

## MONITORING AND ADAPTIVE MANAGEMENT (ELEMENT 5)

Monitoring is a critical element in any conservation effort and forms a keystone of the Arizona Comprehensive Wildlife Conservation Strategy and the Department's Mission to "conserve, enhance and restore Arizona's diverse wildlife resources and habitats." Elzinga and others (1998) defined monitoring as the systematic and repetitive collection of information to evaluate changes in condition and progress toward meeting a management objective. Further, modern approaches to wildlife management and conservation biology acknowledge the need for monitoring in the context of "adaptive management." Adaptive management is a scientific approach that: 1) recognizes uncertainty that is inherent in natural systems (for example, how ecological systems function, or how they might respond to management actions), 2) capitalizes upon change and improvement in data gathering and analysis techniques, and 3) treats actions in an experimental framework in which learning becomes an inherent objective and alternative hypotheses are evaluated. Simply put, adaptive management is a mechanism for continuous improvement based on what has been learned by applying management actions.

Science-based adaptive management generally includes 4 steps (Elliott and others 2003):

1. Set management goals, and identify assumptions within those goals.
2. Implement management actions.
3. Monitor and analyze responses of species and habitats to management.
4. Revise management actions, goals or monitoring strategies as necessary.

The process is then repeated, such that testing and revision become a standard management approach. Perhaps the most important realization of the adaptive management paradigm is that management is not simply an objective, but it is a process, and as the Department gathers information and tests hypotheses, it can adapt its management strategies and policies accordingly (Johnson 1999, Salafsky and others 2001, Schoonmaker and Luscombe 2005). Therefore, monitoring programs are basically research tools designed to address specific conservation action questions (Schoonmaker and Luscombe 2005), the protocols, time frames and study design of which are determined by the characteristics of the species under study (life history characteristics, habitat preferences, etc.).

Monitoring in the context of adaptive management includes 3 interrelated components: effectiveness monitoring, targeted monitoring and implementation monitoring (Atkinson and others 2004). **Effectiveness monitoring** allows the Department to assess the success of a management plan, and might include gathering data on species or habitat trends and status, and the status of stressors. **Targeted monitoring** is the research mechanism through which the Department may improve knowledge of a biological system, stressors or management techniques. This is achieved by either gathering information that can resolve uncertainties (for example, the effects of wind turbines on bat populations) or by applying experimental management techniques (for example, stocking topminnows in various habitats). Whether the data are gathered through observation and measurement, or by experimental manipulation of a system, targeted monitoring through research can address specific questions, either in the long term or short term. **Implementation monitoring** tracks the status of management plan implementation to confirm that management goals were implemented, achieved or require

modification. The Department collaborates with state and federal agencies, tribes, conservation groups, colleges, universities and private citizens to address all components of monitoring.

#### MONITORING HABITAT CONDITION

One of the primary goals of the Arizona Comprehensive Wildlife Conservation Strategy is to "keep common species common," in addition to the immediate, critical conservation needs that must be addressed. It is also clear that wildlife management cannot be considered or practiced without considering the health and welfare of the habitats in which animals live. Thus, monitoring must have several inextricably connected components, including habitat evaluation coupled with multiple-species and single-species efforts.

Monitoring can be conducted at various hierarchical scales, depending on the particular questions being addressed. Ideally, the Department would engage in a comprehensive program that involved monitoring at several levels, including species, landscape and ecoregion. Many current plans approach monitoring from a habitat level and from a more fine-grained, species level; these correspond closely with TNC "course-filter" and "fine-filter" biodiversity conservation targets. While a landscape approach that assesses habitat status, and therefore encompasses many species of interest, is the ultimate goal, the Department has not developed those plans. One desirable outcome of implementing the CWCS is the development of this landscape level of habitat assessment through coordination of multiple partners.

