Habitat Improvement for the Gunnison Sage-grouse

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Introduction

The largest population of Gunnison sage-grouse (*Centrocercus minimus*) is located in the Gunnison Basin of western Colorado. Sagebrush is a critical component in all aspects of the Gunnison sage-grouse's life cycle and there is ongoing debate as to whether sagebrush communities should be treated or not in an attempt to improve habitat quality. Historically, sagebrush was treated in the Basin with the primary goal of improving forage for livestock and big game such as deer and elk. More recently, planning and implementation of sagebrush treatments have taken into account the habitat needs of sage-grouse. The potential exists for sagebrush treatments to negatively impact habitat for sage-grouse, especially in the short term. In the long term, treating sagebrush can create communities with invigorated sagebrush that has a healthy understory of grasses and forbs. These herbaceous species are critical for cover and food, especially during the nesting and early brood rearing phases of the sage-grouse life cycle.

In order to better understand the successional processes occurring in the Gunnison Basin following implementation of various sagebrush treatments, we sampled areas in 2006 that had been treated at different points in time. We then related our findings to the needs of sage-grouse for breeding habitat as outlined in the Rangewide Conservation Plan (Table 1). Parameters measured included cover of sagebrush, standing dead woody material, other shrubs, grasses, and forbs as well as height of sagebrush, grasses, and forbs. Although there are no guidelines for standing dead woody material, we felt that it was important to measure because it can provide significant cover in areas treated with herbicides where sagebrush skeletons are left standing. Each treatment method investigated is discussed separately.

Spike 20P Herbicide

Spike 20P is a pelleted herbicide that is primarily used to control various brush species on pasture and rangeland. For control to occur, the herbicide must first dissolve and move into the soil where it can then be taken up by roots and translocated to aerial portions of plants. Once uptake occurs, individual plants typically go through several cycles of defoliation and subsequent leaf growth before they die. This process can take as long as 3 years. When applied at low rates (0.2 to 0.5 lbs a.i./acre), it can have a thinning effect on sagebrush. Some plants will be totally killed while others will only be partially killed or left undamaged.

The active ingredient in Spike is tebuthiuron which can be inactivated by binding with clay and/or organic matter in soils high in those 2 fractions. It is most active in coarse textured soils that are low in organic matter. Spike can cause damage to some herbaceous plants, especially if in close proximity to where a pellet lands. Damage can be minimized by applying Spike during

Table 1. Gunnison sage-grouse breeding habitat guidelines[a].

BREEDING HABITAT				
Vegetation Variable	**Gunnison sage-grouse**		**Connelly et al. (2000)**	
	Arid	**Mesic**	**Arid**	**Mesic**
Sagebrush Canopy %	15 - 25	10 – 20	15 - 25	15 – 25
Non-sagebrush Canopy %	5 - 15	5 – 15	-	-
Total Shrub Canopy %	20 - 40	15 – 35	-	-
Sagebrush Height cm (inches)	25 – 50 (9.8 – 19.7)	30 – 50 (11.8 – 19.7)	30 – 80 (11.8 – 31.5)	40 – 80 (15.7 – 31.5)
Grass Cover %	10 - 30	20 – 40	-	-
Forb Cover %	5 - 15	20 – 40	≥ 15	≥ 25
Grass Height cm (inches)	10 – 15 (3.9 – 5.9)	10 – 15 (3.9 – 5.9)	> 18 (> 7.1)	> 18 (> 7.1)
Forb Height cm (inches)	5 – 10 (2.0 – 3.9)	5 – 15 (2.0 – 5.9)	-	-

[a] Gunnison Sage-grouse Rangewide Conservation Plan available at: http://wildlife.state.co.us/NR/rdonlyres/ACCF647C-5370-4818-A5EA-96FEA867C20C/0/AppendixHStructuralHabitatGuidelines07.pdf

the dormant season anytime the soil is not frozen. This allows the active ingredient to disperse into the soil with winter moisture and move below the primary rooting zone of non-target herbaceous species before they initiate spring growth.

Spike has not been used much in the Gunnison Basin except in small scale demonstration trials and a few larger scale applications on private land. The oldest treated areas were established by the BLM in 1994 at a number of locations throughout the Basin. At each location, they applied several rates of Spike ranging from 0.2 to 0.5 lbs a.i./acre. We sampled all application rates within 4 of their locations for a total of 10 treated and 4 untreated (control) plots. In addition, we sampled 6 locations on private lands that were all treated at the 0.2 lb a.i./acre rate. Year of application for these treated areas ranged from 1996 to 2002. Only for the 0.2 lb/acre rate were we able to determine the reestablishment rate of sagebrush cover. All areas treated with Spike were in xeric sites dominated by Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). We surveyed one mesic site in which Spike had been applied, but did not collect data because the treatment failed to control the sagebrush. Soil organic matter was apparently high enough at this mesic site to bind with the active ingredient in Spike and inactivate it, especially at the lower rate of application.

