Ecological Process and Function Program

Pacific Northwest Research Station Mission

Our mission is to generate and communicate scientific knowledge that helps people understand and make informed choices about people, natural resources, and the environment.

Program Mission

The mission of the Ecological Process and Function Program is to advance and communicate knowledge of fundamental ecological processes and their interactions at multiple scales, and to develop applications of such knowledge that enable improved management of ecosystems and resources.

Research Problem Statements

Problem 1: How does the biophysical environment influence the function and properties of ecosystems, ecological communities, species, populations, and organisms?
Problem 2: What are the potential influences of climate change on ecosystem attributes, patterns, ecological processes, and their interactions?
Problem 3: How do disturbances influence ecological patterns and processes, and how do disturbances and ecological processes interact to determine the overall function, attributes, and dynamics of ecosystems?
Problem 4: What are the determinants of ecological status and trends of biota and ecosystems?

Key Findings in 2011

Arctic fire releases large amounts of stored carbon to the atmosphere
Arctic tundra soils store large amounts of carbon in cool wet soil hundreds to thousands of years old. Fire has been largely absent from this biome for thousands of years, but its frequency and extent are increasing, probably in response to climate warming. The Anaktuvuk River Fire in 2007 burned 645 square miles of Alaska's Arctic slope, making it the largest fire on record for the tundra biome and doubling the cumulative area burned since 1950. The fire released 20 times more carbon to the atmosphere than what is lost annually from undisturbed tundra. This amount is similar in magnitude to the annual net carbon sink for the entire Arctic tundra biome averaged over the last quarter of the 20th century. If fires become a regular disturbance in the Arctic, massive amounts of stored carbon could be released to the atmosphere, leading to further warming of the Earth's climate.

This research is being used to implement measurement techniques that estimate carbon loss in tundra areas. It is also being used by scientists who are initiating studies on the effect of fire disturbance on tree migration into the Arctic.
Contact: Teresa Hollingsworth, thollingsworth@fs.fed.us, Ecological Process and Function Program
Partners: Bonanza Creek Long-term Ecological Research Program, Marine Biological Laboratory, University of Alaska Fairbanks, University of Florida, USDI Bureau of Land Management Alaska Fire Service

New models aid management of elk habitat
Elk are widely distributed across western Oregon and Washington, and elk hunting and viewing contribute substantially to rural economies. Elk habitat models and management guidelines had become outdated, so station scientists updated elk nutrition and habitat selection models with an innovative approach that incorporates the latest research on elk nutrition and current spatial data. They used elk radiotelemetry data from many sources and geographic areas to develop and validate these models. They also created maps of nutritional adequacy for elk to evaluate how public access and other factors limit the degree to which nutritional resources are available to elk.

Modeling results are being used to coordinate management of elk habitat and populations among state and federal agencies, Indian tribes, hunting organizations, and other interested groups. The station hosted a workshop for users where several beta testers, including biologists with the Muckleshoot Indian Tribe, Oregon Bureau of Land Management, and Forest Service Pacific Northwest Region, demonstrated how they are incorporating modeling results in local habitat evaluation and land management planning.
Contact: Mary Rowland, mrowland@fs.fed.us, Ecological Process and Function Program
Partners: Boone and Crockett Club, Lower Elwha Klallam Tribe, Makah Nation, Muckleshoot Indian Tribe, National Council for Air and Stream Improvement, National Fish and Wildlife Foundation, Oregon Department of Fish and Wildlife, Oregon State University, Quileute Tribe, Rocky Mountain Elk Foundation, Sauk-Suiattle Indian Tribe, Sporting Conservation Council, USDA Forest Service Pacific Northwest Region, USDI Bureau of Land Management, Washington Department of Fish and Wildlife, West, Inc.
Use: Tribe, state, and federal land managers use model to manage elk habitat.

