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Faunal Characteristics of the Southern Rocky Mountains of New Mexico: Implications for Biodiversity Analysis and Assessment

Rosamonde R. Cook, Curtis H. Flather, and Kenneth R. Wilson

Abstract

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To define the faunal context within which local and regional resource management decisions are made, conservation of biological diversity requires an understanding of regional species occurrence patterns. Our study focused on the Southern Rocky Mountains of New Mexico and included the San Juan, the Sangre de Cristo, and the Jemez Mountains. Across this region, we quantified patterns of species richness and faunal diversity based on reported and predicted occurrences for birds, mammals, reptiles, amphibians, fish, and butterflies across this region. Specific hypotheses related to the origin and maintenance of observed diversity patterns were tested and interpreted based on their implication for biodiversity assessment and management. Our results suggest that species richness for any one of the taxonomic groups does not indicate species distributions of other taxa. For terrestrial vertebrates, variation in faunal differentiation among mountain ranges was associated more strongly with differences in dispersal ability than with differences in habitat composition. Those butterflies classified as montane specialists exhibited a higher degree of faunal differentiation than did all other montane specialist species. This pattern may be caused by a high degree of habitat specificity among montane butterflies or incomplete field surveys. Because some species groups show high degrees of faunal differentiation, maintaining the uniqueness of these faunas across the region will require a broad geographic focus and cooperative management among various agencies and groups.

Keywords: faunal differentiation, faunal similarity, Southwest biodiversity, Jemez Mountains, regional biodiversity patterns, species diversity, beta diversity, vertebrates, butterflies

Authors

Rosamonde R. Cook is with the Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523

Curtis H. Flather is with the Rocky Mountain Research Station, U.S. Forest Service, Fort Collins, CO 80526

Kenneth R. Wilson is with the Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523

***Cover photographs**: Silver-bordered fritillary—Paul Opler; Jemez Mountains salamander—Cindy Ramotnik; Townsend's big-eared bat—Alice Chung-MacCoubrey; Collared lizard—Cindy Ramotnik; Three-toed woodpecker—Brad Bergstrom; Southern redbelly dace—Garold Sneegas*

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Introduction

The preservation of biological diversity is a principal goal of ecosystem management (Grumbine 1997), which can only be realized through empirical studies of community structure. In general, little is known about the diversity of species and the structure of communities within any given region. However, it is clear that most habitats and populations are patchily distributed (Wiens 1976), and it is this patchiness that defines the spatial pattern of a region's faunal diversity. Critical to conserving biodiversity at the local level is understanding how diversity varies over regional scales, as processes operating at these scales influence local diversity patterns (Schluter and Ricklefs 1993; Edwards and others 1994).

The regional focus of this study is the Southern Rocky Mountains of New Mexico (SRMNM) (figure 1), an area encompassing 3 major mountain ranges: the San Juan and Sangre de Cristo Mountains, which extend well into southern Colorado, and the Jemez Mountains, which lie completely inside New Mexico to the south of the San Juans. Although they are technically considered a secondary range of the San Juan Mountains, the Jemez Mountains are characterized by a discrete geological history and a marked degree of topographic isolation (Self and others 1996). The SRMNM form the southern boundary of the Rocky Mountain Biotic Province and are bordered by the Chihuahuan Province to the south and the Southwest Interior Province to the west (Reichenbacher and Brown 1994). Three aquatic provinces are also represented in the SRMNM: the Southern Plains, Pecos, and Rio Bravo (Maxwell and others 1995, modified by Ricketts and

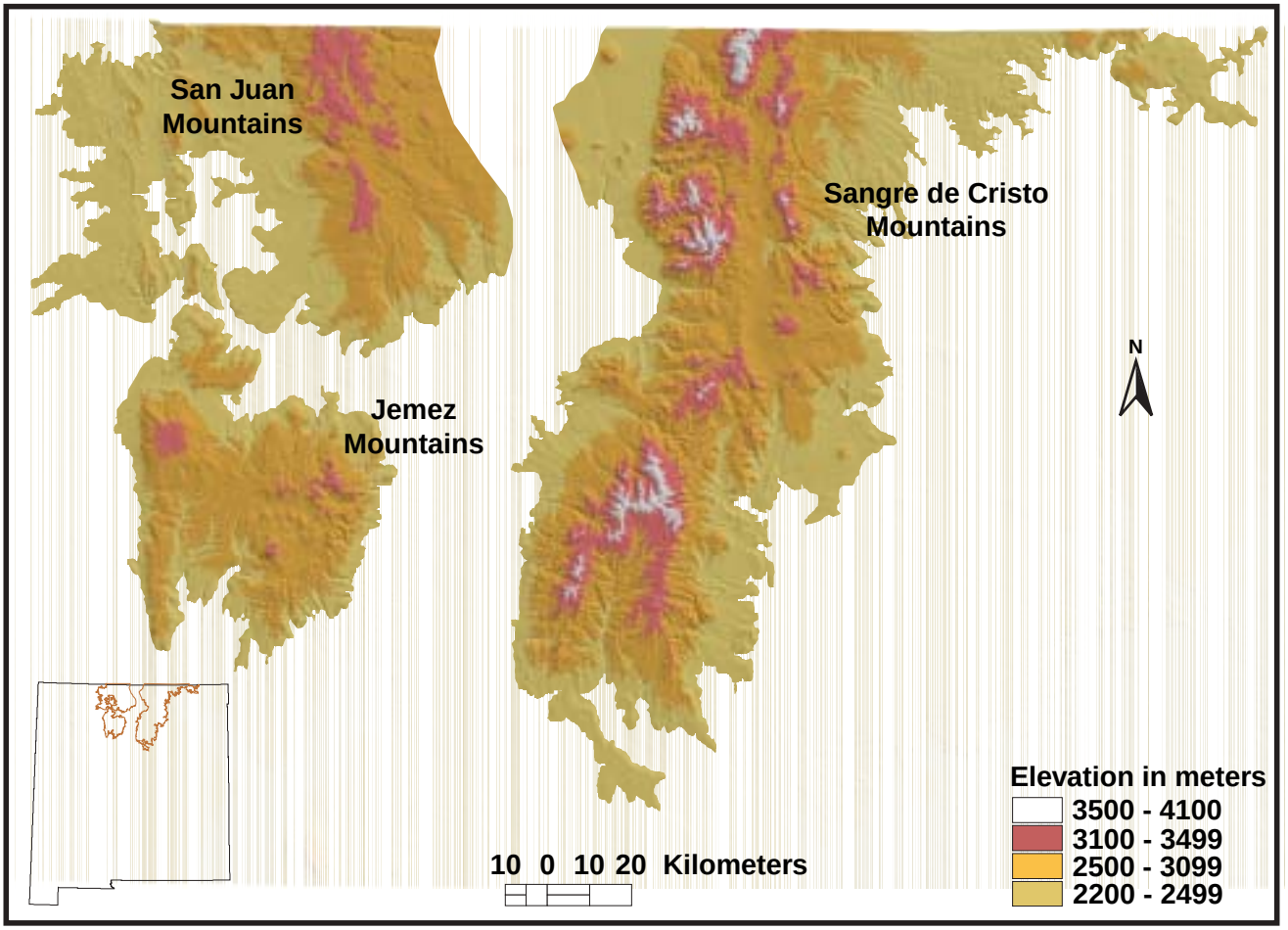

Figure 1—Mountain ranges of the Southern Rocky Mountains of New Mexico. Boundaries represent the 2200 m contour from the U.S. Geological Survey's 1:100,000 scale digital elevation model for New Mexico.

others 1999). Portions of 4 major river basins including the Chama, Rio Grande, Pecos, and Canadian drain the region (figure 2). The geographic convergence of these terrestrial and aquatic provinces undoubtedly accounts for the large diversity of plant and animal species present in this region.

A large proportion of forest land in the SRMNM is administered by the Carson and Santa Fe National Forests (figure 3). At the regional level, conservation of biological diversity will likely require the cooperation of different landowners and local jurisdictions as geography and species distributions rarely coincide with human boundaries. Ecosystem management within and among national forests must account for faunal differences that may exist within similar habitat types and structures. Thus, knowledge of faunal diversity within and among mountain ranges will help establish the faunistic context for management of forest lands within the SRMNM. The goals of this study were to:

1) document the diversity of the native vertebrate and butterfly faunas within the SRMNM;
2) quantify patterns of faunal diversity in this region;
3) test hypotheses related to the origin and maintenance of species diversity patterns;
4) assess the use of faunal similarity / differentiation indices as a basis for biodiversity management decisions in general; and
5) propose considerations for management of this diversity.

A comprehensive assessment of biodiversity would include genetic, species, community, and landscape components. In this study, we focused on patterns of diversity at the species and community levels. Although abundance patterns are important to understanding biodiversity within a region, our analysis was restricted to distributional (i.e., presence / absence) data, which were widely available for the taxa examined. These included all terrestrial and aquatic vertebrates, and 2 superfamilies of butterflies, the Hesperioidea and Papilionoidea. From a bioregional perspective, this analysis would have been more complete if it included Colorado portions of the San Juan and Sangre de Cristo Mountains. However, at the time of our study sufficient species distributional data were unavailable for such an analysis.

Hypotheses

At a regional level, species diversity is determined by 2 components: 1) the number of species that occur at a local level within habitat patches (referred to as alpha diversity) and 2) differences in faunal composition that occur among patches (referred to as beta diversity) (Whittaker1960). We define the local level as that of a mountain range. Elevational range is an important determinant of species richness within mountain systems (Bowers and McLaughlin 1982) because of its influence on local climatic conditions.

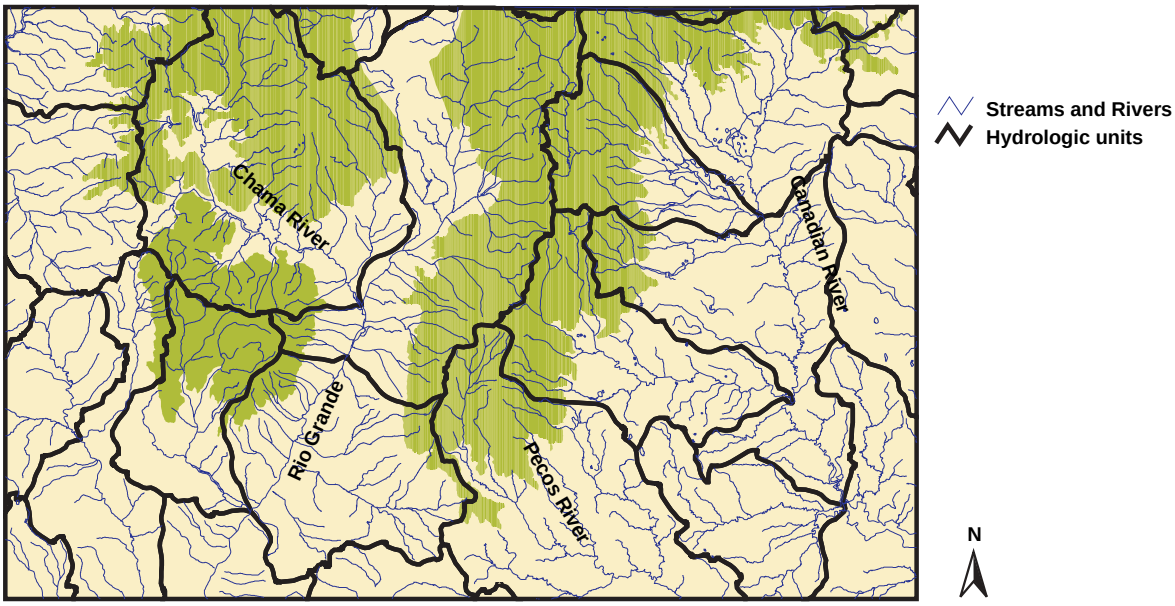

Figure 2—Streams and 8-digit hydrologic units in the Southern Rocky Mountains of New Mexico. Adapted from the U.S. Geological Survey's 1:100,000-scale digital line graphcoverages for New Mexico.

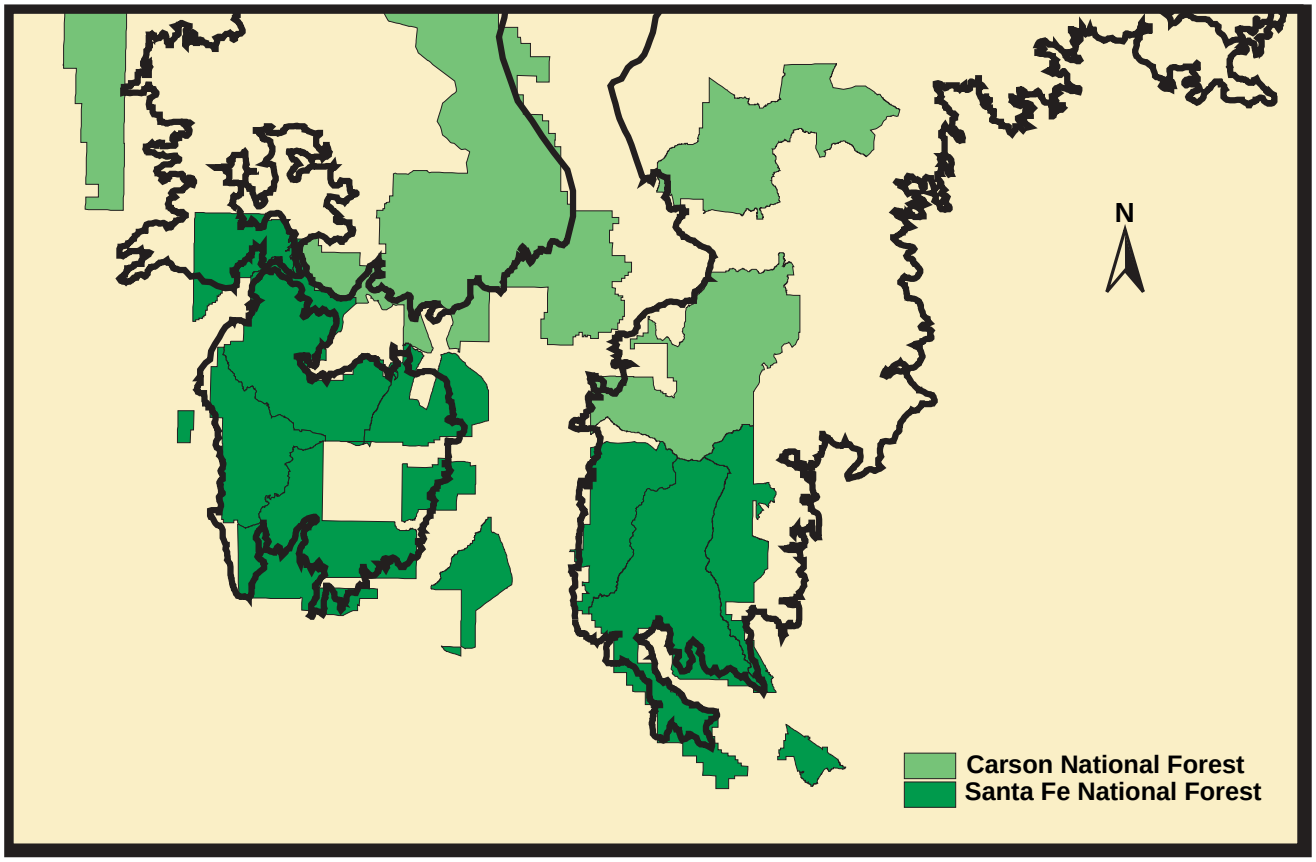

Figure 3—National forest boundaries in the Southern Rocky Mountains of New Mexico. Adapted from the landownership digital line coverage developed by the New Mexico Gap Analysis Project (Thompson and others 1996). Bold boundaries delineate the 3 mountain ranges shown in figure 1.

Extreme elevational variation, particularly in the Sangre de Cristo and Jemez Mountains, produces strong patterns of vertical zonation of vegetation and faunal communities over relatively short distances (e.g., Lowe 1964; Whittaker and Niering 1965). Typically, zonation proceeds from arid grassland and desert scrub in the valleys and lowlands, to open juniper (*Juniperus* spp.) grasslands, pinyon (*Pinus* spp.) -juniper woodland, ponderosa pine (*Pinus ponderosa*) forest, mixed conifer and aspen (*Populus tremuloides*), and subalpine conifer forest. Alpine tundra is present to a very limited extent only on the highest peaks in the Sangre de Cristo Mountains. At a landscape level, vertical zonation produces patchiness in the distributions of major vegetation types (figure 4), and their associated faunas.

Over sufficiently large spatial scales, faunal differentiation results from an absence of suitable habitats within patches and a lack of dispersal among patches containing suitable habitat. Factors such as interspecific interactions, temperature tolerances, and soil conditions also influence species distributions and patterns of habitat occupancy, although probably at smaller scales. Frequency of dispersal is influenced by biological characteristics of species, such as mobility and tolerance to stress, and the interaction of these characteristics with features of the landscape, such as distance between suitable habitats and the ability of the intervening environment to act as a barrier to dispersal. Because similar habitat types are present in all mountain ranges, except alpine tundra, and most species occupy a variety of habitats (see below), we suspect that dispersal ability and isolation of habitats are the most important determinants of faunal differentiation in the SRMNM.

The taxa we examine in this report probably differ significantly in dispersal ability. Birds and bats are undoubtedly better dispersers than non-volant species, although some bird species may not fly far through unsuitable habitat (Desrochers and Hannon 1997).

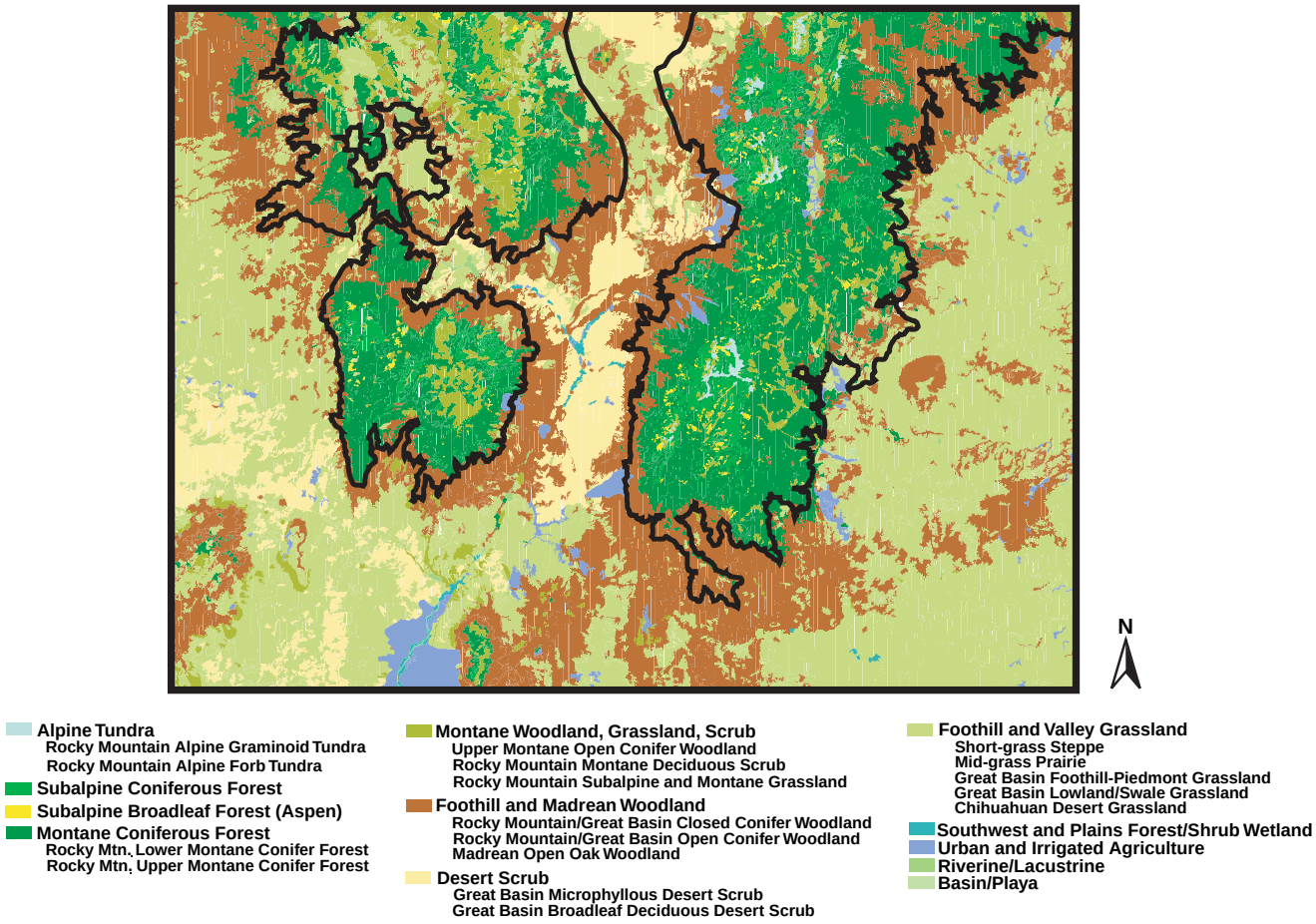

Figure 4—Major vegetation types of the Southern Rocky Mountains of New Mexico. Adapted from the 1:100,000-scale land cover map of New Mexico developed by the New Mexico Gap Analysis Project (Thompson and others 1996). Bold boundaries delineate the 3 mountain ranges shown in figure 1.

