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Chapter 2: Sagebrush-Associated Species of Conservation Concern

Mary M. Rowland, Lowell H. Suring, Matthias Leu, Steven T. Knick, Michael J. Wisdom

Abstract. Selection of species of concern is a critical early step in conducting broad-scale ecological assessments for conservation planning and management. Many criteria can be used to guide this selection, such as conservation status, existing knowledge base, and association with plant communities of interest. In conducting the Wyoming Basins Ecoregional Assessment (WBEA), we followed a step-wise process to select vascular plant and vertebrate species of concern. Based on our selection process, we identified 65 taxa of sagebrush-associated (*Artemisia* spp.) vascular plants of conservation concern. The vast majority were forbs, and nearly all are found in Wyoming (n = 59; 91%), reflecting its central location and spatial dominance (51%) of the study area. Forty-eight plants (74%) were ranked either S1 or S2 (state-level ranks indicating imperilment due to rarity, threats, or other factors) in at least one state within the assessment area. Forty vertebrates of concern were selected for our assessment, including 17 mammals, 18 birds, and 4 reptiles. Among these were 7 vertebrates commonly considered sagebrush-obligate species: sagebrush lizard (*Sceloporus graciosus*), greater sage-grouse (*Centrocercus urophasianus*), sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), pronghorn (*Antilocapra americana*), and pygmy rabbit (*Brachylagus idahoensis*). Several vertebrate species of concern in the Wyoming Basins are either rare or imperiled, including black-footed ferret (*Mustela nigripes*) and Wyoming pocket gopher (*Thomomys clusius*).

Key words: ecoregional assessment, sagebrush ecosystem, species of conservation concern, species selection, terrestrial vertebrates, vascular plants, Wyoming Basins.

Ecoregional assessments may rely on coarse- or fine-filter approaches or both, depending on specific objectives of the assessment. Coarse-filter approaches, which are typically based on conserving ecological communities, are often easier to implement but may not capture occurrences of rare or locally common species or other key habitat elements (Scott et al. 1993, Noss and Cooperrider 1994, Haufler 1999b, Marcot and Flather 2007). Moreover, coarse filters such as plant associations and ecological processes are often less tangible concepts for the public to understand. Fine-scale methods may more effectively conserve the species or special elements addressed but are generally too impractical (i.e., costly and time-intensive) to apply to more than a handful of taxa, especially across large landscapes (Noss and Cooperrider 1994, Haufler 1999b, Groves 2003).

To address the inherent limitations in using only one approach, many broad-scale assessments, including those conducted by The Nature Conservancy (TNC), combine coarse-filter (e.g., plant associations or species guilds) and fine-filter (e.g., species) methods (Noss 1987; Haufler 1999a, b; Stein et al. 2000; Carignan and Villard 2002; Groves 2003; Wisdom et al. 2005a). For example, the conservation plan for the Utah-Wyoming Rocky Mountains Ecoregion, which lies within the boundaries of the WBEA (Ch. 1), identified 17

Artemisia communities as conservation targets (coarse filter) in addition to a suite of focal species (e.g., gray wolf [*Canis lupus*]) and special elements (e.g., petiolate wormwood [*A. campestris* var *petiolata*]) (fine filter; Noss et al. 2001). In the Great Basin ecoregional assessment, Wisdom et al. (2005a) evaluated conditions for both sagebrush-associated species and groups of species, with groupings based on similarities in habitat associations and total habitat area within various land cover types.

Recognizing the advantages of combining strategies, we also used a hybrid approach of coarse- and fine-filter strategies for the WBEA. The primary basis of our assessment was a variant of a coarse-filter strategy; that is, we focused on (1) identifying and quantifying all sagebrush land cover types within the study area and (2) identifying, mapping, and assessing the impact of anthropogenic disturbance on sagebrush cover types within the study area (Introduction). This approach allowed characterization of the entire sagebrush ecosystem within our study area, an advantage of a coarse-filter strategy (Hauffer 1999a).

To complement this approach and meet additional WBEA objectives of identifying plant and wildlife species of conservation concern and assessing impacts of disturbance on these species (Introduction), we also selected a suite of vascular plant and vertebrate species that are associated with sagebrush. Wisdom et al. (2005a) identified >350 species of conservation concern associated with the sagebrush ecosystem in the western United States; we used their list as a starting point for our fine-filter selection, recognizing that we could not address all species of concern in our assessment due to limitations of time and funding. Our approach resembles that described by Marcot and Flather (2007) as a “multiple species” strategy based on entire habitat assemblages, with the assumption that if macrohabitat (i.e., sagebrush)

is provided, the requirements of the entire assemblage will be met.

Criteria for selecting species may be based on a variety of factors, including perceived levels of risk to potential threats; sensitivity to disturbance; conservation status as indicated by state or federal lists of threatened, endangered, or sensitive species; representation of a broad range of spatial scales and ecological processes; current population trend; response to management actions; cost effectiveness of measuring or monitoring the species; and association with a land cover of interest (e.g., riparian communities, sagebrush, old growth forest) (Stephenson and Calcarone 1999, Carignan and Villard 2002, Andelman et al. 2004, Wisdom et al. 2005b). The state-level Comprehensive Wildlife Conservation Strategies use a variety of approaches to identify species of concern (see <http://www.wildlifeactionplans.org/>). For example, the Wyoming Action Plan incorporated a habitat x population status matrix, in which Native Species Status (NSS) ranks from 1 to 7 were assigned and used to select species (Wyoming Game and Fish Department 2005).

Our overall objective in selecting species for the WBEA was to capture a broad range of sagebrush-associated species that represented multiple spatial scales and elements of sagebrush ecosystems and were potentially sensitive to anthropogenic disturbance and management actions in the study area. Primary criteria for selection of species were (1) strong association with sagebrush ecosystems and (2) recognized status of conservation concern due to declining habitats, populations, or both. Our intention was to be more inclusive than exclusive to ensure that we considered all potential species of concern and their habitats in sagebrush ecosystems of the study area. This inclusive approach provided an opportunity to evaluate species that may not currently be of concern but may become so in the future (Wisdom et al. 2005b). Moreover, because information

