

CHAPTER 8

CONSERVATION PLAN

The strategies presented in this Chapter have not been formally approved or adopted by the Colorado Division of Wildlife (CDOW). In a separate process outside of this plan, the CDOW will analyze and prioritize recommended strategies and identify those to be considered during planning and budgeting processes. Timelines for completion of strategies will then be developed. Implementation of strategies by the CDOW is contingent upon adequate staffing and funding as well as agency priorities.

This plan is intended to provide resource managers with a conceptual framework for regional sagebrush conservation planning and management with regard to 11 species of concern. The overarching goal of this plan is to avert further decline of the species of concern within the assessment area. In this chapter, we 1) review the species groups, 2) identify and prioritize management emphasis areas for each species group, and 3) develop goals, objectives, and strategies for conservation of the species of concern.

Species Groups

The following three species groups were identified in [Chapter 7](#):

Group 1: Sagebrush obligate or near-obligate species

- Brewer's sparrow
- Sage sparrow
- Sage thrasher
- Sagebrush vole

Group 2: Species of sagebrush, other low or arid shrublands, and grasslands

- Black-throated sparrow
- Kit fox
- Northern harrier
- Vesper sparrow

Group 3: Species of sagebrush, montane shrublands, woodlands, and edges

- Green-tailed towhee
- Merriam's shrew
- Lark sparrow

Although use of species groups facilitates multi-species conservation planning at the regional scale, groups are imperfect surrogates for the individual species they represent. We acknowledge this limitation and outline management issues between and among individual species to help users of this plan take these limitations into account. [Chapters 4, 5, and 6](#) describe threats to individual species and their sagebrush habitat. [Table 8-1](#) summarizes potential habitat requirement differences between species, data gaps, and management and monitoring issues (more detailed discussion is provided in species profiles in the [Appendix](#)).

Identification of Management Emphasis Areas

For each species group, we identified geographic areas of sagebrush habitat to receive low, moderate, or high management emphasis. To identify these sagebrush habitat areas and assign management emphases, we used GIS to analyze the following data sets developed in previous chapters according to the criteria shown in [Figure 8-1](#):

1. Sagebrush patch size ([Chapter 3, Figure 3-3](#))
2. Species richness analysis ([Chapter 7, Figures 7-1, 7-2, and 7-3](#))
3. Risk to sagebrush from combined threats ([Chapter 4, Figure 4-5](#))

[Figures 8-2, 8-3, and 8-4](#) show areas of sagebrush habitat with recommended levels of management emphasis for Group 1, Group 2, and Group 3, respectively. It should be noted that the emphasis areas consider only sagebrush habitat for the species of concern. Non-sagebrush habitats are also important for conservation of the species of concern to varying degrees, but assessment and conservation of non-sagebrush habitats is beyond the scope of this document. The datasets and the criteria thresholds used to determine emphasis areas are described in more detail below.

Sagebrush Patch Size—Patch size and pattern on the landscape are very important to most of the species of concern (see [Chapter 5](#) and species profiles in the [Appendix](#)). Group 1 species in particular are known or suspected to require fairly large expanses of sagebrush, and Group 2 species generally require extensive shrublands though not exclusively sagebrush. Much of the sagebrush in the assessment area is quite patchy and fragmented, so that very large patches (at least several thousand hectares) are relatively uncommon. In the decision criteria ([Figure 8-1](#)), all sagebrush patches of at least 10,000 ha are characterized as moderate or high emphasis, if species richness and threat criteria are also met. All sagebrush patches of 100 to 10,000 ha are characterized as low or moderate emphasis, depending on other criteria.

Species Richness Analysis—Species richness is defined as the number of species in the species group identified with sagebrush habitat in a 30 x 30 meter sagebrush cell. The species richness datasets were developed for each group in [Chapter 7](#) from species habitat and range maps presented in [Chapter 6](#). Including species richness in the criteria helps to focus management on areas where sagebrush habitat exists for a majority of the species in the group. We used the following thresholds for species richness to determine moderate or high emphasis management areas (depending on other criteria, see [Figure 8-1](#)):

- Group 1: Habitat for at least 3 of the 4 species in the group,
- Group 2: Habitat for at least 2 of the 4 species in the group, and
- Group 3: Habitat for at least 2 of the 3 species in the group.

It was necessary to use a lower threshold for Group 2, because of less habitat overlap for species in that group.

Risk to Sagebrush from Combined Threats—Inclusion of this criterion helps to focus management on sagebrush areas most at risk from the four modeled threats to sagebrush ([Chapters 4 and 6](#)): encroachment by pinyon-juniper and invasive herbaceous plants, energy development, and residential development. Sagebrush in patches of at least 10,000 ha that also met the species richness criteria were characterized as high emphasis if combined threat was high or moderate, and low emphasis if combined threat was low or none. Sagebrush in patches of 100 to 10,000 ha that also met the species richness criteria were characterized as moderate emphasis if combined threat was high or moderate.

All sagebrush in the assessment area not characterized as high or moderate emphasis according to the above criteria and thresholds was characterized as low emphasis.

