FOREST SERVICE RESEARCH DIRECTORY
OF PERSONS ENGAGED IN SOILS RESEARCH

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PACIFIC NORTHWEST RESEARCH STATION (Revised 02/24/03)

BERNARD T. BORMANN
Forest Ecologist
Research Plant Physiologist, Team Leader

PNW-4362

USDA Forest Service
Ecosystem Processes Program
Sustainable Ecosystem Productivity Team
Corvallis Forestry Science Lab
3200 SW Jefferson Way
Corvallis, OR 97331

Phone: 541-750-7323
FAX: 541-750-7329
e-mail: bormannb@fsl.orst.edu
bbormann@fs.fed.us

Selected Studies:

Alaska windthrow-weathering study. A NSF grant supports study of a previously unrecognized connection between windthrow and the weathering release of nutrients required for plant growth, and the large-scale influence of windthrow disturbance on productivity and stream chemistry. Water flowing through watersheds with extensive blowdown is expected to have less acid, less dissolved organic mater (brown water), and more P, Ca, Mg, and HCO3 than watersheds with little disturbance because water will flow through mineral soil. Water flowing through undisturbed watersheds should have the opposite: more acid, more organic matter, and fewer nutrients.

Windthrow-landscape study. The extent and predictability of windthrow effects across an extensive area (Kuiu Island) is being evaluated on the Stikine Area of the Tongass NF to look at the effect of windthrow disturbance history and cation inputs in dust and alluvial deposits on tree productivity, based on Npp and height-growth histories.

Long-term ecosystem productivity: the integrated-research-site (IRS) experiment. An extended debate among scientists and managers established priority for two sets of

treatments in the IRS experiments: long-term effects of changes in plant composition (roughly early, mid, and late-seral groupings) and organic matter removals, in a full factorial design. Species and organic matter questions were thought to have a continuing, not one-time effect on ecosystem development and productivity and were deemed most suitable for study in large, stand-scale experiments extending over 200 years. Concern was based on the simple truth that rotations of single-species plantations sharply reduce the time that both early and late-seral species occupy the land relative to historical successional patterns. Hypotheses include that early and late-seral species affect the land differently than do conifer plantations (mid-seral). Organic matter treatments were prompted by concern for possible negative effects of organic matter removal on nutrient supply, soil structure, and wildlife. Soil chemistry, organic matter, respiration, structure, and biotic composition as well as vegetative production are being monitored.

Mt. Hebo old-growth restoration management experiment. This is a prototype "management experiment" designed to achieved late-successional conditions starting with an 80-year-old plantation of off-site stocky, little downed wood, highly eroded soil from repeated wildfire, and dense stand structure. Four prescription treatments, replicated four times, are being installed: non-action, partial-thinning with downed woody debris, and maintaining 10-30 trees per acre of standing large trees, woody debris, and then growing repeated rotations of hemlock (a late-successional species) or red alder (a soil improving species) between them. Changes in soil organic matter, nutrient content and availability, and composition of fungi, bacteria, and nematodes are being monitored as part of the study. Greenhouse studies look at plant species effects on primary mineral weathering and associative n2 fixation in the rhizosphere.

Long-term ecosystem productivity concepts and small-plot studies. Maintaining the "productivity of the land" the focus of the MUSY Act, has never been well defined. Interpretations have often ended with a definition of "soil productivity" because soil is a fundamental resource from which production comes. Ecologists have measured production in terms of net primary production (Npp). Although conceptually Npp is a generally accepted measure of site potential, Npp's use in assessing changes in site is questioned because of the lack of quantifiable methods. Quantitative indicies of site productivity, e.g., site index; are being combined with standard mensurational measures of timber volume; biomass, and Npp, and related to measures of potential causes and effects, e.g., soil structure, nutrient and carbon status, and plant and soil biological diversity. Short-term, small-plot experiments are being installed to test components of the operational-scale experiments quickly by providing more experimental control, replication, and intensive monitoring. As such, they are a critical element in connecting traditional research approaches with more complex management experiments. The small-plot experiment can also serve to efficiently test existing models and indicators of soil productivity and sustainability.

Soil respiration methods. One of the most difficult challenges facing productivity research is how to measure Npp. Most scientists agree that Npp measured over multiple years would offer the best single estimate of site potential, a measure based now, for lack of alternatives, on the height-growth patterns of dominant crop trees (site index). A new

approach for measuring Npp over long periods requires a measure of soil respiration. measuring soil respiration has other important purposes as well for assaying microbial and root activity.

LTEP Copper River ecosystems. A cooperative study was initiated in the Copper River Delta with J. C. Gordon (Yale) following the work of J. Thelinius (PNW, Juneau, now retired). We're interested in testing the notion that two species in this wetland ecosystem are key drivers of ecosystem productivity: Myrica gale as the only symbiotic N2-fixer and Equisetum spp. as a phosphorous pump (it is the only plant that roots into poorly oxygenated sediments).

Sandbox experiment: unaccounted-for nitrogen fixation. Many studies worldwide have found unbalance nitrogen budgets, including at Hubbard Brook and in the Pacific Northwest. Because of the energy costs of nitrogen fixation, free-living and associated (living outside but in the rhizosphere) nitrogen fixers generally are not thought to be able to balance these budgets with annual rates of only up to 5 kg/ha. We were able to demonstrate, for the first time, that annual N2 fixation associated with tow pines can account for as much as 50 kg/ha with this innovative technique in the sandbox ecosystems at Hubbard Brook New Hampshire.

Sandbox experiments: rates of primary mineral weathering. Nutrients, other than nitrogen, ultimately come from the decomposition or weathering of rocks, yet the current plant-nutrition and biogeochemical paradigms assume that nutrients are supplied to plants by surface exchange reactions, that rates of weathering can be measured as the difference between drainage losses from watersheds minus precipitation inputs, and that soils do not change measurabley over decades to centuries. The sandbox ecosystem method and a sequential extraction analysis technique enable measurement of soil changes over short periods) largely by initial larger homogenization and careful before and after quantitative sampling). Soil changes are much larger than even we thought possible, suggesting that weathering can directly influence plant nutrition and indirectly improve physical characteristics. Disturbed soils weather faster, but the influence of certain plants is even more important.

Relevant Publications:

Bormann, B. T., F. H. Bormann, W. B. Bowden, R. S Pierce, S.P. Hamburg, D. Wang, M.C. Snyder, C. Y. Li, and R. C. Ingersoll. 1993. Rapid N2 fixation in pines, alder and locust: evidence from the sandbox ecosystem study. Ecology 74(2):583-589.

Bormann, B. T. and R.S. Sidle. 1990. Changes in productivity and distribution of nutrients in a chronosequence at Glacier Bay, Alaska. Jornal of Ecology 78:561-578.

Bormann, B. T., H. Spalternstein, M. McClellan, F. C. Ugolini, K. Cromack, Jr. and S. m . Nay. 1995. Rapid soil development after windthrow in pristine forests. Journal of Exology 83 (5): 747-757.

Bormann, B. T., D. Wang, F. H. Bormann, G. Benoit, R. April, and M. Snyder. Submitted. A new ecosystem model evaluating effects of weathering on nutrient cycling and sustainability. Submitted to Biogeochemistry.

Nay, S. N., K. G. Mattson, and B. T. bormann. 1994. Biases of chamber methods for measuring soil CO2 efflux demostrated in a laboratory apparatus. Ecology 75(8): 2460-2463.

ANDREW CAREY
Biologist
Research Team Leader & Scientist

USDA Forest Service
Olympia Forestry Sciences Laboratory
3625 93rd Ave. SW
Olympia, WA 98502-9193

Phone: 360-753-7688
Fax: 360-956-2346
e-mail: efb@olywa.net
acarey@fs.fed.us

Selected Studies:

Principal research is the Forest Ecosystem Study and the Habitat Development Study. Manipulations include variable density **thinning**, understory augmentation, cavity tree augmentation, and **coarse woody debris** augmentation. Response variables include: **soil bacteria: fungi** ratios, **nematode** community composition, hypogeous **ectomycorrhizal** fungal fruiting bodies, epigeous fungal fruiting bodies, vascular plants, **tree growth** and yield, **amphibians** (frogs and salamanders), **forest-floor mammals** (insectivores, mice, and voles), arboreal **rodents** (chipmunks, flying squirrels, and Douglas' squirrels), and forest **bbirds**. The approach is based on food webs and trophic levels. The objective is to test hypothesis about practices that could contribute to sustainable production of ecological and economic goods and services and that would enhance **ecosystem resiliency** and capacity to support **vertebrate diversity**, include vertebrates associated with late-seral forest. Minor objectives include developing indexes to forest floor function and ecological productivity (non-timber productivity). The FES is in its 6th year and is in **Douglas-fir** forest in the Puget Trough of Washington. The HDS is in its 3rd year and is scattered throughout the **Western Hemlock** Zone on the Olympic Peninsula.

Relevant Publications:

Carey et al. 1996. Foundations of biodiversity in managed Douglas-fir forests. IN: D.L. Pearson and C.V. Klimas. The role of restoration in ecosystem management. p 68-82. Society for Ecological Restoration, Madison, WI.

Carey et al. 1996. A pragmatic, ecological approach to small-landscape management. Washington For. Landscape Manage. Proj. Rep. No. 2, Wash. Dept. Natur. Resour., Olympia, WA 99 pp.

Carey A.B. and R.O. Curtis. 1996. Conservation of biodiversity: a useful paradigm for forest ecosystem management. Wildl. Soc. Bull. 24:610-620.

Carey A.B. 1995. Sciurids in Pacific Northwest managed and old-growth forests. Ecol. Appl. 5:648-661.

Carey A.B.,and M.L. Johnson. 1995. Small mammals in managed, naturally young, and old-growth forests. Ecol. Appl. 5:336-352.

Colgan W., J. Trappe, R. Molina, A.B. Carey, and D. Thysell. 1994. Production of hypogeous fungal sporocarps in a variably thinned Douglas-fir forest. In: Proc. 4th European Symp. Mycorrhizae. 1994, 11-14 July, Grenada, Spain.

MICHAEL CASTELLANO
Forest Mycologist
Research Forester

USDA Forest Service
PNW Research Station
Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, Oregon 97330

Phone: 541-750-7382
FAX: 541-750-7329
e-mail: castellano@fsl.orst.edu
castellano@fs.fed.us

Selected Studies:

Am the tax leader for both the **Northwest Forest Plan** and the **Columbia River basin** assessment. My main research area is **taxonomy, systematics, biodiversity**, biology and function of forest **fungi**, particularly **mycorrhizal** species. This work includes the following projects:

Development of survey and **monitoring protocols** for forest fungi. (since 1992)

Development of a **handbook to fungi** of special concern from the Northwest Forest Plan since 1996)

Description of new families, genera and species of sequestrate taxa on a world-wide basis (since 1984)

Phylogeny of sequestrate genera using **molecular** and classical taxonomic tools (since 1988)

Biogeographic analysis of forest fungi, particularly in relation to rare or uncommon taxa (since 1990)

Relevant Publications:

Castellano, M.A. and R. Molina. 1989. The biological component: Mycorrhizae. In: T.D. Landis, R.W. Tinus, S.E. McDonald, J.P. and Barnett (eds.). The container tree nursery manual, Volume 5. Agric. Handbk. 674. Washington, D.C. USDA, Forest Service. pp. 103-167.

Castellano, M.A., J.M. Trappe, Z. Maser, and C. Maser. 1989. Key to spores of the genera of hypogeous fungi of North Temperate forests with special reference to animal mycophagy. Mad River Press, Arcata, Calif. 186 pp.

Castellano, M.A. 1996. Recent developments concerned with monitoring and inventory of fungal diversity in northwestern United States. In, Mycology in Sustainable Development: Expanding concepts, vanishing borders. M. Palm & I. Chapela (eds.). Parkway Publ. Inc., Boone, North Carolina.

Castellano, M.A. 1997. Towards a RED list for Oregon macrofungi. Conservation and management of native plants and fungi. Native Plant Society of Oregon, Corvallis. pp. 222-226.

Castellano, M.A. and J.M. Trappe. 1998. Survey, inventory and monitoring of sequestrate fungi. USDA, Department of Agriculture & The National Biological Service, Beltsville, MD. (In press).

DAVID D'AMORE
Research Soil Scientist
USDA Forest Service
Pacific Northwest Research Station
Resource Management and Productivity Program
Juneau Forestry Sciences Laboratory
2770 Sherwood Lane, Suite 2A
Juneau, AK 99801

Phone: 907-586-8811, ext. 255
Fax: 907-586-7848
e-mail: ddamore@fs.fed.us

Selected Studies:

Forested wetland soil hydrology study. In southeast Alaska, one of the limiting factors in forest productivity is excess soil moisture. Despite this, very little is known about wet-soil processes. Soil research studies in the past have been limited to individual soil types, or to general water table characteristics of the soils; there is no information that combines measurements of soil water tables and soil morphology in the major soil series in sequence on the landscape in southeast Alaska. This project relates the morphological characteristics of several major soil series with the physical (soil saturation) and chemical (reduction-oxidation) processes of the soils. Individual soil hydrologic measurements are compared to the observed soil morphology, and then the hydrological and soil morphological relationships among soils in a sequence from well-drained to poorly-drained sites are evaluated. This study has provided long-term water table records that are linked to major soil types in the region. The results have provided information for more accurate determination of jurisdictional wetland boundaries in forested wetlands on the Tongass National Forest and serve as guides for interpreting water storage in these soils.

Physical characterization and classification of forested Histosols study.
The Tongass National Forest contains 29% wetlands, much of which has organic soil as a substrate. Though a great deal of the acreage of the Tongass National Forest contains organic soils, there is no detailed information on the decomposed organic material of these soils. Fiber decomposition levels in organic soils influence important ecological factors such as carbon cycling and water storage and movement in these soils. This study determined the fiber decomposition levels in forested organic soils on the Tongass National Forest. The sampling conducted in this study is the most extensive investigation of the organic soil decomposition levels on the Tongass National Forest and has increased the understanding of the decomposition properties in these soils. Variability in the fiber contents of the organic soils was much greater than represented in the soil series descriptions. There were very few data on fiber contents during the original survey to distinguish hemic and sapric corollaries among the soil series, though various fiber contents in different pedons of a series were recognized during mapping. There is a wider level of decomposition within the soils than recognized in the original soil mapping. This study established essential information on the decomposition levels of peat in forested organic soils and is being used in current studies of the cycles of essential nutrients and carbon in these soils.

Productivity of forested wetland stands in southeast Alaska study. This study established that the growth rates on forested wetland stands were very slow, but met the minimum requirements for growth according to national forest management guidelines. The tree growth information provided managers with data to evaluate the suitability of forested wetland soils for timber harvest.

Evaluating soil factors as the potential cause of yellow-cedar decline study: This research study is attempting to determine the primary cause of the extensive yellow-cedar mortality in Southeast Alaska. The study is designed to evaluate soil temperature, soil

chemistry, and soil hydrology at the sub-watershed level at two study sites. Extensive sampling was undertaken during the summer of 2002 and the results are presently being evaluated. If this approach yields promising results that seem to implicate one or more soil factors as the primary cause of yellow-cedar decline, then our next phase will be to evaluate these factors with more extensive field sampling at larger spatial scales (including outside of the range of yellow-cedar decline) and with controlled treatments of seedlings.

Relevant Publications:

D'Amore, D.V., S.R. Stewart, J.H. Huddleston, and J.R. Glasmann. 2000. The stratigraphy and hydrology of the Jackson-Frazier wetland, Oregon. Soil Science Society of America Journal 64:1535-1543.

D'Amore, D.V. and W.C. Lynn. 2002. Classification of forested Histosols in southeast Alaska. Soil Science Society of America Journal 66:554-562

Julin, K.R. and D.V. D'Amore. 2003. Tree growth on forested wetlands of southeastern Alaska following clearcutting. Western Journal of Applied Forestry 18:30-34.

CONSTANCE A. HARRINGTON
Silviculture and auteocology
Research Scientist

Forestry Sciences Laboratory
3625 93rd Ave SW
Olympia, WA 98512-9193

Phone: 360-753-7670
FAX: 360-956-2346
e-mail: charrington@fs.fed.us

Selected Studies:

Currently designing irregular **thinnings** (for **wildlife habitat**) with concern for windfirmness.

Past research has: quantified gross **root system morphology** by spacing and genotype for poplar clones with differing susceptibity to **windthrow**, examined function of loblolly pine surface oriented and deep roots (via severing experiments), related pine root system morphology to growth, quantified the relationship between cross-sectional area of pine lateral roots and ground-line area, and examined changes in root systems of alder and cottonwood with flooding

Past research has also related **site quality** to **rooting depth** and **soil characteristics** which influence rooting (structure, stratified soils), and **water/nutrient uptake**.

Relevant Publications:

C.A. Harrington and D.S. DeBell. 1996. Above- and below-ground characteristics associated with wind topling in a young Populus plantation. Trees 11:109-118.

C.A. Harrington, J.C. Brisette, W.C. Carlson. 1989. Root system structure in planted and seeded Loblolly and shortleaf pine. For. Sci. 35:469-480.

W.C. Carlson. C.A. Harrington, P. Farnum, S.W. Hallgren. 1988. Effects of root severing treatments on loblolly pine. Can. J. For. Res. 18:1376-1385.

C.A. Harrington. 1987. Responses of red alder and black cottonwood seedlings to flooding. Physiol. Plantarum 69:35-48.

LINDA HEATH
Quantitative Forester, Systems modeler
Research Scientist, Northern Global Change Research Program

Northwest Global Change Research Program

Pacific Northwest Research Station
1221 SW Yamhill
P.O. Box 3890
Portland, OR 97208

Phone: 503-808-2008
FAX: 503-808-2020
e-mail: lheath@lunar.nena.org
lheath@fs.fed.us

Selected Studies:

Estimate and project **carbon storage** and **flux** on all forest ecosystems of the US using a model. All components of the ecosystem are included: tree (including **belowground**), **understory vegetation, coarse woody debris, litter**, and **soil**. My model includes **land use change** and **harvesting** effects on soils and other forest components. My model is linked with the **TAMM/ATLAS** group of models, which provides economics, timber inventories, and forestland areas in the carbon projections. Site-specific information is used but output tends to be at the large-scale "forest type" level.

Characterization of coarse woody debris, biomass, and amount of **carbon** in forests of Maine.

Effects of **climate change** on forest soil carbon in the United States.

Evaluation of **uncertainty** in carbon of vegetation and soil in U.S. forests

Relevant Publications:

Heath L.S. and R. A. Birdsey. 1993. Carbon trends of productive temperate forests of the coterminous United States. Water, Air, and Soil Pollution 70: 279-293.

Joyce L.A., J.R. Mills, L.S. Heath, A.D. Maguire, R.W. Haynes, and R.A. Birdsey. 1995. Forest sector impacts from changes in forest productivity under climate change. Journal of Boigeography 22:703-713.

RICK KELSEY
Chemical Ecologist; Plant Chemist
Research Scientist

PNW-4577

PNW Station
Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, OR 97331

Phone: 541-750-7368
FAX: 541-758-7760
e-mail: kelseyr@fsl.orst.edu
rkelsey@fs.fed.us

Selected Studies:

Present research includes studies of **chemical changes** in the stems and roots of western conifers after they become infected with **root diseases**. Current efforts are focused on **black-stain root disease**, *Leptographium wageneri* and laminated root rot, *Phellinus weirii*, in Douglas-fir, and *L. wageneri* in **ponderosa pine**. The objectives of these studies are to; 1) determine whether trees infected with root disease produce **volatile compounds**, distinct from healthy trees, that could attract **bark beetles** and other **insects** and 2) determine whether volatile compounds in the lower stem or roots of diseased trees can be monitored to detect the presence of root disease before visual symptoms of the disease appear in the crown. The Douglas-fir sites are in the Coast Range of western Oregon, and the ponderosa pine sites at the south end of the Blue Mountains in eastern Oregon.

Relevant Publications:

Kelsey, R.G. and G. Joseph. Submitted 1997. Ethanol in Douglas-fir and ponderosa pine trees with black-stain root disease (Leptographium wageneri). Can. J. For. Res.

JOHN G. KIE
Research Wildlife Biologist (ungulate ecology), and Team Leader
Elk, Deer, and Cattle Interactions in the Intermountain West

USDA Forest Service
Pacific Northwest Research Station
Managing Natural Disturbances Program
Forestry and Range Sciences Lab
1401 Gekeler Lane
La Grande, OR 97850

Phone: 541-962-6529
FAX: 541-962-6504
e-mail: kien@eosc.osshe.edu
jkie/r6pnw_lagrande@fs.fed.us

Selected Studies:

We are beginning a new series of studies in 1997 on the Starkey Experimental Forest and Range in the Blue Mountains of eastern Oregon on the role of ungulate herbivory on basic ecosystem processes. A major part of this research will include the effects of different population densities of elk, mule deer, and cattle in a multispecies grazing system on rates of **nutrient turnover** and **soil fertility**. Previous work on the effects of high population densities of moose in Alaska have indicated that under such conditions, rates of **soil nitrogen mineralization** are higher than under conditions of low moose density (Molvar et al. 1993). Conversely, high moose population densities on Isle Royale in Minnesota have been shown to retard rates of nitrogen mineralization (Pastor et al. 1993). We suspect the difference is partially the result of different temporal scales. Dense populations of large herbivores can increase the rate of nitrogen turnover on a local scale because of the fertilization effects of dung and urine deposition. However, where chronically high densities of large ungulates result in changes in plant species composition (from palatable deciduous species to unpalatable conifer species, as on Isle Royale), the result can be a decrease in nitrogen turnover rates.

The **role large herbivores** play in such ecosystem processes such as nutrient turnover rates has important spatial as well as temporal components (Turner 1989, Hobbs 1996). As part of the research we are initiating in 1997 on the Starkey Experimental Forest and Range , we will: 1) look at the short-term changes in ecosystem response variables in two pastures (about 7 sq km each) at differing elk densities, 2) examine how elk, deer, and cattle distribution patterns over the last 8 years in the large, main study area (81 sq km) have affected response variables, and 3) look at the effects on ecosystem response variables inside and outside several 30-year large herbivore exclosures elsewhere in the Blue Mountains (not on the Starkey Experimental Forest and Range). With this research, we hope to better understand the spatial and temporal variations in the role large ungulates play in such basic ecosystem processes as nutrient turnover rates.

Relevant Publications:

Hobbs, N.T. 1996. Modification of ecosystems by ungulates. J. Wildl. Manage. 60:695-713.

