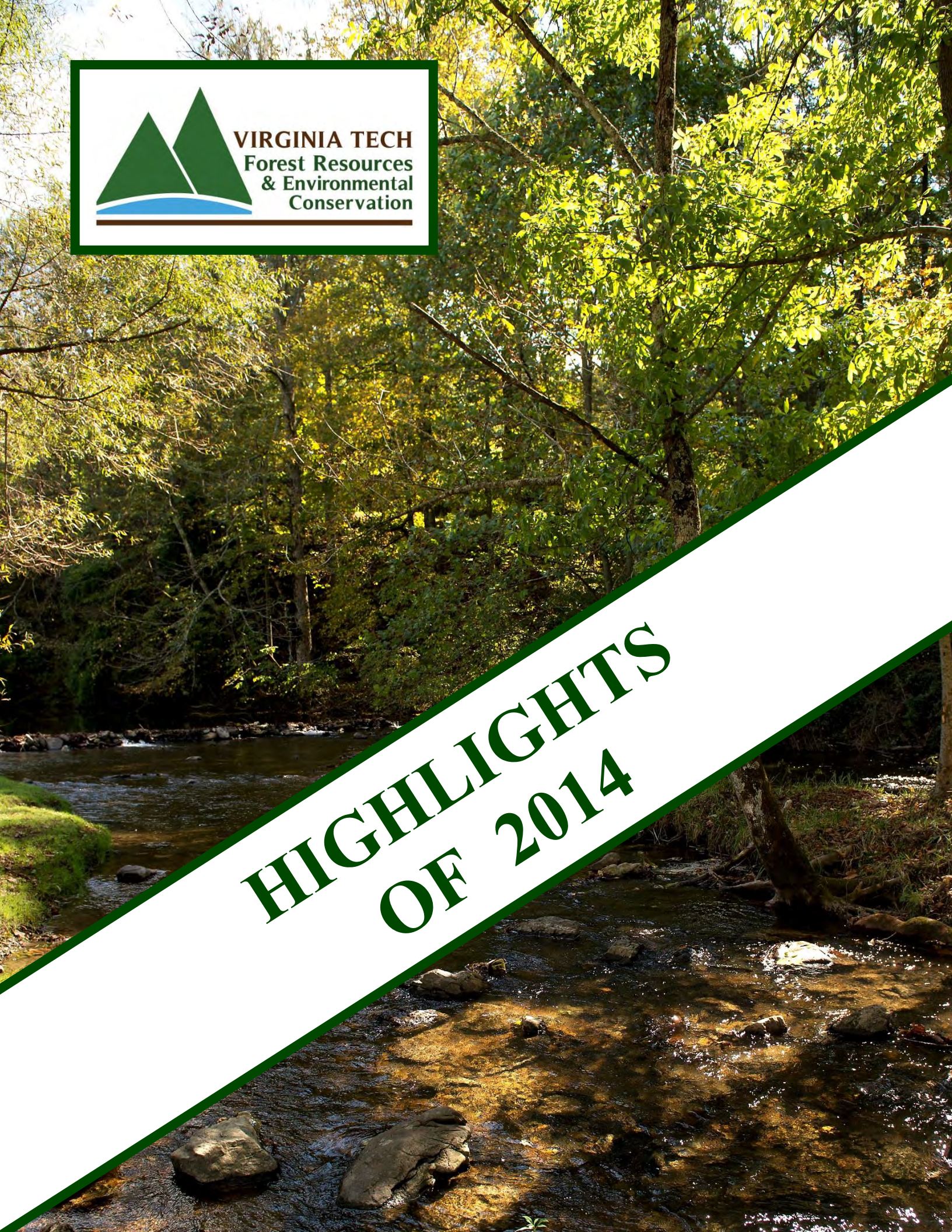


HIGHLIGHTS OF 2014

Highlights of 2014

Department of Forest Resources and Environmental Conservation
College of Natural Resources and Environment
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061 U.S.A.
(540) 231-5483 Fax (540) 231-3698
www.frec.vt.edu
frec@vt.edu

OVERVIEW OF THE DEPARTMENT

This report highlights accomplishments in learning, discovery, and engagement in the Department of Forest Resources and Environmental Conservation (FREC) during 2014. The department continues to be one of the leading programs of its type and is poised to achieve even higher levels of excellence in the future. Following are a few key accomplishments and challenges of 2014.

Learning: Undergraduate enrollment remained steady at 191 in Fall Semester 2014. Virginia Tech's decision to move away from the Academic Common Market was detrimental to FREC's undergraduate enrollment, with more than 20 students lost from Maryland and other areas. Our newly launched Environmental Informatics undergraduate major is receiving significant attention, and we hope that it will attract students soon. The new undergraduate degree, *Water: Resources, Policy, and Management*, has been approved and officially will be offered beginning Fall Semester 2015.

Discovery: You will note from the graph on page 22 that our research expenditures went up in 2014. You will also note from the list of refereed publications that our faculty members are actively engaged in advancing the boundaries of science. Our graduate enrollment is 85, and we expect that the number will increase further as our junior faculty members establish their research programs. We are very proud of our graduate students who organized the Sixth FREC Graduate Research Symposium so successfully! It attracted participants from various departments across campus and from several other universities.

Engagement: Our extension programs are more vibrant than ever. We are proud of the accomplishments and awards that our extension faculty and specialists won during 2014.

New Horizons: FREC is blessed with several new opportunities:

- Dr. Daniel McLaughlin has joined as a tenure-track Assistant Professor in Ecohydrological Modeling and Informatics. This is one of the seven cluster hires that the university made to support the water initiative.

- Dr. Morgan Varner has joined as a tenure-track Assistant Professor in Applied Forest Ecology. The department hired him in the vacancy left by the retirement of Dr. Shep Zedaker.

I cannot list all the awards and accomplishments of our faculty and students here, but let me say that they always make the department proud. We deeply appreciate the solid support from our alumni, friends, and clientele groups throughout the forestry community, and we look forward to the challenges and opportunities ahead.

Janaki Alavalapati
Department Head

NEW FACES IN FREC

Dr. Morgan Varner, Assistant Professor, is a forest fire ecologist with research interests in plant flammability, post-fire tree mortality, ecological consequences of fuels treatments, fire behavior, disease-insect-fire interactions, and impediments to prescribed fire. He serves as the Chair of the Coalition of Prescribed Fire Councils and on the editorial boards of *Forest Science* and *Forest Ecology*. Before joining Virginia Tech in August, 2014, Morgan was on the faculty at Mississippi State University and Humboldt State University. He received his Ph.D. from University of Florida, M.S. from Auburn University, and B.S. from University of Idaho. His work at Virginia Tech will be based in fire-prone woodlands and forests of the Appalachians, continued work in longleaf pine communities in the Coastal Plain and oak-conifer woodlands of California, and ongoing research in fuels treatments in the western U.S. Morgan's teaching responsibilities include undergraduate courses in forest ecology and silvics and fire ecology and management, as well as a graduate course in fire ecology.

Dr. Daniel McLaughlin, Assistant Professor, joined FREC in October, 2014. He is an ecohydrologist with research interests in forested watersheds, wetland and stream processes, emerging environmental sensors, watershed and landscape hydrology, and biogeomorphology. His research spans systems and scales to better understand abiotic and biotic drivers of ecosystem function and is broadly focused on informing water resource management. Daniel's current teaching responsibilities include undergraduate and graduate courses in wetland hydrology and biogeochemistry. He received his Ph.D. from University of Florida and M.S. and B.S. from Clemson University.

Dr. Mihir Mandal, Postdoctoral Associate, came to FREC in March, 2014, after two years as a post-doc in the Virginia Tech Department of Biochemistry. He works with Jason Holliday, and his current project involves applying Next-Generation Sequencing (NGS) to identify genetic variation relevant to local adaptation in trees and to use this information to predict performance in a changing climate. Mihir is from India and earned his Ph.D. at University of Kentucky in 2012.

NEW FACES IN FREC

Dr. Kevin Horn is a Postdoctoral Associate working with Quinn Thomas. Kevin is interested in scaling ecological phenomena from biogeochemical processes to continental scales through collaborations in macrosystems ecological studies. Kevin returned to Blacksburg and joined FREC in April, 2014, after earning a Ph.D. in Wildlife and Wildlands Conservation from Brigham Young University.

Dr. Carol Franco joined the department in August, 2014, as a Senior Research Associate. She is involved in research and policy projects related to global climate change negotiations; REDD+ in Mexico, Peru, and Colombia; and impacts of climate change on human health in the Dominican Republic. Carol received a B.S. from the Universidad Autónoma de Santo Domingo in the Dominican Republic and an M.S. and Ph.D. from SUNY-College of Environmental Science and Forestry. She also held a postdoctoral position at University of Vermont.

Michelle Prysby re-joined the department in September, 2014, as the Virginia Master Naturalist (VMN) Special Projects Coordinator. She works out of the VMN's Charlottesville office on projects to enhance the statewide volunteer program, such as developing training curriculum resources and creating new communication tools. Michelle earned her M.S. from University of Minnesota in 2001, and her research and programming backgrounds include monarch butterfly ecology, citizen science, and volunteer management.

PROMOTIONS

Dr. Susan Day was promoted to Associate Professor and granted tenure on July 1, 2014. Her research interests include urban forestry, urban soil management and soil carbon, stormwater management, root/soil interactions, and interactions of trees with the built environment.

Dr. Kevin McGuire was promoted to Associate Professor and granted tenure on July 1, 2014. His research interests include watershed, hillslope, and forest hydrology; runoff generation processes; tracer and isotope applications in hydrology; land use and climate change effects on watershed processes and water quality; forest watershed management; and interactions between hydrology and biogeochemistry.

Dr. Valerie Thomas was promoted to Associate Professor and granted tenure on July 1, 2014. Her research interests include remote sensing of forest canopy structure and function using lidar and hyperspectral technology, integration of these data with micrometeorological measurements to model canopy-scale photosynthesis, and evaluation of the impact of local heterogeneity on estimates of carbon exchange.

Dr. Stephen Prisley was promoted to Professor on July 1, 2014. His research interests include quantitative and spatial analyses of natural resources for management planning, including modeling of forest carbon inventories, inventory projection for wood supply planning, and evaluation of uncertainty in spatial decision-support systems.

PROMOTIONS

Dr. Thomas Fox was appointed the Garland Gray Professor of Forestry in 2014 in recognition of his contributions to the teaching, research, and outreach missions of Virginia Tech. Tom works in forest soils and silviculture in natural and plantation forests in the U.S. and Latin America. The goal of his program is to improve the productivity and sustainability of forest ecosystems.

The professorship was established in 1985 by the late Virginia Senator Elmon Gray. It was named in memory of his father, Garland Gray, who also served in the Senate of Virginia.

PERSONNEL

TENURE-TRACK FACULTY	POSITION	TERMINAL DEGREE	SPECIAL INTERESTS
Alavalapati, Janaki R. R.	Professor and Department Head	Ph.D., University of Alberta	Exploring market solutions for natural resources, energy, and environmental problems and issues at local, regional, and international levels
Amacher, Gregory S.	Julian N. Cheatham Professor of Forestry	Ph.D., University of Michigan	Natural resource and environmental economics; public economics and policy design; econometrics; international forest development
Aust, W. Michael	Professor	Ph.D., North Carolina State University	Impacts of forestry operations on soil and hydrology; ecology and management of forested wetlands and riparian areas; development and implementation of forestry best management practices
Barrett, Scott M.	Assistant Professor and Extension Specialist	Ph.D., Virginia Tech	Forest operations and biomass utilization; logger education and the impacts of education on logging safety, productivity, and the implementation of sustainable forestry practices
Bolding, M. Chad	Associate Professor	Ph.D., Oregon State University	Forest operations; harvesting; wood supply chain efficiency; biomass utilization
Brunner, Amy M.	Associate Professor	Ph.D., Oregon State University	Genomics of tree development, ecophysiology, and adaptation; molecular genetics of tree maturation, flowering, and crown architecture; epigenetic mechanisms and small RNAs in trees; long-distance signaling in trees; tree biotechnology
Burkhart, Harold E.	University Distinguished Professor	Ph.D., University of Georgia	Development of growth and yield prediction techniques; application of statistical methods to forest measurement problems
Cobourn, Kelly M.	Assistant Professor	Ph.D., University of California-Davis	Natural resource economics; applied econometrics; bio-economic modeling; water resource policy; invasive species management
Copenheaver, Carolyn A.	Associate Professor	Ph.D., Pennsylvania State University	Dendrochronology; land-use history; vegetation distribution; stand dynamics
Day, Susan D. (Joint appointment with Department of Horticulture)	Associate Professor	Ph.D., Virginia Tech	Urban forestry, including urban runoff mitigation; urban soils (rehabilitation and modeling effects on urban forest canopy); construction damage; buried root systems; urban rhizosphere
Fox, Thomas R.	Garland Gray Professor of Forestry	Ph.D., University of Florida	Forest fertilization and tree nutrition; forest soils; silviculture of southern pine plantations and Appalachian hardwoods; silvicultural practices to restore productivity and health of forest ecosystems; sustainability of managed forests
Holliday, Jason A.	Assistant Professor	Ph.D., University of British Columbia	Understanding the genetic basis for complex adaptive traits in widely distributed tree species, as well as molecular studies of abiotic stress and conservation genetics
Hull, R. Bruce	Professor	Ph.D., Virginia Tech	Public ecology and sustainability; human dimensions of natural resource management; negotiation of acceptable environmental quality; forest fragmentation and urbanization; recreation