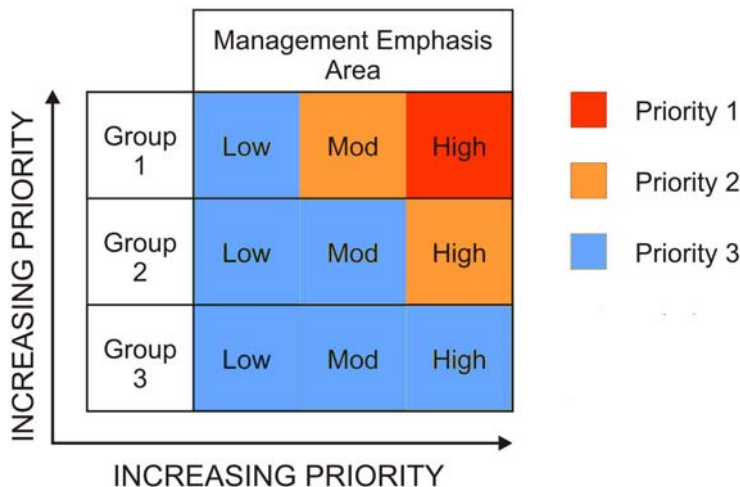
The locations of high and moderate emphasis areas are fairly similar for all groups. High emphasis areas are concentrated in much of Moffat County, the lower White River drainage, North Park, western Middle Park, Piñon Mesa in Mesa County, Dry Creek Basin in San Miguel County, and the lower elevations of the Gunnison Basin and the San Luis Valley in Costilla

County. High emphasis areas for Group 1 also occur in lower elevations of Eagle and southern Routt counties. Moderate emphasis areas generally occur in much of the rest of these areas, although for Group 1 moderate emphasis areas are not extensive in the Gunnison Basin. Moderate emphasis areas are most extensive for Group 3, reflecting the broad ranges and generally wide habitat tolerances of most of the Group 3 species. High and moderate emphasis areas for Group 3 encompass all of the respective emphasis areas for Group 1, but also extend into other geographic areas and in some cases to higher elevations.

Prioritization of Management Emphasis Areas by Species Groups

As explained above, we identified sagebrush management areas for each species group with low, moderate, or high management emphasis (Figures 8-2, 8-3, and 8-4). We recommend further prioritization of management emphasis areas by species groups, with first priority given to Group 1, second priority given to Group 2, and third priority given to Group 3. First priority for Group 1 species is due to their nearly complete reliance on sagebrush habitats. The protection of sagebrush habitat of suitable amounts and quality is the single biggest conservation issue for these species. Second priority for Group 2 is due to their partial dependence on sagebrush, and additional requirements for arid low shrublands that are susceptible to various land use threats including invasive herbaceous plants and residential development (see Chapter 4). Furthermore, two species in Group 2 (kit fox and northern harrier) have large home ranges and require large areas of contiguous habitat (see Appendix, species profiles), and kit fox populations in Colorado are critically depleted. Third priority for Group 3 species reflects their relatively low dependence on sagebrush, or use of edge habitats, and common use of either more mesic mountain shrublands or pinyon-juniper shrublands/open woodlands. These other habitat types tend to be less ecologically brittle than the majority of Group 1 and Group 2 species habitats, and are generally less at risk from the four modeled threats (see Chapter 4).

The relationship between management area emphases and species group priorities is shown in the following diagram.



After some exploratory analysis, we defined sagebrush priority areas, incorporating the management emphasis and species group information. The diagram above illustrates our rationale for the sagebrush priorities, and the sagebrush priorities are mapped in Figure 8-5. Some sagebrush 30 x 30 meter cells fall into different management emphasis areas for different species groups; that is, a sagebrush cell may have high management emphasis for Group 1 species (which we want to select as Priority 1 sagebrush) but moderate management emphasis

for Group 2 species (which we want to select as Priority 3). To resolve this, the sagebrush priority areas shown in [Figure 8-5](#) assign the highest possible priority to each sagebrush cell.

In practice, biologists and managers may want to analyze priorities in different ways, depending on local project objectives. Furthermore, the value of sagebrush patch size varies among species of concern (see [Chapters 3 and 5](#) and species profiles in the [Appendix](#)), and the landscape context. For example, small sagebrush patches (such as patches from 40 to 100 ha) may be of greater value to sagebrush-dependent species if they are well-distributed rather than sparsely distributed, and if they tend to form habitat bridges connecting much larger sagebrush patches. Finally, existing sagebrush habitat quality (shrub stand and understory characteristics, for example) is not identified in this assessment, but will be important for prioritization of projects at the local level. Therefore, we propose the sagebrush priorities shown in [Figure 8-5](#) as a general outline for regional prioritization, and follow this framework in the objectives and strategies below. We recommend that biologists and managers conduct additional prioritization at the local (project) level, to include the following steps:

1. Use the spatial data developed for this assessment (provided separately) to guide identification and prioritization of sagebrush maintenance or enhancement projects at the local level, because different data sets can be compared or combined in many ways to meet different objectives. For example, sagebrush priority areas can be spatially related to a particular threat model such as risk of energy development to define areas where that type of risk should be evaluated and addressed for all species of concern. Alternatively, a species richness model for one species group can be evaluated against a risk model to identify areas where that risk can be addressed for a single species group. In the strategies below, we include recommendations for conducting these types of further GIS analyses.
2. Consider landscape context when prioritizing sagebrush patches for maintenance or enhancement. For small sagebrush patches, higher patch density on the landscape is more valuable than lower patch density (for most species of concern), and patches that enhance connections between larger sagebrush patches are more valuable than patches that do not provide connections.
3. Evaluate sagebrush habitat quality at the local level. Patches of high quality shrub and understory characteristics are more valuable for protection efforts, and patches with lower habitat quality are suited for enhancement projects.

Defining Goals, Objectives, and Strategies

In this section, we define what we mean by goals, objectives, and strategies; define four conservation principles that guide the development of goals; and develop specific goals, objectives, and strategies for conservation of the species of concern.