Molvar, E.M., R.T. Bowyer, and V. Van Ballenberghe. 1993. Moose herbivory, browse quality, and nutrient cycling in an Alaskan treeline community. Oecologia 94:472-479.

Pastor, J., B. Dewey, R.J. Naiman, P.F. McInnes, and Y. Cohen. 1993. Moose browsing and soil fertility in the boreal forests of Isle Royale National Park. Ecology 74:467-480.

Turner, Monica G. 1989. Landscape ecology: the effect of pattern on process. Annual Review of Ecology and Systematics 20:171-197.

CHING Y. LI
Soil Microbiologist
Forestry Sciences Laboratory
3200 SW Jefferson Way
Corvallis, OR 97331

Phone: 541-750-7386
e-mail: lic@fsl.orst.edu
cli@fs.fed.us

Selected Studies:

Research assesses **microbial activity** and the role of functional processes in ecological systems, especially in response to ecosystem disturbance, **management practices**, and **climatic** factors. It focuses on the basic question as to whether there is a general enhancement in forest productivity induced by interacting assemblage of plants and microbes and their abiotic environment. I study the regulatory role of interacting soil microbes in order to understand the overall impact of belowground dynamics on ecosystem productivity, and possibly how to manipulate these interactions to maintain soil productivity, **tree yields**, and **environmental quality**.

I isolate, determines physiology and **biochemistry** of the **nitrogen-fixing** endophyte ***Frankia*** in **actinorhizal** plants, studies host specificity of the endophyte and the phenomenon of **cross-inoculation infectivity**. I design techniques for producing large quantities of endophyte for inoculation and for measuring nitrogen fixation in endophyte and actinorhizal plants. I also study actinorhizal plants in tripartite associations that are make up of hosts, nodules and mycorrhizae.

I also study rates of associative nitrogen fixation among tree species and role of associative fixation in restoring site N after severe disturbance. Also I design better quantification techniques for estimating rates of nitrogen fixation in the rhizosphere.

Other research includes studies of microbial **weathering** of primary **mineral** substrates in **rhizosphere**. Weathering process mobilizes inorganic nutrients required for tree growth, and represents crucial processes fosr governing ecosystem development productivity. Although inorganic ions are abundant elements in earth's crust, the extreme insolubility of ions in natural environments such as soil creates a situation where the soluble concentration falls far below that required for optimal tree growth. Rhizosphere microorganisms have therefore evolved a capacity to generate weathering process whereby increasing nutrient supply to forest trees. The research on soil weathering focuses on the role of the fungal or bacterial species associated with host species in the acquisition of nutrients by trees.

All studies are concentrated on forest ecosystems.

Relevant Publications:

Li C.Y., E. Strzelczyk, and A. Pokojska. 1996. Nitrogen-fiing endophyte Frankia in Polish Alnus glutinosa (L.) Gartn. Microbiological Res. 151:371-374.

Li C.Y., R.H. Crawford, and T.T. Chang. 1997. Frankia in decaying fallen trees devoid of actinorhizal hosts and soil. Microbiological Res. 152: (In Press).

Crawford R.H., C.Y. Li, and M. Floyd. 1997. Nitrogen fixation in root-colonized large woody residue of Oregon coastal forests. For. Ecol. and Mgmt. 92:229-234.

Hope S.M. and C.Y. Li. 1997. Respiration, nitrogen fixation, and mineralizable nitrogen spatial and temporal patterns within two Oregon Douglas-fir stands. Canadian J. Forest Res. 27: 501-509.

Roczyki H., E. Strzelczyk, and C.Y. Li. 1996. Impact of B-group vitamins on the growth of Azospirillum. Acta Microbiologica Polonica 45:203-212.

JAMES MCIVER
Insect Ecologist
Blue Mountains Natural Research Institute,
Research Coordinator

PNW Station,
Blue Mountains Natural Resources Institute
1401 Gekeler Lane
La Grande, Oregon 97850

Phone: 541-962-6528
Fax: 541-962-6504
e-mail: jmciver@fs.fed.us

Selected Studies

I am currently involved in three areas of research, including the organization of foliar arthropod communities, social ecology of ants, and management effects on belowground processes. For the latter area, I am involved in three projects: 1) determining basic patterns of the **soil food web** (fungi, bacteria, nematodes and microarthropods) in various stand types within interior conifer forests; 2) assessing how the soil **impacts of mechanical thinning** influence the soil food web in interior **mixed-conifer stands**; and 3) assessing how **prescribed fire** and mechanical thinning/removal impacts and soil and the soil food web in ponderosa pine stands. The long-term goal of this research is to better understand how management practices influence **long-term site productivity**, in interior coniferous forest ecosystems.

Relevant Publications

No publications thus far.

CHRISTINE G. NIWA
Entomolgist
Research Scientist

PNW-4577

Forestry Sciences Lab
3200 Jefferson Way
Corvallis, OR 97331

Phone: 541-750-7370
FAX: 541-750-7329
e-mail: niwac@fsl.orst.edu
cniwa@fs.fed.us

Selected Studies:

My present position is as a research entomologist for the "Behaviorial chemicals and ecology of forest insects and other organisms" Team in the Pacific Northwest Research Station. I am focusing on two main research areas: semiochemical methods to protect forest health; and effects disturbance on arthropod abundance, function and diversity. The later includes **belowground foodweb** studies dealing with the effects of **natural and anthropogenic disturbance** (primarily fire, thinning, and compaction) on arthropods and microbes. I am also assessing how these changes effect **soil nutrients** and **tree growth**. Current projects:

Impacts of **soil compaction** and displacement on **soil microbes** and soil and **litter dwelling arthropods** in a mixed-conifer forest in eastern Oregon. Cooperators on this study will assess soil disturbance and tree wounding and response associated with different harvesting practices (since 1997).

Effects of **prescribed fire** and **thinning** on soil microbes and microarthropods in the Blue Mountains of eastern Oregon. Cooperators on this study will assess **soil chemistry, tree response, mycorrhizae**, and **morbels** (since 1997).

Effects of spring and fall underburning on soil and litter arthropods in a ponderosa pine forest in southeastern Oregon (since 1997).

Retrospective study of short- and long-term effects of prescribed burns and wildfires on soil and litter arthropods in the southern range of the northern spotted owl (since 1997).

Relevant Publications:

Since I am just initiating belowground studies this year, I have no publications in this field. Related to this subject is a publication associated with my work on the scientific assessment for the Interior Columbia Basin Ecosystem Management Project (to be released in July 1997): "An Assessment of Ecosystem Components in the Interior Columbia Basin, and Portions of the Klamath and Great Basin."

THOMAS E. O'DELL
Mycologist
Microbiologist, term appt.

Corvallis Forestry Sciences Lab.
Ecosystem Porcesses Program
3200 Jefferson Way
Corvallis, OR 97331

Phone: 541-750-7404
FAX: 541-758-7760
e-mail: odellt@fsl.orst.edu
todell@fs.fed.us

Selected Studies:

Developing a **regional survey** for **fungi** as mandated by the northwest forest plan. Testing for correlations of the occurance of survey and manage species with **large woody debris**, and to develop other species specific **habitat** requirements for these taxa. I am working in all ecosystems within the range of the **northern spotted owl**.

Relevant Publications:

Johnson, N.C, O'Dell, T.E and C.S. Bledsoe. in press. Methods for ecological studies of mycorrhizae. In: P. Robertson et al., eds. Standardized Soil Methods for Long-Term Ecological Research. Cambridge U. Press.

O'Dell, T.E.; J.E. Smith; M.A. Castellano and D.L. Luoma. 1996. Diversity and Conservation of Forest Fungi. p. 5-18. In: R. Molina and D. Pilze, eds. Managing Forest Ecosystems to Conserve Fungus Diversity and Sustain Wild Mushroom Harvests. USDA Gen. Tech. Rep. PNW-GTR-371. Portland, OR. 104 p.

O'Dell, T.E, D.J. Lodge, and J.F. Ammirati. submitted. Terrestrial Macrofungi on Soil. In: G. Mueller, G. Bills, A. Rossman, and H. Burdsall, eds. Measuring and Monitoring Biological Diversity: Standard Methods for Fungi. Smithsonian Institution Press.

O'Dell, T.E. D.L. Luoma, R.J. Molina. 1992. Ectomycorrhizal fungal communities in young, managed and old growth Douglas-fir stands. Northwest Environmental Journal 8: 166-168.

DAVID PILZ
Bontanist

Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, Oregon 97331

Phone: 541-750-7362
FAX: 541-750-7329
e-mail: pilzd@fsl.orst.edu
dpilz@fs.fed.us

Selected Studies:

Productivity and sustainable harvest of commercially harvested wild edible forest mushrooms

Started in 1994. 5 field research projects documenting the productivity of edible forest mushrooms (esp. matsutake, chanterelles, and morels) in various coniferous forest habitats of the Pacific Northwest. Research also involves study of how fruiting corresponds to habitat, forest management, and commercial mushroom harvest factors. Sustainabiliity of commercial harvesting is related to the health, distribution, and reproduction of below-ground mycelial colonies and mycorrhizal relations with host plants. Currently designing a regional monitoring program.

Relevant publications:

Pilz, D.; Molina, R. 1996. Managing forest ecosystems to conserve fungus diversity and sustain wild mushroom harvests. Gen. Tech. Rep. PNW-GTR-371. Portland, OR: U. S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 104 p.

Pilz, D.; Molina, R. 1997. Matsutake mushroom harvesting in the United States:opportunities for the study of sustainable development. In: Chapela, I.H.; Palm,

M.E. Mycology in sustainable development:expanding concepts, vanishing borders. Parkway Publishers Inc. Boone, North Carolina. 68-75.

Hosford, D.;Pilz, D.; Molina. R.; Amaranthus, M. 1997. Ecology and management of the commercially harvested American matsutake mushroom. Gen. Tech. Rep. PNW-GTR-???, Portland, Oregon:U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. (In Press)

WALTER G. THIES
Forest Pathology
Research Plant Pathologist

PNW-4577

Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, OR 97331

Phone: 541-750-7408
FAX: 541-758-7760
e-mail: thiesw@ccmail.orst.edu
wthies@fs.fed.us

Selected Studies:

Current research involves root diseases of western conifers.

Efforts have focused on field studies of **laminated root rot** (caused by *Phellinus weirii*) of various conifers but mostly **Douglas-fir**. Studies are conducted in various parts of Oregon and Washington but limited to areas where Douglas-fir is a natural component of the vegetation. **Black stain root disease** (caused by *Leptographium wageneri*) being carried out in eastern Oregon in stands of predominantly ponderosa pine. Each study has many objectives, but most can be grouped into two categories develop: a) tools needed by managers to determine the extent and severity of root disease in conifers and b) strategies to manage root diseases.

Relevant Publications:

Thies, W.G.; Sturrock, R.N. 1995. Laminated root rot in western North America. Gen. Tech. Rep. PNW-GTR-349. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p. In cooperation with: Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre.

Moldenke, A.R.; Thies, W.G. 1996. Effect on soil arthropods 1 year after application of chloropicrin to control laminated root rot. III. Treatment effects on nontarget soil invertebrates. Can. J. For. Res. 26: 120-127

Thies, W.G.; Cunningham, P.G. 1996. Estimating large-root biomass from stump and breast-height diameters for Douglas-fir in western Oregon. Can. J. For. Res. 26: 237-243.

Ingham, E.R.; Thies, W.G. 1996. Responses of soil foodweb organisms in the first year following clearcutting and application of chloropicrin to control laminated root rot. Applied Soil Ecology. 3:35-47.

Thies, W.G.; Nelson, E.E. 1996. Reducing Phellinus weirii inoculum by applying fumigants to living Douglas-fir. Canadian Journal of Forest Research 26: 1158-1165.

PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION

MATT D. BUSSE
Soil Microbiologist
Research Scientist

PSW-4155

USDA Forest Service
2400 Washington Avenue
Redding, CA 96001

Phone: 530-242-2456
FAX: 530-242-2460
e-mail: mattbussse@snowcrest.net
mbusse@fs.fed.us

Selected Studies:

The focus of my research is **C and N cycling** in western forest soils, including, the relationship between **microbial-mediated processes**, principally soil **C decomposition**, and forest **management practices** as well as links between **microbial community structure** and forest soil sustainability. Techniques, including cultural, phenotypic, and genetic analyses, are being utilized to evaluate community structure and **biodiversity**. Selected research:

Microbial community structure and succession during wood decomposition (since 1994). A component of the National LTSP study.

Effects of **organic matter removal, prescribed fire**, and **fertilization** on **litter decomposition** and **microbial biomass** (since 1992).

Estimation of **N fixation** by **actinorhizal shrubs** (since 1991).

Effect of **thinning** and nutrient additions on soil **carbon mineralization** (since 1995).

Interactions of soil **fungal** and **arthropod** populations in response to intensive forest management (since 1997).

Improved methodologies for in situ hybridization using **oligionucleotide probes** for detection of soil bacteria (since 1997).

Relevant Publications:

Busse M. et al. 1996. Changes in ponderosa pine site productivity following removal of understory vegetation. Soil Sci. Soc. Am. J. 60:1614-1621

Busse M.D. 1997. Ecological significance of nitrogen fixation by actinorhizal shrubs in interior forests of California and Oregon. PSW Gen Tech. Rep. (in press).

Busse, M.D. 1994. Downed bole-wood decomposition in lodgepole pine forests of central Oregon. Soil Sci. Soc. Am. J. 58:221-227.

Busse M.D. and P.J. Bottomley. 1989. Growth and nodulating responses of Rhizobium meliloti to water stress induced by permeating and nonpermeating solutes. Appl. Environ. Microbiol. 55:2431-2436.

MARK FENN
Plant pathologist, biogeochemistry, air pollution specialist
Research Scientist, Project Leader as of October 1997

PSW-4451

USDA Forest Service
Forest Fire Laboratory
4955 Canyon Crest Drive
Riverside, CA 92507

Phone: 909-680-1565
FAX: 909-680-1501
E-mail: mfenn@deltanet.com
mfenn@fs.fed.us

Selected Studies:

N cycling across **N deposition gradients**, particularly in the **San Bernardino Mountains** in southern California. Studies include N mineralization and nitrification, **trace gas emissions** from soil, N leaching through the soil profile, and **nitrate export** from the watershed in **streamwater**. This study involves **N fertilization** treatments across a N deposition gradient, and determining N cycling rates, N losses as leachate and

as trace gas emissions, tree growth rates and effects on ozone injury in response to the N amendment treatments. This study continues till 1999. Related studies funded by International Forestry compare N and S deposition and N status of forests near Los Angeles and Mexico City.

Research on **litter decomposition** in mixed conifer forests with varying levels of **N deposition** and **ozone** exposure (from 1987-1989).

Comparisons of **microbial biomass**, **respiration** and N mineralization along a chaparral fire-induced stand age gradient.

Ozone effects on **root diseases** of **ponderosa pine**.

Relevant Publications:

Fenn, M.E. and P.H. Dunn. 1989. Litter decomposition across an air-pollution gradient in the San Bernardino Mountains. Soil Sci. Soc. of Am. J. 53:1560-1567

Fenn, M.E., P.H. Dunn, and R. Wilborn. 1990. Black stain root disease in ozone-stressed ponderosa pine. Plant Disease 74:426-430.

Fenn, M.E. 1991. Increased site fertility and litter decomposition rate in high-pollution sites in the San Bernardino Mountains. Forest Science 37:1163-1181.

Fenn M.E., M.A. Poth, P.H. Dunn, and S.C. Barro. 1993. Microbial N and biomass, respiration and N mineralization in soils beneath two chaparral species along a fire-induced age gradient. Soil Biol. and Biochem. 25:457-466.

Fenn, M.E., M.A. Poth, and D.W. Johnson. 1996. Evidence for nitrogen saturation in the San Bernardino Mountains in southern California. Forest Ecology and Management 82:211-230.

NANCY GRULKE
Research Plant Physiologist
Research Scientist

PSW-4451

Riverside Fire Laboratory
4955 Canyon Crest Drive
Riverside, CA 92507

Phone: 541-754-4649
FAX: 541-754-4799
E-mail: grulken@fsl.orst.edu
ngrulke@fs.fed.us

(Sabbatical at EPA, 200 SW 35th, Corvallis, OR 97333)

Selected Studies:

Effects of atmospheric **air pollutants** on standing **root biomass** within **ponderosa pine** stands. There are three sites across a pollution (ozone and N deposition) gradient: Crestline, Strawberry Peak, and Barton Flats across the San Bernardino Mountains in the Transverse Mountain Range of the Los Angeles Air Basin. Of the 4 techniques used to ascertain root mass, only one is expected to produce publishable results: 6 pits, 20 x 20 by 20 cm depths to 60 cm were dug 1.5 m to the south of 20-60 yr old ponderosa pine trees. A significant reduction in root mass was found at the most polluted sites, with an accompanying error of 25% C.V. The conventional approach to ascertaining root mass (root cores 2" in diameter) yielded approximately 10% of the mass that the pits yielded (when adjusted to the volume of the < 2 mm soil fraction) with a 300-500% C.V. of "replicate" cores (cores taken 1.5 m from the same 20-60 yr old tree, 80 degrees appart). Root observation tubes resulted in few observations. In-growth cores yielded too little regrowth in those particular locations 1 yr after establishment. **Root carbohydrate** content supported root standing biomass trends across the 3 sites.

Relevant Publications:

Grulke, N.E., M. Fenn, C. Andersen, P. Miller. (7/97 submission). "Pollution reduces root standing biomass of ponderosa pine in the San Bernardino Mountains." Targeted for Nature.

Grulke, N.E. and C. Rose. (10/97 submission). "Seasonal flow of carbohydrates throughout 40 yr old and mature ponderosa pine trees. " Targeted for Tree Physiology.

Grulke, N.E. and C. Rose. (10/97 submission). "Comparison of pits versus coring in retrieving root mass." Targeted for CJFR Rapid Communication

MARK POTH
Soil Microbiologist
Research Scientist

PSW-4451

Forest Fire Laboratory
4955 Canyon Crest Drive
Riverside, CA 92507

Phone: 909-680-1566
FAX: 909-680-1501
E-mail: mpoth@deltanet.com
mpoth@fs.fed.us

Selected Studies:

Current work centers on studies of **biogeochemistry**, including soil process changes asociated with **N saturation** in mixed **conifer** forests and the effects of **fire** on N and P movement into **Lake Tahoe**.

Relevant Publications:

Poth M. and D.D. Focht. 1985. 15N kinetic analysis of N2O production by Nitrosomonas europaea: and examination of nitrifier denitrification. Applied and Environmental Microbiology 49: 1134-1141.

Frankenberger W.T. Jr. and M. Poth. 1987. Biosynthesis of indole-3acetic acid by the pine ectomycorrhizal fungus Pisolithus tinctorius. Applied and Environmental Microbiology. 53:2908-2913.

Poth M., I.C. Anderson, H. Miranda, A. Miranda, and P.J. Riggan. 1995 The magnitude and persistence of NO, N2O, CH4 and CO2 fluxes from burned tropical savanna in Brazil. Global Biogeochemical Cycles 9:503-514.

Fenn M.E., M.A. Poth, and D.W. Johnson. 1996. Evidence for nitrogen saturation in the San Bernardino Mountains in southern California. Forest Ecology and Management. 82:211-230.

Professional Affiliations:

Sigma Xi
American Society of Agronomy
Soil Science Society of America

ROBERT POWERS
Silviculture, soil processes, nutrient cycling, plant physiology
Science Team Leader and Principal Research Silviculturist

PSW-4155

PSW Station
2400 Washington Avenue
Redding, CA 96001

Phone: 530-242-2455
FAX: 530-242-2460
e-mail: rpowers@c-zone.net
rpowers@fs.fed.us
(home page: redding.psw.fs.fed.us/soil.html)

Selected Studies:

I have leadership responsibility for, and personally conduct, most of the below-ground research relating to the sustained productivity of managed forests in California. This work began in the early 1970's and continues. In addition, I am cofounder and technical chair for the North American Long-Term Soil Productivity research network, which began in 1989. Included in my research efforts are the following:

Nutrient cycling, nitrogen mineralization, nutrient availability, plant uptake, decomposition, fertilization, soil invertebrates, soil physics (temperature, moisture, strength), leaching, erosion, organic matter.

Objectives of this research are to better understand the soil and site processes affecting net primary productivity and how they are influenced by management.

The principal forest ecosystems are the ponderosa pine, Sierra Nevada mixed conifer, and true fir forests on a broad range of soil types in California. These forests largely are moisture or temperature limited. Thus, climate is a major driver of system processes.

Relevant Publications:

POWERS, R.F. and G.T. FERRELL. 1996. Moisture, nutrient, and insect constraints on plantation growth: The "Garden of Eden" study. New Zealand Journal of Forestry Science 26: 126-144.

POWERS, R.F. 1990. Nitrogen mineralization along an altitudinal gradient: Interactions of soil temperature, moisture, and substrate quality. Forest Ecology and Management 30: 19-29

POWERS, R.F., and P.E. AVERS. 1995. Sustaining forest productivity through soil quality standards: A coordinated U.S. effort. p. 147-190. In: Powter, C.B., S.A. Abboud and W.B. McGill (eds.) Environmental Soil Science: Anthropogenic chemicals and soil quality criteria. Canadian Society of Soil Science, Brandon, Manitoba.

GRESSEL, N., J.G. McCOLL, C.M. PRESTON, R.H. NEWMAN, and R.F. POWERS. 1996. Linkages between phosphorus transformations and carbon decomposition in a forest soil. Biogeochemistry 33: 97-123.

VAN CLEVE, K., and R.F. POWERS. 1995. Soil carbon, soil formation, and ecosystem development. p. 155-199. In: McFee, W.W. and J.M. Kelly (eds.) Carbon Forms and Functions in Forest Soils. Soil Science Society of America, Inc., Madison, WI.

NANCY G. RAPPAPORT
Entomologist, Forest Entomology
Research Entomologist

RWU-4155

Pacific Southwest Station
P.O. Box 245
Berkeley, CA 94701

Phone: 510-559-6474
FAX: 510-559-6499
E-mail: nrappaport@fs.fed.us

Selected Studies:

Impacts of silvicultural treatments (harvesting, fire) on soil arthropod community composition and function (emphasis on arthropod-microbial interactions). Most of the work will take place on the **LTSP** research sites; treatments include **fertilizer, herbicide** and **insecticide** applications; soil compaction and **organic matter removal**. The goal is to **link soil communities** with **ecological functioning**, with an emphsis on assays of essential processes (**decomposition, nutrient cycling**). **Molecular taxonomy** (primarily mtDNA sequencing) will be used to characterize soil biota.

