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Assessment of Native Species and Ungulate Grazing in the Southwest: Terrestrial Wildlife

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Abstract

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Range managers in the Southwestern States are increasingly being required to develop management strategies that take into consideration the conservation of wildlife populations. However, information on many aspects of the fundamental biology and impacts of grazing on individual species is still lacking in the scientific and government literature. This report documents a project designed to assemble this information for terrestrial wildlife in Arizona and New Mexico that have the potential to be negatively impacted by grazing or range management practices. To achieve this, a two-stage panel process was developed that employed a variety of wildlife experts to create a list of potentially vulnerable species and to develop an informational database. Panelists first reviewed and assessed all terrestrial vertebrates in the region to develop an initial list. In the second stage, the panelists refined the list, reviewed published information drafted into individual species accounts, and then augmented these accounts with information from their own experience and observations. The resulting database contains accounts for 305 species and subspecies of amphibians, reptiles, birds and mammals, including a computer database that allows managers to search and query the species accounts based on geographic distribution as well as shared ecological and life history characteristics.

Keywords: Arizona, grazing effects, New Mexico, range management, Southwest, terrestrial wildlife, ungulate grazing, wildlife management

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Assessment of Native Species and Ungulate Grazing in the Southwest: Terrestrial Wildlife

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Introduction:

Background

The past few decades have seen the development of an ecological and wildlife conservation ethic in the United States that has increasingly manifested itself in Federal and State laws. These laws have led to numerous conflicts with people holding economic and social interests in the development and use of natural resources. The relationship between wildlife conservation and livestock grazing in the Southwest has been particularly contentious. Although much of the discourse has been driven by people with extreme views on both sides of the argument, the USDA Forest Service and other public and private groups have sought to balance these conflicting demands on the land and its resources. These groups are part of a growing effort to approach livestock ranching with the aim of using science-based management techniques that conserve wildlife and their habitat (Brown and McDonald 1995).

Today's range manager interested in management techniques that support both livestock and wildlife has an increasing number of resources available (for example, Sayre 2001). However, information on the impacts of grazing on individual wildlife species is still lacking in the scientific and government literature, and many existing publications suffer from a variety of problems of experimental design or failure to take into account all influential environmental variables (Brown and McDonald 1995; Curtin 2002; Jones 2000; Saab and others 1995; Stohlgren and others 1999; Holthausen personal communication). Of the "grazing effects" research that has been published on species that occur in the Southwest, little focus specifically on their occurrence in the ecosystems and communities of this region. This can lead to attempts to extrapolate effects of grazing from regions outside the Southwest, which in many cases has the potential to be highly misleading and in some cases can lead to the recommendation of grazing regimes that are detrimental.

Despite these challenges, range managers in the Southwest, particularly those working in government agencies, are required to develop management strategies that take into consideration the conservation of wildlife populations. The focus is frequently on legally protected wildlife, but increasingly includes other species in the interest of maintaining and protecting the wildlife resource on the landscape. Managers therefore find themselves in the position of being expected to have knowledge of the effects of various management actions on the wildlife and habitat under their purview, despite the shortcomings of the informational resources noted above.

Many ecologists are beginning to focus on grazing effects on a large, landscape-level scale. This view recognizes that a full understanding of the ecological effects of grazing, particularly in relatively homogeneous, widespread ecosystems (for example, desert grasslands), will likely require experimental studies that take into account large-scale disturbance and climate factors (Curtin 2002). However, at the smaller spatial scales in which most land managers work, grazing can directly affect wildlife through impacts to the specific ecological and habitat needs of individual species. This small-scale approach recognizes that there are certain specific parameters that must be met for a species to persist within a local area, and that it is possible to identify the ways that these parameters can be affected by ungulate grazing as well as management actions.

We have based this assessment of wildlife and grazing interactions in the Southwest on the specific ecological and habitat requirements of individual species. As discussed above, most terrestrial vertebrate species in the Southwest have not been studied in the context of grazing effects. However, information is available on the ecology, life history, and habitat needs of most of these species, including the knowledge and expertise of those individuals with extensive field experience with these species. In the absence of direct scientific investigation of grazing effects on a species, this fundamental biological information can be used to infer these effects from a species'

habitat requirements. Such inference, while less desirable than controlled studies, can form the basis for sound grazing management decisions when combined with additional information on climate, soils, vegetation and other critical components of habitat.

Objectives

The primary objective of this effort is to provide land and livestock managers of the Southwest with information on the fundamental biology and habitat requirements of Southwestern wildlife. Rather than include all species, our approach focuses on a subset of the region's terrestrial vertebrate species that have the potential to be negatively impacted by grazing or range management practices.

There are two parts to this approach. The first part is to review all the terrestrial vertebrate species of Arizona and New Mexico in order to create a list of species that could be negatively impacted. The second part is to collect data on each species from a wide variety of sources (peer-reviewed literature, government reports, technical publications, and professional experts) in order to create a species account database. The ultimate product is an easily accessible computerized database that allows managers to search and query the collection of species accounts based on geographic distribution as well as shared ecological, life history, and habitat characteristics among the species.

Methods: The Panel Process

To meet the above objectives, information was gathered from the peer-reviewed literature as well as a series of panels comprising experts in various fields of wildlife ecology in the Southwest. These panels, organized chiefly by taxonomic group, played two major roles: first, to develop an initial list of species that are potentially vulnerable to grazing or range management actions (Stage I of the panel process), and second, to review draft species accounts and supplement them with information from the panelists' personal knowledge and experience (Stage II of the process). The goal was to develop a database of individual species accounts that provide as complete a picture as possible of the ecological and habitat needs of each species and the possible ways in which they may be affected by grazing.

Stage I

The objective of Stage I in the panel process was to review each species from Arizona and New Mexico individually, and from that review create an initial list of species for the database. The panelists considered effects from both grazing and range management practices. "Grazing" was considered to include all impacts on the ecosystem resulting from ungulates (both wild and domestic) feeding on vegetation. This could include direct impacts from herbivory as well as indirect effects to soils, water quality, fire regimes, and so forth. Impacts from "range management" included various human-induced changes to the environment resulting from the management of livestock or range operations, such as the construction of stock tanks, fences, and roads; the clearing of brush or trees to create grasslands; development of natural springs for livestock; planting of exotic grasses; and other human impacts related to raising and managing livestock.

Panelists were invited from a variety of organizations, including universities, Federal and State government agencies, and private organizations and consulting firms (appendix A). Five panels were convened, organized as follows: (1) Herpetofauna (Reptiles and Amphibians), (2) Grassland/Desert Scrub Birds, (3) Woodland Birds, (4) Riparian Birds, and (5) Mammals. A complete list of species for each group was compiled using the Biota Information System of New Mexico (BISON-M) database developed by the New Mexico Department of Game and Fish; this database also contains taxa from Arizona (NMDGF 2004a). The list was further refined through the use of reference books of the Southwest (for example, Hoffmeister 1986; Hubbard 1978; Phillips and others 1964), and by having the list reviewed by several of the expert panelists.

Subspecies were considered separately when they were considered to have significant ecological differences (for example, disjunct distributions or habitat associations), if they had been proposed as separate species, or when they were listed as sensitive from a conservation standpoint (see also Stage II process). Extirpated species were initially included for review; however, it was ultimately decided to only include these species if there was an active program to reintroduce them back into the wild (for example, river otters, black-footed ferrets, and gray wolves are included, whereas sage grouse and bison are not).

For each species or subspecies, panelists were asked to note information on the mechanisms of grazing effects, key habitat components affected, part of life cycle affected, and general appraisal of the status and degree of impact on each species. An open round-table discussion allowed the panelists to share their notes and observations on each species; the panelists were then asked to select answers for three survey questions on the direction, magnitude, and likelihood of the effects of grazing on each species:

- Direction: *Negative/Positive/Unknown/No effect*
- Magnitude: *Severe/Not Severe/Unknown*
- Likelihood: *Definite/Probable/Possible*

The Stage I species selection process was intentionally designed to be highly conservative, with a high rate of inclusion. The selections made by each panelist from the three survey categories were entered into a spreadsheet for analysis; to qualify for this initial inclusion, a species must have had one of the two following selection combinations made by at least one panelist:

- Direction: *Negative*, Magnitude: *Severe*, Likelihood: *(any selection)*
- Direction: *Negative*, Magnitude: *Unknown*, Likelihood: *Definite*

This focused the rejection process on species for which there was general agreement that grazing had little if any effect, and enabled some questionable species to remain on the list pending re-evaluation during Stage II. The complete Stage I list was generated once all the panels were completed for each of the five species groups.

Draft Species Accounts

Individual species accounts were drafted for each species on the Stage I list. The basic species account template (see appendix B and the "Species Account Guide" below) consists of eight text narratives: Status/Trends/Threats, Distribution, Breeding, Habitat, Season of Use, Diet, Grazing Effects, and Fire Regime Requirements. These were developed using information gathered through a search of the technical literature, including scientific journals, government technical reports, books, survey data, and field guides (sources that were frequently used and proved to be particularly important are summarized in appendix C). Interspersed among these narrative sections are a series of menus that present a variety of selections to describe the ecological and life history parameters of the species in the database (defined below in the

"Species Account Guide"). All possible choices appeared in each draft, with the intent that the Stage II panelists would choose the items that apply to each particular species. The menu selections play an important role in the electronic database, serving as search parameters that allow the user to create a list of species that share an item or combination of items under each menu (see appendix F).

Stage II

The objective of the Stage II panels was to review and amend the narrative information in the draft accounts and to make selections from the lists under each menu. In addition, the Stage II panelists were asked to reject or add species, divide species into subspecies accounts if appropriate, and designate priority species in the database. Occasionally, a panel would decide that no one on the panel had the knowledge or experience to review a particular species. In these cases, the panel would recommend that we seek an outside reviewer to provide the menu selections and comments normally provided by a panel (see appendix A for outside reviewers, and tables 1 and 2 for species accounts information).

Review of Text—For each text section, the panelists made the following contributions: (1) information based on their own personal knowledge, research and/or field experience, (2) editing of the language for accuracy and elimination of redundant or irrelevant information, and (3) suggestions for additional sources of information (journal or book references, other experts to contact, and so forth). Information based on the panelists' personal knowledge, experience, or inference is generally undocumented, and is identified in the text by the citation "GP" for "Grazing Panel," followed by the year the panel was convened; for example, (GP 2000) or (GP 2001). (Note: Stage I panels for all species groups were held in 1999; thus, all citations following the general format of GP1999, refer to information or comments provided in those panels.) Some of this information carries a fairly high level of certainty, especially when based on unpublished data or repeated observations made in the field. Information that is less certain or based more on speculation is presented with the appropriate qualifiers.

Menu Selections—Each Stage II panel made menu selections that represent appropriate descriptors for the particular species under review. The panelists could choose from one to all possible items in each list. The selections listed in a species account represent a consensus selection made by the particular panelists working on that species only. The "Panel comments" boxes seen in the template (appendix B) were made available to allow panelists to modify the definition of a selected term or to provide additional information. These boxes only appear in the final account if they were utilized by the panelists; all information in these boxes is attributable to the Stage II panel unless otherwise indicated.

Rejections and Additions—Because of the conservative nature of the selection process in the first stage of panels, it was expected that many species would be inappropriate to include upon closer examination. Each Stage II panel was therefore asked to consider the merits of inclusion for each species under review and to reject any they deemed to be inappropriate for the database. Panelists could also propose adding a species if they felt that its absence was an important oversight (drafts were then written for the additional species to be considered by a future panel). Although the goal was to achieve consensus for all rejections and additions, occasionally one or more panelists would abstain from supporting a change that was made, but did not object.

Multiple Subspecies Accounts—Panelists were also asked to consider whether certain species should be divided into individual accounts by subspecies. This was considered particularly important for subspecies that have markedly different habitat requirements, thus requiring different selections under the various menus. The utility for the user is that it eliminates excess information for subspecies that do not occur in the area or habitat of interest. In these cases, an account was typically divided into multiple subspecific accounts during the panel session, with panelists providing information and menu selections for each.

Designation of Priority Species—Stage II panelists were also asked to determine whether each species should be designated as a "priority species" relative to the other species in the database. These are taxa that, in the opinion of the panelists, should receive greater consideration during development of management strategies related to grazing. The Stage II panels considered the "priority" designation under two landscape-level scales: first, throughout the species' entire distribution within Arizona and New Mexico, and, second, only within specifically identified key areas of abundance or distribution (see "Species Account Guide" below for further descriptions).

Species Account Database

Each account was revised to incorporate all panel comments, as well as any additional literature, references, or other information requested by the panelists. Menu selection lists are reduced in their final versions to include only the selections made by the panelists. The incorporation of information and references provided by the panel frequently involved considerable revision of the draft; thus, an additional "Revision Author" is identified at the end of each account as well as a "Draft Author." Panel participants are identified at the end of each account, with Stage I panelists listed under the citation "GP 1999" and Stage II panelists listed under grazing panel citations with later years.

The species account database is provided here in an accompanying CD as a searchable database based in Microsoft Access. In addition, each account can be viewed in two text formats: Adobe PDF, for printing or on-screen viewing, and Microsoft Word, which allows selective printing as well as copying of text material. Appendix F provides further details on accessing and using the searchable database and species account files.

Table 1—Numbers of species considered throughout the grazing assessment panel process, including the total number assessed in Stage I, the number of species selected after Stage I, the number rejected or added in Stage II, the total number of species included after Stage II, and the final number of accounts in the database (both species and subspecies).

	Total assessed in Stage I[a]	Selected after Stage I	Rejected in Stage II	Added in Stage II	Total after Stage II[b]	Total accounts in database[c]
Herpetofauna	166 (183)	31	–2	+1	30 (18%)	38
Birds (grassland/ desert scrub)	127 (130)	49	–11	+1	39 (31%)	40
Birds (woodland)	125 (128)	60	–13	+4	51 (41%)	53
Birds (riparian/ wetland)	249 (251)	87	–24	+8	71 (29%)	71
Mammals	199 (274)	97	–21	+16	92 (46%)	103
Totals:	866 (966)	323	–71	+30	283 (33%)	305

[a] Many species were considered as multiple subspecies; the first number is species only, the number in parentheses includes the multiple subspecies.
[b] Total number of individual species and percent of original number of species from first column.
[c] Includes species that were divided into separate accounts for multiple subspecies.

Table 2—Scientific and common names of the 305 terrestrial vertebrates in the grazing assessment database. Species and subspecies are arranged taxonomically, first in three major groups (reptiles and amphibians, birds, and mammals), and then by taxonomic order within each group. The last two columns state the panelists' assessment as to whether a species should be considered a priority (yes, no, or unknown) when developing a grazing strategy: first, throughout the species' distribution in Arizona and New Mexico, and, second, only in key distribution, abundance, or management areas within the species' range.

				Priority?	
Genus	Species	Subspecies	Common name	All areas	Key areas
Reptiles and amphibians					
Ambystoma	*tigrinum*	*nebulosum*	Tiger Salamander	NO	NO
Ambystoma	*tigrinum*	*stebbinsi*	Sonora Tiger Salamander	YES	YES
Rana	*blairi*		Plains Leopard Frog	NO	YES
Rana	*chiricahuensis*		Chiricahua Leopard Frog	YES	YES
Rana	*pipiens*		Northern Leopard Frog	YES	YES
Rana	*yavapaiensis*		Lowland Leopard Frog	YES	YES
Gopherus	*agassizi*		Desert Tortoise	YES	YES
Terrapene	*ornata*		Ornate Box Turtle	NO	YES
Kinosternon	*sonoriense*		Sonoran Mud Turtle	NO	NO
Kinosternon	*flavescens*	*flavescens*	Yellow Mud Turtle	NO	YES
Kinosternon	*flavescens*	*arizonense*	Southwestern Mud Turtle	NO	YES
Gambelia	*wislizenii*		Leopard Lizard	NO	NO
Phrynosoma	*douglasii*		Short-Horned Lizard	NO	YES
Sceloporus	*arenicolus*		Sand Dune Lizard	YES	YES
Sceloporus	*clarkii*		Clark's Spiny Lizard	NO	NO
Sceloporus	*scalaris*		Bunch Grass Lizard	YES	YES
Sceloporus	*undulatus*		Prairie (Eastern Fence) Lizard	NO	NO
Cnemidophorus	*burti*		Canyon (Giant) Spotted Whiptail	YES	YES
Cnemidophorus	*inornatus*	*arizonae*	Arizona Little Striped Whiptail	YES	YES
Cnemidophorus	*inornatus*	*heptagrammus*	Trans-Pecos Little Striped Whiptail	YES	YES
Cnemidophorus	*inornatus*	*juniperus*	Woodland Little Striped Whiptail	UNK	UNK
Cnemidophorus	*inornatus*	*llanuras*	Plains Little Striped Whiptail	YES	YES
Cnemidophorus	*inornatus*	*pai*	Pai Little Striped Whiptail	YES	YES
Eumeces	*gilberti*	*arizonensis*	Arizona Skink	UNK	UNK
Coluber	*constrictor*		Yellowbelly Racer	UNK	YES
Lampropeltis	*triangulum*		Milk Snake	UNK	YES
Thamnophis	*eques*		Mexican Garter Snake	YES	YES
Thamnophis	*proximus*		Western Ribbon Snake	YES	YES
Thamnophis	*rufipunctatus*		Narrowhead Garter Snake	YES	YES
Crotalus	*atrox*		Western Diamondback Rattlesnake	NO	NO
Crotalus	*cerastes*		Sidewinder Rattlesnake	NO	NO
Crotalus	*lepidus*	*klauberi*	Banded Rock Rattlesnake	NO	NO
Crotalus	*lepidus*	*lepidus*	Mottled Rock Rattlesnake	UNK	UNK
Crotalus	*molossus*		Blacktail Rattlesnake	NO	NO
Crotalus	*scutulatus*		Mojave Rattlesnake	NO	NO
Crotalus	*willardi*	*obscurus*	New Mexico Ridgenose Rattlesnake	YES	YES
Crotalus	*willardi*	*willardi*	Arizona Ridgenose Rattlesnake	YES	YES
Sistrurus	*catenatus*		Massasauga	YES	YES
Birds					
Botaurus	*lentiginosus*		American Bittern	YES	YES
Ixobrychus	*exilis*		Least Bittern	YES	YES
Ardea	*alba*		Great Egret	NO	YES
Egretta	*thula*		Snowy Egret	NO	YES
Butorides	*virescens*		Green Heron	NO	YES
Nycticorax	*nycticorax*		Black-Crowned Night-Heron	NO	YES
Plegadis	*chihi*		White-Faced Ibis	NO	YES
Dendrocygna	*autumnalis*		Black-Bellied Whistling-Duck	YES	YES
Aix	*sponsa*		Wood Duck	NO	YES

(con.)

Table 2 (Con.)

Genus	Species	Subspecies	Common name	Priority? All areas	Priority? Key areas
Anas	*strepera*		Gadwall	YES	YES
Anas	*americana*		American Wigeon	YES	YES
Anas	*cyanoptera*		Cinnamon Teal	NO	YES
Anas	*clypeata*		Northern Shoveler	YES	YES
Anas	*acuta*		Northern Pintail	YES	YES
Anas	*crecca*		Green-Winged Teal	YES	YES
Mergus	*merganser*		Common Merganser	NO	YES
Pandion	*haliaetus*		Osprey	YES	YES
Haliaeetus	*leucocephalus*		Bald Eagle	YES	YES
Circus	*cyaneus*		Northern Harrier	YES	YES
Accipiter	*cooperii*		Cooper's Hawk	UNK	NO
Accipiter	*gentilis*		Northern Goshawk	YES	YES
Buteogallus	*anthracinus*		Common Black-Hawk	YES	YES
Parabuteo	*unicinctus*		Harris' Hawk	NO	YES
Buteo	*albonotatus*		Zone-Tailed Hawk	YES	YES
Buteo	*regalis*		Ferruginous Hawk	YES	YES
Aquila	*chrysaetos*		Golden Eagle	YES	YES
Falco	*femoralis*		Aplomado Falcon	YES	YES
Falco	*peregrinus*		Peregrine Falcon	NO	NO
Tympanuchus	*pallidicinctus*		Lesser Prairie-Chicken	YES	YES
Meleagris	*gallopavo*	*intermedia*	Rio Grande Wild Turkey	NO	YES
Meleagris	*gallopavo*	*merriami*	Merriam's Wild Turkey	NO	NO
Meleagris	*gallopavo*	*mexicana*	Gould's Wild Turkey	YES	YES
Callipepla	*squamata*		Scaled Quail	NO	NO
Colinus	*virginianus*	*texanus*	Northern Bobwhite	UNK	UNK
Colinus	*virginianus*	*ridgwayi*	Masked Bobwhite	YES	YES
Cyrtonyx	*montezumae*		Montezuma Quail	YES	YES
Laterallus	*jamaicensis*	*coturniculus*	California Black Rail	YES	YES
Rallus	*longirostrus*	*yumanensis*	Yuma Clapper Rail	YES	YES
Rallus	*limicola*		Virginia Rail	YES	YES
Porzana	*carolina*		Sora	NO	YES
Gallinula	*chloropus*		Common Moorhen	YES	YES
Numenius	*americanus*		Long-Billed Curlew	NO	YES
Gallinago	*gallinago*		Common Snipe	NO	YES
Patagioensis	*fasciata*		Band-Tailed Pigeon	NO	NO
Coccyzus	*americanus*		Yellow-Billed Cuckoo	YES	YES
Otus	*flammeolus*		Flammulated Owl	NO	NO
Megascops	*kennicottii*		Western Screech-Owl	UNK	UNK
Megascops	*trichopsis*		Whiskered Screech-Owl	YES	YES
Glaucidium	*gnoma*		Northern Pygmy-Owl	NO	NO
Glaucidium	*brasilianum*	*cactorum*	Cactus Ferruginous Pygmy-Owl	YES	YES
Micrathene	*whitneyi*		Elf Owl	NO	YES
Athene	*cunicularia*		Burrowing Owl	YES	YES
Strix	*occidentalis*	*lucida*	Mexican Spotted Owl	YES	YES
Aegolius	*acadicus*		Northern Saw-Whet Owl	NO	NO
Phalaenoptilus	*nuttalli*		Common Poorwill	NO	NO
Caprimulgus	*ridgwayi*		Buff-Collared Nightjar	YES	YES
Caprimulgus	*vociferus*		Whip-Poor-Will	NO	NO
Cynanthus	*latirostris*		Broad-Billed Hummingbird	YES	YES
Amazilia	*violiceps*		Violet-Crowned Hummingbird	YES	YES
Lampornis	*clemenciae*		Blue-Throated Hummingbird	UNK	YES
Eugenes	*fulgens*		Magnificent Hummingbird	NO	YES
Calypte	*costae*		Costa's Hummingbird	NO	YES
Selasphorus	*platycercus*		Broad-Tailed Hummingbird	NO	NO
Trogon	*elegans*		Elegant Trogon	YES	YES

(con.)

Table 2 (Con.)

Genus	Species	Subspecies	Common name	Priority? All areas	Priority? Key areas
Melanerpes	*lewis*		Lewis' Woodpecker	NO	NO
Melanerpes	*erythrocephalus*		Red-Headed Woodpecker	NO	YES
Melanerpes	*formicivorus*		Acorn Woodpecker	NO	YES
Melanerpes	*uropygialis*		Gila Woodpecker	NO	YES
Sphyrapicus	*thyroideus*		Williamson's Sapsucker	UNK	YES
Sphyrapicus	*nuchalis*		Red-Naped Sapsucker	UNK	YES
Picoides	*villosus*		Hairy Woodpecker	UNK	YES
Colaptes	*auratus*		Northern Flicker	NO	NO
Colaptes	*chrysoides*		Gilded Flicker	YES	YES
Camptostoma	*imberbe*		Northern-Beardless Tyrannulet	YES	YES
Contopus	*cooperi*		Olive-Sided Flycatcher	YES	YES
Contopus	*pertinax*		Greater Pewee	YES	YES
Contopus	*sordidulus*		Western Wood-Pewee	NO	NO
Empidonax	*traillii*	*extimus*	Southwestern Willow Flycatcher	YES	YES
Empidonax	*occidentalis*		Cordilleran Flycatcher	NO	YES
Empidonax	*fulvifrons*		Buff-Breasted Flycatcher	YES	YES
Sayornis	*nigricans*		Black Phoebe	YES	NO
Pyrocephalus	*rubinus*		Vermillion Flycatcher	NO	NO
Myiarchus	*cinerascens*		Ash-Throated Flycatcher	NO	NO
Myiarchus	*tyrannulus*		Brown-Crested Flycatcher	NO	NO
Myiodynastes	*luteiventris*		Sulphur-Bellied Flycatcher	YES	YES
Tyrannus	*melancholicus*		Tropical Kingbird	YES	YES
Tyrannus	*crassirostris*		Thick-Billed Kingbird	YES	YES
Pachyramphus	*aglaiae*		Rose-Throated Becard	YES	YES
Vireo	*bellii*		Bell's Vireo	YES	YES
Vireo	*vicinior*		Gray Vireo	YES	YES
Vireo	*plumbeus*		Plumbeous Vireo	NO	NO
Vireo	*gilvus*		Warbling Vireo	NO	NO
Gymnorhinus	*cyanocephalus*		Pinyon Jay	NO	NO
Tachycineta	*thalassina*		Violet-Green Swallow	NO	YES
Poecile	*atricapillus*		Black-Capped Chickadee	NO	NO
Poecile	*sclateri*		Mexican Chickadee	YES	YES
Sitta	*canadensis*		Red-Breasted Nuthatch	NO	NO
Sitta	*carolinensis*		White-Breasted Nuthatch	NO	NO
Sitta	*pygmaea*		Pygmy Nuthatch	YES	YES
Certhia	*americana*		Brown Creeper	NO	YES
Thryomanes	*bewickii*		Bewick's Wren	NO	NO
Troglodytes	*aedon*		House Wren	NO	NO
Cistothorus	*palustris*		Marsh Wren	YES	YES
Cinclus	*mexicanus*		American Dipper	YES	YES
Polioptila	*caerulea*		Blue-Gray Gnatcatcher	NO	NO
Polioptila	*melanura*		Black-Tailed Gnatcatcher	UNK	UNK
Sialia	*mexicana*		Western Bluebird	UNK	NO
Catharus	*ustulatus*		Swainson's Thrush	NO	YES
Catharus	*guttatus*		Hermit Thrush	NO	NO
Dumetella	*carolinensis*		Gray Catbird	YES	YES
Toxostoma	*crissale*		Crissal Thrasher	UNK	UNK
Toxostoma	*lecontei*		LeConte's Thrasher	YES	YES
Anthus	*spragueii*		Sprague's Pipit	YES	YES
Phainopepla	*nitens*		Phainopepla	YES	YES
Peucedramus	*taeniatus*		Olive Warbler	YES	YES
Vermivora	*celata*		Orange-Crowned Warbler	NO	YES
Vermivora	*luciae*		Lucy's Warbler	YES	YES
Dendroica	*petechia*		Yellow Warbler	YES	YES
Dendroica	*nigrescens*		Black-Throated Gray Warbler	NO	NO

(con.)

Table 2 (Con.)

Genus	Species	Subspecies	Common name	Priority? All areas	Priority? Key areas
Dendroica	*graciae*		Grace's Warbler	YES	YES
Oporornis	*tolmiei*		MacGillivray's Warbler	NO	YES
Geothlypis	*trichas*		Common Yellowthroat	NO	NO
Wilsonia	*pusilla*		Wilson's Warbler	NO	NO
Myioborus	*pictus*		Painted Redstart	NO	YES
Icteria	*virens*		Yellow-Breasted Chat	NO	NO
Piranga	*flava*		Hepatic Tanager	NO	NO
Piranga	*rubra*		Summer Tanager	YES	YES
Piranga	*ludoviciana*		Western Tanager	NO	NO
Pipilo	*chlorurus*		Green-Tailed Towhee	NO	NO
Pipilo	*maculatus*		Spotted Towhee	NO	NO
Pipilo	*aberti*		Abert's Towhee	YES	YES
Aimophila	*carpalis*		Rufous-Winged Sparrow	YES	YES
Aimophila	*cassinii*		Cassin's Sparrow	NO	YES
Aimophila	*botterii*		Botteri's Sparrow	YES	YES
Spizella	*arborea*		American Tree Sparrow	NO	YES
Spizella	*passerina*		Chipping Sparrow	NO	NO
Spizella	*atrogularis*		Black-Chinned Sparrow	NO	YES
Pooecetes	*gramineus*		Vesper Sparrow	NO	NO
Amphispiza	*belli*		Sage Sparrow	NO	YES
Calamospiza	*melanocorys*		Lark Bunting	NO	YES
Passerculus	*sandwichensis*		Savannah Sparrow	NO	YES
Ammodramus	*savannarum*		Grasshopper Sparrow	YES	YES
Ammodramus	*bairdii*		Baird's Sparrow	YES	YES
Melospiza	*melodia*		Song Sparrow	NO	YES
Melospiza	*lincolnii*		Lincoln's Sparrow	NO	YES
Junco	*phaeonotus*		Yellow-Eyed Junco	YES	YES
Calcarius	*ornatus*		Chesnut-Collared Longspur	NO	YES
Cardinalis	*cardinalis*		Northern Cardinal	NO	NO
Cardinalis	*sinuatus*		Pyrrhuloxia	NO	NO
Pheucticus	*melanocephalus*		Black-Headed Grosbeak	NO	YES
Passerina	*caerulea*		Blue Grosbeak	NO	NO
Passerina	*amoena*		Lazuli Bunting	YES	YES
Passerina	*cyanea*		Indigo Bunting	NO	NO
Passerina	*versicolor*		Varied Bunting	YES	YES
Passerina	*ciris*		Painted Bunting	YES	YES
Spiza	*americana*		Dickcissel	UNK	UNK
Dolichonyx	*oryzivorus*		Bobolink	YES	YES
Sturnella	*magna*	*lilianae*	Lilian's Eastern Meadowlark	YES	YES
Xanthocephalus	*xanthocephalus*		Yellow-Headed Blackbird	NO	YES
Icterus	*spurius*		Orchard Oriole	NO	YES
Icterus	*cucullatus*		Hooded Oriole	NO	NO
Icterus	*bullockii*		Bullock's Oriole	NO	NO
Icterus	*parisorum*		Scott's Oriole	YES	YES
Carduelis	*psaltria*		Lesser Goldfinch	NO	NO
Mammals					
Sorex	*arizonae*		Arizona Shrew	YES	YES
Sorex	*cinereus*		Cinereus (Masked) Shrew	YES	YES
Sorex	*merriami*		Merriam's Shrew	UNK	UNK
Sorex	*monticolus*		Montane Shrew	YES	YES
Sorex	*neomexicanus*		New Mexico Shrew	YES	YES
Sorex	*nanus*		Dwarf Shrew	NO	YES
Sorex	*palustris*		Water Shrew	YES	YES
Sorex	*preblei*		Preble's Shrew	YES	YES

(con.)

Table 2 (Con.)

Genus	Species	Subspecies	Common name	Priority? All areas	Priority? Key areas
Cryptotis	*parva*		Least Shrew	YES	YES
Notiosorex	*crawfordi*		(Crawford's) Desert Shrew	NO	NO
Choeronycteris	*mexicana*		Mexican Long-Tongued Bat	YES	YES
Leptonycteris	*nivalis*		Mexican Long-Nosed Bat	YES	YES
Leptonycteris	*curasoae*		Southern Long-Nosed Bat	YES	YES
Lasiurus	*borealis*		Eastern Red Bat	UNK	UNK
Lasiurus	*blossevillii*		Western Red Bat	YES	YES
Lasiurus	*xanthinus*		Western Yellow Bat	YES	YES
Lasionycteris	*noctivagans*		Silver-Haired Bat	UNK	UNK
Euderma	*maculatum*		Spotted Bat	YES	YES
Idionycteris	*phyllotis*		Allen's Big-Eared Bat	YES	YES
Canis	*lupus*	*baileyi*	Mexican Gray Wolf	YES	YES
Vulpes	*velox*		Swift Fox	YES	YES
Vulpes	*macrotis*		Kit Fox	YES	YES
Vulpes	*vulpes*		Red Fox	NO	YES
Ursus	*americanus*		American Black Bear	NO	YES
Mustela	*erminea*		Ermine	YES	YES
Mustela	*frenata*		Long-Tailed Weasel	YES	YES
Mustela	*nigripes*		Black-Footed Ferret	YES	YES
Mustela	*vison*		Mink	YES	YES
Lontra	*canadensis*		Northern River Otter	YES	YES
Mephitis	*macroura*		Hooded Skunk	YES	YES
Puma	*concolor*		Cougar (Mountain Lion)	NO	YES
Lynx	*rufus*		Bobcat	NO	NO
Panthera	*onca*		Jaguar	YES	YES
Pecari	*tajacu*		Collared Peccary (Javelina)	NO	NO
Cervus	*elaphus*	*nelsoni*	Rocky Mountain Elk	YES	YES
Odocoileus	*hemionus*		Mule Deer	YES	YES
Odocoileus	*virginianus*	*texana*	Texas White-Tailed Deer	YES	YES
Odocoileus	*virginianus*	*couesi*	Coues' White-Tailed Deer	YES	YES
Antilocapra	*americana*	*americana*	American Pronghorn	YES	YES
Antilocapra	*americana*	*sonoirensis*	Sonoran Pronghorn	YES	YES
Ovis	*canadensis*	*mexicana*	Mexican Desert Bighorn Sheep	YES	YES
Ovis	*canadensis*	*nelsoni*	Nelson's Desert Bighorn Sheep	YES	YES
Ovis	*canadensis*	*canadensis*	Rocky Mountain Bighorn Sheep	YES	YES
Tamias	*canipes*		Gray-Footed Chipmunk	YES	YES
Tamias	*cinereicollis*		Gray-Collared Chipmunk	NO	YES
Tamias	*dorsalis*		Cliff Chipmunk	NO	NO
Tamias	*minimus*		Least Chipmunk	NO	YES
Tamias	*quadrivittatus*		Colorado Chipmunk	NO	YES
Marmota	*flaviventris*		Yellow-Bellied Marmot	YES	YES
Spermophilus	*lateralis*		Golden-Mantled Ground Squirrel	NO	NO
Spermophilus	*tridecemlineatus*	*arenicola*	Pale Thirteen-Lined Ground Squirrel	NO	NO
Spermophilus	*tridecemlineatus*	*blanca*	San Luis Thirteen-Lined Ground Squirrel	YES	YES
Spermophilus	*tridecemlineatus*	*hollisteri*	Mescalero Thirteen-Lined Ground Squirrel	YES	YES
Spermophilus	*tridecemlineatus*	*monticola*	White Mountains Thirteen-Lined Ground Squirrel	YES	YES
Cynomys	*gunnisoni*		Gunnison's Prairie Dog	NO	YES
Cynomys	*ludovicianus*		Black-Tailed Prairie Dog	NO	YES
Sciurus	*arizonensis*		Arizona Gray Squirrel	NO	YES
Sciurus	*nayaritensis*	*chiricahuae*	Chiricahua Mexican Fox Squirrel	YES	YES
Sciurus	*hudsonicus*		Red Squirrel	NO	YES
Thomomys	*talpoides*		Northern Pocket Gopher	NO	YES

(con.)

