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SAGEBRUSH

Ecological Implications of Sagebrush Manipulation

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Ecological Implications of Sagebrush Manipulation

A Literature Review

BY

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MONTANA FISH, WILDLIFE & PARKS

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Forward

This report discusses the value of big sagebrush (*Artemisia tridentata*) to the ecosystem and explores potential consequences of its eradication. It is intended to bring into focus the importance of sagebrush habitats and to encourage land managers to consider all the potential ramifications of manipulation before implementing an action. It is not intended to discredit the use of vegetation manipulation when used as a tool that will clearly result in improved habitat. However, the Montana Fish, Wildlife & Parks (FWP) believes sagebrush manipulation is too often initiated without proper understanding of effects on wildlife, wildlife habitat and the overall ecosystem.

Elk in mountain big sagebrush near Gardiner, MT. (Photo by Carl Wambolt)

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Contents

Introduction

The Montana Department of Fish, Wildlife & Parks (FWP) has long recognized the importance of sagebrush/grassland vegetative communities as wildlife habitat. Efforts to manipulate these communities concern FWP because of the potential implications to wildlife.

Some groups believe sagebrush control generally will have beneficial results for wildlife, even if the primary reason for a particular program is to produce more livestock forage. FWP has taken part in and endorsed programs designed to alter vegetation for wildlife habitat improvements. However, FWP takes strong exception to the generalization by some that mature sagebrush stands are even-aged monocultures lacking the diversity necessary for optimum wildlife habitat.

There are a number of questions regarding sagebrush control that need to be addressed. For example: (1) Do we need to regulate sagebrush stands to keep them productive for wildlife? and (2) What are the short and long-term ecological consequences of sagebrush eradication practices (particularly burning) to the entire vegetative community?

In order to address these and other pertinent questions, FWP has referred to the literature on the major topics covered by this report.

Sagebrush: Important Forage And Cover For Wildlife

Mule deer fawn hiding under sagebrush canopy. (Photo by Thomas M. Holland)

Sagebrush has been demonstrated to be a critical food source for several wildlife species during various seasons of the year, particularly fall, winter and spring. Cole (1955) found three different species of sagebrush comprised 93% of the winter diet of antelope in Montana. Shrubs (primarily sagebrush) are used almost exclusively by antelope from November through March and moderately through the other months (Pyrah 1987). Big sagebrush ranked first in mule deer diets in the Bridger Mountains of Montana during December, January and February (Wilkins 1956). During a 7-year period (1982-89), the average combined utilization for the various sagebrush species by deer and elk on the Gardiner, Montana, winter range was 59% for mountain big sage (*Artemisia tridentata ssp. vaseyana*), 42% for Wyoming big sage (A. *tridentata ssp. wyomingensis*), 32% for basin big sage *(A. tridentata ssp. tridentata*), and 16% for black sage *(A. nova)* (Wambolt 1990). Rouse (1957) found that three-tip sage *(A. tripartita)* received significant use by elk during severe winters. Sagebrush comprised 62% of the yearlong diet of adult sage grouse and essentially 100% of their winter diet in Montana (Wallestad et al. 1975). Field observations of the feeding behavior of the Pygmy rabbit (*Brachylagus idahoensis*) indicate heavy reliance on big sagebrush, primarily the seedheads and vegetative leaders. Published records of Pygmy rabbit food habits indicate 99% sagebrush in winter and 51% in summer (Green and Flinders 1980).

Elk Feeding on big sagebrush near Gardiner, MT. (Photo by Carl Wambolt)

The winter diet of the sagegrouse consists nearly 100% of sagebrush. (Photo by FWP)

Big sagebrush is a highly nutritious and digestible food source for big game animals such as mule deer (Peterson 1984). Although at one time it was speculated that deer avoid eating big sagebrush due to the monoterpenoids (volatile oils) contained in the foliage, research has shown otherwise (Peterson 1984, Bray et al. 1991). A particular variety of mountain big sagebrush (Hobble Creek) was preferred by wintering mule deer in Utah over a non-monoterpenoid shrub, antelope bitterbrush (*Purshia tridentata*) (Welch et al. 1992). During winter, big sagebrush has a higher crude protein level and digestibility than most other shrubs or grasses. The winter crude protein level of sagebrush was 12.4% compared to only 3.7% for dormant grass and 10.6% for the highly preferred winter shrub, curl-leaf mountain mahogany (*Cercocarpus ledifolius*) (Welch and McArthur 1979). Digestibility of big sagebrush in winter ranged from 40-60% while bluebunch wheatgrass ranged from 43-50% (Ward 1971). The winter digestibility of grass was reported by the National Academy of Sciences (1964) to be 31%. Data from tests of browse and grass[1] species considering the above factors found only big sagebrush and curlleaf mountain mahogany meet or exceed the protein needs of wintering mule deer (Thompson et al. 1973, Welch et al. 1979).

Mule deer relay heavily on sagebrush for winter forage in many areas of Montana. (Photo by FWP)

Sagebrush also provides cover (nesting, resting and escape) for a wide variety of game and non-game species (i.e. protective cover for fawns, calves, nesting birds, grouse broods, etc.). As an example, Brewer's sparrows (*Spizella breweri*) nest off the ground in the foliage of big sagebrush plants (Best 1970). Research in Montana revealed that, during the breeding season, sage grouse utilize habitat with a canopy coverage of big sagebrush ranging from 20-50% (Eng and Schladweiler 1972, Wallestad 1972, Wallestad and Schladweiler 1974). Wintering grouse were found in an average of 28% sagebrush cover (Eng and Schladweiler 1972) and nesting birds in an average of 20-30% sagebrush cover (Wallestad and Pyrah 1974). Another species of special concern is the pygmy rabbit. The pygmy rabbit is limited to habitat types which contain tall dense sagebrush (Green 1980a; Green 1980b; Campbell 1982; Weiss 1984; Lyman 1991).

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[1] Curlleaf mountain mahogany *(Cercocarpus ledifolius)*, chokecherry *(Prunus viginiana)*, cliffrose *(Cowania mexicana)*, bitterbrush *(Purshia tridentata)*, juniper *(Juniperus spp.)*, Gamble oak *(Quercus gambelii)*, and dormant grass.

Brewers sparrow nest in foliage of big sagebrush. (Photo by FWP)

Sagebrush has other assets for wildlife in addition to forage and cover. Its thick canopy protects understory vegetation from livestock grazing. Understory vegetation can be a valuable food source for wildlife. Additionally, the crowns of sagebrush plants tend to breakup and weaken hard crusted snow on winter ranges making it easier for big game to access understory plants for foraging.

Plant physiologists at the Forest Service Intermountain Research Station's Shrub Sciences Laboratory in Provo, Utah, recognize big sagebrush as important wildlife food and cover, and are developing the best varieties for restocking rangelands (Tippets 1992).

Sagebrush Ecology

Historical Occurrence Of Big Sagebrush

Opinions differ on historic sagebrush distribution. Jorgensen (1990) reported that a number of researchers contend big sage has significantly extended its historical range, often due to livestock grazing (Stewart et al. 1940, Stoddart 1941, Woodbury 1947, Wright and Wright 1948, Millin 1950, Cooper 1953, Ellison 1954, Anderson 1956, and Morris et al. 1958). Others believed sagebrush was a dominant species in many areas of the west prior to settlement (Wizlizeners 1839, Fremont 1842, Stansbury 1852, Russell 1902, Passey and Hugie 1962, Cotter 1963, Tisdale et al. 1969, Robertson 1971, Vale 1975, and Johnson 1984).

Vale (1973, 1975) concluded that intermountain rangelands were generally dominated by big sagebrush. His research concluded major areas of the intermountain west were covered by "thick stands of brush" when the first Europeans arrived. For this reason he concluded that "attempts to eradicate brush and encourage pure stands of grass could not be justified in terms of reestablishing the natural plant cover."

An observation by Meriwether Lewis, while traveling in Montana between the Milk and Musselshell Rivers on May 11, 1805, points to the presence of sagebrush in Montana before settlement:

> *the wild hysop [sagebrush] grows here and in all the country through which we have past for many days; tho from big Dry river to this place, it has been more abundant than below, and a smaller variety of it grows on the hills, the leaves of which differ considerably, being more deeply indented near it's extremity. The buffaloe deer and elk feed on this herb in the winter season as they do also on the small willows of the sandbars (Moulton 1987).*

Lewis and Clark made further references regarding the presence of sagebrush in their journey through southwestern Montana (i.e. July 22, 1805, near the present site of Canyon Ferry Reservoir, August 5, 1805, near Twin Bridges (Coues 1965) and August 10, 1805, near the town of Grant (Moulton 1988).

