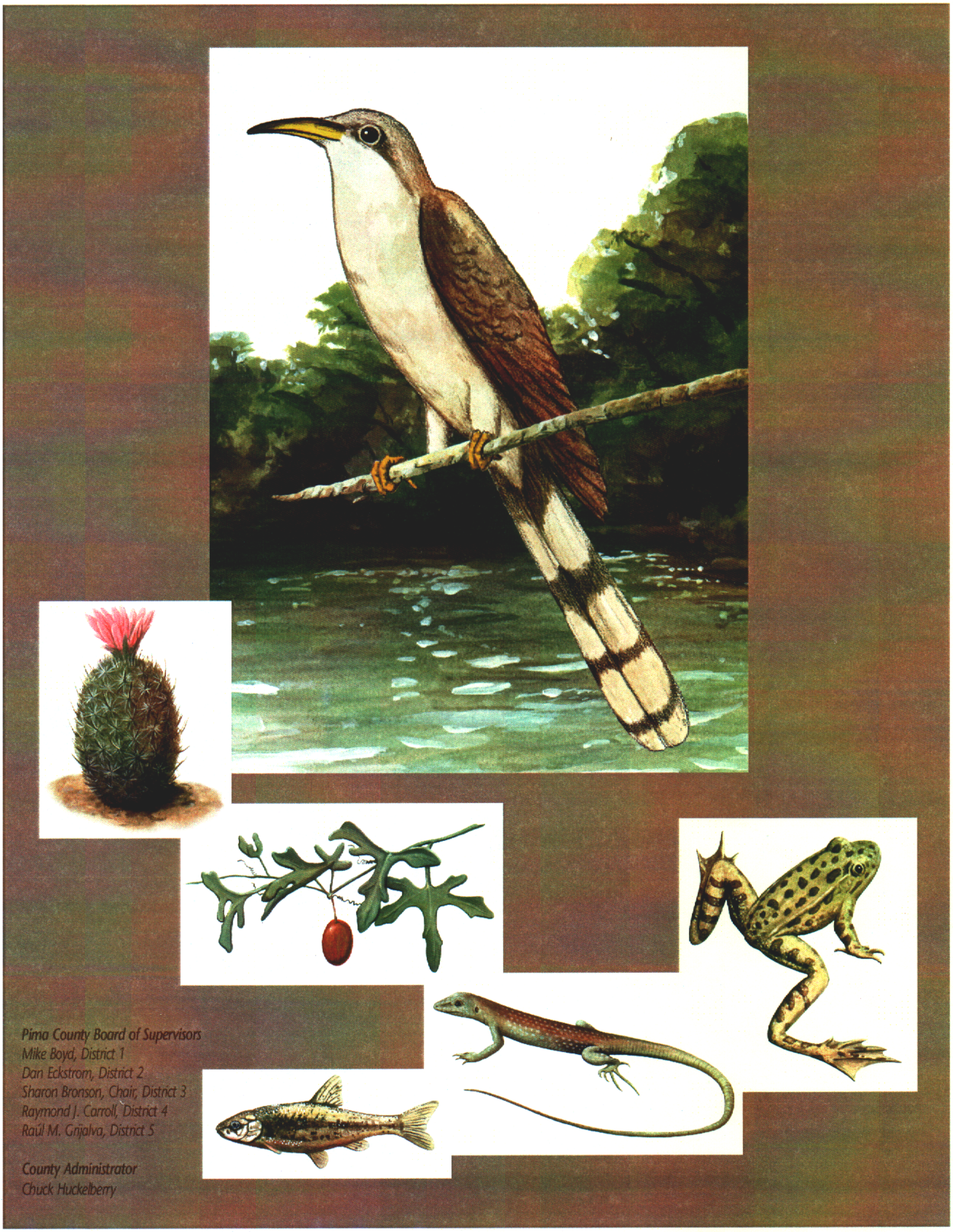
DRAFT

Priority Vulnerable Species:
Data Compilation and Synthesis

Sonoran Desert Conservation Plan

June 2000



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County Administrator
Chuck Huckelberry

MEMORANDUM

Date: June 8, 2000

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Priority Vulnerable Species, Data Compilation and Synthesis**

Background

The attached 300 page document entitled *Priority Vulnerable Species, Data Compilation and Synthesis* is submitted by the Recon Consulting team as part of the biological evaluation of the Sonoran Desert Conservation Plan. It provides a detailed description of plants and animals that are being considered by the Science Technical Advisory Team as potentially covered under the multi-species program. Organized by taxonomic group, the priority vulnerable species accounts include:

- 9 mammals
- 8 birds
- 7 reptiles
- 7 plants
- 6 fish
- 2 amphibians
- Invertebrates

Two strong themes emerge when this compilation of species accounts is read together: one is the enormous importance of aquatic and riparian-based habitats to the majority of priority vulnerable species, and the other is the very bleak biological status of the riparian system.

This memorandum provides an introduction to the potentially covered species of the Sonoran Desert Conservation Plan. Like the *Land Cover Data Assessment* study produced by Recon in March 2000, the *Priority Vulnerable Species* study provides a context for research efforts of recent decades and will allow the scientific community to avoid duplication in future planning initiatives, and target data gaps with greater precision.

Furthermore, the *Priority Vulnerable Species* study has a place in the long history of local conservation scholarship. Citing the work of early naturalists from the 1800s, collectors of the period from 1850 to 1940, and great desert ecologists of the past century, the *Priority Vulnerable Species* study continues to increase this community's ability to describe its resource base and begin to carry out meaningful conservation planning.

Data Compilation and Synthesis for Vulnerable Species

The workplan for the biological evaluation includes this task, which has resulted in the *Priority Vulnerable Species* study:

Compile existing biological and management information: For vulnerable species described in the April 2000 *Review of Vulnerable Species* report and accepted by the Science Technical Advisory Team, the Recon team shall compile existing biological and management information.

Sources: All sources of data must be documented and include at a minimum: Arizona Game and Fish Department (AGFD) records, State and Federal government reports and data compilations, AGFD species Abstracts and BISON-M compilations, as well as the relevant scientific literature.

