3-N L^{-1}. These low numbers are typical of streams in this area. Streams in the Pacific Northwest are generally classified as oligotrophic (low nutrient levels). This is due to the high amounts of rainfall in this region. The nutrients present in the outflow are diluted by vast quantities of precipitation. Average loss rates of stream NO_3-N concentrations in the western Cascades and Olympics are less than 2 kg N ha^{-1} yr^{-1}. In comparison, polluted areas in Europe and Asia average 10-31 kg N ha^{-1} yr^{-1} of stream NO_3-N.

There are several parameters that affect soil nitrogen mineralization rates including carbon to nitrogen ratios, total nitrogen, total carbon, pH and soil temperatures. The only significant difference in these parameters across treatments was between soil pHs. The control sites had more acidic soils than buffered and non-buffered sites which were statistically the same. This difference is probably due to the increased presence of organic acids due to an abundance of leaf litter. The control sites had more red alder than the buffer sites where the trees left on site were mostly Douglas-fir. Nitrogen mineralization rates in the buffered sites were not significantly different from the non-buffered sites but they showed a trend of having slightly higher N-min rates (see Table 2).

Nitrogen mineralization rates are usually higher in clearcut sites due to decreased vegetative uptake. In fact, it has been found that large disturbances, such as clearcuts, could lead to changes in the rate at which nitrogen mineralizes and immobilizes and that subsequent nitrate leaching out of the immediate soil environment is possible. The higher rates in the control sites could be due to increased organic matter input from leaf litter, especially the red alder leaves, which have higher nitrogen contents in their litter than other species. The soil cores were designed to exclude both precipitation and roots and the organic horizon was removed so any organic matter in the mineral horizon would have to have been leached through the profile over time or mixed into the soil during the last harvest 80 years ago. The overall nitrogen immobilization/uptake in the buffered and non-buffered sites could be due to the increased rate of growth of new vegetation. Nitrogen immobilization has also been found to occur in sites with high carbon/nitrogen (C/N) ratios due to slash timber being left on the ground; however the sites included in this study had relatively lower C/N ratios across all of the treatments.

Headwater streams have only just begun to be studied in earnest in the last decade and any research adds to the growing body of knowledge about them. One of the gaps in our understanding of these small streams is the effects of riparian buffers. Future research should include wider riparian buffers. The 15m wide treed buffer in this research project showed a general trend of retaining more inorganic nitrogen compounds and a wider buffer with the possibility of more vegetative uptake could show a statistically significant difference. ♦

Engineers Without Borders University of Washington Chapter—"Building a Better World, One Community at a Time"

Jonathan A. Miller, Past President, EWB-UW Chapter, Doctoral Candidate, Microbiology

High in the Andean mountains of Bolivia lies the isolated village of Yanayo, home to an indigenous population of about a hundred. During their first site assessment trip in 2006, Engineers Without Borders-University of Washington (EWB-UW) found villagers eking out a subsistence lifestyle growing mostly wheat and potatoes in poor soil, and living in thatched-roof houses lacking electricity, toilets, water, and chimneys to ventilate their open-fire cooking. Drought over the past decades had led to decreasing crop yields, forcing villagers to leave their community and look for employment elsewhere, and leading a Bolivian engineer to contact EWB-USA for assistance.

EWB is an international non-profit organization dedicated to improving lives through the implementation of economically and environmentally sustainable engineering solutions, while educating the next generation of globally responsible engineers. The EWB motto is "building a better world, one community at a time".

EWB-University of Washington Chapter: Founded in May 2005 by Austin Polebitski (Civil and Environmental Engineering, MS) and a handful of other dedicated students, the chapter has grown rapidly to an active group of over fifty graduate and undergraduate students from many backgrounds. Building momentum in the early days was difficult. With no formal path previously outlined, founding members learned as they went, meeting week after week to define what the chapter would become. Much time early on was spent on outreach, organizational issues, and fundraising efforts. Initial breakthroughs included establishing what would become the group's annual fundraiser, partnering on a project in Ecuador, and

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applying to take on the project in Bolivia. These events helped spread the word and generate excitement on campus for the group; weekly meetings are now regularly attended by dozens of members, with new students joining regularly. Perhaps most rewarding, some students now cite the successful EWB chapter as an important reason for attending the UW.

