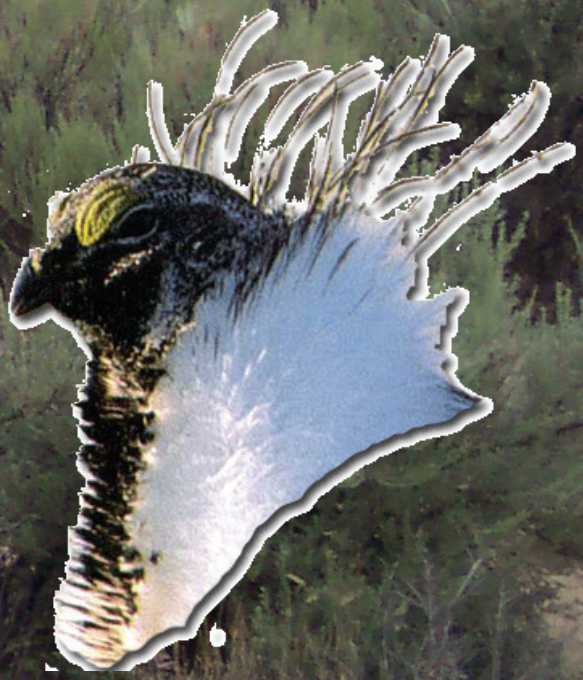
Managing Western Lands for *Sage-grouse*

The USDA NRCS Sage-grouse Restoration Project



Cover photo courtesy of Todd Black (Utah State University).
Inset on left is drawing of Gunnison sage-grouse courtesy of Brian Maxfield (Utah Division of Wildlife Resources).
Inset of right is photo of greater sage-grouse courtesy of Todd Black (Utah State University).

Funding provided by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Agricultural Wildlife Conservation Center (AWCC) through a partnership with Utah State University and the Jack H. Berryman Institute.

Suggestion citation:

U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. Messmer, T. A., and R. F. Hart, Utah State University (eds). Managing western lands for sage-grouse: the USDA NRCS Sage-grouse Restoration Project. Washington, DC.

USDA NRCS Conservation Practice Standards are available online (http://www.nrcs.usda.gov/Technical/Standards/nhcp.html).

All nomenclature for plants and avifauna in this report were obtained from:

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February 2010

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U.S. Department of Agriculture
Natural Resources Conservation Service
Agricultural Wildlife Conservation Center
February 2010

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Acknowledgments

The objective of the USDA NRCS Sage-grouse Restoration Project was to develop technology that assists the Natural Resources Conservation Service (NRCS) field staff in the delivery of conservation practices that contribute to the restoration of sage-grouse habitat and populations throughout the range. This goal was accomplished through a grants-in-aid program that supported research and demonstration projects that evaluated the efficacy of NRCS conservation practices and conservation management systems. This program was made possible through a generous grant from the USDA NRCS Agricultural Wildlife Conservation Center (AWCC, formerly Wildlife Habitat Management Institute) under the leadership of Pete Heard. The grants-in-aid program was developed, delivered, and coordinated through the Jack H. Berryman Institute, Utah State University, under the direction of Terry A. Messmer. Ed Hackett, AWCC, provided invaluable assistance as the technical liaison for the AWCC. Rae Ann F. Hart, Utah State University, coordinated project activities, reporting, and product development. Terry A. Messmer and Rae Ann F. Hart edited technical products and the final report. Rae Ann F. Hart provided graphic design support for the final report. Utah State University and the Jack H. Berryman Institute provided material support throughout the project. The AWCC gratefully acknowledges all of the principal investigators of the individual projects, graduate students and technicians that collected data, private landowners on whose properties the studies were conducted, and NRCS State and field office personnel.

Contents

Forward

Sage-grouse (*Centrocercus* spp.) are restricted to the sagebrush rangelands of western North America. Sage-grouse once inhabited 15 states and 3 Canadian provinces. Currently, populations exist in only 11 states and 1 province. Continued population declines prompted several organizations to petition the U.S. Fish and Wildlife Service (USFWS) to list sage grouse as threatened or endangered under the federal Endangered Species Act. In March of 2010, the USFWS announced that greater sage-grouse would be designated as a Candidate Species for listing. This designation affords federal, state, and private partners additional time to implement conservation actions to mitigate threats to the species.

Approximately 30% of the sagebrush lands in the western United States are privately owned. The greatest percent of privately-owned sagebrush lands occurs in Montana, Colorado, Washington, and South Dakota. In Utah over 50% of the remaining sage-grouse populations in the state occurs on private land. The Natural Resource Conservation Service (NRCS) has the legal mandate to assist farmers and ranchers in identifying and implementing management actions on their property that sustain or enhance economic viability, conserve natural resources (soil and water) and contribute to species conservation. To comply with this mandate, NRCS field staff will need better information regarding the effects of specific conservation practices and technologies on at-risk species.

The Sage-grouse Restoration Project (SGRP) is a cooperative effort between NRCS and Utah State University Extension, Jack H. Berryman Institute that involved private landowners, public and private conservation agencies and organizations, and universities in a process to evaluate and document the effect of NRCS conservation practices in restoring sage-grouse habitat and populations. The scientific literature clearly indicates that sage-grouse are dependent on large expanses of sagebrush dominated shrub-steep ecosystems. However, more information was needed regarding the appropriate sagebrush patch sizes that are needed to provide for seasonal habitat requirements. To address this need, the SGRP provided funding for the design and implementation of research and demonstration projects to evaluate and communicate the effectiveness NRCS conservation practices and technology in restoring or enhancing sage-grouse habitat on private lands.

Within the NRCS, the former Wildlife Habitat Management Institute (WHMI) renamed the Agricultural Wildlife Conservation Center (AWCC) was formed in 1997. The NRCS
is the conservation arm of the USDA and plays a lead role in conservation technology development and implementation of conservation practices on private agricultural land in the United States. The AWCC leads fish and wildlife technology development through a competitive grants program. Because of the partnership formed with Utah State University to lead the NRCS Sage-grouse Restoration Project, we now have clear, concise recommendations regarding the conservation practices to use for sage-grouse restoration. The practices described herein are supported by farm bill programs approved by Congress and administered by USDA NRCS.

It is our fond hope and desire that this information based on research will contribute immeasurably to restoring sage-grouse populations.

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Executive Summary

Sage-grouse (*Centrocercus* spp.) inhabit sagebrush (*Artemisia* spp.) rangelands of western North America (Patterson 1952, Schroeder et al. 2004). Sage-grouse utilize sagebrush during all life stages, thus their distribution is closely associated with sagebrush species occurrence (Patterson 1952, Connelly and Braun 1997). Historically sage-grouse were believed to be one of the most abundant and widely distributed native grouse species in the western United States (Dalke et al. 1963). Sage-grouse once inhabited 15 states and three Canadian provinces (Connelly et al. 2004). Currently, populations exist in only ten states and one province.

Prior to 1970, only one species of sage-grouse was recognized (*C. urophasianus*). In the mid 1970s the Colorado Division of Wildlife began studying sage-grouse populations located within the state, this included the collection of wings from hunted sage-grouse (Young et al. 2000). Based on measurements of the primaries it was noted that the wings collected from sage-grouse in the Gunnison Basin of Colorado were smaller than those of other populations. This observation led to further studies on the Gunnison Basin populations. These studies discovered differences in morphometrics, breeding behavior, plumage, and genetics. This resulted in the reclassification of the grouse species that inhabits the Gunnison Basin in Colorado and southeastern Utah as the Gunnison sage-grouse (*C. minimus*) in 2000 by the American Ornithologists' Union (Young et al. 2000, AOU Checklist Committee 2002, Gunnison Sage-grouse Rangewide Steering Committee 2005).

Currently, all birds located north and west of the Colorado River are classified as greater sage-grouse (Connelly et al. 2004). The Gunnison sage-grouse is found only south and east of the Colorado River in Utah and Colorado (Connelly et al. 2004). Greater sage-grouse currently inhabit about 56% of pre-settlement distribution of potential habitat (Schroeder et al. 2004). Gunnison sage-grouse occur in small isolated populations in southwest Colorado and southeast Utah and inhabit about 10% of pre-settlement distribution of potential habitat (Schroeder et al. 2004). Due to steady declines in overall sage-grouse populations throughout its entire range, several organizations have petitioned the U.S. Fish and Wildlife Service (USFWS) to list both sage-grouse species for protection under the Endangered Species Act of 1973 (Connelly et al. 2004). Gunnison sage-grouse are currently considered as a species of special concern for management purposes because the rapid decline in the species distribution and abundance has caused the remaining populations to be unusually small and isolated (Oyler-McCance et al. 2005). Population declines throughout their range have been largely attributed to habitat loss, degradation, and fragmentation of sagebrush habitats (Braun et al. 1977, Connelly and Braun 1997, Braun 1998, Connelly et al. 2004). The quality of the remaining habitat has been further impacted by urbanization, grazing, agriculture, and energy development.

The scientific literature documents that both species of sage-grouse are dependent upon large expanses of sagebrush. However, more information is needed regarding the appropriate sagebrush-steppe patch sizes that are needed to provide for seasonal habitat requirements (Connelly et al. 2004). In 1999 the Western Association of Fish and Wildlife Agencies (WAFWA) in a memorandum of understanding among its members regarding sage-grouse conservation recognized a need to conduct experiments of sufficient scale that demonstrate how habitats can be managed to stabilize and enhance sage-grouse distribution and abundance (WAFWA 1999). Approximately 30% of the sagebrush lands in the western United States are privately-owned. The greatest percent of privately-owned sagebrush lands occurs in Montana, Colorado, Washington, and South Dakota (Connelly et al. 2004). Because of private landowner's ability to access Farm Bill funds to develop and implement conservation projects, privately-owned lands may provide the greatest opportunity to implement landscape level experiments called for by WAFWA.

The Sage-Grouse Restoration Project (SGRP) was established specifically to provide funds for the design and implementation of research and demonstration projects that evaluate and communicate the effective-

ness of 2002 Farm Bill conservation practices and technologies in restoring or enhancing sage-grouse habitat on private lands. It was a cooperative effort involving private landowners, universities, and conservation agencies and organizations. In a process to identify, integrate, evaluate, and document the effects of 2002 Farm Bill conservation practices in restoring sagebrush-steppe ecosystems to benefit sage-grouse. Partners in this venture included: U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Utah State University (USU), USU College of Natural Resources, USU Extension Service, Jack H. Berryman Institute, Western Governors' Association, WAFWA, Western States Sage and Columbian Sharp-tailed Grouse Technical Committee, North American Grouse Partnership, and Utah Division of Wildlife Resources (UDWR). NRCS had the lead role in establishing and overseeing the SGRP and coordinated with USU to implement the Project.

The goals of the SGRP included:

1. To implement and conduct multi-state management experiments of sufficient scale to evaluate how conservation provisions of the 2002 Farm Bill can benefit sagebrush-steppe obligate species.

2. To develop a multi-state grants-in-aid program to assist researchers and landowners in integrating and evaluating the effects of conservation provisions of the 2002 Farm Bill on sagebrush-steppe obligate species.

3. To develop a web-based Project Library that contains documentation regarding the effects of conservation provisions of the 2002 Farm Bill on sagebrush-steppe obligate species.

Information gained through SGRP projects will be used to assist NRCS, Conservation Districts (CD), and state wildlife agency field staff, as well as private landowners in the planning and implementation of habitat projects and practices on private lands to benefit wildlife species dependent upon sagebrush-steppe. The projects implemented under SGRP contributed to range-wide sage-grouse conservation efforts by documenting the effects of specific management prescriptions on sage-grouse inhabiting western lands.

All SGRP grants were awarded on the federal fiscal year in 1-year increments. Multi-year (up to 3 years) grants were also considered for funding but were awarded in annual increments. All grants were awarded on a cost-reimbursable basis. Up to 75% of the award amount was paid during the project with the final 25% reimbursed when all products (e.g., reports, products, etc.) were submitted.

Each funded project was required to submit annual and final reports, photos of practices, resource management systems, research activities, and a photo-ready 2- to 4-page wildlife technical note describing project outcomes for use by NRCS and partners, a PowerPoint presentation describing project objectives, implementation, and outcomes for use in NRCS training, and copies of publications, theses, dissertations, manuals, handbooks, technical notes or popular articles that resulted from project.

During the duration of the project, grant recipients were also required to host at least one field tour, on-farm demonstration day, or on-site training course for landowners, natural resource management professionals, and/or NRCS field personnel. These events were documented by date, photos of participants, and summary of number of participants, affiliations, and agenda. The completed projects also will be included in the SGRP web site. This web site provides visitors with visual information regarding the effects of integrating 2002 Farm Bill conservation practices on wildlife, agricultural productivity, and natural resource conservation (e.g., soil and water).

In 2005, we received seven proposals from California, Colorado, and Utah. Of these, three proposals were selected to receive a total of $200,000 in funding. The proposals selected for funding were:

1. "Grazing Sagebrush with Sheep to Enhance Greater Sage-Grouse Brood-rearing Habitat." This project was conducted by Utah State University on Parker Mountain in Garfield, Sevier, Piute and Wayne counties of Utah to determine if sheep grazing can be

used to enhance sagebrush habitat for greater sage-grouse and other sagebrush obligate species while maintaining animal performance.

2. "Development of a Sagebrush Habitat Improvement Guide for the Gunnison Sage-grouse by Evaluating Recently and Historically Treated Areas within the Gunnison Basin." This project was conducted by Colorado State University at numerous locations within the Gunnison Basin of western Colorado. This work evaluated the habitat conditions within recently- and historically-treated sagebrush areas in the Gunnison Basin and related those findings to the habitat requirements of sage-grouse as outlined in the Gunnison Sage-grouse Rangewide Conservation Plan.

3. "Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah." This project was conducted by the UDWR in Rich County in northeastern Utah. The UDWR evaluated methods to assess habitat use by greater sage-grouse in areas where sagebrush cover has been treated to benefit the species.

The SGRP project library provides farmers and ranchers with information regarding the role NRCS conservation practices in increasing their productivity and natural resource conservation. This information will allow them optimize the benefits of conservation planning. The SGRP project will benefit NRCS field staff by providing current information on the role of existing conservation practices and technologies relative to conserving sage-grouse and other sagebrush obligate species. In addition SGRP resulted in developing new technology which will assist NRCS field staff and other partners in their conservation planning efforts. Lastly, the SGRP disseminated private lands conservation planning needs to a much wider research audience. This ultimately increased the awareness and involvement researchers in the field to address field level technology needs. Additionally, the agency partners, private landowners, graduate students, and undergraduate technicians involved in these research efforts developed a new appreciation for conservation planning and evaluation.

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Project Overview

Currently, there are two species of sage-grouse recognized in North America; greater (*Centrocercus uropasianus*) and Gunnison (*C. minimus*). Greater sage-grouse (*C. urophasianus*) is the largest species of native grouse in North America with males weighing up to 7 lbs and females 3.3 lbs (Patterson 1952, Autenrieth 1981). Gunnison sage-grouse are about half this size.

Greater sage-grouse current range includes southeast Alberta and southwest Saskatchewan; southwest North Dakota and northwest South Dakota; most of Montana and Wyoming; western Colorado; parts of southern and eastern Idaho; north, northeast, and southern Utah; northern Nevada; east to northeast California; southeast Oregon; and north-central Washington (Connelly and Braun 1997, Schroeder et al. 2004). Gunnison sage-grouse occur in small, isolated populations in southwest Colorado and southeast Utah (Young et al. 2000).

Sage-grouse once inhabited 15 states and 3 Canadian provinces. Currently, populations exist in only 11 states and 1 province. Greater sage-grouse have been extirpated from the fringes of their range in Arizona, New Mexico, Nebraska, and British Columbia (Schroeder et al. 2004).

