

PROJECT GUIDELINES



Baseline Wildlife Study Guidelines

June 2010 (links updated 2024)

ABOUT

The New Mexico Department of Game and Fish Project Guidelines provide conservation measures to minimize impacts of land use and development projects on wildlife and wildlife habitats. These Guidelines address preconstruction wildlife studies necessary to assess project impacts. For more information on this topic, please call 505-321-5485.

The primary author of these Project Guidelines is Rachel Jankowitz.

ERT for NM

The **Environmental Review Tool** (ERT) for New Mexico is a web-based system that quickly screens land use and development projects for potential impacts to wildlife and wildlife habitats. The ERT provides best management practices and guidance to mitigate these impacts. Evaluate your project with the ERT at: <https://nmert.org>.

EEP SECTION

The Ecological and Environmental Planning Section coordinates the Department's environmental review process, and works with community, private sector, state and federal government, nongovernmental organizations, and other project proponents to protect and enhance wildlife habitats. The Section implements the **Share with Wildlife program** and maintains **BISON-M**, a database of New Mexico's wildlife species. It also participates in the development and application of wildlife-related information management and planning tools.

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Photo: Lee Fitzgerald

This guideline is provided to assist in conducting inventories which thoroughly document wildlife and wildlife habitat presence, diversity, relative abundance, and distribution within the proposed project area and area of potential effects. Information obtained from baseline studies can be used for the purpose of preparing a Baseline Data report for a New Mining Permit from the NM Mining and Minerals Division, evaluating potential existing conservation lands or easements, or in support of large-scale planning efforts. The guideline may be used in whole or in part, depending on the purpose of the study; it is intended to be used in its entirety for purposes of the NM Mining Act New Mine permit application. Baseline studies can establish pre-disturbance conditions or an alternate standard against which to evaluate the effects of project activities, identify mitigation measures for construction and operational activities, or serve to establish measurable goals and objectives (desired conditions) for reclamation and/or restoration efforts.

Baseline surveys should grow out of a clear and concise statement of the ultimate objectives of the investigation. Different objectives require different sampling designs. A clear and concise statement of objectives is essential to select appropriate locations for inclusion in the study, take relevant and meaningful measurements at these locations, and perform analyses that will provide a basis for the conclusions necessary for meeting the stated objectives. Studies associated with specific proposed actions should be designed to gather information on key wildlife species and important wildlife habitats based on anticipated project-specific effects.

Surveys, inventories, and monitoring are carried out using protocols. Protocols are detailed study plans that explain how data are to be collected, managed, analyzed, and reported, and are a key component of quality assurance for natural resource monitoring and inventory programs.

Sampling design, including determination of sample size, replication, stratification, and statistical analysis, is as important to a baseline study as survey or inventory method. These considerations will influence the conclusions that can be drawn from collected data and appropriate application of findings to impacts analysis or management decisions. If sufficient resources are available, sampling design should be reviewed by a biological statistician prior to expenditure of money and effort.

Investigations of wildlife likely present in the project area and area of potential effects should begin by accessing existing information. Wildlife and habitat information is often available to the public, and may be archived in online searchable databases. Much information on the distribution, status, habitat affinities and natural history of New Mexico's wildlife is housed in the Biota Information System of New Mexico (**BISON-M**) searchable database, which contains species accounts for all New Mexico vertebrates and selected invertebrates, and the **New Mexico Environmental Review Tool**.

Special attention should be given to documenting the presence or potential occurrence of state and federally listed species, candidate and sensitive species. Special training and certification is often required to survey for state and/or federally listed species. Permits may also be required from the U.S. Fish and Wildlife Service and NMDGF to conduct surveys for certain species, particularly if these species are listed, or if trapping, handling, and/or collecting of wildlife is necessary. For threatened and endangered, candidate and sensitive species, consultation with agency species biologists may be necessary to document potential occurrence within a project area or area of potential effects of a proposed project. Some of this information may not be accessible by the public, and in the case of federally listed species, may require informal or formal consultation with the USFWS.

Some occurrence data for wildlife and plants of conservation concern is housed at Natural Heritage New Mexico. For custom, site-specific database searches on plants and wildlife, go to <https://nhnm.unm.edu/data>. For state-listed plants, call NM State Forestry Division at 505-827-5830 or go to <https://www.emnrd.nm.gov/sfd/rare-plants/>. For federally listed and candidate species, go the USFWS Information for Planning and Consultation website at <https://ipac.ecosphere.fws.gov>.

I. The Wildlife Inventory

Wildlife, as used here, means both terrestrial and aquatic vertebrates and some invertebrate species. Both game and non-game species should be included in the surveys, and each should receive attention in reclamation plans. Suggested survey methods are intended to provide comparable data and yet retain flexibility in methodology. Advance review of sampling plans with the NMDGF may help to avoid delays and requests for supplemental surveys and analysis. The Appendix to this guideline presents a matrix of published survey methods and protocols for specific habitats and species. More detailed technical information about sampling design and data analysis is available from NMDGF on request.

Wildlife information should allow:

- Determination of existing wildlife diversity, densities, and habitat utilization.
- Assessment of impacts upon wildlife and wildlife habitat as a result of completion and operation of the project.
- Assessment of the need to mitigate the impacts of construction for any species or class of wildlife on or near the proposed project site.
- Evaluation of the effectiveness of mitigation or reclamation plan as it pertains to wildlife.
- Comparison of habitat quality in potentially affected habitats before and after project activities.

A. Description of the Area

Briefly describe the character of the study area, and additional affected area if applicable. To accomplish this objective, prepare a general statement of location (county, township, range, and section(s), topography, elevation ranges, geologic features and drainages), and vegetative communities (grassland, desert scrub, woodlands, etc.).