Because sage grouse and sagebrush communities are inseparable, further evidence of the presettlement occurrence of this shrub is found by the fact that the Lewis and Clark expedition members observed sage grouse along the Marias River north of the present site of Great Falls (Cutright 1969). Further, other presettlement explorers killed these birds along the Milk River in Montana (Coues 1874).

A. J. Noyes (1966), in his book regarding the early days in the Big Hole Valley of Montana, commented shortly after the Battle of the Big Hole in 1877 that the area "...had quite a lot of high sagebrush..."

Houston (1982) in his book "The Northern Yellowstone Elk" examined photos of Yellowstone National Park taken in the 1880s. He states that early photos clearly show that big sagebrush was present as a "..dominant overstory shrub..."

Gruell (1983) compared early (1870s) and present day photos of some areas in Montana. The present day photos indicated a variety of situations ranging from increased sagebrush density to a decrease or stability in other situations. While some would term the observed increase in shrub densities as an "invasion" of previously unoccupied sites, what may be occurring is the reestablishment of shrubs to formerly occupied sites that were altered due to a disturbance such as fire. The fact that big sagebrush was present in a number of the photos taken in the early 1870s is strong evidence that big sagebrush was a significant part of the landscape at the time of white man's settlement in Montana. Settlement got its significant beginnings in Montana in the 1860s, brought on by the mining camps of gold seekers (Spence 1978). From that early period to the present day sagebrush canopy coverage in the area near Bannack, Montana has remained similar. Big sagebrush cover on the flats south of the gold mining town of Bannack, is very similar today to what it was over 130 years ago (note photos).

1860's photo near Bannack, MT (Courtesy Bannack State Park Archieves, FWP)

1994 Photo near same site at Bannack, MT. (Photo by FWP)

Additional evidence that much of the present-day sagebrush distribution existed in presettlement days comes from photographs taken by the Hayden Expedition in the 1870s in Wyoming, Idaho and Utah. These were retaken in the 1980s and provide a picture of landscape change over a 100-year period (Johnson 1984). Some of Johnson's interpretations regarding those photos were:

> *There was no major shift in sagebrush distribution as a result of range use. The appearance of the landscape today is a fair indication of its appearance in presettlement times. From these examples of sagebrush stability, it is possible to conclude first that big sagebrush was an important plant dominant of late 19th century Rocky Mountain rangeland, second that the shrub represents a genuine climax for these sites, and third that the use and management of the past 115 years have not significantly altered that status.*

Johnson (1984) further stated:

> *There is no basis for assuming that much of the big sagebrush distribution is a disclimax or a seral stage toward grassland. The photos support those who assert overall stability in sagebrush rangeland.*

One of the examples given by Johnson reads as follows:

> *Granite Ridges on the Sweetwater (a protected cove off the Sweetwater River in central Wyoming) supported a vigorous dominant stand of big sagebrush in 1870. Today, big sagebrush remains dominant... Aside from the increase in size and density of the juniper trees in the rocks, this sandy, protected site retains, in every way, its appearance of 1870. Both the sagebrush dominance and the productive potential of Jackson's time [Hayden expedition] remain, indicating a high degree of site adaptation and ecological stability.*

In this last example, it is obvious that fire was not necessary to maintain the productivity of the site. The continued presence and increase in junipers indicated the lack of fire in over 120 years.

Sagebrush as a "Climax" Species

> *The final or stable community in a successional series is the climax community; it is self-perpetuating and in equilibrium with the physical habitat. Typically, in an ecosystem, community development begins with pioneer stages which are replaced by a series of more mature communities until a relatively stable community is evolved which is in equilibrium with the local conditions (Odum 1959).*

In the USDA Bulletin, "Climax Vegetation of Montana", Ross and Hunter (1976) listed big sagebrush as one of the species occupying thousands of acres of rangeland throughout many areas of Montana.

Mueggler and Stewart (1980), using methods similar to Daubenmire (1970) and also to Pfister et al. (1977), developed a classification system for western Montana rangelands. Sagebrush, and particularly big sagebrush, was an important climax component in several of their described habitat types. Many sites today containing sagebrush in western Montana can be classified as part of a sagebrush climax habitat series as described by Mueggler and Stewart (1980).

Sagebrush is a product of the range. Range ecologist Gus Hormay (1992) has stated, "The condition of the soil determines whether or not sagebrush can grow and persist on a site". Most plant ecologists would likely agree with the following statement by Ross et al. (1976): "soil and climate are two major factors that determine the kind and/or amount of climax vegetation." Big sagebrush is not a foreign invader, but instead, a naturally occurring native component on many western rangeland sites. Generally, where sagebrush is found, it occurs because it is well adapted to that particular site.

Some have contended that big sagebrush occurs primarily because of heavy livestock grazing. This position may have credence in areas where overgrazed ranges result in soil loss that favor sagebrush over other plant species. In such cases, it follows that the new site condition may include sagebrush as an important and perhaps dominant species. However, the fact that sagebrush historically had wide distribution certainly was not related to heavy use by domestic grazing. Sagebrush was present when the livestock industry established in Montana. The livestock industry, which initially followed in the wake of the miners, became big business in the 1870s and 80s when grazing on public lands was free (Spence 1978). In fact, it could be argued that in some situations heavy grazing might actually impede the expansion of sagebrush. A study assessing the effect of livestock grazing on sagebrush regeneration demonstrated a high trampling mortality of sagebrush seedlings (Owens et al. 1992). Some exclosures in Yellowstone National Park exhibit more sagebrush inside than out due to heavy ungulate grazing pressure.

Wild ungulate browsing has eliminated sagebrush from outside this exclosure in Yellowstone National Park near Gardiner, MT. (Photo by FWP)

Sagebrush is found in undisturbed areas as well as in locations grazed by livestock. Examples of such areas can be found in fenced cemeteries and other locations protected from domestic grazing (e.g. the Cliff Lake Natural Area where livestock grazing has not been permitted for over 40 years). This latter area, within the *Artemisia tridentata/ Festuca idahoensis* habitat type, contains "scattered, multi-aged populations of sagebrush [with] abundant understory of grasses and forbs" (Mueggler and Stewart 1980). This observation by Mueggler and Stewart of a productive understory illustrates that sagebrush communities **do not** occur as monocultures. Additionally, had sagebrush not occurred here in a multi-aged stand (indicating it was successfully reproducing), Mueggler and Stewart would not have been able to list that shrub as a climax dominant species.

Another indication that the occurrence of big sagebrush is related primarily to the soil, climate and topography of an area is demonstrated by areas where the shrub was once controlled, but has since returned despite the reduction of domestic grazing pressure. West et al. (1984) recorded that, despite 13 years of protection from grazing, sagebrush continued to reestablish following control in west-central Utah. Thirty years after a sagebrush burn in Idaho, Harniss and Murray (1973) found that the vegetation returned to essentially pre-burn conditions even **under good range management** (Figs. 1-3 in Appendix I).

Because big sagebrush is often a dominant component of stable climax communities, efforts to remove it will set back plant succession: "potential productivity of the environment is reflected by the climax vegetation" (Mueggler et al. 1980). Harniss et al. (1973), reporting on the study of a 30 year-old sagebrush burn in Idaho, stated:

> *Vegetation trends through 1966 show the overwhelmingly dominant role of big sagebrush on this sagebrush-grass range near Dubois, Idaho. Almost all important species of shrubs, grasses and forbs decreased in yield from 1948-66 as the big sagebrush recovered its dominance after the burn (Figs. 1-3 in Appendix I).*

While plant communities are dynamic, the degree and speed of change will depend on the successional stage in which they occur. Plant communities that have generally stabilized in a climax condition with the existing soil and climatic conditions might change, but only very slowly (Odum 1959). Some mature sagebrush communities that have not been altered have been shown to remain relatively stable and unchanged for over 120 years (Johnson 1984). In contrast, those in a subclimax condition (e.g. following sagebrush control) change much more rapidly back towards stability (Harniss and Murray 1973, Bartolome and Heady 1978, West et al. 1984). Hormay (1992) agreed with those recognizing the long-term stability of this shrub when he stated:

> *Sagebrush will yield to other plants higher on the successional scale only as the soil develops to a higher stage. This takes hundreds, if not thousands, of years....*

It is commonly held that competition from big sagebrush will depress production of herbaceous understory species. This observation is often derived from noting the increase in sagebrush and decrease in grasses that eventually occur as disturbed or manipulated habitats (i.e. following burning) make the transition to climax conditions. However, research has shown that in **mature** sagebrush communities, the presence of and even increase in big sage did not depress grass production. In Nevada, Robertson (1971) noted increases in all vegetation in an area rested from livestock grazing for 30 years. Sagebrush coverage increased 76% while grasses and forbs increased 60%. Anderson and Holte (1981) found that after 25 years of no livestock grazing in southeast Idaho, sagebrush canopy coverage increased 154%. During the same period, perennial grass cover increased from 0.3% to 5.8%. In southwestern Montana, Wambolt and Payne (1986) found increased coverage in both forbs and grasses during a 18-year study in a research plot where big sagebrush had not been controlled.

