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Research Interests

Carbon sequestration in soils. Methods for integrating ecological and economic models within GIS for resource assessment. Biomass energy and its environmental implications.

Education/Employment

Education:

- Ph.D., 1982, Forest Ecology, Oregon State University, Corvallis, OR
- A.B., 1976, Biology, Dartmouth College, Hanover, NH *Summa Cum Laude*

Employment:

Adjunct Faculty member of Department of Ecology and Evolutionary Biology at the University of Tennessee. (1992 to present).

Employment at Oak Ridge National Laboratory (6/86 to present):

Group Leader - Environmental Data Science and Analysis, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN. - (10/98 to present)

Research Staff - Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN. - (6/86 to present)

Employment prior to Oak Ridge National Laboratory:

Project Leader - Vegetation Management - Western Forest Research Department, Weyerhaeuser Research and Development, Weyerhaeuser Company, Centralia, WA. (10/81 to 3/86)

Forest Ecologist - Integrative Technology Department, Weyerhaeuser Research and Development, Weyerhaeuser Company, Tacoma, WA. - (1/83 to 9/84)

National Science Foundation Fellow - Oregon State University, Corvallis, OR. (9/77 to 10/81)

Current ORNL Research Activities

Environmental Data Management

Serve as project manager of the NASA-funded **ORNL Distributed Active Archive Center for biogeochemical data**. The Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) is a **NASA**-sponsored source for biogeochemical and ecological data and models useful in environmental research. Data have been collected on the ground, by aircraft, by satellite, and from

computer models. The extent of data and model products ranges from site specific to global, and durations range from days to years.

Carbon Sequestration in Terrestrial Ecosystems

Serve as PI of the ORNL component of the DOE Carbon Sequestration in Terrestrial Ecosystems Project (CSiTE). This project which involves Argonne and Pacific Northwest National Laboratories and several Universities undertakes basic research to understand the processes that control soil carbon sequestration and greenhouse gas implications of management practices to enhance carbon sequestration. The research is focused on using switchgrass production as a model system for exploring the fundamental chemistry of humification processes, elucidating microbial community changes associated with carbon sequestration, understanding soil aggregation processes, quantifying the capacity for subsoils to sequester carbon, developing approaches for scaling research findings to regional assessments, and quantifying the net greenhouse gas emissions associated with agricultural practices to enhance soil carbon content.

Past ORNL Research Activities

Served as Systems Integration and Analysis Taskleader of the DOE Biofuels Feedstock Development Program. Program responsibilities included both Task management and research. Task management activities included extensive DOE sponsor and National Renewable Energy Laboratory interactions, budget development, subcontract placement and oversight, strategic planning for both the Task and the Program, representation on International Bioenergy committees and numerous presentations on various aspects of bioenergy to a wide range of audiences (government officials, researchers, industry, the public). Research was focused on developing and applying innovative analytical tools for assessing the economic potential for biomass crops in the United States, the environmental consequences of large-scale biomass crop production, and the carbon emission benefits of substituting biomass fuels for fossil fuels. Research was highly interdisciplinary involving collaboration with economists, engineers and environmental scientists. Developed a regional-scale, spatially explicit model of energy crop production within a GIS framework. The framework interfaced economic and environmental models of crop production with a transportation model to predict both where energy crops have the greatest economic potential and the environmental implications of their deployment in those areas. Lead project to evaluate the use of forest thinnings for fuel reduction purposes in the Sierra Nevada. Evaluated long term flow of wood from thinning and the hydrologic impact of forest thinning.

Assessed carbon emissions and inventory of Sub-Saharan Africa for AID. Assessment involved integrating continental information on soil, climate, vegetation, and deforestation rates using GIS and developing models to project future carbon emissions under alternative land use management strategies. Used satellite imagery to better determine forest boundaries on the continent and to improve estimates of deforestation and forest degradation.

With scientists at Illinois Natural History Survey on a grant from NASA, developed a methodology for evaluating regional forest cover and productivity by using GIS and scaling coarse resolution AVHRR data with fine resolution LANDSAT data. Later applied methodology to analyze forest cover in Ghana as part of FAO/UNEP ad-hoc Expert Group on Tropical Forest Cover Monitoring.

Aided EPA in development of methodology for assessing the critical load of nitrogen and sulfur to regional ecosystems. Responsible for mapping portion of methodology. Prepared document for international conference on mapping critical loads.

Developed regional risk assessment methodologies for the EPA. Developed probabilistic, spatial model of land cover change to illustrate the unique regional-scale risks posed by ozone to both terrestrial and aquatic endpoints.

Evaluated effect of climate change and elevated CO₂ on forest resources and unmanaged ecosystems as part of the Resource Analysis Research Plan for the Carbon Dioxide Research Program, U.S. Department of Energy.