Bob Powers, Matt Busse and I plan to install a test of sampling protocols for **soil invertebrates** at **Black's Mountain Experimental Forest** (east-side pine ecosystem; treatments include **thinning** and **prescribed burns**). We are also conducting an assessment of **soil invertebrates** and **microbes** on three long-term sites that have been subjected to **fertilizer**, **insecticide**, and **herbicide** treatments (range of sites including pine and mixed conifer systems along an elevational gradient).

Relevant Publications:

Preisler, H.K., N.G. Rappaport and D.I. Wood. 1997. Regression methods for spatially indexed data: an example using beetle attacks on a seed orchard. Forest Science 43(1): 71-77.

ROCKY MOUNTAIN RESEARCH STATION

CARL EDMINSTER
Forest Mensuration
Team Leader, Research Forester

RMRS-4651

USDA Forest Service
Rocky Mountain Research Station
Flagstaff Forest Sciences Laboratory
Southwest Forest Sciences Complex

2500 S. Pine Knoll
Flagstaff, AZ 86001

Phone: 520-556-2001
Fax: 520-556-2130
e-mail: cedminster@fs.fed.us

Selected Studies:

Bio-geochemical cycling, soil nutrient inputs and outputs, soil chemistry. Effects of **fire frequency** on **nutrient budgets** in southwestern degraded grassland savannas; effects of natural fire regimes on soil properties and **plant community composition** in gallery forests.

Relevant Publications:
(next time I'm in Fort Collins)

WILLIAM JOHN ELLIOT
Agricultural Engineer
Project Leader

RMRS-4702 (home page: forest.moscowfsl.wsu.edu)

USDA, Forest Servcie
Rocky Mountain Research Station
Forestry Sciences Lab
1221 South Main, Moscow

Phone: 208-883-2338
Fax: 208-883-2318
e-mail: belliot@forest.moscowfsl.wsu.edu
e-mail: welliot@fs.fed.us

Selected Studies:

Agricultural engineering with research focused on gaining an increased understanding of forest **soil erosion** processes in order to develop management tools and practices to reduce on-site soil erosion and off-site **sedimentation** resulting from forest disturbances inclusing **forest roads, forest operations**, and **fires**.

Application of the Water Erosion Prediction Project (**WEPP**) model to **forest conditions**, forerst soil erosion processes, and stability problems associated with forest roads.

Belowground aspects include **soil water balances**, impacts of **roots** on stability and erosion, and importance of **soil properties** in erosion and stability.

Relevant Publications:

Elliot W. J., P.R. Robichaud, and C.H. Luce. 1995. Applying the WEPP erosion model to timber harvest areas. In: Proc. Symposium sponsored by the Watershed Management Committee of the Water Resources Engineering Division of the American Society of Civil Engineers. NY, NY. ASCE. 83-92.

Elliot W.J., D. Page-Dumroese, and P.R. Robichaud. 1996. The effects of forest management on erosion and soil productivity. Proceedings of the Symposium on Soil Quality and Erosion Interaction, Ankeny, IA: Soil and Water Conservation Society of America.

Elliot W.J., and D.E. Hall. 1997. Water Erosion Prediction Project (WEPP) forest applications. Gen. Tech. Rep. (in press). Ft Collins, CO: Rocky Mountain Research Station, USDA Forest Service.

RUSSELL GRAHAM
Research Silviculturist-silvicultural systems, regeneration processes
Research Scientist

RMRS-4153 (home page: forest.moscowfsl.wsu.edu)

Rocky Mountain Research Station
1221 South Main
Moscow, ID 83843

Phone: 208-882-3557
Fax: 208-882-2318
e-mail: rgraham@fs.fed.us

Selected Studies:

Silvicultural research involved in identifying the appropriate treatments and predicting their responses across various **spatial scales**. Examples include determining the appropriate spatial and **temporal scales** for evaluating silvicultural alternatives and how the information link across the different scales. Response variables involved in this question range from **soil organic matter** to **coarse woody debris**.

Regeneration processes involved in understanding the **biophysical** characteristics that affect the regeneration and establishment of **Rocky Mountain conifers**. The primary response variables include **soil organic matter, coarse woody debris**, and **soil carbon**. Involved in this line of research include **root** borne **fungi** and **bacteria** and treatments (**fumigation, burning, clearing**) that may affect them. Also, the affect **soil disturbance** has soil organic matter and the processes that are affected by organic matter (**nutrition, erosion, nitrification** etc.). Specific studies include:

Effect of manipulating soil organic matter on the establishment of **western white pine** and **Douglas-fir** in northern Idaho, since 1983.

Effects of prescribed fire on the organic reserves in **cedar-hemlock** forests of the northern Rocky Mountains, since 1980.

Coarse woody debris recommentations for maintaining forest **productivity** in Rocky Mountain forests, since 1985.

C storage in organic components of **Rocky Mountain** forests, since 1993.

Relevant Publications:

Graham, Russell T. 1994. Silviculture, fire, and ecosystem management. Journal of Sustainable Forestry: assessing forest ecosystem health in the inland west (2/34):339-351.

Graham Russell T., Harvey, Alan E., and Jurgensen, Martin F. 1992. Coarse woody debris as an integral component of forested ecosystems. In: Proceedings --IUFRO centennial. 1992 August 31-September 4; Berlin, Germany.

Graham, Russell T., Harvey, Alan E. Jurgensen, Martin F., Jain, Theresa B., Tonn, Jonalea R., and Page-Dumroese, Deborah S. 1994. Managing coarse woody debris in forests of the Rocky Mountains. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. Res. Pap. INT-RP-477 13 p.

NED KLOPFENSTEIN
Plant Pathology
Research Plant Pathologist

RMRS-4551 (home page: forest.moscowfsl.wsu.edu)

USDA, FS, Forestry Sciences Lab
1221 S. Main St.
Moscow, Idaho 83843

Phone: 208-883-2360
Fax: 208-883-2318
e-mail: eklopfenstein@fs.fed.us

Selected Studies:

A portion of my research is directed toward developing **molecular diagnostic** tools to detect and identify microorganisms, especially those that reside in the soil. Collaborative work at the University of Nebraska - Lincoln has refined methods for immunological

detection and identification of ***Pythium*** sp., a soil-borne microorganism causing root rot and damping off. These species are difficult to identify by conventional methods. Collaborative work with North Dakota State University will use polymerase chain reaction and immulogical methods to detect **Ash Yellows** phytoplasma, and organism causing die back and root necrosis of ***Fraxinus*** spp. The Ash Yellows pathogen is only detectable by molecular methods. Ongoing surveys by NDSU and other are showing that Ash Yellow is quite prevalent in green ash trees of the Great Plains.

Previously, **genetic engineering** was used to provide poplar trees with proteinase inhibitor genes. These transgenic trees were used to investigate the role of proteinases in nitrogen nutrition of above ground pests including leaf-feeding **insects** and leaf-spot and canker **pathogens**. Because these introduced genes are also expressed in roots, future studies are proposed to evaluate the effects of proteinase inhibitors on rhizosphere organisms, such as mycorrhizal fungi and nematodes.

Tree-based information from previous stress- and pest-resistance studies at the National Agroforestry Center is being applied to new areas. A current area of consideration is the influence of trees on the soil environment toward ameliorating agricultural pollution of water systems. Tree-based **phytoremediation (bioremediation)** can occur directly via tree metabolism or indirectly via associated rhizosphere organisms.

Micropropagation systems were developed for green ash, including rooting techniques. We propose to use green ash clones to study abiotic and biotic (i.e., **mycorrhizae**) interactions in the soil.

Relevant Publications:

Avila, F.J. G.Y. Yuen, and N.B. Klopfenstein. 1995. Characterization of a Pythium ultimum-specific antigen and factors that affect its detection using a monoclonal antibody. Phytopathology. 85: 1378-1387.

Dix, M.E.; N.B. Klopfenstein, J.W. Zhang, S.W. Workman, and M.S. Kim. 1997. Potential use of Populus for phytoremediation of environmental pollution in riparian buffer zones. In: Klopfenstein, N.B.; Chun, Y.W.; Kim, M.-S.; Ahuja, M.R., eds. Micropropagation, genetic engineering, and molecular biology of Populus. General Technical Report, RM-GTR-297. Fort Collins, CO, U.S.A.: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 206-211. Chapter 27.

Dix, M.E.; Akkuzu, E.; Klopfenstein, N.B.; Zhang, J.W.; Kim, M.-S.; Foster, J.E. 1997. Riparian refugia in agroforestry systems. Journal of Forestry. 95: 6-11.

Chun, Y.W.; Klopfenstein, N.B. 1995. Organ specific expression of the nos-NPT II. 1995. Journal of the Korean Forestry Society. 84: 77-86.

Klopfenstein, N.B.; Kerl, J.G. 1995. The potential of biotechnological contributions to temperate agroforestry practices. Agroforestry Systems. 32: 29-44.

SAMUEL R. LOFTIN
Plant and Restoration Ecology
Post-Doctoral Research Ecologist

RMRS-4652

Rocky Mountain Research Station
Middle Rio Grande Basin Research Program
2205 Columbia, SE
Albuquerque, NM 87106

Phone: 505-766-1047
Fax: 505-766-1046
e-mail: sloftin@fs.fed.us

Selected Studies:

Municipal biosolids application to **degraded rangelands** project involves the testing **biosolids** application on **soils** and **vegetation** of semiarid grasslands. Specifc studies include:

Application of municipal sewage sludge to degraded rangeland in the Rio Puerco Resource Area, New Mexico, initiated 1985.

Rangeland restoration with municipal sewage sludge: effects on soils, vegetation, and **surface hydrology**, initiated 1991.

Rangeland restoration with municipal sewage sludge: effects on soils and vegetation - demonstration project, initiated 1994.

Restoration of herbaceous **understory** vegetation in pinyon-juniper woodlands of central New Mexico. Specific studies include:

Ecology of **fire** in semiarid grasslands, initiated 1995.

Influence of mycorrhizal source and seeding method on three native grassland species grown in **soils** from a **disturbed site**, initiated 1997.

Use of prescribed fire and herbicides to restore the herbaceous plant community in a degraded pinyon-juniper woodland (proposed start date, 1998).

Relevant Publications:

Kieft, T.L., C.S. White, S.R. Loftin, R. Aguilar, J. Craig, and D.A. Skaar. Temporal dynamics in soil carbon and nitrogen resources along a grassland-creosotebush shrubland transition. Ecology (accepted).

White, C.S., S.R. Loftin, and R. Aguilar. Application of biosolids to degraded semiarid rangeland: nine year responses. Journal of Environmental Quality (accepted).

Loftin, S.R., R. Aguilar, and G.L. Wolters. 1996. Distribution of soil TOC, TKN, and TP across a Chihuahuan Desertscrub/Desert Grassland Ecotone. pp. 323-324. In: N.E. West (ed.) Rangelands in a Sustainable Biosphere. Proceedings of the Fifth International Rangeland Congress Vol. 1. July 23-28, 1995, Salt Lake City, UT. Society for Range Management, Denver, CO.

Loftin, S.R. and C.S. White. 1996. Potential nitrogen contribution of soil cryptogams to post-disturbance forest ecosystems in Bandelier National Monument, NM. pp. 140-148 In: C. Allen (ed.) Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium. U.S.D.A. Forest Service Gen. Tech. Rep. RM-GTR-286, Rocky Mnt. Forest and Range Exp. St., Fort Collins, CO..

Loftin, S.R. and R. Aguilar. 1994. Semiarid rangeland response to municipal sewage sludge: plant growth and litter decomposition. pp. 221-229. In: Sewage Sludge: Land Utilization and the Environment. ASA-CSSA-SSSA, Madison, WI.

CHARLES LUCE
Research Hydrologist

RMRS-4702 (home page: forest.moscowfsl.wsu.edu)

USDA Forest Service
Rocky Mountain Research Station
Soil and Water Engineering
1221 S. Main
Moscow, ID 83843

Phone: 208-883-2323
Fax: 208-883-2318
e-mail: cluce@forest.moscowfsl.wsu.edu
cluce@fs.fed.us

Selected Studies:

Past research has focused on **runoff** and **soil erosion** from **forest roads**. Current research deals with distributed **hydrologic modeling**. Belowground studies focus on energy and **water balance modeling** at a range of scales. Objectives: 1) determine the effects of **forest harvest, roading, fire**, or other treatments on the point energy and water balance in terms of snowpack accumulation and melt, **ground surface heating,**

evapotranspiration, and runoff. 2) examin accumulating **mass and energy fluxes** over an area of interest, typically a small watershed, and deriving an appropriate description of the aggregate effects of spatially varying conditions. Work to date has been in the coastal disjunct rainforest of the **Northern Rocky Mountains**, and in semi-arid **rangelands** in southwestern Idaho.

Relevant Publications:

Luce C.H., D.G. Tarboton and K.R. Cooley. 1997. Spatially Distributed Snowmelt Inputs to a Semi-Arid Mountain Watershed. In Proceedings of the Western Snow Conference, Banff, Canada, May 5-8, 1997.

Luce C.H. 1997. Effectiveness of Road Ripping in Restoring Infiltration Capacity of Forest Roads. Restoration Ecology, (in press).

Elliot W.J., C.H. Luce, and P.R. Robichaud. 1996. Predicting Sedimentation from Timber Harvest Areas with the WEPP Model. In: Proc. of the Sixth Federal Interagency Sedimentation Conference, Las Vegas, Nevada, March 10-14, 1996.

ROBERT C. MUSSELMAN
Plant Physiologist

RMRS-4452

USDA Forest Service
240 West Prospect Road
Fort Collins, CO 80526-2098

Phone: 970-498-1239
Fax: 970-498-1010 or -1212
e-mail: bobm@lamar.colostate.edu
rmusselman@fs.fed.us

Selected Studies:

Effects of atmospheric deposition and **air pollutants** on **alpine** and **subalpine** ecosystems. Specific studies include:

Effects of **nitrogen deposition** on **Rocky Mountain aquatic** and terrestrial ecosystems.

Monitoring of emissions of **greenhouse gases** (CO_2, CH_4, N_2O) from soils of wet and dry subalpine meadow plots **fertilized** with nitrogen at 0, 10, and 20 kg/ha. Nitrification and denitrification processes will be studied. Changes in **microbial** populations will be examined.

Relevant Publications:

Mosier A.R. L.K. Klemedtsson, R.A. Sommerfeld, and R.C. Musselman. 1993. Methane and nitrous oxide flux in a Wyoming subalpine meadow. Global Biogeochemical Cycles. 7:771-784.

Sommerfeld R.A., A.R. Mosier, R.C. Musselman. 1993. CO2, CH4, and N2O flux through a Wyoming snowpack and implications for global budgets. Nature 361:140-142.

DAN NEARY
Soil Scientist, Hydrologist
Research Scientist, Project Leader

RMRS-4302

USDA Forest Service
2500 South Pine Knoll Drive
Flagstaff, AZ 86001

Phone: 520-556-2130
Fax: 520-556-2130
e-mail: dn@alpine.for.nau.edu
dneary@fs.fed.us

Selected Studies:

Short- and long-term effects of **fire on soil** physical and chemical processes including **erosion** and **nutrient cycling**.

Geomorphology of riparian areas in the Southwest and Mexico

Nonpoint source pollutant transport into riparian areas from disturbances within and outside riparian zones.

Rhizosphere processes in Southwestern riparian areas.

Relevent publications:

Neary, D.G. and J.L. Michael. In Press. The role of herbicides in protecting long-term sustainability and water quality in forest ecosystems. New Zealand Journal of Forestry Sciences

Neary, D.G., S.A. Overby, G.J. Gottfried, and H.M. Perry. 1996. Nutrients in fire-dominated ecosystems. pp. 107-117. In: Ffolliott, P.F., L.F. DeBano, M.B. Baker, Jr., G.J. Gottfried, G. Solis-Garza, C.B. Edminster, D.G. Neary, L.S> Allen, and R.H. Hamre (technical coordinators). Effects of Fire on Madrean Province Ecosystems - A

Symposium Proceedings, March 11-15, 1996, Tucson, AZ. USDA Forest Service General Technical Report RM-GTR-289, Fort Collins, Colorado, 277 p.

Crownover, S.H., N.B. Comerford, D.G. Neary, and J. Montgomery. 1995. Horizontal groundwater flow patterns through a cypress swamp-pine flatwoods landscape. Soil Science Society of America Journal 59:1199-1206

Smethurst, P.J., N.B. Comerford, and D.G. Neary. 1993. Predicting the effects of weeds on K and P uptake by young slash pine on a Spodosol. Forest Ecology and Management 60:27-39.

Neary, D.G., P.B. Bush, and J.L. Michael. 1993. Fate, dissipation, and environmental effects of pesticides in Southern forests: A review of a decaade of progress. Environmental Toxicology and Chemistry 12:411-428.

STEVEN T. OVERBY
soil scientist

RMRS-4302

Rocky Mountain Research Station
SW Forest Science Complex
2500 S. Pine Knoll Drive
Flagstaff, AZ 86001

Phone: 520-556-2184
Fax: 520-556-2130
e-mail: sto@alpine.for.nau.edu
soverby@fs.fed.us

Selected Studies:

Preliminary assessments of wetland and riparian meadows in the White Mountains of east-central Arizona and the Mogollon Rim of northern Arizona for potential sites to do **paleoecological research**. Future involvement includes taking sediment cores from wetlands and riparian meadows to obtain **fossil pollen** and **plant macrofossils** to determine pre-settlement plant communities. The objective is to provide information for **restoration of wetlands and wet meadows** that have been degraded since settlement. Little is known of what plant communities existed before European settlement. Many of these areas have and are being used to graze domestic livestock and were mechanically manipulated to provide stock watering tanks. These areas have been degraded to the point that many are monocultures. We do know these areas respond quickly to protection, but plant communities that previously existed have lost the capacity to reestablish due to loss of viable seed source. Determining the **community structure** prior to settlement would allow for the restoration of appropriate genetic material and allow for functioning

wetland or riparian meaddows. These are extremely critical areas for many of the **threatened and endangered species** in the arid Southwest.

DEBORAH S. PAGE-DUMROESE
Soil Scientist
Research Scientist

RM RWU 4551 and RWU 4153 (home page: forest.moscowfsl.wsu.edu)

USDA, Forest Service
1221 South Main
Moscow, ID 83843

Phone: 208-883-2339
Fax: 208-883-2319
e-mail: ddumroes@forest.moscowfsl.wsu.edu
ddumroese@fs.fed.us

Selected Studies:

Currently involved in the North American **Long-Term Soil Productivity study**, developing the relationships between **soil CO_2 and wood decomposition**, evaluating protocols for sampling soil profile CO_2, and changes in **ectomycorrhizae** after harvesting and site preparation are the primary focus. Also involved in evaluating ecosystem and **soil recovery** after **prescribed burns and wildfire**. This summer I will begin a study on the Ashley National Forest (northeastern Utah) in lodgepole pine/spruce/fir forest to evaluate **regeneration** failures. These failures are most likely the result of harsh weather conditions, loss of ectomycorrhizae, and infertile, quartizite soils. This work is distributed throughout a range of sites from very productive **ash-cap soils** in northern Idaho cedar/hemlock forests to less productive **granitic soils** on the Idaho Batholith (ponderosa pine/Douglas-fir forests). I also have plot locations on **pumice soils** of south-central Oregon (Douglas-fir) and in northwestern Montana.

Relevent publications:

Page-Dumroese, D.S., M.F. Jurgensen, A.E. Harvey, R. T. Graham, J.R. Tonn.1997. Soil changes and tree seedling response associated with site preparation in northern Idaho, USA. W.J. App. For. 7: (in press).

Harvey, A.E., D.S. Page-Dumroese, M.F. Jurgensen, R.T. Graham, J.R. Tonn. 1997. Site preparation alter soil distribution of roots and ectomycorrhizae on outplanted western white pine and Douglas-fir. Plant and Soil 188: 107-117.

Amaranthus, M.P., D.S. Page-Dumroese, A.E. Harvey, E. Casares, L.F. Bednar. 1996. Soil compaction and organic matter effect conifer seeding nonmycorrhizal and ectomycorrhizal root tip abundance and diversity. PNW-RP-494. 12p.

D.S. Page-Dumroese, A.E. Harvey, M.F. Jurgensen, and M.P. Amaranthus. in review. Impacts of soil compactin and tree stump removal on soil properties and outplanted seedlings in northern Idaho, USA. submitted to CJSS.

BURTON K. PENDLETON
Plant Ecology
Research Scientist

RMRS-4351

Rocky Mountain Research Station
Forestry Sciences Laboratory
2205 Columbia SE
Albuquerque, NM 87106

Phone: 505-724-3674
Fax: 505-724-3688
e-mail: bpendleton@fs.fed.us

Selected Studies:

Team approach to reestablish **microphytic soil crusts** in **disturbed aridland** ecosystems (both cold and mixed desert zones). My research focuses on the interaction of crust-forming **blue-green algae** with **mycorrhizal** fungi in the establishment and productivity of vascular plant species. Specific studies include:

Assessed the effect of different disturbance regimes on **soil erosion** and crust regeneration times.

Evaluated plant response to **mass-produced algal inoculum**, alone and in tandem with mycorrhizal inoculum, under a variety of soil nutrient levels.

Examine dependence of native grass, forb and shrub species on VAM fungi.

Relevant Publications:

McArthur E.D., R L. Pendleton, and B.K. Pendleton. 1993. Final report:MIPR E5293N159 Propagation and biology of cryptobiotic crusts. Provo, UT. USDA, FS, Int. Resh. Stn., Shrub Sicences Laboratory. 160 p.

McArthur E.D., R.L. Pendleton, and B.K. Pendleton. 1995. Final report:MIPR 94N107 Microphytic crust biology and propagation. Provo, UT. USDA, FS, Intermountain Research Station, Shrub Sicences Laboratory. 145 p.

Pendleton R.L. and B.K. Pendleton 1995. Final report: MIPR W2V5AA51113582 Microbiologic crust biology. Provo, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Shrub Sciences Laboratory. 30p.

Pendleton R.L. and B.K. Pendleton. 1996. Final report: MIPR W52EU260390969 Benefit of microphytic crust inoculation and arbuscular mycorrhizal fungi on productivity of VAM-dependent forbs. Provo, UT. USDA, FS, Intermountain Research Station, Shrub Sciences Laboratory. 67 p.

