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Turning Trees into Fighter Fuels

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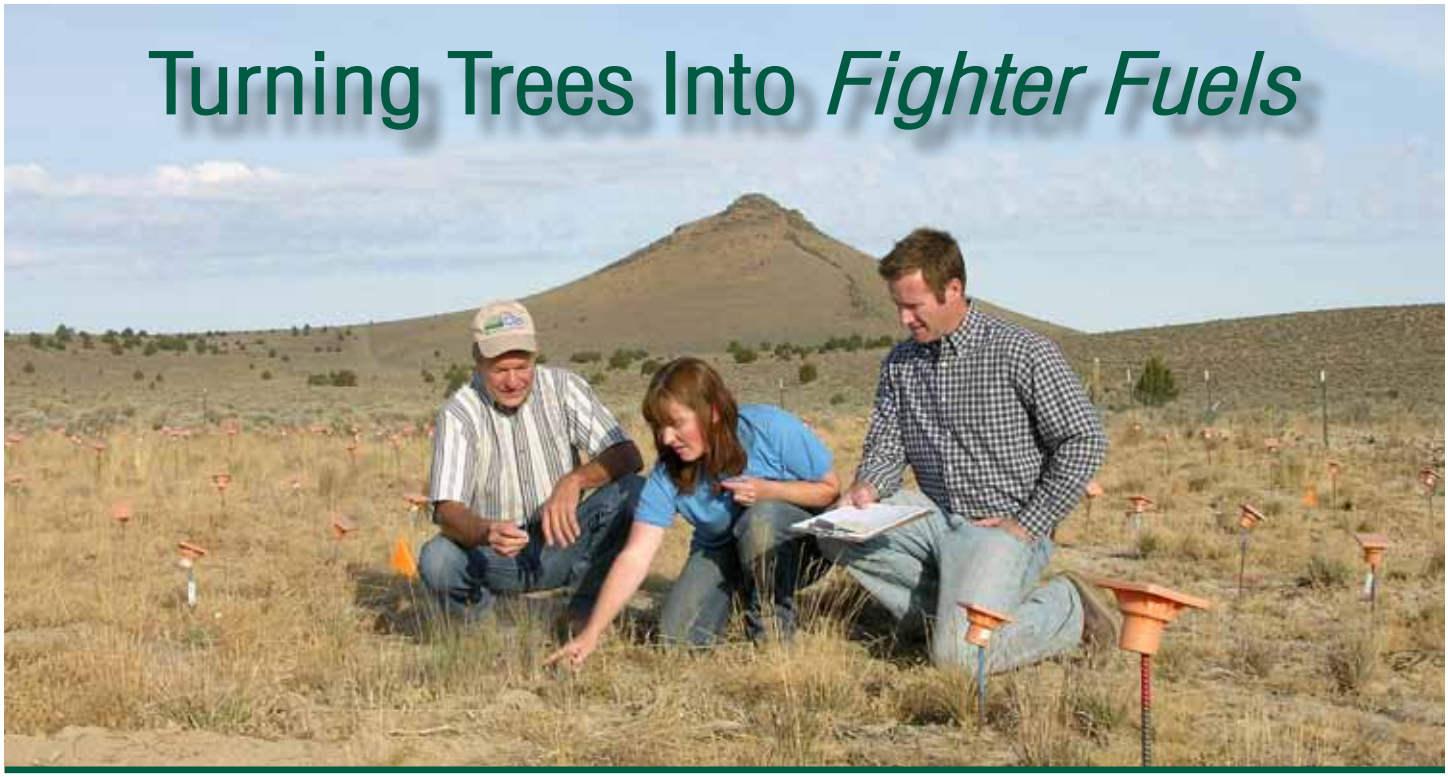
LACY CARPENTER (D2370-1)

Turning Trees Into *Fighter Fuels*



After junipers were removed on this field near Burns, Oregon, rangeland scientist Tony Svejcar (left), technician Lori Ziegenhagen, and plant physiologist Jeremy James examine the establishment of bluebunch wheatgrass as part of research to improve range restoration.

