GREAT BASIN *Wildfire* FORUM

THE SEARCH FOR SOLUTIONS

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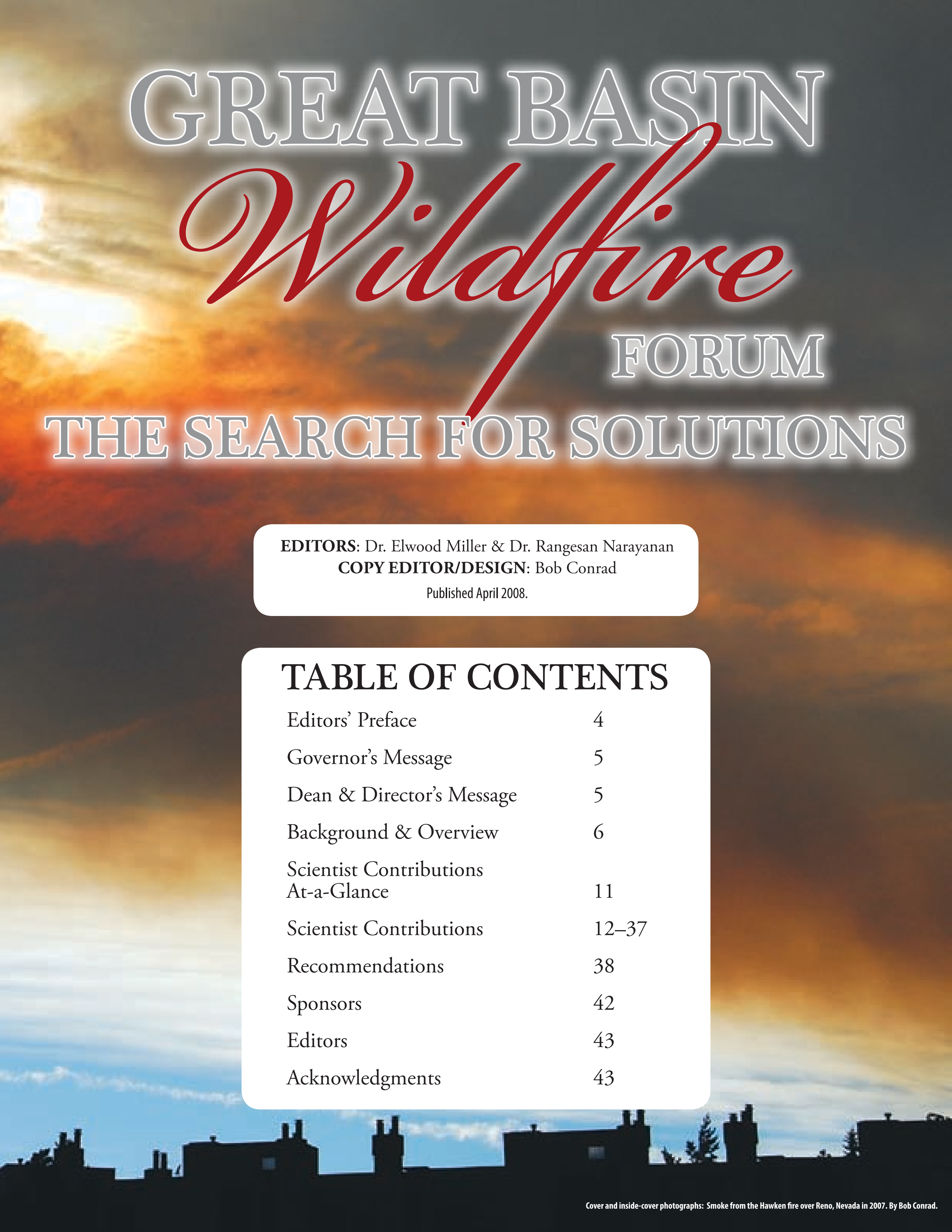

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COPY EDITOR/DESIGN: Bob Conrad
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Cover and inside-cover photographs: Smoke from the Hawken fire over Reno, Nevada in 2007. By Bob Conrad.

Preface

THE PRIMARY IMPETUS for this Wildfire Forum is a document authored by John McLain and Sheila Anderson of Resource Concepts, Inc. entitled “Urgent Need for a Scientific Review of the Ecological and Management History of the Great Basin Natural Resources and Recommendations to Achieve Ecosystem Restoration.” This document urged prominent scientists who have spent their careers studying, observing and working to manage the Great Basin ecosystem to pool their collective knowledge and experience over the last four decades, summarize their studies and provide recommendations to address the critical problems facing the Great Basin.

The response to the call was overwhelming as scientists expressed their willingness to participate, and several private Non-Governmental Organizations (NGOs) and government agencies offered to help. Responding to a request from John McLain, Principal of Resource Concepts, Dr. David Thawley, Director of the Nevada Agricultural Experiment Station (NAES) at the University of Nevada, Reno agreed to host and sponsor a discussion forum and publish the results as an Experiment Station publication.

Dr. Rangesan Narayanan, Associate Dean of Outreach and Professor of Resource Economics, agreed to provide the required leadership to organize the forum and produce an NAES publication. Dr. Elwood Miller, Professor and Associate Director Emeritus, facilitated the forum discussion and participated in writing and editing this publication. The two-day forum was held September 17–18, 2007 at the University of Nevada, Reno campus. The Nevada Department of Conservation and Natural Resources contributed the time of Mr. Bob Conrad to assist Dr. Narayanan and Dr. Miller with the editing and compilation of this publication.

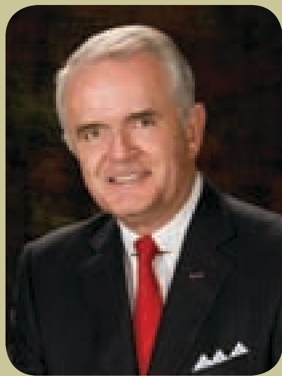
Seventeen prominent scientists with more than 500 years of combined work experience in the Great Basin were invited to participate. Fourteen scientists participated in the forum, and two participated through correspondence. A limited number of observers from various state and federal agencies were invited during the two-day symposium and participated in question-and-answer sessions.

After the welcome and introductions by Dr. Narayanan, Allen Biaggi, Director of the Nevada Department of Conservation and Natural Resources, provided opening remarks. He said: “The Great Basin and the surrounding areas are in crisis. We are seeing wholesale change to our vegetation types. We are seeing wholesale change to our economies, agricultural economies, wildlife values, recreation values, and something has got to change.” Mr. Biaggi pointed out the huge fire suppression cost in addition to loss of grazing, loss of sagebrush habitat, effects on wild horse programs and impacts on watersheds, water quality and recreation. He emphasized the need to base land resource management on science and charged the participants to provide recommendations critical to management and policy.

The symposium format for the first day consisted of individual presentations, followed by questions and answers from the scientists and the observers.

GOVERNOR'S MESSAGE

Jim Gibbons



In the face of exceptionally dry conditions and a lack of available forage, Nevada lost nearly one million acres this past fire season. If we fail to adequately rehabilitate this land, cheatgrass and other invasive species will replace native plants, creating an even greater risk for future fires. This threat of future catastrophic wildfires is not limited to the State of Nevada.

Last November, I signed a memorandum of understanding (MOU) with the governors of Idaho, Utah, and Wyoming to outline and formulate a cooperative plan to ensure the continued coordinated support efforts for wildland fire fuels management and rehabilitation efforts among all four states. Nevada, Idaho, Utah and Wyoming recognize that by working cooperatively, we can pool resources to begin countering the adverse effects of fire, invasive species and other ecologically disruptive changes.

I applaud the action taken by the University of Nevada, Reno in cooperation with both Nevada and other Great Basin institutions for helping to develop partnerships with agencies and nongovernmental organizations as part of the Great Basin Environmental Program. This effort will help direct our resources more efficiently to solve critical problems that we face today in the Great Basin.

This publication, and the wildfire forum held by the University of Nevada's Agricultural Experiment Station, documents the necessary scientific recommendations to help address the state's wildfire problem. In particular, I support the science-based recommendations for improvements to our rangelands. Our state depends on it.

On the second day, individual and group discussions were held about policies and recommendations for future actions. All discussions during both days were recorded. This publication is a condensed version of the scientific discussions, presentations and the recommendations of the scientists and other participants.

In the first section, the editors provide the background and overview of the major issues of the Great Basin as they relate to the wildfire forum discussions. The next section is an edited version of the individual contributions of the scientists based on their oral presentations and written contributions. Each contributor had the opportunity to review this document and provide suggestions prior to final publication. A number of recommendations made by the scientists are edited and organized in groups under appropriate titles in the final section of this publication. We have strived to capture the critically important content and remain true to the spirit of the presentations by the scientists.

Elwood Miller
Rangesan Narayanan
Bob Conrad
April 2008

DEAN & DIRECTOR'S MESSAGE

David G. Thawley

I am pleased to release this timely publication, "Great Basin Wildfire Forum: A Search for Solutions" through the University of Nevada's Agricultural Experiment Station.

The publication deals with the crucial issue of why we are having more frequent catastrophic wildfires in the western United States and what we can do about it. We are indeed honored to have had the participation of some of the most eminent scientists who have spent their entire careers studying the Great Basin region.

This publication is a great example of the cooperative endeavor between universities, government agencies and non-governmental organizations in informing policy makers and the public about the research and solutions to a critical and timely issue facing the West.

The individual scientists' contributions and recommendations reflect the work and the opinions of the participating scientists, and the publication attempts to accurately reflect the discussions at the Wildfire Forum. I commend the editors for their hard work in facilitating the Wildfire Forum and developing this excellent publication, which I hope will stimulate more research and guide our policies for years to come.

Background & OVERVIEW

Dr. Elwood Miller & Dr. Rangesan Narayanan

THE GREAT BASIN IS A HIGH elevation, arid to semi-arid region with annual precipitation ranging from five inches in the most arid, lower-elevation locations to 30 inches in the upper elevations of mountain ranges.

This region extends eastward from the Sierra Nevada Range to the Wasatch Range in Utah and from Southeastern Oregon and Southern Idaho in the north to the Mojave Desert in the south. It includes most of Nevada and parts of Utah, Idaho, Oregon and California. Public land, managed by various state and federal agencies, comprises a substantial portion of the Great Basin.

A highly variable winter snow pack is the primary source of surface as well as subterranean water. Dry land and irrigated crop production, livestock grazing, mining and recreation are the primary economic activities tied to natural resources in the rural areas of the Great Basin. Substantial recent increases in population both within and outside the Basin have intensified the competition for land use and water resources of the Basin.

The distinctive ecosystem of the Great Basin is facing a serious crisis as a result of increased human activity and global climatic change. To a large extent, the spread of exotic invasive plants and noxious weeds, the expansion of the piñon-juniper woodland, the decline in the sagebrush/perennial grass and riparian ecosystems, accelerated soil erosion, changes in water supply and altered fire regimes are both symptoms and causes of this ecological system in peril. In the past decade, the Great Basin has experienced several fire seasons in which more than a million acres have burned. These events have evoked significant public concern and calls for renewed attention to our management of natural resources. However, fire has been a force in the Great Basin for many centuries.

Weather and evolved vegetation have combined to establish fire as a natural and consistent force across the landscape. Lifting of moisture-laden Pacific air masses by the Sierra Nevada and Carson mountain ranges results in west slope precipitation and drier air spilling eastward across the region. While devoid of moisture, these air masses contain the electrical charge necessary to generate high-intensity lightning storms. When this occurs during the hot, dry summer months, the result can be hundreds of fire starts across millions of acres of rangeland.

The frequent occurrence of fire played a significant role in shaping the distribution and species composition of the natural vegetation communities that occupied the Great Basin. Other contributing factors include soil type variations, elevation, erratic precipitation and daily and seasonal temperature fluctuations. The journals of early explorers document the commonplace occurrence of fire and also noted that not all fire ignitions had a natural origin. Fire was an important part of the Native American culture and was used as a tool to increase the availability of desirable plants, improve habitat for wildlife and to drive game species during hunting. Also, because indigenous cultures are not known to have typically extinguished campfires, aboriginal accidental wildfire was probably common. Prehistorically, frequent recurrence of fire and other disturbances—including insects, drought and floods—produced a patchy mosaic of vegetation representing various stages of vegetation transition. In the broadest sense, three vegetation types dominated the landscape: 1) piñon-juniper woodland/mountain big sagebrush at mid-elevations; 2) Wyoming big sagebrush/perennial grass at lower elevations; and 3) salt desert shrub also at lower elevations. A minor plant community consisting of coniferous forest species existed at the highest elevations. The relatively frequent occurrence of fire played a major historic role in the distribution and composition of the first two major types but was a rare occurrence in the salt desert shrub type. However, with the invasion and aggressive establishment of red brome, fire has become more frequent and increasingly detrimental even in this type. Fire return intervals ranged from less than 20 years in the piñon-juniper woodland to more than 50 years in the Wyoming big sagebrush/perennial grass types. This natural rate of fire occurrence limited the expansion of the woodland by killing piñon and juniper seedlings established in the sagebrush / perennial grassland type and prevented sagebrush from becoming the dominant species to the detriment of the perennial grasses. All of this changed in the mid-1800s, coinciding with the end of the Little Ice Age and associated climate changes, and the westward population expansion that resulted in greatly increased permanent habitation dependent upon land use.