Continued population declines prompted several organizations to petition the U.S. Fish and Wildlife Service (USFWS) to list both greater and Gunnison sage-grouse as threatened or endangered under the federal Endangered Species Act (ESA). In March 2010, the USFWS announced that listing greater sage-grouse was "warranted but precluded." In essence, with this decision, the USFWS identified greater sage-grouse as a Candidate Species for listing under the ESA. Although the USFWS believes the species deserve protection under the ESA, the decision reflects a balance between limited resources and the needs of other species which are considered are higher priorities for protection. In the decision the USFWS acknowledged that its federal, state, and private partners have been implementing positive conservation actions designed to benefit the species. However, given the cumulative effects of new threats to the species, the ongoing conservation actions were not enough to outweigh the increased extinction risks presented by the new threats. With this designation, the USFWS will conduct an annual status review. Based on the findings of this review, the species could be removed from the Candidate list or listed. Gunnison sage-grouse were previously designated as a Candidate species for listing, but the USFWS removed this designation in 2005 because the populations were stable. The USFWS is currently reviewing the status of this species.

Sage-grouse are considered sagebrush (Artemisia spp.) obligates and depend on sagebrush habitat throughout their life cycle (Patterson 1952, Braun et al. 1977, Connelly et al. 2000). Sagebrush ecosystems provide wintering, pre-laying, lekking, nesting, and brood-rearing habitat. Sage-grouse populations have decreased as the quality and quantity of sagebrush habitat within their range has declined (Connelly et al. 2004). Connelly et al. (2004) reported that greater sage-grouse populations declined 3.5% per year from the mid-1960s to the mid-1980s, and 0.4% per year from the mid-1980s to 2003. Braun et al. (1977) and Connelly and Braun (1997) argued that mismanagement of the sagebrush-steppe ecosystem has led to the decline of sage-grouse populations and their habitats.

Approximately 30% of the sagebrush lands in the western United States are privately owned. The greatest percent of privately-owned sagebrush lands occurs in Montana, Colorado, Washington, and South Dakota. The Utah Division of Wildlife Resources (UDWR) estimates that over 50% of the remaining sage-grouse populations in the state occur on private land (UDWR 2009).

The USDA Natural Resources Conservation Service (NRCS) has the legal mandate to assist farmers and ranchers in identifying and implementing management actions on their property that sustain or enhance economic viability, conserve natural resources (soil and water) and contribute to species conservation. As such, NRCS has a lead role in developing conservation technology and practices as well as defining the implementation standards. These national conservation practice standards are published in the NRCS

National Handbook of Conservation Practices (www.nrcs.usda.gov/technical/Standards/nhcp.html). The conservation practice standards are science-based and have been validated to ensure predictability in the outcomes. State NRCS Offices subsequently select practices which are applicable to their states and issue them as state conservation practice standards. State offices also include additional technical information of sufficient detail to enable field office staff to implement the practices at the local level.

In support of range wide sage-grouse conservation efforts, USDA NRCS recently announced a new initiative designed to protect and manage sage-grouse populations and their habitats in the U.S. through the Environmental Quality Incentives Program (EQIP) and the Wildlife Habitat Incentive Program (WHIP). USDA NRCS had committed $16 million through these programs to provide financial incentives for private landowners to implement conservation practices to mitigate threats to the species. To comply with this initiative, federal, state, and private partners will need better information regarding the effects of specific conservation practices and technologies on sage-grouse.

The Sage-grouse Restoration Project (SGRP) was a cooperative effort between NRCS and Utah State University that involved private landowners, public and private conservation agencies and organizations, and universities in a process to evaluate and document the effect of NRCS conservation practices in restoring sage-grouse habitat and populations. The scientific literature clearly indicates that sage-grouse are dependent on large expanses of sagebrush dominated shrub-steppe ecosystems. However, more information is needed regarding the appropriate sagebrush patch sizes that are needed to provide for seasonal habitat requirements. To address this need, the SGRP (http://www.sgrp.usu.edu/) sponsored a grant-in-aid program that provided funds for the design and implementation of research and demonstration projects to evaluate and communicate the effectiveness NRCS conservation practices for sage-grouse.

The SGRP grants were awarded on the federal fiscal year basis in 1-year increments.
Multi-year (up to 3 years) grants were also considered for funding but were awarded in annual increments.
In 2005, SGRP received seven proposals from California, Colorado, and Utah. Of these, three proposals were selected to receive a total of $200,000 in funding. The proposals selected for funding were:

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3. “Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah.” This
project was conducted by the Utah Division of Wildlife Resources (UDWR) in Rich County in northeastern Utah. The UDWR evaluated methods to assess habitat use by greater sage-grouse in areas where sagebrush cover has been treated to benefit the species.

Grazing Sagebrush with Sheep to Enhance Greater Sage-Grouse Brood-rearing Habitat

Greater sage-grouse, sagebrush, and cowboys are arguably western icons. Ironically the status of these western icons appears at the mercy of changing economics and social patterns. Sage-grouse populations have declined across most of their range during re-

cent decades. These range wide population declines are primarily attributed to the loss or degradation of sagebrush rangeland habitats as a result of land use changes. As the number of working ranches decline as properties are converted to other uses in the face of economic pressures, sage-grouse may lose important allies. Because many of these working ranches contain important sagebrush habitat upon which sage-grouse depend, they may constitute crucial species conservation bastions because they also provide an important management infrastructure that could assist in range wide effort to reverse population declines.

NRCS has developed several conservation practices which working ranches can receive financial incentives to implement on non-federal land to improve sage-grouse habitat. These practices include Upland Habitat Management (645), Prescribed Grazing (528), Prescribed Fire (338), Brush Management (314), and Grazing Land Mechanical Treatment (548). Because sage-grouse have unique seasonal habitat requirements, NRCS planners must consider all of the possibilities when implementing conservation practices in sagebrush ecosystems. One specific habitat type that is believed to be limiting some sage-grouse populations is brood-rearing habitat. Declining sage-grouse populations typically exhibit low productivity and recruitment. Low productivity and recruitment are artifacts of poor breeding habitat quality.

In Utah, Dahlgren et al. (2006) documented that the proper application of mechanical and chemical brush treatments can enhance brood-rearing areas in higher elevation (> 7000 feet) rangeland habitats dominated by mountain big sagebrush (A. tridentata spp. vaseyana) communities. However because of these treatments depend heavily in fossil fuels, working ranches and their livestock may provide a cost effective alternative.

Dr. Roger Banner and Michael Guttery evaluated the effect of strategic intensive sheep grazing as a mechanism to improve sage-grouse brood-rearing habitat. The greater sage-grouse hens and broods they studied clearly preferred areas grazed by sheep to untreated areas. The grazed areas exhibited greater forb production; a key component in the diet of sage-grouse chicks. Their results suggest that sagebrush rangelands could be managed using strategic late season sheep grazing to create resources patches that maximize sage-grouse brood-rearing habitat benefits and provide important edges for escape cover (Dahlgren et al. 2006). They recommended by applying strategic grazing on an annual basis, it would be possible to create a mosaic of small resource-rich habitat patches across a landscape using existing working ranch infrastructure – domestic sheep. They also recommended the NRCS consider the development of additional criteria under NRCS conservation practices Prescribed Grazing (528), and Brush Management (314) that would allow cooperators to enter into cost-share agreements to defray the cost of supplements to encourage the application of strategic sheep grazing to manage sagebrush rangelands for sage-grouse.

Development of a Sagebrush Habitat Improvement Guide for the Gunnison Sage-grouse by Evaluating Recently and Historically Treated Areas within the Gunnison Basin

Gunnison sage-grouse currently occupy about 10% of their historical range (Schroeder et al. 2004). Seven populations remain southwestern Colorado and one population in southeastern Utah. The largest population inhabits the Gunnison Basin in Colorado. The decline in the range of the species has been attributed to the loss or conversion of sagebrush to other land uses (Gunnison Sage-grouse Rangewide Steering Committee 2005).

In the Gunnison Basin, achieving sagebrush communities that exhibit a diverse vegetation understory is problematic because most of the habitat lies in the more xeric zones dominated by Wyoming sagebrush (A. tridentata ssp. wyomingensis). To increase understory diversity (i.e., grasses and forbs) in the Gunnison Basin, land managers have typically implemented various practices to control sagebrush. Specific NRCS cost-share practices implemented include Grazing Land Mechanical Treatment (548), and Brush Management (314). Historically, these practices were implemented to increase forage production for livestock

and big game. More recently, sagebrush treatments have been implemented to enhance seasonal habitats for Gunnison sage-grouse.

To document the vegetation successional processes occurring in the Gunnison Basin following implementation of various sagebrush treatments, Dr. Joe Bummer and Mr. John Scott evaluated the vegetation response in areas that had been treated at different points in time by different methods to determine how well the sites approximated recommended Gunnison sage-grouse habitat guidelines (Gunnison Sage-grouse Rangewide Steering Committee 2005). Based their retrospective evaluation, they concluded that brushmowing and application of tebuthiuron herbicide constituted more viable options for managing sagebrush cover on xeric sites to increase vegetation diversity and allowed for gradual recovery of the sagebrush community. However, they cautioned that when interpreting findings from their study, the reader needs to keep in mind that the data collected and analyzed were generated through a retrospective study of historical treatments and not a designed study.

To ensure projects implemented in the Gunnison sage-grouse range, they strongly encouraged NRCS planners and their partners that prior to implementing any habitat improvement project they answer the following question. "What is the objective of the project?" and, "What is the vision for the future condition of the landscape?" They recommended that project planners coordinate their efforts early with their state wildlife agency and/or the area's local sage-grouse working group to learn if sage-grouse occur in the project area and if their seasonal habitat use patterns are known. They also urged caution when applying brush management techniques to sites with different elevations, annual precipitation, sagebrush subspecies, or soil substrates. Additionally, because sage-grouse use habitat edges which afford cover and food resources, any treatments conducted to benefit Gunnison sage-grouse must maximize this edge (Dahlgren et al. 2006). Thus, rather than remove or manipulate large blocks of sagebrush at a time, they recommended employing an alternative strategy of treating smaller patches or plots within brood-rearing habitat will increase vegetation

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tion diversity while maximizing edge, hence protective cover. Lastly based on their research, prescribed fire was not recommended as a management practices to manage lower elevation and more xeric sagebrush sites in Gunnison sage-grouse habitats.

Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah

Crawford et al. (2004) suggested that the solutions to sage-grouse population declines are multifaceted and require integration of science and management to solve the problems facing sage-grouse. Connelly et al. (2004) suggested that the adaptive management process is so important because effects of management must receive unbiased evaluation to determine its effectiveness and then management adjustments must be made.

Dr. Frank Howe's and Roger Stringham's research addressed these concerns in research that was partially support by SGRP. Their research involved the following objectives: 1) evaluation of sage-grouse response to sagebrush reduction, 2) determination of Ecological Site Descriptions and habitat characteristics of areas used by sage-grouse; 3) determination of habitat characteristics of sage-grouse use areas; and, 4) the development of "portable" and efficient sage-grouse monitoring techniques through evaluation of various assessment methodologies. They addressed these objectives using sites where sagebrush habitats had been recently manipulated to reduce canopy cover, historic treatments (retrospective), and compared their results to reference (untreated) areas adjacent to the treatment areas. Their study sites were located on Deseret Land and Livestock (DLL) and the Duck Creek Allotment (DCA) managed by private landowners and the Bureau of Land Management (BLM) located in Rich County in northeastern Utah.

At each of the sites, they also evaluated the efficacy of several methods to assess sage-grouse use or response to the treatments. These methods ranged from "quick and dirty" to state-of-the-art in an effort to develop portable and efficient means of evaluating sage-grouse use on a broader scale. Specific methodologies evaluated included; 1) distance sampling to estimate density of sage-grouse pellets (potential index to use), 2) flushing counts using trained dogs and distance sampling techniques (snapshot measure of use), 3) occupancy estimation (proportion of landscape used), and 4) GPS radio-telemetry (roost site and seasonal use).

They reported relatively heavy sage-grouse use in areas where sagebrush cover was reduced with a pasture aerator. However, use patterns also varied by elevation and season. Lower elevation treated sites (< 7,000 feet) had a greater use than higher elevation (> 7,000 feet) sites and grouse, particularly females, used treated sites earlier in the summer. Based on their observations they recommended that sagebrush reduction be used cautiously, particularly at higher elevations where sagebrush is co-dominant with species such as serviceberry (Amelanchier spp.) and only when brood-rearing habitat appears to be limiting.

While their comparison of survey techniques is ongoing, preliminary results indicate that pellet transects provided a relatively inexpensive and reasonably accurate measure of grouse habitat use; though caution must be taken to avoid overestimating use because pellets may persist on the landscape (Dahlgren et al. 2006). Occupancy sampling was also a useful tool, though because it required multiple visits to yield a detection probability, it may be more costly than pellet transects. Use of GPS radio-telemetry proved very informative and was recommended when little is known of local habitat use patterns; GPS telemetry, while highly accurate, is quite expensive and under the current technology requires recapture of the radio. Finally, dog flushing did not prove an effective technique in this study; it required unpractical line transects lengths in order to get the minimum sample size required to yield reliable density estimates. Dahlgren et al. (2010) provide a detailed reviewed comparing pellets counts, observer, transects, and the use of bird dogs in detecting sage-grouse brood use.

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Grazing Sagebrush with Sheep to Enhance Greater Sage-grouse Brood-rearing Habitat

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Acknowledgments and Disclaimer

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Acknowledgments:

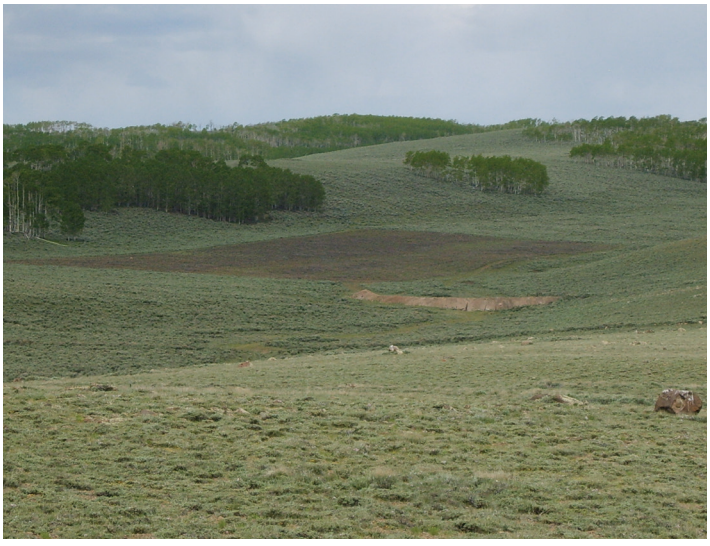
Information in this publication was adapted from the Ph.D. research of Michael R. Guttery working under the direction of Dr. Roger E. Banner and Dr. Terry A. Messmer, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT 84322. This research was conducted on the Parker Mountain/Awapa Plateau of southcentral Utah. Funding for this project was provided by USDA/NRCS, Quinney Professorship for Wildlife Conflict Management, USDA Initiative for the Future of Agriculture and Food Systems, and Jack H. Berryman Institute.

Photos were provided by Michael R. Guttery, David Dahlgren, and Todd Black, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT 84322.