B. Wildlife Habitats

A qualified wildlife biologist should determine habitat types. These should correspond to the vegetation types identified in the vegetation baseline survey. There may also be additional habitats that are not vegetative types, but need to be sampled for wildlife occurrence and/or use (such as, but not limited to, rimrock or ponds). Photographs of each habitat type (preferably taken from a vantage point that can be used throughout the duration of the construction and post-construction phases) should be included. Habitat typing and mapping should include the project area plus a one mile perimeter beyond the proposed area. Include acreages for all habitat types and the total length of linear habitats (such as, but not limited to, arroyos or cliffs) on the proposed area.

Landscape scale satellite imagery of vegetation data is available through the Southwest Regional Gap Analysis Project (SWReGAP, <https://swregap.org/>). We recommend using SWReGAP habitat types for wildlife habitat assessments. Field surveys are required to ground-truth SWReGAP model information. We also recommend consulting the State Wildlife Action Plan for New Mexico (SWAP) (<http://nmswap.org/>) to identify important habitat types (macrogroups). The SWAP identifies Species of Greatest Conservation Need (SGCN) for each habitat type, including state- and federally-listed, sensitive, rare, endemic and declining species. Baseline surveys may focus on a suite of SGCN within the project area and area of potential effects.

C. Description of Vertebrate Fauna; Wildlife Inventory

Potential Species List. This includes all known species that occur in the area according to literature sources and reliable sightings by local residents. Compile this list as soon as the habitat types are known, but before undertaking actual field work.

Observed and Final Species List. Observed species include all species actually detected on the project site or adjacent area. Indicate the method of detection and documentation on this list (observed, tracks, scat, etc.). Observations will rarely, if ever, reflect the entire list of wildlife that actually occurs at a given site. The final list should also include

the potential species that were not detected, but are expected or have a reasonable possibility of occurrence on the site.

Habitat Affinity. Whenever an animal or its sign is located, the habitat in the area should be identified. Determining habitat utilization and preference is one of the most important aspects of the gathering of baseline data and cannot be made with just a few days of data collection. Several systematic surveys conducted seasonally provide the best information on habitat affinity. Data collected incidentally to other work may augment, but are not an appropriate alternative, to systematic observations.

D. Seasonal Data Collection

One year is the **minimum** survey period necessary to obtain data on all classes of wildlife. It is not necessary, however, for all species to be sampled during all seasons. The following guidelines reflect the season and sampling intensity that may be required for various groups of wildlife.

Big Game. Numbers, distribution, and habitat affinity. Winter occurrence (January – February) and reproductive success (August – September) are particularly important data that must be obtained to provide a minimal assessment of big game status.

Other Mammals. Distribution and relative abundance – trapping or other surveys during Fall (August – October)

Birds. Determine raptor nest activity status, without disturbing nesting birds (February – July). Other breeding bird densities (April – August). Timing of surveys should be adjusted relative to the expected local peak breeding activity, which depends on latitude. Winter occurrence and abundance of all birds, especially raptors (December – February).

Reptiles and Amphibians. Species occurrence and relative abundance (May – September). Document breeding ponds for amphibians after periods of precipitation.

Fishes. Occurrence and abundance (any season).

E. Techniques (suggested)

A collecting permit is required for take (sacrifice, capture, salvage or possession) of some species. Contact NMDGF for necessary permits.

Big Game. On large sites, aerial surveys may be required. These should be augmented by ground surveys, either by vehicle or on foot. Determine and document the existence of seasonal concentration areas and migration routes or other habitat linkages. Note the density, sex and age class of animals observed during all seasonal inventories.

Other Mammals. Determine small mammal species composition by live-trapping on plots or along transects that have been randomly located within habitat types on the project area. Place at least two plots, each a minimum of one acre in size, or two transects that are each at least 200 meters long, in each habitat type with a goal of 300 trap-nights on each site. Trapping for relative density estimates should entail a minimum duration of three days at each location.

Occurrence of medium-sized mammals can be determined from sign or observation. Lagomorphs can be sampled by means of driving or walking transects. If driving is the method used, the width illuminated by the vehicle headlights can be used as a belt transect. Spotlighting at night is also useful in detecting other nocturnal mammals. Conducted night surveys just after dark, when there is no precipitation, and when the wind velocity is less than 15 mph. Authorization to conduct spotlighting must be obtained in **advance** from NMDGF law enforcement personnel.

Survey bats through the use of mist nets, and/or by remote monitoring of bat echolocation calls (e.g., Anabat) to determine species presence and abundance. Identification to species level using Anabat devices must include a local calibration of bat echolocation calls with individuals of known species identity.

Passerine and Upland Game Birds. Conduct bird surveys on the area during the breeding season and again during the winter. Survey during migration seasons if the project area includes potentially important stopover areas, such as riparian zones or shelter trees. A variety of survey methods are available (Emlen strip, belt transect, point counts, area searches, spot mapping, etc.). Photographic vouchers or high-quality audio recordings or songs and calls can often be used to identify species. All surveys must be stratified by habitat type with at least two transects, totaling 1000 meters or a single transect totaling 2000 meters, conducted in each type. A single all-inclusive search of one plot per type, encompassing not less than 10% of the area of the type, may be used in lieu of transects. Selection of transects or plots will often depend on the size of the area, local topography and biotic features. Randomly select plot location or starting points and orientation of transects. Conduct a minimum of four surveys, at one or two-week intervals, to take into account weather and temporal variation.

Waterfowl and Shorebirds. Survey all areas of permanent or ephemeral water to determine species and numbers of waterfowl, shorebirds and wetland associated species that occur on the area. Any species observed nesting should be documented.

Raptors. Appropriate species specific raptor survey techniques are available from NMDGF. Determine locations of raptor nests within the area and a one-mile perimeter. Nests may be located opportunistically during aerial surveys for big game, while the location of others will entail ground surveys. Indicated relative density of wintering raptors in the report. Any roosts and feeding areas which are observed should be documented.