Terrestrial mammals are probably more mobile than reptiles as a group, and in general, reptiles and mammals are more tolerant of arid environments than amphibians. Therefore, with respect to ability to disperse over land, we might assume that taxa would tend to order as: birds and bats > mammals > reptiles > amphibians. It is difficult to compare butterflies as a single group because some species are very sedentary while others migrate over large distances (Cary and Holland unpublished report). We do not try to distinguish among species in dispersal characteristics in this report.

Montane habitats in general exhibit the highest degrees of habitat fragmentation at the landscape level in the SRMNM (figure 4). For species restricted to these habitats (species we define below as montane specialists), the presence of unsuitable (woodland and lowland) habitat in the middle and lower elevations can pose a significant barrier to dispersal between mountain ranges (Patterson 1984; Wilcox and others 1986; DeBano and others 1995). Only 3 taxa—birds, non-volant mammals, and butterflies—have more than 2 representatives of montane specialist species in the SRMNM. Patterson (1984) and Patterson and Atmar (1986) have suggested very low rates of dispersal by montane mammals among mountain ranges in the Southwest, over a region that encompasses the SRMNM.

Montane species that also use woodland and lowland habitats (species defined as habitat generalists

below) face fewer restrictions on movement, although large rivers such as the Chama and Rio Grande can pose a significant barrier to dispersal for many nonvolant terrestrial species. Among habitat generalists, patterns of differentiation may be influenced mainly by the innate dispersal abilities of the species in a taxonomic group, and to a lesser degree by the distribution of habitats in the region.

Conversely, dispersal by aquatic species should be strongly favored by the interconnection of habitat, especially within the Chama and Rio Grande River basins (figure 2), which link aquatic habitats of all 3 mountain ranges in the SRMNM. Although dams and diversions can interfere with dispersal and migratory movement of fishes, they are less likely to influence the distributions of amphibians and aquatic mammals and reptiles. The distributions of aquatic birds should be influenced only by the presence or absence of suitable habitat.

From the discussion above, we can make several predictions related to patterns of biodiversity in the SRMNM. Within a taxon, we predict the highest degrees of faunal differentiation to occur among montane specialists, the lowest among aquatic specialists, and intermediate levels among habitat generalists. Within habitat associations groups, we predict a negative relationship between dispersal ability and degree of differentiation. We can formalize these predictions as 3 testable hypotheses:

1) Within taxa (e.g., mammals), differentiation of montane specialists is high compared to aquatic specialists and habitat generalists.
2) Within taxa, differentiation of aquatic specialists is low compared to montane specialists and habitat generalists.
3) Across taxa, differentiation is negatively correlated with dispersal ability, (i.e., differentiation of amphibians > reptiles > mammals > birds and bats).

Methods

Compiling Faunal Lists

Two types of species distributional data were available for this study: maps of predicted occurrence, and site-specific accounts of known or reported occurrences. Appendix A1 through A6 lists all vertebrate and butterfly species predicted and reported from the study area using the following methods.

Predicted Occurrence

Digital maps of predicted occurrence were obtained from the New Mexico Gap Analysis database (Thompson and others 1996). Gap Analysis uses geographic information systems (GIS) to model the predicted occurrence of terrestrial vertebrates using land cover maps of vegetation developed from Landsat Thematic Mapper imagery, along with species-habitat associations that are defined by the vegetation types represented on the maps (Scott and others 1993). The vegetation classification system used by the New Mexico Gap Analysis Project was developed by Muldavin and others (1996) for the New Mexico Natural Heritage Program following the UNESCO framework (Driscoll and others 1984). The classification is hierarchical, with 7 levels. Species associations were defined mostly at the fourth level, which corresponds with series groups (i.e., sets of morphological, environmental, or floristically related cover types). Vegetation series groups mapped for the study area are described in table 1. Vegetation classes mapped in figure 4 are second and third levels in the hierarchy.

Maps of predicted occurrence (e.g., figure 5A) were created by intersecting each species' geographic range, defined by the boundaries of U.S. Geological Survey (USGS) 8-digit hydrologic units (Seaber and others 1987), with the distribution of its associated habitat types (series group vegetation classes). Elevational range and aquatic features were also used if these were important predictors of occurrence. We generated species lists for each mountain range by overlaying these maps with the boundaries of the 3 mountain ranges (figure 1) using ArcView 3.1 GIS software (Environmental Systems Research Institute, Inc. 1996) and tabulating presence/absence in each range (appendix B).

Reported Occurrence

Species lists were generated from reported occurrences as noted in the sources listed in table 2. The majority of data on mammals (Findley and others 1975), amphibians and reptiles (Degenhardt and others 1996), fishes (Sublette and others 1990), and butterflies (Toliver and others 1994) were compiled by the listed authors from specimen collections held in U.S. museums and private collections. We supplemented these data with a small number of field accounts from biologists familiar with species distributions in the region, and with reports from scientific journals compiled after a keyword search of several major bibliographic indices including Biological Abstracts, Zoological Review, and Wildlife Worldwide.

We plotted all records of occurrence for birds, mammals, fishes, and butterflies in ArcView using USGS

Table 1—Description and major cover types of vegetation present in the Southern Rocky Mountains of New Mexico (Muldavin and others 1996). Vegetation classes are roughly equivalent to groups of series-level descriptors developed by Driscoll and others (1984). Accuracy represents percent agreement (± SE) between mapped vegetation type and vegetation observed on the ground, whether observed vegetation is primary, secondary, or adjacent to the mapped vegetation type (Thompson and others 1996).

Habitat	Code	Class	Elevation (m)	Major cover types	Description	Accuracy(%)
Montane	1111	Rocky Mountain Alpine Graminoid Tundra	>3500	Rock sedge (*Carex rupestris*) and Alpine sedge (*Kobresia myosuroides*)	Tundra vegetation dominated by grass-like species. Occurs at the highest elevations in the Sangre de Cristo Mountains	52%± 7.9%
	1112	Rocky Mountain Alpine Forb Tundra	>3500	Alpine avens (*Geum rossii*), Sierra Blanca cinquefoil (*Potentilla Sierra-blancae*) and Nailwort (*Paronychia pulvinata*)	Tundra vegetation dominated by forb species. Occurs at the highest elevations in the Sangre de Cristo Mountains	42% ± 7.8%
	2111	Subalpine Conifer Forest	2900-3600	Engelman spruce (*Picea engelmanii*) and Subalpine fir (*Abies lasiocarpa*)	Closed canopied forest dominated by evergreen needle-leaved, conical-crowned conifers	23% ± 7.1%
	2112	Subalpine Broadleaf Forest	2750-3600	Aspen (*Populus tremuloides*)	Closed canopied forests dominated by cold deciduous, broadleaf trees	64% ± 7.8%
	2121	Rocky Mountain Upper Montane Conifer Forest	2400-3000	Douglas fir (*Pseudotsuga menziesii*), White fir (*Abies concolor)*, and Blue spruce (*Picea pungens*)	Forests dominated by conical crowned conifers which generally form closed canopies	62% ± 7.0%
	2122	Rocky Mountain Lower Montane Conifer Forest	2000-2750	Ponderosa pine (*Pinus ponderosa*)	Forests dominated by rounded crown conifers which form open to closed canopies	64% ± 6.3%
	3111	Upper Montane Open Conifer Woodland	2600-3200	Bristlecone pine (*Pinus aristata*) and Limber pine (*P. flexilis*). Engelman spruce and Douglas-fir can also occur as canopy co-dominants	Woodlands dominated by rounded crowned conifers which form open to very open canopies. Only mapped at the highest elevations of the northern Sangre de Cristo Mountains	0% ± 0.0%
	4111	Rocky Mountain Montane Deciduous Scrub	1800-2750	Mountain mahogany (*Cercocarpus montanus*),Gambel oak (*Quercus gambelii*), andWavyleaf oak (*Q. undulatus*)	Shrublands of mid to lower elevations of mountainous and hilly regions. Common on sites that have been burned	39% ± 5.7%
	5110	Rocky Mountain Subalpine and Montane Grassland	usually> 3000	Mixed sedge (*Carex* spp.) and Thurber fescue (*Festuca thurberi*) or Arizona fescue (*F. arizonica*) and Mountain muhly (*Muhlenbergia montana*)	Grasslands distributed among the highest mountain tops in the state	17% ± 4.9%

Table 1 Cont'd.

Habitat	Code	Class	Elevation (m)	Major cover types	Description	Accuracy(%)
Wood-lands	3121	Rocky Mountain/Great Basin Closed Conifer Woodland	1600-2600	Pinyon pine (*Pinus edulis*)	Woodlands dominated by rounded crown, low-statured conifers that form moderately closed to moderately open canopies (>60% canopy cover)	31% ± 5.8%
	3122	Rocky Mountain/Great Basin Open Conifer Woodland (Savanna)	1600-2300	Oneseed juniper (*Juniperus monosperma*)	Woodlands dominated by rounded crown, low-statured conifers that form moderately open to very open canopies (25% to 50% canopy cover)	31% ± 6.0%
	3222	Madrean Open Oak Woodland (Encinal)	1400-2300	Gray oak (*Quercus grisea*), Arizona white oak (*Q. arizonica*), and Emory oak (*Q. emoryi*)	Woodlands dominated by rounded crown, broadleaf evergreen oaks that form moderately open to very open canopies (25-50% canopy cover). Within the study area, this class occurs only in the southern Jemez Mountains	19% ± 6.6%
Grass-lands/ Desert Scrub	4211	Great Basin Microphyllous Desert Scrub	1750-2400	Big sage (*Artemisia tridentata*) with Black sage (*A. nova*) and Bigelow sage (*A. begelovii*)	Shrublands dominated by microphyllous drought and cold tolerant shrubs	34% ± 6.2%
	4212	Great Basin Broadleaf Deciduous Desert Scrub	1200-2400	Fourwing saltbrush (*Atriplex canescens*) and Rubber rabbitbrush (*Chrysothamnus nauseosus*)	Shrublands dominated by drought and cold-tolerant broadleaf deciduous shrubs	35% ± 6.0%
	5121	Short Grass Steppe	1300-2300	Blue grama (*Bouteloua gracilis*) and Hairy grama (*B. hirsuta*)	Grasslands dominated by grasses usually less than a half meter tall	31% ± 6.5%
	5122	Mid-grass Prairie	1300-2600	Sideoats grama (*Bouteloua curtipenula*), New Mexico needlegrass (*Stipa neomexicanus*), Western wheatgrass (*Pascopyrun smithii*), Little bluestem (*Schizachyrium scoparium*) and Sand dropseed (*Sporobolus cryptandrus*)	Grasslands dominated by grasses between one half and one meter tall but in most of the study area, these are grazed much lower	16% ± 4.8%
	5211	Great Basin Foothill-Piedmont Grassland	1500-2400	Galleta (*Hilaria jamesii*) and Indian ricegrass (*Oryzopsis hymenoides*)	Grasslands of mountain foothills, mesa tops and piedmont slopes	18% ± 4.6%
	5212	Great Basin Lowland/Swale	1200-2400	Alkali sacaton (*Sporobolus airoides*)	Grasses of swales and mesa bottoms	29% ± 6.4%

Table 1 Cont'd.

Habitat	Code	Class	Elevation (m)	Major cover types	Description	Accuracy(%)
		Grassland				
	5221	Chihuahuan Desert Grassland	1300-1700	Black grama (*Bouteloua eripoda*) and Mesa dropseed (*Sporobolus flexuosus*)	Grasslands of mountain foothills, mesa tops and piedmont slopes. Occurs only south of the Jemez Mountains within the study area	33% ± 7.6%
Aquatic	6120	Southwest and Plains Forested/ Shrub Wetland	900-2100	Forested Wetland: Fremont cottonwood (*Populus fremontii*), Plains cottonwood (*P. sargentii*), Arizona walnut (*Juglans major*), Neatleaf hackberry (*Celtis reticulata*), and Arizona sycamore (*Platanus wrightii*). Shrub Wetland: Coyote willow (*Salix exigua*) and Seepwillow (*Baccharis glutinosa*) with Russian olive (*Elaeagnus angustifolia*) and Saltcedar (*Tamarix* spp.) as major exotic cover types	Vegetation dominated by woody species primarily associated with the interior Southwest and Plains biogeographic provinces	31% ± 5.3%
	9120	Irrigated Agriculture	—	—	May contain inclusions of native riparian vegetation in river valleys, or plowed fields classified as barren	—
	9410	Riverine/Lacustrine	—	—	Rivers, stream, and lakes. Streams and rivers less then about 90 feet in width may not be identified	45% ± 5.0%
	9420	Basin/Playa	—	—	Drainage basins, playas, stock tanks. Mapped only on the east side of Sangre de Cristo Mountains in the study area	42% ± 10.3%

a)

b)

Figure 5—Predicted (a) and reported (b) distribution maps for the little brown bat (*Myotis lucifugus*) in the Southern Rocky Mountains of New Mexico. Predicted distribution from the New Mexico Gap Analysis Project (Thompson and others 1996). Reported locations from Findley and others (1975). Bold boundaries delineate the 3 mountain ranges shown in figure 1.

topographic maps at a 1:100,000 scale. This procedure produced maps of georeferenced point occurrences for each species (e.g., figure 5B), which we combined to produce distributional coverages for whole taxonomic groups. Point maps for amphibians and reptiles were provided by Thompson and others (1996) based on data from Degenhardt and others (1996). If available, each record of occurrence (corresponding with a point in the coverage) contains county of occurrence, site description, date of collection or observation, collector/observer identification, data source, and location of voucher specimens. Species' presence/absence by mountain range (appendix B) was generated from the point coverages using spatial query operations in ArcView.

A total of 263 birds, 97 mammals, 49 reptiles, 13 amphibians, 12 fish, and 182 species of butterflies were predicted or reported to occur in the SRMNM (appendix A1-A-6). Additional species of fish have been reported from the primary reaches of the Rio Grande and Chama Rivers (Sublette and others 1990) but are excluded from our species list and analysis because these rivers do not enter the mountains.

Predicted and reported occurrences of species are not completely independent. Species' geographic ranges, used to model predicted occurrence, were defined initially by the point data contained in some of the references listed in table 2 (Thompson and others 1996). Hydrologic units were included as part of a species' range if the species had been reported anywhere within the unit, except where accounts of reported occurrence were made only at the edge of a unit. The range maps that resulted from this initial effort were modified (sometimes greatly) for many species following review by wildlife biologists with extensive knowledge of the New Mexican fauna (Thompson and others 1996).

Classifying Species to Habitat Affinity Groups

To test the hypotheses outlined above, we assigned species to 1 of 3 habitat affinity groups: montane specialist, habitat generalist, and aquatic specialist. We assigned vertebrates to these groups using information on species' associations with vegetation types from the New Mexico Gap Analysis Project (Thompson and others 1996) (appendix C). Butterflies were assigned to groups using information provided by Cary and Holland (unpublished report). Within the study area, species only showed notable specialization at the level of major physiognomic classes (e.g., forest, woodland, grassland, and desert scrub) and the majority of species are broad generalists over these. Only the American bittern (*Botaurus lentiginosus*), American dipper (*Cinclus mexicanus*), Sora (*Porzana carolina*), water shrew (*Sorex palustris*), mink (*Mustela vison*), slider

Table 2—Sources of reported species distributional data used in the analysis of faunal differentiation in the Southern Rocky Mountains of New Mexico study area.

Taxon	Sources
Birds	North American Breeding Bird Survey (unpublished data) North American Bird Banding Laboratory (unpublished data) Museum of Southwestern Biology, Division of Birds (unpublished data) New Mexico Natural Heritage Program (unpublished data) Travis (1992) Pat Kennedy (unpublished data)
Mammals	Findley and others (1975) Hall (1981) Bogan and others (1996) Joan Morrison (unpublished data)
Amphibians and Reptiles	Degenhardt and others (1997) New Mexico Department of Game and Fish (1998)
Fishes	Sublette and others (1990)
Butterflies	Holland and Carey (1996) Swengel and Opler (1997) Toliver and others (1994)

(*Trachemys scripta*), canyon treefrog (*Hyla arenicolor*), and western toad (*Bufo boreas*) are associated with a single mapped habitat type. Montane specialists were defined as species restricted to one or more montane habitats, defined as any vegetation type occurring above the pinyon-juniper woodland zone, beginning at about 2500 m in the SRMNM (Peet 1988) (see appendix C). Habitat generalists were defined as species that use some combination of montane, woodland, and lowland habitat types. These species may also use aquatic habitats, but are not restricted to them. Aquatic specialists are defined as species associated entirely, or nearly entirely, with open water, riparian forest, or wetland habitats.

Measuring Faunal Differentiation

The measurement of faunal differentiation often involves using indices to numerically capture the differences among the faunas of 2 or more habitat patches in a region (e.g., Whittaker 1960; Harrison and others 1992). Understanding the physical and biological mechanisms that generate differentiation patterns involves analysis of potential geo-spatial or ecological covariates. For example, degree of differentiation has been shown in some cases to be correlated with distance between sampling sites (e.g., Flessa 1981; Stork 1987; Harrison and others 1992).

Numerous indices of similarity and differentiation have been applied to studies of biological association, especially where large numbers of species are involved (see Wolda 1981; Shmida and Wilson 1984; and Magurran 1988 for reviews). Indices that use information on presence/absence (i.e., data that can be displayed in matrix form with 1s representing presence and 0s absence [e.g., appendix B]) differ in that some emphasize similarities among faunas, while others emphasize differences. Indices of faunal differentiation are generally more useful in testing hypotheses about controls on species distributions and are best used where potential causal factors may be isolated (Schaeffer and Perry 1986). Since we were interested in faunal differentiation and potential biological covariates of variation in differentiation among taxa, we used an index (N_c) developed by Wright and Reeves (1992) that maximizes faunal differences between mountain ranges:

$$N_c = \sum_{i=1}^{K-1} \sum_{m=i+1}^{K} \sum_{j=1}^{S} X_{ij} X_{mj} \qquad (1)$$

where K is the number of sites being compared and S the total number of species among all sites. The X_s are equal to 1 for presence or 0 for absence of species j at sites i and m. Thus, N_c is equal to the sum of the number of species shared across all pairs of sites. Note that a pair of sites only contributes to the sum when 1 or more species is present in both sites (i.e., when X_{ij} and X_{mj} both equal 1). N_c can be converted to a standardized metric (D) to permit comparisons among suites of species varying in richness or in number of sites:

$$D = 100 - \left(\frac{N_c - E(N_c)}{Max(N_c) - E(N_c)} 100 \right) \qquad (2)$$

where $E(N_c)$ is the expected value of N_c if species were randomly distributed among sites, and Max(N_c) is the maximum value that N_c can take. D is 0 when all faunas are equivalent in species composition or when smaller faunas always comprise subsets of larger faunas. D is a positive value only when 1 or more pairs of sites each contain species not present in the other site. D normally varies between 0 and 100, however it can exceed 100 when species' distributions are hyper-dispersed (i.e., where faunas at sites are more unique than expected under random distributions). Unlike many indices of similarity or differentiation, which are only suitable for measuring differences between pairs of sites (e.g., Jaccard's Index) (Magurran 1988), D can be applied to any number of sites.

Potential Sources of Error

Delineating species' geographic ranges or quantifying patterns of habitat occupancy across a landscape is controversial and imprecise (Rapoport 1982). This imprecision is caused, in part, by the kinds of data and procedures used to estimate species distributions. Museum collections or observation records provide precise information on the location of any given sighting. However, these types of data can bias estimates of species presence or absence because of unequal sampling effort or because of errors in specimen or site identification. Furthermore, these data are composed of historic accounts of occurrence and can introduce error if species distributions have changed over time.