Habitat characteristics can be mapped and monitored as part of individual species management or recovery efforts, but there is no coordinated statewide effort to monitor long term habitat trends in Arizona. Public land management agencies such as USFWS, USFS, BLM, and non-governmental organizations currently monitor wildlife habitats on lands over which they have management authority, or they have been developing habitat monitoring plans. Examples include, TNC grassland plans (Gori and Enquist 2003, Marshall and others 2004), USFS Forest Health Monitoring (FSM) program (Rogers and others 2001) and the nationwide Multiple Species Inventory and Monitoring (MSIM) protocol (Manley and others 2004, Manley and others in press). But, there is currently no comprehensive effort designed for long term assessment and monitoring of habitats for the entire state, nor is there a plan for assessing habitats on most private lands, or on public lands not specifically managed for wildlife (for example, State Trust Lands).

Certain guilds and taxonomic groups of animals are particularly suited to habitat or landscape level monitoring, for example, grassland herbivores, riparian passerine birds, etc. Other animals, for reasons of biology or legal status, require more narrowly focused, species level monitoring, for example, Kanab ambersnail (highly restricted distribution) or Gila topminnow (monitoring success of stocking program), as described previously.

In certain circumstances, a fine-scaled, single-species approach can accomplish the goals of habitat based monitoring, and provide important information regarding habitat condition. Species that are most strongly associated with specific habitats can act as "umbrella species" for other species in the community and for the habitat (Schoonmaker and Luscombe 2005). Umbrella

species are not necessarily linked functionally with a particular habitat or to other species (as are keystone species as defined by Paine (1966), or Keystone and Strongly Interactive Species (Appendix L), but their widespread distribution within a habitat can make them convenient monitoring subjects. In the Arizona CWCS database, the criteria to identify species in the Community Focal category include Habitat Quality Indicator Species, which when present indicate particularly good habitat quality (Appendix L). For example, in high elevation Mixed Conifer habitat, northern goshawks are a Habitat Quality Indicator Species for that vegetative community. The presence of northern goshawks suggests conditions are excellent for other birds that use similar habitat components or respond positively to management for northern goshawks (for example, wild turkey, flammulated owl, Williamson's sapsucker, solitary vireo, Grace's warbler, western tanager, red crossbill) (Latta and others, 1999), as well as for mammals (for example, Mexican vole, dusky shrew, long-tailed weasel), or amphibians and reptiles (for example, tiger salamander, western chorus frog, wandering gartersnake), despite the obvious differences in specific ecological requirements of the various taxa. In this context, several "Vulnerable Species" in the AZ CWCS can serve as Habitat Quality Indicators for more common animals and habitats. Thus, in this particular example, monitoring strategies for northern goshawks outlined in Arizona Partners in Flight Conservation Plan (Latta and others 1999) could accomplish habitat monitoring goals at the landscape level.

#### MONITORING WILDLIFE

The Department monitoring priorities until now have been driven by federal funding sources for threatened and endangered species on the one hand, and game or sportfish funding on the other. As described below, this CWCS plan first lists existing monitoring efforts by the Department and cooperators, then highlights current planning activities that are shifting the Department away from crisis and consumption management. These new efforts such as the Arizona All Birds Conservation Initiative, Arizona Partners for Amphibian and Reptile Conservation, and the Arizona Bat Plan, are multispecies planning efforts that aim at documenting guilds in addition to individual species, and common species in addition to rare elements of our natural heritage. In addition, these multispecies efforts all tier off of national and/or regional planning efforts that provide standards for monitoring measures and metrics. All multispecies planning currently underway with the Department requires conservation and monitoring of SGCN identified by Arizona's CWCS.

The Department has a long history of establishing and implementing research and population monitoring activities that withstand scientific scrutiny, although those efforts have traditionally been focused on consumptive uses of wildlife. Existing consumptive use protocols are developed using a process that incorporates best available science and practices, which are then formalized as official Department methods and taught to biologists for implementation throughout the state. Data collected from those efforts are analyzed on a regular basis, made available to the public, and are used to make management decisions. This process provides a template for the development of similar monitoring protocols for SGCN once secure funding has been acquired.