Reptiles and Amphibians. Determine occurrence by live-trapping, capture, observation, and calls. Drift fences are effective for collecting some species. Reptiles and amphibians can often be located, identified and left unharmed. Only take individuals necessary for positive identification as voucher specimens. Photographic vouchers can often be used. Many frogs and toads can be identified by their calls, but small numbers of voucher specimens may nonetheless be obtained and deposited with the UNM Museum of Southwestern Biology (after consultation with NMDGF herpetologist). Any take of state or federally protected species must have prior authorization by permit.

Rare and Endangered Species. Thoroughly search all suitable habitat within the proposed site boundaries for federal/state threatened or endangered species of plants and animals, as well as all federal candidate species or other species of special concern. If any sensitive species is found on the area, a full assessment of its abundance, habitat requirements and status on the site must be made in order to determine the impact of construction.

Determine and map any active prairie dog towns on the area, recording the size of the colony and density of burrows. A ferret survey may be required in some instances. Ferret surveys must follow techniques approved by NMDGF. Other species associated with the colonies, such as burrowing owl, should also be surveyed. Burrowing owl survey guidelines are available from NMDGF on-line at <https://wildlife.dgf.nm.gov/download/burrowing-owl-surveys-and-mitigation-2007/?wpdmdl=43123&refresh=66995861469e71721325665>.

Fishes. Conduct surveys to document the status of fish species for all waters capable of supporting fish. Electro-shocking is appropriate for surveys (contingent upon approval by NMDGF), but this methodology should be supplemented with other methods such as seines, dip and gill nets, depending on water chemistry and other habitat characteristics.

Aquatic Invertebrates. The importance of surveying aquatic invertebrate communities lies in their value as biological indicators of water quality. Design surveys to assess the health of a specific stream or pond for baseline comparison to subsequent monitoring. Species lists alone are of limited value and thus, the relative abundance of major taxa is required. Make a determination of the importance of individual waters prior to initiating studies. An important stream or lake need not be within the area to receive

attention for impact assessment if activities are likely to affect water quality or quantity via runoff, drawdown, concentration, diversion, etc.

F. Special Studies

Often, companies and/or proponent agencies will encounter circumstances on sites that require specialized studies to obtain more detailed data than is generally required in a baseline inventory. Examples of unique situations may include blockage of big game migration route, or studies of the effects of noise on wildlife that require measurement of noise levels and behavioral or physiological responses to noise. Studies of longer duration and greater depth may therefore be required and should be coordinated with NMDGF.

G. Data Presentation

Correlate all discussion of wildlife data to habitat use by species. The text should reference all tables and maps included in the report. Tables should be easy to understand and adequately labeled and footnoted for clarity. Include a map of habitat types, transect locations, and other important features (e.g., raptor nests). Scale should be appropriate to the scale of the project area but not smaller than 1:1000. If more than one map is submitted for different aspects of the baseline information, they should all be of the same scale.

Summarize the characteristics of the habitats in the area, animal use of those habitats, and provide a discussion of the anticipated short and long term impacts associated with construction and operation of the project being permitted, in the results section of the report. Impacts should also be assessed (with proper documentation) as to their regional importance.

II. Mitigation and Habitat Reclamation

NMDGF supports the preservation, maintenance and improvement of fish and wildlife resources, and the public use thereof, in connection with impacts caused by construction projects. The primary objective is prevention or avoidance of impacts through modification of the project, e.g., design, scheduling, etc. When adverse impacts cannot be avoided through planning and/or design alternatives, NMDGF encourages project proponents to take appropriate measures necessary to fully offset those impacts. This may consist of: a) off-setting impacts by restoration, rehabilitation or replacement by an appropriate quantity of similar resource, or in certain instances, b) direct compensation.

Once companies and/or proponent agencies have assessed potential impacts, methods to minimize impacts to wildlife during and after construction should be presented (including post-construction land management policies, e.g., grazing practices).

III. Monitoring

Companies and/or proponent agencies should monitor wildlife on the area during and after construction and operations. This can occur in less detail than the baseline study, but should consist of general species composition, habitat, and seasonal use on the area, especially on reclaimed sites. Potential presence of special status species may need to be monitored immediately prior to and continuously during construction to assess disturbance.

IV. Appropriate State and Federal Laws

Project managers should be aware of the provisions of the Migratory Bird Treaty Act, which provides protection for all migratory birds. If it becomes necessary to handle, capture, relocate or destroy migratory birds, their nests or eggs, permits must be obtained from the U.S. Fish and Wildlife Service (USFWS) and NMDGF. The Bald and Golden Eagle Protection Act protects bald and golden eagles. The USFWS and NMDGF should also be consulted about disturbance of eagles or their nests. The Endangered Species Act and New Mexico Wildlife Conservation Act protect endangered and threatened species of wildlife. Those species on current and proposed lists (available from either agency) should receive special attention during the pre-construction survey and subsequent monitoring programs. Power lines and transmission facilities should be constructed to prevent electrocution of eagles and other large birds. Specifications are set forth in: Avian Power Line Interaction Committee (APLIC) (2006). Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, DC and Sacramento, CA. <http://www.aplic.org>.

V. Format

Format of the report should closely correspond to the following scheme:

1. Description of the Area

- Location
- Topography
- Vegetative Character
- Habitat Types

2. Methods

- Big Game
- Other Mammals
- Birds
- Reptiles and Amphibians
- Fishes
- Aquatic Invertebrates
- Rare or Endangered Species

3. Results and Discussion

- Big Game
- Other Mammals
- Birds
- Reptiles and Amphibians
- Fishes
- Aquatic Invertebrates
- Rare or Endangered Species
- Species Lists

4. Habitat Affinities (may be combined with Results)

5. Assessment of Impact (Include: direct, indirect, short term, long term and cumulative impacts).

6. Mitigation and Monitoring Plans

VI. Personnel and Documentation

The name(s) of the company or organization and personnel involved in a wildlife study should be included in the report as well as a brief listing of the qualifications of the personnel conducting or associated with wildlife and plant inventories and monitoring should also be documented. Also, include all correspondence between the company and any governmental agency concerning the scope of the study or requests for information.

