



Professor Jim Fraser watches for a red knot flock to hone in on its main food source, tiny mussels called donax.

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COLLEGE OF NATURAL RESOURCES AND ENVIRONMENT

SUSTAINABLE COASTS



The Red Knot's Life Cycle Epitomizes the Heart of Sustainability

The microcosm can reflect the macrocosm because everything is connected; sometimes it just takes scientists a while to figure out *how* in the scheme of the larger ecosystem. By understanding natural systems, we begin to know how to live sustainably in an ever-changing landscape.



Jonathan Cohen, coordinator of the research project, watches red knots approach the cannon net on a barrier island off Virginia's Eastern Shore.

A team of researchers, field technicians, and graduate students led by Professor Jim Fraser and Assistant Professor Sarah Karpanty in the college's Department of Fish and Wildlife Conservation has been studying one piece of the puzzle – a robin-size shorebird called the red knot.

The red knot was named a candidate for Endangered Species Act protection in 2006 and is currently considered seriously imperiled. In fact, its crashing population is one of the most rapid declines of any bird species. Fraser and Karpanty's team has been researching this migratory bird for the past five years and hopes for continued funding to find out why the knot population is spiraling downward.

One-quarter of the world's red knots migrate from their wintering grounds in southern Chile to their breeding grounds in the Arctic. They stop only once or twice en route before reaching the barrier islands of Virginia, where they spend a few weeks in May before continuing their journey. They arrive in Virginia emaciated; on the barrier islands, they feed and rest. "They must at least double their body weight in frenzied feeding before they take off for the Arctic, in order to successfully reach their nesting areas and have their young," explained Karpanty.

While many knots come to Virginia's barrier islands, where they feed on tiny clams called donax, others continue on to the Delaware Bay to feed on horseshoe crab eggs before continuing on to the Arctic. Near the end of summer after the breeding season, the knots make the 9,000-mile journey back to South America, stopping over at various places to rest up along the way.

Fraser and Karpanty's team uses cannon-netting to capture birds feeding along the shoreline of the barrier islands. The researchers carefully weigh them and measure their beaks, and then tag them for radio tracking.

"In the olden days, the red knots were shot for fun and food," Fraser recounts. "But when it became obvious to people that this was not a good thing to do, knot



After weighing and measuring a red knot, Cohen and Fraser attach a tracking device to it in order to monitor its survival and habitat use.

Red knots swarm in flocks before settling on the shoreline to feed on donax. (Photo by Barry Truit)



conservation began as one of the earliest efforts to preserve birds." Inadequate food supplies at Virginia's barrier islands and the Delaware Bay, coastal development, and changing climate are factors that Fraser believes may be reducing the red knot population.

The red knots' massive concentration at their traditional feeding areas during migration makes them vulnerable to pollution and loss of food supply. They spend more than 6 1/2 months flying between wintering and breeding grounds, so the knots' sustainability reflects many of the same things human



The red knot is a migratory bird that travels from Chile to the Arctic each year, stopping at Virginia's barrier islands and other points along the Mid-Atlantic to feed and gain weight before continuing north.

sustainability requires – clean water and air, stable climate, ecological balance for an adequate food supply, undisturbed habitat, healthy coasts and inlands – vital natural systems that sustain all life. If the red knot population dies out, it will be a signal that much more is imperiled.

Fraser's lifetime conservation work with eagles, piping plovers, red knots, and other birds qualified the accomplished wildlife scientist to receive a \$4 million grant this year along with co-investigators Karpanty and Research Assistant Professor Dan Catlin to evaluate the effects of the Gulf of Mexico oil spill on piping plovers, another threatened species of shorebirds.

"We have to understand the effects of human activities on shorebird population dynamics if we are to sustain our shorebird populations" Fraser said, "but beyond that, we must develop the collective will to conserve the few remaining fragments of wild, unpolluted coastline and to restore damaged shores. It is only by combining science with the will to conserve that we can ensure that our grandchildren and their grandchildren will witness the incredible spectacle of shorebird migration and hear the songs of shorebirds nesting on our beaches."



Today's World Through the Sustainability Lens

Sustain. Sustainability. Sustainable natural resources. Sustainable land. Sustainable forests. Sustainable climates. Sustainable wildlife. Sustainable energy. Sustainable materials. Sustainable businesses. Sustaining human existence. Sustainable planet. Actions today to sustain the future. The College of Natural Resources and Environment is positioning itself to lead and help define the sustainability movement. We are focused on clean air and abundant water, biodiversity, aquatic and terrestrial animals, climate issues, carbon sequestration, biomass for energy, sustainable biomaterials, species restoration, geospatial technologies to study landscape systems and environmental change, forested urban and rural landscapes, and more. We are at the foundation of sustainability – as you will see in this newsmagazine issue focusing on the college's groundwork in sustainability.

Paul M. Winistorfer
Dean
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Focus of Pine Cooperative Expands to Include Other Species

Loblolly pine, one of the most important commercial tree species grown in the southern United States, is used in a wide variety of wood products. Since it is highly responsive to management practices, it is often grown in managed plantations. The Loblolly Pine Growth and Yield Research Cooperative was established at Virginia Tech in 1979 to develop tree growth and stand development models for the species. Following ratification by its membership, which presently consists of 21 industrial sponsors, the organization changed its name to the Forest Modeling Research Cooperative (FMRC) in 2010.

While loblolly pine will continue to be a primary focus of the cooperative, the new name communicates a broader scope of modeling work that includes other species, production objectives, and regions. "The FMRC is currently developing models that account for thinning, fertilization, varietal plantings, site preparation, and pruning treatments on tree and stand growth while also investigating aspects of wood quality," said Senior Research Associate Ralph Amateis, assistant director of the cooperative. In addition to traditional wood products, the FMRC is developing modeling capabilities for management systems that include emerging product markets such as carbon credits and bioenergy.