McGee, John A.	Associate Professor and Geospatial Extension Specialist	Ph.D., University of Massachusetts -Amherst	Natural resource management; geospatial applications; technology transfer
McGuire, Kevin J.	Associate Professor	Ph.D., Oregon State University	Watershed, hillslope, and forest hydrology; runoff generation processes; tracer and isotope applications in hydrology; land use and climate change effects on watershed processes and water quality; forest watershed management; interactions between hydrology and biogeochemistry
McLaughlin, Daniel L.	Assistant Professor	Ph.D. University of Florida	Forest and wetland ecohydrology; biotic feedbacks to landform development; watershed and landscape hydrology; emerging environmental sensors; restoration and management of water resources
Munsell, John F.	Associate Professor and Extension Specialist	Ph.D., SUNY College of Environmental Science and Forestry	Forest management extension; private forest stewardship; collaborative conservation; integrated natural resources problem solving
Prisley, Stephen P.	Professor	Ph.D., Virginia Tech	Quantitative and spatial analysis of natural resources for management planning, including spatial harvest scheduling, inventory projection, and forest carbon modeling
Radtke, Philip J.	Associate Professor	Ph.D., University of Minnesota	Assessment and modeling of forest resources; evaluating models used in forestry and ecology; acquisition, management, and analysis of data
Schoenholtz, Stephen H.	Professor and Director of the Virginia Water Resources Research Center	Ph.D., Virginia Tech	Forest management impacts on water and soil quality; restoration of degraded ecosystems; ecology and management of forested wetlands and riparian zones; biogeochemistry; criteria and indicators of sustainable forest management
Seiler, John R.	Alumni Distinguished Professor	Ph.D., Virginia Tech	Forest tree physiology; physiological applications in silviculture; multimedia, computer innovations for teaching forestry
Sorice, Michael G.	Assistant Professor	Ph.D., Texas A&M University	Natural resource recreation; human dimensions of natural resource management; conservation on private lands; research methods
Stern, Marc J.	Associate Professor	Ph.D., Yale University	Human dimensions of natural resource policy and management; environmental communications; protected areas management; international conservation; natural resource management effectiveness; attitudes vs. actions; public responses to natural resource management; evaluation of environmental education and other outreach programs; research methods
Strahm, Brian D.	Assistant Professor	Ph.D., University of Washington	Understanding relationships between soil properties and processes in order to better predict how external forces (e.g., forest management, land use, or global change) affect soil/ecosystem function (e.g., carbon sequestration, forest productivity)
Sullivan, Jay	Professor	Ph.D., University of California, Berkeley	Forest resource economics and management; regional economics; forest landowner behavior and incentives
Thomas, R. Quinn	Assistant Professor	Ph.D., Cornell University	Understanding the interactions between forests and global environmental change working across a wide range of spatial scales using ecosystem and Earth system models, remote sensing, large dataset analysis, and whole-ecosystem experiments

Thomas, Valerie A.	Associate Professor	Ph.D., Queen's University	Remote sensing of forest canopy structure and function using lidar and hyperspectral technology; integration of these data with micrometeorological measurements to model canopy-scale photosynthesis; evaluation of the impact of local heterogeneity on estimates of carbon exchange
Varner, J. Morgan	Assistant Professor	Ph.D., University of Florida	Fire ecology; post-fire tree mortality; wildland fire behavior; operational impediments to prescribed fire; ecological consequences of fuels treatments; plant flammability; disturbance interactions; forest stand dynamics; applied forest ecology; ecological restoration; global change ecology
Wiseman, P. Eric	Associate Professor	Ph.D., Clemson University	Landscape tree establishment and maintenance; tree physiological responses to arboricultural treatments; urban soils; urban forest ecophysiology
Wynne, Randolph H.	Professor	Ph.D., University of Wisconsin-Madison	Application of remote sensing to forestry, natural resource management, environmental monitoring, carbon management, ecosystem services, and Earth systems modeling

RESEARCH PROFESSORS	POSITION	TERMINAL DEGREE	SPECIAL INTERESTS
Marion, Jeffrey L.	Adjunct Faculty*	Ph.D., University of Minnesota	Recreation resources management; recreation ecology; park and wilderness management; ecotourism management *Unit Leader/Scientist, Cooperative Park Studies Unit, USGS Patuxent Wildlife Research Center
Merry, Frank D.	Research Associate Professor	Ph.D., University of Florida	International forest policy and economics

RESEARCH FACULTY	POSITION	TERMINAL DEGREE	SPECIAL INTERESTS
Albaugh, Timothy J.	Research Associate	M.F., Duke University	Management of site resource availability; plantation productivity; loblolly pine ecophysiology
Amateis, Ralph L.	Senior Research Associate	M.S., University of Florida	Statistical techniques applied to forestry problems; growth and yield modeling
Blinn, Christine E.	Research Scientist	Ph.D., Virginia Tech	Remote sensing; geographic information systems; statistical applications for natural resource inventory and management
Brooks, Evan B.	Postdoctoral Associate	Ph.D., Virginia Tech	Expansion and application of Landsat-based models and inputs to the southeastern US
Franco, Carol	Senior Research Associate	Ph.D., SUNY-ESF	Global climate change negotiations; REDD+ in Mexico, Peru, and Colombia; impacts of climate change on human health in the Dominican Republic
Horn, Kevin J.	Postdoctoral Associate	Ph.D., Brigham Young University	Scaling biological and chemical processes across temporal and geospatial scales
Laviner, M. Andrew	Research Associate	M.S., North Carolina State University	Resource management in plantation forestry; silviculture, ecophysiology, and forest management
Mandal, Mihir K.	Postdoctoral Associate	Ph.D., University of Kentucky	Molecular genetics and genomics approach to identify loci involved in local adaptation of trees under variable climatic conditions

Ochuodho, Thomas O.	Postdoctoral Associate	Ph.D., University of New Brunswick	Natural resource economics and policy analysis; economic analysis of bioenergy development; application of computable general equilibrium modeling in assessing economy-wide impacts of forest policy, management, trade, and climate change; applied econometrics
Peer, Kyle R.	Research Associate and Superintendent, Reynolds Homestead Forest Resources Research Center	M.S., University of Maine, Orono	Vegetative propagation; clonal forestry; nursery and greenhouse production; tree breeding
Sheng, Xiaoyan	Research Associate	M.S., University of Saskatchewan	Functional genomics in forestry; biotechnology and molecular breeding of biomass forest trees
Sumnall, Matthew J.	Postdoctoral Associate	Ph.D., Bournemouth University	Use of lidar to separate overstory trees from understory vegetation in loblolly pine plantations
Teixeira, Rita T.	Research Scientist	Ph.D., Swedish University of Agricultural Sciences	Plant molecular biology and genetics
Walker, David M.	Research Associate	M.S., Virginia Tech	Woody biomass estimation and modeling; forest inventory methods; dendrochronology; forest entomology and pathology

EXTENSION FACULTY	POSITION	TERMINAL DEGREE	SPECIAL INTERESTS
Crall, Alycia W.	Coordinator, Virginia Master Naturalist Program	Ph.D., University of Wisconsin	Citizen science; informal science education; environmental education; invasive species; interdisciplinary approaches to conservation; program evaluation; biological data integration
Gagnon, Jennifer L.	Coordinator, Virginia Forest Landowner Education Program	M.S., University of Florida	Landowner education; shortleaf and longleaf pine silviculture; uneven-aged management
Kidd, John B.	Coordinator, PINEMAP Intern Program	M.S., University of Arkansas; M.Ed., Auburn University	Education and extension for secondary students and the general public
Prysby, Michelle D.	Virginia Master Naturalist Special Project Coordinator	M.S., University of Minnesota	Citizen science; long-term ecological monitoring; monarch butterfly ecology; science education

ADJUNCT FACULTY

Anderson, Christopher B.	2012-17	Professor	Institute of Polar Sciences, Natural Resources and Environment, National University of Tierra del Fuego, Argentina
Bailey, Scott W.	2014-19	Research Geologist	USDA Forest Service, Woodstock, NH
Busby, Gwenlyn M.	2011-16	Research Associate	School of Engineering and Applied Science, University of Virginia, Charlottesville, VA
Chojnacky, David C.	2015-20	Unit Leader (retired)	USDA Forest Service, Forest Inventory Research, Washington, DC

Coulston, John W.	2013-18	Research Forester	USDA Forest Service, Southern Research Station, Knoxville, TN
Finkral, Alex J.	2014-19	Senior Forester	The Forestland Group, LLC, Chapel Hill, NC
Horcher, Andy T.	2010-15	Project Leader	USDA Forest Service, Savannah River Site, Aiken, SC
Knoepp, Jennifer D.	2012-17	Research Soil Scientist	USDA Forest Service, Southern Research Station, Coweeta Hydrologic Laboratory, Otto, NC
Lakel, William A.	2014-19	Water Quality Program Supervisor	Virginia Department of Forestry, Charlottesville, VA
Maier, Christopher A.	2013-18	Research Biological Scientist	USDA Forest Service, Southern Research Station, Research Triangle Park, NC
Schilling, Erik B.	2011-16	Senior Research Scientist	National Council for Air and Stream Improvement, Inc., Newberry, FL
Soucek, David J.	2014-19	Associate Research Program Leader	Illinois Natural History Survey, Prairie Research Institute, University of Illinois
Sucre, Eric B.	2010-15	Sustainability Scientist	Weyerhaeuser NR Company, Vanceboro, NC
Westfall, James A.	2015-20	Analytical Sciences Group Leader	USDA Forest Service, Northern Research Station-Forest Inventory and Analysis Unit, Newtown Square, PA

EMERITUS FACULTY

Robert E. Adams
Gregory N. Brown
Gregory J. Buhyoff
James A. Burger
Harry L. Haney, Jr.
John F. Hosner
J. Michael Kelly
Jeffrey L. Kirwan
W. David Klemperer
William A. McElfresh
Robert L. McElwee
Richard G. Oderwald
Marion R. Reynolds, Jr.
Joseph W. Roggenbuck
Robert M. Shaffer
David Wm. Smith
Harold W. Wisdom

TECHNICAL STAFF

Deborah H. Bird
David O. Mitchem
John A. Peterson
E. Talcott Roberts, Jr.
B. Clay Sawyers

OFFICE SUPPORT STAFF

Tiffany N. Brown
Kathryn C. Hollandsworth
Stacey A. Kuhar
Tracey S. Sherman
Suzanne C. Snow
Brooke M. Warrington

2014-15 DEPARTMENTAL COMMITTEES

Budget & Planning:
C. Bolding (Chair)
K. Coleman
T. Fox
P. Radtke
T. Sherman
E. Wiseman

Facilities:
M. Aust (Chair)
S. Barrett
J. McGee
T. Roberts
M. Sorice

Graduate Affairs:
A. Brunner
S. Day
D. Drover
K. McGuire (Chair)
Q. Thomas

Promotion & Tenure:
G. Amacher (Chair)
H. Burkhart
B. Hull
S. Schoenholtz
M. Stern
J. Sullivan
V. Thomas

Undergraduate Affairs:
C. Bolding
C. Copenheaver
J. Seiler
J. Sullivan (Chair)
V. Thomas

2015 FREC ADVISORY BOARD

Michael Cerchiaro, Forest Investment Associates, Atlanta, GA
Keith Cline, USDA Forest Service, Washington, DC
Brad Fuller, Huber Engineered Woods LLC, Crystal Hill, VA
Mike Hincher (Chair-Elect), The Forestland Group, LLC, Abington, VA
Franklin Jackson, Virginia State University, Petersburg, VA
Alan Jones, Bartlett Tree Experts, Charlottesville, VA
Brent Keefer, Hancock Timber Resource Group, Charlotte, NC
James Kuykendall, Glatfelter Pulp Wood Company, Spotsylvania, VA
Easton Loving (Chair), MeadWestvaco, Appomattox, VA
Ed Milhous, TreesPlease, Haymarket, VA
Ken Morgan, Morgan Lumber Company, Inc., Red Oak, VA
Chuks Ogbonnaya, Mountain Empire Community College, Big Stone Gap, VA
Danette Poole, Virginia Department of Conservation and Recreation, Richmond, VA
Paul Revell, Virginia Department of Forestry, Charlottesville, VA
Greg Scheerer, MeadWestvaco, Appomattox, VA
Edward Sontag, Enviva LLP, Richmond, VA
Darrel Williams, Global Science & Technology, Inc., Greenbelt, MD

Ex-Officio Members

- State Forester of Virginia, Virginia Department of Forestry:
  Bettina Ring
- Executive Vice President, Virginia Forestry Association:
  Paul Howe
- Forest Supervisor, USDA Forest Service-George Washington & Jefferson National Forests:
  Tom Speaks
- Station Director, USDA Forest Service–Southern Research Station:
  Robert Doudrick

SELECTED HONORS AND AWARDS

SCOTT BARRETT received the 2014 Virginia Division SAF Young Forester Leadership Award.

CHAD BOLDING, MIKE AUST, and SCOTT BARRETT received the Forest Resources Association Appalachian Region 2014 First Place Technical Writing Award for TR 14-R-11, *Skid Trail Stabilization Research and Logger Training*.

HAROLD BURKHART received the Host Country Scientific Achievement Award at the 2014 International Union of Forest Research Organizations World Congress.

ALYCIA CRALL received the 2014 Outstanding Program Evaluation from the Alliance of Natural Resource Outreach and Service Programs. She also received the 2014 Diversity and Inclusion Award from the College of Natural Resources and Environment at Virginia Tech.

THOMAS FOX was named the Honorable Garland Gray Professor of Forestry by the Virginia Tech Board of Visitors in recognition of his contributions to the teaching, research, and outreach missions of Virginia Tech. The professorship was established in 1985 by the late Virginia Senator Elmon Gray in memory of his father, Garland Gray, who also served in the Senate of Virginia. Dr. Fox was also named a 2014 Virginia Tech Scholar of the Week by the Office of the Vice President for Research.

JENNIFER GAGNON received the 2014 Appalachian Society of American Foresters Distinguished Service to Forestry Award.

JOHN MUNSELL and his colleagues received the Virginia Cooperative Extension 2013 (awarded in 2014) Program Excellence Award State and Northern District.

MICHAEL SORICE was selected as a 2014 Virginia Tech Scholar of the Week by the Office of the Vice President for Research.

BRIAN STRAHM received both the Best (Oral) Paper of Session (General Forest, Range, and Wildland Soils) and the Best (Poster) Paper of Session (General Forest Range, and Wildland Soils) at the 2014 Soil Science Society of America International Annual Meeting. He was also named a 2014 Virginia Tech Scholar of the Week by the Office of the Vice President for Research.

QUINN THOMAS was selected for the Ralph E. Bennett Seminar in Plant Biology at the University of Michigan Biological Station.

ERIC WISEMAN was the 2014 Outstanding Faculty Member in the Virginia Tech Department of Forest Resources and Environmental Conservation.

FREC GRADUATE RESEARCH SYMPOSIUM

The Sixth Annual FREC Graduate Research Symposium on April 1, 2014, was a huge success, with 35 student presentations from several different disciplines coming together to build understanding around the theme "Resilience and Adaptation of Forest Ecosystems." In addition to FREC students, there were Virginia Tech participants from Horticulture, Fish and Wildlife Conservation, and Psychology and presentations by students from the University of Tennessee-Knoxville, SUNY-ESF, University of Georgia, North Carolina State University, and University of Virginia. Many of the FREC faculty were involved as moderators and judges.

The keynote speaker was Dr. Dave White, an alumnus, who received his Ph.D. from FREC in 2002. Dr. White is currently an Associate Professor in the Arizona State University School of Community Resources and Development and a principal investigator and co-director of the NSF-funded Decision Center for a Desert City.