**WILDLIFE BASELINE STUDY GUIDELINE
APPENDIX**

**WILDLIFE BASELINE STUDY MATRIX
METHODS AND PROTOCOLS
NEW MEXICO DEPARTMENT OF GAME AND FISH**

June 2010 (links updated 2024)

Introduction

This document provides an overview to consultants and others preparing environmental analyses, monitoring plans, or management plans of the range of available survey and inventory methods and techniques applicable to baseline studies of terrestrial wildlife and their habitats. The selection of methods presented here is by no means complete but is offered as a starting point for those designing wildlife baseline studies. These guidelines are a companion document to "Wildlife Baseline Study Guideline Design and Data".

CATEGORY	APPROACH	REFERENCE
COMPILATIONS OF METHODS AND PROTOCOLS		
Species Management Abstracts, prepared by The Nature Conservancy	Various	Online at https://www.conservationgateway.org/ConservationPlanning/ToolsData/sitepages/article-list.aspx
Reptiles and amphibians, birds, and mammals	Monitoring of following road de-commissioning	Townsend and Switalski (2004)
Wildlife, fish, and rare plants	Species Protocol Technical Guide with inventory and monitoring protocols using the Forest Service technical guide format	Vesely et al. (2006)
Plants and animals	Comprehensive guides	Elzinga et al. (2001); Thompson et al. (1998); Cornelissen et al. (2003)
Forest amphibians, birds, mammals, terrestrial mollusks, vascular plants	Survey protocols for species closely associated with late successional-old growth forests of Oregon and Washington (Survey and Manage Program of the Northwest Forest Plan)	Online at, https://www.fs.usda.gov/r6/reo/survey-and-manage/
Birds, mammals, amphibians (plethodontid salamanders), reptiles (snakes), and terrestrial arthropods	Inventory methods manuals (British Columbia Integrated Land Management Bureau, Resources Information Standards Committee)	Online at Government of British Columbia, Terrestrial Ecosystems, Biodiversity
Waterfowl and other waterbirds, cranes, raptor nests, and large ungulates (e.g., pronghorn)	Aerial survey estimation procedures	Pollock and Kendall (1987); Guenzel (1997) for pronghorn

CATEGORY	APPROACH	REFERENCE
VEGETATION		
Comprehensive		
Terrestrial vegetation	Protocol for monitoring biodiversity	Roberts-Pichette and Gillespie (1999)
Vegetation	Vegetation monitoring guide	The BLM Interagency Technical Team (1999)
Vegetation	Vegetation sampling methods	Bonham (1989); Stohlgren et al. (1995)
Plants and soils	Comprehensive reference manual for ecological monitoring on military lands	CEMML (2006)
Lichens, trees, indicator plants, downed woody debris, soils	Protocols for sampling lichens, measuring the regeneration of seedlings and saplings, recording the flowering times for indicator plant species, recording downed woody debris in terrestrial systems, and recording average daily soil temperature at a single depth	The Ecological Monitoring and Assessment Network of Environment Canada, online at http://www.eman-rese.ca/eman/ecotools/protocols/
Grasslands		
Grassland plant communities	Annotated bibliography of sampling techniques applicable to grasslands	Sorrells and Glenn (1990)
Rangeland vegetation	Site-specific, field-based protocols for monitoring structural characteristics of rangelands	NRCS (1997); Elzinga et al. (1998); and Barnett and Stohlgren (2003) ; Spaeth (2003)

CATEGORY	APPROACH	REFERENCE
VEGETATION CONT'D		
Rangeland vegetation	Assessment protocol	Pellant et al. (2000, 2020); Pyke et al. (2002)
Intermountain West rangeland vegetation	Rangeland indicators useful in describing rangeland health and functionality: noxious weeds, ground cover, species composition, and shrub cover	O'Brien et al. (2003)
BLM rangeland vegetation	BLM ecological site inventory protocols	Habich (2001)
Forests		
Wildlife, fish, and rare plants	Species Protocol Technical Guide with inventory and monitoring protocols using the Forest Service technical guide format	Vesely et al. (2006)
Vascular plants	Survey protocols for species closely associated with late successional-old growth forests of Oregon and Washington (Survey and Manage Program of the Northwest Forest Plan)	Online at, https://www.fs.usda.gov/r6/reo/survey-and-manage/
Soils		
Soil and vegetation	Monitoring manual for rangeland assessment	Herrick et al. (2005)
Soils	Soil management assessment framework	Andrews et al. (2004)
Soils	Sampling field book	Schoeneberger et al. (2002)
Invasive Species		
Invasive plants	Assessment protocol; monitoring guide; rapid assessment protocol	Morse et al. (2004); Dewey and Andersen (2004); Haber (1997); CNPS Vegetation Committee (2004)

CATEGORY	APPROACH	REFERENCE
HABITAT ASSESSMENT METHODS		
	Protocol documentation for metrics used in habitat ecological integrity assessments	NatureServe, online at https://www.cnps.org/vegetation/vegetation-program-reports
Wildlife habitat	Aspects and methods of measuring wildlife habitat	Cooperrider et al. (1986); Bookhout (1996), Morrison et al. (1992)
Wildlife habitat	Monitoring techniques applicable to wildlife restoration	Morrison (2002)
Wildlife habitat	Design of monitoring to evaluate the success of restoration for wildlife	Block et al. (2001)
Riparian habitats in the Southwest	Integrated, multi-resource method for rapid assessment of functional condition	Stevens et al. (2005)
Wildlife habitat	Habitat Evaluation Procedures (HEP): a quantitative method to account for changes in the suitability of habitat for selected species resulting from project actions	USFWS (1996)

