2009

# Blackbrush Shrublands: Fire Conditions and Solutions in the Mojave Desert

Lisa-Natalie Anjozian
*US Forest Service*, lisa@toeachhisownmedia.com

Joint Fire Science Program
Fire Science Brief
RESEARCH SUPPORTING SOUND DECISIONS

When Mojave fire regimes are rapidly altered, individual species and species assemblages may be significantly affected. Credit: Matt Brooks.

# Blackbrush Shrublands: Fire Conditions and Solutions in the Mojave Desert


## *Summary*

While mature stands of blackbrush present an almost continuous cover that appears to suppress other species, this ecosystem supports a greater array of different plant species than was previously thought. Fire can completely remove blackbrush cover, but it also results in reduced numbers of other native species, and increased dominance of non-native species such as annual grasses that can promote recurrent fire and alter the fire regime. Where blackbrush shrublands historically experienced intense fires with a long fire return interval, the non-native fine fuels that are now prevalent in many stands promote a greater rate of fire spread, and a shorter fire return interval. As blackbrush often requires centuries to recover, this native shrub may not be able to re-establish in areas where the ecosystem has been greatly altered. Appropriate management responses vary depending on the condition that the blackbrush stand is in.

## *Key Findings*

- Though mature blackbrush stands present an almost continuous shrub cover, they support a relatively higher number of plant species than typically thought.
- Where fire totally obliterates blackbrush, non-native species quickly respond, producing fuels that are more prone to burn, promote a greater rate of fire spread, a much more frequent fire return interval, and reduced plant species diversity.
- Blackbrush shrublands typically require centuries to recover, and may not be able to do so where the fire regime has been greatly altered by invasive species.
- Managing for blackbrush shrublands must take into account conditions present on the landscape—recommendations are based on three fire regime condition classes.

## Introduction

Anyone who's ever been to a desert place knows it is spare of moisture, a land often teased by cloudbursts that produce virga—rain that evaporates before it hits the ground. Desert is hardly one impression; it is true that it is a place of scant rain, but it is also a place where context manifests in extreme ways. From increments of rainfall differences over low, mid and high elevations, where plant density and therefore fuels vary, to cycles of relatively high rainfall followed by decades of drought, the desert bioregion of the basin and range geography of western North America includes two distinct ecological provinces and five ecological sections. Within the hot-desert province, lies the Mojave Desert.

As far as scientists can tell, fuel conditions and fire regimes in the Mojave remained relatively constant, at least as long as the last 1,400 years. Significant changes to this arid region began in the late 1880s as people implemented agricultural goals, and invasive species were introduced and spread. Human populations continue to grow in the desert regions, creating an urgent need to understand fire regimes and regime changes. This places land managers in the difficult position of determining prescriptions to protect natural and cultural features, and communities. While the lack of a forest canopy has always made the sun and the moon visible in the desert, the truth of arid ecosystems has been hidden in conjecture.

The Mojave Desert is perhaps the least studied of all the North American deserts. Most of what has been studied has focused on the broad expanses of creosote bush shrubland which covers most of the bioregion and is home to the federally threatened desert tortoise. In contrast, blackbrush shrublands which occur at elevations just above creosote bush, have received very little attention from the scientific world. During recent decades, it has become apparent that many of the fires in the Mojave occur within blackbrush shrublands, and that this vegetation type may be the most vulnerable to altered fire regimes caused by non-native grass invasions. In response to the general lack of information regarding the fire ecology of Mojave Desert blackbrush, Matt Brooks, a research botanist with the U.S. Geological Survey's Western Ecological Research Center, and his team set out to examine fire effects in this vegetation type, and to offer recommendations to manage fuel conditions and promote plant species diversity into the future.


Blackbrush is the dominant shrub between 4,000 and 5,000 feet.

## Surveying the scene, presuming the past

Stand in the mid-elevation landscape of the Mojave, and you will think an almost continuous cover of a single species dominates this desert shrubland zone between 4,000 and 5,000 feet. Blackbrush, an evergreen woody shrub, grows thick. Below this elevation lies creosote; above, is the zone where sagebrush, pinyon, and juniper grows. Because of its thickset and fine fuels, blackbrush is considered one of the most flammable zones in the Mojave. But what was the historic fire regime? Unlike landscapes where scientists can answer that question by reconstructing the natural range and variation of fire regime characteristics using fire scars on trees, such as ponderosa forest, Brooks explains the answer for the desert bioregion must be inferred.

