Ecological Process and Function Program

Station Mission

The mission of the Pacific Northwest Research Station is to generate and communicate impartial knowledge to help people understand and make informed choices about natural resource management and sustainability.

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 2014

Synthesis on mixed-conifer forest science provides scientific and practical guidance to landscape restoration

Millions of acres of mixed-conifer forest across the western United States have been adversely affected by drought and insect outbreaks. The forests are overloaded with fuels, priming them for unusually severe and extensive wildfires. Public support for forest restoration has grown, but natural resource managers and policymakers are awash in information, with little time to assimilate and interpret the science. To that end, Forest Service and university scientists developed a comprehensive synthesis of

the best available science about these forests in eastern Oregon and Washington. It calls for a significant change in the culture and emphasis of vegetation management projects in the region.

The findings in this synthesis will be applied to forest- and project-level planning and to restoration projects on national forests throughout eastern Oregon and Washington. To date, this is the first synthesis and review that has provided scientific guidance on landscape restoration and practical guidance for diagnosing and designing landscape restoration projects.

Contacts: Paul Hessburg, phessburg@fs.fed.us; Tom Spies, tspies@fs.fed.us

Partners: Oregon State University; University of California-Berkeley; University of Florida; University of Montana; USDA Forest Service Pacific Northwest Region, Pacific Southwest Research Station

Citation: Stine, P.; Hessburg, P.F.; Spies, T.A. (et al.). 2014. The ecology and management of moist mixed conifer forests in eastern Oregon and Washington: a synthesis of the relevant biophysical science and implications for future land management. Gen. Tech. Rep. PNW-GTR-897. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 254 p.

Scientists integrate multidiscipline models to estimate impacts of climate change and mitigation policies on global forestry economics sector

In a Climate Change Impacts and Risk Analysis project sponsored by the Environmental Protection Agency, global-scale socioeconomic, climate and climate-impacts models are integrated to estimate the effects of policy scenarios crafted to mitigate greenhouse gases. Forest Service scientists and colleagues worked on one thread of this project by estimating the effects of mitigation policies on the global forestry economic sector for the 21st century. By using an integrated assessment model, an atmosphere model, and MC2—a dynamic global vegetation model developed the PNW Research Station—the scientists simulated a range of climate change impacts on global forest conditions, including shifts in the rate of forest growth and carbon sequestration, and shifts in species distribution and disturbance regimes. Further analysis suggests climate change impacts on forest productivity and disturbance will vary significantly among global timber production regions, which may drive complex market dynamics.

Contact: John B. Kim, jbkim@fs.fed.us

Partners: Environmental Protection Agency, Massachusetts Institute of Technology, Ohio State University

National technical guide provides a foundation for monitoring wildlife habitat on national forests

Information about the status and trends of wildlife habitat is fundamental for meeting the mission and legal and policy requirements of the Forest Service. Many techniques have been used to monitor wildlife habitat in the Forest Service, but no comprehensive guide existed to provide standardized protocols for

habitat monitoring. To that end, working with partners, Forest Service scientists and managers from three research stations, eight regions, and the Washington office published a national, multi-chaptered book.

This technical guide provides current, scientifically credible, and practical protocols to inventory and monitor terrestrial wildlife habitat. It is written for resource professionals (e.g., ecologists, silviculturists, and planners) charged with forest planning, project impacts analysis, and habitat monitoring at ranger district, national forest or grassland, and regional levels. The book also offers guidance to other agencies and organizations in the use of standardized, contemporary approaches for wildlife habitat monitoring.

Contact: Mary Rowland, mrowland@fs.fed.us

Partners: USDA Forest Service, Northern Research Station, Rocky Mountain Research Station; Washington office, Terrestrial Wildlife Ecology Unit and Ecosystem Management Coordination; Forest Service Regions 1, 2, 3, 4, 6, 8, 9, and 10; Forest Inventory and Analysis; Remote Sensing Applications Center; University of Massachusetts; and Western Ecosystems Technology, Inc.