As demand for forest products increases, timber harvesting is being restricted across much of the globe. "Intensive management allows for supplying wood products from a smaller land base, but it raises concerns about the maintenance of long-term soil productivity and environmental services such as clean water and air, wildlife habitat, and biodiversity," said Harold Burkhart, University Distinguished Professor and director of the cooperative. "Models of forest stand development, growth, and yield are required to objectively evaluate the stream of goods and services that might result from plantations."



The Forest Modeling Research Cooperative supports graduate students as they work on a variety of sustainability-related research projects.

The FMRC collaborates with private land managers as well as federal and state agencies on a wide range of research projects to develop improved growth and yield models for intensively managed forests and to incorporate forest stand projection systems into decision support tools. "These tools help managers make efficient use of available resources, including land, genetic material, and fertilizers, to grow wood and provide environmental services to meet the diverse needs of society," Amateis explained.

One of the cooperative's current projects involves developing a model appropriate for "flex stands," which are comprised of two populations of a single tree species planted on the same site and managed for alternative product objectives. "One population may have genetic, growth, or wood quality characteristics that warrant different planting densities or management treatments than the other population," added Amateis. One population is removed early in the growth cycle and used for bioenergy, allowing the other population to grow longer for harvest as lumber, which allows the site to be used more effectively.

SUSTAINABLE BIOMATERIALS

Sustainable Biomaterials Use Natural Resources for a Better World

Researchers in the Department of Wood Science and Forest Products are working to put sustainable, renewable, natural nanocomposites into everyday products and to improve quality of life. "Our faculty members are working to develop new technologies pertaining to nanocellulose and drug delivery systems with a focus on finding new ways to use natural resources in products that make for a better world," Department Head Barry Goodell explained.



Scott Rennekar holds a spool of wood cellulose-derived Lyocell yarn, used to make high-end fabrics and other products.

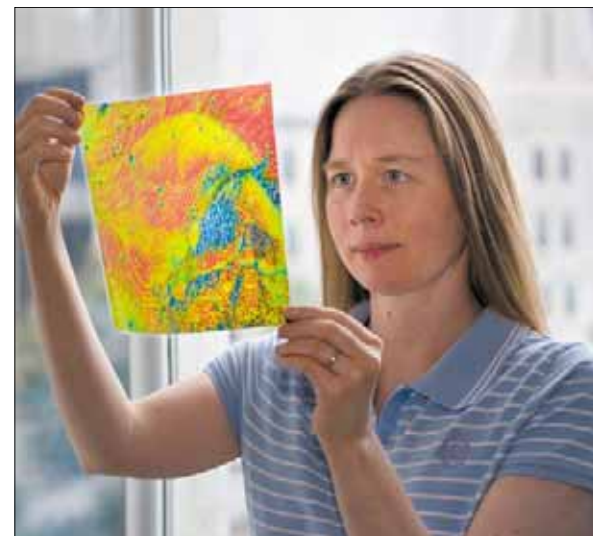
Biomaterials scientist Scott Rennekar is making inroads using biobased nanocomposites with nanomaterials derived from plants for such diverse applications as transparent films, paper additives, reinforcement for high-strength polymer composites, tissue scaffolds, high-end fabrics, and electronics. Nanocellulose materials are an environmentally sustainable form of nanotechnology because they combine utility with sustainability and safety, making them one of the most promising biobased nanomaterials.

"We have characterized these materials that have a thickness, sometimes less than 1 nanometer [one billionth of a meter], and hundreds to thousands of nanometers in length, and combined them with other biobased polymers to make films and foams with controlled architecture," Rennekar explained. "By starting with the basic building blocks found in plants, we hope that we can mimic the structure of the wood cell wall. That way, we may one day be able to take waste agriculture and forest residues, or recycled paper waste streams, and assemble isolated nanomaterials from them into composites that perform like wood, but with additives that enhance durability, aesthetics, and functionality."

Another biomaterials scientist, Maren Roman, is studying the use of cellulose-derived nanoparticles in cancer drug delivery. "My lab has developed a chemical strategy to target cellulose nanocrystals to malignant tumor cells, allowing the selective delivery of anticancer drugs to cancerous tissue while bypassing the healthy cells," stated Roman. In collaboration with a colleague at Virginia Tech-Wake Forest University's School of Biomedical Engineering and Sciences, Roman has

demonstrated that the targeted and drug-loaded cellulose nanocrystals are more effective in eradicating cancer cells than drugs alone.

Biobased polysaccharides are another area of emphasis. "Polysaccharides can make medicines work better, and they can outperform almost any other material, petroleum-based or otherwise, in drug delivery" said Professor Kevin Edgar, who directs the Biobased Materials Center in Virginia Tech's Institute for Critical Technology and Applied Science. Edgar's research group has made recent progress in developing polysaccharide derivatives to attack disease-causing organisms like the tuberculosis bacterium and the HIV virus.



Maren Roman is studying the use of cellulose-derived nanoparticles in cancer drug delivery.

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Wildlife Professor Addresses Sustainability From the Ground Up

Kathleen Alexander, associate professor of wildlife, admits that she was idealistic about sustainability when she first entered her field. "I wanted to save wildlife," she recalled, "but I was focused on conservation without including local communities in the process." All that changed in 2001 when Alexander began studying sustainable community-based wetlands management in northern Botswana. The project focused on actively engaging local communities as stakeholders in the research, something that Alexander had not fully done before. "It was hard," she admitted, "because at first the communities didn't understand who we were, what we were doing, or why we wanted to do it. We initially spent more time dealing with the stakeholders than with the research, but laying that foundation allowed us to address the sustainability issues in a much more meaningful way."