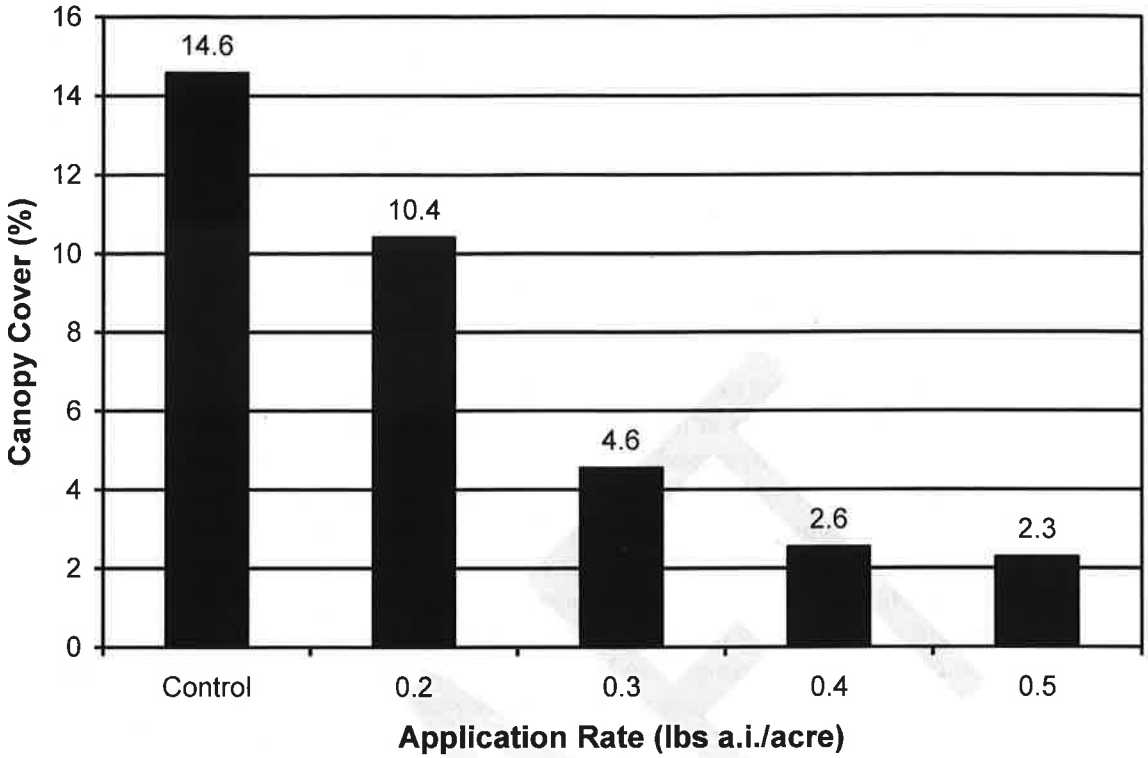

Fig. 1. Canopy cover of Wyoming sagebrush in 2006 following application of Spike herbicide at different rates in 1994.

Spike Comparison across Rates of Application

Using the 10 sample plots treated by the BLM in 1994, it was possible to determine the effect that rate of Spike application had on sagebrush cover (Fig. 1). The mean canopy cover of untreated sagebrush at these sites was 14.6%. This level of sagebrush canopy cover was below the minimum of 15% recommended for breeding habitat on xeric sites. The drought of 2002 caused a significant amount of sagebrush die-off in the Basin, especially on these xeric sites. This fact was evidenced by the 14% average cover of standing dead woody material measured in the untreated controls at these sites. Twelve years following application of Spike, sagebrush canopy cover in plots treated with 0.2 lbs a.i./acre averaged 10.4% which was 4.2 percentage points lower compared to the untreated control. Treatment of sagebrush with higher rates of Spike prolongs recovery because cover values in plots treated with 0.3, 0.4, and 0.5 lbs a.i./acre 12 years earlier averaged only 4.6, 2.6, and 2.3%, respectively. These cover values were significantly lower than either the control or 0.2 lb rate. Cover of standing dead woody material was also high in all treated plots with an average of 12.8% across the different rates. Unlike the untreated control plots, it is difficult to separate out the effects of the herbicide versus the drought on cover of dead material.