ROSEMARY L. PENDLETON
Plant Ecology
Research Scientist

RMRS-4351

Rocky Mountain Research Station
Forestry Sciences Laboratory
2205 Columbia SE
Albuquerque, NM 87106

Phone: 505-724-3673
Fax: 505-724-3688
e-mail: rpendleton@fs.fed.us

Selected Studies:

Team approach to reestablish **microphytic soil crusts** in **disturbed aridland** ecosystems (both cold and mixed desert zones). My research focuses on the interaction of crust-forming **blue-green algae** with **mycorrhizal** fungi in the establishment and productivity of vascular plant species. Specific studies include:

Assess mycorrhizal colonization of plant roots collected from crusted and non-crusted soils

Plant response to **mass-produced algal inoculum**, alone and in tandem with mycorrhizal inoculum, under a variety of soil nutrient levels

Examine the dependence of native grass, forb and shrub species on mycorrhizal fungi.

Examine the influence of **VAM colonization** on male and female reproductive parameters of buffalo gourd (Curcurbita foetidissima).

Relevant Publications:

Harper K.T., and R.L. Pendleton. 1993. Cyanobacteria and cyanolichens: can they enhance availability of eessential mineral for higher plants? Great Basin Naturalist 53: 59-72.

Pendleton R.L. and B.K. Pendleton 1995. Final report:MIPR W2V5AA51113582 Microphytic crust biology. Provo, UT. USDA, FS, Int.Resh. Stn, Shrub Sciences Laboratory. 30 p.

Pendleton R. L. and S. D. Warren. 1996. The effects of cryptobiotic soil crusts and VA mycorrhizal inoculation on frowth and nutrient content of five rangeland plant species. p. 436-437. In: N.E. West, ed. Rangelands in a sustainable biosphere. Proceedings of the Fifth International Rangeland Congress. 1995. July 23-28; Salt Lake City, UT. Denver, CO. Society for Range Management.

Pendleton R.L. and B.K. Pendleton. 1996. Final report: MIPR W52EU260390969 Benefit of microphytic crust inoculation and arbuscular mycorrhizal fungi on productivity of VAM-dependent forbs. Provo, UT. USDA, FS, Intermountain Research Station, Shrub Sciences Laboratory. 67 p.

RICHARD PERIMAN
Interdisciplinary anthropology, archaeology, and environmental history.
Research Social Scientist

RWU 4853.

Rocky Mountain Research Station,
Cultural Heritage Research
2205 Columbia SE,
Albuquerque, New Mexico 87106

Phone: (505) 766-1398
Fax: (505) 766-1046
e-mail: rperiman@fs.fed.us

Selected studies:

My two main areas of research include the management and enhancement of heritage resources, and identifying the human role in the evolution of North American ecosystems.

In my current research I am developing methods for identifying, measuring, and simulating cumulative anthropogenic effects on northern New Mexico landscapes. With the Rio del Oso project, I am examining how prehistoric Archaic (5500 B.C. to A.D. 600), Anasazi (A.D. 1200 to 1600), and historic Hispanic occupations (beginning around 1600) may have influenced landscape development for more than 7,000 years. This study focuses on the processes through which these distinct cultures may have affected the

vegetation, hydrology, and overall physiography of the study area. I am developing three-dimensional Geographic Information System (GIS) models of **vegetational patterns** for specified periods using **archaeological**, **environmental**, and **paleoenvironmental data**. One of the primary sources of the paleoenvironmental data (**pollen, phytoliths, microscopic charcoal, radiocarbon dates**) is located belowground. Preservation of this important material is dependant upon overall subsurface environmental conditions.

Relevant Publications:

This project is in the early stages of data collection and analysis, the results of which will be made available in future publications.

PETER R. ROBICHAUD
Soil erosion, fire effects, timber harvest activities, hydrophobicity, erosion modeling
Research Engineer

RWU-4702 (home page: forest.moscowfsl.wsu.edu)

USDA-Forest Service
1221 South Main Street
Moscow, ID 83843

Phone: 208-883-2349
Fax: 208-883-2318
e-mail: probi@wsunix.wsu.edu
probi@fs.fed.us

Selected Studies:

Overall focus is on **runoff** and **soil erosion** from **disturbances** caused by **management activities** and **fires**, both wildfire and prescribed. Using the WEPP (**Water Erosion Prediction Project**) model as a base, I have begun modeling the variation of **site conditions** following disturbance (e.g., fire, timber and harvesting). Other ongoing research; erosion control techniques, erosion mitigation effectiveness and **salvage logging** after fire. Research activities also include:

Spatial variability of fire severity, specifically, **duff consumption** and bare soil exposure.

Snowmelt from various stand/canopy condition (low to high severity fire) on open and undisturbed forest stands.

Effect of fire severities on **nutrient** changes, soil heating fluxes, erosion, **soil texture** and **moisture** on **hydrophobicity**.

Development of an electronic surface duff moisture meter for prescribed fire use.

Relevant Publicatios:

Robichaud P.R. and T.M. Monroe. 1997. Spatially-varied erosion modeling using the WEPP for timber harvested and burned hillslopes. ASAE paper 97-5015, International Meeting, Minneapolis, MN. American Society of Agricultural Engineers, St. Joseph, MI.

Robichaud P.R. 1997. Forest fire: friend or foe? Resource: Engineering and Technology for a Sustainable World. 4(5):7-8.

Robichaud P.R. 1996. Spatially-varied erosion potential from harvested hillslopes after prescribed fire in the Interior Northwest. Ph.D. diss. Moscow, ID: University of Idaho.

Robichaud P.R. and T.A. Waldrop. 1994. Runoff and sediment production after a low- and high-severity site preparation burn. Water Resources Bulletin 30(1):27-34.

Robichaud P.R., C.H. Luce and R.E. Brown. 1993. Variation among different surface conditions in timber harvest sites in the Southern Appalachians. In: International workshop on soil erosion: Proceedings; 1993 September; Moscow, Russia. West Lafayette, Indiana: The Center of Technology Transfer and Pollution Prevention, Purdue University: 231-241.

KEVIN C. RYAN
Fire Ecologist
Research Scientist/Project Leader

RMRS-4403

USDA Forest Service
Rocky Mountain Research Station
Fire Sciences Laboratory
P.O. Box 8089
Missoula, MT 59807

Phone: 406-329-4807
Fax: 406-329-4877
e-mail: kryan@fs.fed.us

Selected Sudies:

Improving knowledge of **fire** as a dynamic ecosystem process at the community and landscape levels. Field and laboratory experimentation and **process modeling** are used to study the evolution and transfer of heat during burning, the impact of heat on biotic and abiotic components of the ecosystem, and the influences of **climate** and fire on long-term vegetation development. Current study sites include Northern Rocky Mountain **coniferous forests**, and **boreal** and **sub-tropical wetlands**. Research is conducted to

quantify relationships between ecosystem properties, fire characteristics, and fire effects. On-going studies:

Effects of fire and fire injury on the **physiology**, survival, and growth of plants

Relationships between **fuels, fire behavior**, and **heat transfer** as they affect susceptibility to fire injury and **soil physical and chemical processes**.

Methodologies to reintroduce fire into fire-dependant ecosystems. Fuels, weather, and topography are varied to examine how these affect fire behavior, biomass consumption, and the resultant temperature history. Temperatures are combined with physical soil properties and plant morphology to model heat transfer and fire injury. Process modeling is used to expolre the interrelationships berween climate, vegetation, and fire; to improve our understanding of fire and **landscape dynamics**, including **decomposition** and **nutrient cycling**, and to provide a basis for projecting the potential effects of climate change on fire potential.

Relevant Publications:

Albini F., M.R. Amin, R.D. Hungerford, W.H. Frandsen, K.C. Ryan. 1996. Models for Fire-Driven Heat and Moisture Transport in Soils. General Technical Report INT-GTR-335. Ogden, UT: USDA Forest Service, Intermountain Research Station; 16 p.

Keane R.E., K.C. Ryan, S.W. Running. 1995. Simulating effects of fire on Northern Rocky Mountain landscapes with the ecological process model FIRE-BGC. 1996. Tree Physiology 16:319-331.

Hungerford R.D., W.H. Frandsen, and K.C. Ryan. 1995. Ignition and burning characteristics of organic soils. Pgs. 78-91. In: S.I. Cerulean and R. Todd Engstrom, eds. Fire in Wetlands: a management perspective. Proc. of the Tall Timbers Ecology Conference, No. 19. Tall Timbers Research Stn. Tallahasee, FL.

Hungerford R.C., M.G. Harrington, W.H. Frandsen, K.C. Ryan, and G.J. Niehoff. 1991. Influence of fire on factors that affect site productivity. Pgs 32-50. In: Proc. Symp. Management and Productivity of Western-Montane Forest Soils. A.E. Harvey and L.F. Neuenschwander, Compilers. USDA For. Serv. Gen. Tec. Rep. GTR-INT-280. Ogden, UT.

MICHAEL G. RYAN
Forest Ecologist
Research Scientist

RMRS-4352

USDA Forest Service
Rocky Mountain Research Station

240 West Prospect RD
Fort Collins, CO 80526-2098

Phone: 970-498-1012
Fax: 970-498-1010
e-mail: mryan@lamar.colostate.edu
mryan@fs.fed.us

Selected Studies:

Controls on **productivity** and **element fluxes** in ecosystems (particularly **carbon** nutrient interactions), effects of **climate change** on temperate terrestrial ecosystems, mechanisms responsible for **growth decline** with forest stand development, **ecosystem respiration**, **ecosystem modelling**. Specific studies include:

Contribution of **root respiration** to **soil surface respiration** (**boreal** and **tropical** ecosystems).

Allocation to **roots** and **total belowground C** as a fraction of **gross primary productivity** in boreal and tropical ecosystems.

Relevant Publications:

Ryan, M.G., M.B. Lavigne, and S.T. Gower. 1997. Annual carbon cost of autotrophic respiration in boreal forest ecosystems in relation to species and climate. Journal of Geophysical Research, In Press.

Lavigne, M.B., M.G. Ryan et al. 1997. Comparing nocturnal eddy covariance measurements to estimates of ecosystem respiration made by scaling chamber measurements. Journal of Geophysical Research, In Press.

Ryan, M.G., D. Binkley, and J.H. Fownes. 1997. Age-related decline in forest productivity: pattern and process. Advances in Ecological Research 27: 213-262.

Ryan, M.G., R.M. Hubbard, S. Pongeracic, R.R. Ralson, and R. E. McMurtrie. 1996. Foliage, fine-root, woody-tissue and stand respiration in Pinus radiata in relation to nutrient content. Tree Physiology 16: 33-343.

Ryan, M.G., S. Linder, J. Vose, and R.M. Hubbard. 1994. Dark respiration in pines. Ecological Bulletins (Stockholm), 43: 50-63.

MICHELE M. SCHOENEBERGER
Soil science, soil microbiology, agroforestry
Reserach Soil Scientist and Project Leader

RMRS-4551

USDA Forest Service
National Agroforestry Center
East Campus - University of Nebraska
Lincoln, NE 68583-0822

Phone: 402-437-5178, x21
Fax: 402-437-5712
e-mail: mschoenberger@fs.fed.us

Selected Studies:

Tree related **proccess** and **functions** in **agroecosystems**.

Tree/crop interactions of agroecosystems.

Relevant Publications:

Schoeneberger, M.M., R.J. Volk, and C.B. Davey. 1989. Factors influencing early performance of legumionous plants in forest soils. Soil Sci. Soc. Am. J. 53:1429-1434.

Richter, D. and M.M. Schoenberger. 1989. Mechanisms by which regional air pollutants affect forested soils and rhizospheres: significance of long-term perspectives. pp. 119-126. In: Proceedings of the US/USSR Symposium on Air Pollution Effects on Vegetation - Including Forest Ecosystems.

Schoeneberger, M.M. and S.R. Shafer (eds) 1991. Mycorrhizal-mediation of plant response to atmospheric change. Special Issue of Environmental Pollution 73:159-289.

Shafer, S.R. and M.M. Schoeneberger. 1994. Air pollution and ecosysytem health: the mycorrhizal connection. pp. 153-187. In: Pfleger, F.L. and R. Lindermann (eds). Mycorrhizae and Plant Health. APS Press, St. Paul, MN.

Shafer, S.R., M.M. Schoeneberger, S.J. Horton, C.B. Davey, and J.E. Miller. 1995. Interactions of rhizobium and arbuscular-mycorrhizal fungi with acidity and anion content of simulated rain on subterranean clover. Env. Pollution 92:55-66.

NORTH CENTRAL FOREST EXPERIMENT STATION (NC) and FOREST PRODUCTS LABORATORY (FPL)

FPL

HAROLD BURDSALL
Forest mycologist, mycological systematist
Project Leader

FPL-4501

Center for Forest Mycology Research
Forest Products Laboratory
One Gifford Pinchot Dr.
Madison, WI 53705

Phone: 608-231-9234
FAX: 608-231-9592
e-mail: burdsall@facstaff.wisc.edu
hburdsall@fs.fed.us

Selected Studies:

My research involves the delimitation of species in several genera of **root- heart-, and butt-rot fungi.** These include **Armillaria, Phellinus and Laetiporus**. This work intends to define characters that are diagnostic for the various species of these genera . The work includes the use of all aspects of each species, including the macro and micromorphology, mating compatability, cultural characteristics and molecular biology of the isolates and herbarium specimens. Many of these species are soil borne and as a result cause a root- or butt-rot. The others that do not cause such defect are saprophytes and are important in the **lignocellulose recycling** in the forest ecosystems where ever they are. By determining the true identity of these species that are presently species complexes, management of the forest ecosystem will be made more dependable.

Relevant Publications:

Volk, T.J., H.H. Burdsall, Jr. and K. Reynolds. 1994. Checklist and host index of wood-inhabiting fungi of Alaska. Mycotaxon 52:1-46.

Miller, O.K., J.L. Johnson, H.H. Burdsall, Jr., and T. Flynn. 1994. Species dettermination in the genus Armillaria as measured by DNA reassociation. Mycol. Res. 99:1005-1011.

Volk, T.J. and H.H. Burdsall, Jr. A nomenclatural study of Armillaria and Armillariella . Synopsis Fungorum 8: 1-121.

Rizzo, D.M., R.M. Rentmeester, and H.H. Burdsall, Jr. 1995. Sexuality and somatic incompatability in Phellinus gilvus. Mycologia. 87(6):805-820.

Banik, M.T., J.A. Paul, and H.H.Burdsall, Jr. 1995. Identification of Armillaria species from Wisconsin and adjacent areas. Mycologia 87(5):707-712.

Banik, M.T., T.J. Volk and H.H. Burdsall, Jr. 1996. Distribution of Armillaria species on the Olympic Peninsula, Washington. Mycologia 88(3):492-496.

Volk, T.J., H.H. Burdsall, Jr. and M.T. Banik. 1996. A new species of Armillaria from Western North America. Mycologia 88(3):484-491.

NC

JUD ISEBRANDS
Tree Physiologist
Project Leader

NC-4152

USDA Forest Service
5985 Highway K
Rhinelander, WI 54501

Phone: 715-362-1116
Fax: 715-362-1166
e-mail: jisebran@newnorth.net
jisebrands@fs.fed.us

Selected Studies:

Our group is studying above- and belowground processes including: 1) **carbon allocation** and **carbon-nitrogen interactions** controlling growth of northern forest trees and 2) effects of **elevated CO_2, tropospheric ozone**, and their interactions on **carbon fixation**, and carbon allocation in northern forest trees. Developing **genetically** improved **poplar clones** for **short rotation woody biomass** plantations for **wood** and **energy**. This work combines research on quantitative genetics, physiology, silviculture, and modeling in cooperation with the Department of Energy.

Significant Accomplishments:

Forest Service's PI of a joint research venture with Michigan Tech. University studying the "Effects of interacting elevated ozone and CO_2 on northern forest ecosystems using free air carbon dioxide enrichment **FACE** technology". Member Executive Steering Committee of this project that is a collaboration with many agencies (DOE, NASA, USDA, NSF) and universities (Michigan Tech. University, University of Michigan, University of Wisconsin, University of Minnesota-Duluth, and Mississippi State University).

USDA Forest Service representative to **Global Change** and terrestrial Ecosystems (**GCTE**) which is part of the International Geosphere-Biosphere Program (**IGBP**) and on the scientific advisory board of the USDA Forest Service Northern Global Change Program.

USDA Forest Service representative to the International Poplar Commission of the **FAO** and on its Executive Committee.

Relevant Publications:

Coleman M.D., R.E. Dickson, J.G. Isebrands, and D.F. Karnosky. 1995. Carbon allocation and partitioning in aspen clones varying in sensitivity to tropospheric ozone. Tree Physiology 15:593-604.

Coleman M.D., R.E. Dickson, J.G. Isebrands, and D.F. Karnosky. 1996. Root growth and physiology of potted and field-grown trembling aspen exposed to tropospheric ozone. Tree Physiology 16:145-152.

Friend A.L., M.D. Coleman, and J.G. Isebrands. 1994. Carbon allocation to root and shoot systems of woody plants. In: Davis, T.D., B.E. Haissig, comps., eds. Biology of adventitious root formation. New York, NY: Plenum Press: 245-273.

Gower S.T., J.G. Isebrands, and D.W. Sheriff. 1995. Carbon allocation and accumulation in conifers. In: Smith, W.K., T.M. Hinckley, eds. Resource Physiology of Conifers: Acquisition, Allocation, and Utilization. New York, NY: Academic Press: 217-253.

Karnosky D.F., Z.E. Gagnon, R.E. Dickson, M.D. Coleman, E.H. Lee, and J.G. Isebrands. 1996. Changes in growth, leaf abscission, and biomass associated with seasonal troposheric ozone exposures of Populus tremuloides clones and seedlings. Canadian Journal of Forest Research 26:23-37.

WILLIAM J. MATTSON
Insect Ecologist
Research Scientist

NC-4501

North Central Forest Experiment Station
B7 Pesticide Research Center
Michigan State University
E. Lansing, MI 48824

Phone: 517-355-7740
FAX: 517-000-0000
e-mail: wmattson@fs.fed.us

Selected Studies:

My research is conducted in several ecosystems including: **aspen/birch, northern hardwoods**, and **spruce-fir**.

Mechanisms and **genetics** of **woody plant resistance** to **insects**

Effects of **environmental stresses** on the expression of plant resistance to insects

Invasion ecology and **impacts** of **invasive species** on **structure and functioning** of forest ecosystems.

Role of **herbivores** in **nutrient cycling**, **plant-plant competition**, plant **succession**, and ecosystem **productivity**

Effects of **elevated CO_2** on metabolizable **energy** and **nitrogen**, and fiber loading in leaves and plant litter

Effects of **soil compaction, organic matter** depletion on plant **susceptibility** to herbivores

Relevant Publications:

Mattson, W. J., and N. D. Addy. 1975. Phytophagous insects as regulators of forest primary production. Science 190: 515-522.

Mattson, W. J. (ed.). 1977. The role of arthropods in forest ecosystems. Springer-Verlag. New York, New York. 104 p.

Wagner, T. L., W. J. Mattson, and J. A. Witter. 1977. A survey of soil arthropods in two aspen forests in northern Minnesota. USDA For. Serv. Gen. Tech. Rep. NC-40,, 23p.

Mattson, W. J. 1980. Herbivory in relationship to plant nitrogen content. Ann. Rev. Ecol. Syst. 11:119-161.

Herms, D. A., W. J. Mattson, D. N. Karowe, M. D. Coleman, T. M. Trier, B. A. Birr and J. G. Isebrands. 1996. Variable performance of outbreak defoliators on aspen clones exposed to elevated CO2 and O3, pp.43-55, In 1995 Proc. N. Global Change Conf., Pittsburgh, PA.

Strand, M., D. A. Herms, M. G. Kaufman, M. E. Kubiske, W. J. Mattson, E. D. Walker, K. S. Pregitzer, and R. W. Merritt. 1996. The effects of elevated CO2 and shade on the decomposition of senesced tree foliage: impacts on the growth and survival of treehole mosquitoes, pp. 101-110, In 1995 Proc. N. Global Change Conf., Pittsburg, PA

Kaufman, M., N. Walker, D. A. Herms, W. J. Mattson and M. Klugg. 1996. The effects of elevated CO2 on oak leaves and their microbial colonizers, pp.89-100, In 1995 Proc. N. Global Change Conf., Pittsburg, PA

FELIX PONDER Jr.
Soil Scientist, soil plant relationships

Research Scientist, P.I. for a Long-Term Soil Productivity Study.

NC 4154

USDA Forest Service
208 Foster Hall
Lincoln University
Jefferson City, MO 65102

Phone: 573-681-5575
FAX: 573-681-5579
e-mail: fponder@fs.fed.us

Selected Studies:

Sustaining and protecting long-term soil productivity. The objectives of the LTSP research are: 1) quantify the effects of soil disturbance caused by management practices; 2) validate soil quality standards; and 3) understand the fundamental relationships between soil properties, long-term productivity, and forest management practices. My research is to evaluate 1) factors affecting **root development** of natural and planted trees and 2) influence of **soil properties** on **veneer quality** of **high value hardwoods**. This work is the Central Hardwood Region. Specific studies include:

Long-term forest productivity as affected by **soil/water properties**. **Earthworm** activity on soil following hardwood forest disturbance

Impacts of harvesting intensity on **nutrient** and **carbon dynamics** in upland oak-hickory forests.

Quantifying the impacts of forest floor **disturbance** and **soil compaction** on root dynamics, nutrient uptake and **primary productivity** of regeneration.

Impact of harvesting intensity on soil **decomposing organisms**.

Nitrogen and carbon **mineralization** in a central hardwood forest soil after compaction and organic matter removal.

Relevant Publications:

Ponder F., Jr. 1995. Shoot and root growth of northern red oak planted in forest openings and protected by treeshelters. North. J. Appl. For. 12:36-42.

Kaczmarek, D., Jr., K.S. Rodkey, R.T. Reber, P.E. Pope, and F. Ponder, Jr. 1995. Carbon and nitrogen pools in oak hickory forests of varying productivity. p.79-93. In Proc. Tenth Central Hardwood Forest Conf., Morgantown, WV. March 5-8 1995.

