

## Chapter 6 MONITORING STATUS AND TRENDS

This chapter describes proposed strategic plans for monitoring Species of Greatest Conservation Need (SGCN), their habitats, and the effectiveness of proposed actions and for adapting actions to respond appropriately to new information or changing conditions (**Element 5**). It describes how New Mexico Department of Game and Fish (NMDGF) will collaborate with other entities to monitor the effectiveness of proposed conservation actions and lists the performance indicators that will likely be employed to facilitate evaluations leading to adaptive management. The narrative discusses the scales at which monitoring will be conducted, why selected umbrella or keystone species will be used as monitoring surrogates, and our intent to build upon existing monitoring and survey systems. Additional insights into how monitoring and adaptive management will be integrated into the Comprehensive Wildlife Conservation Strategy (CWCS) implementation, review, and revision phases are provided in Chapter 7.

### WHY MONITORING IS IMPORTANT

The following discussion on the importance of monitoring is provided for CWCS readers to emphasize that a commitment to monitoring is necessary for effective wildlife and habitat management and conservation. This discussion is adapted primarily from Gibbs *et al.* (1999), unless otherwise noted.

In general (and in particular with regard to CWCS monitoring efforts), the ultimate goal of monitoring is to develop a scientifically defensible prediction of the status and trends of SGCN and their key habitats, to evaluate management practices and inform necessary modification. Successful monitoring programs provide the foundation for effective wildlife management and conservation. Monitoring establishes a method for evaluating the success of meeting desired management and conservation outcomes, detecting shifts in distribution or changes in habitat, and documenting regulatory compliance. Elzinga *et al.* (1998) defines monitoring as "...the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective..." which "...promotes a problem-oriented approach to monitoring and greatly enhances its rigor, effectiveness, and utility." Monitoring plays a key role in the adaptive management process by its ability to direct future management and potentially change objectives, based on the response of monitored resources to management actions or environmental changes (Holling 1978 and Ringold *et al.* 1996).

Monitoring is most effective if explicitly linked to well-defined management goals and objectives. To effectively conserve biological diversity, changes in wildlife and habitats must be evaluated, and appropriate management decisions must be made in response to those detected changes. Therefore, successful wildlife management and monitoring must be closely linked by defining specific objectives for evaluation at the site- or regional-level. Objectives should be measurable, realistic and easily repeatable and include the following

The goal of monitoring is to develop a scientifically defensible prediction of the status and trends of SGCN and their key habitats, thereby informing a determination as to whether management practices are effective or in need of modification.

components: 1) what is to be monitored; 2) the geographical area where the monitoring will occur; 3) precise identification of the specific metric(s) of the indicator(s) that will be measured; 4) the expected response of the indicators to management or change (to increase, decrease, or remain stable); 5) the magnitude of response or change expected; and (6) the time frame during which the response to management is expected to occur (Elzinga *et al.* 1998). NMDGF will develop project-specific monitoring objectives during the operational planning phase prior to CWCS implementation (See Chapter 7).

Before monitoring programs can perceive and evaluate changes in wildlife populations, baseline conditions must be determined. Field monitoring to detect changes in wildlife populations must have sufficient sampling effort to allow precise enough population or density estimates to have a reasonable chance to detect an important change (Thompson *et al.* 1998). Some of the inherent problems associated with designing and implementing an effective monitoring program include 1) the complexity and quantitative nature of monitoring multiple biological indicators across space and time; 2) determining the necessary sampling effort to adequately generate precise and reliable estimates of change of monitored resources; 3) complete baseline conditions may not be known (or may be unknowable) to allow comparison with perceived changes; 4) management objectives or goals may not be explicitly defined to allow accurate measurement of success, making it difficult to adaptively manage for future success; and 5) data collected must be comparable across monitored sites and time, analyzed correctly, archived effectively, and communicated appropriately to policy makers.

NMDGF will develop project-specific monitoring objectives during the operational planning phase prior to CWCS implementation.

## CURRENT MONITORING EFFORTS

### Species Monitoring

NMDGF gathers information used for monitoring SGCN and key habitats through many approaches including:

- Surveys and inventories conducted by staff biologists;
- Surveys and inventories conducted by private biological contractors;
- Collaboration with federal land management and natural resource agencies such as the US Fish and Wildlife Service, US Forest Service, US Bureau of Land Management, US Bureau of Reclamation, US Geological Survey, and tribal entities;
- Collaboration with academic researchers through consultation, academic and graduate research programs, peer review of scientific publications, scientific collection permitting and reporting requirements;
- Collaboration with citizen science-led efforts such as annual Breeding Bird and Christmas Count Surveys;
- Systematic environmental review and assessment of 1) project proposals that may impact wildlife and habitats; and 2) biological information provided by project proponents; and
- Review of scientific peer-reviewed and gray literature publications.

All federally listed species and all but five state-listed bird species are SGCN. The five state-listed bird species that are not SGCN include: 1) whooping crane (natural occurrence of the species in New Mexico is unproven), 2) white-eared hummingbird (limited distribution in New Mexico and their conservation concerns covered by other species), 3) brown pelican (rare vagrant), 4) buff-collared nightjar (limited distribution in New Mexico, possibly extirpated), and 5) piping plover (very rare migrant to New Mexico). NMDGF monitoring efforts have been focused on state and federally listed species, as indicated by Tables 6-1. Current monitoring efforts for state and federally listed species are primarily systematic efforts, but also include information collected opportunistically. Systematic monitoring efforts generally involve repeated sampling at pre-determined intervals within specific areas. SGCN status and trend information is thereby acquired through annual or periodic surveys, inventories and research efforts conducted by NMDGF personnel, contractors, and other (primarily) federal natural resource and/or land management biologists (Table 6-1). Opportunistically acquired monitoring information tends to be provided through networks of citizen scientists that submit reports and observations to NMDGF taxonomic specialists. This information is usually documented with specimens, recordings and/or photographs for establishing presence/absence, range extension, mortality and habitat information.

Table 6-1. Current monitoring efforts for terrestrial and aquatic SGCN that identify ongoing status, population trend, presence/absence, reproduction, demographic and other monitoring efforts for state- and federally-listed species and other SGCN. This list does not identify all species with monitoring efforts, nor all monitoring efforts for each species.

<b>Lead Agency/ Organization</b>	<b>Monitoring Efforts Underway</b>	<b>Cooperators</b>	<b>Time Frame</b>
<i>Terrestrial SGCN</i>			
NMDGF	Jemez Mountain Salamander	USFWS, USFS, USGS	Annual
NMDGF	Sacramento Mountain Salamander	USFWS, USFS, USGS	Annual
NMDGF	Lowland Leopard Frog	USFWS, USFS	Annual
NMDGF	Chiricahua Leopard Frog	USFWS, USFS	Annual
NMDGF	Colorado River Toad	Private citizen	Annual
NMDGF	Boreal Toad	USFS	Periodic
NMDGF	Sand Dune Lizard	USFWS, BLM, Texas A&M, State Land Office, Natural Heritage New Mexico	Annual
NMDGF	River Cooter	Contractors (2005-2006 Share With Wildlife Project	Periodic
NMDGF	Plainbelly Water Snake	Contractors (2005-2006 Share With Wildlife Project	Periodic
NMDGF	NM Ridgenose Rattlesnake	USFS, Private landowners, University of Arizona	Annual
NMDGF	Gray-banded Kingsnake	NPS	Annual
NMDGF	Black Bear	Legal harvest quota system, Dept. research, pelt tag database for relocation efforts and mortalities	Annual
NMDGF	Mule Deer	Annual Dept. surveys, USFS, BLM	Annual
NMDGF	Rocky Mountain Bighorn Sheep	Frequent Dept. surveys, FNAWS, USFS	Annual
NMDGF	Desert Bighorn Sheep	Frequent Dept. surveys, FNAWS, USFS, BLM, Private landowners	Annual
NMDGF	Mexican Wolf	USFS, Wildlife Services, Arizona Game and Fish, Tribes	Annual
NMDGF	Mexican Long-nosed Bat	USGS, USFS, BLM, Private landowners	Periodic
NMDGF	Lesser Long-nosed Bat	USGS, USFS, BLM, Private landowners	Periodic
NMDGF	White-sided Jackrabbit	Private landowners	Periodic
NMDGF	Least Shrew	USFWS, State Forestry	2004-05
NMDGF	New Mexico Jumping Mouse	USFS, USFWS	2004-05
NMDGF	Arizona Montane Vole	USFS	2004-05
NMDGF	Oscura Mountains Colorado Chipmunk	White Sands Missile Range	Developing
NMDGF	American Pine Marten	USFS	Periodic
NMDGF	Swift Fox	University of New Mexico	Annual
NMDGF	Black-tailed Prairie Dog	APHIS, USFWS, BLM, White Sands Missile Range, Cannon Air Force Base, Turner Foundation, Private landowners	Periodic