Averaged across sites, there were no significant differences in canopy cover among the treatments or between the control and any of the treatments for the other vegetation categories measured at the sites treated in 1994. For shrubs other than sagebrush, canopy cover averaged from 5-7.9% which was at or above the minimum guideline of 5% for breeding habitat. Grass

canopy cover averaged above the recommended minimum of 10% in all plots. On average, grass cover in the control plots tended to be lower at 15.2%, but did not differ from the treated plots that had an overall average of 20.7%. However, when comparing individual treated plots with their associated control area, three of the 8 treatments sampled had significantly higher (138%) grass cover (29.2 and 28.7% vs. 12.2%; 19.1% vs. 8.0%). For forbs, only the control plots had canopy covers that averaged above the 5% minimum guideline at 7.5%. Comparatively, the sites treated with 0.2, 0.3, 0.4 and 0.5 lbs a.i./acre of Spike had mean forb covers of 3.8, 4.9, 4.8 and 4.0%, respectively. Though the control plots met minimum guidelines for forb cover for sage-grouse breeding habitat, there was no statistical difference between the control and treated plots.

In addition to canopy cover, plant height is also an important component of suitable sage-grouse habitat. Height of sagebrush plants in the treated plots was significantly lower than height in the control plots. Sagebrush height averaged 37 cm in the control plots compared to the treated plots which averaged 28 cm. There was no significant difference in sagebrush height between any of the plots treated with different rates of Spike. In all but two of the treated plots, sagebrush exceeded the minimum suggested mean height of 25 cm. Although treatment with Spike led to reduced sagebrush heights, it appears that the majority of plants had recovered sufficiently by 12 years after treatment to meet the minimum height guideline for breeding habitat of sage-grouse. Grass height also contributes to sage-grouse breeding habitat by providing visual obstruction from potential predators. Height of grass in the controls averaged 22 cm which was significantly higher than in the treated plots. All treated plots exceeded the minimum height requirement of 10 cm for breeding habitat. The height of grass in the treated plots was between 16 and 18 cm and there were no height differences between the plots with different rates of application. It would not be totally unexpected for mean grass height to be lower in the treated compared to control plots. As grass plants grow in the shade of dense sagebrush canopies, they tend to grow taller because they compete for light. Once the sagebrush canopy has been reduced by applying Spike, competition for light is reduced and the growth form of grass plants changes from tall and skinny with not much biomass to slightly shorter and more robust with more canopy cover and higher biomass.

There was no observable difference between the height of forbs in the treated and control plots. This could be due to the short lived nature of forbs and timing of sampling.

Comparison of Spike at 0.2 lb a.i./acre Rate over Time

A total of 8 sites were treated with Spike at the 0.2 lb/acre rate at different times, so it was possible to create a regression looking at the relationship between age of treatment and sagebrush cover for that rate of application (Fig. 2). From this regression, it was determined that it would take 19 years for the canopy cover of sagebrush to return to the recommended minimum of 15% for suitable breeding habitat. No such analysis could be performed at rates of 0.3 lbs/acre and above since there were no areas at higher rates that were treated at different points in time. However, since canopy cover of sagebrush was still between 2.3 and 4.6% 12 years after treatment application, one can deduce that it would take longer then 19 years for the sagebrush canopy cover to return to 15%. Thus, Spike applied at 0.2 lbs a.i./acre is capable of thinning the sagebrush cover on these xeric sites without requiring an unreasonable amount of time for the plants to reestablish and/or recover to the point of meeting minimum standards (Fig. 3).

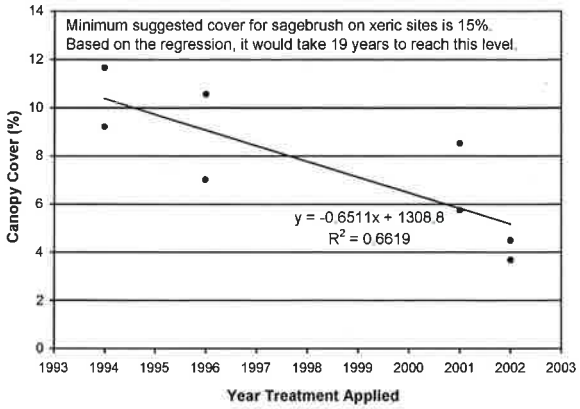

Fig. 2. Canopy cover of Wyoming sagebrush in 2006 following application of Spike herbicide at 0.2 lbs a.i./acre at various points in time.

Fig. 3. Vegetation response following application of Spike herbicide at 0.2 lbs. a.i./acre in 1996, Kezar Basin, Gunnison County, Colorado. Note thinning of sagebrush, with live sagebrush plants, partial live sagebrush plants, and sagebrush skeletons with some release of rabbitbrush. (Photo taken May 23, 2006)

Although the canopy cover of sagebrush was reduced to a greater extent and would require longer periods of time to recover at the higher rates of application, one should not automatically dismiss their use. Since Spike is typically aerially applied, it would be very easy for the pilot to adjust rates and turn the applicator on and off as he flew across the landscape. By doing so, the potential exists to create a mosaic of dead, thinned, and untreated sagebrush with varying degrees of understory plants. A heterogeneous mix of vegetation with increased edge is known to be beneficial for many species of wildlife.