Though the process was difficult, it taught Alexander that practical answers to sustainability problems are only possible when researchers treat communities as partners. The experience set Alexander on a new mission – to help disenfranchised residents identify their own sustainability problems and solutions. Alexander's methods, including participatory geographic information systems (GIS) in which residents map their own wildlife conflicts, address what she defines as "the crux of sus-

tainability." "Outsiders have always told these communities how to address wildlife conflict," she explained, "but for sustainability initiatives to be effective, the people who own the problem also have to own the solution."



Kathleen Alexander began her work with communities while studying the health of domestic dogs living in rural communities around protected areas in Botswana.

To fund her initiatives, Alexander builds sustainability components into grants she receives for other types of research and includes a sustainability service requirement for graduate students in her program. Over the years, Alexander – in partnership with the Center for Conservation of African Resources:

Animals, Communities, and Land Use in Botswana (www.caracal.info) – has built a tiered program to address the country's sustainability issues in age-appropriate ways. A children's conservation club teaches 270 local children to see the beauty and value of their region's natural resources and to imagine the diverse economic opportunities that these resources provide. A youth program allows young adults who have graduated high school but haven't attended college to work alongside Alexander's graduate students in her field research projects, developing skills and a passion for science. A community-run craft center, for which Alexander has secured funding and is now building, will address vulnerable adults' economic needs by teaching them how to make and sell crafts within the area's strong tourism industry.

"In all our initiatives," emphasized Alexander, "we stand behind the communities, not in front of them." This attitude of facilitating community decision making rather than dictating it has earned Alexander the trust of the communities she works with. "Sustainability is about balancing the needs of humans and ecosystems to meet both in an equitable and socially justified way," she added. "My biggest accomplishment so far is that the communities know that I'm trying to serve them and not myself."

"Never underestimate the power of the free market. True sustainability will work for the environment and economics. Sustainability has to work for everyone, including the poorest among us."

Doug Domenech ('78 B.S. in forestry and wildlife)
Virginia Secretary of Natural Resources

"Sustainability is more than just the latest environmental buzzword. Sustainability is a complex system of inter-related functions that impact our lives every day and must be monitored and managed to ensure vital natural resources are here today and tomorrow for our children and grandchildren."

Carl E. Garrison, III, RF, CF ('78 B.S. in forestry and wildlife)
Virginia State Forester



Sustainability Matters

SUSTAINABLE BUSINESS

Forest Products Researchers Help Builders Go "Greener"

Waste from construction sites represents a significant portion of landfill content. To discourage this practice, "green" building systems reward builders for recycling wood construction waste. Daniel Hindman, associate professor of wood science and forest products, and Philip Araman, research team leader at the U.S. Forest Service Southern Research Station, initiated a project with Green Valley Builders in Blacksburg, an EarthCraft House certified builder, to quantify the construction waste generated at the company's Mount Tabor Meadows housing development and to explore options for reusing and recycling it.



Recovered materials are sorted and stored in trailers at the construction site.

"While some of the OSB material is being used for a variety of demonstration projects at the college's Brooks Forest Products Center, the majority of it has been donated to local Habitat for Humanity ReStores," Araman said. Untreated lumber waste was ground into mulch at the Montgomery County Solid Waste Authority Recycling Center. The researchers are searching for an industrial partner so that preservative pressure treated lumber recovered from the site can be finger jointed back together for use as sill plates in future construction projects.

"This collaboration represents a blend of industrial and academic research that could not have been accomplished by either party alone," Hindman remarked. The researchers have taken over two dozen groups to tour the Mount Tabor Meadows development over the last two years, giving students the opportunity to view green building practices firsthand. The collection and recycling of the sheathing and lumber has provided Green Valley Builders with points in the EarthCraft House system while providing data on construction waste generation in the building process, which is not well documented. The researchers are now planning to work with the builder on the next step of the project – implementing steps in the construction process to reduce the amount of waste generated.

Green Valley Builders and the Forest Service each purchased 28-foot trailers to store and transport the excess building materials to the university for analysis. Usable sizes of oriented strand board (OSB) were selected and cut into various-sized sections, which can be used as pallet repair parts, stair risers and treads, shelving, and flooring and wall sheathing.

Course Merges Business and Sustainability

As the world becomes increasingly aware of environmental issues, businesses look for ways to make their operations more sustainable. Tom Hammett, professor of forest products marketing, teaches a business course in the Department of Wood Science and Forest Products on maintaining sustainability. The course examines what it means to be "green" or "sustainable" by focusing on decisions related to sustainability, developing green business strategies and action plans, and product certification, eco-labeling, and chain-of-custody programs.



Students staffed a booth at the Green Living and Energy Expo in Roanoke that highlighted their research and outreach efforts in recycling, sustainable business planning, certification, and energy conservation.

Open to all majors, Sustainable Nature-Based Enterprises draws students from within the college as well as from other disciplines across campus and encourages them to focus on issues of resource sustainability. "We want to discuss what's feasible and what's practical," Hammett said. "We look at three aspects of sustainability: economical, ecological, and social."

Students get hands-on experience in the fields of business and sustainability by completing a service-learning project. "The students write a green business plan for a nonprofit, government, or private organization," explained Hammett. "Last fall, we had groups of students who worked with a green building company, the Matthews State Forest, Virginia Tech Dining Services to help incorporate more local foods into the dining halls, and even a local bed and breakfast interested in working on its sustainability," Hammett added. "These projects offer plenty of opportunities to not just learn these techniques but also to practice them."