However, statewide research projects and population monitoring protocols for many SGCN have been established. The Department has both a Research and Nongame Branch with personnel

dedicated to these activities. Additional efforts are contracted to external partners. Many high priority research and monitoring efforts are conducted by wildlife biologists employed by the Department for their expertise in specific taxon groups. As part of their regular duties, these expert biologists conduct routine survey and monitoring activities, as well as provide training and establish monitoring protocols for other biologists to follow (for example, Chiricahua leopard frog workshop, HDMS, Department School training sessions, etc.). In addition, Wildlife Managers and other biologists located in six regional offices across the state are trained to note the presence or absence of certain SGCN (or invasive nonnative species) and report relevant information to appropriate personnel in the Department, and those data are incorporated into existing repositories (HDMS, ranid frog database, native fishes database, crayfish database etc.). Additional data are collected through the Department's administration of scientific collecting permits and from the general public.

In order to fill gaps in existing monitoring projects and to implement best monitoring practices, the Department will coordinate monitoring projects with external, existing programs such as: the North American Bird Conservation Initiative (NABCI; [www.nabci-us.org](http://www.nabci-us.org)), the North American Bat Conservation Plan ([www.batcon.org/nabcp/newsite/rwg.html](http://www.batcon.org/nabcp/newsite/rwg.html)), Partners in Amphibian and Reptile Conservation (PARC; [www.parcplace.org](http://www.parcplace.org)), The Wildlands Project ([www.twp.org](http://www.twp.org)), Pima County's Sonoran Desert Conservation Plan ([www.pima.gov/sdcp](http://www.pima.gov/sdcp)), and the Central Arizona--Phoenix Long-Term Ecological Research project ([www.capter.asu.edu](http://www.capter.asu.edu)). Many of these initiatives have been further developed for application in Arizona (Latta and others 1999; Foreman and others 2000, Pima County 2002, Hinman and Snow 2003, Grand Canyon Wildlands Council 2004).

The remainder of this section uses examples to provide an overview of monitoring approaches and mechanisms currently used by the Department or in development. Table 22 is a comprehensive list of monitoring efforts underway or planned for the near future. While not all monitoring programs have explicit adaptive management goals written into them, many plans incorporate adaptive management philosophy and discuss the need to reevaluate results at certain intervals and to adjust management protocols accordingly. Other plans have adaptive management clearly built into them. The examples are presented along taxonomic lines, and are meant to illustrate single species and multispecies monitoring (for target and non-target species), habitat monitoring, as well as the incorporation of adaptive management into Departmental protocols. Further, most listed monitoring efforts in Table 22 incorporate both Effectiveness and Targeted monitoring, except those indicated under "Project Follow-up" for which Implementation Monitoring is a major component.

### **Crustaceans and mollusks**

Invertebrate monitoring is in its formative stages in Arizona, and efforts are concentrated on a variety of species of snails, including springsnails, ambersnails, and talussnails. Monitoring is usually single-species based and typically includes a habitat monitoring component. The most well developed monitoring protocols have been established for Kanab ambersnails, for which a fair amount of baseline ecological research has already been done (Stevens and others 1997; Sorensen and Nelson 2002). Monitoring at 6 sites in Arizona comprises standardized plot-based protocols coupled with habitat quality analyses, as outlined in the species recovery plan (USFWS

1995) and an interim conservation plan (Sorensen and Nelson 2002). Based on data accumulated over the past 10 years, Department biologists have recognized the need to modify protocols, and will be testing new methods in the coming years. Where practical and allowable by our enabling legislation, the Department will develop or adjust existing survey and data collection protocol to gather data on all invertebrate SCGN and Unknown Status species).

Monitoring of the Quitobaquito tryonia, a springsnail, is part of a habitat-based, multispecies effort. A conservation agreement that covers the tryonia, Sonoyta pupfish and Sonoyta mud turtle provides for concurrent monitoring among the 3 species where they co-occur in Organ Pipe Cactus National Monument. Monitoring involves strong collaborative efforts between the Department and the NPS.