Table 6-1. Cont

Lead Agency/ Organization	Monitoring Efforts Underway	Cooperators	Time Frame
<i>Terrestrial SGCN</i> Cont.			
NMDGF	Gunnison's Prairie Dog	APHIS, USFWS, USFS, BLM, Pueblos and Tribes, Cities of Albuquerque and Santa Fe, State Land Office, volunteer groups, Kirtland AFB	Periodic
NMDGF	Southern Pocket Gopher	BLM, private lands	Periodic
NMDGF	Southwestern Willow Flycatcher	USFWS, BOR, USFS, Pueblos,	Annual
NMDGF	Mexican Spotted Owl	USFS, Tribes and Pueblos, Contractors	Annual
NMDGF	Northern Goshawk	USFS, contractors	Annual
NMDGF	Peregrine Falcon	USFS, BLM, contractors	Annual
NMDGF	Bald Eagle	USFS, Tribes and Pueblos, Contractors	Annual
NMDGF	Aplomado Falcon	BLM	Annual
NMDGF	Osprey	Contractors	Annual
NMDGF	Gray Vireo	BLM	Periodic
NMDGF	Lesser Prairie Chicken	BLM, State Land Office, Natural Heritage New Mexico, landowners	Annual
NMDGF	Interior Least Tern	USFWS	Annual
NMDGF	Mourning Dove	Annual Dept. surveys, USFWS	Annual
NMDGF	Northern Pintail Duck	Annual Dept. waterfowl surveys	Annual
NMDGF	Shortneck Snaggletooth	USFWS, landowners	Periodic
NMDGF	Animas Peak Woodlandsnail	USFWS, landowners	Periodic
NMDGF	Animas Talussnail	USFWS, landowners	Periodic
NMDGF	Animas Holospira	USFWS, landowners	Periodic
NMDGF	Apache Snaggletooth	USFWS, landowners	Periodic
NMDGF	Mineral Creek Mountainsnail	USFS, USFWS	Periodic
NMDGF	Fringed Mountainsnail		Periodic
NMDGF	Hatcheta Mountainsnail	BLM, USFWS	Periodic
NMDGF	Cook's Peak Woodlandsnail	BLM, USFWS	Periodic
NMDGF	Big Hatchet Woodlandsnail	BLM, USFWS	Periodic
NMDGF	Hacheta Grande Woodlandsnail	BLM, USFWS	Periodic
NMDGF	Dona Ana Talussnail	BLM, USFWS	Periodic
NMDGF	Big Hatchet Mountain Talussnail	BLM, USFWS	Periodic
<i>Aquatic SGCN</i>			
NMDGF	Gila Chub, Chihuahua Chub, Roundtail Chub, Headwater Chub, Spikedace, Loach Minnow, Desert Sucker, Sonora Sucker monitoring in Gila and Mimbres River	USFS	Annual
NMDGF	Pecos Bluntnose Shiner in Pecos River	USFWS	Spring/ Summer/ Fall
NMDGF	Greenthroat Darter, Pecos Pupfish, Pecos Gambusia	USFWS, State Parks	Annual
NMDGF	Gila Trout	USFWS, USFS	Annual

Table 6-1. Cont

Lead Agency/ Organization	Monitoring Efforts Underway	Cooperators	Time Frame
<i>Aquatic SGCN</i> Cont.			
NMDGF	Colorado Pikeminnow, Razorback Sucker, Roundtail Chub; part of San Juan monitoring program	USFWS, Utah DOW, Navajo Game and Fish, Jicarilla Apache	Annual
NMDGF	Blue Sucker, Gray Redhorse		Periodic
NMDGF	White Sands Pupfish	USFWS, Hollaman AFB, White Sands Missile Range, White Sands National Monument	Spring/ Fall
NMDGF	Rio Grande Cutthroat Trout	USFS	Annual
USFWS	Rio Grande Silvery Minnow	NMDGF, UNM, BOR, Interstate Stream Commission	Annual
NMDGF	Zuni Bluehead Sucker	USFWS, USFS, Zuni Pueblo, The Nature Conservancy	Annual
NMDGF	Prosobranch snails (8 species; Hydrobiidae, Assimineidae)	USFWS, White Sands Missile Range	Biannually
NMDGF	Pulmonate snails (state-listed)		Periodic
NMDGF	Texas Hornshell (mussel)	USFWS, Miami University, private landowners	Seasonally (May-Oct.)
NMDGF	Sangre de Cristo Peaclam	USFS	Triennially
NMDGF	Sphaeriid bivalves (state-listed)		Periodic
NMDGF	Socorro Isopod	USFWS, private landowners	Monthly
NMDGF	Gammarid amphipods	USFWS, USFS, White Sands Missile Range, Miami Univ.	Biannual
NMDGF	Decapods		Periodic
NMDGF	Large branchiopods	USFS, BLM	Periodic

Much baseline information on the distribution, status, habitat affinities and natural history of SGCN is being housed in the Biota Information System of New Mexico (BISON-M) database, which contains species accounts for all New Mexico vertebrates and selected invertebrates. BISON-M has received an average of over 1,300 user inquiries per month since January 2004. BISON-M species accounts are constantly being updated and the database is currently being converted to a more user-friendly web-based format. However, the volume of information regarding the status, population trends and habitat preferences of SGCN is constantly growing; thus, at this time no single source contains or has the capability of containing all of this information (see further discussion of BISON-M capabilities in the New Mexico monitoring plans discussion below). Therefore, we provide general information describing some ongoing monitoring efforts, but actual baseline data identifying SGCN status, population trend and habitat information is contained primarily in many individual publications, reports and databases. Status, distribution and population trend studies (some intensive) have, or will soon be, conducted for state-listed and SGCN such as:

- Great Plains Narrowmouth Toad (1992),
- Gila Monster (study completed recently at NMDGF's Red Rock facility),
- Gray-checked Whiptail (1980s),
- Bunch Grass Lizard (1980s),

- Giant Spotted Whiptail (1980s),
- Mountain Skink (1980s),
- Green Rat Snake (1980s),
- Narrowhead Garter Snake (planned for 2006-07),
- Arizona Shrew (2003),
- Penasco Least Chipmunk (anticipated for 2005-06), and
- Spotted Bat (anticipated for 2005-06).

### **Recovery Plans**

Recovery plans for state and federally listed species also provide information on current and recommended future conservation actions and monitoring efforts needed to recover these species. The status of these recovery plans for both federal and state listed species in New Mexico is provided in Table 6-2.

Other federal recovery plans for SGCN not state-listed include the razorback sucker, Mexican spotted owl, and the Chiricahua leopard frog (nearing completion). The Wildlife Conservation Act (N.M. Stat. Ann. §§ 17-2-37-46 (1995)) states that, to the extent practicable, recovery plans shall be developed for species listed by the state as threatened or endangered. NMDGF is actively developing recovery plans for such state-listed species that are also SGCN. These plans describe current species status and trend information, ongoing monitoring efforts and to some degree identify future monitoring needs. Recovery plans for state-listed species under the New Mexico Wildlife Conservation Act include the:

- *Gray-banded Kingsnake Conservation Recovery Plan*
- *Zuni Bluehead Sucker Conservation and Recovery Plan*
- *Chavez County Invertebrates Recovery Plan*
- *Roundtail, Gila and Headwater Chubs Recovery Plan (Draft)*
- *Boreal Toad Recovery Plan (Draft)*

Other state-listed species that are SGCN that are prioritized for recovery plan development or finalization include the sand dune lizard, New Mexico ridgenosed rattlesnake (joint federal and state plan), blue sucker, Chihuahua chub, southern redbelly dace, Gila topminnow, Pecos pupfish, White Sands pupfish, Chupadera springsnail, wrinkled marshsnail, Gila springsnail, Pecos springsnail, New Mexico hot springsnail, and Texas hornshell.

NMDGF is also a party to interstate and interagency conservation agreements for state-listed species that are also SGCN, generally in lieu of federal listing. Conservation agreements that the NMDGF is signatory to include the Sangre de Cristo Peaclam Conservation Agreement, Pecos Pupfish Conservation Agreement, White Sands Pupfish Conservation Agreement, Jemez Mountains Salamander Conservation Agreement, Jaguar Conservation Agreement, Swift Fox Conservation Team, Black-tailed and Gunnison's Prairie Dog Conservation Strategy, and Townsend's Big-eared Bat Conservation Strategy. Additional NMDGF conservation and management plans for state listed species include the Sand Dune Lizard Conservation Plan, and the NMDGF Desert Bighorn Sheep Management and Recovery Plan. NMDGF is committed to non-signatory conservation agreements such as the Lesser Prairie-chicken Conservation Strategy

Table 6-2. Federal Recovery Plans for New Mexico State-listed and SGCN Wildlife.