The history of early European man in the Great Basin is one of discovery and settlement. Discovery brought mining followed by ranching and occupation of remote locations throughout the West. The environment was altered by the various uses, resulting in changes to the landscape. The ecosystem of the Great Basin was altered by Native Americans for millennia prior to settlement by European immigrants. Change by European settlers, however, was accelerated by machinery and grazing animals.

Climate change and variable weather patterns also played a role in the dynamic nature of plant communities in the Great Basin. Periods of extended drought and/or infrequent above-average precipitation brought about corresponding changes in composition, density, distribution and productivity of the vegetation. During the last decades of the 1800s and the early decades of the 1900s, three important events occurred that set the stage for the vegetation complex that now spreads across the land and the degraded range conditions that raise concerns today.

First, the introduction of cattle, sheep and horses in the 1860s resulted in large scale ranching operations and severe overgrazing. The excessive grazing pressure removed the fine fuels that had carried the naturally occurring fire, which resulted in a substantial reduction in the number of fires and the acres burned. In the 32-year period—from 1880 to 1912—only 44 fires burning 11,000 acres were reported.

Second, as the end of the 19th century approached, undesirable exotic plant species were introduced into the Great Basin. The most prominent species is cheatgrass (*Bromus tectorum*), a native of Eurasia. The earliest herbarium collection of this invasive exotic annual grass in the Western U.S. dates to 1894. Not only does cheatgrass germinate in the later winter to early spring, but it sprouts above ground and begins root development before native species. As a result, it is highly competitive for both moisture and soil nutrients. Cheatgrass produces a fine-textured, highly flammable, early maturing fuel that increases the chance of ignition as well as increasing the rate at which wildfires spread. The result is greatly shortened fire recurrence intervals and larger fires. As native plant diversity has been replaced by large expanses of contiguous cheatgrass stands, the self-perpetuating fire cycle has opened the door to further site degradation and invasion by perennial noxious weed species. Every year cheatgrass is replacing sagebrush/perennial grass plant communities important to wildlife and agriculture and is fueling catastrophic wildfires that are devastating millions of acres of productive rangeland in the Great Basin.

Finally, the early decades of the 20th century ushered in a remarkable change in the way humans viewed wildfire. From a natural- or human-caused event that potentially created desirable outcomes, wildfire became viewed as the enemy—an enemy that had to be controlled and suppressed wherever it occurred. Total wildfire control became the widely enforced public policy, with large publicly funded

Wildfire Forum participants

fire fighting forces organized, trained and staged to extinguish any and all ignitions. The nearly century-long period of very successful fire control has greatly altered the frequency and character of fires that historically inhibited woodland expansion and restricted the presence of piñon and juniper to "fire-safe" sites. In addition, the total control of fire created large expanses of single-age sagebrush where the shrub cover is so dominant that herbaceous and perennial grass species are virtually absent.

As a result of these three events, the Great Basin landscape is now characterized by three major vegetation/wildfire fuel complexes: 1) large expanses of monotypic, highly flammable, annual grassland; 2) overly dense sagebrush stands with a meager understory of perennial grasses and forbs or annual exotics; and 3) greatly expanded piñon-juniper woodlands with a rapidly closing crown canopy and non-existent understory of perennial grasses and forbs. No longer is the natural force of fire characterized by frequent, low intensity burns that ensure the persistence of diverse, resilient, fire-adapted plant communities. Rather, the current fuel complexes are prone to large, catastrophic, high intensity burns that destroy the vegetation, degrade the soil and create conditions for the establishment of highly undesirable invasive weed species that defy efforts to rehabilitate the damaged sites.

Recognition of the role of wildfires in maintaining natural ecosystems was incorporated within the 1995 Federal Wildland Fire Management Policy and Program Review followed by a multi-agency effort, entitled "Review and Update of the 1995 Federal Wildland Fire Management Policy," that was published in 2001. Agencies responsible for implementing an aggressive fire suppression policy expressed growing concern over the resultant accumulation of hazardous fuel and the impact on fire-adapted ecosystems. Following the fires of 2000 that burned 7.4 million acres and cost $1.36 billion to suppress, Congress adopted the National Fire Plan that requires a coordinated, multi-agency action plan to address the alarming increase in destruction to communities and natural ecosystems. In response to a presidential initiative following the destruction of 7.2 million acres and fire fighting costs that reached $1.66 billion caused by the fires of 2002, the Healthy Forest Restoration Act of 2003 was passed by Congress. The goal of this congressional action was to reduce large wildfires and restore range and forest lands.

The agency efforts and the subsequent legislation have led to increased appropriations to meet the escalating costs of fire suppression. The rising cost of fire suppression is due in part to a new wave of human settlement and development across the Great Basin. During the period from 1980 to 2000, 8.4 million homes were built in fire-dependent ecosystems across the West. The presence of this development has shifted the suppression resource deployment priorities from protection of natural resources to protection of lives and homes. Records maintained by the National Interagency Fire Center (NIFC) show that nationally, the wildland fire acreage has gone up from 8 million acres in 2004 to more than 10 million acres in 2007. The number of fires has increased from 65,000 in 2004 to more than 100,000 in 2007. The yearly number of fires in the two decades following 1960 typically ranged between 100,000 and 150,000. From 1983 through 2005, the average annual number of fires actually declined compared to the previous two decades and were mostly below 100,000. During the last four decades, the wildland fire acreage has also been smaller, typically ranging from 3 to 5 million acres. In recent years, nationally there has been less of an increase in the number of wildland fires, but the acreage burned has increased dramatically.

A somewhat similar pattern seems to emerge for the eastern and western Great Basin combined (as defined by the NIFC), which includes the states of Nevada, Utah, Idaho and parts of Wyoming. In the last three years, dramatic increases are reported in the acres burned by wildland fire. Burned acres increased from 128,978 acres in 2004 to about 3.3 million acres in 2007. Nationally, total annual fire suppression costs for all federal agencies between 1994 and 2005 ranged from $256 million to $1.66 billion. The Bureau of Land Management estimates its total fire suppression cost for the western

Great Basin alone to be $241 million from 1998 through 2007 to put out approximately 9,000 fires spanning about 7 million acres. Considering the fact that both fire suppression and damage costs are related directly to wildland fire acreage, it is reasonable to assume that total yearly suppression expenditures by agencies, as well as the lost value associated with destroyed natural resources and the ecosystem every year, warrant careful solutions to wildfire issues.

Present conditions are ripe for continued catastrophic wildfire events, the scale and frequency of which will continue to adversely impact the ecosystem and impose high economic costs on society. The prediction by rangeland scientists and fire ecologists is for more of the same unless a successful effort is undertaken to combat this dilemma. Dr. James A. Young, noted Great Basin range scientist, reported at a 2004 sagebrush ecosystem symposium that, "If we continue over the next 20 years as we have over the past 20 years, we will not recognize the Great Basin as we have known it." The vast acreage burned by wildfires in Nevada alone since 2004 is evidence that Dr. Young's prediction is rapidly coming true.

It is apparent that time is not on our side. The destructive force of wildfire is rapidly altering the unparalleled beauty and biodiversity of the Great Basin at an alarming rate. Startling losses of the sagebrush steppe due to wildfire has reduced critical habitat and raised the specter that sage grouse and other species may be listed as threatened or endangered. Further losses of the sagebrush ecosystem will threaten many other land uses including ranching, mining, hunting, fishing, recreation and the economic viability of rural communities.

Scientific discoveries and analyses lead to policy prescriptions and better management practices. Understanding the evolution of the natural ecosystem, the role of fire in that process, the impacts of humans on the landscape and, more recently, the effects of climatic changes, will provide the key to solving the ecological problems that we face today in the Great Basin. Science-based vegetation and wildlife habitat management, appropriate livestock grazing strategies, objective-based monitoring and an improved soil and vegetation database will provide the foundation for successful rangeland management. Reducing the damage caused by wildfire will require increased attention to pre-fire readiness and successful post-fire rehabilitation. Long term success in addressing the wildfire crisis will come from increased investment in rangeland education, research and management.

To gain a better perspective about the problems and possible solutions, recognized scientists were invited to participate in a Great Basin wildfire forum. The careers of these individuals represent decades of experience and research in the rangelands of the Great Basin. The knowledge, ingenuity and ability to provide critical analyses of both natural and administrative processes that have occurred over time resides with these scientists who have worked and lived in this environment for many years. What follows in this publication are the contributions of these scientists to the forum discussion and their recommendations.

Nevada's 2006 fire season / Nevada Division of Forestry

SCIENTIST CONTRIBUTIONS *At-a-Glance*

■ **DR. JAMES YOUNG'S** comprehensive chronology documents important scientific contributions and critical events dating from the early 1800s to the present (page 12).

■ **DR. LYNN JAMES** presents a broad overview of environmental factors, including wildfire and domestic animal grazing, that have influenced the present condition of Great Basin rangelands (page 14). ■ **DR. WILLIAM KRUEGER** points out that efforts to improve range condition based on early successes have fallen victim to changing society views and opposition to the commercial use of public lands (page 16). ■ **DR. PAUL TUELLER** identifies five key areas that require consideration in addressing wildfire issues, including the greatly enhanced capacity for monitoring rangeland conditions using advanced remote sensing technology (page 17). ■ **DR. KEN SANDERS** details both policy and biological threats to the sustainability and restoration of Great Basin rangelands and endorses the use of coordinated resource management to reduce conflict and improve resource management (page 18). ■ **DR. ROBIN TAUSCH** traces the historic development of rangeland ecosystems and examines more recent trends that will have a profound impact on the character of future wildfires (page 20).

■ **DR. NEIL WEST** presents a thoughtful analysis of early assumptions that governed land use by early settlers, as well as stressors that contribute to current range conditions (page 22). ■ **DR. JERRY CHATTERTON** stresses the importance of soil stabilization following fire and offers insights into successful post-fire rehabilitation (page 24). ■ **MR. WILLIAM DOLLARHIDE** reinforces the importance of soil classification tied to ecological site descriptions when land management planning decisions are made (page 25). ■ **DR. WAYNE BURKHARDT** discusses the ramification of past grazing policies and emphasizes the need for rapid and early response to wildfire ignitions by building partnerships with local citizenry. (page 26) ■ **DR. SHERM SWANSON** points out the important role that fire has played in developing resilient plant communities and emphasizes the continuing need to use fire or management activities that simulate fire's effects (page 28). ■ **DR. ROBERT BLANK** discusses the basic science that explains cheatgrass' competitive advantage and the implications of future increases in atmospheric CO_2 (page 30). ■ **DR. DONALD KLEBENOW** points out the diversity of impacts that the current level of wildfire occurrence has on wildlife populations and introduces the complicating factor of a new disease and its impact on population numbers (page 31). ■ **MR. STEPHEN LEONARD** introduces the idea that human activity is not isolated but a part of the evolutionary process and emphasizes the need to use the best available knowledge and technology to increase success of post-fire rehabilitation (page 32).

■ **DR. ELWOOD MILLER** discusses the federal response to the growing number of catastrophic fires and the impact of continued housing development construction on suppression resource deployment (page 34). ■ **DR. NEIL RIMBEY** examines the role of economic trends on livestock management decisions and the substantial economic impact of fire on the viability of livestock grazing enterprises and local rural economies (page 36).

DR. JAMES YOUNG has been a rangeland scientist for 43 years, specializing in exotic and invasive weeds at the USDA Agricultural Research Service in Reno, Nevada. He has authored more than 700 scientific articles and is called the driving force in developing the USDA-ARS laboratory.