From an entirely different perspective, a GIS-linked database has been developed to track the distribution of invasive nonnative crayfish in the White Mountains of Arizona. Crayfish have been implicated in the decline of nongame and sport fishes, as well as mollusks, ranid frogs and gartersnakes. The database is managed by the Department, but data have been contributed largely by private citizens and conservation groups (for example, TNC and Trout Unlimited Zane Gray Chapter), as well as USFS personnel. The Department plans to expand the database to include the entire state.

### **Fishes**

Monitoring of fishes is often single-species focused, primarily because of funding source restrictions, or recovery needs. Information is often collected with respect to downlisting/delisting goals as outlined in recovery plans (or drafts). Examples of this approach include bonytail chub, virgin spinedace, humpback chub, colorado pikeminnow, and razorback sucker monitoring protocols (Table 22). In some cases, despite the necessity of a single species approach, Department biologists often make an effort to gather incidental information on non-target species of fishes and amphibians (for example, Voeltz in lit). Where practical, the Department will develop or adjust existing survey and data collection protocol to gather data on all SCGN and Unknown Status fish species.

Desert pupfish and Gila topminnows, both short lived and inhabitants of small, isolated habitats, require annual monitoring because habitat conditions can change quickly. The draft Gila topminnow recovery plan calls for stocking topminnows into suitable habitat within their former range. At each site, the plan requires monitoring 1 month, 6 months and 1 year post-stocking (Weedman 1999). At each temporal stage in monitoring, the success of the stocking effort is evaluated and subject to adaptive management, the details of which are provided in the draft topminnow and pupfish safe harbor agreement (AGFD in prep.). For example, the plan recognizes, but is not limited to 3 types of "Altered Circumstances" that would lead to modifications in management protocols: drought, invasion by nonnative organisms that may pose a threat to the population, and population failure. The plan outlines possible management alternatives for each circumstance.

Other single species fish surveys, for example, Sonora chub or loach minnow, result in community level data that are incorporated into the monitoring protocols. Multiple species

protocols, such as the Muleshoe Ranch surveys, target up to 5 species of native fishes and involve collaborative efforts between the Department and BLM.

### **Amphibians**

Sonoran tiger salamander surveys are also single species monitoring efforts in which incidental information is gathered on other species. The multispecies approach to a single species work plan has resulted in the development of a GIS database that allows the Department to examine changes, spatially and temporally, in distribution of salamanders. But, it also allows tracking of federally listed Chiricahua leopard frogs and invasive nonnative species such as bullfrogs and crayfish. This has become a powerful tool for management of aquatic habitats in the San Rafael Valley where these animals occur, and provides the potential for rapid adaptive adjustments to recovery efforts. The Department is now incorporating information about Mexican gartersnakes into the database, which will increase its utility for community-wide monitoring.

Conservation action questions have been incorporated into monitoring protocols for several species, including the Tarahumara frog reintroduction program. The success of Tarahumara frog repatriation is measured according to 5 stages in the frog's life history and ecology, all of which are necessary for success and all of which can be measured objectively (and relatively easily): survival of release, survival over winter, long-term survival, reproduction, recruitment. Adaptive management is built into the plan at 1 year, 2 year and 5 year intervals, at which times the project success is evaluated and necessary modifications incorporated. Where practical, the Department will develop or adjust existing survey and data collection protocol to gather data on all amphibian SCGN and Unknown Status amphibian species.

### **Reptiles**

Averill-Murray (2000) outlined a quantitative protocol for monitoring Sonoran desert tortoises on 18, 1km<sup>2</sup> and 1mi<sup>2</sup> plots randomly assigned on BLM lands throughout the Arizona distribution of the tortoise. Recent advancements in population estimate techniques suggest line-distance sampling might be more efficient and more accurate. Initial attempts at evaluating line-distance sampling were positive (Averill-Murray and Averill-Murray 2005), which has led the Department to contract a 2-year study to evaluate more fully the new techniques. Should the 2-year study confirm the utility of the new techniques, the Department will adjust monitoring protocols elsewhere. Where practical, the Department will develop or adjust existing survey and data collection protocol to gather data on all reptilian SCGN and Unknown Status reptile species.

