Threat Characterization and Management 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 Threat Characterization and Management Program is to generate knowledge about the nature, causes, and consequences of large, rapid, or significant changes to ecosystems that potentially threaten societal values. We will use our knowledge to develop and deliver innovative and effective strategies, methods, and tools so people can plan, manage, or mitigate the changes, causes, and consequences.

Research Problem Statements

Problem 1: How do we characterize and measure the cause, occurrence, extent, and consequences of threatening conditions and people's perceptions of them?
Problem 2: How do ecological or social processes interact across multiple temporal and spatial scales to create potential threats?
Problem 3: What thresholds exist in ecosystem dynamics; what are the biological, physical, and social consequences of crossing these thresholds; and how do people perceive and respond to disturbances that are approaching or have crossed their biological or physical thresholds?
Problem 4: How are ecological patterns and processes managed to reduce the probability, magnitude, and consequences of a threat?
Problem 5: What is the range of possible future conditions, and what are the uncertainties and tradeoffs associated with them?

Key Findings and Products in 2011

New book analyzes landscape fire regimes across western North America
Understanding wildfire dynamics across a broad range of spatial scales is critical in an era of rapid climate change. Ecological fire science is most complex at intermediate scales (e.g., watersheds or national forest districts). The recently published book *The Landscape Ecology of Fire* presents new work on the theoretical context of landscape fire, including cross-scale analyses; fire climatology specifically

applied to landscapes; effects of fire on biogeochemistry, wildlife populations, and other ecosystem elements; and management and the human dimension of landscape fire in a warming climate. For example, cross-scale analysis of fire regimes from watersheds to ecoregions suggests that shifting controls on fire occurrence and spread (climate, topography, fuels) can be quantified and projected into new climate regimes. On the human side, regional-scale adaptation strategies are presented along with a West-wide analysis of the effects of population growth on wilderness fire management.

The book is written for university students, agency scientists, and land managers with jurisdictions from local watersheds to broad ecoregions (e.g., Forest Service regions). Two new lines of research stem from this book: the ecohydrology of fire and landscape fire theory.

Contact: Don McKenzie, donaldmckenzie@fs.fed.us, Threat Characterization and Management Program

Partners: University of Arizona, University of Washington, USDA Forest Service Rocky Mountain Research Station

For more info: McKenzie, D.; Miller, C.; Falk, D.A., eds. 2011. The landscape ecology of fire. Ecological Studies. V. 213. New York: Springer Science. 312 p.

Assessing habitat connectivity, land use, and climate gradients facilitates regional wildlife planning

Many wildlife species need to be able to move across the landscape in search of food throughout the year. As human populations increase and more land is developed for human use, links between wildlife habitats are being lost. To address this, the Western Governors Association Wildlife Corridors Initiative and state wildlife action plans call for incorporating wildlife corridors into regional-scale, long-range landscape management planning.

To help with this process, station scientists worked as part of the Washington Wildlife Habitat Connectivity Working Group to assess regional habitat connectivity patterns for 16 focal species, natural landscape integrity connectivity patterns, and climate gradient patterns. The group completed a geographic information system (GIS) analysis of habitat conditions in the state, which can be incorporated into climate change adaptation connectivity planning. Station scientists provided technical guidance on model development and interpretation and facilitated technical peer review of modeling procedures and reports.

The Washington Department of Transportation is using the information and GIS data produced by the group in statewide transportation planning. The Washington Department of Fish and Wildlife also is using the information in

planning efforts, and it is being used to develop decision-support tools under the Western Governors Association Wildlife Corridors Initiative.
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Partners: Conservation Northwest; The Nature Conservancy; USDA Forest Service Pacific Northwest Region; USDI Bureau of Land Management; University of Washington; Washington Departments of Fish and Wildlife, Natural Resources and Transportation; Western Transportation Institute
For more info see: http://www.waconnected.org
Use: Washington Department of Transportation uses findings in statewide planning.