GREAT BASIN RANGELAND CHRONOLOGY

1820s – Hudson Bay Trappers. Abundant forage and very limited numbers of native large herbivores. Peter Skene Odgen reaches Mary's (Humboldt) River. Jedediah Smith crosses central Great Basin from California to the Great Salt Lake and describes empty land of sand and towering mountains.
1830s – Joseph Walker crosses Great Basin to California from Great Salt Lake by Mary's River route.
1840s – Bidwell-Bartelson party first overland emigrants to California. John Fremont discovers Pyramid Lake, names Humboldt River.
1848-1850 – California Gold Rush. Nevada is viewed as waste land.
1860s – Comstock Lode. Large dairy industry in Carson Valley with cows moving to high Sierra Nevada in summer.
1860s – Pony Express and Overland Road across central Nevada, which leads to repeated mineral discoveries. Local agriculture develops to feed miners (meat, butter and cheese) and provide hay for horse and oxen-powered transportation system.
1869 – Central Pacific Railroad complete. Provides transportation to markets for beef outside the state.
1870s – Large scale ranching with longhorn cattle. Barley Harrell and John Sparks establish largest ranch in western United States.
1880s – Western juniper, piñon and Utah juniper begin sudden stand expansion.
1880s – Hillman, first botanist at the University of Nevada, has major interest in native perennial grasses and introduced weeds.
1889-1890 – 95% of cattle lost to winter kill. This leads to cattle production system where one ton of hay per brood cow is required for winter. Hay can only be produced under irrigation and only 5% of landscape can be irrigated.
1890s – Range sheep industry grows. Sheep winter on desert ranges without hay and often use snow for water. Congress threatens to take statehood from Nevada because population drops so low.
1898-1900 – David Griffiths (USDA), is the first range scientist to visit the northern Great Basin and photograph range conditions. He possibly identifies cheatgrass in Humboldt County and describes several other exotic, invasive annual species.
1900 – Redwater vaccine is developed by the University of Nevada, making production of 2- to 3-year-old grass fed beef sustainable. First herbarium collections of cheatgrass is established in Nevada.
1903 – Newlands Project. Surplus of livestock feed for first time in Nevada agriculture.
1905-1910 – National Forests are established on specific mountain ranges. Establishment of National Forest supported by large cattle ranchers as means to control tramp range sheep operations.
1910-1918 – Agriculture boom times. Stock-raising homesteads. Huge rabies outbreak results in massive predator-vector (mountain lion, bob cat, fox, coyote) control program.
1900-1950 – Grazing results in reduction in perennial grasses and increase in shrubs, especially big sagebrush. Mule deer populations expand exponentially. In perspective, the pristine nature of Nevada rangelands was gone by 1880. Stock water development increases the area available for grazing. Excessive utilization of native perennial grasses every year in the early spring at turn-out time and continuous grazing during the growing season eliminate native perennial grasses on lower-elevation, limited-precipitation foothill ranges. Insects serve as vectors of introduced cereal grain viruses to native wheatgrasses, permanently reducing their competitive potential.
1920s – Agriculture depression. Large range sheep industry. Severe excessive grazing. Attempts are made to control grazing on vacant federal rangelands based on ownership of stock water. Cheatgrass becomes common in Nevada, but not recognized as a problem except for injuries from sharp seeds.
1929 – Great Depression. Wingfield banks fail, severely affecting sheep and cattle operations. A decade of drought and economic depression follows.
1932 – Nevada state government stops functioning. Predator control program is greatly reduced.
1933 – Nevada Agricultural Experiment Station establishes project on cheatgrass and fire. The role of cheatgrass in the ignition and spread of wildfires is recognized.
1934 – Taylor Grazing Act. Vacant federal land is closed to homesteading. Halogeton is first collected near Wells.

1939 – A Civilian Conservation Corps fire crew is killed by cheatgrass fueled wildfire near Orovada. The danger of cheatgrass fires becomes recognized.

1941 – Professor Fleming (UNR) writes Bronco (*Bromus tectorum*) grass bulletin which stresses that cheatgrass is the most important forage species on Nevada rangelands.

1942 – Halogeton is determined to be poisonous to sheep. First crested wheatgrass is seeded on Nevada rangelands.

1944 – J.H. Robertson and C.K. Pearce (UNR) publish paper on closed communities created by big sagebrush or cheatgrass stands.

1942-1945 – Agriculture production booms during World War II. A.C. Hull states that 20 years of grazing management intended to restore perennial grasses favors cheatgrass. Management largely moves turn-out date later into the spring.

1946 – Bureau of Land Management is established in U.S. Department of the Interior. Director Marion Clausen: treat disease (insufficient forage), not the symptom (halogeton); and seed crested wheatgrass. In retrospect, Clausen's grasp of the problem and his action plan were brilliant, but he was fired under pressure from the livestock industry.

1945-1960 – Golden age of rangeland seeding. One million acres of degraded sagebrush is seeded to crested wheatgrass. Rangeland plow and drill is developed. Limited cheatgrass competition because of past grazing pressure.

1950s – Seeding failures from cheatgrass competition increase as grazing is restricted.

1952-1954 – P. T. Tueller and R. E. Eckert are Dr. Joe Robertson's students at UNR.

1957-1958 – USDA-ARS hires Drs. Eckert and Evans to study means of controlling cheatgrass. Evans determines that as few as four cheatgrass plants per square foot interfere with growth of crested wheatgrass seedlings.

1964 – Elko fire storms burn approximately 300,000 acres, creating a national concern. The first large-scale wildfire restoration plan is funded and applied.

1965 – The first cheatgrass conference is held in Oregon. Art Sawyer says: "No manager can ethically manage for cheatgrass, we must manage the cheatgrass we already have." Despite being recognized as the most important forage plant on Nevada ranges for at least 20 years, it is given no credit as a forage species by federal range management agencies. Many knowledgeable range managers at this meeting strongly believe that turning back turn-out dates and reducing livestock numbers favors cheatgrass.

1960s – NEPA and associated national environmental laws are enacted. Seeding with crested wheatgrass ends on a large scale. Gus Hormay's rest rotation grazing is applied as an alternative. Permitted livestock on public ranges drops by one-third.

1960-2007 – Precipitous decline in mule deer numbers. This is widely blamed on livestock grazing and especially the seeding of crested wheatgrass.

1968-1975 – Eckert and Evans develop soil-active herbicides—paraquat—for cheatgrass control to improve spring seeding success. Dormancy of accumulated cheatgrass seeds is recognized for the first time.

1973 – Hallelujah Junction wildfire. Dick Holland's last stand. The knowledgeable federal employees who are responsible for the million acres of successful crested wheatgrass are hurried to retirement. This is the first time BLM complies with federal antiquities laws.

1975 – Elko, 1,000 acres. Atrazine fallow test plots. Deep-furrow drill is tested.

1980s – Dr. Wayne Burkhardt is the first range professional to publicly state that rest rotation grazing favors cheatgrass.

1980-1985 – Cheatgrass invades salt desert environments. Frosty Tipton, based on his experiences in innovative management of large desert cattle operations, publishes on the value of cheatgrass as forage on winter ranges. Kent McAdoo at UNR evaluates the natural return of big sagebrush to crested wheatgrass stands in terms of enhancing wildlife habitat.

1985-1995 – Bob Blank publishes series of papers on the influence of repeated burning of sagebrush/cheatgrass communities on soil chemistry.

1990s – The two-year rest of burned areas rule is set in concrete by BLM without any consideration of the perennial grass stand density. Absent sufficient native perennial grasses, this only favors cheatgrass.

1989-1990 – No repeat of winter of 1889-1890 for a century, but the winter of 1890 is still used as model for livestock production.

1990 – Ken Gray and Ken Wilkinson pioneer mule deer winter range restoration in cheatgrass-dominated Dunphy Hills.

1995 – In the name of genetic purity, native species are given the priority to be seeded on federal rangelands. Millions of acres of rangeland, in the name of "science," are condemned to a downward spiral of degradation.

1995-2002 – Trent, Blank and Clements begin research at the ARS in Reno on nitrogen immobilization and inhibition of nitrification to control cheatgrass.

1999 – Second great fire storm. 1.6 million acres burn in a 10-day period after at least 140 simultaneous lightning strikes. $38 million is spent on suppression, and $42 million is spent on revegetation with no success. Fire suppression becomes a multi-million dollar business that reaches from the rangelands of Nevada to corporate America. It is not in everyone's interest to biologically suppress the cheatgrass-wildfire cycle on Nevada rangelands.

2000 – Under certain circumstances, winter grazing by cattle of winterfat communities in eastern Nevada brings a return of concern about halogeton.

2002 – Knowledgeable wildlife habitat managers realize that without crested wheatgrass seedings to break the cheatgrass-wildfire cycle, vast areas, especially Wyoming big sagebrush habitat, are converting to cheatgrass.

2006 – Elko County fires eliminate about 1 million acres of wildlife habitat.

2006-2008 – The number of exotic invasive annual species found on Nevada rangelands continues to increase. The rapid spread of new mustard species is especially alarming.

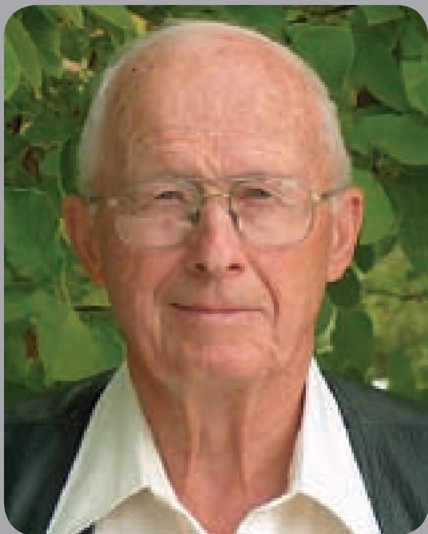
1960-2007 – Long term grazing and cyclic environmental conditions studies are conducted by Lee Sharp and Ken Sanders at Point Springs, Idaho.

1962-2005 – Dr. Neil West's multiple basic contributions to understanding the ecology of Great Basin rangelands, especially his studies of the relation between big sagebrush and perennial grasses. He continues in his retirement with valuable published updates.

2000-2007 – John McLain of Resource Concepts, Inc. continues efforts to allow ranchers to use grazing management to biologically suppress cheatgrass. This is evident in the studies in Humboldt County, Nevada.

2007 – Elko County, Nevada, south-central Idaho—huge wildfires are followed by restoration plans that are doomed even before being applied.

2008 – Young and Clements publish a sequel to Fleming's 1944 bronco grass paper. The problem expands exponentially, and solutions suffer from a refusal to accept the basic science of cheatgrass ecology and from a near equal mixture of ignorance and prejudice.



DR. LYNN JAMES received a BS in animal science, an MS in nutrition and PhD in nutrition and biochemistry from Utah State University. He was director of the USDA ARS Poisonous Plant Research Laboratory at Logan, Utah from February 1972 to July 2007.

LYNN JAMES

RANGELANDS CONSIST PRIMARILY OF GRASSLANDS, shrublands and open woodlands and are managed as natural ecosystems that are traditionally used by grazing animals. These lands occupy about 10 percent of the land area of the United States and 80 percent of the 17 western states (generally west of the Missouri River).

The rangeland is predominantly arid and/or semiarid and referred to as desert. Deserts are characterized by long periods of drought interspersed with periods of adequate to excessive moisture (snow and rain). Droughts are an integral part of the desert ecology. Droughts are cyclic in nature because the climate is highly variable over time and space.

Rangelands provide multiple uses for society that include: high quality water, clean air and open space; wildlife habitat for game and non-game animals; municipal, industrial and agricultural uses; recreational activities (hunting, fishing, hiking, etc.); and low impact renewable food and fiber production systems (livestock grazing and production). The biological systems and plant/animal interactions change over both time and space.

Monitoring must occur in order to manage these rangelands to maintain diverse biological systems and uses. Monitoring is observing, detecting and recording the operation of a system and watching closely for purposes of control and decision-making adaptation. Rangeland monitoring involves measuring major changes in condition and trend over time and space of the principal parameters affecting rangeland health. The four principal parameters (variables) to be monitored to determine condition and trend and as indicators of rangeland health include climate, soils, plants and grazing animals.

Climate includes rain, snow, water, temperature, wind, barometric pressure and lightning. Climate is variable over time and space—it is measurable but not manageable. While the variables listed above are essential parts to a healthy rangeland ecosystem, all may be destructive under certain conditions. Understanding climate is key to understanding the interactions of the other parameters. Monitoring climate holds promise to help develop management strategies to take much of the risk out of grazing during periods of drought as well as under other climatic conditions.

Lightning is one of the principal causes of fire on our rangelands. Fires are dependent on adequate fuels—grasses and certain shrubs. The larger the fuel load, the hotter the fire will burn and the more damaging it will be, especially to the soil. An economical and efficient way to remove excess grass is with an on-off grazing system. Fuel loads are reduced, while producers benefit from forage consumed by their livestock. Other grazing strategies can aid in preventing or managing wildfires and controlled burns. Fires that do occur burn with reduced intensity, and a general upward trend in rangeland condition is sustained.