Li, Fumin, D. Jordan. F. Ponder, Jr. and E. Berry. Earthworm activity affected by organic matter and soil compaction in pot microcosms. Soil Science Society America Journal (in press)

DOUGLAS M. STONE
Silviculture and Forest Soils
Research Forester

NC-4101

USDA Forest Service
1831 Highway 169 East
Grand Rapids, MN 55744

Phone: 218-326-7117
Fax: 218-326-7123
Secretary: 218-326-7107

FS E-mail: dstone@fs.fed.us
Internet: dmstone@paulbunyan.net

Selected Studies:

Principal Investigator for **Long-Term Soil Productivity** (LTSP) research in aspen (Populus tremuloides and P. grandidentata) forests of the Lake States. This is part of a nationally coordinated, National Forest System and FS Research cooperative study to determine potential effects of forest management practices on sustainability and productivity. Objectives are to: (1) determine how changes in **soil porosity** and **organic matter** content affect the fundamental processes controlling **forest productivity and sustainability**; and (2) compare responses among major forest types and soil groups in North America. The experimental design is a complete 3x3 factorial with three levels each of organic matter removal and soil compaction. Levels of organic matter removal are: (1) bole-only harvest (10 cm top diameter); (2) total-tree harvest (all aboveground biomass); and (3) total-tree harvest plus forest floor removal. Levels of soil compaction were designed to increase bulk density of the surface 30 cm of soil by 0%, 15%, and 30%. Studies are in progress on the Marcell Experimental Forest (1991) and on the Ottawa (1992), Chippewa (1993), and Huron-Manistee (1994) National Forests.

To expand the scope of the LTSP research, and to establish linkages between experimental results and actual field conditions on commercially logged sites, we are initiating **Logging Impact studies**. Objectives are to determine effects of commercial timber harvest operations (clearcutting) on soil conditions and site productivity at operational (stand level) scales. This includes evaluating soil physical properties (bulk density and soil strength) and stand conditions before and after logging, and monitoring the composition, growth, and development of the subsequent regeneration. Studies are in

progress in predominantly aspen stands on the Huron-Manistee (1995) and Ottawa (1996) National Forests.

Relevant Publications:

Stone, D.M., A.R. Harris, and W.C. Koskinen. 1993. Leaching of soil-active herbicides in acid, low base saturated sands: worst-case conditions. Environ. Toxicol. Chem. 12: 399-404.

Stone, D.M. and J.L. Robl. 1996. Construction and performance of rugged ceramic cup soil water samplers. Soil Sci. Soc. Am. J. 60: 417-420.

Koskinen, W.C., D.M. Stone, and A.R. Harris. 1996. ?Sorption of hexazinone, sulfometuron methyl, and tebuthiuron on acid, low base saturated sands. Chemosphere: 9: 1681-1689.

Stone, D.M. 1997. A decision tree to evaluate silvicultural alternatives for mature aspen in the northern Lake States. North. J. Appl. For. 14: 95-98.

Stone, D.M. and J.D. Elioff. 199_. Soil properties and aspen development five years after compaction and forest floor removal. (In review).

TERRY STRONG
Silviculture
Research Forester

NC-4152

Forestry Sciences Laboratory
5985 Highway K
Rhinelander WI 54501

Phone: 715-362-1124
FAX: 715-362-1166
e-mail: tstrong@fs.fed.us

Selected Studies:

Influence of northern **hardwood silvicultural** practices on **soil carbon, soil water** relations and **soil temperature regime**.

Site preparation techniques in northern hardwoods.

Relevant Publications:

Rollinger and Strong. 1996. Carbon storage in managed forests of the northern Great Lakes. In Hom et al. (eds.) USDA For. Serv. Gen. Tech. Rep. NE-214. p. 203-207.

Strong. 1997. Harvesting intensity influences the carbon distribution in a northern hardwood ecosystem. USDA For. Serv. Res. Pap. NC-329.

JERRY W. VAN SAMBEEK
Research Plant Physiologist, propagation and ecosystem restoration
Research Scientist

NCFES, RWU-4154

North Central Forest Experiment Station
1-26 Agriculture Bldg.
Columbia, MO 65211

Phone: 573-875-5341
FAX: 618 549-8242 (until June 1998)
FAX: 573-882-1977 (after June 1998)
e-mail: jwvs@siu.edu
jwvso@fs.fed.us

Selected Studies:

In my new position as a research plant physiology with NC-4154, I conduct research in the areas of vegetation propagation including micropropagation, rooting of cuttings, and grafting and of restoration of degraded ecosystems including forest savannas, barrens, and glades in the Central Hardwoods region. Specific emphasis within restoration includes impacts of various **disturbance regimes** on **legume** plants, their **rhizobial symbionts**, and **nitrogen cycling**.

Before 1996 in my position as a research plant physiologist with NC-4151, my primary research efforts where in hardwood micropropagation and vegetation management in hardwood plantings. Within the context of vegetation management some research was done on rooting pattern of seedlings and impacts of **nitrogen-fixing** and no**n-nitrogen-fixing plants** on **soil nitrogen** availability.

Relevant Publications:

Van Sambeek, J.W., Jane M. Kobe, and James S. Fralish. 1997. Interference with shoot growth and flowering of dittany (Cunila origanoides L.) Britton by hardwood leachates. pp. 294-303. in: Proceedings, 11th Central Hardwood Forest Conference, USDA Forest Service General Technical Report NC-188.

Navarrete-Tindall, Nadia E. and J.W. Van Sambeek. 1996. Infectiveness and efficiency of Gliricidia sepium rhizobia strains from different elevations in El Salavador. Forest, Farm, and Community Tree Research Reports 1(1):78-83.

Van Sambeek, J.W. and F.D. McBride. 1991. Grass control improves early growth of black walnut more than either deep ripping or irrigation. pp. 42-57. In: Proceedings, Second Conference on Agroforestry, University of Missouri.

Van Sambeek, J.W. 1989. Vegetation management in established black walnut stands. pp. 114-125. In: Proceedings, Fourth Black Walnut Symposium, Walnut Council, Indianapolis, IN.

Van Sambeek, J.W., Ponder, Felix, Jr., and W.J. Rietveld. 1986. Legumes increase growth and alter foliage nutrient levels of black walnut saplings. Forest Ecology and Management 17(3/4):159-167.

JOHN ZASADA
Research Scientist, Silviculture of northern Great Lakes forests
Project Leader

NC-4101

Forest Service Laboratory
5985 Highway K
Rhinelander WI 54501

Phone: 715-362-1126
Fax: 715-362-1166
e-mail: jzasada@fs.fed.us

Selected Studies:

Effects of **cultural practices** on forest floor and surface soil properties. Development and dynamics of the **forest floor** and surface **soil** as it relates to seed and **vegetative reproduction** of trees, shrubs and herbs.

Distribution, architecture, morphology, and dynamics of the **soil bud bank** present on **roots, rhizomes, bulbs, corms**, etc.

Effect of **site preparation** on forest floor and surface soil properties.

Relevant Publications:

Tappeiner, Zasada and others. 1991. Salmonberry clone and community structure in the Oregon Coast Range. Ecology 72:609-618.

O'Dea, Zasada, Tappeiner. 1995. Clone structure and regeneration of vine maple in the Oregon Coast Range. Ecol. Applications. 51: 63-73.

Huffman, Zasada, Tappeiner. 1994. Growth and morphology of rhizome cuttings and seedlings of salal: effects of four light intensities. Can. J. Bot. 72:1702-1708.

Zasada, Sharik and Nygren. 1991. The reproductive process in boreal forests. In: Shugart et al. eds. Systems analysis of the global boreal forest. Cambridge Univ. Press. p. 85-125.

NORTHEASTERN FOREST EXPERIMENT STATION

MARY BETH ADAMS
Soil Scientist, some experience as a forest ecologist/ecophysiologist
Project Leader, Supervisory Soil Scientist

NE-4353

Northeastern Station
P.O. Box 404
Parsons, WV 26287

Phone: 304-478-2000, x130
FAX: 304-478-8692
e-mail: madams@fs.fed.us

Selected Studies:

Whole-watershed **acidification** study. A forested 85 acre watershed has been receiving ammonium suflate fertilizer 3 times per year at twice ambient inputs of N and S since 1989. Comparing untreated reference catchments for: 1) **stream and soil water chemistry**; 2) soil chemistry and processes; such as N mineralization and nitrification; 3) **CO_2** evolution; 4) vegetative responses; and 5) **nutrient cycling**. My research covers nutrient cycling and evaluating the belowground effects (microbial processes and nutrient movement).

Over the course of a **forest rotation**, evaluate the effects of **harvest removal** and **leaching** from the **soil** of **base nutrients**, notably calcium and magnesium, on forest productivity in the central **Appalachians**. We are looking at nutrient cycling, **stand growth** and **vegetation dynamics** (growth and diversity), soil changes over time. A university cooperator will be looking at diversity of mycorrhizae.

Relevant Publications:

Adams M.B., T.R. Angradi, and J.N. Kochenderfer. 1997. Streamwater and soil solution responses to five years of nitrogen and sulfur additions at the Fernow Experimental Forest. For. Ecol Management. 95:79-91.

Adams M.B., J.N. Kochenderfer, T.R. Angrade, and dP.J. Edwards. 1995. Nutrient budgets of two watersheds on the Fernow Experimental Forest in: Gottschalk, K.W., S.I. Fosbroke (eds) Proceedings, 10th Central Hardwood Forest Conference. 1995 March 508; Morgantown, WV. Gen. Tech. Rpt. NE-197. Radnor, PA:USDA Forest Service, Northeastern Forest Experiment Station pp. 119-130.

Adams M.B., and E.G.O'Neill. 1991. Effects of ozone and acidic deposition on carbon allocation and mycorrhizal colonization of Pinus taeda L. seedlings. For. Sci. 37(1):5-16.

Adams M.B., R.G. Campbell, H.L. Allen. and C.B. Davey. 1987. Root and foliar nutrient concentrations in loblolly pine: Effects of season, site and fertilization. For. Sci. 33: 984-996.

SCOTT BAILEY
Pedological Geologist
Research Geologist with a focus on biogeochemistry

NE-4352

USDA Forest Service
RR1 Box 779
Campton, NH 03223

Phone: 603-726-8902
FAX: 603-726-4851

e-mail sbailey@fs.fed.us

Selected Studies:

Personel research centers on the intersection of **geology, pedology** and **ecology**. Studies include:

Mass balance studies at **Cone Pond Research Watershed**, WMNF, in an attempt to better understand processes regulating **nutrient supply** and **acidification** in a base-poor forest

Model testing to predict **soil parent material chemistry** and **mineralogy** in **glaciated** regions.

Examining relationships between **soil parent materials** and nutrient supply.

Collabotative research:

Our team is examining **landscape relationships** between **sugar maple health** and **productivity**. My work deals with; 1) relationships between **soils** and **forest health** and **species distribution**, 2) transferring results **across scales**: from the laboratory and experimental watersheds to specific sites and region.

Relevant Publications:

Bailey S.W. and J.W. Hornbeck. 1992. Lithologic composition and rock weathering potential of forested, glacial-till soils. Res. Pap. NE-662. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 7p.

Bailey S.W., C.T. Driscoll, and J. W. Hornbeck. 1995. Acid-base chemistry and aluminum transport in an acidic watershed and pond in New Hampshire. Biogeochem. 28:69-91.

Bailey S.W., J W. Hornbeck, C.T. Driscoll, and H.E. Gaudette. 1996. Calcium inputs and transport in a base-poor forest ecosystem as interpreted by Sr-isotopes. Water Resources Research. 32:707-719.

Hornbeck J.W., S.W. Bailey, D.C. Buso, and J.B. Shanley. 1997. Stream water chemistry and nutrient budgets for forested watersheds in New England: variability and management implications. Forest Ecology and Management. 93:73-89.

Lawrence, G.B., M.B. David, S.W. Bailey, and W.C. Shortle. 1997. Assessment of soil calcium status in red spruce forests of the northeastern U.S. Biogeochemistry. 38:19-39.

CHRISTOPHER EAGER
Ecologist
Project Leader

NE-4352

USDA Forest Service
271 Mast Road
Durham, NH 03824

Phone: 603-868-7636
FAX: 603-868-7604
e-mail: ceagar@fs.fed.us

Selected Studies:

My current research seeks to understand the **cumulative effects** of **disturbance** and **atmospheric deposition** on nutrient **base cations**, forest health, and ecosystem function

in northern hardwood forests of New England. I am also continuing long term studies of southern Appalachian spruce-fir forests, with a specific focus on red spruce decline and the role of acidic deposition in this decline. As Project Leader, I have responsibility for Hubbard Brook Experimental Forest and coordinate and facilitate a large cooperative research effort involving scientists from several universities and a private research institute.

The major focus of my research is on **calcium depletion** and how the loss of calcium from the base poor soils of New England is impacting **forest productivity**. In 1994, I began a Ca and Al addition study to forest plots dominated by sugar maple to determine the effects of **nutrient availability** on soil and vegetation. Belowground processes being studied include **soil chemistry, soil leachate chemistry, root chemistry**, and **rhizosphere chemistry**. We are relating these changes to changes in vegetation (growth, foliar chemistry, and wood chemistry) and **nutrient cycling**.

The Hubbard Brook Ecosystem Study began in 1963 and has developed long term data on biogeochemistry in northern hardwood forests and studied the effects of disturbance (acid deposition, forest cutting practices) on ecosystem processes. Much of the current research falls within the NSF LTER Program, however, other grants support research at HB. Current activities related to belowground research include:

Effects of calcium depletion on nutrient cycling and forest productivity (watershed scale).

Effects of soil freezing (via snow removal) on microbial processes, root dynamics, and soil chemistry.

Long term studies of root growth and development.

Long term studies of biogeochemistry using watershed ecosystem analysis.

Linkages between terrestrial and aquatic ecosystems.

Long term changes in forest floor dwelling animals.

Relationship of foliar chemistry to soil chemical characteristics.

Relevant Publications:

Eagar, C. and M. B. Adams. (eds) 1992. Ecology and Decline of Red Spruce in the Eastern United States. Springer-Verlag, New York. 417p.

SHIVANAND HIREMATH
Biochemistry, Molecular Biology
Research Scientist

NE-4509

USDA Forest Service
359 Main Road
Delaware, Ohio 43015

Phone: 614-368-0015
FAX: 614-368-0152
e-mail: ne4509@midohio.net
shiremath@fs.fed.us

Selected Studies:

Development of novel **ectomycorrhizal (EM) fungal** delivery systems for improving tree health and increasing **forest biomass**, initiated 1995. This is a novel strategy of utilizing **genetically-engineered EM** fungi as; 1) **biological control** agents against **insects** and other **plant pests**, and 2) for providing forest trees beneficial factors essential for their health and vigor. Long-term goals are to develop genetically altered EM fungi as delivery system for:

Biological control of **root damaging insect** pests such as white grubs on conifer seedlings and lepidopteran K. gracilis larvae on spruce and fir. EM expressing insect **toxins**, such as **crystal proteins** from ***Bacillus thuringiensis***, will be constructed and their efficacy in protecting the trees from respective insect pests will be assessed.

Improving tree growth by increasing the efficiency of **mycorrhizal** synthesis of **phytohormones**. Genes will be introduced into EM fungi and their effect in increasing **tree growth and vigor** will be evaluated.

Changing adverse **microenvironment** around **root systems** caused by **acidity** or other **pollutants**. Aluminum toxicity in conifers caused by acid pollution increases soluble aluminum in hte soil, thus expression of **aluminum-chelating** factors in **EM** may **reduce metal uptake** by roots.

Expression of specific genes involved in reducing or purging the **virulence** of **bacterial and fungal diseases** of tree pathogens. Microbial pests causing **wilting** (e.g., Dutch elm disease) due to "clogging" of the plant's vascular system may be alleviated by **express genes encoding** a factor that will "unclog" the vascular system and alleviate the stress conditions. Alternatively, factors that are specifically toxic to the invading pathogen can be produced.)

Relevant Publication:

S. Bills, G. Podila and S. Hiremath.1997. Genetic engineering of an ectomycorrhizal fungus Laccaria bicolor for use as a biological control agent. J. Env. Hort. (submitted)

Kim, S.J., S. Hiremath and G. Podila. 1997. Application of mRNA differential display for identification of symbiosis-related genes from Laccaria bicolor. Mol. Plant Microbe Interactions. (submitted)

JOHN HOM
Physiological PlantEcologist
Assistant Program Manager
Global Change Program
Interdisciplinary Scientist

NE-4455

NEFES, Global Change
5 Radnor Corporate Center, Suite 200
Radnor, PA 19087

Phone: 610-975-4097
FAX: 610-9755-4200
e-mail: jhom@lunar.nena.org
jhom@fs.fed.us

Selected Studies:

As the Assistant Program Manager for Northern Stations Global Change Research Program, I help manage forest research programs dealing with the effects of global climate change: elevated CO2, ozone, acid deposition, and nutrient cycling at the physiological, ecosystem, and landscape level.

As an interdisciplinary scientist, I study plant-soil-atmosphere interaction of air pollutants: **ozone, wet and dry deposition, elevated CO_2.**

Nitric acid research on forest species: **deposition, damage**, uptake and incorporation of reactive **nitrogen air pollutants** of **western forest** tree species, Riverside, CA. 1992-present.

Regional assessment of **nitrogen deposition- Chesapeake Bay** Watershed. Modeling study on regional impacts of **chronic N** loading and **nitrate loss** in NE and Mid-Atlantic forested watersheds. Forest response to increased deposition, **nitrogen retention** and **N saturation**. NE, Mid-Atlantic. 1995-present.

Multiple stress effects of **CO_2 X O_3** on aspen using an open Free Air Carbon Dioxide Enrichment (**FACE**) at Rhinelander, WI. Studies will focus on changes in plant and litter **carbon-nitrogen** relationships, diurnal carbon budgets using **gas exchange** systems. 1995-present.

Tree physiological responses to multiple air pollutants in an **urban environment**. **Baltimore LTER sites**. The study will measure different physiological responses of **oak, hickory**, and **tulip poplar** to an **urban to rural air pollution gradient** (ozone, nitrogen deposition, and CO_2). Measurements include air pollution monitoring, **plant gas exchange, nitrogen** content, **litter quality, tree growth**, and **N loading**. Results will be used to paramaterize ecosystem process models. Start Nov. 1, 1997.

Relevant Publications:

Hom, John. 1995. Climate and ecological relationships in northern latitude ecosystems. In: Human Ecology and Climate Change: People and Resources in the Far North. D.L Peterson and D.R. Johnson, eds. Taylor & Francis. P. 75-88.

Krywult, M., J. Hom, A. Bytnerowicz, and K.E. Pearcy. 1996. Deposition of gaseous nitric acid and its effects on foliage of ponderosa pine (Pinus ponderosa Dougl. ex laws.) seedlings. In: Proceedings of the 16th Intl. Meeting of specialists in Air Pollution Effects on Forests Ecosystems: Air Pollution & Multiple Stress. Fredericton, Canada, IUFRO. P. 45-51.

Van Cleve, K. W.C. Oechel, and J.L. Hom. 1990. Response of Black spruce (Picea mariana [Mill] B.S.P.) to soil temperature modification in interior Alaska. Can. J. For. Res. 20:1530-1535.

Hom, J and W Oechel. 1983. The photosynthetic capacity, nutrient content and nutrient use efficiency of different needle age classes of black spruce found in the interior Alaska. Can J For Res. 13:834-839.

RAKESH MINOCHA
Biochemistry, physiology, molecular biology, and ecology
Research Scientist

NEFES-4505

USDA Forest Service, NEFES
271 Mast Road
P.O. Box 640
Durham, NH 03824

Phone: 603-868-7622
FAX: 603-868-7604
e-mail: rminocha@hopper.unh.edu

Selected Studies:

Changes in **molecular** and **biochemical processes of cells** in response to exposure to various types of **environmental stresses** using conifer cell lines. The long-term goal is to

use some of these changes as indicators of stress under field conditions. This involves conducting measurements on cellular levels of antioxidants, polyamines, thymidine/uridine incorporation, **organic acids, inorganic cations, polyamine biosynthetic enzymes, total proteins**, and others.

Evaluation of effects of **pathogens** and **environmental stimuli** (such as Al toxicity due to **acidic deposition** and chronic nitrification) on tree health and quality of wood using the indicators developed under above objectives. Listed below are specific areas of study.

Relationships among foliar chemistry, foliar polyamines, and soil chemistry (with special emphasis on soil Al levels) in red spruce trees growing across the northeastern United States.

Changes in **foliar chemistry** and **foliar polyamines** in relationship to changes in **soil chemistry** in **red pine, oak** and maple trees growing at Harvard Forest, Petersham, MA in response to **chronic nitrification**.

Changes in the stress indicator **Putrescine** and foliar **inorganic ion** content in **maple** and red spruce trees across northeastern United States and Allegheny State Forest in response to **fertilizer** treatments to the **soils** containing variable levels of **Ca** and **Al**.

Tissue culture projects that involve the development of **stess indicators** (e.g. **phytochelatins**, **antioxidants**) in tree species and genetic transformation of **poplar** and **red spruce** using **polyamine biosynthetic genes**. The long-term goal of transformation project is to test the changes in stress resistance in these lines due to over production of cellular polyamines.

Relevant Publications:

Minocha R., W.C. Shortle, G.B. Lawrence, M.B. David, and S.C. Minocha. 1995. Putrescine: A marker of stress in red spruce trees. In: Hom John; Birdsey, Richard; O Brian, Kelly, eds. Proceedings, Northern Global Change Program; March 14-16, 1995. Pittsburgh, PA, Gen. Tech. Rep. NE-214. Radnor, PA:U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 119-130.

Minocha R, W.C. Shortle, D.J. Coughlin, S.C. Minocha. 1996. Effects of Al on growth, polyamine metabolism, and inorganic ions in suspension cultures of red spruce (Picea rubens). Can. J. For. Res. 26:550-559.

Minocha R, W.C. Shortle, G.B. Lawrence, M.B. David, and S.C. Minocha. 1997. Relationships among foliar chemistry, foliar polyamines, and soil chemistry in red spruce trees growing across the northeastern United States. Plant and Soil 191:109-122.

Shortle W.C., K.T. Smith, R. Minocha, G.B. Lawrence, and M.B. David. 1997. Acid depletion, cation mobilization, and biochemical indicators of stress in healthy red spruce trees. J. Environ. Qual., 26:871-876.