Station expertise used to help predict smoke from Southwest fires
This year, numerous large wildfires burned across the Southwestern United States. Fueled by historically low fuel moistures, these fires exhibited explosive growth and grew to unprecedented size—the Wallow Fire is the largest in contemporary Arizona history. The smoke from these fires created a significant public health challenge, blanketing large swaths of Arizona and New Mexico with unhealthy air quality conditions.

Federal, state, tribal, and local government agencies pooled resources to create a coordinated smoke and health effects outlook that was disseminated to the public. Expertise from the Pacific Northwest Research Station was requested and was a key component of this effort. Station scientists provided a core set of customized advanced smoke modeling results and expert analyses to the group on a daily basis. Their efforts were instrumental in determining the daily smoke outlook.

These reports were linked to the Web site that lists information about all active fires in the Nation (Inciweb) and accessed thousands of times by involved agencies and the public. The reports were redistributed by up to 20 agencies that coordinated their message through daily consultations. The smoke outlooks were also picked up by television stations around the region and were used by the public for such things as rescheduling sporting events to avoid times of peak smoke.
Contact: Sim Larkin, larkin@fs.fed.us, Threat Characterization and Management Program
Partners: Desert Research Institute; Lawrence Livermore National Laboratory's National Atmospheric Release Advisory Center; Mazama Science; National Weather Service; Sonoma Technology, Inc.; USDA Forest Service Southwestern

Region Fire and Aviation Management, Wildland Fire Research Development and Application
Use: National Interagency Fire Coordination Center uses expertise to issue daily smoke forecasts.

Researchers identify options for monitoring climate-related changes in Alaska
As temperatures have increased in the boreal forest region of Alaska over the past half century, spruce beetle outbreaks have become larger and more severe, wildfire frequency has increased, permafrost is melting, and boreal tree species in some regions are showing signs of drought stress. Yet impacts on species composition and ecological processes within forests are difficult to monitor.

Researchers from the Pacific Northwest Research Station and the Department of the Interior examined options for monitoring ecoregional-level change in northern latitudes. Climate-related changes to Alaska's forests that could be monitored include changes in abundance and rarity of vascular plants, wildlife habitat, invasive species, fire risk, fire effects, postfire succession, impacts on forest growth and mortality from insects and diseases, and alterations in carbon pools and fluxes. Although managers of individual parks and refuges often have specific needs that require more targeted monitoring, regional level monitoring can help provide context for changes observed within smaller areas.

The researchers published an assessment of the Forest Service's forest inventory program for monitoring climate-related change in Alaska's forests in a 2011 special issue of the journal *Biological Conservation*. This information and an associated 2009 symposium on monitoring in northern latitudes led to the creation of Landscape Conservation Cooperatives, a multiagency effort to coordinate federal monitoring.
Contact: Tara Barrett, tbarrett@fs.fed.us, Threat Characterization and Management Program
Partners: U.S. Geological Survey; USDI Fish and Wildlife Service, National Park Service
Use: Federal agencies use assessment to coordinate monitoring.

Science-management partnership facilitates management adapted to climate change
As part of an agency-wide effort, station scientists have been collaborating with national forest managers and other agencies to ensure that climate change will be addressed effectively on federal land. Through a science-management partnership, they have developed scientific principles, processes, and tools for communicating about climate science, conducting assessments of the vulnerability of natural

resources to climate change, and developing adaptation strategies and tactics that ensure sustainability of resources in a warmer climate.

In the Pacific Northwest, scientists and land managers have developed (1) a vulnerability assessment and climate change adaptation strategy for Olympic National Forest and Olympic National Park, (2) a national adaptation guidebook for national forests, and (3) the North Cascadia Adaptation Partnership (http://northcascadia.org), which is implementing education, vulnerability assessment, and adaptation planning across two national forests and two national parks in Washington state.

This effort is helping national forests follow the U.S. Forest Service Climate Change Roadmap and address specific elements in the Climate Change Scorecard, which is used by national forests to track progress on the integration of climate change into their operations.