Maps summarizing projected change in global and North America vegetation available online

Until now, the sheer volume of information generated by the MC1 dynamic global vegetation model simulations has created a bottleneck when it comes to analysis, limiting its utility to managers, regulators, and policymakers. The MC1 model is routinely used in North America to predict vegetation impacts associated with climate-change projections to the year 2100, as well as associated changes to ecosystem services such as water availability and carbon sequestration. When using 5-by 5-mile grid cells, roughly 350,000 cells cover North America, and MC1 outputs for each cell include over 50 measures for each of three climate realizations (from multiple general-circulation models) and three carbon-emission scenarios, and data are output monthly for a 200-year simulation. The MC1 user community spans a large number of international, federal, state, local, and nongovernmental organizations. Now, the most commonly requested summary map products from the global and North American MC1 simulations are available to this community for viewing and download from the DataBasin Web site at http://databasin.org/.

Contact: Keith Reynolds, kreynolds@fs.fed.us, Ecological Process and Function Program

Partners: Conservation Biology Institute, Environmental Systems Research Institute, Oregon State University

Fire forecasting system provides basis for expenditure forecast and timing of prescribed fire

Station scientists produce continuously updated 7-month forecasts of fire potential and drought for the conterminous United States for use in fire management planning. As of 2010, these high-resolution forecast models are routinely run at the Arctic Region Supercomputer Center in partnership with the University of Alaska. Along with summary maps of predicted drought and fire potential, the MC1 Fire Forecasting System now also predicts area burned, the moisture content of several live and dead fuel classes, and measures of potential fire behavior including rate of spread, fireline intensity, and the energy release component. These detailed data are being provided as input to two new experimental forecasting systems under development by researchers at the Rocky Mountain Research Station and Western Regional Climate Center (WRCC).

The Rocky Mountain Research Station is using MC1 burn forecasts to predict annual firefighting expenditures with results that are significantly better than the professional judgments currently made at the National Interagency Fire Center. The

WRCC is using MC1 forecasts of fuel moisture and fire behavior to predict optimal timing for prescribed fire and posting them monthly to a WRCC-sponsored Web site.
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Partners: Desert Research Institute, National Interagency Fire Center, Oregon State University, University of Alaska, USDA Forest Service Rocky Mountain Research Station, Western Regional Climate Center

Connections between air and stream temperature more complex than previously thought

Recent warming of the terrestrial climate in most parts of the world has motivated concern about corresponding increases in water temperature. Based on observed climate trends in the Pacific Northwest, scientists expected to find warmer streams and increasing temperature variability over time. However, they found as many cooling as warming trends in 18 reference streams across western North America. Winter minimums have been increasing, but summer maximums less so. Scientists compared the reference streams with 45 streams that have been more influenced by humans. The temperatures during the past two decades show mostly cooling trends in minimally human-influenced sites, whereas more human-influenced systems showed mixed responses. The scientists also noted a lack of coherence between air temperature, stream temperature, and flow, which may be related to complex and lagged interactions among nonclimate and climate variables. These findings inform climate researchers as well as state and federal resource managers about temporal trends in stream temperature dynamics.
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Wolverine habitat projected to decline as climate warms

The wolverine's range is confined to cold areas, typically arctic or alpine habitats, where relatively deep snow cover persists through the end of the reproductive denning period in mid-May. In the Western contiguous United States, wolverine habitat occurs in an archipelago of alpine meadows and subalpine parklands that contain the climatic conditions necessary for their persistence. In that region, continued warming is expected to cause wolverine habitat to shift upward in elevation,

decreasing both its geographic extent and connectivity. Consequently, understanding the potential effects of continued climate warming on the distribution, extent, and connectivity of wolverine habitat is essential for their conservation in the contiguous United States.

Researchers modeled the distribution of spring snow cover within the Columbia, Upper Missouri, and Upper Colorado River Basins. They projected that 67 percent of suitable wolverine habitat in the study area will persist through 2030–2059, but only 37 percent will persist through 2070–2099. Although large (>600 square miles) contiguous areas of wolverine habitat are likely to persist throughout the 21st century, such areas will become smaller and more isolated over time. Dispersal modeling indicated that by the late 21st century, habitat isolation will occur at or above levels associated with the genetic isolation of wolverine populations. These findings played a key role in the recent decision by the U.S. Fish and Wildlife Service to list the wolverine in the contiguous United States as a candidate species under the Endangered Species Act (ESA).