Table 2 (Con.)

Genus	Species	Subspecies	Common name	Priority? All areas	Priority? Key areas
Thomomys	*umbrinus*		Southern Pocket Gopher	UNK	UNK
Cratogeomys	*castanops*		Yellow-Faced Pocket Gopher	NO	UNK
Perognathus	*flavus*		Silky Pocket Mouse	NO	YES
Chaetodipus	*hispidus*		Hispid Pocket Mouse	YES	YES
Dipodomys	*microps*		Chisel-Toothed Kangaroo Rat	NO	YES
Dipodomys	*ordii*		Ord's Kangaroo Rat	NO	NO
Dipodomys	*spectabilis*		Banner-Tailed Kangaroo Rat	YES	YES
Castor	*canadensis*		American Beaver	NO	YES
Reithrodontomys	*fulvescens*		Fulvous Harvest Mouse	YES	YES
Reithrodontomys	*megalotis*		Western Harvest Mouse	YES	YES
Reithrodontomys	*montanus*		Plains Harvest Mouse	NO	NO
Peromyscus	*merriami*		Mesquite Mouse	YES	YES
Baiomys	*taylori*		Northern Pygmy Mouse	YES	YES
Sigmodon	*arizonae*		Arizona Cotton Rat	YES	YES
Sigmodon	*fulviventer*		Tawny-Bellied Cotton Rat	YES	YES
Sigmodon	*hispidus*		Hispid Cotton Rat	YES	YES
Sigmodon	*ochrognathus*		Yellow-Nosed Cotton Rat	YES	YES
Neotoma	*cinerea*		Bushy-Tailed Woodrat	YES	YES
Neotoma	*devia*		Arizona Woodrat	NO	YES
Neotoma	*lepida*		Desert Woodrat	NO	YES
Neotoma	*micropus*		Southern Plains Woodrat	YES	YES
Neotoma	*stephensi*		Stephen's Woodrat	NO	YES
Clethrionomys	*gapperi*		Southern Red-Backed Vole	NO	NO
Phenacomys	*intermedius*		Western Heather Vole	YES	YES
Microtus	*longicaudus*		Long-Tailed Vole	YES	YES
Microtus	*mogollonensis*		Mogollon Vole	YES	YES
Microtus	*montanus*		Montane Vole	YES	YES
Microtus	*ochrogaster*		Prairie Vole	YES	YES
Microtus	*pennsylvanicus*		Meadow Vole	YES	YES
Ondatra	*zibethicus*		Muskrat	YES	YES
Zapus	*hudsonius*	*luteus*	New Mexico Meadow Jumping Mouse	YES	YES
Zapus	*princeps*		Western Jumping Mouse	YES	YES
Ochotona	*princeps*	*incana*	American Pika	NO	NO
Ochotona	*princeps*	*nigrescens*	Goat Peak American Pika	YES	YES
Sylvilagus	*floridanus*	*cognatus*	Manzano Mountains Eastern Cottontail	YES	YES
Sylvilagus	*floridanus*	*hesperius*	Arizona Eastern Cottontail	YES	YES
Sylvilagus	*floridanus*	*holzneri*	Holzner's Eastern Cottontail	YES	YES
Sylvilagus	*floridanus*	*llanensis*	Llano Eastern Cottontail	NO	NO
Sylvilagus	*nuttallii*		Mountain (Nuttall's) Cottontail	NO	YES
Sylvilagus	*robustus*		Davis Mountains Cottontail	YES	YES
Lepus	*americanus*		Snowshoe Hare	YES	YES
Lepus	*callotis*		White-Sided Jackrabbit	YES	YES
Lepus	*townsendii*		White-Tailed Jackrabbit	YES	YES

The following user's guide to the species accounts explains the various elements and assists in the interpretation of the inputs made by the panelists. The contents of each account were crafted using specific guidelines and rules provided to the panelists; thus, any user of these accounts should refer to these descriptions when interpreting the informational content. Refer to the template illustrated in appendix B when reviewing the following descriptions and discussions of the various species account elements.

Species Account Elements: Definitions and Descriptions

Scientific Name—This is the latest Latin scientific name for a species or subspecies (listed as genus, species, and subspecies where warranted). In addition to cases where species were divided into multiple subspecies accounts (for example, subspecies of *Sylvilagus floridanus*, the eastern cottontail), subspecific names were used only if (a) one subspecies was potentially threatened by grazing whereas others were considered not to be (for example, *Sturnella magna lilianae*, Lilian's eastern meadowlark), or (b) there is only one subspecies in Arizona/New Mexico, but it is an important taxa for conservation or other reasons (for example, *Strix occidentalis lucida*, the Mexican spotted owl).

Common Name—The common name on an account is the most frequently used English name for a species, based on a standardized list by an authoritative organization when possible. For instance, the American Ornithologists' Union has created a list of standardized common names for all bird species, most recently in AOU (1998). Common names for mammals are less rigorously standardized; however, we have used a standardized list created by the Smithsonian Institution (used in Wilson and Ruff 1999). Common names for reptiles and amphibians are based on authoritative texts (for example, Degenhardt and others 1996).

Subspecific common names are even less standardized; a standard common name is used when available (for example, Mexican spotted owl), but other cases (such as the subspecies of the eastern cottontail) relied on the advice and suggestions of the panelists.

Legal Status (Menu)—Selections are based on status designations recognized under regulation, law, or treaty by various government organizations. Several species in the database are regulated by Arizona and New Mexico as game animals; however, for most species the take and/or collecting of individuals for hunting, commercial, educational, or research purposes is also governed by State laws (for details, consult AGFD 2004; NMDGF 2004b).

- BLM, AZ - Sensitive: listed as "sensitive" by the Department of the Interior, Bureau of Land Management, Arizona State Office.
- BLM, NM - Sensitive: listed as "sensitive" by the Department of the Interior, Bureau of Land Management, New Mexico State Office.
- CITES - Appendix I: listed under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). "Appendix I" species are considered threatened with extinction; commercial international trade is prohibited except for exceptional circumstances (CITES 2003).
- CITES - Appendix II: These species "are not necessarily now threatened with extinction but … may become so unless trade is closely controlled. [Appendix II] also includes so-called 'look-alike species', i.e. species of which the specimens in trade look like those of species listed for conservation reasons…" (CITES 2003).
- ESA - Endangered: species listed as "endangered" by the U.S. Department of the Interior, Fish and Wildlife Service, under the Endangered Species Act.
- ESA - Threatened: species listed as "threatened" by the U.S. Department of the Interior, Fish and Wildlife Service, under the Endangered Species Act.
- ESA - Warranted but Precluded: species for which the U.S. Department of the Interior, Fish and Wildlife Service, has on file "sufficient information on biological vulnerability and threats to support proposals to list them as endangered or threatened. Issuance of proposed rules for these taxa is precluded at present by other higher priority listing actions…" (USDI Fish and Wildlife Service 1999: 57535).
- Migratory Bird Treaty Act: The Migratory Bird Treaty Act of 1918 is the domestic law that affirms, or implements, the U.S. commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of a shared migratory bird resource. This act decreed that the birds and their parts (including eggs, nests, and feathers) are fully protected (USDI Fish and Wildlife Service 2003). Despite the title, this statute covers all native bird species with the exception of upland game birds.
- Navajo - Endangered: species listed as "endangered" by the Navajo Nation Tribal law.
- Navajo - Threatened: species listed as "threatened" by the Navajo Nation Tribal law.
- Arizona - WSCA: species listed as either "endangered" or "threatened" by the State of Arizona Game and Fish Commission in the 1988 publication "Threatened Native Wildlife in Arizona" (AGFD 1988). In 1995, the Arizona Game and Fish Commission voted to change the name of the list of species from "Threatened Native Wildlife" to "Wildlife of Special Concern in Arizona" (WSCA); it also voted to do away with all categories of endangered, threatened, or candidate species. In 1996, a public review draft of a new list of WSCA species was published

(AGFD 1996), but no action by the Arizona Game and Fish Commission has been taken to legally change the complement of the list. Thus, the legal list remains the species published in AGFD (1988), but by the actions in 1995 they are no longer considered endangered or threatened, only categorized as "WSCA" (Schwartz, personal communication 2001).

- New Mexico - Endangered: species listed as "endangered" by the State of New Mexico Department of Game and Fish, under the authority of the Wildlife Conservation Act (NMSA 17-2-37 through 17-2-46, 1978).
- New Mexico - Threatened: species listed as "threatened" by the State of New Mexico Department of Game and Fish, under the authority of the Wildlife Conservation Act (NMSA 17-2-37 through 17-2-46, 1978).
- USFS Region 3 - Sensitive: the Southwestern Region of the USDA Forest Service places species on a list of "sensitive" species according to their vulnerability to decline and their potential for being placed on the "threatened" or "endangered" list. The Forest Service defines sensitive species as those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution; different regions use different criteria for designating "sensitive" species.
- None: this species has no legal designation among the selections provided under this menu. Other regulations, such as those governing hunting or fishing, may apply to this species.

Distribution (Menu)—Selections here indicate notable aspects of the species' geographic range, particularly in regards to endemism and limits to the species' distribution in Arizona and/or New Mexico.

- Endemic to Arizona: the species occurs only in Arizona, and no where else globally.
- Endemic to New Mexico: the species occurs only in New Mexico, and no where else globally.
- Endemic to Arizona and New Mexico: the species occurs only in Arizona and New Mexico, and no where else globally.
- Not restricted to Arizona or New Mexico: the species' geographic range includes areas outside of Arizona and New Mexico; it is not endemic to either State or the region.
- Northern limit of distribution: the northern limit of the species' geographic range occurs in Arizona, New Mexico, or both. Migratory species (such as many birds in the database) may have either breeding or wintering distributions with northern limits in Arizona or New Mexico; this item will also be selected for situations where this occurs. This definition also applies to the following three choices, using their respective geographic references.

1. Southern limit of distribution
2. Eastern limit of distribution
3. Western limit of distribution

Ecological Role (Menu)—Selections here indicate the role this species plays in its ecological community. Selections that refer to the general diet of the species are indicated by the word "dietary." More than one of these "dietary" selections may be made if the species seasonally changes the emphasis of its diet (for example, birds that are primarily insectivorous in the spring and summer, and then switch to being granivorous in the winter).

- Commensal/mutualistic: a species that has an important interaction with another species in the community in which (a) it or the other species benefits while the other is neither harmed nor benefits (commensal), or (b) both species benefit from the interaction (mutualistic).
- Granivore: (dietary) consumes primarily seeds.
- Herbivore: (dietary) consumes primarily plant material, including both grazers and browsers.
- Hybridization/intergradation: this species has important interactions in which it frequently hybridizes with one or more other species.
- Key predator: (dietary) consumes primarily other animals. A "key" predator was defined as one that must exclusively hunt, kill, and feed on other animals (as opposed to occasional or opportunistic predation).
- Insectivore: (dietary) consumes primarily insects, spiders, and other arthropods.
- Key prey species: a species that serves as primary or major prey for another species.
- Key vector: a species that is an important carrier of disease or parasitic organisms.
- Omnivore: (dietary) consumes a wide variety of food types, often opportunistically, and cannot be categorized as primarily feeding on one type or another.
- Parasitic: a species that interacts with one or more other species such that it receives a benefit while causing harm or a detriment to the other species.
- Pollinator: functions as a distributor of pollen among the flowers of one or more plants species (primarily hummingbirds and bats).
- Primary cavity nester: a species that nests, roosts, or dens in a tree or ground cavity that it excavates itself; old cavities may be subsequently used by other species.
- Scavenger/detritivore: (dietary) feeds on dead and/or decomposing organic matter, primarily the carcasses of dead animals.
- Secondary cavity nester: a species that nests, roosts, or dens in a tree or ground cavity that either occurs naturally or was previously excavated by another species. It may do some minor excavations but does not normally construct its own cavity.

Status/Trends/Threats (Narrative)—This text section reports information on the general status of the species (both globally and in the Southwest), and information regarding

trends in population numbers or sizes. This section may also have information on historical trends in the Southwest, changes in species' status or nomenclature, legal issues regarding this species, research or information on reproductive capabilities, and other information that may be regarded as "status" or "trends." If the account is for a subspecies, information regarding the species as a whole is usually included as well.

This section is generally organized with the final paragraph describing any recognized threats there may be to this species. This is not restricted to ranching or grazing issues, and is intended to describe all possible threats that may be an issue with this species. For many species, some of these issues may be more important than grazing or range management effects, and readers may question why they are not discussed more fully. Users are reminded that the emphasis of this project is on grazing effects, and the listing here of any additional threats is to provide a complete record of the various issues of concern for a particular species.

Breeding Bird Survey data: For all bird species, statistical information is reported from the North American Breeding Bird Survey (BBS), conducted by the U.S. Geological Survey and U.S. Fish and Wildlife Service. Data from these surveys, conducted once a year by volunteers along 25-mile-long routes distributed throughout each State in the United States, has been collected annually since 1966. The USGS makes all of the data available via the Breeding Bird Survey Web site (www.mbr-pwrc.usgs.gov/bbs/bbs.html), which also provides the means to conduct analyses of trends for individual species (Sauer and others 2001).

We conducted analyses using data from 1966 through 2000 for each species. Analyses were done for Arizona only, New Mexico only, and surveywide (includes all routes that detected this species). Following BBS convention, trends were considered statistically significant only if the *P*-value was 0.10 or lower. For significant trends the data are reported as follows: (trend = +/- percent per year, *P*-value). However, even significant trends may be misleading and/or erroneous under certain circumstances where the number of routes or the relative abundance (number of birds detected per route) is low. Using BBS guidelines, the number of routes and the relative abundance (birds/route) are also reported with significant *P*-values when the number of routes is less than 14, *or* the relative abundance is less than 1.0. If there are no significant trends indicated for an area (that is, $P > 0.10$), then only the number of routes and relative abundance are reported.

Example 1: "Breeding Bird Survey data from 1966-2000 indicate no significant trends in Arizona (routes = 6, birds/route = 0.63) or New Mexico (routes = 6, birds/route = 0.63), but a significant positive trend surveywide (trend = 1.2 percent/year, $P = 0.02$) (Sauer and others 2001)."

Example 2: "Breeding Bird Survey data from 1966-2000 indicate a significant negative trend in Arizona (trend = –1.4 percent/year, $P = 0.015$, routes = 12, birds/route = 0.7), but significant positive trends in New Mexico (trend = 3.5 percent/year, $P = 0.012$, routes = 7, birds/route = 0.6), and surveywide (trend = 4.1 percent/year, $P < 0.01$) (Sauer and others 2001)."

Distribution (Narrative)—Describes the geographic range and distribution of the species, both globally and within the Southwest, generally in the following format:

Paragraph 1 describes the global distribution of the species, including summer and wintering ranges for migratory species.

Paragraph 2 describes the distribution of the species in Arizona, often using descriptions by county or by important mapped features (mountain ranges, rivers, cities, and so forth), and also may include comments on elevational and/or seasonal distribution.

Paragraph 3 details the distribution of the species in New Mexico in the same manner.

Key Distribution/Abundance/Management Areas: Stage II panelists were asked to identify any key areas for this species within Arizona and/or New Mexico. Such areas could be specific geographic localities within the State, the locations of important populations or population centers, the distribution of specific habitat or vegetation types, or any other area or locality that is of special importance to the species.

The areas identified in this addendum generally reflect the opinion of the panelists but may also be supported by scientific or government publications. General responses can include "anywhere found" (indicating that all areas where the species occurs should be considered especially significant) and "none identified" (indicating that, within the species' range in Arizona and New Mexico, no known area is particularly important relative to the others).

The areas identified here will also be important when interpreting the panel's response to the question regarding prioritization of the species when selecting a grazing strategy (see under "Grazing Effects" below).

Breeding (Narrative)—This section includes information on the breeding biology of the species, emphasizing seasonality and timing of key events in the reproductive cycle. Focus was put on information pertinent to land and range management (such as onset of reproduction, nesting seasons of birds, gestation periods, age at weaning or fledging, and so forth). Some discussion of nesting habitat or vegetation usage may be included here, but these items are chiefly found in the habitat section.

Habitat (Narrative)—Discusses information on the species' habitat, including vegetative community types, individual plant species that are utilized or are characteristic of habitat, structural elements of vegetation, topographic or other landscape features, types of water resources utilized, elevational distribution, home-range sizes, and various other habitat characteristics.

Generally, the species' habitat needs throughout its range are described, followed by more specific descriptions from Arizona and New Mexico. Migratory birds may have separate discussions for breeding habitats and wintering habitats; other species may also have specialized seasonal or behavioral habitat needs that require discussion of different habitat types.

For many species, their habitat characteristics have chiefly been described outside of the Southwest and therefore must be

extrapolated to Southwestern biomes and ecosystems. Literature based outside of the Southwest is usually identified as such, and caution is often advised in making extrapolations to the Southwest due to differences in climate, topography, landscapes, and the different plant communities and species that may make up the species' habitat in this region.

Landscape-Scale Habitat Requirements: The Stage II panel was asked to provide specific information on the landscape-level needs of each species. These are important concepts in the fields of landscape ecology and conservation biology, but unfortunately for most species little research has been conducted regarding these issues. The panelists often chose to advise that more research is necessary to evaluate these requirements.

Panelists were asked to evaluate the following landscape-level issues:

- Edge Requirements/Effects: refers to the species' association with habitat "edges" or transition zones between one habitat type and another. The classic example occurs with birds at the edge of forests transitioning into open meadows or grasslands. Some species are "edge-specialists," whereas other species, adapted to deep-forest conditions, are negatively affected when in proximity to edge or by increases in the amount of edge in a forest plot (Murcia 1995).
- Connectivity Between Habitat Patches: considers whether a species requires connectivity between habitat patches (or habitat "corridors") in order to disperse among separated areas. Usually not an issue with birds, the lack of connective corridors can impact ground-dwelling animals and can create habitat "islands," effectively isolating populations from each other.
- Habitat Area: considers the minimum habitat patch size required by the species. For example, this can be addressed as the minimum habitat patch to support a nesting pair of birds, or minimum area to support the home range of a large mammal.
- Distance Between Patches: considers the maximum distance tolerated between habitat patches not connected by habitat corridors. This maximum distance can vary depending on whether the intervening habitat is unsuitable or simply marginal.

Part of Life Cycle (Menu)—Lists parts of the species' life cycle that occurs in Arizona and/or New Mexico.

- Breeding
- Hibernation/estivation
- Migration
- Wintering

Season of Use (Narrative)—Discusses any aspect of the species' life cycle that is seasonal in nature. This includes descriptions of periods of breeding, migration, hibernation, overwintering, or any other activity that occurs within specific time frames during the course of a year.

Season of Use (Menu)—Lists the 12 months of the year individually, with selections indicating all months when the species may occur in either Arizona or New Mexico.

Specific Habitat Associations (Menu)—The 27 vegetation classifications described in Milchunas (in press). For the selections "Developed lands" and "Other," the panel comments box is used to define these categories for the species.

Important Habitat Functions for This Species (Menu)—Provides a list of important functions that the various habitat elements serve for this species.

- Berry production—provides fruit as a food resource during part or all of the year.
- Escape cover—opportunistic cover from predators that can be used quickly when required.
- Forage production—provides grass or leaves as a food resource during part or all of the year.
- Hiding cover—any cover to conceal the species from conspecific individuals or individuals of other species; includes but is not limited to cover from predators or cover to conceal a predator from potential prey.
- Insect production—supports insects as a food resource during part or all of the year.
- Perches for hunting—typically, a viewing platform or perch used by a predatory species (for example, shrubs or trees used by hawks in grasslands).
- Perches not for hunting—used for other important activities that require perching (for example, territorial singing in birds, mating displays, and so forth)
- Prey production—supports noninsect animals as a food resource during part or all of the year.
- Reproductive cover—habitat components provide important shelter or concealment for reproductive activities, for example protection or concealment of nests, eggs, young, and so forth.
- Seed production—provides grains or seeds as food resources during part or all of the year.
- Shade/thermal cover—provides shelter from extreme heat or sunshine in summer, or cover that prevents radiative heat loss in winter.
- Water availability—selected when a body or source of water is required or is an important feature of the species' habitat (not selected for general drinking water availability).

Important Structural Features of Habitat (Menu)—This section consists of a series of menus intended to create a detailed characterization of the structural features of the vegetative component of the species' habitat. The lists are divided into three general divisions (height, density, and distribution), with each division covering trees, shrubs, and herbaceous vegetation (forbs and grasses). Herbaceous vegetation selections that indicate "residual" refer to the standing dead vegetation after the growing season.

Within each menu, selections are based on a range of sizes for each parameter. Each selection indicates that the species requires vegetation specifically within that size range, regardless

of what other sizes are present. Multiple selections of several of these options indicate that the species can utilize all size classes separately. "Variable" should be interpreted to mean that the species requires a habitat structure with varying sizes all present simultaneously. "Not important" indicates that the parameter can be of any dimension; it does not automatically mean that the feature should be absent (for example, tree canopy of "not important" does not necessarily mean that the ideal habitat has no trees, it simply means that the canopy is not an important feature). As in all cases, panelists were able to use the comment boxes to modify or clarify the definition as they understood them while making selections.

It should be noted that for many if not most species, the majority of these characteristics will have never been measured and may be completely unknown, even through the panelists' experience in the field. Readers should recognize that these gaps in knowledge represent needs and opportunities for additional research to further our understanding of these species' habitat requirements and to improve management capabilities.

- Vegetation height:
  - o Trees/saguaros: (>10 m, 5-10 m, <5 m, mixed size trees, not important, unknown, variable).
  - o Shrub layer: (>2 m, 0.5-2.0 m, <0.5 m, not important, unknown, variable).
  - o Forb layer: (residual >1.0 m, 0.5-1.0 m, 0.25-0.5 m, 0.1-0.25 m, <0.1 m, not important, unknown, variable).
  - o Grass layer: (residual >1.0 m, 0.5-1.0 m, 0.25-0.5 m, 0.1-0.25 m, <0.1 m, not important, unknown, variable).
- Vegetation density:
  - o Tree/saguaro canopy: (>60 percent, 40-59 percent, 1-39 percent, 0 percent, not important, unknown, variable).
  - o Shrub layer: (dense understory, intermediate understory, sparse understory, shrubs absent, not important, unknown, variable).
  - o Herbaceous (forbs/grasses) layer: (dense cover, intermediate cover, sparse cover, bare ground, not important, unknown, variable).
- Vegetation distribution:
  - o Trees/saguaros: (Scattered, Clumps, Even, Not important, Unknown, Variable).
  - o Shrubs: (Scattered, Clumps, Even, Not important, Unknown, Variable).
  - o Forbs/Grasses: (Clumps, Even, Not important, Unknown, Variable).
- Tree age: the optimal age of the trees that the species prefers. Although based in forestry terminology that implies even-aged stands, it should be recognized that natural environments are usually a mix of tree ages, and that this section simply highlights any characteristic preferences of the species.
- Elevation: Three categories are provided to characterize a species in a general elevational association: "high," "low," or "all." A dividing line of 7,000 feet is used that conforms generally to the start of the ponderosa pine forests in the Southwest.

Other Important Habitat Features (Menu)—This section contains five general categories of nonvegetation habitat features. Most of the selections are self-explanatory, but a few are defined more specifically below. (In all cases, "Variable" indicates that the species uses a wide variety of the listed selections and cannot be characterized by just one or a few of the listed items).

- Body of water: Many species are associated with specific bodies of water but often are attracted not to the water itself but rather to the vegetation that grows in association with it (for example, many riparian or wetland birds); these cases will generally be noted in the comments box.
  - o Acequias: small irrigation channels.
  - o Livestock tanks: can refer to either metal tanks or earthen berm stock tanks; the latter can often support shoreline vegetation.
  - o Surface water: Surface characteristics of standing water, ponds, or lakes.
  - o Tinajas: natural depressions, usually in rock substrates, that act as water catchments after rains.
- Soil substrate/ground features: Detailed attributes of soil and other ground substrates as well as groundcoverings that are important habitat components. Besides soil characteristics, the list also contains "crevices" and "burrows" that can be important for species that utilize these features but do not excavate them on their own.
- Topography: Physical features of the landscape that are important to the species. Selections made by the panelists typically convey the features that best characterize the species' habitat, although it may actually be found in many of the other listed topographical features.
- Tree-related features: This list contains several features associated with trees that are not related to the vegetative structure or growth of the tree.
  - o Logs: downed tree trunks; can be solid or hollow but typically will be in some state of decay.
  - o Snags: standing dead trees, often utilized as a substrate for cavities by woodpeckers. For some small mammals, this term is also used to refer to the base of a standing dead tree (or stump) at ground level.
- Human structures: Human-made features used by the species. The items listed here are the most common, but additional ones may be described in the comments box.

Diet (Narrative)—The emphasis here is on the major items that make up the diet of the species, rather than information on food-gathering or hunting techniques or foraging ecology. Listing or discussion of seldom-consumed diet items was avoided.

Diet Items (Menu)—Lists relatively specific categories of possible diet items. Again, selection of these items, as in the text narrative above, emphasizes the characteristic diet items and avoids listing items reported as rare or unique consumption events.

Grazing Effects (Narrative)—The discussion of grazing effects includes information from the scientific literature,

combined with statements of inference, observation, or opinion as provided by both the Stage I and Stage II grazing panels. It is necessarily focused on negative impacts, given that the objective is to create awareness of potential harm to a species and to provide the information necessary to take steps to mitigate any harmful effects. However, in addition, any positive effects are also included when reported in the literature or considered to be likely possibilities by the panel.

Users should read this section with the understanding that the objective of this narrative is to discuss *potential* impacts on a species by grazing or range management practices, and the conditions under which these impacts may occur. Whether or not these actually occur will depend on local conditions and situations, as well as the subsequent actions of managers to mitigate or avoid these impacts.

Limiting habitat component relative to grazing: The Stage II panel was asked to identify the key habitat components that both (a) limit the presence and/or persistence of the species and (b) are impacted by domestic or native ungulate grazing and/or range management practices. These should be considered the most important components of the ones that could be potentially impacted.

Panel Assessment: Is this species a priority for selecting a grazing strategy?—This set of questions for the Stage II panel recognizes that the habitat requirements and the associated grazing strategies for different species will often conflict among two or more species within this database. Therefore, the panel was asked to provide guidance for prioritizing among several species that may be found within a single area and have conflicting habitat management requirements.

Question 1 ("Throughout the species' distribution in New Mexico and Arizona?") asks the panel whether this species is a priority wherever it may be found throughout the two-State area. "Yes" is selected for the highest priority species, indicating that they should be given the greatest consideration no matter where they occur. Species receiving this designation are generally the most likely to be negatively impacted, or are considered endangered or rare.

Question 2 ("In key management areas?") provides an opportunity for the panel to selectively prioritize a species, based on its key distribution/abundance/management areas (see above under "Distribution"). When answered "Yes," with "No" for Question 1, these species are not considered to be important enough to be a priority *anywhere* they occur, but should be considered a priority within its specific key areas. Some general guidelines:

- Selecting "Yes" to Question 1 automatically results in a "Yes" for Question 2.
- If "Yes" is indicated for Question 2, then either a corresponding "key area" has been described earlier under "Distribution," or the key area is defined as "anywhere found."
- If "None identified" is described under Key Areas, then Question 2 should not be answered "Yes."
- Specifying one or more localities under "Key Areas" does not automatically mean that the species is to be considered a priority in these areas under Question 2.
- Any selection of "Unknown" indicates that it may be a priority species, but not enough information is available to make that determination.

Possible Grazing Impact Mechanisms (Menu)—This includes:

- Alteration of soil structure—includes erosion, compaction, and other impacts to soils that can affect plant growth, plant community composition, streambank structure, or even the ability of the species to create dens or burrows.
- Alteration of water regimes—includes both changes induced by the presence of cattle (lowering of water tables, drying of springs, and so forth) as well as changes resulting from range management activities (for example, groundwater pumping, water diversions, conversion of springs to watering tanks, and so forth.).
- Altered fire regime—includes both changes induced by the presence of cattle (for example, removal of grasses that carry low-intensity surface fires) as well as changes resulting from management activities (fire suppression, introduction of nonnative grasses that increase fuel loads, and so forth.).
- Altered vegetation composition—changes to the species composition of plant communities, including removal of dominant species, introduction of nonnative plants, and facilitating the encroachment or invasion of plant species from outside the local community (for example, shrub encroachment into grasslands).
- Altered vegetation structure—changes to the height, density, or distribution of plant species, by either ungulate grazing or range management activities.
- Change in prey/food availability—elimination or decline in the abundance of important prey species, or the availability of important food items such as seeds.
- Change in water quality—increases in silt or sedimentation, or the introduction of waste material, fertilizers, or other pollutants that change the chemical balance of natural water sources.
- Competition for forage—the species in the account and grazing and/or browsing ungulates rely on the same plant species and/or plant components for forage.
- Cowbird parasitism—the species is subject to brood parasitism by one or both of two cowbird species in the Southwest: the brown-headed cowbird and the bronzed cowbird. Brood parasitism occurs when one species of bird (parasite) lays its eggs in the nest of a different bird species (host). The host parent then expends energy and food feeding and rearing the parasitic chick, often at the expense of its own reproductive output. Cowbirds are known to parasitize a variety of host species in the Southwest. In addition, they tend to congregate near herds of cattle; therefore, the presence of cattle may increase the

likelihood of host exposure to cowbirds (Goguen and Matthews 1999; also see discussion below under "Summary of Ecological Interactions with Wildlife").

- Habitat fragmentation—alteration of the distribution of vegetation such that the species' habitat is broken into smaller, discontinuous fragments. This is especially consequential to species that require either large patches of habitat, new habitat areas to disperse into, or low amounts of edge habitat.
- Increased predation—refers to changes to a species' habitat or environment that increase the likelihood of predation on the species. These changes can include reduction or removal of sources of cover, or changes to habitat structure that allow greater access by predators.
- Intentional killing—mortality as a direct result of human hunting, trapping, poisoning, shooting, and so forth, conducted for the benefit of livestock or range conditions.
- Killing burrowing rodents—the specific killing of rodents that create burrows or dens (and thus may contribute to habitat for other species), for example, prairie-dogs and kangaroo rats. Species with this selection may also be important prey items for predators.
- Other biotic factors—includes any biological phenomena not found elsewhere on this list. If selected, the specific definition should be included in the comments box.
- Parasites or pathogens—the introduction, spread, or facilitation of any parasitic or pathogenic organisms to the species covered in the account.
- Population genetic structure loss—the elimination of certain populations of a species may have larger consequences if the population contains important or unique genetic elements of the species, is a source of genetic variability for the species, or is otherwise important in the population genetic structure of the species.
- Range improvements—includes any modification, alteration or addition to the range and/or range landscape as a result of activities in support of livestock or range operations. Examples include construction of stock tanks, roads, or fences; clearing of shrubs to create pure grasslands and other vegetation alterations; seeding of nonnative grasses; and so forth. This selection is accompanied by additional definitions in the comments box.
- Trampling, scratching—the species experiences direct impacts from livestock or native ungulates through these mechanisms.

Fire Regime Requirements (Narrative)—Each Stage II panel was requested to evaluate whether the species' habitat required a natural fire regime to maintain the specific requirements of that species. If the panel determined that a fire regime was important, they then made selections from the three menus for fire frequency, intensity, and timing (otherwise, "Not important" was selected).

The panelists were chosen for their knowledge as wildlife experts, so their knowledge of fire ecology varied considerably; often they chose to select "unknown" to emphasize that fire may be important but it was beyond their capability to evaluate. In some cases, fire was known to be important, but the specifics of frequency, intensity, and timing were not known. The panelists also recognized that some habitats do not tolerate any level of fire frequency or intensity, and thus could be said to have a regime of "no fires" that was critically important for the species.

Fire Regime Requirements (Menu)—This includes:

- Frequency - High (1- to 10-year interval), Intermediate (11- to 100-year interval), Low (>100-year interval), None (the absence of fire is considered important for this habitat), Unknown, Not important.
- Intensity - High (stand replacing), Medium (affects shrubs), Low (surface fire), None (the absence of fire is considered important to this habitat), Unknown, Not important.
- Timing - Spring, Summer, Fall, Winter, Never (the absence of fire is considered important to this habitat), Unknown, Not important.

References—This section lists all literature, reports, publications, or personal communications cited in the individual species account.

Authors/Panelists—These include:

- Draft: author(s) responsible for researching and writing the draft species account presented to the Stage II panel.
- GP 1999: participants on the Stage I panel.
- GP 2000 (or other year): participants on the Stage II panel.
- Revision: author(s) responsible for rewriting the draft to incorporate the Stage II panelists' comments, changes, new information, or new references.

Results: Species List Generated by the Panel Process

Stage I Results

The Stage I process resulted in a list of 323 species, or approximately 37 percent of the 866 total number of species considered (table 1). By taxonomic group, 19 percent of the herpetofauna were selected, 39 percent of the grassland/desert scrub bird species, 48 percent of woodland birds, 35 percent of riparian/wetland birds, and 49 percent of the mammals.

Several species were considered in the Stage I process as multiple subspecies. Table 1 reports both the number of species considered as well as the total number of taxa, including subspecies that were considered individually. Larger numbers of mammalian taxa were considered as subspecies, both because the ecology and natural history of many small mammals more readily leads to the evolution of recognizable subspecies, and because the field of mammalogy tends to use subspecific designations more readily than do other fields of vertebrate zoology (it should also be noted, however, that the American Ornithologists' Union endorses the biological reality and practical utility of subspecies; see AOU 1998, p. xii).

Stage II Results

Rejections and Additions—The panelists in Stage II consistently removed more species than they added across all taxonomic groups, averaging 2.4 species removed for every one added (table 1). In all, the number of species from the Stage I process was reduced by approximately 13 percent. The fewest changes based on percent loss of species were in the herpetofauna (net loss of one species, or approximately 3 percent) and the mammals (net loss of five species, or 5 percent). The largest changes were in the birds: grassland/desert scrub species were reduced by 10 species (20 percent), riparian/wetland birds by 16 species (18 percent), and the woodland species by 9 species (15 percent). Removal of grassland/desert scrub birds probably reflects the varying responses of many of these species depending on grazing intensity, habitats, climate, and short-term versus long-term effects. Several riparian bird species were removed that utilize Southwestern riparian habitat corridors for migration, but do not regularly winter or breed here. Despite the importance of this habitat during migration, the impact on these species from grazing was considered to be minimal (see species accounts as well as appendix D for details). The final tally represents approximately one-third of the total number of taxa reviewed in Stage I, with mammals having the greatest rate of inclusion (46 percent) and herpetofauna the smallest (18 percent). When the three bird categories are combined, herpetofauna make up approximately 10 percent of the final list of 283 species, birds 57 percent, and mammals 33 percent.

Many of the species removed in the Stage II process may still warrant consideration by the reader in order to understand why these species were rejected, and the circumstances under which these taxa could be negatively impacted (if at all) by grazing or range management. Therefore, a short account discussing distribution, habitat, and issues surrounding grazing effects is provided for these species in appendix D.