Working with scientists at Illinois Natural History Survey, analyzed feasibility of using Thematic Mapper satellite imagery in conjunction with a GIS to evaluate forest productivity at a landscape scale.

Management Experience at Oak Ridge National Laboratory

Currently serve as groupleader for the three environmental data teams within ESD with an annual research budget of \$9M engaging 20+ staff, contractors and students in addition to my research activities. For the past 15 years have served in a variety of line management roles with a staff load of anywhere from 12 to 50 scientists and their associated postdoctoral students and guests. Between 1998 and 2001 I was a full time manager. The collective value of the research has been up to \$25M and varied with the group. The research of the technical staff in my groups has been quite diverse but could be broadly grouped into the four topics – Ecosystem and plant response to environmental factors such as elevated CO₂, altered precipitation, ozone; Remediation of rad and/or organic contamination of soils; Ecosystem and regional response to disturbance; and Ecosystem to global scale modeling of terrestrial ecosystems and their response to climate change. As line manager I am responsible for strategic planning, performance planning and reviews, staff coverage and laboratory safety. I have also served on numerous ORNL review committees including the Invention Disclosure committee which oversees patenting.

Bioenergy Publications

Graham, R.L., R. Nelson, J. Sheehan, R.D. Perlack, and L.L. Wright. 2007. Current and potential U.S. corn stover supplies. **Agronomy Journal**. 99:1-11.

Graham, R.L., R. Nelson, J. Sheehan, R.D. Perlack, and L.L. Wright. 2007. Will corn stover become a significant bioenergy feedstock? **CSA News**. 52(2):2..

Perlack, R.D., L.L. Wright, A.F. Turhollow, R.L. Graham, B. J. Stokes, and D.C. Erbach. 2005. "Biomass as feedstock for a bioenergy and bioproducts industry: The technical feasibility of a billion-ton supply". DOE/GO-102005-2135; ORNL/TM-2005/66, Oak Ridge National laboratory, Oak Ridge , TN 37831. 59 pgs.

Nelson, R.G., M. Walsh, J.J. Sheehan and R. Graham. 2004. Methodology for estimating removable quantities of agricultural residues for bioenergy and bioproduct use. **Applied Biochemistry and Biotechnology**. 113:13-26.

Noon, C.E., F.B. Zhan, and R.L. Graham. 2002. "GIS-based analysis of marginal price variation with an application in the identification of candidate ethanol conversion plant locations". **Networks and Spatial Economics**. 2:79-93.

Huff, D.D., W.H. Hargrove, R.L. Graham, N. Nikolov, and M.L. Tharp. 2002. "A GIS/simulation framework for assessing change in water yield over large spatial scales". **Environmental Management**. 29 (1):164-181.

Hollenstein, K., R.L. Graham, and W. D. Shepperd. 2001. "Biomass flow in western forests: Simulating the effects of fuel reduction and presettlement restoration treatments". **J. of Forestry** 99 (10): 12-19.