Predicting species distributional patterns based on knowledge of habitat requirements can help extrapolate occurrence into unsampled areas. However, while a species distribution can be predicted across its range regardless of the reporting frequency, we may lose some accuracy due to errors in mapping vegetation and to limitations in our knowledge of the factors determining a species' distribution (e.g., Verner and others 1986; VanHorne and Wiens 1991). Error rates associated with the vegetation map used by the New

Mexico Gap Analysis Project vary substantially among vegetation types, with agreement between mapped vegetation types and vegetation observed on the ground ranging from 0% to 64% for vegetation types in the study area (table 1). Species-habitat relationships have not been determined for many obscure taxa (e.g., amphibians, bats, insectivorous mammals, and invertebrates). Even for well-studied groups, strong patterns of habitat affinity can be clouded by numerous ecological factors (e.g., interspecific interactions, spatial arrangement of habitat, and temporal dynamics) that are unrelated to vegetation characteristics. Furthermore, vegetation may be less important to many species of small mammals and reptiles than are physical features such as slope, substrate type, or soil structure.

Given the uncertainty in both types of data, it is difficult to determine which more accurately represents current species distributions. To a large degree, accuracy will depend on the spatial scale at which the data are analyzed (Thompson and others 1996). We are unaware of any studies that have attempted to validate the predictions made by the New Mexico Gap Analysis models at any scale. However, Edwards and others (1996) compared predicted occurrence from the Utah Gap Analysis Project with long-term species lists from 8 national parks in Utah. Their results suggest that errors of commission (predicting a false occurrence of a species) outnumbered errors of omission (failing to predict a true occurrence) for all 4 terrestrial vertebrate classes, and that total number of errors decreased with increasing park size. Likewise, we suspect that, at the scale of our study, errors of commission will outnumber errors of omission in faunal lists from maps of predicted occurrence. This is because the spatial units used to define species geographic ranges (8-digit USGS hydrologic units) are large enough to encompass 2 or more mountain ranges, although a species may actually have been reported from fewer ranges. Errors of omission are likely to outnumber errors of commission in lists of reported occurrence because the greatest source of uncertainty in these data probably arises from incomplete sampling of mountain ranges (e.g., see Grayson and Livingston 1993; Lawlor 1998)

In general, errors of omission will reduce estimates of local species richness and increase estimates of faunal differentiation if different species are omitted from lists in different mountain ranges. Figure 5 illustrates this point for the little brown bat. Alternatively, errors of commission increase estimates of local species richness but may decrease estimates of faunal differentiation if many species are predicted to occur in more ranges than they actually do. We present measures of faunal differentiation for both types of data under the assumption that they bound actual levels of faunal differentiation among the 3 mountain ranges.

Results

For most taxa, the majority of species predicted to occur within the study area have also been reported as occurring there (table 3). Only 8 species, including 7 birds and 1 reptile, have been reported but are not predicted to occur in the SRMNM. Of these, the yellow mud turtle (*Kinosternon flavescens*) has only one record of occurrence in the region (in the Jemez Mountains) and this appears well outside of its normal distribution in the state (Degenhardt and others 1996). Most likely, this occurrence is the result of accidental or intentional introduction. Similarly, 4 of the 7 bird species, the black-chinned sparrow (*Spizella atrogularis*), clay-colored sparrow (*Spizella pallida*), Bonaparte's gull (*Larus philadelphia*), and the eastern meadowlark (*Sturnella magna*) have only been reported once in the study area, which suggests that these are unusual or accidental occurrences in this region although not in the state.

Table 3—Comparison of predicted and reported numbers of species by taxonomic group for the Southern Rocky Mountains of New Mexico. "ND" indicates no data were available on predicted occurrence.

Number of species	Birds	Mammals	Reptiles	Amphibians	Fishes	Butterflies
Reported and predicted	219 (83%)	89 (94%)	36 (73%)	13 (100%)	ND	ND
Reported not predicted	7	0	1 (2%)	0 (0%)	ND (2%)	ND 0%
Predicted not reported	37 (15%)	8 (6%)	12 (24%)	0 (0%)	ND	ND
Total	263	97	49	13	12	182

By contrast, 57 species (37 birds, 8 mammals, and 12 reptiles) were predicted to occur in the SRMNM but have not been reported, according to the data sources reviewed in this study. All 8 mammals, and 9 of the 12 reptiles have mapped distributions that are only marginal to the SRMNM. Five species, the desert shrew (*Notiosorex crawfordi*), Merriam's kangaroo rat (*Dipodomys merriami*), rock pocket mouse (*Chaetodipus intermedius*), massasauga (*Sistrurus catenatus*), and the longnose snake (*Rhinocheilus lecontei*), reach the northern limits of their New Mexico distributions in this region. By contrast, only 5 of the 37 bird species, Baird's sparrow (*Ammodramus bairdii),* Chihuahuan raven *(Corvus cryptoleucus),* grasshopper sparrow *(Ammodramus savannarum),* red-headed woodpecker *(Melanerpes erythrocephalus*), and upland sandpiper *(Bartramia longicauda),* are marginal to the SRMNM. The others are predicted to occur widely throughout the region.

As we suspected, use of predicted occurrences resulted in higher species richness estimates (table 4) and lower faunal differentiation estimates (table 5) when compared to reported occurrence. Differences between values of *D* for predicted and reported occurrence range from 0 to 118, with an average difference of 56.

Patterns of Species Richness

Overall, the Sangre de Cristo Mountains supported the largest number of terrestrial and aquatic vertebrates and butterflies combined (table 4). However, patterns of species richness across mountain ranges varies among taxonomic groups, and to some degree between the two types of distributional data. Predicted numbers of birds and mammals were highest in the Sangre de Cristo Mountains, while the largest numbers of reptiles and amphibians were predicted for the Jemez Mountains. Reported numbers of birds were highest in the Jemez Mountains, as were reptiles and amphibians, while the largest numbers of mammals, fish, and butterflies were reported from the Sangre de Cristo Mountains.

Table 4—Numbers of predicted and reported species by habitat affinity group in the Southern Rocky Mountains of New Mexico. Italic numbers indicate the largest value within each group by each data type. "ND" indicates that no data were available.

		Predicted			Reported		
Taxon	Habitat group	Jemez	San Juan	Sangre de Cristo	Jemez	San Juan	Sangre de Cristo
Birds	All species	240	230	*243*	*169*	160	161
	Montane specialists	4	4	*5*	3	3	*5*
	Habitat generalists	157	148	*159*	*136*	116	127
	Aquatic specialists	*79*	78	*79*	30	*41*	29
Mammals	All species	84	82	*88*	61	63	*68*
	Montane specialists	9	*11*	*11*	7	10	*11*
	Habitat generalists	70	67	*71*	52	50	*54*
	Aquatic specialists	5	4	*6*	3	3	*4*
Reptiles	All species	*44*	32	41	*29*	19	23
	Montane specialists	0	0	0	0	0	0
	Habitat generalists	*39*	29	34	*25*	17	20
	Aquatic specialists	5	3	*7*	*4*	2	3
Amphibians	All species	*12*	8	9	*11*	7	8
	Montane specialists	*1*	*1*	0	*1*	*1*	0
	Habitat generalists	*7*	5	6	*7*	4	5
	Aquatic specialists	*4*	2	3	*3*	2	*3*
Fishes	All species	ND	ND	ND	7	8	*12*
Butterflies	All species	ND	ND	ND	147	100	*157*
	Montane specialists	ND	ND	ND	14	18	*29*
	Habitat generalists	ND	ND	ND	*113*	72	108
	Aquatic specialists	ND	ND	ND	6	4	*8*
All Taxa	All species	405	326	*412*	428	360	*436*
	Montane specialists	14	*17*	*17*	25	30	*43*
	Habitat generalists	*272*	224	265	290	257	*313*
	Aquatic specialists	94	87	*132*	58	50	*66*

Table 5—Measures of faunal differentiation for predicted and reported species presence/absence data for the Southern Rocky Mountains of New Mexico. *S* = number of species in each comparison. *D* = faunal differentiation (Eq. 2). Delta (Δ) is the difference in predicted and reported *D*. *D* was not calculated for fewer than 3 species (indicated by "—"). "ND" indicates that no data were available.

		Predicted		Reported		
Taxon	**Habitat group**	***S***	***D***	***S***	***D***	**Δ**
Birds	Montane specialists	5	0	5	0	0
	Habitat generalists	161	27	153	69	42
	Aquatic specialists	80	0	59	118	118
Mammals	Montane specialists	11	0	11	0	0
	Non-volant habitat generalists	58	42	52	87	45
	Bats (all generalists)	16	0	15	78	78
	Aquatic specialists	6	0	5	84	84
Reptiles	Montane specialists	0	—	0	—	—
	Habitat generalists	40	34	30	93	59
	Aquatic specialists	8	47	7	122	75
Amphibians	Montane specialists	2	—	2	—	—
	Habitat generalists	7	0	7	0	0
	Aquatic specialists	4	0	4	114	114
Fishes	All species	ND	ND	12	0	
Butterflies	Montane specialists	ND	ND	31	85	
	Habitat generalists	ND	ND	125	81	
	Aquatic specialists	ND	ND	9	61	

Within habitat association groups, patterns of species richness are similar to those of whole faunas except for the reported occurrence of montane and aquatic birds, aquatic reptiles, and generalist butterflies. The maximum diversities of these groups occurred in mountain ranges other than those of all species combined.

Patterns of Faunal Differentiation

Montane Specialists

Contrary to our hypothesis, predicted and reported occurrence of montane specialists indicated a complete lack of faunal differentiation with $D = 0$ for birds and mammals (table 5). The small number of montane amphibians (2 species), and the absence of montane reptiles in the SRMNM precluded involvement of these taxa in the comparison. For birds and mammals, Jemez species comprised a subset of the larger San Juan and Sangre de Cristo faunas. That is, the San Juan and Sangre de Cristo Mountains contained all species of montane birds and mammals present in the Jemez Mountains plus additional species not present in the Jemez Mountains. These relationships are evident by examining the distributions of these taxa in appendix B. For predicted occurrence, montane mammal faunas of the San Juan and Sangre de Cristo Mountains were equivalent, while 2 species present in these ranges, the heather vole (*Phenacomys intermedius*) and snowshoe hare (*Lepus americanus*), were absent from the Jemez Mountains. These 2 species were also absent from our records of reported occurrence for the Jemez Mountains, along with the American marten (*Martes americana*) and the meadow vole (*Microtus pennsylvanicus*), the latter of which was also not reported from the San Juan Mountains. All 5 montane specialist bird species were predicted and reported to occur in the Sangre de Cristo Mountains. The white-tailed ptarmigan (*Lagopus leucurus*) was absent in predicted occurrence from the San Juan and Jemez Mountains due to lack of suitable alpine habitat. The boreal owl (*Aegolius funereus*) was reported only from the Sangre de Cristo Mountains, although it was predicted to occur in all 3 ranges.

Contrary to our results for birds and mammals, montane butterfly faunas exhibited a high degree of faunal differentiation ($D = 85$). Most of this is attributable to differences between the Jemez and San Juan faunas. Six species reported from the Jemez Mountains were not reported from the San Juan Mountains, and 7 species reported from the San Juans were not

reported from the Jemez Mountains. One species, the silver-bordered fritillary (*Boloria selene)*, was reported only from the Jemez Mountains.

Aquatic Specialists

A lack of faunal differentiation was observed in predicted occurrence of birds, mammals, and amphibians and in reported occurrence of fish (table 5). For predicted occurrence, differentiation is lower in aquatic birds and mammals than habitat generalists of these taxa but equal to amphibians because generalist amphibians also lack differentiation. These results support in part, our second hypothesis, however differentiation of aquatic birds and mammals are equal, not less than, those of montane specialists, which also exhibited a lack of differentiation.

By contrast, differentiation among aquatic specialists in reported occurrence is higher than all other habitat affinity groups for all taxonomic groups except butterflies and non-volant mammals. For all taxonomic groups (except fishes and butterflies), aquatic specialists exhibited the largest differences in faunal differentiation between predicted and reported occurrence, which suggests either a large number of unreported occurrences or substantial errors of commission in predicted occurrence.

Habitat Generalists

Among habitat generalists, *D* varies from 0 (predicted and reported occurrence of amphibians) to 93 (reported occurrence of reptiles) (table 5), and the relationship between faunal differentiation and dispersal ability generally agrees with our hypothesized pattern. For both predicted and reported occurrence data sets, birds and bats exhibited a lower degree of differentiation than reptiles and non-volant mammals. For reported occurrence, differentiation among mammals was less than that of reptiles, although the reverse was true for predicted occurrence. Contrary to prediction, amphibians exhibited a lack of differentiation in both predicted and reported occurrence.

Bats also exhibited a lack of differentiation in predicted occurrence, owing to the fact that 15 of the 16 species were predicted in all 3 mountain ranges. However, differentiation was high (D = 78) for reported occurrence. Although 14 of the 15 species reported in the SRMNM occurred in the Jemez Mountains, only 8 and 10 of these species have been reported from the San Juan and Sangre de Cristo Mountains, respectively, and these tend to be different species (appendix B).

Discussion

Predicted Versus Reported Species Occurrence

Extrapolating species occurrence into unsampled areas based on models of habitat association have the potential to overestimate species richness and underestimate faunal differences between sites. By contrast, under-sampling populations where they actually occur, is likely to underestimate species richness and overestimate faunal differences between sites. Two lines of evidence suggest that both types of error influenced the data sets we examined. First, estimates of species richness were higher and measures of faunal differentiation (Eq. 2) were lower using data on predicted versus reported species occurrence. Secondly, we predicted that errors of commission (false predictions in species occurrence) would be greater than errors of omission (failing to predict actual occurrences) in species lists derived from predicted species distributions. Errors of commission appear to be the cause for most discrepancies in species lists of mammals and reptiles because the predicted distributions of most unreported species were only marginal to the study area. Species tend to become rare at the limits of their ranges, making predictions of occurrence more susceptible to error. However, for most of the 37 unreported bird species, discrepancies between predicted and reported occurrence were probably due to undersampling. This was suggested by the widespread predicted distribution of most of these species in the SRMNM and by the fact that much of our locational data for this taxon originated from surveys of breeding birds, while only 9 of the unreported species are known to breed in the region (Thompson and others 1996).

It is important to remember that species lists are based on historic and current information. Species ranges do not remain static; a fact that is underscored by the many changes that have occurred in the Southwest over the last 100 years (Brown and Davis 1995). Within a species' range, local populations are often in temporal flux between extinction and recolonization. The temporal and spatial scales over which these processes operate are generally not well understood. Furthermore, various forms of human disturbance, such as fire suppression, habitat alteration, livestock grazing, predator removal, and other factors (Foxx 1981;

Allen 1989; Wolters 1996), have recently influenced the composition of natural communities in the SRMNM. The extirpations of species, including the black-footed ferret (*Mustela nigripes*), gray wolf (*Canus lupus*), grizzly bear (*Ursus arctos*), wolverine (*Gulo gulo*), and river otter (*Lutra canadensis*), are well documented (USDA Forest Service 1986). Another possible example of a recent extirpation is the black-tailed prairie dog (*Cynomys ludovicianus*), which was last formally reported in the SRMNM in 1916 (Findley and others 1975).

These factors, along with errors in the vegetation map and incomplete knowledge of species associations with different vegetation types, can lead to errors in predicted occurrence. Furthermore, factors such as substrate and soil type may be stronger determinants of distribution for many small mammals and reptiles than vegetation. Small scale delineation of species habitats and improved models for predicting species distributions will be important for protecting the habitats of many species.

Resolving discrepancies between predicted and reported occurrence and validating prediction models can be best accomplished with further field surveys, although additional information may be obtained from recent museum collections and literary sources not included in our analysis. Special effort is needed to acquire distributional information on species with no recent records of occurrence and on species at the edge of their distribution in the study area. The magnitude of differences in measures of faunal differentiation between predicted and reported occurrence could be used to identify groups of species to target in future field surveys. For example, in our analysis, we found that the largest discrepancies between these measures existed among bats and aquatic specialists of all taxa. The latter group represents a large portion of the regional fauna. Another approach might focus on smaller groups of species whose distributions and habitat associations are poorly understood (e.g., insectivorous mammals, some of the butterflies).

Patterns of Species Richness

Recently, conservationists have focused on a search for indicator taxa—species whose distributions can be used as a surrogate for species whose distributions are less well-known (see Flather and others 1997 for a review of indicator taxa in biodiversity conservation). Birds, butterflies, and mammals are used most often as indicators of species distributions in other taxa (Scott and others 1993; Sisk and others 1994; Long and others 1996). However, results from our analysis suggest that patterns of species richness observed for any one taxonomic group do not generally indicate similar patterns for other taxa. For example, patterns of species richness in reported occurrence for amphibians and reptiles were similar to birds, but those of butterflies were similar to mammals. Furthermore, patterns of species' distributions within habitat types may also differ from overall patterns. For example, we found the diversity of habitat generalist butterflies (the largest component of the regional butterfly fauna) to be highest in the Jemez Mountains, while total butterfly diversity was highest in the Sangre de Cristo Mountains.

Patterns of Faunal Differentiation

For terrestrial vertebrates, comparisons among taxa suggest that variation in faunal differentiation in the SRMNM was associated more strongly with differences in dispersal ability than with potential differences in habitat composition among mountain ranges. Errors in the vegetation map and limitations in our knowledge of species-habitat associations might have affected the validity of these conclusions. However, the scale of this analysis, the occurrence of most vegetation types in all 3 mountain ranges, and the fact that most terrestrial vertebrate species in the SRMNM are broad habitat generalists, minimized the potential influence of these problems. The only species whose distribution is clearly limited by its requirement for habitat not present throughout the region is the white-tailed ptarmigan, which is restricted to alpine tundra habitats present only in the Sangre de Cristo Mountains.

Relationships between faunal differentiation and dispersal ability were consistent with 2 out of the 3 hypotheses we tested. These included a negative relationship between dispersal ability and differentiation among habitat generalists and a lack of faunal differentiation among aquatic specialists (in predicted but not reported occurrence).

The inverse relationship between dispersal ability and faunal differentiation among habitat generalists suggest that limitations to dispersal are experienced by some species, despite a relatively high degree of connectivity among woodland habitats in the landscape. Although we presumed amphibians as a group to be the poorest dispersers among habitat generalists, we observed a complete lack of differentiation in this group, as we did in fishes and the predicted occurrence of aquatic specialists of most taxa. One plausible explanation for the lack of differentiation in the generalist amphibian faunas and aquatic specialists is dispersal through the region's highly connected riverine systems.

The high degrees of differentiation measured in reported occurrence of aquatic specialists (not including fish) (average D = 99.8) were unexpected and deviated sharply from values obtained for predicted occurrence (average D = 11.8). It is possible that the distributions of aquatic specialists as a whole, have been less well documented than those of the other habitat associations groups.

Also contrary to what we hypothesized, was a lack of differentiation among montane birds and mammals. These results might be better understood if we consider the changes that have occurred in the distribution of montane forests of the Southwest in recent geologic time. During the last glacial episode, prior to the end of the Pleistocene 10,000 to 12,000 years ago, subalpine conifer forests were broadly and continuously distributed across most of north-central New Mexico, and mixed conifer forests occupied most of the middle and lower elevations (Van Devender and others 1987). Dispersal by montane species between mountain ranges would have been relatively unimpeded at that time and it is very likely that all 3 mountain ranges in the SRMNM contained the same faunal contingent. However, as climates became warmer, forests became restricted to the higher elevations. Woodland and lowland vegetation invaded from the south, filling in the low and middle elevations to produce the landscape patterns we see today (Van Devender and Spaulding 1979). Stochastic extinctions of forest-dependent species likely followed forest fragmentation and isolation of montane habitats, causing mountain ranges like the Jemez to lose a portion of their former faunas (Patterson 1984; Patterson and Atmar 1986). Thus, differences in faunal composition are likely to be influenced more by local extinctions than a failure to colonize mountain ranges. Because extinction risk is correlated with habitat area (as reviewed by Diamond 1984), a smaller, more isolated mountain range like the Jemez would be expected to lose more species than the San Juan and Sangre de Cristo Mountains, which are larger and more closely connected to Rocky Mountain montane habitats to the north. Although montane mammals of the San Juan Mountains appeared to contain fewer species than the Sangre de Cristo Mountains, this was probably an artifact of incomplete sampling due to limiting our analysis to the New Mexican portion of these mountain ranges. In their analysis, which included the whole of the Southern Rocky Mountains along with the smaller ranges to the south of the SRMNM, Patterson and Atmar (1986) report fewer species of montane mammals in the Sangre de Cristo Mountains than the San Juan Mountains, which contain a complete Southern Rocky Mountain montane fauna.