Final List of Species and Subspecies Accounts—Using the guidelines for breaking species into separate accounts by subspecies, the panelists directed that 13 species be separated into multiple subspecific accounts. Few of these were among birds (two species divided into five accounts), with most occurring for herpetofauna (five species divided into 13 accounts) and mammals (six species divided into 17 accounts). Most of the mammal subspecific accounts are due to splitting two species (eastern cottontail and thirteen-lined ground squirrel) into four separate subspecies accounts each. The final number of individual accounts in the database is 305, the majority being birds (half of those being riparian/wetland species), approximately one-third mammals, and one-eighth herpetofauna (table 2).

Designation of "Priority Species"—Among the three categories of prioritization—priorities in key areas only, priorities in all areas, and unknown or not a priority)—proportions were generally similar across the five groups (fig. 1). Of all the accounts in the database, almost three-quarters were given some type of priority designation, with 79 (26 percent) listed as nonpriority species or unknown. Approximately half (159, or 52 percent, of the 305 taxa) were ranked as priorities throughout their respective ranges, while almost one-quarter (67 taxa, or 22 percent) were considered priorities only within key areas. Notable departures from these averages include the mammals, with 66 percent of taxa receiving priority designations in all areas, and woodland birds, with a substantially greater proportion of taxa being nonpriority (47 percent) and a smaller proportion designated as priority species throughout their range (28 percent). Herpetofauna had a slightly greater proportion of nonpriority species (34 percent) than the overall average, and grassland/desert-scrub birds had slightly more categorized as priorities in key areas only (28 percent). Analyzed by raw numbers, mammals have the most taxa with some type of priority designation (87), followed by riparian birds (55); species of grassland/desertscrub birds (31), woodland birds (28), and herpetofauna (25) have similar numbers of priority taxa.

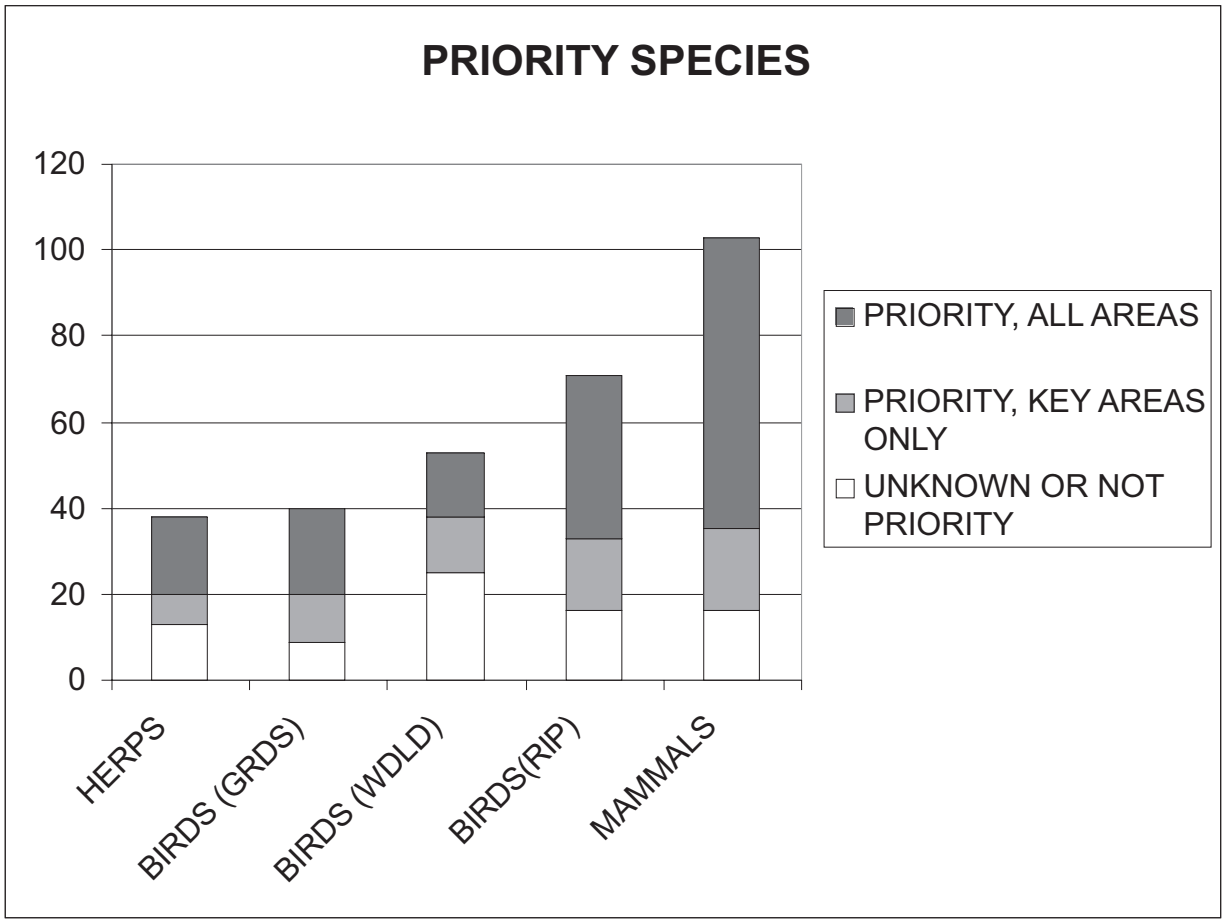

Figure 1—Comparison of the numbers of species assigned to different prioritization categories in herpetofauna, grassland/desert scrub (GRDS) birds, woodland (WDLD) birds, riparian (RIP) birds, and mammals. Categories include priority species in designated key areas only, priority species in their entire range in the Southwest, and those designated as "unknown" or otherwise nonpriority species.

Interpreting the "Grazing Effects" Section

Within each account, grazing impacts are discussed in the "Grazing Effects" narrative, which includes information based on the scientific literature as well as the knowledge, experience, and assessment of the panelists. Although the focus of this study is on Arizona and New Mexico, some references may be included that involve studies from outside these two States. Readers should use caution in extrapolating information from outside the Southwest to this region. The climatic and ecological attributes of these "outside" studies (for example, precipitation, soils, vegetation communities and structure, vertebrate communities, evolutionary grazing histories, and so forth.) are often very different. Such studies often suggest management strategies that are inappropriate for the vegetation and wildlife communities of the Southwest. Nevertheless, in cases where the ecosystems are quite similar (for example, ponderosa pine forests, high-altitude willow-riparian), or when there is little information from the Southwest, these studies can prove useful when interpreted carefully.

Readers will also note that the discussion of grazing effects in the accounts can include both short-term and long-term effects. Short-term effects tend to be relatively direct, whereas long-term effects often involve more complex ecological processes and are often indirect. For example, grazing that reduces grass heights or groundcover is considered a short-term effect, occurring within a single grazing season. Long-term ecological effects include such processes as grazing-induced shrub encroachment into desert grasslands and grazing-related fire suppression in ponderosa pine forests that leads to dense thickets of small trees (see further discussion below and in Milchunas, in press). Such effects typically are not recognizable over one or even a few seasons but rather manifest themselves over a period of many years.

In all cases, it is important to recognize that the goal of this process was to identify *potential* impacts on each species. This is not an attempt to document that these effects are occurring today, or that any of these species are currently in decline because of grazing or range management. Neither should they be interpreted to imply that these effects are inevitable under all grazing conditions or management programs. Rather, the "Grazing Effects" sections are intended to present information on potential impacts that can occur and the mechanisms by which these may be realized. In this way, the database provides information for land managers interested in mitigating possible adverse effects on the wildlife species identified here.

Summary of Panel Findings on Ecological Interactions with Wildlife

The following sections comprise a synopsis of the major findings of the panels for terrestrial wildlife species in the Southwest. These sections are intended to provide a summary of the information presented in the individual species accounts and not act as a substitute. The discussion here is intentionally generalized and does not cover every species in the database, nor does it contain all effects identified for a particular species. Readers should consult the accounts for more detailed and complete presentations of the panelists' assessments of individual species.

Readers will recognize that while several species are affected by similar impacts, there are also situations where different species have conflicting habitat and management needs. Part of this is due to the fact that differences in geographical distribution are not taken into account here; however, there are likely to be species with overlapping distributions and habitat utilization that experience conflicting grazing effects. In these cases, land managers will need to develop a system to prioritize among species; the priority designations provided by the panelists can facilitate this effort. However, managers are also encouraged to use the more detailed ecological information provided in the individual accounts in order to develop a more comprehensive grazing strategy for their area.

Herpetofauna - Riparian/Aquatic Habitats—A variety of factors associated with ungulate grazing and range management interact with the ecological requirements of reptiles and amphibians, but probably the most important concerns impacts to aquatic habitats and associated riparian and shoreline vegetation. Given the arid nature of the Southwest, these habitats are both rare and highly vulnerable, yet many species depend on them in order to persist in an otherwise hostile environment. Amphibians are considered sensitive indicators of environmental quality not only because they require the presence of water but also because most species are capable of conducting gas exchange and absorbing environmental chemicals across the skin. This increases their environmental sensitivity and makes them more vulnerable to pollutants and reduced water quality. Many reptiles listed in this database are also dependent on riparian or aquatic resources, and for that reason are more vulnerable than other reptile species in the Southwest.

High-quality water sources, along with emergent riparian and aquatic vegetation, are important not only for the amphibians listed in the database (tiger salamanders, leopard frogs) but also for turtles (yellow mud turtle, Sonoran mud turtle, ornate box turtle) and species of snake from the genus *Thamnophis* (narrowhead garter snake, Mexican garter snake, western ribbon snake). Impacts to riparian or aquatic habitats can occur when high densities of ungulates are attracted to natural water sources. This can result in the degradation or elimination of dense herbaceous vegetation, increased erosion of banks and shorelines leading to increased siltation, as well as potentially increasing pollutants from animal wastes. Salamanders and frogs would be most sensitive to these effects, but they will also be a concern for reptile species that are dependent on these habitats. The disruption of natural water regimes,

specifically in the playa lakes region, is likely the main potential impact on the yellow mud turtles (GP 2000a). In Arizona, increased runoff from denuded grasslands and water diversion from valley floors into deepened reservoirs may have contributed to the reduction of ephemeral wetlands in flooded valley floors (GP 2000a). All *Thamnophis* snakes require dense shoreline vegetation, but the narrowhead garter snake has a greater reliance on aquatic habitat than the other species of *Thamnophis*. In addition to dense shoreline vegetation, other habitat requirements include clear water, undercut banks, and abundant fish prey species, all of which could be degraded by ungulate densities that increase erosion and sedimentation, and decrease water quality. The giant spotted whiptail requires dense riparian vegetation and groundcover, whereas the leopard lizard appears not to be sensitive to grazing intensities but nevertheless requires a minimum amount of vegetative cover in its riparian habitats. The yellowbelly racer, while found in a variety of different vegetation communities, does have a strong association with water sources in arid localities. It is strongly associated with riparian areas where it still occurs in New Mexico, and loss of the most lush grassland and riparian bottoms may have led to the extinction of this species from most or all of its Arizona range (GP 1999a, 2000a).

The development of surface water sources (earthen stock tanks, windmills, and spring developments) can provide suitable aquatic habitat for some species, resulting in increased habitat and water permanence. However, it can also negatively impact natural habitats as well as promote concentrations of livestock and other ungulates. The creation of stock tank habitat has the potential to increase a species' overall abundance, number of populations, and probably distribution, with likely consequences for population genetic structure and integrity. For example, many artificial surface water sites are known to support large populations of the Sonoran mud turtle (GP 2000a). For many species, however, these tanks can create a population "sink," a locality where individuals die off at a faster rate than they are recruited. Stock tanks can often be introduced with bullfrogs, crawfish, and exotic fishes that are highly predatory on adult frogs and salamanders as well as tadpoles (GP 1999a, 2000a). Bullfrogs also prey heavily on garter snakes. For the Mexican garter snake, introduced species of predatory bullfrogs and fish seem to be the most important reason for population declines. Converting cienega and stream habitats into ponds often favors introduced predators. However, in areas where introduced predator problems are not reversible, grazing management practices may not have a great affect on this species (GP 2000a).

Herpetofauna - Grassland/Shrub Habitats—Several species require a well-developed, healthy grass layer, in some cases simply as a component of a variety of vegetative community types. Maintenance of grasslands or the herbaceous component of other habitats likely provides support for an insect prey base as well as cover for lizard or snake species (GP 2000a). The Arizona skink, although found in a variety of vegetation communities, requires areas with tall herbaceous vegetation and lower population densities have been documented in heavily versus lightly grazed sites (Jones 1981). The short-horned lizard has been documented to occur in lower abundance in heavily versus lightly grazed areas (Jones 1981), but the causal mechanism has not been identified. The difference may be attributable to a reduction in food sources (such as seed-eating ants and other insects) due to depletion of herbaceous cover (GP 2000a). In addition, conversion of sagebrush habitats to invasive nonnative grasses has been reported to be detrimental to this species (Reynolds 1979).

Grazing and range management practices also interact with the natural processes balancing the distribution of pure grasslands with that of scrublands in the Southwest. Fire and drought once maintained mosaics of grass and grass/shrub habitats in the American Southwest lowlands. In recent times, livestock grazing reduced fire frequency by removing herbaceous fuel loads, thus exacerbating the effects of drought and generally increasing woody species at the expense of grasslands (Bock and Bock 1998 and references cited therein). However, fire and other forms of shrub removal can also be used as a range management tool to remove woody vegetation and create a landscape dominated by grasses and other herbaceous vegetation.

Several species of lizards and snakes respond differently to these broad landscape effects. All five subspecies of the little striped whiptail prefer well-developed grassland habitat, and any effects that lead to shrub invasion/conversion noticeably and quickly increase populations of competing whiptails, primarily the desert grassland whiptail (GP 1999a, 2000a). The milk snake occurs in a variety of habitats, but is reliant on sufficient herbaceous vegetation; in Arizona, it is found only in healthy grasslands. Conversion of grasslands to scrublands, and other grassland degradation due to improper grazing, may lead to declines or extinctions in some areas (GP 2000a). Among the rattlesnakes, two (the Mojave rattlesnake and desert massasauga) are grassland specialists that respond negatively to degradation of pure grasslands by shrub encroachment. The relative abundance of the Mojave rattlesnake (a grassland species) has decreased, and the western diamondback rattlesnake (shrub and mixed shrub/grassland species) has increased over a 30-year period in an area of southeastern Arizona and southwestern New Mexico (Mendelson and Jennings 1992). These changes in relative abundance are associated with a decrease in desert grassland and an increase in desert scrub in this area (Mendelson and Jennings 1992). In Missouri, the desert massasauga has been shown to increase in prairie grasslands when grazing pressures are removed (Siegel 1986). In the Southwest, any conversion of grasslands to scrublands would definitely have a severe negative effect on most populations of this species due to a loss of protective cover (which leads to more predation) (GP 2000a).

Other species, such as the western diamondback rattlesnake, may respond positively to grazing-induced shrub encroachment into grasslands. Both the Clark's spiny lizard and eastern fence lizard may benefit from an increase of woodland and spread of woody vegetation into pure grassland. Indeed, Jones

(1981) found the eastern fence lizard to be more abundant in heavily grazed chaparral and grassland. In some cases grazing may still be detrimental: the reduction of riparian vegetation and negative impacts on the recruitment of large deciduous riparian trees could negatively affect Clark's spiny lizard. In yucca grasslands, grazing that impacts yucca and yucca stalks can remove important cover components of the eastern fence lizard's habitat (GP 1999a, 2000a).

The sand dune lizard poses a unique situation in that grazing itself does not negatively affect the species, but rather, the chemical treatment of shinnery oak to promote habitat conversion to grassland has had serious negative impacts (GP 2000a). Several authors (Gorum and others 1995; Snell and Landwer 1992; Snell and others 1993; Snell and others 1994) agree that while grazing does not appear to negatively impact this lizard, the range improvement program of clearing shinnery oak causes drastic reductions in sand dune lizard abundance. The desert massasauga (discussed earlier) has a specialized shinnery oak population in New Mexico, which would likely suffer from the chemical treatment of shinnery oak in a similar manner as the sand dune lizard (GP 2000a).

Herpetofauna - Fire and Grazing Interactions—Over long periods of time, particularly in drier forest types such as ponderosa pine, improper grazing has the potential to contribute to buildups of woody vegetation and increase the risk of catastrophic fire (see discussions of fire and grazing in Milchunas, in press). The two subspecies of the ridgenose rattlesnake are noteworthy here because each occurs in small isolated populations occupying wooded canyons and are of conservation concern (the New Mexico ridgenose rattlesnake is Federally listed as threatened). Habitat destruction of any sort could negatively affect the small New Mexico population, or the isolated population in the Whetstone Mountains of Arizona. The major concern, however, is the loss of woodland due to heavy fuel accumulations leading to intense wildfire. This could lead either to direct mortality or to the loss of the brush mouse, an important food item (GP 1999a).

Herpetofauna - Direct Mortality—The panelists recognized that rattlesnakes in general are frequent targets of eradication by many landowners in the Southwest (that is, not just by ranchers or range managers) and considered this direct mortality (especially den massacres) to be a significant negative factor for rattlesnakes in relationship to range management (GP 1999a, 2000a). Loss of vegetative cover and exposure on roads can increase their detectability and thus the incidence of direct mortality.

Herpetofauna - Effects on Prey Species—As predators, rattlesnakes require a prey population base greater than that required to simply maintain the prey population. Several grazing or range management effects could lead to a reduction of prey populations (for example, elimination of vegetative food base or cover of prey, invasion of nonnative grasses, and so forth). These effects have the potential to reduce the abundance of prey to a level where the rattlesnake population cannot be maintained. (See later discussions under Mammals for further discussion of the issue of indirect effects on predators via the food chain.)

Other Effects on Herpetofauna—Another issue associated with large concentrations of ungulates for long periods is soil compaction. Many turtles require soil that is easily penetrated for the excavation of nesting, resting, and hibernation sites, and deep enough to escape freezing winter temperatures (Legler 1960 as cited in Degenhardt and others 1996). Because of this requirement, compaction of soils by heavy ungulate use would negatively impact the habitat. For the ornate box turtle, the loss of prairie dog towns (due to disease or control efforts) may have negative effects because box turtles are known to utilize the burrows (GP 2000a).

The desert tortoise is a species of high conservation concern; however, there is some dispute in the scientific literature as to the nature and extent of the impacts of cattle and grazing on this species. Reported effects include competition for forage, alteration of vegetation structure and composition, introduction and spread of exotic vegetation, trampling of young tortoises, and trampling of burrows. Other authors (for example, Oldemeyer 1994) note that experimental information on the effect of livestock grazing on tortoises is lacking and that research has not yet examined whether forage remaining after grazing is sufficient to meet the nutritional requirements of tortoises.

Birds – Introduction—The effects of grazing and range management on bird species in the Southwest are varied, but the potential for negative impact is almost entirely related to the alteration or elimination of required components of the vegetative substrate. This is largely connected to requirements for breeding and/or hiding and escape cover, but it is also related to effects on the food supply. This includes not only the production of seeds from grasses and forbs, but also the productivity of the animal prey base, primarily insects but also other animal food sources such as small mammals.

The details of these ecological requirements, and how grazing and range management may affect them, vary tremendously among the different vegetative communities of the Southwest as well as from species to species. This discussion of the panelists' identification of potential effects on birds therefore includes five broad ecological categories: grasslands, scrublands, woodlands, riparian areas, and wetlands. Other major effects discussed are the impacts on ground-nesters in all habitats, and the impact of brood parasitism by cowbirds.

Birds - Grassland Habitats— By its nature, the grazing of livestock reduces the height and density of available grasses; this alteration can both degrade ecological conditions for some species while improving them for others. Species such as the savannah sparrow are highly sensitive to grazing, responding negatively in almost all situations in which this has been studied (see Saab and others 1995). However, for some grassland species, the overall effect can depend on the grassland ecosystem in which the grazing takes place. Several species breed in the grasslands of the Great Plains as well as those of

the Southwest. In many of these cases the same intensity of grazing can be beneficial in the former (creating preferred habitat conditions in the taller, denser grasses of the Great Plains) while eliminating vegetative requirements in the Southwest (where grasses tend to be shorter and sparser). Species such as the bobolink and dickcissel reach the periphery of their range in the Southwest and are most abundant in the Great Plains grasslands. Both are more sensitive to grazing pressures in shorter grasslands, although they may respond positively to grazing in tallgrass prairie (Bock and others 1993; Kantrud and Kologiski 1982; Skinner 1975). Species such as the eastern meadowlark, grasshopper sparrow, and Cassin's sparrow may also benefit from light to moderate grazing in parts of their breeding range outside the Southwest, but in sparse, arid grasslands, the required amount of grassy groundcover can easily be eliminated (Ruth 2000; Vickery 1996). Similarly, lark buntings are sensitive to heavy grazing in arid, short-grass habitats, but may tolerate less intense grazing regimes (Finch and others 1987; Giezentanner and Ryder 1969 as cited in Shane 2000). Some birds such as the long-billed curlew prefer low grass heights for nesting, and grazing has actually been recommended to improve breeding habitat for this species in some areas (Bicak and others 1982). However, grazing that reduces grass heights to extremely low levels or increases the area of barren ground would degrade the habitat necessary to support breeding birds (GP 2001a).

Some species appear to rely on specific native grasses for essential habitat. Botteri's sparrow requires tall, dense stands of sacaton grasses, which can be affected by grazing as well as management practices that repeatedly burn stands of sacaton to produce livestock forage from the new growth. Phillips (1968) found that the most "flourishing colonies" of rufous-winged sparrows were formerly found in meadows of tobosa, a grass that disappears under heavy grazing pressure, and that grazing reduces the overall grass cover required to provide suitable habitat for this sparrow (Phillips and others 1964).

Wintering grassland birds can be affected by reductions in grasses and forbs that provide important food resources in the form of seeds during the winter months. Several grassland birds (such as the Baird's sparrow, grasshopper sparrow, chestnut-collared longspur, savannah sparrow, vesper sparrow, and eastern meadowlark, among others) that are insectivorous during the breeding season often switch to a primarily granivorous diet during winter months. Lark buntings in winter feed primarily on seeds and tend to occur more frequently in areas that have received greater summer rainfalls; thus, they appear to prefer areas with greater herbaceous seed production (GP 2000b). The American tree sparrow also relies heavily on grass and forb seeds during the winter. These wintering birds could be negatively impacted by grazing levels that reduce or eliminate seedhead formation by grasses and forbs.

One element of habitat alteration in Southwestern grasslands that is due more to range management than ungulate grazing of the grass per se is the introduction of exotic grass species adapted to arid environments in order to increase the forage available for livestock. An example is the African lovegrasses, which have become well-established in some areas of the Southwest, particularly the desert grasslands of Arizona. For some bird species, the effects of these grasses can be positive: the Botteri's sparrow, a tall-grass specialist adapted to the native sacaton grasses, has increased in abundance in stands of exotic lovegrasses (GP 1999b). The invasion of some exotic grasses may actually increase the suitability of grazed areas for some species (such as the Baird's sparrow) by providing cover (C. Gordon, personal communication as cited in Jones and Green 1998). However, other species (for example, eastern meadowlark, vesper sparrow) have been shown to avoid pastures of introduced exotic African lovegrasses in favor of native grasslands (Bock and Bock 1988).

The presence of a significant shrub component can also prove detrimental to many species that are adapted to a pure grassland ecosystem. Several studies have documented how excessive grazing can result in the invasion of woody shrubs into formerly pure grassland, and a gradual conversion to a mixed or even shrub-dominated community (Milchunas, in press). The preferential grazing of grasses over shrubs (which alters the balance of competition for soil and water resources) also results in fire suppression due to the removal of grasses as a fuel and conductor of fire across the landscape (thus removing a mechanism for eliminating woody shrub growth). Such "shrub encroachment" is thus recognized as a potential long-term effect of grazing in Southwestern grasslands (although conditions such as extended drought or climate change can also be contributing, as well as primary, factors in this conversion; Milchunas, in press). Several species were identified that rely on pure, open grassland habitats: breeding birds, such as the burrowing owl, vesper sparrow, and Botteri's sparrow, and wintering birds, such as the chestnut-collared longspur, Sprague's pipit, and Baird's sparrow, are considered particularly sensitive to shrub encroachment into grasslands. Grassland raptors, such as the aplomado falcon and ferruginous hawk, may also decline in abundance when grassland converts to scrubland, possibly through indirect effects on preferred small mammal prey species.

The presence of prairie dog colonies in Southwestern grasslands is important for several grassland bird species, and their eradication may negatively impact grassland raptors. Most directly affected by prairie dog towns are burrowing owls, which do not actually burrow themselves but rely on prairie dog colonies for nesting burrows. In tallgrass prairie, grazing can help create prairie dog habitat (Kantrud and Kologiski 1982), but it is not considered necessary in the sparser grasslands of the Southwest (GP 2000c). Some authors (for example, Phillips and others 1964) believe that prairie dog eradication efforts have had a negative effect on owl populations. Prairie dogs also are important prey species for raptors such as the ferruginous hawk and golden eagle that hunt in open grasslands. Truett (2002) suggested that prairie dog elimination, rather than overgrazing, contributed to the decline of the aplomado falcon in the Southwest. None of these raptors relies exclusively on prairie dogs, and impacts to a variety of small mammal species could indirectly affect these birds (see further discussion under Mammals, below).

Birds - Desert-Scrub and Shrub Habitats—A number of bird species require a shrub component as part of their preferred habitat, ranging from scattered shrubs in grassland (for example, as required by Cassin's sparrows) to dense stands of shrubs. As discussed briefly above, over the long term, livestock grazing in grasslands can contribute to the encroachment of woody shrubs and cactus into pure grassland. Indeed, such interactions led the Stage II panels to reject species such as the cactus wren that benefit from these effects (see appendix D). In shrub and desertscrub habitats, the potential for negative consequences comes from two sources: high densities of livestock that adversely affect shrubs and/or cacti, and management activities that chemically or mechanically clear away shrubs and cactus in order to create grassland habitats.

Many shrub and desertscrub species also benefit from the herbaceous component of these habitats and may respond negatively if this is degraded as well. Several birds require substantial grass and forb understory along with a shrub component for building nest structures or to use as breeding cover. Habitat requirements often include low to moderate shrub densities and can become unsuitable if shrubs become too dominant. Black-chinned sparrows and northern cardinals both require the seeds produced by grasses and forbs as well as low to moderate densities of chaparral or desert-scrub. Several species of gallinaceous birds also fit in this category. Scaled quail, lesser prairie-chicken and masked bobwhite all require some cover of woody vegetation along with a healthy layer of herbaceous vegetation. Light to moderate grazing may be tolerated by or even beneficial for many of these species (depending on intensity and climatic conditions, such as drought), while heavy grazing resulting in desertification or that promotes high shrub density could have severe negative effects (GP 1999b).

Other species require higher densities of shrubs or desert-scrub, which may be more readily reduced from optimum densities by high stocking levels of livestock. The varied bunting and black-tailed gnatcatcher are examples of species that inhabit areas of high shrub density in desert scrub habitats, particularly desert washes. The pyrrhuloxia in Arizona is a bird of Sonoran Desert xeroriparian scrub, and the crissal and LeConte's thrashers also inhabit areas of desert-scrub, although LeConte's thrasher is characteristic of more open and arid habitats. Some of these (varied bunting, crissal thrasher, pyrrhuloxia) appear to have a special affinity for mesquite thickets (Cody 1999; Wolfe 1968) and may have benefited to some degree from grazing-induced expansion of mesquite into grasslands. In addition to shrub removal or degradation, the presence of livestock may also impact the insect prey base by removing available herbaceous vegetation in arid environments, or, as in the case of LeConte's thrasher, by disturbing the groundcover of litter that supports its arthropod prey (Sheppard 1996).

The Sonoran desert ecosystem hosts bird species that specifically rely on the saguaro cactus for breeding structures, as well as components of the shrub and cactus understory as part of their habitat requirements. The Gila woodpecker and gilded flicker are important primary cavity nesters in saguaros, excavating cavities that will later be utilized by species of secondary cavity nesters. Species that utilize abandoned woodpecker cavities in saguaros for nesting include the American kestrel, elf owl, cactus ferruginous pygmy-owl, western screech-owl, ash-throated flycatcher, brown-crested flycatcher, and purple martin (Kerpez and Smith 1990). The Harris' hawk, in addition to large mesquites and riparian trees, also utilizes saguaros for nesting structures. Sonoran Desert vegetation, particularly the long-lived and slow-growing cacti, is relatively fragile compared to vegetation in other Southwestern vegetation communities and is thus more vulnerable to heavy browsing and trampling. As seedlings, large cacti such as saguaros are particularly vulnerable and can be affected either by direct trampling or by clearing of other vegetation ("nurse plants") required for protection from exposure to the sun. In addition, livestock grazing in the Sonoran Desert has contributed to the expansion of exotic grasses (for example, red brome, lovegrass), which have in turn led to an increased probability of destructive fires (GP 2000d). The incidence of wildfire in the Sonoran Desert has increased in recent decades (Narog and others 1995; Schmid and Rogers 1988). Because they are unadapted to frequent fire, saguaros experience high mortality rates during or after wildfire, and their numbers sharply decrease in burned areas (Cave and Patten 1984; Wilson and others 1996); postfire mortality among saguaros can reach 80 percent (Wilson and others 1996). In this ecosystem, clearing desert scrub and increasing the grass component can be detrimental to species such as the common poorwill, which prefers more mid-canopy perennial vegetation rather than grassy groundcover (Hardy and others 1998).

Other species have strong affinities for specific types of scrub vegetation. Scott's oriole is common in yucca grasslands and in low-elevation desert scrub or pinyon-juniper woodlands with a yucca component; it utilizes the large stalks in order to construct its pendant nest (Kozma and Matthews 1997). Similarly, the sage sparrow is closely associated with pure stands of big sagebrush or stands intermingled with other desert scrub vegetation (Martin and Carlson 1998). In each case, any range improvement involving the clearing of the required vegetation to create a grass monoculture would be detrimental.

The next section focuses on woodland habitats, but there are several species that are strongly associated with dense shrub habitats in conjunction with coniferous woodlands. The green-tailed towhee is considered a breeding bird of montane habitats, but it is found almost exclusively in open areas adjacent to woodlands or forest edge where there is a substantial shrub component (it also breeds at lower elevations in sagebrush shrub-steppe and other mixed-species shrub communities). The blue-gray gnatcatcher is also a species of dense shrubs and small trees in a variety of shrub-woodland habitats, including Upper Sonoran oak woodland and chaparral habitats, and habitats dominated by pinyon pine up to stands of Gambel oak and mountain mahogany (GP 2000c; Phillips and others 1964). Again, reduction of the shrub component through clearing or high stocking densities could rapidly reduce the shrub densities below the suitability thresholds for these species.

Birds - Woodland Habitats—In both Arizona and New Mexico, woodland habitats vary tremendously as a function of elevation and water availability (either annual precipitation or ground water). Within these woodland ecosystems, the distribution of birds is often affected by the amount of canopy cover, forest density, and the amount of understory shrubs and herbaceous vegetation. Most of the effects of ungulate grazing in these habitats manifest themselves over long periods; for example, intensive grazing in ponderosa pine woodland, which contributes to the suppression of low-intensity fires (thus ultimately affecting forest structure and catastrophic fire risks), and browsing of deciduous tree seedlings, which affects the long-term recruitment of large, mature trees required for nesting or food supplies. However, short-term effects can also be recognized through the removal of understory shrubs and herbaceous vegetation that provide food supplies through the insect prey base, seeds, or fruits and flowers.

Similar to the earlier discussions of potential impacts to birds in grasslands and desert scrublands, several species in woodlands are vulnerable to the reduction or elimination of herbaceous vegetation and/or understory shrubs. In their respective habitats, birds such as the elegant trogon and northern flicker depend on fruiting shrubs to provide important food resources, and insectivores such as the olive-sided flycatcher and hermit thrush require enough shrub and herbaceous understory in coniferous forests to support the insect prey base. Shrubs and grasses in pine-oak woodland settings are important to Gould's turkey, whip-poor-will, and Montezuma quail, and to Merriam's turkey in a variety of montane woodland settings, providing insects as well as cover and roost sites. Pinyon pine and pinyon-juniper woodlands have also been subject to large-scale clearing efforts in order to improve forage availability for livestock. The removal of these woodlands impacts several species, including pinyon jays (that depend on mature, cone-bearing pinyons), gray vireos (that utilize junipers for breeding), and species such as the western bluebird that use juniper berries as a source of food. Mast-producing oak trees are important for turkeys and band-tailed pigeons and can be impacted by continuous browsing that keeps them in a prostrate growth form (GP 1999c).

Perhaps one of the most significant ecological interactions between livestock and montane woodlands in the Southwest is in the ponderosa pine forests. The natural state of old-growth ponderosa pine forests is believed to consist of a relatively low density of large diameter trees, widely spaced, with a grassy, parklike understory. Fires in these systems are fueled primarily by the grassy understory and are frequent but with relatively low intensity. The larger trees are resistant to such fires, which nevertheless burn out many new seedlings and other invading woody species. Due in part to heavy livestock grazing in the past century (as well as climatic factors such as drought), ponderosa pine communities have changed through time, with some now characterized by a dense cover of smaller trees. Livestock grazing is thought to have contributed to fire suppression in these systems through the elimination of grass, which is important to the spreading of the low intensity fires. The depletion of competing grasses and lack of fire in turn encourage the growth of shrubs and dense stands of young conifers (dog-hair thickets). This has not only changed the structure of the forest, but has also altered the fire regime to a greater risk of large, hot, catastrophic events, rather than the cooler, grass-fueled fires, which the larger trees are able to withstand (Allen and others 2002; Chambers and Holthausen 2000; Covington and Moore 1994; Swetnam and others 1999; Touchan and others 1996).

Several species are likely to be impacted by this change in structure in ponderosa pine forests. The classic condition of open ponderosa pine savannah with few mature trees is ideal for the pygmy nuthatch, Lewis' woodpecker, Grace's warbler, and olive warbler. Other species require a dense overstory in concert with maintenance of an open understory for hunting and foraging, including the northern goshawk, flammulated owl, and northern saw-whet owl. Increased catastrophic fire from dog-hair thickets threatens the habitat of a variety of species, but fire also impacts the large mature trees that are important as nest trees for primary cavity nesters such as the northern flicker and as feeding substrates for bark gleaners such as the brown creeper and pygmy nuthatch, which can be driven out by severe fires (Lowe and others 1978). Several species require diverse forest structure in which the presence of large trees is an important component; these include the Mexican spotted owl, western tanager, and hepatic tanager. Grazing is not likely to impact the fire regimes of other forest types such as mixed-conifer or spruce-fir, but the risk of catastrophic fire in these forests may be increased if they are adjacent to dog-hair thicket ponderosa pine forests. The ecological forest dynamics described above are also believed to be at work in Madrean pine forests communities of southwestern Arizona (Morrison and Martin 1997). Increases in dog-hair thickets and risks of catastrophic fire could impact relatively rare and highly local species such as the yellow-eyed junco, Mexican chickadee, and buff-breasted flycatcher.