Ecologists Help Land Managers Sustain Wildlife

Carola Haas, associate professor of wildlife ecology, and her research team have been assisting land managers in developing and implementing techniques for sustaining wildlife populations on lands used for agricultural production, timber harvest, or military activities. Haas' recent research examines how livestock activity affects habitat quality for the federally threatened bog turtle. She is also collaborating with colleagues in the College of Agriculture and Life Sciences to determine whether planting native species in pastures will result in more diverse populations of beneficial insects and grassland birds. "Several rare or declining species, such as bog turtles and grasshopper sparrows, occur in grasslands and emergent wetlands in Virginia, co-existing with livestock," noted Haas.

Haas' work is especially vital for forest landowners in Virginia who are interested in sustainable land management and protecting biodiversity. A landowner selling timber may opt for a partial harvest in order to retain some standing trees for wildlife. Through an ongoing



Graduate students Jeff Feaga and N. Danielle Bridgers help in the research effort by weighing, measuring, marking, and attaching radio transmitters to bog turtles.

study initiated in the early 1990s, faculty in several departments collaborated on the Southern Appalachian Silviculture and Biodiversity (SASAB) project. "Many

forest landowners are highly motivated to protect or improve habitat for wildlife but lack information about the best practices to achieve those goals," Haas commented. Researchers on the SASAB project found that small clearcuts may be the most sustainable approach, since they result in reduced soil erosion, improved regeneration of oak trees (which have high wildlife and timber values) through stump sprouting, and healthier populations of forest salamanders.

Tom Gorman, a research scientist in Haas' lab, leads an adaptive management project to restore wetlands on Eglin Air Force Base in Florida, an area in the range of the federally endangered reticulated flatwoods salamander. Since the project's initiation in 2009, the Florida Fish and Wildlife Conservation Commission and Hurlburt Field, an Air Force installation adjacent to Eglin, have implemented recommended wetland restoration techniques. Several rare or declining amphibians are expected to respond positively to efforts to restore or mimic natural processes in these wetlands.

Keeping National Park Visitors on the Beaten Path

National Park Service managers are faced with the increasing challenge of accommodating intensive visitation in areas that contain rare plant communities and species. In the Potomac Gorge area near Washington, D.C., visitors venturing off formal park trails to sightsee, explore, climb, and fish have created extensive networks of informal trails in the biologically significant natural area. Past efforts to restrict off-trail activities have been largely unsuccessful in reducing impacts to the riparian rocky areas that support the highest densities of rare plants.



Research efforts seek to protect rare plants near trails and recreation sites that are being harmed by visitor traffic in Potomac Gorge. (Photo by Russ Kennedy)

Responding to these concerns, a team led by Jeff Marion, a U.S. Geological Survey scientist and adjunct professor in the Department of Forest Resources and Environmental Conservation, developed a research program to make park visitation more sustainable by documenting the nature and severity of visitor impacts and developing management recommendations to avoid or minimize those impacts.

In one study, GPS units were used to locate and map a surprising 27.7 miles of informal trails, which were evaluated for various attributes. Another study assessed the efficacy of several experimentally applied treatments designed to reduce off-trail activity, including educational signs and site management actions. A visitor survey and observation of off-trail hiking behaviors along a popular park trail were used to evaluate success. Based on this research, off-trail hiking was reduced from 70 percent to 43 percent of visitors for the best treatment. The final study examined visitor impacts to cliffs and rocky areas at Potomac Gorge. "Visitor trampling has created 122 informal recreation sites with approximately two acres of intensive vegetation and soil disturbance," noted Marion.

Research results will document visitor impacts, describe the principal factors that influence them, and present a comprehensive array of recreation and site management options for increasing the sustainability of park visitation, including actions to promote low impact outdoor practices, close and restore duplicative or unnecessary recreation sites and informal trails, and reduce rates of off-trail hiking.

Sustainably Transferring Land to Generation "NEXT"

Virginia is poised to see one of the greatest shifts in forest landownership since the Kings' Grants. An aging baby boomer generation now owns the majority of Virginia's woodlands. Forty-one percent of private forest landowners are at least 65 years old and own a combined 10 million acres of forest land. Many are preparing to pass that land on to members of the next generation, whether they are ready for it or not.

Unfortunately, high land values and taxes force many heirs to sell inherited property to meet financial obligations, contributing to a loss of 27,000 forested acres per year. Proper estate planning, however, can help reduce this number and mitigate the tax burden. Without a plan, the sustainability of land ownership and natural resources are threatened as the pressure to sell, subdivide, and develop increases. "All the best science and practice of sustainable forest resource management mean nothing if the resource is sold, divided, developed, or otherwise transitions from viable forestland," said Adam Downing, forestry Extension agent.



Specialists can work directly with private landowners and their family members to discuss estate planning options. (Photo by Kathy Dixon, Virginia Farm Bureau)

Focusing on Land Transfer to Generation "NEXT" is making a difference by helping families make plans for managing their estates. Downing and Mike Santucci, forest conservation specialist with the Virginia Department of Forestry, developed the idea for this high-impact course, which has enabled land-

owners to better articulate their land transfer goals and begin planning for the future of their forests. Over the past two years, the 12-hour short course has graduated 79 individuals representing 44 family units. Participants estimated an average family savings of \$750,000 as a result of the program, and follow-up surveys revealed that over 90 percent of participants had begun estate planning in the six months following the course. As these landowners continue executing their plans, over 6,800 acres of land are expected to remain sustainable and family owned.

"As a result of either not knowing their options or an unwillingness to do the hard work of succession planning," Santucci added, "many families will end up either losing their land or dividing it up so small it's only a building lot, but it doesn't have to be that way." In addition to Santucci, Downing, and other Extension agents, partners in this effort include the Virginia Department of Agriculture and Consumer Services' Farm Transition grant program, the Piedmont Environmental Council, Farm Credit, the Ballyshannon Fund, and the Southern Risk Management Education Center.



Sustainability Matters

"Sustainability involves stepping out from under the umbrella of conventional thinking to consider a wider array of values, perspectives, and forms of knowledge, and reconsidering the ways we communicate with each other about each."

