# The Idaho National Engineering and Environmental Laboratory: An Ecological Treasure of the Upper Snake River Plain

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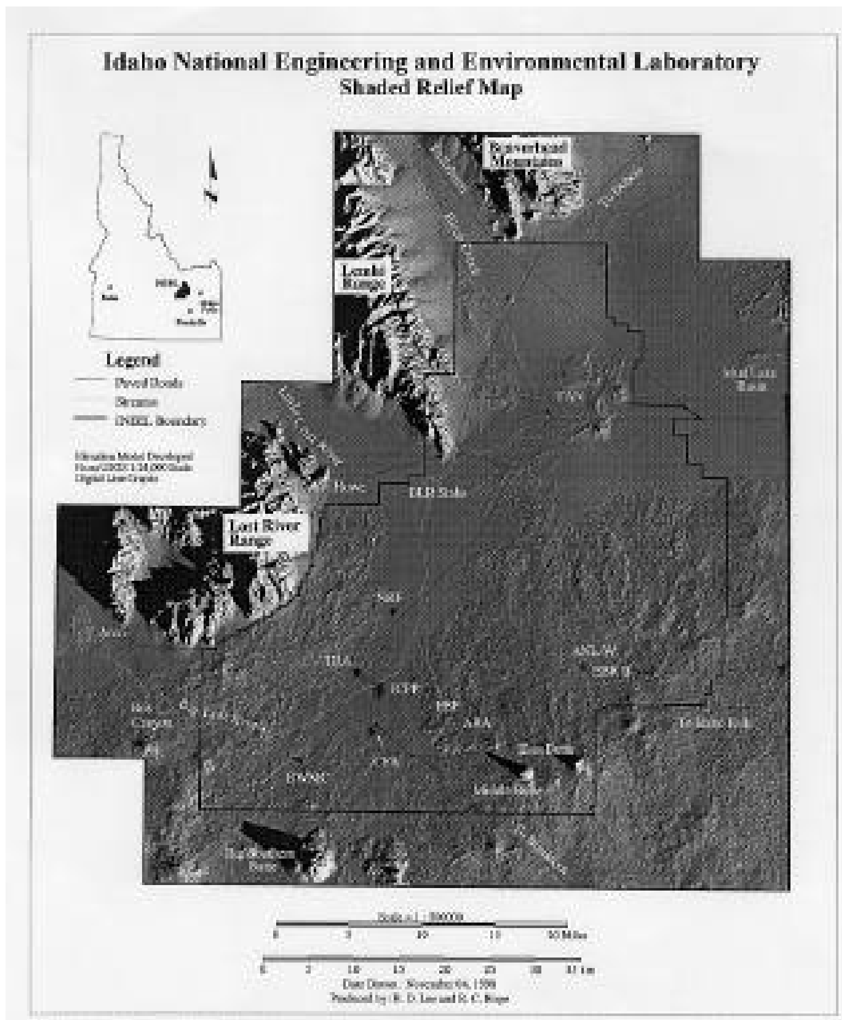
Establishment of the National Reactor Testing Station on the sagebrush desert of the upper Snake River Plain in 1949 had an unforeseen public benefit: the protection of the rich natural flora and fauna of sagebrush steppe ecosystems. About 40% of the 890 square miles now known as the Idaho National Engineering and Environmental Laboratory (INEEL) has not been grazed by livestock for the past 50 years. This is the largest ungrazed reserve within the sagebrush steppe, the most extensive semidesert vegetation type of the Intermountain West (West 1988). Recognition of the importance of the INEEL as a field laboratory for ecological research resulted in its designation in 1975 as the second of the Department of Energy's National Environmental Research Parks.

## Physiographic Setting, Climate, and Water

The INEEL lies along the northwestern edge of the eastern Snake River Plain, at an average elevation of about 5,000 ft. It is bounded on the west and northwest by the Lost River and Lemhi Mountains and on the north by the southern tip of the Beaverhead Mountains of the Bitterroot Range (Figure 1). The eastern and southern edges of the laboratory are contiguous with sagebrush rangelands of the Snake River Plain, but are punctuated by the Plain's predominant topographic features, Big Southern, Middle, and East Buttes. The latter two, also referred to as the Twin Buttes, are within the INEEL boundary; the prominent Big Southern Butte, which rises to 7,500 ft., is 2.5 miles south. These buttes are the most conspicuous among the many reminders of the volcanic origin of the Snake River Plain (Kuntz et al. 1994, Hackett and Smith 1992). Many smaller buttes and cinder cones dot the landscape, and lava outcrops and lava tubes are common features of the rolling and broken terrain of the southern two-thirds of the laboratory area. The most recent basalt flow at the INEEL, the Cerro Grande, occurred about 13,000 years ago; it extends only for a few miles north of the southern boundary. At nearby Craters of the Moon National Monument, basalt was extruded as recently as 2,100 years ago.