Written species accounts: For each vulnerable species the Recon team shall prepare a written summary of information, including

1. Federal status.
2. State and federal recovery goals.
3. Other status (global rankings, state lists, other lists).
4. Taxonomy, especially of Pima County populations.
5. Past and present distribution.
6. Habitat requirements, including home range requirements and ability to utilize major human land use categories.
7. Life history.
8. All available demographic (population density, status, trend, survival rates, reproductive rates, sex and age ratios, etc.) and distributional information within Pima County and range-wide. Define population or (sub-population) basis in the planning area, and identify any areas of special significance to the Pima County populations.
9. Habitat trends within the planning area, if known.
10. Current and potential threats to species or populations in Pima County, considering the location, amount, and quality of habitat already protected, as well as existing and potential pest species. Identify the mechanism of threats.
11. Management needs, including sensitivity to human activity and densities, corridor needs, key relationships, migratory requirements, etc.
12. Results of past mitigation activities.
13. Existing monitoring and research programs.

Maps: Maps will be prepared depicting distribution of species within Pima County and, where appropriate, range-wide.

The *Priority Vulnerable Species* report organizes information by this workplan and provides a readable account of biological and management information about the members of the animal and plant community that are vulnerable, and that present potential compliance dilemmas.

Mammals

Detailed accounts of nine mammals considered to be priority vulnerable species are included in the first 69 pages of the attached study.

Number of Priority Vulnerable Mammal Species by Subarea

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	4
Cienega-Rincon	7
Upper Santa Cruz	7
Middle Santa Cruz	6
Tortolita Fan	6
Altar Valley	7
Avra Valley	6
Western Pima County	7

Priority Vulnerable Mammal Species

SCIENTIFIC NAME	COMMON NAME
Choeronycteris mexicana	Mexican long-tongued bat
Idionycteris phyllotis	Allen's big-eared bat
Lasiuris blossevillii	Western red bat
Lasiurus xanthinus	Southern yellow bat
Leptonycteris curasoae yerbabuena	Lesser long-nosed bat
Macrotus californicus	California leaf-nosed bat
Peromyscus merriami	Merriam's mouse
Plecotus townsendii pallescens	Pale Townsend's big-eared bat
Sorex arizonae	Arizona Shrew

A number of the bat species depend on, or occur along, riparian corridors. Riparian losses have had a negative impact on the Merriam's mouse, listed above, and water is thought to be important to the Arizona shrew.

Birds

Eight birds are considered to be priority vulnerable species, and they are described in detail on pages 70 through 127 of the attached study.

Number of Priority Vulnerable Bird Species by Subarea

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	5
Cienega-Rincon	7
Upper Santa Cruz	7
Middle Santa Cruz	7
Tortolita Fan	6
Altar Valley	7
Avra Valley	6
Western Pima County	5

Priority Vulnerable Bird Species

SCIENTIFIC NAME	COMMON NAME
Aimophila carpalis	Rufous-winged sparrow
Athene cunicularia hypugaea	Burrowing owl
Buteo swainsoni	Swainson's hawk
Coccyzus americanus occidentalis	Western Yellow-billed Cuckoo
Empidonax traillii extimus	Southwestern willow flycatcher
Glaucidium brasilianum cactorum	Cactus ferruginous pygmy-owl
Pipilo aberti	Abert's Towhee
Vireo bellii	Bell's Vireo

The report traces records back to the earliest naturalists in Pima County. Captain Charles Bendire's records from the 1870s along the Rillito are cited. Again, the importance of riparian habitat is a recurring theme in the species accounts. Six of the eight birds described in the text have an association with riparian areas. These areas have been seriously altered from baseline conditions and continue to decline.

Reptiles

Detailed accounts of seven reptiles considered to be priority vulnerable species are included in pages 128 through169 of the attached study.

Number of Priority Vulnerable Reptile Species by Subarea

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	1
Cienega-Rincon	2
Upper Santa Cruz	2
Middle Santa Cruz	4
Tortolita Fan	2
Altar Valley	4
Avra Valley	2
Western Pima County	2

Priority Vulnerable Reptile Species

SCIENTIFIC NAME	COMMON NAME
Chionactis occipitalis klauberi	Tucson shovel-nosed snake
Chionactis palarostris organica	Organ Pipe shovel-nosed snake
Cnemidophorus burti stictogrammus	Giant Spotted whiptail
Cnemidophorus burti xanthonotus	Red-backed whiptail
Sonora semiannulata	Ground snake
Terrapene ornata luteola	Desert box turtle
Thamnophis eques megalops	Mexican Garter Snake

Mixed riparian scrub (xeroriparian) and Mesquite Bosque are identified as important to the Tucson shovel-nosed snake. Giant spotted whiptail lizards are found in riparian areas, as are Desert box turtles and Mexican garter snakes. In addition to the importance of riparian areas, the species accounts, read one after another, reflect the importance of the natural system outside Pima County boundaries. The footprint made by range and distribution maps consistently includes areas to the south of Pima County and across administrative boundaries where land use and resource protection can not be controlled.

Amphibians

Detailed accounts of two amphibians considered to be priority vulnerable species are included in pages 170-186 of the attached study.

Number of Priority Vulnerable Amphibian Species by Subarea

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	1
Cienega-Rincon	2
Upper Santa Cruz	2
Middle Santa Cruz	1
Tortolita Fan	0
Altar Valley	2
Avra Valley	0
Western Pima County	0

Priority Vulnerable Amphibian Species

SCIENTIFIC NAME	COMMON NAME
Rana chiricahuensis	Chiricahua Leopard Frog
Rana yavapaiensis	Lowland Leopard Frog

The perilous status of species dependent on aquatic habitats, such as the frog population, is captured in descriptions within the accounts, such as this one for the Chiricahua leopard frog: "Massive historical loss and isolation of local populations has disrupted the metapopulation structure of this species. Multiple threats impact local populations, and without a healthy metapopulation structure, recovery of local populations is not possible."

A series of management proposals to assure available habitat are outlined on page 177, including: (1) maintenance or development of permanent water sources within a metapopulation area, while preventing further groundwater pumping; (2) development and maintenance of heterogeneous habitats that include cover, shelter, breeding micro habitats; (3) increase depth, duration, and surface area of water to increase mean annual oxygen levels; (4) prevent overgrazing to recover bank vegetation and to increase water quality; (5) prevent introduction of non-native predators and eradicate such species whenever possible..."

Pima County staff is currently working with biologists and agency scientists to draft a reintroduction proposal that will be issued in June, 2000.

Fish

Detailed accounts of six fishes considered to be priority vulnerable species are included in pages 187-226 of the attached study.