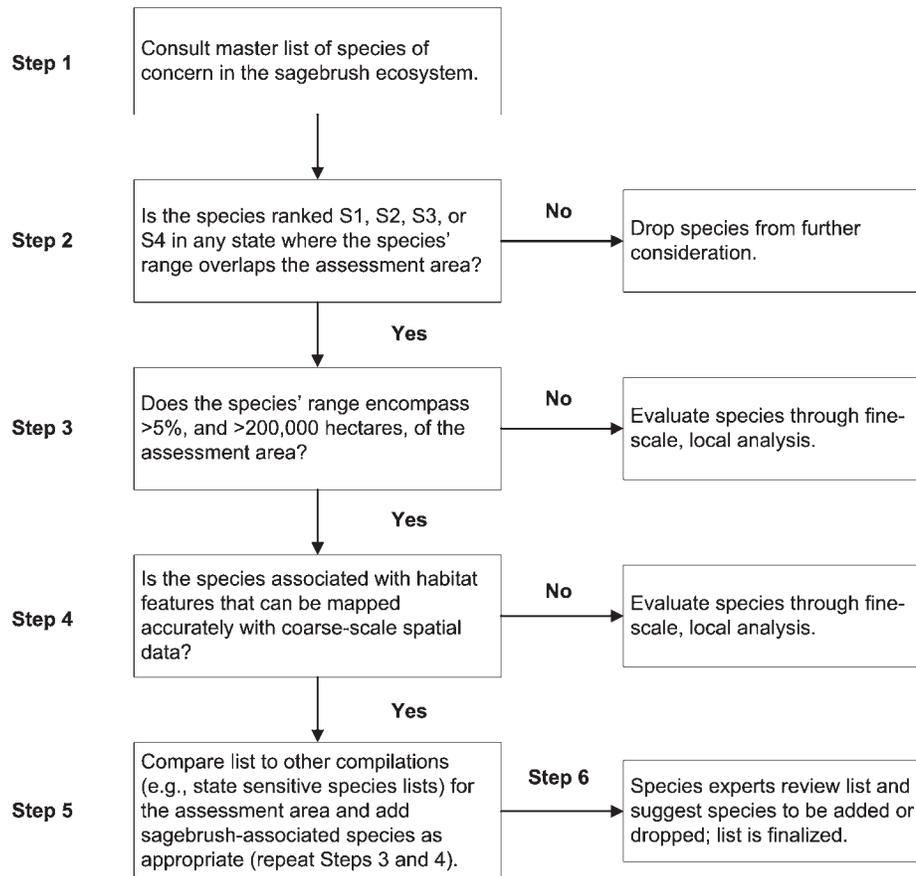


FIG. 2.1. Criteria and decision diagram for selecting species of conservation concern for multi-species assessment in an ecoregion (from Wisdom et al. [2005a]).

about populations and habitat association is relatively scarce for many species in non-forested ecosystems such as sagebrush (Dobkin and Sauder 2004), our approach increased the likelihood of evaluating species that are at risk but whose conservation status is not well understood.

The initial step in conducting the WBEA was to select species of concern, specifically vascular plants and terrestrial vertebrates. We then acquired or created range maps for vertebrates to understand patterns of species distribution across the study area and for constraining areas for modeling a subset of species of concern (Ch. 4).

SELECTING SPECIES FOR ASSESSMENT

The process for selection of species of concern for the WBEA followed a sequence of steps; species had to meet all criteria in this process to be retained for consideration (Fig. 2.1). Species with fine-grained environmental requirements were eliminated because of the coarse-scale spatial data available for assessing environmental conditions across the study area. Species with very limited geographic ranges, such as low bladderpod (*Lesquerella prostrata*), were generally not selected for this assessment because they are best

suites for small-scale evaluations (Wisdom et al. 2005b) (see “Mapping Geographic Ranges” for the definition of geographic range used). We chose to limit our selection to major taxonomic groups of plants (vascular only) and animals (terrestrial vertebrates) because of the relatively greater knowledge base for these groups, the number of species in these groups, their relevance to management in the sagebrush ecosystem, and the large area encompassed by the WBEA (Raphael et al. 2007).

The list generated by Wisdom et al. (2005a) for species of conservation concern associated with the sagebrush ecosystem relied on state ranks (S-ranks; NatureServe 2007) to assess conservation status (this list is found in Appendix 2 of Wisdom et al. [2005a] and is available online at: <http://www.fs.fed.us/pnw/pubs/sagebrush-appendices/>). This ranking system, based on several factors such as number of occurrences of populations within each state, population size, and threats, is widely used in conservation planning throughout the United States and Canada (Master 1991, Raphael et al. 2007). The species selected by Wisdom et al. (2005a) were considered to be potentially at risk of regional extirpation in the sagebrush ecosystem owing to declines or rarity of habitat or populations, or both.

We consulted this “master” list as the first step in identifying potential species of concern for inclusion in the WBEA (Step 1, Fig. 2.1). First, we recorded the current (2007) S-ranks for each species in any state within the overlap of its geographic range and the boundaries of the WBEA area (Step 2, Fig. 2.1). Additional criteria for species selection were a geographic range that (1) was large enough to be appropriate for regional, broad-scale assessment and (2) overlapped sufficiently with the study area boundaries to warrant inclusion in the assessment (Wisdom et al. 2005b; Fig. 2.1). The 27 invertebrates listed by Wisdom et al. (2005a) were not retained

on our list for the WBEA because they did not meet these criteria for inclusion.

Vascular Plants

We compiled an initial list of vascular plants of concern for the Wyoming Basins assessment from four primary sources: (1) the master list of Wisdom et al. (2005a), (2) a list of regional endemic vascular plants created by TNC, (3) a list of plants developed for the Wyoming GAP (Gap Analysis Program) project (Merrill et al. 1996), and (4) a report on globally rare plant taxa in the U.S. Bureau of Land Management (BLM) Dillon, Montana Field Office (Lesica 2003). Several botanists reviewed the draft list resulting from these four sources to evaluate the validity of the selection process and the taxa selected (Appendix 2.1).

Wisdom et al. (2005b) procedures

We identified 20 vascular plant taxa in the Wyoming Basins study area by applying the process outlined by Wisdom et al. (2005b) (Fig. 2.1). The resulting list was reviewed by a botanist for the Wyoming Natural Diversity Database (WYNDD), which maintains a comprehensive database of information about the distribution and ecological relationships of rare plants and animals in the state (B. Heidel, WYNDD, pers. comm.).

Fertig (1999) appendix

Heidel (WYNDD, pers. comm.) recommended expanding our list by focusing on regional endemics to identify sagebrush-associated plant taxa not currently tracked or treated as targets by WYNDD or TNC, but potentially of concern. Regional endemic species are found in a limited geographic area, usually 520-1,300 km² in one or more states (Fertig 1999). The Wyoming Basins Ecoregion has one of the highest rates of regional endemism for vascular plants in the north-central United States (Fertig 1999). Although we identified several regional endemics in our origi-

nal selection process (source 1, above), we lacked range-wide distribution data for many of these taxa. Consequently, we were unable to determine whether some of these plants occurred in >5% of the study area (Fig. 2.1). We retained these taxa on our list of plants of concern, without full knowledge of their ranges, but recommend further evaluation of their suitability for regional assessment.

Additional regional endemics to consider for the WBEA were found in a TNC report for their Wyoming Basins ecoregional assessment (Appendix B in Fertig [1999]). This list was also reviewed by a U.S. Forest Service botanist who evaluated the association of the endemics with sagebrush plant communities (Appendix 2.2). Last, we reviewed Table 1 in Fertig (1999; targeted vascular plant elements) to identify other vascular plant taxa that might be suitable for our assessment.

Wyoming GAP project

We evaluated a list of plants developed for the Wyoming GAP project (Merrill et al. 1996) to identify additional regional endemics that met our criteria. We selected species on this list if they (1) were regional endemics, (2) had state rankings in Wyoming of S2 or S3, and (3) occurred in the Intermountain Desert Steppe biome, as described by Merrill et al. (1996). The rationale for our state rank screen was that species ranked S1 were rare and thus unsuitable for broad-scale evaluation, and that species ranked S4 or S5 were potentially secure and thus not of concern. We assumed that species in the Intermountain Desert Steppe biome would have a high probability of being associated with sagebrush ecosystems in Wyoming; thus, we used this attribute as a proxy for association with sagebrush.

BLM Dillon Field Office list of rare plants

We reviewed a report on the globally rare plant species of the BLM Dillon Field Office (Lesica 2003) to evaluate plants in

the Montana portion of the study area. The Dillon Field Office contains the majority of the sagebrush in the Montana portion of the WBEA and is almost completely (97%) contained within the study area boundaries.