The availability of snags (standing dead trees) within a diverse forest habitat is important for a variety of cavity-nesting birds. Catastrophic fires may increase the number of standing dead trees but effectively eliminate the habitat matrix of existing snags within living habitat components. Thus, grazing that indirectly contributes to increased risk of such fires would threaten important nesting substrates for a variety of cavity nesting birds, including woodpeckers, but also secondary cavity-nesting species such as the northern saw-whet owl, flammulated owl, northern pygmy-owl, ash-throated flycatcher, violet-green swallow, elegant trogon, and others.

Open meadows interspersed among forest stands are also important foraging and hunting areas for birds such as the Mexican spotted owl, northern saw-whet owl, and northern pygmy-owl. The grassy understory in these meadows often supports prey for these bird species, which also need open, unobstructed areas in which to hunt. The same ecological dynamics among livestock grazing, fire suppression, and woody shrub or conifer invasion can be at work in these areas. Prey species can be driven out as grassy cover is eliminated, and as

shrubs and conifers invade a meadow, they can make it structurally unsuitable for foraging. These conditions in meadows apply to a variety of forest types and elevations (not just ponderosa pine); higher elevation forest meadows are also important for species such as the violet-green swallow (foraging) and the broad-tailed hummingbird (foraging and mating displays).

An important element of high-altitude woodlands that can be directly impacted by ungulate browsing are aspen stands. Large aspen trees are important substrates for nest cavities for the hairy woodpecker, red-naped sapsucker, Williamson's sapsucker, and black-capped chickadees, and serve as an important habitat component for some species such as the red-breasted nuthatch. Wild ungulates often have just as much if not more impact on aspen as do domestic livestock; in some areas, the impact from elk on aspen can be extremely high. Intensive browsing or grazing in conjunction with fire suppression is thought to cause the recruitment of young aspen trees to be sporadic or eliminated altogether (Dobkin and others 1995). Heavy browsing of aspen "suckers" in the first several growing seasons and during the initial growth period can eliminate a sucker stand and deplete the parent root system. In addition, ungulate use of adult aspens can scar the tree bole, which leads to an increase in canker infections (Patton and Jones 1977; DeByle and Winokur 1985).

Birds - Riparian Habitats—The importance of riparian habitats to wildlife in the American West has been recognized for some time. This is particularly true in the Southwest, where broadly arid conditions magnify the importance of the mesic habitat conditions found in riparian zones. Because of this, birds and other terrestrial vertebrates occur in disproportionate numbers in riparian areas of the Southwest and are particularly vulnerable to degradation or alteration of these habitats (Cartron and others 2000; Krueper and others 2003; Saab and others 1995).

Riparian situations exist at a variety of altitudes and under a variety of climatic conditions that shape the distribution and types of vegetation. All the habitat components that make them attractive to wildlife also make them attractive to livestock: succulent forage, water, and shade. While several authors have identified livestock grazing as an important agent of change in western riparian habitats (for example, Saab and others 1995 and authors cited therein), it should be noted that wild ungulates such as elk can also degrade or alter these habitats, particularly in high-elevation systems. For birds and other terrestrial vertebrates, it is this change in habitat structure and composition, rather than the presence of ungulates per se, that affects the suitability of riparian areas.

As with other habitat types, potential impacts from ungulates in riparian habitats can be both short term and long term. Because riparian zones in the Southwest are frequently surrounded by sparser and more arid landscapes, riparian habitats will often attract and concentrate livestock in high densities. Thus, more immediate impacts can result from high stocking densities and intensive grazing, which will likely eliminate much of the available herbaceous vegetation and impact the shrub layer through browsing and/or trampling. Riparian vegetation can often recover rapidly following removal of the pressures exerted by ungulate use (Ohmart 1996). For example, Krueper and others (2003) report the impact of livestock removal in the San Pedro River National Conservation Area (Arizona) on bird communities. The removal of cattle in 1987 resulted in a fourfold to sixfold increase in herbaceous vegetation after 3 years, accompanied by significant increases in a variety of bird species that are riparian specialists in the Southwest. The increase in vegetation may have also induced an increase in the insect prey base, as many of the species that showed significant increases were primarily (if not obligate) insectivores. This includes species in this database such as the northern beardless-tyrannulet, western wood-pewee, ash-throated flycatcher, common yellowthroat, vermilion flycatcher, Bewick's wren, yellow-breasted chat, and brown-crested flycatcher. The interactions among livestock grazing, herbaceous vegetation, insect diversity and abundance, and insectivores have not been rigorously studied, and the panelists identified these interactions as being in particular need of further research (for example, GP 2001b).

In riparian habitats at low elevation similar to the situation on the San Pedro River, substantial herbaceous and shrubby vegetation support a variety of bird species, some of which (for example, blue grosbeaks) are considered riparian obligates in the Southwest. Dense, brushy riparian vegetation, including willow thickets (usually with some component of tall trees; see below), is a required habitat component for species such as the blue grosbeak, Bell's vireo, yellow-breasted chat, lesser goldfinch, indigo bunting, lazuli bunting, and painted bunting, among others. The tall tree component is more important for some species (such as the northern-beardless tyrannulet, lazuli bunting, and willow flycatcher), but all require dense shrubby understory for the habitat to be suitable. Dense mesquite bosques that make up or are at least adjacent to riparian areas appear to be important aspects of riparian habitat for several species, including the phainopepla, Bell's vireo, vermilion flycatcher, and Lucy's warbler. High cover of tall mesquite can be important for Bullock's oriole, yellow-billed cuckoo, western screech-owl, and buff-collared nightjar. All these species could be negatively impacted by the clearing of mesquite, small trees, or shrubs in xeroriparian washes or riparian habitats. The presence of cattle can result in browsing of important thicket and brush components such as willow, as well as opening dense understory shrubs through trampling and other physical contact.

Besides removing riparian scrub vegetation, the presence of livestock can also facilitate the establishment of exotic vegetation. Salt cedar (or tamarisk), a large, introduced shrub from Asia, has proven to be especially invasive in Southwestern riparian ecosystems. Its greater tolerance of drought and its resilience in surviving and regenerating after fire has allowed salt cedar to outcompete and replace native species throughout the Southwest. In addition, livestock generally find salt cedar to be unpalatable relative to native species, and will preferentially browse the latter, thus exacerbating the competitive

disadvantage of the native species (Cartron and others 2000). Some studies have shown that salt cedar habitats support fewer birds and less species diversity (for example, Anderson and Ohmart 1985), while other studies have shown that for birds requiring dense brushy riparian vegetation, these habitats provide some substitute for native vegetation (for example, Ellis 1995; Hunter and others 1985). Southwestern willow flycatchers readily utilize salt cedar habitats of sufficient size and density, as do the yellow warbler, summer tanager, Abert's towhee, song sparrow, and blue grosbeak. In the Grand Canyon, thickets of salt cedar support the Lucy's warbler (Johnson and others 1997), and on the Pecos River north of Carlsbad, painted buntings are found almost exclusively in salt cedar stands (Howe, personal communication). Bullock's orioles use salt cedar if it is very tall, although the birds avoid the understory (Rosenberg and others 1991). It is generally believed that salt cedar provides poorer habitat conditions than do native plant communities in good condition (Anderson and others 1983 as cited in Cartron and others 2000) and that there are sound ecological reasons to remove salt cedar and prevent livestock from encouraging its establishment. However, in the absence of native vegetation, it is clear that many species of birds can successfully utilize salt cedar for breeding habitat in Southwestern riparian zones.

At higher elevations, willow thickets and other dense streamside vegetation are also important to a variety of bird species. Willow flycatchers at high elevations are found almost exclusively in willow habitats (Sogge and Marshall 2000), and dense streamside thickets and ground vegetation are important for the gray catbird, Lincoln's sparrow, MacGillivray's warbler, Wilson's warbler, song sparrow, and orange-crowned warbler. Some birds such as the Wilson's warbler require no tree overstory (Finch 1989), whereas others (for example, orange-crowned warblers) require an overstory of ponderosa pine, Douglas-fir, spruce, or aspen (Sogge and others 1994). In addition to livestock, elk and deer can also heavily impact willow thickets and other riparian shrub vegetation, particularly when population densities increase beyond natural carrying capacities. It should also be noted that beavers and their systems of dams and lodges often raise water tables and create pond systems that allow willow thickets and other riparian shrub communities to become established. Thus, elimination of these animals and destruction of their dams may ultimately have an indirect impact on the habitat needs of these birds (see further discussion below under Mammals).

Among the most important features of riparian habitat in the Southwest are the large deciduous trees that can form large gallery forests with tall, enclosed canopies. At low elevations, cottonwoods and in some areas sycamores dominate these deciduous forests. Depending on location, other trees such as walnut, oak, and ash can also be major components of the tall deciduous canopy. Continuous grazing or browsing in a riparian area can affect these trees over long periods by eliminating recruitment of new trees into the forest community. New saplings of cottonwood and other deciduous trees may be preferentially browsed by ungulates as well as trampled when first sprouting; these impacts on new trees eventually create even-aged, nonreproducing stands (Cartron and others 2000 and authors cited therein). Mature forests of a single-age structure can provide benefits to birds for many years after the impacts of grazing have already been initiated, but without replacement of dying and decadent trees, this habitat component will eventually be eliminated. In addition to browsing, water diversion and flood control projects in streams and rivers can also affect recruitment of species such as cottonwoods, which require periodic flooding to allow seedlings to become established.

The tall trees and high canopy of riparian gallery forests are essential elements for a variety of birds that use them for nesting and foraging. In far southeastern Arizona and southwestern New Mexico, large, mature riparian trees are required by the zone-tailed hawk, common black-hawk, thick-billed and tropical kingbirds, Bullock's and hooded orioles, rose-throated becard, summer tanager, and others. In the Southwest, Cooper's hawks are mainly riparian birds, using the tall trees for nesting (GP 2000e). Wild turkeys will use the tall trees for roosting habitat. Many species utilize cottonwood-sycamore-willow associations containing a dense brushy understory or a multiple-layer canopy, including the Southwestern willow flycatcher, blue grosbeak, Abert's towhee, and lesser goldfinch. Yellow-billed cuckoos require closed canopies with a substantial subcanopy; yellow warblers utilize all vegetation layers within riparian forests of cottonwood, box elder, and willow. Sycamore stands appear to be preferred by some species, including hooded orioles (Powell and Steidl 2002), violet-crowned hummingbirds, which nest almost exclusively in sycamores (Zimmerman and Levy 1960), and sulphur-bellied flycatchers, which are found in sycamore/walnut riparian woodlands of deep canyons (Lowther and Stotz 1999).

Among specific habitat components provided by large mature cottonwoods and sycamores are nesting substrates for cavity nesting birds. These trees and their associated riparian habitats are important for a variety of primary cavity-nesting species, such as the northern flicker and the red-headed, Lewis', and acorn woodpeckers (the last of which also requires mature, mast-producing oaks). The Gila woodpecker, a denizen of the Sonoran desert and its saguaro stands in Arizona, also nests in mature cottonwoods; in New Mexico it is considered an obligate riparian species (Edwards and Schnell 2000; GP 2000c). Cavities constructed by these species, as well as natural cavities, become important for secondary cavity nesters in riparian zones, including common mergansers, wood ducks, black-bellied whistling ducks, elf owls, western screech-owls, ash-throated and brown-crested flycatchers, black-capped chickadees, white-breasted nuthatches, and violet-green swallows. Some species more frequently use cavities in sycamore trees, such as the elegant trogon and whiskered screech-owl. For all these birds, maintenance and continuous recruitment of tall, mature deciduous cottonwood and sycamore trees in riparian woodlands is essential to provide suitable nesting habitat.

Up to this point, the discussion has primarily focused on low-elevation riparian woodlands. This emphasis is justified by the fact that, throughout desert or arid grassland environments, these are frequently the only habitats available with tall tree structure and mesic conditions. However, in higher elevation systems, deciduous riparian woodlands provide important habitat components for bird species that also utilize surrounding coniferous woodlands. Many species that are found in lower elevation riparian woodlands also inhabit high elevation cottonwood/aspen riparian zones (for example, white-breasted nuthatch, black-capped chickadee, black-headed grosbeak). Habitat requirements for species such as the western wood-pewee and cordilleran flycatcher are characterized by riparian deciduous trees within coniferous woodland. Swainson's thrush is a bird of montane coniferous forest, but with an affinity for dense willow and alder thickets in riparian zones (Latta and others 1999). Red-naped sapsuckers prefer aspens that are located within riparian zones (Dobkin and others 1995), and Mexican spotted owls require the cottonwoods and oaks of montane riparian systems within coniferous forests to provide the high structural complexity of vegetation for suitable roost-site structure (Stacey and Hodgson 1999). In southeastern Arizona, montane canyons of pine-oak woodland characterized by riparian deciduous trees (particularly sycamore) with pine at the edge are characteristic habitat for species such as the elegant trogon, blue-throated hummingbird, and whiskered screech-owl. In all these riparian habitats, the same impacts of livestock and wild ungulate grazing, browsing, and trampling (short-term effects of herbaceous and shrub cover removal; long-term impacts on recruitment of large deciduous trees) have the potential to affect habitat suitability for the bird species in these systems.

In addition to direct effects on vegetation, livestock grazing and range management can impact the availability of water and water quality in riparian stream systems. Heavy livestock use can lead to soil compaction and lowering of the water table, and large numbers of livestock can reduce water clarity and quality by increasing erosion and sedimentation and by polluting waters with waste. Reduction in the availability of water can negatively affect riparian vegetation and the habitat suitability of birds, as discussed above. Degradation of water quality can also impact various aquatic organisms (including fish, aquatic insects, and other invertebrates), and thereby have an indirect effect on the birds that feed on them. Bald eagles and osprey, which also require tall riparian trees for nest platforms or perches, both feed on larger species of fish. The common black-hawk feeds on animals such as fish, frogs, and crayfish, and occasionally hunts aquatic prey by wading in shallow pools (Schnell 1994). The American dipper is a specialist of high-altitude streams and creeks, foraging entirely in the water for aquatic invertebrates (Kingery 1996). The common merganser also requires clear, fresh water for foraging in the streams and waterways within forest zones (Johnsgard 1975). Other riparian species may be characterized more by other dietary needs but have some dependence on aquatic prey during part of their life cycle. For example, the blue-throated hummingbird is better known as a flower-feeding nectivore, but during some parts of the breeding season it feeds exclusively on small insects that swarm in high abundance over creeks and streams (Kuban and Neill 1980; Wagner 1946); this may explain the importance of water sources in association with its territories. For all these species, dependence on aquatic organisms for prey will require clear, fast-flowing, and unpolluted water sources in order to maintain suitable habitat.

As mentioned above, water availability is an important feature of wildlife habitat in Southwest riparian systems, and there are mechanisms by which grazing or management can both negatively and positively impact this availability. The impacts of heavy livestock usage on water tables were mentioned above, but natural springs and creek systems can also be drawn down or eliminated if water is collected into tanks or otherwise developed for livestock use. However, the presence of artificial stock ponds or tanks in general can often provide water for wildlife where none would have otherwise existed. This can benefit woodland birds such as wild turkeys, which need a source of open water, as well as birds that forage for insects over open water, such as the black phoebe and the violet-green swallow. Large earthen ponds can be especially beneficial for birds if shoreline vegetation is allowed to grow and create stands of brushy riparian habitat and/or emergent vegetation. Stock tanks can also be used in active management by providing alternative water sources for livestock away from streams and creeks, thus preventing the high concentrations of livestock that cause damage to riparian ecosystems.

Birds - Wetland/Marsh Habitats—Of all the water-dependent habitats in the Southwest, the rarest and most ecologically fragile are probably the wetlands and marshes. Numerous species of birds are rare or sparsely distributed in the Southwest because their required habitats are as well. The American bittern, least bittern, common moorhen, snowy egret, sora, and the Virginia rail utilize habitats that are generally characterized by shallow water marshland with dense stands of emergent vegetation, often interspersed with areas of open water. Marsh vegetation includes sedges, rushes, and cattails, sometimes with a willow component on the shorelines. Some species (for example, great egret, black-crowned night heron) also require scattered tall trees for nesting or roosting; others are more frequently found in marshland associated with deeper water (for example, yellow-headed blackbird). Most marshlands are found at low elevations, but other species use this habitat type in high-elevation moist meadows (for example, common snipe).

The impacts of livestock on these habitats are varied, but it is one of the few habitat types in which the panelists considered livestock use to have a consistently negative impact and therefore to be generally incompatible with habitat maintenance (GP 2001c). Marshes with tall emergent vegetation are fragile and highly sensitive to the impacts of livestock and grazing. Livestock can have immediate impact on this vegetation by trampling, opening up dense stands or even eliminating patches of emergent vegetation. Heavy livestock use can also lead to channelization of water courses and drying of marshes, making them susceptible to fire. Water quality can also be

impacted by excessive stocking densities. The underlying substrate of the marsh is typically rich in organic nutrients and aquatic invertebrates, thus supplying important food resources for many marsh birds. These conditions can be degraded by livestock that trample this muddy substrate, increase water sedimentation, and introduce large amounts of animal waste. In addition, overgrazing can lead to increased erosion and silt runoff into wetlands. However, it should also be noted that limited trampling of marsh vegetation after the avian breeding season can have a positive effect by introducing organic matter into the marsh substrate, leading to increased invertebrate productivity (GP 2001c).

Various range management activities can also affect marshlands and the required water supplies necessary to maintain proper depths. Draining of marshes or diversion of water for livestock use can have negative consequences for a number of species as their habitat is eliminated. In the case of the American bittern, conversion of marshes to pasture has caused population losses in northern New Mexico. Short of actual elimination or conversion of marshes and wetlands to pasturelands, activities that result in habitat fragmentation or even altered vegetation structure and composition can have detrimental effects (GP 2001c).

Numerous studies have been conducted on the effects of cattle grazing on ducks and other waterfowl species. Braun (1978, as cited in Ryder 1980) reported that at least 55 studies had shown grazing to be detrimental to waterfowl production. In reviewing the available literature, Kirsch (1969) was unable to find any example where grazing or other cover removal activity increased waterfowl production. When disturbed by cattle, breeding pairs of waterfowl tend to move away from cattle grazing and concentration areas (Kirsch 1969). In addition, activity that reduces residual vegetative cover may adversely affect waterfowl production because most waterfowl species begin to nest prior to the availability of new growth suitable for nesting. The presence of the previous year's residual cover permits hens to nest earlier; this provides a longer period for renesting (Leopold 1933 as cited in Kirsch 1969). Cover removal by grazing (Kirsch 1969) and by other sources of land development such as haying, mowing, and cultivation (Drewien 1968 as cited in Kirsch 1969) adversely affects breeding populations. Kirsch (1969) also reported higher nest densities and nest success rates in ungrazed or idle lands compared to grazed areas. Hoff (1993) found similar results in wetlands of the White Mountains of Arizona: decreased vegetative cover due to cattle grazing led to decreased numbers of breeding pairs, nesting density, and nest success of ground-nesting waterfowl. Alterations to vegetation composition and structure that reduce available cover also make ducks more vulnerable to predation (GP 1999d, 2001c). Also, excessive grazing has been found to reduce pond use by broods of ducks (Kantrud 1986 as cited in Weller 1996). Many species of ducks (for example, the northern pintail, American wigeon, gadwall, green-winged, and cinnamon teal) require dense terrestrial vegetation during nesting, and grazing can potentially degrade upland vegetation used as nesting habitat (GP 2001c).

Certain range practices could result in benefits for various species of ducks. For example, nest success for the American wigeon could be enhanced by grazing and burning practices that encourage brush and brush/grass vegetation height greater than 25 cm (10 inches) at the time of nesting (Mowbray 1999). In addition, irrigated pastures and stock tanks can have positive effects on all these species during migration and winter (GP 1999d, 2001c).

Birds - Ground Nesting—Many species of birds in this database are ground-nesters, building nests and/or laying eggs directly on the soil surface. It is these species that are most likely to suffer directly from the presence of livestock (Saab and others 1995), particularly when stocking densities are high and the chances of trampling of nests and eggs are greatest. In grasslands, this includes species such as the long-billed curlew, northern bobwhite, eastern meadowlark, savannah sparrow, grasshopper sparrow, vesper sparrow, and lark bunting; in desert-scrub or arid woodlands, species such as the common poorwill and whip-poor-will. High-elevation riparian willow thickets support ground-nesters such as the Lincoln's sparrow, Wilson's warbler, and orange-crowned warbler, and mountain meadows have ground-nesters such as common snipe. In the more southerly mountain regions, this category also includes the yellow-eyed junco of pine-oak woodlands and the painted redstart of riparian/coniferous woodland habitats. Many marshland birds (for example, all bitterns and rails) are low-nesters in shallow waters. Gjershing (1975) reported increased nest trampling by livestock on wetland shorelines. All of these species, as well as other ground-nesters, may experience nest failures due to trampling or other disturbances when livestock densities are high.

Birds - Cowbird Parasitism—Certain species of passerine birds are particularly vulnerable to brood parasitism by the brown-headed and (less frequently) bronzed cowbirds. Brood parasites lay their eggs in the nests of the host species, many of which raise the cowbird chick in addition to or even instead of their own young. High levels of brood parasitism can cause reductions in reproductive output and eventually lead to population declines in the host species. The brown-headed cowbird feeds on the ground, utilizing areas of short grass and bare ground. Historically they likely followed bison herds through the short-grass prairie region but later became associated with the herds of livestock introduced by Euro-American settlers. Brown-headed cowbirds have increased in abundance in many areas of North America during the last century due to the expansion of livestock herds, corrals, and feedlots, and the birds' ability to exploit human-provided resources of hay, seeds, and grain (Robinson and others 1995).

Cowbird densities tend to increase with the presence of cattle, thus the introduction of cattle into passerine bird habitats can potentially lead to increased opportunities for cowbird parasitism (Goguen and Matthews 1999). This appears to be particularly true in riparian areas of the Southwest, affecting

Bell's vireo and the willow flycatcher (Franzreb 1989; Stoleson and Finch 2000; see also references reviewed in Saab and others 1995), but it can also include pinyon-juniper woodland (Goguen and Matthews 1998) up to ponderosa pine and Douglas-fir forests (Hejl and Young 1999). However, the presence of cattle is not by itself a sufficient condition leading to increased parasitism rates. For instance, the willow flycatcher is one species that is threatened by cowbird parasitism, but whereas some populations are heavily parasitized, others show only low or moderate levels, even when adjacent to grazed areas (Boren 1997; Harris 1991; Whitfield and Strong 1995). In addition, loss of habitat in riparian zones can confound attempts to assess the impact of cowbird parasitism on passerine birds in these areas (Rothstein 1994 as cited in Cartron and others 2000). In general, the panelists recognized (1) that in the Southwest cowbirds are associated with concentrations of domestic livestock, (2) that cowbird parasitism can negatively affect host productivity, and (3) that certain populations of some species (such as Bell's vireo, Southwestern willow flycatcher) are known to be negatively impacted by cowbird parasitism.

Mammals – Introduction—As with other taxa, the effects of grazing and range management on mammals are chiefly related to the short-term and long-term impacts on the structure and composition of vegetation in the various communities of the Southwest. The general impacts on the different vegetation communities as discussed above under Herpetofauna and Birds will also affect the mammals that depend on these communities. Although specific effects vary depending on the habitats and other ecological requirements of individual species, the general issues of cover and food supply are critical limiting factors for a variety of small mammals. Sufficient groundcover (in the form of grass and forb cover as well as woody debris and logs) is a widely shared habitat requirement among various species of small mammals, including chipmunks, voles, mice, rats, and shrews. Many of these small mammals are also granivores, thus requiring the seeds produced by grasses and forbs.

In addition to these issues, several species of large mammals come into direct competition with livestock for forage, or prey upon livestock, thus creating special challenges for range managers. Domestic livestock (including cattle, sheep, and goats) can experience competition for forage with large ungulates such as elk and deer, but also with species such as pronghorn, bighorn sheep, and even bear. Livestock and range management practices also complicate the ecological interactions among top predators, small carnivores, and their prey species; not only can prey populations be reduced to levels that can no longer support predators, but actions taken against particular species of predator can have indirect effects on that species' suite of predatory competitors. The summary discussions of general habitat types below mainly focus on small mammal species, followed by separate discussions of large mammal interactions including competitors and predators of livestock.

Mammals – Low-Elevation Grassland Habitats—Many Southwestern mammals rely on the cover and food resources provided in the grassland habitats located below high-elevation forested zones, with some even responding negatively to increases in shrub and tree cover. Some species need dense grass cover (and generally respond negatively to any grazing) whereas others prefer sparser conditions (their responses vary depending on grazing intensity and the type of grassland).

Perhaps no other species relies on pure grassland conditions more than the white-sided jackrabbit, a specialist of plains and desert grasslands. This species requires well-developed grass cover and virtually no shrubs (Bednarz and Cook 1984). The white-tailed jackrabbit also inhabits grasslands but can be found from plains grasslands to alpine tundra; it is slightly more tolerant of shrub cover. Both of these species succumb to competition with the black-tailed jackrabbit when shrub densities increase (GP 2001d). Other species requiring dense grass cover are the tawny-bellied and hispid cotton rats (both of which require tall grasses for construction of "runways"; Baker and Shump 1978), northern pygmy mouse, and fulvous, western, and plains harvest mice. These species can be expected to respond negatively to grazing that depletes the required dense, grassy or weedy groundcover and, over the long-term, facilitates the encroachment of dense stands of mesquite and/or other shrubs into grassland habitats (see discussion above under Birds; also Milchunas, in press). Many of these species are also granivores that depend on grass and forb seeds for food resources and can be affected if these are prevented from developing. Other species (such as the hispid and silky pocket mice, and the thirteen-lined ground squirrel) are less dependent on tall, dense grass cover, and are more frequently found in short-grass or arid grasslands. In these cases, grazing may be beneficial to these species in dense productive grasslands by opening the herbaceous layer and creating some open ground. Grazing would have greater negative effects in the sparser desert grasslands where productivity is lower and grass cover and seed production are more easily eliminated.

Burrowing rodents in Southwestern grasslands can be impacted by high stocking densities that not only eliminate grasses and forbs but also compact soils and trample burrow systems. This is particularly true of the kangaroo rats (in grasslands, the Ord's and banner-tailed kangaroo rats). As granivores, these rodents are also impacted by reductions in grasses and the seeds they provide, and they also respond negatively over time to high levels of shrub encroachment into grasslands (Fagerstone and Ramey 1996; Krogh and others 2002). Kangaroo rats construct elaborate burrow systems that create above-surface mounds that are susceptible to trampling; furthermore, these mounds may make them subject to eradication efforts by land managers who perceive the mounds as a threat to livestock (GP 2001e). Such impacts extend beyond these species because the burrow systems are important features of the surrounding landscape for a wide variety of arid grassland species (Hawkins and Nicoletto 1992). Soils must be friable and allow extensive burrowing; thus high stocking

densities that concentrate cattle and result in high levels of soil compaction can make soil habitats unsuitable for these species. Kangaroo rats utilize fine-textured sandy soils (Ord's) to clay/gravel soils (banner-tailed) for burrow construction. Other grassland burrowing mammals such as the yellow-faced pocket gopher utilize deep, sandy or silty soils (Davidow-Henry and others 1989; MacMahon 1999). Pocket gophers in general depend upon air diffusion through soils, so their tunnels do best in light-textured porous soils (Fagerstone and Ramey 1996).

Perhaps the most well-known burrowing rodents that interact with livestock in the low-elevation grasslands of the Southwest are the prairie dogs. The ecological interactions here are complicated by the other species of wildlife that either depend on the prairie dog for food, or depend on their burrow systems for cover (for example, burrowing owls, as discussed earlier, and swift and kit foxes, which modify prairie dog burrows for their own use). In general, the grazing panel determined that, while prairie dogs suffer from eradication efforts on rangelands, the level of competition for forage between prairie dogs and cattle has likely been exaggerated, and that livestock and prairie dogs may even confer beneficial ecological effects on each other (GP 2001d). Prairie dogs prefer areas with short, sparse vegetation and compact soils. Studies have shown that, while prairie dogs can change the types of food plants in an area, they do not significantly decrease the amount of weight gain in cattle (for example, O'Meilia and others 1982), and the elimination of prairie dogs has had little effect on increasing the amount of food available for cattle (Collins and others 1984; Crocker-Bedford 1976; Klatt and Hein 1978; Uresk 1985—all as cited in Fagerstone and Ramey 1996). Other studies indicate that prairie dog foraging, while reducing overall forage quantity, creates high quality regrowth and produces plants with greater palatability for cattle (for example, Coppock and others 1983; Krueger 1986; O'Meilia and others 1982; Whicker and Detling 1988); likewise, reasonable levels of domestic livestock grazing can actually increase the nutritional quality of the forage for prairie dogs (GP 2001d). Range improvements that result in a concentration of cattle can be positive if, through the trampling and grazing of taller vegetation, they create conditions that aid dispersal and expansion of prairie dog colonies (Knowles 1985, 1986 as cited in Wuerthner 1997). One irony of the eradication campaign is that the elimination of prairie dogs may have led to an increase of a number of woody plants (such as mesquite), thus exacerbating shrub encroachment into grasslands (see Weltzin and others 1997). The poisoning of prairie dogs should also be considered in regards to its impacts on nontarget species; the use of poisoned seed baits can be detrimental to a variety of granivorous rodents in grassland ecosystems (GP 2001d). Finally, a number of mammalian predators prey on prairie dogs, none as much as the endangered black-footed ferret, which relies almost entirely on prairie dogs for food (Campbell and others 1987).

Of large mammals in low-elevation grassland habitats, perhaps none are as reliant on the vegetative productivity of these communities as the pronghorn. Pronghorn inhabit large areas of open grassland and shrub-steppe and require areas with low (less than 5 percent) shrub coverage (Yoakum and others 1996). In addition, they rely on abundant forb coverage for food, along with some species of small shrubs. Livestock can impact these habitats by eliminating forb and palatable shrub coverage in the short term (mostly by sheep - GP 2001f; Howard and others 1990) and by facilitating shrub invasion (especially taller shrubs) through selective grazing over the long term. In addition, net wire and close-strand barbed wire fences can cause artificial habitat fragmentation by restricting pronghorn movement to water and forage, especially as availability of these resources becomes limited by drought or excessive livestock use (GP 1999e; Yoakum and others 1996). Other large ungulates also utilize low-elevation grassland and shrub-steppe habitats and the forage they provide (for example, desert bighorn sheep) but are generally not as reliant on these as is the pronghorn. Interactions among livestock and their large ungulate competitors are discussed more fully below.

Mammals - Desert Scrub Habitats—Several mammals require a significant shrub component in desert grasslands or desert scrub. As discussed for birds, potential negative effects come from high densities of livestock that degrade the shrub or cactus components and management activities that clear away shrubs and cactus in order to create grassland habitats; increases in shrubs facilitated by grazing on herbaceous vegetation will often benefit these mammals.

Among small mammals, some may be considered grassland species that also require a low density of shrubs or trees. For example, the southern plains woodrat occupies well-developed desert grasslands and is expected to respond negatively to increases in the densities of shrubs. However, it occupies grassland with cactus or yucca, as well as savannahs with mesquite or shinnery oak; in addition, the joints of *Opuntia* cacti are a preferred food resource (Braun and Mares 1989; GP 2001d). Such a "transitional" species between grassland and scrubland could be negatively impacted by grazing-facilitated shrub encroachment, but also by clearing efforts to create pure grassland for livestock.

The preference for shrub habitats is stronger in other rodent species. The chisel-toothed kangaroo rat, in contrast to the Ord's and banner-tailed kangaroo rats discussed above, needs good shrub cover and is especially affected by browsing or trampling of saltbush (Larrison and Johnson 1973). The Arizona and desert woodrats are often tied to rocky areas, but also rely heavily on desert scrub as a food source and for cover (Smith 1995a,b). Golden-mantled ground squirrels can benefit from grazing in arid grasslands when the grazing results in increased shrub cover and reductions in the height of the herbaceous layer, but the squirrels are negatively impacted by shrub removal. The mesquite mouse is a denizen of xeroriparian thickets of mesquite, a habitat that is now considered localized and fragmented to some degree because of clearing as part of range improvement activities (AGFD 1996; Armstrong 1999). Large mammals such as peccaries and the desert subspecies of the mule deer also prefer areas where thick, tall shrubs with thickets of cacti provide cover, food, and moisture (GP 2001f).

Agaves, saguaro cacti, and other flowering plants also provide important food resources for nectar feeding bats. The endangered Mexican long-nosed and southern long-nosed bats, as well as the Mexican long-tongued bat, feed not only on the nectar of agaves and cacti, but also on jimson weed, wax mallow, and mescal. They also rely on the cacti for fruits and on other desert vegetation to support an insect prey base to supplement their nectar diet (Hensley and Wilkins 1988; Hoffmeister 1986).

As discussed above for birds, many Sonoran Desert habitats can also be impacted by the spread of exotic grasses, which increases fire frequencies to unnatural levels. Another effect of the invasion by exotic grasses may be to reduce the availability of preferred seeds for granivorous species. The seeds of red bromes and African lovegrasses are smaller and of lower nutritional quality than those of native grasses. Thus when the latter are replaced by exotic species introduced for livestock forage, food resources for granivores may be reduced (GP 1999e, 2001e).

Mammals - Woodland and Boreal Habitats—Within many woodland habitats, many small mammal species still depend mostly on the grass and forb understories for cover and food and thus are affected by impacts to these resources just as in grasslands and scrublands. This is particularly true in savannahlike ecosystems such as pinyon-juniper woodlands, but there are many species that also rely on grass understory in ponderosa pine forests as well as meadows between stands of mixed conifer or spruce-fir. Still other species require "old growth" conditions of open ponderosa pine forests or dense-canopy mixed conifer or spruce-fir forests, and thus could be potentially impacted by grazing regimes that, over the long term, help create conditions that are at increased risk of catastrophic fires.

Species such as the desert woodrat and fulvous harvest mouse are often found in pinyon-juniper woodlands but usually occupy rocky areas containing grasses and shrubs interspersed among the trees. Likewise, the yellow-nosed cotton-rat occurs in oak/pinyon/juniper woodlands but is more tied to the bunchgrasses and other groundcover (although not as reliant on mesic, dense grassy conditions as are the other cotton rats). Cliff chipmunks mostly occupy rocky outcrops and cliffs within these vegetative habitats, but consume the seeds and berries of pinyons, junipers, and other trees. Thus, grazing regimes that lead to increases in berry-producing trees and shrubs can benefit cliff chipmunks and other species, but large-scale clearing of shrubs and trees would eliminate suitable habitat. Perhaps the most affected by such action would be the Stephen's woodrat, a specialist of juniper woodlands. While it is often associated with rocky outcrops and rock piles at the base of cliffs, its diet is almost completely composed of juniper berries and leaves (Fitzgerald and others 1994; Hoffmeister 1986).

