Native Northwest prairie plants being grown at three sites under future climate conditions

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The experimental research plot near Selma, Ore., is one of three sites in the Pacific Northwest that are being manipulated to grow native prairie plants under conditions projected for climate change at the end of the century. Findings at the Selma site in southwest Oregon, another site in Eugene and a third near Olympia, Wash., are geared to provide conservation groups with information to guide their future decision-making. Credit: University of Oregon

University of Oregon-led research in prairies of the Pacific Northwest could be a roadmap for the conservation of native plants facing stresses from projected climate changes and invasive species.

By 2100, the region is expected to have a more severe Mediterranean-like climate, with wetter winters and longer, hotter summers, said project leader Scott D. Bridgham, professor in the Department of Biology, director of the Environmental Science Institute and member of the Institute for Ecology and Evolution. The Intergovernmental Panel on Climate Change (IPCC) predicts that the global mean temperature will increase by about 1.8 to 5.4 degrees Fahrenheit (1 to 3 degrees Celsius) above 1990 levels by the end of the century.

To simulate the projections, 12 species of range-limited native grasses and forbs are being grown in 60 plots. The sites are the Siskiyou Field Institute's Deer Creek Center at the headwaters of the Illinois River Valley in southern Oregon, the Nature Conservancy's Willow Creek Preserve in Eugene and the Tenalquot Prairie Preserve in near Olympia, Washington.

Infrared lamps generate warmer temperatures and dry the soils. An irrigation system, which recycles captured rainfall, increases precipitation by 20 percent. The three sites are in a 300-mile-long crosscut of the region that represents a gradient of increasing Mediterranean climate conditions, with warmer temperatures and more severe summer drought from north to south, allowing for an climate-change experiment embedded in a natural climate gradient.

"We are making the Washington prairie site more like what projections are for the end of the century, which are more like southern Oregon is now," Bridgham said. "By then, southern Oregon will be more like much of California."

Also working at the sites are collaborating scientists from Portland State University, the University of Colorado at Boulder and Duke University, who are focusing on regional demographic modeling and long distance dispersal using genetic methods for the various plants under scrutiny.

This will allow the plot-level results to apply to the entire Pacific Northwest.

Under a four-year $1.8 million grant awarded in 2008 from the U.S. Department of Energy, Bridgham's team completed 2.5 years of experiments after spending 18 months installing equipment and preparing the plots. Under a new $2.3 million, five-year grant (No. 1340847) from the MacroSystems Biology program of the National Science Foundation, another four years of data will be gathered.

"The previous work and the new work revolve around a fundamental conservation biology question involving the impacts of climate change on native plant species in these imperiled ecosystems," Bridgham said. "While none of our focal species are officially endangered or threatened, they are not common, because less than 5 percent of the prairies are left in the Pacific Northwest. Also, our research is pertinent to plants in other areas that have experienced broad human impacts and are facing impending climate change. "

While the plants placed in each prairie are the same, the genotypes of each species that grow best in each region's soils are used to study local impacts.

The first two years harvested noteworthy trends. Plants in their current ranges struggled to germinate with warming, but species moved beyond their current ranges experienced no negative effects of warming. Increased rainy season precipitation, however, had few effects. The results suggest that native plants may need to move further north or to higher elevations to survive.

An early surprise finding, detailed in a paper under submission by UO doctoral student Lorien Reynolds, is that emissions of carbon dioxide from soil microbes and plant roots in Pacific Northwest prairies will not

increase with climatic warming, and may even decrease, in contrast to the predictions of many Earth system models. This is because warmer temperatures dry out the soil. The Pacific Northwest also gets lower amounts of rain during late spring and summer, so warm temperatures are coincidental with drought-like conditions for soil microbes and roots.

"The response of soil respiration to warming depended on the current climate gradient across our sites," he said. "In southern Oregon, we found that warming actually often decreased soil respiration during much of the year because of its drying effect, whereas it tended to have a positive effect in the milder Washington site. This may apply as well to soils in the Great Plains with the increasing summer droughts that are being experienced there. This is a bit of good news."

The project also is studying invasive plant species. At each site, some 30 native species, including the 12 range-limited prairie plants, were planted after treatment with a common herbicide. After a year of light weeding, the invasive species emerging from the seed banks were allowed to grow unimpeded.

Warming and drying Northwest soils, Bridgham said, may make the Northwest more like present-day California grasslands—dominated by annual invasive plants instead of the current mix of native and invasive perennial species.

Members of the UO team are biologists Bridgham and Barbara "Bitty" Roy, Bart R. Johnson of the Department of Landscape Architecture, and Laurel Pfeifer-Meister, a research associate in the Institute of Ecology and Evolution. Under the NSF grant, the UO team will integrate the research with the training of students from high-school age through postdoctoral associates. Information about the project also will be incorporated into a website for dissemination.

Portland State University's Mitchell B. Cruzan will focus on population genetics of the native prairie plants to determine their abilities to migrate to new locations in today's highly fragmented landscape. William F. Morris of Duke University and Daniel F. Doak of UC-Boulder will combine demographics and population genetics to prepare detailed modeling of the migration capacities of the native species and the invasive perennials and annuals through the end of the century.

"It's known that humans have decreased biodiversity through a number of different mechanisms, with land use being the most important currently," Bridgham said. "Invasive species have also been detrimental to native species biodiversity. However, future climate change may greatly exacerbate the effects of these other factors. We're looking at all of these factors in close collaboration with the Nature Conservancy, the Center for Natural Land Management and the Siskiyou Field Research Institute.

"All are interested in these questions for management practices to enhance and maintain native biodiversity. They need to know what will happen in the future to the native species that they are managing. Will assisted migration of plants northward work to assure they can conserve our native species? We, as scientists, want to provide the data for those who make these decisions. We also have to consider the impact of extinction of our local habitats."

Provided by University of Oregon