For the grasses, there was no relationship between age of treatment and canopy cover (R^2=0.07). One would expect the canopy cover of grasses to increase within the first couple of years following sagebrush control (i.e. release from competition) and then decrease over time as the sagebrush reestablishes, but this was not the case for Spike or the other treatments investigated. Although not always significant, there was a general trend of increased canopy cover of grasses in the treated compared to control areas. Across all sites, canopy cover of grasses averaged 18.8% which was 4.2 percentage points higher compared to the untreated control areas. Three of the 8 sites had significantly higher grass cover, averaging over double the cover compared to the control areas. All of the treated sites met the minimum of 10% grass cover suggested in the guidelines, ranging from 11.3 to 25.9%. Canopy cover of forbs exhibited a weak relationship (R^2=0.33) to age of treatment with the older treated areas having less forb cover compared to the more recently treated areas. Forb canopy cover ranged from 3.5 to 9.7% with 5 of the 8 treated areas at or above the suggested minimum of 5%.

Sagebrush height increased with age of treatment (R^2=0.54) ranging from 12.8 cm in the recently treated areas to 33.5 cm in the older treated areas. Only 2 of the 8 treated areas did not meet the minimum suggested standard height for sagebrush of 25 cm. Just like with canopy cover, there was no relationship of grass height to age of treatment (R^2=0.02). All sites sampled met the minimum suggested grass height of 10 cm with an average across all sites of 16.4 cm. Similarly,

there was no relationship between forb height and age of treatment (R^2=0.04) with an overall average of 5.1 cm. Half of the sites met the minimum suggested standard of 5 cm and half did not (range of 3.1 to 7.2 cm).

2,4-D Herbicide

Since its introduction in the 1940s, 2,4-D herbicide has been used as a means of controlling sagebrush. Unlike Spike, 2,4-D is a foliar contact herbicide that is most effective when there is adequate soil moisture and plants are actively growing at time of application. Because of these requirements, effective control of sagebrush is often sporadic on the more xeric sites. Control is generally more consistent on the mesic sites dominated by mountain sagebrush (*Artemisia tridentata* ssp. *vaseyana*) because soil moisture is not limiting. In the Gunnison Basin, 2,4-D has been used to control sagebrush on both xeric and mesic sites and we were able to obtain data from both types of sites.

Mesic Sites

A total of 10 mesic sites were sampled that had been treated with 2,4-D from 1 to 15 years prior to 2006. A regression of the relationship between sagebrush cover and age of treatment revealed that it would take about 8 years for the sagebrush canopy to recover to the minimum of 10% cover for breeding habitat following application of 2,4-D on these mesic type sites (Figs. 4 and 5). To reach the average of 15% cover suggested for breeding habitat on mesic sites, it would take 12 years for the sagebrush to recover. Other shrubs were a minor component of the composition on the mesic sites sampled with a range in canopy cover from 0.7 to 8.5%. There was only a weak relationship between age of treatment and cover of other shrubs (R^2=0.22). Canopy cover of forbs was quite variable, especially in the older treated areas. This may have been partially due to the fact that

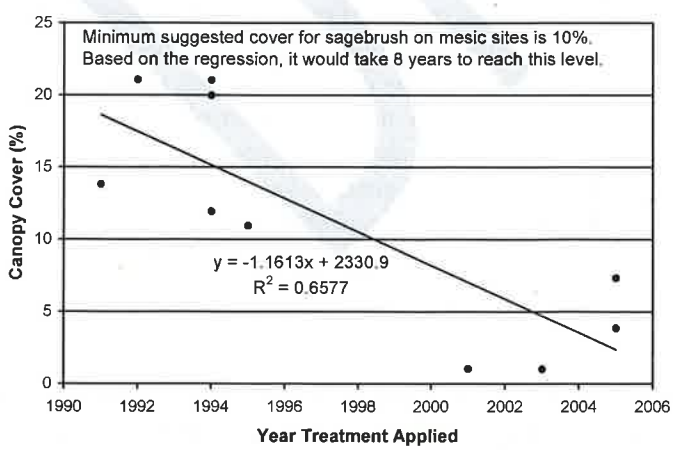

Fig. 4. Canopy cover of mountain sagebrush in 2006 following application of 2,4-D herbicide at 2 lbs a.i./acre at various points in time.