Other sources

Last, we compared our revised draft list of vascular plants with other lists of species of concern (e.g., sensitive species lists developed by the BLM for states within the project area and state Natural Heritage Program lists) and added any species that met our criteria. Several BLM botanists reviewed the final list (Appendix 2.1; Table 2.1).

Vertebrates

To select vertebrates for the WBEA, we first reviewed the master list of sagebrush-associated species of concern, as described above. We consulted other existing lists (Step 5, Fig. 2.1), including conservation targets identified by TNC within the WBEA area (The Nature Conservancy 2000, Freilich et al. 2001, Neely et al. 2001, Noss et al. 2001) and several sensitive species lists (e.g., Montana Natural Heritage Program 2004, Wyoming Game and Fish Department 2005).

Vertebrate species were removed at all steps of the screening process; for example, six mammals on the master list either did not occur within the study area or did not have a rank of S4 or lower in at least one of the five states within the assessment boundary. Application of the complete selection process (Fig. 2.1) resulted in 39 vertebrate taxa as potential species of concern.

The draft list of vertebrates was then reviewed by four biologists, who suggested changes. For example, bighorn sheep (*Ovis canadensis*) was added owing to (1) the importance of sagebrush for winter range habitats of this species in the Wyoming Basins (Irwin et al. 1993) and (2) the species' state rank (e.g., S3S4 in Wyoming).

TABLE 2.1. Vascular plants of conservation concern identified for regional assessment of sagebrush ecosystems in the Wyoming Basins Ecoregional Assessment area.

Species/subspecies/variety	Family	Life form	Global rank ^a	State rank					Source ^b
				CO	ID	MT	UT	WY	
<i>Achnatherum contractum</i> Contracted ricegrass ^c	Poaceae	Graminoid	G3G4	SU	S3	S1	S1	S3S4	8, 9, 12
<i>Achnatherum swallenii</i> Swallen's needlegrass	Poaceae	Graminoid	G5	S5				S2	2, 7, 9
<i>Antennaria arcuata</i> Box pussytoes	Asteraceae	Forb	G2	S1				S2	1, 2, 5, 6, 7, 18
<i>Artemisia tripartita</i> var. <i>rupicola</i> Wyoming threetip sagebrush	Asteraceae	Shrub	G5T3					S3	17
<i>Astragalus [sericoleucus var.] aretioides</i> Cushion milkvetch ^d	Fabaceae	Forb	G4	S1	S2	S1	S1	S3	8, 9, 14
<i>Astragalus detritalis</i> Debris milkvetch	Fabaceae	Forb	G3	S2			S3		1, 5, 7, 12, 14, 15
<i>Astragalus grayi</i> Gray's milkvetch	Fabaceae	Forb	G4?		S2			S3	7, 9, 11
<i>Astragalus jejunus</i> var. <i>jejunus</i> Starveling milkvetch	Fabaceae	Forb	G3T3	S1	S2	S1	S1	S3	6, 7, 9, 14, 16, 18
<i>Astragalus nelsonianus</i> Nelson's milkvetch	Fabaceae	Forb	G3	S1			S1	S3	6, 7, 9, 14
<i>Astragalus oregonus</i> Oregon milkvetch	Fabaceae	Forb	G4?		S1			S3	7, 9, 11
<i>Astragalus pubentissimus</i> var. <i>pubentissimus</i> Green River milkvetch ^e	Fabaceae	Forb	G4	SNR			SNR	S2	8, 9
<i>Astragalus scaphoides</i> Bitterroot milkvetch	Fabaceae	Forb	G3		S3	S2			1, 3, 10, 11
<i>Astragalus simplicifolius</i> Little bun milkvetch	Fabaceae	Forb	G3					S3	7, 9
<i>Castilleja pilosa</i> var. <i>longispica</i> Longspike Indian paintbrush	Scrophulariaceae	Forb	G4G5T4	SNR	S3			S2	8, 8
<i>Cirsium ownbeyi</i> Ownbey's thistle	Asteraceae	Forb	G3	S2			S1	S2	1, 2, 4, 5, 6, 7, 9, 13, 14, 15, 16
<i>Cryptantha caespitosa</i> Tufted cryptantha	Boraginaceae	Subshrub Forb	G4	S2	S1		S1?	S3	1, 4, 5, 7, 9, 14
<i>Cryptantha sericea</i> Silky cryptantha	Boraginaceae	Subshrub Forb	G4	SNR			SNR	S3	8, 9, 18
<i>Cryptantha stricta</i> Yampa River cryptantha [Erect cat's-eye]	Boraginaceae	Subshrub Forb	G3	S3			S2S3	S3	7, 9, 14
<i>Cymopterus evertii</i> Evert's springparsley	Apiaceae	Forb	G2G3				S1	S2S3	2, 6, 7, 9

TABLE 2.1. Continued

Species/subspecies/variety	Family	Life form	Global rank ^a	State rank					Source ^b
				CO	ID	MT	UT	WY	
<i>Cymopterus lapidosus</i> Talus springparsley	Apiaceae	Forb	G2G3			S1	S2S3	7, 9	
<i>Cymopterus longipes</i> Longstalk springparsley	Apiaceae	Forb	G4?	SNR		SNR	S3	8, 9	
<i>Descurainia pinnata</i> var. <i>paysonii</i> Western tansy-mustard [Payson's tansymustard]	Brassicaceae	Forb	G5T3?	SNR		SNR	S2	2, 7, 9, 12	
<i>Draba oligosperma</i> Fewseed draba ^f	Brassicaceae	Forb	G5	S2	SNR	SNR	S5	2, 7, 9	
<i>Erigeron nanus</i> Dwarf fleabane	Asteraceae	Forb	G4	SNR		S1	S2	8, 9	
<i>Erigeron nematophyllus</i> Needleleaf fleabane	Asteraceae	Forb	G3	S2?		S1S2	S3	8, 9, 14	
<i>Eriogonum acaule</i> Singlestem buckwheat	Polygonaceae	Forb	G3	S1		S3	S3	7, 9, 14	
<i>Eriogonum brevicaulis</i> var. <i>micranthum</i> Shortstem buckwheat	Polygonaceae	Forb	G4T3				S3	8	
<i>Eriogonum exilifolium</i> Dropleaf buckwheat	Polygonaceae	Forb	G3	S2			S2	2, 7, 9, 14, 19	
<i>Eriogonum lagopus</i> Parasol buckwheat [Rabbit buckwheat] ^g	Polygonaceae	Forb	G3		S3		S2	1, 6, 7, 9	
<i>Hymenopappus fitifolius</i> var. <i>luteus</i> Fineleaf hymenopappus	Asteraceae	Subshrub Forb	G5T3T5	SNR	SU	SNR	S3S4	8, 11, 12	
<i>Hymenopappus fitifolius</i> var. <i>nudipes</i> Fineleaf woollywhite	Asteraceae	Subshrub Forb	G5T4			SNR	S2	8, 9, 12	
<i>Tetranetis torreyana</i> Torrey's four-nerve-daisy ^h	Asteraceae	Forb	G4	SNR	S3	S1	S3	8, 9	
<i>Ipomopsis congesta</i> Ballhead ipomopsis [Compact glia] ⁱ	Polemoniaceae	Subshrub Forb	G5T3T4	S1	S2	SNR	S3	7, 9, 14	
<i>Lesquerella condensata</i> Dense bladderpod ⁱ	Brassicaceae	Forb	G4Q	SU	S3		S2	8, 9	
<i>Leymus simplex</i> var. <i>simplex</i> Alkali lyme grass [Alkali wildrye] ^k	Poaceae	Graminoid	G4?Q	SNR		S1	S2?	7, 9	
<i>Lomatium bicolor</i> var. <i>bicolor</i> Wasatch desertparsley	Apiaceae	Forb	G4T3T4	S1	SNR	S3	S2	8, 14	
<i>Lomatium juniperinum</i> Juniper biscuitroot	Apiaceae	Forb	G3G5	SNR	SNR	SNR	S2	8, 9	
<i>Lomatium nuttallii</i> Nuttall's biscuitroot	Apiaceae	Forb	G3	S1	S1		S3	8, 9, 11, 14	