Marc Stern
Assistant Professor of Natural Resources
Education and Communication



Aquatic Ecosystem Services Impact Human Well-being

Researchers in the college's Department of Fish and Wildlife Conservation are working with colleagues from the University of Maryland and McGill University to explore the extent to which biodiversity conservation provides social benefits via effects on key aquatic ecosystem services. These services include water supply, water purification, nitrogen regulation, and wildlife-based recreation (e.g., bird watching and recreational fishing). Data will be collected from the Albemarle-Pamlico Basin, which spans Virginia and North Carolina. Researchers are also exploring applications of the findings to the New River Valley.

The project will focus on mapping current and future capacity flow capabilities of each service, as well as developing tools to analyze how conservation actions provide social and economic benefits. Findings will be used

to assist stakeholders and managers in planning and achieving conservation goals. Knowledge of how these services benefit human well-being can greatly improve the cost-effectiveness and political support of conservation programs. "We use human well-being very generally

to mean those things that enhance quality of life, including personal health, spiritual renewal, income, longevity, and protection from disasters," said Professor Paul Angermeier, assistant leader of the Virginia Cooperative Fish and Wildlife Research Unit.



Researchers are examining the extent to which biodiversity conservation efforts provide social benefits by means of their effects on key aquatic ecosystem services.

A key component of this research is the involvement and participation of stakeholders in developing plausible future environmental scenarios – intended to reflect potential environmental-response actions such as resource-use change, urban development, or climate change – that would be of special interest to decision makers in the basin. Ultimately, scenarios will be used in a series of basin-wide models to investigate the outcome of management decisions for delivery of aquatic ecosystem services important to area residents.



CMI Mapping National Wetlands

Wetlands, once considered useless, are now valued for providing a diverse range of beneficial ecosystem services, including flood control, water quality, and wildlife habitat. The college's Conservation Management Institute (CMI) is working with the U.S. Fish and Wildlife Service to complete updates to the National Wetland Inventory and provide additional information to help understand wetland functions and inform decision making at all levels of government.

CMI researchers are using a combination of traditional photogrammetry and more sophisticated geospatial techniques to identify and delineate wetlands from aerial photographs. Projects are staffed with a combination of research faculty, staff, and student workers. "Working with students allows us to offer an opportunity for their professional growth while providing quality results for our sponsors," CMI Project Manager Kevin McGuckin explained.

Wetlands are critical to ecosystem service sustainability.

Congress assigned the job of mapping, monitoring, and disseminating the extent and location of U.S. wetlands to the Fish and Wildlife Service through the National Wetland Inventory program in the mid-1970s. "The majority of these wetland maps are now outdated, significantly reducing their usefulness," said McGuckin.

"Wetlands are critical to ecosystem service sustainability," noted CMI Executive Director Scott Klopfer. "Unless we can provide a more expedient and efficient way of identifying and managing them, they will be lost." The Fish and Wildlife Service, CMI, and other groups are working to ensure that remaining wetlands are identified and continue to provide valuable ecosystem services. "The approach is working," Klopfer added. "CMI has now completed updated and enhanced wetland maps from Maine to the Gulf Coast."

College Plays Role in Hydropower Expansion

Hydropower is a clean, renewable source of energy that has been used in the United States since the late 1800s. Hydropower accounted for 25 percent of the country's electricity prior to the Great Depression, and capacity had tripled by 1980. Hydropower now makes up only 7 percent of electricity production, yet it is still the largest renewable source. "North America is at the cusp of another hydropower expansion, through the modernization of existing plants, adding turbines at existing non-powered dams, and building small, non-commercial turbines and water current projects," said Donald Orth, the Thomas H. Jones Professor of Fisheries and Wildlife Sciences. Recent analysis predicts that America's hydropower industry could add up to 1.4 million jobs by 2025 if a national policy mandating a 25 percent renewable electricity requirement is adopted.

The college is positioned to assist in these endeavors by producing a specialized workforce to deal with the issues of operations, maintenance, regulation, fish and wildlife damage mitigation, and fair distribution of benefits. "Faculty members have expertise in river and

reservoir water quality, fish protection and screening at hydropower plants, population viability analysis, and environmental analysis of the costs and benefits of alternative operation regimes," Orth added. All of these skills are essential to the process of licensing new hydropower facilities as well as the rehabilitation and upgrade of existing facilities.

During a recent collaborative project with Alcoa Power Generating, Inc., the U.S. Forest Service, and North Carolina wildlife and environmental management agencies, Orth performed a follow-up evaluation of 2004 license requirements for an Alcoa project on North Carolina's Cheoah River along with Associate Professor Andrew Dolloff and doctoral student Ryan McManamay. "The study was instrumental in isolating key pathways by which fish populations are influenced by dams via channel changes as well as streamflow changes," said Orth. The study showcased a collaborative approach to research, allowing the college to provide a new restoration template that will be used for restoring native stream flora and fauna in the upper Tennessee River basin.



College researchers are studying how hydropower expansion might affect fish species and their habitats.



Center Director Stephen Schoenholtz (R) and Research Scientist Charlene Kelly collect samples to determine the amount of dissolved nitrogen and carbon in stream water leaving a forested watershed.

Water Center Continues to Aid and Educate Virginians

Virginia's water resources have become central in many debates regarding the commonwealth's economic and environmental health. "Virginia has an ongoing need for information on water resources as energy use and climate change impose more demands on water resources. Since 1965, the Virginia Water Resources Research Center has been providing reliable, objective information on water resources," said Center Director Stephen Schoenholtz. The Water Center, based in the College of Natural Resources and Environment since 2005, has a three-fold mission: developing water information required for decision making by Virginia officials and citizens; advancing educational

opportunities for water-sciences students; and ensuring that water information is available to the public.