*Juniper woodland at the Idaho National Engineering and Environmental Laboratory. Middle Butte is on the left and the Big lost River Range is in the background.*

This is cold desert country, characterized by large daily and seasonal temperature fluctuations. Average annual temperature is 42°F, and snow cover typically persists for 2 to 3 winter months. During summer, low humidity and clear skies result in relatively high maximum temperatures (86–95°F) and high evaporative demand during the day, while at night, temperatures often drop to below 50°F.

The INEEL lies in the rainshadow of the numerous mountain ranges to the west. Average annual precipitation is 8.6 in. About one-third of that falls early in the growing season during April, May, and June. Melting snow and spring rains account for most of the soil moisture, and most of the plant-available water is used by early July.

Much of the INEEL lies within a closed topographic basin that encompasses the mouth of the Big Lost River Valley near Arco and then slopes gently to the north to the "sinks" of the Big Lost River and Birch Creek (Figure 1). Earlier, three major perennial streams drained into this basin. The Big Lost River enters the southwest corner of the INEEL and meanders 30 miles before reaching the "sinks" of the Big Lost River/Birch Creek playas. Birch Creek and the Little Lost River also flowed into this closed basin. The sinks and playas of these streams occupy a portion of ancient Lake Terreton, which in the cooler, wetter conditions of the late Pleistocene, covered approximately 35 square miles of the northern half of the laboratory areas. During the Holocene, the playas formed extensive wetland areas that likely supported a rich diversity of plants and animals. Now, as a result of extensive upstream irrigation diversions, water flows into the sinks only during years when precipitation is well above normal.

A cataclysmic Pleistocene glacial flood sent an estimated 2 million cubic feet per second of water down the Big Lost River and carried boulders from Copper Basin in the Pioneer Mountains to Box Canyon near the labortaory's southwestern border. That torrential discharge

*Sagebrush-juniper community at the Idaho National Engineering and Environmental Laboratory. Saddle Mountain on the south end of the Lemhi Range is in the background.*

*Juniper woodland at the Idaho National Engineering and Environmental Laboratory. Middle Butte is on the left and the Big lost River Range is in the background.*

ranks as the third most powerful flood known, exceeded only by the Lake Missoula and Lake Bonneville floods (Rathburn 1993). Rathburn estimated that water velocity in Box Canyon at peak discharge reached 27 mph. The flood, thought to have occurred about 20,000 years ago, left distinctive scabland topography, boulder bars, and cataracts (Hackett and Smith 1992, Rathburn 1993).

## Soils and Vegetation

Most laboratory area soils consist of a thin veneer of loess derived from older silicic volcanic and paleozoic rocks from the surrounding mountains. Major episodes of loess deposition apparently occurred between 10,000 and 70,000 years ago and between 140,000 and 200,000 years ago. Little loess has accumulated on the most recent flows of the upper Snake River Plain. Because of the uneven, broken surface of the basalt, depths of the silt loam and sandy loam soils vary from a few inches on recent lava flows or ridges of older flows to over a-meter in lower lying areas. Alluvial soils are found along the Big Lost River flood plain and on alluvial fans along the western and northern sides of the INEEL. Alluvial soils are often gravelly on the surface and underlain by sandy loams. The sandy texture of these soils resulted in the failure of a network of irrigation canals established on the north and west sides of the INEEL in the early 1900s.