Number of Priority Vulnerable Fish Species by Subarea

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	4
Cienega-Rincon	3
Upper Santa Cruz	0
Middle Santa Cruz	1
Tortolita Fan	0
Altar Valley	2
Avra Valley	0
Western Pima County	0

Priority Vulnerable Fish Species

SCIENTIFIC NAME	COMMON NAME
Agosia chrysogaster	Longfin dace
Catostomus clarki	Desert sucker
Catostomus insignis	Sonora sucker
Cyprinodon macularius macularius	Desert pupfish
Gila intermedia	Gila Chub
Poeciliopsis occidentalis occidentalis	Gila Topminnow

Like the status of Amphibians, the dire state of fish species reflects the state of our aquatic and riparian systems. As early as 1904, the mining, grazing and range practices of the day, combined with the presence of non-native fish, were identified by the aquatic biologist Frederic Morton Chamberlain as predictors of the demise of our aquatic systems. After surveying the area for native fish he concluded: "The only hope for fish in this region lies in pond culture." In reprinting the Chamberlain survey and reflecting on the further decline since 1904, Dr. W.L. Minckley provides this perspective: "Of the 16 native species Chamberlain caught, one is extinct and eight are listed as Threatened or Endangered by the U.S. Department of the Interior. Eleven also are formally listed by the Republic of Mexico, and most of the remainder are considered imperiled by state agencies or private conservation groups and may soon be proposed for listing." (*Chamberlain's 1904 Survey of Arizona Fishes*, J. of the Southwest)

Plants

Seven plants considered to be priority vulnerable species are included in pages 256 through 303 of the attached study, following a discussion of invertebrates on pages 227 through 255.

Number of Priority Vulnerable Plant Species by Subarea

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	0
Cienega-Rincon	3
Upper Santa Cruz	3
Middle Santa Cruz	2
Tortolita Fan	1
Altar Valley	2
Avra Valley	2
Western Pima County	2

Priority Vulnerable Plant Species

SCIENTIFIC NAME	COMMON NAME
Coryphantha scheeri var. robustispina	Pima pineapple cactus
Dalea tentaculoides	Gentry indigo bush
Echinocactus horizonthalonius var. nicholii	Nichol's Turk's head cactus
Echinomastus erectocentrus var. acunensis	Acuna cactus
Echinomastus erectocentrus var. erectocentrus	Needle-spined pineapple cactus
Lilaeopsis schaffneriana recurva	Huachuca water umbel
Tumamoca macdougalii	Tumamoc globeberry

Again, riparian or aquatic habitat plays an important role for some of these species, including the Gentry indigo bush and the Huachuca water umbel. A number of plants have federal status.

Summary of Priority Vulnerable Species by Subarea

The chart below combines the total number of priority vulnerable species from the categories mammals, birds, reptiles, amphibians, fish, invertebrates, and plants.

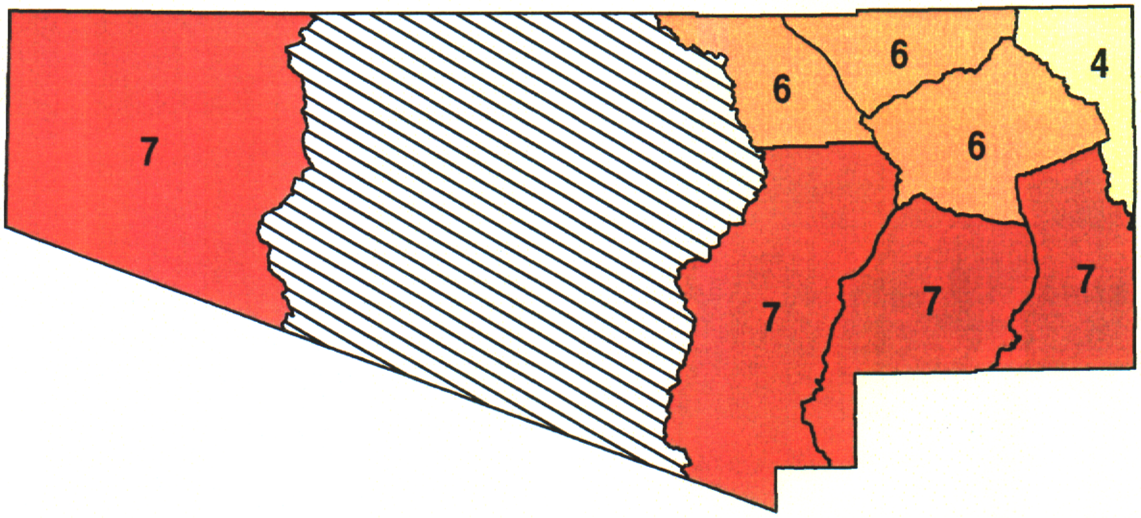
WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Middle San Pedro	16
Cienega-Rincon	29
Upper Santa Cruz	23
Middle Santa Cruz	22
Tortolita Fan	17
Altar Valley	31
Avra Valley	16
Western Pima County	17

Conclusion

The attached report on *Priority Vulnerable Species* is now in draft form. The Science Technical Advisory Team and peer reviewers will discuss and amend this draft report. It is likely that the list of species to include within the Sonoran Desert Conservation Plan will be among the highest priority discussions for the local science community. This attention will ensure that the plan is carefully crafted, and the subsequent adaptive management programs are effective and permanent aspects of future resource protection and land use decision making.

Attachment

Number of Priority Vulnerable Mammal Species



Potentially Occurring in Each Subarea

MAMMALS

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FIGURES

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APPENDIX

Introduction

The following species accounts provide a compilation of existing biological and management information for selected vulnerable species in Pima County. The vulnerable species included in this document represent those species that were recommended for further analysis and priority consideration by the Science Technical Advisory Team (STAT) as potentially covered species under a future multi-species habitat conservation plan. These recommendations were based on the Review of Vulnerable Species List (April 2000) compiled by RECON following review and discussion with STAT and Pima County staff.

Priority Vulnerable Species

A list of vulnerable species or species of concern was first published in an April 1999 report prepared by Pima County staff and the STAT (Fonseca et al. 1999).

That list was based on a compilation of plants and animals that were recognized by the federal government as imperiled species, species that had been extirpated, and a large number of species that were considered in decline either locally or nationally. Other species were added to the list as a result of interviews with members of the local scientific community. The list was divided into two subcategories. Species in Subcategory 1 were considered to be those species at risk in Pima County and for whom habitat in Pima County is crucial for their existence. Species in Subcategory 2 were considered to be those species at risk in Pima County or generally declining throughout their range. There were 37 species in Subcategory 1 and 38 species in Subcategory 2.