The lead scientist was interviewed by several media outlets, including National Public Radio, *Wenatchee World*, *Yakima Herald-Republic*, and the *Methow Valley News*, about this wolverine research.

Contact: Keith Aubry, kaubry@fs.fed.us, Ecological Process and Function Program
Partners: University of Washington Climate Impacts Group, USDA Forest Service Rocky Mountain Research Station
Use: U.S. Fish and Wildlife Service uses findings in decision to list wolverine as a candidate species under the ESA.

Additional Findings

Mycorrhizal fungi on roots of tundra shrubs may facilitate postfire establishment of tree seedlings

Understanding the complex mechanisms controlling treeline advance or retreat has important implications for projecting ecosystem responses to direct and indirect effects of global environmental change. A warming climate not only promotes growth of seedlings and mature trees; it also enhances disturbances, such as fire that leads to further seedling establishment. Critical factors in postfire tree seedling establishment at treeline may be availability of fungal inoculum for the formation of critical mycorrhizas, which facilitate water and nutrient acquisition.

Preliminary results indicate that most species of tree seedlings can have overlapping fungal taxa with adjacent resprouting shrubs. Also, mature or late-successional fungi may be housed on the roots of tundra shrubs during fire

disturbance, which are then available for recruiting seedlings. Synergistic activity between resprouting tundra shrubs and newly established seedlings after fire could either maintain boreal community dynamics at the limit of tree establishment or provide a mechanism for expansion under future scenarios of warming and fire. Land and fire managers are using these results to help predict future successional trajectories in treeline and tundra ecosystems, and modelers are using these results to more accurately model mechanisms that limit and facilitate tree migration into previously unoccupied areas.
Contact: Teresa Hollingsworth, thollingsworth@fs.fed.us, Ecological Process and Function Program

Understanding physical processes of tree development offers clues to tree response to warmer climate

A tree undergoes many physical changes during its life. Leaf physiology, wood structure, mechanical properties, reproductive ability, and interactions with herbivores and pathogens are just some of the features that change as a seedling grows to maturity. Many of these changes are presumed to allow trees to acclimate to the environment and endure for millennia. Understanding these processes may be key to anticipating their response to warmer climates.

A new book, *Size- and Age-Related Changes in Tree Structure and Function,* highlights some implications of these size- and age-related changes for commercial forestry plantations with shortened rotational ages. It also discusses how current and future forests will likely respond to climate and other environmental changes.
Contact: Rick Meinzer, fmeinzer@fs.fed.us, Ecological Process and Function Program
Partners: Oregon State University, University of California Berkeley
For more info: Meinzer, F.C.; Lachenbruch, B.; Dawson, T.E., eds. 2011. Size- and age-related changes in tree structure and function. Tree Physiology 4. Springer Science and Business Media. http://www.springer.com/life+sciences/forestry/book/978-94-007-1241-6.

Scientists model cheatgrass invasion and pinyon-juniper woodland encroachment into sagebrush

Sagebrush ecosystems are one of the most imperiled in the United States, and the Great Basin ecoregion is particularly threatened by nonnative, invasive cheatgrass and encroaching pinyon-juniper woodland. Cheatgrass invasion can alter fire cycles, leading to more frequent and intense fires that eventually eliminate sagebrush shrublands. Pinyon-juniper encroachment can lead to soil erosion, altered

plant communities, losses in forage production, and high risk of crown fires.