2014 Symposium Winners

	Poster Presentations		Oral Presentations
1st	Ksenia Brazhnik, UVA	1st	Pamela Braff, VT FREC
2nd	Andrew Kniowski, VT FWC	2nd	Michael Cherry, UGA
3rd	Francisco de la Mota, VT HORT	3rd	Bethany Avera, VT FREC

The success of the symposium was due to the commitment and hard work of the symposium planning committee:

Bethany Avera, Chair
Rajesh Bawa
Pamela Braff
Kimberly Coleman
Daniel DeBruler
John Gannon
Ranjith Gopalakrishnan
Nathan Hanzelka
AJ Lang
David Mitchell
Brian Morris
Keith O'Herrin
Brett Rivers

TEACHING

The College of Natural Resources and Environment (CNRE) is firmly committed to excellence in teaching. Our stated educational goals are: (1) to educate high-quality professionals who can function effectively in entry-level positions and assume positions of ever-increasing responsibility throughout their careers; (2) to provide graduate programs that combine (a) a high-quality faculty, (b) a student body selected from the best undergraduate degree recipients in this country and abroad, and (c) courses offering the most advanced knowledge in order to produce outstanding researchers, educators, and practitioners; (3) to provide students not enrolled in the college's majors with an understanding of renewable natural resources so they can assume leadership roles and foster a rational conservation ethic within the general public; (4) to effectively disseminate knowledge and to provide a new program of public service to the college's constituencies, which will enhance the benefits, goods, and services obtained from natural resources of the state and surrounding region.

Obviously, teaching is an extremely important part of the mission of the Department of Forest Resources and Environmental Conservation, and students—defined in the broadest sense—are a principal constituent. All members of the faculty participate in the teaching program, which includes formal undergraduate and graduate on-campus instruction and a variety of extension courses, including continuing education for professionals. Evaluations of these educational efforts continue to be outstanding. The overall evaluation for all formal courses taught by full-time FREC teaching faculty in Fall Semester 2014 was 5.33 out of a possible 6.0.

The Department of Forest Resources and Environmental Conservation now has five majors and eight options:

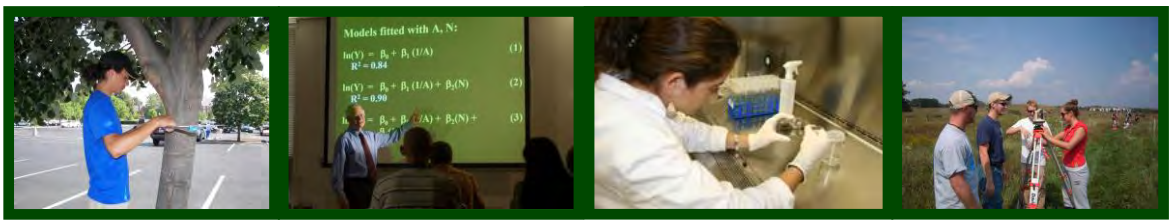
FORESTRY MAJOR
Forest Resource Management Option
Forest Operations and Business Option
Urban Forestry Option

NATURAL RESOURCES CONSERVATION MAJOR
Conservation and Recreation Management Option
Environmental Education Option
Natural Resources Science Education Option

ENVIRONMENTAL RESOURCES MANAGEMENT MAJOR
Environmental Resources Management Option
Watershed Management Option

ENVIRONMENTAL INFORMATICS MAJOR

WATER: RESOURCES, POLICY AND MANAGEMENT MAJOR
*** New in 2014 ***



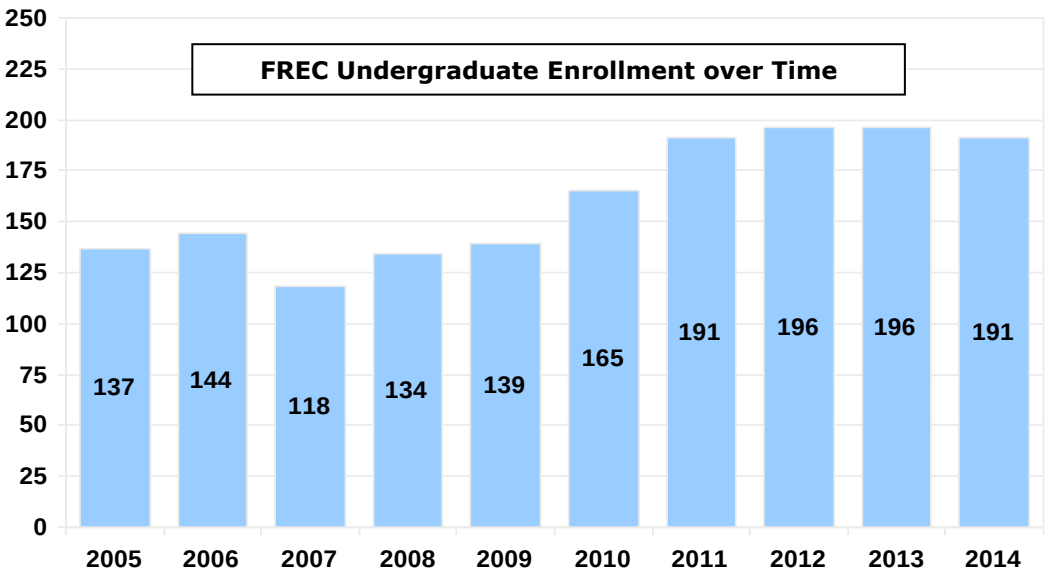
New B.S. Degree
Water: Resources, Policy, and Management

A new B.S. program, *Water: Resources, Policy, and Management,* was approved by the State Council for Higher Education in Virginia in December, 2014, and will begin accepting students in Fall Semester 2015.

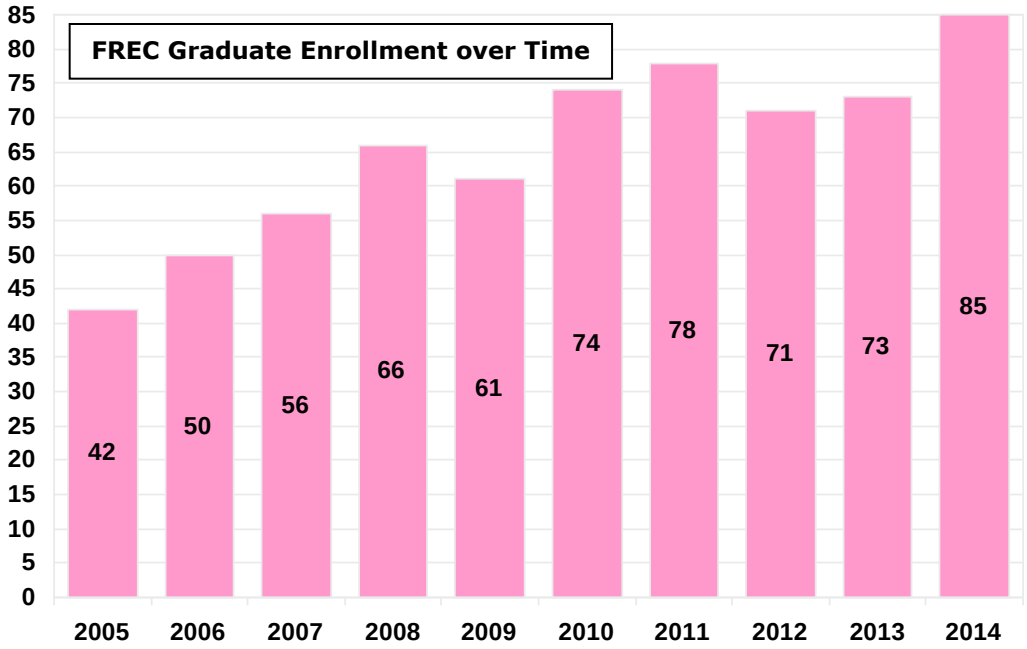
The program's academic home is the Department of Forest Resources and Environmental Conservation, but the major is designed to be highly interdisciplinary, with involvement and course offerings from other colleges at Virginia Tech, including Agriculture and Life Sciences, Architecture and Urban Studies, Engineering, and Science. This comprehensive, interdisciplinary major is the first of its kind available for undergraduates in the United States. The Virginia Water Resources Research Center's director, Stephen Schoenholtz, will coordinate the new major, assisted by an advisory committee comprised of faculty from ten Virginia Tech departments.

All students in the program will take courses pertaining to water resources and environmental issues; physics; watershed hydrology; environmental science; water quality; and watershed assessment, management, and policy. In addition, they can select courses in water science, policy, law, planning, economics, and geospatial technology.

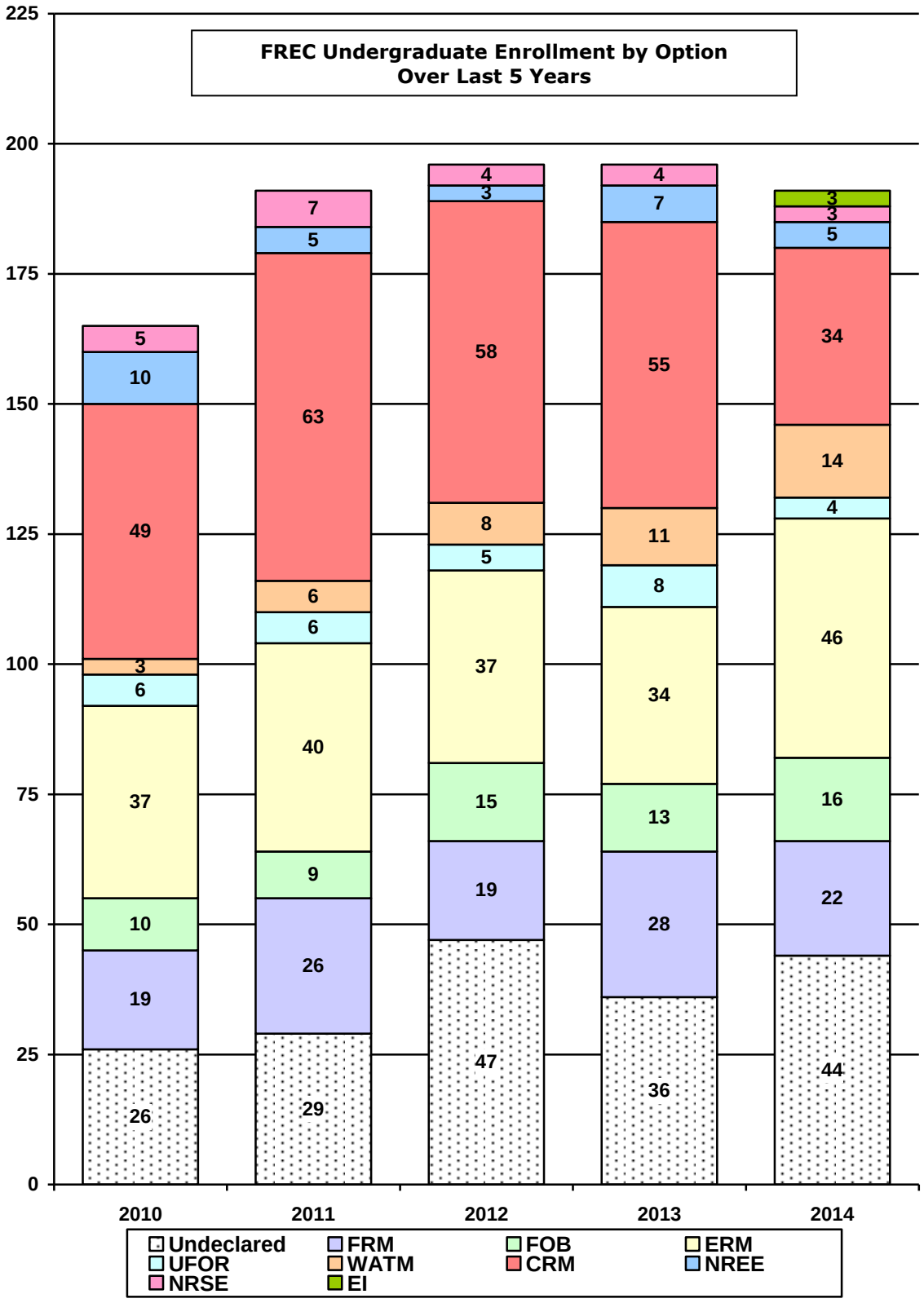
The new major's development, which began in 2011, took place in concert with Tech's hiring of a "cluster" of seven new water resources faculty members in 2013-14. FREC's Dr. Kelly Cobourn and Dr. Daniel McLaughlin are part of this cluster.



The department's educational programs continue to thrive. There were 742 undergraduates in the College of Natural Resources and Environment in Fall Semester 2014; of these, 191 students—or approximately 26%—were in options associated with the Department of Forest Resources and Environmental Conservation.



There were 85 graduate students in our department Fall Semester 2014. We continue to have more qualified applicants to our graduate program every year than we have faculty, funds, and space to accommodate.