<b>Species</b>	<b>Year (most recent version)</b>
Socorro Isopod	1982
Socorro/Alamosa Springsnails	1994
Gila Trout	1983, revision in progress
Chihuahua Chub	1986
Spikedace	1991
Loach Minnow	1991
Colorado Pikeminnow	1991
Pecos Gambusia	1990
Rio Grande Silvery Minnow	1999
Gila Topminnow	1984
Pecos Bluntnose Shiner	1992
New Mexico Ridgenose Rattlesnake	1985
Southwestern Bald Eagle	1982
Northern Aplomado Falcon	1989
Whooping Crane	1994
Interior Least Tern	1990
Southwestern Willow Flycatcher	2002
Brown Pelican (Eastern)	1980
Piping Plover (Great Lakes, N. Great Plains)	1988
Mexican Gray Wolf	1982
Mexican Long-nosed Bat	1994
Lesser Long-nosed Bat	1994

and the Boreal Toad Conservation Agreement. Other recovery or conservation plans in progress include a federal plan for the Arkansas River shiner and a plan for the Organ Mountains Colorado chipmunk, being developed by a contractor for White Sands Missile Range.

NMDGF personnel also are active members of Federal Recovery Teams for federally listed species, such as the Mexican spotted owl, Southwestern willow flycatcher, Mexican wolf, Chiricahua leopard frog, Boreal toad, Gila trout, Chihuahua chub, Rio Grande fishes and Rio Grande silvery minnow recovery teams. NMDGF endangered species biologists are also key members of the Middle Rio Grande Endangered Species Collaborative Program, Spikedace and Loachminnow Working Group, Central Arizona Project Fishes Mitigation Program, San Juan River Recovery Implementation Program, Pecos Pupfish Conservation Team, White Sands Pupfish Conservation Team, Roundtail Chub, Flannelmouth Sucker, and Zuni Bluehead Sucker Conservation Team, Aplomado Falcon Working Group, New Mexico Bat Working Group, Endemic Salamander Team, and New Mexico and Southwest Section Carnivore Working Groups. Membership to these teams requires that individual participants “monitor” or otherwise stay abreast of the most current information and research regarding species conservation status and population trends, habitat parameters, and survey and monitoring data.

NMDGF is required by the New Mexico’s Wildlife Conservation Act to conduct a biennial review of all species of wildlife named on the Wildlife Conservation Act Threatened and Endangered Species List. In addition to status information, the 2004 Threatened and Endangered Species of New Mexico Biennial Review also provides information on conservation actions and survey and monitoring efforts needed for state-listed species, all but five of which are SGCN.

NMDGF also is involved with regional and national level conservation and monitoring efforts, such as the national and international (Mexico) Breeding Bird Surveys, Christmas Bird Counts, and Playa Lakes Joint Venture. Coordinated survey/monitoring efforts at a regional scale, such as the annual Breeding Bird Surveys, allow the long-term evaluation of migratory and year-round resident bird populations at a much larger national and even international scale. Bird monitoring efforts conducted by NMDGF and cooperators in New Mexico contribute to regional, national and international conservation efforts, such as the North American Waterbird Conservation Plan (Kushlan *et al.* 2002), United States Shorebird Conservation Plan (Brown *et al.* 2001), and North American Landbird Conservation Plan. NMDGF also gathers species status, distribution, natural history and habitat information for species of concern from our Share with Wildlife (SwW) program as participant researchers are required to submit reports of their findings.

Natural Heritage New Mexico (NHNM), formerly the New Mexico Natural Heritage Program, investigates the biological richness of New Mexico, monitors changes of natural systems, stores and retrieves data, and maps the distribution of plants and animals of New Mexico. NMDGF coordinates certain activities, such as the BISON-M database update and the Comprehensive Wildlife Conservation Strategy development effort with NHNM.

Each of the National Wildlife Refuges (NWR) in New Mexico, which includes Bosque del Apache NWR, Bitter Lakes NWR, Las Vegas NWR, Maxwell NWR, Grulla NWR, and San Andres NWR, conduct their own wildlife monitoring efforts and provide important information to NMDGF. For example, Bitter Lakes NWR provides important least shrew information through its small mammal trapping surveys and shorebird surveys, which provide information on the status and trends of nesting species like Interior least terns, a federal and state endangered species, and a SGCN. Bosque del Apache NWR conducts important wintering waterfowl surveys that NMDGF uses to compare diversity and abundance with our annual winter aerial waterfowl surveys. San Andres NWR routinely monitors desert bighorn sheep herds in the San Andres Mountain, one of the most important populations of this state endangered mammal, and a SGCN. Many more research projects of species status, trend, distribution, natural history, ecology and evolution are being conducted by academic and private researchers around the state. An exhaustive discussion of these is beyond the scope of this chapter.

### **Habitat Monitoring**

Aquatic species monitoring for state and federally listed fishes and aquatic invertebrates generally includes systematic water quality parameter sampling in conjunction with population monitoring activities. Parameters sampled and monitored for these species generally include water temperature, dissolved oxygen, pH, turbidity and flow rates. These measurements may be conducted at the microhabitat level for species such as springsnails, which may occur only in very small springhead systems, or for large riverine systems. Flow rates for New Mexico's larger streams and rivers and lake capacities are measured and documented by the Bureau of Reclamation and US Army Corps of Engineers, generally on a daily basis. Water quality and chemistry are routinely monitored throughout the state by the New Mexico Environment Department.

Aquatic, riparian and wetland habitats are some of the most important habitats in the state, due to the aridity of the desert Southwest and the reliance of so many wildlife species on these habitats during some portion (or all) of their life cycles. Because of the importance of these habitats for New Mexico SGCN, this portion of the following habitat monitoring discussion will focus on these habitats, rather than attempting to include additional discussion for other key terrestrial habitats beyond what was already addressed in Assessments and Strategies for SGCN and Key Habitats (Chapter 5). Many riparian monitoring projects are underway, following monitoring plans and programs designed specifically for New Mexico. This following discussion includes only a sampling of ongoing riparian habitat restoration and monitoring efforts in the state.

NMDGF stays abreast of these aquatic/riparian monitoring efforts by participating in cooperative programs for the management of these sites, and by review of reports and publications documenting these efforts.

- The *Conceptual Restoration Plan, Active Floodplain of the Rio Grande, San Acacia to San Marcial, New Mexico* (TetraTech 2004), presents a Monitoring and Adaptive Management Strategy for the River/Riparian Restoration Plan. This monitoring strategy is one of the most thoroughly researched and carefully designed monitoring efforts in New Mexico. It is the product of several years of compilation of baseline data, analysis of existing conditions, modeling of potential outcomes of various restoration scenarios, and coordination of a broad array of stakeholders. It should serve as a model for riparian restoration and monitoring efforts elsewhere along the Rio Grande, and in the state where large river floodplain restoration is taking place or being considered.
- The Bosque Ecosystem Monitoring Program conducts ongoing ecological monitoring in the floodplain of the Rio Grande. The program has produced a guidebook for monitoring and three monitoring reports that provide specific protocols for floodplain monitoring.
- The Sevilleta Long Term Ecological Research Project, located in and around the Sevilleta NWR, is part of the National Science Foundation's Long Term Ecological Research Network and is managed by the Department of Biology, University of New Mexico. The Sevilleta LTER conducts ongoing research, including research on riparian systems that includes long-term monitoring.
- The Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA) Program is a NSF-funded research effort aimed at developing an integrated, multidisciplinary understanding of the hydrology of semi-arid regions, and building partnerships with a broad spectrum of stakeholders (both public agencies and private organizations) so that this understanding is effectively applied to the management of water resources and to the rational implementation of public policy. Functioning of riparian ecosystems is one of SAHRA's primary focus areas, which includes monitoring elements.
- Bosque del Apache NWR conducts monitoring of saltcedar (*Tamarix sp.*) removal projects, plus other floodplain functions. Bosque del Apache NWR is recognized nationally as a leader in implementing successful removal of tamarisk and Rio Grande cottonwood and willow riparian restoration efforts.