Healthy herbaceous understory co-inhabiting a site with big sagebrush. (Photo by FWP)

ALLELOPATHY

Definition: The suppression of growth of one plant species by another due to the release of toxic substances (Webster 1983).

Big sagebrush foliage contains chemical properties capable of producing allelopathic affects (Schlatterer et al. 1969; McCahon et al. 1973; Kelsey et al. 1978). The allelopathic affects observed under laboratory conditions include the retardation of plant growth and prevention of seedling germination.

While allelopathic properties of big sagebrush have been reported in laboratory situations, the effect of this phenomena **under natural field conditions** has not been demonstrated. Observations made by Hoffman et al. (1977) illustrate the problem of applying laboratory results to natural field situations. They reported: "not all examples of germination inhibition under laboratory conditions can be supported by correspondingly favorable observation in the field." They found the aqueous extracts of big sagebrush litter inhibited germination of such species as western wheatgrass (*Agropyron smithii*), pellitory (*Parietaria pennsylvanica*), spurge (*Euphorbia podperae*), rough pennyroyal (*Hedeoma hispida*), and yarrow (*Achillea millefolium*). Yet, they noted those same species are often abundant directly under or very near big sagebrush shrubs. In fact, well-developed grass and forb understories are commonly associated with big sagebrush stands on ranges that have proper grazing management practices.

Native grass species growing under the canopy of big sagebrush. (Photo by FWP)

Kelsey and Everett (1992) have conducted extensive research on the phenomena of allelopathy. They report that the importance of allelopathy in the ecology of sagebrush shrublands has not been demonstrated to date. They concluded that allelopathy "is probably not the single most important cause of changes in plant patterns, succession, productivity, or plant response to management."

Sagebrush and hydrology

It has been contended that elimination of deep rooted sagebrush plants will decrease transpiration and thereby allow more precipitation to reach groundwater. This, in turn, would increase stream flows. USDA Forest Service Hydrologist Alden Hibbert (1983) states:

> *"Potential for increasing water yield by type conversion of sagebrush is poor..." He further noted that "most sites are too dry to increase water yields in this way; probably less than one percent of the western rangelands can be managed for this purpose."*

Hibbert (1983) report noted that any stream flow increases would be small at best and would only occur where annual precipitation exceeded 16-18 inches. The annual precipitation reported for most of the rangeland east of the Continental Divide in Montana falls below these levels (Montana Climatological Data 1990).

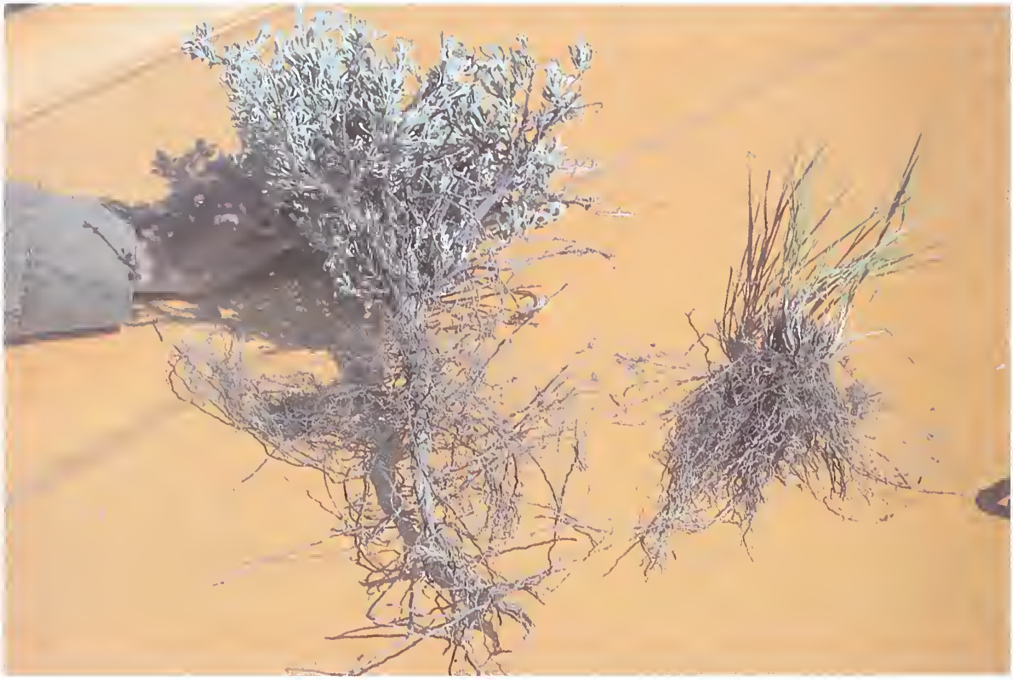
Under the right conditions (deep soils and adequate precipitation), small water yield increases maybe Possible. Sturges (1994) conducted a 23-year study on the effects of sagebrush removal (through spraying) in Wyoming and reported an approximate 20% increase (1.08 cm./ .43 inches) in total annual water yield. Only 35% of the increase came in the form of increased groundwater flow. Sturges felt that soils would need to be nearly a meter or more in depth for any increase to occur. Opposite results were obtained in Colorado (Lusby 1979) where sagebrush stands were converted to grasslands by plowing and seeding. In that project, a 20% decrease in water yield occurred on the treated sites. This latter site had less annual precipitation and a shallower soil profile than the Wyoming site.

Although some groundwater recharge may occur during periods of heavy spring rains, most recharge occurs during snowmelt in much of Montana (Brustkern 1990). Accumulated snow in sagebrush stands would be more likely to contribute to the water table than "open" areas with less buildup. Hutchinson (1965) reported the rate of snow accumulation in a sagebrush stand in Colorado, where the brush was above the snow level, was greater than in adjacent grass vegetation. Hutchinson (1965) observed that during snowmelt:

> *Depressions formed around individual sagebrush plants, while the snowpack between plants remained relatively unchanged. The trapping of snow in the depressions after spring snowfalls may be important in terms of water yields.*

In Colorado, Hutchinson (1965) observed that:

> *In April, an important difference in the snowpacks between cover types was observed. A continuous, thin ice sheet had developed in grass plots... In sagebrush, this feature was nonexistent... The hydrologic importance of the continuous ice sheets over soil in the grass-covered areas could be considerable. Since these sheets are impermeable, meltwater may not enter the soil beneath, but may run off over the ice as surface flow... Incomplete soil moisture recharge could result.*



Comparison of root structure between big sagebrush and grass showing both the diffuse and tap rooted nature of sage. (Photo by FWP)

Some researchers have reported reduced infiltration rates and increased runoff due to burning (Ahlgren et al. 1960; Salih et al. 1973; Brown et al. 1985). For example, in a study of burn effects on a Wyoming big sagebrush community, Brown et al. (1985)

found that infiltration rates were reduced, sediment concentrations doubled, and runoff increased the first year after treatment. The effects were even more pronounced the second year of the study. Such adverse hydrologic effects were attributed to water repellency induced at the surface by burning of the organic matter originating from sagebrush plants. Buckhouse (1985) noted:

> *with an increase in bare ground (after a burn) and the possibility of hydrophobic (lacking affinity for water) soils, infiltration rates decrease and the possibility of overland flows increases.*

The root system of big sagebrush is characterized by a deep tap root along with a shallow, diffuse root system. It has been demonstrated that a phenomena called "hydraulic lift" occurs with big sagebrush that will bring deep soil moisture to the upper surface layers (Richards and Caldwell 1987, Caldwell and Richards 1989). Caldwell and Richards (1989) observed:

> *...water absorbed by deep roots in moist soil moves through the roots, is released in the upper soil profile at night, and is stored there until it is reabsorbed by roots the following day.*

These Utah researchers showed that this moisture transported to the upper soil surface provides normally unavailable moisture for both the diffuse root system of sagebrush and neighboring plants. They noted this activity, which facilitates mineral nutrient uptake and microbial activity, is important in dry climates.