The Holocene fire regime in the blackbrush shrubland zone, Brooks and his team believe, was probably characterized by very infrequent moderate to large fires that sometimes burned among fine surface fuels, but mostly carried through the crowns of shrubs. Though blackbrush shrubs usually do not survive fire, perennial grasses such as desert needlegrass, galleta grass, and Indian ricegrass resprout and establish quickly after burning. Spiny menodora and Mormon tea survive because they do not burn easily. As it appears blackbrush stands take centuries to recover, the scientists believe the interval before fire would return to this zone would have been a long one.

Blackbrush shrubland of the mid-elevation Mojave has been an arid land for millennia.

## A study in three views

Brooks and his team established three study sites, located from the northeast to the southwest, in the Mojave Desert. The Beaver Dam site in the Bureau of Land Management's (BLM) St. George Field office region of southwestern Utah, the Spring Mountain site in the Humboldt-Toiyabe National Forest of southern Nevada, and the Joshua Tree site in Joshua Tree National Park in southern California each contained mature blackbrush and an adjacent burned area located on similar soils and topography. Wildfire had burned Beaver Dam in 1995 and Spring Mountain in 1987, and prescribed fire had burned the Joshua Tree site in 1993.

The scientists compared density, species composition, and diversity of plants and seedbanks in the burned and unburned areas at each site. At Beaver Dam, they also applied mechanical thinning to blackbrush to study the effect of that treatment. In 2005, a wildfire swept through the entire study site and burned all the study plots.

Field crew measuring plant community variables in a blackbrush stand where non-native annual grass fuels are greater than 1,000 pounds per acre. Credit: Matt Brooks.

## Interpreting the images

Because blackbrush often grows thick, people commonly believed that few other plant species would have opportunities to grow. Brooks and his team, however, found the number of different plants species in blackbrush was comparable to other vegetation types in the Mojave. The scientists found a greater number of different native plant species, also known as species richness, over larger landscape scales that involved more variation in the environment such as gaps in shrub cover, the finer texture soils of rainfall runoff areas that are hummocks, and the coarser texture soils of run-on areas that are washlets. Over larger landscape scales, they found perennials increased in species richness more than annuals. Looking at the blackbrush shrubland landscape over different scales also revealed to the scientists different proportions in the numbers of native and non-native plant species, and among different plant life forms. An even proportion among different species, known as species evenness, in unburned blackbrush appeared to be low, Brooks found, as blackbrush dominated the landscape.

Fire dramatically changed that picture. Where blackbrush was almost totally obliterated, two to five other species established co-dominance in the six to fourteen year post-fire period. An even proportion among the different species growing resulted (species evenness increased), but the number of different species declined (species richness declined). This, the scientists found, demonstrated that removal of blackbrush led to a decreased number of different plant species, which is contrary to the view that removal of blackbrush should increase species richness.

A burning blackbrush stand with flames over 15 feet high. Credit: Matt Brooks.

Non-native species responded quickly after fire, and the numbers of different non-native species increased, though not as dramatically in areas where grazing had already allowed non-natives to establish before the fire. "These results," Brooks offers, "suggest that relatively undisturbed blackbrush may be somewhat resistant to invasion by non-native species, and the effects of fire on previously disturbed blackbrush may not affect dominance of non-native annual plants if disturbance levels are already high." The post-fire response of plant communities in blackbrush shrublands, the scientists offer, is illustrative of the general responses of other desert communities in the middle and high-elevation ecological zones.

Not only did fire remove nearly all blackbrush, but the scientists confirmed the effects of burning appear to be long term. They found annuals dominate in the first few years, then perennials after the first few decades, with red brome and cheat grass the most common species after fire. Brooks found that these non-native annual grasses can create a continuous cover of fine fuels (especially during years of higher rainfall), that lasts for years. This creates a new cycle of recurrent fire that promotes non-native grasses. “Although blackbrush produces the highest cover of all native vegetation types in the Mojave Desert, which is partly why it is considered the most flammable,” Brooks offers, “high cover and frequency of non-native annual grasses may create even more flammable fuel conditions.”

*“...high cover and frequency of non-native annual grasses may create even more flammable fuel conditions.”*

Brooks speculates that prior to European contact, blackbrush stands in a late ecologic stage were more extensive than they are today, and where blackbrush was extensively burned to create forage opportunities for stock during the early 1900s, this effort must have created many of the areas where blackbrush is currently absent, or subordinate in the landscape. The scientists believe the historical fuels in late ecological stage blackbrush stands were probably similar to what we find in undisturbed sites today, with the exception of non-native grasses that are present in many stands. Low amounts of fine fuels between the blackbrush shrubs probably limited fire spread to only extreme fire conditions, they believe, of high winds, low relative humidity, low plant moisture, and multiple dry lightning ignitions—high intensity, stand-replacing events. We now can find non-native annual grasses growing in most blackbrush stands, and these fine fuels burgeon after years of high rainfall. The current fuels composition in blackbrush shrublands is more able to burn than in the native fuel complex of past Holocene millennia.