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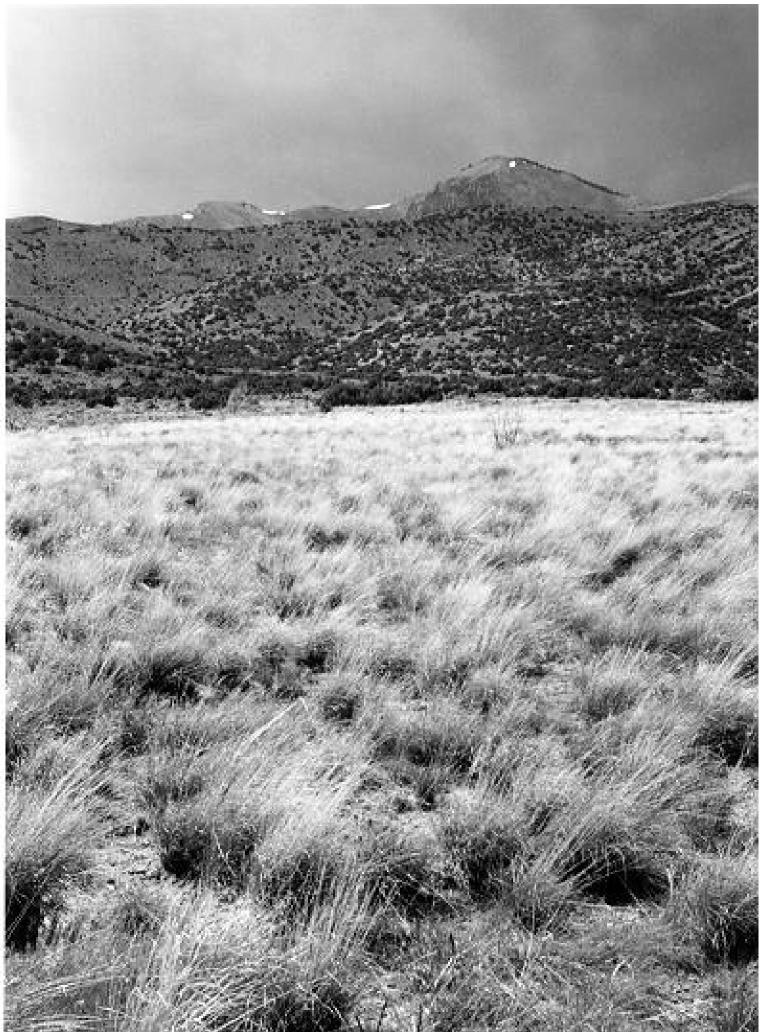
The most common native grasses include thick-spiked wheatgrass, bottlebrush squirreltail, Indian ricegrass, needle-and-thread grass, and Nevada bluegrass. Patches of creeping wildrye and western wheatgrass are locally abundant. Bluebunch wheatgrass is rare at the lowest elevations but is often the dominant grass on alluvial fans and slopes of buttes and foothills.

Unlike much of the sagebrush steppe that has a long history of livestock grazing, the INEEL supports a



*Bluebunch wheatgrass on a 1994 burn site on the west side of the Idaho National Engineering and Environmental Laboratory. Juniper woodland on foothills of the Lost River Range in the distance.*

high diversity of forbs. Eighty-five percent of the vascular plant species are native, and three-fourths of those are forbs. Common native forbs include tapertip hawksbeard, Hood's phlox, hoary false yarrow, paintbrushes, globe-mallow, buckwheats, evening primrose, lupines, bastard toadflax, milkvetches, and mustards.

Data from 92 permanent vegetation plots established in 1950 show that cover of shrubs and perennial grasses fluctuate by as much as 100% and 500%, respectively, in the absence of any major disturbance. Average species richness per plot has increased over the past 45 years, as has the variability in species composition among plots that were very similar in 1950. These changes reflect an increase in the size and distribution of local populations that were depleted prior to 1950 by livestock grazing and an extended drought during the 1930's and 1940's.

## Fire

The regional climate predisposes many sagebrush communities to recurring fire, and it is clear that fire played an important role in the evolution of many cold-desert plants. The majority of shrubs, perennial grasses and forbs can survive wildfires, especially those that occur in late summer or fall when plants are dormant. Some species respond vigorously to postfire conditions (Wright et al. 1979, Ratzlaff and Anderson 1995). The notable exception is big sagebrush, which must recolonize burned areas by seed dispersal.

Sixteen fires are known to have burned during this century at the INEEL. These ranged in size from a few to over 19,000 acres. Wildfires have been aggressively controlled at the INEEL since 1950, which may have decreased the area that would have burned. Despite the fire suppression policy, the three largest fires of the century occurred in 1995, 1996, and 1997. All were human caused. The conditions for these large fires likely were established by very wet growing seasons in 1993 and 1995, which resulted in the production of abundant fine fuels.