TABLE 2.1. Continued

Species/subspecies/variety	Family	Life form	Global rank ^a	State rank					Source ^b
				CO	ID	MT	UT	WY	
<i>Mentzelia pumila</i> Dwarf mentzelia ¹	Loasaceae	Forb	G4	SNR	S2	S2	S2	S3	8, 9, 11
<i>Mertensia oblongifolia</i> Oblongleaf bluebells	Boraginaceae	Forb	G4G5	SNR		SNR	SNR	S2	8, 9
<i>Oenothera pallida</i> var. <i>trichocalyx</i> Pale evening primrose	Onagraceae	Forb	G5T3T5	SNR		SNR	SNR	S3	8
<i>Oxytropis besseyi</i> var. <i>ventosa</i> Bessey's locoweed	Fabaceae	Forb	G5T3?		SU	S1?	S1?	S3	8, 9, 11
<i>Oxytropis nana</i> Wyoming locoweed	Fabaceae	Forb	G3					S3	7, 9
<i>Penstemon angustifolius</i> var. <i>vernalis</i> Broadbeard beardtongue	Scrophulariaceae	Subshrub Forb	G5T3	S1		S3			1, 8, 14
<i>Penstemon arenicola</i> Sand penstemon	Scrophulariaceae	Forb	G3G4	SNR	SNR			S3S4	8, 9, 12
<i>Penstemon eriantherus</i> var. <i>cleburnei</i> Cleburn's penstemon	Scrophulariaceae	Subshrub Forb	G4T2T3		SU	S1		S2S3	8, 9
<i>Penstemon fremontii</i> var. <i>fremontii</i> Fremont's beardtongue	Scrophulariaceae	Subshrub Forb	G3G4T3T4	SNR		S2S3		S3	8, 9, 12
<i>Penstemon laricifolius</i> var. <i>exilifolius</i> Larchleaf beardtongue	Scrophulariaceae	Forb	G4T2Q	S2				S2	2, 8, 9, 14
<i>Penstemon lemhiensis</i> Lemhi penstemon	Scrophulariaceae	Forb	G3	S3	S2				10
<i>Penstemon pachyphyllus</i> var. <i>mucronatus</i> Mucronate penstemon	Scrophulariaceae	Forb	G5T4	SNR		SNR		S2	8, 9
<i>Penstemon paysoniorum</i> Payson's beardtongue	Scrophulariaceae	Subshrub Forb	G3			SNR		S3	7, 9, 12
<i>Phacelia glandulosa</i> Glandular phacelia	Hydrophyllaceae	Forb	G4	SNR	SNR	S3	S1	S2?	7, 9
<i>Phlox opalensis</i> Opal phlox	Polemoniaceae	Forb	G3			S1	S1	S3	6, 7, 9, 16
<i>Physaria acutifolia</i> var. <i>purpurea</i> Sharpleaf twinpod	Brassicaceae	Forb	G5T2			S2			8
<i>Platyschkuhria integrifolia</i> Basindaisy	Asteraceae	Subshrub Forb	G5	SNR	SU	S3		S3	8, 9, 11
<i>Sphaeromeria argentea</i> Silver chickensage	Asteraceae	Subshrub Forb	G3G4	S1	SNR	S3		S3	10, 14
<i>Sphaeromeria capitata</i> Rock tansy	Asteraceae	Forb	G3	S1	S3	S1		S3	8, 9, 11, 14, 16
<i>Stanleya tomentosa</i> var. <i>tomentosa</i> Woolly princesplume	Brassicaceae	Subshrub Forb	G4T3					S2	7, 9

TABLE 2.1. Continued

Species/subspecies/variety	Family	Life form	Global rank ^a	State rank					Source ^b
				CO	ID	MT	UT	WY	
<i>Tetradymia nuttallii</i> Nuttall's horsebrush	Asteraceae	Shrub	G3G4	SNR			SNR	S2S3	8, 9
<i>Tetranneuris torreyana</i> Torrey's four-nerve-daisy ^m	Asteraceae	Forb	G4	SNR		S3	S1	S3	8, 9
<i>Thelypodopsis elegans</i> Westwater tumblemustard	Brassicaceae	Forb	G3G5	SNR			S3	S2S3	8, 9, 12
<i>Townsendia nuttallii</i> Nuttall's Townsend daisy	Asteraceae	Forb	G3			S3	S1	S3	8, 9, 11
<i>Townsendia spathulata</i> Sword Townsend daisy	Asteraceae	Forb	G3			S3		S3	8, 9, 11
<i>Townsendia strigosa</i> Hairy Townsend daisy	Asteraceae	Forb	G4	S1			SNR	S3	8, 9, 14
<i>Trifolium andinum</i> Intermountain clover	Fabaceae	Forb	G3	S1			S2	S3	8, 9, 14

^a Rankings obtained October 15, 2007 from NatureServe (<http://www.natureserve.org/explorer/>); G = Global rank indicator, based on worldwide distribution at the species level; T = Global trinomial rank indicator, based on worldwide distribution at the infraspecific level; S = State rank indicator, based on distribution within the state/province at the lowest taxonomic level; 1 = Critically imperiled, at very high risk of extinction or extirpation due to extreme rarity, very steep declines, or other factors; 2 = Imperiled due to rarity from very restricted range, very few populations, steep declines, or other factors; 3 = Vulnerable due to restricted range, relatively few populations, recent and widespread declines, or other factors; 4 = Apparently secure, uncommon but not rare, some cause for long-term concern due to declines or other factors; 5 = Secure, common, widespread, and abundant; SNR = Conservation status not yet assessed at the state/province level; ? = Inexact or uncertain numeric rank; Q = Questionable taxonomy; SU = Unrankable; present and possibly in peril, but not enough data yet to estimate rank.

^b Sources were: (1) the selection procedures described in the text and Fig. 2.1; (2) Keinath et al. 2003 (includes both Species of Concern and Species of Potential Concern); (3) The Nature Conservancy 2000; (4) Noss et al. 2001; (5) Freilich et al. 2001; (6) U.S. Bureau of Land Management 2004d; (7) Fertig 1999, Table 1; (8) Fertig 1999, Appendix B; (9) Wyoming GAP screen (see "Selecting Species for Assessment"); (10) Lesica 2003; (11) Montana Natural Heritage Program 2003; (12) Seeds of Success 2004; (13) U.S. Bureau of Land Management 2002a; (14) Colorado Natural Heritage Program 2005; (15) Colorado Natural Heritage Program 2003; (16) Utah Native Plant Society, Inc. 2004; (17) C. Spurrer (Appendix 3.1); (18) Idaho Rare Plant Society 2004; and (19) Neely et al. 2001.