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Partners: University of Washington Climate Impacts Group, USDI National Park Service

For more info: Peterson, David L.; Millar, Connie I.; Joyce, Linda A. [et al.]. 2011. Responding to climate change in national forests: a guidebook for developing adaptation options. Gen. Tech. Rep. PNW-GTR-855. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 109 p.

Simulating thinning and fuel treatments on 40,000 stands yields quantitative guidelines for resource managers

Dry forest ecosystems prevalent in western North America historically exhibited high-frequency and low- to moderate-severity fire regimes. Several decades of fire exclusion have made these forests more susceptible to active crown fire and higher burn severity. Fuel treatments are often implemented to reduce fire hazard caused by increased stem densities in low- to moderate-severity fire regimes. With millions of hectares of dry forests in the Western United States requiring fuel treatment, forest and fire managers need information to support science-based decisionmaking for fuel management.

In the largest study ever evaluating the effectiveness of fuel treatments, researchers used simulation results from over 40,000 stands to infer that thinning to 50 to 100 trees per acre followed by prescribed burning to remove slash was the most effective treatment combination to reduce crown fire hazard in dry forest types throughout the Western United States. These quantitative guidelines for thinning and fuel treatment provide resource managers and fire managers with the scientific basis for reducing stand densities and surface fuels.

This study received significant media coverage; it was featured in *Land Letter, Greenwire,* National Public Radio, and the *Arizona Daily Sun*, among others.
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Partner: University of Washington

Additional Findings in 2011

Analysis of atmospheric thermal troughs suggests why they cause more active fire behavior

Thermal troughs are atmospheric structures found along the west coast of the United States, characterized by high surface temperatures and low pressure. They typically form along the coast or in Oregon's Willamette Valley and eventually move eastward across the Cascade Range. They are associated with active, highly variable fire behavior at all times, but most notably as they cross the ridge of the Cascades. Analysis of historical thermal troughs using atmospheric models revealed characteristic wind patterns aloft, patterns that are not detectable on the ground but capable of intensifying winds and fire behavior. Continuing, more detailed analysis of a small set of thermal trough events and the associated fire behavior is clarifying finer scale structure and the forces causing the wind patterns.

A prototype Web page has been created and shared with the Northwest fire weather community for their use and evaluation. The numerical prediction maps and atmospheric cross-sections displayed were chosen based on ongoing discussions with National Weather Service and the Northwest Interagency Coordination Center.
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Partners: National Weather Service, Northwest Interagency Coordination Center, University of Washington, USDA Forest Service Washington office
For more information: http://www.atmos.washington.edu/mm5rt/firewatch.html

Summer prescribed burns can reduce acorn production by Oregon white oak

The Oregon white oak is a sun-loving tree. Without fire, conifers increasingly dominate the stand, and oak is eventually shaded out. Prior to Euro-American settlement, American Indians who gathered acorns for food frequently burned Oregon white oak woodlands to favor the tree. This killed the young conifers and led to grassy understories. These low-intensity grass fires often caused only minor canopy damage to oaks. Prescribed fire is once again being used in many Pacific Northwest woodlands to control competition from woody vegetation. Understory

conditions have changed, however. Where shrubs have replaced grass, fire burns hotter and causes more tree damage.

Because white oak flowers and leaves form inside the buds one year prior to actual flowering, researchers found that buds are particularly vulnerable to summer fire damage. Researchers were able to relate fire intensity to acorn production. Even when tree buds are not killed, flowering and acorn production the following year may be reduced. This information will help land mangers effectively use prescribed burns to manage oak woodlands and wildlife that depend on acorns for food.
Contact: David Peter, dpeter@fs.fed.us, Threat Characterization and Management Program
Partner: U.S. Department of Defense, Joint Base Lewis McChord

Seeding native grasses on soil containing Scotch broom seeds slows development of this aggressive invasive species
Scotch broom (*Cytisus scoparius*) is a large nonnative shrub that has invaded forest and prairie sites throughout western Oregon and Washington. It produces many seeds that remain viable for several years, enabling Scotch broom to occupy sites for decades. Several native grasses of the Pacific Northwest, however, show promise as effective competitors for inhibiting development of Scotch broom seedlings.