In western U.S. rangelands, native juniper and pinyon pine trees are spreading beyond their historical ecological niches and disrupting the environmental balance of their expanded range. Meanwhile, Agricultural Research Service scientists are teaming with university and industry colleagues to turn this problem into a source of fuel for U.S. Navy fighter jets.

"Juniper competes with grass and forbs for water and nutrients, and this leaves bare soil that is vulnerable to erosion," says ARS scientist Mark Weltz, who works at the Great Basin Rangelands Research Unit in Reno, Nevada. "We have also lost habitat for sage grouse and mule deer, and the amount of forage available for cattle has declined as well."

"Our options for controlling juniper expansion are limited," adds ARS rangeland scientist Tony Svejcar, who is the research leader at the Eastern Oregon Agricultural Research Center in Burns, Oregon. "There's not much of a market for cut juniper, so we usually just cut the trees and leave them where they fall."

Pinyon pine trees, which in the western United States often grow alongside juniper, present similar management problems. The good news is that some preliminary estimates suggest that harvesting a percentage of these hardy trees every year could supply enough biomass to produce millions of gallons of renewable jet fuel. Removing the trees would help restore productive rangeland for livestock and protect critical sagebrush habitat for threatened species such as the western sage grouse. The time is right to develop a comprehensive strategy for harvesting the trees and using the woody biomass to jumpstart a regional biofuel industry.

This project, called "Accelerated Renewable Jet Fuel Supplies from Western Woody Species," is headed up by rangeland ecologist Tamzen Stringham at the University of Nevada-Reno. The effort

An adult male sage grouse. On western U.S. rangeland, removing excessive junipers and pinyon pine trees for biofuel production can help restore land for livestock and protect sagebrush habitat critical to the survival of the sage grouse.

STEPHEN AUSMUS (D552-18)

ROBIN TAUSCH (D2904-1)

ROBIN TAUSCH (D2905-1)

In 1973, this area in central Nevada had little juniper tree coverage, and the junipers were mostly at the higher elevations (top photo). By 2005, at the same area, the junipers had expanded substantially (middle photo).

includes numerous public and private collaborators and is part of the U.S. Department of Agriculture's Regional Biomass Research Centers initiative, which supports research on and development of dependable feedstock supplies to promote advanced biofuels production throughout the United States. (See box on page 7.)

"The arid west has traditionally been overlooked as a source of biomass for bioenergy," says Dallas Hanks, director of Utah State University's Extension Center for Agronomic and Woody Biofuels. "With new technology and the knowledge from cooperating organizations, we've learned that this region has tremendous opportunity to contribute significant quantities of biomass that can be used to meet the nation's growing need for renewable fuels."

Taking Stock

The first step in the process is taking an inventory of how many trees could be harvested for use as biofuel feedstocks. Current remote-sensing work by ARS rangeland scientists—using satellite data to identify juniper and pinyon pine trees and estimate the density of mature trees—has given the process a head start. (See story on page 8).

"This will help us locate where trees can be harvested and figure out how many trees are actually available to use for biofuel development," says Svejcar. "We can also use this information to determine where wildlife habitat would be best restored and avoid harvesting in areas where it could harm existing wildlife populations."

The next task will be to devise plans for harvesting the trees in a sustainable manner, a process dictated in part by environmental characteristics that differ across the vast western rangelands. ARS scientists have already conducted considerable research

STEPHEN AUSMUS (D2115-7)

In Arizona, hydraulic engineer David Goodrich (right) and technician Jim Riley are working to improve modeling estimates of watershed-level rainfall runoff and erosion—information that will help guide decisions on where, and how many, juniper trees can be harvested without having an adverse effect on runoff and erosion.

that will help determine how harvesting the trees could affect the ecological health of this region.

For instance, ARS scientist Fred Pierson is using watershed data gathered over the past 50 years from the Reynolds Creek Experimental Watershed in Idaho to simulate how tree harvests would affect water runoff from the surrounding terrain. His previous work involved studying hillslope erosion processes across the Great Basin. Now he plans to conduct experimental juniper harvests on a variety of sites to observe how the removal affects soil erosion from snow runoff water. He'll use the information to model the environmental impacts of large-scale tree harvests.