Much of the discussion of grazing impacts in ponderosa pine woodlands centers on the long-term effects of fire suppression leading to the growth of dog-hair thickets, which are at a greater risk of catastrophic fire (see discussion above under Birds and in Milchunas, in press). These effects on forest structure can also impact species such as the spotted and Allen's big-eared bats, which navigate through open ponderosa pine stands and forage in open grassy areas, both of which can be degraded by an increase in the density of small diameter trees. However, the removal of the grassy understory, one of the agents in the ecological interactions leading to dog-hair thickets, can have a more immediate impact on the small mammal species that use this habitat. The Mogollon vole in particular relies on grassy groundcover in ponderosa pine and other coniferous forests, especially when pushed out of more mesic habitats through competitive exclusion by other voles such as the montane vole (Findley and others 1975; Frey 1999). It will not use grassy areas that are below a threshold necessary for cover and building the runways that are characteristic of voles (GP 2001g). For other species, such as the gray-footed and gray-collared chipmunks, the berry and seed-producing shrubs and small trees used for food and cover are the important habitat component, and are likely to be severely impacted only at high densities of livestock consistently occupying the forest understory.

Transitioning into mixed conifer and spruce-fir forests are species such as the bushy-tailed woodrat and least chipmunk, both of which use berry and seed-producing shrubs for food and cover in high-elevation forests. Rocky outcrops interspersed within these forest types are also important to these and other species. While cattle may not venture into these areas, the grass and shrub cover may be subject to browsing by domestic goats or wild ungulates such as bighorn sheep, elk, or deer. It should also be noted, however, that these small mammals may benefit from increased seed production of some shrubs and trees under certain grazing regimes. Other species such as the southern red-backed vole rely on mesic forest floor conditions in spruce/fir/aspen forests, along with woody debris and logs. High livestock use and trampling in these forests could result in degradation of this cover, as well as churning up the forest floor, drying it out, and making it unsuitable for this and other voles reliant on mesic forest floor conditions. One species that is considered a specialist of these forests is the red squirrel, an inhabitant of mixed conifer, Douglas-fir, and Englemann spruce-corkbark/subalpine fir habitats (Findley and others 1975). Red squirrels require damp, shady, cool environments to construct pine cone storage middens, as well as dense understory canopy and groundcover (Hoffmeister 1986; Young 1999), thus making it vulnerable to ungulate densities that result in an opening of the understory, reduction in foliage volume, and/or the reduction or desiccation of groundcover.

In the high-elevation regions of northern New Mexico, a few small mammals occur near or above timberline that may be impacted, if not by domestic livestock such as goats, then by wild ungulate usage. Excessive grazing and browsing in spruce-fir and boreal forest can lead to a reduction in cover and/or a loss of desired forage species for snowshoe hares, which could be subject to competition with domestic and wild ungulates for grasses, forbs, and browse. Marmots also occur from spruce-fir forests to above the timberline but are typically found

among boulders and rock fields. However, they require abundant lush vegetation prior to entering winter torpor as well as after coming out in spring, and can be vulnerable to starvation if such vegetation is not available. Likewise, the pika is a denizen of talus slides and boulders above timberline and relies on subalpine grassland and tundra grassland vegetation. We lack information on the effects of grazing in these areas, but depletion of the food resources here would likely be detrimental to this species (GP 2001d).

Mammals - Riparian and Wet Meadow Habitats—As with birds, a number of mammals also rely on the vegetation structure and/or mesic environments of riparian habitats. In addition, there are several species, particularly among the voles and shrews, that chiefly utilize or even specialize on high-elevation wet meadows. These habitats are characterized by muddy or even marshy or boggy soil substrates, lush herbaceous vegetation, and typically little if any shrub cover. As discussed above for birds, the various wetland habitats are particularly vulnerable in the Southwest because of their rarity and isolation within the larger arid landscapes of the region.

Among Southwestern riparian habitats, numerous species utilize the shrubby understory for cover and food, but some species are also strongly associated with the large deciduous trees typical of cottonwood or sycamore riparian forests. Both the Arizona gray squirrel and the Chiricahua subspecies of the Mexican fox squirrel are strongly associated with riparian woodland within various coniferous forests systems and thus could be impacted by ungulate browsing that removes deciduous tree seedlings, leading to a lack of recruitment of these trees. Oaks are also important to these squirrels and must be able to grow and mature into the mast-producing stage. Adjacent to ponderosa pine forests, the issue of increased fire risk becomes important, as fire within riparian woodlands is typically catastrophic.

Tall, dense grass in cottonwood/willow associations can be important for some rodents such as the Arizona cotton-rat, which needs heavy grass cover to construct the "runways" characteristic of all cotton-rats. Pine-oak and desert riparian areas with a dense understory of brush is important to species such as the hooded skunk, and elsewhere at low elevations this habitat is utilized by other small mammals such as the llano (plains) subspecies of the eastern cottontail. Riparian scrub at higher elevations often provides food and cover for other species of cottontail, but also for chipmunks such as the gray-footed and gray-collared chipmunks. Species such as the western jumping mouse inhabit alder-willow-aspen riparian vegetation with a dense cover of grasses and forbs. In all these cases, heavy grazing or browsing in conjunction with prolonged occupation by large numbers of ungulates can result in the removal of both the shrub understory and the herbaceous cover needed by these species.

Other species require wetland habitats with permanent water and abundant emergent vegetation. As mentioned earlier, such wetlands are generally incompatible with livestock use; in addition, the water sources can be subject to depletion or pollution. Representative species include the least shrew, the muskrat, and the New Mexico meadow jumping mouse, all of which require moist, dense grassy areas with emergent vegetation (spikerush, sedges, rushes, cattails) near marshes, ponds, or riparian areas. The muskrat in particular is an aquatic specialist, occupying all water habitats with sufficient vegetation (Willner and others 1980). The northern river otter, rare to extirpated in the Southwest, requires permanent water with similar vegetation as described above, and it is particularly sensitive to pollution or increased sedimentation (Ceballos 1999). In addition to these species, the mink is an obligate riparian specialist that formerly occupied the streams and rivers of northern New Mexico (Bailey 1932); in addition to the vegetation, it also requires abundant aquatic prey (for example, muskrats and crayfish; see discussion of predator and prey issues below).

No discussion of mammals and riparian habitats is complete without including the American beaver. An inhabitant of riparian wetlands with abundant willow and other woody vegetation for browsing, the beaver is renowned for its system of lodges and dams that alter the hydrology of stream systems and create ponds of standing water. The resulting herbaceous and woody vegetation at the shoreline and abundant water supplies create wetland habitat for a number of bird and mammal species. Willow and aspen are favorite food items for beaver that can be reduced through competition for food resources with large densities of ungulates, particularly elk (Zeigenfuss and others 2002). Continuous water flow and good water quality are additional habitat requirements that can be impacted by the presence of large numbers of livestock or by range improvements meant to increase livestock access to water. Beaver dams can be targeted by people wishing to eliminate ponds and increase areas of vegetation for livestock, but the presence of beaver can also potentially improve conditions for livestock through raising water tables, stabilizing water regimes, and promoting riparian forage (GP 2001d; Olson and Hubert 1994). In the Southwest, beaver ponds have proven to be important sources of water for agricultural uses during droughts (Albert 1999).

Wetland areas and wet meadows support a variety of species of voles and shrews that rely on the mesic conditions and dense herbaceous vegetation provided by these habitats. As stated above, these areas are characterized by saturated soils, bogs, or marshes, with a grass/sedge community that is frequently thick and dense. Most are high elevation, montane habitats, but some of the species mentioned occupy these types of habitats at all elevations. The montane vole is perhaps the vole most associated with these conditions within coniferous forest zones, which also support the meadow vole (also found at lower elevations) and the Mogollon vole (also found in drier grassy areas). Long-tailed voles are also found in these habitats in concert with shrubby riparian areas. Among the shrews, the cinereus (or masked) shrew inhabits boggy or marshy fields as well as willow thickets and (relatively) drier forest thickets; this is also true of the montane and New Mexico shrews. Many of these shrews also require abundant groundcover in the form of logs or woody debris in addition to a generally moist

environment. The most aquatic is the aptly named water shrew, which requires running water at high elevations, undercut streambanks, and luxuriant grass cover, and feeds on aquatic insects (Beneski and Stinson 1987).

Numerous populations of microtine voles in the Western United States may be near extinction because the highly limited moist habitat on which they depend is also attractive to people and livestock (Nowak 1999), and grazing can negatively impact wetland habitat in a variety of ways. Alteration of vegetation structure and composition can affect the quality of habitat available. For example, montane voles require a thick cover of grass or forbs, and livestock grazing causes strong decreases in montane vole numbers, in some cases even the local disappearance of the species (Fagerstone and Ramey 1996; Kauffman and others 1982; Medin and Clary 1989). Birney and others (1976) suggest that a threshold level of grass cover is necessary for meadow voles to reach peak population densities. Hence, grazing activities that suppress vegetative cover below the threshold may restrict populations. In addition to removal of cover by grazing, wet vegetated meadows and spring seeps are highly fragile and susceptible to trampling that causes soil surface distortion ("plowing" of the surface by hooves) and degradation of cover, both of which would render this habitat unsuitable for many voles and shrews. High ungulate densities and soil compaction can also stop seeps and springs from flowing and eliminate required habitat. These effects can be exacerbated by periodic cycles of excessively dry climatic conditions experienced in the Southwest (GP 2001g,h).

Mammals - Large Herbivore Interactions—Livestock will have the greatest ecological interactions and competitive effects with similarly sized herbivorous mammals, particularly those species that are most closely related to the livestock (for example, bighorn and domestic sheep). Deer, elk, bighorn sheep, and pronghorn can all come into conflict with livestock for palatable vegetation, and in some cases the transmission of disease can be an issue. For many of these species of wild ungulates (especially elk), the panelists considered them as a priority when selecting grazing strategies because land managers must consider the effect of both the wild ungulates on habitat as well as the effects of the domestic grazers upon the wild ungulates (GP 2001i).

The effect of grazing on mule deer is much debated. These effects are probably quite variable depending on habitat type, vegetation structure and composition, and the intensity and duration of grazing. Grazing is generally detrimental in arid and semiarid habitats and less detrimental in chaparral and other more mesic habitats, with the exception of mountain meadows where competition can be severe (GP 1999e). Vegetation changes may influence mule deer survival and recruitment. Several studies suggest a correlation between grazing intensity and local fawn survival. In addition, grazing that reduces succulent vegetation during fawning and early lactation could potentially reduce fawn survival (GP 2001i). Grazing as well as fire and other vegetation disturbances that promote shrub seral stages may be of benefit to mule deer (GP 1999e; Julander 1955, 1962). However, vegetation disturbances that decrease shrubs and herbaceous plants or fail to maintain a young and vigorous seral stage will be detrimental (Julander 1955, 1962).

Many of these same issues apply to white-tailed deer: heavy grazing has the potential to decrease residual groundcover, important for hiding fawns, and reduce forbs for forage. Additionally, brush management practices used to increase herbaceous vegetation for livestock may reduce preferred browse species and reduce or eliminate escape cover. Grazing systems that increase availability of browse and improve nutritional quality of forage may be of benefit, and enhanced water availability associated with stock operations may improve suitability of habitat (GP 1999e, 2001i). Recent dietary information indicates a potential overlap of diet between elk and Texas white-tailed deer (*Odocoileus virginianus texana*), where both species occur (Tafoya and others 2001). Therefore, where multiple species of native ungulates occur, management practices should take grazing by these natives into account, as well as grazing by domestic livestock, when creating grazing management plans (GP 2001i).

The effect of livestock grazing on elk has not been well documented, and there are differing reports on the effects of grazing on elk (GP 2001i). In areas of heavy livestock grazing the effect on elk can be negative because of competition for forage, inappropriate changes in vegetation structure and composition, and changes in fire regime leading to the loss of adequate forage and cover areas (GP 1999e). Competition—defined as an interaction through which both species suffer reduced survival or lower reproductive success (Wagner 1983)—has not been documented between elk and cattle (Edge and Marcum 1990). Potential conflicts between elk and cattle focus on dietary overlap, common use of space, and social incompatibility (Edge and Marcum 1990). Competition can occur only if elk and livestock are using the same area, forage species are in short supply, or elk and livestock are using the same forage species (Holechek 1980). Other authors report that elk use appears to be inversely related to cattle use (Nelson 1982); in other words, less cattle use equals more elk use.

Under certain management regimes and stocking levels, grazing may have a positive influence on elk in Arizona and New Mexico. Elk have increased in distribution and numbers due to the conversion of dense forests to earlier successional stages through moderate livestock grazing, reductions in overstory vegetation, seeding projects to increase herbaceous vegetation, and water developments (GP 1999e).

Disease transmission from livestock (primarily domestic sheep) to bighorn sheep is the primary detrimental impact to this species from livestock grazing and ranching. Domestic livestock diseases infect bighorn sheep and are known or strongly suspected to cause significant mortality, including extinction of local populations (Dunn 1996 and authors cited therein; Foreyt and Jessup 1982). Competition for forage and alteration of vegetation structure and composition are also important negative effects from livestock grazing, and in the case of cattle these are more important impacts than disease

transmission (Krausman and others 1996). Pronghorn in shrub-steppe are discussed above under Low-Elevation Grassland Habitats, but they too can interact with livestock via transmission of disease organisms: cattle may act as a reservoir for bluetongue, a disease highly fatal to pronghorn (Yoakum and others 1996).

In addition to large ungulate herbivores, livestock can also come into competition with black bear for important food resources. Grass cover in the springtime near den sites is important for the survival of cubs, therefore any grazing intensity that results in the reduction of spring grasses will likely have a negative impact on black bear (GP 2001j). Pregnant females require much greater fat deposits going into winter hibernation than do nonreproductive females (Harlow and others 2002); thus, reproductive success in this species may be reduced if vegetative food resources are not available prior to the hibernation period. Habitat treatments that reduce oak, juniper, or other mast-producing plants would have negative effects on black bear, but any treatments that stimulate the growth of mast-producing plants could be positive (GP 2001j).

Mammals – Predator Interactions—Whereas many wildlife species are affected by grazing through direct impacts on the vegetative components of their habitat, the effects on mammalian predators are varied and complex. There are multiple indirect effects among competing predators, prey species, as well as other species not directly associated with the predator-prey interactions. Livestock themselves are often potential prey, thus inducing management activities aimed at controlling or eliminating large predators. This in turn has its own effects, not only on potential wild prey species, but also on competing predators in the larger community. Both large and small predators can also be impacted by reductions in prey, and if the prey species are also impacted by grazing effects, then the effects can be amplified up the food chain.

Among large predators, the cougar, black bear, gray wolf, and jaguar can be expected to occasionally take livestock. Contemporary attitudes toward large predators tend to be highly negative within the ranching industry, and intentional killing of these animals is probably the key factor, related to livestock management, that threatens these species. Cougar will predominantly take sheep and goats, but also cattle and horses. Black bear will take sheep, goats, and calves. Wolves can learn to prey on livestock such as sheep, goats, and cattle, and thus come into conflict with ranchers (GP 2001f). Jaguars rarely wander into the United States and are not likely to inflict many losses at this time. Research has shown that when abundant natural prey is available, jaguars tend not to menace livestock (Weber and Rabinowitz 1996).

Wolves were historically targeted by predator control operations, and the intentional killing of wolves resulted in the extirpation of this species from Arizona and New Mexico (Brown 1983; GP 1999e, 2001f). The absence of the wolf as a major predator has likely had major effects not only on the ungulate prey species but also indirectly on the vegetation used by those prey. For example, research in Yellowstone National Park indicates that wolves have an indirect positive effect on aspen regeneration by altering elk foraging behavior and browsing patterns (Ripple and others 2001). Research by Berger and others (2001) suggests that, in high-elevation riparian willow ecosystems, the lack of a top mammalian predator can allow ungulate densities to increase, leading to increased browsing on willow and in turn reduced densities of birds that use these riparian habitats. Thus, management approaches that allow wolves to interact with their natural prey species in Southwestern ecosystems should have broader positive effects on a variety of wildlife species and their habitats.

Predator-prey interactions are but one component of the ecological processes through which wolves have indirect effects on other wildlife. The other component is the competitive relationship that wolves have with other canids such as the coyote and the red fox, and the impact these relationships have on additional canids as well as small mammal prey species. In Yellowstone National Park, the presence of wolves appears to keep coyote populations in check (Arjo and Pletscher 1999). The reintroduction of wolves here has led to a decrease in coyote numbers by 50 percent along with a reduction of coyote pack size; the wolves have been killing approximately 25 to 33 percent of the coyote population each winter (Crabtree and Sheldon 1999). However, it should also be noted that these declines are not expected to continue and should reach equilibrium as coyotes respond and adapt to a competing predator with which it has co-evolved (Crabtree and Sheldon 1999; Mlot 1998). Again, given that reintroductions of the gray wolf have only recently been initiated in the Southwest, this has yet to be demonstrated in this region; if realized, it would have repercussions throughout the suite of competing canid species. The coyote is a major competitor of the red fox, and its expansion is believed to have had a negative impact on red fox distribution (GP 2001j). Coyotes are also major predators and competitors of the kit fox and swift fox (Ralls and White 1995). Thus, reductions in coyote numbers would ultimately be favorable to the fox populations in the Southwest.

Many smaller predators are not impacted as much by eradication efforts but can be affected by nonspecific trapping or poisoning and by eradication efforts aimed at prey species. Grazing or management practices that cause declines in small rodent or rabbit populations may negatively impact species such as the long-tailed weasel, kit fox, swift fox, red fox, and bobcat. Several predator species rely on small mammals that are also in this database. The red fox relies on prey such as the Nuttall's cottontail and the montane vole, among others (GP 2001j). The ermine also relies heavily on montane and meadow voles, and the mink, a riparian obligate, relies on abundant populations of muskrats as well as voles. The same holds true for some birds as well; for example, the Mogollon vole is a key prey species of the Mexican spotted owl in New Mexico (Ward 2001). Thus, management aimed at preserving these prey species must not only provide the resources necessary to sustain a minimum population size, it must also provide additional resources for larger populations in order to maintain a prey base for predatory species of concern.

Summary

This assessment of the ecological interactions among native wildlife species of the Southwest and grazing and range management practices is designed to provide an informational tool for the region's land managers and biologists. The resulting database contains 305 accounts for species and subspecies believed to be potentially vulnerable to both short-term and long-term effects of native and domestic ungulate grazing. Species were selected through a panel process that first derived an initial list of species for the database and then utilized the expertise of the panelists to review and amend individual species accounts.

The accounts are included with this publication in the form of a computer database (based on Microsoft Access) as well as individual files for either on-screen viewing or printing of hard copies (see appendix F for more details). The computer database allows the user to search for individual species by a variety of criteria, including taxonomic affiliation, designation of priority status, or by any shared selection of menu items (described above in the Species Account Guide and in appendix B). Searches can also be made for species that share certain elements of text within the text narrative blocks.

It is intended that this database be used in concert with the geospatial databases provided in Bender and others (2005). We assume that most land and range managers will usually be interested in only a specific geographic area; the geospatial database can help develop a list of species based on the database included here as well as the distribution of vegetation communities and predicted occurrence areas generated by the geospatial database. Managers can also develop a species list by searching the species account database by specific habitat type, and then referring to the individual species distribution information to winnow down the list to only those occupying the area of interest. Also, additional information on grazing impacts on the vegetative communities and vegetation components of habitats can be obtained in Milchunas (in press).

Once a list of species is generated, then additional queries can aid in determining information such as shared habitat requirements or other ecological parameters, as well as shared grazing effects, fire regime requirements, and so forth. Priority species can be isolated from others on the list, and, in cases of conflicting habitat needs or grazing effects, this can help in developing a prioritization strategy when considering conflicting needs of various species of wildlife and livestock utilization.

Finally, users should keep in mind that research will continue on wildlife and grazing interactions, and the results will undoubtedly alter some of the information contained in these accounts. In addition, many of the species in the database may prove to be tolerant of grazing, whereas others not on the list may turn out to be more vulnerable than is now realized. Therefore, it is highly recommended that users supplement this database with a thorough literature search for material published after the date of this assessment.

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Undocumented information based on the panelists' personal knowledge, experience, or inference is identified in the text and the species accounts by the citation "GP" for "Grazing Panel," followed by the year the panel was convened. For additional information on the names and affiliations of the panelists listed under the Grazing Panel citations, see appendix A.

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Appendix A—Grazing Assessment Panelists

The following is a list of the 49 participants in the grazing assessment panel process and their professional affiliations at the time of their participation. Panelists from the first stage of the process are identified using a superscript (I); second stage panelists are also identified by a superscript (II). Some individuals participated in both stages of the process (I, II). Those that participated under more than one taxonomic group are listed separately under each. Individuals with an asterisk (*) participated as "outside reviewers" (see Methods: The Panel Process - Stage II), providing reviews of species accounts by electronic or regular mail. For individual species, the specific panel members are listed at the end of each account.

Reptiles and Amphibians	
Hakkila, Mark D. [I, II]	*Bureau of Land Management, Las Cruces, NM*
Holm, Peter A. [II]	*University of Arizona, Tucson, AZ*
Holycross, Andrew T. [I, II]	*Arizona State University, Tempe, AZ*
Jennings, Randy D. [I, II]	*Western New Mexico University, Silver City, NM*
Painter, Charles W. [I, II]	*New Mexico Department of Game and Fish, Santa Fe, NM*
Persons, Trevor B. [II]	*U.S. Geological Survey, Flagstaff, AZ*
Rosen, Phillip C. [I, II]	*University of Arizona, Tucson, AZ*
Birds	
Baltosser, William H. [*]	*University of Arkansas, Little Rock, AR*
Block, William M. [I]	*U.S. Forest Service Rocky Mountain Research Station, Flagstaff, AZ*
Bock, Carl E. [I]	*University of Colorado, Boulder, CO*
Boren, Jon C. [I, *]	*New Mexico State University, Las Cruces, NM*
Cartron, Jean-Luc E. [II]	*University of New Mexico, Albuquerque, NM*
Cox, Steven W. [II]	*Private consultant, Albuquerque, NM*
Cox, Nancy S. [I, II]	*Private consultant, Albuquerque, NM*
Evans, Jules G. [*]	*Private consultant, Point Reyes Station, CA*
Gall, Sally A. [*]	*U.S. Fish and Wildife Service, Buenos Aires NWR*
Howe, William H. [II]	*U.S. Fish and Wildife Service, Albuquerque, NM*
Johnson, Kris [*]	*New Mexico Natural Heritage Program, Albuquerque, NM*
Johnson, R. Roy [I, II]	*Private consultant, Tucson, AZ*
Kingsley, Kenneth J. [I]	*Private consultant, Flagstaff, AZ*
Krueper, David J. [II]	*Bureau of Land Management, Sierra Vista, AZ*
Ligon, J. David [II]	*University of New Mexico, Albuquerque, NM*
Meyer, Raymond [II]	*Private consultant, Las Cruces, NM*
Ohmart, Robert D. [I]	*Arizona State University, Tempe, AZ*
Rustay, Christopher H. [I, II]	*Hawks Aloft and Partners-In-Flight, Albuquerque, NM*
Ruth, Janet M. [II]	*U.S. Geological Survey, Albuquerque, NM*
Sheppard, Jay M. [*]	*U.S. Fish and Wildife Service (ret), Laurel, MD*
Stacey, Peter B. [I, II]	*University of New Mexico, Albuquerque, NM*
Stoleson, Scott H. [I, II]	*U.S. Forest Service Rocky Mountain Research Station, Albuquerque, NM*
Taylor, John P. [II]	*U.S. Fish and Wildife Service, Bosque del Apache NWR*
Thompson, Bruce [I]	*U.S. Geological Survey, Las Cruces, NM*
Warrick, Gordon [II]	*U.S. Fish and Wildife Service, Bitter Lakes NWR*
Williams, Sartor O., III [I]	*New Mexico Department of Game and Fish, Santa Fe, NM*
Mammals	
Boren, Jon C. [II]	*New Mexico State University, Las Cruces, NM*
Brown, David E. [I]	*Arizona State University, Tempe, AZ*
Cook, Roseanne [I]	*Colorado State University, Ft. Collins, CO*
Cryan, Paul M. [*]	*U.S. Geological Survey, Albuquerque, NM*
Ditto, Amy [I]	*University of New Mexico, Albuquerque, NM*
Dragoo, Jerry W. [II]	*University of New Mexico, Albuquerque, NM*
Findley, James S. [II]	*University of New Mexico (ret), Albuquerque, NM*
Frey, Jennifer K. [I, II]	*Eastern New Mexico University, Portales, NM*
Hakkila, Mark D. [*]	*Bureau of Land Management, Las Cruces, NM*
Harrison, Robert L. [II]	*University of New Mexico, Albuquerque, NM*
Hayward, Bruce J. [II]	*Western New Mexico University (ret), Silver City, NM*
Howard, Volney W., Jr. [II]	*New Mexico State University (ret), Las Cruces, NM*
Kingsley, Kenneth J. [I]	*Private consultant, Flagstaff, AZ*
Koprowski, John L. [II]	*University of Arizona, Tucson, AZ*
Shaw, Harley G. [II]	*Arizona Game and Fish Department (ret), Phoenix, AZ*
Smith, Felisa A. [I, II]	*University of New Mexico, Albuquerque, NM*
Snow, Timothy K. [*]	*Arizona Game and Fish Department, Phoenix, AZ*
Parmenter, Robert R. [II]	*University of New Mexico, Albuquerque, NM*
Vahle, Bob [I, II]	*Arizona Game and Fish Department, Phoenix, AZ*

Appendix B—Species Account Template

The following is the basic template of the draft species account (see text for further descriptions and definitions). All choices are shown for each menu of ecological parameters from which the panelists made selections appropriate to the individual species. Areas where draft text would appear are indicated by (text---text---text---). Panel comment boxes were used to make additional comments or alterations to the definition of menu choices; blank boxes do not appear in the final version of an account.

Scientific Name: *Scientific name*
Common Name: Common Name
Legal Status:
- Arizona - WSCA
- BLM, AZ - Sensitive
- BLM, NM - Sensitive
- CITES - Appendix I
- CITES - Appendix II
- ESA - Endangered
- ESA - Threatened
- ESA - Warranted but Precluded
- Migratory Bird Treaty Act
- Navajo - Endangered
- Navajo - Threatened
- New Mexico -Endangered
- New Mexico - Threatened
- USFS Region 3 - Sensitive
- None

Distribution:
- Endemic to Arizona
- Endemic to Arizona and New Mexico
- Endemic to New Mexico
- Not restricted to Arizona or New Mexico
- Northern limit of distribution
- Southern limit of distribution
- Eastern limit of distribution
- Western limit of distribution
- Very local

Ecological Role:
- Commensal/mutualistic
- Granivore
- Herbivore
- Hybridization/intergradation
- Key predator
- Insectivore
- Key prey species
- Key vector
- Omnivore
- Parasitic
- Pollinator
- Primary cavity nester
- Scavenger/detritivore
- Secondary cavity nester

Status/Trends/Threats: text-----

Distribution: text-----

Key Distribution/Abundance/Management Areas: key areas

Breeding: text-----

Habitat: text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text--text-----

Landscape-Level Habitat Requirements: landscape-level requirements.

LANDSCAPE-LEVEL HABITAT REQUIREMENTS:
- Amount of edge:
- Connectivity between patches of suitable habitat:
- Patch size and distance to nearest suitable patch:
  - If isolated patch:
  - If patches connected via marginal habitat:
- Other comments:

Part of Life Cycle:
- Breeding
- Hibernation/estivation
- Migrating
- Wintering

Season of Use: text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text--text-----text-----text-----text-----text----- text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text----- text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text-----text----- text-----text-----

Season of Use:

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December

Specific Habitat Associations:

- Alpine tundra
- Boreal forest
- Mixed conifer (C)
- Mixed conifer (M)
- Ponderosa pine forest
- Madrean pine forest
- Pinyon-juniper woodland
- Madrean woodland
- Great Basin juniper-sagebrush savanna
- Interior chaparral
- Subalpine grasslands (includes *Festuca thurberi* meadow)
- Montane meadow
- Temperate grassland
- Mesquite savanna
- Great Basin sagebrush shrubsteppe
- Shinnery oak/sand sage
- Great Basin temperate desert
- Sonoran/Mojavean Desert
- Chihuahuan Desert
- Narrowleaf cottonwood
- Cold broadleaf cottonwood
- Warm broadleaf cottonwood
- Riparian scrub
- Dry washes
- Wetlands
- Developed lands
- Other

Panel comments: habitat associations

Important Habitat Functions for this Species:

- Berry production
- Escape cover
- Forage production
- Hiding cover
- Insect production
- Perches for hunting
- Perches not for hunting
- Prey production
- Reproductive cover
- Seed production
- Shade/thermal cover
- Water availability

Panel comments: important vegetation components

Important Structural Features of Habitat (By Vegetation Layer):

Trees/saguaros (height)

- Trees >10 m
- Trees 5-10 m
- Trees <5 m
- Mixed size trees
- Not important
- Unknown
- Variable

Shrub layer (height)

- Shrubs >2 m
- Shrubs 0.5-2 m
- Shrubs <0.5 m
- Not important
- Unknown
- Variable

Forb layer (height)

- Residual >1 m
- Residual 0.5-1 m
- Residual 0.25-0.5 m
- Residual 0.1-0.25 m
- Residual <0.1 m
- Not important
- Unknown
- Variable

Grass layer (height)

- Residual >1 m
- Residual 0.5-1 m
- Residual 0.25-0.5 m
- Residual 0.1-0.25 m
- Residual <0.1 m
- Not important
- Unknown
- Variable

Panel comments: vegetation height

Trees (canopy)
- Canopy cover >60%
- Canopy cover 40-59%
- Canopy cover 1-39%
- Canopy cover 0%
- Not important
- Unknown
- Variable

Shrub layer (density)
- Dense understory
- Intermediate understory
- Sparse understory
- Shrubs absent
- Not important
- Unknown
- Variable

Herbaceous layer (density)
- Dense cover
- Intermediate cover
- Sparse cover
- Bare ground
- Not important
- Unknown
- Variable

Panel comments: canopy cover and vegetation density

Trees/saguaros (distribution)
- Scattered
- Clumps
- Even
- Not important
- Unknown
- Variable

Shrub (distribution)
- Scattered
- Clumps
- Even
- Not important
- Unknown
- Variable

Grass/forbs (distribution)
- Clumps
- Even
- Not important
- Unknown
- Variable

Panel comments: vegetation distribution

Trees/saguaros (age)
- Old growth
- Mixed age stand
- Mature
- Sapling/pole
- Young (seedling)
- Not important
- Unknown
- Variable

Elevation
- High >7,000 ft
- Low <7,000 ft
- All elevations

Panel comments: age and elevation

Other Important Habitat Features:

Body of water
- Acequias/ditches
- Backwaters
- Livestock tanks
- Ponds/lakes
- Pools, deep
- Pools, shallow
- Riffles
- Seeps/saturated soil
- Springs
- Streams and rivers
- Surface water
- Tinajas
- Not important
- Unknown
- Variable

Soil substrate/ground features
- Bare ground
- Bedrock
- Brush/debris piles
- Burrows
- Clay
- Crevices
- Leaf litter
- Loam
- Mud
- Pebbles/gravel
- Rocks/boulders
- Sand
- Soil for burrowing
- Not important
- Unknown
- Variable

Topography
- Arroyos
- Bajadas
- Canyon bottoms, broad
- Canyon bottoms, narrow
- Canyon slopes, gentle
- Canyon slopes, steep
- Caves
- Cliffs
- Flats
- Floodplains
- Rolling hills
- Sand dunes
- Talus
- Not important
- Unknown
- Variable

Tree-related features
- Logs
- Loose bark
- Snags
- Tree cavities
- Not important
- Unknown

Human structures
- Bridges
- Buildings
- Fences
- Mines
- Utility poles
- Not important
- Unknown
- Variable

Panel comments: other habitat features

Diet: text-----

Diet Items:

- Acorns
- Amphibians
- Aquatic invertebrates
- Aquatic vegetation
- Arthropods
- Bird eggs
- Birds
- Browse (tree and shrub)
- Butterflies/moths
- Carrion
- Crops, agricultural
- Dung
- Earthworms
- Fish
- Flowers
- Forbs
- Fruits (fleshy)
- Fungi
- Grass
- Herp eggs
- Insect larvae
- Insects
- Invertebrates
- Livestock
- Mammals
- Nectar/pollen
- Pine nuts
- Reptiles
- Rodents/rabbits
- Roots
- Sap
- Seeds
- Trash/garbage
- Vertebrates
- Wild ungulates

Grazing Effects: text-----

LIMITING HABITAT COMPONENT RELATIVE TO GRAZING: limiting habitat component

Is this species a priority for selecting a grazing strategy?

Throughout the species' distribution in New Mexico and Arizona

YES NO UNKNOWN

In key management area(s)

YES NO UNKNOWN

Possible Grazing Impact Mechanisms:

- Alteration of soil structure
- Alteration of water regimes
- Altered fire regime
- Altered vegetation composition
- Altered vegetation structure
- Change in prey/food availability
- Change in water quality
- Competition for forage
- Cowbird parasitism
- Habitat fragmentation
- Increased predation
- Intentional killing
- Killing burrowing rodents
- Other biotic factors
- Parasites or pathogens
- Population genetic structure loss
- Range improvements
- Trampling, scratching

Panel comments: grazing impact mechanisms

Fire Regime Requirements: text-----

Is fire regime critically important for this species?

YES NO UNKNOWN

If YES:

Frequency

- High (1-10-year interval)
- Intermediate (11-100-year interval)
- Low (>100-year interval)
- None
- Unknown

Intensity

- High (stand replacing)
- Medium (affects shrubs)
- Low (surface fire)
- None
- Unknown

Timing

- Spring
- Summer
- Fall
- Winter
- Never
- Unknown

References:

references

references

references

references

Authors/Panelists:

- **Draft:** draft author(s)
- **GP 1999:** panelists' names
- **GP 2001:** panelists' names
- **Revision:** revision author(s)

Appendix C—Annotated Bibliography of Major Information Sources

This list contains those resources that were repeatedly used during the development of the species accounts and that are believed to be some of the most useful sources of information for individuals wishing to obtain further details on the species of interest.

Grazing

Jemison, R.; Raish, C., eds. 2000. **Livestock Management in the American Southwest: Ecology, Society, and Economics**. Amsterdam: Elsevier Science.

This publication by scientists with the U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station (Albuquerque), and their scientific colleagues not only examines livestock interactions with specific ecosystems (for example, range grasslands, riparian areas, and so forth), but also provides chapters on land use history, grazing systems, and the economic, social, and cultural aspects of the ranching industry in the Southwest.

Krausman, P. R., ed. 1996. **Rangeland wildlife**. Denver, CO: Society for Range Management.

This compilation by the Society for Range Management presents information on the major vertebrate species in the Western United States and their interactions with livestock. Presented from a management perspective, the document contains chapters on a variety of taxa by experts on those species, as well as information pertaining to management issues (manipulation of plants, prescribed fire, range improvements, diseases, and so forth) and a section on political and economic issues.

Herpetofauna

Degenhardt, W. G.; Painter, C. W.; Price, A. H. 1996. **Amphibians and reptiles of New Mexico**. Albuquerque: University of New Mexico Press.

A thorough and authoritative compilation of the herpetofauna of New Mexico, including information on basic biology, ecology, distribution, and natural history. Distribution maps and color photographs are included; many of these species also are known to occur in Arizona.

Birds

Arizona Game and Fish Department (AGFD). 1988. **Threatened native wildlife in Arizona**. Publication. Phoenix, AZ: Arizona Game and Fish Department.