Contributions of Sagebrush to its community

As earlier mentioned, sagebrush has a significant diffuse root system near the surface of the ground as well as a tap root. These roots continually add to the soil organic material. Hormay (1970) stated:

> *Approximately one-third of the roots die each year... A large amount of organic matter gets into the soil each year this way.*

When most other plants (grasses and forbs) have ceased growing, sagebrush is still active. Daubenmire (1970) stated:

> *During this time (grass and forb growth cessation) Artemisia (sagebrush) is actively drawing water from the subsoil, photosynthesizing, and elaborating proteins and other compounds necessary to develop sizeable inflorescence with pollen and fruits. But for the activities of this plant, vegetation activity is virtually suspended, and all the extremely high energy supply of this season would be wasted. These plants (sagebrush) are therefore responsible for more than doubling the thickness of the soil profile that is actively involved in mineral cycling, and in creating litter and humus that is important in the cycling process as well as in soil moisture relations... Even though shrub elimination might tend to increase the depth of grass root penetration, the increase would represent only a small fraction of the volume formerly kept active by the shrub alone.*

Harniss et al. (1973) stated:

> *Apparently, sagebrush must also use soil, water and nutrients that are not utilized or are not available to these other species, because maximum vegetation yields result when sagebrush is present.*

Sagebrush forms a protective barrier against heavy trampling and impedes grazing by livestock, thereby protecting grasses growing around the base of these shrubs. Daubenmire (1970) stated:

> *The protection afforded many grass plants by dense clumps of shrubs is the sole reason why any perennial grass remains in much of the depleted range.*

Canopy of big sagebrush protecting grass from grazing pressure. (Photo by FWP)

Caldwell and Richards (1987 and 1989) as previously noted, reported the capability of big sagebrush roots to recycle deep soil moisture to the upper soil profile where it becomes available for use.

Manipulation of sagebrush habitat types

Vegetative consequences of burning sagebrush

Controlled sagebrush burn. (Photo by FWP)

Total vegetative (including sagebrush and/or other woody species) production is greatest in untreated habitats (Harniss and Murray 1973; McNeal 1984). Mueggler and Blaisdell (1958) compared sagebrush control techniques involving burning, rotobeating, spraying and railing. They found that regardless of treatment, total vegetative production three years after treatment was still considerably less than on untreated areas.

Effect on Sagebrush

While the degree of grass and forb production following manipulation is variable depending on a variety of factors including the type of burn, time of year, and the species involved, the consequences of burning to big sagebrush are predictably negative. Burned sites were compared with adjacent unburned sites near Gardiner, Montana, illustrating the reduction of big sagebrush and total vegetative production (see Table 1) (McNeal 1984).

Table 1. Production comparison of two burned sites with environmentally paired unburned sites in 1980 (McNeal 1984).

	Production (kg/ha)			
Location	Grass	Forb	Shrub	Total
Spring 1980 burn site	387	479	17	883
Unburned site	511	191*	227*	929
Summer 1974 burn site	851	175	38	1064
Unburned site	823	143	634*	1600*

*P<0.05

The cover value of big sagebrush will be lost for a number of years following a fire. (Photo by FWP)

Most research indicates that fire will eliminate sagebrush for at least several years. Wyoming big sage was reported to have an exceptionally long recovery period, while mountain big sage has a tendency to recover more quickly. One researcher reported mountain sagebrush seed germination is actually stimulated by fire (Hironaka et al. 1983). However, because big sagebrush reproduces by seed and not by sprouting, recovery can be very prolonged on many sites. In most cases, big sagebrush eventually returns. Hormay (1992) stated:

> *Efforts to control sagebrush by cultural means, such as spraying, burning, chaining and discing are doomed to failure. Millions of acres have been treated by these means throughout the West. Reductions in stands have been achieved but were short lived. The stands reestablished in a relatively few years because of soil condition.*

In some situations as found in southwest Montana, sage recovery has been delayed and/or eliminated when the shrub was replaced by rabbitbrush *(Chrysothamnus spp.)* and horsebrush *(Tetradymia canescens),* species which sprout following fire (Hammond 1995).

Effect on Herbaceous Vegetation - General

Although some studies have shown sagebrush removal to result in an overall increase in total herbaceous production for a number of years following treatment, this effect will not be permanent (Fig. 1 in Appendix I). Thilenius and Brown (1974) found that increased herbage production following spraying lasted only ten years. Johnson (1969) found that on a grazed Wyoming big sagebrush range, benefits of spraying sagebrush began to decrease within five years after spraying, and within 14 years there was no production advantage. Fraas et al. (1992) found total herbaceous canopy cover **did not** differ between burned and unburned sites in an area near Butte, Montana, eight years after initial treatment.

Effect on Grasses

Grass production increases that may occur following burning may not always be related simply to the removal of sagebrush. Daubenmire (1970) stated:

> *Where fire is used to eliminate Artemisia, the stimulation (in grass production) can be attributed to the fire itself, for a protracted increase in production can be observed following steppe fires outside the range of this shrub.*

Uresk et al. (1976, 1980), studying effects of a wildfire on **grassland without sagebrush** in Washington, found that burning increased production of bluebunch wheatgrass by 24% compared with unburned treatments.

When there are initial increases in grass production following a disturbance such as fire, those gains are typically followed by subsequent declines. These declines in grass production are a natural transition of the plant community back again toward climax conditions. Thilenius and Brown (1974) reported in their study:

> *Declines in production and in the proportion of graminoids in the herbage did not appear to be related to re-invasion of sagebrush as this re-invasion was minimal on all three sites even after 10 to 11 years.*

They found that total average grass production for all sites ranged from 458 pounds per acre before treatment to 1263 pounds per acre three years later. Grass production then declined to an average of 361 pounds per acre by 11 years post-burn. This decline occurred despite minimal re-invasion by sagebrush (big sagebrush canopy coverage changed from 18% pretreatment to 3% 11 years post-treatment).

Although some species of grasses may show an increase after burning, others can be harmed. This difference is demonstrated when reviewing the effects of an eight year-old controlled burn on a sagebrush/bitterbrush grassland near Butte, Montana (Fraas et al. 1992). In this instance, the **total** canopy coverage of grasses declined from pre-burn conditions, while individual species exhibited the following responses: bluebunch wheatgrass was unchanged, Kentucky bluegrass (*Poa pratensis*) increased, and Idaho fescue (*Festuca idahoensis*) declined. In another study, forbs and bluebunch wheatgrass increased near Gardiner, Montana, while Idaho fescue and prairie junegrass (*Koeleria macrantha*) decreased following a wild fire and a controlled burn in sagebrush habitat (McNeal 1984).

It is not uncommon for most grasses to react negatively the first year following a burn (Figs. 1 & 2 in Appendix I). Increases in grasses may not appear for a year or more after a burn, if at all. Jorgensen (unpubl. rep. 1990) compared the results of over 30 research studies[2] on the effects of fire on vegetation. The most common effect on Idaho fescue was negative (particularly with fall burns). The **initial** reaction (generally a year following the burn) of Idaho fescue to burning was negative in 13 cases as **foot noted** (1, 2, 4, 5, 10, 11, 13-15, 18, 19, 22, 31), neutral in three (15, 23, 25), none were positive. The effect on Idaho fescue several years after the burn was still negative in 12 (1, 2, 4, 5, 10, 11, 13, 15, 18, 19, 22, 28) of those cases and neutral in four (48, 51, 52, 70). Due to the negative reaction of Idaho fescue to burning, Hironaka et al. (1983) expressed concern

[2](1) Pickford 1932, (2) Blaisdell 1953, (3) Pechanec et al. 1954, (4) Moomaw 1957, (5) Mueggler et al. 1958, (6) Tesdale 1959, (7) Dix 1960, (8) Robocker et al. 1965, (9) Wright et al. 1965, (10) Conrad et al. 1966, (11) Harniss et al. 1973, (12) Daubenmire 1975, (13) Ralphs et al. 1975, (14) Beardall et al. 1976, (15) McGee 1976, (16) Smolik et al. 1976, (17) Uresk et al. 1976. (18) Nimir et al. 1978, (19) Young et al. 1978, (20) Peek et al. 1979, (21) Ralphs et al. 1979, (22) Britton et al. 1981, (23) Blaisdell et al. 1982, (24) Kuntz 1982, (25)Britton et al. 1983, (26) Johnson 1983, (27) Hobbs et al. 1984, (28) Mangan et al. 1985, (29) Raper et al. 1985, (30) Zschaechner 1985, (31) Patton et al. 1988.

that repeated burns of mountain sage/Idaho fescue habitats could lead to the opposite effect of the desired result and lead to a reduction or elimination of the grass species, giving a greater competitive edge to sagebrush.