Soils vary spatially but are fixed in place unless floods or fires remove the vegetation and wind or uncontrolled water erode the topsoil. Soils should be monitored and managed to maintain their integrity in order to prevent erosion, enhance water absorption and holding capacity and preserve their organic components in case of fire. Hot, intense fires can damage or destroy essential parts of this reproductive system. The lighter and organic portions of the soil will be destroyed, and the water holding capacity will be greatly diminished. Microorganisms in the soil will be lost, and seed stored therein will be destroyed or made non-viable. Wind erosion can take away much of the topsoil. Weeds may then become established in this marginal system.

Plants and plant communities vary over time and space depending on climate, soils, elevation, geographical locations and land uses. Plant communities are dynamic, not static. The rate of change is most likely associated with the nature of the factor(s) causing the change (fire, climate, insects, etc.). If plant material isn't properly harvested, it can become fuel for fires that result in denuded rangeland. This in turn opens up the land to both water and wind erosion through the destruction of vegetation, soil structure, organic material and soil microorganisms. Additionally, there will be a loss of forage used by livestock and wildlife, habitat loss and in some cases a loss of animal life by burning. Humans may also lose their lives fighting such intense fires.

Grazing animals—including livestock, wildlife, wild horses and upland game birds—rely on interactions of the previous parameters for the production of forage (feed) and habitat. Management of cattle and sheep to maintain rangeland health is of the greatest importance. Animals function in the cycling of nutrients. Plants provide organic material for the soil, and animals play a major role in the transport of seeds and their movement into the soil. Grazing animals can provide an economic and feasible way of controlling fire fuel loads, which is necessary in the prevention, control and management of wildfires and in the management of controlled burns. If you manage the fuel, you can control how hot the fire will burn. If there is less fuel, the fire will burn out over a shorter time and less heat will be generated, leading to less damage to the soil.

If plant material isn't properly harvested, it can become fuel for fires that result in denuded rangeland. This in turn opens up the land to both water and wind erosion through the destruction of vegetation, soil structure, organic material and soil microorganisms.

DR. WILLIAM KRUEGER has been a professor of rangeland ecology and management for 37 years. He was head of the range department at Oregon State University for 32 years. He is senior or co-author of 178 papers—67 refereed and 43 invited. His research focus has been rangeland ecology, grazing management and rangeland rehabilitation.

WILLIAM KRUEGER

WHILE THERE IS MUCH TALK ABOUT THE WILDFIRE PROBLEM, fire is not an intrinsic problem but rather a symptom of the greater problem related to the deterioration of rangelands. If the rangelands of the Great Basin are properly managed to provide the blends of plant communities interspersed appropriately, fire will be a small problem in the long term.

Rangelands have changed in ways that prevent return to the equilibrium in time and space that existed before settlement by European man. Consequently, management to "restore" Great Basin ecosystems must be site specific and based on an understanding of what is necessary to create the kind of ecosystem desired. Great Basin rangelands are always changing, and disturbance is required to maintain a healthy ecosystem. Without disturbance, the vegetation community will transition to one with large scale dominance of shrubs lacking an understory of perennial grasses and forbs. It must also be recognized that some changes are irreversible by management activities or protection from use.

Rangeland conditions have improved since the prevalence of overgrazing in the early 1900s. Seeding crested wheatgrass, developing and distributing water, and developing better grazing management approaches not only resulted in improved conditions on depleted rangeland, but also substantial improvement in the native rangelands. Improvement in a wide variety of wildlife from antelope to waterfowl also was noted. The success of these efforts prompted similar vegetation enhancement efforts over millions of acres of private rangeland. Livestock grazing also was used to control cheatgrass and improve the success of wheatgrass seedings. Since the 1980s, substantially reduced rangeland improvement efforts have been made. Those opposing rangeland improvement practices argued that only livestock grazing benefited from these range improvement practices. Other benefits that accrue with enhanced conditions of the rangeland such as improved wildlife habitat were discounted or not considered. The changing attitudes of society, coupled with the environmental focus of the Clinton administration, resulted in public agencies hiring a variety of professionals who did not understand the use and management of rangelands and often were opposed to any commercial use of public lands. Soaring overhead costs brought about by excessive litigation between environmental extremists and public agencies, as well as the loss of trust between agency personnel and livestock producers, has resulted in little effort to improve land conditions. During this same time period, land grant universities in the West dismantled many departments and programs with a focus on rangeland use and management. The consequence of this action is a small pool of range programs with insufficient critical mass to make a positive impact on range management science.

Fire is not an intrinsic problem but rather a symptom of the greater problem related to the deterioration of rangelands.

What can be done? Much is known that can be implemented immediately to improve rangelands for a wide variety of uses. Natural and current fire cycles are sufficiently understood to develop sustainable management programs. Successful rehabilitation has been realized in large scale applications. What is needed is the will to change our approach to managing the land and thereby achieving a condition that society wants.

PAUL TUELLER

THERE ARE FIVE IMPORTANT AREAS FOR CONSIDERATION in addressing wildfire issues. The first has to do with potentially changing public land policy and creating new laws that reduce litigation. The annual budget cycle is a major culprit in preventing success in rangeland enhancement efforts.

A second important consideration is the need to use grazing management to help solve the fire problem. The extreme fire years in the recent past must be due, in part, to the noted reduction in grazing the forage base, resulting in significant fuel buildup. The lower and sometimes upper reaches of the mountain ranges have turned yellow as a result of post-fire cheatgrass establishment. The buildup of cheatgrass has tended to shorten the grazing season across the state, as this grass is only green with a sufficient biomass for a short time—one month or less in the spring. Development of intensive grazing management strategies is needed to allow utilization of cheatgrass and reduce future fuel loads. Grazing animals will be the tools that must be used to make desirable changes in vegetation.

A third area is seeding with species that are known to be effective. It is important to highlight the scientific evidence that the most adapted and useful species have heretofore been non-native species. The argument about native versus non-native species is not useful and must be resolved based on available scientific findings. There is no good reason why the best and most useful species should not be used independent of origin.

Fourth, there is a need to maintain or develop strong rangeland management programs at universities that graduate well-trained, competent students who can enter into careers leading to management of these landscapes. In addition, increased support for herbaria is critical since individual plant species form the basis of sound rangeland management. Every good manager must be able to identify these species and have knowledge of their characteristics.

Fifth, the final area of concern relates to the under-utilized technology of remote sensing. Remote sensing, Global Positioning Systems and Geographic Information Systems can be used to provide important information to help refine our understanding of Great Basin vegetation and soil ecosystems in relation to fire ecology. Remotely obtained imagery can be used to follow greenness and maturation of vegetation for grazing management plans and a general consideration of fuel loads across large landscape areas. Remote sensing data would be useful for the design of experiments related to fire management efforts both pre- and post-fire. These data could also assist in the design of grazing management plans and the selection of sites that have the highest probability for success in revegetation efforts.

DR. PAUL TUELLER is professor of range ecology emeritus at the University of Nevada, Reno. He received his BS in wildlife management from Idaho State University and his PhD in range ecology from Oregon State University. He spent 42 years at the University of Nevada. His primary area of interest is rangeland ecology and remote sensing, and he is a certified range management consultant.

Remote sensing, Global Positioning Systems and Geographic Information Systems can be used to provide important information to help refine our understanding of (the) Great Basin...

DR. KENNETH SANDERS has been a professor of rangeland ecology and management at the University of Idaho for 32 years. He received his BS in range management from New Mexico State University, his MS from Oregon State University and PhD in range science at Texas Tech University. His research focus has been on rangeland monitoring, grazing management and rangeland improvements.

KEN SANDERS

THE INVASION OF GREAT BASIN RANGELANDS by undesirable invasive species, especially highly flammable annual grasses, as well as the continued spread and increasing density of juniper, coupled with the resulting increase in wildfire frequency, pose the greatest threat to the sustainability and restoration of these rangelands. In southern Idaho, cheatgrass and medusahead wildrye grass have evolved to grow under a wider range of soils and environmental conditions, resulting in a great expansion of their range. Cheatgrass is starting to dominate salt desert shrub communities. Once these communities burn, which is inevitable, it will be extremely difficult to restore them.

The restoration of cheatgrass-infested rangelands, while challenging in the best of circumstances, has been doomed to failure ever since the Bureau of Land Management put emphasis on seeding native species instead of what we know has the best chance of becoming established (i.e., crested wheatgrass). Millions of dollars of taxpayer money have been wasted on high-priced native seed mixes, with very little success. The result has been increased fire frequency, increased spread and dominance of cheatgrass and loss of livestock forage and wildlife habitat.

Increased recreational use of rangelands, especially off-road vehicle use, poses the second biggest threat to the sustainability of Great Basin rangelands. Much of the increased spread of noxious weeds is due to increased recreational traffic. Lightning is the primary ignition source of wildfires, but ignition from recreationists is second.

The third biggest threat is the reduction in grazing on public rangelands. If the proposed sage grouse habitat management guideline that recommends leaving a grass stubble height of 18 centimeters is applied, it will not only result in an adverse economic impact on livestock producers, but it also will result in increased, higher intensity wildfire due to a larger fuel load. Any adverse economic impact on livestock operators will lead to private ground being sold to developers, resulting in less open space, increased recreational use on rangelands and the resulting negative impacts mentioned above.

The greatest administrative threat to the long term stability and productivity of Great Basin ecosystems is "analysis paralysis." Both the courts and the public agencies managing Great Basin rangelands have made a far more restrictive interpretation of the National Environmental Policy Act (NEPA) than Congress ever intended. When he first became Idaho BLM Director, K. Lynn Bennett documented that in 2003 Idaho alone had 74 active administrative appeals and 18 district court cases, resulting in direct litigation costs of $677,000. However, the greatest costs were indirect: deferred work such as monitoring, permit renewal, range improvements, etc., loss of public trust and loss of employee morale. Environmental organizations filed 61 percent of the cases, with the challenges primarily based on the BLM not following established procedures—not the condition of the resource.

There are numerous other polices that also threaten the long term stability of Great Basin ecosystems. These include disposal limitations on the management of wild horses, a blanket policy of at least two growing seasons of rest following wildfire, rangeland restoration using only native species, suitability and capability standards of the U.S. Forest Service, stubble height requirements on riparian areas, Threatened and Endangered Species Act listings and resulting management restrictions. Such policies give agency wildlife and fisheries biologists, botanists and cultural and recreation specialists equal—or greater—say on monitoring, grazing management and restoration than knowledgeable range conservationists.

Millions of dollars of taxpayer money have been wasted on high-priced native seed mixes with very little success.

The first and perhaps most achievable step in policy change is to get more range conservationists back on the ground monitoring and actively managing rangelands. Range conservationists should be given a more prominent role interpreting monitoring data, grazing management and rangeland restoration decisions.

The first priority in rangeland restoration following wildfire should be to stabilize the soil, which means seeding species with the best chance of establishment. The same applies in trying to convert cheatgrass-infested rangelands to perennial grasses. The native species, which are more difficult to establish, should be seeded only after the soil is stabilized and cheatgrass competition is reduced.

Changes are needed in NEPA, the Threatened and Endangered Species Act and having the U.S. Attorney's Office representing the BLM in District Court cases. Changing the two acts is probably not realistic, but getting attorneys knowledgeable about natural resource issues representing the BLM in District Court should be obtainable. It should be more difficult and expensive to file frivolous lawsuits. The Experimental Stewardship Program showed that the use of coordinated resource management not only reduced resource management conflict, but also resulted in improved management of the resources. The procedure should be more widely used. If individuals or groups are given the opportunity to participate in such a process but choose not to, they should lose their right to appeal the resulting decisions.

SCIENTIST CONTRIBUTIONS

DR. ROBIN TAUSCH is a research range scientist with the Rocky Mountain Research Station, USDA Forest Service. He has a PhD in range ecology from Utah State University and 38 years of research experience in the Great Basin focusing on piñon-juniper woodlands and associated sagebrush ecosystems.