Technical Summary

Grazing Sagebrush with Sheep to Enhance Greater Sage-grouse Brood-rearing Habitat

Greater sage-grouse (*Centrocercus urophasianus*) have long been an icon of western rangelands. The species is dependent on the sagebrush (*Artemisia* spp.) communities that are synonymous with western culture. However, populations have declined across most of their range during recent decades. These range wide population declines are primarily attributed to the loss or degradation of sagebrush rangeland habitats. The decline of sage-grouse populations and their associated habitats is of great concern to wildlife managers and private landowners. Current estimates suggest that private lands may constitute up to 30 percent of the remaining habitat base for sage-grouse. The Utah Division of Wildlife Resources estimates the up to 50% of the sage-grouse population in the state inhabit private land. While much is known about sage-grouse biology and seasonal habitat selection, more information is needed regarding the effects of specific management actions on sage-grouse populations and their habitats. The Natural Resources Conservation Service (NRCS) has developed several conservation practices which private landowners can receive cost-share to implement on manage sagebrush rangelands to improve wildlife grouse habitat. These practices include Upland Habitat Management (645), Prescribed Grazing (528), Prescribed Fire (338), Brush Management (314), and Grazing Land Mechanical Treatment (548). Each of these practices has specific criteria and standards NRCS planners must consider in developing landowner conservation plans. However, in the case of sage-grouse, additional considerations may be warranted because of their unique seasonal habitat requirements. For example, sage-grouse may use different types of sagebrush habitats for nesting, brood-rearing, and as fall and winter habitats. One specific habitat type that is believed to be limiting some sage-grouse populations is brood-rearing habitat. Several studies have described the importance of high quality brood-rearing habitat to chick survival and population recruitment. Dahlgren et al. (2006) documented that the proper application of mechanical and chemical brush treatments (314) can enhance brood-rearing habitats in higher elevation (> 7000 feet) rangeland habitats dominated by mountain big sagebrush (A. *tridentata* spp. *vaseyana*) habitats. While the proper application of these methods may work well for managing brood-rearing habitat, there is increasing concern about their cost, fossil fuel dependence, and longevity. In response to these concerns, we implemented an experiment to determine if properly managed livestock grazing could achieve the same habitat goals while minimizing costs and the dependence on fossil fuels. The experiment was initiated in 2006 to determine if strategic intensive sheep grazing could be used to improve sage-grouse brood-rearing habitat. Included in this experiment were areas that had been previously mechanically treated in 2001 under the NRCS Practice Brush Management 314. These sites were included in the experiment because the sagebrush canopy cover in the sites had returned to pre-treatment baselines. Preliminary habitat and grouse use measurements were taken during July 2006. Grazing treatments began in mid-October. The timing of treatments was selected



to increase the palatability of sagebrush to the sheep while minimizing the impact of grazing on the forb and grass community. Vegetation and sage-grouse responses to the treatments were recorded annually through 2009 and compared to reference areas that were not grazed. Sagebrush cover in grazed plots was reduced from approximately 27% in 2006 to less than 9% in 2007. Sagebrush cover has increased in subsequent years but as of 2009 was less than pre-treatment conditions. Forb cover, the factor of greatest interest since they are a major component of the diet of sage-grouse chicks, declined in 2007 on both the reference and treatment sites because of drought conditions. Forb cover on the grazing treatments was greater than the reference areas in 2008 and 2009 as precipitation levels returned to normal. Similarly, grass cover declined in 2007 but increased in 2008 and 2009. The increased grass cover afforded additional forage for cattle and wildlife. Sage-grouse broods preferred the grazed plots to the reference areas in each of the three years following the treatment. The cost per acre for the mechanical treatments was $150. Including the cost of the supplement used for the sheep, the cost per acre of the grazing treatment was $100. Because of logistic constraints (i.e. lack of sheep herds), the application of strategic intensive sheep grazing to manage sage-grouse brood-rearing habitat will be limited in terms of the acres that could be managed annually. Mechanical and chemical treatments can be applied over extensive areas and have demonstrated the capability of achieving the same goal (i.e. reducing sagebrush cover and increasing forb cover). However, an important aspect of managing sagebrush rangelands to maximize sage-grouse habitat benefits is maintaining habitat edges that provide escape cover (Dahlgren et al. 2006). By applying this method on an annual basis, it would be possible to create a mosaic of small resource-rich habitat patches across a landscape using readily available tools. Also, the development of additional criteria under NRCS conservation practices Prescribed Grazing (528), and Brush Management (314) that would allow cooperators to enter into cost-share agreements to defray the cost of the supplement would encourage the application of strategic sheep grazing to manage sagebrush rangelands for sage-grouse. For mechanical treatments to be cost effective, they must be applied to large acreages resulting in a landscape mosaic dominated by large openings with small islands of untreated sagebrush.

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Dahlgren, D. K., R. Chi, and T. A. Messmer. 2006. Greater sage-grouse response to sagebrush management in Utah. Wildlife Society Bulletin 34:975-985.

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Technical Report

Grazing Sagebrush with Sheep to Enhance Greater Sage-grouse Brood-rearing Habitat

Greater sage-grouse (*Centrocercus urophasianus*, hereafter sage-grouse) and sagebrush (*Artemisia* spp.) are synonymous with Western culture and rangelands (Figure 1). However, the long-term status of sage-grouse has become increasingly uncertain as the rangeland sagebrush habitats on which they depend are impacted. Sage-grouse once occurred in 16 states in the western United States and 3 Canadian Provinces (Schroeder et al. 1999). Today, sage-grouse are found in 11 states and 2 provinces, and remaining populations in these areas have declined (Schroeder et al. 1999). Sage-grouse are a sagebrush obligate species, as such their survival is tied to having access to sagebrush plant communities. The general reduction and fragmentation of sagebrush habitats throughout western North America is cited as the primary factor in the decline of sage-grouse populations. At the local level, factors such as a lack of suitable seasonal rangeland sagebrush habitats may limit species production and survival thus further hastening declines.

The decline of sage-grouse populations and their associated habitats is of great concern to wildlife managers and private landowners. Current estimates suggest that private lands may constitute up to 30 percent of the remaining habitat base for sage-grouse. In Utah, the Division of Wildlife Resources estimates the up to 50% of the sage-grouse population in the state inhabit private land. While much is known about sage-grouse biology and seasonal habitat selection, more information is needed regarding the effects of specific management actions on sage-grouse populations and their habitats.

Figure 1. Greater sage-grouse and sagebrush (*Artemisia* spp.) are synonymous with Western culture and rangelands.

The Natural Resources Conservation Service (NRCS) has developed several conservation practices which private landowners can receive cost-share to manage sagebrush rangelands to improve wildlife grouse habitat. These practices include Upland Wildlife Habitat Management (645), Prescribed Grazing (528), Prescribed Fire (338), Brush Management (314), and Grazing Land Mechanical Treatment (548). Each of these practices has specific criteria and standards NRCS planners must consider when developing landowner conservation plans. However, in the case of sage-grouse, additional considerations may be warranted because of their unique seasonal habitat requirements. For example, sage-grouse may use different types of sagebrush habitats for nesting, brood-rearing, and as fall and winter habitats. One specific habitat type that may be limiting in some sage-grouse populations is brood-rearing habitat. Several studies have described the importance of high quality brood-rearing habitat to chick survival and population recruitment. Dahlgren et al. (2006) documented that the proper application of mechanical and chemical brush treatments (314) can enhance brood-rearing habitats in higher elevation (> 7000 feet) rangeland habitats dominated by mountain big sagebrush (*A. tridentata* spp. *vaseyana*) habitats. While both chemical and mechanical treatments can reduce sagebrush cover and increase forb cover to within the levels suggested in the brood-rearing habitat guidelines (Connelly et al.

2000), concerns have been expressed about the longevity, environmental impacts, and fossil fuel dependency of these methods.

One possible alternative, although somewhat controversial, method of managing sagebrush ecosystems is through grazing by livestock. When improperly applied, grazing can suppress succession and alter community composition and ecosystem structure and function. Properly managed grazing systems can have 4 generally beneficial impacts on landscapes. These benefits include: 1) alteration of the composition of the plant community, 2) increased productivity of selected species, 3) increased nutritive quality of the forage, and 4) increased habitat diversity through altering structure (Vavra 2005). Much of the available literature on the impacts of grazing on wildlife species consists of largely of observational studies. Thus, there is a need for designed, controlled experiments on the interaction between appropriate grazing regimes and wildlife.
This information will assist NRCS planners in incorporating additional criteria and considerations established conservation practices to include Upland Wildlife Habitat Management (645), Prescribed Grazing (528), and Brush Management (314).

Study Area

This research was conducted on Parker Mountain in Garfield, Sevier, Piute and Wayne Counties located in south central Utah. The study area consists of 265,500 acres of which 53,500 acres are managed by the U.S. Forest Service (USFS), 89,900 by Bureau of Land Management (BLM), 108,300 by Utah School and Institutional Trust Lands Administration (SITLA), and 13,700 acres by private landowners. Parker Mountain is a sagebrush-dominated plateau at the southern edge of sage-grouse range. It is one of the four remaining areas in Utah with relatively stable numbers of sage-grouse and it includes some of the largest contiguous tracts of sagebrush in the state. The predominant land use is grazing by domestic livestock at a stocking rate of 3.6 acres per AUM. Sheep and cattle are moved seasonally through 10 grazing pastures beginning in lower elevation pastures in June. As vegetation in these pastures desiccates, livestock are sequentially herded into more mesic higher elevation pastures. This study was conducted at approximately 9000 feet elevation. The area is dominated by mountain big sagebrush and used by sage-grouse during the brood-rearing period. This area receives from 16-20 inches of precipitation annually. Precipitation in this area generally exhibits a bi-modal pattern with most precipitation occurring either as rain during the seasonal monsoonal period from late summer and early autumn or as snow during winter.

Experimental Design

To conduct this experiment we identified 8 paired-plots (1 paired-plot = 1 treatment plot and 1 reference plot) on similar ecological sites in 2006. Four paired-plots were located in areas previously treated in 2001 using a once-over mechanical treatment using a Dixie harrow (Figure 2). The other 4 paired-plots were located to the south of the Dixie harrow treatment in areas where no vegetation management had previously been conducted. The plots were approximately 8 acres in size. Where possible, plots were elongated to increase edge/area ratios. The plots were randomly assigned to as treatment or reference areas. Within each plot, 4 randomly located 33 foot vegetation transects

Figure 2. The Dixie harrow is popular grazing land mechanical treatment used to reduce sagebrush canopy cover and enhance understory vegetation diversity.

were established.

An electric fence was built around each plot randomly selected grazing treatment. The average perimeter of the plots was 2700 feet. Fences consisted of 3 strands of wire (~8100 total linear feet) with fiberglass posts spaced approximately 20 feet apart for a total of 135 posts per plot. A solar panel charged a 12 volt battery that kept current flowing through the wire. Fences were constructed in October 2006 once all cattle were removed from the area. Waiting until cattle were removed helped insure that there were no preexisting differences in vegetation resulting from some plots being protected from cattle grazing. Plots were grazed using a local sheep herd that was familiar with the vegetation on Parker Mountain. Approximately 1,000 sheep were used in conducting the experiment. Prior to moving sheep into the plots, the sheep were temporarily staged at a nearby site for initial fence and supplement conditioning. Sheep were not moved onto the plots until there had been at least 1 killing frost.

Waiting to begin grazing until after a killing frost

Figure 3. Plots were grazed until an adequate level of utilization had been achieved. We moved the sheep to new pasture when the level of utilization approximated that depicted in the photograph.

insured that most grasses and forbs had gone dormant and were therefore not negatively affected by grazing. Waiting until after frost also resulted in reduced monoterpene levels in sagebrush, thereby increasing palatability. Once the above mentioned conditions were met and sheep were moderately familiar with the aversive nature of the electric fence and had learned to eat the supplement, the flock was divided into 2 groups of approximately 500 sheep each. Each of the 2 groups was moved onto a different plot resulting in a stocking density of approximately 63 sheep per acre in each plot. A protein and energy supplement was provided inside the plot daily at a rate of approximately 3lbs/head/day. Sheep were taken to water once per day unless sufficient snow was available for their consumption.

Plots were grazed until an adequate level of utilization had been achieved (Figure 3). Prior to beginning the grazing treatments, the average sheep body condition was determined. Average body condition was also determined at the end of the grazing treatment to determine the general impact of grazing sagebrush on the sheep.

Immediately after sheep were removed from each plot a series of 3 levels of herbivore exclosure was established. The exclosures were randomly located within the plots and exclosures were abutted against one another. Each herbivore exclosure was approximately 26.4 square feet. The 3 levels of herbivore exclosure were: open to all herbivores, exclusion of large herbivores (cattle, pronghorn antelope, mule deer, elk), and total exclusion (insects and some very small mammals were still be able to access the area but lagomorphs and larger rodents were excluded). The purpose of these exclosures was to assess the impact of different guilds of herbivores on vegetation in plots. No measurements were taken in the exclosures until the summer of 2007. Vegetation in exclosures was measured using the Daubenmire frame method for understory cover, species composition, and height (Connelly et al. 2003).

Initial vegetation measurements were conducted in mid-July 2006 during peak plant production. Param-

eters measured include shrub species composition, height, and cover (line-intercept), and understory cover (rock, bare, litter, forb, grass) and height. Understory cover was estimated using the Daubenmire frame method (Connelly et al. 2003). Once vegetation measurements were taken on all plots sage-grouse pellet counts (at each end of each transect, 3 foot radius) were conducted in each plot.

Beginning in mid-June, when most sage-grouse chicks are able to fly, we conducted walking surveys in each plot. These surveys consisted of 4 people spaced approximately 66 feet apart. Plots were surveyed for sage-grouse by walking along one of the long sides of the roughly rectangular plot and then walking back along the adjacent side. Two walking surveys were conducted per year. In late-July when once sage-grouse chicks flight capabilities were further refined, we conducted bird-dog surveys in each plot (Figure 4). All plots are surveyed with bird-dogs at least once per summer. During walking and bird-dog survey, all grouse flushed from within or around plots are counted and recorded as male, female, juvenile or unknown. Sage-grouse pellet counts, walking surveys, bird-dog surveys, shrub density sampling, plot vegetation measurements, and exclosure vegetation measurements were repeated yearly through 2009.

Figure 4. Bird dog surveys constitute and effective and efficient methods of conducting late brood-rearing season sage-grouse use surveys.

Response of Vegetation

Prior to the application of the grazing treatments, sagebrush cover was virtually equal in plots assigned to the grazing and reference treatments (Figure 5). In 2007, plots having received the grazing treatment the previous Fall had an average sagebrush coverage of 8.6 percent whereas sagebrush coverage in reference plots increased slightly from the previous summer to 27 percent. Over subsequent years, sagebrush coverage has continued to increase in both reference and grazed plots. A regression analysis of sagebrush cover in grazed plots indicates that cover is increasing at a rate of approximately 4 percent per year (Figure 6).

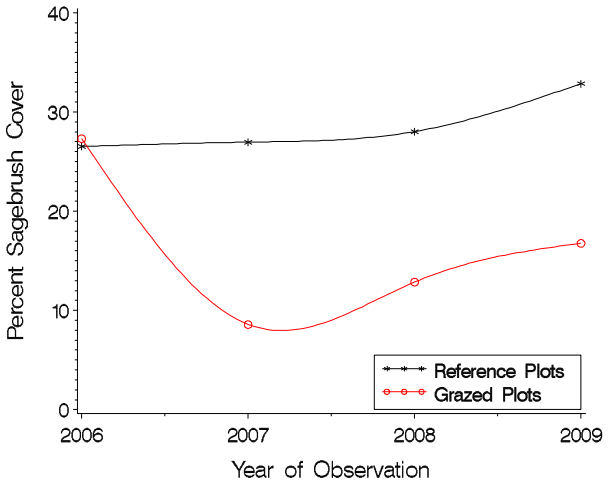

Figure 5. Percent sagebrush cover in grazed and reference plots.