### **Birds**

Strategic planning that incorporates pre-existing and future monitoring efforts is best expressed in the Arizona Partners in Flight Bird Conservation Plan implementation strategy. Through this, the Arizona Bird Conservation Initiative (ABCI) has begun to canvas key stakeholders to determine levels of support for implementing an integrated and coordinated approach to statewide bird monitoring efforts in Arizona. ABCI is coordinated by the Department and consists of participants from state, federal and tribal entities, as well as universities and non-governmental organizations. The mission is to coordinate statewide efforts to monitor bird populations of most species in Arizona to provide long-term trend data, as well as to identify species of concern and evaluate land management actions. Recent preliminary efforts have

indicated a strong support from many key partners for initiating such an endeavor. Further, bird monitoring efforts in Arizona, as elsewhere, benefit greatly from the input of citizen science (see Table 22 for examples of monitoring programs). As Schoonmaker and Luscombe (2005) pointed out, "properly trained citizens not only reduce the cost of data collection and ground-truthing, they can also become engaged supporters of fish and wildlife conservation." Where practical, the Department will develop or adjust existing survey and data collection protocol to gather data on all avian SCGN and Unknown Status avian species.

### **Mammals**

The Department's Mammals Program has developed the Arizona Bat Conservation Strategic Plan. Like the Arizona Partners in Flight Bird Conservation Plan implementation strategy, the Bat Conservation Plan calls for statewide species and habitat monitoring. Although some species recovery plans, for example, lesser long-nosed bat, require single species monitoring protocols, the vast majority of bat monitoring efforts target multiple species, through mist net and roost surveys. This plan highlights the ability to monitor species regardless of priority, such that rare and common species can be assessed equally.

Another strategic plan is being developed, the Small Mammal Conservation Plan (Appendix P). With direction from the Arizona CWCS, this ambitious document will incorporate the goals of adaptive management into plans for monitoring multiple species across multiple landscapes and ecoregions. This will include efforts for all mammalian SCGN and Unknown Status mammal species.

### **Unknown Status Species and Monitoring Needs**

A critical challenge facing the Department concerns the appropriate mechanisms for accumulating information on the status and distribution of Unknown Status Species (Appendix N). In part, responsibilities for conservation agreements, recovery plans, draft recovery plans, etc. consume many of the resources available to the Department for conservation of Arizona's wildlife. Nonetheless, the Department is committed to gathering data on Unknown Status Species. Many of the monitoring efforts in which the Department is currently involved, or plans for the near future, have built into them mechanisms either explicitly designed for monitoring multiple species, or for including "non-target" species into the protocols (Table 22). These monitoring programs will continue to accumulate significant amounts of data on many Unknown Status Species. Excellent examples of these include: Long-term Bat Monitoring, in which mist net sampling and roost surveys are not species specific; the San Pedro Habitat Management Plan, in which fish monitoring protocols sample the entire community; Chiricahua Leopard Frog Visual Encounter Surveys that collect information on all species of non-target amphibians and reptiles in addition to Chiricahua leopard frogs; and the Hummingbird Monitoring Network that, like the bat monitoring protocols, collects data on all species of hummingbirds in the White Mountains and from throughout southeastern Arizona.

Finally, in addition to programs highlighted above and in Table 22, the Department is actively soliciting proposals from outside cooperators to initiate surveys in areas where little is known about the distribution or status of native wildlife. For example, a specific objective on the 2005

Heritage Sensitive Elements list (the list of species or topics about which outside cooperators may submit proposals to the Department for research funding) was an inventory of amphibians and reptiles of the Arizona Strip, a remote, poorly known part of the State in which many Unknown Status Species occur. The Arizona Bird Conservation Initiative also highlights research needs and solicits proposals to work in areas or with species about which little is known. A clear Departmental commitment is apparent in native fish management. To address gaps in our knowledge of native fishes, the Department has moved towards year round monitoring conducted by native fish specialists that have been stationed at the regional offices. These are only a few examples of a fledgling effort to understand more about the many lesser known species of wildlife which have historically received little attention.