Differences in habitat composition and disturbance history may be more important determinants of butterfly distributions and patterns of differentiation in the SRMNM than for terrestrial vertebrates. Butterflies differed greatly from vertebrates in patterns of differentiation. Most notably, montane butterflies of the Jemez Mountains are not subsets of the San Juan or Sangre de Cristo Mountains. Although they are of Rocky Mountain origin (Cary and Holland, unpublished report), 15 species have been reported from the Jemez Mountains but nowhere else in the SRMNM. For this reason, montane butterflies exhibited a higher degree of differentiation than either habitat generalists or aquatic specialists. However, we do note that in the absence of variance estimates on D, the significance of such differences in differentiation can not be judged.

There are several possible explanations for the relatively high levels of differentiation observed among montane butterflies. First, our species lists for the San Juan and Sangre de Cristos were incomplete. We only document occurrence of species in New Mexico, while a large portion of these mountain ranges lie in southern Colorado. Second, habitat specificity (i.e., dependence on particular larval host plants) is generally higher among butterflies than vertebrates (Wilcox and others 1986). Thus, the distributions of butterfly species may be influenced as much by differences in habitat availability among mountain ranges as by dispersal ability. Third, the ranges of many butterfly species may be comparatively more restricted than those of vertebrates in general, making them more susceptible to local forms of disturbance. For example, the Nokomis fritillary (*Speyeria nokomis*), a New Mexico State Species of Concern, is restricted to scarce montane wetland habitats that are vulnerable to adverse changes such as drainage for cultivation or excessive livestock grazing (Holland and Cary 1996). Finally, the persistence of undisturbed habitats in Los Alamos County in the Jemez Mountains might explain the unique occurrence of many butterfly species reported in the Jemez Mountains. Due to the restrictions placed on land use since the middle of World War II, it is possible that this area is a de facto refuge for species whose populations have declined or disappeared elsewhere (Holland and Cary 1996).

Implications for Biodiversity Assessment and Management

Variation in faunal differentiation and the patterns that emerge from it have important implications for biodiversity assessments in general, and for management of biodiversity in the SRMNM in particular.

Because some species groups (as defined by taxonomy and habitat affinity) show high degrees of faunal differentiation (table 5), maintaining the uniqueness of these faunas across the region will require a broad geographic focus and cooperative management among national forests, forest districts, and other landownerships.

A common strategy for regional biodiversity assessment and management is to judiciously select a species or group of species as an indicator for all other taxa (Flather and others 1997; Reid 1998). The indicator concept is generally applied to patterns of species richness, not to differences in faunal composition. The identity of a suitable indicator taxon for monitoring changes in species richness is not suggested by comparisons among the vertebrate and invertebrate taxa examined in this study. Patterns of species richness among both reported and predicted occurrence suggest that no single taxonomic group is an indicator of all other taxa (table 4).

However, relationships among taxa, with respect to patterns of faunal differentiation, may allow us to identify groups of species that are especially vulnerable to regional extirpation as a result of habitat fragmentation. For example, among forest species able to use habitats at middle and lower elevations (habitat generalists), combinations of relatively poor dispersal ability and high degree of faunal differentiation, such as we see in reptiles and mammals (table 5), may be good indicators of local and regional extinction risk. This is because immigration rates are relatively low for poorer dispersers and sources of immigrants are generally few compared with faunal groups possessing stronger dispersal abilities and lower levels of differentiation. Therefore, changes in faunal differentiation within groups such as these may be early warnings for other taxa of the effects that habitat fragmentation may have on the compositional patterns of regional biodiversity, particularly as these changes affect the distribution of habitat corridors both within and between mountain ranges.

The distribution of mammalian montane specialists from the Jemez Mountains (appendix B) may be the result of extinctions over the last 10,000 to 12,000 years, following fragmentation of forest habitats in the Southern Rocky Mountains as climates became warmer and drier (Patterson 1984; Patterson and Atmar 1986). The absence of species, such as the heather vole and snowshoe hare from the Jemez Mountains, which occur today in the Sangre de Cristo and San Juan Mountains, supports the theory that the frequency of successful colonization of the Jemez Mountains by montane specialist mammals is low (Patterson 1984; Patterson and Atmar 1986). This suggests that further extinctions of mammalian montane specialists in the Jemez Mountains are unlikely to be reversed by immigration from nearby mountain ranges except over very long periods of time (Patterson and Atmar 1986). Preservation of habitat in sufficient quantity and quality will be necessary to preserve viable populations of these species over the long run.

The high degree of differentiation among montane butterfly species (table 5) suggests that their distributions are more tightly correlated with those of finer-grained resources than are montane birds and mammals (Wilcox and others 1986). If this is true, then butterfly occurrence may be less predictable in time and space and more susceptible to disturbance by factors such as livestock grazing (Holland and Cary 1996). For this reason, it may be important to preserve habitat for these species even if there is no current occupancy (Smallidge and Leopold 1997). However, implementation of this recommendation will require a more comprehensive understanding of butterfly life histories and habitat requirements than presented in this report.

Finally, efforts should be made to improve the species database and to complete verification studies for questionable species occurrences in the field. Overall, there are large differences between measures of differentiation in predicted and reported occurrence (table 5), the average being equal to 56. These differences call for properly planned field surveys to better document species distributions, and for further studies of species-habitat relationships for species whose habitat requirements are not well known so that species-habitat prediction models may be improved. Discrepancies between predicted and reported occurrence could be used to indicate where future survey efforts are needed. For example, results of this analysis indicate that greater information is needed on the distribution of bat species in particular (D = 78) and aquatic vertebrates in general (average D = 98).

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Appendix A1. Birds of the Southern Rocky Mountains of New Mexico by predicted and reported occurrence. FE: Federally Endangered; FT: Federally Threatened; FC: Federal Candidate; SE: State Endangered; ST: State Threatened; SOC: New Mexico Species of Concern; Sen: Forest Service Region 3 Sensitive (New Mexico Department of Game and Fish 1998). Common and scientific names follow the American Ornithologists' Union, Committee on Classification and Nomenclature (1998).

Common Name	Scientific Name	Status	Predicted	Reported
Acorn woodpecker	*Melanerpes formicivorus*		Y	Y
American avocet	*Recurvirostra americana*		Y	Y
American bittern	*Botaurus lentiginosus*	Sen	Y	
American coot	*Fulica americana*		Y	Y
American crow	*Corvus brachyrhynchos*		Y	Y
American dipper	*Cinclus mexicanus*		Y	Y
American goldfinch	*Carduelis tristis*		Y	Y
American kestrel	*Falco sparverius*		Y	Y
American pipit	*Anthus rubescens*		Y	Y
American robin	*Turdus migratorius*		Y	Y
American tree sparrow	*Spizella arborea*		Y	Y
American white pelican	*Pelecanus erythrorhynchos*		Y	
American wigeon	*Anas americana*		Y	Y
Ash-throated flycatcher	*Myiarchus cinerascens*		Y	Y
Baird's sandpiper	*Calidris bairdii*		Y	Y
Baird's sparrow	*Ammodramus bairdii*		Y	
Bald eagle	*Haliaeetus leucocephalus*	FT, ST, Sen	Y	Y
Band-tailed pigeon	*Columba fasciata*		Y	Y
Bank swallow	*Riparia riparia*		Y	Y
Barn owl	*Tyto alba*		Y	Y
Barn swallow	*Hirundo rustica*		Y	Y
Belted kingfisher	*Ceryle alcyon*	Sen	Y	Y
Bendire's thrasher	*Toxostoma bendirei*		Y	
Bewick's wren	*Thryomanes bewickii*		Y	Y
Black phoebe	*Sayornis nigricans*			Y
Black swift	*Cypseloides niger*		Y	Y
Black tern	*Chlidonias niger*	SOC	Y	
Black-bellied plover	*Pluvialis squatarola*		Y	
Black-billed magpie	*Pica pica*		Y	Y
Black-capped chickadee	*Poecile atricapillus*		Y	Y
Black-chinned hummingbird	*Archilochus alexandri*		Y	Y
Black-chinned sparrow	*Spizella atrogularis*			Y
Black-crowned night-heron	*Nycticorax nycticorax*	Sen	Y	Y
Black-headed grosbeak	*Pheucticus melanocephalus*		Y	Y
Black-necked stilt	*Himantopus mexicanus*	Sen	Y	Y
Black-throated gray warbler	*Dendroica nigrescens*		Y	Y
Black-throated sparrow	*Amphispiza bilineata*		Y	
Blue grosbeak	*Guiraca caerulea*		Y	Y
Blue grouse	*Dendragapus obscurus*		Y	Y
Blue-gray gnatcatcher	*Polioptila caerulea*		Y	Y
Blue-winged teal	*Anas discors*		Y	Y
Bonaparte's gull	*Larus philadelphia*			Y
Boreal owl	*Aegolius funereus*		Y	Y
Brewer's blackbird	*Euphagus cyanocephalus*		Y	Y
Brewer's sparrow	*Spizella breweri*		Y	Y
Broad-tailed hummingbird	*Selasphorus platycercus*		Y	Y
Brown creeper	*Certhia americana*		Y	Y
Brown-capped rosy-finch	*Leucosticte australis*		Y	
Brown-headed cowbird	*Molothrus ater*		Y	Y
Bufflehead	*Bucephala albeola*		Y	Y
Burrowing owl	*Athene cunicularia*	SOC	Y	
Bushtit	*Psaltriparus minimus*		Y	Y

Appendix A1. (Cont'd.)

Common Name	Scientific Name	Status	Predicted	Reported
Calliope hummingbird	*Stellula calliope*		Y	Y
Canada goose	*Branta canadensis*		Y	Y
Canvasback	*Aythya valisineria*		Y	Y
Canyon towhee	*Pipilo fuscus*		Y	Y
Canyon wren	*Catherpes mexicanus*		Y	Y
Cassin's finch	*Carpodacus cassinii*		Y	Y
Cassin's kingbird	*Tyrannus vociferans*		Y	Y
Cassin's sparrow	*Aimophila cassinii*		Y	Y
Cedar waxwing	*Bombycilla cedrorum*		Y	Y
Chestnut-collared longspur	*Calcarius ornatus*		Y	Y
Chihuahuan raven	*Corvus cryptoleucus*		Y	
Chipping sparrow	*Spizella passerina*		Y	Y
Cinnamon teal	*Anas cyanoptera*		Y	Y
Clark's nutcracker	*Nucifraga columbiana*		Y	Y
Clay-colored sparrow	*Spizella pallida*			Y
Cliff swallow	*Petrochelidon pyrrhonota*		Y	Y
Common goldeneye	*Bucephala clangula*		Y	Y
Common grackle	*Quiscalus quiscula*		Y	Y
Common loon	*Gavia immer*		Y	Y
Common merganser	*Mergus merganser*		Y	Y
Common nighthawk	*Chordeiles minor*		Y	Y
Common poorwill	*Phalaenoptilus nuttalli*		Y	Y
Common raven	*Corvus corax*		Y	Y
Common snipe	*Gallinago gallinago*		Y	Y
Common yellowthroat	*Geothlypis trichas*		Y	Y
Cooper's hawk	*Accipiter cooperii*		Y	Y
Cordilleran flycatcher	*Empidonax occidentalis*		Y	Y
Curve-billed thrasher	*Toxostoma curvirostre*		Y	
Dark-eyed junco	*Junco hyemalis*		Y	Y
Dickcissel	*Spiza americana*		Y	Y
Double-crested cormorant	*Phalacrocorax auritus*		Y	Y
Downy woodpecker	*Picoides pubescens*		Y	Y
Dusky flycatcher	*Empidonax oberholseri*		Y	Y
Eared grebe	*Podiceps nigricollis*		Y	Y
Eastern bluebird	*Sialia sialis*		Y	Y
Eastern kingbird	*Tyrannus tyrannus*		Y	
Eastern meadowlark	*Sturnella magna*			Y
Evening grosbeak	*Coccothraustes vespertinus*		Y	Y
Ferruginous hawk	*Buteo regalis*	Sen, SOC	Y	Y
Field sparrow	*Spizella pusilla*		Y	Y
Flammulated owl	*Otus flammeolus*	Sen	Y	Y
Forster's tern	*Sterna forsteri*		Y	Y
Fox sparrow	*Passerella iliaca*		Y	
Franklin's gull	*Larus pipixcan*		Y	Y
Gadwall	*Anas strepera*		Y	Y
Gambel's quail	*Callipepla gambelii*			Y
Golden eagle	*Aquila chrysaetos*		Y	Y
Golden-crowned kinglet	*Regulus satrapa*		Y	Y
Grace's warbler	*Dendroica graciae*		Y	Y
Grasshopper sparrow	*Ammodramus savannarum*		Y	Y
Gray catbird	*Dumetella carolinensis*	Sen	Y	Y
Gray flycatcher	*Empidonax wrightii*		Y	Y
Gray jay	*Perisoreus canadensis*		Y	Y
Gray vireo	*Vireo vicinior*	ST, Sen	Y	Y
Great blue heron	*Ardea herodias*		Y	Y
Great egret	*Ardea alba*	Sen	Y	

Appendix A1. (Cont'd.)

Common Name	Scientific Name	Status	Predicted	Reported
Great horned owl	*Bubo virginianus*		Y	Y
Greater roadrunner	*Geococcyx californianus*		Y	
Greater white-fronted goose	*Anser albifrons*		Y	Y
Greater yellowlegs	*Tringa melanoleuca*		Y	
Great-tailed grackle	*Quiscalus mexicanus*		Y	Y
Green heron	*Butorides virescens*		Y	
Green-tailed towhee	*Pipilo chlorurus*		Y	Y
Green-winged teal	*Anas crecca*		Y	Y
Hairy woodpecker	*Picoides villosus*		Y	Y
Hammond's flycatcher	*Empidonax hammondii*		Y	Y
Hepatic tanager	*Piranga flava*		Y	Y
Hermit thrush	*Catharus guttatus*		Y	Y
Herring gull	*Larus argentatus*		Y	Y
Hooded merganser	*Lophodytes cucullatus*		Y	
Horned lark	*Eremophila alpestris*		Y	Y
House finch	*Carpodacus mexicanus*		Y	Y
House wren	*Troglodytes aedon*		Y	Y
Indigo bunting	*Passerina cyanea*		Y	Y
Juniper titmouse	*Baeolophus griseus*		Y	Y
Killdeer	*Charadrius vociferus*		Y	Y
Ladder-backed woodpecker	*Picoides scalaris*		Y	Y
Lark bunting	*Calamospiza melanocorys*		Y	
Lark sparrow	*Chondestes grammacus*		Y	Y
Lazuli bunting	*Passerina amoena*		Y	Y
Least sandpiper	*Calidris minutilla*		Y	Y
Lesser goldfinch	*Carduelis psaltria*		Y	Y
Lesser scaup	*Aythya affinis*		Y	Y
Lesser yellowlegs	*Tringa flavipes*		Y	Y
Lewis's woodpecker	*Melanerpes lewis*		Y	Y
Lincoln's sparrow	*Melospiza lincolnii*		Y	Y
Loggerhead shrike	*Lanius ludovicianus*	SOC	Y	Y
Long-billed curlew	*Numenius americanus*	Sen	Y	Y
Long-billed dowitcher	*Limnodromus scolopaceus*		Y	Y
Long-eared owl	*Asio otus*		Y	Y
MacGillivray's warbler	*Oporornis tolmiei*		Y	Y
Mallard	*Anas platyrhynchos*		Y	Y
Marbled godwit	*Limosa fedoa*		Y	Y
Marsh wren	*Cistothorus palustris*		Y	Y
McCown's longspur	*Calcarius mccownii*	Sen	Y	
Merlin	*Falco columbarius*		Y	Y
Mountain bluebird	*Sialia currucoides*		Y	Y
Mountain chickadee	*Poecile gambeli*		Y	Y
Mountain plover	*Charadrius montanus*	FC, Sen	Y	Y
Mourning dove	*Zenaida macroura*		Y	Y
Nashville warbler	*Vermivora ruficapilla*		Y	
Northern bobwhite	*Colinus virginianus*		Y	
Northern flicker	*Colaptes auratus*		Y	Y
Northern goshawk	*Accipiter gentilis*	Sen, SOC	Y	Y
Northern harrier	*Circus cyaneus*		Y	Y
Northern mockingbird	*Mimus polyglottos*		Y	Y
Northern oriole[a]	*Icterus galbula*		Y	Y
Northern pintail	*Anas acuta*		Y	Y
Northern pygmy owl	*Glaucidium gnoma*		Y	Y
Northern rough-winged swallow	*Stelgidopteryx serripennis*		Y	Y
Northern saw-whet owl	*Aegolius acadicus*		Y	Y
Northern shoveler	*Anas clypeata*		Y	

Appendix A1. (Cont'd.)

Common Name	Scientific Name	Status	Predicted	Reported
Northern shrike	*Lanius excubitor*		Y	Y
Northern waterthrush	*Seiurus noveboracensis*		Y	Y
Olive-sided flycatcher	*Contopus cooperi*		Y	Y
Orange-crowned warbler	*Vermivora celata*		Y	Y
Osprey	*Pandion haliaetus*		Y	
Peregrine falcon	*Falco peregrinus*	SE, Sen	Y	Y
Pied-billed grebe	*Podilymbus podiceps*		Y	Y
Pine grosbeak	*Pinicola enucleator*		Y	Y
Pine siskin	*Carduelis pinus*		Y	Y
Pinyon jay	*Gymnorhinus cyanocephalus*		Y	Y
Plumbeous vireo	*Vireo plumbeus*		Y	Y
Prairie falcon	*Falco mexicanus*		Y	Y
Purple martin	*Progne subis*		Y	Y
Pygmy nuthatch	*Sitta pigmaea*		Y	Y
Red crossbill	*Loxia curvirostra*		Y	Y
Red-breasted merganser	*Mergus serrator*		Y	
Red-breasted nuthatch	*Sitta canadensis*		Y	Y
Red-eyed vireo	*Vireo olivaceus*		Y	Y
Redhead	*Aythya americana*		Y	Y
Red-headed woodpecker	*Melanerpes erythrocephalus*		Y	
Red-naped sapsucker	*Sphyrapicus nuchalis*		Y	Y
Red-necked phalarope	*Phalaropus lobatus*		Y	
Red-tailed hawk	*Buteo jamaicensis*		Y	Y
Red-winged blackbird	*Agelaius phoeniceus*		Y	Y
Ring-billed gull	*Larus delawarensis*		Y	Y
Ring-necked duck	*Aythya collaris*		Y	Y
Rock wren	*Salpinctes obsoletus*		Y	Y
Rose-breasted grosbeak	*Pheucticus ludovicianus*		Y	Y
Ross's goose	*Chen rossii*		Y	
Rough-legged hawk	*Buteo lagopus*		Y	Y
Ruby-crowned kinglet	*Regulus calendula*		Y	Y
Ruddy duck	*Oxyura jamaicensis*		Y	Y
Rufous hummingbird	*Selasphorus rufus*		Y	Y
Rufous-crowned sparrow	*Aimophila ruficeps*		Y	Y
Sage sparrow	*Amphispiza belli*		Y	Y
Sage thrasher	*Oreoscoptes montanus*		Y	Y
Sandhill crane	*Grus canadensis*		Y	Y
Savannah sparrow	*Passaculus sandwichensis*		Y	Y
Say's phoebe	*Sayornis saya*		Y	Y
Scaled quail	*Callipepla squamata*		Y	Y
Scott's oriole	*Icterus parisorum*		Y	Y
Semipalmated plover	*Charadrius semipalmatus*		Y	Y
Sharp-shinned hawk	*Accipiter striatus*		Y	Y
Snow goose	*Chen caerulescens*		Y	
Snowy egret	*Egretta thula*	Sen	Y	
Solitary sandpiper	*Tringa solitaria*		Y	Y
Song sparrow	*Melospiza melodia*		Y	Y
Sora	*Porzana carolina*	Sen	Y	Y
Spotted owl	*Strix occidentalis*	FT, Sen	Y	Y
Spotted sandpiper	*Actitis macularia*		Y	Y
Spotted towhee	*Pipilo maculatus*		Y	Y
Steller's jay	*Cyanocitta stelleri*		Y	Y
Stilt sandpiper	*Calidris himantopus*		Y	Y
Summer tanager	*Piranga rubra*		Y	
Swainson's hawk	*Buteo swainsoni*	Sen	Y	Y

Appendix A1. (Cont'd.)