- The Middle Rio Grande Endangered Species Act Collaborative Program funds and oversees riparian monitoring projects.
- The Taos Field Office of the BLM initiated a riparian vegetation-monitoring program, in cooperation with Natural Heritage New Mexico, for its lands along the lower Santa Fe River just west of La Cienega, New Mexico. The intent of this program was to detect long-term trends in riparian plant communities within a two-mile reach of the river that has been recently excluded from livestock grazing. Milford *et al.* (2004) present the results of 2002 and 2003 monitoring. The sampling system used was designed to allow the detection of changes in species composition and abundance, major shifts in vegetation zones, and the restructuring of the floodplain. This report presents a riparian monitoring protocol useful in northern New Mexico.
- The Roswell Field Office of the BLM initiated a riparian monitoring program for its grazing allotments within the floodplain corridor of the Pecos River in southeast New Mexico (Milford *et al.* 2001). The intent of this program is to detect long-term trends in riparian plant communities in relation to grazing management practices and vegetation manipulation projects. In addition, the monitoring program is intended to help managers and ranchers effectively implement adaptive management techniques in response to trends indicated by the monitoring data.
- Beginning in 1999 and continuing through 2000, the New Mexico Natural Heritage Program (NMNHP) established a set of high-resolution monitoring plots and reconnaissance surveys to collect the necessary baseline data for the 15 BLM allotments that are directly adjacent to the river. This baseline survey provides the foundation for future monitoring and also details current vegetation information for use in the development or revision of allotment management plans.

Additional terrestrial and aquatic habitat monitoring by the NMDGF include efforts associated with our Technical Guidance and Endangered Species Sections project reviews of all types of statewide projects that may impact wildlife populations or habitats. All of these efforts necessarily include the review and assessment of species and habitat information. For example, by Presidential Executive Order, wetland loss must be mitigated by replacement; therefore in reviewing NEPA documentation for proposed New Mexico Department of Transportation projects, NMDGF is able to monitor impacts of highway projects to state wetlands. From 1 July 2004 to 30 June 2005, Department's Technical Guidance Section received 725 project notifications and generated 555 responses, many of which included recommendations for wildlife and habitat recommendations. Unfortunately, Technical Guidance staff is not currently sufficiently manned or funded to follow up on project recommendations to see if mitigation has been implemented.

NMDGF monitors existing hard rock, coal and uranium mining operations and their effects on habitats in New Mexico by having considerable involvement in the implementation of the New Mexico Mining Act of 1993. NMDGF and the Mining and Minerals Division, through hard rock mine permit fees, jointly fund a full-time Mining Habitat Specialist, who reviews and provides

recommendations on biological reports, permit applications, closeout and reclamation plans for all of these mines in New Mexico. NMDGF is therefore involved in developing reclamation and monitoring plans for a substantial number of mines throughout the state, many of which will become wildlife habitat after mine closure. The NMDGF also reviews and comments on US Fish and Wildlife Service Comprehensive National Wildlife Refuge Plans for New Mexico's National Wildlife Refuges, which include Bosque del Apache NWR, Bitter Lakes NWR, Las Vegas NWR, Maxwell NWR, Grulla NWR, and San Andres NWR.

In an effort to further our knowledge of on-the-ground habitat conservation actions to benefit federally listed species in New Mexico, NMDGF has been seeking enhanced opportunities to be advised of implementation of Endangered Species Act conservation tools for federal agencies and private landowners in New Mexico, such as Habitat Conservation Plans, Safe Harbor Agreements, and Candidate Conservation Agreements. For example, the NMDGF has participated in meetings of the Malpais Borderlands Group (MBG) Habitat Conservation Plan (HCP) Working Group, prepared draft summaries, and reviewed existing documents to support development of a HCP to address both federal and state listed species in the MBG area of southwestern New Mexico. These efforts will allow the NMDGF to monitor ongoing habitat conservation actions directed toward federally listed species that are also state listed and SGCN.

The NMDGF is a voting member of the State Forest Stewardship Committee and Forest Legacy Program Subcommittee. The Forest Stewardship Committee administers Farm Bill conservation program grants (such as EQUIP) for forest and woodland habitat improvement projects that directly benefit wildlife. The Forest Legacy Program is a cost-share conservation easement program provided by the US Forest Service. The Forest Legacy Subcommittee evaluates, prioritizes and selects proposals by private landowners to protect valuable forest and woodland habitats with conservation easements, thereby protecting these properties from development for perpetuity. The NMDGF stays abreast of habitat improvement projects and conservation easements on privately-owned forests and woodlands in New Mexico, whose owners participate in these programs.

The NMDGF is also developing enhanced working relationships with private landowners who wish to implement wildlife habitat improvements on their private lands with State Wildlife Grants and Landowner Incentive Program Grants offered through the State and Tribal Wildlife Grants Program. Monitoring of the success of conservation actions instituted through these grants is an important component of this program.

In summary, these efforts allow NMDGF biologists to monitor important habitats in a secondary, non-systematic method. Other than the efforts of the USGS Southwest Regional Gap Analysis Project (SWReGAP) to map vegetation and wildlife species distribution of the southwestern United States, to our knowledge, no formal, systematic, standardized monitoring of key habitats (e.g. Madrea Encinal) at a landscape level within ecoregions is occurring in New Mexico.

## **Monitoring Needs**

SGCN and habitat monitoring needs are addressed individually for key habitats within the *Information Gaps* and *Research, Survey, and Monitoring Needs* sections of Chapter 5. For example, the first bullet under *Research, Survey, and Monitoring Needs* in the *Statewide Distributed Ephemeral Habitats and Perennial Tanks* section states:

“Comprehensive spatial data designating the location, number, total area, and functional classification of geographically isolated wetlands would provide the foundation for monitoring impacts, quantifying wetland loss/gain, and facilitating risk assessment for these waters.”

Therefore, this discussion will not attempt to recapture those recommendations more specific to key habitat types, but focus on a larger scale monitoring needs and challenges.

The NMDGF has not had a sufficient dedicated source of funds or the personnel necessary to conduct monitoring activities for all wildlife species, particularly the non-game species. Many state listed species (all but five of which are SGCN) currently do not have systematic, ongoing survey, sampling and monitoring efforts to determine population trends, nor have protocols been developed to conduct monitoring. Basic life history information, status, distribution and habitat affinities still need to be determined for many SGCN. In general, money has not been available to conduct the research needed on these species until they become federally or state listed, with most efforts being directed toward federally listed species. Even once a species is federally or state listed, oftentimes not enough money and personnel are available to conduct this work.

Other difficulties associated with implementing field monitoring efforts, in addition to those stated above regarding monitoring plan design and goals, include differences in the ability to sample certain groups of organisms. For example, bats species are difficult to sample in the field without roost location information, as they are nocturnal, often occur at very low densities across the landscape, and are difficult to capture. However, individual states associated with the Western Bat Working Group are developing sampling protocols for bat species. Colorado, Arizona, Texas and Utah have all adopted bat survey and monitoring protocols. The NMDGF is a participant in the New Mexico Bat Working Group, which is considering developing a bat conservation plan, likely using similar protocols as surrounding states. Existing resources that will likely be used include the North American Bat Conservation Partnership State Planning Guide for Bats (see <http://www.batcon.org/nabcp/newsite/index.html>).

As stated above, recovery and conservation plans and agreements are good sources of population status and trend information, and usually identify needed conservation actions monitoring efforts. State listed wildlife with no type of recovery plan, conservation plan, or conservation agreement are provided in Table 6-3.

Table 6-3. State listed wildlife without a recovery plan, conservation plan, or conservation agreement.

Common Name	Scientific Name
<b>Fish</b>	
Gila Chub	<i>Gila intermedia</i>
Roundtail Chub	<i>Gila robusta</i>
Southern Redbelly Dace	<i>Phoxinus erythrogaster</i>
Colorado Pikeminnow	<i>Ptychocheilus lucius</i>
Blue Sucker	<i>Cycleptus elongates</i>
Mexican Tetra	<i>Astyanax mexicanus</i>
Arkansas River Speckled Chub	<i>Macrhybopsis tetranema</i>
Suckermouth Minnow	<i>Phenacobius mirabilis</i>
Gray Redhorse	<i>Scartomyzon congestum</i>
Greenthroat Darter	<i>Etheostoma lepidum</i>
Bigscale Logperch	<i>Percina macrolepada</i>
<b>Birds</b>	
White-Tailed Ptarmigan	<i>Lagopus leucurus</i>
Common Ground-Dove	<i>Columbina passerina</i>
Buff-Collared Nightjar	<i>Caprimulgus ridgwayi</i>
Elegant Trogon	<i>Trogon elegans</i>
Northern Beardless-Tryannulet	<i>Camptostoma imberbe</i>
Thick-Billed Kingbird	<i>Tyrannus crassirostris</i>
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>
Common Black-Hawk	<i>Buteogallus anthracinus</i>
Peregrine Falcon	<i>Falco peregrinus</i>
(Previously Had Federal Recovery Plan)	
Whiskered Screech-Owl	<i>Otus trichopsis</i>
Boreal Owl	<i>Aegolius funereus</i>
Broad-Billed Hummingbird	<i>Cynanthus latirostris</i>
White-Eared Hummingbird	<i>Hylocharis leucotis</i>
Violet-Crowned Hummingbird	<i>Amazilia violiceps</i>
Lucifer Hummingbird	<i>Calothorax lucifer</i>
Costa's Hummingbird	<i>Calypte costae</i>
Gila Woodpecker	<i>Melanerpes uropygialis</i>
Bell's Vireo	<i>Vireo bellii</i>
Gray Vireo	<i>Vireo vicinior</i>
Abert's Towhee	<i>Pipilo aberti</i>
(Arizona) Grasshopper Sparrow	<i>Ammodramus savannarum ammoregus</i>
Baird's Sparrow	<i>Ammodramus bairdii</i>
Yellow-Eyed Junco	<i>Junco phaeonotus</i>
Varied Bunting	<i>Passerina versicolor</i>
<b>Mammals</b>	
Arizona Shrew	<i>Sorex arizonae</i>
(Penasco) Least Chipmunk	<i>Tamias minimus atristriatus</i>
(Arizona) Montane Vole	<i>Microtus montanus arizonensis</i>
Least Shrew	<i>Cryptotis parva</i>
Spotted Bat	<i>Euderma maculatum</i>
Western Yellow Bat	<i>Lasiurus xanthinus</i>
White-Sided Jackrabbit	<i>Lepus callotis</i>
Southern Pocket Gopher	<i>Thomomys umbrinus</i>
Meadow Jumping Mouse	<i>Zapus hudsonius</i>
American Marten	<i>Martes americana</i>