This publication was the last list of species officially approved by the Arizona Game and Fish Commission for legal designation. This publication breaks down the species into categories of endangered, threatened, or candidate species, but action by the commission since then has eliminated these categories in favor of a single designation WSCA, or Wildlife of Special Concern in Arizona (Schwarz, personal communication).

Bent, A. C. (Various years). **Life histories of North American [birds]. Bulletin [various]**. Washington, DC: U.S. National Museum.

These bulletins form a classic collection of detailed species accounts written or edited by Arthur C. Bent. Compiled primarily in the mid 20th century, these bulletins present detailed descriptions of the various species' ecology and natural history. While superceded in many instances by information published in "Birds of North America" (see below), these bulletins remain the primary source for many aspects of basic biology and ecology. As with other historical sources listed here, they also provide a window into habitat conditions present at an earlier time.

Hubbard, J. P. 1978. **Revised check-list of the birds of New Mexico**. Publication No. 6. Albuquerque, NM: New Mexico Ornithological Society.

A review of all species known to occur in New Mexico, with notes on distribution, specimen records, seasonal occurrence, and habitat affiliations. Users should contact the New Mexico Ornithological Society for further updates or revisions of this publication.

Monson, G.; Phillips, A. R. 1981. **Annotated checklist of the birds of Arizona, second edition**. Tucson, AZ: University of Arizona Press.

An update to the more detailed accounts of Phillips and others (1964) (see below), this publication contains a review of all species known to occur in Arizona, with notes on distribution, seasonal occurrence, and habitat affiliations.

Phillips, A.; Marshall, J.; Monson, G. 1964. **The birds of Arizona**. Tucson, AZ: University of Arizona Press.

A collection of thorough accounts of all birds known to occur in Arizona. Although somewhat dated, this publication presents an authoritative review of the distribution, specimen records, seasonal occurrence, and habitat affiliations of these species.

Poole, A.; Gill, F., eds. (Various years). **The birds of North America**. Philadelphia, PA: The Birds of North America, Inc. (Species list available on-line at: www.birdsofna.org).

An ambitious project started by the American Ornithologists' Union and the American Museum of Natural History in Philadelphia to create the most detailed species accounts available of all birds known to occur in North America and the Hawaiian islands. Carried by most university libraries, these accounts are considered to be the most complete compilation of all research and information available for each species covered, and they should be the starting point for anyone looking to compile additional information on individual species.

Sauer, J. R.; Hines, J. E.; Fallon, J. 2001. **The North American Breeding Bird Survey, results and analysis 1966-2000 (version 2001.2)** [Online]. Laurel, MD: U.S. Department of Interior, Geological Survey, Patuxent Wildlife Research Center. Available: http://www.mbr-pwrc.usgs.gov/bbs/bbs00.html [2003, August 12].

This Web site provides complete documentation and opportunities for analysis of Breeding Bird Survey information across all areas covered and for all years of its operation, down to the level of individual survey routes. The site also contains complete information regarding data collection protocols and the assumptions and cautions involved in the different statistical analyses.

Mammals

American Society of Mammalogists. Various years. **Mammalian Species Accounts**. [Online]. Available: www.science.smith.edu/departments/Biology/VHAYSSEN/msi/ (2003 November 20).

Another ambitious species account project analogous to the Birds of North America, but designed to eventually cover all species of mammals throughout the world. Detailed accounts have been written for many North American species, and most can be downloaded at the above Web address. Because of the global nature of this project, not all North American species have had accounts published.

Bailey, V. 1932. **Mammals of New Mexico**. North American Fauna No. 53. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey.

A classic collection of detailed species accounts from early 20th century New Mexico. As with the Bent series on birds (see above), much of this information may be dated, but the basic biology is sound and it gives insight into ecological conditions from almost a century ago.

Findley, J. S.; Harris, A. H.; Wilson, D. E.; Jones, C. 1975. **Mammals of New Mexico**. Albuquerque, NM: University of New Mexico Press.

An authoritative account of the all the various mammals known to occur in New Mexico. Includes detailed information on taxonomy, distribution, specimen records, ecology, and life history.

Hoffmeister, D. F. 1986. **Mammals of Arizona**. Tucson, AZ: University of Arizona Press.

An authoritative account of the all the various mammals known to occur in Arizona. Includes detailed information on taxonomy and species identification, but also distribution, ecology, and life history.

Demarais, S.; Krausman, P. R.; eds. 2000. **Ecology and management of large mammals in North America**. Upper Saddle River, NJ: Prentice-Hall Inc.

An extensive textbook on large mammal management, with thorough coverage of issues pertaining to many species in this database including elk, deer, bear, predatory cats, wild sheep, and more. Chapters are written by research scientists and are thoroughly researched and documented by references from the latest scientific literature.

Internet Web Sites

Arizona Game and Fish Department (AGFD). (2004, September 2—last update). Arizona Game and Fish [Homepage of Arizona Game and Fish Department], [Online]. Available: http://www.gf.state.az.us/ [2004, September 6].

Online resources for species information and state regulations.

New Mexico Department of Game and Fish (NMDGF). (2004, August 19—last update). New Mexico Wildlife [Homepage of New Mexico Department of Game and Fish], [Online]. Available: http://www.wildlife.state.nm.us/ [2004, September 6].

Online resources for species information and State regulations. Particularly useful are downloadable copies of the biennial reviews of threatened and endangered species of New Mexico.

Appendix D—Species Removed by Stage II Panels

This annotated list documents the species that were selected for inclusion by the Stage I panel process, but then subsequently removed after further consideration in Stage II. Readers should keep in mind that the Stage II panels were frequently staffed by different panelists, especially among the major vertebrate taxa (herpetofauna, birds, and mammals). The panelists may have determined that grazing more frequently benefits a species, or that the negative impact on a species is insignificant or unlikely to occur. It is important to recognize that the decision to remove a species was not necessarily a unanimous one; nor does it indicate an unequivocal conclusion on the part of those who agreed to remove it. In fact, the publication of this appendix was often a critical factor for the panelists when deciding to remove a species. Panelists considered probability as well as possibility within the larger goal of focusing on the species with the greatest likelihood of being negatively impacted. Thus, each decision represents a general consensus of the panel within these guidelines, and users should not conclude that these species cannot be or are never affected negatively by grazing or range management practices. We recommend that all users review this list and the annotated information to determine if any conditions that can lead to negative impacts are likely to occur.

The descriptions below present information on the geographic range and ecology of each species, with some discussion of potential grazing impacts (or lack thereof). Species are organized into three groups (Herpetofauna, Birds, and Mammals), and are then listed in taxonomical order as determined by the respective authorities (for example, AOU 1998 for birds).

Herpetofauna

Gilbert's Skink (*Eumeces gilberti*): The database includes one subspecies of *E. gilberti*, the Arizona skink (*E. g. arizonensis*). The other subspecies are almost all endemic to California, with some populations of the western red-tailed skink (*E. g. rubricaudatus*) occurring in southern Nevada and northern Baja California, Mexico. Gilbert's skink (as a species) was rejected to restrict the database to the one subspecies from Arizona.

Desert Grassland Whiptail (*Cnemidophorus uniparens*): A Chihuahuan Desert species of southeastern Arizona and southwestern New Mexico, up into the central Rio Grande valley. It is common in desert grassland habitats, as well as grasslands that have been degraded, thus allowing the expansion of shrubs (Degenhardt and others1996). Other species of *Cnemidophorus* included in this database generally require well-developed grassland habitat, and any degradation of grasslands, especially leading to shrub encroachment, will benefit the desert grassland whiptail in competitive interactions (GP 1999a, 2000a). It is believed that overgrazing and increased desertification of grasslands and riparian areas has actually contributed to the expansion of this species' range in New Mexico (Degenhardt and others1996).

Birds

Little Blue Heron (*Egretta caerulea*): In the United States, this species occupies breeding grounds primarily in the Southeast (AOU 1998); it summers irregularly in New Mexico (Hubbard 1978). Its occurrence here is not considered to be significant enough to be affected by grazing or range management practices (GP 2001k).

California Condor (*Gymnogyps californicus*): As of August 2002, this endangered species numbered 206 birds in four subpopulations: 113 in captivity (in Los Angeles, CA; San Diego, CA; Boise, ID; soon to include Oregon) and the rest in reintroduced wild populations in California (50), Arizona (37), and Baja California, Mexico (6) (Ralls and Ballou 2004). The California condor once occupied a range extending from Canada south through the Western United States to Baja California, and fossils have been recovered as far east as New York and Florida (Snyder and Rea 1998; Terres 1996). Birds released in Arizona are currently located north of the Grand Canyon (Snyder and Rea 1998). The Grazing Panel (2001a) determined that condors experience both positive and negative impacts resulting from the presence of grazing operations. However, while ultimately deciding to remove this species, the panel also felt that it is important to address the role of grazing management and the grazing industry in the protection and perpetuation of the species. Condors in the wild, as scavengers of dead carcasses, are attracted to cattle as a potential source of food (Snyder and Rea 1998); a positive effect could result from the presence of cattle in its range, assuming that dead cattle are not removed from the range. However, fencing, poisoning for coyotes (resulting in poisoned carrion), and incidental shooting all have the potential for negative impacts (with the understanding that these activities can occur even without grazing).

Canada Goose (*Branta canadensis*): A common, widespread species, the Canada goose has increased tremendously over the past three decades and is one of the success stories for wildlife management (Bellrose 1980). In Arizona, the Canada goose winters commonly to abundantly in southwestern and central Arizona and along the Virgin River (Monson and Phillips 1981). In New Mexico, the Canada goose is resident locally in the northern portion of the State and southward in the Rio Grande and Pecos valleys; it migrates and winters almost Statewide (Hubbard 1978). There is no indication that grazing has negative impacts on this species; in addition, these geese are known to frequent (and even breed) in artificial water habitats in urban environments (GP 2001l).

Mallard (*Anas platyrhynchos platyrhynchos*): The mallard is probably the most recognized species of duck in the Northern Hemisphere, especially the subspecies *A. p. platyrhynchos*

because it is the most abundant (Bellrose 1980). In Arizona, the mallard is both a transient and a winter resident wherever there is open water. It breeds on high mountain lakes in the northern part of the State, as well as locally in the lower Colorado Valley, and formerly near Phoenix and elsewhere (Monson and Phillips 1981). In New Mexico, the mallard is resident in the northeast (east to Clayton, where it breeds) and from the Pecos Valley westward; it migrates and winters Statewide in suitable habitats (Hubbard 1978). Mallards breed near any type of fresh water, in a variety of habitats (Bellrose 1980). Pastures and stock tanks can be positive during migration and winter; however, reduced vegetation due to grazing can have negative impacts on this species. Reduced herbaceous cover increases the risk of predation on nesting females in the breeding season (GP 1999d). This species is common in the Southwest and widespread and abundant throughout North America; it is unlikely to be significantly impacted by grazing or range management practices conducted in the Southwest (GP 2001m).

Mexican Duck (*Anas platyrhynchos diazi*): Once considered a separate species, the Mexican duck is now considered a subspecies of the mallard by the American Ornithologists' Union (AOU 1998). Hubbard (1977) estimated that the total population in the United States to be 650 to 900; 200 to 300 for New Mexico, 150 to 200 for Arizona and 300 to 400 for Texas. In Arizona, the Mexican duck is locally resident in the southeastern portion of the State (Monson and Phillips 1981; Phillips and others 1964). In New Mexico, the Mexican duck is rare due to hybridization with the mallard (*A. p. platyrhynchos*). Hybrid forms are resident in the Southwest, south of the Mogollon Plateau, and in the lower and middle Rio Grande Valley northward to Bosque Del Apache National Wildlife Refuge (Hubbard 1978). Hubbard (1977) reported that grazing, burning, and other factors might reduce nesting cover by late spring to the point that breeding is delayed in some regions. Aldrich and Baer (1970 as cited in Bellrose 1980) reported that disturbance of the Mexican duck's habitat by people (for example, conversion of wetlands to cropland and rangeland) and livestock is so extensive that its survival is probably in jeopardy. The Grazing Panel (2001m) believed that, in the Southwest, it is unlikely to be significantly impacted by grazing or range management practices and instead is more likely to be jeopardized by continued hybridization with the mallard.

Blue-Winged Teal (*Anas discors*): The blue-winged teal is a common duck throughout the United States; however, in the West it is generally replaced by cinnamon teal (Bellrose 1980). It breeds from southern Canada down through California, New Mexico, Texas, and Louisiana with breeding densities highest in the prairie pothole region (Bellrose 1980; Johnsgard 1975). In Arizona, blue-winged teal are transients throughout the State in spring and fall, with numbers and dates variable from year to year (Monson and Phillips 1981). In New Mexico, blue-winged teal have been recorded breeding at Burford Lake and at Bosque del Apache and Bitter Lake National Wildlife Refuges. This species migrates and summers almost Statewide and is irregular in winter in the Rio Grande and Pecos valleys, casual to occasional elsewhere (Hubbard 1978). The blue-winged teal is at the southern edge of its breeding range in New Mexico and generally winters outside of the Southwest. Thus, relative to other ducks, it is less likely to be impacted by grazing or range management practices in the Southwest (GP 2001l).

Hooded Merganser (*Lophodytes cucullatus*): The hooded merganser is split into eastern and western populations that are seemingly isolated from one another (Johnsgard 1975). Hooded mergansers breed throughout the east and Pacific Northwest but most commonly in forested regions around the Great Lakes. In Western North America, they breed as far north as southeastern Alaska (Bellrose 1980). Monson and Phillips (1981) reported the hooded merganser as a winter resident in small numbers in southern Arizona, principally in the lower Colorado Valley above Parker Dam. In New Mexico, hooded mergansers migrate and winter almost Statewide, being rare to uncommon and local; unverified breeding records on the upper Pecos River are doubtful (Hubbard 1978). Due to the lack of breeding in the Southwest and its generally rare to uncommon occurrence there, it is not likely to be impacted by grazing or range management practices (GP 2001k).

Gray Hawk (*Asturina nitida*): The gray hawk is at the northern limit of its distribution in Arizona, New Mexico, and Texas (Russell and Monson 1998). In the Uunited States, the largest population of gray hawks is in Arizona, but the species appears to be increasing in numbers in Texas (Glinski 1998). In New Mexico, the gray hawk may be essentially an accidental breeder (GP 1999d). Throughout the Southwest, the gray hawk usually nests in tall cottonwood trees along permanent streams (Glinski 1998; Ligon 1961; Russell and Monson 1998). Thus, overgrazing in riparian areas may impact the recruitment of these and other large deciduous trees used for nesting.

American Kestrel (*Falco sparverius*): This is a small, common, and widespread falcon that breeds throughout the United States and Canada and occurs year-round in Arizona and New Mexico. Generally associated with open areas, they are found in a variety of habitat types (grassland, desert scrub, woodland, and forests) (Mills 1998). Heavy grazing may impact prey availability and, in riparian areas, may affect the recruitment of large trees for nest cavities (GP 1999d). However, results from various studies on the impact of grazing on kestrels have been mixed (see Saab and others1995), and the panel (GP 1999d) did not believe it to be negatively impacting the species in the Southwest.

Gambel's Quail (*Callipepla gambelii*): The center of the distribution of Gambel's quail is in Arizona and northwestern Sonora, Mexico; this distribution extends into all adjacent States. Gambel's quail is common in desert mountain foothills and wash-laced plains within several vegetative communities of the Southwest. These include the Upland subdivision of the Sonoran Desert, shrubbier and wetter portions of the Mojave Desert, scrub-invaded semidesert grassland, and open interior chaparral in southern and western Arizona (Brown 1989). Some of the best areas for Gambel's quail include scrub-infested grasslands (Brown and others 1998). It is not believed to be as sensitive to grazing as other quail species. However,

heavy livestock grazing and shrub removal could potentially impact this species' habitat requirements, which include a shrub component in grasslands as well as sufficient grasses and forbs to produce a standing seed crop (GP 1999b).

American Coot (*Fulica americana*): This species is widespread and relatively common throughout North America. In Arizona, the American coot is a common summer resident and winters throughout the State in open water, especially along the lower Colorado River (Phillips and others 1964). In New Mexico, it is resident almost Statewide and is most widespread during migration, except on the eastern plains (Hubbard 1978). While the Stage I panel (GP 1999d) recognized that this species could potentially be impacted locally by the loss of emergent vegetation used for nesting cover, the Stage II panel (GP 2001k) noted that it appears highly resilient to habitat degradation. The panel ultimately decided that it was unlikely that grazing operations in the Southwest would severly impact this species, based on its general abundance and its occurrence in degraded wetlands as well as artificial water sources.

Anna's Hummingbird (*Calypte anna*): This hummingbird breeds from southern Arizona north through California (west of the Sierra Nevada range) to British Columbia, Canada. Breeding range in Arizona spans the area south of Phoenix and continues north along the Colorado River. Summer records include southern New Mexico and west Texas (AOU 1998). In breeding sites in Arizona, this species is highly dependent on the flowering of plants in the chaparral of the Upper Sonoran zone, which occurs with the onset of winter rains (Stiles 1973). In addition, during the postbreeding movements to the east and southeast out of California, Anna's hummingbird highly depends on the blossoming of flowering plants tied to seasonal rainfalls (mid to late summer). Although the effect was not thought to be severe (GP 2000d), grazing activities could negatively impact this species if these food resources were degraded; fence lines and roadsides that encourage the growth of flowering forbs may be a benefit (GP 1999c).

Calliope Hummingbird (*Stellula calliope*): This bird breeds in montane environments of the Western United States and Southwestern Canada. It occurs in Arizona and New Mexico as a fall south-bound migrant, mimicking the "oval racetrack" pattern of the rufous hummingbird: north-bound in spring along the Pacific Coast, south-bound in fall via the Rocky Mountains (Phillips 1975). Grazing that degrades the flowering plants in high-altitude alpine and sub-alpine meadows that are utilized for food resources during this migration could potentially affect this species (GP 1999c). However, the likelihood of any severe negative impacts from grazing was thought to be low (GP 2000d).

Rufous Hummingbird (*Selasphorus rufus*): This hummingbird occurs in the Southwest almost exclusively in migration. In the spring, it may pass through southwestern Arizona along its West Coast route. In fall, it follows the Sierra Nevada and Rocky Mountains south into Mexico. Flowering plants in montane meadows and high-altitude disturbed habitats are utilized for food resources during this migratory trek (Calder 1993). Grazing in these high-altitude meadows may impact the availability of flowering plants (GP 1999b), but overall the status of this species is not likely to be impacted by grazing in the Southwest (GP 2000b).

Allen's Hummingbird (*Selasphorus sasin*): Breeds along a narrow strip of the California coast, from Ventura County into extreme southwestern Oregon (AOU 1998; Mitchell 2000). Its northward migratory path tends to track the Pacific Coast, while the southbound migration is more inland, along interior mountain ranges (Mitchell 2000); in migration it occurs east, at least casually, to southern Arizona and New Mexico (AOU 1998). Its occasional occurrence in the Southwest is not considered to be significant enough to be affected by grazing or range management practices (GP 2000d).

American Three-Toed Woodpecker (*Picoides dorsalis*): Formerly classified as *P. tridactylus* (Banks and others 2003). A resident of coniferous forests across Canada to Alaska and south into the Rocky Mountains; Arizona and New Mexico represent the southern edge of its range (Leonard 2001). Many woodpeckers and other woodland birds are listed in this database because of concern for the long-term potential of grazing in forest areas (particularly ponderosa pine) to remove grass cover that carries low-intensity fires, thus encouraging growth of dog-hair thickets of small pine trees and increasing the threat of catastrophic fire. However, the three-toed woodpecker is a specialist of recently burned-over forest and is one of the first species to invade after a forest fire (Leonard 2001), and thus it could be positively affected by these mechanisms.

Pacific-Slope Flycatcher (*Empidonax difficilis*): This species, formerly a race of the western flycatcher, breeds west of the Sierra Nevada and Cascade ranges (AOU 1998). It occurs as a migrant in the Southwest and also along the lower Colorado River as a wintering bird (Rosenberg and others 1991). Because the Pacific-slope flycatcher depends on lush riparian foraging areas while migrating, the loss of such vegetation would have a negative impact on this species (GP1999d). However, its occurrence in the Southwest is not considered to be significant enough to be affected by grazing or range management practices in the region (GP 2001k).

Dusky-Capped Flycatcher (*Myiarchus tuberculifer*): This species is at the northern limit of its distribution in Arizona and New Mexico (AOU 1998). In Arizona, the dusky-capped flycatcher occurs as a summer resident in mountain ranges from Guadadalupe Canyon in the extreme southeastern corner of the State, west to the Baboquivari Mountains and north to the Pinal and Pinaleno Mountains (Monson and Phillips 1981). In New Mexico, the species breeds in the Animas Mountains and in Guadalupe Canyon (Hubbard 1987; Zimmerman and others 1992). In the Southwestern United States, the dusky-capped flycatcher is usually found in dense hillside thickets of live oaks and shady riparian areas with large trees, especially sycamores (Bent 1942; GP 1999d; Monson and Phillips 1981; Phillips and others 1964). Because it probably does not show a preference for sycamores and/or other riparian vegetation (typically occurring farther upland), it is not as likely to be affected by grazing in this habitat as other, riparian-obligate species of birds (GP 2001k).

Tree Swallow (*Tachycineta bicolor*): Its breeding range includes much of northern and central North America from the East Coast to the West Coast, and it winters from southern California, southwestern Arizona, the Gulf of Mexico Coast, and Florida south through Mexico and Central America to Northern South America (Robertson and others 1992). Typical habitat for the tree swallow over its entire range includes open areas usually near water, with snags nearby for nesting in the summer or wooded areas for roosting during the winter. In the Southwest, tree swallows are associated with bodies of water, wetlands, agricultural fields near riparian areas, aspen stands, and wet meadows (Brown and others 1987; Ligon 1961; Robertson and others 1992; Rosenberg and others 1991). Where tree swallows nest near water, they may be negatively affected by grazing through the loss of recruitment of riparian nest trees (see Cartron and others 2000). Changes in fire regimes and browsing in montane forests may adversely impact aspen stands and thus reduce the availability of nesting habitat; however, this was not believed to be significant enough to severly impact this species (GP 1999c).

Bank Swallow (*Riparia riparia*): The bank swallow is one of the most widely distributed swallows in the world, with a Holarctic breeding distribution (Garrison 1999). In Arizona, it is a fairly common to rare migrant throughout the State (Phillips and others 1964), whereas in New Mexico, it summers locally in the north and southward through the lower Rio Grande and occasionally the lower Pecos River valleys (Hubbard 1978). The bank swallow breeds mostly in lowland areas along rivers, streams, lakes, reservoirs, and wetlands; it burrows its nest in alluvial and friable soils (mostly sandy, silty, or loamy) in vertical banks, cliffs, and bluffs (Garrison 1999). In some situations, large densities of ungulates could potentially impact breeding sites by causing erosion of streamside banks. It was ultimately decided that this factor was not likely to have a significant negative impact on this species (GP 2001k).

Barn Swallow (*Hirundo rustica*): The barn swallow is the most widely distributed swallow in the world. In the Southwest, it breeds throughout New Mexico and eastern Arizona. Overall, human activity (largely human-made structures providing nesting habitat) has had strongly positive effects on this species, and currently no human activities are considered to pose serious threats to this species (Brown and Brown 1999). Barn swallows could be locally affected by grazing if water regimes are altered enough to destroy water sources, drying up the source of mud for nesting and insects for foraging (GP 1999b). However, overall, this species appears to be increasing and is unlikely to be impacted by grazing (GP 2000b).

Verdin (*Auriparus flaviceps*): The verdin is at the northern limit of its distribution in the Southwest. It ranges from southeastern California, southern Nevada, southwestern Utah, western and southern Arizona, southern New Mexico, and Texas south to southern Baja California and central Mexico (Terres 1996). In the Southwest the verdin occupies mesquite bosques, cottonwood-willow woodlands, xeroriparian vegetation, and desert scrub (Bent 1946; Ligon 1961; Phillips and others 1964; Rosenberg and others 1991). Its general preferred habitat appears to be bosques of honey mesquite. It may also occur in areas inhabited by humans and is found, at low elevation, in salt cedar (Rosenberg and others 1991). The verdin may be negatively affected where mesquite bosques are cleared for rangeland (GP 1999d).

Cactus Wren (*Campylorhynchus brunneicapillus*): The cactus wren is a bird of Southwestern desert scrub; in the United States it is found from central Texas across central and southern New Mexico and Arizona into southern Nevada and southern California. Cactus wrens are found in areas of desert scrub that are dominated by spinescent vegetation; that is, thorny shrubs, trees, and cacti (Anderson and Anderson 1973; Woods 1948). Cholla cactus appears to be particularly reliable indicators of good cactus wren habitat (Woods 1948). Lloyd and others (1998) found that cactus wren abundance declined in an Arizona grassland as mesquite density increased, a change they attributed to the absence of cholla cacti in the areas with high densities of mesquite. Whereas the clearing of cactus and desert scrub for rangeland would negatively impact this species, it is likely that grazing has historically promoted encroachment of cholla and other shrubs into grasslands to the benefit of this species (GP 1999b, 2000b).

Winter Wren (*Troglodytes troglodytes*): The winter wren is a breeding bird of the densest northern coniferous forests, typically encountered there only in limited numbers (Bent 1948). In Arizona, this species is considered a local and rare winter resident of permanent streams in the Transition Zone and adjacent zones (Phillips and others 1964). In southern New Mexico, it can occur both in winter and migration (Hubbard 1978). Throughout the Southwest, the winter wren is rare and highly irregular, with unpredictable occurrences in both time and locality. Thus, it is unlikely to be affected by grazing or any range management practices (GP 2001k).

Veery (*Catharus fuscescens*): This bird breeds across the length of the Canada-United States border, with the exception of the far West Coast; it is an isolated breeder in Arizona and an unrecorded but suspected breeding bird of New Mexico. The veery has a strong affiliation with damp, deciduous forests, with a preference for riparian areas in many regions. Across its breeding range, the veery's habitat selection may depend on the presence of other thrushes, preferring deciduous forest but moving into coniferous and mixed forests when sharing breeding grounds (Moskoff 1995). The veery is believed to be impacted negatively by grazing due its ground-nesting habits and the loss of brush and understory in riparian woodlands (GP 1999d). However, the Southwest may be outside the southern extent of its range; it no longer breeds in the area around Springerville, AZ, and there are no documented breeding records in New Mexico. Therefore its occurrence is not considered to be significant enough to be affected by grazing or range management practices in the region (GP 2001n).

Brown Thrasher (*Toxostoma rufum*): The brown thrasher is a common species of Eastern North America, from the Rocky Mountains east to the Atlantic Coast (Terres 1996). It inhabits

shrubland/woodland and residential areas at lower elevations (Hubbard 1978). In Arizona, the brown thrasher is a rare fall and winter migrant or vagrant to the Sonoran Zones of the southeastern part of the State (Phillips and others 1964). In New Mexico, it has been recorded east of the Rio Grande Valley (Ligon 1961). This species summers occasionally and locally in the east and casually farther west, and it migrates and winters irregularly almost Statewide (Hubbard 1978). Its occurrence in the Southwest is not considered to be significant enough for the species to be affected by grazing or range management practices in this region (GP 2000f).

Bendire's Thrasher (*Toxostoma bendirei*): This species is widespread throughout the Southwestern United States and Northwestern Mexico. This bird is common in open grassland or shrubland with scattered shrubs or trees and in sagebrush habitats with scattered junipers. In southern Arizona and New Mexico, this species also breeds in degraded desert-grassland and desert scrubland with various xerophytic and microphyllous shrubs and little grass cover (England and Laudenslayer 1993). Long-term grazing effects may be positive, and this species is believed to generally respond positively to grazing (GP 2001a). In New Mexico, the range of the Bendire's thrasher may have expanded due to overgrazing, which has increased areas with scattered junipers (Darling 1970). It should be noted that in California the loss of Joshua trees and other yuccas to overgrazing has been suggested as potential threats to local populations (Remsen 1978 as cited in England and Laudenslayer 1993).

Cedar Waxwing (*Bombycilla cedrorum*): The cedar waxwing's breeding range is across the northern portion of North America, from southeastern Alaska across Canada and in the Northern United States (Terres 1996). It rarely breeds as far south as portions of New Mexico (GP 1999d). It is a migrant and an erratic winter visitor in Arizona (Phillips and others 1964), and a common migrant and winter visitor in New Mexico (GP 1999d). The cedar waxwing depends on riparian habitat, and any activity that decreases this habitat is likely to reduce population numbers, especially the loss of berry-producing shrubs and trees for foraging and nesting, and the loss of substrates for mistletoe (GP 1999d). However, this species is so widespread across North America that activities in the Southwest would likely have little if any impact (GP 2001n).

Nashville Warbler (*Vermivora ruficapilla*): A common migrant and summer resident of lower deciduous brush in the higher mountains of Arizona (Monson and Phillips 1981) and, locally, a fairly common migrant Statewide in New Mexico (Hubbard 1978). However, its breeding and wintering range is almost exclusively outside of the Southwest; thus, grazing activity in the Southwest is likely to have little if any impact on this species (GP 2001n).

Northern Parula (*Parula americana*): In Arizona, the northern parula is a rare spring, fall, and winter visitor in the southern part of the State, with several records from the Tucson area (Phillips and others 1964). In New Mexico, this species is a casual summer visitor. It migrates irregularly in the east, west to the Rio Grande Valley, and in the extreme southwest (Hubbard 1978). As an irregular, uncommon migrant, its occurrence in the Southwest is not considered to be significant enough to be affected by grazing or range management practices in the region (GP 2001n).

Yellow-Rumped Warbler (*Dendroica coronata*): The yellow-rumped warbler is generally described as abundant rangewide and is considered the most common wood warbler in Canada (Ehrlich and others 1988; Terres 1996). Ligon (1961) described it as one of the most abundant warblers in New Mexico during its breeding season. In Arizona the yellow-rumped warbler is considererd common during the nesting season, in migration, and in the winter (Monson and Phillips 1981). Several studies of grazing effects on birds indicate a mixed response of this species to grazing, but without statistical significance in any case (see Saab and others 1995). Given the widespread distribution of this species across North America, activities in the Southwest would likely have little if any impact (GP 2001n).

Townsend's Warbler (*Dendroica townsendi*): This species breeds in the Northwestern United States, north to southeastern Alaska. It is a fairly common migrant through Arizona and New Mexico, particularly at higher elevations (Hubbard 1978; Phillips and others 1964). It irregularly occurs during winter in southeastern Arizona (Monson and Phillips 1981). Townsend's warbler could potentially be affected by grazing regimes in the Southwest that degrade dense riparian midstory and understory vegetation used as stopover foraging habitat, but any effect is unlikely to be severe (GP 1999d).

Black-and-White Warbler (*Mniotilta varia*): This species occurs in the Southwest only as a rare visitor in migration, with its main migration taking place outside of the Southwest. Thus, grazing activity here is likely to have little if any impact on this species (GP 2001n).

American Redstart (*Setophaga ruticilla*): This species occurs in the Southwest only as a rare visitor in migration, with its main migration taking place outside of the Southwest. Thus, grazing activity in the region is likely to have little if any impact on this species (GP 2001n).

Ovenbird (*Seiurus aurocapilla*): This species occurs in the Southwest only as a vagrant in migration, with its main migration route east of New Mexico. Thus, grazing activity in the Southwest is likely to have little if any impact on this species (GP 2001n).

Northern Waterthrush (*Seiurus noveboracensis*): This species occurs in the Southwest as a rare to uncommon migrant, with most of its migration route east of New Mexico. Thus, grazing activity in the Southwest is likely to have little if any impact on this species (GP 2001n).

Hooded Warbler (*Wilsonia citrina*): This species occurs in the Southwest only as a rare vagrant in migration, with its main route well east of New Mexico. Thus, grazing activity in the Southwest is likely to have little if any impact on this species (GP 2001n).

Red-Faced Warbler (*Cardellina rubifrons*): The red-faced warbler reaches the northern edge of its breeding distribution in the Southwestern United States (Martin and Barber 1995).

In Arizona, this species is described as a common summer resident of montane forests (Phillips and others 1964). In New Mexico, it is considered as an uncommon to common summer resident (Hubbard 1978; Ligon 1961). It is most common in pine-fir or fir forests, often along streams or low on canyon slopes, where mesic conditions are prevalent; it is also present in pine and pine-oak forests (Ligon 1961; Martin and Barber 1995; Monson and Phillips 1981; Phillips and others 1964). Red-faced warblers nest on the ground, often on the banks of montane drainages. In this habitat, they are susceptible to trampling of nests and vegetation serving as reproductive cover. They may also be negatively affected by ungulate overgrazing leading to the loss of cool, damp, and shady conditions (GP 1999d). The Stage II panel (GP 2001n) noted that, because the red-faced warbler tends to prefer the steeper montane slopes, cattle are unlikely to impact it in these areas.

Canyon Towhee (*Pipilo fuscus*): This species is relatively common in mountain foothills and lower canyons throughout the Southwest, associated with brushlands, arid scrub, mesquite, riparian thickets, and human habitations (AOU 1998; Terres 1996). Severe overgrazing would likely be detrimental through the removal of grasses (seeds) used for food and grass and shrub cover for foraging. However, in the long-term this species may benefit from the expansion of shrubs in lower elevation grasslands facilitated by grazing and fire suppression (GP 1999c).

Fox Sparrow (*Passerella iliaca*): The fox sparrow breeds from Alaska east across northernmost Canada, and in the Rocky Mountains south to Nevada, Utah, and Colorado. It is a rare winter resident in Arizona and is considered rare to uncommon as a winter resident in New Mexico, being absent from the west-central/northwestern parts of this State (Hubbard 1978; Phillips and others 1964). While grazing may be a threat to this species on its breeding grounds elsewhere in the West (see Bock and others 1992), it is likely too sparse as a wintering species in Arizona and/or New Mexico, and its habitat use is too variable to be threatened by grazing activities in the Southwest (GP 2000b; GP 2001n).

Swamp Sparrow (*Melospiza georgiana*): The swamp sparrow is a breeding bird of Canada and the Northeastern United States. Its wintering grounds are primarily in the Midwestern and Southeastern United States, Texas, and Northeastern Mexico (AOU 1998; Mowbray 1997). In the Southwest, it winters along the Colorado River south of Parker, AZ, and is considered a "rare and irregular visitant in southeastern Arizona west to Tucson" (Phillips and others 1964). Winter records exist from southern New Mexico, specifically the lower Pecos River and Rio Grande valleys (Hubbard 1978; Mowbray 1997). Potential threats from grazing in the Southwest include the degradation of dense weedy, grassy riparian bottomlands containing rushes and sedges, riparian scrub, and moist shrubby areas with cattails (GP 1999d). However, wintering numbers are believed to be quite sparse, with no breeding activity in the Southwest; thus, any impact on this species would be unlikely to be severe (GP 2001n).