Common Name	Scientific Name	Status	Predicted	Reported
Swainson's thrush	*Catharus ustulatus*		Y	Y
Swamp sparrow	*Melospiza georgiana*		Y	
Tennessee warbler	*Vermivora peregrina*		Y	
Three-toed woodpecker	*Picoides tridactylus*		Y	Y
Townsend's solitaire	*Myadestes townsendi*		Y	Y
Townsend's warbler	*Dendroica townsendi*		Y	Y
Tree swallow	*Tachycineta bicolor*		Y	Y
Tundra swan	*Cygnus columbianus*		Y	
Turkey vulture	*Cathartes aura*		Y	Y
Upland sandpiper	*Bartramia longicauda*		Y	
Vesper sparrow	*Pooecetes gramineus*		Y	Y
Violet-green swallow	*Tachycineta thalassina*		Y	Y
Virginia rail	*Rallus limicola*		Y	Y
Virginia's warbler	*Vermivora virginiae*		Y	Y
Warbling vireo	*Vireo gilvus*		Y	Y
Western bluebird	*Sialia mexicana*		Y	Y
Western grebe	*Aechmophorus occidentalis*	ST, Sen, SOC	Y	Y
Western kingbird	*Tyrannus verticalis*		Y	Y
Western meadowlark	*Sturnella neglecta*		Y	Y
Western sandpiper	*Calidris mauri*		Y	Y
Western screech-owl	*Otus kennicottii*		Y	Y
Western scrub-jay	*Aphelocoma californica*		Y	Y
Western tanager	*Piranga ludoviciana*		Y	Y
Western wood pewee	*Contopus sordidulus*		Y	Y
Whip-poor-will	*Caprimulgus vociferus*			Y
White-breasted nuthatch	*Sitta carolinensis*		Y	Y
White-crowned sparrow	*Zonotrichia leucophrys*		Y	Y
White-faced ibis	*Plegadis chihi*	Sen, SOC	Y	Y
White-tailed ptarmigan	*Lagopus leucurus*	SE, Sen	Y	Y
White-throated sparrow	*Zonotrichia albicollis*		Y	Y
White-throated swift	*Aeronautes saxatalis*		Y	Y
Wild turkey	*Meleagris gallopavo*		Y	Y
Willet	*Catoptrophorus semipalmatus*		Y	
Williamson's sapsucker	*Sphyrapicus thyroideus*		Y	Y
Willow flycatcher	*Empidonax traillii*	FE, SE, Sen	Y	Y
Wilson's phalarope	*Phalaropus tricolor*		Y	Y
Wilson's warbler	*Wilsonia pusilla*		Y	Y
Wood duck	*Aix sponsa*		Y	
Yellow warbler	*Dendroica petechia*		Y	Y
Yellow-billed cuckoo	*Coccyzus americanus*	Sen	Y	Y
Yellow-breasted chat	*Icteria virens*		Y	Y
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*		Y	Y
Yellow-rumped warbler	*Dendroica coronata*		Y	Y
Zone-tailed hawk	*Buteo albonotatus*	Sen	Y	Y

[a]Includes both Baltimore oriole (*Icterus galbula*) and Bullock's oriole (*I. bullockii*).

Appendix A2. Mammals of the Southern Rocky Mountains of New Mexico by predicted and reported occurrence. FC: Federal Candidate; ST: State Threatened; SOC: New Mexico Species of Concern; Sen: Forest Service Region 3 Sensitive (New Mexico Department of Game and Fish 1998). Common and scientific names follow the American Society of Mammologists (http://asm.wku.edu/committees/pubed/statelists/default.html).

Common Name	Scientific Name	Status	Predicted	Reported
Abert's squirrel	*Sciurus aberti*		Y	Y
American marten	*Martes americana*	ST, Sen	Y	Y
Badger	*Taxidea taxus*		Y	Y
Banner-tailed kangaroo rat	*Dipodomys spectabilis*		Y	Y
Beaver	*Castor canadensis*		Y	Y
Big brown bat	*Eptesicus fuscus*		Y	Y
Big free-tailed bat	*Nyctinomops macrotis*	SOC	Y	Y
Bighorn sheep	*Ovis canadensis*	Sen	Y	Y
Black bear	*Ursus americanus*		Y	Y
Black-tailed jack rabbit	*Lepus californicus*		Y	Y
Black-tailed prairie dog	*Cynomys ludovicianus*		Y	Y
Bobcat	*Lynx rufus*		Y	Y
Botta's pocket gopher	*Thomomys bottae*		Y	Y
Brazilian free-tailed bat	*Tadarida brasiliensis*		Y	Y
Brush mouse	*Peromyscus boylii*		Y	Y
Bushy-tailed woodrat	*Neotoma cinerea*		Y	Y
California myotis	*Myotis californicus*		Y	Y
Colorado chipmunk	*Tamias quadrivittatus*		Y	Y
Common raccoon	*Procyon lotor*		Y	Y
Coyote	*Canis latrans*		Y	Y
Deer mouse	*Peromyscus maniculatus*		Y	Y
Desert cottontail	*Sylvilagus audubonii*		Y	Y
Desert shrew	*Notiosorex crawfordi*		Y	
Dwarf shrew	*Sorex nanus*		Y	Y
Elk	*Cervus elaphus*		Y	Y
Ermine	*Mustela erminea*		Y	Y
Fringed myotis	*Myotis thysanodes*	SOC	Y	Y
Golden-mantled ground squirrel	*Spermophilus lateralis*		Y	Y
Gray fox	*Urocyon cinereoargenteus*		Y	Y
Gunnison's prairie dog	*Cynomys gunnisoni*		Y	Y
Heather vole	*Phenacomys intermedius*		Y	Y
Hispid cotton rat	*Sigmodon hispidus*		Y	
Hispid pocket mouse	*Chaetodipus hispidus*		Y	
Hoary bat	*Lasiurus cinereus*		Y	Y
Kit/Swift fox	*Vulpes velox*		Y	
Least chipmunk	*Tamias minimus*		Y	Y
Little brown myotis	*Myotis lucifugus*	SOC, Sen	Y	Y
Long-eared myotis	*Myotis evotis*	SOC	Y	Y
Long-legged myotis	*Myotis volans*	SOC	Y	Y
Long-tailed vole	*Microtus longicaudus*		Y	Y
Long-tailed weasel	*Mustela frenata*		Y	Y
Masked shrew	*Sorex cinereus*		Y	Y
Meadow jumping mouse	*Zapus hudsonius*	Sen, SOC	Y	Y
Meadow vole	*Microtus pennsylvanicus*		Y	Y
Merriam's kangaroo rat	*Dipodomys merriami*		Y	
Mexican woodrat	*Neotoma mexicana*		Y	Y
Mink	*Mustela vison*		Y	Y
Montane shrew	*Sorex monticolus*		Y	Y
Montane vole	*Microtus montanus*		Y	Y
Mountain lion	*Felis concolor*		Y	Y
Mule deer	*Odocoileus hemionus*		Y	Y
Muskrat	*Ondatra zibethicus*		Y	Y

Appendix A2. (Cont'd.)

Common Name	Scientific Name	Status	Predicted	Reported
Northern grasshopper mouse	*Onychomys leucogaster*		Y	Y
Northern pocket gopher	*Thomomys talpoides*		Y	Y
Northern rock mouse	*Peromyscus nasutus*		Y	Y
Nuttall's cottontail	*Sylvilagus nuttallii*		Y	Y
Ord's kangaroo rat	*Dipodomys ordii*		Y	Y
Pallid bat	*Antrozous pallidus*		Y	Y
Pika	*Ochotona princeps*		Y	Y
Pinon mouse	*Peromyscus truei*		Y	Y
Plains harvest mouse	*Reithrodontomys montanus*		Y	Y
Plains pocket gopher	*Geomys bursarius*	SOC	Y	Y
Plains pocket mouse	*Perognathus flavescens*		Y	Y
Porcupine	*Erethizon dorsatum*		Y	Y
Prairie vole	*Microtus ochrogaster*		Y	Y
Pronghorn	*Antilocapra americana*	Sen	Y	Y
Red fox	*Vulpes vulpes*		Y	Y
Red squirrel	*Tamiasciurus hudsonicus*		Y	Y
Ringtail	*Bassariscus astutus*	Sen	Y	Y
Rock pocket mouse	*Chaetodipus intermedius*		Y	
Rock squirrel	*Spermophilus variegatus*		Y	Y
Silky pocket mouse	*Perognathus flavus*		Y	Y
Silver-haired bat	*Lasionycteris noctivagans*		Y	Y
Small-footed myotis	*Myotis ciliolabrum*	SOC	Y	Y
Snowshoe hare	*Lepus americanus*		Y	Y
Southern plains woodrat	*Neotoma micropus*		Y	Y
Southern red-backed vole	*Clethrionomys gapperi*		Y	Y
Spotted bat	*Euderma maculatum*	ST, SOC, Sen	Y	Y
Spotted ground squirrel	*Spermophilus spilosoma*		Y	Y
Stephen's woodrat	*Neotoma stephensi*		Y	Y
Striped skunk	*Mephitis mephitis*		Y	Y
Tawny-bellied cotton rat	*Sigmodon fulviventer*		Y	Y
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*		Y	Y
Townsend's big-eared bat	*Corynorhinus townsendii*	SOC, Sen	Y	Y
Virginia opossum	*Didelphis virginiana*		Y	
Water shrew	*Sorex palustris*		Y	Y
Western harvest mouse	*Reithrodontomys megalotis*		Y	Y
Western jumping mouse	*Zapus princeps*		Y	Y
Western pipistrelle	*Pipistrellus hesperus*		Y	Y
Western spotted skunk	*Spilogale gracilis*		Y	Y
White-footed mouse	*Peromyscus leucopus*		Y	Y
White-tailed antelope squirrel	*Ammospermophilus leucurus*		Y	Y
White-tailed jack rabbit	*Lepus townsendii*		Y	Y
White-throated woodrat	*Neotoma albigula*		Y	Y
Yellow-bellied marmot	*Marmota flaviventris*		Y	Y
Yellow-faced pocket gopher	*Cratogeomys castanops*		Y	
Yuma myotis	*Myotis yumanensis*	SOC	Y	Y

Appendix A3. Reptiles of the Southern Rocky Mountains of New Mexico by predicted and reported occurrence. Common and scientific names follow Degenhardt and others (1996).

Common Name	Scientific Name	Predicted	Reported
Blackneck garter snake	*Thamnophis cyrtopsis*	Y	Y
Blacktail rattlesnake	*Crotalus molossus*	Y	
Checkered garter snake	*Thamnophis marcianus*	Y	Y
Checkered whiptail	*Cnemidophorus grahamii*	Y	Y
Chihuahuan spotted whiptail	*Cnemidophorus exsanguis*	Y	Y
Coachwhip	*Masticophis flagellum*	Y	Y
Collared lizard	*Crotaphytus collaris*	Y	Y
Common garter snake	*Thamnophis sirtalis*	Y	Y
Common kingsnake	*Lampropeltis getula*	Y	
Corn snake	*Elaphe guttata*	Y	Y
Desert spiny lizard	*Sceloporus magister*	Y	
Glossy snake	*Arizona elegans*	Y	Y
Gopher snake	*Pituophis melanoleucus*	Y	Y
Great plains skink	*Eumeces obsoletus*	Y	Y
Greater earless lizard	*Cophosaurus texanus*	Y	Y
Leopard lizard	*Gambelia wislizenii*	Y	Y
Lesser earless lizard	*Holbrookia maculata*	Y	Y
Lined snake	*Tropidoclonion lineatum*	Y	
Little striped whiptail	*Cnemidophorus inornatus*	Y	Y
Longnose snake	*Rhinocheilus lecontei*	Y	
Many-lined skink	*Eumeces multivirgatus*	Y	Y
Massasauga	*Sistrurus catenatus*	Y	
Milk snake	*Lampropeltis triangulum*	Y	
Mountain patchnose snake	*Salvadora grahamiae*	Y	
New Mexico whiptail	*Cnemidophorus neomexicanus*	Y	Y
Night snake	*Hypsiglena torquata*	Y	Y
Ornate box turtle	*Terrapene ornata*	Y	
Painted turtle	*Chrysemys picta*	Y	Y
Plains black-headed snake	*Tantilla nigriceps*	Y	
Plains garter snake	*Thamnophis radix*	Y	Y
Plateau striped whiptail	*Cnemidophorus velox*	Y	Y
Prairie lizard	*Sceloporus undulatus*	Y	Y
Ringneck snake	*Diadophis punctatus*	Y	Y
Roundtail horned lizard	*Phrynosoma modestum*	Y	Y
Sagebrush lizard	*Sceloporus graciosus*	Y	Y
Short-horned lizard	*Phrynosoma douglasii*	Y	Y
Side-blotched lizard	*Uta stansburiana*	Y	Y
Slider	*Trachemys scripta*	Y	
Smooth green snake	*Liochlorophis vernalis*	Y	Y
Snapping turtle	*Chelydra serpentina*	Y	Y
Spiny softshell	*Trionyx spiniferus*	Y	
Striped whipsnake	*Masticophis taeniatus*	Y	Y
Texas blind snake	*Leptotyphlops dulcis*	Y	Y
Tree lizard	*Urosaurus ornatus*	Y	Y
Western diamondback rattlesnake	*Crotalus atrox*	Y	Y
Western hognose snake	*Heterodon nasicus*	Y	Y
Western rattlesnake	*Crotalus viridis*	Y	Y
Western terrestrial garter snake	*Thamnophis elegans*	Y	Y
Yellow mud turtle	*Kinosternon flavescens*		Y

Appendix A4. Amphibians of the Southern Rocky Mountains of New Mexico by predicted and reported occurrence. FC: Federal Candidate; SE: State Endangered; ST: State Threatened; Sen: Forest Service Region 3 Sensitive (New Mexico Department of Game and Fish 1998). Common and scientific names follow Degenhardt and others (1996).

Common Name	Scientific Name	Status	Predicted	Reported
Canyon treefrog	*Hyla arenicolor*		Y	Y
Couch's spadefoot	*Scaphiopus couchii*		Y	Y
Great Plains toad	*Bufo cognatus*		Y	Y
Jemez Mountains salamander	*Plethodon neomexicanus*	ST, Sen	Y	Y
New Mexico spadefoot	*Spea multiplicata*		Y	Y
Northern leopard frog	*Rana pipiens*	Sen	Y	Y
Plains leopard frog	*Rana blairi*		Y	Y
Plains spadefoot	*Spea bombifrons*		Y	Y
Red-spotted toad	*Bufo punctatus*		Y	Y
Tiger salamander	*Ambystoma tigrinum*		Y	Y
Western chorus frog	*Pseudacris triseriata*		Y	Y
Western toad	*Bufo boreas*	FC, SE, Sen	Y	Y
Woodhouse's toad	*Bufo woodhouseii*		Y	Y

Appendix A5. Native Fishes of the Southern Rocky Mountains of New Mexico by reported occurrence. SE: State Endangered; ST: State Threatened; SOC: New Mexico Species of Concern; Sen: Forest Service Region 3 Sensitive (New Mexico Department of Game and Fish 1998). Common and scientific names follow Sublette and others (1990).

Common Name	Scientific Name	Status
Brook stickleback[a]	*Culaea inconstans*	ST
Central stoneroller	*Campostoma anomalum*	
Creek chub	*Semotilus atromaculatus*	
Cutthroat trout	*Oncorhynchus clarki*	Sen
Fathead minnow	*Pimephales promelas*	
Flathead chub	*Platygobio gracilis*	SOC
Largemouth bass	*Micropterus salmoides*	
Longnose dace	*Rhinichthys cataractae*	
Rio Grande chub	*Gila pandora*	
Rio Grande sucker	*Catostomus plebeius*	Sen
Southern redbelly dace	*Phoxinus erythrogaster*	SE, Sen
White sucker	*Catostomus commersoni*	

[a]There is some question as to whether this species is native to New Mexico (Sublette and others 1990).

Appendix A6. Butterflies of the Southern Rocky Mountains of New Mexico by reported occurrence. SOC: New Mexico Species of Concern (New Mexico Department of Game and Fish 1998). Common and scientific names follow Opler and others (1995).

Common Name	Scientific Name	Status
Afranius duskywing	*Erynnis afranius*	
American lady	*Vanessa virginiensis*	
American snout	*Libytheana carinenta*	
Ancilla blue	*Euphilotes ancilla*	
Anise swallowtail	*Papilio zelicaon*	
Apache skipper	*Hesperia woodgatei*	
Aphrodite fritillary	*Speyeria aphrodite*	
Arctic blue	*Agriades aquilo*	
Arrowhead blue	*Glaucopsyche piasus*	
Banded hairstreak	*Satyrium calanus*	
Behr's hairstreak	*Satyrium behrii*	
Black swallowtail	*Papilio polyxenes*	
Blue copper	*Lycaena heteronea*	
Boisduval's blue	*Icaricia icaroides*	
Bordered patch	*Chlosyne lacinia*	
Bronze roadside-skipper	*Amblyscirtes aenus*	
Brown elfin	*Callophrys augustinus*	
Cabbage white	*Pieris rapae*	
California sister	*Adelpha bredowii*	
California tortoiseshell	*Nymphalis californica*	
Canyonland satyr	*Cyllopsis pertepida*	
Cassius blue	*Leptotes cassius*	
Cassus roadside-skipper	*Amblyscirtes cassus*	
Ceraunus blue	*Hemiargus ceraunus*	
Checkered white	*Pontia protodice*	
Chryxus arctic	*Oeneis chryxus*	
Clouded sulphur	*Colias philodice*	
Cloudless sulphur	*Phoebis sennae*	
Colorado hairstreak	*Hypaurotis crysalus*	
Colorado skipper	*Hesperia colorado*	
Common alpine	*Erebia epipsodea*	
Common buckeye	*Junonia coenia*	
Common checkered skipper	*Pyrgus communis*	
Common ringlet	*Coenonympha tullia*	
Common roadside-skipper	*Amblyscirtes vialis*	
Common sootywing	*Pholisora catullus*	
Common wood-nymph	*Cercyonis pegala*	
Coral hairstreak	*Satyrium titus*	
Dainty sulphur	*Nathalis iole*	
Dark buckeye	*Junonia genoveva*	
Desert elfin	*Callophrys fotis*	
Desert marble	*Euchloe lotta*	
Dotted checkerspot	*Poladryas minuta*	
Dotted roadside-skipper	*Amblyscirtes eos*	
Draco skipper	*Polites draco*	
Dreamy duskywing	*Erynnis icelus*	
Dun skipper	*Euphyes vestris*	
Dusted skipper	*Atrytonopsis hianna*	
Edwards' fritillary	*Speyeria edwardsii*	
Edwards' skipperling	*Oarisma edwardsii*	
Field crescent	*Phyciodes pratensis*	
Freija fritillary	*Boloria freija*	
Frosted elfin	*Callophrys polios*	

Appendix A6. (Cont'd.)

Common Name	Scientific Name	Status
Fulvia checkerspot	*Thessalia fulvia*	
Funereal duskywing	*Erynnis funeralis*	
Garita skipperling	*Oarisma garita*	
Goatweed leafwing	*Anaea andria*	
Gorgone checkerspot	*Chlosyne gorgone*	
Gray hairstreak	*Strymon melinus*	
Great purple hairstreak	*Atlides halesus*	
Great spangled fritillary	*Speyeria cybele*	
Green comma	*Polygonia faunus*	
Green skipper	*Hesperia viridis*	
Greenish blue	*Plebejus saepiolus*	
Grizzled skipper	*Pyrgus centaureae*	
Gulf fritillary	*Agraulis vanillae*	
Hedge-row hairstreak	*Satyrium saepium*	
Helena fritillary	*Clossiana titania*	
Hoary comma	*Polygonia gracilis*	
Horace's duskywing	*Erynnis horatius*	
Indra swallowtail	*Papilio indra*	
Juba skipper	*Hesperia juba*	
Juniper hairstreak	*Callophrys gryneus*	
Large marble	*Euchloe ausonides*	
Leda ministreak	*Ministrymon leda*	
Little yellow	*Eurema lisa*	
Lupine blue	*Icaricia lupini*	
Lustrous copper	*Lycaena cupreus*	
Lyside sulphur	*Kricogonia lyside*	
Magdalena alpine	*Erebia magdalena*	
Margined white	*Pieris marginata*	
Marine blue	*Leptotes marina*	
Mead's sulphur	*Colias meadii*	
Mead's wood nymph	*Cercyonis meadii*	
Melissa arctic	*Oeneis melissa*	
Melissa blue	*Lycaeides melissa*	
Meridian duskywing	*Erynnis meridianus*	
Mexican cloudywing	*Thorybes mexicana*	
Mexican sootywing	*Pholisora mejicana*	
Mexican yellow	*Eurema mexicana*	
Milbert's tortoiseshell	*Nymphalis milberti*	
Monarch	*Danaus plexippus*	
Mormon fritillary	*Speyeria mormonia*	
Mormon metalmark	*Apodemia mormo*	
Morrison's skipper	*Stinga morrisoni*	
Mottled duskywing	*Erynnis martialis*	
Mountain checkered-skipper	*Pyrgus xanthus*	
Mourning cloak	*Nymphalis antiopa*	
Mylitta crescent	*Phyciodes mylitta*	
Nais metalmark	*Apodemia nais*	
Nevada skipper	*Hesperia nevada*	
Nokomis fritillary	*Speyeria nokomis*	SOC
Northern cloudywing	*Thorybes pylades*	
Northern white-skipper	*Heliopetes ericetorum*	
Northwestern fritillary	*Speyeria hesperis*	
Old World swallowtail	*Papilio machaon*	
Orange sulphur	*Colias eurytheme*	
Orange-headed roadside-skipper	*Amblyscirtes phylace*	
Oslar's roadside-skipper	*Amblyscirtes oslari*	

Appendix A6. (Cont'd.)