Citation: Rowland, M.M.; Vojta, C.D. tech. eds. 2013. A technical guide for monitoring wildlife habitat. Gen. Tech. Rep. WO-GTR-89. Washington, DC: U.S. Department of Agriculture, Forest Service. 400 p. http://www.treesearch.fs.fed.us/pubs/45213.

Projecting the effects of climate change on ecosystems and wildlife habitats in northwest Alaska

Climate change is affecting terrestrial and aquatic ecosystems and associated wildlife habitats in the arctic and subarctic more rapidly than anywhere else. Such changes are likely to reduce snow-based access to areas used for hunting and trapping and alter the abundance and availability of wildlife, including species used for subsistence by native Alaskans and local communities.

To project the effects of such changes over the 21st century in northwest Alaska, scientists developed a set of state-transition models and wildlife-habitat relationship models that summarize knowledge on the extent and transitions of ecosystems and wildlife habitats and their biophysical drivers. Projections indicate habitat increases in some ecosystems and decreases in others, with associated changes in dependent birds and mammals. Expansion of tall shrubs and trees, increase in fire, vegetation succession, and melting of permafrost are some of the major disturbances that will drive the transitions.

Of the 201 bird and mammal species currently occurring in the area, the model projects that 52 percent will experience habitat expansion, 45 percent will see habitat contractions, and only 3 percent will have no change. Declines will occur in half of the 50 bird and mammal species currently used for subsistence hunting and trapping. These results were shared with federal agencies in the region and presented at public conferences and information sessions for local communities.

Contact: Bruce G. Marcot, bmarcot@fs.fed.us

Partners: USDI Geological Survey and National Park Service

Citation: DeGange, A.; Marcot, B.G.; Lawler, J.; Jorgenson, T.; Winfree. R. 2014. Predicting the effects of climate change on ecosystems and wildlife habitat in northwest Alaska: results of the WildCast project. Alaska Park Science. 12(2):66–73.

Marcot, B.G.; Jorgenson. M.T.; Lawler. J.P. et al. 2015. Projected changes in wildlife habitats in Arctic natural areas of northwest Alaska. Climatic Change. Feb. DOI: 10.1007/s10584-015-1354-x.

Offshore abundance of marbled murrelets is most strongly associated with amount and pattern of adjacent suitable forest nesting habitat

The marbled murrelet is a threatened species of seabird that forages on small fish and invertebrates in nearshore marine waters, and nests inland on limbs of large coniferous trees. A major objective of the Northwest Forest Plan is to conserve the bird's nesting habitat. However, because the bird forages in ocean waters, managers have not been certain if conservation of nesting habitat is key to the species conservation or if marine factors that influence the bird's prey are more important. Scientists developed a model that evaluates the relative contributions of a set of marine variables and nesting habitat variables. They found that the nesting habitat variables were the strongest contributor to predictions of murrelet abundance, which means that conservation of nesting habitat appears essential to conservation of murrelet populations.

This work has been immediately applied by U.S. Fish and Wildlife Service managers who are tasked with consulting on projects that may harm marbled murrelets. It has also been applied by Forest Service and U.S. Fish and Wildlife Service managers in setting policy for management of nesting habitat within the range of the murrelet. The work also has informed the marbled murrelet effectiveness monitoring group about the relevance of habitat monitoring in assessing effectiveness of the Northwest Forest Plan.

Contact: Martin G. Raphael, mraphael@fs.fed.us

Partners: California Department of Fish and Wildlife, Oregon Department of Forestry, U.S. Fish and Wildlife Service, USDI Bureau of Land Management, Washington Department of Natural Resources

Citation: Raphael, M.; Shirk, A.J;. Falxa, G.A.; Pearson, S.F. 2015. Habitat associations of marbled murrelets during the nesting season in nearshore waters along the Washington to California coast. Journal of Marine Systems. 146: 17–25.