The center is involved in many initiatives, such as participating in the Academic Advisory Committee, formed to help the Virginia Department of Environmental Quality research water quality issues. The center uses e-mail, a radio show and podcast, newsletters, and an annual symposium to inform the public about the commonwealth's water resources and awards the annual William Walker Fellowship to support a graduate student entering the field of water resources.



D.C. Program on Sustainability Cusp

The natural resources programs offered by the college in the National Capital Region are specifically designed to meet the needs of working professionals seeking credentials for job advancement, a career change, or a graduate degree. Two recent additions complement the existing programs.

The college welcomed its first cohort of students to the Executive Master of Natural Resources program in leadership for sustainability in January 2011. "A primary goal of the program is to help students develop advanced leadership, management, and administration skills for addressing complex sustainability challenges. Interdisciplinary teamwork and cross-sector partnerships are essential professional skills that we emphasize in this program," explained David Robertson,

program coordinator. The 18-month accelerated graduate degree program includes a 10-day international residency and capstone project in which students, who represent a wide variety of disciplines and professions, work with a team of faculty mentors and real-world clients to tackle complex sustainability challenges.

The China Sustainability Initiative, a series of professional development programs and client services, offers a variety of cultural exchange and applied research experiences. The program includes a two-week study abroad trip to China in which participants – including graduate and senior undergraduate students, alumni, and professionals – gain international work experience as part of a consulting team performing service-learning projects for local clients and international partner organizations. "Our overall approach is to look broadly at sustainability challenges in rapidly developing and sensitive areas, combining the ecological,

economic, and cultural components common to all of these places," said Michael Mortimer, director of the National Capital Region's natural resources programs. Similar programs are currently being developed in India and Africa.



The National Capital Region's leadership programs enable students to work directly with stakeholders to address complex sustainability challenges.

Engagement Dean Forges Robust Outreach Program

In recent years Virginia Tech's outreach efforts, once thought of mainly in the context of Extension, have broadened significantly to include many other kinds of activities, not just in the state but across the nation and around the globe. "Our engagement mission today is to assist communities with sustainable management and



Virginia Master Naturalists provide education and outreach within their communities. Members of the Historic Rivers Chapter installed and monitored nest boxes for prothonotary warblers, a bird species that relies on swamps, bottom-land forests, and other wet, wooded areas.

utilization of our natural resources," explained Bob Smith, associate dean for engagement. "We accomplish this by integrating science that is developed within the college and university, and working with our community partners to implement programs that will allow future generations to enjoy our environment." Programs include the college's award-winning natural resource Cooperative Extension

programs, numerous service-learning programs, research at the undergraduate and graduate level that helps communities better understand the impact of our actions on the environment, and international programs that bring Virginia Tech's expertise around the world to help solve natural resource challenges.

Two leading and very successful programs in sustainable natural resources are within Virginia Cooperative Extension. The popular Virginia Master Naturalist Program is training a corps of volunteers to provide education, outreach, and other services dedicated to the sustainable management of natural resources within their communities. The high profile Virginia Forest Landowner Education Program helps Virginians keep their forests healthy and productive by educating landowners through a variety of courses and workshops so that they can meet their ownership objectives through sound forest stewardship and sustainable forestry practices. The program also helps build relationships among experienced and novice private forest landowners and Virginia's natural resource community.

Service-learning courses and undergraduate research projects offer students the opportunity to combine education with community service. In a multiyear effort, urban forestry students assessed the abundance, diversity, condition, and maintenance needs of publicly owned street trees for the City of Radford, and offered recommendations on how to improve the value of the city's street tree resource. Students work with community members and grassroots coordinators through the university's Catawba Sustainability Center to develop agroforestry plans that



Forestry graduate student Katie Trozzo (L) organized a tree planting event at the Catawba Sustainability Center last fall in which more than 50 students and community members planted edible perennial plants along the center's stream banks and roads.

incorporate whole-farm management while meeting landowner needs and investigate alternative forestry crops that could provide income for local landowners. Wood science and forest products students work with small businesses to address their real-world business problems, from product development to marketing research.

"Basically, the goal of engagement is to encourage collaboration among communities, students, and faculty to sustainably manage our natural resources for future generations," Smith concluded.

Students "Walk the Talk"

Students in the college take their commitment to preserving natural resources and the environment personally and often far beyond the classroom.

As president of the Environmental Coalition at Virginia Tech, **Kara Dodson**, a junior in the University Honors program majoring in environmental resources management, serves as a mediator between all coalition members to ensure that environmental initiatives are properly prioritized. She helps coordinate many events for the student-run organization, which promotes sustainable practices through various activities on campus, including Earth Week. Dodson is also a student representative on the University Energy and Sustainability Committee with Dean Paul Winistorfer.

Dodson, who recently switched majors from civil engineering where she focused on water sanitation and distribution, attributes her decision to a change in perspective on how to solve environmental issues. "Over the last few years I've really focused my personal education from technical answers to environmental issues to natural ones," said Dodson. In her three years of involvement with the Environmental Coalition, she has seen an increased awareness of sustainable practices on campus, which she credits to a shift in the academic climate towards sustainability and the addition of the university's Office of Sustainability and Energy. While there is still room for improvement, the Environmental Coalition also wants to be a platform that shapes leaders. "We want to empower and inspire people to make effective change," said Dodson.

Dodson's experience with the Environmental Coalition was shaped, in part, by the influence of **Angie DeSoto** ('09 B.S. in environmental policy and planning), who was a leader in the organization as a student. DeSoto, now enrolled in the college's Master of Natural Resources program in the National Capital Region, still works closely with the organization in her current position as the Virginia Tech campus sustainability planner.