^c Synonymous with *Oryzopsis contracta*.

^d Synonymous with *A. sericoleucus* var. *aretioides*.

^e Ranks are for species, not variety.

^f Ranks are for *D. oligosperma*; WY ranks *D. oligosperma* ssp. *juniperina* S2.

^g Ranks are for *E. lagopus*; synonymous with *Eriogonum lagopus*.

^h Synonymous with *Tetranneuris torreyana*.

ⁱ Synonymous with *I. congesta* var. *crebrifolia*.

^j Synonymous with *L. alpina* var. *condensata*.

^k Synonymous with *Leymus simplex*; ranks are for species, not variety.

^l Includes *M. pumila* var. *pumila*.

^m Synonymous with *Hymenoxys torreyana*.

Following this review, we addressed discrepancies among reviewers and finalized a list of 40 vertebrate taxa for analysis (Table 2.2).

Our list was intended to include all species of concern meeting our criteria and associated with sagebrush. The degree of dependency on sagebrush for many species is uncertain, and some species are likely to rely on some combination of sagebrush and other shrublands. Consequently, we referred to our list of species of concern as sagebrush-associated, rather than sagebrush-dependent. We assumed that any reduction in amount or quality of sagebrush was likely to affect all sagebrush-associated species on our list.

Species Modeled in the WBEA

To meet one of our assessment objectives, developing predictive models for species of concern (Introduction), we developed a modeling procedure (Ch. 4) to facilitate the development of robust empirical models from field collected data. Our field sampling effort was directed toward collecting the data necessary to model maximum number of sagebrush-associated species of concern (Ch. 5–9). We were able to develop spatially explicit models for 10 of the 40 vertebrate species of concern on our list as well as 5 other sagebrush-associated species.

MAPPING GEOGRAPHIC RANGES

Current range maps are necessary to quantify environmental conditions for species of concern in regional assessments and to ensure that conditions are evaluated in the area of relevance for the species. For our assessment, we defined a species' range as the polygon or polygons that encompass the outer boundaries of a species' geographic occurrence within the study area; this definition concurs with Gaston (1991) as the "extent of occurrence," rather than the area of occupancy of a species. These maps often overestimate the true

range of species, especially when considered over large spatial extents (Fertig and Reiners 2002, Dobkin and Sauder 2004), but are commonly used in conservation planning and assessment at regional scales (e.g., Knick *et al.* 2003, Laliberte and Ripple 2004). Many species included in our assessment have geographic ranges that are largely based on incomplete data regarding the internal population structure or distribution within their range. Consequently, we used the more general definition of range as the outer boundaries of each species' currently estimated occurrence.

Vascular Plants

Geographic range maps, as defined above, are not readily available for many plant species. Digitized coverages of such maps are especially lacking, other than maps of presence/absence by state or county. Challenges in producing range maps for plants include (1) the large number of species (e.g., Wyoming supports >2,700 taxa of plants), (2) the necessity of merging state-level maps for many taxa, and (3) the fine-scale data (e.g., soils) typically needed to accurately map plant distributions. Given these challenges, we did not create range maps for vascular plants of concern in the WBEA.

Vertebrates

We developed geographic range maps in two primary ways for the 40 vertebrate species of concern in the WBEA. First, we imported existing range maps from six sources, most of them previously compiled by NatureServe for mammals (Patterson *et al.* 2003) and birds (Ridgely *et al.* 2003) of the western hemisphere (Appendix 2.3; Fig. 2.2). When more detailed, hard-copy range maps or distribution data were available ($n = 8$), primarily for amphibians and reptiles, we scanned and digitized the maps. Digital versions of the vertebrate range maps were used to highlight areas of

TABLE 2.2. Forty vertebrate species of conservation concern identified for regional assessment within sagebrush ecosystems of the Wyoming Basins Ecoregional Assessment area.

Common name	Scientific name	Global rank ^a	State rank					Wyoming	Source ^b
			Colorado	Idaho	Montana	Utah	Wyoming		
Amphibians									
Great Basin spadefoot	<i>Spea intermontana</i>	G5	S3	S4		S5	S3	1, 2, 7, 9, 16, 17	
Reptiles									
Short-horned lizard ^c	<i>Phrynosoma hernandesi</i>	G5	S5		S3	S4	S4	1, 3, 6, 16, 17	
Sagebrush lizard	<i>Sceloporus graciosus</i>	G5	S5	S5	S3	S5	S5	1, 3, 14, 17	
Midget faded rattlesnake	<i>Crotalus viridis concolor</i>	G5T4	S3?				S1	1, 2, 4, 9, 16, 17	
Great Basin gopher snake	<i>Pituophis catenifer deserticola</i>	G5T5	S4				S3	2, 17	
Birds									
Ferruginous hawk	<i>Buteo regalis</i>	G4	S3B,S4N	S3B	S2B	S2S3B, S2N	S4B,S5N	1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19(II), 21	
Golden eagle	<i>Aquila chrysaetos</i>	G5	S3S4B, S4N	S4B,S4N	S4	S4	S3B, S3N	2	
Swainson's hawk	<i>Buteo swainsoni</i>	G5	S5B	S4B	S3B	S3B	S4B	1, 3, 6, 10, 13, 17, 21	
Prairie falcon	<i>Falco mexicanus</i>	G5	S4B,S4N	S5B,S3N	S4	S4	S4B,S4N	1, 3, 10 (III), 13, 15, 16	
Greater sage-grouse ^c	<i>Centrocercus urophasianus</i>	G4	S4	S4	S3	S2?	S4	1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19(II), 20, 21	
Columbian sharp-tailed grouse	<i>Tympanuchus phasianellus columbianus</i>	G4T3	S2	S3	S1		S1	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 15, 16, 17, 19(II), 20, 21	
Mountain plover	<i>Charadrius montanus</i>	G2	S2B		S2B	S1B	S2	2, 3, 6, 10, 11, 14, 16, 17, 19(II), 20	
Burrowing owl	<i>Athene cunicularia</i>	G4	S4B	S3S4	S2B	S3B	S3	1, 2, 3, 4, 7, 8, 9, 10, 12, 13, 15, 16, 17, 19(II), 20, 21	