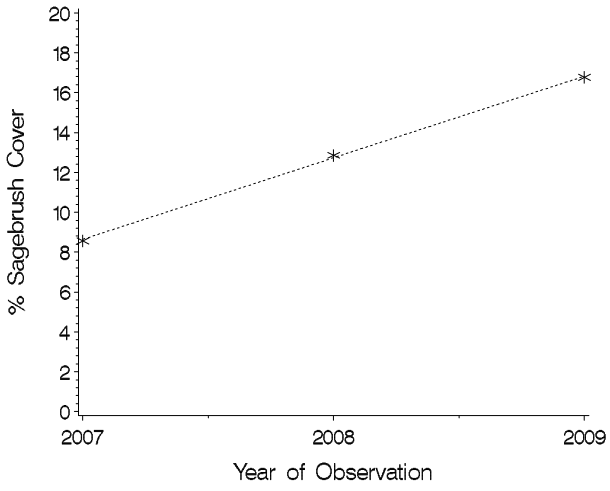

Figure 6. Increase of sagebrush cover in plots having received the grazing treatment (slope = 4.09, R_2 = 0.999, p = 0.0171.

At this estimated rate of increase, sagebrush canopy cover in grazed plots may have return to pretreatment levels by 2012. When sagebrush canopy cover was evaluated relative to the effects of the previous 2001 sagebrush mechanical treatment (Figure 7), the canopy cover in the plots that were grazed by sheep was lower when compared to the grazed plots that had not been mechanically treated.

Forb percent cover was initially 4 % more in reference plots than in randomly selected grazing treatment plots (Figure 8). In 2007, forb cover declined in both grazed and reference plots, but was slightly higher in grazed plots. This overall decline in forb cover was likely attributable to the drought conditions experienced during the spring and summer of 2007. Snowpack and rainfall were greater in both 2008 and 2009. During these two years forb cover increased in all plots relative to the 2007 levels with the greatest increases occurring in grazed plots. The plots were not fenced throughout the duration of the experiment and thus subjected to grazing both wildlife and domestic livestock. Because we anticipated that herbivory might occur at different levels in treated and reference plots, we placed herbivore exclosures in each plot in 2007. Examination of forb coverage in the various levels of exclosure reveals several interesting observations (Figure 9). In general, forb coverage was greater in ungulate and total exclosure areas. When we only examined the data from the grazed plots, we discovered that areas that had not been protected by exclosures, had considerably less forb cover than the grazing exclosures. This indicated that wild and domestic herbivores were impacting forb cover. Interestingly, forb cover was highest in treated plots with total herbivore exclusion. These data suggested that rabbits and small rodents may be reducing forb cover by as much, or possibly more, than large herbivores. Figure 10 depicts the forb response to the experimental grazing varied considerably across years and between the sagebrush manipulation. Forb cover in 2007 was lower for all treatment combinations than it had been

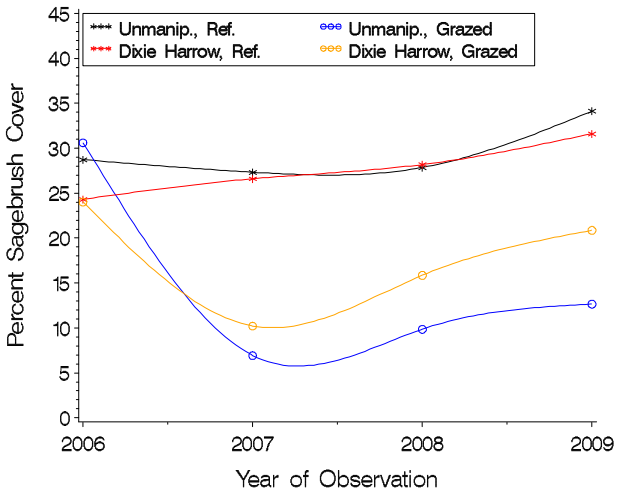

Figure 7. Percent sagebrush cover in grazed and reference plots by pretreatment of sagebrush.

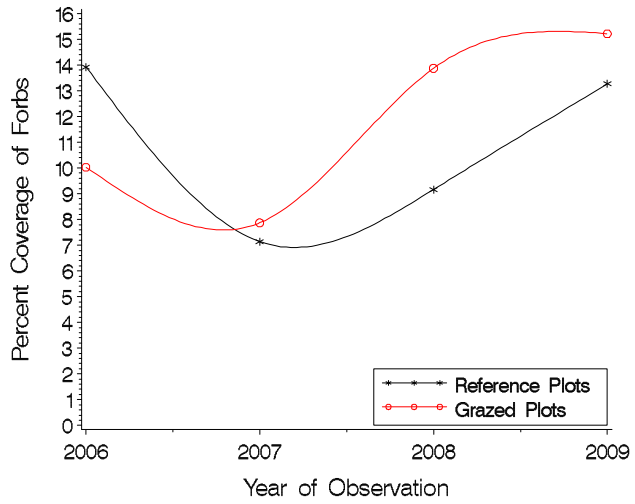

Figure 8. Percent forb cover in grazed and reference plots.

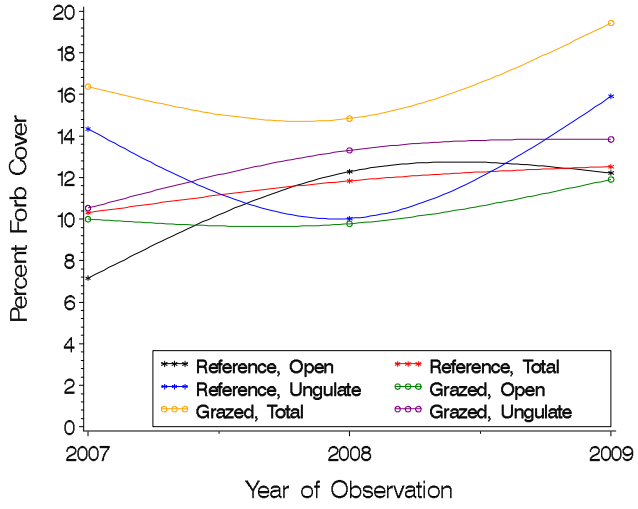

Figure 9. Average forb cover in grazed and reference plots by level of herbivore exclosure.

the previous year except for the previously unmanipulated-grazed plots where an increase in forb cover was detected. From 2007 through 2009, forb cover increased in all plots with coverage being greatest in the unmanipulated-grazed plots every year.

Grasses provide important forage and habitat for many wild and domesticated animals. Grass cover responded in a similar manner as did forbs. Figure 11 depicts the response of grass cover when herbivores were not excluded. The percent grass cover varied little across years or between treatments. Exclusion of herbivores in reference plots results in an increase in grass cover compared to open areas, however, the two levels of exclosure did not differ. Similarly, there was little difference between the two levels of exclosure in grazed plots. However, in 2008 and 2009 grass cover was higher in grazed exclosures than in reference exclosures. This indicates both that the grazing treatment result resulted in increased grass cover and that rabbits and small rodents herbivory did impact grass forage production.

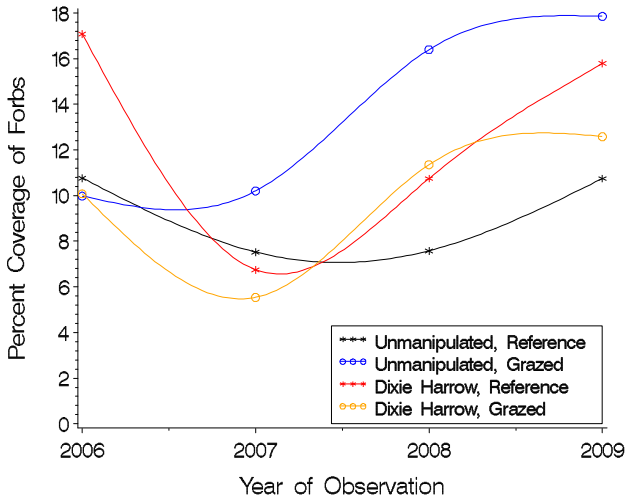

Figure 10. Average forb cover in grazed and reefernce plots by pretreatment of sagebrush.

Sage-grouse Responses

Bird-dog surveys conducted in July 2006, prior to application of grazing treatments, indicated that sage-grouse selected for plots that would become the ungrazed reference sites (Figure 12). During the three years following the grazing treatments, sage-grouse numbers recorded in reference plots declined, while twice as many birds flushed from grazed plots.

Area constrained surveys were not conducted in 2006 because the actual grazing plots were established in late summer. Surveys conducted in 2007-2009 indicate that sage-grouse selected for the grazed plots

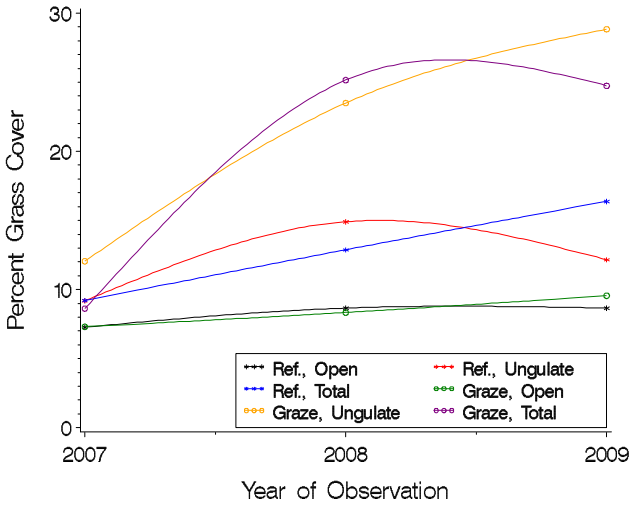

Figure11. Average grass cover in grazed and reference plots by level of herbivore exclosure.

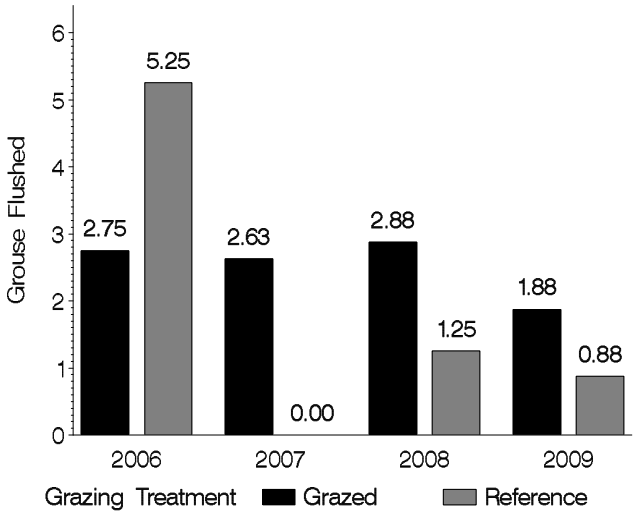

Figure 12. Average number of sage-grouse observed during bird-dog flush counts.

(Figure 13). Although forb cover during our study was lowest in both grazed and reference plots in 2007, sage-grouse densities were the highest that year. This may be explained by the fact that the study site experienced a severe drought during the late spring and early summer of 2007. Therefore, even thought the grazed plots did differed little from reference plots, this difference was biologically important. Conversely, the site received excellent spring and summer precipitation in 2008 and although forb cover was much higher in grazed plots the habitat overall was in better condition.

Summary

Land managers in the western United States do have options for managing sage-grouse habitat. Formerly, these options have largely been limited to herbicides and mechanical treatments with little consideration given to the role that domesticated livestock could play in a part of sustainability management system. Our study demonstrated that strategic intensive sheep grazing constituted a viable means of managing sage-grouse brood-rearing habitat at higher elevations that receive at least 16 inches of precipitation annually. However, it must be noted that this method, like any other land management option, can be applied incorrectly and even to the detriment of wildlife. As the term implies, there are both strategic and intensity considerations that must factor in to the application of this method. The strategic component is actually 2-fold. First, habitats must be clearly defined. It would not be appropriate to apply a tool aimed at improving brood-rearing habitat to nesting habitat. Secondly, the timing of the application must be chosen carefully to maximize the likelihood of achieving the desired goal. High grazing intensity is key to the success of the method. Livestock have been conditioned over many successive generations to avoid eating sagebrush. High stocking density forces animals to consume sagebrush more quickly and allows for the desired utilization level to be achieved quickly with little to no detrimental effect on the animals.

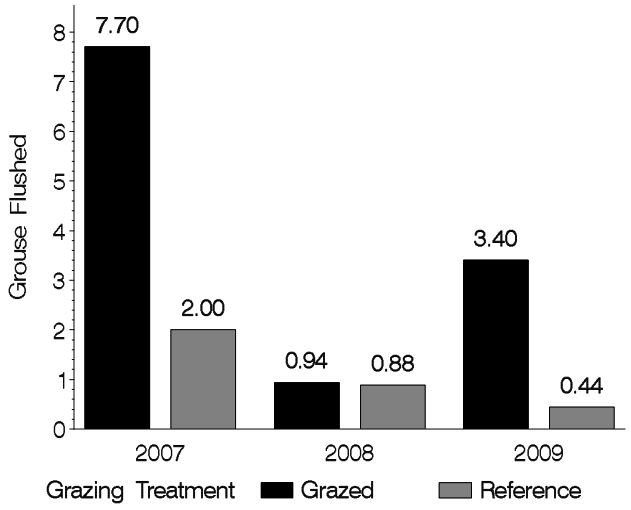

Figure 13. Average number of sage-grouse observed during area constrained surveys.

The cost per acre for the mechanical treatments was $150 per acre. Including the cost of the supplement used for the sheep, the cost per acre of the grazing treatment was $100 per acre. Because of logistic constraints (i.e. lack of sheep herds), the application of strategic intensive sheep grazing to manage sage-grouse brood-rearing habitat will be limited in terms of the acres that could be managed annually. Mechanical and chemical treatments can be applied over extensive areas and have demonstrated the capability of achieving the same goal (i.e. reducing sagebrush cover and increasing forb cover). However, an important aspect of managing sagebrush rangelands to maximize sage-grouse habitat benefits is maintaining habitat edges that provide escape cover (Dahlgren et al. 2006). By applying this method on an annual basis, it would be possible to create a mosaic of small resource-rich habitat patches across a landscape using readily available tools. Additionally, the development of additional criteria under NRCS conservation practices Prescribed Grazing (528), and Brush Management (314) that would allow cooperators to enter into cost-share agreements to defray the cost of the supplement would encourage the application of strategic sheep grazing to manage sagebrush rangelands for sage-grouse. For mechanical treatments to be cost effective, they must be applied to large acreages resulting in a landscape mosaic dominated by large open-

ings with small islands of untreated sagebrush.

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Field Day Summary

Grazing Sagebrush with Sheep to Enhance Greater Sage-grouse Brood-rearing Habitat

Summer field tours have been held annually on Parker Mountain since 1997. These field tours are sponsored by the Parker Mountain Adaptive Resources Management Sage-grouse Local Working Group (LWG). The LWG was organized in 1996 to develop and implement a sage-grouse conservation plan. On 17 May 2007 we toured the project site as part of the LWG's annual tour. The tour was attended by over 50 private landowners, grazing permittees, representatives from state and federal land management agencies (including the U.S. Forest Service, U.S. Bureau of Land Management, Utah Division of Wildlife Resources, and Utah School and Institutional Trust Lands Administration), County Agricultural Extension Agents, Utah Farm Bureau, and faculty and staff from Utah State University. Grazing treatments had been applied the previous fall and the full impact of the highly intensive grazing was evident. In 2008 we participated on the LWG field tour that was held on 19 June. Attendance was similar to the 2007 field tour with the addition of representatives from the U.S. Fish and Wildlife Service, Southern Utah University, the Western Watersheds Project, and Wild Utah Project. Data from the 2007 and early 2008 field seasons was presented (Figures 1-4). In 2009, the LWG field tour was conducted on 23 June. The attendance was similar to previous tours. By this time of this tour, most participants were familiar with the project, its objectives, and results. Reaction to this research by agricultural producers and land management agencies has been overwhelmingly positive.