Table 6-3 Cont.

Common Name	Scientific Name
<b>Amphibians</b>	
Lowland Leopard Frog	<i>Rana yavapaiensis</i>
Great Plains Narrowmouth Toad	<i>Gastrophryne olivacea</i>
Sacramento Mountain Salamander	<i>Aneides hardii</i>
Colorado River Toad	<i>Bufo alvarius</i>
<b>Reptiles</b>	
Gila Monster	<i>Heloderma suspectum</i>
Gray-Checkered Whiptail	<i>Cnemidophorus dixonii</i>
Mexican Garter Snake	<i>Thamnophis eques</i>
Plainbelly Water Snake	<i>Nerodia erythrogaster</i>
Western River Cooter	<i>Pseudemys gorzugi</i>
Bunch Grass Lizard	<i>Sceloporus scalaris</i>
Giant Spotted Whiptail	<i>Cnemidophorus burti</i>
Mountain Skink	<i>Eumeces tetragrammus</i>
Green Rat Snake	<i>Senticolis triaspis</i>
Narrowhead Garter Snake	<i>Thamnophis rufipunctatus</i>
Western Ribbon Snake	<i>Thamnophis proximus</i>
(Mottled) Rock Rattlesnake	<i>Crotalus lepidus lepidus</i>
<b>Invertebrates</b>	
Papershell Pondshell Mussel	<i>Utterbackia imbecillis</i>
Texas Hornshell	<i>Popenaias popeii</i>
Chupadera Pyrg	<i>Pyrgulopsis chupaderae</i>
Ovate Vertigo	<i>Vertigo ovata</i>
Wrinkled Marshsnail	<i>Stagnicola caperata</i>
Shortneck Snaggletooth	<i>Gastrocopta dalliana dalliana</i>
Florida Mountain Snail	<i>Oreohelix florida</i>
Lake Fingernailclam	<i>Musculium lacustre</i>
Swamp Fingernailclam	<i>Musculium partumeium</i>
Long Fingernailclam	<i>Musculium transversum</i>
Lilljeborg Peaclam	<i>Pisidium lilljeborgi</i>
Sangre De Cristo Peaclam	<i>Pisidium sanguinichristi</i>
Gila Pyrg	<i>Pyrgulopsis gilae</i>
Pecos Pyrg	<i>Pyrgulopsis pecosensis</i>
New Mexico Hot Spring Pyrg	<i>Pyrgulopsis thermalis</i>
Star Gyro	<i>Gyraulus crista</i>
Hacheta Grande Woodlandsnail	<i>Ashmunella hebardei</i>
Cooke's Peak Woodlandsnail	<i>Ashmunella macromphala</i>
Mineral Creek Mountain snail	<i>Oreohelix pilsbryi</i>
Doña Ana Talussnail	<i>Sonorella todseni</i>

Unless addressed in Table 6-1, most of the state listed and SGCN species do not have systematic population trend monitoring efforts in place. Exceptions to that are the avian SGCN, which have the potential to be generally surveyed at least once annually during citizen survey efforts such as the Breeding Bird Surveys and Christmas Counts. However, limitations of these surveys include the limited coverage of routes surveyed throughout the state, and they are primarily presence/absence surveys, although distribution, density and long-term trend information can be inferred.

National and regional level organizations such as Partners in Amphibian and Reptile Conservation (PARC) have, or are developing, regional guidelines (e.g. Southwest United States) for habitat management for groups of organisms such as reptiles and amphibians. These efforts will assist NMDGF in developing similar guidelines for future management and conservation actions.

To our knowledge, no systematic, standardized monitoring of introduced, non-native plant and animal species is occurring. Introduced non-native species are a primary cause of the decline of native biological diversity globally, and should be addressed at a state, regional and national level, in part by instituting monitoring programs at these different scales. Monitoring and efforts to identify new invasions (both deliberate and accidental) are technically feasible, but lack sufficient funding and coordination (Simberloff *et al.* 2005). This information should be incorporated into a dynamic statewide Geographical Information System (GIS) database to allow tracking of these trends.

A more efficient monitoring program needs to be developed to track the effectiveness of conservation actions such as riparian and terrestrial habitat restoration programs at a statewide level. This information should be incorporated into a dynamic statewide GIS database to allow the tracking and assessment of project performance at a landscape level.

As stated above, other than the efforts of the USGS Southwest Regional Gap Analysis Project (SWReGAP) to map vegetation and wildlife species distribution of the southwestern United States, to our knowledge, no formal, systematic, standardized monitoring of key habitats (e.g. Madrean Encinal) at a landscape level within ecoregions is occurring in New Mexico. Development of the capacity to detect habitat changes and compare them directly with SGCN monitoring results is essential to evaluating the effectiveness of our conservation actions.

## NEW MEXICO'S MONITORING PLANS

Our strategic approach to monitoring the status and trends of SGCN and their habitats and the effectiveness of our conservation actions will include adopting a focused approach, enhancing cooperation and coordination, establishing a fish and wildlife habitat monitoring group, monitoring habitat connectivity, establishing a centralized database and clearinghouse, and integrating citizen science. Operational considerations for monitoring plan design, data management, quality control, and reporting are also provided as are suggested performance indicators.

### **Adopt a Focused Approach to Monitoring**

Because 452 SGCN and 19 key habitats have been selected for the CWCS for New Mexico, it is *not reasonable* to assume that NMDGF and our cooperators will be able to effectively monitor all SGCN and their habitats, particularly SGCN for which NMDGF currently lacks legal authority, such as insects. Nor can NMDGF directly affect or monitor habitats over which it lacks jurisdiction. However, we believe that expanding our monitoring capabilities to include all state and federally listed species, and selected SGCN “umbrella”, “indicator” or “keystone” species, and/or guilds or functional groups of SGCN associated with key habitats will greatly assist us and our cooperators to meet our primary conservation goals and the intent of the State and Tribal Wildlife Grants Program. This expansion of monitoring capacity will necessarily require an associated ability to monitor the effectiveness of conservation actions, as well as provide adaptive response capability to modify future management decisions and objectives based on conservation action outcomes.

With regard to developing individual state habitat monitoring programs to meet the intent of the State and Tribal Wildlife Grants Program, Schoonmaker and Luscombe (2005) state:

“To the extent species are monitored in the context of habitat, it is more efficient to select a few easily sampled indicator species that are strongly associated with priority habitats, and that act as “umbrella species” for other taxa of interest. Indicators are functionally linked to other species and habitats (but aren’t necessarily keystone species), whereas umbrella species may or may not be functionally linked, but rather are used as conservation tools owing to their widespread distribution compared to the species and habitats they are used to protect. In any case, it is not possible nor especially informative to attempt to monitor all species, or even all species of greatest conservation need, so the list of species to be monitored is more likely to be useful if it is short and strategically developed.”

In further support of this monitoring strategy, Gibbs *et al.* (1999) state:

“Indicators that represent broad changes in the resources of concern [wildlife diversity and habitats] are useful. Good candidates are umbrella species (those species whose habitat hosts many other, associated species) or keystone species (those species whose strong interactive effects with other species generate effects that are large relative to the keystone species’ abundance).”