- Huff, D.D, W. Hargrove., M.L. Tharp, and R. Graham. 2000. "Managing forest for water yield: The importance of scale". **J. of Forestry**. 98(12): 15-19.
- Graham, R. L., B. C. English and C. E. Noon. 2000. A GIS-based modeling system for evaluating the cost of delivered energy crop feedstock. **Biomass and Bioenergy** 18:309-332.
- Anders, R., B. Hektor, R. L. Graham and C. Rakos. 1999. Critical factors to bioenergy implementation. **Biomass and Bioenergy** 17:113-126.
- Graham, R. L. and M. E. Walsh. 1999. A national assessment of promising areas for switchgrass, hybrid poplar, or willow energy crop production. **ORNL-6944**. Oak Ridge National Laboratory, Oak Ridge, TN 37831. 49 pgs.
- Graham, R. L., D. D. Huff, M. R. Kaufmann, W. D. Shepperd and J. Sheehan. 1998. Bioenergy and watershed restoration in regions of the west: What are the environmental/community issues? Pgs. 1262-1271. In **Proceedings of Bioenergy '98--Expanding Bioenergy Partnerships, October 4-8, Madison, Wisconsin**. Great Lakes Regional Biomass Energy Program, Chicago, Illinois.
- Graham, R. L. 1998. Systems Studies. Pgs. 199-214. In **Accomplishments in Bioenergy Production Research 1995-1997, Proceedings of the IEA Bioenergy Task XII End-Of -Task Workshop, March 17-20, Canberra, Australia** (R. Gamble and G. Page, eds). University of Toronto Press, Toronto, Canada.
- Anders, A..B. Hektor, R. L. Graham and C. Rakos. 1998. Factors for bioenergy market development. Pgs. 45-54. In **Proceedings of Bioenergy '98--Expanding Bioenergy Partnerships, October 4-8, Madison, Wisconsin**. Great Lakes Regional Biomass Energy Program, Chicago, Illinois.
- Walsh, M. E., D. de La Torre Ugarte, S. Slinsky, R. L. Graham, H. Shapouri and D. Ray. 1998. Economic analysis of energy crop production in the U.S. – Location, quantities, price and impacts on traditional crops. Pgs. 1302-1310. In **Proceedings of Bioenergy '98--Expanding Bioenergy Partnerships, October 4-8, Madison, Wisconsin**. Great Lakes Regional Biomass Energy Program, Chicago, Illinois.
- Graham, R. L., B. C. English, C. E. Noon, H. I. Jager and M. J. Daly. 1997. Predicting Switchgrass farmgate and delivered costs: An 11-state analysis. Pgs. 121-129. In **Making a business from biomass in energy, environment, chemical, fibers and materials. Proceedings of the 3rd Biomass Conference of the Americas, August 24-28, Montreal, Quebec** (R. P. Overend and E. Chornet, eds). Elsevier Science, Inc., New York, New York.
- Graham, R. L., W. Liu, M. Downing, C. E. Noon, M. Daly and A. Moore. 1997. The effect of location and facility demand on the marginal cost of delivered wood chips from energy crops: A case study of the State of Tennessee. **Biomass and Bioenergy** 13:117-123.
- Graham, R. L., L. J. Allison and D. A. Becker. 1997. ORECCL - Oak Ridge Energy Crop County Level Database. Pgs. 205-213. In **Making a business from biomass in energy, environment, chemical, fibers and materials. Proceedings of the 3rd Biomass Conference of the Americas, August 24-28, Montreal, Quebec** (R. P. Overend and E. Chornet, eds). Elsevier Science, Inc., New York, New York.
- Graham, R. L., L. J. Allison and D. A. Becker. 1996. ORRECL - Oak Ridge Energy Crop County Level Database. Pgs. 522-529. In **Proceedings of Bioenergy '96--The Seventh National Bioenergy Conference, Sept. 15-19, Nashville, Tennessee**. Southeastern Regional Biomass Energy Program, Muscle Shoals, Alabama.
- Downing, M. and R. L. Graham. 1996. The potential supply and cost of biomass energy crops in the Tennessee Valley Authority Region. **Biomass and Bioenergy** 11:283-303.
- Host, G. E., J. G. Isebrands, G. W. Theseira, J. R. Kinery and R. L. Graham. 1996. Temporal and spatial scaling from individual trees to plantations: A modeling strategy. **Biomass and Bioenergy** 11:233-243.

Graham, R. L., M. Downing and M. E. Walsh. 1996. A framework to assess the regional environmental impacts of dedicated energy crop production. **Environmental Management** 20:475-485.

Graham, R. L. 1994. An analysis of the potential landbase for energy crops in the conterminous United States. **Biomass and Bioenergy** 6:175-190.

Graham, R. L. 1992. Biomass Fuel Costs Predicted for East Tennessee Power Plant. **Biologue** 10:23-26.

Graham, R. L., L. L. Wright and A. F. Turhollow. 1992. The potential for short-rotation woody crops to reduce U.S. CO₂ emissions. **Climatic Change** 22:223-238.

Wright, L. L., R. L. Graham, A. F. Turhollow and B. C. English. 1992. Growing Short-Rotation Woody Crops for Energy production. Chapter 8, pgs. 123-156. In **Forests and Global Change: Vol 1: Opportunities for Increasing Forest Cover** (R. N. Neil and D. Hair, eds). American Forests, Washington, D.C.

Other Publications [\[Top \]](#)

Mann, L. K., P. D. Parr, L. R. Pounds and R. L. Graham. 1996. Protection of biota on nonpark lands: Examples from the U.S. Department of Energy Oak Ridge Reservation. **Environmental Management** 20:207-218.

Iverson, L. R., E. A. Cook and R. L. Graham. 1994. Regional forest cover estimation via remote-sensing - The calibration center concept. **Landscape Ecology** 9:159-174.

Perlack, R. D., R. L. Graham and A. M. G. Prasad. 1994. Land-use management and carbon sequestering in Sub-Saharan Africa. **J. of Environmental Systems** 22:199-210.

Hunsaker, C. T., R. L. Graham, P. L. Ringold, G. R. Holdren, Jr. and T. S. Strickland. 1993. A national critical loads framework for establishing pollutant loading standards: II. Defining regulatory endpoints, indicators, and functional subregions. **Environmental Management** 17:335-341.

Hunsaker, C. T. and R. L. Graham. 1991. Regional ecological assessment for air pollution. Chapter 21, pgs. 312-334. In **Air Pollution: Environmental Issues and Health Effects** (S. K. Majumdar, E. W. Miller, and J. Cahir, eds). Pennsylvania Academy of Science Publication, Easton, Pennsylvania.