Fig. 5. Recovery of mountain sagebrush following 2,4-D application at 2 lbs a.i./acre in 1992, Antelope Creek, Gunnison County, Colorado. Note thick understory of grasses and forbs and remnants of old sagebrush skeletons. (Photo taken June 12, 2006)

forbs tend to come and go over the growing season. Since we sampled over the season, our numbers may not reflect the forbs present at any one point in time. Despite this potential problem, we were able to develop a weak relationship between forb cover and age of treatment (R^2=0.34) which indicated that it would take about 19 years to reach the minimum of 20% cover suggested for breeding habitat on mesic sites. There was little relationship between grass cover and age of treatment (R^2=0.20) with an overall average of 34% cover of grass across all sites (range 23.4 to 45.5%). Grass cover was above the 20% minimum for mesic areas at all sites.

Height of sagebrush, grasses, and forbs was not related or very weakly related to age of treatment for the mesic sites treated with 2,4-D (R^2=0.08, 0.25, and 0.14, respectively). For sagebrush, four of the 10 sites did not meet the minimum height of 30 cm recommended for breeding habitat at mesic sites. Sagebrush height ranged from 23 to 43 cm with an overall average of 31 cm for the 10 sites. Forb height was fairly consistent and exceeded the minimum of 5 cm for breeding habitat at all sites with an overall average slightly greater than 8 cm. Average grass height ranged from 10 to 21 cm with an overall mean of 14 cm. Height of grass exceeded the suggested minimum of 10 cm for mesic areas at all sites that were sampled.

Xeric Sites

Seven xeric sites were sampled that had been treated with 2,4-D from 3 to 22 years prior to 2006. On these dry sites, we found no relationship between canopy cover of sagebrush and age of treatment (R^2=0.03). Although we had no beginning estimate of sagebrush kill, this response could be partially related to variable degrees of initial sagebrush control among sites. Since 2,4-D is a contact herbicide, the greatest degree of control is generally obtained when there is adequate soil moisture at time of application and the plants are actively growing. These conditions

Fig. 6. Partial control of Wyoming sagebrush on a xeric site following application of 2,4-D at 2 lbs a.i./acre in 2003, Razor Creek, Gunnison County, Colorado. Control was less than optimal due to dry conditions. Note release of rabbitbrush as well as sagebrush skeletons which can provide cover for sage-grouse. (Photo taken July 19, 2006)

Fig. 7. Recovery of Wyoming sagebrush following 2,4-D application at 2 lbs a.i./acre in 1992, Kezar Basin, Gunnison County, Colorado. Note remnant sagebrush skeletons. (Photo taken May 25, 2006)

are often lacking in the Gunnison Basin which results in varying degrees of partial sagebrush control (Fig. 6). Unlike the mesic sites, none of the xeric sites had sagebrush canopy covers greater than the recommended minimum of 15% for breeding habitat. Sagebrush cover ranged from a low of just over 2% to a high of 13.4% with an overall average of 9%. In comparison, canopy cover of sagebrush in the untreated control areas ranged from 12.2 to 26.3% with a mean of 18.3%. Recovery of sagebrush appears to be relatively slow following treatment on some of these xeric sites (Fig. 7).

Canopy cover of other shrubs was above the 5% minimum at all xeric sites treated with 2,4-D. Following control of the sagebrush, there was a release of other shrubs, primarily various species of rabbitbrush. The oldest treated area (1984) had an average cover of other shrubs of 14.1%. This was in comparison to the untreated control sites where cover of other shrubs averaged 7.8%. Similar to the mesic sites treated with 2,4-D, there was no relationship between grass cover and age of treatment (R^2=0.01). For all xeric sites sampled, grass cover exceeded the recommended minimum of 10% for breeding habitat. Canopy cover of grasses ranged from 11.3 to 20.7% with a mean of 15.9%. For forbs, there was a relationship between cover and age of treatment with the older treated areas having slightly higher forb cover (R^2=0.43). The majority of both treated and untreated control areas met the minimum standard of 5% forb cover. Because of this, the regression relationship indicated that it would only take 4 years following treatment with 2,4-D for forb cover to meet the 5% minimum. In the older treatments, forb cover ranged from 6.2 (1986) to 7.3% (1984).

Similar to the mesic sites, heights of sagebrush, grasses, and forbs at the xeric sites were not related to age of treatment (R^2=0.08, <0.01, and 0.01, respectively). For all but one of the sites, sagebrush heights met the minimum standard of 25 cm. The average sagebrush height across the 7 sites was 29 cm. For grasses, all sites had average heights above the 10 cm minimum for breeding habitat with an overall average of 13 cm. Only 2 of the 7 sites did not meet the minimum height standard of 5 cm for forbs, the oldest (1984 - 3.8 cm) and most recently (2003 - 3.3 cm) treated areas. Across all sites, forbs averaged 6 cm in height.