Species in Subcategories 1 and 2 were reviewed by RECON as contractors to the County, in order to prioritize vulnerable species for further evaluation and potential coverage under the Sonoran Desert Conservation Plan (SDCP). RECON applied the following criteria as directed by the STAT and by the terms of their contract, with the intention of identifying to the STAT those species not recommended for further evaluation for one or more of the following reasons:

1. Species conservation can be accomplished as a result of other species, habitat, or plant community protection afforded by the SDCP.

2. Insignificant or nonviable numbers of the species occur in the planning area and conservation is best accomplished elsewhere (accidentals, range peripherals, etc.).

3. The species does not occur in the study area, nor is it likely to occur in the study area within the planning horizon.

4. The species is too broadly distributed to help differentiate among a range of plan alternatives.

RECON also removed from the priority vulnerable species list species whose only or predominant occurrence within Pima County is on lands managed by the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the National Park Service. Species in this category are not included on the priority list at this time because they are already being managed by federal agencies with commitments to protect them. RECON added a list of species that had not been previously considered by the STAT in Subcategories 1 and 2, with the recommendation that they be included in the review process (RECON 2000).

Subsequently, the STAT added several species not presently known to be established in Pima County but for which some members of the STAT have hopes of reestablishing or discovering in the county. These species are Arizona shrew, southwestern willow flycatcher, desert sucker, Sonora sucker, and Gentry indigo bush. Following further review, the STAT also added the longfin dace and removed the song sparrow. The final list of priority vulnerable species consists of 56 plant and animal species, which are organized by taxonomic group in this report (Table 1).

Data Compilation and Synthesis

The species accounts were compiled following specifications detailed in the contract between Pima County and RECON.

> For vulnerable species categories 1 and 2 affirmed in Task III, the RECON team will compile existing biological and management information. All sources of data must be documented. Consultant will review, at a minimum: AGFD HDMS records, State and Federal government reports and data compilations, AGFD Species Abstracts and BISON-M compilations, as well as the relevant scientific literature. Consultant will secure review of each compilation by qualified species experts. For each vulnerable species, the consultant shall provide a written summary of information in manual format including:
>
> 1. Federal status.
> 2. State and federal recovery goals.
> 3. Other status.
> 4. Taxonomy, especially Pima County populations.
> 5. Past and present distribution.
> 6. Habitat requirements, including home range requirements and ability to utilize major human land use categories.
> 7. Life history.
> 8. All available demographic and distributional information within Pima County and range-wide. Define population or (subpopulation) basis in the planning area, and identify any areas of special significance to the Pima County populations.
> 9. Habitat trends within the planning area, if known.
> 10. Current and potential threats to species or populations in Pima County, considering the location, amount, and quality of habitat already protected, as well as existing and potential pest species. Identify the mechanism of threats.
> 11. Management needs, including sensitivity to human activity and densities, corridor needs, key relationships, migratory requirements, etc.
> 12. Results of past mitigation activities.
> 13. Existing monitoring and research programs.

These terms provided the outline for the species accounts and the minimum literature that should be considered.

The compilation and writing of these species accounts was necessarily a time-sensitive enterprise. Inevitably, some sources of information that might have been useful to pursue were left out, either intentionally or unintentionally, in order to accommodate the project deadline. These accounts should not be considered truly exhaustive compilations of all of the available literature and unpublished information on all of the species.

The information was compiled by SWCA, Inc. Environmental Consultants staff under the direction of Kenneth J. Kingsley. Dr. Kingsley is responsible for the final writing of all of the accounts. All of the

TABLE 1
LIST OF SPECIES INCLUDED IN THESE ACCOUNTS

Common Name	Scientific Name
Mammals	
Mexican long-tongued bat	*Choeronycteris mexicana*
Allen's big-eared bat	*Idionycteris phyllotis*
Western red bat	*Lasiurus blossevillii*
Western yellow bat	*Lasiurus xanthinus*
Lesser long-nosed bat	*Leptonycteris curasoae*
California leaf-nosed bat	*Macrotis californicus*
Merriam's mouse	*Peromyscus merriami*
Pale Townsend's big-eared bat	*Plecotus townsendii*
Arizona shrew	*Sorex arizonae*
Birds	
Rufous-winged sparrow	*Aimophila carpalis*
Burrowing owl	*Athene cunicularia*
Swainson's hawk	*Buteo swainsoni*
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*
Southwestern willow flycatcher	*Empidonax traillii extimus*
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*
Abert's towhee	*Pipilo aberti*
Bell's vireo	*Vireo belli*
Reptiles	
Tucson shovel-nosed snake	*Chionactis occipitalis klauberi*
Organ Pipe shovel-nosed snake	*Chionactis palurostris organica*
Giant spotted whiptail	*Cnemidophorus burti stictogrammus*
Red-backed whiptail	*Cnemidophorus burti xanthonotus*
Ground snake	*Sonora semiannulata*
Desert box turtle	*Terrapene ornata luteola*
Mexican garter snake	*Thamnophis eques megalops*
Amphibians	
Chiricahua leopard frog	*Rana chiricahuensis*
Lowland leopard frog	*Rana yavapaiensis*
Fish	
Longfin dace	*Agosia chrysogaster*
Desert sucker	*Catostomus clarkii*
Sonora sucker	*Catostomus insignus*
Desert pupfish	*Cyprinodon macularius macularius*
Gila chub	*Gila intermedia*
Gila topminnow	*Poeciliopsis occidentalis occidentalis*
Invertebrates	
Arkenstone Cave pseudoscorpion	*Albiorix anopthalmus*
Talus snails	*Sonorella* spp.
Plants	
Pima pineapple cactus	*Coryphantha scheeri robustispina*
Gentry indigo bush	*Dalea tentaculoides*
Nichol's Turk's head cactus	*Echinocactus horizonthalonius var. nicholii*
Acuña cactus	*Echinomastus erectocentrus acuñensis*
Needle-spined pineapple cactus	*Echinomastus erectocentrus erectocentrus*
Huachuca water umbel	*Lilaeopsis schaffneriana recurvata*
Tumamoc globeberry	*Tumamoca macdougalii*

accounts were reviewed by Dr. R. Roy Johnson and Dr. G. Scott Mills. Some of the accounts were also reviewed by Ms. Mima Falk, U.S. Fish and Wildlife Service, and Ms. Tina Lee, SWCA.