The observed effects of fire on bluebunch wheatgrass were variable. The initial reactions of bluebunch in the studies reported by Jorgensen (1990)[2] were negative in ten cases (2, 4, 5, 10, 12, 17, 19, 22, 26, 30), neutral in two (24, 28), and positive in one (17). Several years after the initial burns, three studies (11, 12, 19) demonstrated continued negative affects on bluebunch, four (2, 10, 24, 28) showed neutral effects and four (2, 4, 17, 31) reported positive results. In comparing the above **numbered** references for both bluebunch and Idaho fescue, some report two different findings that resulted from the same study using two different parameter measurements such as biomass vs basal area or fall vs spring, etc.

The effect of burning on other grasses is also explored in the above studies reported by Jorgensen (1990). An example of differential species response is demonstrated in Appendix I, Figures 1 and 2.

These studies make a **very strong** point that range managers need to proceed with caution when considering sagebrush burning as a management tool to increase forage production. Blaisdell et al. (1982) in the USDA report "Managing Intermountain Rangelands," commented that:

> *It is true that forage production on a fairly recent burn might surpass that on a similar area in climax condition because of replacement of sagebrush by perennial grasses and forbs. However, ranges that are* ***naturally*** *sagebrush grass climax cannot be entirely freed of sagebrush (by burning) for an indefinite period. Repeated burning, especially at close intervals, to maintain such a subclimax stage would probably result in eventual impoverishment of the soil and loss of desirable species.*

Effect on Forbs

In the studies reviewed by Jorgensen (1990), he reported that fire effects on forb density are variable; when total forb cover does increase following burns, those gains are generally shorter lived than those of grasses (Fig. 1 in Appendix I). Some forbs may flourish following a fire. These species likely existed at some lower density in the understory of the original sage community. Biodini et al. (1989) concluded "fire alone is not a large enough disturbance to cause drastic changes in forb composition of northern mixed prairies." Duvall and Linnartz (1967) found essentially no change in vegetational composition as a result of fires.

Changes in nutrient content of vegetation

Normally, nutrients contained in vegetation are released slowly by decomposition of the plant litter. However, burning immediately releases these stored nutrients in the form of volatiles or ash. Nitrogen and sulfur are at least partially volatilized by combustion and may be lost from the system (Mueggler 1976). Tiedemann et al. (1978) noted that the combustion losses resulting from a fire in a Douglas-fir forest for nitrogen, calcium, magnesium, potassium, and sodium were 38, 11, 15, 35, and 83% respectively (Grier 1975). Other nutrients such as phosphorus, potassium, calcium, and magnesium are changed to water-soluble salts, which are immediately available for plant growth (Mueggler 1976). After reviewing the literature regarding the effects of burning, Ahlgren et al. (1960) reports ".....since productivity depends on gradual mineralization and utilization of fallen litter, it would not be reasonable to expect continued and repeated burning to improve soil fertility...."

Burning may result in a short-term increase in grass nutrient levels. Hobbs and Spowart (1984) demonstrated slight but significantly increased crude protein in grasses and forbs due to burning. Van Dyke (1988) in south-central Montana reported a two year increase in protein levels in grasses following burning on a sagebrush-grassland elk winter range. Jourdonnais (1985) found crude protein increases following burning were similar to those recorded after cattle grazing on the Sun River elk winter range. In Jourdonnais' study, the resulting increases in crude protein levels from the burn and grazing treatments were **negated by fall** when the plants became desiccated. In Texas, Lay (1957) found that "burning increased protein content as much as 42.8% and phosphoric acid content as much as 77.8% in the species involved, but most of the benefits disappeared within a year or two."

In their literature review, Ahlgren et al. (1960) noted that while various studies examining the affect of fires on soil nutrition have had contradictory results, they state: "Reports of lower nitrogen content following burning are frequent."

The aftermath of some fires has caused serious soil erosion which can add significantly to loss of nutrients (Helvey et al. 1985). Tiedemann et al. (1978) reported significant solution losses of the various soil nutrients following a burn and concluded ..."the losses may be sufficient to restrict development of vegetation." A soil chemist (Dormaar 1992), warned that even the practice of grain stubble burning can have detrimental effects:

> *Burning exacerbates the whole process of organic matter loss from the soil due to wind erosion. Moreover, substances which are released during decomposition of straw help maintain a desirable soil structure.*

There has been contention that older sagebrush plants contain less nutritional value than younger ones. However no differences were found in levels of protein between young and old sagebrush plants collected on the same sites in southwestern Montana (Table 2).

Table 2. Crude protein content of big sagebrush in young vs mature plants, in and outside of burned areas in southwest Montana, 1991.

Coll. date	Site	Location	B.Sage ssp.	Age	Protein %	Comment
11/90	1	Robb Cr.WMA	*vaseyana*	15	9.01	Unaltered range
"	1	"	"	2	9.64	"
"	2	"	"	25	8.86	"
"	2	"	"	4	9.79	"
"	3	"	"	20	9.56	"
"	3	"	"	5	8.30	"
12/91	5	Virginia	*vaseyana*	3	8.89	Inside burn
"	5	City Hill	"	4	8.44	"
"	5	"	"	6	8.12	"
"	5	"	"	18	8.59	Outside burn
"	5	"	"	21	9.24	"

Sagebrush samples were mountain big sage (Artemisia tridentata ssp. vaseyana). Dry matter protein analysis was done by the Nutrition Center, Montana State University, Bozeman, Montana. The sagebrush burn on site 5 occurred sometime during the 1980s. Collection by Joel Peterson and Mike Frisina, FWP.

The aftermath of a fire can leave soil exposed to wind and water erosion. (Photo by FWP)

Sagebrush Control and Wildlife

Wildlife professionals for a long time have been concerned about the effects of sagebrush manipulation on wildlife (Quimby 1966). The literature provides documentation of the reduction in sage grouse resulting from the eradication or significant alteration of big sagebrush habitats (Higby 1969, Martin 1970, Peterson 1970, Pyrah 1972). Many of the studies looked at the results of chemical spraying or plowing (conversion to crop land).

Sagebrush grassland converted to cropland near White Sulphur Springs, Montana where a 50% reduction in big sagebrush resulted in a dramatic decline in sage grouse numbers (Peterson 1970). (Photo by Joel Peterson)

Klebenow (1972), suggested that fire could be an ideal tool to achieve a diverse habitat providing for all the needs of sage grouse. There has been ongoing research in Idaho evaluating the effects of fire on wildlife species such as sage grouse (Gates 1983; Moritz 1988; Sime 1991; Fischer et al. 1994; Connelly et al. 1994). Researchers found that sage grouse and antelope made use of burn sites to various degrees; however, there was no evidence that the treatment resulted in a greater yearlong habitat carrying capacity for those species. Initial results of pre- and post-burn studies in the area of the Idaho National Engineering Laboratory site have not indicated any improvement in brood rearing areas (Connelly 1991). Investigations by Fisher et al. (1994) of sage grouse ecology for 4 years after a 5,800 ha fire in Idaho which compared burned and unburned habitats found that "Fire appeared to negatively impact insect abundance . . . important in sage grouse diets." They discovered that although a mosaic of burned and unburned sage was created by the burn, "there was no positive response of sage grouse to the burned area." Connelly et al. (1994) studying the effects of prescribed burning in southeastern Idaho from 1986-94 (area burned in 1989) found a greater decline in active sage grouse leks in the burned treatment than in the unburned (58% vs 35%). Similarly, the decline in overall grouse attendance at leks was greater in the burn area than in the control (66% vs 40%). Overall grouse declines in the entire study area were considered a result of the drought.

Other studies have shown big game species, such as elk, are attracted to burned areas (Jourdonnais 1985, Van Dyke et al. 1988). Jourdonnais (1985) found the affinity of elk to burned areas was similar to the response they exhibited toward pastures previously grazed by livestock. He believed this attraction on winter range was largely due to the removal of old standing litter because protein levels in the grasses in all three situations (burn, unburned and grazed) were similar during most of the elk foraging period.