TABLE 2.2. Continued

Common name	Scientific name	Global rank ^a	State rank					Source ^b
			Colorado	Idaho	Montana	Utah	Wyoming	
Gray flycatcher	<i>Empidonax wrightii</i>	G5	S5B	S2B,S2N	S3B	S4S5B	S4B,S4N	1, 10, 13, 15
Sage thrasher ^c	<i>Oreoscoptes montanus</i>	G5	S5	S5B	S3B	S4S5B	S5	1, 2, 3, 9, 10, 13, 14, 15, 17, 19(II)
Loggerhead shrike	<i>Lanius ludovicianus</i>	G4	S3S4B	S3	S3B	S4B, S3S4N	S3	1, 2, 3, 9, 10, 11, 13, 14, 15
Sage sparrow ^c	<i>Amphispiza belli</i>	G5	S3B	S4B	S1S3B	S3S4	S3	1, 2, 3, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 19(III)
Lark sparrow	<i>Chondestes grammacus</i>	G5	S4	S5B	S5B	S5B,S2N	S5B,S5N	1, 10, 13, 15
Green-tailed towhee ^c	<i>Pipilo chlorurus</i>	G5	S5	S5B	S4B	S4B	S5B,S5N	1, 13, 15
Vesper sparrow ^c	<i>Poocetes gramineus</i>	G5	S5	S4B	S5B	S5B,S2N	S5B,S5N	1, 10, 13, 15
Brewer's sparrow ^c	<i>Spizella breweri</i>	G5	S4B	S4B	S2B	S4S5B	S5	1, 2, 3, 6, 9, 10, 13, 14, 15, 17, 19(II), 21
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	G5	S5B,S4N	S5B,S5N	S5B	S4S5	S5B,S5N	1, 15
Western meadowlark	<i>Sturnella neglecta</i>	G5	S5	S5B,S3N	S5B	S5	S5B,S5N	1, 13, 15
Mammals								
Merriam's shrew	<i>Sorex merriami</i>	G5	S3	S2?	S3	SH	S3S4	1, 3, 7, 15, 18, 19(III), 21
Spotted bat	<i>Euderma maculatum</i>	G4	S2	S2	S2	S2S3	S3	1, 2, 3, 12, 15, 16, 17, 18, 19(II), 20, 21
Western small-footed myotis	<i>Myotis ciliolabrum</i>	G5	S4	S4?	S4	S3S4	S3B	1, 2, 17, 18
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	G4	S2	S2	S2	S3?	S2	1, 2, 3, 4, 12, 16, 17, 18, 19(II), 20, 21
Pronghorn ^c	<i>Antilocapra americana</i>	G5	S4	S5	S5	S4	S5	1, 14
Bighorn sheep	<i>Ovis canadensis</i>	G4	S4	S3	S4	S3?	S3S4	2, 6, 14, 17, 19(II), 21
Black-footed ferret	<i>Mustela nigripes</i>	G1	S1		S1	S1	S1	2, 3, 4, 6, 12, 14, 16, 17, 19(I), 20

TABLE 2.2. Continued

Common name	Scientific name	Global rank ^a	State rank					Wyoming	Source ^b
			Colorado	Idaho	Montana	Utah	Wyoming		
White-tailed prairie dog	<i>Cynomys leucurus</i>	G4	S4		S1	S2?	S3	1, 2, 3, 6, 9, 12, 16, 17, 19(II), 20	
Uinta ground squirrel	<i>Spermophilus armatus</i>	G5		S4?	S3S4	S5	S3S4	1, 2, 3, 8, 17	
Wyoming ground squirrel	<i>Spermophilus elegans</i>	G5	S5	S4?	S3S4	SH	S3S4	1, 2, 3, 8, 17, 19(III), 21	
Wyoming pocket gopher	<i>Thomomys clusius</i>	G2					S2	2, 9, 17	
Idaho pocket gopher	<i>Thomomys idahoensis</i>	G4		S4?	S2S3	SH	S2	1, 2, 3, 8, 9, 17, 19(III), 21	
Great Basin pocket mouse	<i>Perognathus parvus</i>	G5	S1	S5	S2S3	S4	S2	2, 3, 15, 16, 17, 20	
Sagebrush vole	<i>Lemniscus curtatus</i>	G5	S1	S4	S4	S3S4	S5	1, 6, 15, 16, 17	
White-tailed jackrabbit ^c	<i>Lepus townsendii</i>	G5	S4	S5	S4	S3S4	S4	1	
Black-tailed jackrabbit	<i>Lepus californicus</i>	G5	S5	S5	S2	S5	S5	1, 3	
Pygmy rabbit	<i>Brachylagus idahoensis</i>	G4		S3	S3	S2	S1	1, 2, 3, 8, 9, 12, 14, 15, 17, 18, 19(II), 20, 21	

^a Rankings were obtained on October 15, 2007 from NatureServe (<http://www.natureserve.org/explorer/>) and are as follows: G = Global rank indicator; based on worldwide distribution at the species level; T = Global trinomial rank indicator; based on worldwide distribution at the infraspecific level; S = State rank indicator; based on distribution within the state/province at the lowest taxonomic level; 1 = Critically imperiled, at very high risk of extinction or extirpation due to extreme rarity, very steep declines, or other factors; 2 = Imperiled due to rarity from very restricted range, very few populations, steep declines, or other factors; 3 = Vulnerable due to restricted range, relatively few populations, recent and widespread declines, or other factors; 4 = Apparently secure, uncommon but not rare, some cause for long-term concern due to declines or other factors; 5 = Secure, common, widespread, and abundant; SH = Possibly extirpated; ? = Inexact or uncertain numeric rank; B = Conservation status for breeding populations in the state/province; N = Conservation status for non-breeding populations in the state/province.

^b Sources included: (1) the selection procedure developed by Wisdom et al. (2005b); (2) Keinath et al. 2003 (includes both Species of Concern and Species of Potential Concern); (3) Montana Natural Heritage Program 2004; (4) Colorado Division of Wildlife 2005b; (5) The Nature Conservancy 2000; (6) Neely et al. 2001; (7) Noss et al. 2001; (8) Freilich et al. 2001; (9) U.S. Bureau of Land Management 2002b, (10) Nicholoff 2003; (11) U.S. Bureau of Land Management 2004e; (12) Utah Department of Natural Resources 2005; (13) Rich et al. 2005; (14) International Union for the Conservation of Nature 2007; (15) Dobkin and Sauter 2004; (16) Colorado Natural Heritage Program 2005; (17) Wyoming Game and Fish Department 2005; (18) Idaho's Special Status Mammals <http://fishandgame.idaho.gov/cms/tech/CDC/animals/mammals.cfm> (copyright 2006, Idaho Fish and Game); (19) Utah Division of Wildlife Resources 2005; (20) Montana Fish, Wildlife and Parks 2005; and (21) Idaho Department of Fish and Game 2005.

^c Spatially explicit models developed for these species in Ch. 5-10.

uncertainty in the maps of species occurrence and abundance in Chapters 5–9.

For two species, pygmy rabbit (*Brachylagus idahoensis*) and pronghorn (*Antilocapra americana*), we created hand-digitized range maps specifically for our assessment. The most current range map for pygmy rabbit when we initiated our study (Patterson et al. 2003) did not extend into Wyoming. However, pygmy rabbits were known to occur in the state (e.g., Campbell et al. 1982; Clark and Stromberg 1987; Beauvais 2004; WYNDD, unpublished data). To update the range map for this species in Wyoming, we used the predicted distribution from an Optimal DOMAIN Model developed by WYNDD (Beauvais 2004; D. Keinath, WYNDD, pers. comm.). The map was expanded and refined in 2005 based on recent surveys conducted by the University of Wyoming in Carbon and Fremont counties (Purcell 2006). In Idaho, surveys for pygmy rabbits revealed locations of active burrows in the southeastern corner of the state, east of the boundary displayed by Patterson et al. (2003) (Rachlow and Svancara 2003); we updated the map accordingly. For the Montana portion of the WBEA, we used the map of Rauscher (1997); in Utah, we relied on a map of recent (2004) positive occurrences of pygmy rabbit (A. Kozlowski, Utah Division of Wildlife Resources, pers. comm.). The final, combined range map for pygmy rabbit in the WBEA encompassed about 611 km² of the study area (Fig. 7.1c).