Common Name	Scientific Name	Status
Pacuvius duskywing	*Erynnis pacuvius*	
Pahaska skipper	*Hesperia pahaska*	
Painted crescent	*Phyciodes picta*	
Painted lady	*Vanessa cardui*	
Pale swallowtail	*Papilio eurymedon*	
Pearl crescent	*Phyciodes tharos*	
Pearly checkerspot	*Charidryas acastus*	SOC
Pine white	*Neophasia menapia*	
Pipevine swallowtail	*Battus philenor*	
Polixenes arctic	*Oeneis polixenes*	
Purplish copper	*Lycaena helloides*	
Python skipper	*Atrytonopsis python*	
Queen	*Danaus gilippus*	
Queen Alexandra's sulphur	*Colias alexandra*	
Question mark	*Polygonia interrogationis*	
Reakirt's blue	*Hemiargus isola*	
Red admiral	*Vanessa atalanta*	
Rhesus skipper	*Polites rhesus*	
Riding's satyr	*Neominois ridingsii*	
Rita dotted-blue	*Euphilotes rita*	
Rocky Mountain duskywing	*Erynnis telemachus*	
Rocky Mountain parnassius	*Parnassius smintheus*	
Ruddy copper	*Lycaena rubidus*	
Russet skipperling	*Piruna pirus*	
Sachem	*Atalopedes campestris*	
Saltbush sootywing	*Hesperopsis alpheus*	
Sandhill skipper	*Polites sabuleti*	
Sandia hairstreak	*Callophrys mcfarlandi*	
Satyr comma	*Polygonia satyrus*	
Scudder's sulphur	*Colias scudderi*	
Short-tailed skipper	*Zestusa dorus*	
Silver-bordered fritillary	*Boloria selene*	
Silver-spotted skipper	*Eparygyreus clarus*	
Silvery blue	*Glaucopsyche lygdamus*	
Silvery checkerspot	*Chlosyne nycteis*	
Simius roadside-skipper	*Amblyscirtes simius*	
Sleepy duskywing	*Erynnis brizo*	
Sleepy orange	*Eurema nicippe*	
Small checkered-skipper	*Pyrgus scriptura*	
Small wood nymph	*Cercyonis oetus*	
Snow's skipper	*Paratrytone snowi*	
Southern dog face	*Zerene cesonia*	
Southwestern orangetip	*Anthocharis thoosa*	
Spalding's dotted-blue	*Euphilotes spaldingi*	
Spring azure	*Celastrina ladon*	
Spring white	*Pontia sisymbrii*	
Strecker's giant-skipper	*Megathymus streckeri*	
Sylvan hairstreak	*Satyrium sylvinus*	
Tailed copper	*Lycaena arota*	
Tailed orange	*Eurema proterpia*	
Tawny-edged skipper	*Polites themistocles*	
Taxiles skipper	*Poanes taxiles*	
Thicket hairstreak	*Callophrys spinetorum*	
Two-tailed swallowtail	*Papilio multicaudatus*	
Uhler's arctic	*Oeneis uhleri*	
Uncas skipper	*Hesperia uncas*	

Appendix A6. (Cont'd.)

Common Name	Scientific Name	Status
Variable checkerspot	*Euphydryas anicia*	
Variegated fritillary	*Euptoieta claudia*	
Viceroy	*Limenitis archippus*	
Viereck's skipper	*Atrytonopsis vierecki*	
Weidemeyer's admiral	*Limenitis weidemeyerii*	
West Coast lady	*Vanessa annabella*	
Western green-hairstreak	*Callophrys affinis*	
Western pigmy-blue	*Brephidium exile*	
Western pine elfin	*Callophrys eryphon*	
Western square-dotted blue	*Euphilotes battoides*	
Western tailed-blue	*Everes amyntula*	
Western tiger swallowtail	*Papilio rutulus*	
Western white	*Pontia occidentalis*	
White-angled sulphur	*Anteos clorinde*	
Woodland skipper	*Ochlodes sylvanoides*	
Yucca giant-skipper	*Megathymus yuccae*	
Yuma skipper	*Ochlodes yuma*	

Appendix B. Presence/absence matrices for predicted and reported occurrence of terrestrial vertebrates and butterflies in the Southern Rocky Mountains of New Mexico (1 denotes presence, 0 denotes absence).

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Birds						
Montane Specialists						
Boreal owl	1	0	1	0	1	1
Gray jay	1	1	1	1	1	1
Pine grosbeak	1	1	1	1	1	1
Three-toed woodpecker	1	1	1	1	1	1
White-tailed ptarmigan	0	0	0	0	1	1
Habitat Generalists						
Acorn woodpecker	1	1	0	0	1	0
American crow	1	1	1	1	1	1
American goldfinch	1	0	1	1	1	0
American kestrel	1	1	1	1	1	1
American pipit	1	1	1	0	1	1
American robin	1	1	1	1	1	1
American tree sparrow	1	0	1	0	1	1
Ash-throated flycatcher	1	1	1	1	1	1
Baird's sparrow	1	0	1	0	1	0
Bald eagle	1	1	1	0	1	1
Band-tailed pigeon	1	1	1	1	1	1
Barn owl	1	1	1	0	1	0
Barn swallow	1	1	1	1	1	1
Bendire's thrasher	1	0	1	0	1	0
Bewick's wren	1	1	1	1	1	1
Black swift	1	0	1	1	1	0
Black-billed magpie	1	1	1	1	1	1
Black-capped chickadee	1	1	1	1	1	1
Black-chinned hummingbird	1	1	1	1	1	1
Black-chinned sparrow	0	1	0	0	0	0
Black-headed grosbeak	1	1	1	1	1	1
Black-throated gray warbler	1	1	1	1	1	1
Blue grosbeak	1	1	1	1	1	1
Blue grouse	1	1	1	1	1	1
Blue-gray gnatcatcher	1	1	1	1	1	1
Brewer's blackbird	1	1	1	1	1	1
Brewer's sparrow	1	1	1	1	1	0
Broad-tailed hummingbird	1	1	1	1	1	1
Brown creeper	1	1	1	1	1	1
Brown-capped rosy-finch	1	0	1	0	1	0
Brown-headed cowbird	1	1	1	1	1	1
Burrowing owl	1	0	0	0	1	0
Bushtit	1	1	1	1	1	1
Calliope hummingbird	1	1	0	0	1	0
Canyon towhee	1	1	1	0	1	1
Canyon wren	1	1	1	0	1	1
Cassin's finch	1	1	1	1	1	1
Cassin's kingbird	1	1	1	1	1	1
Cedar waxwing	1	1	1	0	1	0
Chestnut-collared longspur	1	0	1	0	1	1
Chihuahuan raven	0	0	0	0	1	0
Chipping sparrow	1	1	1	1	1	1
Clark's nutcracker	1	1	1	1	1	1
Cliff swallow	1	1	1	1	1	1

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Birds						
Habitat Generalists						
Common nighthawk	1	1	1	1	1	1
Common poorwill	1	1	1	1	1	1
Common raven	1	1	1	1	1	1
Cooper's hawk	1	1	1	1	1	1
Cordilleran flycatcher	1	1	1	1	1	1
Curve-billed thrasher	1	0	1	0	1	0
Dark-eyed junco	1	1	1	1	1	1
Downy woodpecker	1	1	1	1	1	1
Dusky flycatcher	1	1	1	1	1	1
Eastern meadowlark	0	0	0	0	0	1
Evening grosbeak	1	1	1	1	1	1
Ferruginous hawk	1	1	1	0	1	1
Flammulated owl	1	1	1	0	1	1
Gambel's quail	1	1	1	0	1	0
Golden eagle	1	1	1	1	1	0
Golden-crowned kinglet	1	1	1	1	1	1
Grace's warbler	1	1	1	1	1	1
Grasshopper sparrow	1	0	1	0	1	1
Gray catbird	1	1	1	1	1	1
Gray flycatcher	1	1	1	0	1	1
Gray vireo	1	0	0	0	0	1
Great horned owl	1	1	1	1	1	1
Greater roadrunner	1	0	1	0	1	0
Green-tailed towhee	1	1	1	1	1	1
Hairy woodpecker	1	1	1	1	1	1
Hammond's flycatcher	1	1	1	1	1	1
Hepatic tanager	1	1	1	0	1	1
Hermit thrush	1	1	1	1	1	1
Horned lark	1	0	1	1	1	1
House finch	1	1	1	1	1	1
House wren	1	1	1	1	1	1
Indigo bunting	1	1	1	1	1	1
Juniper titmouse	1	1	1	1	1	1
Killdeer	1	1	1	1	1	1
Ladder-backed woodpecker	1	1	1	0	1	1
Lark bunting	1	0	1	0	1	0
Lark sparrow	1	1	1	1	1	1
Lazuli bunting	1	1	1	1	1	1
Lesser goldfinch	1	1	1	1	1	1
Lewis's woodpecker	1	1	1	1	1	1
Lincoln's sparrow	1	1	1	1	1	1
Loggerhead shrike	1	1	1	0	1	1
Long-eared owl	1	1	1	1	1	1
MacGillivray's warbler	1	1	1	1	1	1
Marsh wren	1	1	1	1	1	1
McCown's longspur	1	0	1	0	1	0
Merlin	1	0	1	0	1	1
Mountain bluebird	1	1	1	1	1	1
Mountain chickadee	1	1	1	1	1	1
Mourning dove	1	1	1	1	1	1
Nashville warbler	1	0	1	0	1	0

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Birds						
Habitat Generalists						
Northern bobwhite	0	0	0	0	1	0
Northern flicker	1	1	1	0	1	0
Northern goshawk	1	1	1	1	1	1
Northern harrier	1	0	1	0	1	1
Northern mockingbird	1	1	1	1	1	1
Northern oriole	1	1	1	1	1	1
Northern pygmy owl	1	1	1	1	1	1
Northern saw-whet owl	1	1	0	1	1	1
Northern shrike	1	0	1	1	1	1
Olive-sided flycatcher	1	1	1	1	1	1
Orange-crowned warbler	1	1	1	1	1	1
Peregrine falcon	1	1	1	1	1	0
Pine grosbeak	1	0	1	0	1	0
Pine siskin	1	1	1	1	1	1
Pinyon jay	1	1	1	1	1	1
Plumbeous vireo	1	1	1	1	1	1
Prairie falcon	1	1	1	1	1	1
Purple martin	1	0	1	1	1	1
Pygmy nuthatch	1	1	1	1	1	1
Red crossbill	1	1	1	1	1	1
Red-breasted nuthatch	1	1	1	1	1	1
Red-eyed vireo	1	1	1	1	1	0
Red-headed woodpecker	0	1	0	1	1	1
Red-naped sapsucker	1	1	1	1	1	1
Red-tailed hawk	1	1	1	1	1	1
Rock wren	1	1	1	0	1	0
Rose-breasted grosbeak	1	0	1	0	1	1
Rough-legged hawk	1	1	1	1	1	1
Ruby-crowned kinglet	1	1	1	0	1	0
Rufous hummingbird	1	1	1	0	1	0
Rufous-crowned sparrow	1	1	0	0	1	0
Sage thrasher	1	1	1	1	1	0
Sandhill crane	1	0	1	1	1	0
Savannah sparrow	1	1	1	1	1	0
Say's phoebe	1	1	1	1	1	1
Scaled quail	1	1	1	0	1	1
Scott's oriole	1	1	0	1	0	0
Sharp-shinned hawk	1	1	1	1	1	1
Song sparrow	1	1	1	1	1	1
Spotted owl	1	1	0	0	1	0
Spotted towhee	1	1	1	0	1	0
Steller's jay	1	1	1	1	1	1
Swainson's hawk	1	0	1	0	1	1
Swainson's thrush	1	1	1	0	1	1
Townsend's solitaire	1	1	1	1	1	1
Townsend's warbler	1	1	1	0	1	0
Tree swallow	1	0	1	1	1	1
Turkey vulture	1	1	1	1	1	1
Upland sandpiper	0	0	0	0	1	0
Vesper sparrow	1	1	1	1	1	1
Violet-green swallow	1	1	1	1	1	1

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Birds						
Habitat Generalists						
Virginia's warbler	1	1	0	1	1	1
Warbling vireo	1	1	1	1	1	1
Western bluebird	1	1	1	1	1	1
Western kingbird	1	1	1	1	1	1
Western meadowlark	1	1	1	1	1	1
Western screech-owl	1	1	1	1	1	0
Western scrub-jay	1	1	1	1	1	1
Western tanager	1	1	1	1	1	1
Western wood pewee	1	1	1	1	1	1
Whip-poor-will	0	1	0	0	0	0
White-breasted nuthatch	1	1	1	1	1	1
White-crowned sparrow	1	1	1	1	1	1
White-throated swift	1	1	1	1	1	1
Wild turkey	1	1	1	0	1	1
Williamson's sapsucker	1	1	1	1	1	1
Wilson's warbler	1	1	1	1	1	1
Yellow warbler	1	1	1	1	1	1
Yellow-breasted chat	1	1	1	1	1	1
Yellow-rumped warbler	1	1	1	1	1	1
Zone-tailed hawk	1	1	1	0	1	0
Aquatic Specialists						
American avocet	1	0	1	1	1	0
American bittern	1	0	1	0	1	0
American coot	1	0	1	1	1	0
American dipper	1	1	1	0	1	1
American white pelican	1	0	1	0	1	0
American wigeon	1	0	1	1	1	0
Baird's sandpiper	1	0	1	0	1	1
Bank swallow	1	0	1	0	1	1
Belted kingfisher	1	1	1	1	1	1
Black phoebe	0	1	0	0	0	1
Black tern	1	0	1	0	1	0
Black-bellied plover	1	0	1	0	1	0
Black-crowned night-heron	1	1	1	1	1	0
Black-necked stilt	1	0	1	1	1	0
Blue-winged teal	1	0	1	1	1	1
Bonaparte's gull	0	0	0	1	0	0
Bufflehead	1	0	1	1	1	0
Canada goose	1	1	1	1	1	1
Canvasback	1	0	1	0	1	1
Cinnamon teal	1	1	1	0	1	0
Common goldeneye	1	0	1	1	1	1
Common loon	1	0	1	1	1	0
Common merganser	1	1	1	1	1	0
Common snipe	1	0	1	1	1	0
Common yellowthroat	1	1	1	1	1	1
Double-crested cormorant	1	0	1	1	1	0
Eared grebe	1	0	1	1	1	0
Eastern bluebird	1	0	0	0	1	1
Eastern kingbird	1	0	1	0	1	0
Forster's tern	1	0	1	1	1	0

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Birds						
Aquatic Specialists						
Franklin's gull	1	0	1	1	1	1
Gadwall	1	1	1	1	1	1
Great blue heron	1	1	1	0	1	1
Great egret	1	0	1	0	1	0
Greater white-fronted goose	1	0	1	0	1	1
Greater yellowlegs	1	0	1	0	1	0
Green heron	1	0	1	0	1	0
Green-winged teal	1	1	1	1	1	1
Herring gull	1	1	1	1	1	0
Hooded merganser	1	0	1	0	1	0
Least sandpiper	1	0	1	0	1	1
Lesser scaup	1	1	1	0	1	0
Lesser yellowlegs	1	0	1	1	1	0
Long-billed dowitcher	1	1	1	1	1	0
Mallard	1	1	1	1	1	1
Marbled godwit	1	0	1	0	1	1
Northern pintail	1	1	1	1	1	1
Northern rough-winged swallow	1	1	1	1	1	1
Northern shoveler	1	0	1	0	1	0
Northern waterthrush	1	1	1	0	1	0
Osprey	1	1	1	1	1	0
Pied-billed grebe	1	0	1	0	1	0
Red-breasted merganser	1	0	1	0	1	0
Redhead	1	1	1	1	1	1
Red-necked phalarope	1	0	1	0	1	0
Red-winged blackbird	1	1	1	1	1	1
Ring-billed gull	1	1	1	1	1	0
Ring-necked duck	1	0	1	1	1	0
Ross's goose	1	1	1	1	1	0
Ruddy duck	1	0	1	0	1	1
Semipalmated plover	1	0	1	0	1	0
Snow goose	1	0	1	0	1	0
Snowy egret	1	0	1	0	1	0
Solitary sandpiper	1	0	1	0	1	1
Sora	1	1	1	0	1	0
Spotted sandpiper	1	1	1	1	1	1
Stilt sandpiper	1	0	1	1	1	0
Summer tanager	1	0	1	0	1	0
Swamp sparrow	1	0	1	0	1	0
Tennessee warbler	1	0	1	0	1	0
Tundra swan	1	0	1	0	1	0
Virginia rail	1	1	1	0	1	1
Western grebe	1	0	1	1	1	1
Western sandpiper	1	0	1	1	1	0
White-faced ibis	1	0	1	1	1	0
White-throated sparrow	1	1	1	0	1	0
Willet	1	0	1	0	1	0
Willow flycatcher	1	1	1	1	1	1
Wilson's phalarope	1	1	1	1	1	0
Wood duck	1	0	1	0	1	0
Yellow-billed cuckoo	1	1	1	1	1	0

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Mammals						
Montane Specialists						
American marten	1	0	1	1	1	1
Dwarf shrew	1	1	1	1	1	1
Heather vole	0	0	1	1	1	1
Meadow jumping mouse	1	1	1	0	1	0
Meadow vole	1	0	1	0	1	1
Montane shrew	1	1	1	1	1	1
Northern pocket gopher	1	1	1	1	1	1
Pika	1	1	1	1	1	1
Red squirrel	1	1	1	1	1	1
Snowshoe hare	0	0	1	1	1	1
Southern red-backed vole	1	1	1	1	1	1
Water shrew	1	1	1	1	1	1
Habitat Generalists						
Abert's squirrel	1	1	1	1	1	1
Badger	1	0	1	1	1	1
Big brown bat	1	1	1	1	1	1
Big free-tailed bat	0	1	0	0	0	0
Bighorn sheep	0	1	0	0	1	1
Black bear	1	1	1	1	1	1
Black-tailed jack rabbit	1	1	1	1	1	0
Black-tailed prairie dog	0	0	0	0	1	1
Bobcat	1	1	1	1	1	1
Botta's pocket gopher	1	1	1	1	1	1
Brazilian free-tailed bat	1	1	1	0	1	0
Brush mouse	1	1	1	1	1	1
Bushy-tailed woodrat	1	1	1	1	1	1
California myotis	1	1	1	1	1	0
Colorado chipmunk	1	1	1	1	1	1
Coyote	1	1	1	1	1	1
Deer mouse	1	1	1	1	1	1
Desert cottontail	1	1	1	1	1	1
Desert shrew	1	0	0	0	0	0
Elk	1	1	1	1	1	1
Ermine	1	1	1	0	1	1
Fringed myotis	1	1	1	0	1	1
Golden-mantled ground squirrel	1	1	1	1	1	1
Gray fox	1	1	1	1	1	1
Gunnison's prairie dog	1	1	1	1	1	1
Hispid cotton rat	0	0	0	0	1	0
Hispid pocket mouse	1	0	1	0	1	0
Hoary bat	1	1	1	1	1	1
Kit/Swift fox	1	0	1	0	1	0
Least chipmunk	1	1	1	1	1	1
Little brown myotis	1	0	1	0	1	1
Long-eared myotis	1	1	1	1	1	1
Long-legged myotis	1	1	1	1	1	1
Long-tailed vole	1	1	1	1	1	1
Long-tailed weasel	1	1	1	1	1	1
Masked shrew	1	0	1	1	1	1
Merriam's kangaroo rat	1	0	1	0	1	0
Mexican woodrat	1	1	1	1	1	1