We define *goals* as qualitative statements that describe long-term visions or standards; we define *objectives* as specific benchmarks that indicate progress toward or completion of goals; and we define *strategies* as tasks, actions, or projects that will lead to the accomplishment of the objectives. Timelines for completion of strategies will be developed by CDOW during a separate implementation process.

We begin by stating the following four *conservation principles* for the species of concern:

1. Identify and preserve high-quality sagebrush habitats and restore degraded sagebrush habitats for the species of concern.
2. Maintain self-sustaining populations of the species of concern in the assessment area.

3. Promote scientifically sound research to improve understanding of species of concern sagebrush habitat requirements and responses to habitat change.
4. Use new research-based knowledge to update and inform goals, objectives, and strategies in an adaptive management approach.

Coordination with Other Conservation Programs

The habitat-related goals in this document should be coordinated with sage-grouse habitat protection, improvement, and research efforts where possible and relevant. These include goals and actions described in the Gunnison Sage-grouse Rangewide Conservation Plan (GSRSC 2005) and the BLM National Sage-Grouse Habitat Conservation Strategy (BLM 2004). The BLM is also developing a state-level sage-grouse habitat conservation strategy for Colorado, tiered to the national strategy. Actions carried out in the assessment area under these programs that relate to surveys of habitat condition and trend, and to restoration of sagebrush habitats, are of particular importance to the conservation of species of concern addressed in this assessment. Conservation plans and actions completed or in preparation for Colorado covering greater sage-grouse, white-tailed prairie dog, and black-footed ferret also may relate to the goals of this assessment and strategy, and should be integrated where possible to avoid duplicative or contradictory efforts.

Existing species monitoring in the assessment area, particularly the Monitoring Colorado's Birds (MCB) program supported by CDOW, are also of potentially high value to the goals of this assessment and strategy. Detailed discussion of integration of this plan's goals with other monitoring programs is provided under Objective 2 below.

Adaptive Management

Adaptive management is a concept that has been applied to problems of natural resources conservation since the 1970s, and since the 1990s has gained widespread attention and use as a way to increase the efficiency and reliability of conservation programs (Salafsky et al. 2001). In its essence, adaptive management is both a set of steps for organizing effort and resources (the "process"), and a series of concepts and viewpoints for analytical thinking (the "principles"). Salafsky et al. (2001) define the following steps in the process of adaptive management:

START: Establish a clear and common purpose

Step A: Design an explicit model of your system

Step B: Develop a management plan that maximizes results and learning

Step C: Develop a monitoring plan to test your assumptions

Step D: Implement your management and monitoring plans

Step E: Analyze data and communicate results

ITERATE: Use results to adapt and learn

Salafsky et al. (2001) outline the following principles to consider for adaptive management:

Principle 1: Do adaptive management yourself

Principle 2: Promote institutional curiosity and innovation

Principle 3: Value failures

Principle 4: Expect surprise and capitalize on crisis

Principle 5: Encourage personal growth

Principle 6: Create learning organizations and partnerships

Principle 7: Contribute to global learning

Principle 8: Practice the art of adaptive management

Adaptive management is a concept that applies to all phases of the conservation strategy for species of concern. The objectives and strategies developed below incorporate adaptive management concepts to define specific issues and needs, monitor and evaluate results, communicate needs and results, and use the lessons learned to improve performance.

Statement of Goals, Objectives, and Strategies

The remainder of this chapter presents three goals relating to maintenance and management of sagebrush habitat, monitoring of species of concern, and research needs. Under each goal one or more objectives is established, and for each objective a series of strategies is presented. The strategies represent “pick lists” of specific, measurable tasks that can be undertaken to meet the objectives. It is recognized that not all of the strategies may be undertaken because of limits on agency resources, so the strategies are presented in order of importance to meeting the objectives.

GOAL 1: MAINTAIN SAGEBRUSH HABITAT OF ADEQUATE QUANTITY, LANDSCAPE ARRANGEMENT, AND QUALITY FOR SPECIES OF CONCERN IN THE ASSESSMENT AREA.

Discussion: Conservation of the species of concern depends on the existence of suitable sagebrush habitat. Many aspects of sagebrush habitat may comprise suitability, and these factors vary among the species of concern. However, three factors are most important at the landscape scale and are treated in this assessment and plan: total area of sagebrush (sagebrush quantity), size and arrangement of sagebrush patches on the landscape, and quality of sagebrush habitat in terms of vegetation composition.

Objective 1.1: *Minimize sagebrush habitat loss and fragmentation, emphasizing Priority 1 and 2 patches.*

Discussion: [Figure 8-5](#) shows the locations of Priority 1, 2, and 3 sagebrush patches. Several of the species of concern are sensitive to patch size, and either require or reach maximum densities in large areas of contiguous sagebrush (see [Appendix](#), species profiles). Kit fox and northern harrier require open habitats on the order of thousands of hectares. Sage sparrow may require sagebrush of at least a few hundred hectares; Brewer’s sparrow and sage thrasher may require sagebrush patches of at least 40 hectares. Because of their limited mobility compared to birds, sagebrush vole and Merriam’s shrew are probably much less able to find and use small sagebrush patches; while little is known of the habitat needs of these species, the known range of the sagebrush vole suggests that this species requires very large expanses of sagebrush to persist over time.