The inspiring and innovative work of **Lars Battle**, another master's student in the National Capital Region, with the nonprofit organization Long Way Home is changing how people handle sustainability and waste management issues. In 2009, Long Way Home started building Escuela Técnico Maya, a 17-building primary and vocational school in the highlands of Guatemala, using alternative building techniques. The building strategy is extremely low-cost because it uses mostly local waste materials and on-site dirt in construction. "Residents cannot easily afford standard homes. However, by teaching them the skills they need to apply green building techniques for their personal benefit, they will recognize the potential for an improved quality of life through more resourceful behavior," Battle observed.



Kara Dodson (R) led a student project with the Environmental Coalition to help bring reusable drinking containers into campus dining halls.



CNRE Courses Reflect Growing Importance of Sustainability

It would be difficult to enter any discussion on natural resources and environmental issues without addressing sustainability in some manner. Accordingly, principles of sustainability permeate most of the courses offered within the College of Natural Resources and Environment.

First-year students may be enrolled in courses as diverse as Introduction to Human Geography (GEOG 1004), where they are exposed to evaluating human-environment relationships and global issues that include sustainability concerns, to Introduction to Wood Science and Forest Products (WOOD 1234), which introduces students to concepts of sustainability as they pertain to assessing wood materials as a resource and sustainable manufacturing processes.

Seniors, who will have been exposed to a great diversity of aspects of sustainability, typically enroll in a capstone course that helps them understand how to apply the principles they have learned to managing and sustaining the resources for which they will be responsible. Representative capstone courses across the college are Fisheries Management (FIW 4714), Conservation of Biological Diversity (FIW 4314), Integrated Forest Management Practicum (FOR 4444), Special Study: Urban Sustainability (GEOG 4984), Geography of Resources (GEOG 4204), and Senior Seminar in Forest Products Marketing and Management (WOOD 4004). At the conclusion of their undergraduate academic career, students are prepared to apply sustainability principles to environmental and resource management.



Principles of Fisheries and Wildlife Management (FIW 2114), a sophomore-level course, includes issues related to sustaining viable populations of fish and wildlife worldwide in the face of mounting environmental challenges. Nature and American Values (FOR 2554) helps students identify and celebrate the social and environmental qualities of a thriving and sustainable future. Global Forest Resource Sustainability (FOR/WOOD 2784) examines community management, certification, and the impact of conflict on forest-based resources such as wildlife, water, and ecosystem services. These three courses are open to all students, so many outside the college have opportunities to be exposed to concepts of environmental and resource sustainability.

Sustainability is a major focus of junior-level courses such as Wood Chemistry, Products, and Processes (WOOD 3434), Sustainable Nature-Based Enterprise (WOOD 3004), Mountain Geography (GEOG 3404), Forest Ecology and Sustainability (FOR 3364), Outdoor Recreation Planning (FOR 3564), Sustaining Human Societies and the Natural Environment (NR 3954/5954), and Ecology and Management of Wetland Systems (FIW 4534). For example, Forest Ecology and Sustainability (FOR 3364) provides non-forestry majors a broad education in the sustainability of forest resources and the communities upon which they depend. Sustaining Human Societies and the Natural Environment (NR 3954/5954) examines the impacts of human actions on natural systems and the challenges of balancing conservation with economic development.

Many other courses, such as Wildlife Field Biology (FIW 2324), Ichthyology (FIW 4424), Forest Biology and Dendrology (FOR 2314), and Dendrology Laboratory (FOR 2324), support sustainability efforts by teaching students how to identify and understand the ecology of the organisms that they seek to conserve. In Introduction to Land and Field Measurements (FOR 2214), Forest Boundaries and Roads (FOR 3724), Freshwater Biomonitoring (FIW 4484), Cartography (GEOG 3314), Introduction to Remote Sensing (GEOG 4354), Wood Materials Science and Technology (WOOD 2554), and other similar courses, students learn the techniques and methods necessary to monitor, manage, and enhance natural systems for sustainability. Without these tools, sustainable management of our resources would be much more difficult.

Graduate students within the college also have a number of courses available that allow them to build their sustainability portfolios, including Constructing Sustainability (NR/FOR 5014), Global Issues in Natural Resources (NR 5114), Advanced Fisheries Management (FIW 5714G), Stream Habitat Management (FIW 5814), Forest Soils and Hydrology (FOR 5354G), and Advanced Studies in Urban Forest Ecosystems (FOR 5474). In many cases, graduate students can also avail themselves of the college's senior-level courses to strengthen their background in sustainability.

Though not a comprehensive list, the courses below address sustainability in some way. Many additional courses sustain and support others that may focus more directly on sustainability.

Natural Resources (cross-listed courses)

NR 3954/5954 Sustaining Human Societies and the Natural Environment
NR/ALS 4614 Watershed Assessment, Management, and Policy
NR/FOR/FIW 5014 Constructing Sustainability
NR 5114 Global Issues in Natural Resources
NR 5714 Ecosystem Management
NR 5724 Conservation Ecology
NR 5864 Sustainability Science
NR 5884 International Conservation Development
NR 5984 Special Study: Conservation Project Design and Planning

Department of Fish and Wildlife Conservation

FIW 2114 Principles of Fisheries and Wildlife Management
FIW 2324 Wildlife Field Biology
FIW 4314 Conservation of Biological Diversity
FIW 4454 Vertebrate Pest Management
FIW 4534 Ecology and Management of Wetland Systems
FIW 4624 Marine Ecology
FIW 4714 Fisheries Management

FIW 5454G Advanced Vertebrate Pest Management
FIW 5534G Advanced Wetland Ecology and Management
FIW 5714G Advanced Fisheries Management
FIW 5814 Stream Habitat Management