David M.B., G.B. Lawrence, R. Minocha, W.C. Shortle, K.T. Smith, D. Vogt, K. Vogt, and P. Wargo. Aluminum mobilization and calcium depletion in the forest floor and vitality of red spruce in the forests in the northeastern United States. Proceedings of the calcium workshop, 1996 April 10-17, Ludlow, PA

LINDA PARDO
Ecosystems Ecology and Biogeochemistry
Environmental Engineer

NE-4352

USDA Forest Service
P.O. Box 968
Burlington, VT 05402

Phone: 802-951-6771 x1330
FAX: 802-951-6368
e-mail: lhpardo@athena.mit.edu
lpardo@fs.fed.us

Selected Studies:

Response of natural abundance of ^{15}N in **northern hardwood** forest soils to clearcutting. The objective is to determine whether elevated **nitrification** and **nitrate loss** induced by clearcutting can cause a measurable increase in soil delta ^{15}N.

Comparison of 3 sites across a **nitrate-loss gradient** in New Hampshire. The primary is to determine whether **stable isotopes** (natural abundance of ^{15}N) can be used to evaluate the **N cycling** status and N loss history of a forested catchment. In conjunction, we are measuring **N mineralization**, nitrification, **denitrification and microbial biomass**.

^{15}N and ^{18}O of nitrate in **streamwater**. The objective is to determine the source of nitrate in streamwater--what fraction comes directly from deposition and what fraction is formed via microbial processes within the ecosystem.

RICHARD POUYAT
Ecologist
Research Scientist

2. Institute for Ecosystem Studies
Millbrook, NY

Phone: 914-677-5343
e-mail: rpouyat@fs.fed.us

contact for **Baltimore LTER**

Selected Studies:

Urban-Rural Gradient Ecology (URGE) Program**: urban and suburban environmental effects** on **soil properties (chemical and physical), soil biota**, and **C and N dynamics** in unmanaged oak forest stands. Studies include:

Effects of urban atmospheric deposition on forest properties, soil biota, and **nutrient cycling** processes in eastern hardwood deciduous forest.

Effects of urban-suburban environments on forest ecosystem structure and function. Urban environmental effects on forest patches include **atmospheric deposition** of N and heavy metals, exposure to ozone, elevated temperatures (**heat island** effect), modified disturbance regimes, and introductions of **non-native species** (above and below ground species). These environmental effects have influenced C and N dynamics and thus N availability in urban and suburban forest patches. Changes in N availability in urban and suburban forest patches. changes in N availability ay be affecting competitive interactions between native and non-native tree species.

Research being conducted as part of NE-4952 research mission, . Research focuses on urban-wildland interface and remnant forest patches embedded within urban and suburban landscapes. In addition, research part of NE/NC Global Change Program (effects of land use change on global environmental change).

Introductions of non-native species of earthworms in urban and suburban forest patches has had a tremendous impact on C and N dynamics. Earthworms have increased decomposition rates in urban and suburban stands despite the input of lower quality leaf litter (compensation effect) and have stimulated nitrification rates. Results in shallow forest floor layer and soils dominated by nitrate rather than ammonium. Forest floor layer effects seed germination and seedling performance. Greater nitrate availability many differentially effect tree uptake of N.

To investigate the effects of non-native earthworm species on C and N dynamics in eastern hardwood deciduous forest (state land).

Research being conducted as part of NE-4952 research mission . Research focuses on **urban-wildland interface** and remenat forest patches embedded within urban and suburban landscapes. In addition, research part of NE/NC Global Change Program (effects of land use change on global environmental change).

Relevant publications:

Pouyat, R.V., M.J. McDonnell, and S.T.A. Pickett. Litter decomposition and nitrogen cycling processes along an urban-rural land use gradient. Urban Ecosystems (in press).

McDonnell, M.J., R.V. Pouyat, S.T.A. Pickett, and W.C. Zipperer. Ecosystem processes along urban-to-rural gradients. Urban Ecosystems (in press).

Steinberg, D.A., R.V. Pouyat, R.W. Parmelee, and P.M. Groffman. 1996. Earthworm abundance and nitrogen mineralization rates along an urban-rural land use gradient. Soil Biology and Biochemistry (in press).

Pouyat, R.V., M.J. McDonnell, S.T.A. Pickett, P.M. Groffman, M.M. Carreiro R.W. Parmelee, K.E. Medley, and W.C. Zipperer. 1995. Carbon and nitrogen dynamics in oak stands along an urban-rural gradient. pages 569-587. In Kelly, J.M. and W.W. McFee (eds.). carbon forms and functions in Forest Soils. Soil Science Society of America,, Madison, Wisconsin.

Pouyat, R.V., M.J. McDonnell, and S.T.A. Pickett. 1995. Soil Characteristics of oak stands along an urban-rural land use gradient. Journal Environmental Quality 24:516-526.

Goldman, M.B., P.M. Groffman, R.V. Pouyat, M.J. McDonnell and S.T.A. Pickett. 1995. Methane uptake and nitrogen availabilit in forest soils along an urban to rural gradient. Soil Biology and Biochemistry 27:281-286.

Professional society affiliation;

WALTER SHORTLE
Plant Pathologist, and biochemistry
Senior Scientist

NE-4505

USDA-FS-NE-4505
PO Box 640
Durham, NH 03824

Phone: 603-868-7620
FAX: 603-868-7604

e-mail wshortle@fs.fed.us

Selected Studies:

My current research activities are to determine major interactions among agents of **stress, tree hosts**, and **tree pathogens** and to determine indicators of increasing stress which are likely to precede the decline of health in **eastern forests**. Working hypotheses are derived from 30 years of active research related to **tree health**, e.g. **salt injury**, **stemwood and bark diseases**, tree **defense mechanisms**, electrical methods to detect changes in tree growth and infection, basic concepts of **tree biology** and **acidic**

deposition. From this background has come new concepts about soil-tree-atmosphere interactions which need to be studied in relationship to disturbances of eastern forest ecosystems.

Belowground research focuses on the **physical, chemical**, and **biochemical** interactions of the mineral **soil**, the **forest floor, tree roots, mycorrhiza**, and **macrothallic decay** fungi decomposing wood on the forest floor. Changes in root zone chemistry, which is strongly influenced by **atmospheric deposition**, over time are being linked to **dendrochemical** changes in tree tissue of stemwood so that periods of major **environmental change** can be dated. Changes in the current health status of trees following major changes in the environment are being studied by looking for biochemical **stress markers** in foliage after screening potential markers in cell suspension cultures.

Relevant Publications:

Shortle, W.C.; Smith, K.T. 1988. Aluminum-induced calcium deficiency syndrome in declining red spruce. Science 240:1017-1018.

Lawrence, G.B.; David, M.B.; Shortle, W.C. 1995. A new mechanism for calcium loss in forest-floor soils. Nature 378:162-165.

Shortle, W.C.; Smith, K.T.; Minocha, R.; Alexeyev, V.A. 1995. Similar patterns of change in stemwood calcium concentrations in red spruce and siberian fir. J. Biogeography 22:467-475.

Shortle, W.C.; Smith, K.T.; Minocha, R.; Lawrence, G.B.; David, M.B. 1997. Acidic deposition, cation mobilization, and biochemical indicators of stress in healthy red spruce. J. Environ. Qual. 26:871-876.

Minocha, R.; Shortle, W.C.; Lawrence, G.B.; David, M.B.; Minocha, S.C. 1997. Relationship among foliar chemistry, foliar polyamines, and soil chemistry in red spruce trees growing across the northeastern United States. Plant and Soil (in press).

KEVIN T. SMITH
Tree Physiologist, Fungal Physiologist
Research Scientist

NE-4505

U.S. Forest Service
Northeastern Forest Experiment Station
P.O. Box 640
Durham, NH 03924

Phone: 603-868-7624
Fax: 603-868-7604

e-mail: kts@hopper.unh.edu

Selected Studies:

Forest floor processes and tree stress and growth. Our team has been studying forest locations dominated by red spruce in the northeastern US. Process markers being investigated include **soil** and **soil solution chemistry**, production of **roots and litter, foliar putrescine content**, radial growth of stems, and changes in the response of growth to climate. My research is on **dendrochronological** and **dendroclimatological** analyses.

Effects of coarse woody debris on **soil development** and **cation** enrichment in **red maple** and **red spruce** stands in the Northeastern US.

Determine the role of **wood decay fungi** in transport of base cations between the **mineral soil** and **organic soil** layers .

Relevant Publications:

Shortle W.C., K.T. Smith, R. Minocha, G.B. Lawrence, M.B. David. 1997. Acidic deposition, cation mobilization, and biochemical indicators of stress in healthy red spruce.

Shortle W.C., K.T. Smith. 1988. Aluminum-induced calcium deficiency syndrome in declining red spruce. Science 240:1017-1018.

Smith K.T., W.C. Shortle, W.D. Ostrofsky. 1995. Aluminum and calcium in fine root tips of red spruce collected from the forest floor. Canadian Journal of Forest Research 25:1237-1242

PHIL WARGO
Plant pathologist/physiologist
Research scientist and project leader

NE-4505

USDA Forest Service
51 Mill Pond Road
Hamden, CT 06514

Phone: 203-230-4312
FAX: 203-230-4315
e-mail: pwargo@fs.fed.us

Selected Studies:

Fine root vitality and **pathology** in **red spruce** related to **soil chemistry** especially Al/Ca ratios. Attempting to determine if there are **fine root fungi** that act as **secondary pathogens** on **stress-weakened** nonwoody or fine woody (<2 mm diam) roots. With cooperators will identify organisms that have been demonstrated to be pathogenic on fine roots through survey and inoculation techniques.

Determining the relation of **soil chemistry** to **soil volumes** available for **fine root** occupancy and the **biomass of roots** in the various horizons in the surficial **organic layer** (forest floor).

Studying the role of **Armillaria root disease** in **sugar maple decline**, identifying species of Armillaria, determining their distribution and abundance in sugar maple stands in relationship to local and regional (glaciated vs. unglaciated sites) **soil chemistry** properties, and studying the relationships between soil chemistry, **soil microbes**, and growth and pathogenicity of rhizomorphs of Armillaria.

Relevant Publications:

Onsando J.M., P.M. Wargo, and S.W. Waudo. 1997. Distribution, severity, and spread of Armillaria root disease on Kenya tea plantations. Plant Dis. 81:133-137.

Bloomfield J., K. Vogt, and P.M. Wargo. 1996. Tree root turnover and senescence. In: Plant roots. The hidden half. (Y. Waisel, A. Eshel and U. Kafkafi, eds). Marcel Dekker, Inc. p 363-381.

Castello J.D., P.M. Wargo, V. Jacobi, G.D. Bachand, D.R. Tobi and M.A.M. Rogers. 1995. Tomato mosaic virus infection of red spruce on Whiteface Mountain, New York: prevalence and potential impact. Can. J. For. Res. 25:1340-1345.

Wargo P.M., D.R. Bergdahl, D.R. Tobi and C.W. Olson. 1993. Root vitality and decline of red spruce. Contributiones Biologiae Arborumm, Vol. 4.

BETTY L. WONG
Plant Pysiology
Research Scientist

NE-4103

USDA Forest Service
Northeastern Forest Experiment Station
705 Spear St.
PO Box 968
Burlington, VT 05403

Phone: 802-951-6771 ext 1280
FAX: 802-951-6368

e-mail: bwong@fs.fed.us

Selected Studies:

Atmospheric deposition affects the normal **physiological** function of plant roots. Elevated levels of pollutants in the soil solution affecting the physiological function of the **mycorrhizal** fungi and the associated plant.

Evaluate and characterize the effect of **heavy metal pollutants** and acidity on the root system at the **cellular** and **subcellular** levels: their effect on (a) the nutrient content of the plant and (b) cellular **respiration**.

Effects of different forms of **inorganic nitrogen** (NH_4^+, NO_3^-, NH_4NO_3) at different concentration levels on: (a) **tree growth**; (b) the capacity of the **roots** and associated **fungus** to take up and metabolize these various forms of nitrogen compounds; (c) the mineral nutrient status of the plant; and (d) **enzymes** associated with nitrogen assimilation.

Relevant Publications:

Zahka G.A., K.L. Baggett and B.L. Wong. 1995. Inoculum potential and other V.A.M. fungi parameters in four sugar maple forests with different levels of stand dieback. Forest Ecology and Management 75: 123-134.

McQuattie C.J., J.H. Melhuish and B.L. Wong. 1993. Cytological changes in mycorrhizal loblolly pine roots after exposure to lead or zinc at three acidity levels. In: Heavy Metals in the Environment. R.J. Allen and J.O. Nriagu, eds. 1:73-76.

Melhuish J.H., B.L. Wong, and C.J. McQuattie. 1988. A culture unit system for the study response of mycorrhizal and non-mycorrhizal seedlings to treatments. Plant and Soil 129: 157-163.

SOUTHERN RESEARCH STATION (SRS) and INTERNATIONAL INSTITUTE OF TROPICAL FORESTRY (IITF)

IITF

MICHAEL KELLER
Biogeochemistry, Biosphere-Atmosphere Exchange
Research Physical Scientist

IITF

USDA Forest Service
P.O. Box 25000

Rio Piedras, PR 00928-5000

Phone: 787-766-5335
Fax: 787-766-6302
e-mail: 0003950814@mcimail.com

Selected Studies:

Soil Biogeochemistry of Carbon, Nutrients, and Trace Gases in the **Amazon Region** of **Brazil**: Field Studies and Models of Natural and Managed Conditions. Work in undisturbed and logged forest and in pastures in the area of the Tapajos National Forest south of Santarem, Parà where will contrast soil biogeochemical processes on sandy Ultisols and clay Oxisols. Link above- and belowground productivity and nutrient cycles to trace gas exchange. Measurements at a variety of **temporal and spatial scales** will be synthesized using the framework of the **DNDC biogeochemical model** modified for forest conditions. Studies include:

Carbon Storage and Exchange. Measure **litter-fall** and **fine root biomass**, **productivity**, and **decomposition** on 2 common soil types in both logged and undisturbed old-growth forest. Provide a multi-year record of **CO_2** exchange between the soil and the atmosphere for old growth and **logged forest** on 2 soil types, as well as for old and young pastures using different management approaches. For ol**d-growth** forest, we will deploy automated soil enclosures to determine the largest component of **ecosystem respiration** thereby providing a critical check on **eddy covariance** estimators of carbon exchange.

Nutrient Dynamics. Compare **nutrient stocks** and cycling in **litter** and **roots** on 2 contrasting soils. Analysis of **nutrient retranslocation** and experimental fertilization of root-ingrowth cores will allow us to identify nutrient limitations.

Trace Gas Fluxes. Obtain a continuous multi-year record of soil **atmosphere CO_2, N_2O, NO, and CH_4 fluxes** from **old-growth, logged forest**, and **pasture** using automated and manual enclosures. Measurements will be complemented by N_2O and CH_4 concentration profile measurements obtained continuously from **towers** in undisturbed and logged forest. Determine the linkage between ecosystem **productivity** and N-oxide emissions in both pastures and forests through measurements and simulations using **DNDC**.

Relevant Publications:

Keller M., J.M. Melillo, and W.Z. de Mello. (in press). Trace gas emissions from ecosystems of the Amazon Basin. Ciencia e Cultura.

Lerdau M.T. and M. Keller (in press). Isoprene emission from trees in a sub-tropical dry forest. Plant, Cell, and Environment.

Veldkamp E. and M. Keller. (in press). Nitrogen oxide emissions from a banana plantation in the humid tropics. Journal of Geophysical Research.

Veldkamp E. and M. Keller (in press). Fertilizer induced nitric oxide emissions from agricultural soils. Nutrient Cycling in Agroecosystems.

Weitz A.M., W.T. Grauel, M. Keller, and E. Veldkamp. (in press). Calibration of time domain reflectometry technique using undisturbed soil samples from humid tropical soils of volcanic origin. Water Resource Research.

Keller M., D.A. Clark, D.B. Clark, A.M. Weitz, and E. Veldkamp. 1996. If a tree falls in the forest. Science, 273:201

JEAN D. LODGE
Research Scientist/Team Member, Fungal systematist, microbial ecologist

IITF

Center for Forest Mycology Research
Forest Products Laboratory
USDA-Forest Service
PO Box 1377
Luquillo, PR 00773-1377
or
c/o International Institute of Tropical Forestry
PO Box 490
Palmer, PR 00721-0490

Phone: 787-889-7445
Fax: 787-889-7477

Selected Studies:

My present research position is as a research botanist with the Center for Forest Mycology Research, Forest Products Lab, Madison WI, stationed permanently in Puerto Rico at the International Institute of Tropical Forestry, Sabana Research Station in the Caribbean National Forest/Luquillo Expt. Forest. Our focus is on **biosystematics, fungal diversity** and its assessment, and the role of fungi in **nutrient cycling**.

Currently, our main project is to survey **basidiomycete fungi** in the Greater Antilles, with main emphasis on the Luquillo Experimental Forest, describe the new species, and prepare identification manuals. The Basidiomycetes of the Greater Antilles is funded by the National Science Foundation Biotic Surveys & Inventories Program.

Past research projects are listed below:

Factors related to diversity of decomposer fungi

Assessment of diversity of endophytic fungi in tropical trees.

Role of decomposer fungi in nutrient immobilization in response to addition of woody debris, and its effects on recovery of canopy trees and understory following hurricane damage.

Availability of phosphorus and arbuscular mycorrhizal fungal inoculum in determining pathways and rates of revegetation on landslides.

Relevant Publications:

Lodge, D. Jean. 1997. Factors related to diversity of decomposer fungi in tropical forests. Biodiversity & Conservation 6:681-688.

Lodge, D. Jean. 1993. Nutrient cycling by fungi in wet tropical forests. In S. Isaac, J.C. Frankland, R. Watling, A.J.S. Whalley, Eds. Aspects of Tropical Mycology. BMS Symposium Series 19:37-57. Cambridge Univ. Press.

Lodge, D.J., W.H. McDowell, & C.P. McSwiney. 1994. The importance of nutrient pulses in tropical forests. Trends in Ecology and Evolution 9:384-387.

Lodge, D.J. Microorganisms. 1996. In D.P. Reagan and R.B. Waide, Eds. The Food Web of a Tropical Forest. Univ. of Chicago Press.

Polishook, J., G.F. Bills, & D.J. Lodge. 1996. Microfungi from decaying leaves of two rain forest trees in Puerto Rico. J. Indust. Microbiol. 17:284-294.

Zimmerman, J.K., W.M. Pulliam, D.J. Lodge, V. Quinones-Orfila, N. Fetcher, S. Guzman-Grajales, J.A. Parrotta, C.E. Asbury, L.R. Walker, & R.B. Waide. 1995. Nitrogen immobilization by decomposing woody debris and the recovery of tropical wet forest from hurricane damage. Oikos 72:314-322.

Current active grants:
Basidiomycetes of the Greater Antilles, National Science Foundation Biotic Surveys & Inventories, April 1996 to March 31 2000.

WHENDEE SILVER
Ecosystem Ecologist and Biogeochemist
Adjunct Research Scientist, Ecologist

IITF

International Institute of Tropical Forestry
USDA Forest Service

c/o University of California
Division of Ecosystem Sciences
151 Hilgard Hall, #3110
Berkeley, CA 94720

Phone: 510-643-3074
Fax: 510-643-5098
e-mail: wsilver@nature.ESPMberkeley.edu

Selected Studies:

Our research focuses on three primary areas of ecosystem ecology including **biogeochemical cycling** in the **plant-soil-atmosphere** interfaces, the effects of **disturbance** on nutrient cycling, and the relationships between nutrient cycling, **land-use**, and **biodiversity**. Most of our work is conducted in both managed and natural **tropical forest** ecosystems. Recently, we have begun work looking at the ecological consequences of different forest **restoration** strategies in the tropics. Project titles and dates are given below.

Soil Oxygen Availability in Forest Ecosystems: **Spatial Patterns** and Functional Relationships. 6/97-6/01.

Montane Vegetation in the Tropics: Controls on the Development, Structure, and Function of **Cloud Forest** Ecosystems. 1/94-12/97.

Long Term Ecological Research on the **Luquillo Experimental Forest**, II. 10/94-10/00. LEF LTER Program.

Changes in the Biodiversity and **Biomass of Epiphytes** along an Elevational Gradient in the Bano de Oro Research National Area, Luquillo Experimental Forest, Puerto Rico. 11/94-11/95.

Change in Biodiversity and Ecosystem Function along a **Moisture Gradient** in the Bano de Oro RNA, LEF, Puerto Rico. 11/93-11/94

The Effects of **Hurricane Hugo** on Belowground Nutrient Pools in the Luquillo Forest, Puerto Rico. 10/89 and onward.

Changes in Belowground Nutrient Pools Following Disturbance in a **Wet Tropical Forest** in Puerto Rico. 5/88 and onward.

Relevant Publications:

Silver, W.L. 1996. The potential effects of elevated CO?2? and climate change on tropical forest biogeochemical cycling. Climatic Change. In press.

Silver, W.L., S. Brown and A.E. Lugo. 1996. Biodiversity Biogeochemical Cycling. Pages 49-67 in G. Orians, R. Dirzo, and H. Cushman eds. The Ecosystem Function of Biological Diversity in Tropical Forests. Springer-Verlag.

Silver, W.L., F.N. Scatena, A.H. Johnson, T.G. Siccama, and F. Watt. 1996. At what temporal scales does disturbance affect belowground nutrient pools? Biotropica 28:441-457.

Silver, W.L. 1994. Is nutrient availability related to plant nutrient use in humid tropical forests? Oecologia 98:336-343.

Silver, W.L., F.N. Scatena, A.H. Johnson, T.G. Siccama, and M.J. Sanchez. 1994. Nutrient availability in a montane wet tropical forest in Puerto Rico: spatial patterns and methodolgical considerations. Plant and Soil 164:129-145.

Silver, W.L., and K.A. Vogt. 1993. Fine root dynamics following single and multiple disturbances in a subtropical wet forest ecosystem. Journal of Ecology 81:729-738.

SRS

WILLIAM BOYER
Silvicuture; Fire Ecology
Research Forester

SRS-4105

USDA Forest Service
Andrews Forestry Sciences Laboratory
DeVall Drive, Auburn University, AL 36849

Phone: 334-826-8700
Fax: 334-821-0037
e-mail: boyer@forestry.auburn.edu
wboyer@fs.fed.us

Selectied Studies:

Management alternatives for **longleaf pine** forests.

Natural **regeneration** of longleaf pine including the biology and ecology of the process.

Use and effects of **fire** in longleaf pine ecosystems, including season and periodicity of burn.