Objective 1.1: Minimize sagebrush habitat loss and fragmentation, emphasizing Priority 1 and 2 sagebrush patches.	
Strategies:	
1.1.A	Formulate and publicize a CDOW position encouraging protection of Priority 1 and 2 sagebrush patches from substantial further loss, fragmentation, or degradation, while acknowledging all existing legal rights.
1.1.B	Participate in land use planning processes for public lands containing Priority 1 and 2 sagebrush, and suggest land use alternatives that minimize substantial further loss, fragmentation, or degradation.
1.1.C	Participate in county and local land use planning processes for private lands containing Priority 1 and 2 sagebrush, and encourage land use alternatives that minimize substantial further loss, fragmentation, or degradation.

Objective 1.2: Reduce the impacts of understory encroachment by invasive herbaceous plants.

Discussion: Risk of understory encroachment by non-native, invasive herbaceous vegetation is probably the most extensive sagebrush habitat threat to the species of concern (Chapter 6). Priority 1 and 2 sagebrush patches (Figure 8-5) at high or moderate risk from weed encroachment (Figure 4-2) are the best candidates for preventive measures, especially where other widespread threats, which act as vectors for weed dispersal, are low. Significant understory encroachment likely already exists to varying degrees in sagebrush habitat in high risk areas. Understory restoration and maintenance are costly and success rates vary. Understory treatments should be focused on areas where chances of success are highest (Monsen 2004a; 2004b).

Objective 1.2: Reduce the impacts of understory encroachment by invasive herbaceous plants.	
Strategies:	
1.2.A	Based on availability of agency resources, select appropriate Priority level sagebrush patches and level of herbaceous weed threat for evaluation and management. Use GIS to identify the selected Priority patches that contain the selected level of herbaceous weed threat. Further prioritize sagebrush patches, if necessary, based on local knowledge of herbaceous weed threat.
1.2.B	In sagebrush patches selected in strategy 1.2.A, inventory and map the degree of understory encroachment by invasive herbaceous plants. Use the data to evaluate the performance of current understory encroachment threat modeling. Revise map as necessary.
1.2.C	Develop digital spatial data and criteria for identifying suitable sagebrush habitat patches for protection and treatment, using considerations in <i>Restoration Manual for Colorado Sagebrush and Associated Shrubland Communities</i> (Monsen 2004a, 2004b).
1.2.D	Develop or adapt existing model to predict rates of understory encroachment under different habitat conditions and management scenarios to assist with planning efforts to meet this objective.
1.2.E	Develop and initiate preventive measures by coordinating with private landowners and public agencies.
1.2.F	Develop and initiate treatment measures in selected sagebrush patches where substantial invasive herbaceous vegetation exists.
1.2.G	Monitor 1) spread of understory encroachment, 2) effectiveness of prevention and treatments; 3) how species of concern respond to treatments using controlled experiments designed directly into treatment regime and integrated with research in other goal areas, 4) overall effectiveness of different treatment methods. Integrate with research in other objectives under Goal 1. Biannually review results or progress.
1.2.H	Refine and revise the herbaceous weed threat model (see Assumptions and Limitations and Recommendations in Chapter 4). Potential improvements include: <ul style="list-style-type: none"> • Incorporate new published information as it becomes available on site characteristics favoring spread of cheatgrass, annual mustards, and other principal weed species. • Use the results of field checks of model predictions to test the model parameters. • Incorporate additional spatial data on existing weed infestations, such as county-level survey data. • Incorporate additional spatial data on disturbance locations, such as fine-scale roads, areas of energy development, and transmission line corridors. • Biannually review results or progress.

Objective 1.3: Reduce adverse impacts of energy development to species of concern.

Discussion: Risk of energy development is broadly moderate for sagebrush habitats of all species of concern (Chapter 6). Efforts should be focused in areas of Priority 1 and 2 sagebrush patches (Figure 8-5) that contain moderate or high risk from energy development (Figure 4-3). Strategies for this objective should be coordinated with sage-grouse habitat protection, improvement, and research efforts where possible and relevant.

Objective 1.3: Reduce adverse impacts of energy development to species of concern.

Strategies:

- 1.3.A Based on availability of agency resources, select appropriate level of Priority sagebrush patches and level of energy development threat for evaluation and management. Use GIS to identify the selected level of Priority patches that contain the selected level of energy development threat.
- 1.3.B In sagebrush patches identified in strategy 1.3.A, use field inventory and spatial data where available to map energy development. Use the data to identify sagebrush areas of greatest concern. Revise map as necessary.
- 1.3.C Establish preferred mitigation measures for energy development. These may include :
- Timing restrictions during sensitive periods such as breeding or wintering,
 - Speed limits on roads,
 - Minimizing infrastructure construction, and minimizing the number of trips and general disturbance associated with construction and operation of energy facilities,
 - Use of off-site mitigation where applicable to achieve the goals and objectives of this plan,
 - Evaluation and implementation of mitigation trust/banking opportunities where appropriate.
- 1.3.D During land use planning processes for energy development projects, provide and encourage the use of preferred mitigation measures on sagebrush patches identified in strategy 1.3.A. Opportunities exist during federal scoping and analysis, as well as at county and local levels.
- 1.3.E For private lands with sagebrush patches identified in strategy 1.3.A, encourage energy development agreements that incorporate preferred mitigation measures.
- 1.3.F Refine and revise the energy development threat model (see Assumptions and Limitations and Recommendations in [Chapter 4](#)). Potential improvements include:
- Incorporate new published information as it becomes available on potential impacts of energy development on the species of concern, and modify model parameters such as buffer distances as necessary.
 - Use the results of field checks of model predictions to test the model parameters.
 - Incorporate new spatial data on existing energy development as it becomes available.