Definition of Terms

Certain conventions and terms were used in the accounts that warrant explanation and clarification. Throughout the text, standard common names were given as the first identifier of the organism and used throughout the account for that species. Those common names were taken, wherever possible, from existing documents, generally the Arizona Game and Fish Department Species Abstracts, for those species for which such were available. Where no common names were available (e.g., Arkenstone Cave pseudoscorpion), a common name was invented.

The concept of threats was taken broadly as any factor or situation that appears likely to have an adverse impact on populations, individuals, or species survival. Usually this was based on existing literature. Where appropriate and available, specific evaluations of threats were included, or it was pointed out that there was a lack of documentation supporting conclusions on the severity of the alleged threats.

The term "overgrazing" is used here specifically to mean grazing of domestic livestock to the extent that it results in a downward trend of the rangeland plant community and alteration of that community from its natural condition.

The term "development" is used here specifically to mean conversion of vegetation and surface land cover by human means from a previously natural state to one with anthropogenic characteristics.

The term "depletion of groundwater" means extraction of groundwater in excess of natural recharge.

The term "non-native" means having its natural origin outside of the Sonoran Desert ecoregion and introduced to the area either by human agency or by natural expansion.

Where "global climate change" is said to be a threat to a species, it means that species appears to be likely to be especially sensitive to repercussions of global climate change.

The following acronyms were used in this report:

AGFD	Arizona Game and Fish Department
BISON-M	Biota Information System of New Mexico
CASA	Center of Applied Spatial Analysis
CITES	Convention on International Trade in Endangered Species
CNDDB	California Natural Diversity Data Base
EES	Earth and Environmental Science, Los Alamos National Laboratory
ESA	Endangered Species Act (federal)
ESIS	Endangered Species Information System (USFWS)
FWIE	Fish and Wildlife Information Exchange
HDMS	Heritage Data Management System
LCR MSCP	Lower Colorado River Multi-Species Conservation Plan
NGS	National Geographic Society
OPCNM	Organ Pipe Cactus National Monument
SDCP	Sonoran Desert Conservation Plan
STAT	Science Technical Advisory Team

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WBWG	Western Bats Working Group

Rankings Codes

Standard rankings codes originally developed by the Nature Conservancy were used for Global Rank and State Rank. These were taken from the Priority Ranking Definitions compiled by the Arizona Game and Fish Department Heritage Data Management System (AGFD 1998).

Grank Global Rank: priority ranking (1 to 5) based on the number of occurrences throughout the entire range of the element (species or subspecies)

G1	Very Rare: 1 to 5 occurrences or very few individuals or acres
G2	Rare: 6 to 20 occurrences or few individuals or acres
G3	Uncommon or Restricted: 21 to 100 occurrences, rather rare throughout a fairly wide range, or fairly common in a rather restricted range
G4	Apparently Secure: more than 100 occurrences, though it could be quite rare in some parts of its range
G5	Demonstrably Secure: more than 100 occurrences
G#T#	Subspecies: numeric designations based on same criteria as those for global ranks
G#?	Uncertain: insufficient information to give a definitive ranking. Confidence of numeric rank is plus or minus one rank.

Srank State Rank: priority ranking (1 to 5) based on the number of occurrences of an element within a state.

S1	Very Rare: 1 to 5 occurrences in the state or very few individuals or acres within the state.
S2	Rare: 6 to 20 occurrences in the state or few individuals or acres within the state.
S3	Uncommon or Restricted: 21 to 50 occurrences in the state, either rather rare throughout a fairly wide range or fairly common in a rather restricted range within the state.
S3S4	Fairly Common: 51 to 100 occurrences and found over a rather wide range within the state.
S4	Apparently Secure: more than 100 occurrences within the state, though it could be quite rare in some parts of the state.
S5	Demonstrably Secure: more than 100 occurrences within the state.

Mapping

Each species account includes a species range map and a map of species distribution in Pima County. These maps were compiled by RECON from various sources and represent the best available knowledge at this time. These maps will be revised as additional data becomes available as part of RECON's work program for the SDCP.

Species range maps were digitized on a map of North America using illustrations from multiple guide books including Stebbins 1985, MacMahon 1985, Page and Burr 1991, Burt 1952, Stebbins 1966, Whitaker 1980, Stokes and Stokes 1996, Peterson 1990, Minckley 1973, USFWS 1995, Sogge et al. 1997, Cartron and Finch 2000, Hoffmeister 1986, and Benson 1969. These maps are graphical representations of the known historical extent or potential occurrence of species and are included to give the reader an understanding of how narrowly or broadly the species is distributed.

Maps of species' known locations and potential habitat in Pima County were also compiled from several sources. The primary source of known location data is the Arizona Game & Fish Heritage Data Management System (HDMS). Point locations of species occurrence were converted from the HDMS spreadsheet into a geographic information system (GIS) based on latitude and longitude fields. Other known location data were compiled by SWCA based on several sources including Muchmore and Pape (1999) for pseudoscorpion locations; Colossal Cave Mountain Park web site (http://www.colossalcave.com/bats.html) (Yeatts n.d.) for pale Townsend's big-eared bat, Mexican long-tongued bat, lesser long-nosed bat, and southern yellow bat; Organ Pipe Cactus National Monument report (NPS 1995) for California leaf-nosed bat, Bell's vireo, and Acuña cactus; Baequaert and Miller (1973) for talus snails; and Hoffmeister (1986) for Merriam's mouse.

Potential habitat is included on the Pima County maps for species where Gap Analysis Program (GAP) mapping exists. As part of the Arizona GAP program, administered by the USGS Biological Resources Division (BRD) and housed within the Advanced Resources Technology Program (ART) in the School of Renewable Natural Resources at the University of Arizona, selected species distributions were mapped for the state based on habitat and known locations. These maps, which depict high-, medium-, and low-value habitat for species, are based on GAP vegetation, which contains significant errors. However, the GAP habitat model also includes tens of thousands of known locations from museum records and other sources. The resulting maps were reviewed by species experts and are thought to be a good representation of statewide species distributions (Kunzmann, pers. comm. 2000). A published report describing and assessing GAP species distribution maps is expected in December 2000. Species' known location data, upon which GAP modeling is based, could be very valuable for county-wide species modeling but probably will not become available this year (Kunzmann, pers. comm. 2000). Where GAP mapping is not available, known location data is shown together with vegetation biomes and land cover. For some species, there is a correlation between vegetation and/or hydrologic, geologic, and other features that appear in this land cover map. These correlations will be further explored in the species analysis report.