Practice-based, service-learning education: The UW chapter can claim numerous accomplishments in its short history. Early on, EWB-UW partnered with the Puget Sound Professionals chapter on an irrigation project in Susudel, Ecuador. Twice a year, the chapter offers a course for credit on 'sustainable engineering in an international development setting', taught by faculty mentor Dr. Susan Bolton, PE (College of Forest Resources) with TA support and lectures by chapter members. This course gives students a chance to learn development concepts while working on actual projects. Each winter, EWB-UW hosts their annual 'Dessert & Wine Fundraiser with Silent Auction'; this year's event boasted thirty five different desserts baked by chapter members, wine donated by DiStefano Winery, and silent auction items from Bolivia as well as products donated by local supporters.

In addition to their project in Yanayo, students are initiating two new projects, one focused on providing potable water in Suriname, and the other a local project here in the San Juan islands. Earlier this year, the chapter partnered with the Seattle University and Puget Sound Professionals chapters to host the Engineers Without Borders International Conference at the UW campus. For three days, nearly 700 attendees representing many of the 250 student and professional chapters across the country assembled to focus on issues involving sustainable engineering and global health. The conference was the culmination of a year of planning by student leaders, faculty mentor Dr. Mark Benjamin, PE (Civil and Environmental Engineering), and the College of Engineering, among others. In recognition of their work in Yanayo, EWB-UW was awarded the EWB-USA 2007-2008 International Humanitarian Award.

The Yanayo Project: During the site assessment trip in September 2006, multiple community meetings were held during which villagers were asked to prioritize their needs. It quickly became apparent that much more was needed than the irrigation system EWB was initially asked to install. Upon returning to Seattle, the chapter undertook an ambitious plan to implement several projects within a year, to help improve living conditions as soon as possible and demonstrate that the villagers' enthusiasm and trust in EWB were well placed.

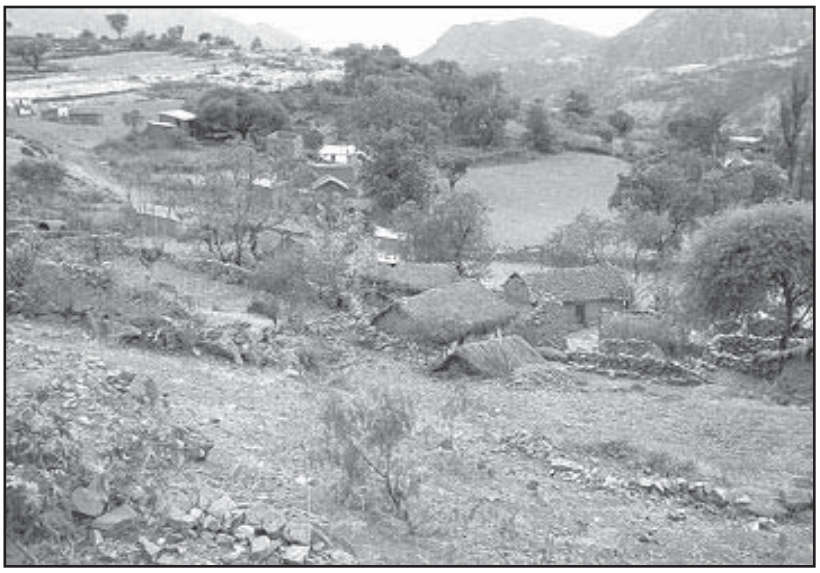
In July and August 2008, seven members of EWB-UW, accompanied by Dr. Bolton and Peter Sturtevant, PE, the chapter's Professional Mentor, returned to Yanayo to implement three main projects:

Replacement of thatched roofing with corrugated metal: Replacing thatched-roofs with corrugated metal is a proven method for reducing incidence of Chagas disease—for which many of the villagers test positive—by removing habitat of the vector.