White-Throated Sparrow (*Zonotrichia albicollis*): This sparrow breeds chiefly across Canada and into northern New England; it winters in southern New Mexico, and more rarely in Arizona. Breeding Bird Survey data show this species to be declining throughout much of its breeding range (Sauer and others 2001). Wintering habitat includes thick brush in ravines and along watercourses (Falls and Kopachena 1994). Grazing can negatively impact this species when shrub communities are destroyed or removed; conversely, promotion of shrub expansion can increase wintering habitat (GP 1999d). White-throated sparrows are at the westernmost fringe of their wintering range in the Southwest, and there is no identifiable limiting habitat component here. Because they are not considered to be numerous in this region, grazing is not likely to impact this species (GP 2001a).

Harris' Sparrow (*Zonotrichia querula*): This primarily Great Plains species is considered "rare" to "uncommon and local" as a migrant and wintering bird in New Mexico (Hubbard 1978). Its occurrence in New Mexico is not considered to be significant enough for the species to be affected by grazing or range management practices in the region (GP 2000b).

Dark-Eyed Junco (*Junco hyemalis*): An apparently common and relatively abundant species, the dark-eyed junco breeds and winters extensively throughout North America, including Arizona and New Mexico (Williams 1993). In Arizona, this species is a common resident in the boreal forests of the Kaibab and Mogollon Plateaus and a fairly common summer resident in the adjacent Transition Zone and on the Coconino Plateau. It is an abundant transient throughout the State and an abundant winter resident of the open forests and woods of the Upper Sonoran Zone and higher zones (Phillips and others 1964). In New Mexico, it occurs widely in the eastern part of the State and is local in the western part of the State (Hubbard 1978). The dark-eyed junco may respond negatively to grazing because it is largely a ground forager and nester (Bock and others 1994). Detrimental effects would include removal of herbaceous plants and litter necessary for nest cover and insect production, especially the loss of suitable vegetation in riparian areas (GP 1999c). Given this species' widespread distribution over a variety of riparian and woodland habitats in the Southwest, these effects were not considered to be significant enough to affect this species (GP 2000e).

McCown's Longspur (*Calcarius mccownii*): This species winters in southern New Mexico and far southeastern Arizona after breeding in Wyoming, Montana, and adjoining provinces of Canada; this breeding range is considered to have been "drastically reduced" (Krause 1968). Winter range consists of open habitats with sparse vegetation in shortgrass prairie, overgrazed pastures, plowed fields, and dry lakebeds (With 1994). The effect of grazing on this species is unclear in the breeding range and virtually unknown in the winter range; McCown's longspur is considered one of the few avian species that may actually benefit from grazing (With 1994). At the Muleshoe National Wildlife Refuge (western Texas), McCown's longspur is most abundant (62 birds per 100 ha) on lightly grazed pastures (Grzybowski 1982).

Bronzed Cowbird (*Molothrus aeneus*): This cowbird reaches the southern extent of its breeding range in southern Arizona, New Mexico, and Texas (AOU 1998). As a brood parasite, similar to the brown-headed cowbird, it may be threatened by any activity that reduces the availability of host species. However, grazing is unlikely to impact this species, and the presence of cattle herds and pastures may in fact be beneficial (GP 2000b).

Red Crossbill (*Loxia curvirostra*): A bird of high-elevation coniferous forests, the red crossbill specializes on feeding on seeds within pine cones. It is found in northern and eastern Arizona, and north-central and western New Mexico. Breeding habitat is in mature conifer forests, where large seed crops have been produced by spruce, Douglas-fir, hemlock, or pines (Adkisson 1996). Ungulate grazing (along with fire suppression and logging) has the potential to cause fire regime changes leading to growth limits on big trees, limits on recruitment of large trees, and catastrophic fire (GP 1999c). However, it was considered unlikely that the effects of grazing among these factors would be significant enough to create a severe negative impact on this species (GP 2000e).

American Goldfinch (*Carduelis tristis*): The American goldfinch is abundant and widely distributed in adequate habitat throughout temperate North America (Middleton 1993). In Arizona, it is "rather common" but variable in numbers during the winter (Monson and Phillips 1981; Phillips and others 1964). This species is abundant in New Mexico in winter in a wide variety of habitats with deciduous trees; it is not necessarily tied to riparian areas (GP 2001n). Studies of grazing effects on the American goldfinch have found lower abundance of this species in cottonwood/willow, cottonwood/pine, and willow riparian areas where grazing occurred (Crouch 1982; Mosconi and Hutto 1982; Taylor 1986), but none of these decreases were statistically significant. The general abundance of this species in a variety of deciduous habitats and the lack of unequivocal evidence of negative effects from grazing led the Stage II panel to conclude that it would be unlikely to suffer severe impacts from grazing in the Southwest (GP 2001b).

Mammals

Occult Bat (*Myotis occultus*): In the recent scientific literature, there is some disagreement as to whether this taxon should be considered a separate species (Piaggio and others 2002) or a subspecies of the little brown bat (Valdez and others 1999). Also known as the Arizona bat (Hoffmeister 1986), it ranges from New Mexico across Arizona and into far southern California adjacent to the lower Colorado River. Hall (1981) placed the subspecies *M. lucifugus occultus* in all areas of New Mexico except the eastern plains and the north-central mountains; its distribution now includes Colorado (Piaggio and others 2002). Hoffmeister (1986) reports that this bat is usually found in ponderosa pine and oak-pine woodlands, and in areas with cottonwoods, willows, and sycamores. However, in New Mexico, Findley and others (1975) report that vegetation zone appears to be unimportant in determining distribution. In the arid Southwest, grazing could potentially impact the riparian areas that are important in providing water sources to support an insect prey base, as well as in creating a relatively humid microclimate for roost sites. However, their wider distribution and greater abundance relative to other species makes them less likely to be impacted by grazing or range management practices in the Southwest (GP 2003).

Yuma Myotis (*Myotis yumanensis*): The Yuma myotis is generally considered a species of special concern (Harvey and others 1999) and is on some State lists of sensitive species (for example, Oregon; Marshall and others 1996 as cited in Betts 1997). Population declines over a 25-year period have been recorded for specific sites in Arizona (O'Shea and Vaughan 1999). The Yuma myotis occurs across a wide range of habitats, from British Columbia, south to include Washington, Oregon, Idaho, western Montana, California, south-central Utah, southeastern Colorado, Arizona, New Mexico, and western Texas. In Mexico, it occupies Baja California and Northwestern to Central Mexico (Harris 1999). This bat occurs in a wide variety of habitats across its range; in the Southwest, it is generally associated with cottonwood streamside forests, although it is often found in areas without trees if open water is present (Harvey and others 1999). In Arizona, they are found wherever permanent water sources provide foraging habitat (Hoffmeister 1986). The Yuma myotis could be impacted by grazing systems or management practices that degrade riparian water sources, divert water, or eliminate streams. However, given that these bats are found in a wide variety of habitats, choose a variety of structures for roost sites, and are generally widespread and common, it is unlikely that grazing or range management activities would have severe negative impacts on this species (GP 2003).

Western Hog-Nosed Skunk (*Conepatus mesoleucus*): The range of this species extends from Arizona and New Mexico east to central Texas, and south through most of Mexico to Nicaragua. The modern distribution is reduced from its historical range, which included Colorado and Oklahoma (Dragoo and Honeycutt 1999). In Arizona, hog-nosed skunks range from southeastern Arizona, north to the Mogollons, and occasionally further north and northwest (Hoffmeister 1986). Findley and others (1975) describe the hog-nosed skunk as a species of southern New Mexico; Bernalillo County represents a northern limit to its range. Throughout the Southwest, western hog-nosed skunks are known from canyons, stream beds, and the rocky terrain of desert-scrub and mesquite grasslands (Dragoo and Honeycutt 1999). They appear to occupy open and wooded areas but avoid dense forest (Nowak 1999). Although unlikely to have significant negative impacts on this species (GP 2001p), grazing may alter the vegetation structure that serves as groundcover, and any reduction in vegetation may also reduce the insect prey base (GP 1999e).

Northern Raccoon (*Procyon lotor*): Racoons are quite common throughout the United States and range from southern Canada across the entire United States (with the exception of extremely arid desert areas of the Southwest), Mexico, and Central America, south to Panama (Nowak 1999). In Arizona,

the raccoon occurs along the waterways of central and southern Arizona, as well as along the Colorado and Little Colorado Rivers and their tributaries, and streams in the Chuska-Lukachukai Mountains (Hoffmeister 1986). In New Mexico, raccoons are common near all permanent watercourses up to timberline (Findley and others 1975). Raccoons depend on riparian vegetation for habitat, and aquatic vertebrates and invertebrates are important food resources. Although unlikely to have significant negative impacts on this species (GP 2001q), grazing and stocking practices that degrade riparian vegetation, marshlands, and water quality may eliminate habitat and prey species of the raccoon (GP 1999e).

Harris' Antelope Squirrel (*Ammospermophilus harrisii*): The Harris' antelope squirrel ranges from western and southern Arizona and southwestern New Mexico south to west-central Sonora, Mexico (Hall 1981 as cited in Best and others 1990). In Arizona the Harris's antelope squirrel occurs in nonwooded areas south of the Mogollon Plateau in the western and southern sections of the State (Hoffmeister 1986). In New Mexico, the species occurs in the foothills and valleys of the far southwestern counties (Bailey 1932; Findley 1987; Findley and others 1975). The Harris's antelope squirrel occupies low deserts often in association with rocky soils or rocky slopes, with cacti or desert shrubs used for locating burrow entrances (Best and others 1990; Hoffmeister 1986). The effects of grazing are unlikely to be severe (2001d) but may be mixed: conversion of grassland to scrubland could benefit this animal, but there could be damage to burrows and competition for food items (GP 1999e).

White-Tailed Antelope Squirrel (*Ammospermophilus leucurus*): This a species primarily of the Great Basin and is at the southern/southeastern edge of its distribution in Arizona and New Mexico. It occurs in Arizona north of the Mogollon Plateau (Hoffmeister 1986), and in New Mexico its distribution extends from the Four-Corners area south and east along the Rio Grande Valley to Socorro County; it is evidently absent from west-central New Mexico (Findley 1987; Findley and others 1975). Habitats occupied by white-tailed antelope squirrels range from grassland and shrub land to the lower edge of pinyon-juniper woodland. Although they are also found on rocky slopes, they may prefer flat, often sandy areas (Findley and others 1975; Hoffmeister 1986). Given that the dietary components for this species are broad and variable, its habitat requirements are unlikely to be negatively impacted by grazing or range management practices (GP 2001d).

Spotted Ground Squirrel (*Spermophilus spilosoma*): The spotted ground squirrel ranges from the central and western Great Plains through the Southwestern United States to central Mexico (Fitzgerald and others 1994). It occurs in grasslands and deserts throughout New Mexico (Findley and others 1975). In Arizona it occurs in two distinct areas: the northern part of the State, south and east of the Colorado River and north of the Mogollon Plateau, and in the southeast (Hoffmeister 1986). The spotted ground squirrel occupies a wide variety of habitats ranging from arid deserts and grasslands to montane meadows. In southeastern Arizona the species is associated with mesquite and acacia, while in the north it is found in saltbush and sagebrush (Hoffmeister 1986). In New Mexico it can be found in arid deserts and grasslands, shinnery oak-mesquite grassland, shortgrass plains, sacaton grassland, sycamore, cottonwood, and rabbitbrush (Best and others 1993; Cook 1986; Findley 1987; Findley and others 1975). The spotted ground squirrel seems especially common in arid, often disturbed, areas with scarce vegetation (Findley and others 1975; Fitzgerald and others 1994). Many studies have indicated that livestock grazing appears to benefit the spotted ground squirrel, as it appears to prefer sandy areas with scarce vegetation such as overgrazed sandhills and lightly-grazed mixed-grass prairie (see Streubel and Fitzgerald 1978 and authors cited therein).

Botta's Pocket Gopher (*Thomomys bottae*): Broad in distribution, from southern Oregon south through all of Baja California and eastward to central Texas. It is found throughout Arizona except for several local absences (Hoffmeister 1986) and in all but easternmost New Mexico (Findley and others 1975). Throughout its range, this species can be found in almost any friable soil, from rich bottomlands to rocky mountain slopes, in habitats ranging from desert scrub to coniferous forests (Patton 1999). This species was found to be significantly lower in abundance in grazed versus ungrazed annual grasslands in California; soil compaction by heavy livestock use was speculated to be at least partially responsible (Hunter 1991). While some of the numerous subspecies described under *T. bottae* may be locally vulnerable to heavy livestock use, the species as a whole is unlikely to be severely impacted by grazing in the Southwest (GP 2001d).

Plains Pocket Mouse (*Perognathus flavescens*): The plains pocket mouse is found in southeastern North Dakota, southwestern Minnesota, and northern Iowa, southwest to the Rio Grande and San Juan valleys of New Mexico, and northeastern Arizona (Bailey 1932; Hoffmeister 1986). This pocket mouse lives in sandy habitats (including dunes or shifting sands). The vegetation tends to be sparse and widespread; as long as sand is available, it can live in pinyon-juniper or ponderosa pine woodlands (Bailey 1932; Findley and others 1975; Hoffmeister 1986). In Arizona in some cases, the expanse of sand is so extensive that there is no plant material visible for many surrounding meters (Hoffmeister 1986). In New Mexico, this species is not always restricted to sandy soils, especially in woodlands (Findley and others 1975). Rangeland practices such as mechanical clearing of brush may actually benefit this species, and livestock use would have to be extremely high, essentially denuding all vegetation, to cause any negative impacts (GP 2001o).

Merriam's Pocket Mouse (*Perognathus merriami*): This species is found from eastern New Mexico (east of the Pecos River and south of the Canadian River), the western two-thirds of Texas, and extreme southwestern Oklahoma, south into Mexico (Best and Skupski 1994); it does not occur in Arizona (Hoffmeister 1986). The Merriam's pocket mouse is a resident of shortgrass prairie and desert scrub over most of its range, often with sparse vegetation. In northern Texas, it is most

common in well-grazed or over-grazed pastures with mesquite (Dalquest and Horner 1984 as cited in Best and Skupski 1994). Grazing in dense grasslands may benefit this species by opening up the vegetation, which aids its movement for foraging (GP 1999e).

Bailey's Pocket Mouse (*Chaetodipus baileyi*): The Bailey's pocket mouse occurs in the Southwest at the northern edge of its distribution. It ranges from extreme southern California, central Arizona, and extreme southwestern New Mexico (Peloncillo Mountains, Hidalgo County, and Burro Mountains, Grant County), south into Baja California and mainland Mexico (GP 2001o; Findley and others 1975; Hoffmeister 1986; Price 1999). In New Mexico, Findley and others (1975) describe the Bailey's pocket mouse as inhabiting "xeric brushy hillsides." In Arizona the species occurs in Chihuahuan Desert plant communities and in saguaro-palo verde associations of the Sonoran Desert (Hoffmeister 1986; Reichman 1975). Habitat is characterized by relatively sparse grass cover, with grasses interspersed with open ground and with shrubs (GP 2001e). Heavy grazing that reduces grasses for seed production would locally impact this mouse; however, light grazing that increases small to medium shrubs for cover while retaining herbaceous plants for seed production would be positive (GP 1999e).

Rock Pocket Mouse (*Chaetodipus intermedius*): The rock pocket mouse is found from south-central Utah through central Arizona, central New Mexico, and western Texas south into western Sonora and Chihuahua, Mexico (Rogers 1999). Rock pocket mice nearly always live in rocky areas, such as rock ledges, rock piles, lava flows, and steep canyon slopes (Findley and others 1975; Frey and Yates 1996; Hoffmeister 1986), especially rocky areas within desert scrub habitats with creosote bush and salt-bush (GP 1999e). Vegetation is often shrubby and scarce (Hoffmeister 1986). Because of the rocky component of this species' habitat, as well as the sparse, shrubby nature of surrounding vegetation, grazing is not expected to have a negative impact on this species (GP 2001e).

Chihuahuan Pocket Mouse (*Chaetodipus eremicus*): The Chihuahuan pocket mouse was formerly considered as a subspecies of the desert pocket mouse (*C. penicillatus*); the distribution of *C. eremicus* generally corresponds to the Chihuahuan Desert (Hall 1981). It occurs in Chihuahuan desertscrub or associated xeroriparian vegetation, avoiding rocky slopes in preference of sandy or silty soils, often near desert washes. It is associated with shrubs such as mesquite, catclaw, or creosote (Davis and Schmidly 1994; Findley and others 1975; Schmidly 1977). Grazing could potentially benefit this species through opening of the herbaceous vegetation layer, creating sandy soil areas, and increasing shrubby vegetation; however, heavy grazing intensities could potentially reduce available seed availability (GP 1999e).

Desert Kangaroo Rat (*Dipodomys deserti*): The desert kangaroo rat ranges from Nevada south through California and western Arizona to Baja California and Sonora, Mexico (Best 1999). It occurs in northwestern Arizona from Grand Canyon National Park along the Nevada border north to the Utah border; along the eastern side of the Colorado River in west-central Arizona; in southwestern Arizona east to Scottsdale, Florence, and Picacho (Hoffmeister 1986). The desert kangaroo rat occurs in the most arid regions of Southwestern North America, in desert areas with loose sandy soil such as sand dunes or arroyo bottoms (Best 1999; Best and others 1989; Hoffmeister 1986). Although this species does require seeds as a major diet item, grazing activity is not likely to have a negative impact as it occupies arid, sandy habitats sparsely vegetated with shrubs such as creosote (GP 2001e).

Merriam's Kangaroo Rat (*Dipodomys merriami*): This species ranges from northwestern Nevada and southwestern Utah south through western and southern Arizona, southern New Mexico, and western Texas into Mexico (Bailey 1932; Reynolds 1958). In the Southwest the Merriam's kangaroo-rat is found in the Chihuahuan and Sonoran deserts (Findley 1987; Findley and others 1975; Hoffmeister 1986). It is commonly associated with mesquite, creosote, and cacti in both Arizona and New Mexico (Findley and others 1975; Hoffmeister 1986). It seems to prefer areas with annual grasses and scattered woody plants, avoiding perennial grass areas. Numbers decrease with an increase in the abundance of perennial grasses for any given elevation or vegetation type (Reynolds 1958). The seeds of grasses are an essential dietary item, but Merriam's kangaroo rat habitat is characterized by relatively sparse grass cover, with grasses interspersed with open ground and with shrubs (Hoffmeister 1986). Overall, livestock grazing is viewed as having had a positive effect on the species in desert grassland sites (Bock and others 1994; Loftin and others 2000; Reynolds 1958). Grazing reduces grass stubble height, but continuous heavy grazing over several years also reduces perennial grass cover. These influences make habitat more favorable to Merriam's kangaroo-rat, and this species is more abundant on ranges grazed by cattle (Reynolds 1958). However, burrow trampling and soil compaction may potentially produce negative effects (Heske and Campbell 1991).

White-Footed Mouse (*Peromyscus leucopus*): The white-footed mouse ranges from the Northeastern United States, south to northern South Carolina, and west to eastern Montana, northern Colorado, and central Arizona (Hall 1981). In Arizona, Hoffmeister (1986) describes a variety of habitats, including areas along streams and rivers that had grasses, tumbleweeds, alder, cottonwoods, willow, and so forth growing alongside them. In New Mexico, this species' habitat is often described as brushy or weedy places (Bailey 1932). Findley and others (1975) described it as soft or sandy soils in arroyos and grasslands below the woodland, with vegetation of Apache plumes, saltbush, mesquites, and "other leguminous shrubs." White-footed mice can also be found in "tall grass and cottonwood groves" in some riparian areas (Findley and others 1975). Because of the variety of habitats it occupies, this species was not considered to be vulnerable to grazing in the Southwest (GP 2001o). However, because it is utilizes riparian habitats of thick grass, brushy clumps, cottonwood-willow, and tamarisk, the degradation of this habitat type and vegetation could locally affect this species (GP 1999e).

Black-Eared Mouse (*Peromyscus melanotis*): The black-eared mouse is considered a sister species of the more widespread deer mouse (*P. maniculatus*) and is one of several closely related species that form the *P. maniculatus* group. Primarily a high-elevation species of central Mexico (Handley 1999), the black-eared mouse ranges as far north as southeastern Arizona and may occur in the Chiricahua, Graham, and Santa Catalina Mountains (Bowers 1974; Bowers and others 1973). It is not known to occur in New Mexico. In Arizona, black-eared mice are primarily known from montane meadows in the southeastern mountains where they could be locally impacted by intense grazing in these areas (GP 1999e).

Pinyon Mouse (*Peromyscus truei*): The pinyon mouse occurs from Oregon and Wyoming south through portions of California, Nevada, Utah, Colorado, Arizona, New Mexico, Texas, and Oklahoma, and south into Oaxaca, Mexico (Hoffmeister 1981). It is usually found in conjunction with pinyon trees or pinyon-juniper, especially where stands of these trees are near walls, cliffs, outcrops, or rocky slopes. They can also occasionally be found in cottonwood stands in riparian areas such as along the Little Colorado River, or sandy grassland habitats with scattered shrubs or junipers (Bailey 1932; Cornely and others 1981; Findley and others 1975; Hoffmeister 1981). If range management practices include clearing of pinyon woodlands, the pinyon mouse will be negatively affected (GP 1999e); however, the Stage II panel (GP 2001o) did not considered this to be a significant threat to this species in the Southwest.

Northern Grasshopper Mouse (*Onychomys leucogaster*): The northern grasshopper mouse occurs from "Saskatchewan, Alberta, and Manitoba south to extreme northern Mexico, west into northeastern California and central Oregon and east to western Minnesota and Iowa" (McCarty 1978). In Arizona, it occurs mostly in the northern portion of the State (north of the Mogollon Plateau) but also "south in Yavapai County to Camp Verde; south of the Mogollon Plateau from near the Gila River south through Cochise County" (Hoffmeister 1986). In New Mexico, it occurs in scattered locations throughout the state (Bailey 1932; Findley and others 1975). Northern grasshopper mice prefer areas with sparse vegetation (including sagebrush flats, yucca, and mesquite, all with sparse grass) and friable soil (Hoffmeister 1986). In New Mexico, they are found in the plains country, in sandy grasslands, mesquite stands, weedy areas, and dunes (Bailey 1932; Findley and others 1975). Overall, the Stage II panel concluded that severe effects on this species were unlikely (GP 2001o), but there are negative factors related to grazing worth noting. A study in southeastern Arizona found a "modest negative effect of cattle grazing" on some rodents, especially kangaroo rats and grasshopper mice (Heske and Campbell 1991). These authors speculated that negative effects could include trampling of burrows, alteration of plant composition, loss of food for insect prey, direct competition for seed heads, and soil compaction (Heske and Campbell 1991). While grasshopper mice choose unvegetated areas, possibly for "ease of travel or because these areas support higher densities of insect prey," they also have a high affinity for burrows associated with gopher mounds (Stapp 1997). Thus, any management program that eradicated gophers would likely have a negative effect on these mice as well.

White-Throated Woodrat (*Neotoma albigula*): The white-throated woodrat is considered the most common woodrat of New Mexico (Findley 1987) and is common in Arizona (Hoffmeister 1986). It is widespread throughout both States, except for the northwestern corner of Arizona, north and west of the upper Colorado River (Hoffmeister 1986). The white-throated woodrat is found in desertscrub, desert grassland, oak associations, pinyon-juniper woodland, and riparian areas (Cook 1986; Findley 1987; Hoffmeister 1986). A key component of the white-throated woodrat's habitat in many areas is cactus, which is consumed and used for shelter (Findley 1987; Hoffmeister 1986; Vorhies and Taylor 1940). According to Vorhies and Taylor (1940), the white-throated woodrat is often found at highest densities in heavily-grazed areas. However, Steenbergh and Warren (1977) observed the opposite, with the species preferring areas with more vegetation cover and avoiding overgrazed rangelands. The Stage II panel ultimately decided that effects were not serious enough to warrant inclusion in the database (GP 2001e).

Mexican Woodrat (*Neotoma mexicanus*): This species is associated with the mountain ranges of Arizona and New Mexico (Findley and others 1975; Hoffmeister 1986). It is found in eastern Arizona, as far west as the Hualapai Mountains and as far north as the Colorado River (Hoffmeister 1986). In New Mexico, this species has also been found at low elevation sites such as at Elephant Butte, Carrizozo malpais, and Alamogordo Reservoir (Findley and others 1975). The Mexican woodrat is associated with montane coniferous forests and reaches greatest abundance in mixed coniferous forests; it prefers rock outcrops, rocky slopes, and cliffs in the upper Sonoran and transition zones (Findley and others 1975; Hoffmeister 1986). It is unlikely to be affected by grazing except for impacts to important food items (for example, leaves, green plants, berries, fruits, seeds, nuts, acorns, and mushrooms) (GP 2001d).

North American Porcupine (*Erethizon dorsatum*): The porcupine occurs throughout most of Alaska and Canada, south to Virginia, Tennessee, central Illinois, and Iowa, and then into the American Southwest and the northern part of Mexico (Hall 1981). It occurs in appropriate habitat throughout New Mexico and Arizona (Findley and others 1975; Hoffmeister 1986). Records from Arizona south of the Gila River are primarily from desert scrub (Hoffmeister 1986). Bailey (1932) reports them as common in the mountains of northern New Mexico and "not infrequently found" elsewhere in valleys, canyons, and on cliffs. In the Southwestern United States, porcupines are considered most abundant in forested areas, especially coniferous forests, as well as riparian woodlands (Woods 1973, 1999). In Mexico, the habitat of the North American porcupine is negatively impacted by overgrazing, which alters the structure and composition of riparian vegetation (List and others 1999). The Stage II panel (GP 2001o) did not consider the potential for negative impacts to be significant but noted

that in Arizona and New Mexico porcupines may be affected by grazing in riparian or xeroriparian areas that results in the degradation of deciduous woodlands and the loss of trees and shrubs used as food and cover. In low elevation grasslands, grazing may have long-term positive effects by increasing shrub densities (GP 1999e).

Desert Cottontail (*Sylvilagus audubonii*): This rabbit ranges throughout much of the Western United States to Southern Mexico (Hall 1981). It is widespread and considered common to abundant at lower elevations throughout New Mexico and Arizona (Findley 1987; Hoffmeister 1986). The desert cottontail is chiefly a grassland and shrubland species; it may also occur in oak or pinyon-juniper woodlands (Findley 1987; Hoffmeister 1986). In the Animas Mountains area, it occupies cottonwood-sycamore associations and rabbitbrush of riparian areas (Cook 1986). Elsewhere the desert cottontail is often associated with xeroriparian vegetation (Hoffmeister 1986). Desert cottontails prefer plant associations that include some shrubs. In Colorado, moderate livestock grazing has a positive effect on the desert cottontail when it promotes an increase in shrub cover and in broad-leaved herbs (Flinders and Hansen 1975).

Appendix E—Common Names and Scientific Names

Common names for various organisms are used in lieu of Latin scientific names throughout the text of the species accounts, with the exception of discussions specifically related to taxonomic relationships or nomenclature. The following list allows users to cross reference the scientific name for any common name used in the accounts. Species are listed first by major taxonomic group, then alphabetically by common name. Some scientific names are associated with multiple common names, which is noted parenthetically. (Names of species that are part of the grazing assessment database are not included here; see table 2.)

Bacteria	
Plague Bacterium	*Yersinia pestis*
Fungi	
Shelf Fungus	*Fomes igniarius* var. *populinus*
Plants	
Acacia	*Acacia* spp.
Agave	*Agave* spp.
Alder	*Alnus* spp. (includes *A. oblongifolia*)
Alfalfa	*Medicago sativa*
Algerita	*Berberis* spp.
Alkali Bulrush	*Scirpus maritimus*
Alkali Sacaton	*Sporobolus airoides*
Alligator-Bark Juniper	*Juniperus deppeana*
Allthorn	*Koeberlinia* spp.
American Lotus	*Nelumbo lutea* (see also Water Chinquapin)
Antelope Bush	*Purshia tridentata*
Apache Pine	*Pinus engelmannii*
Apache Plume	*Fallugia paradoxa*
Arizona Cypress	*Cupressus arizonica*
Arizona Hackberry	*Celtis pallida*
Arizona Madrone	*Arbutus arizonica*
Arizona Pine	*Pinus strobiformis* (see also White and Southwestern Pine)
Arizona Sycamore	*Platanus wrightii*
Arizona Walnut	*Juglans major*
Arizona White Oak	*Quercus arizonica*
Arrow Arum	*Peltandra virginica*
Arrowweed	*Tesseria sericea*
Ash	*Fraxinus* spp.
Aspen	*Populus* spp.
Baccharis	*Baccharis* spp.
Balsam Fir	*Abies balsamea*
Baltic Rush	*Juncus balticus*
Barrel Cactus	*Ferocactus* spp.
Bear Grass	*Xerophyllum tenax*
Bearberry	*Arctostaphylos uva-ursi* (see also Kinnickinnick)
Beargrass	*Nolina microcarpa*
Bedstraw	*Galium* spp.
Bermuda Grass	*Cynodon dactylon*
Big Sagebrush	*Artemesia tridentata*
Birch	*Betula* spp.
Bird-of-paradise	*Caesalpinia gilliesii*
Bitterbrush	*Encelia farinose*

Black Grama	*Bouteloua eriopoda*
Black Greasewood	*Sarcobatus vermiculatus*
Black Oak	*Quercus kelloggii*
Black Spruce	*Picea mariana*
Black Walnut	*Juglans major*
Blackberry	*Rubus* spp.
Blackbrush	*Coleogyne ramosissima*
Blackbush	*Acacia rigidula*
Blanketflower	*Gaillardia aristata*
Blazing Star	*Mentzilia pumila*
Blue Elderberry	*Sambucus nigra cerulea*
Blue Grama	*Bouteloua gracilis*
Blue Oak	*Quercus douglasii*
Blue Paloverde	*Cercidium florida*
Blue Spruce	*Picea pungens*
Blueberry	*Vaccinium* spp.
Bluegrass	*Poa* spp.
Bluestem	*Andropogon* spp.
Bog Birch	*Betula glandulosa*
Border Pinyon Pine	*Pinus discolor*
Bouvardia	*Bouvardia glaberma*
Box-elder	*Acer negundo*
Boxthorn	*Lycium* spp. (see also Desert Thorn)
Bristlegrass	*Setaria* spp.
Brome	*Bromus* spp.
Broom(-weed)	*Gutierrezia sarothrae*
Buckhorn (Cholla)	*Opuntia acanthocarpa*; also *O. whipplea*
Buckhorn (-thorn)	*Rhamnus* spp.
Buckwheat	*Eriogonum* spp.
Buffalograss	*Buchloe dactyloides*
Bull Muhly	*Muhlenbergia emersleyi*
Bullthorn	*Acacia cornigera*
Bulrush	*Scirpus* spp.
Bur Reed	*Sparganium americanum*
Burro Grass	*Scleropogon brevifolius*
Burrobrush (-bush)	*Hymenoclea monogyra*
Burroweed	*Ambrosia dumosa*
Bursage	*Franseria* spp.
Buttonbush	*Cephalanthus occidentalis*
California Bulrush	*Scirpus californicus*
Cane Bluestem	*Bothriochloa barbinodis*
Canyon Grape	*Vitis arizonica*
Canyon Live Oak	*Quercus chrysolepis*
Canyon Maple	*Acer grandidentatum*
Canyon Ragweed	*Ambrosia artemisifolia*
Cardón Cactus	*Pachycereus pringlei*
Carpetweed	*Mollugo verticillata*
Catclaw	*Acacia greggii*
Catclaw Acacia	*Acacia greggii*
Cattail	*Typha* spp.; includes *T. angustifolia*
Ceanothus	*Ceanothus* spp.
Cedar Elm	*Ulmus crassifolia*
Celery	*Vallisneria americana*
Cheatgrass	*Bromus tectorum*
Cherry	*Prunus serotina*
Chihuahuan Pine	*Pinus leiophylla*

Chokecherry	*Prunus virginiana*
Cholla Cactus	*Opuntia* spp. (includes *O. imbricata*)
Chuparosa	*Justicia californica*
Cinquefoil	*Potentilla fruticos*a
Clover	*Trifolium* spp.; also *Dalea* spp.
Common Watercress	*Nasturtium officinale*
Copper Mallow	*Sphaeralcea coccinea*
Coralbean	*Erythrina flabelliformis*
Corkbark Fir	*Abies lasiocarpa* var. *arizonica*
Cottonwood	*Populus* spp.
Cottonwood Mistletoe	*Phoradendron flavescens*
Coyote Bush	*Baccharis* spp.
Creosote (-bush)	*Larrea tridentat*a
Crested Wheatgrass	*Agropyron cristatum*
Curly Dock	*Rumex crispus*
Dalea	*Dalea* spp. (see also Clover)
Dandelion	*Taraxacum* spp.
Dasylirion	*Dasylirion* spp. (see also Sotol)
Desert Hackberry	*Celtis pallida*
Desert Mistletoe	*Phoradendron californicum*
Desert Honeysuckle	*Anisacanthus thurberi*
Desert Lavender	*Hyptis emoryi*
Desert Penstemon	*Penstemon pseudospectabilis*
Desert Saltgrass	*Distichlis spicata*
Desert thorn	*Lycium* spp. (see also Boxthorn)
Desert Willow	*Chilopsis linearis*
Dock	*Rumex* spp.
Douglas-fir	*Pseudostuga menziesii*
Dropseed	*Sporobolus* spp. (includes *S. contractus*; see also Sacaton)
Duckweed	*Lemna* spp.; also *Spirodela* spp.
Dwarf Birch	*Betula nana*
Elderberry	*Sambucus* spp.
Elephant Tree	*Bursera microphylla*
Elm	*Ulmus* spp.
Emory Oak	*Quercus emoryi*
Englemann Spruce	*Picea engelmannii*
Ephedra	*Ephedra* spp. (see also Joint-fir, Mormon Tea)
Evening Primrose	*Oenothera minor*
False Grama	*Cathestecum brevifolium*
Fig	*Ficus* spp.
Fir	*Abies* spp.
Fireweed	*Epilobium canum*
Flatsedge	*Cyperus* spp.
Foothill Paloverde	*Cercidium microphylla*
Four-winged Saltbush	*Atriplex canescens*
Fremont Cottonwood	*Populus fremontii*
Galleta	*Hilaria jamesii*
Gambel Oak	*Quercus gambelii*
Giant Cane	*Arundo donax*
Giant Reed	*Arundo donax*
Giant Sacaton	*Sporobolus wrightii*
Globemallow	*Sphaeralcea* spp.
Goldenrod	*Solidago* spp.
Goldenweed	*Pyrrocoma* spp.
Gooding Willow	*Salix goodingii*
Gooseberry	*Ribes* spp.