Figure 1. Participants in the 2008 Annual Parker Mountain Adaptive Resources Management Sage-grouse Local Working Group discuss sage-grouse conservation.

In addition to the field tours, presentations were made at the following events:

March 13-14, 2007 at the Utah Sage-grouse Summit in Salt Lake City, Utah, 125 participants.

June 22-25, 2008 at the Western State's Grouse Conference in Mammoth Lake, CA, 230 participants.

October 30, 2008 at the BEHAVE Conference in Park City, Utah, 120 participants.

Reports

Guttery, M. R., D. K. Dahlgren, D. Caudill, G. Hochnedel, T. Black, and T. A. Messmer. 2008. Parker

Figure 2. The sheep grazing experiment was implemented in October 2006. We used one herd of sheep divieded into two flocks to graze the plots.

Mountain Adaptive Resource Management Group. 2008 Annual Report. Utah State University. 24.pp.

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Figure 3. After a brief period of adjustment, the sheep seemed to relish eating sagebrush, totally removing all of the leaves and nipping the stems.

Figure 4. This 2006 photo provides a landscape view of a plot after grazing. Within a matter of days, the sheep removed all of the sagebrush leaves and turned the soil over.

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Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah

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Acknowledgments and Disclaimer

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For information on the USDA NRCS Sage-grouse Restoration Project, contact Terry A. Messmer, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT 84322; (435) 797-3975; terry.messmer@usu.edu.

Acknowledgments:

We would like to gratefully acknowledge the cooperation and assistance of the Rich County landowners involved in this project. Partners in this project included Utah Division of Wildlife Resources, Utah Department of Natural Resources - Endangered Species Mitigation Fund, U.S. Fish and Wildlife Resources - State Wildlife Grants, NRCS, Intermountain West Joint Venture, USU, and the Bureau of Land Management Utah State Office. The Rich County Cooperative Resource Management group and Deseret Land and Livestock also provided valuable assistance. Thanks also to the various USU graduates who shared data and resources as well as the dedicated technicians who made the project possible.

Photos were provided by Frank Howe and Roger Stringham, Utah Division of Wildlife Resources, 1594 W. North Temple, Suite 2110, Salt Lake City, UT 84114-6301; Phone: 801-244-4329; E-mail:frankhowe@utah.gov. (See photos of Frank and Roger working with sage-grouse.)

Frank Howe working with sage-grouse.

Roger Stringham working with sage-grouse.

Technical Summary

Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah

Greater sage-grouse (*Centrocercus urophasianus* hereafter sage-grouse) are sagebrush (*Artemisia* spp.) obligates that inhabit sagebrush-steppe ecosystems in western North America. Schroeder et al. (2004) reported that prior to European settlement, sage-grouse occupied habitats in 15 states and 3 Canadian providences. Currently sage-grouse inhabit 11 western states and 2 Canadian providences. Sage-grouse populations have also declined range wide by as much as 47% in the last 50 years (Connelly and Braun 1997). These declines have been attributed to the direct loss and degradation of habitat (Connelly et al. 2000, Crawford et al. 2004).

Crawford et al. (2004) suggested that the solutions to sage-grouse population declines are multifaceted and require integration of science and management to solve the problems facing sage-grouse. Connelly et al. (2004) suggested that the adaptive management process is so important because effects of management must receive unbiased evaluation to determine its effectiveness and then management adjustments must be made. Concern over sage-grouse population declines has increased interest in the management of sagebrush habitats to benefit the species.

There are basically 3 categories of manipulations that have been used to manage sagebrush. These include mechanical, chemical, and biological. These techniques have been used to remove sagebrush to increase livestock forage and to manage sagebrush habits to increase sage-grouse productivity. The scale at which projects are carried out may be critical to their success as sage-grouse management strategies. Connelly et al. (2000) recommended that habitat improvements that result in the direct loss of sagebrush cover should be implemented at small scales. Additionally, there also is a need for replicated controlled studies to evaluate the effects of activities on sage-grouse populations and to identify the proper protocols to monitor habitat and population responses.

We employed a 2-tiered study design that encompassed a the county-wide level where habitat and sage-grouse use data were collected at random locations across a tessellated grid at grid points separated by 5,000 m to 10,000 m; and where data were collected at the study site level at grid points separated by 625 m to 2,500 m. At the study site level, we focused on two areas where large scale treatments have been recently conducted and where additional treatments were planned. These study sites included areas on Deseret Land and Livestock (DLL) and the Duck Creek Allotment (DCA) managed by the Bureau of Land Management (BLM) located in Rich County in northeastern Utah. In these areas, we collected data before and after treatments in treated and untreated areas. We also collected information from historically treated areas in the two primary study sites and across the county. This combination of approaches allowed us to assess the immediate impact of sage reduction treatments on sage-grouse as well as evaluate long-term recovery after such treatments.

We used several methods to assess greater sage-grouse habitat use in areas where sagebrush cover is being actively reduced (treated), areas of historic treatment (retrospective), and reference (untreated) areas. We assessed the efficacy of several methods which range from "quick and dirty" to state-of-the-art. This allowed us to develop portable and efficient means of evaluating sage-grouse use on a broader scale. Methodologies evaluated included: 1) distance sampling to estimate density of sage-grouse pellets (potential index to use), 2) flushing counts using trained dogs and distance sampling techniques (snapshot measure of use), 3) occupancy estimation (proportion of landscape used), and 4) GPS radio-telemetry (roost site and seasonal use). Because habitat use may vary with population size, we also conducted lek counts and attempted

to associate these counts with habitat use measures.

We found relatively heavy sage-grouse use in areas where sagebrush cover was reduced with a pasture aerator. However, use patterns varied by elevation and season. Lower elevation treated sites (< 7,000 feet) had a greater use than higher elevation (> 7,000 feet) sites and grouse, particularly females, used treated sites earlier in the summer. We recommend that sagebrush reduction be used cautiously, particularly at higher elevations where sagebrush is co-dominant with species such as serviceberry (Amelanchier spp.) and only when brood-rearing habitat appears to be limiting.

While comparison of techniques is ongoing, preliminary results indicate that pellet transects provided a relatively inexpensive and reasonably accurate measure of grouse habitat use; though caution must be taken to avoid overestimating use because pellets may persist on the landscape. Occupancy sampling may also be a useful tool, though because it requires multiple visits to yield a detection probability, it may be more costly than pellet transects. Use of GPS radio-telemetry proved very informative and is recommended when little is known of local habitat use patterns; GPS telemetry, while highly accurate, is quite expensive and under the current technology requires recapture of the radio. Finally, dog flushing did not prove an effective technique in this study; because it required unpractical line transects lengths in order to get the minimum sample size required to yield reliable density estimates.

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Technical Report

Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah

Greater sage-grouse (*Centrocercus urophasianus* hereafter sage-grouse) are sagebrush (*Artemisia* spp.) obligates that inhabit sagebrush-steppe ecosystems in western North America. Schroeder et al. (2004) reported that prior to European settlement, sage-grouse occupied habitats in 15 states and 3 Canadian providences. Currently sage-grouse inhabit 11 western states and 2 Canadian providences. Sage-grouse populations have also declined range wide by as much as 47% in the last 50 years (Connelly and Braun 1997). These declines have been attributed to the direct loss and degradation of habitat (Connelly et al. 2000, Crawford et al. 2004).

Crawford et al. (2004) suggested that the solutions to sage-grouse population declines are multifaceted and require integration of science and management to solve the problems facing sage-grouse. Connelly et al. (2004) suggested that the adaptive management process is so important because effects of management must receive unbiased evaluation to determine its effectiveness and then management adjustments must be made. Concern over sage-grouse population declines has increased interest in the management of sagebrush habitats to benefit the species.

There are basically 3 categories of manipulations that have been used to manage sagebrush. These include mechanical, chemical, and biological. These practices have been previously implemented on private and public land to remove sagebrush to increase livestock forage. More recently, the practices are being used to manage sagebrush habits to improve sage-grouse habitat. Many of these practices implemented on private land were cost-shared by the Natural Resources Conservation Service (NRCS). Specific cost-share practices implemented included Prescribed Grazing (528), Grazing Land Mechanical Treatment (548), and Brush Management (314).

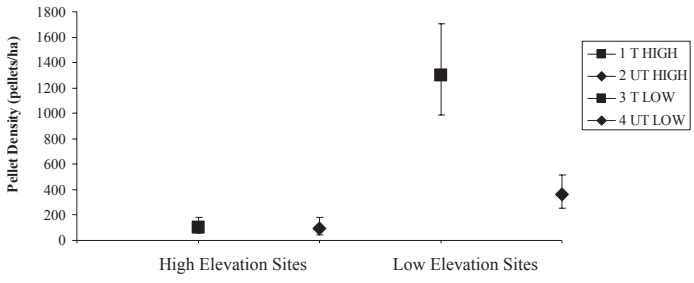

Figure 2. Pellet densities from distance sampling transects on treated and untreated sites at high and low elevation sites in Duck Creek Grazing Allotment Utah.

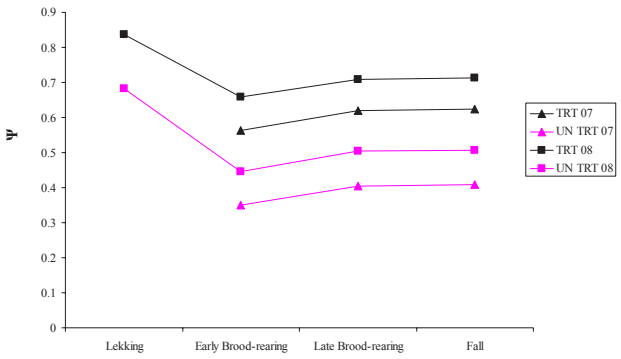

Figure 3. Seasonal probability of occupancy (Ψ) for treated and untreated sites in Duck Creek Allotment Utah in 2008 and 2009 seasons.

The scale at which projects are carried out may be critical to their success as sage-grouse management strategies. Connelly et al. (2000) recommended that habitat improvements that result in the direct loss of sagebrush cover should be implemented at small scales. Additionally, there also is a need for replicated controlled studies to evaluate the effects of management actions on sage-grouse populations and to identify the proper protocols to monitor habitat and population responses.

Our project addressed the following objectives: 1) evaluation of sage-grouse response to sagebrush reduction, 2) determination of Ecological Site Descriptions and habitat characteristics of areas used by sage-grouse; 3) determination of habitat characteristics of sage-grouse use areas; and, 4) the development of "portable" and efficient sage-grouse monitoring techniques through evaluation of various assessment methodologies.

Figure 4. Greater sage-grouse showing GPS/VHF radio attachment. Radio unit is glued to an upper layer of thin plastic which is affixed to a lower layer of plastic with a zip tie. The lower plastic is glued to the clipped and acetone-cleaned back feathers of the bird. The radio can be removed for data downloading by clipping the zip tie and the will eventually be "molted".

Study Area and Design

We employed a 2-tiered study design that encompassed the county-wide level where habitat and sage-grouse use data were collected at random locations across a tessellated grid at grid points separated by 5,000 m to 10,000 m; and where data were collected at the study site level at grid points separated by 625 m to 2,500 m. At the study site level, we focused on two areas where large scale treatments have been recently conducted and where additional treatments were planned. These study sites included areas on Deseret Land and Livestock (DLL) and the Duck Creek Allotment (DCA) managed by the Bureau of Land Management (BLM) located in Rich County in northeastern Utah (Figure 1). In these areas, we collected data before and after treatments in treated and untreated areas. We also collected information from historically treated areas in the two primary study sites and across the county. This combination of approaches allowed us to assess the immediate impact of sage reduction treatments on sage-grouse as well as evaluate long-term recovery after such treatments.

Project Status

The Sage-grouse Restoration Project (SGRP) provided the pivotal seed money for this multi-partner project. Unfortunately SGRP funding was only available for one year of this four-year project. Despite the lack of SGRP funding, the project is on schedule to meet

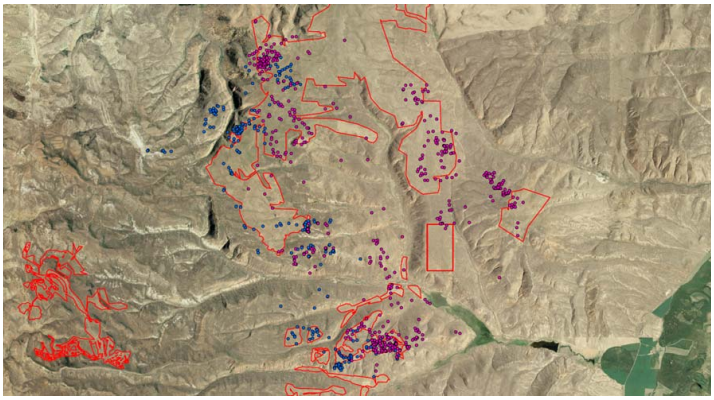

Figure 5. GPS locations of male (purple) and female (blue) greater sage-grouse in and adjacent to Duck Creek Allotment Utah. Areas within red polygons were treated to reduce sagebrush cover.

all primary objectives by the end of 2010. The Utah Division of Wildlife Resources (UDWR) and the Utah Department of Natural Resources (DNR) have provided additional funding to complete this project. This report summarizes our preliminary findings by the stated objectives. This project is being coordinated with several other shrub steppe wildlife research projects in Rich County. While the UDWR and NRCS/SGRP were the main funding sources, additional in-kind and personnel support has been provided by the Intermountain West Joint Venture, U.S. Fish and Wildlife Service (USFWS), BLM, S.J. and Jessie Quinney Foundation, the Rich County Coordinated Resource Management (CRM), U.S. Forest Service (USFS), U.S. Geological Survey, North American Space Administration, and private landowners. We are also coordinating with Utah State University (USU) researchers who are developing Ecological Site Descriptions and state-transition models for shrub steppe in Rich County and USU researchers studying sage-grouse in other areas of the state.

Preliminary Results

Objective 1: Evaluation of sage-grouse response to sagebrush reduction

Pellet transects: In 2008 and 2009, we collected sage-grouse use data on 77 transects in treated areas and 50 transects in untreated areas in DCA (where sampling was most intense). In several areas we found high densities of pellets that indicated possible lekking activity. We visited these sites in the spring and discovered several new satellite leks in these areas.

Our initial analysis indicated that treatments in DCA had higher densities of pellets than untreated sites. We sampled treatments in high and low elevation areas, and found apparent differences also occurred between elevations. Preliminary analysis (Figure 2) shows that treatments at low elevations contained higher densities of pellets than treatments at high elevations. At high elevation sites, pellet densities did not differ between treated and untreated areas; however, at low elevations pellet densities were higher in treated than untreated sites.

We have been able to collect before-after treatment pellet data on a 150 acre site at DLL in 2007, 2008 and 2009. We conducted 20 pellet transects per year within and adjacent to the treatment area. Our preliminary data showed little change in densities of sage-grouse pellets before and after the treatment. We observed a slight decline in pellet densities immediately following the treatment, but nothing that would suggest a major affect on sage-grouse use of the area.

Occupancy plots: We collected four seasons of occupancy sampling data at DCA in 2008: Season 1: May 5 – May 23; Season 2: 16 June- 4 July; Season 3: 28 July - 15 August; Season 4: 8 - 26. Results indicated that sage-grouse use is highest in Season 1. Preliminary analysis (Figure 3) indicates that sage-grouse use declines in Season 2, but remains fairly constant thereafter. We suspect that densities of sage-grouse decline from Season 2 through Season 4 based on our anecdotal observations of sage-grouse within the area, and data from our GPS telemetry. However, use of plots by sage-grouse continued throughout the year.