CATEGORY	APPROACH	REFERENCE
MAMMALS		
Compilations		
Mammals	Standard measuring and monitoring methods	Wilson et al. (1996)
Mammals	Cites books and articles on management of given species that present specific management techniques, including inventory and monitoring; also makes general recommendations regarding sampling	Feldhamer et al. (2003).
Mammals in winter	Evaluated winter tracking protocols as a method for monitoring mammals in Alberta	Bayne et al. (2005)
Mammals caught in traps	Lure point transects and trapping point transects	Buckland et al. (2006)
Marked mammals	Mark/recapture or mark/resight techniques	Pollack et al. (1990), White (1996); Borchers et al. (2002)
Taxon-Specific		
Prairie dogs (<i>Cynomys</i> sp.)	Methods to estimate population densities and monitoring protocol	Severson and Plumb (1998) and Plumb et al. (2001) ; Magle et al. (2007); Facka et al. (2008); Pruett et al. (2009)
Black-footed ferret	Technique for evaluating black-footed ferret habitat and survey protocol	Biggins et al. (1993) and BLM (2005)
River otter	Monitoring data collection protocols	Breaux et al. (2002), CDOW (2003), Maxfield et al. (2005), and Boyle (2006)
Bobcat	Use of cameras to estimate abundance	Heilbrun et al. (2006)
American marten	Winter surveys and track detection survey methods	Corbould and Hengeveld (1998) and Zielinski and Kucera (1995)
Snowshoe hare	Fecal pellet count methods and comparison to mark-recapture methods	Keith et al. (1968), Murray et al. (2002), and Mills et al. (2005)
Tree squirrels	Survey and monitoring techniques	Gurnell et al. (2001)
Black bear	Mast survey methods	Costello et al. (2003)
Bears	Manual of inventory methods for bears in British Columbia	The British Columbia Resources Inventory Committee (1998)
Bats		
New Mexico bats	Presentations on bat survey methods potentially applicable to New Mexico bat species	Western Bat Working Group
New Mexico bats	Bat bibliography for New Mexico that includes numerous publications that address species-specific bat survey methods	Stuart (2005)
Long-nosed bats (Genus <i>Leptonycteris</i>) in New Mexico	Roost survey protocol	Weise (2005)

CATEGORY	APPROACH	REFERENCE
MAMMALS CONT'D		
Bats Cont'd		
New Mexico bats	Bat monitoring protocol using mist-netting applicable to New Mexico bat species	Petryszyn (1994)
Western bats	Overview of techniques available for monitoring bat populations in specified habitats or vegetation types	Thomas and West (1989)
Bats in mines	Mine survey and gating protocol	The North American Bat Conservation Partnership (NABCP) Management subcommittee
Bats in mines	Guidelines for developing a bat survey and inventory program for pre-mine closure planning	Altenbach et al. (2001)
Bats in mines	Guidelines for survey and monitoring of mines	Riddle (1995)
Bats	Bat surveys and monitoring in the context of bat conservation	The NABCP State Planning Guide for Bats (Tuttle 2004)
Bats under bridges	Guano collection techniques and analysis for conducting bridge surveys	Ormsbee et al. (2005)
Bats in buildings	Survey protocol for bats occupying buildings in Pacific Northwest	Joyner (2006)
Bats	Bat study and sampling design	British Columbia Resources Inventory Committee (1998)
Food Habits		
Vertebrates; raptors	Methods for investigating the food habits of terrestrial vertebrates; statistical power necessary for dietary analysis from fecal samples; methods for assessing raptor diet	Litvaitis (2000); Trites and Joy (2005); Lewis et al. (2004)
Body Condition		
Deer and elk	Protocol for evaluating relative body condition of harvested deer and elk in New Mexico	Bender (2003)
State-listed mammal species		
Spotted bat (<i>Euderma maculatum</i>)	survey methodology	Pierson and Rainey (1998)
Western yellow bat (<i>Lasiurus xanthinus</i>)	Survey methods for <i>Lasiurus</i> bats; recommendations for complimentary research methodologies applicable to <i>Lasiurus</i> species	Stokes et al. (2003)
White-sided jackrabbit (<i>Lepus callotis</i>)	Inventory methods for hares and cottontails that likely apply to white-sided jackrabbit	The British Columbia Ministry of Environment, Lands and Parks (1998)
Small mammals		
Small mammals	Census methods	Davis (1982)

CATEGORY	APPROACH	REFERENCE
MAMMALS CONT'D		
Small mammals Cont'd		
Small mammals	Capture-recapture methods	Williams et al. (2002)
Small mammals	Comparison of capture–recapture or removal sampling techniques with distance-sampling methods (e.g., transect lines or trapping webs)	Parmenter et al. (2003)
Small mammals	Field and statistical methods for surveys of closed populations	Russell (2003)
Small mammals	Trapping protocol to determine small mammal abundance	Converse et al. (2004)
Small mammals	Comprehensive evaluation of field methods	Sibbald et al. (2006)
Small mammals, including shrews, voles, mice and rats	Inventory methods	The British Columbia Ministry of Environment, Lands and Parks (1998)