Maps on section dividers show the number of priority vulnerable species known or potentially occurring in each subarea. These maps are based on species' known locations and habitat potential and are meant to represent potential priority vulnerable species issues by subarea. Appendix A includes a brief discussion of species assignments to subareas together with lists of species per subarea which provided the basis for mapping.

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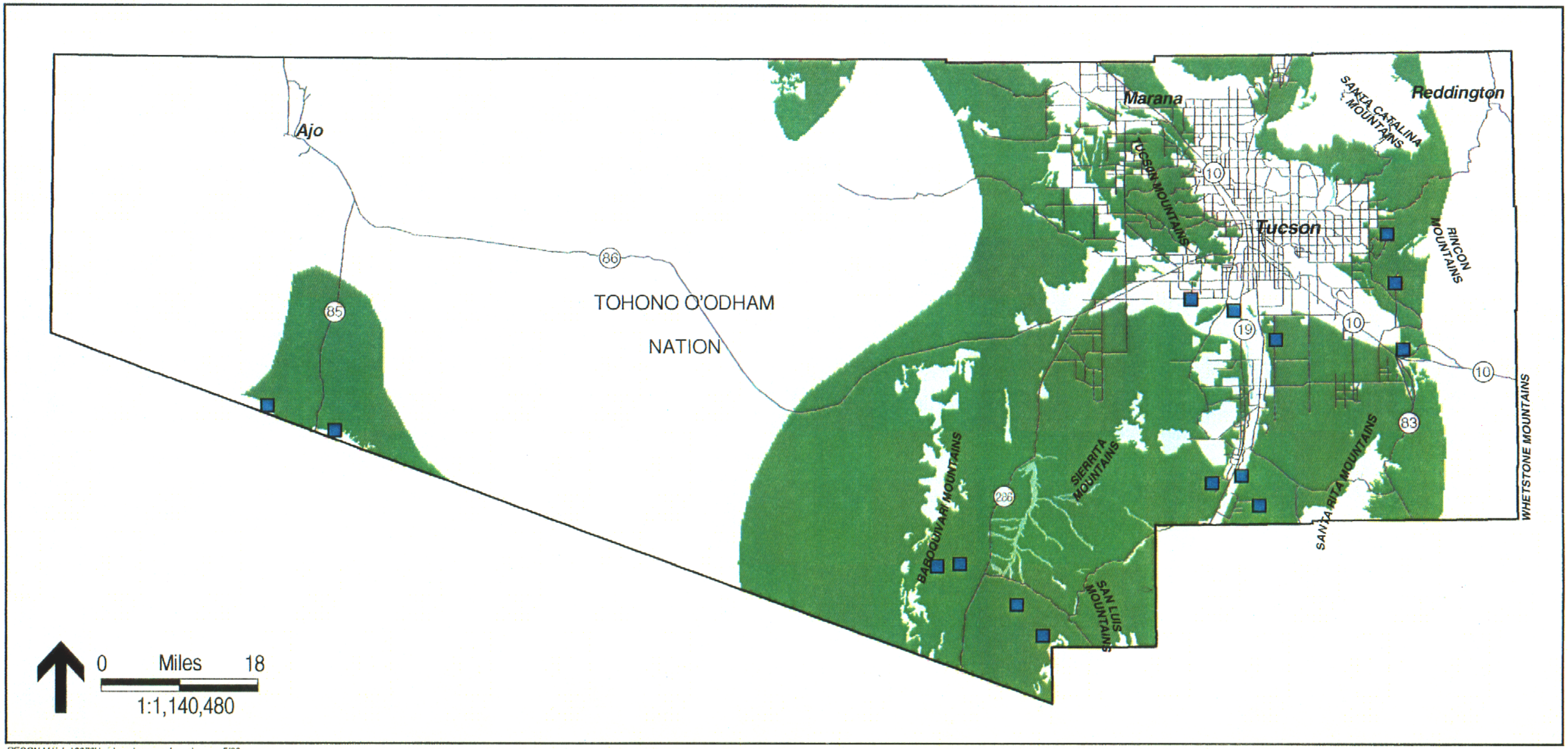

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Merriam's Mouse
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(SWCA, 2000)
Merriam's Mouse
(Peromyscus merriami)

Potential Habitat
(GAP, 1994)
Low Value
Medium Value

Figure 7

Mexican long-tongued bat (*Choeronycteris mexicana*)

Status

Federal	Species of Concern (former Category 2 candidate for federal listing) (AGFD 1998)
State	Wildlife of Special Concern in Arizona (AGFD 1998); this species is on the Arizona Game and Fish Department's 1988 list of *Threatened Native Wildlife in Arizona* as a threatened species (AGFD 1988)
Other	California Natural Diversity Database (California Species of Special Concern); Nevada Natural Heritage Program: SA (accidental); Forest Service Sensitive; Mexico Rara (determined Rare in Mexico). The Western Bat Working Group (1999) rates this species as "Red or High" in this area. "Based on available information on distribution, status, ecology, and known threats, this designation should result in these species being considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment" (Western Bat Working Group 1999).
Rankings	G2 S1

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: *Choeronycteris* is 1 of 3 genera in Phyllostomidae in Arizona. *C. mexicana* is the only species whose range extends as far north as Arizona (AGFD 1997).

Classification: Order: Chiroptera; Family: Phyllostomidae, Genus: *Choeronycteris*, Species: *mexicana*.

Life History

Description: The Mexican long-tongued bat has a long and slender nose, with a leaf-like structure that is broad at the base, pointed at tip, and about 0.2 in. (5.0 mm) high. The forearm is 1.68-1.92 inches (42.0-48.0 mm) long, and the hind foot is 0.44-0.56 in. (11.0-14.0 mm) long. The tail approximately 1/3 inch (10 mm) in length, about 1/3 the length of the interfemoral membrane. Dorsal pelage varies from buffy brown to dark grayish brown, palest on shoulders; the venter is paler, and the short ears are pale brownish gray. The tongue is long and extendable. The upper incisors are small, and do not fill the space between the canines. There are no permanent lower incisors, but 1 to 4 deciduous teeth may persist in adults (AGFD 1997).