Although some nongame species such as meadowlark (*Sturnella neglecta*) and horned larks (*Eremophila alpestris*) might benefit from more open grassland habitat generated by sagebrush removal, other species like the sage thrasher (*Oreoscoptes montanus*) and Brewer's sparrow are more likely to be harmed. For example, there was a "significant" reduction in nesting pairs of the Brewer's sparrow following a total kill (spray) of sagebrush near Winnett, Montana (Best 1970). Brewer's sparrows nest in the foliage of sagebrush plants. Similar results occurred in a Wyoming study (Schroeder et al. 1975). Walcheck (1970) reported total declines in breeding bird populations in sprayed sagebrush for Brewer's and vesper (*Pooccetes gramineus*) sparrows. In a Washington Study of bird distribution in the shrub steppe community, the following conclusion was made:

> *". . . of the 17 species shown for which comparisons were made, seven had a positive relationship with the cover of big sagebrush, two were inversely related, and eight were not related. Therefore, more shrub-steppe species would benefit by preservation of big sagebrush than by any other policy indicated by these data." (Dobler 1994).*

A previously sprayed site provides no cover or forage values for wildlife during winter months. (Photo by FWP)

Bird species that were related positively to sagebrush cover were the sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), Brewer's sparrow, loggerhead shrike (*Lanius ludovicianus*), brown-headed cowbird (*Molothrus ater*), and mourning dove (*Zenaida macroura*). The two that were inversely related were the savannah sparrow (*Passerculus sandwichensis*) and long-billed curlew (*Numenius americanus*). The other eight showed no relationship, positive or negative. Due to specialized habitat features selected by pygmy rabbits (Green 1980a; Green 1980b; Campbell 1982; Weiss 1984; Lyman 1991), control or eradication of tall dense sagebrush could be very detrimental.

The overall effects of removing sagebrush will obviously vary depending on which wildlife species are involved. However, the habitat with greater structural and plant species diversity logically would tend to support a greater variety of wildlife than one less diverse (i.e. sagebrush-grassland over grassland)

Improvement of wildlife habitat is often cited as one of the goals for prescribed sagebrush burns. A controlled burn by the Forest Service that took place near Butte, Montana is an example (USDA 1981). In that situation, the existing 20% canopy coverage of mountain big sagebrush and bitterbrush was considered too dense and, therefore, undesirable by the agency. Consequently, the burn was conducted to "kill sagebrush and enhance grass and forb production for livestock and wildlife."

Controlled burns are not always beneficial for wildlife. In 1979 the U.S. Forest Service implemented a program of controlled sagebrush burns in the Gardiner, Montana, area to promote increased forage production for wintering ungulates (McNeal 1984). McNeal reported: "..... it appears that there may be no potential benefit to animals from increased herbage production in burn sites on the study area." That conclusion was based on two findings: (1) sagebrush, an important big game winter food, was nearly eliminated (Table 1), and (2) even while the amounts of some grasses and forbs increased, they became desiccated by winter and had low protein values compared to sagebrush. He also found that Idaho fescue, an important forage for elk, was reduced on the burn sites.

A "controlled" burn on Forest Service land in SW Montana that left no vegetative mosaic over a large area. (Photo by FWP)

Control of sagebrush may lead to replacement by less desirable shrubs for forage and cover needs. Following a burn in Idaho, both horsebrush and rabbitbrush sprouted quickly after the fire, while sagebrush took years to reestablish (Harness and Murray, 1973-Fig. 3 in Appendix I). Another example is found in the Snowline area of southwestern Montana where controlled burning has resulted in the reduction and or elimination of big sagebrush in a significant number of sites that are now dominated by rabbitbrush and horsebrush (Hammond 1995). Cheatgrass (*Bromus tectorum*) has replaced desirable plant species in a number of areas following fire (McArthur et al. 1989).

The Need For Sagebrush Control?

In recent years, the use of fire to remove or alter sagebrush stands has become a common practice. FWP is concerned that some of the potential consequences of this practice are frequently overlooked. Some consequences have been pointed out by a number of plant ecologists. Hormay (1992) commented in a letter to FWP that:

> *"Cultural control of sagebrush can hardly be justified on any basis. The threat of further soil and site degradation is ever present with the use of these measures because of removal of cover.....sagebrush is here to stay for a long time on most sites it now occupies. It is a valuable component of the plant cover and ecosystem providing livestock, wildlife, recreation, watershed and other renewable resource values."*

Blaisdell et al. (1982) noted:

> *Ranges that are naturally sagebrush-grass climax cannot be entirely freed of sagebrush for an indefinite period. Repeated burning, especially at close intervals, to maintain such a subclimax stage would probably result in eventual impoverishment of the soil and loss of desirable species.*

Daubenmire (1970) was notably concerned over the practice of sagebrush eradication:

> *Simplification of shrub-steppe vegetation by removing a major component (big sagebrush) that contributes a distinctive life form and phenology, and is necessary for other species to remain in the community, cannot fail to have significant consequences.*

Harniss and Murray (1973) commented:

> *Haphazard burning and improper grazing practices after burning have resulted in serious deterioration of vegetation and soil.*

Wildfires were reported as a fact of life on the presettlement landscape (Gruell 1983). However, the frequency of fires in forested areas may have been greater than in associated rangelands of the intermountain shrub type where sagebrush dominates. Fire frequency in the sagebrush plains of the Snake River prior to the "cheatgrass invasion" was 60-110 years (Whisenant 1989). In a study of vegetative succession in northeastern Yellowstone National Park, Patton (1969) noted that fire history was found only in forested areas and not in the sagebrush type. In studying the effects of a controlled burn on Wyoming big sagebrush in southwestern Montana, Watts and Wambolt, (1995) found that brush canopy cover after 30 years in the burned plots had reestablished at levels below those that originally occurred on the site. Their modeling of projected sagebrush recovery indicated pre-burn canopy cover would likely never be reached. The study points out that any wildfires in the area had to have been very infrequent in order for the current level of canopy cover in the untreated sagebrush to be sustained.

FWP endorses and has taken part in site specific projects that manipulate vegetation to improve wildlife habitat. The agency is not opposed to the use of burning to improve wildlife habitat if the potential for improvement has been properly identified and documented. FWP does not support the assertion by some that fire is necessary to create habitat diversity that they feel is lacking in many, if not most, mature sagebrush stands. Well managed sagebrush-grasslands inherently contain vegetative diversity.

Odum (1971), discussing plant succession in his textbook **Fundamentals of Ecology,** states "...diversity (species) tends to be high in older communities and low in newly established ones."

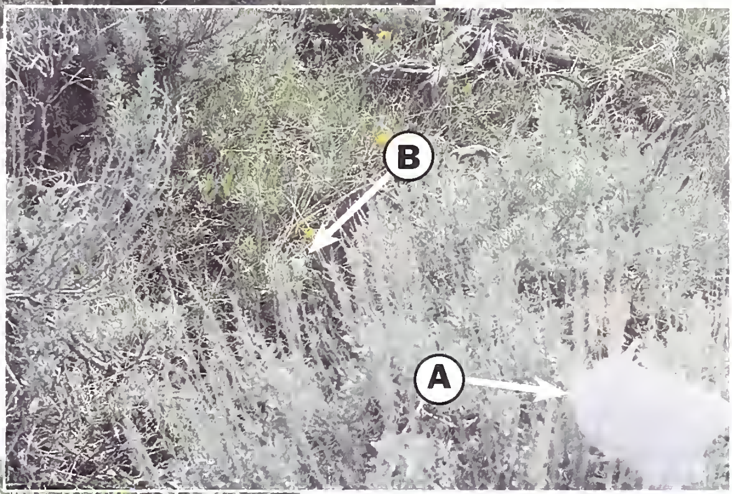
FWP and Bureau of Reclamation crew burning residual vegetation along a reservoir to create a feeding area for brood rearing geese. (Photo by FWP)

The logic that we must makeup for the lack of wildfires by using controlled burns to maintain vegetative landscapes in optimum and diverse conditions overlooks the fact that diversity often already exists. Grasslands do not automatically become continuous thick stands of big sagebrush if man does not intervene. As McArthur (1994) notes:

> *"Sagebrush taxa are distributed in patterns generally controlled by moisture-elevation gradients, seasonal moisture, and soil properties."*

Mature sagebrush communities generally contain a diversity of age classes interspersed with understory vegetation that is more dense on well managed ranges. In other words, the type of livestock management coupled with the soil type and climate will have more to do with the degree of understory in sagebrush stands than the density of the stand. No evidence exists to support the "need" to manipulate a sagebrush stand to maintain it in a healthy condition over time. Sagebrush communities have been shown to survive and maintain their productivity for extended periods (Lommasson 1948). According to Johnson (1984), this period exceeded 120 years. This is expected of any climax dominant like big sagebrush.