In greenhouse experiments, three native perennial grass species were seeded into soils containing Scotch broom seeds. Biomass of Scotch broom seedlings decreased by 72 to 90 percent when grown under grass competition. The most competitive species, spike bentgrass (*Agrostis exarata*), was able to colonize all growing space and deplete soil water rapidly. The least competitive species, western fescue (*Festuca occidentalis*), developed more slowly. When combined with Scotch broom control treatments and seedbed preparation, native grass seeding is a promising approach for restoring invaded areas to native grasslands.
Contact: Tim Harrington, tharrington@fs.fed.us, Threat Characterization and Management Program
Partner: Center for Invasive Plant Management, Bozeman, Montana

Native grasses need time but are part of an effective restoration effort
Worldwide, invasive exotic plants have become one of the most pressing issues of grassland conservation and management. Herbicides are the primary method used to control invasive plants. Working in the Oregon Wenaha Wildlife Area, station scientists evaluated restoration efforts applied to grasslands dominated by the invasive plant, sulfur cinquefoil, 6 years after treatments. They found that combining herbicide use with sowing native grass seed was an effective grassland restoration strategy, when combined with temporary livestock exclusion.

Of the five herbicides they evaluated, picloram best controlled sulfur cinquefoil during the study. However, without the addition of native perennial grass seeds, the sites continued to be dominated by exotic grasses. Seeding with native perennial grasses resulted in a 20-percent decrease in exotic grass cover, although success was not apparent until 6 years after treatment. Seeding success of grassland restoration projects may appear poor in the first years because of the slow growth of native perennial grass species in the interior West, even though recovery is well underway.
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Partners: Oregon Department of Fish and Wildlife, Oregon State University, Wallowa Resources

Postfire cattle grazing affects ponderosa pine forest understory plants more than reintroduction of fire

Prescribed fire is used to manage and restore millions of acres of forests in western North America, and livestock grazing occurs on approximately 91 percent of all federal lands in the West. Yet, few studies have experimentally examined the interaction of prescribed fire and cattle grazing in western interior forests.

To better understand ecosystem response to these combined management regimes, station scientists evaluated grazing effects (grazing, no grazing) on ponderosa pine plant communities over five growing seasons after prescribed fire reburns (spring, fall, no burn). They found that for all treatments (including no burning), excluding cattle grazing for five seasons significantly increased the total vegetative cover, native perennial forb cover, grass height, grass flowering density, and shrub cover. The 5-year study found that grazing exclusion in this setting caused a greater degree of change in vegetation than the initial reintroduction of fire.
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Partner: USDA Forest Service Malheur National Forest

Retaining logging debris on site sustains soil productivity

Logging debris that remains after forest harvesting is currently viewed by some land managers as a hindrance to tree planting, a source of fuels for wildfire, and a potential feedstock for energy, but new research indicates that it provides important ecosystem functions. At two sites in western Oregon and Washington, logging debris was found to act as a mulch to conserve soil water, and the additional water promoted survival and growth of planted Douglas-fir seedlings. On soils low in carbon and nitrogen, retaining logging debris resulted in greater accumulations of

these elements after 5 years, compared to areas where debris had been removed. By insulating and cooling the soil surface, the debris reduced losses of soil carbon from microbial respiration or leaching of soluble forms. These accumulations of soil carbon and nitrogen will help to improve and sustain productivity of forest soils.

Glacial outwash soils of the Puget Sound region are likely to benefit from logging debris retention after forest harvesting because of their droughty, coarse texture and innately small pools of soil carbon and nitrogen.