FREC Undergraduate Enrollment by Option
Over Last 5 Years
225
200
175
150
125
100
75
50
25
0
2010
2011
2012
2013
2014
5
10
49
3
6
37
10
19
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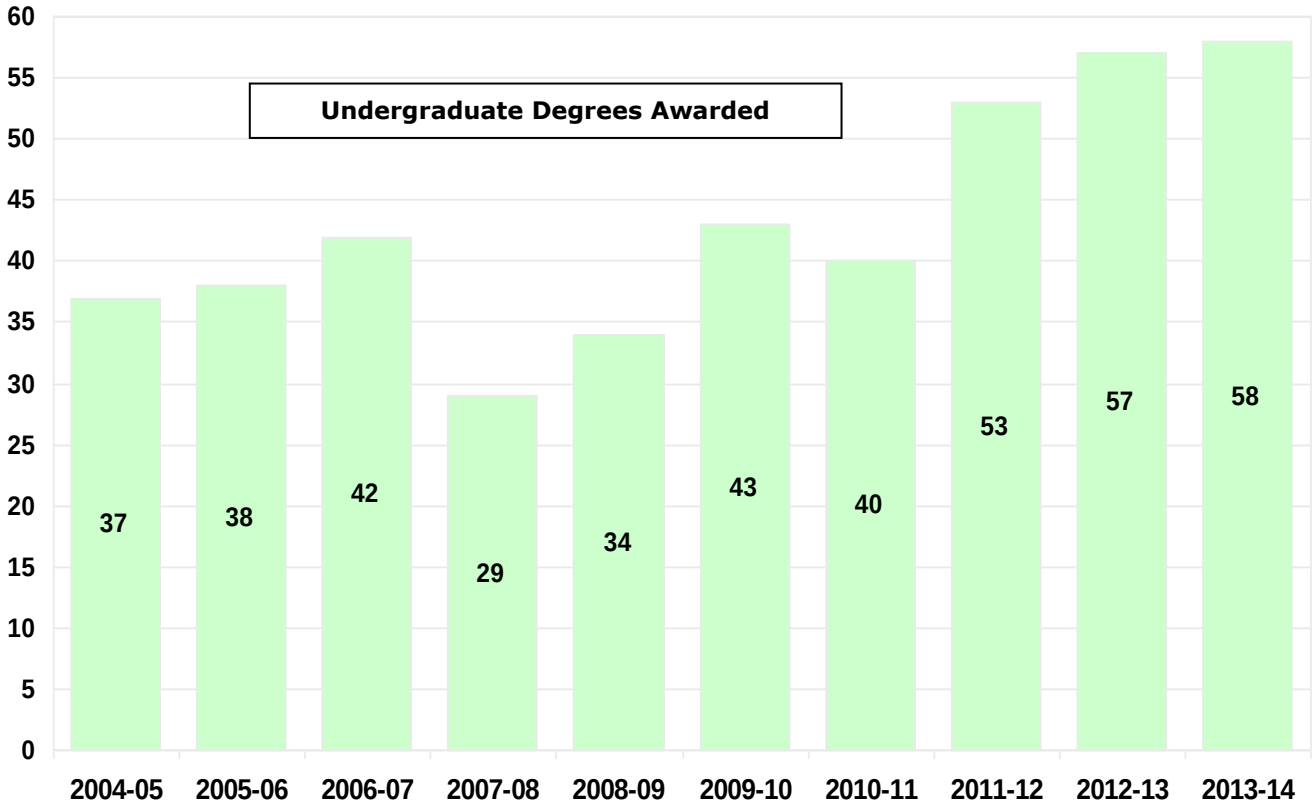
Undergraduate Degrees Awarded
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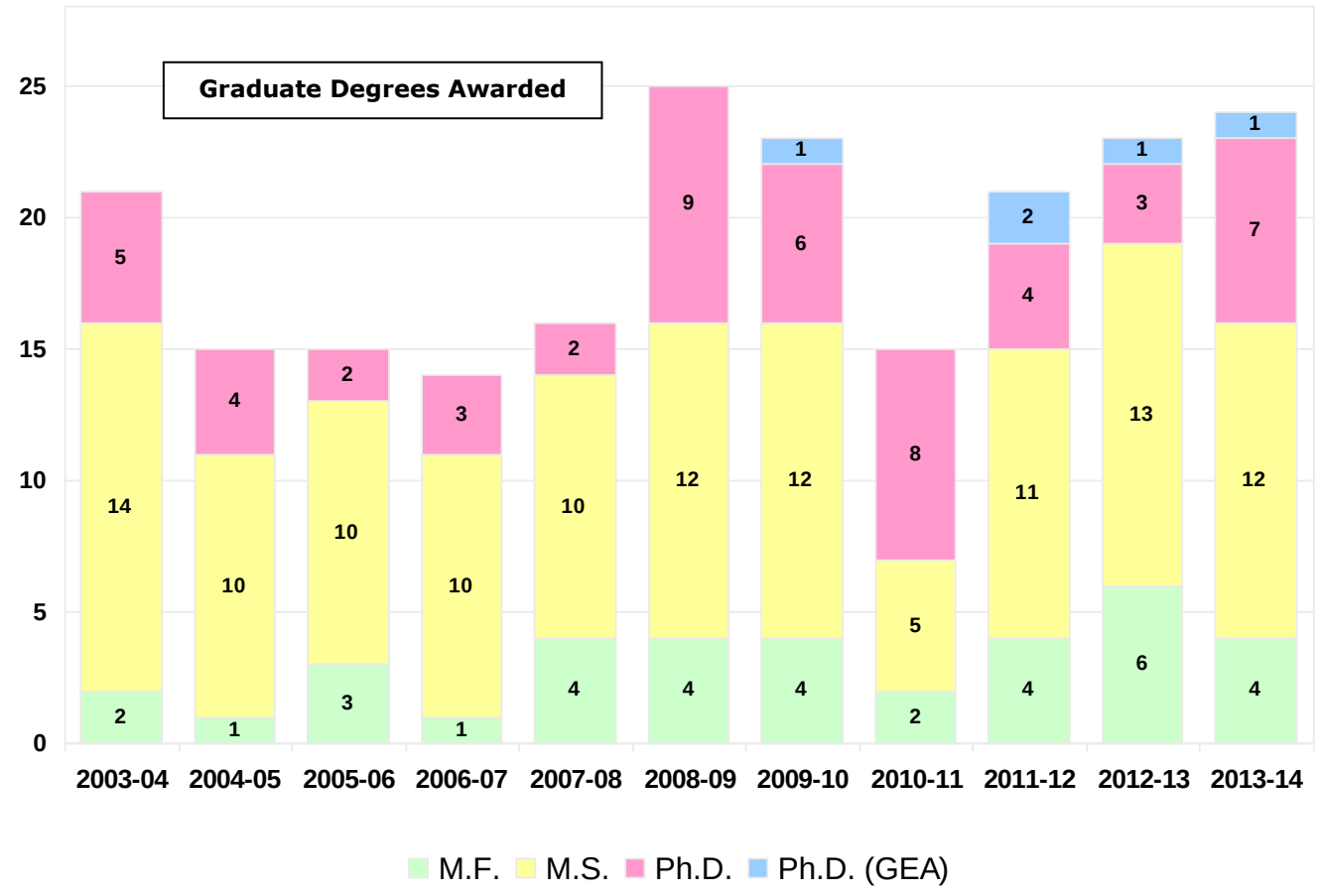
Graduate Degrees Awarded
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2005-06: 3, 10, 2
2006-07: 1, 10, 3
2007-08: 4, 10, 2
2008-09: 4, 12, 9
2009-10: 4, 12, 6, 1
2010-11: 2, 5, 8
2011-12: 4, 11, 4, 2
2012-13: 6, 13, 3, 1
2013-14: 4, 12, 7, 1
M.F.
M.S.
Ph.D.
Ph.D. (GEA)

Graduate Degrees Awarded During Calendar Year 2014

Master of Forestry (2)	Graduate Chair(s)	Title of Paper
Cockram, Andrew G.	S. M. Barrett M. C. Bolding	An Analysis of Unique Biomass Harvesting Strategies in Steep Terrain of Virginia
Gaines, Steven M.	S. M. Zedaker	Feasibility Analysis of Ailanthus Control on Three Disturbance Corridors in Southwestern Virginia

Master of Science (10)	Graduate Chair(s)	Title of Thesis
Avera, Bethany N.	B. D. Strahm	Development of Ecosystem Structure and Function on Reforested Surface-Mined Land
Braff, Pamela H.	S. P. Prisley	Not All Biomass is Created Equal: An Assessment of Social and Biophysical Factors Constraining Wood Availability in Virginia
DeBruler, Daniel G.	S. H. Schoenholtz B. D. Strahm	Soil Carbon, Nutrients, and Phosphorus Fractions: Responses to Weed Control and Harvest Residual Retention in Two 10-Year-Old Douglas-fir (*Pseudotsuga menziesii*) Stands of the Pacific Northwest
DeYoung, Clara	P. J. Radtke	Biomass Estimation Using the Component Ratio Method for White Oak
Heim, Brett C.	J. R. Seiler B. D. Strahm	Partitioning Soil Respiration in Response to Drought and Fertilization in Loblolly Pine: Laboratory and Field Approaches
Kimball, Pulelehua L.	P. E. Wiseman	Urban Tree Canopy Assessments in the Chesapeake Bay Watershed
Mitchell, David K.	S. D. Day	Urban Landscape Management Practices as Tools for Stormwater Mitigation by Trees and Soils
Neal, Andrew W.	S. H. Schoenholtz	Soil Carbon and Nitrogen Dynamics Across the Hillslope-Riparian Interface in Adjacent Watersheds with Contrasting Cellulosic Biofuel Systems
Oubida, Regis W.	J. A. Holliday	Partitioning of Multivariate Phenotypes Using Regression Trees Reveals Complex Patterns of Adaptation to Climate Across the Range of Black Cottonwood (*Populus trichocarpa*)
Wu, Yi-Jei	V. A. Thomas R. D. Oliver	Forest Change Dynamics Across Levels of Urbanization in the Eastern U.S.

Doctor of Philosophy (7)	Graduate Chair(s)	Title of Dissertation
Brown, Kristopher R.	W. M. Aust K. J. McGuire	Sediment Delivery from Reopened Forest Roads at Stream Crossings in the Virginia Piedmont Physiographic Region, U.S.A.
Gannon, John P.	K. J. McGuire	Hydrological Processes and Soil Development in a Headwater Catchment at the Hubbard Brook Experimental Forest, NH, U.S.A.

Doctor of Philosophy (7)	Graduate Chair(s)	Title of Dissertation
Minick, Kevan J.	T. R. Fox B. D. Strahm	Belowground Carbon and Nitrogen Cycling in a Loblolly Pine Forest Managed for Bioenergy Production
Quirino, Valquiria	R. H. Wynne	Evaluating the Potential for Estimating Age of Even-aged Loblolly Pine Stands Using Active and Passive Remote Sensing Data
Thapa, Ram	H. E. Burkhart	Modeling Mortality of Loblolly Pine Plantations
Yanez Arce, Marco A.	T. R. Fox J. R. Seiler	Management Intensity Effects on Growth and Physiological Responses of Loblolly Pine Varieties and Families Growing in the Virginia Piedmont and North Carolina Coastal Plain of the United States
Xu, Ying	G. S. Amacher J. Sullivan	Three Essays on Forestry Economics and Management

RESEARCH

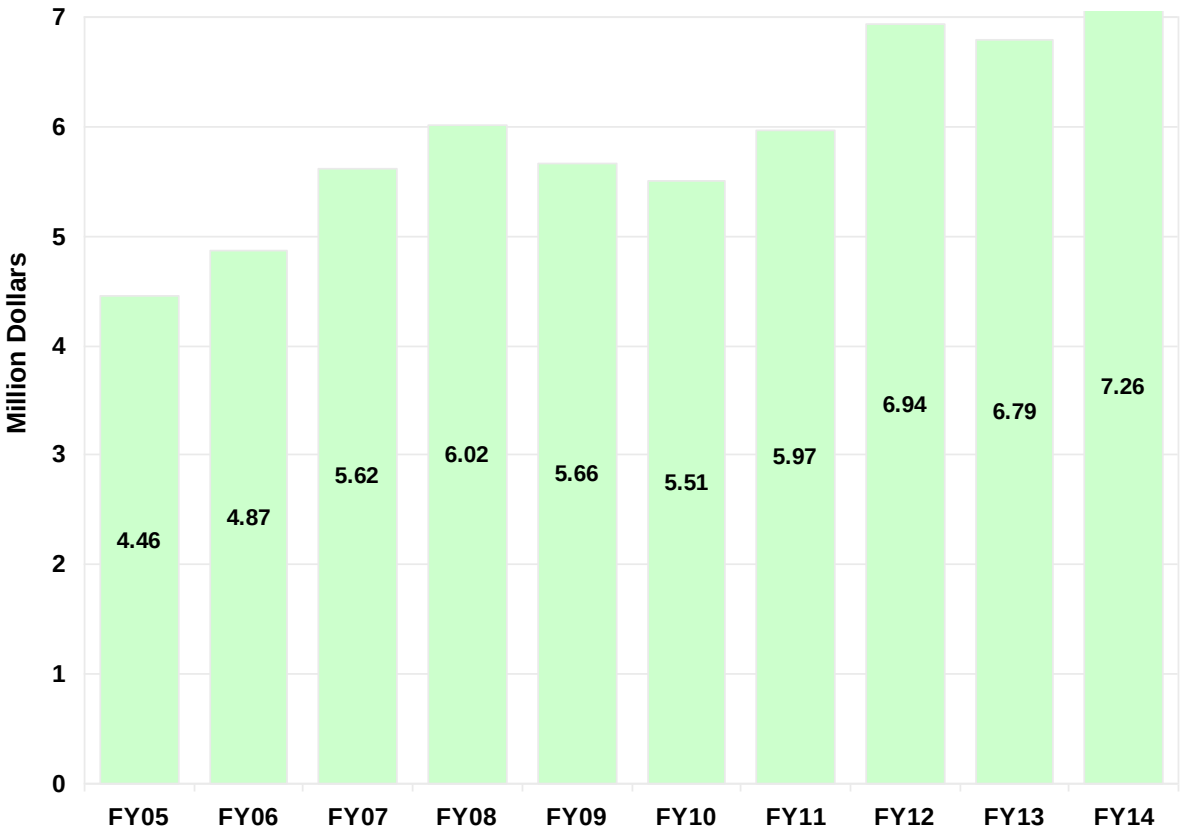
The Department of Forest Resources and Environmental Conservation at Virginia Tech undertakes research in a number of focus areas. These include:

- biometrics and geomatics
- ecosystem science and management
- forest economics and policy
- forest genetics and biotechnology
- forest operations and business
- human dimensions of natural resources
- urban forestry
- water resources

Funding from contracts and grants generated by the faculty totaled $5.32 million in fiscal year 2014. Twenty-four students completed graduate degrees in the Department of Forest Resources and Environmental Conservation during the 2013-14 academic year; 4 M.F., 12 M.S., and 8 Ph.D.s were awarded. Twenty-three new graduate students entered our graduate program during 2013-14.

Highlights of research activities during 2014 are contained on the following pages.

Research Expenditures



Biometrics and Geomatics

Research and outreach in forest biometrics and geomatics at Virginia Tech is focused on applying cutting-edge science and information technologies to address critical questions related to the measurement, modeling, management, and monitoring of natural resources. We aim to expand the frontiers of forest resources management through powerful new applications that merge remote sensing, computer and statistical modeling, and field studies, often synthesizing results and delivering them to policymakers and the public via geographic information systems (GIS) and internet technology.

Research in the biometrics and geomatics area falls into four broad categories: growth modeling and simulation, forest inventory and sampling, remote sensing and geographic information systems, and ecosystem and Earth system modeling.

Growth Modeling and Simulation

Growth and yield modeling consists of a continuous cycle of data collection, analysis, and interpretation. The Forest Modeling Research Cooperative (FMRC) is an outgrowth of the Loblolly Pine Growth and Yield Research Cooperative that was founded at Virginia Tech in 1979 for the purpose of developing growth and yield models for intensively managed loblolly pine plantations. Although loblolly pine remains a primary research thrust, we are addressing an expanded array of growth and yield modeling projects that span diverse species and production objectives and that include genetic improvement, management treatments, and environmental influences on forest productivity.

Forest Inventory and Sampling

Work is ongoing on developing improved methods for forest inventories, including methods to improve forest carbon estimates for the U.S. New biomass estimation procedures for national-scale forest inventories are being developed in collaboration with U.S. Forest Service researchers and scientists from five other universities. Use of forest inventory data for state and regional assessments is also a focus of biometrics/geomatics faculty engaged with the college's Center for Natural Resources Assessment and Decision Support (CeNRADS).