Diet: Specific food habits for this species throughout its range are not well known (BISON-M). This species feeds on nectar, pollen, and probably some insects found in flowers. In Pima County and elsewhere, paniculate agaves are the primary food source. Occasionally long-tongued bats may feed on the fruit and flowers of columnar cacti, but these bats are not typically found in low desert environments. The bristle-like tongue and lack of lower incisors of *C. mexicana* facilitate feeding on flower nectar and pollen. This species has also been reported to feed at hummingbird feeders (AGFD 1997) as an alternate food source prior to and following the primary agave flowering season. Whereas the range of *C. mexicana* and *Leptonycteris sanborni* may overlap according to Hevly (1979), Hoffmeister (1986) speculated that *C. mexicana* may be able to utilize nectar that *L. sanborni* cannot reach because of their longer tongues; this allows the Mexican long-tongued bat to feed on a wider range of night-blooming plants (Hoffmeister 1986).

Reproduction: Female members of this species separate themselves from the males, with only the adult females migrating north into the United States from Mexico (AGFD 1997). Males stay "in the southern part of the range during the time that young are being nourished by the mothers in the north" (AGFD 1997). Young are then born between mid to late June and early July, growing rapidly and accomplishing flight within approximately 2 to 3 weeks. Once fledging occurs, Mexican long-tongued bats begin to circulate opportunistically in pursuit of suitable forage (AGFD 1997).

Behavior: This species roosts in caves and mines, usually singly or in small groups. It is less gregarious than other colonial bat species. Instead of clumping together in roosts, they hang approximately 2.0-5.0 cm (0.8-2.0 in.) apart, commonly by 1 foot so they can turn 360 degrees to observe any intruders. This species has been found in mine tunnels, caves, rock fissures, and rarely, buildings. Population groups of this migratory species contain approximately 15 individuals or less. In winter, *C. mexicana* resides in Mexico; it does not hibernate. Females of the species spend the summer at the northern extreme of its range, in southern Arizona, where they exist in sexually segregated and nursery colonies (AGFD 1997). Juveniles of both species wander widely after they leave the maternity roost (LCR MSCP 1999).

Distribution

Historic: This species is known from Venezuela northward through Central America and Mexico to southeastern Arizona, southwestern New Mexico, and San Diego, California (Barbour and Davis 1969). There is 1 photographic record from Texas (Arroyo-Cabrales et al. 1987). The range map in Arroyo-Cabrales shows the distribution of this species in a continuous band across southern Arizona and southern California, but that is not supported by distribution records. There are no records for this species from California counties along the Colorado River (CNDDB 1999; LCR MSCP 2000). There are no published records of this species from Arizona west of the Baboquivari Mountains (AGFD 1997a); however, there is 1 recent record of a nectarivorous bat that may be this species from Planet Ranch on the Bill Williams River (Brown 1996), and 1 from Phantom Ranch in Grand Canyon National Park (T. Snow, AGFD, pers. comm., cited in LCR MSCP 1999). There is 1 record of this species from Las Vegas, Nevada (Constantine 1987). This is a migratory bat that reaches the northern limits of its normal distribution just north of the international border. Only adult females migrate into the United States, but juvenile bats of both sexes wander widely after they leave the maternity roost (AGFD 1997a). Cockrum et al. (1996) speculated that this species would eventually be recorded from Mohave County, Arizona.

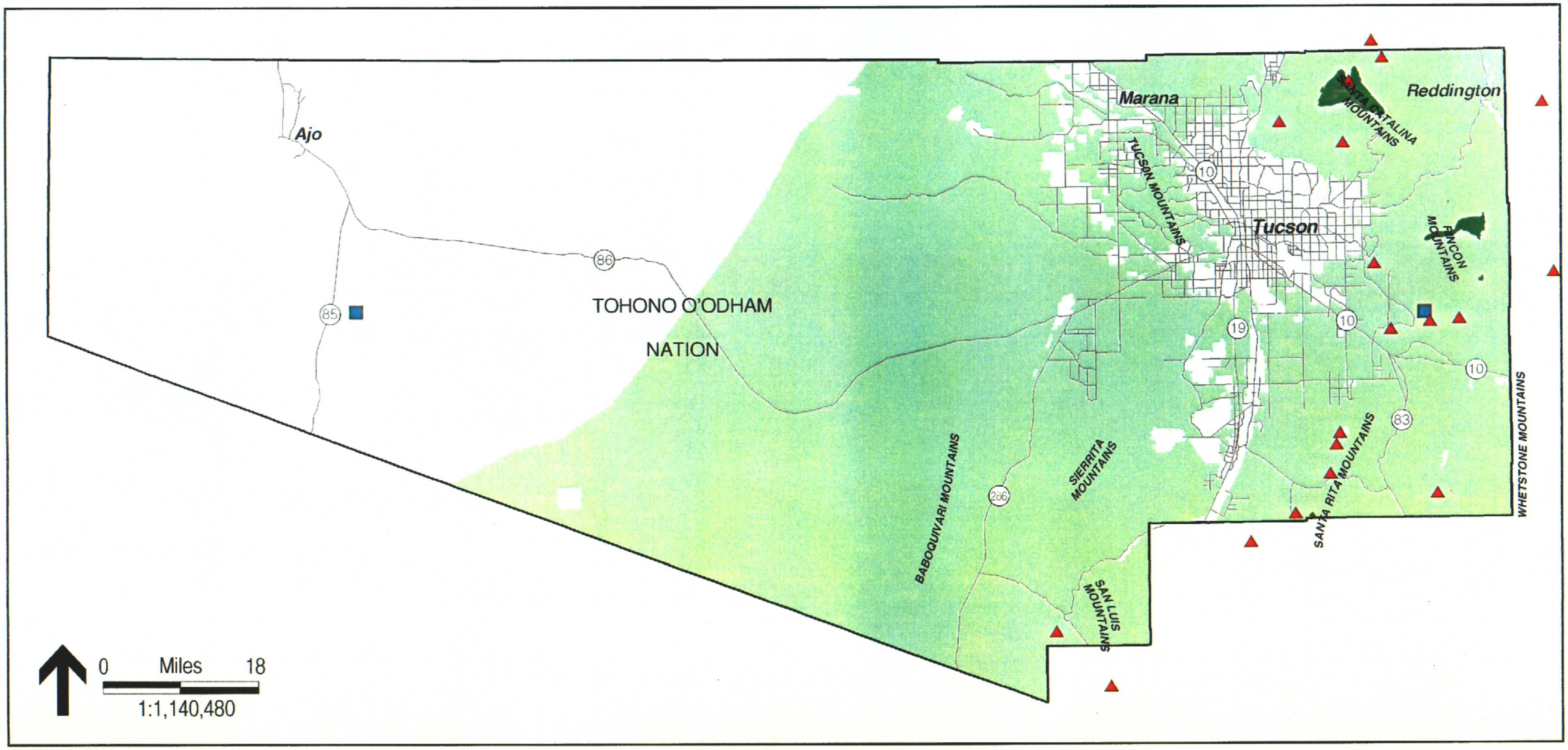
Present: In Arizona, the species is known to occur in the canyons of mixed oak-conifer forests in mountains rising from the desert (AGFD 1997). In Pima County, potential habitat and known locations occur in the eastern one-half of the county (Figure 1).