CATEGORY	APPROACH	REFERENCE
BIRDS		
Compilations		
Birds	Monitoring methods	Bart (2005).
Quail and songbirds	Survey protocols	Burger et al. (2004)
Birds	Eleven bird survey methods	Bart (2003)
Birds	Survey techniques for monitoring native birds in MT	Young et al. (2005)
Birds	Bird census techniques	Bibby et al. (2000)
Birds	Distance sampling methods	Buckland et al. (1993, 2001, 2004); Thomas et al. (2002); Norvell et al. (2003); Strindberg et al. (2004)
Crossbills	Lure point transects and trapping point transects for crossbills	Buckland et al. (2006)
Birds	Bird census and survey techniques; bird survey techniques used in Europe	Gregory et al. (2004) and Bibby et al. (1998).
Birds in New Mexico	Population inventory and monitoring	New Mexico research conducted by Hawks Aloft, online at http://hawksaloft.org/research/#projects
Birds	Guide to conducting point counts of birds, including discussion of sample size determination, distribution among habitats, vegetation sampling, and cooperation with land managers	Hamel et al.(1996); online at https://research.fs.usda.gov/treesearch/1594

CATEGORY	APPROACH	REFERENCE
BIRDS CONT'D		
Compilations Cont'd		
Landbirds	Field methods for monitoring landbirds, including mist-netting, nest searches, and census methods	Ralph et al. (1993)
Landbirds	Monitoring methods	Altman (1995); Bonney et al. (1999); Rosenstock et al. (2002)
Birds of SW riparian and scrub habitats	Comparison of variable circular-plot and spot-map methods applied to desert riparian and scrub habitat in the Southwest	Szaro and Jakle (1982)
Point Counts:		
Birds	Point counts	Ralph et al. (1995)
Birds	Survey methods that account for individuals present but not detected	Thompson (2002)
Grassland birds	Bird counts that consider species detection rates	Diefenbach et al. 2003)
Birds	Point counts and other count-based survey methods	McCallum (2005)
Birds	Distance sampling	Buckland et al. (2001)
Birds	Removal Models	Farnsworth et al. (2002); Moore et al. (2004)
Birds	Double observer sampling	Nichols et al. (2000); Moore et al. (2004)
Birds	Double sampling	Manly et al. (1996); Bart and Earnst (2002)
Birds	Six approaches for estimating point survey detection probabilities	Wintle et al. (2004)
Birds caught in mist nets	MAPS (Monitoring Avian Productivity and Survivorship) program	DeSante et al. (2015)
Birds	Monitoring of migrants using mist-netting	Hussell and Ralph (1995)
Landbirds	A method for landbird migration monitoring at a single station	Thomas et al. (2004)
Birds	Breeding Biology Research and Monitoring Database (BBIRD) Program	Conway and Martin (2000)
Breeding Bird Survey		
Birds	Breeding Bird Survey (BBS) as applied to landbirds and comparison of BBS to the Breeding Bird Census and Breeding Bird Atlas	Rosenberg and Blancher (2005)
Landbirds	Methods applicable to landbird species not adequately monitored by the Breeding Bird Survey	Altman and Bart (2001)
Gallinaceous Birds		
Gould's turkey	Survey methodology	New Mexico Game and Fish
Rio Grande wild turkey	Literature review of population estimation techniques	Butler (2003)
Rio Grande turkey	Using roads as transects for distance sampling	Butler et al. (2005)
Rio Grande wild turkey	Comparison of techniques for counting at winter roosts	Butler et al. (2006)
Lesser prairie chicken	Survey protocol	Massey and Dunn (2000)

CATEGORY	APPROACH	REFERENCE
BIRDS CONT'D		
Gallinaceous Birds Cont'd		
Scaled quail	Bibliography of literature on population estimation and food habits analysis	Lerich (2006)
Greater sage grouse	Lek survey and count methodology	Western Association of Fish and Wildlife Agencies (2004)
Raptors		
Burrowing owl	Survey and monitoring protocol	New Mexico Burrowing Owl Working Group (2004)
American peregrine falcon	Monitoring protocols	USFWS (2003) and Daw et al. (2004)
Bald eagle	Standardized breeding and wintering monitoring protocols; protocol for surveying bald eagle winter roost sites; survey techniques to identify bald eagle use of potential habitat in site assessments for proposed projects	Steenhof et al. (2002); BLM (2005); Jackman and Jenkins (2004)
Golden eagle	Population monitoring methods	Fuller et al. (2001) and Good et al. (2004)
Raptors	Inventory methods	British Columbia Ministry of Sustainable Resource Management (2001)
Marsh Birds		
Black rail, least bittern, yellow rail, sora, Virginia rail, American bittern, common moorhen, purple gallinule, american coot, and pied-billed grebe	Standardized monitoring protocols	Conway (2006)
Rails and bitterns	Survey methods for secretive marsh birds	Conway and Nadeau (2006) and Conway and Gibbs (2005)
Hérons, egrets, ibises, gulls, terns	Species-specific survey methods for colonial waterbirds	Steinkamp et al. (2003)
Colonial waterbirds	Standardization of survey protocols	Steinkamp et al. (2005)
Aquatic birds	The Coordinated Bird Monitoring Plan in New Mexico: Bird Monitoring Regions (BMR) and species that regularly use each BMR	Hartley (2004) and Bart and Manning (2006)