Given these observations, our strategic approach to acquiring information of SGCN status and trends will be to monitor unique indicator guilds or functional groups of SGCN, other suites of SGCN that are indicators of the health of key habitats, umbrella species whose persistence in a key habitat is likely to ensure the persistence of other species that occur in those habitats, and keystone species, whose conservation within a key habitat is important for the persistence of many other species in that habitat type. As a broad example, birds have been shown to be effective indicators of biological integrity in wetland and riparian ecosystems (Adamus and Brandt 1990, Croonquist and Brooks 1991), and they have been considered good indicators of environmental change (Verner 1984). Several metrics for the bird community (e.g., bird abundance, diet and foraging guilds, and disturbance tolerance) are generally well correlated with degree of degradation of forest riparian systems in the northeastern US as a result of several types of anthropogenic activities (Moors 1993). A bird biological integrity index tested by Bryce *et al.* (2002) was shown to be a useful management and monitoring tool for assessing riparian integrity.

Because the Comprehensive Wildlife Conservation Strategy for New Mexico is a strategic planning document, NMDGF and its cooperators will develop monitoring details to meet the intent of the State and Tribal Wildlife Grants Program during the operational planning process described in Chapter 7. However, the NMDGF and federal land management and private landowner cooperators are already moving in the direction of the concepts identified above, by recognizing the importance of monitoring of the status and trends of the lesser prairie chicken, sand dune lizard, and black-tailed prairie dog, three very important indicator and keystone SGCN, to assess the status of key habitats within the Southern Shortgrass Prairie Ecosystem.

### **Enhance Cooperation and Coordination**

The greatest challenge that the NMDGF and cooperator's will likely face in implementing Comprehensive Wildlife Conservation Strategy for New Mexico will be the effective monitoring of key habitats, habitat changes and evaluating outcomes of conservation actions, as required by Element 5. Schoonmaker and Luscombe (2005) adequately identify some of the inherent difficulties of effectively monitoring habitats. They state:

“Ownership and jurisdictional boundaries add at least four more challenges to the already complex question of how to monitor habitats. First, ownership and jurisdictional boundaries sometimes coincide with habitat boundaries, but often they do not. Second, not only are the goals of federal, state, local and private land owners different, but conservation goals within each of these categories can vary widely. Third, ownership changes over time, with these changes being moderately linked to (either caused by, or causing) changes in habitat condition. And finally, the motivations for habitat monitoring and the resulting habitat monitoring programs (if any) vary widely in terms of approach, proprietary versus public information, and data compatibility.”

In consideration of these observations our strategic approach to monitoring will include a dedicated effort to enhance cooperation and coordination with state and federal land management and natural resource agencies, Native American tribes, non-governmental organizations such as land conservation trusts and agricultural organizations, and private landowners. For example,

irreplaceably important monitoring efforts of SGCN and key habitats are carried out by federal land management agencies, primarily the USFS and BLM. Their efforts are essential to informing wildlife management and conservation initiatives. Likewise, 22 sovereign tribes manage wildlife and habitat on 9% of the land surface within New Mexico's borders. It therefore behooves us to maintain and improve effective communication and information and technology transfer among these entities.

Private lands encompass approximately 45% of New Mexico's land base. About 54% of New Mexico consists of rangeland, croplands, or pasture important to supporting our agricultural industry. Long-term conservation of many species (e.g., lesser prairie-chicken, black-tailed and Gunnison's prairie dogs) will be impossible without substantial buy-in and support from a significant proportion of landowners and agricultural interests in key habitats. The development and implementation of monitoring programs for habitat improvement projects (conservation actions) for SGCN on private lands will be an important component of meeting our desired conservation outcomes. The State Wildlife Grants and Landowner Incentive Programs have allowed the NMDGF to begin developing relationships that will lead to the necessary cooperation and coordination.

We have recently begun working with land conservation trusts such as the New Mexico Land Conservancy, Trust for Public Land and The Nature Conservancy to enact conservation easements on important private lands whose willing owners wish to protect them from future development. The 2005 New Mexico state legislature provided the NMDGF and State Game Commission with \$4 million dollars to assist in purchasing important private lands from willing sellers for wildlife, agriculture and open space conservation. As a result, the NMDGF anticipates building enhanced cooperation and coordination with landowners and land conservation trusts. The NMDGF will also collaborate with land conservation trust organizations to evaluate important wildlife habitats on private lands of willing sellers.

NMDGF will seek to further cooperation and coordination with the State Land Office to facilitate the effective monitoring of SGCN and key habitats on the significant portion of New Mexico's land base managed by that entity for the purpose of financially supporting the state's schools. NMDGF will seek closer cooperation and coordination with the State Forestry Division, to facilitate coordination and cooperation in monitoring New Mexico's privately-owned forests and woodlands, whose owners participate in federal and state wildlife and habitat conservation programs.

### **Establish a Fish and Wildlife Habitat Monitoring Group**

Our strategic approach to monitoring will include pursuing the establishment of a Fish and Wildlife Habitat Monitoring Group. Schoonmaker and Luscombe (2005) state:

“In order to develop and implement a monitoring program, each state may consider establishing a fish and wildlife habitat monitoring group, to facilitate cooperative monitoring, assessment, and reporting activities. The monitoring group could be a collaborative partnership among federal, state, and local agencies, as well as landowners, conservation organizations and other interest groups. Members could also be drawn from

various geographic regions within the state to ensure broad biological and policy knowledge within the group...Collaborative initiatives, such as...establishing multi-stakeholder monitoring groups are fundamental to developing a fish and wildlife monitoring program that has credibility within and beyond the stakeholder group.”

Our strategic approach will follow Schoonmaker and Luscombe's (2005) recommended framework for establishing a habitat monitoring program for state comprehensive wildlife conservation strategies. In doing so we will:

1. Identify the decision-makers, partners, and resources needed for a fish and wildlife habitat monitoring group to track conservation actions, adaptive management hypotheses, and longer-term changes in habitat distribution, condition, and conservation status.
2. Work with partners to identify available information sources, determine whether existing data are adequate to establish a meaningful baseline, and secure and/or enhance GIS layers. Data can include statewide registry of conservation actions, present and historic land use/land cover map, aquatic resources map, existing conservation network areas, priority habitats identified in the CWCS, and existing conservation projects.
3. Determine what elements of the strategy are suitable for monitoring by agencies, organizations and citizens. Set up systems to train field naturalists and citizen volunteers to collect data, using consistent protocols.
4. Evaluate the impacts of conservation actions periodically and make adjustments as necessary within an adaptive management framework.
5. Update the land use and land cover data every five to ten years to track habitat changes.
6. Develop an efficient and effective communication system for reporting and disseminating information to decision-makers and other stakeholders, including the public.

To address the development of a fish and wildlife habitat monitoring group, the NMDGF anticipates organizing a conference consisting of two phases. Phase one would be conducted to develop a habitat monitoring group and otherwise meet guidelines 1, 2, 3, and 6 above. The second phase would entail summit meetings with surrounding state wildlife agencies (Arizona, Colorado, and Texas to develop interstate habitat connectivity priorities and facilitate information and technology transfer between states. This effort is necessary to better coordinate SGCN and habitat conservation and monitoring across state and ecoregional boundaries.

Challenges to coordinating effective wildlife and habitat conservation and monitoring across state and land ownership boundaries include the facts that states have different species assemblages, habitat types, economic and political pressures, land use regulations, development priorities, stakeholders and conservation opportunities (Schoonmaker and Luscombe 2005). However, because habitat loss, fragmentation and degradation are the leading causes of species decline globally, there is a great need for communication and cooperation across state and land

ownership lines, and a necessity for compatibility in monitoring data collection efforts. Therefore, we believe that this regional coordination effort is necessary.