Dog flushing transects: We were largely unsuccessful in locating sage-grouse with this technique during the sampling period. We expanded our sampling effort to cover treated and untreated sites during various seasons but still had difficulties locating enough sage-grouse for an adequate sample size. We feel that this method failed because our sampling periods did not coincide with highest periods of sage-grouse use. To prevent disruption of nesting and newly hatched grouse, we avoided using dog flushing during lekking and nesting periods which is when sage-grouse use of treatments was highest.

GPS telemetry: In 2008 and 2009 we conducted trapping work, by spot lighting and netting, during the months of April and May. Telemetry units were affixed to the backs (Figure 4) of over 33 birds (18 males and 15 females), resulting in ~100-200 locations per bird (~2 locations per bird per day). The small (<30 g) "micro-GPS" could not be remotely downloaded, so grouse were recaptured to collect to location data and recharge the telemetry units (which were left on

the birds). As intended, many of the GPS units were "molted" off grouse before the birds needed to be recaptured. VHF transmitters allowed relocation of marked birds and "molted" radios for up to 6 months.

Initial radio telemetry (Figure 5) results indicate that male sage-grouse used DCA treated areas primarily during the lekking season. By mid June most males had moved to higher elevation sites away from the DC treatments. Most female sage-grouse used DCA treatments until July, and then began moving to higher elevation habitats. Both male and female grouse used the same area for summer habitat, which largely consisted of agricultural land enrolled in the Conservation Reserve Program located northwest of DCA.

Objectives 2 and 3: Determination of Ecological Site Descriptions and habitat characteristics of areas used by sage-grouse

Vegetation data were collected at all pellet transects, occupancy plots, and GPS telemetry locations from during the summer of 2008 and 2009. Vegetation was also sampled at locations across the county where sage-grouse were incidentally flushed; all Rich County technicians and graduate students recorded GPS locations of all sage-grouse "sightings" made during incidental field work. Through cooperation with other researchers in Rich County, vegetation sampling was conducted at several thousand sampling points in treated, untreated and retrospective study sites across the county. Imagery (as described in the 2006 report) and on-the-ground vegetation samples are being used to develop a continuous-field vegetation map of the area. This vegetation map will in turn be used in the development of habitat models and species abundance estimates for sage-grouse. The vegetation data will contribute to the determination of habitat characteristics and Ecological Site Descriptions (ESDs) at our study sites and across Rich County (our data were shared with Drs. Douglas Ramsey and Neil West). This work will be completed in 2010.

Objective 4: Development of "portable" and efficient sage-grouse monitoring techniques through evaluation of various assessment methodologies.

During our 3 field seasons, we field tested distance and occupancy pellet sampling, dog flushing (with distance sampling) and GPS telemetry methods (see Objective 1 for results). We collected information on effort and cost required to conduct each of the field methods and weighed this against data quality to determine which methods or combinations are most efficient. Distance sampling has worked well with sage-grouse pellets. It has been relatively easy to use, and is not very time consuming. It provided good data for comparing use of treated and untreated areas. Distance sampling was not efficient when using dogs to locate sage-grouse. We found that it required impractically long transects to meet the minimum independent observation requirements.

Occupancy sampling also appeared to be a good way to monitor sage-grouse use of an area. However, we found that occupancy sampling required relatively intense effort compared to distance sampling especially when collecting multiple seasons of data within a year. Reliable occupancy estimated requires 3 visits per season and we sampled for 4 seasons.

Preliminary assessment of our GPS telemetry data indicates that the data was consistent and very accurate (compared to VHF triangulation). GPS radios allowed us to collect two locations per bird per day for approximately 2.5 months. However, GPS telemetry technology is new to sage-grouse and has some considerable drawbacks. GPS units small enough to fit on sage-grouse can not be remotely downloaded or released; radios (and usually the birds) must be recaptured to get the stored-on-board data. Recapturing grouse on our study site proved extremely difficult and time-consuming as grouse moved in to areas of heavy cover late in the summer; we averaged 6 nights of effort for each radioed bird recaptured. Also, our GPS radios did not collect locations at the same time each day, but persistently collected locations several minutes later each day throughout the sampling period. This method is also expensive as each GPS/VHF radio unit cost approximately $1,700.

Summary and Recommendations

We found relatively heavy sage-grouse use in areas where sagebrush cover was reduced with a pasture aerator. However, use patterns varied by elevation and season. Lower elevation treated sites (< 7,000 feet) had a greater use than higher elevation (> 7,000 feet) sites and grouse, particularly females, used treated sites earlier in the summer. We recommend that sagebrush reduction be used cautiously, particularly at higher elevations where sagebrush is co-dominant with species such as serviceberry (*Amelanchier* spp.) and only when brood-rearing habitat appears to be limiting.

While comparison of techniques is ongoing, preliminary results indicate that pellet transects can provide a relatively inexpensive and reasonably accurate measure of grouse habitat use; though caution must be taken to avoid overestimating use because pellets may persist on the landscape. Occupancy sampling may also be a useful tool, though because it requires multiple visits to yield a detection probability, it may be more costly than pellet transects. Use of GPS radio-telemetry proved very informative and is recommended when little is known of local habitat use patterns; GPS telemetry, while highly accurate, is quite expensive and under the current technology requires recapture of the radio. Finally, dog flushing did not prove an effective technique in our study to estimate populations; it required unpractical line transects lengths to get the minimum sample size required to yield reliable density estimates. However, Dahlgren et al. (2010) reported that the use of bird dogs to determine sage-grouse brood use of treated plots was highly effective. In their study, they compare several techniques for determining sage-grouse brood response to management actions. They reported pellet count transects were also highly effective (Figure 6).

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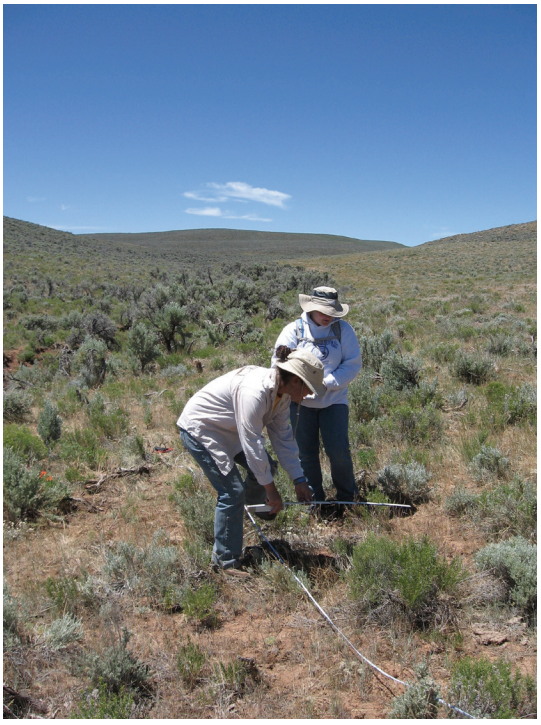

Figure 6. Photo shows one transect from research trial.

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Field Day Summary

Greater Sage-grouse Use of Restored Sagebrush Areas in Rich County Utah

The Rich County Coordinated Resources Management Local Working Group (CRM) was organized in 2001 for the purposes of coordinating land management activities. The CRM is composed of local landowners, businessmen, state and federal agency representatives and environmental interests. The group meets quarterly to plan and review proposed management actions. Additionally they host annual field tours of project sites. Beginning in 2007, the annual CRM tours included visits to our study site. These tours attracted over 50 participants representing the CRM membership. In 2007, we hosted a fields tour for 100 managers and scientists from across the United States that were attending the Restoring the West Symposium sponsored by Utah State University.

Photo 1. Annual field tours of the project sites attracted a cross section of stakeholders to include private landowners, county officials, agency representative, and environmental interests. These tours increased public awareness of and interest in the conservation implications of the research.

Photo 2. Duck Creek Tour in 2006.

Photo 3. Young boy who was able to attend research tours.

Development of a Sagebrush Habitat Improvement Guide for the Gunnison Sage-grouse by Evaluating Recently and Historically Treated Areas within the Gunnison Basin

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Associate Professor
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Acknowledgments and Disclaimer

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Acknowledgments:

I would like to express my appreciation to John Scott, NRCS District Conservationist in Gunnison, for his insight, GIS support, help in locating many of the historically treated areas, and technical review of the results. This project would not have happened without his support. Sincere appreciation also goes out to Scott Borden, Tyler Brummer, Sarah Cannon, Rachel Estrada, Dana Higgins, and Brent Walker for their many hours in the field collecting vegetation data. I would also like to acknowledge the USDA-NRCS/Utah State University Sage-grouse Restoration Project, Gunnison County Colorado, and the Colorado Division of Wildlife for providing funding for this project.

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Technical Summary

Development of a Sagebrush Habitat Improvement Guide for the Gunnison Sage-grouse by Evaluating Recently and Historically Treated Areas within the Gunnison Basin

Gunnison sage-grouse (*Centrocercus minimus*) were classified as a separate species of grouse in 2000 (Gunnison Sage-grouse Rangewide Steering Committee 2005). This species inhabits the Gunnison Basin in Colorado and southeastern Utah. Gunnison sage-grouse currently occupy 8.5% of their historical range (Schroeder et al. 2004). The species is now limited to seven known populations in Colorado and one population in southeastern Utah The decline in the range of the species has been attributed to the loss or conversion of sagebrush (*Artemisia* spp.) to other land uses (Gunnison Sage-grouse Rangewide Steering Committee 2005).

Gunnison sage-grouse are considered as a species of special concern for management purposes because the rapid decline in the species distribution and abundance. The greatest threat to the species is loss, fragmentation, and degradation of sagebrush (*Artemisia* spp.) habitats. In 1995, the first local working group had formed to develop a local conservation plan to guide species management in the Gunnison Basin (Gunnison Sage-grouse Rangewide Steering Committee 2005). In 2005, the Gunnison Sage-grouse Rangewide Steering Committee published the Rangewide Conservation Plan (RCP) to help guide conservation efforts of local working groups (Gunnison Sage-grouse Rangewide Steering Committee 2005).

Gunnison sage-grouse are a sagebrush obligate species that also require a diversity of plant species to meet their seasonal habitat needs. In the Gunnison Basin, achieving sagebrush communities that exhibit a diverse vegetation understory is difficult because most of the sage-grouse habitat lies in the more xeric zones. This zone tends to be dominated by Wyoming sagebrush (*A. tridentata* ssp. *wyomingensis*), because this deeper rooted plant species can access limited water resources. To increase understory diversity (i.e., grasses and forbs) on sagebrush dominated rangeland in the Gunnison Basin, land managers have implemented various practices to remove sagebrush. Many of these practices implemented on private land were cost-shared by the Natural Resources Conservation Service (NRCS). Specific cost-share practices included Prescribed Grazing (528), Grazing Land Mechanical Treatment (548), and Brush Management (314). Historically, these removal measures were implemented in an effort to increase forage production for livestock and big game. More recently, sagebrush treatments have been implemented to enhance seasonal habitats for Gunnison sage-grouse.

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 percent cover for sagebrush on xeric sites is 15% (Gunnison Sage-grouse Rangewide Steering Committee 2005). Based on the treatments we evaluated, the use of brushmowing and application of tebuthiuron herbicide are viable options for managing sagebrush cover on xeric sites to increase vegetation diversity and allow for gradual recovery of the sagebrush community. Sagebrush canopy cover on xeric sites recovered the quickest following brushmowing (12 years). For tebuthiuron 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 tebuthiuron, the longer the recovery period. Prescribed fire is not commonly used to manage sagebrush cover on xeric sites because the fuel load is lacking. Sagebrush management on xeric sites following application of 2,4-D herbicide is not recommended because slow moisture is lacking. On the more mesic

sites dominated by mountain sagebrush (*A. t.* ssp. *vaseyana*), sagebrush recovered within 8 years following application of 2,4-D (8 years). The suggested minimum canopy cover level in the guidelines for mesic sites is 10%. The use of prescribed fire should be discouraged because our measurements indicated it would take 36 plus years for sagebrush to recover to the 10% level. However, prescribed fire should not be ruled out entirely as a management option in the more mesic sites, but the length of recovery and size of the burn must be considered during the planning phase.

In general, 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 as high as 17% 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. For the other treatments, grass cover increased soon after treatment which, although quite variable in magnitude, maintained over time. Overall, the grasses met the minimum height standard of 4 in. 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. Similar to grasses, there was generally no or only very weak relationships between age of a given treatment and canopy cover or height of forbs. Likewise, we did not find a relationship between age or type of treatment that corresponded to whether or not the forbs met the minimum cover guidelines.

Although increases in other shrubs following sagebrush control are often looked on unfavorably, some may actually benefit sage-grouse. For example, many species of rabbitbrush increase following treatment of sagebrush. We observed this response many areas treated with 2,4-D. Although not measured directly in this study, field observations indicated an increase in the abundance and diversity of insects that are potentially important for survival of sage-grouse chicks.

When interpreting findings from this study, please keep in mind that the data we collected and analyzed were generated through a retrospective study of historical treatments and not 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. However, in general the results we report can assist managers in selecting techniques as they plan and implementing projects designed to improve Gunnison sage-grouse habitats.

Before implementing any habitat improvement project, we encourage managers to consider the following questions: "What is the objective of the project?" and "What is the vision for the future condition of the landscape?" The next step is to inventory and evaluate available resources to better understand existing conditions and trends. This will help you select a course of action to achieve your objective.

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 landscape objectives.

Before implementing practices designed to reduce sagebrush cover to the current range of Gunnison sage-grouse, project planners and proponents should consult their state wildlife agency and/or the area's sage-grouse local working group to learn if sage-grouse occur in the project area and their seasonal habitat use patterns. Caution should be exercised in applying brush management techniques to sites with different elevations, annual precipitation, sagebrush, subspecies or soil substrates. Additionally, because sage-grouse use habitat edges which afford cover and food resources, any treatments conducted to benefit Gunnison sage-grouse must maximize this edge (Dahlgren et al. 2006). Thus rather than remove or manipulate large blocks of sagebrush at a time, employing an

alternative strategy of treating smaller patches or plots within brood-rearing habitat will increase vegetation diversity while maximizing edge hence protective cover. The use of tebuthiron at the lowest application rates on xeric soils will maximize edge by removing single sagebrush plants rather than entire communities. Incorporating sinuous treatment designs with mechanical treatments will create more edge habitat and may be more beneficial to sage-grouse. Based on our research, the use of fire to manage lower elevation and more xeric sagebrush sites in habitat occupied by Gunnison sage-grouse should be discouraged.

Literature Referenced

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Technical Report

Development of a Sagebrush Habitat Improvement Guide for the Gunnison Sage-grouse by Evaluating Recently and Historically Treated Areas within the Gunnison Basin

Introduction

In the mid 1970s the Colorado Division of Wildlife (CDOW) began studying sage-grouse (*Centrocercus* spp.) populations located within the state. Biologist noticed that the wings collected from sage-grouse in the Gunnison Basin of Colorado were smaller than those of other populations. These observations led to further studies on the Gunnison Basin populations which discovered differences in morphometrics, breeding behavior, plumage, and genetics (Figure 1). This resulted in the reclassification of the grouse species that inhabits the Gunnison Basin in Colorado and southeastern Utah as the Gunnison sage-grouse (*C. minimus*) in 2000 (Young et al. 2000, Gunnison Sage-grouse Rangewide Steering Committee 2005).