Additional Findings and Accomplishments

Fungus-to-plant ratio in boreal black spruce forest soils is at least 17 to 1

Molecular techniques have increased our ability to study the diversity of fungi in the soil and to better understand the key roles that fungi play in ecosystems. Knowledge about the distribution of species, community composition, and ecological niche of fungi is critical in light of global climate change. In Alaska's boreal forests, for example, wildfires are increasingly prevalent in tundra and at treeline. A critical but often overlooked factor to seedling establishment at treeline is the symbiosis with belowground, ectomycorrhizal fungi. Ectomycorrhizal fungi provide soil nutrients and water to seedlings and protect seedlings against pathogens, enhancing their growth and reducing drought stress.

Researchers found that the fungus-to-plant ratio in boreal black spruce forest soils is at least 17:1 and is regionally stable. The global extrapolation of this suggests 6 million species of fungi, a sixfold increase in diversity from previous estimates. Results also illustrate the important role ectomycorrhizal fungi-tree interactions play in seedling performance after fire. This information is being used to improve simulation models of treeline dynamics and in particular the most current ALFRESCO landscape model with the Scenarios Network for Alaska and Arctic Planning.

Contact: Teresa Hollingsworth, thollingsworth@fs.fed.us

Partners: University of Alaska–Fairbanks, University of New Mexico

Citation: Taylor, D.L.; Hollingsworth, T.N.; McFarland, J. (et al.). 2014. A first comprehensive census of fungi in soil reveals both hyperdiversity and fine-scale niche partitioning. Ecological Monographs. 84(1): 3–20.

New insights on determinants of drought vulnerability in piñon-juniper ecosystems

Episodes of drought-induced tree mortality are on the increase worldwide, but some species are more vulnerable than others. Information about the plant functional traits that determine species-specific vulnerability to drought is needed before vegetation models can generate realistic predictions of the fate of woody vegetation under episodic drought. In the southwestern United States, drought-induced mortality events have been particularly severe in ecosystems dominated by ponderosa pine, piñon pine, and juniper in the last several decades.

This study focused on leaf osmotic and turgor regulation in juniper and piñon pine in a multiyear drought mortality field experiment at Los Alamos Laboratory in New Mexico. Juniper was able to rapidly regulate its leaf osmotic properties and turgor to track fluctuations in soil water availability, whereas piñon pine exhibited static behavior in this regard. This contrasting behavior resulted in leaves of piñon pine losing turgor when the soil was dry. The findings were consistent with the greater drought resistance of juniper. Because plants cannot grow or take up carbon dioxide when their cells lose turgor, the inability of piñon pine to regulate its turgor may set it on a trajectory to drought-induced mortality

sooner than juniper. The findings should contribute to more accurate estimates of thresholds for drought-induced mortality in the two species.

Contact: Rick Meinzer, fmeinzer@fs.fed.us, and David Woodruff, dwoodruff@fs.fed.us

Partner: Los Alamos National Laboratory

Citation: Meinzer, F.C.; D.R. Woodruff; D.E. Marias; Sevanto, S. 2014. Dynamics of leaf water relations components in co-occurring iso- and anisohydric conifer species. Plant, Cell and Environment. DOI: 10.1111/pce.12327.

How does drought affect tree physiology?

Phloem is living tissue, part of a plant's complex vascular system. Phloem transports carbohydrates produced by photosynthesis to all parts of the plant to fuel growth and respiration. Measuring phloem function in trees is difficult, and the specific mechanisms involved in phloem transport, and how environmental parameters influence these processes, are still unknown. Improving our fundamental understanding of this central component of the plant's vascular system may provide insight into ways that trees will be affected by changing climatic conditions.

This study examined how sieve cell radius, sap sugar concentration, phloem relative water content, and sap viscosity vary across a range of water stress using tree height as a proxy for increasing soil moisture stress. Accounting for sugar concentration and water content, the sap viscosity and molar concentration of sucrose did not vary with tree height, but the viscosity and molar concentration of total sugars increased with sample height. Combining the decreased sieve lumen diameter and increased viscosity resulted in a 60-percent reduction in conductivity with increased tree height/water stress. The development and application of models that effectively incorporate the response of phloem content and phloem cell anatomy to drought as described in this study will represent a substantial advancement in our ability to more accurately predict plant responses to environmental and competitive stressors.