Pierson will also be monitoring how juniper removal affects large-scale water cycles. "Junipers draw a great deal of water from the soil," says Pierson, research leader at the ARS Northwest Watershed Research Center in Boise, Idaho. "Up to this point, we've only looked at the water demand of individual trees. But now we're looking at how whole juniper forests affect water cycles in entire watersheds, which is important for calculating how much more water could be available after the trees are removed."

Pierson's preliminary findings suggest that invasive juniper stands have affected long-term patterns of snowpack formation and snowmelt schedules—two essential processes in the availability and delivery of irrigation water to farmers. Harvesting trees will allow him to observe any shifts in water supplies that result from clearing juniper trees from the landscape.

Models for Management

Much of the harvest planning will be conducted with computer models that have been developed by ARS scientists and their colleagues. One of these models, the Rangeland Hydrology and Erosion Model (RHEM), was developed in 2009 and produces estimates for storm-water runoff and soil erosion for hillslopes. Another ARS program, called "KINEROS2," incorporates RHEM to provide estimates of watershed-level rainfall runoff and erosion as well.

The newest modeling program is the Automated Geospatial Watershed Assessment tool, known as "AGWA." It fine-tunes watershed delineations by incorporating layers of GIS data, such as soils and land-cover data, into KINEROS2 watershed models. David Goodrich, a hydraulic engineer at the ARS Southwest Watershed Research Center in Tucson, Arizona, will work with the team to improve modeling estimates of watershed-level rainfall runoff and erosion, which will help guide decisions on where to harvest trees.

Stringham and Keirith Snyder, an ARS scientist with the Reno unit, will also design site-restoration plans so landowners and those who utilize the biomass can ensure that the harvests are conducted sustainably from beginning to end. One of the tools that can help with this process is an ARS decisionmaking model called "Ecologically Based Invasive-Plant Management" (EBIPM), which can be used to develop plans for restoring native plants on terrain previously overrun by invasive vegetation. (See "Step-by-Step Strategies for Restoring Western Rangelands," *Agricultural Research,* February 2012.)

In addition, using state-and-transition model mapping techniques to obtain information about soils and other site characteristics that affect restoration plans could make EBIPM assessments even more effective. (See story on p. 10.) Carefully integrating plans that include tree inventory, harvest, and site-restoration methods will be essential to ensuring that an emergent biofuel industry leaves the landscape in better shape than before.

End of the Line

While ARS scientists are figuring out how to assess and harvest the woody biomass, other partners in the project will be developing feedstock logistics plans and strategies for transporting the harvested trees and processing the biomass into fuel. Part of this effort will include finding coproduct market possibilities for the materials generated during the fuel-conversion process. Honeywell UOP, a developer and licenser of technologies that produces aviation and other biofuels, will conduct tests of the biofuels produced from the rangeland tree biomass. Amaron Energy will contribute work on methods for preprocessing woody biomass into a bio-oil to reduce transportation costs of the harvested trees.

"All of this work is part of an overall plan to ensure that regional biomass businesses for jet fuel enhance regional business and environmental conditions," says former ARS national program leader Jeffrey Steiner, who has helped lead the project. "We want to align participant and

A slash bundler harvesting device being used to harvest a whole juniper tree. ARS scientists are working with collaborators to use this invasive tree as a potential renewable source, or feedstock, for producing biofuels.

RANDY PARKS, BURNS TIME-HERALD (D2908-1)

stakeholder interests to form effective partnerships along supply chains to create new rural job opportunities based on renewable jet fuel production."

"The federal government is already spending millions of dollars every year to remove these trees that could be used to make jet fuel," says Weltz, who will be assisting in some of the modeling work. "Development of a biofuel industry would add new job opportunities in rural areas that need new businesses. It could be a win-win-win for everyone."—By **Ann Perry,** ARS.

This research is part of Pasture, Forage, and Rangeland Systems (#215) and Water Availability and Watershed Management (#211), two ARS national programs described at www.nps.ars.usda.gov.