#### TRACKING PROGRESS

Perhaps the most difficult aspect of adaptive management is developing the appropriate mechanisms for tracking the success or failure of management protocols, especially when those protocols cover the multitude of species found in Arizona. In its simplest form, tracking progress can be broadly interpreted, for example, achieving recovery of certain threatened or endangered species would indicate healthy habitat and thus ensure the long term success of other, non-target species. But, current mechanisms for most species are imperfect, relying on individual project deliverables and guidelines. Considerable effort is being put into place to attempt to provide for more effective tracking.

The Department's database of planning documents and conservation agreements (Appendix P) includes stressors for species and habitats. Plans are in place to incorporate specific actions into the database according to particular projects, such that management efforts can be updated and tracked. The development of this database will depend on funding and personnel priorities.

Field Operations Division has developed an operational plans database. This database includes information from Regional office annual work plans and is designed to allow the Regions to track progress with respect to expectations. Again, CWCS actions could be incorporated into this database to allow tracking of regionally-based projects. A relational database was developed to facilitate building the Arizona CWCS (see Processes section), and that database can be modified to link with the operational plans database to facilitate communication and data exchange, and to track the implementation of conservation actions.

As a public agency, the Department provides wildlife information to the public and Department cooperators. To that end, the Heritage Database Management System has developed the Arizona Heritage GIS Environmental Review Tool. This is an online pre-screening tool that will allow cooperators to access information regarding development projects and will ultimately track progress on wildlife related progress. The concept for this Tool was presented and accepted during the Governor's Efficiency Review in 2003, awarded funding in 2005 and plans to open to the public in spring 2006.

Because of the reality of limited resources and logistical constraints the Department is involved in many collaborative monitoring efforts with other entities (for example, USFWS, USFS, BLM, USBR, tribes, non-governmental organizations, colleges and universities, etc.). While there is strength in collaboration, these efforts underscore the need for strong data standards for collection, management, and analysis so that information can be shared easily among cooperators. There remains a need for more detailed habitat assessments throughout the State. In many instances, it will be necessary to conduct inventories of habitats and taxa for which there are few or no data, before monitoring programs can be established.

The time frame for reaching CWCS objectives will vary depending on several factors, including: the condition of the habitat necessary to sustain priority species, understanding species requirements, and the capability of the land owner or land manager to manage for the species. Fortunately, the CWCS is a dynamic document for which adaptive management provides the central theme. With an approved CWCS, the Department will examine closely the monitoring activities, priorities and databases to determine where changes are necessary. Through systematic and ongoing review of conservation management strategies and monitoring programs, the Department will ensure that Arizona is effectively conserving species and associated habitats at the statewide and ecoregional scales. Research questions will continue to be developed through the course of monitoring that will have direct application to land managers, and thus provide constant feedback of new information with which to manage Arizona's biodiversity.

Details are described in references under "Document #" which refers to the list of documents in Appendix P.

Table 22. Summary of ongoing and planned SGCN and habitat condition monitoring efforts currently carried out by Arizona Game and Fish Department and cooperators.								
Details are described in references under "Document #" which refers to the list of documents in Appendix P.								
Project	Document #	Single species	Multi-species	Habitat	Long-term	Project Follow-up	Geographic Scope	Agency Lead
<b>Crustaceans and mollusks</b>								
Kanab ambersnail	26, 27		X	X	X		rangewide	AGFD WMNG
Page springsnail	214, 215	X		X	X		local	AGFD WMNG
Three Forks springsnail	212, 215	X		X	X		local	AGFD WMNG
Quitobaquito tryonia	215, 241		X	X	X		local	AGFD WMNG
Wet canyon talussnail	29	X		X	X		local	AGFD WMNG
San Xavier talussnail	28	X		X	X		local	AGFD WMNG
<b>Fishes</b>								
Gila topminnow	145, 35, 235, 237, 249	X		X	X	X	statewide	AGFD WMNG
Desert pupfish	145, 34, 235, 237	X		X	X	X	statewide	AGFD WMNG
Sonoyta pupfish	241		X		X		local	AGFD WMNG