Graham, R. L., C. T. Hunsaker, R. V. O'Neill and B. L. Jackson. 1991. Ecological risk assessment at the regional scale. **Ecological Applications** 1:196-206.

Graham, R. L., M. G. Turner and V. D. Dale. 1990. How climate change and increasing CO₂ affect forests. **Bioscience** 40:575-587.

Berta, S. M., P. W. Mausel, J. A. Harrington, Jr. and R. L. Graham. 1990. Multidate image analysis of forest degradation in equatorial Africa. **Geocarta International** 5:57-61.

Hunsaker, C. T., R. L. Graham, L. W. Barnthouse, S. M. Bartell, R. H. Gardner, R. B. O'Neill and G. W. Suter II. 1990. Assessing ecological risk at a regional scale. **Environmental Management** 14:325-332.

Iverson, L. R., R. L. Graham and E. A. Cook. 1990. Applications of remote sensing to forested ecosystems. **Landscape Ecology** 3:131-143.

Iverson, L. R., E. A. Cook and R. L. Graham. 1989. A technique for extrapolating and validating forest cover across large regions: calibrating AVHRR data with TM. **International Journal for Remote Sensing** 10:1805-1812.

Webb, W. and R. L. Graham. 1989. The Greenhouse Effect, Climate Change, and U.S. Forests (book review). **Environmental Professional** 11:178-179.

Cook, E. A., L. R. Iverson and R. L. Graham. 1989. Estimating forest productivity with thematic mapper and biogeographical data. **Remote Sensing of the Environment** 28:131-141.

O'Neill, R. V., J. R. Krummel, R. H. Gardner, G. Sugihara, B. Jackson, D. L. DeAngelis, B. T. Milne, M. G. Turner, B. Zygmunt, S. Christensen, V. H. Dale and R. L. Graham. 1988. Indices of landscape pattern. **Landscape Ecology** 1:153-162.

Graham, R. L. and K. Cromack, Jr. 1982. Mass, nutrient content, and decay rate of dead boles in rain forests of Olympic National Park. **Canadian Journal of Forest Research** 12:511-521.

Binkley, D. and R. L. Graham. 1981. Biomass, production and nutrient cycling of mosses in an old-growth Douglas-fir forest. **Ecology** 62:1387-1389.

Lambert, R. L., G. R. Lang and W. A. Reiners. 1980. Loss of mass and chemical change in decaying boles of a subalpine balsam fir forest. **Ecology** 61:1460-1473.

Lambert, R. L. and W. A. Reiners. 1979. Nitrogen-fixing moss associations in the subalpine zone of the White Mountains, New Hampshire. **Arctic and Alpine Research** 11:325-333.

Professional Activities

Secretary of the [Association of Ecosystem Research Centers](#) – 2001 to present.

Participant in U.S. Climate Change Technology Program ([CCTP](#)) workshops during 2006.

Member of the California Spotted Owl Federal Advisory Committee - 1997; A committee to provide the Sec. of Agriculture advice on the USFS draft EIS "Managing California Spotted Owl Habitat in the Sierra Nevada National Forests of California An Ecosystem Approach."

Activity Leader for Systems Integration Activity of Task XII under the Bioenergy Agreement of the International Energy Agreement. Activity duration - 1995-1997; Austria and Sweden were co-members.

Organized and chaired session on Integrated Assessment at the International MODSS Conference. Honolulu, Hawaii, Aug. 22-26, 1995.

Chairperson of Technical Steering Committee for the Center for Forest Environmental Studies of the U.S. Forest Service. Aug. 1992 - Aug. 1994.

Invited participant on EPRI Workshop on Assessing the Potential for Biomass Energy in the United States. Palo Alto, California, Aug. 6-7, 1992.

Invited participant on Office of Technology Assessment Workshop on Mitigating Climate Change Impacts on Forests and Forestry. Washington, D.C., June 18-19, 1992.

Invited participant on Interagency Workshop on Global Deforestation. Arlington, Virginia, Apr. 2-3, 1990.

Organized and chaired symposium on ecological risk assessment at the summer meeting of the American Institute for Chemical Engineers. Philadelphia, Pennsylvania, August 1989.

Chairperson of NAPAP Review Committee on Site Characterization and Dendrochronological Studies. Atlanta, Georgia, Mar. 9-13, 1987.

Served on review panels for DOE, NASA, NSF, EPA, USDA, and NPS.

Advisor to post-graduate, graduate and undergraduate students on research internships in the Environmental Sciences Division (Dr. Kurt Hollenstein; Dr. Mark Downing; Ms Wei Liu; Mr. Thomas Chatfield, Mr. Evan Kaiser, Mr. Nathan Moyer).