A mature sagebrush community on the Virgina City hill near Ennis, MT containing a diversity of vegetative species and age classes. (Photo by Joel Peterson)



Close-up of above photo using A as a reference point, showing diverse understory. (Photo by Joel Peterson)

Close-up of middle photo using B as a reference point, showing sage seedlings (C), forbs and grasses. (Photo by Joel Peterson)

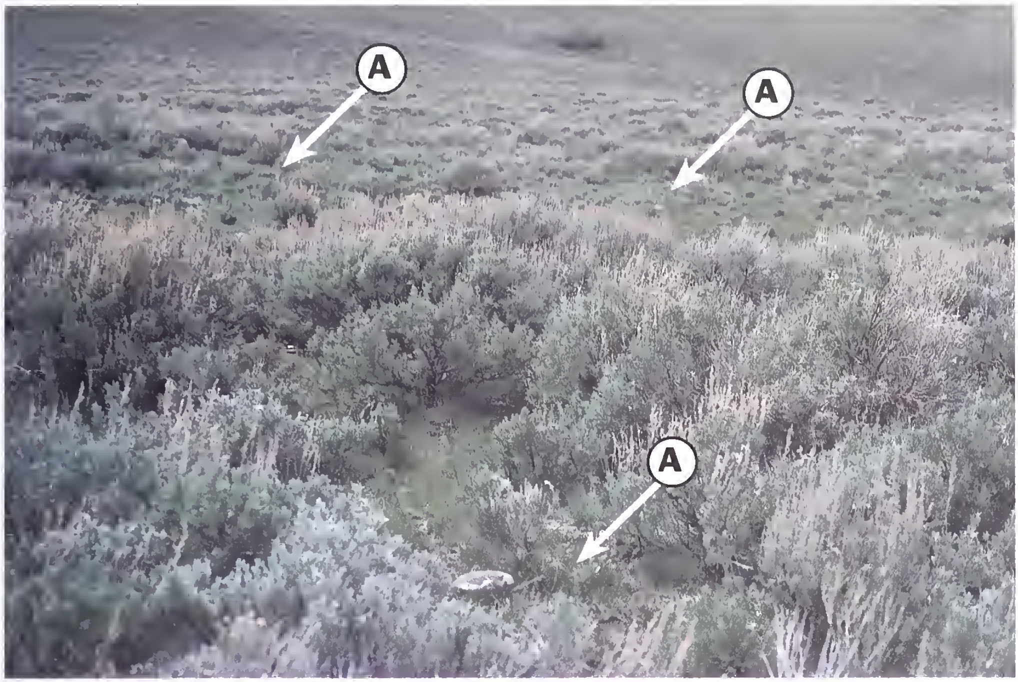
In addition to the diversity that exists in sagebrush stands themselves, most broad landscapes include a variety of timber, grasslands, riparian areas, aspen, etc. These are all part of habitat diversity.

Landscape diversity of the Snowcrest Range near Dillon, MT. (Photo by FWP)

Even though sagebrush has been reported to live over 200 years (Ferguson 1964), like any living thing, it also will eventually succumb to old age, disease or other mortality factors. However, in climax communities, this phenomena generally results in replacement by younger sagebrush plants. A revealing study documenting natural sagebrush turnover and replacement was conducted by the Forest Service in the Gravelly mountain range of the Beaverhead Forest in Montana from 1915 through 1945 (Lommasson 1948). Plant ages and plant density were measured in a stand of sagebrush over a 31-year period. An important conclusion in the study was that:

> *Common sagebrush (Artemisia tridentata), on the high grasslands of the Gravelly Range of the Beaverhead National Forest in southwestern Montana, apparently will maintain itself indefinitely under natural conditions... Unless the habitat is disturbed unduly, sagebrush on sites favorable for growth probably will continue to reproduce itself indefinitely.*

The Gravelly study demonstrated natural plant mortality creates interspaces in the sagebrush stand that provides areas for new seedling establishment. The study further demonstrated that over time, sites favorable for sagebrush growth will eventually be made up of a stand of brush that is **multi-aged**.



Multi-aged sagebrush stand on the Robb-Ledford Wildlife Management Area near Alder, MT. "A" shows young sage. (Photos by FWP)

Miscellaneous Big Sagebrush Mortality Agents

Big sagebrush density is not regulated solely by fire or old age. Other natural factors affect sagebrush densities.

Big Sagebrush near Specimen Creek in Yellowstone National Park that died from natural, non-fire related causes. (Photo by Joel Peterson)

Other biological and physical MORTALITY AGENTS for big sagebrush that have been identified in the literature include:

Rodents:

In Utah, Frischknecht et al. (1972) reported that voles girdled the bark of big sagebrush, and had killed or damaged this shrub over large areas.

Moths:

Gates (1964) noted leaf defoliation of sagebrush by the Aroga moth (*Aroga websteri*).

Beetles:

Pringle (1960) reported that leaf beetles (*Trirhabde pilosa*) can cause significant mortality to sagebrush stands.

Snow Mold

Sturges et al. (1984) reported that snow mold induced by a fungus reduces the canopy area of sagebrush and is capable of killing the plants.

Excessive Moisture:

Sturges (1986 & 1989) reported sagebrush was killed by prolonged snow cover in drifted areas due to extended periods of soil saturation.

Animal Browsing:

McArthur et al. (1988) reported mountain big sagebrush experienced mortality and partial dieback in Utah due to winter browsing by mule deer.

Wambolt (in press) found similar mortality from mule deer and elk use of four sagebrush taxa on the northern Yellowstone winter range.

Exclosure established in 1951 by Colorado Division of Wildlife on a Wildlife Management Area winter range showing reduction of sagebrush due to mule deer browsing. (Photo by Mike Frisina)

Some individuals advocate sagebrush manipulation because they believe the presence of the shrub indicates poor range condition. Removing sagebrush **will not** enhance the soil condition. Good vegetative cover, **whatever** the species, will improve soil conditions over time by providing protective ground cover, holding soil, and building soil through root decay. As noted earlier, the highest vegetative production is on **untreated** habitats. When general guidelines were developed by Pechanec and Stewart (1949) in southern Idaho to assess condition and trend in rangelands, they noted that sagebrush habitats with a good understory of perennial grasses and forbs "have likely not been greatly changed from their original condition, and forage production is not far below the potential." They observed sagebrush habitats can exist in a vegetative condition class of **good or excellent**. This observation is held by Bartolome and Heady (1978) who reported in a research paper on sagebrush control in Oregon that they:

> *". . . reject the negative correlation between sagebrush density and gross production on well-managed ranges."*

Often poor range conditions are blamed on the presence of certain plant species instead of on the real culprit—poor range management practices. Ecologist Allen Savory (1989) appears to agree with this assessment when he made the following comment:

> *"No plant, noxious weed or any other, can ever cause soil erosion. . . . Ranch management practices cause plant communities to change, soil to erode."*

Sagebrush is a Product of the Range, Range Condition is not a Product of Sagebrush

Two big sagebrush sites with similar brush canopy cover. The profoundly different ground cover is not related to sagebrush density. (Photo by FWP)

Summary

Sagebrush Importance for Wildlife

Sagebrush and sagebrush-grassland habitats provide important food and cover values for wildlife.

Sagebrush historical occurrence

Big sagebrush was common on western rangelands prior to man's settlement.

Early explorers documented the occurrence of sagebrush in Montana during pre- and early settlement periods.

Photographic evidence indicates stability at many sagebrush sites in the west from presettlement days to present.

Range fires periodically occurred in the presettlement West. However, sagebrush communities have been found to maintain their productivity without the influence of fire.

Sagebrush is a "climax" species

Sagebrush has been classified as a climax dominant on much of Montana rangelands.

Accordingly the species is successfully reproducing and sustaining itself on many, if not most, sites where it occurs.

Grass and forbs exist with sagebrush in a multi-storied plant community. On properly managed rangelands, grasses can increase under mature sagebrush canopies.

Allelopathy

This phenomena has not been exhibited by big sagebrush under natural conditions.

Hydrology

The removal of sagebrush will rarely have any positive affect on increasing water yield. Shallow soils and/or low precipitation on most Montana rangelands preempt this potential. Even under the best of conditions, water yields increases would be low.