Objective 1.4: Reduce the impacts of pinyon-juniper encroachment.

Discussion: Efforts should be focused in areas of Priority 1 and 2 sagebrush patches ([Figure 8-5](#)) that contain moderate or high risk from pinyon-juniper encroachment ([Figure 4-1](#)). Group 3 species are generally tolerant of scattered trees in sagebrush habitat, and are less likely to respond negatively to pinyon-juniper encroachment during early- to mid-successional stages. Overall risk of pinyon-juniper encroachment is higher for Group 2 sagebrush habitats than for Group 1, although much of the Group 2 risk is contributed by risk to historic kit fox habitat. To best benefit Groups 1 and 2, focus pinyon-juniper removal efforts where the largest patches of sagebrush would result. For example, a removal effort targeting 100 ha of relatively open woodland with a sagebrush-dominated understory of 20 percent canopy cover adjacent to a 100 ha sagebrush patch could effectively double the size of the sagebrush patch, potentially increasing its suitability for area-sensitive species in Group 1. Strategies for this objective should be integrated with sage-grouse habitat improvement efforts and the BLM's Pinyon-Juniper Treatment Inventory for the Colorado Plateau (<http://www.mpcer.nau.edu/pj/pjwood/>) or similar existing programs where possible.

Objective 1.4: Reduce the impacts of pinyon-juniper encroachment.

Strategies:

- 1.4.A Based on availability of agency resources, select level of Priority sagebrush patches and level of pinyon-juniper threat for evaluation and management. Use GIS to identify the selected Priority patches

	that contain the selected level of pinyon-juniper threat.
1.4.B	In selected sagebrush patches, use field inventory and spatial data where available to map pinyon-juniper encroachment. Use the data to identify sagebrush patches of greatest concern. Revise map as necessary.
1.4.C	Coordinate with BLM's Pinyon-Juniper Treatment Inventory for the Colorado Plateau, and with other entities as appropriate for other parts of the assessment area. Determine whether existing pinyon-juniper treatment programs in the selected Priority areas will meet the objective, and identify additional areas for treatment as necessary.
1.4.D	Initiate treatments to reduce pinyon-juniper in selected Priority areas.
1.4.E	Monitor 1) how species of concern respond to treatments using controlled experiments designed directly into treatment regime, and 2) overall effectiveness of different treatment methods. Biannually review results or progress.
1.4.F	Evaluate the completeness and effectiveness of this objective and the effort vs. the benefit of implementing each strategy. Review objective against population monitoring data (or models) and other relevant research to assess whether objective is sufficient to contribute to averting the decline of species of concern in the assessment area.
1.4.G	Refine and revise the pinyon-juniper encroachment threat model (see Assumptions and Limitations and Recommendations in Chapter 4). Potential improvements include: <ul style="list-style-type: none"> • Incorporate new published information as it becomes available on site characteristics favoring pinyon-juniper encroachment, and modify model parameters as necessary. • Incorporate digital soil data of sufficient scale and attributes, when it becomes available.

Objective 1.5: Reduce the impacts of residential development.

Discussion: The impacts of residential development are potentially greatest on Group 1 and Group 2 species, because of their requirements for sagebrush habitats (Group 1 species) or other low shrubland types and large habitat area (Group 2 species). Group 3 species may still be negatively affected, but some low-density developments may cause little impact or occasional benefit to these species because of increased woodland or edge habitat. Priority for managing residential development impacts could be focused in Priority 1 and 2 sagebrush habitats ([Figure 8-5](#)) that contain moderate or high risk from residential development ([Figure 4-4](#)).

Implementing strategies to achieve this objective will also benefit other goals by building general public recognition of the importance of sagebrush habitat and support for its conservation on both private and public lands. Many of the strategies for achieving this objective should be integrated with sage-grouse public information efforts when applicable.

Objective 1.5: Reduce the impacts of residential development.	
Strategies:	
1.5.A	Create and implement public education efforts to publicize the importance of sagebrush conservation, and this assessment and conservation plan. Efforts may include: <ul style="list-style-type: none"> • Make this assessment and conservation plan available to the public on appropriate websites, including SageMap, and publicize this assessment and conservation plan in press releases and/or public service announcements. • Develop, promote, and distribute educational materials of appropriate content to primary and secondary school teachers and non-profit environmental organizations. Suggested formats: graphics-rich Microsoft PowerPoint lesson, web-based learning module, video, interactive games, or similar, suitable for posting on CDOW website Education Hotlinks page. Promote through <i>Colorado Connections</i> and/or similar outlet.. • Develop, promote, and distribute a graphics-rich pamphlet and poster for placement in land management information kiosks, in disclosures to future landowners, etc. Materials could include a

summary of the Colorado sagebrush assessment results, explain functions and values of sagebrush habitat, introduce species of concern, and suggest voluntary conservation and mitigation measures for private landowners.