Installation of efficient adobe brick stoves with chimneys: Metal roofs allow for stoves with chimneys; women previously cooked on indoor open stoves, resulting in poor air quality that contributed to eye damage and respiratory difficulties. Higher efficiency stoves were designed by four Mechanical Engineering students as their senior design project.

Design and installation of an irrigation system: This system will allow for desperately needed irrigation especially during the dry months.

Each project was implemented with the help of Yanayo community members. During a return trip to Yanayo in February 2008—both to assess last year's projects, and to lay groundwork for continuing efforts this summer—the obvious impact of the work was seen. With the new irrigation system, villagers were able to grow a second crop during the dry season, generating sufficient surpluses of food to allow sale to market in the city of Cochabamba. It is hoped this will help alleviate poverty in the community and allow villagers to implement future improvements with increased independence. Additionally, the clear health benefits from the



The village of Yanayo, Bolivia.

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improved cookstoves and roofs attracted the attention of neighboring communities; a contingent of EWB-UW students just returned at the end of July from a second implementation trip to reproduce last summer's successes in two neighboring communities. Word of these successes has spread, and now seven nearby communities have asked for future assistance on implementing these projects. With a number of villagers in Yanayo and the two nearby communities now possessing the knowledge and tools to make this a reality, it is hoped, with assistance from EWB-UW, that these projects can likewise spread in the region.

The children of Yanayo.

EWB-UW is preparing for a second return trip to Yanayo this summer. On the agenda: agriculture, health and sanitation education, further water supply upgrades, and implementing road design improvements to prevent washout during the rainy season. Although the road improvements are an enormous undertaking, they are critical in allowing for outside medical assistance, trade, and improved contacts within the region. EWB-UW anticipates a minimum five-year commitment to Yanayo and is excited about the possible impacts their involvement with the community and surrounding region will foster.

Raising the money: Much effort is spent on the critical work of fundraising. Area businesses, organizations, individuals and the University of Washington have all lent their support to the cause. In their first year, the chapter raised $6,000; this past year this number grew to $30,000, and this year the number has surpassed that. However, finances remain a major limitation. Given the substantial impact the implementation trips have had on the region, and the opportunities awaiting, the chapter is working hard to raise many tens of thousands more in the coming months.

How you can help: Help is always gratefully received. For more information or to offer assistance, please visit *http://students.washington.edu/ewbuw/* or contact Jonathan Miller at *millerja@u.washington.edu*. To make a secure, on-line donation to this worthwhile project, visit: *http://students.washington.edu/ewbuw/help/donate.php.* ♦

Announcements

Dean Rae Berg Endowed Student Support Fund newly established at the UW

This fund was created to honor the life's work of Dean Rae Berg, our late alumnus, who in his career became a very highly respected member of our extended forestry and natural resources community.

It is the intent of this endowment to honor the richness of Dr. Berg's life's work by helping others achieve their goals through the pursuit of higher education. The endowment will provide support for undergraduate and graduate students in the College of Forest Resources engaged in the study or research of riparian areas and or watersheds, and who are working with or funded through the Water Center, with preference given to students who are enrolled members of a federally recognized American Indian tribe in Washington State.

Dr. Dean Rae Berg received his PhD from the College of Forest Resources in 1995, following completion of his Masters of Science and Bachelors of Science degrees in Forestry in 1990 and 1978. After completing his PhD, Dr. Berg continued as an affiliate faculty member, offering lectures, serving on committees, advising students, and working closely with his colleagues.

Throughout his professional career, Dr. Berg cared deeply about balancing sustainable forest practices with wildlife habitat and stream resource protection. He was an expert in forest management and harvest design and always emphasized the development of practical ways of utilizing natural resources and sustaining the environment. He focused primarily on sustaining riparian zones and watersheds in the Pacific Northwest, through intensive scientific work involving colleagues in universities, public agencies, local Indian tribes, and industrial and non-industrial landowner organizations.