Contact: David Woodruff, dwoodruff@fs.fed.us

Citation: Woodruff, D.R. 2014. The impacts of water stress on phloem transport in Douglas-fir trees. Tree Physiology. 34:5–14.

Transparent environmental management decisions

The Ecosystem Management Decision Support (EMDS) system is a spatially enabled decision support framework for environmental analysis and planning. The system has steadily evolved since it was first released by the Pacific Northwest Research Station in 1997. It remains one of the state-of-the-art decision support solutions for environmental analysis and planning. The longstanding success of EMDS can be attributed to its rational approach to spatial decision support that is transparent and repeatable.

A newly published book documents diverse applications of EMDS spanning many different problem areas, spatial scales, and geographic contexts. Many of the applications described in the book have contributed to formulating environmental management policy.

Contact: Keith M. Reynolds, kreynolds@fs.fed.us

Partners: InfoHarvest, Inc.; National Oceanic and Atmospheric Administration; Rules of Thumb, Inc.; The Nature Conservancy; University of California– Santa Barbara; University of Cantabria (Spain); University of Colorado; University of Redlands; USDA Forest Service Okanogan-Wenatchee National Forest, Northern Region, Pacific Northwest Region, and Rocky Mountain Research Station; Washington Department of Natural Resources

Citation: Reynolds, K.M.; Hessburg, P.F.; Bourgeron, P.S., eds. 2014. Making transparent environmental management decisions: applications of the Ecosystem Management Decision Support system. Berlin: Springer. 337 p.

Projections indicate that some California ecoregions may see widespread shifts in vegetation types

Climate change is expected to profoundly affect California's diverse vegetation. Until recently, vegetation simulation results were too coarse or incomplete to assess climate change impacts at the subregional scale. In an effort coordinated by the California Public Interest Energy Research Program, scientists worked with four climate projections developed by the Intergovernmental Panel on Climate Change. The scientists used the MC1 dynamic general vegetation model to simulate climate change impacts on vegetation at 800-meter resolution, suitable for planning at the national forest and watershed levels. The simulation results show that exposure to climate change and sensitivity to this change differ greatly by ecoregions in California. Ecoregions projected to have high exposure do not necessarily have high sensitivity, and vice versa. In many ecoregions, simulation results from all four climate projections agree that 60 to 70 percent of the ecoregion will change vegetation types. Fire is projected to decrease in the coastal ecoregions while mediating type-shifts in interior forested or shrubland ecoregions. The Pacific Southwest Region of the Forest Service will be using this information in forest planning.

Contact: John B. Kim, jbkim@fs.fed.us

Partners: University of California Davis, USDA Forest Service Pacific Southwest Region

Making model results useful for vulnerability assessments

It is still uncommon for national forests to use output from fine-scale, dynamic global vegetation models in vulnerability assessments. Technical, administrative, and social barriers exist. As part of a science-management partnership, Forest Service scientists performed simulations of vegetation response to

climate change for four national forests in the Blue Mountains, Oregon, for use in vulnerability assessments. The simulation results under business-as-usual scenarios suggest starkly different future forest conditions for three of the four national forests in the study area. This may cause some forest managers to be more reluctant to adopt them. However, output from dynamic global vegetation models can be used to structure discussion of the dynamic nature of vegetation change in relation to more commonly available model output.

Key lessons from this coordinated work with the national forests include (1) strategically selecting a small number of climate change scenarios that capture the range of variability in future conditions simplified results; (2) collecting and integrating data from managers for use in simulations increased support and interest in applying output; (3) a structured, regionally focused, and hierarchical calibration of the dynamic global vegetation models produced well-validated results; (4) simple approaches to quantifying uncertainty in simulation results facilitated communication; and (5) interpretation of model results in a holistic context in relation to multiple lines of evidence produced balanced guidance. This demonstrates the importance of using model output as a forum for discussion along with other information, rather than using model outputs in an inappropriately predictive sense.

These lessons are being applied to other national forests in the Pacific Northwest to contribute in vulnerability assessments.