- Sponsor a symposium or conference, or panels and posters in relevant symposia or conferences, targeting developers and county / local planning departments operating in Priority sagebrush habitat for residential development risk. Panels and posters should address habitat loss and fragmentation issues and promote best management practices for developers interested in maximizing preservation of native sagebrush habitats in their project areas.
 - Provide county governments with information (created for public awareness objective) on species of concern status, habitat distribution, and possible effects of subdivisions and different land uses. Provide example policy language.
- 1.5.B Add 10 species of concern identified in this document (excluding kit fox, which is already state-listed as endangered) to Colorado's list of species of special concern.
- 1.5.C Promote conservation easements on private lands in selected Priority areas. Efforts may include:
- Communicate to land trusts the summary information of this assessment, and recommend that land trusts seek conservation easements to protect sagebrush areas of at least 80 ha (200 acres). Deadline: December 2006.
 - Enroll properties with sagebrush habitats in selected Priority areas in appropriate Farm Bill conservation programs with incentive payments to landowners. Deadline: ongoing.
 - Obtain new conservation easements with suitable attributes and implement management plans through the Colorado Species Conservation Partnership (CSCP) program.
- 1.5.D During county and local government planning processes in selected Priority sagebrush areas (see Objective 1.5.A), encourage the inclusion and implementation of mitigation strategies in county and local land use plans to minimize adverse impacts to sagebrush habitats from residential development.
- 1.5.E Refine and revise the residential development threat model (see Assumptions and Limitations and Recommendations in [Chapter 4](#)). Potential improvements include:
- Modify to incorporate the areas surrounding resort communities that are subject to increased development pressure but are not adequately modeled.
 - Obtain SERGoM data classified to a finer resolution, predicting development at one residence per 160 and 320 acres. Using the reclassified SERGoM data, redefine sagebrush risk categories to capture risk associated with lighter density development; for example, low risk = less than one residence per 320 acres, moderate risk = one house per 80 to 320 acres, and high risk = greater than one house per 80 acres.
 - Obtain additional SERGoM model predictions beyond 2020; for example to 2040.

Objective 1.6: Manage the impacts of domestic and wild ungulate grazing.

Grazing by domestic and wild ungulates (hooved mammals) in sagebrush habitats may alter shrub and herbaceous species composition, shrub vigor and stand characteristics, soil properties, and nutrient cycling. Actions to manage livestock grazing such as brush removal and fencing may also affect sagebrush habitats. Excessive browsing by wild ungulates in winter can cause severe hedging of sagebrush and reduce shrub height and vigor. The risk of grazing by domestic and wild ungulates to sagebrush habitat was not modeled in this assessment.

However, ungulate grazing may impact habitat for all of the species of concern. The influence of ungulate grazing on sagebrush habitats should be addressed in selected sagebrush areas.

Objective 1.6: Manage the impacts of domestic and wild ungulate grazing.

Strategies:

- 1.6.A Based on availability of agency resources, select level of Priority sagebrush patches for evaluation and management of ungulate grazing influences. Use GIS to identify the selected Priority patches.
- 1.6.B In selected sagebrush patches, use field inventory and spatial data where available to map sagebrush areas with ungulate grazing concerns. Revise map as necessary.

- 1.6.C Participate in federal land planning processes that involve ungulate grazing and livestock management in selected priority sagebrush. Address potential influences of ungulate grazing on sagebrush habitat, and advocate management practices for domestic and wild ungulates that minimize undesirable influences on sagebrush habitat.
- 1.6.D Develop, in coordination with other agencies and affected stakeholders, grazing Best Management Practices in sagebrush systems for wild and domestic ungulate grazing.
- 1.6.E Coordinate with agency programs for big game habitat management. Where appropriate, incorporate in big game management plans the habitat objectives of this plan for conservation of sagebrush habitat for species of concern.
- 1.6.F Collaborate with public agency biologists to develop methods for using livestock grazing to improve sagebrush habitat for species of concern.
- 1.6.G Review new findings on the influence of ungulate grazing on sagebrush habitats. Use new information to improve recommendations for domestic and wild ungulate grazing management to conserve habitat for species of concern.

GOAL 2: MAINTAIN VIABLE POPULATIONS AND AVERT FURTHER DECLINE OF SPECIES OF CONCERN IN THE ASSESSMENT AREA.

This goal relates to further assessment and monitoring of individual species. A detailed management plan for each species is beyond the scope of this document. Instead, we address monitoring needs and key management issues for each species of concern ([Table 8-1](#)).

Objective 2.1: *Determine the need for population monitoring for species of concern, and implement monitoring where appropriate.*

Discussion: The sagebrush-dependent species of concern identified in this assessment are believed to be declining in numbers within the assessment area, or their population trend is unknown so we regard them as potentially declining. As a result, monitoring populations of the species of concern in the assessment area is important to identify which species are actually declining, which are continuing to decline, and to assess the efficacy of conservation efforts (Possingham et al. 2001). We define “population monitoring” as the repeated assessment of a population for the purpose of detecting change within a defined area over time (Thompson et al. 1998). Effective population monitoring must entail robust sampling over spatial and temporal scales, using methods that permit detectability estimates and identify sources of variation (Knick et al. 2003).

For birds, existing bird monitoring programs that cover the assessment area including the North American Breeding Bird Survey (BBS) (Robbins et al. 1986; Peterjohn and Sauer 1999) and the Audubon Society’s Christmas Bird Count (Root 1988) probably do not adequately sample many sagebrush habitats (Saab and Rich 1997). Furthermore, these programs are unable to estimate detectability of birds, and thus cannot incorporate detectability bias into trend estimates (Anderson 2001). The Rocky Mountain Bird Observatory’s MCB program (Leukering et al. 2000), supported in part by CDOW, began a more robust program in 2000 that is designed to incorporate detectability biases into trend estimates and provide statistically defensible estimates of bird population changes over time, but insufficient data has been collected to date to provide statistically significant trend estimates (T. Leukering, pers. comm.). Existing monitoring of sagebrush-dependent birds in the assessment area by the BBS and the MCB rely on counts of singing males along transects, yet the relationship between number of singing males and population size has not been established (Knick et al. 2003). Counting nonbreeding territorial males in these surveys may overestimate the breeding segment of the population, confounding estimates of population trends. Another source of bias is timing of counts in relation to the breeding season (Best and Petersen 1985), which may vary from year to year due to

fluctuations in climate. Road-based surveys (used by the BBS but not by the MCB) introduce another source of bias if proximity to roads affects bird density (Knick et al. 2003), although Rotenberry and Knick (1995) found that unpaved or little-used roads in sagebrush habitats had insignificant effects on bird counts.