Remote Sensing and Geographic Information Systems

Net ecosystem productivity is being modeled for a wide range of management intensities using both *in situ* and remotely sensed data. Efforts are continuing to develop remote sensing applications needed to improve the statistical efficiency and spatial specificity of carbon monitoring and management in Virginia's timberland and urban forests. Geospatial analysis involves the combination of multiple sources of spatial data, each with differing source scale, timeliness, and reliability.

Ecosystem and Earth System Modeling

Forest carbon, nitrogen, and energy balances are being modeled at the stand- to global-scale using ecosystem models, remote sensing, and Earth system models. The interactions between forests and the changing environment (climate, nitrogen pollution, and land-use) are being simulated using high-performance computing. In particular, net ecosystem productivity is being modeled for a wide range of management intensities and climate scenarios.

For additional information, contact:

Dr. Harold Burkhart	(540) 231-6952	burkhart@vt.edu
Dr. John McGee	(540) 231-2428	jmcg@vt.edu
Dr. Stephen Prisley	(540) 231-7674	prisley@vt.edu
Dr. Philip Radtke	(540) 231-8863	pradtke@vt.edu
Dr. Quinn Thomas	(540) 231-7608	rqthomas@vt.edu
Dr. Valerie Thomas	(540) 231-0958	thomasv@vt.edu
Dr. Randy Wynne	(540) 231-7811	wynne@vt.edu

Economics and Policy

The faculty of the forest and natural resources economics section of the Department of Forest Resources and Environmental Conservation is engaged in a comprehensive research and teaching program that revolves around understanding use and exploitation of natural resources, both domestically and internationally, and designing policies to achieve a sustainable and socially-best use of forest and land resources. Concurrent with these objectives is to model and understand the behavior of forest landowners and users with multiple objectives and of agencies involved in public policy.

Some specific projects include:

- the economics of forest risks (fire, invasive species)
- the optimal design of ecosystem restoration, the development of woody-based alternative energy sources, and the design and implementation of natural resource policies to achieve various goals in the United States, Africa, Latin America, and Asia
- modeling developing country forest exploitation at community and regional levels
- understanding the implications of corruption and illegal logging along with design of better enforcement systems
- modeling the spatial nature of forest landowner and policy maker cooperation

We visit these problems using a variety of quantitative methods drawn from economic theory, econometrics, and operations research. Our graduate students are trained in these quantitative methods while having freedom to tailor their programs to suit their specific interests.

Department faculty members in our section either currently serve or have served on editorial boards of a number of important scholarly journals in the field, including *Forest Science*, *Forest Policy and Economics, Journal of Forestry*, *Journal of Environmental Economics and Management*, *Natural Resource Modeling*, and *Journal of Forest Economics*, and serve on several advisory committees.

We have secured funding for projects from sponsors including the U.S. Departments of Agriculture and Energy, the National Science Foundation, the USDA Forest Service, and other international and national donors. Faculty teach graduate and undergraduate courses in forest economics, natural resource and environmental economics, forest management, and natural resource policy. Previous graduate students now hold positions in academia, private research think tanks, forest industry, the financial sector, international organizations, and government agencies.

For additional information, contact:

Dr. Janaki Alavalapati	(540) 231-5676	jrra@vt.edu
Dr. Gregory Amacher	(540) 231-5943	gamacher@vt.edu
Dr. Kelly Cobourn	(540) 231-0338	kcobourn@vt.edu
Dr. Carol Franco	(540) 231-2967	carol@vt.edu
Dr. Frank Merry		fmerry@vt.edu
Dr. Jay Sullivan	(540) 231-4356	jsulliv@vt.edu

Forest Ecology

Forest ecology at Virginia Tech focuses on community ecology, dendroecology, historical ecology, and disturbance ecology. The research projects are directed towards examining human impacts on the environment, quantifying natural variation in ecosystems, and identifying detectable growth responses to climate. Some current research projects include:

- reconstructing stand dynamics in forests from tree-ring widths
- reconstructing historical patterns of disturbance from public land survey records
- quantifying the ecological impact of recreation on forest communities
- identifying the response of eastern hemlock to infestation by hemlock woolly adelgid
- integrating wood anatomy and dendrochronology to identify historical frost patterns, insect outbreaks, flooding regimes, and periods of drought or extreme cold

Funding sources to support these research projects include Bureau of Land Management, Environmental Protection Agency, National Fish and Wildlife Foundation, United States Department of Agriculture, and Sustainable Engineered Materials Institute.

Results of our research are regularly presented at national and international conferences, including the International Tree-Ring Conference; Ecological Society of America Annual Meeting; Tree Rings in Archeology, Climatology, and Ecology; and North American Forest Ecology Workshop.

For additional information, contact:
Dr. Carolyn Copenheaver (540) 231-4031 ccopenhe@vt.edu

Forest Operations and Business

The Virginia Tech forest operations team works in four major research areas related to forest management activities:

- Evaluating operations with regard to safety, productivity, planning, and logistics
- Creating tools to improve the efficiency and profitability of forest operations
- Analyzing forest business issues such as supply chain management/biomass utilization
- Evaluating the environmental impacts of forest operations.

Comparison of Five Erosion Control Techniques for Bladed Skid Trails in Virginia

This study evaluated five bladed skid trail closure BMPs for erosion control in the Piedmont of Virginia. BMP closures evaluated were: (1) water-bar only (Water-bar); (2) water-bar and grass seed (Grass); (3) water-bar, grass seed, and straw mulch (Mulch); (4) water-bar and piled hardwood slash (H-Slash); and (5) water-bar and piled pine slash (P-Slash). The study was arranged as a randomized complete block design where six newly constructed trails provided six blocks. Five treatments were applied to five segments within each block. Erosion from the 30 treatment plots was captured in sediment traps and weighed monthly for 13 months, providing 78 erosion weights per treatment. Results indicate that Water-bar was the most erosive closure method (137.7 tonnes ha^{-1} yr^{-1}), followed by Grass (31.5 tonnes ha^{-1} yr^{-1}), H-Slash (8.9 tonnes ha^{-1} yr^{-1}), P-Slash (5.9 tonnes ha^{-1} yr^{-1}), and Mulch (3.0 tonnes ha^{-1} yr^{-1}). Overall, BMPs that provide soil coverage levels similar to either slash or mulch closure should provide good erosion control, and final selection should be based on costs, availability of material, or landowner objectives.

Treatment	Erosion (tonnes ha^{-1} yr^{-1})	
Water-bar	137.7	a
Grass	31.5	b
H-Slash	8.9	bc
P-Slash	5.9	cd
Mulch	3.0	d

Effectiveness of Best Management Practices for Sediment Reduction at Operational Forest Stream Crossings

Three skid trail stream crossing BMP treatments were installed and replicated three times to quantify BMP efficacy for reducing sedimentation. BMP treatments were: (1) slash, (2) mulch and grass seed, and (3) mulch, grass seed, and silt fence. Water samples were collected daily both upstream and downstream from operational skidder stream crossings for one year following timber harvesting and BMP treatment installation. Samples were evaluated for total suspended solids (TSS). Results indicate that both slash and mulch treatments effectively reduced TSS following harvesting. Slash could be the preferred method of stream crossing closure due to lower cost, especially if application is incorporated into logging operations. However, if slash was being utilized for biomass and was not available, seed and mulch is a viable option for stream crossing closure. The mulch, seed, and silt fence treatment was the most expensive treatment and led to increased TSS, probably due to silt fence installation disturbances near the streams. Thus, silt fences should not be installed directly adjacent to stream banks if other alternatives exist.

For additional information, contact:

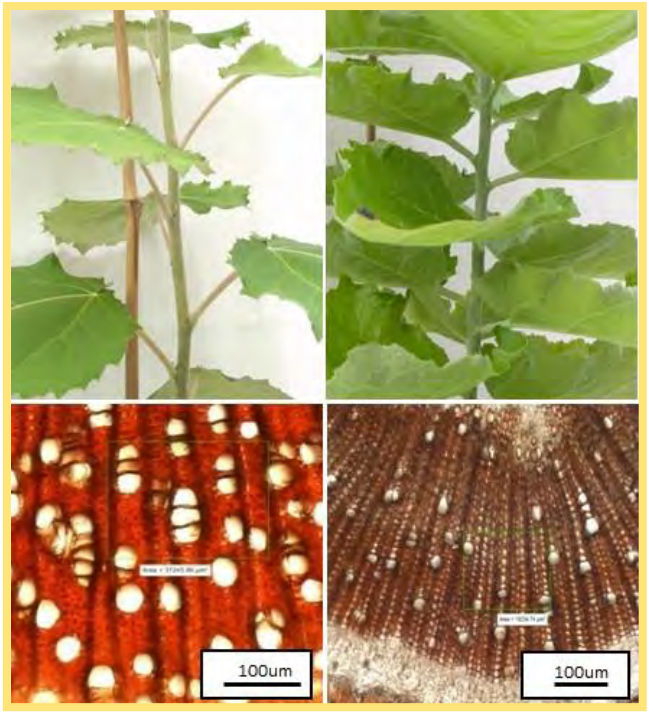
Dr. Mike Aust	(540) 231-4523	waust@vt.edu
Dr. Scott Barrett	(540) 231-6702	sbarrett@vt.edu
Dr. Chad Bolding	(540) 231-6924	bolding@vt.edu

Genomics and Biotechnology

The genomics and biotechnology program focuses on identifying and characterizing genes and their regulatory interactions that control economically and ecologically important traits in forest trees. An ultimate goal is to translate fundamental tree biology research into tools and methods that can accelerate tree improvement for various end uses, including traditional wood products, bioenergy, and biomaterials. Our state-of-the-art laboratories are located in Latham Hall, and we also participate in the interdepartmental Molecular Plant Sciences Graduate Program (http://www.molplantsci.org.vt.edu/) based in Latham Hall. Our program is supported by grants from the National Science Foundation, U.S. Department of Energy, USDA National Institute of Food and Agriculture (NIFA), and the Virginia Agricultural Council.

Populus (Poplar) Functional Genomics and Field Testing

The structure, arrangement, and relative proportions of the specialized xylem cell types that constitute wood and the composition of their secondary cell walls determine the physical and chemical properties of wood and, hence, its suitability for specific commercial applications. Research in Amy Brunner's lab studies the regulation of wood formation in poplar using a variety of techniques. Funded by the DOE/USDA Plant Feedstock Genomics for Bioenergy Program, a collaborative project with Eric Beers in the Horticulture Department, Richard Helm in Biochemistry, and Allan Dickerman in the Virginia Bioinformatics Institute is continuing to map a large number of protein-protein interactions that occur during wood formation (http://xylome.vbi.vt.edu/). Drs. Brunner and Beers and doctoral student Stephen Rigoulot are also collaborating with colleagues at Oregon State University to map protein-protein interactions regulating responses to drought and other abiotic stresses. In addition to the mapping, doctoral students Xiaoyan Sheng, Earl Petzold, and post-doctoral fellow Bidisha Chanda are studying how these proteins affect growth and wood development in order to ultimately guide design of new strategies for molecular breeding of woody biomass crops. Ms. Sheng has identified a gene that regulates shoot elongation and radial growth, in part by affecting the biosynthesis of the phytohormone gibberellin. Drs. Brunner, Beers, and Helm are also collaborating on a new USDA-NIFA-funded project that seeks to discover new approaches to increasing tree growth and carbon partitioning to wood.



In collaboration with Harold Burkhart, GreenWood Resources, Inc., and the Virginia Department of Forestry, the top 12 performing clones from hybrid poplar screening trials are being validated in yield-verification trials planted in May-June of 2012 at the Appomattox-Buckingham State Forest and the Reynolds Homestead Forest Resources Research Center in Patrick County. The ultimate goal is to develop hybrid poplar as a bioenergy crop for Virginia that could also be grown for pulp, paper, and wood products.

Genomics of Climatic Adaptation

The capacity of the world's forests to provide ecosystem and economic services requires that adaptive traits of local populations track optimums enforced by their respective climatic conditions. With anthropogenic climate change substantially altering adaptive landscapes, natural tree populations will be forced to adapt, migrate, or be extirpated. Selection of families and clones for

the production of timber, pulp, and bioenergy feedstocks will face similar challenges. A technological revolution is currently underway that is rapidly making the genomics tools once reserved for model species available for use in trees. The research of Jason Holliday focuses on understanding the causes and consequences of natural genetic variation in complex adaptive traits in trees and in applying this knowledge to improve forest health and productivity. A better understanding of adaptive genetic variation facilitates genome-enabled breeding for the sustainable production of wood biomass, enables predictions of carbon sequestration in future forests under climate change, and enhances the adaptive potential of local populations through conservation of ecologically relevant genetic variation.

The population genomics group led by Dr. Holliday focuses primarily on the genera *Populus* (cottonwoods and aspens), *Picea* (spruce), and *Pinus* (pine), which contain the most economically and ecologically important tree species in the United States and for which extensive genomic tools have been developed. Our primary interest is in the genomic dissection of complex traits using association mapping and landscape genomics, which employ large natural populations and contemporary high-throughput sequencing to find the relevant genes. A significant current focus is the genus *Populus*, for which the National Science Foundation funded a study aimed at elucidating the genomic architecture of climatic adaptation. A recently developed sequence capture technology is being used to retrieve exons and regulatory sequences for all expressed genes in *P. trichocarpa* (black cottonwood), which have been sequenced in a replicated mapping population developed for this project. In addition to encompassing the wide latitudinal range of poplar, this population includes collections along altitudinal transects, which will allow us to better understand adaptation at coarse versus fine spatial scales. Associations are being sought with key adaptive traits (e.g., growth, bud phenology, cold hardiness, drought tolerance, etc.), as well as with climate variables that represent the principle environmental constraints related to these traits. Having planted our mapping population in two contrasting environments (Virginia and southwest British Columbia), we will be able to identify genotype-by-environment interactions, and using data provided by collaborators, comparative studies of adaptation will be undertaken in both *P. tremuloides* (trembling aspen) and *P. deltoides* (eastern cottonwood).

In addition to our work on poplars, we are involved in collaborations that have resulted in funded projects focused on spruce and pine. Loblolly pine is the preeminent softwood timber species in the United States, and the Holliday lab is part of the successful USDA NIFA Climate Change CAP (Coordinated Agricultural Project) proposal aimed at developing management strategies to mitigate and adapt loblolly pine forestry practices to climate change. Dr. Holliday is also collaborating on a Genome Canada-funded project that uses genomics to facilitate predictions of climate change outcomes for two economically and ecologically important western tree species, lodgepole pine (*Pinus contorta*) and interior spruce (*Picea glauca x Engelmanii*). Extensive sequencing has been carried out in both natural populations and seed orchards (used for reforestation) to map adaptive loci and better understand the adaptive genomic portfolio of current deployment populations. In addition the results of this study will be used to develop new seed transfer policies aimed at maximizing productivity and adaptability of reforested lands.