Contact: Tim Harrington, tharrington@fs.fed.us, Threat Characterization and Management Program

Partners: Green Diamond Resource Company; Port Blakely Tree Farms, LLC; University of Minnesota; Virginia Tech

Understanding barred owls habitat preferences may help northern spotted owl recovery

Interactions with barred owls are a leading cause of the northern spotted owls' continuing decline in the Pacific Northwest. Substantial information on forest structure characteristics used by spotted owls has been collected over the past two decades, but little is known about forest structure characteristics used by barred owls. Understanding barred owls' habitat preferences will help managers evaluate how forest restoration treatments in fire-prone forests may affect interactions between spotted owls and barred owls.

Station scientists used radiotelemetry to conduct the first extensive study of habitat use by barred owls. They learned barred owls use structurally diverse mixed grand fir forest more intensively than open ponderosa pine or even-aged Douglas-fir forest types within their home ranges in central Washington. The scientists shared their findings with the Barred Owl and Modeling Working Groups of the Northern Spotted Owl Recovery Team convened by the U.S. Fish and Wildlife Service. This information has contributed to recovery planning for the northern spotted owl.

Contact: Peter Singleton, psingleton@fs.fed.us, Threat Characterization and Management Program

Partners: USDA Forest Service Okanogan-Wenatchee National Forest, USDI Fish and Wildlife Service

Tools

Tool: Fuel Characteristic Classification System (FCCS) v. 2.2

Description: The Fuel Characteristic Classification System (FCCS) was designed to build and catalog fuelbeds by using inventoried fuel data, photo series, or

literature. Fuelbeds span the canopy to the ground and have been mapped for the continental United States. The system predicts surface fire behavior including reaction intensity, flame length, and rate of spread; and surface fire behavior, crown fire, and available fuel potential using a 9-point index. Version 2.2 was released in 2011 with refined fire behavior equations, a total carbon calculator, and options for both metric and English units. Station scientists are working with the University of Aveiro, Portugal, and the University of Alcala, Spain, to build FCCS fuelbeds representing Portugal and the world.

Use: The FCCS is used to build and characterize fuels for specified areas at any scale of interest. FCCS fuelbeds have been created for the Okanogan-Wenatchee National Forest, central Oregon, the Lake Tahoe Basin, and the U.S. Department of Energy's Savannah River Site. The associated fire behavior predictions and total carbon represented by the fuelbeds for these areas also have been mapped. This information is being used for fire hazard planning and evaluating fuels treatment effectiveness.

How to get it: http://www.fs.fed.us/pnw/fera/fccs/

Contact: Roger Ottmar, rottmar@fs.fed.us, Threat Characterization and Management Program

Tool: Fuel Characteristics Classification System/Forest Vegetation Simulator Postprocessor

Description: The Forest Vegetation Simulator (FVS) is used to predict forest stand dynamics. It is used extensively throughout the United States. The Fire and Fuels Extension to FVS, when combined with the Fuel Characteristic Classification System (FCCS), has the potential to model fire effects and succession more realistically and with higher resolution. Postprocessors are stand-alone applications that extend the capabilities of a model. This new postprocessor will integrate the effects of silvicultural and surface fuel treatments, using realistic fuels and making the fuels component more visible, user friendly, and flexible within the modeling system.

Use: The FVS is the standard model used by various government agencies including the USDA Forest Service, USDI Bureau of Land Management, and USDI Bureau of Indian Affairs. The new interface provided by this postprocessor will allow managers to more accurately determine the outcomes of fuel treatments, especially with respect to duration of treatment effectiveness.

How to get it: Tool will be distributed with the FVS program, or download from http://www.fs.fed.us/fmsc/fvs/software/postprocessors.php

Contact: Morris C. Johnson, mcjohnson@fs.fed.us, Threat Characterization and Management Program

Symposia, Workshops, and Tours

BlueSky Training: Station scientists led four training sessions and a Webinar for National Forest System staff on using the BlueSky framework to model fire information, fuel loading, smoke dispersal, and more. About 190 people attended the sessions held at different locations throughout the country.