We developed a range map for pronghorn based on information obtained from the wildlife agencies of each state in our study area (Montana Fish, Wildlife and Parks 2002, Idaho Department of Fish and Game 2004, Utah Division of Wildlife Resources 2004, Wyoming Game and Fish Department 2004, Colorado Division of Wildlife 2005a). The range maps were merged into a single shapefile. Our range map combined all seasonal ranges of pronghorn (i.e., year-round, summer, winter).

SELECTED VASCULAR PLANTS OF CONSERVATION CONCERN

We identified 65 taxa of sagebrush-associated vascular plants of conservation concern for our assessment (Table 2.1). Nearly all are found in Wyoming (n = 59; 91%), reflecting its central location and relatively large percentage (51%) of the study area. Only 15 taxa on the list occur in Idaho, which had the smallest area among the five states within the assessment boundary (Ch. 1). Colorado and Utah had similar representation on the list (n = 40 and 43, respectively). By contrast, Montana comprised 21% of the study area, nearly twice the percentage of Colorado (12.6%) and Utah (10.4%), but had only 28 taxa on the list.

The vast majority (n = 47; 72%) of the vascular plants of concern were forbs, followed by subshrubs/forbs (n = 13; 20%) and graminoids (n = 3; 5%). Only two shrub species, Wyoming threetip sagebrush (*Artemisia tripartita* ssp. *rupicola*) and Nuttall's horsebrush (*Tetradymia nuttallii*), were included (Table 2.1). Families most commonly represented included Asteraceae (n = 16), Fabaceae (n = 12; primarily *Astragalus* spp.), and Scrophulariaceae (n = 9). Many of the plants on the list, such as Ownbey's thistle (*Cirsium ownbeyi*), were found on several other lists of special status or sensitive species, or were brought forward from more than one of our selection approaches (Table 2.1).

Although no taxa were ranked G1, one was ranked G2 (box [meadow] pussytoes [*Antennaria arcuata*]) and two as G2G3 (Evert's springparsley [*Cymopterus evertii*] and talus springparsley [*C. lapidosus*]). Global rank indicators ("G-ranks") reflect the status of each taxon based on worldwide distributions (Master 1991). Only three plants were ranked G5 ("demonstrably secure" at a global scale; see footnotes, Table 2.1); most taxa were ranked intermediate to these extremes (i.e., G3 and G4), consistent with our culling of plants

either too rare or ubiquitous for effective assessment at a regional scale. Forty-eight plants (74%) were ranked S1 or S2 in at least one state within the assessment area (Table 2.1). Fifteen subspecies or varieties had trinomial ranks of T2 to T4, indicating low to moderate risk to these taxa at the infraspecific level (Table 2.1).

Of the 20 plants brought forward from the selection process outlined by Wisdom et al. (2005b), seven were retained (taxa retained have a source code of "1" in Table 2.1) and 13 were dropped. Plants excluded from further consideration either were not associated with sagebrush, were too common (e.g., ranked S5 in all states within their range in the study area) to retain as species of concern or had distributions largely outside the study area.

SELECTED VERTEBRATES OF CONSERVATION CONCERN

Forty vertebrates of concern were identified for the WBEA: one amphibian (Great Basin spadefoot [*Spea intermontana*]), four reptiles, 18 birds, and 17 mammals (Table 2.2). The reptiles included two snakes and two lizards. The majority of the avian taxa were passerines; also included were five raptors and two gallinaceous species (greater sage-grouse [*Centrocercus urophasianus*] and Columbian sharp-tailed grouse [*Tympanuchus phasianellus columbianus*]). The 17 mammals included a wide range of taxa, from small mammals to bats, a carnivore, and two ungulates (Table 2.2). All seven vertebrates commonly denoted as sagebrush-obligate species (Paige and Ritter 1999) were identified as species of concern: sagebrush lizard (*Sceloporus graciosus*), greater sage-grouse, sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), pronghorn, and pygmy rabbit.

Most species occurred in all five states of our assessment, and all 40 were found in Wyoming (Table 2.2). Idaho had the low-

est representation, with 33 of the 40 species (83%) present. Species not found in all states had limited distributions in the region, such as midget faded rattlesnake (*Crotalus viridis concolor*) and mountain plover (*Charadrius montanus*). Some species on our list are endemic to shrubsteppe vegetation of the Intermountain West, such as Great Basin pocket mouse (*Perognathus parvus*) and pygmy rabbit (Dobkin and Sauder 2004).

Several vertebrate species of concern in the WBEA area are either rare or imperiled (see G-ranks, Table 2.2). The rarest species on our list, black-footed ferret (*Mustela nigripes*), is ranked G1 and listed as endangered by the U.S. Fish and Wildlife Service (FWS) (NatureServe 2007). This species had been extirpated in the wild and is now found only in very limited numbers in sites where animals have been successfully re-introduced (Dobson and Lyles 2000, NatureServe 2009). Two additional species, mountain plover and Wyoming pocket gopher (*Thomomys clusius*), were ranked G2, which indicates imperilment at a global scale. The mountain plover is currently ranked G3 (NatureServe 2009). The Wyoming pocket gopher is endemic to Wyoming, where it was ranked S2. At the trinomial (i.e., infraspecific) level, two subspecies were ranked T3 or T4: midget faded rattlesnake (T4) and Columbian sharp-tailed grouse (T3; Table 2.2). The majority of the species on our list, however, were considered secure on a global basis, ranked either G4 (n = 10; 25%) or G5 (n = 24; 60%).

At the state level, nine species (23%) were ranked S1 in one or more of the five states in the study area. Only three species were ranked either S4 or S5 (i.e., relatively secure status) in all states in which they occurred in the study area: green-tailed towhee (*Pipilo chlorurus*), Brewer's blackbird (*Euphagus cyanocephalus*), and pronghorn (Table 2.2).