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Native fish post-stocking evaluations	239, 250, 251		X		X	X	statewide	AGFD WMNG
Multispecies Conservation Plan	32, 33, 41, 44, 231, 246, 248, 250, 251		X		X	X	local	AGFD WMNG
Rio Yaqui fishes	31		X		X		rangewide	AGFD FOR5
El Coronado Ranch monitoring	21		X		X		local	AGFD FOR5; FWS
Virgin River fishes	47		X		X		rangewide	AGFD FOR2
Gila trout	36	X		X	X		statewide	AGFD WMNG/WMFS; FWS-AZFRO
Apache trout	230, 87, 82	X		X	X	X	rangewide	AGFD WMNG/FOR1/WMFS; FWS-AZFRO
Little Colorado River spinedace	42, 107, 115, 116, 252		X		X		rangewide	AGFD WMNG/FOR1/FOR2
Loach minnow	43	X			X		statewide	AGFD WMNG
Sonora chub	45	X			X		local	AGFD WMNG/FOR5
Spikedace	129, 46	X			X		statewide	AGFD WMNG
San Pedro Habitat Mgmt Plan	69		X				local	AGFD WMNG/ FOR5; BLM
Draft Lower Colorado River National Wildlife Mgmt Plan	70		X				local	FWS
Horseshoe Lake and Bartlett Lake monitoring	76		X		X		local	SRP; FWS; AGFD WMHB
Sipe native fish monitoring	115		X		X		local	AGFD FOR1
Packard Ranch/Tavasci Marsh monitoring	129		X		X		local	AGFD FOR3
Muleshoe Ranch monitoring	147		X		X		local	AGFD WMNG/ FOR5; BLM
Statewide Conservation Agreement and Strategy for 6 fish species	239		X		X		statewide	AGFD WMNG
Bonytail chub	246	X			X		statewide	AGFD FOR3/ FOR4
Virgin spinedace	247	X			X		local	AGFD FOR2
Humpback chub	248	X			X		local	AGFD WMRS
Colorado pikeminnow	250	X			X		statewide	AGFD FOR6
Razorback sucker	251	X			X		statewide	AGFD WMNG/ FOR3/ FOR4/ FOR6
CAP Monitoring	none		X		X		ecoregion	AGFD WMNG

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Nutrioso Creek	252		X		X		local	AGFD FOR1
<b>Amphibians</b>								
Sonora tiger salamander	53		X	X	X		local	AGFD WMNG/FOR5
Chiricahua Leopard Frog Visual Encounter Surveys	217, 223		X		X		rangewide	AGFD WMNG
Chiricahua leopard frog Sierra Blanca release	217, 222, 223	X				X	local	AGFD FOR1
Chiricahua leopard frog Buckskin Hills Site	217, 222, 223	X			X		local	AGFD FOR2
Chiricahua leopard frog Gentry Site	217, 222, 223	X			X	X	local	AGFD FOR6
Ramsey Canyon leopard frog	50, 219, 223	X			X	X	local	AGFD WMNG/ FOR5
Tarahumara frog reintroduction	223, 234	X		X	X	X	local	AGFD WMNG; USFS; USFWS
Relict leopard frog	218, 223	X			X		rangewide	Relict Leopard Frog Conservation Team; AGFD FOR3
Lowland and Plains leopard frogs	223		X				statewide	AGFD Regional offices
Northern leopard frog	223	X			X		rangewide	AGFD FOR2
Chytridiomycosis surveys	223		X		X		statewide	AGFD WMNG
<b>Reptiles</b>								
Flat-tailed horned lizard	48	X		X	X		local	AGFD FOR4./WMNG
Sonoran Desert tortoise permanent plots	49, 52, 240	X			X		rangewide	AGFD WMNG; BLM
Sonoran Desert tortoise line-distance sampling	49, 240	X					local	UA; AGFD WMNG
Sonoran Desert tortoise disease monitoring	49, 52, 240	X			X		rangewide	AGFD WMNG
Sonoyta mud turtle	241		X		X		local	AGFD; NPS; CEDES
Narrow-headed gartersnake	none	X					rangewide	AGFD Regional offices
Mexican gartersnake	none	X					rangewide	AGFD Regional offices
Tucson shovel-nosed snake	none	X					Rangewide	AGFD FOR6
New Mexico ridgenose rattlesnake	51	X					local	AGFD WMNG
<b>Mammals</b>								
Arizona Bat Conservation Strategic Plan	54		X	X	X		Statewide	AGFD WMNG/ Regional offices