Contact: John B. Kim, jbkim@fs.fed.us

Partners: USDA Forest Service Malheur, Umatilla, and Wallowa-Whitman National Forests

Managing forests to retain water

As the climate warms, drought and associated water stress on vegetation are emerging as critical issues underlying a host of forest disturbances, including fire, insect and disease attacks, and forest dieback. Forest landscapes have historically been seen as sources of water for downstream uses. Given the changing risks to forests, a new paradigm suggests managing forests to provide sufficient water to maintain healthy vegetation. Although management actions cannot stop droughts from occurring, many strategies potentially could be used to increase water availability for vegetation in forests. For example, modeling studies suggest that specific strategies, including thinning or mulching, can be sufficient to keep forests below water stress levels at which tree mortality occurs. These kinds of strategies could be used to offset, mitigate, or potentially forestall water stress, thereby increasing forest health and resilience.

Contact: Gordon Grant, ggrant@fs.fed.us

Behavior and nutritional condition buffer elk against direct and indirect effects of climate

Changes in net energy balance strongly influence animal fitness; thus natural selection should favor behaviors that buffer individual animals against negative effects of environmental variation. However, little is known about how energy balances in animals are affected by climate, animal condition, and behavior. Scientists studied elk in two contrasting ecosystems—montane forest at the Starkey Experimental Forest and Range in eastern Oregon and an arid high desert in Idaho—to test the hypothesis that elk behavior from spring to autumn varies as a function of contrasting climates and by the nutritional condition of individual elk.

In the high desert, elk selected sites that required less energy for them to maintain body temperature rather than areas with the highest quality forage. By contrast, elk at Starkey selected sites that provided high-quality forage even if they had to expend more energy in thermoregulation. At the Starkey sites, the nutritional condition of an individual elk did not affect its foraging-site selection. In the desert, however, elk in poorest condition at winter's end strongly selected areas that reduced thermoregulatory costs during summer.

This study highlights the importance of understanding the roles of animal behavior and nutritional condition in buffering individuals against effects of climate. As climate warms in areas occupied by elk, managers can use this information to balance habitat management for sites that reduce thermoregulatory costs vs. those that provide high-quality forage.

Contact: Mary Rowland, mrowland@fs.fed.us, or Michael Wisdom, mwisdom@fs.fed.us

Partners: Idaho State University, Princeton University, University of Idaho, University of Wisconsin–Madison, Wyoming Cooperative Fish and Wildlife Research Unit

Citation: Long, R.A.; Bowyer, R.T.; Porter, W.P. (et al.). 2014. Behavior and nutritional condition buffer a large-bodied endotherm against direct and indirect effects of climate. Ecological Monographs. 84(3): 513–532.

Ungulate herbivory maintains shrub diversity in forests in the absence of disturbance

Herbivory by elk, cattle, and other ungulates can dramatically affect vegetation in forest understories. However, little is known about how ungulate herbivory interacts with episodic disturbances such as fire and fuels removal. This knowledge is important because ungulates can potentially alter shrub and conifer composition in ways that increase fuel loading and fire risk.

Over 6 years, scientists evaluated shrub responses to grazing pressure by cattle and elk in forested areas where fuel had been reduced by mechanical means, followed by prescribed burning, and in untreated forested sites at Starkey Experimental Forest and Range. Their findings suggest that without fuels reduction and ungulate herbivory, shrub diversity is reduced. Increased dominance was observed in species that would have been suppressed by ungulates and fuels removal. Ungulate herbivory, even at low intensities, can be used to suppress dominant shrub species and maintain diversity in the absence of episodic disturbances.

Contacts: Michael Wisdom, mwisdom@fs.fed.us

Partners: Oregon State University, San Diego Zoo Global Conservation Program

Citation: Pekin, B.K.; Wisdom, M.J.; Endress, B.A.; Naylor, B.J.; Parks, C.G. 2014. Ungulate browsing maintains shrub diversity in the absence of episodic disturbance in seasonally-arid conifer forest. Plos ONE 9(1): e86288. doi:10.1371/journal.pone.0086288.