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Mammals						
Habitat Generalists						
Montane vole	1	1	1	1	1	0
Mountain lion	1	1	1	1	1	1
Mule deer	1	1	1	1	1	1
Northern grasshopper mouse	1	1	1	1	1	1
Northern rock mouse	1	0	1	0	1	1
Nuttall's cottontail	1	1	1	1	1	1
Ord's kangaroo rat	1	0	1	1	1	1
Pallid bat	1	1	1	0	1	0
Pinon mouse	1	1	1	1	1	1
Plains harvest mouse	1	1	0	0	1	0
Plains pocket mouse	1	0	1	1	1	1
Porcupine	1	1	1	1	1	1
Red fox	1	0	1	1	1	1
Ringtail	1	0	1	0	1	1
Rock pocket mouse	1	0	0	0	0	0
Rock squirrel	1	1	1	1	1	1
Silky pocket mouse	1	1	1	1	1	1
Silver-haired bat	1	1	1	1	1	1
Small-footed myotis	1	1	1	1	1	1
Southern plains woodrat	1	0	1	0	1	1
Spotted bat	1	1	1	1	1	0
Striped skunk	1	0	1	1	1	1
Thirteen-lined ground squirrel	1	0	1	1	1	1
Townsend's big-eared bat	1	1	1	0	1	1
Western harvest mouse	1	1	1	1	1	1
Western jumping mouse	1	1	1	1	1	1
Western pipistrelle	1	1	1	0	1	0
Western spotted skunk	1	0	1	1	1	0
White-footed mouse	1	1	1	1	1	0
White-tailed antelope squirrel	1	1	1	0	1	0
White-tailed jack rabbit	1	0	1	1	1	1
White-throated woodrat	1	1	1	1	1	1
Yellow-bellied marmot	0	0	1	1	1	1
Yellow-faced pocket gopher	1	0	1	0	1	0
Yuma myotis	1	1	1	0	1	1
Aquatic Specialists						
Beaver	1	1	1	1	1	1
Meadow jumping mouse	1	1	1	0	1	0
Mink	1	0	1	0	1	1
Muskrat	1	0	1	1	1	1
Water shrew	1	1	1	1	1	1
Taxon: Reptiles						
Habitat Generalists						
Blacktail rattlesnake	1	0	0	0	1	0
Checkered whiptail	1	1	1	0	1	0
Chihuahuan spotted whiptail	1	1	1	1	1	0
Coachwhip	1	1	1	1	1	1
Collared lizard	1	1	1	1	1	1
Common kingsnake	1	1	1	0	1	0

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Reptiles						
Habitat Generalists						
Corn snake	1	1	1	0	1	1
Desert spiny lizard	1	0	0	0	0	0
Glossy snake	1	1	0	0	0	0
Gopher snake	1	1	1	1	1	1
Great plains skink	1	1	1	0	1	1
Greater earless lizard	0	0	0	0	1	0
Leopard lizard	1	0	0	0	0	1
Lesser earless lizard	1	1	1	1	1	1
Lined snake	1	0	0	0	1	0
Little striped whiptail	1	1	0	0	1	1
Longnose snake	1	0	1	0	1	0
Many-lined skink	1	1	0	1	1	1
Massasauga	1	0	0	0	0	0
Milk snake	1	0	1	0	1	0
Mountain patchnose snake	1	0	1	0	1	0
New Mexico whiptail	1	0	1	1	1	0
Night snake	1	1	1	0	1	1
Ornate box turtle	1	0	1	0	1	0
Plains black-headed snake	1	0	1	0	1	0
Plateau striped whiptail	1	1	1	1	1	1
Prairie lizard	1	1	1	1	1	1
Ringneck snake	1	1	1	0	1	1
Roundtail horned lizard	1	1	0	0	0	1
Sagebrush lizard	1	0	1	1	0	0
Short-horned lizard	1	1	1	1	1	1
Side-blotched lizard	1	1	0	0	1	0
Smooth green snake	1	1	1	1	1	1
Striped whipsnake	1	1	1	1	1	0
Texas blind snake	1	0	1	0	1	1
Tree lizard	1	1	1	1	1	0
Western diamondback rattlesnake	1	1	1	1	1	0
Western hognose snake	1	0	1	0	1	1
Western rattlesnake	1	1	1	1	1	1
Western terrestrial garter snake	1	1	1	1	1	1
Aquatic Specialists						
Blackneck garter snake	1	1	1	1	1	1
Checkered garter snake	1	0	0	0	1	1
Common garter snake	1	0	1	1	1	0
Painted turtle	1	1	1	0	1	0
Plains garter snake	0	0	0	0	1	1
Slider	0	0	0	0	1	0
Snapping turtle	0	1	0	0	1	0
Spiny softshell	1	1	0	0	0	0
Yellow mud turtle	0	1	0	0	0	0
Taxon: Amphibians						
Montane Specialists						
Jemez Mountains salamander	1	1	0	0	0	0
Western toad	0	0	1	1	0	0

Appendix B. (Cont'd.)

	Jemez		San Juan		Sangre de Cristo	
	Predicted	**Reported**	**Predicted**	**Reported**	**Predicted**	**Reported**
Taxon: Amphibians						
Habitat Generalists						
Great Plains toad	1	1	0	0	0	0
New Mexico spadefoot	1	1	1	0	1	1
Plains spadefoot	1	1	1	1	1	1
Red-spotted toad	1	1	0	0	1	0
Tiger salamander	1	1	1	1	1	1
Western chorus frog	1	1	1	1	1	1
Woodhouse's toad	1	1	1	1	1	1
Aquatic Specialists						
Canyon treefrog	1	1	0	0	1	1
Couch's spadefoot	1	1	0	0	0	0
Northern leopard frog	1	1	1	1	1	1
Plains leopard frog	1	0	1	1	1	1
Taxon: Fish						
Taxon						
Brook stickleback		0		0		1
Central stoneroller		0		0		1
Creek chub		0		0		1
Cutthroat trout		1		1		1
Fathead minnow		1		1		1
Flathead chub		1		1		1
Largemouth bass		0		1		1
Longnose dace		1		1		1
Rio Grande chub		1		1		1
Rio Grande sucker		1		1		1
Southern redbelly dace		0		0		1
White sucker		1		1		1
Taxon: Butterflies						
Montane Specialists						
Anise swallowtail		1		0		1
Arctic blue		1		1		1
Blue copper		0		1		1
Chryxus arctic		1		1		1
Colorado skipper		1		1		1
Common alpine		0		1		1
Draco skipper		1		1		1
Dreamy duskywing		1		1		1
Freija fritillary		0		1		0
Garita skipperling		1		1		1
Silvery checkerspot		1		0		1
Great spangled fritillary		1		1		1
Greenish blue		1		1		1
Grizzled skipper		0		0		1
Helena fritillary		1		0		1
Large marble		0		1		1
Lustrous copper		0		0		1
Magdalena alpine		0		0		1
Mead's sulphur		0		0		1
Melissa arctic		0		1		1
Mexican cloudywing		1		1		1

Appendix B. (Cont'd.)

	Jemez Reported	San Juan Reported	Sangre de Cristo Reported
Mormon fritillary	1	1	1
Nevada skipper	1	0	1
Northwestern fritillary	1	1	1
Polixenes arctic	0	1	1
Rocky Mountain parnassius	0	0	1
Scudder's sulphur	0	0	1
Silver-bordered fritillary	1	0	0
Uhler's arctic	0	1	1
Western tiger swallowtail	1	0	1
Western white	0	0	1
Habitat Generalists			
Afranius duskywing	1	1	1
American lady	1	1	1
Ancilla blue	1	0	1
Taxon: Butterflies			
Habitat Generalists			
Apache skipper	1	0	1
Aphrodite fritillary	1	0	1
Arrowhead blue	1	0	0
Banded hairstreak	1	1	1
Behr's hairstreak	1	1	1
Black swallowtail	1	1	1
Boisduval's blue	1	1	1
Bronze roadside-skipper	1	0	1
Brown elfin	1	0	0
Cabbage white	1	0	1
California sister	1	1	1
California tortoiseshell	1	0	1
Canyonland satyr	1	1	1
Gorgone checkerspot	1	0	1
Cassus roadside-skipper	1	0	1
Ceraunus blue	0	0	1
Checkered white	1	1	1
Clouded sulphur	1	1	1
Colorado hairstreak	1	1	1
Common checkered skipper	1	1	1
Common ringlet	1	1	1
Common roadside-skipper	1	1	1
Common sootywing	1	0	1
Common wood-nymph	1	1	1
Coral hairstreak	1	1	1
Dainty sulphur	1	1	1
Desert elfin	1	0	0
Desert marble	0	1	1
Dotted checkerspot	1	1	1
Dotted roadside-skipper	1	0	0
Dun skipper	1	1	1
Dusted skipper	1	0	0
Edwards' fritillary	1	1	1
Edwards' skipperling	1	1	1
Field crescent	1	1	1
Frosted elfin	1	0	0
Fulvia checkerspot	1	1	1
Funereal duskywing	1	0	1

Appendix B. (Cont'd.)

	Jemez Reported	San Juan Reported	Sangre de Cristo Reported
Goatweed leafwing	1	0	1
Gray hairstreak	1	1	1
Great purple hairstreak	1	0	1
Green comma	1	0	1
Green skipper	1	1	1
Hedge-row hairstreak	1	0	0
Hoary comma	1	1	1
Horace's duskywing	1	0	1
Juba skipper	1	0	0
Juniper hairstreak	0	1	1
Leda ministreak	0	1	1
Lupine blue	1	1	1
Margined white	1	1	1
Marine blue	1	1	1
Taxon: Butterflies			
Habitat Generalists			
Mead's wood nymph	1	1	1
Melissa blue	1	1	1
Meridian duskywing	1	0	0
Mexican sootywing	0	0	1
Mexican yellow	1	0	1
Milbert's tortoiseshell	1	0	1
Monarch	1	0	1
Mormon metalmark	0	1	1
Morrison's skipper	1	1	1
Mountain checkered-skipper	1	0	1
Mourning cloak	1	0	1
Mylitta crescent	1	1	1
Nais metalmark	1	1	1
Nokomis fritillary	0	0	1
Northern cloudywing	1	1	1
Northern white-skipper	0	1	0
Old World swallowtail	1	0	1
Orange sulphur	1	1	1
Orange-headed roadside-skipper	1	1	1
Oslar's roadside-skipper	1	1	1
Pacuvius duskywing	1	1	1
Pahaska skipper	1	1	1
Painted crescent	1	0	1
Painted lady	1	1	1
Pale swallowtail	1	0	1
Pearly checkerspot	1	1	1
Pine white	1	1	1
Pipevine swallowtail	0	0	1
Purplish copper	1	1	1
Python skipper	1	0	0
Queen	1	1	1
Queen Alexandra's sulphur	1	1	1
Question mark	0	0	1
Reakirt's blue	1	1	1
Red admiral	1	1	1
Rhesus skipper	1	0	1
Riding's satyr	1	0	1
Rita dotted-blue	1	0	0

Appendix B. (Cont'd.)

	Jemez Reported	San Juan Reported	Sangre de Cristo Reported
Rocky Mountain duskywing	1	1	1
Ruddy copper	0	1	1
Russet skipperling	1	1	1
Sachem	1	0	1
Saltbush sootywing	1	1	0
Sandia hairstreak	1	0	0
Satyr comma	1	0	1
Short-tailed skipper	1	1	1
Silver-spotted skipper	1	0	1
Silvery blue	1	1	1
Simius roadside-skipper	1	0	1
Sleepy duskywing	1	1	1
Small checkered-skipper	1	0	1
Taxon: Butterflies			
Habitat Generalists			
Small wood nymph	1	1	1
Snow's skipper	1	0	1
Southern dog face	1	1	1
Southwestern orangetip	1	0	1
Spalding's dotted-blue	1	1	0
Spring azure	1	0	1
Strecker's giant-skipper	1	1	0
Sylvan hairstreak	1	0	1
Tailed copper	1	1	1
Taxiles skipper	1	1	1
Thicket hairstreak	1	0	1
Two-tailed swallowtail	1	0	1
Uncas skipper	1	1	1
Variable checkerspot	0	1	1
Variegated fritillary	1	1	1
Viereck's skipper	1	0	0
Weidemeyer's admiral	1	1	1
West Coast lady	1	1	1
Western green-hairstreak	1	1	1
Western pine elfin	1	1	1
Western square-dotted blue	1	1	1
Western tailed-blue	1	1	1
Aquatic Specialists			
American snout	1	1	1
Common buckeye	1	0	0
Dark buckeye	0	0	1
Pearl crescent	1	1	1
Sandhill skipper	0	0	1
Tawny-edged skipper	1	1	1
Viceroy	1	0	1
Woodland skipper	1	1	1
Yuma skipper	0	0	1

Appendix C. Species-habitat associations for terrestrial vertebrates in the Southern Rocky Mountains of New Mexico. Numbers represent vegetation types present in the region (see table 1 for a description of vegetation types and appendix A1-A6 for species scientific names).

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Birds																							
Acorn woodpecker			Y	Y	Y	Y		Y		Y	Y	Y							Y	Y			
American avocet																					Y	Y	Y
American bittern																						Y	
American coot																				Y		Y	Y
American crow			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y				Y	Y	Y		
American dipper																						Y	
American goldfinch							Y	Y		Y	Y		Y	Y	Y	Y			Y	Y	Y		
American kestrel			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
American pipit	Y	Y																		Y	Y	Y	Y
American robin			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y				Y	Y			
American tree sparrow										Y	Y		Y	Y	Y					Y			
American white pelican																						Y	Y
American wigeon																					Y	Y	Y
Ash-throated flycatcher						Y		Y		Y	Y	Y			Y	Y		Y	Y	Y			
Baird's sandpiper																					Y	Y	Y
Baird's sparrow															Y	Y							
Bald eagle								Y	Y		Y				Y	Y	Y	Y	Y	Y		Y	Y
Band-tailed pigeon			Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y									
Bank swallow																				Y		Y	Y
Barn owl					Y	Y		Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Barn swallow						Y		Y		Y	Y	Y	Y	Y	Y				Y	Y	Y	Y	
Belted kingfisher																				Y		Y	
Bendire's thrasher											Y		Y	Y									
Bewick's wren			Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y			
Black phoebe																				Y	Y	Y	
Black swift			Y	Y	Y	Y	Y		Y	Y	Y											Y	
Black tern																						Y	Y
Black-bellied plover																					Y	Y	Y
Black-billed magpie											Y		Y	Y	Y					Y	Y		
Black-capped chickadee			Y	Y	Y	Y	Y		Y	Y	Y		Y	Y						Y	Y	Y	
Black-chinned hummingbird				Y				Y		Y	Y	Y	Y	Y	Y	Y			Y	Y	Y		
Black-chinned sparrow								Y		Y	Y								Y	Y			
Black-crowned night-heron																				Y		Y	Y
Black-headed grosbeak			Y	Y	Y	Y		Y		Y	Y	Y	Y	Y						Y	Y	Y	
Black-necked stilt																					Y	Y	Y
Black-throated gray warbler						Y		Y		Y	Y	Y								Y			
Black-throated sparrow													Y	Y	Y				Y				
Blue grosbeak										Y	Y		Y		Y			Y	Y	Y	Y		
Blue grouse			Y	Y	Y	Y		Y	Y	Y	Y												
Blue-gray gnatcatcher								Y		Y	Y	Y	Y	Y	Y					Y			
Blue-winged teal																					Y	Y	Y
Bonaparte's gull																					Y	Y	Y
Boreal owl			Y	Y	Y																		
Brewer's blackbird									Y						Y				Y	Y	Y	Y	
Brewer's sparrow											Y		Y	Y	Y		Y	Y	Y	Y			

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Birds																							
Broad-tailed hummingbird			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y	Y			Y	Y			
Brown creeper			Y	Y	Y	Y	Y			Y	Y									Y			
Brown-capped rosy-finch	Y	Y	Y	Y	Y	Y			Y	Y			Y	Y	Y								
Brown-headed cowbird					Y	Y			Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Bufflehead																						Y	Y
Burrowing owl									Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Bushtit				Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y					Y			
Calliope hummingbird			Y	Y	Y	Y	Y		Y											Y			
Canada goose																					Y	Y	Y
Canvasback																						Y	Y
Canyon towhee								Y		Y	Y		Y	Y	Y				Y	Y			
Canyon wren						Y		Y		Y	Y		Y	Y						Y			
Cassin's finch			Y	Y	Y	Y	Y			Y	Y												
Cassin's kingbird						Y		Y		Y	Y		Y	Y						Y		Y	
Cassin's sparrow															Y	Y	Y	Y	Y				
Cedar waxwing						Y		Y		Y	Y									Y			
Chestnut-collared longspur											Y				Y	Y	Y	Y	Y		Y		
Chihuahuan raven										Y	Y				Y	Y			Y	Y	Y		
Chipping sparrow			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Cinnamon teal																					Y	Y	Y
Clark's nutcracker			Y	Y	Y	Y	Y		Y	Y	Y								Y			Y	
Clay-colored sparrow															Y	Y			Y	Y			
Cliff swallow			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
Common goldeneye																						Y	Y
Common grackle															Y				Y	Y	Y		
Common loon																						Y	Y
Common merganser																						Y	Y
Common nighthawk						Y		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y
Common poorwill						Y		Y		Y	Y		Y	Y	Y	Y			Y	Y			
Common raven			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Common snipe									Y												Y	Y	Y
Common yellowthroat																				Y	Y	Y	
Cooper's hawk			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y			
Cordilleran flycatcher			Y	Y	Y	Y		Y		Y	Y									Y		Y	
Curve-billed thrasher								Y		Y	Y				Y	Y			Y	Y			
Dark-eyed junco			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y				Y	Y			
Dickcissel																Y	Y	Y		Y	Y		
Double-crested cormorant																				Y		Y	Y
Downy woodpecker			Y	Y	Y	Y				Y										Y			
Dusky flycatcher			Y	Y	Y	Y	Y	Y		Y	Y									Y			
Eared grebe																				Y		Y	Y
Eastern bluebird																				Y	Y		
Eastern kingbird																				Y	Y	Y	
Eastern meadowlark										Y	Y				Y	Y		Y	Y		Y		
Evening grosbeak			Y	Y	Y	Y		Y		Y	Y		Y	Y						Y			
Ferruginous hawk						Y				Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Birds																							
Field sparrow															Y				Y				
Flammulated owl			Y	Y	Y	Y	Y			Y	Y		Y	Y	Y				Y	Y			
Forster's tern																						Y	Y
Fox sparrow													Y	Y						Y			
Franklin's gull																					Y	Y	Y
Gadwall																				Y	Y	Y	Y
Gambel's quail								Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y			
Golden eagle			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Golden-crowned kinglet			Y	Y	Y	Y	Y													Y			
Grace's warbler					Y	Y														Y			
Grasshopper sparrow									Y						Y	Y		Y	Y	Y	Y		
Gray catbird								Y		Y									Y	Y			
Gray flycatcher					Y	Y				Y	Y		Y	Y	Y				Y	Y			
Gray jay			Y	Y	Y	Y	Y		Y													Y	
Gray vireo								Y		Y	Y									Y			
Great blue heron																				Y	Y	Y	Y
Great egret																						Y	Y
Great horned owl			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Greater roadrunner						Y				Y	Y				Y	Y	Y	Y	Y	Y	Y		
Greater white-fronted goose																					Y	Y	Y
Greater yellowlegs																					Y	Y	Y
Great-tailed grackle									Y						Y				Y	Y	Y		
Green heron																				Y		Y	
Green-tailed towhee			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			Y		Y		Y	
Green-winged teal																					Y	Y	Y
Hairy woodpecker			Y	Y	Y	Y	Y	Y		Y	Y									Y			
Hammond's flycatcher			Y	Y	Y	Y	Y	Y		Y	Y	Y								Y			
Hepatic tanager					Y	Y		Y		Y	Y	Y								Y		Y	
Hermit thrush			Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	Y		Y	Y		Y			
Herring gull																					Y	Y	Y
Hooded merganser																						Y	Y
Horned lark	Y	Y							Y		Y		Y	Y	Y	Y	Y	Y	Y		Y	Y	
House finch					Y	Y	Y	Y	Y	Y	Y		Y	Y	Y			Y	Y	Y	Y		
House wren			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y					Y	Y	Y	
Indigo bunting										Y	Y	Y	Y	Y						Y		Y	Y
Juniper titmouse						Y		Y		Y	Y	Y	Y	Y	Y				Y	Y			
Killdeer									Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ladder-backed woodpecker								Y		Y	Y				Y	Y			Y	Y			
Lark bunting											Y				Y	Y	Y	Y	Y				
Lark sparrow								Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
Lazuli bunting								Y					Y	Y						Y		Y	
Least sandpiper																					Y	Y	Y
Lesser goldfinch						Y	Y	Y		Y	Y		Y	Y	Y			Y	Y	Y			
Lesser scaup																						Y	Y
Lesser yellowlegs																					Y	Y	Y
Lewis's woodpecker					Y	Y				Y	Y		Y	Y						Y	Y		

