

PROJECT SUMMARY - NSF-CNH

The Interactions of Climate Change, Land-Management Policies, and Forest Succession on Fire Hazard and Ecosystem Trajectories in the Wildland-Urban Interface

Intellectual Merit. Projecting the future effects of climate change on coupled natural/human systems at local extents has become increasingly important in a wide array of land use planning and policy contexts. The goal of this proposal is to identify policies that reduce wildfire hazard and the loss of imperiled ecosystems by exploring the coupled effects of climatic and land use changes in western Oregon's rapidly changing Willamette Valley Ecoregion (WVE). We investigate human/natural systems by linking models of how climate change affects forest succession and wildfire in historic savanna and prairie ecosystems with an agent-based model of human land use and land management decisions. We contrast conventional predict-then-act approaches with our explore-then-test approach in which we build a transferable analysis platform that allows us to: a) explore large numbers of alternative future landscapes; b) seek robust rather than optimal alternatives for reducing risk of wildfire and biodiversity loss given the uncertainties of local climate change effects; and c) identify land management policies that facilitate such robustness. We employ an approach that downscales from the coarse scales of Atmospheric-Ocean General Circulation Models (AOGCMs) and Dynamic Global Vegetation Models to the fine scales at which human land use and management decisions are made, and then scales back up to represent the landscape-scale effects of human actions on vegetation and fire hazard. Through the use of an agent-based model, individual decision makers respond to a suite of factors including climate, land use regulation and incentives, land markets, fire hazard, land management costs and aesthetics. Agent behaviors will be parameterized probabilistically based on a survey of study area landowners as well as census and other local data. We will test three hypotheses: 1) climate change will lead to altered fuel loads and greater wildfire hazard in the WVE; 2) current WVE land use trajectories will lead to increased wildland-urban interface area and changes in vegetation that together increase the risk of wildfire and loss of imperiled ecosystems; and 3) some policy sets will be more robust than others in managing fire risk and sustaining imperiled ecosystems across a range of future climate scenarios.

Within this framework we will test a range of plausible future scenarios that vary across three dimensions: 1) different combinations of AOGCMs and emissions scenarios, 2) different land use scenarios that accommodate projected increases in human populations, and 3) different land management scenarios in which landowners are encouraged to reduce fire hazard and conserve or restore imperiled prairie and oak ecosystems through a variety of accepted policy mechanisms.

Broader Impacts. Global climate change models have become increasingly mechanistic, sophisticated and spatially explicit. However, the development of mechanistic models of how coupled biological and human cultural systems will respond to climate change at

local extents is in its infancy. This research will produce a transferable methodology for modeling such systems that is tractable, spatially explicit, and directly linked to policy-based decision-making. Through our investigations, we will advance knowledge of how to bridge key theoretical and practical issues related to multiple types of system uncertainties, different spatial and temporal scales, and complex interactions and feedbacks among coupled natural and human systems.

Further, the risk of catastrophic wildfire in the wildland-urban interface is a growing nationwide threat, and accepted climate change projections will exacerbate the risks. The loss of biodiversity due to urbanization is also the subject of intensive inquiry and increasing concern. Our approach links these two issues by examining the potential to conserve and restore imperiled grassland ecosystems that are declining due to forest succession and residential development by providing key ecosystem services, in this case, protection from catastrophic wildfire.

Our proposed research supports emerging national, regional and local initiatives to provide tools for responding to climate change. To this end, the project engages graduate and undergraduate students in interdisciplinary research and coursework with faculty and students from diverse fields at two universities. It also involves students with key stakeholder groups in workshops designed to support policy makers and the public in making more informed decisions that address the challenges of climate change.

Key Project Personnel

Overall project coordination will be performed by PI Bart Johnson. His dual background as a landscape architect and ecologist includes experience that ranges from participatory planning to ecological restoration. He has extensive experience managing and participating in collaborative interdisciplinary research. His current research focuses on landscape planning to integrate prairie and oak habitat restoration with fire hazard reduction in the WUI. This research, conducted with co-PI Scott Bridgham, has coupled intensive ecological data collection and analysis of successional trajectories on former WVE prairie and oak savanna with extensive stakeholder involvement to craft land management alternatives to restore imperiled habitats and reduce the risk of catastrophic fire.

Climate/Vegetation/Fire Modeling System

Scott Bridgham, an ecosystem ecologist, will be the overall lead for coordination of the climate change, vegetation and fire modeling system. In particular, he will oversee the modeling efforts to investigate the effects on climate change on succession and fire hazard in the WVE. He has published widely on carbon budgets in relation to climate change and ecological restoration. Bart Johnson will assist in coordinating this modeling system.