Co-mingling of cattle and elk may facilitate disease transmission between the two species

The potential for disease transmission between wild and domestic ungulates is increasing throughout the world, with substantial economic and ecological ramifications. Estimating the probability of disease transmission on ranges co-occupied by wild and domestic ungulates, however, is notoriously difficult. The first step for estimating the potential for between-species disease transmission is to quantify the proximity between individuals of different species in space and time.

Station scientists and partners assessed the likelihood of disease transmission between domestic and wild ungulates by using long-term location data on cattle, elk, and mule deer collected at the PNW Research Station's Starkey Experimental Forest and Range. They used novel statistical methods to estimate the frequency at which domestic and wild ungulates, tracked with global positioning system collars, would occur in proximity sufficiently close for disease transmission to potentially occur. The scientists found that elk and cattle had rare co-mingling events, but when the two species did meet, they were closer to each other than expected, based on general space use by these species. This pattern also held for deer and elk, but not for deer and cattle. Understanding the causes for such events is important for designing grazing practices that minimize wild ungulate–livestock contacts. Co-mingling between domestic and wild ungulates, although rare, may facilitate disease transmission. This is a critical issue across the world where co-occupied ranges are common.

Contact: Mary Rowland, mrowland@fs.fed.us, or Michael Wisdom, mwisdom@fs.fed.us

Partners: Oregon Department of Fish and Wildlife, University of Calgary, University of California, University of Wyoming

Citation: Dohna, H.Z.; Peck, D.E.; Johnson, B.K.; Reeves, A.; Schumaker, B.A. 2014. Wildlife-livestock interactions in a western rangeland setting: Quantifying disease-relevant contacts. Preventive Veterinary Medicine. 113: 447–456.

An innovative, multidisciplinary riparian restoration project

Federal agencies have spent millions of dollars restoring streams and riparian habitats to recover endangered salmonids, including placement of woody debris and planting native shrubs and trees to stabilize banks and mediate stream temperatures. Small mammals, birds, and native pollinators may

also benefit from stream restoration. However, browsing by native and domestic ungulates such as cattle, elk, and mule deer can dramatically affect riparian vegetation, even eliminating key species such as willows. Knowledge about effects of cattle versus deer/elk herbivory on shrub recovery is limited, posing major obstacles in designing best ungulate management practices to improve riparian systems for salmonids. Moreover, knowledge is limited about effects of climate change on stream temperature, and how these effects may be ameliorated by restoration plantings.

To address these complex and important issues, the PNW Research Station initiated a long-term research project at Meadow Creek within the Starkey Experimental Forest and Range. This project offers novel opportunities for cross-cutting research to understand links between abiotic and biotic systems in arid environments. The integrative approach addresses holistic management of complex riparian ecosystems and their multiple stressors. The Meadow Creek restoration project will result in a comprehensive set of best management practices for recovery of riparian systems that include effective ungulate management in the intermountain West.

Contact: Michael Wisdom, mwisdom@fs.fed.us

Partners: Bonneville Power Administration; Columbia River Intertribal Fish Commission; Grande Ronde Model Watershed; Oregon Department of Fish and Wildlife; Oregon State University; USDA Forest Service Pacific Northwest Region, Wallowa-Whitman National Forest

Panel evaluates techniques to control raptors preying on western snowy plovers

Raptors, particularly northern harriers and great horned owls, prey on western snowy plovers—a federally threatened seabird that lives along the Pacific coast. A seven-member expert panel reviewed the feasibility and efficacy of 26 humane raptor-control techniques. The panel also identified information and monitoring methods to help inform raptor control management as well as extenuating considerations for policy application such as cost consideration, training personnel, workloads, and information management.

The raptor control techniques identified with the highest potential feasibility and effectiveness included lethal removal, and use of various trapping methods, including a cube trap, a Swedish style goshawk trap, and a dho-gaza net trap. The panel also identified a need for monitoring plover nest sites with cameras and observers.

The U.S. Fish and Wildlife Service is applying these findings at designated western snowy plover recovery sites along the Oregon coast. The findings have also been shared with the U.S. Forest Service and Bureau of Land Management for use at their sites. To date, several instances of potential raptor predation have been thwarted by using the identified techniques, and plover monitoring is being refined based on the panel's suggestions.