For additional information, contact:

Dr. Amy Brunner	(540) 231-3165	abrunner@vt.edu
Dr. Jason Holliday	(540) 231-7267	jah1@vt.edu

Human Dimensions of Natural Resources

Natural resource problems are created and solved by people. Our program emphasizes human organization and behavior as they relate to natural resources. We address a wide range of contexts, including land change, land management agency practices and policies, urbanization, conservation movements, environmental education, outdoor recreation visitor behavior and experience, collaborative community-based conservation, and sustainable development. We work both domestically and internationally on issues regarding the interactions among people, their environments, and the multiple competing interests associated with natural resource use.

The Human Dimensions faculty members employ a variety of qualitative and quantitative methods, often using mixed-methods approaches. We work at different scales of social organization—from individuals to institutions. We collaborate with experts from sociology, ecology, economics, political science, anthropology, communications, social psychology, urban planning, and public administration disciplines.

Current research is addressing:

How can web-based technologies support agroforestry education and outreach?
Forest farming is an agroforestry practice that intentionally cultivates edible, floral, medicinal, and craft products that grow underneath a forest canopy. Forest farming is an alternative to wild gathering that can tap into existing markets while also enhancing product consistency and resource sustainability. John Munsell is leading a national group of academics, agency personnel, and forest farmers that is developing web-based methods to support on-the-ground application. The project also includes a joint venture with the USDA Forest Service Southern Research Station to create procedures for a non-timber product output system that will provide market information to forest farmers via public reports and maps.

How can agroforestry be used to support refugee settlements?
Elizabeth Moore is a master's student working under the direction of John Munsell. She is studying preferences and procedures for agroforestry projects in support of refugees from the Central African Republic (CAR) that have crossed into Cameroon's East and Adamaoua provinces. The Diaspora, referred to as the hidden Darfur, is comprised predominantly of Mbororo, a tribe of nomadic cattle herders that has fled its villages due to violence, insecurity, and frequent kidnappings. Elizabeth's work uses illustrations and focus group data, along with land availability, to develop a decision-support framework for agroforestry projects.

Cross-sector partnership and collaboration
Sustainability leadership requires collaborations among businesses, government programs, and civil-society organizations. Faculty and students work with existing and forming partnerships around the world. For example, faculty and students traveled with the Center for Leadership in Global Sustainability to work on collaboration among Cargill, The Nature Conservancy, Brazilian landowners, and Brazilian government agencies to reduce conversion of tropical rainforest to soy fields, promote climate change mitigation, assist farmer profitability and stability, and minimize displacement of indigenous cultures.

How do we empower local communities to engage in conservation?

Faculty and graduate students in our section assist local communities wrestle challenges of sustainable development. One example is our Landcare research and outreach efforts, such as can be found in Catawba Valley, which lies between Blacksburg and Roanoke and is the headwaters to several national watersheds, including the Chesapeake Bay. We facilitated community meetings and community actions promoting the triple bottom line of economic development, community vitality, and environmental sustainability. Another example is working with serious objections by Tea Party and other new activist groups concerned with local land use planning efforts promoting smart growth, climate adaption, green infrastructure, and land use taxation.

How can biodiversity conservation on private lands be enhanced?

Over 60% of the land in the United States is privately held, and over 80% of threatened and endangered species use or rely on private lands for habitat. The rise of market-based mechanisms to encourage private landowners to contribute to conservation has led Michael Sorice and his colleagues to explore the social factors associated with participation in conservation programs. What tradeoffs are landowners willing to consider when deciding to help imperiled species? Dr. Sorice's work on songbirds in Texas and gopher tortoises in the southeastern United States finds that it isn't all about the money—other factors related to program design and administration play a big role.

What social drivers perpetuate undesirable ecosystem change?

Afforestation can be considered "bad" when grasslands that have existed for millennia are transformed into woodlands, threatening the rural livelihoods of ranchers in the Southern Great Plains of the United States. In South America another invasive is rampantly transforming riparian forests. The North American beaver (*Castor canadensis*) was introduced into the southern islands of Argentina and Chile in the 1950s to start a fur trade. Michael Sorice works with ecologists to address invasive species issues focusing on the management decisions landowners make that facilitate or impede their spread.

What makes for better outcomes in natural resource management planning processes?
Marc Stern's research has uncovered key lessons about leadership and the internal dynamics of interdisciplinary teams, approaches to public involvement, risk assessment, and compliance with the National Environmental Policy Act by the U.S. National Forest Service over the past seven years. Dr. Stern has collaborated with colleagues to publish 13 peer-reviewed journal articles on this work, and key findings are now being incorporated in agency-wide training. Dr. Stern is now studying collaborative process on large landscape-scale restoration initiatives in the United States.

What makes one conservation grant more successful than another?
Marc Stern has partnered with colleagues from Clemson University and Stanford University on a five-year study to examine the key drivers of success in conservation granting programs. The research involves examining the characteristics and outcomes of 400 conservation grants provided through the TogetherGreen Conservation Initiative of National Audubon Society and Toyota. The study aims to uncover key lessons about training, community engagement strategies, partnerships, and adaptive management for achieving conservation success.

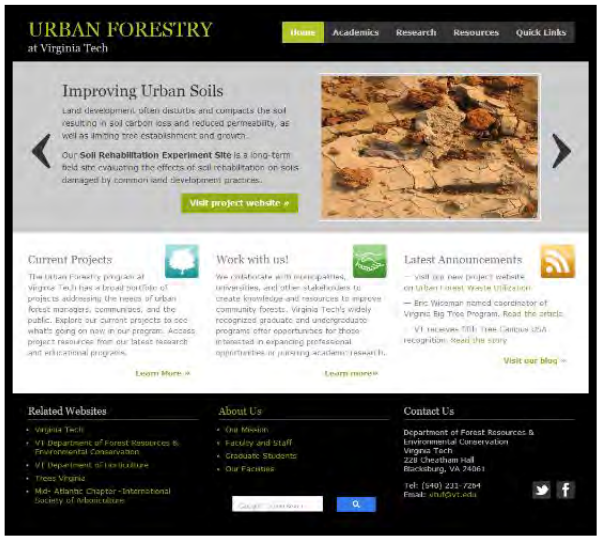
What drives visitor outcomes in interpretive experience in national parks?
Marc Stern and a colleague at Clemson University sent a team of graduate students to nearly 400 ranger programs across 24 units of the National Park Service, tracking in detail multiple attributes of the ranger, the context, the visitors, and the program's delivery. Through visitor surveys immediately following these programs, the study identified the characteristics that lead to enhancing visitor experiences and inspiring stewardship. The study is the first of its kind and its results are informing both training and monitoring across all 398 units of the U.S. National Park Service.

How can protected natural area managers avoid or minimize recreation impacts?
Jeff Marion, a U.S. Geological Survey scientist and an Adjunct Faculty member in our program, conducts recreation ecology research to assess, monitor, and manage recreation impacts. This work includes field assessments of trail, campsite, and recreation site conditions, evaluations of the efficacy of management actions such as Leave No Trace education, and research to improve carrying capacity planning and decision-making. Recent research in Alaska's Arctic National Wildlife Refuge and Denali National Park developed a suite of efficient methods employing GIS and GPS technologies in monitoring visitor-created trails in remote settings. New research is evaluating the sustainability of the Appalachian Trail, including alignment of the tread and locations and physical characteristics of campsites.

For additional information, contact:

Dr. Bruce Hull	(540) 231-7272	hullrb@vt.edu
Dr. Jeffrey Marion	(540) 231-6603	jmarion@vt.edu
Dr. John Munsell	(540) 231-1611	jfmunsel@vt.edu
Dr. Michael Sorice	(540) 231-8303	msorice@vt.edu
Dr. Marc Stern	(540) 231-7418	mjstern@vt.edu

Urban Forestry



Program website serves as a resource for the professional and academic communities.

Virginia is a rapidly urbanizing state, which creates challenges and opportunities for managing forest resources. Departmental faculty conduct research and outreach in a variety of urbanized landscapes—from densely populated cities to rural woodlots at the urban fringe. The mission of the urban forestry program is to produce information and technology about urban forests that citizens, professionals, and policy makers can use to create sustainable cities and improve quality of life. We address urban forestry technical challenges at the state, regional, and national levels. Research sponsors include private industry, foundations, and state and federal government. In the Commonwealth we envision urban forests that are planned and managed based on sound principles and science to create safe, sustainable communities.

Assessing the Structure, Function, and Value of Virginia's Urban Forests

Urban forests' tangible values can only be fully realized when they are properly planned, established, and maintained. To be successful in these aspects of stewardship, a community must first understand the extent, location, and composition of its urban forest. Urban forestry faculty and the Virginia Geospatial Extension Program have collaborated with the Virginia Department of Forestry and numerous municipalities and agencies throughout the state to assess urban forests using geospatial and field inventory techniques to improve our understanding of this critical resource. Interactive web tools are available for communities and the public to analyze urban tree canopy data (*utcmapper.frec.vt.edu*). With this knowledge Virginia communities are drafting effective urban forest policy and management plans. In addition to assisting Virginia communities, FREC researchers are also advancing the technology of urban forest assessment through developing new sampling protocols and strategic approaches to implementing plans to help improve urban forest assessment nationally.

High resolution aerial imagery used to generate urban tree canopy assessments.

This demonstration parking lot design retains 100% of stormwater.

Innovative Site Design and Technology

Urban forests and greenways have always been important parts of any city or suburb, but the accelerated pace of urbanization is increasing pressure on our environmental resources. This green infrastructure plays a crucial role in protecting our environment, including water supplies and the water quality in our rivers and coastal regions. Urban forests, like rural forest land, play a pivotal role in mitigating stormwater impacts on surface and groundwater, but developing approaches that exploit the ability of trees to handle stormwater is difficult in highly built city cores or in urban sprawl where asphalt can be the dominant cover feature. Urban forestry faculty are exploring creative ways to enhance the ability of urban sites to support large trees while simultaneously providing specific ecosystem services—such as stormwater mitigation—for society. A new technology has been developed that places stormwater reservoirs beneath pavement in a special soil mix that supports tree roots and pavement and water storage simultaneously. This stormwater best management practice can be employed in dense urban cores or sprawling suburban parking lots. We are collaborating with local governments and agencies to evaluate new streetscape technology, such as flexible pavement, and its effect on trees. Canopy is declining in many cities and towns, but with innovative approaches to creating sustainable urban landscapes, we can bring the green back to the city. Projects have been supported by the USDA Forest Service's Urban and Community Forestry Grants Program, the TreeFund, and through partnerships with local governments.

Urban Soil Rehabilitation with Soil Profile Rebuilding and Improved Surface Treatments

Urban land use change results in significant loss of ecosystem services from soils. Significant soil carbon is lost during urbanization, and the ability of soils to manage stormwater and support vegetation is severely impaired. Urbanization typically damages soils during the construction process when land is subjected to heavy equipment use and grading. These activities produce compacted soils with low organic matter, even in the lower soil horizons. In addition, soil surface treatments (mulch or turf) have traditionally been evaluated for their aesthetics and ability to suppress weeds. However, these treatments play a pivotal role in soil protection and quality as well as the ability of the surface to infiltrate stormwater. Virginia Tech research is evaluating surface treatments for these qualities to improve the performance of urban green infrastructure. An ongoing series of experiments is evaluating these effects and developing best management practices for soils and surface coverings in urban sites.

Confined rooting space creates special challenges for trees.

Urban Forestry—the Growth of the Profession

Urban forestry is still a new profession, but recent years have seen significant changes. Municipalities are demanding more expertise in management of forest resources, the Society of American Foresters initiated an accreditation program for urban forestry (Virginia Tech's program was the first to meet the new standard), and urban forestry certification credentials are on the horizon. However, municipalities continue to have difficulty recruiting qualified urban foresters, professional societies that serve urban foresters are diverse and not always coordinated, and educational programs are poorly understood by the public and employers. Virginia Tech has taken the lead in a regional project (supported by the National Urban and Community Forestry Advisory Council) with University of Maryland, West Virginia University, and Virginia State University to analyze the links between these professional structures and the development of the urban forestry profession and offer solutions to move the profession forward.

Urban Wood Waste Utilization

Several new research initiatives are underway to investigate the potential for wood waste utilization in urban forests. By fully understanding the lifecycle of urban trees, there is potential to improve urban forest sustainability. FREC faculty and students are investigating strategies for identifying the best use for urban trees after their useful lifespan in the urban forest is at an end. Partners include Davey Resource Group, Casey Trees, and the Virginia Department of Forestry.

Urban forests generate significant amounts of wood waste, mostly in the form of chips and brush

For additional information, contact:

Dr. Susan Day	(540) 231-7264	sdd@vt.edu
Dr. John McGee	(540) 231-2428	jmcg@vt.edu
Dr. Eric Wiseman	(540) 231-5148	pwiseman@vt.edu

urbanforestry.frec.vt.edu

gep.frec.vt.edu

Water Resources

The Department of Forest Resources and Environmental Conservation is deeply engaged in research addressing the myriad challenges facing water resources. Research projects range in scale (from ecosystems to regions) and focus (e.g., watershed hydrology, aquatic ecosystem health, public supply). Projects are designed to guide water resource management while also broadening our understanding of the interactions among ecosystems, humans, and water. Current research projects include:

The Ecological Drill Hypothesis: Biotic Control on Carbonate Dissolution in a Low-Relief Patterned Landscape. This study is exploring the role of wetland metabolism and hydrology in creating the striking landscape pattern in Big Cypress National Preserve, where wetland distribution increases spatial diversity in habitat and function.

Monitoring the Effectiveness of Forest Fertilization Best Management Practices. State-of-the-art water quality sensors are being used to evaluate the effects of forest fertilization and related best management practices on stream nutrient loading and metabolism.

Ecological and Hydrological Impacts of the Emerald Ash Borer (EAB). This project seeks to understand the coupled hydrologic and vegetative impacts resulting from EAB-induced mortality in Minnesota black ash forests. It is part of a large, multi-institutional (University of Minnesota and USDA Forest Service-Northern Research Station) study examining potential adaptation strategies for mitigating the impacts of EAB on the structure and function of black ash forest systems.

Water Quality Impacts Associated with Forest Roads in Watersheds of Virginia. This project measures surface runoff and sediment delivery ratios from forest roads during controlled field experiments in the Virginia Piedmont. These data are used to evaluate the predictive capability of common models used for erosion estimation.

Managing Forests for Increased Regional Water Availability. This study is measuring water use (i.e., evapotranspiration rates) in 36 stands with varying management actions (e.g., fire and thinning) to understand the effect of forest management on water delivery to aquifers and water bodies.

Landform Controls on Hydrologic Flowpaths and Pedogenesis Explain Solute Retention and Export from Pedon to Catchment Scales. This project is aimed at explaining the spatial and temporal patterns of stream water chemistry at the headwater catchment scale using a framework based on the combined study of hydrology and soil development—hydropedology. The project is designed to demonstrate how hydrology strongly influences soil development and soil chemistry and, in turn, controls stream water quality in headwater catchments.