In addition to black-footed ferret, several species of concern in the WBEA have

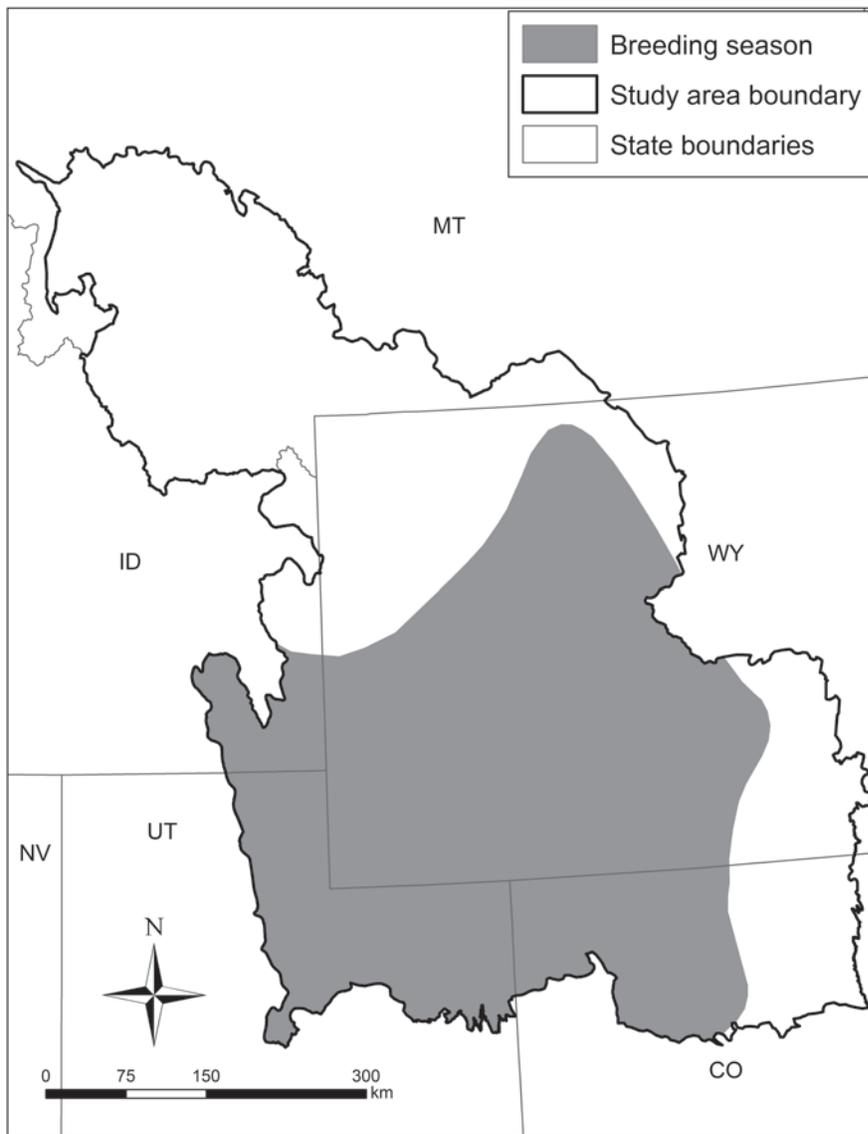


FIG. 2.2. Example geographic range map used in the Wyoming Basins Ecoregional Assessment; sage sparrow shown (from Ridgely *et al.* 2003).

been considered for listing by the FWS in response to petitions submitted under the Endangered Species Act (ESA). Petitions to list the greater sage-grouse as threatened or endangered range-wide were found not warranted by the FWS in January 2005 (U.S. Fish and Wildlife Service 2005a). A court challenge to the decision resulted in an additional review and

determination in 2010 that listing greater sage-grouse as endangered was warranted but precluded (U.S. Fish and Wildlife Service 2008c, 2010a). Two petitions to list the pygmy rabbit as threatened or endangered across its range have been considered by FWS, May 2005 and September 2010, but the agency found listing to be “not warranted” (U.S. Fish and Wildlife Service

2005b, 2010d). The mountain plover was petitioned for listing under the ESA, but withdrawn in 2003 (Dinsmore 2003); in 2010, the FWS reinstated a proposal to list the species as threatened under the ESA (U.S. Fish and Wildlife Service 2010b). The white-tailed prairie dog (*Cynomys leucurus*) was petitioned for listing in 2002, but listing was denied by the FWS in 2004; the FWS initiated another status review in May 2008, again finding that listing as an endangered species was not warranted (U.S. Fish and Wildlife Service 2008a, 2010c). A petition to list the Columbian sharp-tailed grouse as threatened or endangered across its historical range was submitted in 2004 (Banerjee 2004), with a finding by FWS that current information did not warrant listing (U.S. Fish and Wildlife Service 2006).

Twenty-eight (70%) of the vertebrate species of concern selected for the WBEA were also found on at least one of the state-level lists of species of concern compiled as part of the Comprehensive Wildlife Conservation Strategy process (Table 2.2). For example, 27 (68%) species of concern in the WBEA are listed in Wyoming's action plan (Wyoming Game and Fish Department 2005). Similarly, 17 of our selected vertebrate species (43%) are listed in Utah's strategy (Table 2.2; Utah Division of Wildlife Resources 2005).

Species of Concern Modeled in the WBEA

We modeled 10 vertebrate species of concern in the WBEA area based on vegetation, abiotic, and anthropogenic disturbance variables: Brewer's sparrow, greater sage-grouse, green-tailed towhee, lark sparrow (*Chondestes grammacus*), pronghorn, sage sparrow, sage thrasher, short-horned lizard (*Phrynosoma hernandes*), vesper sparrow (*Pooecetes gramineus*), and white-tailed jackrabbit (*Lepus townsendii*) (see Ch. 5-10 for modeling methods and results). Greater sage-grouse was modeled owing to its prominence as a spe-

cies of concern in sagebrush ecosystems (Knick and Connelly 2011) and the commitment by the BLM to managing habitats for this species (U.S. Bureau of Land Management 2004a, b, c). Moreover, five of these species—Brewer's sparrow, greater sage-grouse, pronghorn, sage sparrow, and sage thrasher—were included in the 2007 "red list" of threatened species (International Union for the Conservation of Nature 2007).

SUMMARY

Our assessment area harbors a large proportion of the sagebrush remaining in the western U.S. (Ch. 1). These expansive tracts support a wide array of vertebrates and plants that rely on sagebrush communities for all or part of their life cycles. Many of the avian species selected for our evaluation have declined in abundance, including greater sage-grouse (Connelly et al. 2004, Knick and Connelly 2011) and a host of shrub steppe passerines (Vander Haegen et al. 2000, Knick and Rotenberry 2002, Knick et al. 2003, Dobkin and Sauder 2004). Likewise, population declines for several of the mammals on our list, such as white-tailed prairie dog and pygmy rabbit, have been noted in portions of their ranges (Hays 2003, Thines et al. 2004).

The 65 vascular plants and 40 vertebrates of concern identified for our assessment met our criteria of strong association with sagebrush and a recognized status of conservation concern. The group is diverse; species selected span a range of taxonomic groups (e.g., avian vs. herptile species), sensitivity to disturbance (short-horned lizard [no important anthropogenic disturbance factors; Ch 7] vs. greater sage-grouse [three anthropogenic disturbance factors; Ch. 5]), levels of conservation risk (e.g., Wyoming pocket gopher [G2] vs. Great Basin spadefoot [G5]), spatial extents at which they select habitats (midget faded rattlesnake vs. American pronghorn), and reliance on sagebrush communities (e.g.,

sagebrush obligates such as greater sage-grouse vs. species that use sagebrush in tandem with a variety of shrublands, such as Swainson's hawk [*Buteo swainsoni*]). Together these species provide a comprehensive basis for an integrated assessment of potential threats from anthropogenic disturbance, including land use change, on species of concern and their habitats in sagebrush communities of the WBEA. Many of our selected taxa are also featured in other contemporary assessments of species of concern in shrub steppe communities (Knick et al. 2003, Connelly et al. 2004, Dobkin and Sauder 2004, Rich et al. 2005, Wisdom et al. 2005a). Thus, our selection corroborates the importance of these taxa for management consideration in sagebrush ecosystems of the Wyoming Basins.

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APPENDIX 2.1

Experts consulted for (1) review of selection methods and draft lists of species of conservation concern, or (2) predictive

models of example species, in conjunction with the Wyoming Basins Ecoregional Assessment. This appendix is archived electronically and can be downloaded at the following URL: <http://sagemap.wr.usgs.gov/wbea.aspx>.

APPENDIX 2.2

Literature sources used to determine sagebrush association of potential vascular plant species of concern for the Wyoming Basins Ecoregional Assessment area. This appendix is archived electronically and can be downloaded at the following URL: <http://sagemap.wr.usgs.gov/wbea.aspx>.

APPENDIX 2.3

Sources used for developing geographic range maps for 40 vertebrates of conservation concern in the Wyoming Basins Ecoregional Assessment area. This appendix is archived electronically and can be downloaded at the following URL: <http://sagemap.wr.usgs.gov/wbea.aspx>.