ROBIN TAUSCH

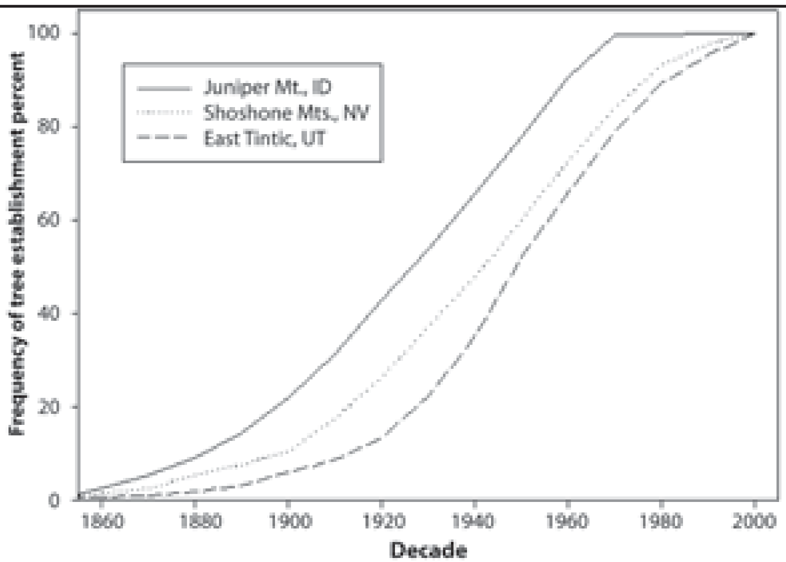
IN ORDER TO BETTER UNDERSTAND the present vegetation conditions and how those conditions will change in the future, the landscape distribution of woodlands, their ongoing changes and their effects on sagebrush were studied. Representative sites were selected for study in Nevada, Idaho and Oregon. To determine the time period of stand establishment, tree ages were taken and the woodlands divided into pre-settlement (trees greater 140 years old) and expansion stands (trees less than 140 years old). On the sites in Nevada and Utah, about 20 percent of the trees were classified as pre-settlement, with nearly 80 percent falling into the expansion age distribution. Therefore, two-thirds to three-quarters of the trees in our woodlands have established and resulted in stand expansion during the past 140 to 150 years.

From the mid-1800s on, there has been a significant and rapid increase in the number of established trees. This expansion includes both infilling in existing stands and expansion of the piñon-juniper woodlands into sagebrush ecosystems. For two to three centuries prior to the mid-1800s, tree densities were relatively low, with an average of 34 trees per hectare. Data from samples across the region show that during this period, stand densities increased by approximately one tree per decade. In contrast, from the late-1800s into the early-1900s, the rate of tree acquisition exploded. However, since the 1960s there has been a significant decline in additional tree establishment. The rate of new tree acquisition today is about what it was in 1900 (see graph below).

The expansion of woodlands across the Great Basin was a pulse. That pulse is coming to an end. If you retrace the paleoecology of vegetation communities, these pulses are commonplace in the historic record. Just because the establishment pulse is coming to an end, however, does not mean that change within the woodland type will cease. In fact, the greatest change may well occur over the next 40 to 50 years, as the substantial number of trees that became established during the last hundred years grow and mature, filling in those sites.

As individual trees grow and occupy an ever increasing amount of space, there is a trade-off between tree canopy increase and understory decline. With 40 to 50 percent relative tree cover, there is a more limited decline in the understory. As tree cover increases to 40 to 70 percent, a more rapid decline occurs in the

Accumulative frequency of decadal tree establishment since 1860 for three woodland populations in the intensive plots.

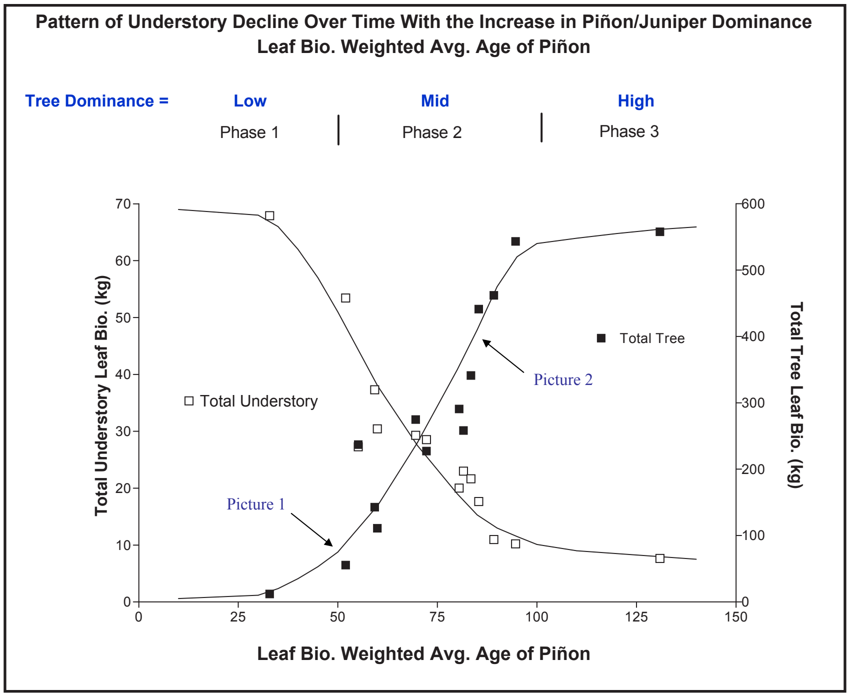


understory. Beyond 70 percent there is, basically, very little understory left. As shown on the graph below, it is at approximately 60 percent relative tree cover that a tipping point occurs where the understory is largely lost and trees dominate the site.

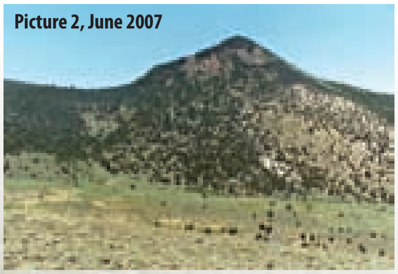
The majority of the Great Basin woodlands are now transitioning toward full tree dominance. (Picture one and picture two below illustrate this transition from 1973 to 2007.) The consequence is an ongoing increase in fire intensity and extreme behavior. As the post-settlement woodland continues to transition to tree dominance, fuel accumulation accelerates, reaching exceedingly dangerous levels across larger and larger landscape areas. Wildfire burning through these sites results in enormous loss of vegetation and groundcover—needles, sticks, everything—leaving a wide open site. As a result, we are increasingly seeing not only an increase in post-fire occupancy by cheatgrass, but even more undesirable annuals are increasingly finding these locations hospitable sites for establishment.

Just like woodland expansion has a pulse, the expansion of cheatgrass establishment is also a pulse. The encroachment of this annual exotic is going to end, and something else will replace it. As this pulse ends, the plant community that emerges as a replacement will be significant, and its makeup will depend heavily upon our land use management during the first half of this century.

The Rocky Mountain Station lab in Moscow, Idaho has produced climate and vegetation models based on global climate change projections focused on potential plant community transitions across the West and Southwest. Results for the Mojave Desert show that the climate that currently exists for Las Vegas will be present around Winnemucca by the end of this century. That's a shift 400 miles north and 2,000 feet in elevation. These are not trivial changes. Basically, the Little Ice Age is over. It's a whole new world, and many real challenges lie ahead. In fact, the amount of change that we're going to be seeing over the rest of this century could well mimic the changes that have occurred over the last thousand years, but in a far shorter time.




Picture 1, June 1973


Picture 2, June 2007

The amount of change that we're going to be seeing over the rest of this century could well mimic the changes that have occurred over the last thousand years, but in a far shorter time.

DR. NEIL WEST went to Oregon State University, receiving a BS in 1960 and a PhD in 1964. He was on the faculty of Utah State University for 41 years, retiring as emeritus professor of rangeland ecology in 2005.

NEIL WEST

TWO CRITICAL ASSUMPTIONS HAVE PERSISTED and guided the use of Great Basin lands and natural resources over the years: "desert denial" and the "ever lasting hills." "Desert denial" is the wishful thinking that drought is an anomaly that will be corrected next year. The earliest settlers from Europe all migrated from wetter climates, desiring the productivity that those ancestral lands provided. The only way to achieve high levels of productivity was through intensive irrigated agriculture. We are still living with the impacts of those days of exploitation when the limitations of our desert environment were denied.

The second primary assumption called the "everlasting hills" expressed the view that while climate was variable, the surrounding forests and rangelands didn't change. It was simply a matter of waiting out the temporary drought to see recovery.

The earliest and most easily recognized stressor of Great Basin ecosystems was livestock grazing. Early introductions of grazing animals included cows and horses, mostly brought into the region from Texas following the Civil War. Sheep were later used to exploit the expansion of woody plants resulting from the overuse of grasses. While the creation of forest reserves led to the beginning of regulation in livestock use, open and free range conditions prevailed in our desert lowlands until passage of the Taylor Grazing Act in 1934.

Only in the middle of the 20th century was it shown scientifically that excessive grazing during the plant's growing season did the most damage.

Grazing in late spring during drought years was especially detrimental. Today there is a prevailing belief that total removal of all domestic grazing animals will automatically result in a return to the pristine. More recent sophisticated research has shown that targeted livestock grazing during the non-growth season actually helps reach certain objectives such as weed control, fire reduction and wildlife habitat improvement.

Other major but localized stressors within this region include intensive agriculture, mining, military activity and population growth. These stressors are local. We are now facing a set of new stressors that are global. These include increased CO_2, which is fertilizing the growth of both native increasers (e.g., juniper) and exotic invaders (e.g., cheatgrass). The increased amounts of fuel, along with longer, hotter periods of summer, are making the fire seasons longer and influential over a wider area.

Fire always has been a part of the Great Basin environments and is therefore incidental to the major stressors. The usually infrequent and smaller fires of the past played a role in diversifying the age-class structure and patchiness of the vegetation. This was a major positive influence of natural burning that has been curbed through aggressive fire control during the 20th century. Today, fires have changed becoming hotter, more frequent and covering larger patches, homogenizing the plant cover in its wake.

Rather than thinking about single stressors, it is more realistic to view the cumulative effects of many stressors that act together, mainly synergistically. It is these non-counter-balancing interactions that cause the biggest concerns before us now.

All of the above stressors have been at work over the past century and a half, becoming progressively more pronounced during the past 50 years. What is different about the present is that the effects finally have become apparent to nearly everyone because they occur on such huge spatial and more frequent temporal scales. Larger and larger fires occur nearly every year and favor shorter-lived or root sprouting plants over the slower-growing, long-lived, non-sprouting perennials. The result has been widespread conversion of patchy vegetation with diverse life forms to continuous sweeps of entire landscapes by a few exotics, especially annual grasses. Because the land is bared during the summer thunderstorm period, accelerated soil erosion has become common.

The biggest human error that allows this unraveling of regional ecosystems to proceed is to focus on using averages. Mean values are a human construct that nature doesn't honor, especially in deserts where a few wet years cause the average to exceed what is usual. Thus to plan based on an average makes us overestimate expected plant response.

Larger and larger fires occur nearly every year and favor shorter-lived or root sprouting plants over the slower-growing, long-lived, non-sprouting perennials.

SCIENTIST CONTRIBUTIONS

N. JERRY CHATTERTON, recently retired, has been a research plant physiologist for the USDA Agricultural Research Service for 37 years, including time as research leader of the forage and range research laboratory in Utah. The laboratory helps develop new and improved plant materials for use in vegetating arid and semiarid rangelands in the Great Basin and Intermountain West.

JERRY CHATTERTON

A CRITICAL CONSIDERATION FOLLOWING A WILDFIRE is soil stabilization. Soil is best protected by the proper selection of plants that will become established and minimize soil losses. Thus the proper response to wildfires is to reseed with the correct plant species at the proper time.

An excellent example of successful site stabilization on a burned site was recently brought to light with the July 2007 Milford Flats Fire in central Utah. In 1988 forage kochia, crested and Siberian crested wheatgrasses and Russian wildrye were dormant seeded on about 20 acres where three to eight inches of topsoil was lost in the previous 18 months following a 1986 wildfire (the Twin Peaks Wildfire). Native grasses, including western wheatgrass, thickspike wheatgrass and Indian ricegrass, failed to establish. An assessment of the seeding in 2004, 16 years after the burn, revealed the natural recruitment of native species of shadscale, green molly and bottlebrush squirreltail within the reseeded area.

The 350,000-acre Milford Flat Fire burned up to but was stopped by the planting of forage kochia, crested and Siberian wheatgrasses and Russian wildrye. The native plants that had become established within the seeded area were protected from the fire, while the few natives that existed outside the planting burned and died.

Stopping the wildfire cycle, soil erosion and invasion of cheatgrass is a choice. Similarly, cheatgrass invasion, repeated burning, and loss of topsoil is also a choice. What is required to make the right choice? Land managers need to accept the available science. They must have the fortitude to plan for and implement a reseeding effort in the fall following the burn. To be successful, they must use the best available plant materials based on management objectives. In other words, on marginal areas (less than 10 inches annual precipitation), or areas with repeated wildfires and/or heavy cheatgrass stands, plant only crested and Siberian wheatgrasses, Russian wildrye and forage kochia. Use mixes of grasses, forbs and shrubs where more favorable rangeland conditions exist.