Fire

Wildfire has always occurred naturally in the sagebrush ecosystems of the Gunnison Basin. Prior to the arrival of European man, this was the main factor that set succession back in these systems. After years of fire suppression, the use of prescribed fire has gained in popularity as a tool to manipulate sagebrush ecosystems for various purposes including forage for livestock and habitat for various species of wildlife, including sage-grouse. Of the many tools available for manipulating sagebrush habitat, fire will generally have the longest lasting effect on suppression of the sagebrush. Factors such as size and shape of treatment are also more difficult to control with fire. Since sage-grouse depend on sagebrush for both cover and food, fire may not be the best choice for improving sage-grouse habitat. Also, prescribed fire is generally best suited for use in the more mesic sites which have enough fine fuels (i.e. understory vegetation) to carry the fire.

Mesic Sites

For the fire treatment, we sampled 16 sites in mesic type areas that had burned under either controlled (12 sites) or natural (4 sites) conditions. The age of the fires ranged from 4 (2002) to 22 years (1984) old at time of sampling in 2006. Sagebrush recovery tended to be very slow in all but 3 of the treated areas. These 3 sites, all treated in 1984, had sagebrush covers that ranged from 9.2 to 15.2%. Sagebrush canopy cover on the remainder of the sites sampled never exceeded 5%, regardless of year of treatment (Fig. 8). Covers ranged from 0.2% (two separate sites burned in 1987 and 2001) to 4.6% (1987). Using all 16 sites, the relationship between cover and age of treatment indicated that it would take about 36 years for the sagebrush to recover to the 10% level recommended for breeding habitat in mesic sites (Fig. 9). If one were to exclude the 3 sites that exhibited the greatest recovery, then the relationship indicated it would take over 100 years for sagebrush canopy cover to reach the 10% level. Looking only at 1984, we sampled 4 sites where cover of sagebrush ranged from 1.6 to 15.2% which is just another illustration of how long and how variable recovery can be. Taking into account all the data we collected, at best it would take 22 years before sagebrush would meet the 10% cover minimum, about 36 years on average, and potentially up to 100 years for some sites.

Fig. 8. View of 1984 controlled burn, Sheep's Gulch, Gunnison County, Colorado. Note the landscape mosaic created by burned and unburned areas and lack of sagebrush recovery. (Photo taken July 18, 2006)

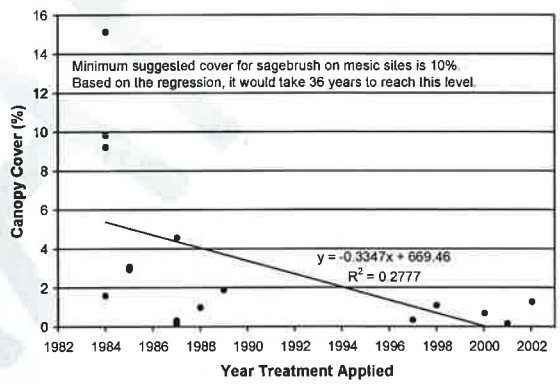

Fig. 9. Canopy cover of mountain sagebrush in 2006 following wild and prescribed fire at various points in time.

There are numerous factors that can affect the speed of sagebrush recovery at a particular site such as slope, aspect, soil type and depth, timing and amount of precipitation the first few years following the burn, and grazing intensity by both livestock and wildlife. All of these factors can affect the response of the understory vegetation. Compared to xeric sites, mesic sites generally have a thicker understory of plants which respond vigorously to removal of sagebrush by fire. If the timing and amount of precipitation is adequate and the grazing intensity can be controlled, then the grasses and forbs become so competitive that they cause the death of most sagebrush seedlings that emerge. If few sagebrush plants survive the initial flush of growth shortly after the burn, then it may take many years for plants to reestablish since the bank of sagebrush seeds in the soil will have been depleted.

Fig. 10. Grass and forb response to 1998 controlled burn on a mesic site, Almont area, Gunnison County, Colorado. (Photo taken August 10, 2006)

For cover of other shrubs, grasses, and forbs, there was basically no relationship to age of treatment (R^2=0.02, 0.11, and 0.15, respectively). Canopy cover of other shrubs was highly variable ranging from 2.3 to 17.4%. Only 3 of the 16 sites did not meet the 5% minimum for cover of other shrubs. Of all the treatments sampled, forb cover was highest in the burned sites with an overall average of 9.2% (Fig. 10). Even so, only one site met the 20% minimum for forb cover at mesic areas. Grass cover was fairly high at all sites, regardless of age of treatment, with an overall average of about 28%. Only 3 of the 16 sites did not meet the minimum standard of 20% for grass cover at mesic sites. Cover of grass ranged from 16.8 to 42.8% (Fig. 11).