Mature Condition Class 1 blackbrush stands contain a wider range of plant species than previously thought. Credit: Matt Brooks.

## Prescriptions for the condition

Having scrutinized a landscape hidden in assumptions, Brooks and his team can offer land managers recommendations for managing blackbrush shrublands that are based on actualities. Taking into account changes in plant communities, and therefore fire regimes, the scientists present managers with three solutions for the three fire regime conditions.

### *Condition Class 1*

Plants and fire characteristics are within historic ranges, the condition class of mature blackbrush stands. The fire regime is active crown fire supported by blackbrush and perennial grass fuels—intense, stand-replacing fire—with a long return interval, greater than a hundred years. This cycle has allowed blackbrush to slowly re-establish. Brooks and his team recommend suppressing human-caused fires, but encourage managers to let wildfires ignited by lightning to burn, unless large populations of non-native grasses are present. Prescribed fires should not be set, except for research purposes. Treatments should only be applied to fuels, they suggest, at the wildland-urban interface to reduce fire hazards for communities, or in wildland areas where managers have determined fuel breaks are necessary. Managers may have to regularly maintain treated areas because removing the woody shrubs will lead to colonizing by grasses that create fine fuels, and while fire intensity may be reduced, the these fuels are more prone to burn, with a greater rate of fire spread.

Condition Class 2 blackbrush stand dominated by early to mid-successional perennial grasses, shrubs, and Joshua trees. Credit: Matt Brooks.

### *Condition Class 2*

Plants and fire characteristics are moderately altered from their historic range. Blackbrush stands include a mixture of late ecological stage, unburned mature patches, with early ecological stage burned patches. Stands that have been overgrazed, burned by treatments, or have different kinds of disturbed areas are also within this class. Disturbed areas have less blackbrush cover, and greater numbers of shrub and herbaceous perennial species that grow in the early ecological stages, as well as perennial and non-native annual grasses. Fire in late ecological stage blackbrush patches displays active crown fires—the burns are intense and complete. In early ecological stage patches, grasses and sparse, early stage shrubs carry passive crown or ground fires—burns are patchy and fire intensity is low to moderate. Because the fire return interval in this condition class is shorter, 50–100 years, and because these areas may also have continuing pressure from stock grazing, early ecological stage species are helped in maintaining their dominance. As a result, blackbrush may be unable to re-establish.

The scientists recommend excluding all wildfires, and using prescribed fire only for research. Livestock grazing and an array of other disturbances should be limited as much as possible on stands where early, or mixed early and late stage plant communities are growing. As with condition class 1, Brooks and the team exhort managers to apply treatments only if necessary at the wildland-urban interface, or in wildland areas for fuel breaks. Treatments otherwise should not be applied to late stage blackbrush stands. Managers must maintain treated areas, as the fuels that will grow in these areas are more prone to burn, with an increased the rate of fire spread and frequency. In treating early stage plant communities where non-native plants dominate, managers may use grass-specific herbicides. While livestock obviously reduce fine fuel loads through grazing, the disturbance they create may prevent blackbrush and other late-stage plant species from establishing. This makes using livestock to control fuels contrary to long-term goals of promoting and sustaining late-stage blackbrush shrublands.

Condition Class 3 stand devoid of shrub cover aside from a few hardy early-successional species, and dominated by non-native annual grasses. Credit: Matt Brooks.

### *Condition Class 3*

Plants and fire characteristics are significantly altered from their historic range. Blackbrush stands, burned early in the twentieth century, have burned again, at least once. Non-native annuals and early ecological stage perennials dominate this class, and those areas that are not overgrazed by stock have large populations of perennial grasses. Surface fires are the regime—patchy, low intensity—carried by non-native plants. Fire returns in less than fifty years. Blackbrush will probably not re-establish in this invasive plant-fire scene.

The scientists recommend suppressing wildfires and using prescribed fire only for research. In this view of the blackbrush picture, Brooks sees that these extreme conditions may require extreme measures. Not allowing stock grazing or permitting other surface disturbances, along with planting blackbrush and other late ecological stage shrubs and grasses may be necessary. Applying herbicides to destroy non-native annual grasses, or setting prescribed fires early in the season right before planting may improve the survival rate of transplants, Brooks suggests. The current conditions on this condition class will not lead to restored blackbrush shrublands without managers' active efforts.