Stopping the wildfire cycle, soil erosion and invasion of cheatgrass is a choice. Similarly, cheatgrass invasion, repeated burning, and loss of topsoil is also a choice.

Native plants are not all good, and introduced plants are not all bad. For example, forage kochia has the following characteristics: 1. It is a perennial semi-shrub and is not the same species as the common, annual, weedy kochia; 2. It provides high quality forage, including excellent winter forage for livestock and wildlife and contains no known toxins; 3. It grows well on marginal, dry rangelands (5–15 inches annual precipitation), including alkali and saline soils (up to EC of 17); 4. It enhances rangelands for stabilizing disturbed soils and does not invade perennial plant communities; and 5. It is considered by those who have studied it as a "miracle plant" and has been called "the alfalfa of the desert." The few natives that had reestablished in the cheatgrass dominated areas outside of the forage kochia plot burned and were killed. Forage kochia provided cover for natives to reestablish themselves and protected them from destruction by fire.

SCIENTIST CONTRIBUTIONS

WILLIAM DOLLARHIDE

THE NRCS SOIL INVENTORY DATABASE is an excellent resource for the Great Basin. Each ecological site has a potential natural plant community correlated to a soil component. Knowing the relationship between soil type and vegetation allows one to manage for the establishment and health of the potential plant community. The database is of great value in making other management decisions, such as what to seed, where roads and fuel breaks should be located to have the least erosion impact and where the greatest probability of establishment success for reseeding exists.

Also of importance is the completed initial soil survey for most of the Great Basin with the soils classified and described. As data are maintained or updated, there is the opportunity to study soil properties as they may relate to areas taken over by cheatgrass or areas with encroachment of piñon/juniper. The relationships between dynamic soil properties and the state(s) after transition of a plant community will be a critically important refinement of the available information. The soils database can be found at *soildatamart.nrcs.usda.gov*.

WILLIAM DOLLARHIDE has been the NRCS northern basin and range soil survey region leader/state soil scientist in Nevada since 1995. He received his BS in soil science from Cal Poly, San Luis Obispo and mapped soils in California and Nevada from 1965 to 1977.

Knowing the relationship between soil type and vegetation allows one to manage for the establishment and health of the potential plant community.

DR. J. WAYNE BURKHARDT is professor emeritus of range management from the University of Nevada, Reno. He has been involved in many aspects of rangeland management for nearly four decades, including teaching, research, extension and public land policy. He and his wife operate Ranges West, a private rangeland consulting firm in Idaho.

WAYNE BURKHARDT

THE TWO MOST SIGNIFICANT ADVERSE IMPACTS to the Intermountain ecosystem since European settlement are the inadvertent introduction of exotic plants and our failure to recognize the proper role of fire in natural systems. Ecologically, the region is an ecosystem in a state of flux and change. Some of these changes are undoubtedly irreversible and represent a permanent change in the flora of more arid rangelands. The most obvious and pervasive exotic introductions include species like cheatgrass, red brome and medusahead on Wyoming big sagebrush and shadscale sites. The introduction of these extremely pre-adapted exotic species has set the stage, ecologically, for a permanent change in the flora on certain sites.

Although these introduced grasses provide some soil protection, cycle nutrients, water and energy, as well as provide usable forage, they also contribute substantially to fine fuel buildup and flammability. For the past 40 years, the management strategy, at least on public lands, has been to reduce or modify livestock grazing on these annual grasses, presumably to allow the re-establishment of native bunchgrasses. This has proven to be disastrous. Pre-adapted annual grasses can out-compete native bunchgrasses for early spring moisture on arid range sites. Reductions in grazing on these rangelands have not promoted the establishment of native flora, but rather have allowed flammable fuel build-up and increased fire frequency, intensity and spread. These unnatural fires remove the sagebrush overstory, prevent shrub re-establishment and create the conditions for the establishment of monotypic annual grasslands on what should be a shrub/grassland vegetation community.

Until native species can be successfully established and replace the exotic introductions, annual grasses should be managed to reduce fire frequency and provide sagebrush a chance to re-establish. Methodology exists to replace annual grasses on Wyoming big sage sites with less flammable perennial grasses such as crested wheatgrass, intermediate wheatgrass, Russian wildrye and others. These species are more fire resistant and provide some protection to promote shrub regeneration. They should be seeded as a replacement for annual grasses, especially following fires. On public lands, however, these proven reseeding species are not used. Instead repeated attempts are made to reseed with native species that cannot compete with cheatgrass on arid sites.

On salt desert shrub ranges, cheatgrass and red brome form a carpet of fine fuel in the understory. The shadscale community, which evolved without periodic fire, has become highly susceptible to fire, resulting in the establishment of annual grasslands. When these salt desert shrub ranges burn, we lose desirable shrubs and do not generally have the ability to re-establish them. At higher elevations the mountain big sagebrush type adapted to frequent burns. The absence of fire has resulted in heavy fuel buildup in the form of dense decadent brush or a dense overstory of piñon and juniper. These ranges need periodic

burns to maintain the balance between the herbaceous understory species and the woody overstory. In the piñon/juniper woodlands and coniferous forests, decades of fire suppression and lack of logging have produced dense stands of often diseased timber, predisposed to catastrophic fires.

Another pertinent issue is the agencies' initial fire response. In the 1950s and 1960s, fire fighting tool caches were made available and could be put to immediate use by local citizens who usually were the first to see and report fires. This early response allowed fires to be contained much more quickly. A mutually beneficial partnership could be developed that more effectively suppresses fires while they are small and uses community members' close proximity and sincere desire to protect the resource. Basic fire safety and training could easily be provided, and tool caches could once again be housed in various locations to be used when needed.

Public land grazers have an important role in protecting the resource by reducing fire danger, by managing fuels and improving the health and productivity of the range. Grazing should be firmly established as a necessary tool in reducing fire danger. The public needs to understand that fine fuel reduction and weed control are positive aspects of grazing and that properly managed grazing is good for the land.

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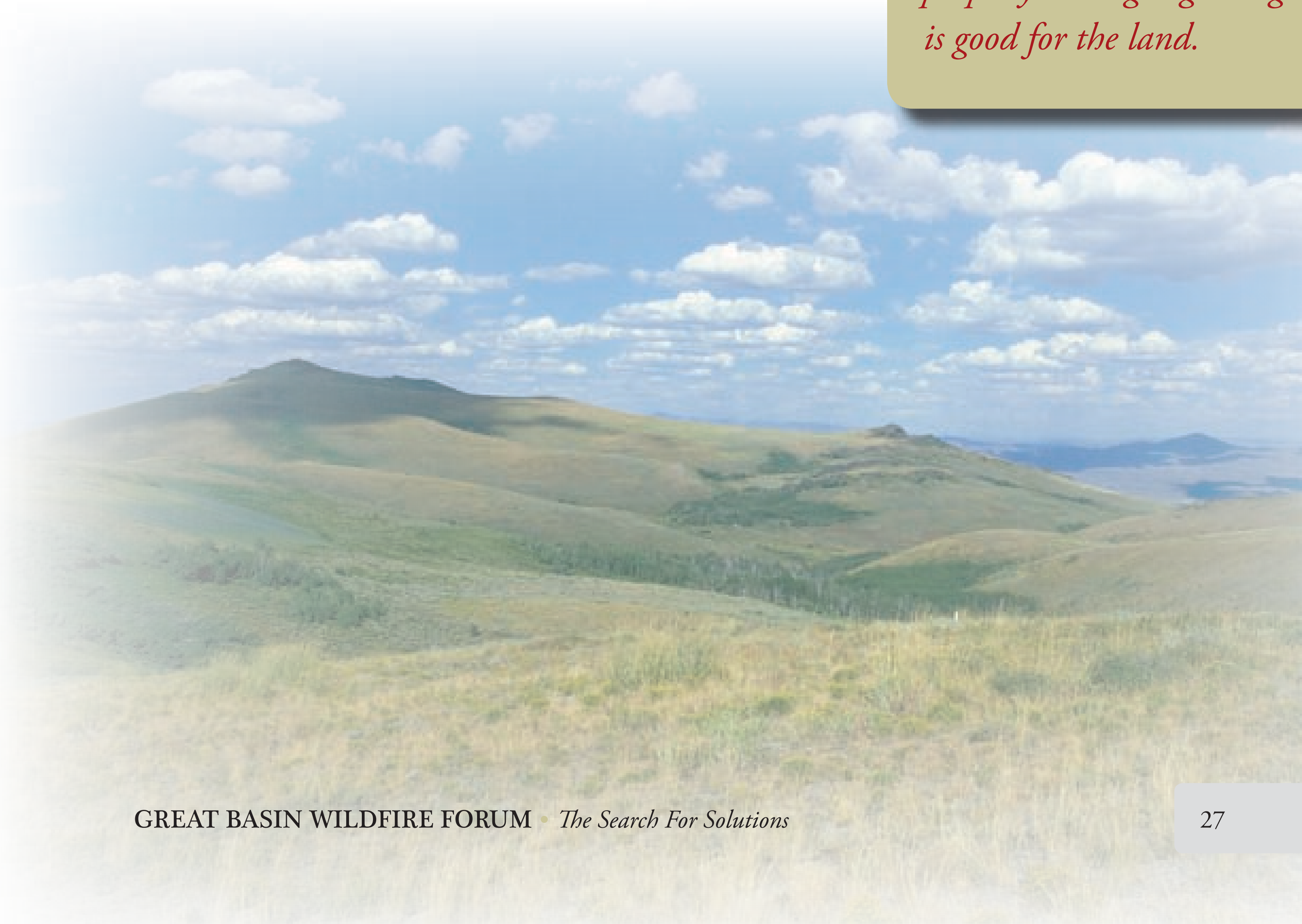

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SHERM SWANSON

MANY PLANT SPECIES EVOLVED with natural and anthropogenic fire. A normal fire regime left native vegetation in a resilient state and produced a dynamic landscape with mosaic distributions of species adapted to various seral stages in different locations. Severe reduction of fire through historic overgrazing of fine fuels, fire control under a national anti-fire policy and invasive weeds have permanently altered Great Basin plant communities and landscapes. The absence of fire has allowed the expansion of the piñon-juniper woodland into sites formerly occupied by sagebrush and perennial grasses. This expansion is documented by the fact that 90 percent of the piñon and juniper trees in the Great Basin are younger than 150 years. Sagebrush density and cover is abnormally high in most sagebrush areas. These changes dramatically, but temporarily, increased wildlife species dependent on sagebrush and piñon-juniper.

Wildfires have become unusually large, homogenous and frequent as they burn the accumulated woody fuel or carpet of fine replacement fuel in a 'cheatgrass fire cycle.' Nevada has two opposing fire problems: 1) too little fire, which leads to; 2) too much fire that is too hot when it burns accumulated woody fuel and too frequent when it burns excessively flammable fine annual fuels. Fire policies in land use plans often do not embrace prescribed fire, fire use and fire surrogates to replicate a natural fire regime at a level needed to sustain resilient landscapes. The decision to use fire as a vegetation management tool involves risks that must be mitigated by extensive training, careful planning and risk reduction policies. Vegetation treatments to avoid catastrophic fire require adequate funding and administrative support.

The 1997 Natural Resource Conservation Service (NRCS) *Range and Pasture Handbook* replaced the overemphasis on range condition with state and transition model-based ecological site descriptions (ESDs). Unfortunately, there has been little effort on developing these new ecological site descriptions, and the funding to create this intellectual infrastructure has not been forthcoming. In the absence of modern ESDs, the NRCS, Bureau of Land Management and U.S. Geological Survey have developed a process for assessing rangeland health.

The Forest Service, having rejected rangeland health assessment, drafted matrices that describe irreversible thresholds. Although useful, these suffer from excessive lumping without the benefit of soil surveys and ESDs to create maps, making it difficult to identify management needed to avoid transitioning to a new undesirable state. As a result, irreversible thresholds are crossed yearly. Perennial herbaceous plant communities that could survive and thrive with a normal fire regime are weakened by woody plant competition and then killed by intense fires. Cheatgrass dominates millions of acres, and this acreage grows each fire year. Weed symbols on maps grow every time we look for invasive weeds. Soils in too many places show excessive soil erosion or rills.