Determining Water Quality Criteria in Streams of Southwestern Virginia. This research, initiated in 2008, seeks to evaluate the response of aquatic life to total dissolved solids (TDS) and to dissolved selenium, two common water-quality concerns in Central Appalachian headwater streams where coal mining occurs. Five graduate students in FREC have been supported by this project to date.

Assessing Effectiveness of Restoration Efforts in Central Appalachian Coalfield Streams.
Continued permitting of coal mining in the central Appalachian region has become increasingly dependent on maintaining or restoring hydrologic and ecological function in streams affected by coal extraction. This research is assessing the functional status of a range of restored streams using measures that are relatively simple to implement and relate directly to stream carbon dynamics, an important determinant of stream condition.

For additional information, contact:

Dr. Mike Aust	(540) 231-4523	waust@vt.edu
Dr. Chad Bolding	(540) 231-6924	bolding@vt.edu
Dr. Kelly Cobourn	(540) 231-0338	kcobourn@vt.edu
Dr. Kevin McGuire	(540) 231-6017	kevin.mcguire@vt.edu
Dr. Daniel McLaughlin	(540) 231-6616	mclaugd@vt.edu
Dr. Stephen Schoenholtz	(540) 231-0711	stephen.schoenholtz@vt.edu
Dr. Brian Strahm	(540) 231-8627	brian.strahm@vt.edu

Forest Modeling Research Cooperative

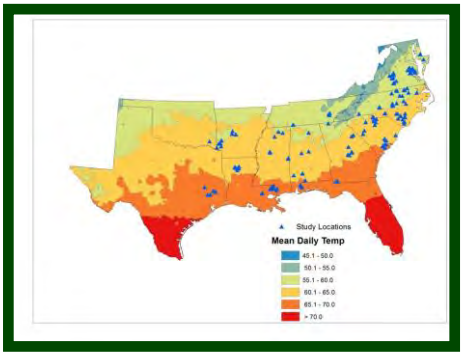
The Forest Modeling Research Cooperative (FMRC) is an outgrowth of the Loblolly Pine Growth and Yield Research Cooperative that was founded at Virginia Tech in 1979 for the purpose of developing growth and yield models for intensively managed loblolly pine plantations. Although loblolly pine remains a primary research thrust, the FMRC is addressing an expanded array of growth and yield modeling projects both in the United States and South America.

Growth Modeling and Simulation

A wide range of research projects is being conducted to develop improved growth and yield models for intensively managed forests. These studies include:

- Quantification of site quality
- Tree and stand increment equations
- Mortality modeling
- Tree volume and taper modeling
- Quantification of stem quality
- Quantification of wood quality characteristics
- Incorporation of cultural practices (e.g., planting genetically improved and varietal stock, applying fertilizers, controlling competing vegetation, thinning) into growth and yield models
- Modeling environmental influences on forest growth.

Integration of models into prediction and projection systems and incorporation of these systems into decision support tools (including web-based applications) comprises a significant part of the work of the FMRC.



In addition to loblolly pine, the FMRC has developed models for Appalachian hardwoods and pure stands of yellow-poplar. Current work includes development of models for South American pine plantations. Work is also ongoing for developing models for short-rotation "bioenergy" plantations.

Collaboration

The FMRC has a long history of collaboration and maintains strong working relationships with other research cooperatives, the Forest Service, and—through the National Science Foundation's Center for Advanced Forestry Systems—industry-supported research programs at other universities. In addition, FMRC is an integral part of the regional PINEMAP effort that is focused on climatic influences on forest productivity. Staff of the Forest Modeling Research Cooperative consists of a Director (Harold Burkhart), an Associate Director (Ralph Amateis), cooperating faculty in forest biometrics and geomatics at Virginia Tech, and graduate research assistants and postdoctoral research associates.

For additional information, contact:

Dr. Harold Burkhart	(540) 231-6952	burkhart@vt.edu
Mr. Ralph Amateis	(540) 231-7263	ralph@vt.edu

http://web1.cnre.vt.edu/forestry/forestmodelingresearchcooperative/

Forest Productivity Cooperative

The Forest Productivity Cooperative (FPC) is an international industry/university cooperative research and technology transfer program working to create innovative solutions to enhance forest productivity and value through the sustainable management of site resources. The FPC conducts research in plantation silviculture, forest nutrition and fertilization, ecophysiology, soils, plant community ecology, growth and yield modeling, remote sensing, spatial analysis, and GIS applications. This is done in cooperation with forest industry in the United States and Latin America and scientists at Virginia Tech, North Carolina State University, The University of Concepcion in Chile and the Institute for Forest Research in Brazil. Thomas Fox serves as the Co-Director of the FPC at Virginia Tech.

The goal of the FPC is to increase the productivity, profitability, and sustainability of plantation management in the United States and Latin America. We work with both pine and eucalyptus plantations throughout these regions. The approach of the FPC includes a mix of applied research, fundamental research, graduate and undergraduate education, technology transfer, continuing education, and consulting. This mix provides a productive environment for addressing questions and immediately incorporating research results into silvicultural practices for cost-effective and environmentally sustainable plantation management.

The FPC is one of the world's largest cooperative silviculture research and education programs. Partners include the host universities, forest industry, timber management investment organizations, forestry consultants, governmental agencies, private landowners, and others interested in intensive plantation management. There are currently more than 60 members with operations in 11 countries, including the southern United States, Argentina, Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, Uruguay, and Venezuela. These members of the FPC collectively own or manage over 40 million acres of pine and eucalyptus plantations.

For additional information, contact:
Dr. Thomas Fox (540) 231-8862 trfox@vt.edu
http://www.forestproductivitycoop.org/

National Science Foundation
Center for Advanced Forestry Systems

The Center for Advanced Forestry Systems (CAFS) is sponsored by the National Science Foundation (NSF) as part of the Industry/University Cooperative Research Centers (I/UCRC) Program within the Engineering Directorate. CAFS links existing cooperative forestry research programs at Virginia Tech, North Carolina State University, Oregon State University, University of Georgia, University of Florida, University of Washington, University of Maine, Purdue University, and University of Idaho. At Virginia Tech this includes the Forest Productivity Cooperative led by Tom Fox and the Forest Modeling Research Cooperative led by Harold Burkhart. The NSF Center for Advanced Forestry Systems is designed to foster collaborative research between universities and forest industry that will increase the productivity, profitability, and sustainability of plantation forest management. The overall goal is to facilitate the development and application of forest science and technology needed by forest industry to remain globally competitive.

CAFS-sponsored research underway at Virginia Tech includes:

- Developing precision silvicultural regimes for clonal plantations of loblolly pine in the United States and South America
- Evaluating the potential productivity of loblolly pine in the southeastern United States and in Latin America across climatic-geologic-edaphic gradients
- Improving our understanding of the ecophysiology of loblolly pine and the responses in nutrient uptake, leaf area, light interception, photosynthesis, and respiration to silvicultural treatments in loblolly pine plantations
- Using stable isotopes of nitrogen to trace the fate of applied nitrogen fertilizers in forest plantations to evaluate fertilizer uptake efficiency
- Developing growth and yield predictions for diverse genotypes and silvicultural practices
- Developing improved understanding of stand response of loblolly pine to silvicultural treatments such as thinning and fertilization
- Determining the influence of soils and climate variables on tree and stand growth and mortality
- Integrating growth and yield models into decision-support systems

For additional information, contact:

Dr. Thomas Fox	(540) 231-8862	trfox@vt.edu
Dr. Harold Burkhart	(540) 231-6952	burkhart@vt.edu

http://www.cnr.ncsu.edu/fer/cafs/

OUTREACH AND ENGAGEMENT

The outreach and engagement programs in the Department of Forest Resources and Environmental Conservation seek to strengthen and enhance the management of forest resources through educational programming and information transfer to all publics of our society. Programming is diversified to serve many audiences having varied objectives and interests.

Outreach programs are conducted in a variety of fields and using a host of methods. In the College of Natural Resources and Environment, outreach programs are organized into the following five categories:

- Cooperative and industrial Extension programs
- Continuing education programs
- Youth and teacher education programs
- Economic development programs
- International development programs

In the Department of Forest Resources and Environmental Conservation, faculty, staff, and students are actively involved in programs within all of these categories. Cooperative and industrial Extension programs are offered to a variety of audiences, such as forest landowners and loggers. Primary subject areas include forest management and economics, silvicultural applications, and timber harvesting. Educational programs are offered throughout the state in cooperation with the Virginia Department of Forestry, the Virginia Forestry Association, the State Implementation Committee of the Sustainable Forestry Initiative, and many other groups. One or more of the department's Extension specialists and associates generally coordinates Extension programs.

Continuing education (CE) programs are offered to professional audiences such as foresters, wildlife managers, certified public accountants, etc. These fee-based programs are conducted in cooperation with Virginia Tech's Office of Outreach Program Development and include several different types, such as open enrollment programs, contract programs, conference services, and research dissemination programs. The Department of Forest Resources and Environmental Conservation has an active CE program, involving both Extension and non-Extension faculty as coordinators and instructors. Programs are regularly offered in the areas of forest management and economics, silviculture, forest biometrics, and timber harvesting.

The Department of Forest Resources and Environmental Conservation is actively involved in educational programs to benefit youth and the teachers and adult leaders who work with school-aged children. Departmental faculty, staff, and students are actively involved through 4-H summer camp programs, 4-H in-school projects and judging programs, and middle school teacher and student projects.

In addition to educational programs and projects, faculty in the department are actively engaged in publishing educational bulletins, developing educational curriculum materials, producing newsletters and magazine columns, preparing videotapes, and developing and maintaining educational web sites.

The Department of Forest Resources and Environmental Conservation is committed to supporting economic development activities throughout the Commonwealth. Faculty and staff regularly consult and provide technical assistance to companies and other state agencies in support of broad-based economic development efforts. In addition, many of the continuing education and Cooperative Extension programs support the economic development mission.

International programs are an important component of the Department of Forest Resources and Environmental Conservation's outreach portfolio. Active involvement in international projects broadens the knowledge base of faculty, staff, and students and helps to connect the department with the rest of the world.

Virginia Forest Landowner Education Program

The Virginia Forest Landowner Education Program (VFLEP) develops and delivers educational programs about sustainable forest management to over 10,000 Virginia forest owners annually. This program is coordinated through Virginia Tech's Department of Forest Resources and Environmental Conservation.

Specific goals of VFLEP include:

- providing woodland owners with the knowledge and tools they need to practice sustainable forest management
- increasing the health and productivity of Virginia's 10.1 million acres of privately-owned woodlands
- generating public understanding and support for the management of Virginia's vast forest resources
- conserving Virginia's woodland base

Forest Landowner Weekend Retreats

Forestry is the third largest industry in Virginia. It contributes over $17 billion a year to the economy. Forests also provide clean water and air, plant and wildlife habitat, scenery and recreational opportunities, and soil protection and enhancement. The annual value of these environmental benefits is estimated to be $21.8 billion.

Most of our forests (68%) are owned by private families. An aging ownership and rapid turnover of land results in constantly changing ownership. While most owners claim a conservation ethic, few have the knowledge and experience to recognize and practice sustainability. Research into landowner decision making highlights the importance of planning, professional assistance, and peer influence to increase stewardship while meeting society's demands.

To reach these new landowners, the VFLEP and the Virginia Department of Forestry developed the Forest Landowner Weekend Retreat Program. This day-and-a-half program combines classroom, field, and hands-on learning experiences to introduce landowners to basic forest management concepts, skills, and natural resource professionals.

From its inception in 2008 through 2012, this program was offered annually in central Virginia locations. Due to its success the program was expanded in 2013 to include a southeastern location and expanded again in 2014 to include a southwestern location. To date nine retreats have been held.

Over 200 landowners have attended retreats. The average ownership size of attendees is 90 acres. As a result of attending a retreat, exit surveys indicate that 10% of landowners intended to contact a natural resource professional, 9% intended to obtain a management plan, 5% planned to control invasive species on their land, and 5% intended to harvest timber.

However, the interesting story lies in anecdotal evidence. After the retreats we hear from our speakers, who tell us they have been contacted by participants who want to donate easements, join Tree Farm, obtain a management plan, sell timber, etc. We are in the process of refining our exit survey tool and developing a follow-up survey for early participants in the program so we can better tell this story. The follow-up survey will be distributed in spring 2015.

For additional information, contact:
Ms. Jennifer Gagnon (540) 231-6391 jgagnon@vt.edu
http://forestupdate.frec.vt.edu/

Virginia Geospatial Extension Program

Geospatial tools include the application of geographic information systems (GIS), global positioning systems (GPS), and remote sensing. The Virginia Geospatial Extension Specialist (VGES) acts as a knowledge broker, or the two-way conduit, between geospatial research, applications development, and practice. The VGES has a national reach and leverages the expertise of Virginia Cooperative Extension agents and specialists.

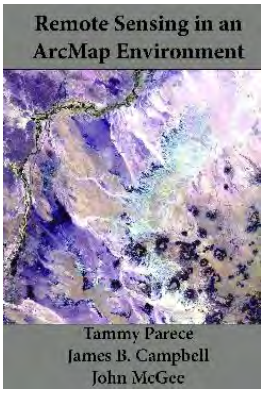
VirginiaGeospatial ExtensionPROGRAM
gep.frec.vt.edu

The program provides:

- the development of resources to facilitate geospatial pipeline education initiatives
- hands-on geospatial technical training through workforce development initiatives
- strategic planning for local governments
- expertise to facilitate the integration of computer-aided tools with the planning and management needs of stakeholders

In addition to working closely with extension agents and specialists, the program works closely with local, state, and federal government employees; Virginia's vibrant geospatial private sector; precollege educators; and faculty throughout Virginia's institutions of higher education.