> Humans arrived on the eastern Snake River Plain about 11,000 years ago, a date obtained from cultural deposits in a lava cave just east of the INEEL.

There is evidence that large fires were not unprecedented at the INEEL. A distinct linear feature 17 miles long is conspicuous on the earliest aerial photographs of the INEEL. Early investigators assumed that this feature was geologic, but Malde (1971) concluded that the feature consisted of an anomalous strip of sand on the surface that increased infiltration and storage of water. Improved water availability resulted in a corresponding strip of lush vegetation. In the fall of 1996, charcoal was found at the interface of the sand veneer and the underlying bess, providing evidence that the feature marks the eastern edge of a large burned area. The fire burned in a more northerly direction than the prevailing southwest to northeast winds, thereby setting the stage for substantial accumulations of wind-blown sand in unburned vegetation along its eastern edge. Based on radiocarbon dating, it is likely that this large fire occurred in the early 1800's. Clearly, the effects of wildfire can persist for a very long time, even in cold-desert communities.

## Early History

Humans arrived on the eastern Snake River Plain about 11,000 years ago, a date obtained from cultural deposits in a lava cave just east of the INEEL. Some 850 local archaeological sites indicate a slow but steady increase in human activity over the intervening years. The ancestors of the Shoshone and Bannock migrated north from the Great Basin about 4,500 years ago. Archaeological sites in the region document continuity of the Shoshonean culture from 4,000 years until historic times. These native peoples primarily were hunters of large game. Lithic tools from the earliest strata of cultural deposition include large spear points often associated with the bones of now extinct mammoth, caribou, bison, and horse. The archaeological record indicates a gradual reduction in projectile point size corresponding roughly with the extinction of large, relatively slow moving mammals and their replacement by the swifter-footed, smaller mammals that exist on or about the INEEL today, mountain sheep, deer, elk, and pronghorn. Smaller projectile points are accompanied first by evidence of spear-throwing technology and later by evidence of the bow and arrow, both of which seem to be adaptations to the hunting of smaller, faster animals (Ringe 1995).

Palynological studies indicate little change in plant communities during most of the Holocene. The archeological record only infrequently indicates direct use of plants by the aboriginal inhabitants, but the artifacts found at one INEEL site, Aviator Cave, suggest a variety of uses including foods, fiber, and fuel. These artifacts include charred cactus seeds and spines, twined plant fiber, matted and charred sagebrush, and a bunchgrass apparently used as a makeshift broom.

### Scientific Names of Species Mentioned in Text

basin big sagebrush = *Artemisia tridentata* subspecies *tridentata*
bastard toadflax = *Comandra umbellata*
black sagebrush = *Artemisia nova*
bluebunch wheatgrass = *Pseudoroegneria spicata*
bottlebrush squirreltail = *Elymus elymoides*
buckwheats = *Eric gonum* spp.
creeping wildrye = *Leymus triticoides*
evening primrose = *Qenothera caespitosa*
globe-mallow = *Sphaeralcea munroana*
gray rabbitbrush = *Chrysothamnus nauseosus*
green rabbitbrush = *Chrysothamnus viscidflorus*
hoary false yarrow = *Chaenactis douglasii*
Hood's phlox = *Phlox hoodii*
Indian ricegrass = *Oryzopsis hymenoides*
lupine = *Lupinus argenteus*
milkvetches = *Astragalus* spp.
mustards = *Thelepodium laciniatum, Stanleya viridflora, Arabis* spp.).
needle-and-thread grass = *Stipa comata*
Nevada bluegrass = *Poa secunda*
paintbrushes = *Castilleja* spp.
saltbushes = *Atriplex* spp.
tapertip hawksbeard = *Crepis acuminata*
thick-spiked wheatgrass = *Elymus lanceolatus*
threetip sagebrush = *Artemisia tripartita*
Utah juniper = *Juniperus osteospermaartita*
western wheatgrass = *Pascopyrum smithii*
winterfat = *Krascheninnikovia lanata*
Wyoming big sagebrush = *Artemisia tridentata* subspecies *wyomingensis*