Contact: Bruce G. Marcot, bmarcot@fs.fed.us

Partner: U.S. Fish and Wildlife Service

Citation: Marcot, B. G.; Elbert, D.C. In press. Assessing raptor management for western snowy plover recovery. Gen. Tech. Rep. Portland, OR: U.S. Department of Agriculture, Forest Service.

Salamander benefits from large amounts of wood debris along headwater streams following clearcutting

Woodland salamanders may be used to monitor biodiversity and ecosystem integrity following forest disturbance. As part of a study of alternative riparian buffer treatments along headwater streams, scientists trapped western red-backed salamanders (*Plethodon vehiculum*) before and after treatments to determine treatment effects. Their goal was to learn how alternative buffering strategies could be used to conserve and protect headwater streams during timber harvest.

They found that the reduced forest canopy caused by clearcut harvest and partial clearcut harvest (forest islands on fragile sites in a clearcut landscape) had detrimental effects on moist micro-environments used by salamanders. Retaining dead downwood plus adding three to six times more dead downwood than occurred before harvest to create moist microenvironments seemed to lessen the expected adverse treatment effects on salamanders in clearcut areas.

Contact: Martin G. Raphael, mraphael@fs.fed.us

Partner: Washington Department of Natural Resources

Citation: Wilk, R.J.; Ricklefs, J.D.; Raphael, M.G. 2014. Abundance of western red-backed salamanders in the Washington Coast Range after headwater stream-buffer manipulation. Northwestern Naturalist. 95: 92-102.

Tools

Tool: Database of low-altitude photographs and videos of northwestern Alaska

Description: A database has been produced with 19,167 high-resolution photographs and 80 minutes of high-resolution videos (290,580 frames) taken along three aerial transect in arctic and subarctic northwestern Alaska, along with a database of the specific global positioning system (GPS) location (latitude- longitude) and content (land and water cover categories) in each image, and GPS locations of each flight transect. The small-plane flight transects occurred over 3 days in July 2013 over 1,609 miles, totaling 17 hours 46 minutes of flight time, and covered five administrative units of the National Park Service and one of the U.S. Fish and Wildlife Service. Project collaborators include the USDA Forest Service, U.S. Geological Survey, National Park Service, and Alaska Ecoscience.

Use: This product serves as a massive, detailed baseline from which future (and, in some locations, past) changes in terrestrial conditions can be measured, particularly from climate change effects. It is expected to provide a legacy for many such studies to come. The work was initiated to track effects of climate change on arctic and subarctic tundra. Worldwide, these are the most rapidly affected areas and can serve as an early warning of impending ecosystem changes in lower latitudes.

Distribution: The full information set of photographs, videos, and associated maps and databases are being made available on a U.S. Geological Survey website, and have been provided also to the National Park Service for their posting.

How to get it: Contact Bruce G. Marcot, bmarcot@fs.fed.us

New tool: A self-adjusting, expandable telemetry collar for elk

Forest Service scientists at the Starkey Experimental Forest and Range in eastern Oregon collaborated with the Oregon Department of Fish and Wildlife to successfully develop and deploy a novel expandable telemetry collar for male elk. The collar is safe, humane, and effective in collecting location and survival data for research and management of wild male cervids (deer and elk). Successful placement of telemetry collars on male deer and elk has been extremely challenging because their neck size can increase substantially during the rut, and their bodies grow substantially as they mature. The new expandable collar is used on yearling or adult male elk for telemetry tracking of animal locations and survival estimation.

The majority of collars were successfully worn by elk over a 1- to 3-year period. No deaths or injuries were attributed to the collars, and recaptured animals were in excellent health after wearing the collars for long periods. This new technology represents a breakthrough opportunity to gain desired knowledge on ecology of male cervids throughout the world, which has been difficult in the past. Use of the expandable collar technology will allow implementation of important new lines of research needed to address long-standing knowledge voids of keen interest regarding ecology and management of male deer and elk.

Contact: Brian Dick, bldick@fs.fed.us, or Michael Wisdom, mwisdom@fs.fed.us