Dr. Berg contributed to numerous scientific publications, provided expert testimonies, and was a longstanding member of the Society of American Foresters, and other prestigious professional and academic organizations.

Secure online donations can be made at: **http://water.washington.edu/Outreach/DeanRaeBergFund.html.** ♦

Water Center Seminars—Free and Open to All Interested Persons

You are invited to attend the weekly, free Water Center Seminars throughout the academic year. During Autumn, Winter, and Spring quarters, the UW Water Center offers seminars on timely water-related topics—presented by UW faculty and off-campus experts. The seminar is open to the public and no advance registration is required. The seminar is also offered for academic credit to graduate and undergraduate UW students who wish to learn more about contemporary water issues from a multidisciplinary perspective.

A sampling of titles for fall quarter include:
• Wetland monitoring with high resolution remote sensing and GIS
• The Virtual Puget Sound—a process to evaluate alternative futures for Puget Sound?
• Geoduck clam aquaculture on the intertidal habitats of southern Puget Sound: assessment of ecological impacts and mitigation of regional-scale cultural conflict
• Cold water fishes and thermal refuges in hot water
• Green Lake alum treatment—dose for a decade

Check out the current and past seminar offerings, information about the speakers, slide presentations, audiotaped seminars, and supplemental reading materials at the Center's website:
http://water.washington.edu/Outreach/Events/Tuesday/tuesday.html

The Fall 2008 seminar series begins:
September 30, 2008 through December 9, 2008, from 8:30 a.m. to 9:20 a.m.
Location: 223 Anderson Hall
University of Washington, Seattle campus
Anderson Hall is located here:
http://www.washington.edu/home/maps/?AND ♦

Leave a Legacy—Support The Water Center

A bequest to the University of Washington's Water Center is a thoughtful way to help solve pressing water resource problems through community-based research, education, and outreach.

If you would like to learn more about how you can achieve your philanthropic goals and receive estate tax benefits through a charitable bequest or other planned gift to the Water Center, please contact the UW Office of Gift Planning.

If you are considering a bequest gift to the University of Washington and would like to receive specific language, a member of the gift planning staff would be happy to work with you or your advisor to ensure your gift does exactly what you intend. ♦

Office of Gift Planning
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Seattle, Washington 98101
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phone: (206) 685-1001
toll-free: 1-800-284-3679

The UW's *Construction Site Erosion and Pollution Control* course is starting soon!

This civil and environmental engineering short course satisfies the Washington State Department of Ecology's Certified Erosion and Sediment Control Lead (CESCL) training course requirement and leads to CESCL certification.

For information on this and other Engineering Professional Programs—Civil and Environmental Engineering, contact:
Engineering Professional Programs
www.engr.washington.edu/epp/cee
E-mail: *uw-epp@engr.washington.edu* ♦

Puget Sound Low Impact Development Technical Workshop Series

As part of the Puget Sound Initiative, Washington State University is presenting a series of new LID technical workshops in locations around Puget Sound. These two day workshops, with instruction by regional and national experts in the field, provide the technical details necessary to properly design, build and maintain LID practices.

Locations:
Bellingham: September–November 2008
Lacey: January–February 2009
Seattle: April–May 2009

The workshops are developed by Washington State University Pierce County Extension and funded by the Puget Sound Partnership. Registration is $75.00 each workshop.

More information and online registration is available at: http://capps.wsu.edu/conferences/lidworkshops/

Congratulations to the winners of The Water Center's 2008 Annual Review of Research Awards:

Best student poster: **Julie Vano**
Civil and Environmntal Engineering

Best student rehearsal presentation:
Shraddhanand Shukla, Civil and Environmental Engineering

The high quality and professionalism of all student presentations and posters were greatly appreciated.

Coming up!

Sept. 30 - Dec. 9, 2008	**The Water Center Seminars** Free and open to the public Tuesdays, 8:30 a.m. to 9:20 a.m. Location: UW Anderson Hall, Rm. 223 See the schedule online at our website
Feb. 18, 2009 (note new date)	Save the Date! **19th Annual Review of Research** HUB, University of Washington Seattle campus

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