Station scientists developed models to predict the risk of cheatgrass invasion and woodland encroachment across watersheds of the Great Basin. They found that watersheds differ in their spatial patterns of habitat abundance and risk, resulting in different implications for conservation and restoration. In central Oregon, they found that the densities and distribution of juniper trees pose substantial risk to sagebrush. Few of the juniper trees that were growing prior to Euro-American settlement (about 140 years ago) remain, and high densities of juniper seedlings and postsettlement junipers indicate extensive encroachment into sagebrush. This information can guide active restoration through targeted removal of encroaching juniper in sagebrush communities in this region.

Land managers from the USDI Bureau of Land Management have used these model projections to quantify potential habitat loss to sagebrush-associated species and to highlight watersheds for potential restoration.

Contact: Mary Rowland, mrowland@fs.fed.us, Ecological Process and Function Program

Partners: USDA Forest Service Remote Sensing Applications Center, Rocky Mountain Research Station, Washington Office Terrestrial Ecology Unit

Drought-related constraints on Douglas-fir growth are not primarily driven by constraints on photosynthesis

As trees grow, they sequester increasing amounts of atmospheric carbon, and thus have a crucial role in mitigating climate change. Climate projections for many areas of the Western United States indicate the likelihood of longer dry spells, which would inhibit tree growth. The exact mechanisms behind drought and decreased tree growth, however, are not known.

To better understand this, researchers analyzed shoot growth, plant and soil water stress, and storage of nonstructural carbohydrates in stem wood, branch tips, and foliage of Douglas-fir across a range of tree heights over 17 months. They found that contrary to previously accepted hypotheses, increasing drought severity leads to scenarios in which photosynthesis is less a determinant of productivity than other factors such as cell expansion and long-distance transport of carbon within trees.

Findings from this study can be used to improve models in which tree growth is primarily determined by the degree to which parameters such as humidity, soil moisture, and temperature limit a tree's ability to obtain carbon via photosynthesis. This may improve our understanding of how current and future climates may influence forest productivity.

Contact: David Woodruff, dwoodruff@fs.fed.us, Ecological Process and Function Program

Alternative buffer designs influence abundance of small mammals along headwater streams

Under the Northwest Forest Plan, all streams on federal land are protected by buffer zones intended to protect riparian and stream ecosystems from logging effects and other human disturbances. Different rules apply to state and private land, however. In Washington state, headwater streams in state and private industrial forests generally are less protected than those on federal land. This discrepancy has led to debate over how much protection fishless headwater streams should receive during logging. In an effort to find middle ground, station scientists worked with the Washington Department of Natural Resources (DNR) to evaluate alternative buffering strategies.

The scientists found that several small mammal species responded differently to different buffer widths following logging. The northwestern deer mouse declined in all treatments compared to unlogged drainages, while more creeping vole, southern red-backed vole, and Townsend's chipmunk were found after logging in all buffer treatments. The overall diversity and total abundance of small mammals did not change significantly following logging in any of the treatments relative to unlogged, control drainages.

These findings support the development of a long-term headwater stream conservation strategy for the DNR and the proposed adaptive management strategy for western Washington.

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Partner: Washington State Department of Natural Resources

Decision-support systems developed to assess vulnerability and impacts of sulfur deposition across southern Appalachia

The Environmental Protection Agency (EPA) and other federal land management agencies are concerned with the health of aquatic ecosystems in the southern Appalachian Mountains. Acid rain and dry acidic deposition has increased the sulfate concentration in many Appalachian streams. Coal-fired electric generating facilities, cars, and factories are the main sources of human-caused sulfur emissions.

A large water-sampling network was built in the region over the last few decades, but locations of sampling sites historically were highly biased toward watersheds with high sulfur depositions. Station scientists worked to develop statistical methods that overcame sampling biases and allowed accurate predictions of spatial variables required to assess vulnerability of ecosystems and aquatic biota to atmospheric sulfur deposition across the region. Their results were used to develop

a decision-support system of immediate practical value to regional land managers, regulators, and policymakers with the Forest Service, National Park Service, and EPA.

A second decision-support system was developed to predict ecological and biotic impacts of atmospheric sulfur deposition across the southern Appalachian region. It can be used to prioritize watersheds for restoration and protection activities. Policymakers in the region can use the same system to explore the biological and ecosystem implications of alternative sulfur emission scenarios.

