On Great Plains, Juniper Invasion Signals Prairies in Distress

TULSA, Oklahoma—When the first Europeans made their way to the Great Plains in the center of the North American continent, they found vast prairies extending to the horizon, with the waves of grass hardly broken by trees. But a visitor to those same prairies today—from Texas up to South Dakota—is likely to find an army of shrubby junipers overtaking the grass.

Far more than an aesthetic change, the shifting ecology places both wildlife and humans at risk: The trees crowd into grazing land and consume water that might otherwise nourish the prairie or provide supplies for local towns and cities. They discharge clouds of highly allergenic pollen and harbor mosquitoes that carry West Nile virus. And they usurp habitat crucial to species such as the lesser prairie chicken and the prairie mole cricket.

“Juniper invasion has emerged as a dominant threat to some of the most threatened ecosystems of North America,” says Samuel Fuhlendorf, a professor in the Natural Resource Ecology and Management program at Oklahoma State University (OSU). At the recent meeting here of the AAAS Southwestern and Rocky Mountain Division, Fuhlendorf and others detailed how human activity over the past 150 years has upset a natural balance that endured on the prairies for millennia. The question now—for farmers and ranchers, hunters, conservationists, consumers, policy-makers, and scientists—is whether humans can help restore the balance and the prairie’s health.

The 86th Annual Meeting of the Southwestern and Rocky Mountain Division convened 31 March to 4 April at the University of Tulsa (TU) to explore regional issues with global resonance—cybersecurity, new digital tools for archaeology, research ethics, and the relationship between science and religion, among others. The meeting was held in conjunction with the 15th Annual TU Research Colloquium and the 10th Annual University of Oklahoma-Tulsa Research Day.

Symposia on the juniper invasion and Oklahoma’s endangered species explored the health of the Great Plains, but the lessons apply to grasslands worldwide.

Eastern redcedar (Juniperus virginiana) and mountain cedar (Juniperus ashei) are native to the region, but for millions of years a natural cycle of wildfires held them in check.

Then, in the 19th century, European pioneers brought intensive cattle-grazing. The sodbusters soon followed, turning up millions of acres of native grass to plant wheat. After the disastrous Dust Bowl of the 1930s, thousands of Eastern redcedar were planted as windbreaks to hold the soil in place. Wildfires were suppressed as a threat to human communities.

Not until it was too late did people realize that the disrupted soil and lack of fires create favorable conditions for the juniper.

March of the junipers. The trees’ aggressive spread “has emerged as a dominant threat to some of the most threatened ecosystems of North America,” says one researcher.

In 2002, the U.S. Department of Agriculture estimated that 8 million acres in Oklahoma alone were “infested” with 50-plus junipers per acre. The conquest was growing by 762 acres a day, doubling every 18 years. New birds follow the trees into the prairie; they eat the juniper berries and expel the seeds, aiding the invasion with each meal. Rising levels of atmospheric carbon dioxide, associated with climate change, may also be fueling the advance, researchers told the AAAS division audience.

Researchers see the lesser prairie chicken as symptomatic of the plains’ stressed condition. Agriculture, overgrazing, and energy development have helped reduce its population by 90% since 1900. Fuhlendorf says that junipers and wind turbines pose similar threats: The bird “tolerates basically no vertical structures,” he said, because it perceives them as haven for predators.

The impact of juniper proliferation is felt even in urban centers. Estelle Levetin, a TU aerobiologist, reported that eastern redcedars around Tulsa appear to be driving “a significant increase” in airborne juniper pollen. Early results in a study covering 25 years suggest a 110% increase in the city’s springtime pollen, she said.

Other research indicates that the junipers disrupt the prairie water cycle. Mature trees may consume up to 35 liters of water a day. Don Turton, a forest hydrologist at OSU, said that preliminary research results attribute a 20% average net loss of water to redcedar canopies. That leaves soil drier and reduces the flow of surface streams. In heavily infested watershed areas along the Canadian River, that may reduce water supplies for Oklahoma City.

In an arid state like Oklahoma, water is a rallying point for diverse interests, from ranchers and farmers to hunters, anglers, and environmentalists. Over the past decade, campaigns to control the junipers have intensified in many parts of the Great Plains. Some are working to conserve blocks of native grassland and reintroducing herds of buffalo. Others have established cooperatives to manage controlled burns, using new science to help bring an ancient balance back to the prairie.
The Payoff of Federal R&D: iPod, Google, and Human Genome Project

With the U.S. budget under intense pressure, lawmakers increasingly are looking to save money by cutting federal spending on research and development. But at two Capitol Hill briefings, experts offered compelling evidence that that federal investment can yield enormous dividends and warned that cuts to R&D could hinder future economic growth.