Brooks hopes the increased understanding of fire regimes in desert ecosystems will help managers as they develop plans for the dry desert lands of the American southwest. Further studies, he believes, are needed to examine the effects of rainfall patterns that may change in the future, the levels of carbon dioxide in the atmosphere and the deposits of nitrogen, on fuel conditions and fire regimes. By continuing to look, the truths will emerge.

### *Management Implications*

- Fuels management should be closely tied to invasive plant management, because the predominant plant invaders in the southern part of the desert bioregion are relatively flammable herbaceous species.
- Managers should control invasive plants that are currently present and work to prevent new invasive plants from establishing that may change the fuel structure and cause even greater fire problems in the future.
- Prescribed fires should not be set, except for research purposes.
- Managers may have to regularly maintain treated areas because removing woody shrubs will lead to colonizing by fine fuels that are more prone to burn.

## Further Information: Publications and Web Resources

Brooks, M.L. 2007. Effects of land management practices on plant invasions in wildland areas. Pages 147-162 in: W. Nentwig (ed.) Biological Invasions. Ecological Studies, Vol. 193, Springer, Heidelberg, Germany.

Brooks, M.L.2002. Peak fire temperatures and effects on annual plants in the Mojave Desert. Ecological Applications 12:1088-1102.

Brooks, M.L. C.M. D'Antonio, D.M. Richardson, J. Grace, J.J. Keeley, DiTomaso, R. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. BioScience 54:677-688.

Brooks, M.L. and J.R. Matchett. 2006. Spatial and temporal patterns of wildfires in the Mojave Desert. 1980-2004. Journal of Arid Environments 67:148-164.

Brooks, M.L. and R.A. Minnich. 2006. Southeastern Deserts Bioregion. P.p. 391-414 *In*: Sugihara, Neil G., Jan W. van Wagtendonk, Kevin E. Shaffer, JoAnn Fites-Kaufman, and Andrea E. Thode, editors. Fire in California's Ecosystems The University of California Press, Berkeley.

## *Scientist Profile*

Dr. Matthew Brooks was born and raised in southern California. His education includes a B.S. in Biological Sciences from the University of California, Irvine, an M.A. in Biology and a Professional Clear Single Subject Teaching Credential from California State University, Fresno, and a Ph.D. in Biology from the University of California, Riverside. Dr. Brooks has conducted research related to the ecology and management of natural resources in arid and semi-arid ecosystems since the late 1980s, and his research has focused primarily on interactions between fire and non-native plant species since the early 1990s. He has also taught various science courses at the high school, community college, and university levels. Dr. Brooks is currently a Research Botanist with the U.S. Geological Survey, Western Ecological Research Center.

*Matt Brooks* can be reached at:
USGS-Yosemite Field Station
5083 Foresta Rd., Box 700
El Portal, CA 95318
Phone: 559-240-7622
Email: mlbrooks@usgs.gov

## Collaborators

Carla D'Antonio, University of California, Santa Barbara

Curt Deuser, NPS, Lake Mead National Recreation Area

Tom Dudley, University of California, Santa Barbara

Jodie Holt, University of California, Riverside

David Pyke, USGS, Forest and Rangeland Ecosystem Science Center

Helen Smith, USFS, Rocky Mountain Research Station, Missoula Fire Sciences Lab

Andrea Thode, Northern Arizona University

Jennifer Vollmer, BASF, Professional Vegetation Management

*Results presented in JFSP Final Reports may not have been peer-reviewed and should be interpreted as tentative until published in a peer-reviewed source.*

***The information in this Brief is written from JFSP Project Number 00-2-32, which is available at www.firescience.gov.***

An Interagency Research, Development, and Applications Partnership

USGS
science for a changing world

JFSP *Fire Science Brief* is published monthly. Our goal is to help managers find and use the best available fire science information.

Learn more about the Joint Fire Science Program at *www.firescience.gov*

John Cissel
Program Manager
208-387-5349
National Interagency Fire Center
3833 S. Development Ave.
Boise, ID 83705-5354

Tim Swedberg
Communication Director
*Timothy_Swedberg@nifc.blm.gov*
208-387-5865

Writer
Lisa-Natalie Anjozian
*lisa@toeachhisownmedia.com*

Design and Layout
RED, Inc. Communications
*red@redinc.com*
208-528-0051