Examples of programming efforts include:



- *Geospatial Workshops* – for local government employees, state agency employees, the private sector, and others. These are offered free or at very low cost basis to facilitate the diffusion of geospatial knowledge.
- *Geospatial Technician Education* (GeoTEd) – provides training and resources necessary to develop and implement a GIS program to support industry needs. This effort has been expanded to support the mid-Atlantic region and has resulted in 20 new geospatial course offerings across Virginia's community colleges.
- *Urban Tree Canopy Project* – provides a baseline inventory of tree canopy and online map viewer applications (http://utcmapper.frec.vt.edu) for local jurisdictions and other stakeholders. Version 2 of the mapper was published in fall 2013.
- *VirginiaView* – provides educators and other stakeholders across Virginia with access to remote sensing imagery and educational resources to support their educational and workforce development efforts (http://www.virginiaview.net). Video tutorials developed in November, 2013, were downloaded over 30,000 times via the Geospatial YouTube Channel during the first nine months. (http://www.youtube.com/user/VaGeoExtension).
- *UAS Implementation* – The Geospatial Extension Program is working with other stakeholders across the state and the nation to safely and efficiently initiate Unmanned Aircraft Systems educational efforts.
- *Map@syst* – an eXtension community of practice designed to develop a Wiki-based clearinghouse for geospatial information

For additional information, contact:
Dr. John McGee (540) 231-2428 jmcg@vt.edu
http://gep.frec.vt.edu/

Virginia Master Naturalist Program

The Virginia Master Naturalist program is a volunteer training and service program providing education, outreach, and service to benefit natural resources and natural areas in Virginia. Volunteer training includes a minimum of 40 hours of classroom and field time in natural history and natural resource management. To become a Certified Virginia Master Naturalist, each volunteer must complete 40 hours of service in education, citizen science, or land stewardship. The program is sponsored jointly by Virginia Cooperative Extension, Virginia Department of Conservation and Recreation, Virginia Department of Environmental Quality, Virginia Department of Forestry, Virginia Department of Game and Inland Fisheries, and the Virginia Museum of Natural History, with additional support from the Virginia Tech College of Natural Resources and Environment and the Department of Forest Resources and Environmental Conservation. In addition the 29 program chapters across the state work with more than 300 local partners, including schools, nature centers, nonprofits, and local governments. Currently the program has 1,467 active volunteers. Since the program's inception in 2005, these volunteers have contributed 526,570 hours of service—with a value of $12.4 million—to the Commonwealth of Virginia.

Responding to a request from a resident, VMN volunteers prepared tree labels, a book, and pamphlets that identified the trees at a continuing-care facility in Richmond.

In 2014 Virginia Master Naturalist volunteers completed more than 26,000 hours of service on projects to educate the public about natural resources. They made more than 102,000 youth and adult contacts through these educational efforts. Some example programs included advising landowners about landscaping to protect water quality, leading Meaningful Watershed Educational Experiences for youth, and presenting at public outreach events in state parks and other natural areas.

Virginia Master Naturalists completed more than 25,000 hours of service on stewardship projects, such as habitat restoration and trail maintenance, in 2014. Their efforts positively impacted more than 1,200 acres of land and more than 1,000 miles of trails and streams in Virginia.

VMN volunteers are leading an effort to restore wildlife habitat at Pleasant Grove Park in Fluvanna County. They have planted hundreds of trees and spearheaded an effort to replace mowed turf with grasslands to support quail.

Also in 2014 Virginia Master Naturalists completed more than 35,000 hours of citizen science, collecting data on wildlife populations, urban forests, and aquatic habitats in their communities. A grant from the National Science Foundation is providing support for online training and coordinating for regional citizen science projects that directly meet the needs of Virginia's natural resource managers. New projects include mapping the extent of invasive grasses in a threatened, fire-managed ecosystem and testing the effectiveness of treatment methods and measuring the effect of stream buffers around buffered agricultural land under conservation easement.

For additional information, contact:
Dr. Alycia W. Crall (434) 872-4580 masternaturalist@vt.edu
http://www.virginiamasternaturalist.org/

Virginia SHARP Logger Program

Virginia's **SHARP** Logger Program (**SHARP** = **S**ustainable **H**arvesting **A**nd **R**esource **P**rofessional) provides training to loggers, foresters, and others throughout Virginia. This training focuses on the principles of sustainable forestry, environmental protection, and workplace safety. The SHARP Logger Program was implemented in 1996 as part of the nationwide Sustainable Forestry Initiative (SFI). Since 2002 the Virginia Tech Department of Forest Resources and Environmental Conservation has been responsible for the administration and coordination of the SHARP Logger Program as a Virginia Tech Forestry Extension Program. The SHARP Logger Program is a cooperative effort between the Department of Forest Resources and Environmental Conservation, the Virginia SFI Implementation Committee, Virginia Cooperative Extension District Forestry and Natural Resources Extension Agents, and many others in Virginia's forest industry.

In order to become a SHARP Logger, participants must complete a three-part core program consisting of classes on sustainable forestry, logging safety, and pre-harvest planning and BMPs. After completing the core program, SHARP Loggers must earn 12 hours of Continuing Education (CE) credits every three years to maintain their SHARP Logger status. Over 3,700 individuals have completed the core program requirements to become SHARP loggers.

In 2014 the core SHARP Logger Program was offered at four locations throughout the Commonwealth, and 117 "new" SHARP loggers completed the core program. Twenty continuing education classes were offered across Virginia for SHARP Logger CE credits, and 1,312 individuals attended at least one program to earn SHARP Logger CE credits. These SHARP Loggers received a combined total of over 8,300 hours of training in 2014. As of January 1, 2015, there were a total of 1,353 active SHARP Loggers. The goal of the SHARP Logger Continuing Education program is to offer a diverse mixture of classes with face-to-face training provided by experts in their fields. The program also offers seven online courses available on the SHARP Logger website.

Examples of CE classes offered in 2014 include:

- Chipper maintenance and productivity workshop
- Logging business management workshop
- BMP & water quality workshops
- GPS for loggers
- Logging safety awareness workshop & OSHA refresher
- Invasive exotic species workshop

For additional information, contact:
Dr. Scott Barrett (540) 231-6702 sbarrett@vt.edu
http://sharplogger.vt.edu/

INTERNATIONAL ACTIVITIES

JANAKI ALAVALAPATI worked with the U.S. Embassy in Sao Paulo, Brazil, to build networks among Federal University of Parana, Brazilian Forest Service, Brazilian forest industry, and other civil societies to enhance forestry education, research, and outreach capacities in the states of Sao Paulo and Parana.

GREGORY AMACHER continues to manage projects in Amazonia and to collaborate with colleagues at University of Helsinki, Natural Resources Institute Finland, and INRA in Nancy, France.

HAROLD BURKHART made a presentation at the joint meeting of the International Union of Forest Research Organizations World Congress and the Society of American Foresters National Convention, Salt Lake City, Utah.

CAROLYN COPENHEAVER co-instructed (with Dr. Jim Speer from Indiana University and Dr. David Frank from the Swiss Federal Institute for Forest, Snow and Landscape Research) a workshop on dendroclimatology at the International Dendroecological Fieldweek in Tazmania, Australia. The results of the workshop were later presented at the WorldDendro 2014 Conference in Melbourne, Australia.

SUSAN DAY co-led a Study Abroad course during the 2014 Wintermester. She traveled with 16 students to Barcelona and Valencia, Spain, to experience agriculture and natural resources management in Spain and learn the Spanish language.

THOMAS FOX continues to serve as Co-Director of the Forest Productivity Cooperative (FPC), which has 65 industrial members located in 11 countries. The FPC conducts translational research designed to increase the productivity and sustainability of plantation forestry throughout North and South America. Dr. Fox travels extensively throughout the United States and Latin America working with members of the FPC to develop silvicultural regimes for pine and eucalyptus species that optimize productivity and value.

In 2014 Dr. Fox was elected chair of the International Union of Forest Research Organizations (IUFRO) Forest Soils Working Group. In this position he helps organize IUFRO activities and meetings on forest soils and related topics.

Dr. Fox hosted Dr. Chandra B. Pandey as a visiting Fulbright Scholar during 2014. Dr. Pandey is the Principal Scientist and Head of the Division of Natural Resources and Environment at the Central Arid Zone Research Institute in India. While at Virginia Tech he worked on a study of nitrate reduction in forest soils.

JASON HOLLIDAY collaborated on a grant proposal to the Comisión Nacional de Investigación Científica y Tecnológica (CONICYT) with Dr. Fernando Guerra (Instituto de Ciencias Biológicas Universidad de Talca, Chile) and on a grant proposal to the USAID Partnerships for Enhanced Engagement in Research (PEER) with Dr. Alice Muchugi (World Agroforestry Center, Nairobi, Kenya). He also continues to participate in the Genome Canada-funded "Adaptree" project. In collaboration with co-PIs at University of British Columbia and University of Alberta, this project aims at better understanding the genomic basis for climatic adaptation in lodgepole pine (*Pinus contorta*) and interior spruce (*Picea glauca* x *Engelmanii*). This information will then be used to develop new seed transfer policy aimed at maximizing productivity and adaptability of reforested lands.

CAROL FRANCO participated in the United Nations Framework Convention on Climate Change (UNFCCC)-COP 20 in Lima, Peru, as a Dominican delegate and technical advisor in the following topics: the New Climate Change Agreement (ADP), REDD+, Financing and the Green Climate Fund, and Response Measures. She also worked in Mexico providing technical support for the development of their Forest Monitoring, Reporting, and Verification (MRV) System and conducted research on the development of an operational research framework to assess local response to flooding in coastal areas in the Dominican Republic.

JEFFREY MARION hosted a visit by three scientists from the Chinese Academy of Forestry (CAF) to facilitate discussions with U.S. agency staff and the collection of U.S. literature related to the study objectives. Dr. Marion accompanied the CAF scientists on visits to the Patuxent Wildlife Research Center and Refuge, to Washington, DC, to meet with senior staff of the National Park Service and U.S. Forest Service, and to several Virginia area federal agency field offices. He also planned their visits to Muir Woods in California and Yellowstone National Park. Field visits to U.S. national parks, forests, and wildlife refuges allowed the Chinese visitors to see sustainable recreation actions in practice and to see or collect their recreation data collection and planning documents at the unit level.

During 2014 ***JOHN McGEE*** developed, organized, and marketed a two-week Wintermester 2015 global studies course in Panama. The course provided 13 students with five days in an urban environment (Panama City), a week collecting data and supporting research with biologists in a tropical rainforest in the Cocobolo conservation area, and three days on the San Blas islands (a marine environment) living with the Kuna. In addition to learning about Panama, students were involved in a service learning project designed to support a rural farming family.

DANIEL McLAUGHLIN collaborated with a colleague at University of Waterloo (Canada) on a project focused on improving water sustainability in rural South India. Specifically, this project employed hydrologic monitoring and analysis to quantify unaccounted losses from reservoirs being used for irrigation supply, with the goal of informing village-based management of these systems.

JOHN MUNSELL conducted a study of Cameroonian farmers who have used agroforestry practices for at least three years and evaluated impacts of agroforestry practices on economy, environment, and community. He visited 10 villages and spoke with nearly 80 men and women over the course of two trips to Cameroon and observed that planting configurations have not changed much since the farmers started incorporating agroforestry practices, but understanding and appreciation of agroforestry's conservation benefits has increased.

Not only does agroforestry benefit farmers, it can reduce pressure on wildlife habitat. To help further conservation in the region, Munsell linked local nongovernment organizations with Virginia Tech wildlife monitoring specialist Michael St. Germain, a research associate with the college's Conservation Management Institute. Munsell and St. Germain are working with the Environmental and Rural Development Foundation in Cameroon, and Munsell is working with Trees for the Future, a U.S. nongovernment organization that has partnered with the foundation. The multi-organizational partnership is geared to simultaneously address both human and wildlife issues in the developing rural areas of Cameroon.

MICHAEL SORICE and his colleagues continue work in Tierra del Fuego, Argentina, to understand perspectives of private landowners toward an invasive species, the North American beaver. He also continues to work with a colleague at Pontificia Universidad Católica de Chile on a project to evaluate the potential for a conservation incentive program to encourage artisanal fishers to set aside marine protected areas within their fishing zones.

Dr. Sorice continued his role as part of a technical advisory team to United Nations Environment Programme Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range. He provided input into current issues regarding mortality of the dugong, a marine mammal, as a result of interactions with the fishing gear of artisanal fishers.

He also volunteered during the summer of 2014 at the Royal University of Phnom Penh, Cambodia, to assist with the development of curricula for an outdoor recreation undergraduate major as well as advising on planning for a graduate program in the Department of Tourism & Resource Management.

MARC STERN traveled to Bali, Indonesia, on research leave from January-June, 2014. While there, he worked on a book project, on setting up study abroad experiences for Executive Master of Natural Resources students, and on numerous sustainability projects. Dr. Stern also traveled to Sydney, Australia, to serve as a delegate to the World Parks Congress, which was attended by over 6,000 participants from over 170 countries. Dr. Stern was involved in five presentations at the conference focused on conflict resolution, adaptive governance of protected areas, and creative and innovative approaches to environmental education and communication.

Virginia Tech and Virginia State University are working in South Sudan on a USAID-sponsored program entitled "Rebuilding Higher Education in Agriculture." The goal of the program is to help redevelop agricultural education in post-conflict South Sudan. Within our department ***JOHN SEILER*** and ***BRIAN STRAHM*** are currently serving as graduate advisors to Ruba Bilal, an instructor at the University of Juba, as he pursues a Ph.D. at Virginia Tech. Ruba is here to develop the techniques and skills required to return to South Sudan and become one of the country's leaders in forest productivity and resources, particularly in the country's teak (*Tectona grandis*) plantations.

Under a USAID grant, ***JAY SULLIVAN*** and ***JOHN SEILER*** are co-advising a Senegalese student who is studying gum Arabic production from *Acacia senegal* trees. They are examining the physiology of seven provenances from around Senegal to determine the best seed sources to use when drought or saline conditions are prevalent. They are also measuring tree growth and gum production in an established research site in rural Senegal to aid in understanding the economics of gum and fuelwood production for local producers, hoping to improve the efficiency of production and use of the species in agroforestry systems.

MATTHEW SUMNALL is collaborating with Dr. Ross Hill (Bournemouth University, UK) and Dr. Shelley Hinsley (Centre for Ecology and Hydrology, UK) on a peer-reviewed publication entitled *Comparison of discrete return and full waveform lidar data and their fusion with hyperspectral data for estimating multiple forest variables*.

QUINN THOMAS gave an invited talk in Beijing, China, as part of a joint China-U.S. sponsored meeting focused on better using observations from ecosystem studies of global change factors (N inputs, elevated CO_2, higher temperatures, and altered precipitation patterns) to evaluate and improve Earth system models. Earth system models are the primary models that are used to predict future climate. He also gave an invited lecture at University of Edinburgh and developed a new ecosystem model designed to predict forest carbon and nitrogen cycling with Dr. Mathew Williams at the University of Edinburgh. Dr. Thomas was an invited instructor at a summer course for Ph.D. students as part of the MICMoR Summer School "Examining Mountain Ecosystems in Regional to Global Environments of Carbon-cycling and Climate (EMERGE-CC)" at the Institute of Meteorology and Climate Research KIT/IMK-IFU, Garmisch-Partenkirchen, Germany, where he designed and led activities that provided the students with hands-on experience with climate modeling.

The research of ***VALERIE THOMAS*** was selected to be re-highlighted as a guest field note in a widely-used Canadian undergraduate textbook, *Human Geography: People, Place, and Culture – Canadian Second Edition*, by Fouberg, Murphy, de Blij, and Nash.

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