At the briefings, co-organized by AAAS, they pointed to the Google search engine, iPod technology, and the Human Genome Project as examples of how federal funding has aided transformational innovation and economic growth. Especially when economic stresses are acute, they said, the nation must maintain its longstanding commitment to invest in future prosperity.

“We have very powerful evidence of the productivity” of R&D spending, said University of California-Davis sociologist Fred Block. “When we’re cutting back on that R&D spending, we are eating our seed corn, and upsetting the possibilities of future economic growth and development.”

Block joined a panel of experts at the 16 March briefings, organized by the University Corporation for Atmospheric Research and AAAS, and cosponsored by eight other scientific societies. In discussions moderated by Vijay Vaitheeswaran, a senior correspondent for The Economist, they grappled with some of the challenges facing the United States as stress on R&D budgets and competition from abroad increases.

Under President Barack Obama’s 2013 budget proposal, R&D investment would increase by 1.2% over 2012 funding levels. Nondefense R&D spending would increase by 5.1% over last year’s budget, according to the AAAS R&D Budget and Policy Program, while the proposed defense R&D budget would shrink by 1.9%. The House of Representatives’ 2013 budget resolution would reduce discretionary spending further, according to analyses by AAAS. The House proposal would cut nondefense R&D spending by 8% compared to the president’s budget request, or 5% below the funding levels approved for 2012.

The prospect of tighter federal funding comes as the focus of U.S. innovation is shifting away from large corporations to universities and smaller start-up companies, and technologies are converging in unexpected ways across disparate fields. These trends point to an increasingly important role for federal R&D spending, the panelists said, since federal programs already support significant cross-disciplinary work at public laboratories and universities.

While they agreed that it is difficult to come up with clear-cut quantitative measures of the impact of federal R&D, data compiled by the U.S. Bureau of Labor Statistics offer some perspective. The data show that the output per unit of labor in the U.S. economy from 1948 to 2007 grew at an annual rate of 2.5%, with 58% of the growth attributed to the increase in knowledge that comes from R&D investment.

The investment in knowledge represented by the federally funded Human Genome Project had a $796.3 billion economic impact from 1998 to 2010, according to a 2011 study by Battelle Memorial Institute. Simon Tripp, senior director of Battelle’s Technology Partnership Practice, said that CEOs of major bioscience companies interviewed for the study agreed that without the federal project, “we would be nowhere near where we are today.”

This decade’s equivalent of the genome project may be the renewed federal investment in energy innovation and sustainable technologies at The Dow Chemical Company, described several Dow projects that have benefited from federal funding, including solar shingles, lithium-ion batteries for electric and hybrid cars, and lightweight carbon fiber blades for next-generation wind turbines.

History suggests that great countries, like great companies, invest during an economic downturn, Vaitheeswaran said. The United States can reap future economic benefits, he suggested, by building on historical strengths in science and technology education and “reinvesting in our base of R&D that fuels the innovation fire.”

—Earl Lane and Becky Ham

EDUCATION

AAAS Project 2061 Site Debuts Online Science Tests

Middle and high school teachers can now test their students’ knowledge of key science concepts at an innovative Web site developed by Project 2061, AAAS’s science literacy initiative.

The “Create & Take Tests” module was added in March to the AAAS Science Assessment site (http://assessment.aaas.org), which contains more than 700 test questions on topics from evolution and natural selection to atoms, molecules, and states of matter. Teachers can use the new module to build multiple-choice tests from items that they select from the site’s full database of questions.

The tests can be administered and scored online, providing quick feedback for instructors, said George DeBoer, the deputy director of Project 2061 who led the assessment project. “Getting reliable and timely information about what students know or don’t know means that teachers can adjust their instruction to respond quickly to their students’ needs.”

Josh Flory, an 8th-grade science teacher at New Albany Middle School in Ohio, has used the feature to design pre- and post-tests for his students in biology, geology, and the physical sciences. The immediate feedback from the online test, he said, “has been a very powerful tool for students, and gives them a chance to see where they’re starting from and where they can grow.”

Project 2061 developed the assessment items and collected data on them in a 7-year effort funded by a grant from the U.S. National Science Foundation. The site has logged 12,000 registered users and nearly 70,000 visitors since its launch in April 2011.

—Becky Ham