Relevant Publications:

Boyer W.D. 1994. Eighteen years of seasonal burning in longleaf pine: effects on overstory growth. In: Proceedings of the 12th International Conference on Fire and Forest Meteorology. 1993 October 26-28; Jekyll Island, GA. Society of American Foresters, Bethesda, MD 602-610.

Boyer W.D. and J.H. Miller. 1994. Effects of burning and brush treatments on nutrient and soil physical properties in young longleaf pine stands. Forest Ecology and Management 70:311-318.

Boyer W.D. 1995. Responses of groundcover under longleaf pine to biennial seasonal burning and hardwood control. In: Proc. 8th Biennial Southern Silviculture Research Conf., M.B. Edwards, comp. 1994 November 1-3, Auburn, AL. Gen. Tech. Report SRS-1. USDA FS, Southern Resh. Stn., Asheville, NC. 512-516.

Dale G. Brockway
Research Ecologist

SRS-4105 Vegetation Management Research and Longleaf Pine Research for Southern Forest Ecosystems

G.W. Forestry Sciences Laboratory
520 Devall Drive
Auburn, AL 36849

Ph (334) 826-8700
Fax 334-821- 0037
e-mail: dbrockway@fs.fed.us

Selected Studies

Analysis of the gap-phase reproductive dynamics of longleaf pine forests as a means of developing silvicultural approaches for sustaining the biological diversity **and long-term productivity** of longleaf pine bunchgrass ecosystems. Evaluation of growth regulators (herbicides) and prescribed fire as treatments useful in the restoration of degraded longleaf pine wiregrass ecosystems. Assessment of the long-term influence **of site preparation, fertilization** and **prescribed fire** on **plant community dynamics and soil properties** in southern forest ecosystems. Examination of the role and risk of fire in the southern urban-wildland interface and development of approaches for **ecological restoration**, fuels management and fire danger mitigation in forest ecosystems.

Relevant Publications:

Brockway D.G. and K.W. Outcalt. 1997. Solar radiation, fire and edaphic influences on gap-phase regeneration in longleaf pine wiregrass ecosystems. Forest Ecology and Management (In Review).

Brockway D.G., G.L. Wolters, H.A. Pearson, R.E. Thill, V.C. Baldwin and A. Martin. 1997. Understory plant response to site preparation and fertilization of loblolly and shortleaf pine forests. Journal of Range Management (In Press).

Brockway D.G., K.W. Outcalt and R.N. Wilkins. 1997. Restoring longleaf pine wiregrass ecosystems: plant cover, diversity and biomass following low-rate hexazinone application on Florida sandhills. Forest Ecology and Management (In Press).

Brockway D.G. and C.E. Lewis. 1997. Long-term effects of dormant-season fire on plant community diversity, structure and productivity in a longleaf pine wiregrass ecosystem. Forest Ecology and Management (in press).

MARIANNE K. BURK
Wetland (plant) ecologist, and biogeochemistry
Research Scientist, P.I. for Coosawhatchie Bottomland Ecosystem Study
Team Leader for Bottomland Hardwood Research
Team Leader for Belowground Processes Research

SRS-4103 (home page www.srs.fs.fed.us/charleston)

Center for Forested Wetlands Research
730 Savannah Highway
Charleston, South Carolina 29414

Phone: 803-727-4271 x118
Fax: 803-727-4152
e-mail: burkm@cofc.edu
mburk@fs.fed.us

Selected Studies:

Charleston lab has four main research areas 1) the basic **functions and processes** of **forested wetlands** including tree biology, **community dynamics**, hydrology, and biogeochemistry, 2) **silvicultural prescriptions** for wetland forests that will ensure **sustainable** yields of high quality wood products while sustaining or improving environmental quality, 3) technologies and assessment frameworks that will ensure effective restoration of forested wetlands, and 4) landscape level analyses on forest health and sustainability with new modeling approaches and remote sensing data.

My research involves:

Above and belowground **primary productivity** and **turnover of organic matter**.

Decomposition of root and foliage detritus.

Nutrient cycling along flooding gradients.

The interaction of **hydroperiod** and **fertility** on forest productivity.

The influence of hydroperiod, **edaphic factors** and light regime on **plant community structure**.

Structure and functional changes associated with **timber harvesting** in forested wetlands.

Relevant Publications:

Burke M.K., W.C. Dennison, and K.A. Moore. 1996. Non-structural carbohydrate reserves of eelgrass Zostera marina. Marine Ecology Progress Series 137:195-201.

Burke M.K. and D.J. Raynal. 1994. Fine root growth phenology, production and turnover in a northern hardwood forest ecosystem. Plant and Soil 162:135-146.

Burke M.K., D.J. Raynal, and M.J. Mitchell. 1992. Soil nitrogen availability influences seasonal carbon allocation patterns in sugar maple (Acer saccharum). Can. J. For Res. 22:447-456.

Mitchell M.J., M.K. Burke, and J.P. Shepard. 1992. Seasonal and spatial patterns of S, Ca, and N dynamics of a Northern Hardwood forest ecosystem. Biogeochemistry 17:165-189.

Burke, M.K. and D.C. LeBlanc. 1988. Rapid measurement of fine root length using photoelectronic image analysis. Ecology 69:1286-1289.

EMILY CARTER
Soil Science
Research Soil Scientist

SRS 4703 (home page srs4703.usfs.auburn.edu/unit.html)

USDA Forest Service
DeVall Drive
Auburn University, AL 36849

Phone: 334-826-8700
Fax: 334-821-0037
e-mail: carter@usfs.auburn.edu
ecarter@fs.fed.us

Selected Studies:

My research activities as a Research Soil Scientist concentrate on the relationship between **forest harvest operations and forest soil properties and processes**. The program currently in place emphasizes tree aspects of the interaction between forest operations and soil properties: the **impact of forest harvest operations** on the physical, chemical and biological properties of soils, **alteration of ecological processes of forest soils** as a result of harvest impacts to soil properties, and **methods of lessening impacts** through utilization of current harvest technologies and site preparation methods.

Studies have been conducted or initiated in three locations in the Southeast to characterize the **alteration of soil physical properties** in response to forest harvest operations and differences in **soil response due to soil origin**. Projects currently underway include the following:

Sustaining the Productivity and Function of Intensively Managed Forests. (Since 1993)

A collaborative project to understand the impact of **forest operations on soil properties and their role in sustainability** as well as **recovery of soil properties and processes.**

Study: **Soil strength** and **soil roughness** modifications by site preparation of a wet pine flat harvested under two soil moisture conditions. (1995)

Evaluation of Alternative Silvicultural Prescriptions in an Upland Hardwood Forest. (Since 1996)

A collaborative project to investigate the **benefits of alternative silvicultural practices** on **regeneration**, harvest economics, **soil physical properties and soil movement**, and aesthetics.

Study: Impacts to soil physical properties and soil movement associated with **strip cutting**, **deferment cutting and clearcutting** of an **upland hardwood forest**. (1996)

Impact of Forest Operations on Root Production, Root Injury, and Water Relations of Loblolly Pine. (Since 1996)

A collaborative project designed to understand the response of loblolly pine to machine traffic specifically, the impact on below and above ground biological processes and changes in **soil physical properties and water infiltration**.

Study:**Root injury** from forwarder traffic - preliminary results. Interaction of **machine traffic, soil physical properties**, and **loblolly pine root production** in a Piedmont soil.

Pending studies include assessing the cumulative impacts of forestry management practices on water quality at the watershed level (Coastal Plain) and application of the Water Erosion Prediction Project (WEPP) to predict soil movement (erosion) associated with forest harvest operations (Piedmont and Coastal Plain).

Relevant Publications:

Carter, E.A., W.M. Aust, J.A. Burger, D.P. Preston, and S.C. Patterson 1997. Visually-determined soil disturbance classes used as indices of forest harvesting disturbance. (Submitted to Southern Journal of Applied Forestry).

Carter, E.A., W.M. Aust, J.A. Burger, M.A. Burger, D.P. Preston, and S.C. Patterson. 1997. Soil Strength Modifications of Selected Soil Disturbance Classes by Site Preparation of a Wet Pine Flat Harvested Under Two Mois?

Carter, E.A., and T.P. McDonald. 1997. Interaction Among Machine Traffic, Soil Physical Properties, and Loblolly Pine Root Proliferation in a Piedmont Soil (in press - Proceedings of the Ninth Biennial Southern Silvicultural Research Conference).

Carter, E.A., W.M. Aust, J.A. Burger, and S.C. Patterson. 1997. Soil Strength, Volumetric Water Content, and Soil Roughness Characteristices of a Bedded Wet Pine Flat (in press - Proceedings of the Ninth Biennial Southern Silvicultural Research Conference).

Carter, E.A., T.P. McDonald, L.J. Samuelson. 1996. Root Damage from Forwarder Traffic - Preliminary Results (ASAE Paper 96-5007).

Mark Coleman
Biological Scientist

SRS-4103 Center for Forested Wetlands Research

Sevannah River Institute
PO Box 700
New Ellenton, SC 29809-0700

Ph: 803-725-0513
e-mail: mcoleman@fs.fed.us
mcoleman@ifx.net

Selected Studies:

The Short-Rotation Wood Crops (SRWC) Cooperative Research Program is investigating the feasibility of **intensive silviculture** to rapidly produce high quality wood products in a manner which is sustainable, cost effective and with low environmental impacts. The priority issues that will be investigated by the cooperative include, but are not limited to, understanding fundamental **mechanisms involved in productivity**, monitoring local **environmental impacts** of SRWC, studying **pest susceptibility and data base compilation**. The initial scientific experiment for this cooperative will be installed at the DOE's Savannah River Site during 1999 and 2000. This experiment is designed to determine processes and mechanisms controlling productivity by **manipulating nutrient**

and water regimes. Nutrient mass balance and water and nutrient fluxes will be monitored throughout the rotation.

Other research involves modeling seasonal fine-root production and turn-over among species; studying the impacts of **soil fertility** on poplar productivity **and fine-root dynamics**; development of management tools for diagnosing **mineral nutrient deficiencies** in trees and prescribing **fertilizer amendments** to maximize productivity.

Relevant Publications:

Coleman, M.D., R.E. Dickson, J.G. Isebrands, and D.F. Karnosky. 1995. Carbon allocation and partitioning in aspen clones varying in sensitivity to tropospheric ozone. Tree Physiology 15:593-604.

Coleman, M.D., R.E. Dickson, J.G. Isebrands, and D.F. Karnosky. 1996. Root growth and physiology of potted and field-grown trembling aspen exposed to tropospheric ozone. Tree Physiology 16:145-152.

Coleman, M.D., T.M. Hinckley, G. McNaughton and B.A. Smit. 1992. Root cold hardiness and native distribution of subalpine conifers. Can. J. For. Res. 22:932-938.

Friend, A.L., M.D. Coleman, and J.G. Isebrands. 1994. Carbon allocation to root and shoot systems of woody plants. In: Davis, T.D., B.E. Haissig, comps., eds. Biology of adventitious root formation. New York, NY: Plenum Press: 245-273.

Coleman, M.D., C.S. Bledsoe and B. Smit. 1990. Ectomycorrhizas decrease root hydraulic conductivity and xylem sap levels of zeatin riboside in Douglas-fir seedlings. New Phytol. 115:275-284.

Coleman, M.D., C.S. Bledsoe and W. Lopushinsky. 1989. Pure culture response of ectomycorrhizal fungi to imposed water stress. Can. J. Bot. 67:29-39

Current active grants:
The Wisconsin FACE project receives support from multiple agencies including NSF, DOE, USDA Forest Service and NCASI.

Coleman, M.D. and J.G. Isebrands. Inensive fertilization of a commercial poplar plantation, Boise Cascade Cooperative Research and Development Agreement, June 1997 - December 1998.

Friend, A.L. and Coleman, M.D. Nitrogen controls over tree root production. USDA, National Research Initiative, #9700732, July 1997 - December 1999.

Kurt Johnsen
Plant Physiologist

SRS-4154 Boilogical Foundations of Southern Forest Productivity and Sustainability

Forestry Sciences Laboratory
PO Box 12254
3041 Cornwallis Road
Research Triangle Park, NC 27709

Ph: 919-549-4012
Fax: 919-549-4047
e-mail: kjohnsen@fs.fed.us

Selected Studies:

Forest tree growth and physiological response to variation in **water and nutrient availability**, **temperature, and atmospheric CO2 environment**. **Process model** development and validation.

KIER KLEPZIG
Research Scientist
Ecologist/Microbiologist/Entomologist

SRS-4501 (home page www.fs.fed.us/4501)

USDA Forest Service
2500 Shreveport Hwy.
Pineville, LA 71360

Phone: 318-473-7238
Fax: 318-473-7222
e-mail: kklepzig@asrr.arsusda.gov
kklepzig@fs.fed.us

Selected Studies:

Microbial ecology of **bark beetles** and **weevils** colonizing the stem and roots of **southern pines**. Relationships of the **root infesting beetles**, *weevils (Hylastes salebrosus*, *Hylobius pales and Pachylobius picivorus*), and the saprogenic fungi (*Leptographium terebrantis* and *L. procerum*) they vector.

Root insect/root pathogen interactions in pine plantations under **prescribed burning** regimes.

Occurrence, vectors, and impacts of Leptographium spp. in roots of southern pine beetle host trees as related to **thinning** practices.

Relevant Publications:

Klepzig K.D., E.B. Smalley and K.F. Raffa. 1996. Interactions of ecologically similar saprogenic fungi with healthy and abiotically stressed conifers. For. Ecol. Manag. 86:163-169.

Klepzig K.D., E.B. Smalley and K.F. Raffa. 1996. Combined chemical defenses against an insect-fungal complex. J. Chem. Ecol. 22:1367-1388.

Klepzig K.D., E.B. Smalley and K.F. Raffa. 1995. *Dendroctonus valens* and *Hylastes porculus*: vectors of pathogenic fungi associated with red pine decline disease. Great Lakes Entomol. 28:81-87.

Klepzig K.D., E.L. Kruger, E.B. Smalley and K.F. Raffa. 1995. Effects of biotic and abiotic stress on induced accumulation of terpenes and phenolics in red pines inoculated with bark beetle-vectored fungus. J. Chem. Ecol. 21:601-626.

Klepzig K.D., K.F. Raffa and E.B. Smalley. 1991. Association of an insect-fungal complex with red pine decline in Wisconsin. Forest Sci. 37:1119-1139.

JENNIFER D. KNOEPP
Research Soil Scientist

SO-4351 (home page spark.ecology.uga.edu)

Coweeta Hydrologic Laboratory
Southern Research Station
3160 Coweeta Lab Road
Otto, NC 28763

Phone: 828-524-2128 x103
Fax: 828-369-6768
email: jknoepp@sparc.ecology.uga.edu
jknoepp@fs.fed.us

Selected Studies:

Long-term effects of forest management practices on **soil chemistry** and **nutrient cycling**.

Effects of changes in soil chemical composition on **litter decomposition** and **dendrochemistry**.

Changes in soil chemistry and **nutrient availability** along **climatic**, **vegetation**, and **elevation gradients**.

Impacts of **site-preparation burning** on soils in the **southern Appalachians**.

Relevant Publications:

Knoepp J.D. and W.T. Swank. 1997. Forest management effects on surface soil carbon and nitrogen. Soil Science Society of America Journal 61:928-935.

Knoepp, J.D. and W.T. Swank. 1997. Long-term effects of commercial sawlog harvest on soil cation concentrations. Forest Ecology and Management 93:1-7.

Knoepp, J.D. and W.T. Swank. 1995. Comparison of available soil nitrogen assays in control and burned forested sites. Soil Science Society of America Journal 59:1750-1754.

Knoepp, J.D. and W.T. Swank. 1994. Long-term soil chemistry changes in aggrading forest ecosystems. Soil Science Soc. of Amrica Journal 58:325-331.

Knoepp, J.D. and W.T. Swank. 1993. Site preparation burning to improve southern Appalachian pine-hardwood stands: nitrogen responses in soil, soil water, and streams. Canadian Journal of Forest Research 23:2263-2270

PAUL P. KORMANIK
Silviculture - Morphology and Anatomy
Principal Silviculturist

Attached administratively to SRS-4154 at
Research Triangle Park, NC (home page www.rtp.srs.fs.fed.us/soils/soilhome.htm)

Southern Research Station
Institute of Tree Root Biology
Forestry Sciences Laboratory
320 Green Street, Athens, GA 30606

Phone: 706-559-4288
Fax: 706-559-4291
e-mail: pkormani@fs.fed.us

Selected Studies:

Physiological and morphological attributes of forest species: Below- and aboveground characteristics that affect **regeneration** success. Objective is to qualitatively and quantitatively characterize the biological traits of individual hardwood and conifer species in the **nursery** and in the field to meet their growth requirements for successful regeneration. Over twenty active field and nursery studies are being monitored based upon initial root development of individual seedlings. **Nursery fertility** studies have been essential in clarifying the importance of a seedling root system for successful establishment and early growth in the field. These studies are broadly located on several

geographic areas and cover several ecosystems, i.e., the Coastal plain, Piedmont and Southern Appalachian Mountains. The biological principles being developed are not ecosystem specific but should have universal application. Example, furniture manufacturers and over 200 species of **bird** and **wildlife** depend upon continued presense of **obbbak**. This research began in 1986 and include these broad study areas:

Root development properties of nursery seedlings affecting competitive ability of seedlings after outplanting.

Heritability of **first-order lateral roots** of open pollinated, half-sib progeny of forest species as a selection basis for evaluating mother tree for inclusion into breeding programs.

Enrichment plantings for artificial regeneration of oak forests in eastern United States.

Long-term effects of **loblolly pine** and **sweetgum** quantity assessed in the nursery on stand development.

Relevant Publications:

Kormanik P.P. and H.D. Muse. 1986. Lateral roots a potential indicator of nursery seedling quality. In: TAPPI Proceedings 1986 Research and Development Conference, Raleigh, NC, Sept. 28-Oct. 1. pp. 187-190.

Kormanik P.P. 1986. Lateral root morphology as an expression of sweetgum seedling quality. For. Sci. 32:595-604.

Kormanik, P.P. 1989. Importance of First-order lateral roots in the early development of forest tree seedlings. pp 157-169 in Interrelationships between microorganisms and plants in soil (Vancura, V. and F. Kune, eds). Proc International Symp, Liblice, Czechoslovakia, 22-27 June 1987, Academia, Publ House of Czecchoslovak Academy of Sciences, Praha 1989.

Kormanik, P.P., J.L. Ruehle and H.D. Muse. 1990. Frequency distribution and heritability of First-order lateral roots in loblolly pine seedlings. For. Sci. 36:802-814.

Kormanik, P.P., S. Sung, T.L. Kormanik and S.J. Zarnock. 1995. Oak Regeneration - Why Big is Better. pp. 117-123 in National Proceedings: Forest and Conservation Nursery Association, 1995. Thomas D. Landis and Bert Cregg, Tech. Coordinators.

Kormanik, P.P., S.S.Sung and T.L. Kormanik. 1994. Toward a single nursery protocol for oak seedlings. pp. 89-98 in Proc. 22nd Southern Forest Tree Improvement Conf, 14-17Jun 1993, Atlanta, GA.

KIM H. LUDOVICI
Research Scientist

Soil Scientist, Root Ecologist

SRS-4154 (home page www.rtp.srs.fs.fed.us/soils/soilhome.htm)

USDA Forest Service
Biological Foundations of Forest
Productivity and Sustainability
3041 Cornwallis Rd.
RTP, NC 27709

Phone: 919-549-4044
Fax: 919-549-4047
e-mail: kludovici@rtpmail.emapfhm.gov
kludovici@fs.fed.us

Selected Studies:

A primary research effort involves the **Long Term Site Productivity Study** at the Croatan National Forest (for further discription see Dr. Marilyn Buford, P.I.). My studies include:

Long-term effects of **soil compaction** and **organic matter** removal on l**oblolly pine root growth**, foliar **carbohydrate** dynamics, **litter decomposition** and **nutrient cycling** and biomass allocation.

SETRES (SouthEastern Tree Research and Education Site), investigates effects of climate change and silvicultural prescriptions on the sustainability of stand productivity. This is a cooperative effort, between USDA Forest Service, the Southern Global Change Program, NC State Univeristy and forest industry. My research projects include:

Root carbohydrate pools over a 12 month period at SETRES.

Carbon cycling in a mid-rotation loblolly pine stand subjected to fertilization, irrigation and **CO_2** treatments.

Loblolly pine root decomposition in situ under two levels of fertilization.

Loblolly pine root growth and distribution in a mid-rotation stand exposed to elevated CO2.

Other studies include; the viability of using **belowground biomass** to understand root growth, and root growth and carbohydrate response to **soil carbon** and **nitrogen** transformations across an elevation and vegetational gradient.

Relevant Publications:

Ludovici K.H. and L.A. Morris. 1997. Competition-Induced Reductions in Soil Water Availability Reduced Pine Root Extension Rates. Soil Sci. Soc. Am. J. 61:1196-1202

Ludovici K.H. and L.A. Morris. 1996. Responses of loblolly pine, sweetgum and crab grass roots to localized increases in nitrogen in two watering regimes. Tree Phys. 16:933-939

Ludovici, K.H. 1997. The Viability of Using Belowground Biomass to Understand Root Growth Dynamics. (in preparation for Forest Science)

STEVE MCNULTY
Landscape Ecologist
Research Scientist, Project Leader and Program Manager

SRS-4852 (home page www.sgcp.ncsu.edu)

USDA Forest Service
1509 Varsity Drive
Raleigh, NC 27606

Phone: 919-515-9489/919-515-3529
Fax: 919-369-6768
e-mail: smcnulty@ncsu.edu

Selected Studies:

Overall objectives are **landscape** to **regional scale modeling** and **assessments** of southern U.S. forest processes.

During the 1980's, high rates of **N deposition** were postulated as a cause of **N saturation** and **forest mortality**. The objective is to assess how chronic long-term N additions affect the structure and function of **spruce-fir** forests. We have been **fertilizing** eight forest plots with chronic low levels of N since 1988 on Mt. Ascutney Vermont. Measurement of net N **mineralization** and **nitrification** in the **forest floor, litter-fall** and forest floor mass and elemental concentration, **foliar elemental concentration**, and basal area growth by species, nitrate leaching, **nitrate reductase** activity, foliar **respiration, photosynthetic** rates and cold tolerance have been conducted at various times between 1988 and present. These research plots are the longest, and most intensively studied experimental spruce-fir stands in North America as well as the first and longest fertilization field study to observe a mature forest as it changes from N deficient to N saturated. We are demonstrating that N alone can cause the spruce decline observed across New England. The results will be; 1) used to reassess which environmental factors need to be controlled to minimize forest decline, and 2) useful for predicting which tree species might replace declining species if high N deposition rates continue.