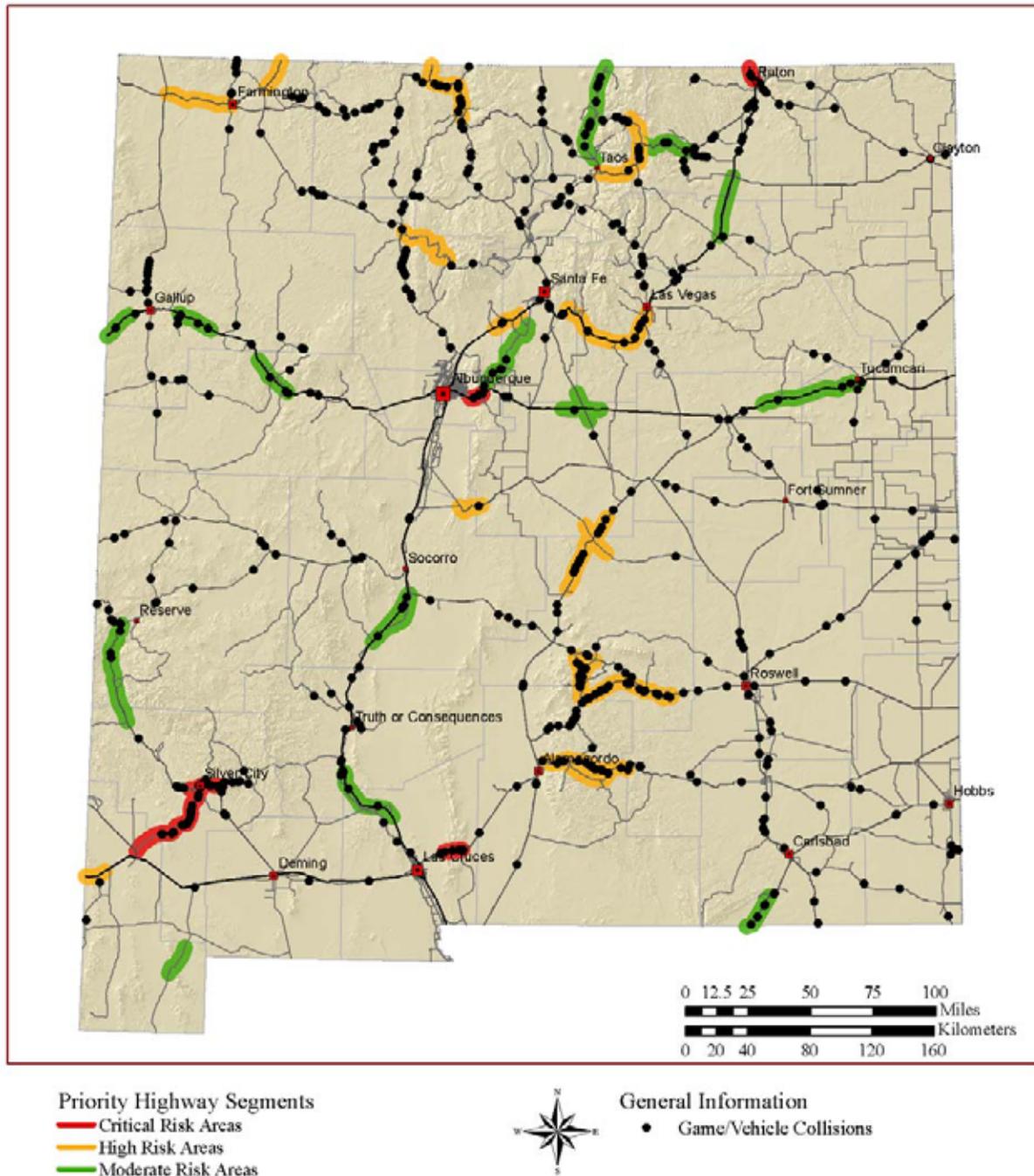
### **Monitor Habitat Connectivity**

Because habitat loss, fragmentation and degradation are the leading causes of species decline globally, monitoring the connectivity or “linkages” of major habitat in New Mexico and across state boundaries is essential. A promising opportunity lies in cooperating and coordinating with the New Mexico Department of Transportation and Federal Highways Administration to identify important wildlife habitat linkages and wildlife movement corridors that have been fragmented by highways, roadways and other human travel corridors. Important work in this regard has been ongoing in New Mexico and surrounding states (Arizona and Colorado), but efforts to address opportunities to reconnect important habitats are just beginning.

For example, in June of 2003, the New Mexico Carnivore Working Group, in conjunction with NMDGF, USFWS and USFS, conducted the “Critical Mass” workshop to educate participants in ongoing efforts to reconnect habitats across highways in Europe, Canada and (more recently) the United States and to prioritize important wildlife habitat linkages across highway barriers in New Mexico to assist agencies to direct mitigation solutions. Over 100 federal and state wildlife and land management agency personnel, New Mexico Department of Transportation personnel, private highway consultants, conservationists and interested members of the public attended this two-day workshop. Through a consensus-building process, 30 high-priority highway/transportation corridor sections were identified based on three criteria: 1) potential for wildlife/vehicle collisions based on large game animal/vehicle collision accident report data; 2) connectivity of major tracts of public lands; and 3) threatened, endangered and sensitive species concerns. Spatial depictions of these prioritized highway segments are provided in Figure 6-1.

The Critical Mass workshop essentially initiated important work that is ongoing at two identified high-priority habitat linkages, Tijeras Canyon and Abo Canyon, which connect central cordillera mountain chains and allow habitat connectivity between southern and northern New Mexico. Each project is slated for wildlife passage enhancements and protections across Interstate 40 in Tijeras Canyon and a major railway line in Abo Canyon. The importance of these two locations as wildlife travel corridors are indicated by monitoring results indicating a high mortality of mule deer, black bear and Rocky Mountain bighorn sheep (all SGCN) from collisions with vehicles and trains. Continued monitoring of future wildlife mortality from vehicles and trains and wildlife use of constructed and enhanced wildlife passages below the interstate and railroad line will allow the evaluation of the effectiveness of these projects at maintaining and improving habitat connectivity.

As further priority habitat linkages and wildlife travel corridors are identified and enhanced in New Mexico, monitoring of wildlife roadkill mortality data and wildlife passage indicator data (e.g., track monitoring, camera detection) will allow a determination of habitat connectivity capabilities at important sites. Monitoring the “connectivity” of important wildlife linkages is essential to determining the ability of key habitats to support SGCN.



The source of data is Earth Data Analysis Center, University of New Mexico. Data compiled by the "Critical Mass" workshop conducted by the New Mexico Carnivore Working Group, in conjunction with NMDGF, USFWS and USFS.

Figure 6-1. Spatial depictions of these priority highway segments identified during the 2003 "Critical Mass" workshop sponsored by the New Mexico Carnivore Working Group, NMDGF, USFWS and USFS.

Subsequent to the Critical Mass workshop, similar habitat linkage identification workshops have occurred in Arizona and Colorado, and interstate coordination efforts are ongoing. The recent signing by the President of the 2005 Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFTEA-LU), in addition to providing additional funding opportunities for "...reduce[ing] vehicle-caused wildlife mortality while maintaining habitat connectivity," requires that state departments of transportation consult with state wildlife management agencies in the development of 20-year long-range plans, and provides funding for joint positions between the state wildlife agencies and DOTs to enhance collaboration and consultation. To increase the ability of NMDGF and cooperators to implement wildlife passage enhancements and monitor important wildlife habitat linkages across human transportation corridors, the NMDGF will consider the feasibility of creating a cooperative joint position with NMDOT.

### **Establish a Centralized Monitoring Database and Clearinghouse**

Establishing effective collaborative monitoring efforts requires the development of standardized data collection methods and a centralized data collection system to act as a clearinghouse for housing, managing, analyzing and distributing data collected from monitoring. NMDGF is therefore committed to collaborating with other state and federal agency and non-governmental organization cooperators to develop a dynamic database to collect, store, and manage monitoring data at a scale appropriate to that of our performance measures and targets so as to facilitate communication and utility across agency and organization information systems.

The NMDGF's Biota Information System of New Mexico (BISON-M), which contains species accounts of status, distribution, habitat preferences and other natural history information on all New Mexico vertebrates and many invertebrates, is planned for expansion to store spatially-explicit geographic information, and after consideration and analysis, may be the most appropriate platform to serve as the clearinghouse for the integrated geographical information system (GIS)/biological database monitoring system. However, as noted below, a number of other entities have the capacities and data to substantially enhance this effort.

Landscape scale satellite imagery and vegetation analysis is also available through the Southwest Regional Gap Analysis Project (SWReGAP). SWReGAP is an update of the Gap Analysis Program's mapping and assessment of biodiversity for the five-state region encompassing Arizona, Colorado, Nevada, New Mexico, and Utah. It is a multi-institutional cooperative effort coordinated by the US Geological Survey Gap Analysis Program. The primary objective of the update is to use a coordinated mapping approach to create detailed, seamless GIS maps of land cover, all native terrestrial vertebrate species, land stewardship, and management status, and to analyze this information to identify those biotic elements that are under-represented (considered "gaps") on lands managed for their long term conservation. SWReGAP provides baseline information to guide monitoring efforts. If institutionalized, the products of this effort can provide current information regarding state habitats and detection of habitat change. Data provided by SWReGAP can help identify SGCN areas for monitoring, research, or conservation. When monitoring for a specific species is necessary, the use of habitat models to limit the sampling frame for the monitoring effort can provide efficiency.

Changes in ownership or in management intent over time are another important aspect of monitoring. SWReGAP stewardship is designed to provide the baseline for this effort and to place context to conservation actions and provide areas to focus these actions. Institutionalizing this effort can provide states with current information. Currently SWReGAP is not funded to pursue these types of endeavors. Data from SWReGAP provides a common baseline to use in regionalization of conservation efforts within Arizona, Colorado, Nevada, New Mexico, and Utah. This seamless dataset of land cover, terrestrial species, and stewardship can be used to synthesize conservation efforts across the region.