Ron Nielson a bioclimatologist and Jim Lenihan, an ecosystem modeler will provide the primary climate change modeling expertise through their dynamic global vegetation model MC1. They will supervise the formulation of the logic and mechanism of information transfer from MC1 to FVS and how this information is incorporated within FVS and the overall modeling effort, and guide implementation by UO Ph.D. student

Gabe Yospin. Nielson has been a member of the Intergovernmental Panel on Climate Change, the U.S. Global Change Research Program, and the coordinating scientist for the EPA's 1987 Report to Congress on the ecological effects of climate change. As a federal scientist, Neilson leads the MAPSS team, which includes Jim Lenihan as a Senior Scientist. The scope of this proposal falls within the mission of their federal funding, which is for climate change research as well as in support of the National Fire Plan.

Alan Ager, a USFS wildfire risk modeler, will provide direction on the incorporation of stand-level and landscape-scale simulation scenarios within ARCFuels, and provide refinements to improve the software interface for the purposes of this project. He has published widely on simulation of fuels treatments for WUI fire hazard reduction.

Constance Harrington and Peter Gould are silviculturalists and research foresters for the USDA Forest Service. They will be project leads for refitting FVS for Oregon White oak, as they have previously done for the forest growth simulator ORGANON. Harrington is one of the foremost researchers of Oregon white oak biology in relation to restoration treatments and forestry practices.

Jane Kertis, a fire ecologist, will be the project lead on assessing and improving fire model behavior for Oregon white oak plant communities. Current research includes the ecology, restoration, fire history and fire risk assessment of oak and dry site ecosystems in northwest Oregon. She is a founding member of the Oregon Oak Communities Working Group and lead PI for describing successional pathways for federal forest lands in Northwest Oregon.

Gabriel Yospin, a UO Ph.D. student, will be responsible for developing and implementing the protocols to link MC1 to FVS as the foundation for stand-level and landscape-scale simulation modeling that incorporates climate change. He will also work closely with Bart Johnson, who will take the lead on stand-level simulation modeling of land management alternatives. Yospin has worked on the current JFSP research of PIs Johnson and Bridgman for over two years, focusing on tree growth rates, successional pathways and fuel loadings.

Land Use/Land Management Decision Modeling

David Hulse and John Bolte will share responsibility for coordination of the land use/land management decision modeling. David Hulse brings extensive experience in alternative futures planning and knowledge of Willamette Valley social and ecological systems. He has been the co-PI of a multiuniversity/ federal agency consortium, The Pacific Northwest Ecosystem Research Consortium, whose goal is to understand ecological consequences of possible societal decisions related to changes in human populations and ecosystems in the PNW and to develop transferable tools to support management of ecosystems at multiple spatial scales. He will also be the project lead for coordination, assembly and development of the GIS data bases used in the project's modeling efforts. John Bolte is an ecological engineer and ecosystems analyst who is the lead developer of Envision, the agent-based modeling program that is the foundation of the land use land management decision modeling system for this project. He has been involved with or led a number of highly multidisciplinary efforts related to coupled natural/human systems analysis, and developed models and decision tools for various aspects of ecosystem management for the last twenty years. He has expertise in spatial

analysis, multiagent-based modeling, ecosystem simulation, software development and engineering, and spatial data management.

Robert Ribe, a landscape architect, planner and social scientist, will be the project lead on the landowner survey and decision preference analysis. He has conducted substantial research on aesthetic perceptions, most recently in the context of public views of the acceptability and aesthetics of alternative silvicultural treatments in Pacific Northwest national forests. He is Director of the UO Institute for a Sustainable Environment. He has experience and training as a land use planner, emphasized social psychology in his Ph.D. and has graduate training in agricultural economics.

Paul Slovic, a risk analyst and psychologist, will assist Rob Ribe as a survey design consultant to assess landowner risk perceptions and responses to fire. He publishes extensively on human judgment, decision making and risk analysis, and serves as a government/industry consultant. Dr. Slovic is a past President of the Society for Risk Analysis, and has received Distinguished Contribution awards from the Society for Risk Analysis, the American Psychological Association and the Oregon Academy of Science.

Finally, Bart Johnson will be the project lead for selecting study areas and for stakeholder involvement and outreach through selected presentations and workshops with community fire planning groups, and in local and regional policy forums with participation of students involved in project.