Sagebrush height met the minimum standard of 30 cm for mesic areas on only 3 of the 16 sites. This would tend to support the idea that the sagebrush was stunted due to competition from the grasses and forbs. Sagebrush height ranged from 18 to 33 cm with an average across all sites of 26 cm. Only four of the sites did not meet the minimum of 5 cm for forb height. Average forb height was quite variable with a range of 4 to 14 cm across sites and an average of 7.5 cm. The grasses were quite vigorous on these mesic burned sites as indicated by the relatively high cover values as well as plant heights. All sites met the minimum standard of 10 cm for grass height with an average of about 17 cm and a range of 13.5 to 25.5 cm.

Fig. 11. Vegetation response to 1987 controlled burn, Lost Canyon, Gunnison County, Colorado. Note grass cover, rabbitbrush release, and size of sagebrush plants. (Photo taken August 8, 2006)

Brushmow

Brushmowing is a common method of controlling or at least setting back sagebrush. Of the different control methods available, it tends to be one of the shorter lived treatments and have one of the higher costs per acre. For these reasons, this method has not been widely used in the Gunnison Basin in the past. Despite these drawbacks, brushmowing has grown in popularity within the last 10 years as a means of improving habitat for sage-grouse. With the needs of sage-grouse in mind, a shorter lived treatment may be ideal. All that may be required is to reduce the

canopy cover of sagebrush for a short period of time which will then allow the understory grasses and forbs to respond. Brushmowing also lays down a layer of litter on the soil surface which acts as mulch to improve soil water retention that aids seedling establishment of new grasses and forbs. Depending on height of mowing, not all sagebrush plants will be killed. Many younger plants will be spared while portions of older plants often escape the mower and continue to grow. One of the most important advantages of brushmowing is that it can be used to target removal of sagebrush. Areas of varying sizes can be mowed and they can be mowed in various shapes which create the edge needed by many wildlife species, including sage-grouse. For these latter reasons, use of brushmowing has gained in popularity in the Gunnison Basin despite the higher cost of implementation.

Xeric Sites

Brushmowing has mainly been applied as a treatment in the Gunnison Basin on the more xeric sites dominated by Wyoming sagebrush. We were able to sample 8 sites that had been treated from 3 to 9 years prior to 2006. Even though the spread in years between treatments was relatively small (6 years), we were able to develop some significant relationships.

Based on the sites sampled, it appears that it would take about 12 years for sagebrush canopy cover to return to the 15% minimum following brushmowing (Fig. 12). None of the sites met the minimum for sagebrush cover with a range of 2.1 to 13.4% for sites treated in 2002 and 1997, respectively. There was no

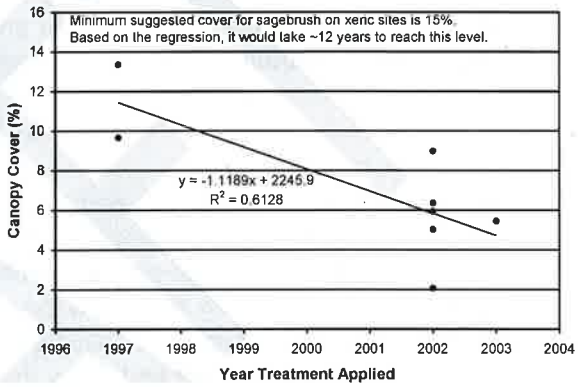

Fig. 12. Canopy cover of Wyoming sagebrush in 2006 following brushmowing at various points in time.

Fig. 13. Muttongrass response in 2001 brushmow, Long Gulch, Gunnison County, Colorado. Untreated area on left; treated area on right. (Photo taken June 29, 2006)

Fig. 14. Muttongrass response in 2001 brushmow, Long Gulch, Gunnison County, Colorado. This treatment was mowed high leaving a number of sagebrush skeletons. (Photo taken June 29, 2006)

relationship between age of treatment and canopy cover of other shrubs and forbs (R^2=0.09 and 0.10, respectively). Unlike some of the other treatments, there was a significant grass response (R^2=0.44). Grass cover was greatest in the younger treatments and declined as the treatments got older (Fig. 13). All but one of the sites had grass cover above the recommended minimum of 10%. Grass cover in the brushmowed areas ranged from a low of 7.6% to a high of 31.4% with an overall average of 18.5% (Fig. 14).

For sagebrush, there was a weak relationship between age of treatment and canopy cover R^2=0.33) with the older treated areas having taller sagebrush. Only two of the eight treated sites had mean sagebrush heights above the recommended 25 cm minimum. The overall average sagebrush height in the treated sites was 23 cm compared to 36 cm in the untreated controls. As with the other treatments, there was no relationship between height of grasses or forbs and age of treatment in brushmowed areas (R^2=0.09 and 0.01, respectively). Forb height was only above the recommended minimum of 5 cm in three of the eight treated sites. Forb heights ranged from 2.3 to 8.3 cm with an average of 4.8 cm. For grasses, all but one site met the 10 cm minimum height standard for breeding habitat with an overall average of about 14 cm.