CATEGORY	APPROACH	REFERENCE
BIRDS CONT'D		
Marsh Birds Cont'd		
Hérons, egrets, bitterns, ibises, pelicans, cormorants, gulls, terns, grebes, herons, egrets, waterfowl, Forster's and black terns, common snipe, sandhill cranes, northern harriers, belted kingfishers, marsh wrens, red-winged and yellow-headed blackbirds, common yellowthroats, and migrating shorebirds	Survey protocols that should be applicable to New Mexico	Moulton et al. (2004)
Marsh birds	Protocols	Seglund et al. (2005)
Shorebirds		
Snowy plover, mountain plover, black-necked stilt, American avocet, willet, marled godwit, dunlin, wandering tattler, whimbrel, long-billed curlew, western sandpiper, and Wilson's phalarope	Monitoring protocols for shorebirds	Howe et al. (2000)
Long-billed curlew	Protocol for conducting range-wide breeding population surveys	USFWS (2005) and Saunders (2001)
Mountain plover	Survey protocols and guidelines; monitoring methods	Williams (1997); BLM (2005); USFWS (2002); Dreitz et al. (2006); Royle and Nichols (2003)
Hérons and egrets, nesting gulls and terns, shorebirds, and waterfowl	Data collection protocols for monitoring of wetland birds	Wetland Regional Monitoring Program for San Francisco Bay, Bird Focus Group, Wetland Regional Monitoring Program (2002)
Shorebirds	Sampling design and approaches to regional shorebird monitoring	Bart et al. (2005)
Cavity-nesters		
Cavity-nesting birds	Field protocol for monitoring	Dudley and Saab (2003)
Other Species		
Black swift	Survey protocol	Earnst and Heltzel (2005) and Schultz and Levad (2001)
Crossbills	Survey methods	Buckland et al. (2006)
State-listed bird species		
State-listed passerine landbirds	Can be surveyed using standardized methods described elsewhere in this document	

CATEGORY	APPROACH	REFERENCE
BIRDS CONT'D		
State-listed bird species Cont'd		
Common black-hawk (<i>Buteogallus anthracinus</i>)	Monitoring strategy	Boal (2001)
Neotropic cormorant (<i>Phalacrocorax brasilianus</i>)	Survey methods and sampling designs, including measuring detection probability	Steinkamp et al. (2003)
Whooping crane (<i>Grus americana</i>)	Aerial census flights	Pollock and Kendall (1987)
Common ground-dove (<i>Columbina passerina</i>)	Count methods and sampling design; fixed radius point count surveys; unlimited distance point count surveys; point-transect distance sampling	Rivera-Milan (1995); Askins and Ewert (1991); Wauer and Wunderle (1992)
Hummingbirds	Protocols applicable to hummingbirds, including point-transects and on-road and off-road point counts that focus on known or suspected use areas	Altman and Bart (2001)
Boreal Owl and Whiskered Screech Owl	Owl Survey playback protocol; nocturnal survey protocol; night-time call-back surveys for boreal owls that target suitable habitat	Cannings (2005); Takats et al. (2001), Takats Priestley (2004); Grosshuesch (2006); British Columbia Ministry of Sustainable Resource Management (2001)
Brown pelican (<i>Pelecanus occidentalis</i>)	Survey protocol	Lewis et al. (1988), online at https://irma.nps.gov/DataStore/Reference/Profile/110435
White-tailed ptarmigan (<i>Lagopus leucurus</i>)	Inventory survey protocol	British Columbia Ministry of Environment, Lands and Parks (1997)
Gray vireo (<i>Vireo vicinior</i>)	Monitoring methods	Winter and Hargrove (2004)

CATEGORY	APPROACH	REFERENCE
AMPHIBIANS AND REPTILES		
Compilations		
Terrestrial reptiles and amphibians	Drift fences with pitfalls or funnel traps, or a combination of both	Row and Blouin-Demers (2006)
Terrestrial reptiles and amphibians	Pitfalls or funnel traps with visual encounters, cover boards, and anuran calling surveys	Block and Morrison (1998); Ryan et al. (2001); Marsh and Goicochea (2003); Zorn et al. (2004)
Terrestrial reptiles and amphibians	Pitfalls and funnel traps associated with drift fences	Ryan et al. (2001)
Plethodontid salamanders	Comparison of mark-recapture and depletion methods	Bailey et al. (2004a)
Terrestrial salamanders	Method for estimating site occupancy and species detection probability parameters	Bailey et al. (2004b)
Amphibians	Method for estimation of detection probability through double sampling	Pollock et al. (2002)

CATEGORY	APPROACH	REFERENCE
AMPHIBIANS AND REPTILES		
Compilations Cont'd		
Reptiles and amphibians	Recommended inventory and monitoring techniques for reptiles and amphibians, with application to the United States and Canada.	Inventory and Monitoring: Recommended Techniques for Reptiles and Amphibians, with application to the United States and Canada
Amphibians	Standard methods for measuring and monitoring biological diversity	Heyer et al. (1994)
Reptiles caught in traps	Lure point transects and trapping point transects	Buckland et al. (2006)
Diurnal lizards	Time-constrained searches or transect surveys	Persons and Nowak (2006)
Slevin's bunchgrass lizard (<i>Sceloporus slevini</i>)	Time-constrained searches or transect surveys	Persons and Nowak (2006)
Reticulate Gila monster (<i>Heloderma suspectum</i>)	Time-constrained searches or transect surveys	Persons and Nowak (2006)
Mountain skink (<i>Eumeces callicephalus</i>)	Time-constrained searches or transect surveys	Persons and Nowak (2006)
Gray-checked whiptail (<i>Aspidoscelis dixonii</i>)	Time-constrained searches or transect surveys	Persons and Nowak (2006)
Canyon spotted whiptail (<i>Aspidoscelis burti stictogrammus</i>)	Time-constrained searches or transect surveys	Persons and Nowak (2006)
Terrestrial life stages of pond or wetland-breeding amphibians	Fences and pitfall traps placed around the perimeter of ponds or wetlands	Pierce, Pers. Comm. (2006)
Boreal toad (<i>Bufo boreas boreas</i>)	Fences and pitfall traps placed around the perimeter of ponds or wetlands	Pierce, Pers. Comm. (2006)
Sonoran desert toad (<i>Bufo alvarius</i>)	Fences and pitfall traps placed around the perimeter of ponds or wetlands	Pierce, Pers. Comm. (2006)
Great Plains narrow-mouthed toad (<i>Gastrophryne olivacea</i>)	Fences and pitfall traps placed around the perimeter of ponds or wetlands	Pierce, Pers. Comm. (2006)
Snakes	Inventory methods	British Columbia Ministry of Environment, Lands and Parks (1998)
Taxon-Specific		
Jemez Mountains salamander (<i>Plethodon neomexicanus</i>)	Survey and monitoring protocols; Bandelier National Monument protocol for non-destructive long-term monitoring of the Jemez Mountains Salamander using sampling with artificial cover	New Mexico Endemic Salamander Team (2000); Persons and Nowak (2006); Fellers and Drost (1994)
Sacramento Mountains salamander (<i>Aneides hardii</i>)	A formal inventory protocol specifically for the Sacramento Mountains salamander has not been developed, but the protocol developed for the Jemez Mountains salamander is used	New Mexico Endemic Salamander Team (2000); Persons and Nowak (2006); Fellers and Drost (1994)