The fur trade, the Oregon Trail (including Goodale's Cutoff, which crossed the southwest corner of the INEEL), and the establishment of Fort Hall all impacted the natural ecosystems and aboriginal culture of the area during the early to mid 1800's. Bison were still numerous in 1834, but numbers declined rapidly thereafter. The only travelers that settled prior to the 1860's were Mormon farmers sent by Brigham Young to colonize the region. In 1855, they were digging irrigation canals and successfully homesteading northeast of the INEEL. The late 1800's witnessed severe overgrazing by domestic cattle and sheep throughout the Intermountain West, but impact on native plant communities in this area is unknown. Livestock production was a commercial industry along the Snake River Plain by the late 1860's, but it remained transient as cattle and sheep were trailed between the coastal states and grasslands east of the Rockies. It was not until the 1880's that the livestock industry took root in the area (Wentworth 1948). Archaeological remains of historic livestock drives and early grazing are embodied in numerous roads and trails at the INEEL.

Real incentive to settle the eastern Snake River Plain came with the Homestead Act of 1862, the Desert Claim Act of 1877, and the Carey Act of 1894. In this era Idaho obtained one million acres of federal land for homesteading. In 1902, Idaho received funding through the Reclamation Act to build canals to "reclaim arid lands" (Reed et al. 1987). During the next 3 decades, hundreds of miles of irrigation canals were dug in the vicinity of the INEEL. Of those, only part of the Mud Lake project near the INEEL's northeast corner, was successful. The Carey Act's Powell Reclamation Project involved a diversion dam on the Big Lost River and nearly 100 miles of canals and distribution laterals to supply water to the INEEL's southwest corner. The canals, the larger of which were 40 feet wide and 8 feet deep, would not hold water and the project was abandoned in 1927. A similar project with the same fate was attempted on the Little Lost River, with portions of canals extending across the northwestern portions of the INEEL. Abandoned canals remain as reminders of these efforts to "reclaim" the desert.

## Recent History and Some Environmental Legacies

During World War II, the Navy and the Army Air Corps used several hundred square miles of the INEEL as gunnery and bombing ranges. In 1949, those ranges were coupled with a large parcel of land withdrawn from the public domain to form the National Reactor Testing Station for the testing of prototype nuclear power and propulsion reactors. Since its establishment, 52 original-design reactors have been constructed. The first was Experimental Breeder Reactor I, the world's first to generate electricity using plutonium as fuel. It was decommissioned in 1964 and is now a National Historic Landmark.

In the 1950's, the Naval Reactor Facility developed prototype reactors for submarines and aircraft carriers. A huge hanger is all that remains of the Aircraft Nuclear Propulsion program, terminated by Executive Order of President Kennedy in 1961. In 1953 the Idaho Chemical Processing Plant began reprocessing spent reactor fuel elements. The Radioactive Waste Management Complex (RWMC) was established in 1952. The 56-acre Subsurface Disposal Area at RWMC has been used for the shallow land burial of low level nuclear and other hazardous wastes. The RWMC also stores high level wastes that ultimately will be shipped to a final waste repository.

The laboratory facilities and programs have made innumerable fundamental contributions to the development and safe use of nuclear power and propulsion systems and to the safe handling and storage of nuclear materials. Those achievements have not been without substantial costs, however, including a legacy of contaminated sites and polluted groundwater. The INEEL is a Superfund Site that consists of 10 "waste area groups" encompassing contaminated soil and groundwater at various facilities. Beginning in 1953, injection wells were used to pump radioactive, heavy metal, and other chemical wastes directly into the aquifer at three facilities; these were taken out of service in 1972, 1982, and 1986. Contamination of soil near other facilities resulted from shallow burial of non-radioactive industrial wastes, from wastewater leaching beds, and from a steam explosion involving an Army reactor in 1961. Collectively, these activities have resulted in three known plumes of contaminants in the Snake River aquifer. Although radiation has been detected just south of the INEEL boundary, the plumes where one or more contaminants exceed 10% of drinking water standards are all within that boundary.

Groundwater contamination at the INEEL persists, but more restrictive environmental requirements and improved industrial processes have greatly reduced introduction of contaminants into the aquifer. Because of the importance of the aquifer for drinking water, irrigation, aquaculture, and industry, water quality in the aquifer down gradient from the INEEL is closely monitored in 74 wells and 8 springs by the USGS and the State of Idaho Oversight Program. Current data indicate that contaminants in the aquifer underneath the INEEL pose no threat to residents or activities downstream. Nevertheless, knowledge of the presence of these contaminants and their perceived risks continue to be a source of public concern and debate.