Department of Forest Resources and Environmental Management

FOR 2554 Nature and American Values
FOR/WOOD 2784 Global Forest Resource Sustainability
FOR 3364 Forest Ecology and Sustainability
FOR 3524 Environmental Interpretation
FOR 3554 Outdoor Recreation Management
FOR 3564 Outdoor Recreation Planning
FOR 3574 Environmental Education Service Learning
FOR 3724 Forest Boundaries and Roads
FOR 4354/5354G Forest Soils and Hydrology
FOR 4374 Forested Wetlands
FOR 4434 Forest Resource Policy
FOR 4444 Integrated Forest Management Practicum
FOR 5354 Advanced Forest Soils

FOR 5474 Advanced Studies in Urban Forest Ecosystems
HORT 2134 Plants and Greenspaces in Urban Communities
HORT 3644 Landscape Establishment and Maintenance

Department of Geography

GEOG 1004 Introduction to Human Geography
GEOG 3404 Mountain Geography
GEOG 4204 Geography of Resources
GEOG 4984 Special Study: Urban Sustainability

Department of Wood Science and Forest Products

WOOD 2104 Principles of Packaging
WOOD 3004 Sustainable Nature-Based Enterprise
WOOD 3124 Paper and Paperboard Packaging
WOOD 3324 Green Building Systems
WOOD 3434 Wood Chemistry, Products, and Processes
WOOD 3634 Wood Products Manufacturing
WOOD 4444 Wood-Based Composite Materials



Sustainability Matters

"From my perspective, sustainability simply means the ability to maintain key components of a system over a chosen period of time. The difficult part of the process is identifying the necessary 'key' components and establishing the correct time period (which doesn't necessarily have to be 'forever')."

J. R. (Randy) Bush, CAE ('73 B.S. in forestry and wildlife)
President, Virginia Forest Products Association

"When something is sustainable, it has the capability to last without causing detriment to future generations. If these future generations are able to grow and thrive in the same way as previous generations, then a healthy and sustainable cycle has been formed."

Brittany Schultz Class of 2011, Conservation Education
CNRE Leadership Institute



Tree Line Ecosystems in the Rockies

Introduced species, pests, and pathogens increasingly threaten the sustainability of forests in North America. Invasive, exotic disease may result in the rapid decline of a tree species, thereby impacting ecosystem function; global warming may intensify these effects through heightened disease transmission rates or escalated susceptibility of stressed host species. Whitebark pine, a keystone and foundation species of subalpine and tree line communities of the western United States and Canada, is rapidly declining across most of its range, primarily from damage and death caused by the exotic and invasive disease, white pine blister rust. This decline is beginning to affect both the services and biodiversity of ecosystems located on mountains and around their bases.

Lynn Resler uses a GPS to record her location in the subalpine, where Ribes, the alternate host in the blister rust life cycle, is typically found in high abundance.

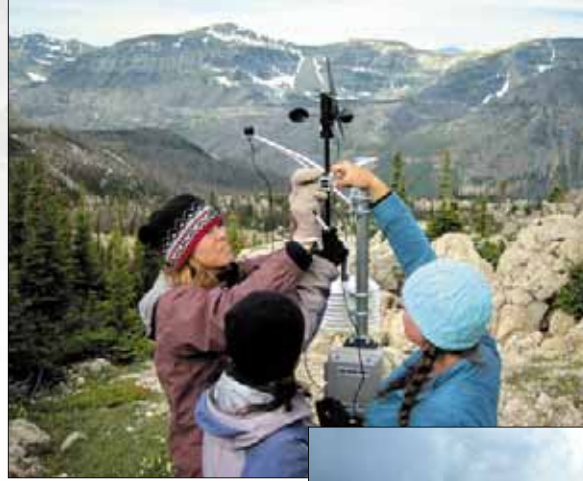


Lynn Resler, associate professor of geography, along with colleagues from the University of Colorado-Denver and the University of Iowa, is leading a four-year study funded by the National Science Foundation to investigate how white pine blister rust can alter ecosystem function through the mortality of whitebark pine. "Although whitebark pine is not an economically valuable tree species, it has tremendous ecological worth. Its decline due to white pine blister rust and stress from climate warming will affect mountain animals that rely on the pine seeds for food, decrease biodiversity, and threaten community stability," said Resler.

A key objective of Resler's research is to predict the combined impact of climate change and whitebark pine mortality at alpine tree lines. To achieve this goal, Resler and her graduate students are analyzing geographic variations in whitebark pine and blister rust incidence in the American and Canadian Rocky Mountains, and using spatial analysis to model the extent of blister rust infection in whitebark pine at alpine tree lines.

Ultimately, the team seeks to develop a predictive model to determine how the loss of whitebark pine to blister rust will affect alpine tree line and downslope ecosystems. Additionally, they believe natural experiments will uncover how the mortality of whitebark pine from the disease may affect ecosystem function. The results will provide direction for the development of mitigation techniques unique to tree line ecosystems.

Lauren Franklin (L) and Emily Smith measure a tree island at the upper limit of tree growth in Glacier National Park. Information on tree island size and composition will be used to understand how white pine blister rust is affecting tree line ecosystems.



Student researchers (L-R) Emily Smith, Kathryn Prociw, and Lauren Franklin set up a weather station at the tree line in northern Montana. The data will be used to understand how climate relates to infection of whitebark pine.

Emily Smith uses a hand lens to inspect needle morphology of a pine. Proper identification of whitebark pine can be challenging at the tree line, where cones are typically absent.



Lauren Franklin records her position with a GPS (above) and the position of a whitebark pine tree for subsequent mapping (right).



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CNRE "Green" Commuters

CNRE faculty, staff, and students walk the "green" talk. And some bike, bus, and carpool it! Pictured outside of Cheatham Hall are some of those who use sustainable means of getting to campus.