Natural Heritage New Mexico (formerly the New Mexico Natural Heritage Program) also has GIS capabilities and maintains a database of species of concern records and conducts research and monitoring and the US Bureau of Land Management maintains the most comprehensive geospatial database of land ownership in the state. To meet CWCS monitoring needs and the intent of the State and Tribal Wildlife Grants Program it may be necessary to employ all of these existing resources to develop a workable central clearinghouse dynamic monitoring database.

### **Integrate Citizen Science into CWCS Monitoring**

NMDGF already promotes citizen science to collect habitat data, primarily for watersheds. The Watershed Watch Program, a component of the Aquatic Resources Education Program, is active in approximately twenty high schools around New Mexico. Each school adopts a watershed (or portion of a watershed) and collects water quality and aquatic macroinvertebrate abundance and diversity data. Water parameter data such as temperature, pH, turbidity, nitrates and phosphates are collected. NMDGF contracts a facilitator to conduct training workshops and develop standardized protocols to implement these programs among schools and watersheds.

For terrestrial habitats and species monitoring, opportunistic monitoring efforts occur with the Natural History Workshops sponsored by NMDGF through our Conservation Education Program. Teachers from schools around the state have participated in these workshops to document biological information (primarily presence/absence data) on butterflies, birds, bats, and reptiles and amphibians. These observations and data are usually provided to the appropriate wildlife specialists, but a central clearinghouse is needed to act as a repository and center of distribution for this data.

NMDGF is in the process of planning “BioBlitzes”, similar in nature to rapid ecological assessments, except that they are directed at the public primarily for educational value. However, these programs do provide opportunistic monitoring value of wildlife and plant species diversity and abundance. The similar “Discovery Days” program operated by New Mexico State Parks has documented new species occurrence records for the state and individual counties.

These programs have a great potential to expand in New Mexico, as there are many more schools, teachers and members of the public who interested in science, natural history and conservation. NMDGF is committed to expanding the use of citizen science through the Watershed Watch, Natural History Workshop and BioBlitz programs, and to exploring other training and protocol development options, to gather wildlife and habitat data in New Mexico to assist us in meeting our CWCS monitoring needs.

Citizens are becoming more active statewide in monitoring wildlife/vehicle collisions on local highways, documenting wildlife corridors across highways and proposing that habitat connectivity be reestablished using technologies similar to those being implemented for Tijeras and Abo Canyons. The formation of local groups of citizens that identify the need for projects at the local level, work with local NMDOT planners and engineers, and conduct monitoring of the effectiveness of these solutions will be an important component of implementing these types of projects statewide. This process has already begun in several locations around the state.

### **Considerations for Monitoring Plan Design**

The following information is included to provide guidance in the future when working with cooperators to implement conservation actions and habitat monitoring programs. This knowledge was gained from monitoring efforts of successful and unsuccessful riparian habitat restoration projects, but is applicable to all types of habitat improvement projects. Because of the importance of riparian habitats to New Mexico's SGCN, this discussion should be particularly useful to future monitoring plan design efforts.

Restoration projects are often developed with little consideration for understanding their effects on wildlife. Block *et al.* (2001) contend that monitoring treatment effects on wildlife should be an integral component of the design and execution of any management activity, including restoration. Block *et al.* (2001) provide a conceptual framework for the design and implementation of monitoring studies to understand the effects of restoration on wildlife. Their underlying premise is that effective monitoring hinges on an appropriate study design for unbiased and precise estimates of the response variables. They advocate using measures of population dynamics for response variables given that these indicators provide the most direct measures of wildlife status and trends. The species to be monitored should be those constituting an assemblage of umbrella species that represent the range of spatial and functional requirements of wildlife in a restored ecological system. Selection of umbrella species should be based on strong empirical evidence that justifies their usage. They also advocate that monitoring be designed as true experiments or quasi-experiments rather than as observational studies to allow for stronger inferences regarding the effects of restoration on wildlife. Their framework is applicable to riparian ecosystems.

An important aspect of riparian monitoring is adaptive management of ongoing operations. This entails monitoring of operations or practices, measuring the outcomes against standards or desired outcomes, learning from outcomes of existing operations or practices, adjusting operations or practices to improve the outcomes, and monitoring again as an iterative process. Good adaptive management produces information on what works and what does not. This information can be disseminated through various means, from published articles or agency reports to presentations at workshops and training sessions.

Reid (2001) conducted an informal sample of 30 riparian monitoring projects and discovered that 70% had design problems, and 50% had procedural problems. Monitoring projects implemented by land-management agencies tended to have a higher proportion of procedural problems than did university-based programs (generally graduate student research), while the frequency of design problems was similar between agencies and universities. The most common problems

were poorly trained or unmotivated field crews (37% of projects, a procedural problem), a sampling plan that was not capable of measuring what was needed to meet project objectives (30%, design), delays in analyzing data (27%, procedure), inadequate monitoring durations (27%, design), and absence of the collateral information needed to interpret results (20%, procedure). Most of the problems could have been avoided by submission of the study design to thorough technical and statistical review, active participation of the principal investigators in field data collection, and analysis of at least some of the data as soon as information was collected so that problems could be recognized early enough to be corrected.

### **Data Management, Quality Control, and Reporting Considerations**

The following discussion by Gibbs *et al.* (1999) provides valuable technical guidance for data management, quality control and reporting for monitoring efforts, and should be considered as those efforts occur. Therefore, we include this discussion for future reference.

“Even modest monitoring efforts can generate substantial amounts of information to proof, digitize, analyze, and interpret (Elzinga *et al.* 1998). Issues of data management are best dealt with early in the planning of a monitoring program. Streamlining and troubleshooting data collection are therefore two key themes to focus upon early in developing a monitoring program.”

“Even after a dataset is compiled, issues of reporting, sharing and archiving data also are critical. The value of monitoring data increases substantially as it ages. Properly organizing and archiving today's monitoring data can permit that opportunity for future wildlife biologists.”

“Explicit documentation of sampling protocols must be made so that new personnel can repeat measurements exactly. Proven and standardized methods should be implemented that are not susceptible to the vagaries of technology change or changing observer ability (Ringold *et al.* 1996). Use of such protocols also increases the comparability of monitoring data among different sites and programs and thereby generates a valuable spatial component as well as true replication on a large scale.”

“An effective communication strategy is necessary to ensure that the results of the monitoring program reach the broadest number of individuals involved in management processes.”

## **Performance Indicators**

Schoonmaker and Luscombe (2005) state “A monitoring program begins with clearly defined goals that are linked directly to the state wildlife strategies. Goals should generate action, performance indicators and targets, which can then be used to assess if goals were met and whether they need to be adapted to changing conditions.” Table 6-4 provides potential conservation actions and performance indicators.

Table 6-4. Potential conservation actions and performance indicators for the CWCS in New Mexico.

<b>Action Category</b>	<b>Performance Indicators</b>
Technical Guidance and Endangered Species Sections Environmental Review	Number of responses generated as compared to the number of project request notifications received; number of site visits; number of projects with NMDGF recommendations implemented; number of new habitat guideline papers developed; number of consultations with project proponents
Surveys, research	Number of new SGCN or key habitat research projects funded and/or initiated; number of new survey sites and/or acreage surveyed, sampled or inventoried; development of revised comprehensive SGCN species accounts; number of conservation action affects detected on SGCN and or/key habitats; number of publications in scientific peer-reviewed journals generated on SGCN, key habitats
Monitoring	Number of new species or suites of species to receive recovery plans, monitoring programs, and/or monitoring protocols developed; number of population recovery targets achieved; number of species for which trend information can be assessed, number of adaptive management decisions made based on outcomes of conservation actions; number of database users; volume of new information input into database; database user evaluation comments
Conservation Actions (Terrestrial)	Number of conservation actions implemented; acreage of successful habitat improvement/restoration projects successfully implemented; number of state- and/or federally-listed species populations replicated; acreage of habitat in key habitat areas protected; number of improved measures of terrestrial species abundance/diversity indices documented
Conservation Actions (Aquatic)	Number of stream/river miles restored; number of improved measures of water flow regimes and/or aquatic species abundance/diversity/indices measured
Program coordination, cooperation	Number of new partners enjoined in CWCS efforts; number of new sources of non-federal match funding dedicated to SWG and LIP programs; number of contacts/information changes documented
Education/outreach efforts	Number of media/outreach products developed; number of publications generated; members of the public reached; number of teachers/students/and/or other members of the public to attend “Citizen Scientist” educational efforts; number of presentations given; number of outreach/educational programs offered; number of positive comments generated; number of successful public survey results obtained