## The Future

Only one reactor remains operational, and the INEEL's mission and research emphasis have changed to include investigations in engineering and the physical and biological sciences that are not directly related to the nuclear industry. Emphases on bioremediation, hazardous waste management, and environmental cleanup and restoration resulted in the addition of "Environmental" to the name Idaho National Engineering Laboratory in 1997. Research in these areas will undoubtedly continue. Nevertheless, the future of the Idaho National Environmental Research Park is uncertain as the Department of Energy seeks to divest itself of lands no longer thought essential to its missions (Brown 1988). In that context, the importance of the INEEL as a haven for native plants and animals and as a natural laboratory for ecological research cannot be overemphasized and every effort should be made to ensure its continuance as an ecological preserve. The area supports thriving populations of native wildlife including raptors and songbirds, pronghorn, elk, pigmy rabbits, small mammals, and reptiles. The surrounding mountain valleys funnel pronghorn and sage grouse onto the INEEL for critical, high quality winter range. Those valleys also funnel a diverse assemblage of migratory birds across the area. Breeding bird surveys indicate that populations of some sagebrush obligate species such as sage and Brewer's sparrows, which are declining elsewhere, are orders of magnitude higher at the laboratory area. The INEEL is an ecological treasure—a place where relatively undisturbed lands and natural processes dominate the landscape, a sizeable remnant of the biodiversity of the sagebrush steppe.

## Supporting Literature

**Anderson, JE., K.T. Ruppel, J.M. Glennon, K.E. Holte, and R.C. Rope. 1996.** Plant communities, ethnoecology and flora of the Idaho National Engineering Laboratory. Environmental Science and Research Foundation, Idaho Falls, Idaho, 111 pp.

**Brown, K.S. 1998.** The great DOE land rush? Science 282:616–617.

**Hackett, W.R., and R.P. Smith. 1992.** Quaternary volcanism tectonics, and sedimentation in the Idaho National Engineering Laboratory Area. Pages 1–18 in J.R. Wilson, editor. Field guide to geologic excursions in Utah and adjacent areas of Nevada, Idaho, and Wyoming. Miscellaneous Publication 92–3. Utah Geological Survey, Salt Lake City, Utah.

**Kuntz, M.A., B. Skipp, M.A. Lanphere, W.E. Scott, K.L. Pierce, G.B. Dalrymple, D.E. Champion, G.F. Embree, W.R. Page, L.A. Morgan, R.P. Smith, W.R. Hackett, and D.W. Rodgers. 1994.** Geologic map of the INEL and adjoining areas, eastern Idaho. U.S. Geological Survey Miscellaneous Investigation Series Map 1-2330.

**Malde, H. E. 1971.** Geologic investigation of faulting near the National Reactor Testing Station, Idaho. U.S. Geological Survey Open-File Report

**Rathburn, S.L. 1993.** Pleistocene cataclysmic flooding along the Big Lost River, east central Idaho. Geomorphology 8:305-319.

**Ratzlaff, T. D. and J. E. Anderson. 1995.** Vegetal recovery following wildfire in seeded and unseeded sagebrush steppe. Journal of Range Management 48:386–391.

**Reed, W.G., J.W. Ross, B.L. Ringe, and R.N. Holmer. 1987.** Archaeological investigations on the Idaho National Engineering Laboratory. SCARLab Reports of Investigations 87-1. Idaho State University, Pocatello, Idaho.

**Ringe, B.L. 1995.** Locational analysis and preliminary predictive model for prehistoric cultural resources on the Idaho National Engineering Laboratory. Thesis. Idaho State University, Pocatello, Idaho.

**Wentworth, E.N. 1948.** America's sheep trails: history and personalities. Iowa State College Press, Ames, Iowa.

**West, N.E. 1988.** Intermountain deserts, shrub steppes, and woodlands. Pages 209–230 *In:* M. G. Barbour and W. D. Billings, editors. North American terrestrial vegetation. Cambridge University Press, New York

**Wright, H.A., L.F. Neuenschwander, and C.M. Britton. 1979.** sagebrush-grass and pinyon-juniper plant communities: USDA Forest Service General Technical Report INT-58, Range Experiment Station, Ogden, Utah.

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