A single monitoring technique may not adequately sample all bird species, and among the species of concern addressed in this assessment northern harrier must be monitored with different techniques than the passerine bird species.

For small mammals, no regional-scale monitoring program covering the assessment area has been undertaken. A statewide Mammal Atlas project led by CDOW is underway to estimate the distribution of mammals in Colorado; distribution data are not yet available for mammalian species of concern addressed in this assessment. Studies of kit fox in the assessment area by CDOW between 1994 and 2000 included minimum population estimates (Fitzgerald 1996; Beck 2000), but no work has been done since that time. Of the three mammal species of concern addressed in this assessment (sagebrush vole, Merriam's shrew, and kit fox), each will require different population monitoring techniques (see [Table 8-1](#) and species profiles in the [Appendix](#)).

Population monitoring for all species needs to be reliable—that is, managers and decision-makers must have confidence in the monitoring program's ability to detect population changes of a specified magnitude, with a specified level of statistical power (Possingham et al. 2001). Monitoring also needs to address gradients in habitats and population dynamics by employing methods that take into account habitat variations at multiple scales, since populations of sagebrush-dependent species appear to respond to habitat factors beyond the local scale (J. Rotenberry, pers. comm.). Ultimately, population counts need to be related to habitat characteristics to understand source-sink dynamics and the mechanisms that affect population trends (Morrison 2001; Noon and Franklin 2002). Thomas (1996) and Thompson et al. (1998) provide extensive guidance and theory on the design of effective population monitoring.

Most species of concern in the assessment area are fairly to very widespread. Exceptions are kit fox, which are rare and possibly extirpated, and Merriam's shrew, which may be widespread but little is known of their distribution and abundance (see [Appendix](#), species profiles). Sagebrush vole is possibly widespread within its limited range in the assessment area, but substantial gaps in knowledge also exist for this species' distribution and abundance. For the remaining species of concern, all birds, breeding distribution is well documented in the assessment area. Population numbers are unknown but believed to be relatively high. Population trends are less clear. Regional monitoring programs suggest declining trends over various regional scales, all substantially larger than the assessment area. These trend estimates are subject to various biases of unknown magnitude, reducing confidence in the direction and estimated magnitude of the trend. Furthermore, no trend data specific to the assessment area are available, and it is possible that a species could be declining regionally but stable in the assessment area, or vice versa. Based on the above, we recommend that the species of concern addressed in this document be prioritized for population studies and monitoring as follows (the species listed under each priority are listed in order of secondary priority):

First priority: 1. Merriam's shrew
 2. sagebrush vole

Second priority: 1. Brewer's sparrow
 2. sage sparrow
 3. sage thrasher
 4. northern harrier

5. kit fox

- Third priority:
1. green-tailed towhee
 2. lark sparrow
 3. black-throated sparrow
 4. vesper sparrow

For sagebrush vole and Merriam's shrew, the most immediate need is to verify the range and determine distribution within the range. For Merriam's shrew, the most basic habitat association information is lacking, and also needs to be determined. For these reasons, these species are ranked highest priority, although they are also the most expensive to study and monitor. For kit fox, the greatest threats to the species are probably not related to sagebrush habitat (T. Beck, pers. comm.); that species' decline in the assessment area is probably more related to large-scale loss and fragmentation of desert shrubland habitat, human-caused mortality, and competition or predation by other canid species. However, population monitoring is still worthwhile to verify the presence and population trend of this species and better understand the causes of its decline. Other second priority species are sagebrush obligates placed in this priority category because of their strong reliance on sagebrush habitats. The third priority species have a large North American range and relatively low reliance on sagebrush habitats.

Objective 2.1: Determine the need for population monitoring for species of concern, and implement monitoring where appropriate.	
Strategies:	
2.1.A	Select species of concern that will be evaluated for monitoring, using the species priorities presented above. This could be done annually, or repeated over intervals of 2 to 5 years..
2.1.B	For each species, define an acceptable detection level (the minimum percent change detected over time) for population abundance and determine the spatial scale(s) at which monitoring will be conducted..
2.1.C	Evaluate existing monitoring programs for adequacy in meeting the detection level and geographic goals defined in the above strategy. In the evaluation, consider the different monitoring needs of species of concern, and the field techniques, geographic extent, and statistical analysis methods of existing programs.
2.1.D	Prioritize the species of concern, and choose species to be monitored based on available agency resources.
2.1.E	Where existing programs are inadequate or cannot be modified to meet the monitoring goals, design additional monitoring to meet monitoring goals. Important considerations for developing monitoring procedures include: <ul style="list-style-type: none"> • Devise specific strategies for field techniques, geographic extent, and statistical analysis, addressing the differing monitoring requirements of target species. • Use monitoring techniques that minimize bias, and have the ability to measure and account for detection bias in population performance estimates. • When possible, integrate monitoring with planned research on population performance-habitat relationships (see Goal 3, below) and habitat manipulation or restoration projects (see Goal 1, above), to improve understanding of the causes and mechanisms of population changes. • Budget for and implement analysis of monitoring data sufficient to draw valid statistical conclusions on population change.
2.1.F	Create, publicize, and make available in electronic and print media annual reports describing the goals, methods, and results of monitoring.
2.1.G	Evaluate the performance of monitoring efforts in achieving monitoring goals, and adjust monitoring techniques to correct deficiencies or take advantage of new methods or technologies.