Technical Summary

Gunnison sage-grouse (*Centrocercus minimus*) require a balance of overstory and understory plant species to meet their habitat needs. In the Gunnison Basin, this balance is often difficult to achieve since the majority of sage-grouse habitat lies in the more xeric zone dominated by Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). Because water is the most limiting factor on these xeric sites, the deeper rooted Wyoming sagebrush can come to dominate. In an effort to set succession back and allow the understory grasses and forbs to express themselves, various methods have been employed to control sagebrush. Historically, these control measures were implemented in an effort to increase forage production for livestock and big game. More recently, sagebrush treatments have been implemented with the habitat needs of sage-grouse in mind. In order to better understand the successional processes occurring in the Gunnison Basin following implementation of various sagebrush treatments, we sampled areas in 2006 that had been treated at different points in time.

Because sage-grouse are sagebrush obligates, the first habitat parameter of interest is generally recovery of the sagebrush canopy. The minimum recommended level of cover for sagebrush on xeric sites is 15%. Based on the treatments in which there were enough areas for us to sample, it appears that brushmowing and application of Spike herbicide are 2 options for reducing sagebrush cover on xeric sites without exceptionally long recovery periods. Sagebrush canopy cover on xeric sites recovered the quickest following brushmowing (12 years). For Spike herbicide applied at 0.2 lbs a.i./acre, we found that it would take about 19 years for sagebrush to recover to that level. The higher the rate of Spike, the longer the recovery period will be. Prescribed fire is not commonly used to control sagebrush on xeric sites because there are not enough fine fuels to carry the fire. Control of sagebrush on xeric sites following application of 2,4-D herbicide is often inconsistent because there must be adequate soil moisture so the sagebrush plants are actively growing to take up the herbicide.

On the more mesic sites dominated by mountain sagebrush (*Artemisia tridentata* ssp. *vaseyana*), we found that sagebrush recovered rather quickly following application of 2,4-D (8 years). The suggested minimum canopy cover level in the guidelines for mesic sites is 10%. On the other hand, prescribed fire would have to be used judiciously because our measurements indicated it would take 36 plus years for sagebrush to recover to the 10% level. Prescribed fire should not be ruled out as a management tool, but the length of recovery and size of the burn must be considered during the planning phase.

Although not always significant, canopy cover of grasses in the treated areas tended to be higher compared to the untreated control areas. This increase ranged from as little as 1 to 2 percentage points to as high as 17 percentage points and occurred regardless of treatment and whether the site was xeric or mesic. Interestingly, there was no relationship between age of treatment and grass cover for any of the treatments except brushmowing where we found that cover decreased as the treatment aged and sagebrush reestablished. This is the type of response one would expect. For the other treatments, it appears that there was a release of grasses shortly after treatment which, although quite variable in magnitude, maintained over time. Overall, the grasses met the minimum height standard of 10 cm regardless of treatment or moisture regime at the site.

Forbs are an important component of the vegetation that contributes to sage-grouse survival, especially of the chicks. However, forbs are difficult to accurately measure because there are numerous species that come and go over the growing season. Because we sampled from late May through mid August, our forb data should be interpreted with caution. Just like the grasses, there was generally no or only very weak relationships between age of a given treatment and canopy cover or height of forbs. Likewise, there was no relationship to age or type of treatment that corresponded to whether or not the forbs met the minimum cover and height guidelines.

Although increases in other shrubs following sagebrush control are often looked on unfavorably, they may actually benefit sage-grouse. For example, various species of rabbitbrush increase following treatment of sagebrush. We observed this response in many of the areas sampled, especially in those treated with 2,4-D. Although not measured directly in this study, field observations point to an increase in the abundance and diversity of insects in treated areas where rabbitbrush increased. Again, insects are an important food source that contributes to survival of sage-grouse chicks.

When interpreting findings from this study, please keep in mind that the data we collected was not from a designed study. We basically monitored historically treated areas at a point in time. In some cases, the sample size was small and there were numerous factors that could have potentially confounded the results.

Before implementing any habitat improvement project, you must first answer the following questions: "What is the objective of the project?" and "What is my vision for the future condition of the landscape?" The next step is to inventory and evaluate your resources to help understand where you are today. This will help you set your course of action to achieve your objective.

For any project being implemented that deals with natural resource management, you need to understand that there are many factors outside of your control that can affect the final outcome of the project. The key to implementing a successful project will hinge on efforts made to collect as much baseline information as possible about the soils, current plant community, potential plant community, landscape position, intended and potential uses, and climatic conditions for the particular site. Only with this base of knowledge can you then begin to document changes as you manipulate the landscape to meet your overall objectives for the land.

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