CATEGORY	APPROACH	REFERENCE
AMPHIBIANS AND REPTILES		
Taxon - Specific Cont'd		
Barking frog (<i>Eleutherodactylus augusti</i>)	Standardized call surveys; visual location on paved highways following rains; methods for monitoring population size, including mark-recapture, distance sampling, call counts, and visual encounter surveys	North American Amphibian Monitoring Program (2005); Painter, Pers. Comm. (2006); Goldberg and Schwalbe (2004).

CATEGORY	APPROACH	REFERENCE
TERRESTRIAL INVERTEBRATES		
Arthropods in terrestrial ecosystems	Protocols for monitoring	Finnamore et al. (1998); Battigelli (2004); Stambaugh and Schieck (2006)
Sacramento Mountains checkerspot butterfly (<i>Euphydryas anicia cloudcrofti</i>)	Population estimation methods used	USFWS et al. (2004)
State-listed invertebrate species		
Woodlandsnails (<i>Ashmunella hebari</i> and <i>Ashmunella macromphala</i>)	Survey procedures for terrestrial mollusks	Duncan et al. (2003)

CATEGORY	APPROACH	REFERENCE
PROTOCOLS FOR FEDERALLY-LISTED SPECIES, INCLUDING PROPOSED AND CANDIDATE SPECIES		
Flat-tail horned lizard (<i>Phrynosoma mcallii</i>)	Protocols for population monitoring, distribution monitoring, project evaluation monitoring, and fencing and removal survey	Flat-tailed Horned Lizard Interagency Coordinating Committee (2003)
Sand dune lizard, (<i>Sceloporus arenicolus</i>)	Recommended survey methodology for surveys	Painter et al. (1999)
Ridgenose rattlesnake (<i>Crotalus willardi</i>)	Methods used to survey in New Mexico	Holycross and Painter (2000)
Yellow-billed cuckoo (<i>Coccyzus americanus occidentalis</i>)	Standardized protocol to determine presence or absence; comparison of three census techniques used for cuckoos on the Gila River and Rio Grande in New Mexico: standard point counts, tape playbacks, and single-species spot-mapping; survey and monitoring protocol for California	Magill and Halterman, (1999); Woodward et al. (2003); Laymon (1998)
Applomado falcon (<i>Falco femoralis</i>)	Survey methods used in a study of falcon abundance and distribution in the northern Chihuahuan Desert	Young et al. (2004)

CATEGORY	APPROACH	REFERENCE
PROTOCOLS FOR FEDERALLY-LISTED SPECIES, INCLUDING PROPOSED AND CANDIDATE SPECIES CONT'D		
Piping plover (<i>Charadrius melodus</i>)	Sampling and field methods	Erwin et al. (2003)
Interior least tern, (<i>Sterna antillarum</i>)	Range-wide monitoring protocol to assess abundance	Guilfoyle et al. (2004)
Mexican spotted owl (<i>Strix occidentalis lucida</i>)	Survey and inventory methods	Forsman (1983); US Forest Service (1986, 1989, 1990); USFWS (1989); Ward et al. (1995); USFWS (1995); Franklin et al. (1996); Arundel (1999); Ganey and Benoit (2002); Bowden et al. (2003); and Ganey et al. (2004)
Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)	Official survey protocol	Sogge et al. (1997) and USFWS (2000)
Black-capped vireo (<i>Vireo atricapillus</i>)	Procedures for determining presence/absence	Environmental Defense, Inc. and U.S. Fish and Wildlife Service (2002)

CATEGORY	APPROACH	REFERENCE
PROTOCOLS FOR FEDERALLY-LISTED SPECIES, INCLUDING PROPOSED AND CANDIDATE SPECIES		
Mexican long-nosed bat, (<i>Leptonycteris nivalis</i>) and Southern long-nosed bat, (<i>Leptonycteris curasoae yerbabuena</i>)	Roost survey protocol	Weise (2005)
Black-footed ferret (<i>Mustela nigripes</i>)	Habitat evaluation technique; survey protocol	Biggins et al. (1993) and BLM (2005)
Jaguar (<i>Panthera onca</i>)	Method for conducting jaguar abundance surveys using camera traps; comparative study of track measurement techniques, camera-trap methods, and scent lures to study jaguars, and track collection protocols	Silver (2004); Miller (2001)
Gray wolf (<i>Canis lupus</i>)	Standard Operating Procedures for howling surveys, ground telemetry, aerial telemetry, and intensive winter wolf monitoring	The Adaptive Management Oversight Committee (2005) for re-introduction of the Mexican gray wolf into Arizona and New Mexico
San Xavier talussnail (<i>Sonorella eremite</i>) and Wet canyon talussnail (<i>Sonorella macrophallus</i>)	Guidelines for development of a monitoring plan for Wet Canyon talussnail and its habitat; survey procedures used for land snails in southern New Mexico; survey procedures for terrestrial mollusks that include methods specific to talus habitats	USFS (1999); Lang (2000); Duncan et al. (2003)

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