"Development of a biofuel industry would add new job opportunities in rural areas that need new businesses."
— Mark Weltz

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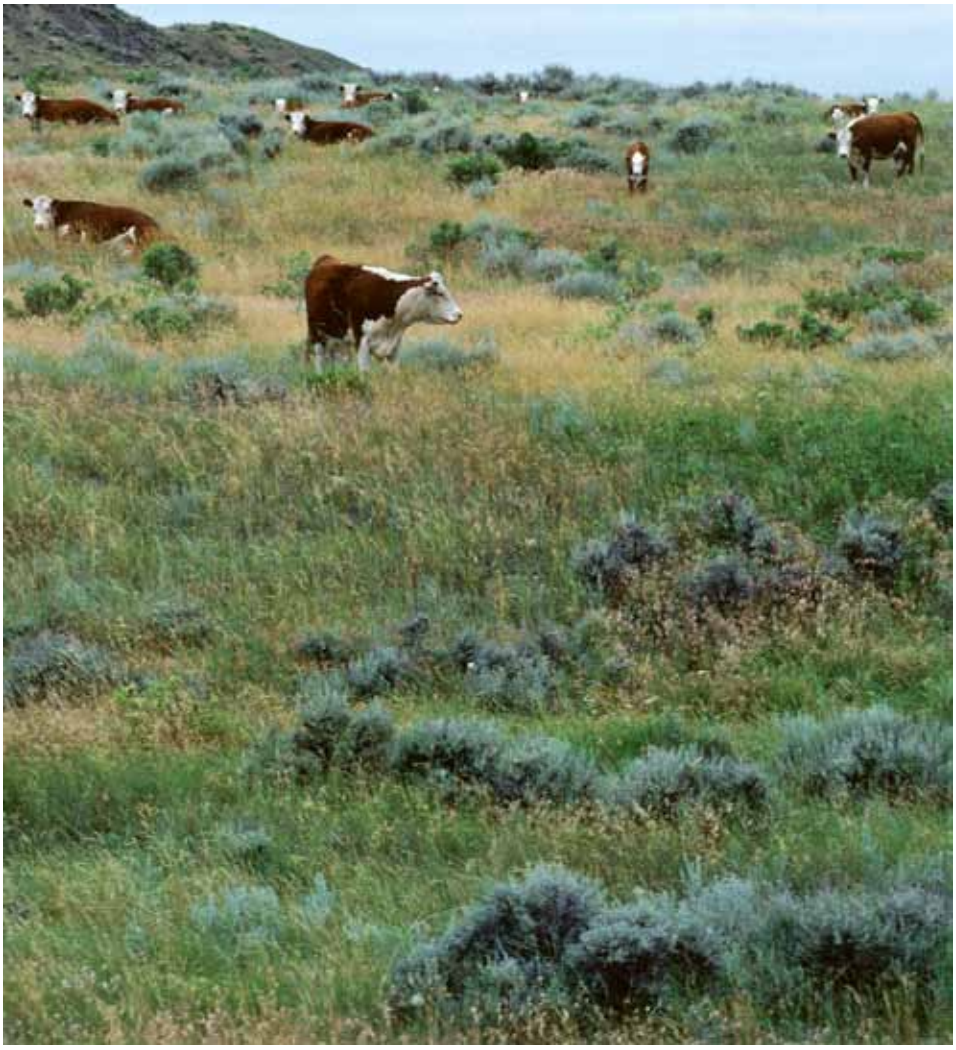
DOUG WILSON (K1223-19)



This healthy pasture provides a variety of plants for livestock and wildlife. Pastures covered with invasive juniper could be restored to look something like this after the excessive juniper cover is removed for biofuel production.

The ARS Network of Biomass Centers

The **Agricultural Research Service** locations included in this story are parts of the U.S. Department of Agriculture's Western and Northwestern Regional Biomass Research Centers network. The network is made up of five national centers whose mission is to help accelerate the establishment and production of sustainable commercial biomass from farms and forests without disrupting the production and marketing of food, feed, and fiber.

Collaborators on the research covered in this story include: Amaron Energy, Brigham Young University, Honeywell UOP, Michigan Technological University, Montana State University, National Aeronautics and Space Administration, Oregon State University, Resource Concepts Incorporated, USDA Forest Service, USDA National Agricultural Library, USDA Rural Development, Utah State University, and Vermont and Nevada Extension.*