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Partners: E&S Environmental Services, Environmental Protection Agency, University of Virginia, USDA Forest Service Southern Region

Cattle and sheep reduce fawning habitat available to Columbian white-tailed deer in western Oregon

Columbian white-tailed deer historically ranged throughout much of western Oregon and southwestern Washington. The deer prefer oak woodlands and savannas, ecosystems that have greatly declined since Euro-American settlement. Today, two remnant populations of the deer remain: one lives along the lower Columbia River and the second lives in the interior valleys of the Umpqua Basin in Douglas County, Oregon.

The lower Columbia River population has been federally listed as an endangered species since 1967. The Douglas County population has been protected by the state of Oregon since 1978 and is considered a discrete population with separate recovery goals. The minimum recovery goals have been met, but the deer occupies less than 5 percent of its historical range. Understanding how land use affects its fawning habitat is fundamental to supporting further recovery of the species.

Scientists found that the does avoided areas with livestock during fawning and chose to give birth in areas concealed by dense vegetation, typically along a permanent stream. Areas with livestock offered less vegetative cover. Reducing sheep and cattle grazing along streams will provide more fawning habitat.

Contact: Winston Smith, winstonsmith@fs.fed.us, Ecological Process and Function Program

Partners: Oregon Department of Fish and Wildlife, Oregon State University

***Population Demography of Northern Spotted Owls* analyzes best available science**

The northern spotted owl, a threatened species under the Endangered Species Act, has become a well-known environmental symbol, and managing for the owl has

been a complex issue for land managers. Station scientists collaborated with 27 owl researchers associated with 12 institutions or agencies to produce a monograph that provides the most complete picture of the spotted owl's population status to date. It assesses relationships between reproductive and recruitment rates and covariates such as habitat, weather, and the invasive barred owl. *Population Demography of Northern Spotted Owls* demonstrates how collaboration among scientists can provide an analysis template for species assessments and conservation.

The U.S. Fish and Wildlife Service used results from a draft version of this analysis when developing its Spotted Owl Recovery plan. With general release of the book, conservation biologists, federal and state land managers, and the public will have a clear picture of the current population status of northern spotted owls.
Contact: Eric Forsman, eforsman@fs.fed.us, Ecological Process and Function Program
Partners: Colorado State University, Green Diamond Resource Company, Hoopa Tribal Forestry, Olympic National Park, Oregon State University, Raedeke Associates, Inc., Simon Fraser University, USDA\APHIS National Wildlife Research Center, USDI Bureau of Land Management, Mount Rainier National Park, USGS Patuxent Wildlife Research Center
For more info: Forsman, E.D.; Anthony, R.G.; Dugger, K.M. [et al.]. 2011. Population demography of northern spotted owls. Studies in Avian Biology No. 40. Berkeley, CA: University of California Press. 103 p.

Study identifies causes for demise of sage-grouse populations

Greater sage-grouse populations in North America have declined for decades as their habitat has decreased. Station scientists examined how changes in land use could be contributing to these declines. They found that areas where local sage-grouse populations had been eradicated had less sagebrush, were at lower elevations, were farther from power lines and communication towers, and were privately owned. Areas of extirpation were more often found along the periphery of the sage-grouse range. Rates of habitat decline are increasing across large areas of western sage-grouse range from continued and pervasive expansion of invasive plants and associated changes in wildfire regimes. Oil and gas development is also leading to habitat decline.

The scientists also measured the threshold values of sagebrush cover and elevation needed by sage grouse. These thresholds values are easily and accurately measured with existing spatial data across the range of the sage grouse.