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Birds																							
Lincoln's sparrow								Y											Y	Y			
Loggerhead shrike								Y			Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Long-billed curlew															Y	Y					Y		
Long-billed dowitcher																					Y	Y	Y
Long-eared owl			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y		
MacGillivray's warbler			Y	Y	Y	Y		Y		Y	Y		Y	Y						Y		Y	
Mallard																					Y	Y	Y
Marbled godwit																					Y	Y	Y
Marsh wren									Y				Y	Y						Y		Y	
McCown's longspur											Y				Y	Y	Y	Y	Y	Y	Y		
Merlin					Y	Y			Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Mountain bluebird	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y			Y		Y			
Mountain chickadee			Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y				Y	Y			
Mountain plover														Y	Y	Y	Y	Y			Y		
Mourning dove					Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Nashville warbler						Y		Y			Y									Y			
Northern bobwhite											Y				Y						Y	Y	Y
Northern flicker			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Northern goshawk			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y						Y			
Northern harrier									Y		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Northern mockingbird						Y		Y		Y	Y		Y	Y	Y			Y	Y	Y	Y		
Northern oriole										Y	Y									Y	Y	Y	Y
Northern pintail																					Y	Y	Y
Northern pygmy owl			Y	Y	Y	Y		Y		Y	Y									Y	Y		
Northern rough-winged swallow																			Y	Y	Y	Y	
Northern saw-whet owl			Y	Y	Y	Y		Y		Y	Y								Y				
Northern shoveler									Y												Y	Y	Y
Northern shrike										Y	Y		Y	Y	Y	Y	Y	Y		Y			
Northern waterthrush																				Y	Y	Y	Y
Olive-sided flycatcher			Y	Y	Y	Y	Y			Y	Y	Y								Y			
Orange-crowned warbler			Y	Y	Y	Y		Y		Y	Y		Y	Y						Y		Y	
Osprey																				Y		Y	Y
Peregrine falcon			Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y
Pied-billed grebe																						Y	Y
Pine grosbeak			Y	Y	Y	Y																	
Pine siskin			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y			
Pinyon jay						Y	Y			Y	Y		Y	Y	Y								
Plumbeous vireo			Y	Y	Y	Y		Y		Y	Y									Y			
Prairie falcon						Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y
Purple martin			Y	Y	Y	Y				Y	Y									Y			
Pygmy nuthatch			Y	Y	Y	Y														Y			
Red crossbill			Y		Y	Y	Y	Y		Y	Y												
Red-breasted merganser																						Y	Y
Red-breasted nuthatch				Y	Y	Y	Y			Y	Y									Y			
Red-eyed vireo						Y				Y	Y									Y			
Redhead																						Y	Y

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Birds																							
Red-headed woodpecker											Y				Y					Y	Y	Y	
Red-naped sapsucker			Y	Y	Y	Y	Y	Y		Y		Y								Y			
Red-necked phalarope																				Y		Y	Y
Red-tailed hawk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Red-winged blackbird																				Y	Y	Y	
Ring-billed gull																					Y	Y	Y
Ring-necked duck																						Y	Y
Rock wren			Y	Y	Y	Y		Y		Y	Y		Y	Y	Y			Y	Y	Y			
Rose-breasted grosbeak					Y	Y				Y	Y									Y			
Ross's goose																					Y	Y	Y
Rough-legged hawk									Y		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Ruby-crowned kinglet			Y	Y	Y	Y	Y	Y		Y	Y									Y			
Ruddy duck																						Y	Y
Rufous hummingbird			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		
Rufous-crowned sparrow								Y		Y	Y												
Sage sparrow													Y	Y	Y		Y	Y	Y				
Sage thrasher										Y	Y		Y	Y	Y		Y	Y	Y	Y			
Sandhill crane									Y						Y	Y					Y	Y	Y
Savannah sparrow									Y				Y	Y	Y	Y	Y	Y	Y			Y	Y
Say's phoebe						Y		Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Scaled quail									Y		Y				Y	Y	Y	Y	Y	Y			
Scott's oriole								Y		Y	Y	Y	Y	Y						Y			
Semipalmated plover																					Y	Y	Y
Sharp-shinned hawk	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Snow goose																					Y	Y	Y
Snowy egret																						Y	Y
Solitary sandpiper																						Y	Y
Song sparrow								Y	Y				Y	Y						Y			
Sora																						Y	
Spotted owl			Y	Y	Y	Y				Y	Y									Y			
Spotted sandpiper																				Y		Y	Y
Spotted towhee			Y	Y	Y	Y		Y		Y	Y	Y	Y	Y						Y		Y	
Steller's jay			Y	Y	Y	Y	Y			Y	Y	Y											
Stilt sandpiper																					Y	Y	Y
Summer tanager																				Y		Y	
Swainson's hawk						Y			Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
Swainson's thrush			Y	Y	Y	Y				Y	Y									Y			
Swamp sparrow																				Y		Y	Y
Tennessee warbler																				Y		Y	
Three-toed woodpecker			Y	Y	Y	Y																	
Townsend's solitaire			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y							Y	Y		
Townsend's warbler			Y	Y	Y	Y				Y	Y									Y		Y	
Tree swallow			Y	Y	Y	Y	Y	Y		Y	Y									Y		Y	
Tundra swan																					Y	Y	Y
Turkey vulture			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Upland sandpiper									Y						Y	Y					Y	Y	Y

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Birds																							
Vesper sparrow									Y		Y		Y	Y	Y		Y	Y	Y	Y			
Violet-green swallow			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y				Y	Y		Y	
Virginia rail																						Y	
Virginia's warbler				Y	Y	Y		Y		Y	Y		Y	Y	Y				Y	Y			
Warbling vireo			Y	Y	Y	Y	Y	Y		Y	Y									Y			
Western bluebird			Y	Y	Y	Y		Y		Y	Y	Y	Y	Y			Y	Y		Y			
Western grebe																						Y	Y
Western kingbird						Y		Y		Y	Y		Y	Y	Y			Y	Y	Y	Y		
Western meadowlark									Y		Y		Y	Y	Y	Y	Y	Y	Y		Y		
Western sandpiper																					Y	Y	Y
Western screech-owl					Y	Y		Y		Y	Y	Y	Y	Y						Y	Y		
Western scrub-jay					Y	Y		Y		Y	Y	Y	Y	Y						Y			
Western tanager			Y	Y	Y	Y		Y		Y	Y		Y	Y						Y			
Western wood pewee					Y	Y		Y		Y	Y	Y	Y	Y						Y	Y		
Whip-poor-will					Y	Y				Y	Y									Y			
White-breasted nuthatch			Y	Y	Y	Y	Y	Y		Y	Y									Y		Y	
White-crowned sparrow	Y	Y						Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
White-faced ibis																					Y	Y	Y
White-tailed ptarmigan	Y	Y			Y	Y			Y														
White-throated sparrow																				Y		Y	
White-throated swift			Y	Y	Y	Y			Y	Y	Y		Y	Y	Y				Y	Y		Y	
Wild turkey					Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y				Y		Y	
Willet																					Y	Y	Y
Williamson's sapsucker			Y	Y	Y	Y				Y	Y									Y			
Willow flycatcher																				Y		Y	
Wilson's phalarope																				Y		Y	Y
Wilson's warbler			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y			
Wood duck																				Y	Y	Y	Y
Yellow warbler				Y	Y	Y				Y	Y									Y	Y	Y	
Yellow-billed cuckoo																				Y		Y	
Yellow-breasted chat								Y	Y					Y	Y	Y				Y		Y	
Yellow-headed blackbird														Y	Y	Y				Y	Y		
Yellow-rumped warbler			Y	Y	Y	Y		Y	Y	Y	Y		Y	Y						Y		Y	
Zone-tailed hawk					Y	Y		Y		Y	Y	Y							Y	Y		Y	
Mammals																							
Abert's squirrel					Y	Y					Y												
American marten	Y	Y	Y		Y	Y	Y		Y														
Badger			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Banner-tailed kangaroo rat													Y	Y	Y			Y	Y	Y			
Beaver																				Y		Y	
Big brown bat			Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	Y		Y		Y	Y		Y	
Big free-tailed bat					Y	Y					Y	Y	Y		Y	Y	Y			Y	Y		Y
Bighorn sheep	Y	Y							Y				Y	Y	Y	Y	Y		Y				
Black bear			Y	Y	Y	Y	Y	Y		Y	Y									Y			
Black-tailed jack rabbit					Y	Y		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Mammals																							
Black-tailed prairie dog										Y	Y		Y	Y	Y	Y			Y	Y			
Bobcat			Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	Y		Y	
Botta's pocket gopher					Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	
Brazilian free-tailed bat					Y	Y		Y		Y	Y	Y	Y	Y	Y			Y	Y	Y		Y	
Brush mouse										Y	Y	Y	Y	Y									
Bushy-tailed woodrat			Y	Y	Y	Y	Y			Y			Y	Y									
California myotis					Y	Y		Y		Y	Y		Y	Y	Y		Y	Y	Y	Y			
Colorado chipmunk				Y	Y	Y	Y				Y	Y		Y	Y								
Common raccoon																				Y	Y	Y	Y
Coyote	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Deer mouse	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Desert cottontail								Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		
Desert shrew								Y		Y	Y	Y	Y	Y	Y				Y	Y			
Dwarf shrew			Y		Y	Y																	
Elk	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y					Y		
Ermine			Y	Y	Y	Y	Y	Y	Y	Y	Y										Y		
Fringed myotis					Y	Y		Y		Y	Y	Y	Y		Y			Y	Y	Y		Y	Y
Golden-mantled ground squirrel	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y												
Gray fox					Y	Y		Y		Y	Y	Y	Y	Y	Y		Y		Y	Y	Y		
Gunnison's prairie dog									Y	Y	Y		Y	Y	Y	Y	Y						
Heather vole			Y		Y	Y			Y														
Hispid cotton rat										Y	Y				Y				Y	Y	Y	Y	
Hispid pocket mouse												Y	Y	Y	Y	Y		Y	Y	Y			
Hoary bat			Y	Y	Y	Y	Y	Y		Y	Y	Y			Y				Y	Y	Y	Y	
Kit/Swift fox										Y	Y		Y	Y	Y	Y	Y	Y	Y				
Least chipmunk	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y												
Little brown myotis			Y	Y	Y	Y				Y	Y		Y		Y				Y	Y	Y	Y	
Long-eared myotis			Y		Y	Y				Y	Y											Y	
Long-legged myotis			Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y				Y	Y		Y	
Long-tailed vole			Y	Y	Y	Y	Y		Y		Y		Y	Y	Y							Y	Y
Long-tailed weasel			Y	Y	Y	Y	Y		Y	Y	Y				Y				Y	Y	Y		
Masked shrew	Y	Y	Y	Y	Y				Y	Y	Y		Y	Y								Y	Y
Meadow jumping mouse									Y													Y	
Meadow vole									Y													Y	
Merriam's kangaroo rat												Y	Y	Y	Y				Y	Y			
Mexican woodrat					Y	Y		Y		Y	Y	Y			Y								
Mink																						Y	
Montane shrew			Y	Y	Y	Y			Y														
Montane vole			Y	Y	Y	Y			Y		Y												Y
Mountain lion			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y				Y			
Mule deer			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y		
Muskrat																				Y		Y	
Northern grasshopper mouse								Y		Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y	
Northern pocket gopher	Y	Y	Y	Y	Y	Y			Y														
Northern rock mouse					Y	Y		Y		Y	Y				Y		Y		Y				

Appendix C. (Cont'd.)

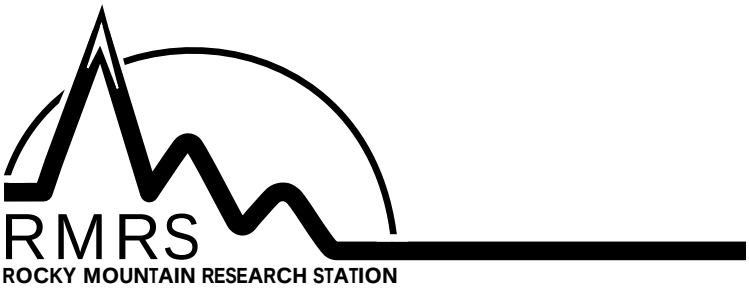
	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Mammals																							
Nuttall's cottontail			Y	Y	Y	Y	Y	Y		Y	Y		Y	Y			Y						
Ord's kangaroo rat										Y	Y		Y	Y	Y	Y		Y	Y	Y		Y	
Pallid bat						Y				Y	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y	
Pika	Y	Y	Y	Y	Y	Y	Y		Y														
Pinon mouse								Y		Y	Y		Y	Y	Y								
Plains harvest mouse								Y			Y				Y	Y					Y	Y	
Plains pocket gopher															Y				Y		Y	Y	
Plains pocket mouse										Y	Y		Y	Y	Y	Y			Y				
Porcupine	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Prairie vole															Y	Y							
Pronghorn													Y	Y	Y	Y	Y		Y	Y			
Red fox			Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y				Y	Y	Y		Y
Red squirrel			Y		Y	Y																	
Ringtail			Y		Y	Y		Y		Y	Y	Y	Y	Y	Y				Y	Y	Y		
Rock pocket mouse								Y							Y	Y			Y				
Rock squirrel					Y	Y		Y		Y	Y	Y	Y	Y	Y				Y	Y	Y		
Silky pocket mouse											Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
Silver-haired bat			Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y			Y	
Small-footed myotis			Y		Y	Y		Y		Y	Y	Y		Y	Y				Y	Y		Y	
Snowshoe hare			Y	Y	Y		Y		Y														
Southern plains woodrat										Y	Y		Y	Y	Y				Y				
Southern red-backed vole			Y	Y	Y	Y			Y														
Spotted bat					Y	Y				Y	Y		Y	Y					Y	Y		Y	
Spotted ground squirrel															Y	Y	Y	Y	Y	Y			
Stephen's woodrat										Y	Y												
Striped skunk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y
Tawny-bellied cotton rat															Y	Y			Y		Y		Y
Thirteen-lined ground squirrel			Y		Y	Y			Y	Y	Y			Y	Y				Y		Y		
Townsend's big-eared bat					Y	Y	Y	Y		Y	Y		Y	Y	Y		Y		Y	Y			
Virginia opossum																				Y	Y		
Water shrew																						Y	
Western harvest mouse					Y	Y			Y	Y	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y
Western jumping mouse									Y											Y		Y	
Western pipistrelle								Y		Y	Y	Y	Y		Y			Y	Y	Y	Y	Y	
Western spotted skunk								Y		Y	Y	Y	Y	Y	Y			Y	Y	Y			Y
White-footed mouse								Y		Y	Y				Y			Y	Y	Y			
White-tailed antelope squirrel									Y	Y	Y		Y	Y	Y		Y			Y			
White-tailed jack rabbit	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y					Y		
White-throated woodrat								Y		Y	Y	Y	Y	Y	Y			Y	Y	Y		Y	
Yellow-bellied marmot	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y												
Yellow-faced pocket gopher										Y	Y		Y	Y	Y	Y			Y	Y	Y	Y	
Yuma myotis										Y	Y		Y	Y	Y				Y	Y	Y	Y	Y

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Reptiles																							
Blackneck garter snake																				Y		Y	
Blacktail rattlesnake					Y	Y		Y		Y	Y	Y	Y	Y					Y	Y			
Checkered garter snake																				Y	Y	Y	
Checkered whiptail										Y	Y	Y			Y		Y		Y	Y			
Chihuahuan spotted whiptail					Y	Y				Y	Y	Y	Y	Y	Y				Y	Y			
Coachwhip					Y	Y				Y	Y	Y	Y	Y	Y	Y			Y	Y	Y		
Collared lizard					Y	Y				Y	Y	Y	Y	Y	Y				Y	Y			
Common garter snake																				Y	Y	Y	
Common kingsnake										Y	Y	Y	Y		Y				Y	Y			
Corn snake					Y	Y		Y		Y	Y		Y	Y	Y				Y	Y		Y	
Desert spiny lizard										Y	Y	Y	Y	Y			Y		Y	Y			Y
Glossy snake								Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y			
Gopher snake					Y	Y			Y	Y	Y	Y			Y		Y	Y	Y	Y			
Great plains skink					Y	Y				Y	Y	Y	Y	Y	Y		Y		Y	Y		Y	Y
Greater earless lizard						Y				Y	Y	Y	Y	Y	Y	Y			Y	Y			
Leopard lizard										Y	Y	Y	Y	Y	Y		Y		Y	Y			
Lesser earless lizard										Y	Y	Y	Y	Y	Y	Y	Y		Y	Y			
Lined snake										Y	Y				Y							Y	
Little striped whiptail										Y	Y	Y	Y	Y	Y		Y		Y	Y			
Longnose snake										Y	Y	Y			Y	Y	Y		Y	Y	Y		
Many-lined skink				Y	Y	Y		Y		Y	Y		Y	Y	Y		Y		Y	Y		Y	Y
Massasauga											Y				Y	Y			Y	Y			
Milk snake						Y				Y	Y		Y	Y	Y		Y		Y	Y			
Mountain patchnose snake			Y		Y	Y				Y	Y	Y								Y			
New Mexico whiptail										Y	Y	Y	Y	Y				Y	Y	Y		Y	Y
Night snake						Y		Y		Y	Y	Y	Y	Y	Y				Y	Y			
Ornate box turtle						Y				Y	Y	Y			Y				Y	Y			
Painted turtle																				Y	Y	Y	
Plains black-headed snake								Y		Y	Y	Y	Y	Y	Y				Y	Y			
Plains garter snake																				Y		Y	Y
Plateau striped whiptail						Y		Y	Y	Y	Y	Y	Y	Y	Y					Y			
Prairie lizard			Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y			
Ringneck snake					Y	Y		Y		Y	Y	Y			Y				Y	Y			
Roundtail horned lizard												Y	Y	Y	Y				Y	Y			
Sagebrush lizard			Y	Y	Y			Y		Y	Y		Y	Y			Y						
Short-horned lizard	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y				
Side-blotched lizard					Y	Y		Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	
Slider																						Y	
Smooth green snake			Y	Y	Y	Y			Y	Y	Y				Y	Y							
Snapping turtle																				Y		Y	
Spiny softshell																				Y		Y	
Striped whipsnake					Y	Y	Y	Y		Y	Y	Y		Y	Y		Y		Y	Y			
Texas blind snake										Y	Y	Y	Y	Y	Y				Y				
Tree lizard			Y		Y	Y				Y	Y	Y	Y	Y	Y		Y		Y	Y			
Western diamondback rattlesnake					Y	Y				Y	Y	Y	Y	Y	Y		Y		Y	Y			

Appendix C. (Cont'd.)

	Montane habitats									Woodland			Grassland/desert scrub							Aquatic			
	1111	1112	2111	2112	2121	2122	3111	4111	5110	3121	3122	3222	4211	4212	5121	5122	5211	5212	5221	6120	9120	9410	9420
Reptiles																							
Western hognose snake										Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		
Western rattlesnake			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y			
Western terrestrial garter snake			Y	Y	Y	Y			Y	Y	Y	Y	Y	Y						Y		Y	
Yellow mud turtle																				Y	Y	Y	Y
Amphibians																							
Canyon treefrog																						Y	
Couch's spadefoot													Y	Y	Y				Y	Y	Y	Y	Y
Great Plains toad										Y	Y		Y	Y	Y				Y	Y		Y	Y
Jemez Mountains salamander			Y	Y	Y	Y																	
New Mexico spadefoot					Y	Y				Y	Y		Y	Y	Y		Y	Y	Y		Y		Y
Northern leopard frog																				Y	Y	Y	Y
Plains leopard frog																				Y		Y	
Plains spadefoot											Y		Y	Y	Y		Y	Y	Y				Y
Red-spotted toad					Y	Y				Y	Y		Y	Y	Y				Y	Y			Y
Tiger salamander	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y				Y	Y	Y	Y	Y
Western chorus frog			Y	Y	Y	Y			Y	Y	Y				Y	Y				Y	Y	Y	Y
Western toad																						Y	
Woodhouse's toad										Y	Y		Y	Y	Y				Y	Y	Y	Y	Y



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