Sagebrush stands often accumulate a greater snowpack than grasslands, increasing the potential to improve the water table. Ground water is replenished primarily by snowmelt.

Burning creates the potential for reduced infiltration rates (hydrophobic soils) and can increase soil and nutrient loss through accelerated erosion.

Deep moisture is moved to near the soil surface by big sage tap roots where it can be utilized by other plants through "hydraulic lift".

Contribution of sagebrush to the community

Sagebrush physically protects understory plants, holds soil and provides vertical structure which adds diversity to the plant community.

Sagebrush provides for snow retention which potentially benefits the water table.

Sagebrush roots help build both the shallow and deep soil profile.

Sagebrush roots bring deep moisture to the soil surface where it becomes available for all adjacent vegetation (hydraulic lift).

Consequences of burning to sagebrush

Burning can eliminate sagebrush from a site for a variable period of years.

Consequences of burning to herbaceous plants

May result in a temporary increase in **total herbaceous** vegetation for several years although **total plant production** will decrease.

Commonly grasses are negatively affected the first year.

Some grass species, such as Idaho fescue, are often negatively affected by burning, both short and long term.

Some grass species such as bluebunch wheatgrass may increase several years following a burn (results are variable).

Grasses reacting positively to burning under most conditions will eventually return to near pretreatment abundance.

Some forb species may flourish for a period following a burn. Any increase may last only a few years.

Nutrition

Burning immediately releases stored nutrients in the form of volatiles or ash.

Nutrient level increases in grasses following a burn are short lived (one-two years).

Nutrient level increases in grasses are not realized during the fall and winter.

Productivity may decline on some sites due to transport of nutrients in solution. Repeated burning is especially harmful.

Burning creates the potential for soil erosion which can result in nutritional loss to the system.

Nutrient level increases in grasses are similar to those reported following livestock grazing.

Mature sagebrush plants have similar protein levels to young ones.

Sagebrush control and wildlife

While some wildlife species may benefit from sagebrush control a greater number can be negatively affected due to loss of vegetative and structural diversity.

Adverse affects of sagebrush control to certain wildlife such as Brewer's sparrows, sage grouse and other species have been documented.

The need for sagebrush control

The necessity and desirability of controlling big sagebrush has been strongly questioned from an ecological standpoint by renowned plant ecologists like G. Hormay and R. Daubenmire.

Removal of big sagebrush can decrease the soil building capability of an area (particularly the deep soil profile).

Controlled sagebrush burns do not automatically equate to improved wildlife habitat.

Well managed sagebrush communities are in as high an ecological condition as are similarly managed grasslands.

Sagebrush stands are an important facet of diverse habitat landscapes that can include grasslands, riparian areas, timber stands, etc.

Fire is only one of a variety of agents that will naturally regulate sagebrush and sagebrush density. Others include insects, disease, old age, herbivory (browsing) pressure, excessive moisture and rodents.

Conclusion

FWP recognizes sagebrush-grassland habitat as very important for wildlife. Big sagebrush also provides benefits to the ecosystem such as: soil building through normal root decay, soil holding capabilities, protection of understory vegetation, snow holding capability and recycling of deep soil moisture and nutrients. While wildfires have historically occurred on the landscape, these natural events can have destructive as well as beneficial results. Fire is not required to maintain the sagebrush grassland habitat. Efforts to manipulate this habitat through total or partial control of sagebrush has the potential of negatively impacting the soil and vegetative resource and reducing habitat diversity by eliminating shrub structure and function.

Removing sagebrush in an effort to improve forage for livestock does not **automatically** equate to benefits for wildlife. However, FWP recognizes situations may occur where there is potential for improving wildlife habitat for a particular species through sagebrush manipulation. These special projects must be carefully planned with clear objectives coupled with an effective monitoring program. It needs to be understood that even in cases where altering sagebrush habitats might benefit a particular animal species, overall negative impacts on other species, as well as on the soil and vegetative resource may occur.

FWP endorses the wise and proper management of our "natural" rangeland resource. However, FWP believes proper maintenance, management and improvement of rangelands in most cases does not necessitate the removal of sagebrush.

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APPENDIX I

Figures 1-3: Published in Journal of Range Management 26(5) Sept. 73. "30 Years of Vegetal Change following Burning of Sagebrush—Grass Range" by R. O. Harniss and R. B. Murray.

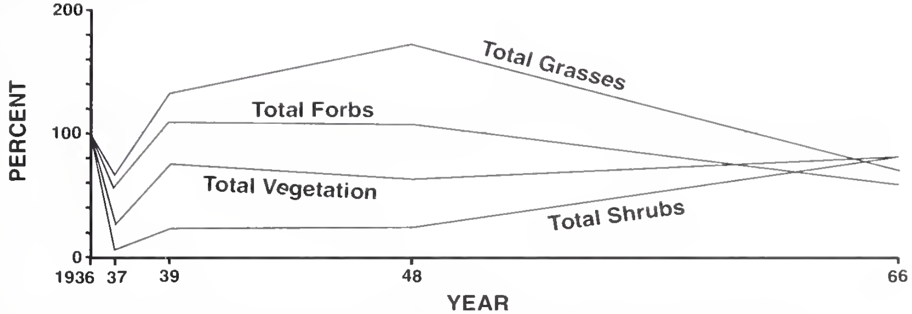

Figure 1. *Trends of species classes on a planned burn near Dubois, ID, 1936-1966. Values on burned plots are adjusted for the natural variation between years.*

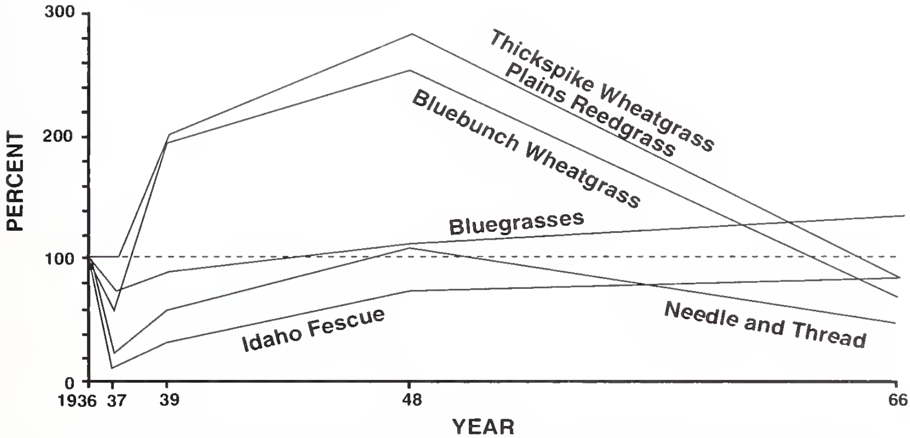

Figure 2. *Trend of important grass species on a planned burn area near Dubois, ID, 1936-1966. Values are adjusted for the natural variation (a) between burned and unburned plots and (b) between years.*

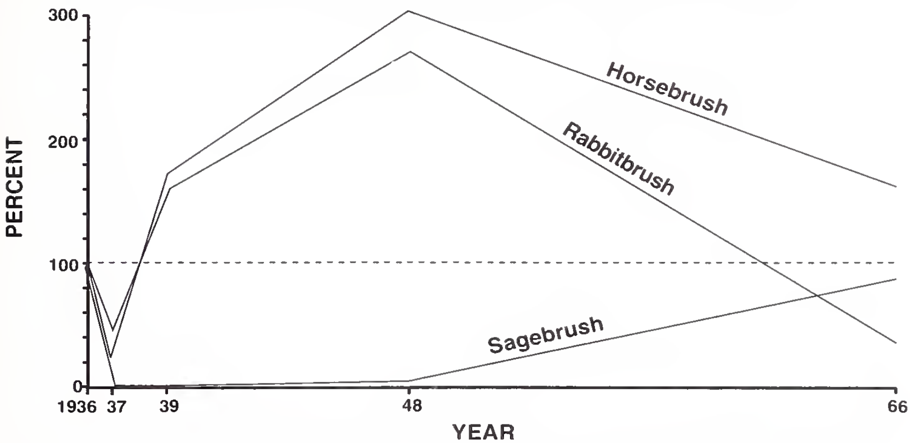

Figure 3. *Trend of important shrub species on a planned burn area near Dubois, ID, 1936-1966. Values are adjusted for the natural variation (a) between burned and unburned plots and (b) between years.*

Montana Fish, Wildlife & Parks