Overgrazing has become a semantic issue. Emphasis on controlling overgrazing began when overgrazing was obviously a serious problem. Reductions in grazing continue—along with long periods of growing season use that provide little opportunity for plant recovery. As a result, excessive utilization in some areas exacerbates uneven distribution of forage. Failing to implement sustainable practices misses an opportunity to effect change. Emphasis on private property rights often invites the promulgation of regulations formulated without the foundation of sound scientific evidence. A much more effective grazing management approach should focus on season, duration, and rotation of use along with a plethora of additional tools to meet site-specific objectives (see the 2006 *Nevada Rangeland Monitoring Handbook*).

To make grazing management work, we must correct both of the fire problems described above with prescribed fire, fire use and fire surrogates, as well as fuels management and fire control. This requires monitoring for quality control. Failure to monitor is failure to manage. NRCS should be funded to produce modern ecological site descriptions that are incorporated into land management plan objectives. The presence of grazing animals on the range should not be viewed as overgrazing, but rather as a valuable tool. When used properly, grazing can help achieve resiliency in desirable plant communities and responsible fire and fuels management.

Nevada has two opposing fire problems: 1) too little fire, which leads to; 2) too much fire that is too hot when it burns accumulated woody fuel and too frequent when it burns excessively flammable fine annual fuels.

Controlled burn in Lockwood, Nevada / Nevada Division of Forestry

DR. ROBERT BLANK has been a soil scientist since 1987 with the USDA-Agricultural Research Service in Reno, Nevada. From 1973 through 1983 he worked for the Soil Conservation Service (now NRCS) in South Dakota and mapped soils in McPherson and Brown Counties. He received his MS and PhD degrees from the University of Idaho.

Elevated atmospheric carbon dioxide has fundamentally altered plant competitive relationships in the Great Basin. Simply put, there are winners and losers. Unfortunately, many of the winners are introduced annual grasses and weeds.

ROBERT BLANK

ELEVATED ATMOSPHERIC CARBON DIOXIDE has fundamentally altered plant competitive relationships in the Great Basin. Simply put, there are winners and losers. Unfortunately, many of the winners are introduced annual grasses and weeds. The growth response of selected species to a doubling of atmospheric CO_2 can be seen in the table below. Overall, growth of cheatgrass increases markedly with increasing atmospheric CO_2. It also appears that this increase has a bearing on cheatgrass invasiveness. First, the CO_2 enhanced growth response contributes to increased fuel loads, thereby fostering wildfires. Second, data indicate that many of the native perennial plant species that compete with cheatgrass often have less growth response with increasing CO_2 than cheatgrass. All things being equal, the greater growth afforded by increased CO_2 to cheatgrass may increase its competitive ability.

Conversely, a greater understanding is needed of the processes that suppress cheatgrass establishment when perennials are present along with the inhibiting factors in certain soils that prevent cheatgrass establishment. Given the abundance of cheatgrass, it is reasonable to expect that some of the native soil organisms such as nematodes, fungi, and bacteria have evolved or could be coerced to evolve to become pathogenic to cheatgrass. We know that available soil nitrogen is a key factor in controlling invasiveness. Increasing the availability of nitrogen to cheatgrass accelerates its growth relative to native perennials. Therefore native perennial species should experience a competitive edge if nitrogen mineralization can be reduced, resulting in decreased levels of available nitrogen. Basic research should be undertaken to determine how and which plants or guild of plants reduce the nitrogen mineralization potential in Great Basin soils. Cheatgrass fosters wildfires, and considerable nitrogen is lost via volatilization from fires. Given these facts, it is reasonable to suspect that sufficient nitrogen loss from the soil after many wildfire events will result in cheatgrass becoming self-limiting. We are presently researching these topics.

GROWTH RESPONSE OF DOUBLING CO_2
300–360 to 600–720 ppmv

C3 GRASS	WEIGHT RATIO
Western Wheatgrass	1.57
Cheatgrass	1.72
Indian ricegrass	1.32
Soft brome	3.60
Annual bluegrass	1.00
Rough bluegrass	1.03

Ziska, L.H. 2002. Evaluation of the growth response of six invasive species to past, present and future atmospheric carbon dioxide. *Journal of Experimental Botany*. 54:395–404.

DONALD KLEBENOW

URBANIZATION, AGRICULTURE DEVELOPMENT, ecological shifts and climate change are major stressors that have led to reduced densities of many wildlife species in the Great Basin. Fire protection policies and early grazing practices permitted shrubs to increase, creating ubiquitous stands dominated by sagebrush or piñon and juniper.

Wildfires, now larger and more widespread, often burn these woody habitats, setting the stage for exotic invaders to replace native vegetation. Wildfire is now considered by many as the major threat to wildlife populations. Often fires burn at elevations that are winter habitat for many wild species. Sagebrush-dependent birds and mammals lose their habitat. Conversion to exotic dominated vegetation monotypes often prevents natural ecological succession from recovering what once was a native habitat.

The wildlife impact has varied. Shrub-dependent species such as sage grouse and mule deer are suffering from the widespread conversion of their habitat. Others may respond differently. While sagebrush fires may remove important winter forage, overall pronghorn antelope are doing well in Nevada. Their population is at an all-time high. Elk is another big game species that continues to extend its distribution in Nevada. Possibly these last two big game species are responding to rangeland management practices that are providing habitat more suited to their needs.

Recently, the presence of disease is arousing concern. West Nile virus has been confirmed in bird species in the Great Basin. Corvid family birds are the most susceptible, but West Nile also affects others. In Nevada, the virus has been confirmed in sage grouse and Brewer's sparrow, both sagebrush-dependent species. The role of disease in the decline of these two species, as well as others, is essentially not known due to the disease's recent discovery. While data on population numbers exist for hunted species, information on non-hunted species is limited. For example, Brewer's sparrow may well have been the most common bird in sagebrush habitats in the 1955–1975 period. It is noticeably less seen today. Is its occurrence threatened? What about the sage sparrow? This shrub-nesting, secretive bird is less noticeable even when population numbers are abundant. If it has declined, we are apt to not to even realize it. The impact of diseases such as West Nile virus, as well as habitat loss from fires, leads to another factor involved with management of the Great Basin wildlife habitat: litigation. Litigation continues between conservation groups and the U.S. Fish and Wildlife Service regarding the potential listing of sage grouse as an endangered species. The rationale for the present litigation is based on new information regarding numbers, population densities, genetics, disease impact and other related population features, i.e., nesting and brood success, habitat characteristics, etc.

Great efforts are being made to ensure healthy sage grouse populations. The knowledge of this bird's population features, status, habitats and habitat conditions is better than it ever has been. Management projects have been initiated to improve their habitat.

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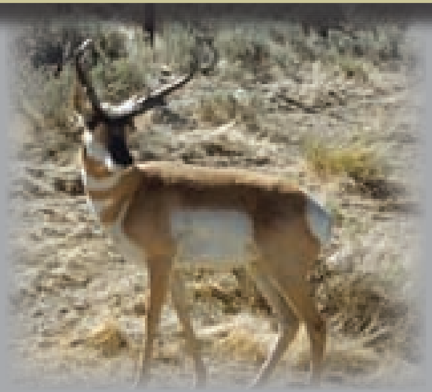
Wildfire is now considered by many as the major threat to wildlife populations.



STEPHEN LEONARD has more than 35 years experience in rangeland ecology and grazing management with the private sector, the Bureau of Land Management and various interagency teams. He received his degree in range and forest management at Colorado State University. Steve is a certified range management consultant and certified professional in rangeland management. He served as ecologist and grazing management specialist on the national riparian team.

STEPHEN LEONARD

ENVIRONMENTAL AND FIRE REGIME CHANGES in the Great Basin initiated by farm and ranch development, timber production, mining and colonization are the result of the natural expansion of human populations seeking basic needs. If man is a natural inhabitant of the earth and its ecosystem, then the changes associated with man's presence and migration are in fact natural processes of evolution with heritable and learned characteristics. Migration of plant species (including pre-adapted flammable exotics) and animal species is a natural process associated with immigration and emigration of human populations. Land fragmentation, changes in land cover types and fire control also are natural socioeconomic attributes of the human species seeking food, water, shelter and comfort.

The ecological changes associated with the past socioeconomic evolution, combined with recent catastrophic fire effects, could be perceived as an imminent threat to the socioeconomic well-being of the nation. The crisis has greater impact at the local level and is already a reality for many individuals. The most immediate benefits from mitigating the deleterious impacts can be achieved utilizing the best available technologies while developing new methods and materials on public lands where willing cooperators exist.

Best available technologies include the use of migrant plant species that can successfully coexist with human socioeconomic systems. Crested wheatgrass is one. It approximates the structure of many indigenous grasses, and sagebrush can be grown with it. Planted in patches, crested wheatgrass can survive in a relatively more fire-resistant understory; then, adjacent areas can be repopulated. Established wheatgrass seedings inhibit cheatgrass establishment while allowing native plant species to be more successfully established. For a reasonable cost, the historically large, 10,000-acre seedings of crested wheatgrass can be displaced with smaller, dispersed areas more closely approximating the natural vegetation mosaics that benefit wildlife species and stabilize the soil. Basic costs for reseeding are directly affected by the high risks associated with climatic variations in desert environments. Successful trials have demonstrated that crested wheatgrass can be reseeded with a low risk of failure compared with a high risk of failure using so-called natives.

Mechanical options such as the Lawson Aerator exist to treat over-aged, closed-canopy stands of sagebrush to increase both understory productivity and age-class structure without the financial or ecological liability of prescribed fire. Because the equipment does not kill everything, the ratio of shrub overstory to native grasses can be substantially improved. Financial incentives may be necessary to make such practices cost effective.

Emerging technologies may include the re-invention of ageless practices like livestock herding to achieve desired results such as fuel breaks or limiting competition from undesirable vegetation to achieve desired results. Such practices may require a change from expecting an economic return for forage consumed to paying a cost for intensive management services received from the producer.

Many more available and emerging technologies are being developed by research. The scale at which these technologies are accepted and implemented ultimately will depend on the scale and degree of socioeconomic threat the public perceives in the present situation. Possibly the best thing to do is articulate the long term socioeconomic impacts of wildfires and undertake measures to mitigate these impacts rather than focus on ecological changes.

The ecological changes associated with the past socioeconomic evolution, combined with recent catastrophic fire effects, could be perceived as an imminent threat to the socioeconomic well-being of the nation.

SCIENTIST CONTRIBUTIONS

DR. ELWOOD MILLER, professor emeritus, received his PhD from Michigan State University. His career spans ten years with the U.S. Forest Service and 30 years as a forestry professor and administrator with the University of Nevada, Reno. Miller also served as the founding executive director of the Nevada Fire Safe Council.

ELWOOD MILLER

FOLLOWING THE DEVASTATING FIRES OF 2000, Congress enacted the National Fire Plan. In response, a broad spectrum of individuals at the federal level developed a 10-year strategy and plan to implement a collaborative approach for reducing wildland fire risks to communities and the environment. The plan was approved in 2002.

In 2003 Congress passed the Healthy Forest Restoration Act that included new authority for stewardship contracting on federal land and Community Wildfire Protection Planning. In all of this effort, congressional direction has been clear and consistent. Collaboration at all levels is essential, and key decisions should be made at the local level. From the beginning, federal legislation and the strategy and implementation plans that followed have stressed four goals:

1. Improve fire prevention and suppression.
2. Reduce hazardous fuels.
3. Restore and implement post-fire recovery of fire-adapted ecosystems.
4. Promote community assistance.

Into the Great Basin, an environment where fire is a natural and frequent visitor, we are injecting a new invasive fuel. Undersecretary for Natural Resources Mark Rey reported that between 1980 and 1999, 8.4 million homes were built in the interface with forests and rangelands across the West. This equates to the entire population of California being sprinkled across fire dependent ecosystems. In Nevada, the number of homes built in wildfire prone areas doubled in the 1990s. Ninety-four percent of the land projected for developments is rated at a very high or extreme threat level for wildfire. Scientists studying climate trends, fuel buildup and forest and rangeland health tell us that in Nevada's future, there will be more fire, not less.

Priorities are shifting from natural resource protection to the protection of lives and homes. The first national wildland fire policy document was the 1995 Federal Wildland Fire Management Policy and Program Review. This document reaffirmed that the protection of human life is the first priority in fire suppression. As a result, the priority for deployment of suppression resources has increasingly shifted from wildland to community protection. This has contributed to the increasing size of fires and driven the cost of fire fighting steadily higher. According to Secretary Rey, the proportion of the U.S. Forest Service's overall budget committed to fire fighting will grow from 17 percent in 1990 to a projected 45 percent by 2008. The 2006 Inspector General's audit of the U.S. Forest Service reported that the major strategy for 87 percent of the large fires reviewed was the protection of private property.