Relevant Publication:

McNulty, S.G., J.D. Aber, S.D. Newman. 1996. Nitrogen Saturation Induced on a High Elevation New England Spruce-Fir Stand. Forest Ecology and Management. 84: 109-121.

J.D. Aber, A. Magill, S.G. McNulty, R. Boone, K.J. Nadelhoffer, M. Downs, R. Hallett. 1996. Forest Biogeochemistry and Primary Production Altered by Nitrogen Saturation. Water Air and Soil Pollution 8:1665-1670.

McNulty, S.G. and J.D. Aber. 1993. The Effects of Nitrogen Fertilizer on Nitrogen Cycling in a High Elevation Spruce-Fir Stand. Canadian Journal of Forest Research 23:1252-1263.

McNulty, S.G., J.D. Aber and R.D. Boone. 1991. Spatial changes in forest floor and foliar chemistry in spruce-fir forests forests across New England. Biogeochemistry 14:13-26.

McNulty, S.G., J.D. Aber, T.M. McLellan, and S.K. Katt. 1990. Nitrogen cycling in high elevation forests of the northeastern U.S. in relation to nitrogen deposition. Ambio 19:38-40

JAMES H. MILLER
Forest Ecologist, Vegetation Management Scientist, and Silviculturalist.
Team Leader Vegetation Management Research.

SRS-4105

USDA Forest Service
DeVall Drive
Auburn University, AL 36849

Phone: 334-826-8700
Fax: 334-821-0037
e-mail: miller@forestry.auburn.edu
jmiller@fs.fed.us

Selected Studies:

My present position is as a **forest ecologist** and **team leader** addressing the problem area: Lack of integrated vegetation management prescriptions for ecosystem management and the knowledge of their multi-resource benefits and impacts limit their acceptance and application in southern forestry. I lead two multi-discipline teams and have joint studies addressing the floristic and soil changes following operational and research stand-level treatments:

EM Research Team with universities, forest industries, and National Forest Systems: Ecological and economical sustainable site preparation methods for public and private forest lands in the Southeastern U.S. (since 1994). Stand-**level soil/litter C and N and macro-nutrients**, litterfall transfers, floristic diversity, and stand structure evaluated with economic projections of commodity production.

USFS, University, and Forest Industry Team: A regional study (14 locations in 7 states) of competition impacts on loblolly **pine growth, early succession**, and **biogeochemistry**--The Competition Omission Monitoring Project (COMP) (since 1983). Stand-level soil/litter C and N and macro-nutrients?

The **long-term effect** of varying intensities of **site preparation** on soil resources (since 1982). **Soil nutritional and physical changes** monitored over 10 years after six site preparation treatments in Georgia Piedmont.

The long-term effects of herbicide site preparation and release on floristic diversity (since 1984).

Relevant Publications:

Lockaby, B.G., J.H. Miller, and R.G. Clawson. 1995. Influences of community composition on biogeochemistry of loblolly pine (Pinus taeda) Systems. Am. Midland Nat. 134:176-184.

Miller, J.H., B.R. Zutter, S.M. Zedaker, M.B. Edwards, and R.A. Newbold. 1995. Early plant succession in loblolly pine plantations as affected by vegetation management. South. J. Appl. For. 19:109-126.

Boyd, R.S., J.D. Freeman, J.H. Miller, and M.B. Edwards. 1995. Forest herbicide influences on floristic diversity seven years after broadcast pine release treatments in central Georgia, USA. New For. 10:17-37.

Boyer, W.D. and J.H. Miller. 1995. Effect of burning and brush treatments on nutrient and soil physical properties in young longleaf pine stands. For. Ecol. Mgmt 70:311-318.

WILLIAM J. OTROSINA
Forest Pathology
Research Scientist/Team Leader, Tree Root Biology Team

SRS-4154 (home page www.rtp.srs.fs.fed.us/soils/soilhome.htm)

Forest Sciences Laboratory
320 Green Street
Athens, GA 30602

Phone: 706-559-4295

Fax: 706-559-4291
e-mail: ostrosina@negia.net
wotrosina@fs.fed.us

Selected Studies:

Interaction between **fire**, **pathogenic root infecting fungi, insects** and mortality in longleaf pine. The objective of this study is to determine association of prescribed fire, "**exotic ecosystems**", and mortality in longleaf **pine** stands. Changes in fungal biomass and fine root damage are being quantified.

Relationships between **root infecting fungi** (*Leptographium* complex*, Heterobasidion annosum*, etc.) and **southern pine beetle** susceptibility. The objective of this study is to determine roles of Leptographium complex and other **root pathogens** in susceptibility of southern pines to southern pine beetle.

Comparisons of **genetic** distributions and **infection origins** of ***Heterobasidion annosum*** between **southern** and **western** United States **pine** stands. The objective of this study is to determine interactions between mode of infection, **spread**, **population structure**, and **susceptiblity** of conifer stands in the southeast and western USA to the woody root pathogen, *H. annosum*. Ecosystems: loblolly pine, longleaf pine, east-side ponderosa pine and Jeffrey pine (East-side Sierra Nevada ecosystems).

Site **disturbance** effects on **root pathogens** and **mycorrhizal fungal** biomass on east-side **pine** stands in **California**. The objective of this study is to determine the effects of **soil/site disturbance** (logging intensity, other silvicultural treatments) on root damage, root infecting fungi, and symbiotic and soil fungal biomass.

Refinement of techniques for measuring **soil fungal biomass**. The objective of this study is to develop more efficient methods using ergosterol to quanitify soil fungal biomass.

Significant Accomplishments:

We demonstrated the presence of cryptic infections in longleaf pine roots previously thought to be resistant or tolerant and linked the relationships to fire, soils, etc. We also developed the DNA technology to study and quantify spread dynamics of root pathogens such as Heterobasidion annosum in stands. As a result of misleading mycorrhizal fungal biomass field measurements we now are actively using ergosterol for measuring mycorrhizal and free living fungal biomass.

Relevant Publications:

Otrosina et al. 1997. Blue-stain fungi associated with roots of southern pien trees attacked by the southern pine beetle, *Dentroctonus frontalis*. Plant Disease 81:942-945.

Otrosina, Sung, and White. 1996. Effects of subsoiling on lateral roots, sucrose metabolizing enzymes, and soil ergosterol in two Jeffrey pine stands. Tree Physiology 16:1009-1013.

Otrosina, et al. 1993. Population structure of *Heterobasidion annosum* from North America and Europe. Canadian Journal of Botany 71:1064-1071.

Garbelotto, Ratcliff, Bruns, Cobb, and Otrosina. 1996. Use of taxon specific competitive priming PCR to study host specificity, hybridization, and intergroup gene flow in intersterility groups of *Heterobasidion annosum*. Phytopatholgy: 86:543-551.

Otrosina and Ferrell. 1995. Root diseases: Primary agents and secondary consequences of disturbance. In/ Forest Health Through Silviculture Workshop, Mescalero NM. General Technical Report RM-GTR-267, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, 246 p.

FELIPE SANCHEZ
Organic and Analystical Chemist
Research Scientist

RM-4154 (home page www.rtp.srs.fs.fed.us/soils/soilhome.htm)

Southern Research Station
P.O. Box 12254
Research Triangle Park, NC 27709

Phone: 919-549-4043
Fax: 919-549-4047
e-mail: fsanchez@rtpmail.emapfhm.gov
fsanchez@fs.fed.us

Selected Studies:

My current research position is as a research organic chemist under the soils component of the Foundations of Southern Forest Productivity in the Southern Station. My research focuses on **soil organic matter**. General project areas cover:

Characterization of the active and stable components of soil organic matter and their relation to **stand productivity**.

Modeling soil organic matter physical protection in the soils of the Southen United States.

Examining the effect of land management practices on active and stable **organic matter pools.**

Examining land management effects on the **carbon and nutrient cycling** of forest litter and soil organic matter.

Relevant Publications:

Sanchez, F.G. and Ruark, G.A. 1995. Fractionation of soil organic matter with supercritical Freon: IN: W.W. McFee and J.M. Kelly (ed.) Carbon Forms and Functions in Forest Soils. SSSA. Madison, WI.

Sanchez, F.G. 1996. Soil organic matter and soil productivity: Searching for the missing link. IN: R.A. Mickler and S.Fox (ed.). The Productivity and Sustainability of Southern Forest Ecosystems in a Changing Environment. Springer-Verlag (in press).

Sanchez, F.G., and M.M. Bursey. 1996. Carbon in the "Reoccurring Rhizosphere" region of Loblolly pines. Soil Sci. Soc. Am. J. (in review).

PAULINE SPAINE
Plant Pathologist
Research Scientist

SRS-4505

USDA Forest Service
320 Green Street
Athens, GA 30602

Phone: 706-559-4278
Fax: 706-559-4287
e-mail: pspaine@negia.net
pspaine@fs.fed.us

Selected Studies:

Effect of **dogwood anthracnose** disease on the loss of dogwood from the natural forest. Dogwoods are one of the primary recyclers for **calcium** in the forest as well as a mast producer. Eventually we will look at whether other species will be able to fill this niche in the forest.

JOHN A. STANTURF

Project Leader/Research Ecologist
USDA Forest Service
Forestry Sciences Laboratory
320 Green St.
Athens, GA 30602

SRS-4104

Phone: 706-559-4263
Fax: 706-559-4317
e-mail: jstanturf@fs.fed.us

Selected Studies:

My major research interests are ecology and sustainable management of **hardwood forests**. My work fits into three broad categories**: ecosystem renewal, ecosystem restoration, and intensive planation culture**. Areas of work in Ecosystem Renewal include: **soil and site factors** affecting **regeneration** of commercially desirable bottomland hardwood species, particularly oaks, maintenance of **site productivity; nutrient cycling; coarse woody debris** and **leaf litter decomposition**. In the arena of Ecosystem Restoration, my work includes: **afforestation** of bottomland hardwoods, including establishing multi-species stands, **interplanting** fast and slow growing species; effects of restoration on **soil quality**; methods for evaluating restoration success. I am beginning a research program on Intensive Planation Culture, but work includes: intensive fiber production of Eastern cottonwood using fertigation technology; fertilizer movement in fertigation treatments; and generally, managing cottonwood plantations for fiber production.

Relevant Publications:

Stanturf, J.A. and Stone, E.L. 1985. Measuring fertilizer response in mixed species hardwood stands. In Proc. 5th Central States Hardwood Forest Conf., Urbana, Ill; pp. 78-89.

Stanturf, J.A., Stone, E.L., and McKittrick, R.C. 1989. Effects of added nitrogen on growth of hardwood trees in southern New York. Canadian J. Forest Research 19:279-284.

Stanturf, J.A. 1990. Cable logging impacts on soils on the Allegheny Plateau. J. Pennsylvania Academy of Sciences 64(3):127-130.

Stanturf, J.A. and Stone, E.L. 1994. Loss of nitrogen and bases after fertilization of second-growth hardwood forest soils: A field study. Forest Ecology and Management 65:265-277.

Stanturf, J.A. and Bradshaw, R.D. 1996. Growth of loblolly and slash pine seedlings on spodic horizons. P. 275-280 in Proceedings 8th Biennial Silvicultural Research Conference, 1-3 Nov., 1994, Auburn, AL. US Department of Agriculture, Forest Service, Southern Research Station General Technical Report SRS-1, Asheville, NC.

Stanturf, J.A. and Messina, M.G. (Editors) 1997. Harvesting impacts on southern bottomland hardwood ecosystems. Forest Ecology and Management 90:93-252.

Lockaby, B.G., Clawson, R.G., Flynn, K., Rummer, R., Meadows, S., Stokes, B., and Stanturf, J. 1997. Influence of harvesting on biogeochemical exchange in sheetflow and soil processes in a eutrophic floodplain forest. Forest Ecology and Management 90:187-194.

Lockaby, B.G., Jones, R.H., Clawson, R.G., Meadows, J.S., Stanturf, J.A. and Thornton, F.C. 1997. Influences of harvesting on functions of floodplain forests associated with low-order, blackwater streams. Forest Ecology and Management 90:217-224.

Lockaby, B.G., Stanturf, J.A., and Messina, M.G. 1997. Effects of silvicultural activity on ecological processes in floodplain forests of the southern United States: A review of existing reports. Forest Ecology and Management 90:93-100.

McNabb, K.L., Miller, M.S., Lockaby, B.G., Stokes, B.J., Clawson, R.G., Stanturf, J.A., and Silva, J.N.M. 1997. Selection harvests in Amazonian rainforests: Long-term impacts on soil properties. Forest Ecology and Management 93:153-160.

Rice, M.D., Lockaby, B.G., Stanturf, J.A. and Keeland, B.D. 1997. Woody debris decomposition in the Atchafalaya River Basin following hurricane disturbance. Soil Science Society America Journal 61:1264-1274.

Stanturf, J.A. and Schoenholtz, S.H. 1997. Soils and landforms of southern forested wetlands. Chapter 6 (P. 123-147) in Messina, M.G. and Conner, W.A. Southern Forested Wetlands: Ecology and Management. CRC Press-Lewis Publishers, Boca Raton, FL.

Stanturf, J.A., Schweitzer, C.J., and Gardiner, E.S. 1998. Afforestation of marginal agricultural land in the Lower Mississippi River Alluvial Valley, U.S.A. Silva Fennica 32(3):281-297.

Lockaby, B.G., Keeland, B.L., Stanturf, J.A., Rice, M.D., Hodges, G., and Clawson, R.L. In press. Microarthropods in decomposing woody debris in the Atchafalaya River Basin of Louisiana. American Midland Naturalist.

SUNG, SHI-JEAN SUSANA
Tree physiology and biochemistry
Research scientist

Administratively attached to SRS-4154
(home page www.rtp.srs.fs.fed.us/soils/soilhome.htm)

Southern Research Station
Tree Root Biology Team
320 Green Street
Athens, GA 30602-2044

Phone: 706-559-4289
Fax: 706-559-4291
e-mail: ssung@fs.fed.us

Selected Studies:

Overall goal are to assess physiological and morphological attributes of forest tree species: belowground and aboveground characteristics that affect regeneration success. Start Date: 1987. Objectives: To qualitatively and qunatitatively characterize the biological traits of individual hardwood and pine species in the nursery and in fields to meet their growth requirements for successful regeneration. This broad research includes several independent, yet interrelated, studies during the last decade, below are current long-term field evaluation studies.

Enrichment planting for the artificial regeneration of oak forests in the eastern United States. Seasonal and spatial **root** and **stem sucrose metabolism** as well as **biomass allocation** patterns in nursery-grown seedlings of more than ten oak species are being determined. On a percent dry wieght basis, northern red and white oak plants decrease carbon allocation to lateral roots more than to the rest of plants when grown under shaded conditions (re: **light quality and quantity**) such as under hardwood or pine stands. Responses of individual species to low light or **flooding** are being assessed in the areas of **photosynthesis, photoinhibition**, xanthophyl cycle-mediated **photoprotection**, periodical sucrose metabolism between roots and stems, root biomass allocation.

Long-term effects of cultural practices and seedling first-order **lateral root** number on growth of sweetgum plantations and **soil fertility**. Effects of subsoiling, **endomycorrhizal** inoculation and **fertilization** with fertilizer or sludge, and seedling root grade at outplanting are being evaluated in the areas of seasonal lateral **root and stem sucrose metabolism, photosyonthetic rate** and duration, and soil fertility.

Long-term effects of **loblolly pine** seedling quality on tree growth. The periodicity of growth between the belowground and aboveground parts of loblolly pine seedlings and trees is illustrated with **sucrose metabolism**, biomass allocation, and **ectomycorrhizal** fungal biomass. Results are been used to develop a biologically sound and economically feasible **nursery protbocol** for loblolly pine and for slash pine. Use of first-order **lateral root** number is an intergral part of nusery seedling grading system and proves to be successful for ensuring great field performance. Trees have similar **seasonal and spatial patterns** of sucrose metabolism and **biomass allocation** to those of **seedlings**. Moreover, during active belowground growth seasons, individual lateral roots may not be active. This trait of root growth needs to be emphsized when conducting root research using random root sampling procedures.

Effects of **fire** on **longleaf pine** stands. Effects of various degrees of winter prescribed burning on seasonal development of **ectomycorrhizal** and **saprophytic fungal biomass** in the **organic** layer and the first 10 cm of **soil profile** are being determined. Ergosterol,

and fungal membrane sterol, is used as the surrogate for live fungal hyphal biomass. The physiological status of longleaf pine trees will be determined using **sucrose** synthase activity as an indicator.

Relevant Publications:

Sung, SS, PP Kormanik, CC Black. 1993. Vascular cambial sucrose metabolism and growth in loblolly pine (Pinus taeda L.) in relation to transplanting stress. Tree Physiology 12:243-258.

Sung, SS, MN Angelov, RR Doong, WH Harms, PP Kormanik, CC Black. 1994. The physiological diversity and similarity of ten Quercus species. In: Proceedings Eighth Biennial Southern Silvicultural Research Conference, Auburn, AL. p.324-331.

Sung, SS, LM White, DH Marx, WJ Otrosina. 1995. Seasonal ectomycorrhizal fungal biomass development on loblolly pine (Pinus taeda L.) seedlings. Mycorrhiza 5:439-447.

Angelov, MN, SS Sung, RL Doong, WR Harms, PP Kormanik, CC Black. 1995. Long- and short-term flooding effects on survival and sink-source relationships of swamp-adapted tree species. Tree Physiology 16:447-484.

Sung, SS, PP KOrmanik, CC Black. 1996. Temporal and spatial aspects of root and stem surcrose metabolism in loblolly pine trees. Tree Physiology 16:1003-1008.

MARY A. SWORD
Forest Ecophysiology
Research Plant Physiologist

SRS-4111

USDA Forest Service
Alexandria Forestry Center
2500 Shreveport Highway
Pineville, LA 71360

Phone: 318-473-7275
Fax: 318-473-7117
e-mail: msword@fs.fed.us

Selected Studies:

Root system development (**radicle and primary lateral root** development, **root primordia** formation and elongation, **carbon partitioning** between tap and lateral roots) of **longleaf pine** seedlings in response to temperature, light, moisture and genotype. The objective of this work is to understand how environmental variables in the early seedling

cultural environment can be manipulated to improve longleaf pine seedling root system quality at planting.

Ecophysiology of even-aged southern pine forests to better understand and define the physiological mechanisms that control stand growth. Different stand environments, created by operational **silvicultural treatment**, are being evaluated as to how silvicultural manipulation of key physiological mechanisms can be used to ensure sustained forest productivity in a changing environment. Research on young **loblolly pine** stands at a N- and P-defficient site are receiving two levels of fertilization (none, and N+P+K). Relationships among seasonal **root system growth and development, climate** and its effect on soil and canopy enironment, branch **phenology** and seasonal physiology, and seasonal fine root and foliage **carbohydrate** relations are being evaluated. Some of the methods used for these observations are: Plexiglas **rhizotrons**, **image analysis** softeware, **time domain reflectometry** (multiplexed and scanned at 6-hour intervals), crown access **towers**, software for upper and lower canopy environmental data collection at 15-minute intervals, bulk density sampler for rapid **soil core, extraction, root elutriator**, enzymatic assay of non-structural carbohydrates (**starch, sucrose, glucose** equivelents). Other studies include:

Soil property effects on pathogenic and beneficial fungi in southern pine plantations.

Influence of climate on loblolly pine litter **decomposition** and quality.

Relevant Publications:

Sword M.A. 1995. Root-zone temperature and water availability affect early root growth of planted longleaf pine. In: Edwards, M.B., ed., Gen. Tech. Rep. SRS-1. Proc. of the Eighth Biennial Southern Silvicultural Research Conference, Nov. 1-3, 1994, Auburn, AL. Ashville, NC: USDA Forest Service, p 343-353.

Sword M.A., D. Gravatt, P. Faulkner, J. Chambers J. 1996. Seasonal root and branch growth of 13-year-old loblolly pine five years after fertilization. Tree Physiol. 16: 899-904.

Sword M.A., J.L. Chambers, D.A. Gravatt, J.D. Haywood. 1997. Ecophysiological responses of managed loblolly pine to changes in stand environment. In: R.A. Mickler, ed. The Productivity and Sustainability of Southern Forest Ecosystems in a Changing Environment. NY. Springer Verlag, Inc. (in press)

Sword M.A. J.D. Haywood, C.D. Andries. 1997. Root system and above-ground growth of juvenile loblolly pine after thinning and fertilization on an upper Gulf Coastal Plain site. In: T. Waldrop, ed. Proc. of the Ninth Biennial Southern Silvicultural Research Conference, Feb. 25-27, 1997, Clemson, SC. Ashville, NC: USDA Forest Service (in press)

Lockaby B.G. A.H. Chappelka, M.A. Sword, and A.E. Tiarks. 1997. Influence of microclimate on short-term litter decomposition in loblolly pine ecosystems. In: R.A. Mickler, ed., The Productivity and Sustainabiltiy of Southern Forest Ecosystems in a Changing Environment. NY. Springer Verlag, Inc. (in press).

James M. Vose
Research Ecologist

SRS-4351 Evaluation of Watershed Ecosystem Response to Natural, Management, and Other Human Disturbances of Southern Forests (home page: Spark.ecology.uga.edu)

Coweeta Hydrologic Laboratory
3160 Coweeta Lab Road
(10 miles south of Franklin and west 3 miles from US 441)
Otto, NC 28763

Ph: 828-524-2128 ext.114
Fax: 828-369-6768
e-mail: jvose@fs.fed.us
jvose@sparc.ecology.uga.edu

Selected Studies:

Phytoremediation of **ground water pollutants, riparian zone restoration, forest carbon, nutrient, and water cycling**, modeling of biological systems, **fire ecology** and restoration of fire dependent ecosystems, **old-growth** structure and function.

DALE WADE
Research Forester
Research Scientist, Team Leader, Fire

SRS-4104

USDA, Forest Service
320 Green St.,
Athens, GA 30602-2044

Phone: 706-559-4307
Fax: 706-559-4317
e-mail: dwade@fs.fed.us

Selected Studies:

No current research on belowground problems, but strong interest in southern pine **root mortality** caused by prescribed **fire**.

Relevent publications

Wade, D. & R. Johansen. 1986. Effects of fire on souithern pine:observations and recommendations. GTR SE-41.