Gunnison sage-grouse currently occupy 8.5% of their historic range (Schroeder et al. 2004). Their original range encompassed 21,376 mi^2, but is now estimated to be 822 mi^2 (Schroeder et al. 2004, Figure 2). The decline in the range of the species has been attributed to the loss or conversion of sagebrush habitats (*Artemisia* spp.) to other uses.

The species is now limited to seven known populations in Colorado and one population in southeastern Utah (Figure 3). In 2004, the population was estimated to be fewer than 3,200 birds; of which 2,400 occur in the Gunnison Basin, Colorado population (Gunnison Sage-grouse Rangewide Steering Committee 2005).

Gunnison sage-grouse are considered as a species of special concern because the rapid decline in the species distribution and abundance has caused the remaining populations to be unusually small and isolated. Identified potential threats to the Gunnison sage-grouse include low genetic diversity, genetic drift from small population sizes, habitat loss, degradation and

Figure 1. Comparison between greater sage-grouse and Gunnison sage-grouse. Comparison photos courtesy of Dean Mitchell, Utah Division of Wildlife Resources.

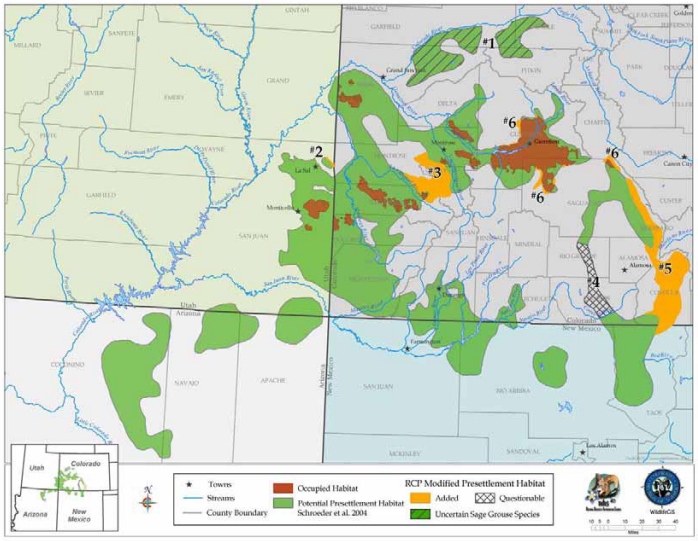

Figure 2. Current and historical Gunnison sage-grouse range (Gunnison Sage-grouse Rangewide Steering Committee 2005).

fragmentation, impacts of drought, predator communities, and the interactions of all these threats (Gunnison Sage-grouse Rangewide Steering Committee 2005). The greatest threat to the species is loss, fragmentation, and degradation of sagebrush habitats.

Wildlife managers became concern about the small population sizes in the 1990's. In 1995, before the Gunnison sage-grouse was classified as a separate species, the first local working group had formed in the Gunnison Basin of Colorado. This local working group published a species conservation plan in 1997 (Gunnison Sage-grouse Rangewide Steering Committee 2005). Shortly afterward, 6 other local working groups were formed and each prepared a conservation plan to address the threats to the local other populations.

Environmental groups petition the U. S. Fish and Wildlife Service (USFWS) in January 2000 to list the species as endangered (Gunnison Sage-grouse Rangewide Steering Committee 2005). However, prior to this petition the USFWS had taken steps to designate the species as a candidate for listing as threatened or endangered. Because of this designation the status of the species was annually reviewed annually to determine if a listing was warranted. In 2004 the USFWS removed the species from the Candidate Species list

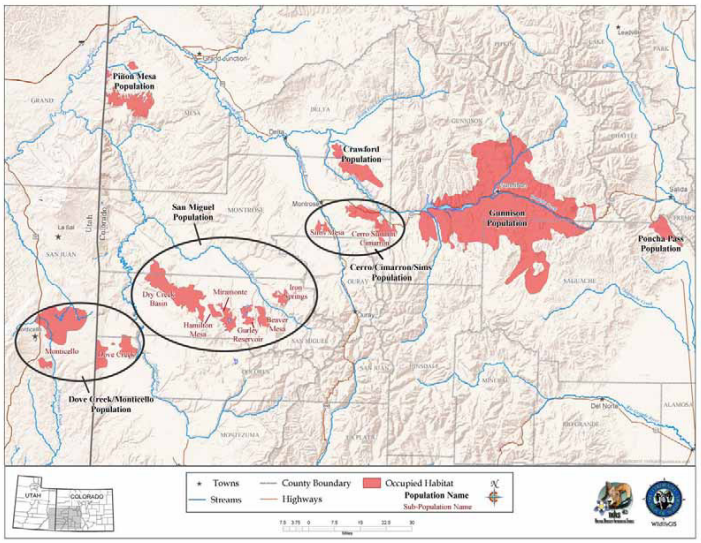

Figure 3. Locations of current Gunnison sage-grouse populations (Gunnison Sage-grouse Rangewide Steering Committee 2005).

because of stable population trends in the Gunnison Basin. In 2005, the Gunnison Sage-grouse Rangewide Steering Committee published the Rangewide Conservation Plan (RCP) to guide conservation efforts of local working groups.

Gunnison sage-grouse are a sagebrush obligate species. In addition to sagebrush, they also require a diversity of plant species to meet their seasonal habitat needs. Managing sagebrush dominated rangelands in the Basin for Gunnison sage-grouse has received increased attention because of the species status. In the Gunnison Basin, achieving sagebrush communities that exhibit a diverse vegetation understory is difficult to achieve because most of the sage-grouse habitat lies in the more xeric zones. This zone tends to be dominated by Wyoming sagebrush (*A. tridentata* ssp. *wyomingensis*), because of the ability of this deeper rooted plant species to access and use limited water resources. To increase understory diversity (i.e., grasses and forbs) on sagebrush dominated rangeland in the Gunnison Basin, land managers have implemented various practices to remove sagebrush. Many of these practices implemented on private land were cost-shared by the Natural Resources Conservation Service (NRCS). Specific cost-share practices implemented included Prescribed Grazing (528), Grazing Land Mechanical Treatment (548), and Brush Management (314). Historically, these practices were implemented to increase forage production for livestock and big game. More recently, sagebrush treatments have been implemented to enhance seasonal habitats for Gunnison sage-grouse.

The potential exists for sagebrush management practices to negatively impact Gunnison sage-grouse habitat potentials, especially over the short term. Over the long term, periodic sagebrush treatments coupled with prescribed grazing may create sagebrush communities that contain a diverse understory of grasses and forbs. These herbaceous species are critical for cover and food, especially during the nesting and early brood rearing phases Gunnison sage-grouse life cycle.

To better understand ecological processes occurring in the Gunnison Basin following implementation of

various NRCS practices, in 2006 we evaluated the vegetation responses in sagebrush communities that had been manipulated using various protocols at different points in time. We related our findings to the vegetation parameters published for sage-grouse breeding habitat (RCP 2005, Table 1). Parameters measured included vegetation 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 specific guidelines for standing dead woody material, we included this metric because standing dead material may provide cover in areas treated with herbicides where defoliated and dead sagebrush trucks and branches; i.e. skeletons, are left standing (Dahlgren et al. 2006). Each treatment method investigated is discussed separately.

Herbicide Treatment

Under the NRCS Brush Management Practice (314) landowners have been able to receive cost-share to apply herbicides to eradicate sagebrush. Two of the more popular herbicides used are tebuthiuron and 2,4-D. Thousands of acres of sagebrush have been treated with these herbicides range wide to increase forage production for livestock.

Tebuthiuron

Tebuthiuron is applied as a pelleted herbicide. Its primary use is the control of 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. Depending on application rates, soil composition, and moisture, this process can take as long as 3 years. When applied at low rates of 0.2 to 0.5 lbs active ingredient (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.

Tebuthiuron can be inactivated by binding with clay and/or organic matter in soils high in those two fractions. It is most active in coarse textured soils that are low in organic matter. The chemical can also damage herbaceous plants, especially if in close proximity to a pellet. Damage can be minimized by applying

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

tebuthiuron during the dormant season prior to the soil freezing. 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.

Tebuthiuron has been used in the Gunnison Basin in small scale demonstration trials and a few larger scale applications on private land. The oldest treated areas were established by the Bureau of Land Management (BLM) in 1994 at a number of locations throughout the Basin. At each location, BLM managers applied several rates of tebuthiuron 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 treated at the 0.2 lb a.i./acre rate. Year of application ranged from 1996 to 2002. We were only able to determine a sagebrush reestablishment for sites treated at the 0.2 lb a.i./acre rate. All of the areas treated were xeric sites dominated by Wyoming sagebrush. We did however survey one mesic site in which tebuthiuron had been applied, but did not collect data because the treatment had not effective. The soil organic matter may have been high enough at this mesic site to bind with the tebuthiuron and inactivate it at the lower rate of application.

Effects of Tebuthiuron on Vegetation Cover By Application Rates

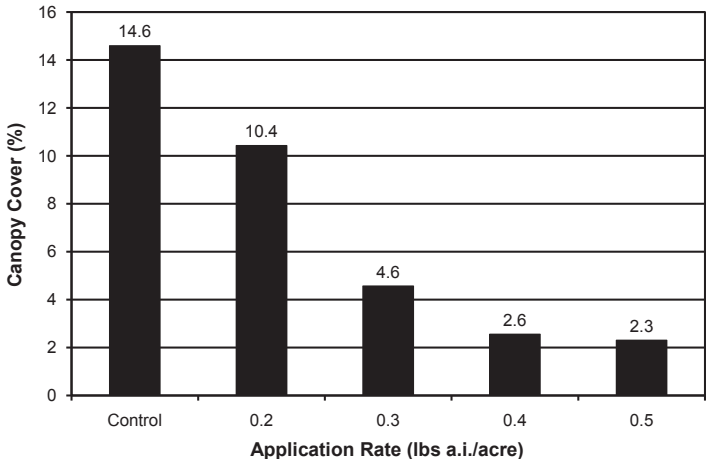

Figure 4. Canopy cover of Wyoming sagebrush in 2006 following application of tebuthiuron herbicide at different rates in 1994.

Using data collected from the 10 sample plots treated by the BLM in 1994, we were able to determine the effect of tebuthiuron application rates on sagebrush canopy cover (Figure 4). 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 dramatic sagebrush die-off in the Basin, especially on these xeric sites. The effect of the drought was also evident in the untreated areas near our sample plots. The average cover of standing dead woody material measured in the untreated controls at these sites was 14%.

Twelve years following application of tebuthiuron, sagebrush canopy cover in plots treated with 0.2 lbs a.i./acre averaged 10.4%. This was 4.2 % lower than the untreated plots. Treatment of sagebrush with 0.3, 0.4, and 0.5 lbs a.i./acre of tebuthiuron further inhibited recovery. The sagebrush canopy cover in these plots 12 years after treatment averaged only 4.6, 2.6, and 2.3%, respectively. Standing dead woody material was higher in all treated plots, averaging 12.8% across the different rates. In treated plots, it is difficult to separate out the effects of the herbicide versus the drought on percent cover of dead material.

Averaged across sites, we found no differences in canopy cover among the treatment or control plots or between the treatments for the other vegetation parameters measured for 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. Grass cover in the control plots averaged 15.2%, compared to 20.7% in the treated plots. However, when individual treated plots were compared to associated control plots, three of the 8 treatments sampled had higher grass cover (29.2 and 28.7% vs. 12.2%; 19.1% vs. 8.0%).

The Gunnison sage-grouse habitat guidelines recommend a minimum of 5% forb cover in breeding

habitat. Of the sites we studied, only the control plots exhibited forb canopy cover averages (7.5%) above the minimum guideline. The sites treated with 0.2, 0.3, 0.4 and 0.5 lbs a.i./acre of tebuthiuron had percent forb cover averages of 3.8, 4.9, 4.8 and 4.0%, respectively. Although, the control plots exhibited higher forb cover than treated plots, the differences were not statistically significant.

In addition to canopy cover, plant height is also an important component of Gunnison sage-grouse habitat. Average height of sagebrush plants in the treated plots (14.6 in.) was lower than in the control plots (11 in.). There was no difference in average sagebrush height between any of the plots treated with different rates of tebuthiuron. In all but two of the treated plots, sagebrush exceeded the minimum suggested mean height of 9.8 in. Although treatment with tebuthiuron applications 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 control plots averaged 8.7 in. compared to 6.3-7.1 in. in the treated plots. The recommended minimum height requirement for grass cover in breeding habitat is 4 in. We did not find any height differences between the plots

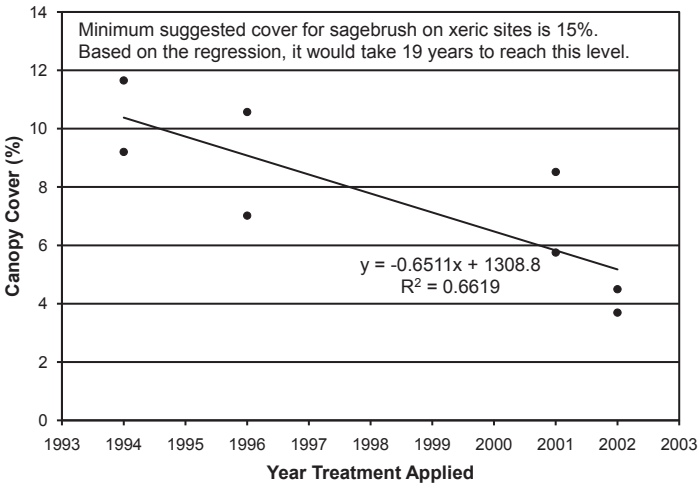

Figure 5. Canopy cover of Wyoming sagebrush in 2006 following application of tebuthiuron herbicide at 0.2 lbs a.i./acre at various points in time.

based on application rates. This observation was not totally unexpected. 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 tebuthiuron, competition for light is reduced and the growth form of grass plants changes from few taller stems with lower biomass to shorter and more robust stems with more canopy cover and higher biomass. We did not record any difference in forb heights in the treated and control plots.

Temporal Effects of Tebuthiuron Application Rates on Vegetation Response

Because 8 sites were treated with tebuthiuron at the 0.2 lb/acre rate at different times, we were able to create a regression equation to describe the relationship between age of treatment and sagebrush cover (Figure 5). Using this regression equation, we determined that it would take 19 years for sagebrush canopy cover to return to the recommended minimum of 15% for suitable breeding habitat. No similar analysis could be conducted for application rates 0.3 lbs a.i./acre and above because all of the areas sampled were treated at the same time. However, because canopy cover of sagebrush in these plots averaged between 2.3 and

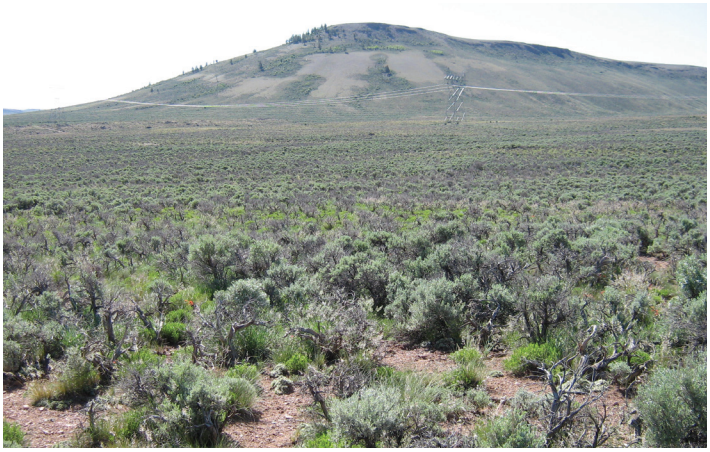

Figure 6. Vegetation response following application of tebuthiuron herbicide at 0.2 lbs. a.i./acre in 1996, Kezar Basin, Gunnison County, Colorado. Note thinning of sagebrush, with live sagebrush plants, partial live sagebrush plants, and sagebrush skeletons with some release of rabbitbrush. (Photo taken May 23, 2006)

4.6% 12 years after the treatment, we deduced that it would take longer than 19 years for the sagebrush canopy cover to return to 15%. Based on our evaluation, tebuthiuron applied at 0.2 lbs a.i./acre would thin the sagebrush canopy cover on xeric sites in the Gunnison Basin, promoting increased grass and forb cover, and allowing a gradual recovery of the site to achieve minimum habitat standards (Figure 6).