Goosefoot	*Chenopodium* spp.
Grama	*Bouteloua* spp.
Grand Fir	*Abies grandis*
Grape	*Vitis* spp.
Graves Oak	*Quercus gravesii*
Gray Oak	*Quercus grisea*
Graythorn	*Ziziphus obtusifolis*
Greasebrush (-bush)	*Glossopetalon spinescens*
Greasewood	*Sarcobatus vermiculatus*
Green Joint-Fir	*Ephedra viridis* (see also Mormon Tea)
Groundsel	*Senecio vulgaris*
Hackberry	*Celtis* spp.
Hairy Grama	*Bouteloua hirsute*
Hall's Panic Grass	*Panicum hallii*
Heather	Family Ericaceae (see Manzanita, Madrone, Kinnikinnick)
Hemlock	*Tsuga* spp.
Honey Mesquite	*Prosopis glandulosa*
Hopbush	*Dodonaea viscosa*
Horsetail	*Equisetum* spp.
Huckleberry	*Vaccinium myrtillus*
Incense Cedar	*Calocedrus decurrens*
Indian Paintbrush	*Castilleja confusa*
Ironwood	*Olneya tesota*
Jeffery Pine	*Pinus jeffreyi*
Jimsonweed	*Datura stramonium*
Joint-Fir	*Ephedra torreyana* (see also Mormon Tea)
Jojoba	*Simmondsia chinensis*
Joshua Tree	*Yucca brevifolia*
Juniper	*Juniperus* spp.
Kentucky Bluegrass	*Poa pratensis*
Kinnikinnick	*Arctostaphylos uva-ursi* (see also Bearberry)
Knotgrass	*Paspalum* spp.
Lamb's Quarters	*Chenopodium album*
Limber Pine	*Pinus flexilis*
Little Bluestem	*Schizachyrium scoparium*
Little-Leaf Sumac	*Rhus microphylla*
Lodgepole Pine	*Pinus contorta*
Lousewort	*Pedicularis* spp.
Lovegrass	*Eragrostis* spp.
Madrone	*Arbutus* spp.
Manzanita	*Arctostaphylos* spp.
Maple	*Acer* spp.
Mescal	*Sophora secundiflora*
Mesquite	*Prosopis* spp.
Mesquite Mistletoe	*Phoradendron californicum*
Mexican Elderberry	*Sambucus* spp.
Mexican Pinyon Pine	*Pinus cembroides*
Milkweed	*Asclepias* spp.
Mistletoe	*Phoradendron* spp.
Mojave Beard-Tongue	*Penstemon pseudospectabilis* (see also Desert Penstemon)
Mormon Tea	*Ephedra torreyana*; also *E. viridis* (see also Joint-fir)
Mountain Birch	*Betula glandulosa*
Mountain Dandelion	*Agoseris glauca*
Mountain Lover	*Pachystima myrsinites*
Mountain Mahogany	*Cercocarpus montanus*
Muhly	*Muhlenbergia* spp.

Mulberry	*Morus* spp.
Muscadine	*Vitis rotundifolia*
Mustard	*Brassica* spp.
Narrowleaf Cottonwood	*Populus angustifolia*
Netleaf Hackberry	*Celtis reticulata*
New Mexico Locust	*Robinia neomexicana*
New Mexico Thistle	*Cirsium neomexicanum*
Nipple Cactus	*Mammilaria* spp.
Nuttall Oak	*Quercus nuttallii*
Oak	*Quercus* spp.
Ocotillo	*Fouquieria splendens*
One-Seeded Juniper	*Juniperus monosperma*
Onion	*Allium* spp.
Paintbrush	*Castilleja* spp.
Palm	*Washingtonia* spp.
Palmillo	*Yucca elata*
Paloverde	*Cercidium* spp.
Panic Grass	*Panicum* spp.
Panicum	*Panicum* spp.
Parry's Beard-Tongue	*Penstemon parryi*
Parry's Century-Plant	*Agave parryi*
Pecan	*Carya illinoinensis*
Penstemon	*Penstemon* spp.
Pigweed	*Amaranthus retroflexus*
Pin Oak	*Quercus palustris*
Pine	*Pinus* spp.
Pinyon Ricegrass	*Piptochaetium fimbriatum*
Pointleaf Manzanita	*Arctostaphylos pungens*
Poison Ivy	*Rhus radicans*
Ponderosa Pine	*Pinus ponderosa*
Pondweed	*Potamogeton* spp.
Poplar	*Populus* spp.
Prickly-Pear Cactus	*Opuntia* spp. (includes *O. phaeacantha*)
Purple Sandgrass	*Triplasis purpurea*
Quaking Aspen	*Populus tremuloides*
Rabbitbrush (-bush)	*Chrysothamnus* spp.
Ragweed	*Ambrosia artemisifolia*
Raspberry	*Rubus* spp.
Red Alder	*Alnus rubra*
Red Barberry	*Berberis haematocarpa*
Red Brome	*Bromus rubens*
Red Cedar	*Thuja* spp.
Red Maple	*Acer rubrum*
Redberry	*Rhamnus* spp. (see also Buckhorn, -thorn)
Reed	*Phragmites* spp.
Rice	*Zizania* spp.
Ricegrass	*Oryzopsis* spp.
Rocky Mountain Maple	*Acer glabrum*
Rocky Mountain Pinyon Pine	*Pinus edulis*
Rose	*Rosa* spp.
Rush	*Juncus* spp.; also *Scirpus* spp.
Russian Olive	*Eleagnus angustifolia*
Russian Thistle	*Salsola kali*
Sacaton	*Sporobolus* spp. (see also Dropseed)
Sagebrush	*Artemesia* spp.
Saguaro Cactus	*Carnegiea gigantea*

Salt Cedar	*Tamarix pentandra*; also *T. chinensis*, *T. ramosissina*
Saltbush	*Atriplex* spp.
Saltgrass	*Distichlis* spp.
Sand Bluestem	*Andropogon hallii*
Sand Dropseed	*Sporobolus cryptandrus*
Sand Sagebrush	*Artemisia filifolia*
Sandbur	*Cenchrus* spp.
Saw Grass	*Cladium jamaicense*
Scarlet Bugler	*Penstemon barbatus*
Scenecio	*Scenecio* spp.
Schott Yucca	*Yucca schottii*
Screwbean Mesquite	*Prosopis pubescens*
Scrub Oak	*Quercus turbinella*
Sedge	*Carex* spp.; also *Cyperus* spp.
Sedge Nutgrass	*Cyperus rotundus*
Seepwillow	*Baccharis glutinosa*
Serviceberry	*Amelanchier utahensis*
Shadscale	*Atriplex confertifolia*
Shindagger	*Agave schottii*
Shinnery Oak	*Quercus havardii*
Sideoats Grama	*Bouteloua curtipendula*
Silver-Leaf Oak	*Quercus hypoleucoides*
Singleleaf Pinyon Pine	*Pinus monophylla*
Skunkbush	*Rhus* spp.
Smartweed	*Polygonum* spp.
Smoketree	*Psorothamnus spinosa*
Snakeweed	*Gutierrezia sarothrae*
Snowberry	*Symphoricarpos* spp.
Soapberry	*Sapindus saponaria*
Soaptree Yucca	*Yucca elata*
Sorghum	*Sorghum* spp.
Sotol	*Dasylirion wheeleri*
Southwestern Pine	*Pinus strobiformis* (see also Arizona and White Pine)
Spikerush	*Eleocharis* spp.
Spineless Hopsage	*Grayia brandegei*
Spruce	*Picea* spp.
Squaw Currant	*Ribes cereum*
Stickleaf	*Mentzilia pumila*
Subalpine Fir	*Abies lasiocarpa*
Sugar (or Sugarberry) Hackberry	*Celtis laevigata*
Sumac	*Rhus* spp.
Sunflower	*Helianthus* spp.
Superb Penstemon	*Penstemon superbus*
Switch Grass	*Panicum* spp.
Sycamore	*Plantanus* spp.
Tabosa Grass	*Hilaria mutica*
Tall Mesquite	*Prosopis glandulosa*
Tamarack	*Larix* spp.; includes *L. laricina*
Tamarisk	*Tamarix pentandra*; also *T. ramosissima, T. chinensis*
Tarbush	*Flourensia cernua*
Tetetzo Cactus	*Neobuxbaumia tetetzo*
Texas Betony	*Stachys coccinea*
Thistle	*Cirsium* spp.
Three-Awn	*Aristada* spp.
Three-Square Bulrush	*Scirpus olneyi*

Torpedograss	*Panicum* spp.
Torrey Yucca	*Yucca torreyi*
Toumey Oak	*Quercus toumeyi*
Tridens	*Tridens* spp.
Trumpet Honeysuckle	*Lonicera sempervirens*
Tule	*Schoenoplectus acutus*
Tumbleweed	*Amaranthus albus*
Utah Juniper	*Juniperus osteosperma*
Velvet Ash	*Fraxinus velutina*
Velvet Mesquite	*Prosopis velutina*
Vetch	*Vicia americana*
Vine Mesquite	*Panicum obtusum*
Walnut	*Juglans* spp.
Water Chinquapin	*Nelumbo lutea* (see also American Lotus)
Water Milfoil	*Myriophyllum sibiricum*
Water Oak	*Quercus nigra*
Water Star Grass	*Heteranthera dubia*
Wavyleaf Oak	*Quercus undulata*
Wax Mallow	*Malvaviscus arboreus*
Weeping Brome	*Bromus frondosus*
Weeping Lovegrass	*Eragrostis curvula*
Western Wheatgrass	*Agropyron smithii*
Wheatgrass	*Agropyron* spp.
White Bursage	*Franseria dumosa*
White Cedar	*Thuja occidentalis*
White Fir	*Abies concolor*
White Heather	*Cassiope* spp.
White Pine	*Pinus strobiformis* (also Arizona and Southwestern Pine)
White Water Lily	*Nymphaea odorata*
White-Thorn	*Acacia constricta*
Wigeon Grass	*Ruppia maritime*
Willow	*Salix* spp.
Willow Oak	*Quercus phellos*
Winterfat	*Eurotia lanata*
Wolfberry	*Lycium exsertum*
Wolftail	*Lycurus pheloides*
Wood Sorrel	*Oxalis violacea*
Woolly Buckthorn	*Bumelia lanuginose*
Yarrow	*Achillea millefolium*
Yellow Paloverde	*Cercidium microphylla*
Yellow Pine	*Pinus leiophylla*
Yucca	*Yucca* spp.

Invertebrates

Brown-Tail Moth	*Euprocitis chrysorrhoea*
Coddling Moth	*Cydia pomonella*
Crayfish	*Orconectes virilis*
Douglas-fir Tussock Moth	*Orgyia pseudotsugata*
Gypsy Moth	*Lymantria dispar*
Tent Caterpillar	*Malacosoma* spp.
Western Spruce Budworm	*Choristoneura occidentalis*

Fish

Bass	*Micropterus* spp.
Desert Sucker	*Catostomus clarki*

Fathead Minnow	*Pimephales promelas*
Green Sunfish	*Lepomis cyanellus*
Longfin Dace	*Agosia chrysogaster*
Rainbow Trout	*Oncorhynchus mykiss*
Sonoran Sucker	*Catostomus insignis*

Amphibians

Bullfrog	*Rana catesbeiana*

Reptiles

Desert Grassland Whiptail	*Cnemidophorus uniparens*
New Mexican Whiptail	*Cnemidophorus neomexicanus*
Yarrow's Spiny Lizard	*Sceloporus jarrovii*

Birds

American Kestrel	*Falco sparverius*
Black-Chinned Hummingbird	*Archilocus alexandri*
Blue Grouse	*Dendragapus obscurus*
Blue-Headed Vireo	*Vireo solitarius*
Bronzed Cowbird	*Molothrus aeneus*
Brown-Headed Cowbird	*Molothrus ater*
Carolina Wren	*Thryothorus ludovicianus*
Cassin's Vireo	*Vireo cassinii*
Cattle Egret	*Bubulcus ibis*
Cowbird	*Molothrus* spp.
Cuban Black-Hawk	*Buteogallus anthracinus gundlachii*
Eastern Black Rail	*Laterallus jamaicensis jamaicensis*
European Starling	*Sturnus vulgaris*
Evening Grosbeak	*Coccothraustes vespertinus*
Great Horned Owl	*Bubo virginianus*
Greater Roadrunner	*Geococcyx californianus*
Horned Lark	*Eremophila alpestris*
House Sparrow	*Passer domesticus*
Mangrove Black-Hawk	*Buteogallus subtilis*
Meadowlark	*Sturnella* spp.
Mourning Dove	*Zenaida macroura*
Nighthawk	*Chordeiles* spp.
Northern Mockingbird	*Mimus polyglottos*
Pine Siskin	*Carduelis pinus*
Ptarmigan	*Lagopus* spp.
Purple Gallinule	*Porphyrula martinica*
Purple Martin	*Progne subis*
Ruffed Grouse	*Bonasa umbellus*
Rufous Crab-Hawk	*Buteogallus aequinoctialis*
Solitary Vireo	*Vireo solitarius*
Southern Beardless-Tyrannulet	*Camptostoma obsoletum*
Spruce Grouse	*Falcipennis canadensis*
Stellar's Jay	*Cyanocitta stelleri*
Turkey Vulture	*Cathartes aura*
Utila Black-Hawk	*Buteogallus subtilis utilensis*
Western Kingbird	*Tyrannus verticalis*
Western Meadowlark	*Sturnella neglecta*
Yellow-Bellied Sapsucker	*Sphyrapicus varius*
Yellow-Rumped Warbler	*Dendroica coronata*

Mammals

Abert's Squirrel	*Sciurus aberti*
Antelope Squirrel	*Ammospermophilus* spp.
Bison	*Bison bison*
Black-Tailed Jackrabbit	*Lepus californicus*
Botta's Pocket Gopher	*Thomomys bottae*
Brush Mouse	*Peromyscus boylei*
Cactus Mouse	*Peromyscus eremicus*
Canada Lynx	*Lynx canadensis*
Cottontail	*Sylvilagus* spp.
Coyote	*Canis latrans*
Deer Mouse	*Peromyscus maniculatus*
Desert Pocket Mouse	*Perognathus penicillatus*
Ground Squirrel	*Spermophilus* spp.
Hare	*Lepus* spp.
Hog-Nosed Skunk	*Conepatus mesoleucus*
Jackrabbit	*Lepus* spp.
Kangaroo Rat	*Dipodomys* spp.
Little Brown Bat	*Myotis lucifugus*
Merriam's Kangaroo Rat	*Dipodomys merriami*
Mountain Goat	*Oreamnos americanus*
Nine-Banded Armadillo	*Dasypus novemcincus*
Plains Pocket Gopher	*Geomys bursarius*
Pocket Mouse	*Perognathus* spp. or *Chaetodipus* spp.
Richardson's Ground Squirrel	*Spermophilus richardsonii*
San Joaquin Kit Fox	*Vulpes macrotis mutica*
Spotted Ground Squirrel	*Spermophilus spilosoma*
Striped Skunk	*Mephitis mephitis*
White-Footed Mouse	*Peromyscus leucopus*
White-Nosed Coati	*Nasua narica*
White-Throated Woodrat	*Neotoma albigula*
Woodrat	*Neotoma* spp.

Appendix F—Users Guide to the Species Account Database CD

The compact disc (CD) that accompanies this publication contains all 305 species accounts in a searchable database constructed in Microsoft (MS) Access. Two file formats are available for viewing each individual account: Adobe PDF and MS Word. Access to these files is regulated through the main database, which has been designed to allow the user to search for certain species or species groups, and to conduct queries based on shared characteristics of the species accounts. (This user's guide is also provided on the CD in Adobe PDF format.)

System Requirements and Start Up

Use of this CD requires a MS Windows operating system (Windows 2000 or later). The first time it is used, the CD will download the database and associated files. If required, a runtime version of Access 2003 and Adobe Acrobat Reader 7.0 will also download. However, a version of MS Word (2000 or later) will need to be previously installed in order to view files using the "Export to Word" function described below. (Note: Local controls on the installation of software may make it necessary to obtain local administrative rights in order to download software from this CD.)

Installation of Database and Software

- Insert the CD into the computer's CD-ROM drive.
- An on-screen, automated process will guide you through the installation. Follow the instructions presented on the screen to complete the installation. (Note: you will be asked to select from a "Standard" or "Custom" installation; select the "Standard" option.)
- The CD will download under "Program Files" to a main folder with the title "GTR-142 Species Accounts". This folder will also house subfolders that contain Adobe Acrobat Reader 7.0, PDF Files, Word files, and Support files. (In order for the database to function correctly, do not alter the contents of these folders.)

Start Up of Database

Once the installation is complete, there are two ways to open the database:

1. An icon will appear on the Windows desktop; double-clicking on this icon will start the database.
2. The Windows "Start" button at the lower left corner of the desktop allows you to access "Programs" and then a series of subfolders. Move the cursor to "Programs," then over the main folder "GTR-142 Species Accounts." Click on the selection "GTR-142 Species Accounts" to start MS Access and the database.

Viewing the User's Guide

This User's Guide is also available in Adobe PDF format for on-screen viewing or printing. Follow the instructions above for starting the database. To view the PDF version, follow the instructions above for starting the database. Click on the lower left button of the main screen ("User's Guide"; see fig. F-1), which will start Adobe Acrobat Reader 7.0 and open the User's Guide file.

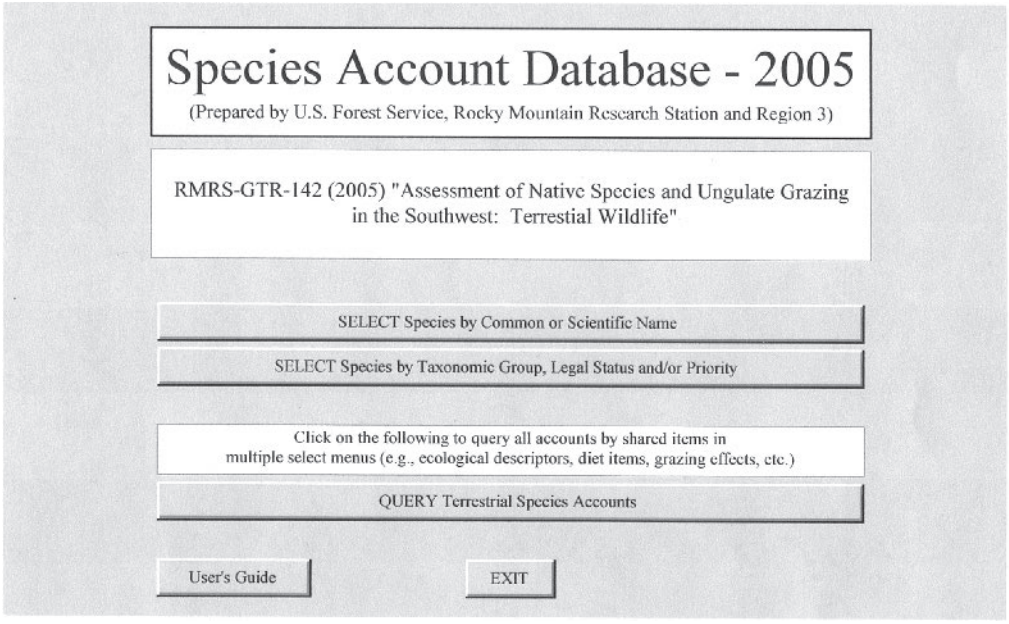

Figure F-1.

Using the Database: Selecting Species

Species accounts are accessed in three basic steps: (1) The user instructs the database to generate a list of species of interest, either by selecting certain species or species groups, or by querying the accounts. (2) The database presents this list of species on a screen titled "Display Requested Species," along with options as to the type of file you wish to view. (3) The user selects which species to view and the desired viewing format (Adobe PDF or MS Word files).

Generating a Search or Query

When the database is first opened, the main screen (fig. F-1) will be displayed. Under the title panels, three bars provide choices for (1) selecting species by common or scientific name, (2) selecting species according to general taxonomic groupings, legal status, or panel priority designations, and (3) querying the entire database. (An additional "Exit" button allows you to exit the program.)

Selecting Species by Common or Scientific Name—Click on this bar to bring up a screen that gives you the option of selecting either "common name" or "scientific name" of the desired species. Species are presented in alphabetical order for each. The common names are written using a left-to-right convention of increasing specificity (for example: Owl, Saw-whet, Northern) in order to make it easier to find a species on the list.

Click on each desired species name once to highlight the name (remove a species by clicking a second time). When finished, click the "Select Output" button in the lower right to generate your list on the "Display Requested Species" screen. (Otherwise, click the "Return to Main" button in the lower left to return to the main screen.)

Selecting Species by Taxonomic Groupings, Legal Status, or Priority—This option opens the screen shown in figure F-2. The two upper boxes allow you to generate a species list based on taxonomic groupings (presented alphabetically). Selections here may be made in either broad taxonomic categories (left menu) or more specific categories (right menu). Note that while multiple selections can be made within each menu, selections should be made from one or the other, but not both.

The broad categories are:

- Amphibians
- Birds
- Mammals
- Reptiles

The specific categories are:

- Bats
- Carnivores
- Ducks
- Frogs / Toads
- Heteromyid Rodents (Pocket Mice, Kangaroo Rats)
- Hummingbirds
- Lagomorphs
- Lizards / Skinks

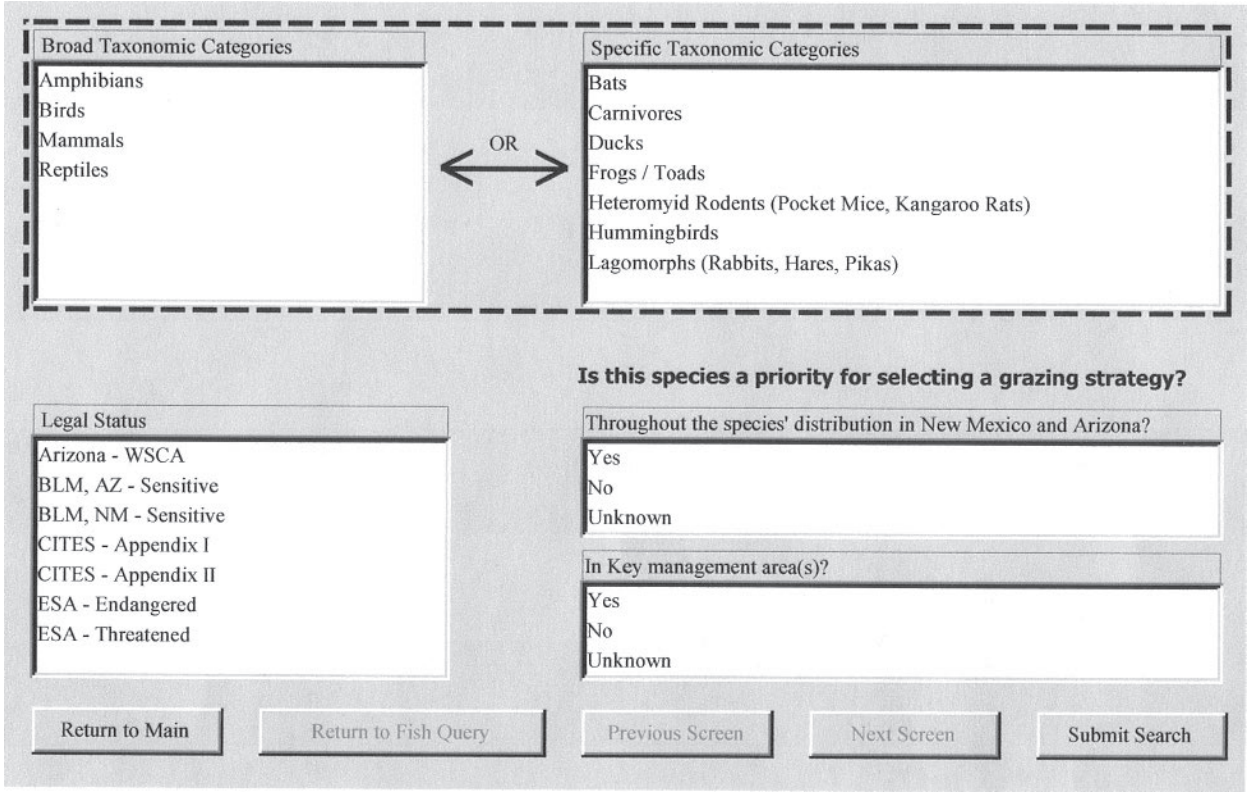

Figure F-2.

- Marsh Birds / Shorebirds
- Misc. Non-Passerines (Caprimulgids, Pigeons, Trogons, Cuckoos)
- Misc. Rodents (Beaver, Pocket Gophers, Jumping Mice)
- Murid Rodents (Mice, Rats, Voles, Muskrats)
- Passerines (Songbirds)
- Salamanders
- Sciurid Rodents (Squirrels, Chipmunks, Prairie-dogs, Marmots)
- Shrews
- Snakes
- Turtles / Tortoises
- Ungulates
- Upland Game Birds
- Woodpeckers

Below these menus are boxes that allow choices based on legal status and priority designation as presented in the species accounts menus (see appendix B as well as the definitions within the Species Account Guide). Selections can be made from one or all of these menus, as well as with or without the taxonomic selections above.

When your selections are complete, click the "Submit Search" button to generate your list on the "Display Requested Species" screen, or exit this screen by clicking the "Return to Main" button.

Query Terrestrial Species Accounts—This section allows the user to query all accounts for shared menu selections as well as for shared words or phrases within the text narratives. Click on the bar on the main screen to initiate a query; the first screen presented is titled "Terrestrial Species Account Query" (fig. F-3).

This opening page explains that multiple query selections can be made both within and between menus. One or more choices (or none) may be highlighted in each menu on every screen. Within a menu, the database will look for all species that have at least one of the selections highlighted for the query (similar to using an "OR" search operator); thus, more selections within a menu will result in a larger number of species being returned. However, between menus (and narratives) the database looks for species that contain all the highlighted selections (similar to an "AND" search operator). Thus, including more menus or text narratives creates a more restrictive query and results in fewer species.

The query section presents all species account menus and text narratives in the same sequence as the basic template (appendix B) in a series of 9 pages. The menus and narratives displayed on these pages are as follows:

- Page 1: Menus (2) - Distribution, Ecological Role
- Page 2: Narratives (5) - Status/Threats/Trends, Distribution, Breeding, Habitat, and Season of Use
- Page 3: Menus (3) - Season of Use, Specific Habitat Associations, Important Habitat Functions
- Page 4: Menus (4) - Important Structural Features of Habitat: Height
- Page 5: Menus (3) - Important Structural Features of Habitat: Density
- Page 6: Menus (5) - Important Structural Features of Habitat: Distribution; Tree/Saguaro Age; Elevation
- Page 7: Menus (5) - Other Important Habitat Features
- Page 8: Menus (2) - Diet Items, Grazing Impact Mechanisms; Narratives (2) - Diet, Grazing Effects

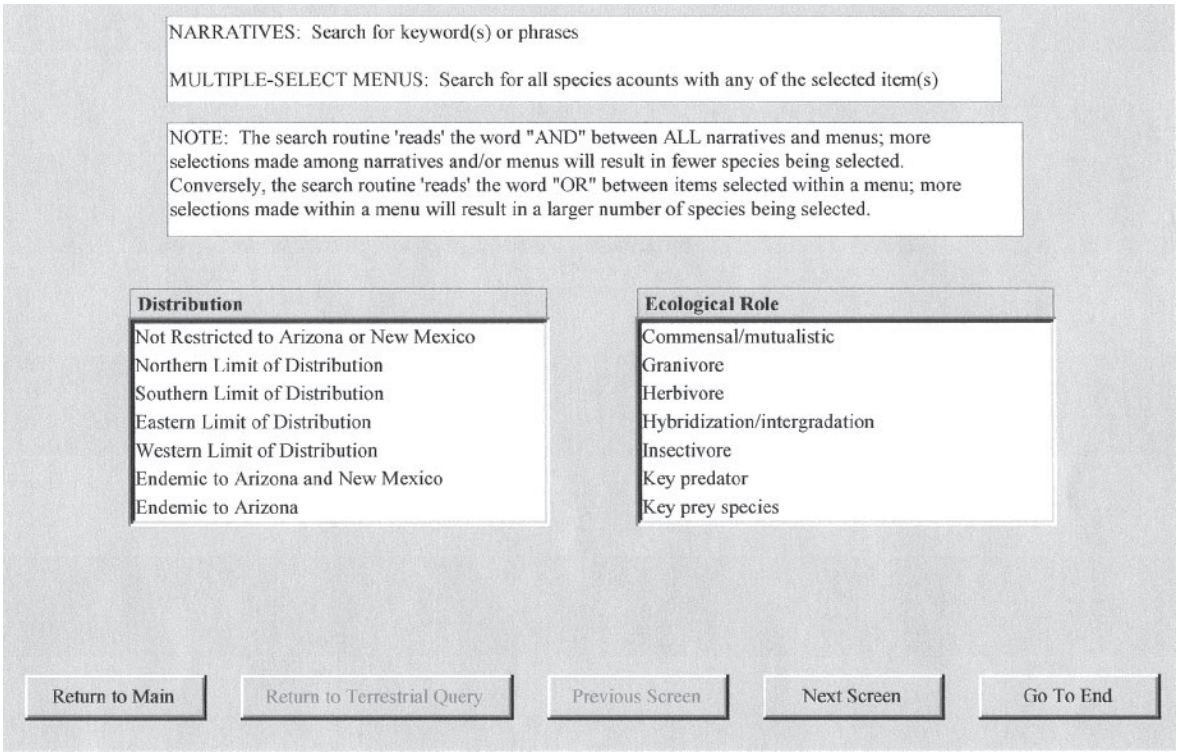

Figure F-3.

- Page 9: Narrative (1) - Fire Regime; Menus (4) - Fire Regime Critically Important?, Fire Frequency, Fire Intensity, Fire Timing.

Using Keywords, Phrases—Queries within narratives require that the user enter a keyword or phrases to search for these terms within that narrative only. The basic rules are as follows:

- Enter one word or multiple words separated by spaces (that is, phrases); quotation marks are not required. The database will search for and return all matches to whatever is typed within the query box.
- For shorter words, quotations, and bounding, spaces can be utilized to prevent returns on fragments of larger words. For example, a search on the word "red" will also return any narrative with the words "tired", "reduced", "redirect", and so forth. In most cases, the user is actually looking for the word "red" with spaces on either side. This is solved by using quotation marks to type "red". This entry will return matches to only the word "red" without any matching word fragments. Users may also wish to conduct additional searches that use variations which include trailing punctuation marks after the word (for example, "red.", "red,", "red?", "red;", or "red:") to ensure that all occurrences of the word are captured by the query.

Running the Query—At the bottom of each page are five buttons for exiting the current screen: "Return to Main," "Return to Query," "Previous Screen," "Next Screen," or "Go To End." Click on this last button ("Go To End") when you have finished entering all your query parameters. This will take you to the last page, where this button is replaced by one reading "Submit Search"; click here to generate your query list on the "Display Requested Species" screen.

Using the Database: Viewing the Species Accounts

After a search is generated, a screen titled "Display Requested Species" is shown that contains all species that fit the criteria entered by the user, with scientific names followed by common names (fig. F-4). Highlight all the species you wish to view by clicking on the name once; remove by clicking the name again. Once highlighted, the species accounts may be viewed in two formats by clicking on one of the following two buttons (a third button ["Return to Main"] returns you to the main screen):

Preview PDF—This option will open Adobe Acrobat Reader and present the species account in Adobe PDF format, which can then be read on-screen or printed out.

Export to Word—This option opens the species account as a MS Word file. This version can only be printed or read on-screen; it also allows the user to select specific text in the account to "cut-and-paste" the information into another document. (Important: a version of MS Word 2000 or later is required in order for this function to operate properly.)

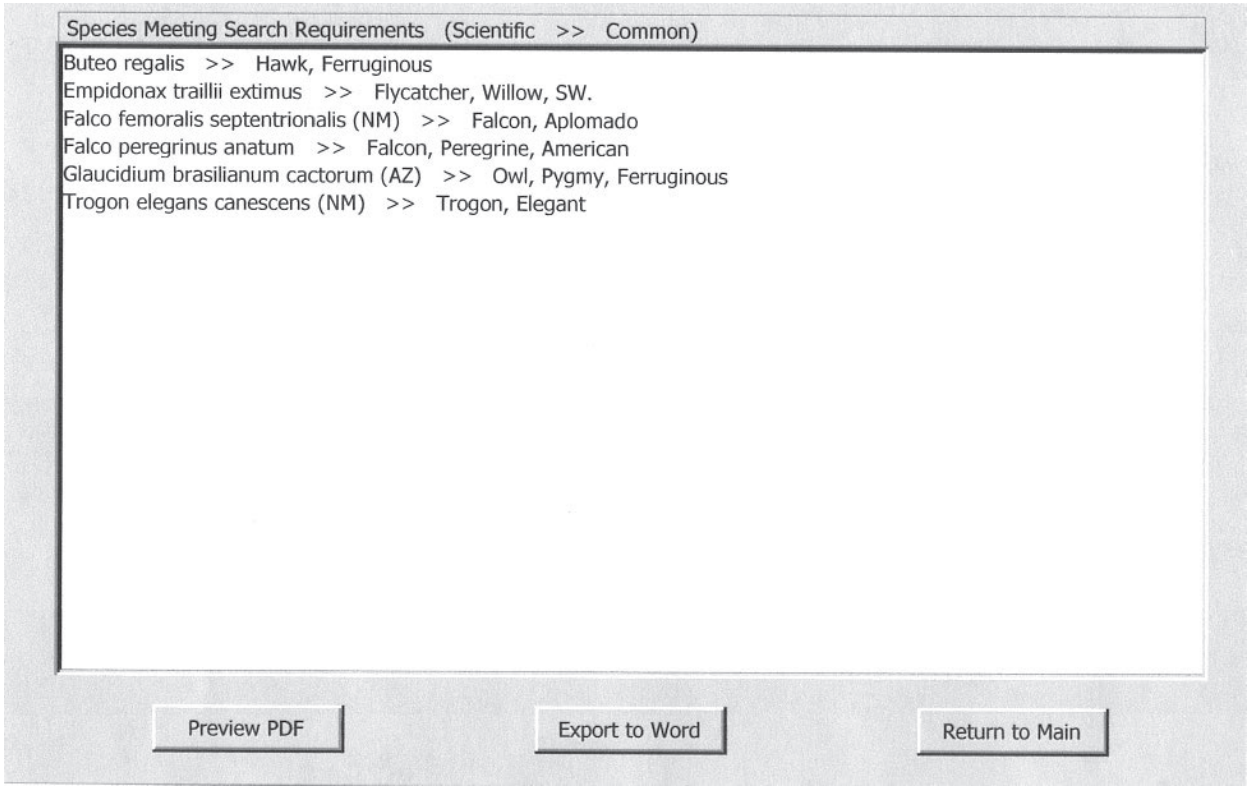

Figure F-4.

The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of the forests and rangelands. Research is designed to meet the needs of National Forest managers, Federal and State agencies, public and private organizations, academic institutions, industry, and individuals.

Studies accelerate solutions to problems involving ecosystems, range, forests, water, recreation, fire, resource inventory, land reclamation, community sustainability, forest engineering technology, multiple use economics, wildlife and fish habitat, and forest insects and diseases. Studies are conducted cooperatively, and applications may be found worldwide.

Research Locations

Flagstaff, Arizona
Fort Collins, Colorado*
Boise, Idaho
Moscow, Idaho
Bozeman, Montana
Missoula, Montana
Reno, Nevada
Albuquerque, New Mexico
Rapid City, South Dakota
Logan, Utah
Ogden, Utah
Provo, Utah

*Station Headquarters, Natural Resources Research Center,
2150 Centre Avenue, Building A, Fort Collins, CO 80526