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Lesser long-nosed bat roost monitoring	54, 161	X		X	X		Rangewide AGFD WMNG/ FOR5; many partners
Long-term bat monitoring	54		X	X	X		Statewide AGFD WMNG/ Regional offices
Fort Huachuca bat monitoring	54, 78		X		X		Local DOD Ft. Huachuca
SE Arizona bat monitoring	54		X		X		Local NPS (Ft. Bowie NHS, Chiricahua NM)
Mt. Graham red squirrel	160	X			X		Local AGFD FOR5; USFS; UA
Sonoran pronghorn	162	X			X		rangewide AGFD FOR4; CEDES
Jaguar	55	X			X		borderlands AGFD WMNG
Mexican wolf	57	X			X	X	White Mtns AGFD FOR1
Black-footed ferret	58	X			X	X	Local AGFD WMNG
Prairie dog monitoring	58	X			X		Local AGFD WMNG
Disease monitoring	58		X		X		Local AGFD WMNG
Mammal track surveys	none		X		X		Local Sky Island Alliance
Gunnison's prairie dog	253	X			X		statewide AGFD Regional offices
<b>Birds</b>							
Arizona Bird Conservation Initiative (ABCI)	169		X	X	X		statewide AGFD WMNG
Bald eagle (breeding and winter)	211	X			X		statewide AGFD WMNG
Golden eagle nesting surveys	166	X					statewide AGFD Regional offices
Peregrine falcon	206	X			X		statewide AGFD; USFWS
Southwestern willow flycatcher	165, 203	X			X		statewide AGFD WMRS
Cactus ferruginous pygmy-owl	22, 205	X			X		rangewide AGFD FOR5
California condor	170, 171, 201	X			X		local AGFD FOR2 and Peregrine Fund
(Mexican) spotted owl	204	X			X		rangewide USFS
Burrowing owl	168	X			X	X	rangewide AGFD WMRS/WMNG; Wild At Heart
Yuma clapper rail	210		X		X		rangewide AGFD FOR3/FOR4/FOR6
Northern (masked) bobwhite	72	X			X		local USFWS (Buenos Aires NWR)
Chiricahua elegant trogon count	169	X			X		local USFS (Coronado National Forest)
Breeding Bird Survey	169		X		X		statewide USGS – Laurel; MD
Christmas Bird Count	169		X		X		statewide National Audubon Society

Table 22. Summary of ongoing and planned SGCN and habitat condition monitoring efforts currently carried out by Arizona Game and Fish Department and cooperators.								
Details are described in references under "Document #" which refers to the list of documents in Appendix P.								
Hummingbird Monitoring Network	169		X		X		local	Hummingbird Monitoring Network
Sipe hummingbird banding project	169		X		X		local	AGFD FOR1
Fall Hawk Watch	169		X		X		local	HawkWatch International
SE Arizona bird migration monitoring	169		X		X		local	SE Arizona Bird Observatory
San Pedro River MAPS Station	69, 169		X		X		local	BLM
Colonial nesting heron/egret counts	169		X				local	AGFD FOR3
Tucson bird count	169		X		X		local	Univ of AZ
Important bird area (IBA) monitoring	169		X		X		local	Audubon AZ/Tucson Audubon Society
Phoenix area winter urban waterbird count	none		X		X		local	AGFD WMNG

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