Ecological Effects of Invasive Plants: This 1-day meeting of the Western Society of Weed Science included presentations on impacts of invasive, nonnative plants on forest, range, grassland, and estuary ecosystems of the western United States, as well as recent advances in research to restore invaded ecosystems. There were 93 attendees.

Genetics of Host-Parasite Interactions in Forestry: At this 4th international workshop, held in Eugene, Oregon, 87 participants provided overviews of the most current scientific information available on forest insect and disease resistance for a range of forests pests.

International Association for Landscape Ecology Annual Symposium: The station cosponsored this event with the U.S. chapter of the association, and a station scientist was the program chair. Held in Portland, Oregon, the meeting brought together more than 500 landscape ecologists from the United States and abroad.

Introduction to Wildland Fire Decision Support System-Air Quality Tools: A station scientist introduced these tools to about 20 attendees of the Southwest Interagency Fuels Workshop held in Flagstaff, Arizona.

Model Uncertainty: Two half-day workshops engaged extension specialists in discussion of ways to frame the inherent uncertainty and assumptions in the output of most models, and how to discuss that uncertainty in the context of global climate models. Fourteen people attended the workshop in Wenatchee, Washington; 25 attended the workshop in Corvallis, Oregon.

Molalla Forest Productivity Study Field Visits: Six district silviculturists with USDI Bureau of Land Management toured the study site in Molalla, Oregon, to learn about effects of forest harvesting, logging debris manipulation, and vegetation control on Douglas-fir productivity.

North Cascadia Adaptation Partnership Climate Change Fish Workshop: This partnership, organized by station scientists and the University of Washington's Climate Impacts Group, hosted four resource-specific workshops on climate change vulnerability assessment and adaptation planning for the North Cascadia region. About 45 participants from national parks and forests in the region attended.

North Cascadia Adaptation Partnership Project: The station facilitated four climate change education workshops where scientists and resource management representatives presented the basics of climate change science and expected effects

on natural resources in the Pacific Northwest. About 340 staff from national parks and forests in the region attended.

Smoke and Air Quality Management Tools Training: Station scientists provided training for about 30 attendees at the third Fire Behavior and Fuels Conference of the International Association of Wildland Fire held in Spokane, Washington.

Conservation Education

Importance of Yellow-Cedar and Its Regeneration to Native People in Alaska: Seven students and elders of the Douglas Indian Association visited the yellow-cedar planting area on Goldbelt Corporation land in Echo Cove, Alaska, to discuss use of yellow-cedar by Native people and learn about forest management efforts to ensure the sustainability of this tree into the future.

Honors

2010 Regional Forester's Partnership Award

John Lundquist, a forest entomologist the Threat Characterization and Management Program, was honored for his outstanding contributions in engaging youth, families, and communities in outdoor experiences and natural resource stewardship through the Youth Employment in Parks Program.

2011 Environmental Excellence Award

Peter Singleton, an ecologist with the Threat Characterization and Management Program, received this award from the Federal Highway Administration for his exemplary achievement in Ecosystems, Habitat, and Wildlife for the Washington Connected Landscapes Project: Statewide Analysis. The assessment will influence many aspects of construction and maintenance of Washington's highway system.

2011 National Wilderness Award

Don McKenzie, a research ecologist with the Threat Characterization and Management Program, received this award for his research exploring the challenges of adapting to changing disturbance regimes while maintaining the integrity of wilderness areas in a warming world.

David F. Thomas Award

Paul Hennon, a research plant pathologist with the Threat Characterization and Management Program, received this national award from the Forest Service for his outstanding customer service as a forest health expert.

Outstanding Achievement Award

Paul Hennon, a research plant pathologist with the Threat Characterization and Management Program, was recognized by the 2010 Western International Forest Disease Work Conference as the individual who has contributed the most to the field of forest pathology in western North America.

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