The general strategy to reverse this trend is to increase resistance to structure ignition within developed communities and reduce fire intensity so that fewer fire fighting resources are required to protect lives and homes, and those that are deployed can accomplish the task with greater safety. Implementing this strategy will allow a greater proportion of the available suppression assets to be deployed to reduce the size of fires and protect valuable natural resources. To accomplish this we need to:

1. Organize local community action groups focused on the mitigation of the fire threat.
2. Modify fuels in the interface by reducing fuel volume, changing its distribution and altering plant composition to reduce fire intensity and slow the rate of spread.
3. Alter fuels in the immediate vicinity of structures to reduce the probability of ignition sources coming in contact with buildings.
4. Increase resistance of structures to ignition.
5. Create a favorable environment for the development of a viable bio-industry that can use the biomass generated by fuel treatment projects and help offset the cost of pre-ignition, preemptive fire suppression.

Priorities are shifting from natural resource protection to the protection of lives and homes.

Controlled burn in Lockwood, Nevada / Nevada Division of Forestry

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NEIL RIMBEY

STRESSORS OF RANGE ECOSYSTEMS IN THE WEST often discussed are mostly physical. Socioeconomic issues as stressors are not given adequate consideration. Financial stresses brought about in the early- to mid-1980s with major adjustments of financial markets have had profound effects on cattle ranching in the West. There is also livestock market stress that has contributed to significant declines in livestock numbers.

If one considers the record cattle prices now and adjusts them to real dollar terms (based on price index), there is no difference between the situation right now and what happened 20 or 30 years ago. Price has been relatively stable, and significant increases only have resulted through the inflation of fuel prices, fertilizer, etc. As a result, profit margins are shrinking. In Idaho immediately after World War II, there were about 1.5 million head of sheep compared to current numbers of approximately 200,000 head of ewes. Based on the census data of ranch numbers, there are fewer ranches currently in operation. The ranches that do exist are larger in terms of both number of livestock and acreage. Vacant allotments and other significant regulatory changes that have taken place have impacted the social structure and brought about community changes in the rural areas of the Great Basin.

Any policy changes that take place on public lands must include social and economic analysis in addition to the analysis of the physical changes that take place. An important economic issue is related primarily to whether investment should be made on prevention or rehabilitation. There are concerns with some of the native seedings that are being proposed primarily due to the cost in relation to a probable 90-percent failure rate. In reseeding, one has to include those risks of failure in the total cost. This is particularly true when the future benefits of rangeland rehabilitation are discounted back to present value. Therefore, the high up-front costs are only offset by benefits that typically accrue over a long term planning horizon.

There are also serious concerns with the longer term nonuse period following a fire. Rehabilitation efforts using native seed mixtures have a high initial cost. Discounting benefits that accrue five to eight years in the future and comparing returns to the immediate costs makes it difficult to arrive at a positive net financial benefit. In addressing ranch level impacts of alternative management strategies, failure to include fire impacts results in underestimating the total cost of range management on public lands.

A tour of Idaho's Murphy Complex fire and the Tongue Complex on Juniper Mountain in the late summer revealed graphic evidence that grazing may reduce fuel loads and even stop fires. Targeted grazing has potential in some small areas.

However, current livestock numbers in the western United States are insufficient to control cheatgrass, particularly in those years in which it flourishes.

Declining livestock numbers due to unfavorable economic conditions, combined with high costs of range rehabilitation, make it difficult for individual livestock producers to invest in rangeland improvements. The greater public good that results from successful rangeland improvement projects such as improved air quality, riparian area enhancement, soil stabilization and expansion of wildlife habitat needs to be assessed using non-market valuation techniques. Enhanced rangeland condition creates benefits that extend far beyond those that accrue directly to individual livestock producers.

A tour of Idaho's Murphy Complex fire and the Tongue Complex ... revealed graphic evidence that grazing may reduce fuel loads and even stop fires.

Recommendations

THE SCIENTISTS WHO PARTICIPATED IN THE FORUM were asked to list their recommendations for solving the critical wildfire problems of the Great Basin based upon their knowledge and experience. They were asked to consider and produce a prioritized list of both short-term and long-term issues. Their recommendations were then categorized by the editors into seven areas. The scientists were provided an opportunity to review all of the recommendations, and their comments were incorporated. The editors provide a summary of the detailed list of recommendations corresponding to each category.

Rangelands devastated by megafires must be successfully rehabilitated utilizing desirable seed, equipment and financial resources. Use of these resources must be accompanied by advanced planning and expeditious project implementation using not only proven native species, but also adapted non-native species and techniques with a historic record of success. Existing vegetation communities that potentially would support megafires must be treated using prescribed or naturally occurring fire, or fire surrogates such as grazing animals, herbicides and/or mechanical methods. Large-scale projects demonstrating successful management and treatment strategies should be created.

RANGELAND REVEGETATION & REHABILITATION

1. Integrate current knowledge into a large-scale vegetation management and site rehabilitation demonstration project.
2. Place increased emphasis on planning, staging and accumulating resources for post-fire rehabilitation. This would include the development of large seed caches, equipment pools, site descriptions, treatment prescriptions based on research findings and historic successes, and funding. The required planning and implementation strategy would be developed in a non-crisis atmosphere and staged to respond quickly following the inevitable wildfire.
3. In those areas where cheatgrass was dominant in the pre-fire understory and/or where perennial grasses were sparse and cheatgrass is expected to substantially increase (typically lower elevations with less than 10 inches of annual precipitation), use adapted, non-native plant species such as forage kochia, crested wheatgrass, Siberian wheatgrass and Russian wildrye for reseeding. Use methods that have proven successful over years of research and application to preserve the soil, improve range conditions and rehabilitate sites devastated by wildfire.
4. To increase the probability of establishment, utilize soil type and precipitation data to select native plant species or combinations of species that have demonstrated success in stabilizing burned cheatgrass ranges and effectively reducing fire intensity and the rate of spread.
5. Consider the increase in atmospheric CO_2 in plant breeding programs designed to increase success of rangeland revegetation efforts.
6. Focus rangeland management plans and projects on keeping herbaceous perennials resilient, resulting in increased carbon sequestration.

7. Use financial incentives to encourage the use of fire surrogates, such as targeted livestock grazing, herbicides or mechanical options to treat over-aged, closed stands of sagebrush to increase both understory productivity and adjust age-class structure of sagebrush in those situations where prescribed fire is deemed untenable.
8. Implement sound management practices to maintain rangeland health by utilizing cattle, sheep and/or goats in targeted areas to provide an economic and feasible way of reducing fire fuel loads, controlling weeds and cycling nutrients. In some cases, livestock also may be used to transport seeds of desirable species and facilitate their movement into the soil.

FIRE PREVENTION AND FUELS MANAGEMENT

> **Develop long-term fuels management strategies that establish priorities for treatments based on fire threat levels, interrupt contiguous fuels, use prescribed fire where possible, formulate effective community protection ordinances and seek to re-establish fire as a natural force. Include options to maintain cheatgrass as a forage crop where rehabilitation is not possible and provide incentives to foster the development of a viable biomass utilizing industry to offset the cost of fuels treatment.**

1. Recognize cheatgrass as a major forage species on the rangelands of the Great Basin and develop grazing management systems that optimize the use of this resource while reducing uncontrollable wildfires.
2. Develop management systems to establish adapted species, or alternatively, maintain cheatgrass where site degradation has proceeded to the point that rehabilitation of native plant communities is not economically possible.
3. Use prescribed fire in those instances where the expansion and growth of sagebrush is threatening established seedings.
4. Construct strategically located fuel breaks to break up the continuity of fuel and increase the probability of safely suppressing an ignition before it becomes a mega-fire.
5. Create a business development environment that fosters the establishment of a biomass utilizing industry that can create beneficial uses for the fuel being removed.
6. Adopt and/or enforce ordinances for housing developments in high fire threat locations, such as requiring structural features that increase resistance to ignition, implementation of funded long-term fuel management programs and infrastructure characteristics that facilitate safe fire suppression action.
7. Complete a landscape scale risk/hazard assessment that identifies high values at risk, prescribes preemptive action to protect the values and sets priorities for implementation.
8. Develop and implement land use and fire management plans that incorporate prescriptions for fire use.
9. Provide financial incentives to use livestock for achieving desired fire breaks or to limit competition from undesirable vegetation.

Fuels treatment in the Lake Tahoe, Nevada backcountry / Nevada Division of Forestry

Reduce the risk of rehabilitation failure by examining the record of historic successes through cost/benefit considerations. Conduct an ongoing and long-term analysis of the local and regional economic and social impacts of wildfire including both market and non-market values.

ECONOMIC ANALYSIS

1. Complete a long-term cost analysis of wild fires and assess the impacts to regional economies and social systems, considering market and non-market values as well as costs to local, state and federal governments.
2. Where native plant species are to be used in cheatgrass-prone rangelands, ensure there is supporting evidence regarding the historic success of the species mix and seeding prescriptions. Provide economic incentives to offset the risk of failure if they are to be used.
3. Evaluate the effectiveness of the policy that requires two or more years of rest period with no grazing following a fire and develop policy and management alternatives
4. Develop methods or techniques to improve evaluation of non-market goods to estimate costs of wildfires and assess benefits from rangeland rehabilitation.
5. As required by legislation and policy, ensure that economic analysis is a critical part of formulating management and rehabilitation plans.

Forge effective partnerships between public land managers and citizens to more effectively increase community and resource protection.

PUBLIC INVOLVEMENT AND PARTNERSHIPS

1. Train and equip qualified local citizens to provide prompt initial attack while wildfires are small.
2. Develop policies that recognize the dependence of rural communities on public land resources and increase efforts to forge stronger partnerships between public land managers and communities.
3. Create community-level citizen action groups that focus on the wildfire threat and create partnerships with fire services obligated to ensure their protection.

Take advantage of the annual variation in forage production by facilitating the movement of livestock to targeted areas and controlling grazing pressure by focusing on season of use, duration, rotation and growing season recovery period as well as forage utilization. Establish a fiscal policy that allows public funds to be held in abeyance until a higher probability of rangeland improvement success is assured.

ADAPTIVE AND FLEXIBLE MANAGEMENT

1. Develop a production model that administratively allows the movement of livestock across targeted areas of the landscape to take advantage of the annual variation in forage production.
2. Broaden the purpose of emergency stabilization and rehabilitation (ESR) to include prescribed fire and its surrogates as well as for wildfires.
3. Elevate the importance of season of use, duration, rotation and growing season recovery period to the same level of consideration as forage utilization and intensity of use in developing grazing management plans and programs.
4. Develop a means for government funds to be carried over if climatic and seed availability are not opportune for expenditure, thereby having money available when conditions are more favorable for success.

5. Identify and correct budgetary processes, as well as legal and policy areas that inhibit rangeland enhancement efforts.

MONITORING

Establish continuous monitoring systems using advanced technology to determine conditions and trends at a local level and abandon the use of long-term or large-scale geographic averages.

1. Abandon assumptions of average conditions and more closely monitor actual changes in local conditions.
2. Increase monitoring efforts of wildlife populations to determine cause-and-effect relationships that result in population fluctuations.
3. Establish multi-year monitoring of rangeland revegetation improvement projects to determine and document level of success and influencing factors.
4. Increase the use of remote sensing, Global Positioning Systems (GPS) and Geographic Information Systems (GIS) to collect, compile and disseminate data and information on Great Basin soil and vegetation ecosystems in relation to fire ecology.
5. Establish monitoring protocols that determine conditions and trends as indicators of rangeland health. The four principal parameters to be monitored include climatic and weather conditions, soil, plants and grazing animals.
6. Update soil surveys and databases to include ecological site descriptions for the Great Basin.
7. Conduct research to develop state and transition models of vegetation.

EDUCATION, RESEARCH AND DEVELOPMENT

Establish or enhance research efforts to find natural processes to inhibit the establishment of undesirable exotic and/or noxious plant species. Increase support for university-level education and research programs focused on rangeland management.

1. Evaluate the potential of cheatgrass suppression by perennials and identify inherent soil characteristics that inhibit establishment.
2. Develop research to enhance or develop pathogenic characteristics of native soil fauna that increase their ability to inhibit the successful establishment and site domination of invasive annuals such as cheatgrass.
3. Evaluate the establishment of guilds of plants that could potentially cut off availability of soil nitrogen, such as decreasing nitrogen mineralization.
4. Maintain and improve herbaria in land grant institutions through the staffing of trained systematic botanists.
5. Maintain and increase the number of strong university rangeland management programs that graduate well-trained, competent professionals needed to manage Great Basin landscapes.

Forage kochia

Sponsors

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