The U.S. Fish and Wildlife Service used these findings when deciding if listing under the Endangered Species Act was warranted. The agency decided not to list

the sage grouse and continues to negotiate changes in landscape management with other federal agencies to prevent future listings. This research provides the scientific foundation for these negotiations. These findings also are being used by private landowners and many different administrative entities that include county, state, and federal planning activities across western North America.
Contact: Michael Wisdom, mwisdom@fs.fed.us, Ecological Process and Function Program
Partners: U.S. Geological Survey, Washington Department of Fish and Wildlife
Use: Public and private land managers are using results to design and implement sage-grouse recovery strategies.

Hope remains for polar bears' sea ice habitat if greenhouse gases are reduced
No "tipping point" has been reached or is foreseeable for polar bear sea ice habitat over the next century, researchers determined. And, if global greenhouse gas levels are reduced, polar bear populations could be conserved or recovered. This work continues the research that led the U.S. Fish and Wildlife Service (USFWS) to list the polar bear as a threatened species in 2008. It provided new analyses on how several future greenhouse gas scenarios will likely affect polar bear sea ice habitat and populations. The analysis indicates that only major mitigation of greenhouse gasses will avoid sea ice loss and reduce the probability of polar bear populations becoming more vulnerable. It indicates that current sea ice loss resulting from climate change may still be reversible, providing new hope for conserving polar bears. This information can be used by the USFWS to help develop recovery actions for polar bears.

The research appeared as the December 2010 cover story in *Nature*.
Contact: Bruce Marcot, bmarcot@fs.fed.us, Ecological Process and Function Program
Partners: National Center for Atmospheric Research, U.S. Geological Survey, University of Washington

Pacific walrus is vulnerable to continued loss of Arctic sea ice
The Pacific walrus was recommended as a candidate for federal protection under the Endangered Species Act. Before making a final decision, however, the U.S. Fish and Wildlife Service (USFWS) needed more information on the potential viability of Pacific walrus populations, particularly under climate change and associated human impacts. To help inform that decision, a station scientist provided projections of potential future impacts to the walrus in the foreseeable future.

The findings were presented to the USFWS, which, as a result, reversed its previous draft finding not to list the Pacific walrus, and instead, listed the species as potentially threatened. This work also provides information on key stressors that could inform the USFWS recovery plan.
Contact: Bruce Marcot, bmarcot@fs.fed.us, Ecological Process and Function Program
Partner: U.S. Geological Survey
Use: U.S. Fish and Wildlife Service uses study as basis for listing walrus as potentially threatened.

Tools

Tool: Forest Sector Carbon Calculator software (FSCC)
Description: This online tool allows users to compare how stores of carbon in the forest and in forest products change over time following forest harvest and wildfire. The calculator is designed to give users a way to compare the short- and long-term effects of different forest management practices, wildfire occurrence, and assumptions about forest product use. It contains tutorials and produces graphs and data that can be downloaded for further analysis. It is intended to complement more technical models that are used to give precise estimates of actual levels of carbon storage for particular stands or landscapes with good forest inventory information.
Use: This carbon calculator is designed for forest managers and educators who want to know how forest management practices might affect carbon storage and flux in forests and forest products. The tool will facilitate more informed debates, decisions, and policies concerning carbon and forest management.
How to get it: http://landcarb.forestry.oregonstate.edu
Contact: Tom Spies, tspies@fs.fed.us, Ecological Process and Function Program

Tool: Equations for evaluating nutritional quality of available moose forage
Description: These equations for evaluating the nutritional quality of moose forages are based on laboratory analyses of small quantities of forage samples. Prior to their development, predictive equations for quantifying the nutritional quality of wild, native forages for moose in their natural habitats did not exist.
Use: Wildlife scientists and land managers can use these equations to quantitatively evaluate habitat for moose anywhere in the world.
How to get it: Spalinger, D.E.; Collins, W.B.; Hanley, T.A.; Cassara, N.E.; Carnahan, A.M. 2010. The impact of tannins on protein, dry matter, and energy digestion in moose (*Alces alces*). Canadian Journal of Zoology. 88: 977–987.
Contact: Tom Hanley, thanley@fs.fed.us, Ecological Process and Function Program