Objective 2.2: Periodically reevaluate the sagebrush-dependent species of concern and their management priorities in the assessment area.

Discussion: The priority ranking of species of concern presented in this plan is based on incomplete knowledge. Furthermore, the conservation status and population trends of sagebrush-associated species will change over time. It will be important to periodically reevaluate the species of concern, and add or remove species from the list selected for this assessment and conservation plan. It will also be important to periodically reevaluate the priorities among the species of concern, to ensure that the species of greatest conservation concern are given higher priority.

Objective 2.2: Periodically reevaluate the sagebrush-dependent species of concern and their management priorities in the assessment area.	
Strategies:	
2.2.A	Every three years, reevaluate the following based on new knowledge of species' conservation status or habitat relationships from monitoring or other sources: <ul style="list-style-type: none"> • The list of sagebrush-dependent species of concern. • Species groups and geographic areas that are of greatest conservation concern and uncertainty. • Conservation priorities among the species of concern.
2.2.B	Communicate the results of above evaluations to agency personnel, the scientific community, and the public.

GOAL 3: CONDUCT RESEARCH TO ADDRESS KNOWLEDGE GAPS IN BIOLOGY, ECOLOGY, AND HABITAT RESPONSES OF SAGEBRUSH-DEPENDENT SPECIES OF CONCERN.

Research needs for the conservation of sagebrush-dependent species of concern include research that should be conducted prior to or during population monitoring, and research that may be suggested later by the results of monitoring.

Objective 3.1: Prioritize and conduct research to answer management-related questions about species biology, distribution, abundance, habitat requirements, and responses to habitat conditions.

Discussion: Rotenberry (1998) reviewed research needs for avian conservation in western North American shrublands and reported that the highest priorities were 1) removal of invasive annual plants; 2) ways to speed recovery of damaged native shrublands, particularly the reestablishment of native plant species; 3) grazing impacts; and 4) mechanisms of impacts due to increased habitat fragmentation. These research priorities are valid for all of the species of concern addressed in this document. However, additional research on basic biology and habitat use of some of the species of concern, particularly mammals, is also necessary. The most fundamental research needs for the species of concern in the assessment area are:

- Understand the basic biology of the species of concern, particularly small mammals.
- Understand the habitat requirements of species of concern, particularly small mammals.
- Understand population trends and demography.
- Understand species responses to environmental change.

Table 8-1 summarizes research needs and management issues for the 11 species of concern. Based on these species-specific needs, and the general research needs noted above, the following research priorities are proposed for the next 15 years:

1. Determine the basic biology and habitat requirements of sagebrush vole and Merriam's shrew in the assessment area: distribution, habitat use at macro- and micro-scales including seasonal variation, relationship to sagebrush in the landscape including assessment of minimum patch size requirements, and reproduction.
2. Determine population trends and demography of sagebrush vole and Merriam's shrew in sagebrush habitats in the assessment area. This will require population monitoring (described in Goal 2 above) and interpretation of monitoring data, and may require development of monitoring techniques.
3. Determine population trends and demography of other Group 1 species (sage sparrow, Brewer's sparrow, and sage thrasher), including assessment of relationship to sagebrush in the landscape and minimum patch size requirements.
4. Determine demographic responses of sagebrush vole and Merriam's shrew to environmental change. Environmental changes to be evaluated could include mechanical treatment and burning of sagebrush that removes or drastically reduces sagebrush cover, and increasing abundance of invasive herbaceous plants.
5. Determine demographic responses of other Group 1 species (sage sparrow, Brewer's sparrow, and sage thrasher) to environmental change. Environmental changes to be evaluated could include increasing habitat fragmentation, increasing abundance of invasive herbaceous plants, and increasing invasion by pinyon-juniper. Note that confounding effects to population change, such as population responses to climate change or conditions on wintering grounds, may need to be accounted for.

Objective 3.1: Prioritize and conduct research to answer management-related questions about species biology, distribution, abundance, habitat requirements, and responses to habitat conditions.

Strategies:

- 3.1.A Refine the research priorities presented in this assessment after discussion with biologists within CDOW and with species experts in other agencies and academic institutions, and considering available agency resources.
- 3.1.B Initiate and conduct research for as many of the top 5 priority research needs as possible. Suggested timeframes are:
- Research Priorities 1 and 2: 2007-2011.
 - Research Priorities 3 and 4: 2012-2016.
 - Research Priority 5: 2017-2021.

Objective 3.2: *Use research results to improve monitoring and conservation actions through adaptive management.*

Discussion: Research plays a key role in adaptive management for conservation of the species of concern, because research can answer fundamental questions about species persistence and responses to environmental change. To be effective for species conservation, research should be designed to test hypotheses about species persistence and responses to the environmental changes most likely to affect species persistence, and research results should be carefully evaluated and integrated into habitat management and conservation planning at all scales.

Objective 3: Use research results to improve monitoring and conservation actions through adaptive management.

Strategies:

- 3.2.A Report and publicize research results within CDOW and to other agencies, the scientific community, and the public.
- 3.2.B Engage communication with habitat and species management personnel regarding research results, to enable improvements in management practices and obtain feedback on research goals and priorities.
- 3.2.C Evaluate research goals and techniques in light of changing species priorities and conservation status, and advances in scientific methods. Refine research goals and methods as necessary.

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