Although sagebrush canopy cover on the sites we studied was considerably reduced and took a longer period to recovery under higher application rates, we believe the use of higher application rates should not be eliminated. Because tebuthiuron is typically aerially applied, it would be very easy for the pilot to adjust rates and turn the applicator on and off as the plane navigates 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.

For the grasses, there was no relationship between age of treatment and canopy cover (R^2=0.07). We expected 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 tebuthiuron or the other treatments investigated. There was a general trend of increased canopy cover of grasses in the treated compared to control plots. Across all sites, canopy cover of grasses averaged 18.8% which was 4.2% higher compared to the untreated control areas. Three of the 8 sites had 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 5 in. in the recently treated areas to 19.2 in. in the older treated areas. Only 2 of the 8 treated areas did not meet the minimum suggested standard height for sagebrush of 9.8 in. 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 4 in. with an average across all sites of 6.5 in. Similarly, there was no relationship between forb height and age of treatment (R2=0.04) with an overall average of 2 in. Half of the sites achieved the minimum suggested standard of 2 in. and half did not (range of 1.2 to 2.8 in.).

2,4-D Herbicide

Since its introduction in the 1940s, 2,4-D herbicide has been used as a means of controlling sagebrush. Unlike tebuthiuron, 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 (*A. t.* 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

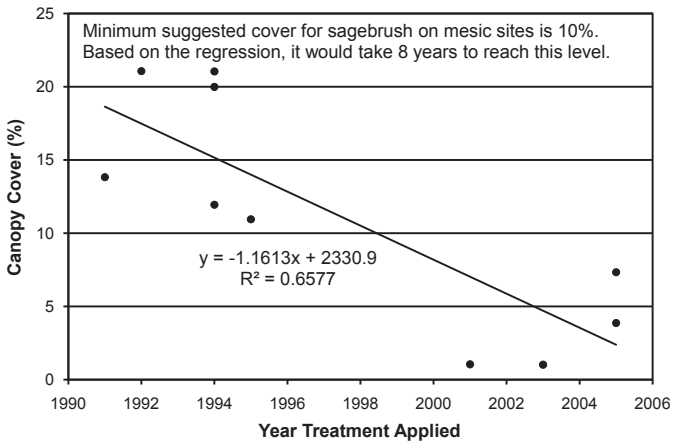

Figure 7. Canopy cover of mountain sagebrush in 2006 following application of 2,4-D herbicide at 2 lbs a.i./acre at various points in time.

We sampled 10 mesic sites 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 (Figures 7 and 8). To achieve 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 forbs tend to come and go over the growing season. Because 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.

Figure 8. 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)

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 11.8 in recommended for breeding habitat at mesic sites. Sagebrush height ranged from 9 to 17 in with an overall average of 12 in. for the 10 sites. Forb height was fairly consistent and exceeded the minimum of 2 in. for breeding habitat at all sites with an overall average slightly greater than 3 in. Average grass height ranged from 4 to 8 in. with an overall mean of 5.5 in. Height of grass exceeded the suggested minimum of 4 in. for mesic areas at all sites that were sampled.

Xeric Sites

Figure 9. 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)

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 are often lacking in the Gunnison Basin which results in varying degrees of partial sagebrush control (Figure 9). 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 (Figure 10).

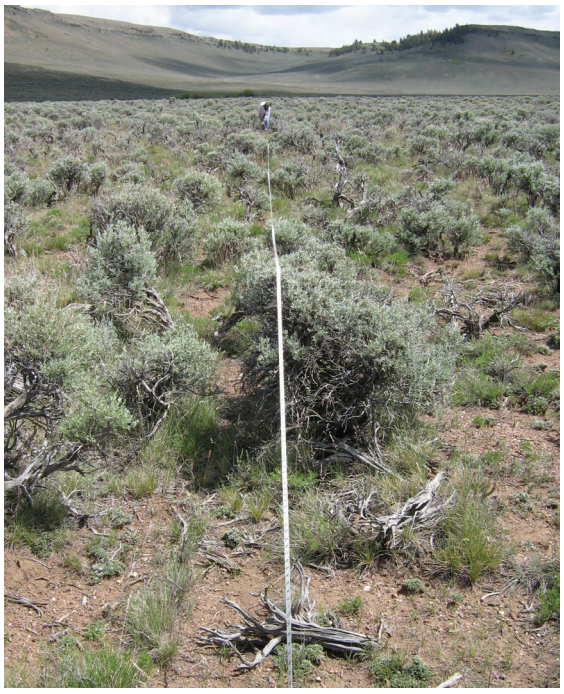

Figure 10. Recovery of Wyoming sagebrush following 2,4-D application at 2 lbs a.i./acre in 1992, Kezar Basin, Gunnison County, Colorado. Note remnant sagebrush skeletons. (Photo taken May 25, 2006)

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 (*Chrysothamnus* spp.). The oldest treated area (1984) had an average cover of other shrubs of 14.1%. This compared 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 9.8 in. The average sagebrush height across the 7 sites was 11.4 in. For grasses, all sites had average heights above the 4 in. minimum for breeding habitat with an overall average of 5.1 cm. Only 2 of the 7 sites did not meet the minimum height standard of 2 in. for forbs, the oldest (1984 – 1.5 in.) and most recently (2003 – 1.3 in.) treated areas. Across all sites, forbs averaged 2.4 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. However, because Gunnison 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 (Figure 11).

Figure 11. Example of a prescribed burn. Photo courtesy of Frank Howe.

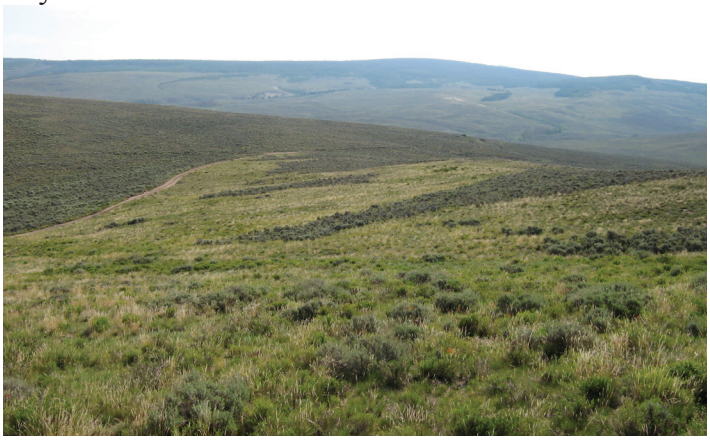

Figure 12. View of 1984 controlled burn, Sheep's Gulch, Gunnison County, Colorado. Note the landscape mosaic created by burned and unburned areas and lack of sagebrush recovery. (Photo taken July 18, 2006)

Mesic Sites

We sampled 16 mesic sites 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 cover 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 (Figure 12). Cover ranged from 0.2% (two separate sites burned in 1987 and 2001) to 4.6% (1987). Using data from 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 (Figure 13). If we excluded 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. Using only 1984 burns, we sampled 4 sites where cover of sagebrush ranged from 1.6 to 15.2% to illustrate how long and variable recovery can be. Taking into account these data, we estimated 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.

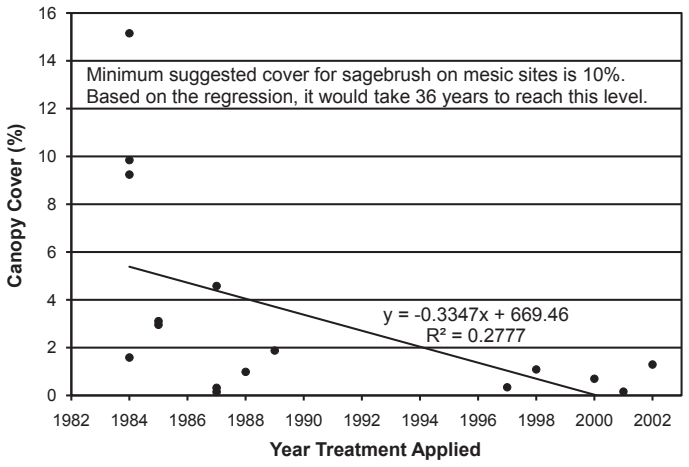

Figure 13. Canopy cover of mountain sagebrush in 2006 following wild and prescribed fire at various points in time.

There are several factors that can affect the speed of sagebrush recovery at a particular site. These factors include slope, aspect, soil type and depth, timing and amount of precipitation the first few years following the burn, as well as the 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.

For other shrubs, grasses, and forbs, we did not detect any relationship between percent cover and age of treatment (R^2=0.02, 0.11, and 0.15, respectively).

Figure 14. Grass and forb response to 1998 controlled burn on a mesic site, Almont area, Gunnison County, Colorado. (Photo taken August 10, 2006)

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% (Figure 14). Even so, only one site met the 20% minimum for forb cover at mesic areas. Grass cover was higher 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% (Figure 15).

Sagebrush height met the minimum standard of 11.8 in. 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 7.1 to 13 in. with an average across all sites of 10.2 in. Only four of the sites did not meet the minimum of 2 in. for forb height. Average forb height was quite variable with a range of 1.6 to 5.5 in. across sites and an average of 3.0 in. 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 4 in for grass height with an average of about 6.7 in. and a range of 5.3 to 10 in.

Figure 15. 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 sagebrush management practices, it tends to be one of the shorter lived brush management treatments and has one of the highest costs per acre. For these reasons, this method has not been widely used in the Gunnison Basin. Despite these drawbacks, brushmowing has grown in popularity within the last 10 years as a means of improving habitat for sage-grouse. With the habitat 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.

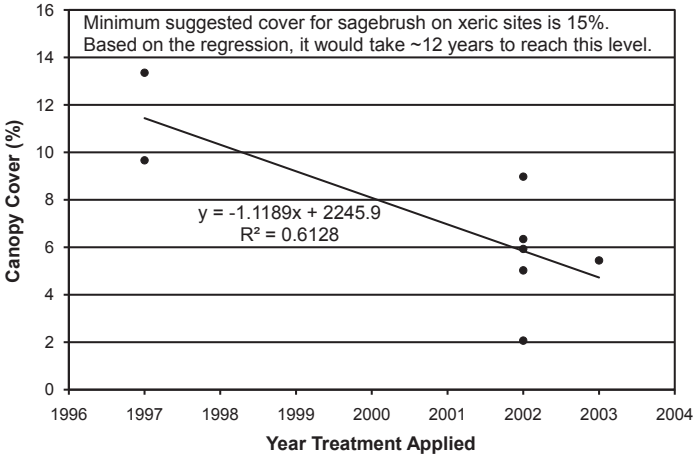

Figure 16. Canopy cover of Wyoming sagebrush in 2006 following brushmowing at various points in time.

Xeric Sites

Brushmowing has mainly been applied as a treatment in the Gunnison Basin on the more xeric sites dominated by Wyoming sagebrush. We sampled 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 determine some relationships.

Based on the sites sampled, we estimated it would take about 12 years for sagebrush canopy cover to return to the 15% minimum following brushmowing (Figure 16). None of the sites treated achieved 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 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 we reported on, there was a significant grass response (R^2=0.44). Grass cover was greatest in the younger treatments and declined as the treatments aged (Figure 17). 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 aver-

Figure 17. Muttongrass response in 2001 brushmow, Long Gulch, Gunnison County, Colorado. Untreated area on left; treated area on right. (Photo taken June 29, 2006)

age of 18.5% (Figure 18).

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 9.8 in. minimum. The overall average sagebrush height in the treated sites was 9 in. compared to 14.2 in. 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 2 in. in three of the eight treated sites. Forb heights ranged from 1.0 to 3.3 in. with an average of 1.9 in. For grasses, all but one site met the 4 in. minimum height standard for breeding habitat with an overall average of about 5.5 in.

Management Recommendations

When interpreting findings from this study, the reader should keep in mind the data we collected and analyzed were generated through a retrospective study of historical treatments and not a rigorously designed study. We evaluated historically treated areas at a point in time and compared our findings to Gunnison sage-grouse habitat guidelines. Thus, the results we report can assist managers in selecting techniques as they plan and implementing projects designed to improve Gunnison sage-grouse habitats.

Before implementing any habitat improvement project, we encourage managers to consider the following questions: "What is the objective of the project?" and "What is the vision for the future condition of the landscape?" The next step is to inventory and evaluate available resources to better understand existing conditions and trends. This will help you select a course of action to achieve your objective. 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 landscape objectives.

Before implementing practices designed to reduce sagebrush cover to the current range of Gunnison sage-grouse, project planners and proponents should consult their state wildlife agency and/or the area's sage-grouse local working group to learn if sage-grouse occur in the project area and their seasonal habitat use patterns. Caution should be exercised in applying brush management techniques to sites with different elevations, annual precipitation, sagebrush, subspecies or soil substrates. Additionally, because sage-grouse use habitat edges which afford cover and food resources, any treatments conducted to benefit Gunnison sage-grouse must maximize this edge. Thus rather than remove or manipulate large blocks of sagebrush at a time, employing an alternative strategy of treating smaller patches or plots within brood-rearing habitat will increase vegetation diversity while maximizing edge hence protective cover. The use of tebuthiron at the lowest application rates on xeric soils will maximize edge by removing single sagebrush plants rather than entire communities. Incorporating sinuous treatment designs with mechanical treatments will create more edge habitat and may be more beneficial to sage-grouse. Based on our research, the use of fire to manage lower elevation and more xeric sagebrush sites in habitat occupied by Gunnison sage-

Figure 18. 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)

grouse should be discouraged.

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Field Day Summary

Development of a Sagebrush Habitat Improvement Guide for the Gunnison Sage-grouse by Evaluating Recently and Historically Treated Areas within the Gunnison Basin

During the summer of 2006, I participated in 3 tours held were organized by the Natural Resources Conservation Service. The tours were organized by John Scott, NRCS District Conservationist, Gunnison Co. The tours focused on sagebrush habitat improvements for the Gunnison sage-grouse. I presented information concerning development of the habitat improvement guide at each tour. The first tour was held on the morning of June 14, 2006 to discuss the habitat assessment protocol we were using for this project. Information was presented to 17 people from the Gunnison Basin Strategic Committee for Sage-grouse (Figure 1). The committee has representatives from state and federal agencies and private landowners. The second tour was held on the afternoon of June 14, 2006 at the request of the U.S. Fish and Wildlife Service (USFWS) to highlight projects connected with the Gunnison sage-grouse. Of the 7 people in attendance, one was a congressional aide for a Colorado senator and one was a USFWS congressional liaison (Figure 2). The third tour was held for state legislators on August 17, 2006 with 50 people in attendance. The tour was hosted by the Gunnison-Dolores Watershed Group to highlight projects that local Conservation Districts have been involved in (Figure 3).

Figure 1. Field Tour June 14; Gunnison Basin Strategic Committee for Sage-grouse.

Figure 2. Field Tour June 14; U.S. Fish and Wildlife Service.

Power Point Presentations and Reports

We prepared 3 annual project reports and a PowerPoint presentation to summarize the project. These were posted on the Sage-grouse Restoration Project website.

Figure 3. Field Tour August 17; Gunnison-Dolores Watershed Group.