Tool: New model predicts marten age based on genetic material
Description: Researchers developed a Bayesian network model that can be used to predict the age of martens based on chromosomal evidence and other environmental factors. This is the first model of its kind—calibrated and tested with empirical data—that can accurately predict a marten's age by using hair samples or other genetic material collected without actually trapping the animal.
Use: Researchers can now estimate the population structure (number of animals by age class) solely from indirect evidence such as hair samples, rather than needing to trap and mark or biopsy individual animals. With further testing, such an approach could revolutionize wildlife field research of mammals.
How to get it: Pauli, J.N.; Whiteman, J.P.; Marcot, B.G. [et al.]. 2011. DNA-based approach to aging martens (*Martes americana* and *M. caurina*). Journal of Mammalogy. 92(3): 500–510.
Contact: Bruce Marcot, bmarcot@fs.fed.us, Ecological Process and Function Program

Tool: Framework facilitates designing effective wildlife corridors
Description: Wildlife populations in fragmented landscapes experience reduced gene flow, lose genetic diversity over time, and ultimately face greater extinction risk. Improving connectivity in fragmented landscapes is now a major focus of conservation biology. Designing effective wildlife corridors for this purpose, however, requires understanding of how landscapes shape gene flow.

Station scientists developed a framework that uses expert opinion as a starting point and then systematically either validates the assumptions of expert opinion or identifies a peak of support for a new model more highly related to genetic isolation. This approach also accounts for interactions between variables, allows for nonlinear responses, and excludes variables that reduce model performance. Station scientists demonstrated its utility on a population of mountain goats inhabiting a fragmented landscape in the Cascade Range, Washington.

Wildlife planners with Washington Department of Transportation are using this tool to assess connectivity along the I-90 freeway in Washington.
How to get it: Andrew Shirk, ashirk@fs.fed.us, Ecological Process and Function Program

Symposia, Workshops, and Tours

Elk Habitat Selection in Western Oregon and Washington—Final Models and Management Applications: About 120 people attended this workshop in Portland, Oregon, featuring innovative models of elk nutrition and habitat selection in western Oregon and Washington. The models will benefit current land management plan revisions and habitat management and restoration for elk.

Long-Term Ecological Research (LTER) Artist/Science Field Trip: Bonanza Creek Experimental Forest, LTER site near Fairbanks, Alaska, collaborated with 16 local artists to describe the effects of a changing climate on Alaskan boreal forests.

Starkey Experimental Forest and Range Tour: Several tours were held at the experimental forest and range throughout the year highlighting the relevance of past and ongoing research to forest management. About 70 visitors from the Wallowa-Whitman, Umatilla, and Malheur National Forests; Eastern Oregon University; World Forestry Center International Students; and University of Wyoming Cooperating Faculty participated.

Honors

Fulbright Scholarship

Michael Wisdom, a research wildlife biologist with the Ecological Process and Function Program, will be teaching and conducting ungulate research at the Arid-lands Research Institute in Mendoza, Argentina, during the 2011–2012 academic year. Recipients of Fulbright grants are selected on the basis of academic or professional achievement, as well as demonstrated leadership potential in their fields.

Highly Cited Authors

Marty Vavra, Catherine Parks, and Michael Wisdom, with the Ecological Process and Function Program, received the Highly Cited Author Award 2007–2010 from the journal *Forest Ecology and Management.* Their paper, *Biodiversity, exotic plants, and herbivory: The good, the bad, and the ungulate* (2007), was one of the journal's top 50 cited papers.

Olaus J. Murie Award

Michael Wisdom, a research wildlife biologist with the Ecological Process and Function Program, was honored by the Rocky Mountain Elk Foundation for his work on the science of wildlife management. The award is based on five criteria: (1) relevance of work to the conservation of wild, free-ranging elk; (2) application of work "on the ground" to benefit wild, free-ranging elk; (3) dedication to his profession; (4) commitment to the conservation of wild, free-ranging elk; and (5) credibility and respect among peers.

Ecological Process and Function, Program Manager

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