Pima County records are summarized in the following table:

Records of Mexican Long-tongued Bat from Pima County

Date	Location	USGS Quad	Township	Ownership
07/14/91	Long Shot Mine: San Luis Mountains	Arivaca 7.5'	T22S, R10E	USFS Coronado NF Nogales Ranger District
Pre-1986	Santa Catalina Mountains	Campo Bonito 7.5'	T11S, R16E	State Land Department
05/24/58	Santa Rita Mountains	Helvetia 7.5'	T18S, R15E	Private
Pre-1986	Box Canyon: Santa Rita Mountains	Helvetia 7.5'	T19S, R15E	State Land Department
06/15/95	Peach Knob: Santa Rita Mountains	Helvetia 7.5'	T18S, R15E	BLM
Pre-1986	Mouth of Madera Canyon: Santa Rita Mountains	Mt. Hopkins 7.5'	T19S, R14E	USFS Coronado NF Nogales Ranger District
Pre-1986	Reef of Rock Vicinity: Santa Catalina Mountains	Mt. Lemmon 7.5'	T11S, R15E	USFS Coronado NF Santa Catalina Ranger Dist.
Pre-1960	Head of Alamo Canyon: Santa Catalina Mountains	Oro Valley 7.5'	T12S, R14E	USFS Coronado NF Santa Catalina Ranger Dist.
08/26/95	Distillery Canyon: South Rincon Mountains	Rincon Peak 7.5'	T16S, R18E	USFS Coronado NF Santa Catalina Ranger Dist.
09/27/95	South of Posta Quemada: North of Aqua Verde Creek: South of Rincon Mountains	Rincon Peak 7.5'	T16S, R17E	Private
09/20/20	Sabino Canyon: Santa Catalina Mountains	Sabino Canyon 7.5'	T12S, R15E	USFS Coronado NF Santa Catalina Ranger Dist.
08/24/96	Cienega Creek: South Empire Mountains: East of Santa Rita Mountains	Spring Water Canyon 7.5'	T19S, R17E	BLM
Pre-1986	Box Canyon: Rincon Mountains	Tanque Verde Peak 7.5'	T15S, R16E	Saguaro National Park West
09/02/95	Pantano Wash: Southwest of Pistol Hill: Rincon Valley	Vail 7.5'	T16S, R16E	Private

SOURCE: AGFD 2000.



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Mexican Long-tongued Bat
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(SWCA, 2000)
Mexican Long-tongued Bat
(Choeronycteris mexicana)

Known Locations
(HDMS, 2000)
Mexican Long-tongued Bat
(Choeronycteris mexicana)

Potential Habitat
(GAP, 1994)
Low Value
High Value

Figure 1

This species is known to roost at Colossal Cave Mountain Park, which has the largest number of known maternity roosts for this species (Yeats n.d.). It was not found in the Rincon Mountains, but its presence is expected (Davis and Sidner 1992). It has been recently found at Organ Pipe Cactus National Monument, following many years of bat netting and surveys of potentially suitable roost sites (Organ Pipe Cactus National Monument 1999).

Demographics

Density: No known information is currently available regarding density of natural populations. Populations fluctuate as this species is only a summer resident of Arizona (AGFD 1997).

Status: Numbers for this species are said to be declining (AGFD 1996).

Trend: While the biology and population status remain poorly understood, numbers are clearly declining for this species (AGFD 1996) and roost disturbance by human activity appears to be an important factor. Agave harvests in Mexico may also affect *C. mexicana*, as the nectar and pollen of agave and saguaro flowers comprise a major portion of their diet (AGFD 1988).

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations.

Age ratios: No known information is currently available regarding age ratios in natural populations.

Sex ratios: No known information is currently available regarding sex ratios in natural populations. Adult males are not known from Arizona, because only the females migrate this far north. Juvenile males born here remain in Mexico after they migrate southward.

Significant Pima Co. populations: Too little is currently known about the distribution of this species in Pima County to determine whether any populations should be considered significant.

Habitat Requirements

Ability to use major land use categories: The Mexican long-tongued bat is known from the canyons of mixed oak-conifer forests in mountain ranges surrounded by desert (AGFD 1997). It requires caves or inactive mines or unoccupied buildings to use as both day and night roosts.

Habitat trends in planning area: This species is extremely sensitive to disturbance at roost sites, and may abandon roosts if disturbed, the females taking babies with them (Arroyo-Cabrales et al. 1987). Caves and inactive mines are popular areas for exploration by people, and disturbance by people can drive these bats from the roosts upon which they depend. Undisturbed roosts are becoming less common (K. Kingsley, pers. obs.).

Long-tongued bats feed on nectar and pollen, also probably ingesting insects found in the flowers. Food plants include paniculate agaves and occasionally columnar cacti, and the total number of these is declining as a result of human activities. The impact of this has not been determined, but it is evident that nectarivorous bats are not food-limited in this area, and there are abundant food resources that are not tapped by them, possibly because there are insufficient suitable roosts.

Nectarivorous bats have also been observed feeding at hummingbird feeders on the edges of urban Tucson (AGFD 1997; K. J. Kingsley, pers. obs.). The value of this novel resource has not been determined.

Home range requirements: This species migrates seasonally. It summers in the southwestern United States. When in Arizona, *C. mexicana* is found in mine tunnels, caves, rock fissures, and rarely from buildings, at elevations ranging from 4,000 to 6,000 feet from the lower extreme of the oak zone through the pine-oak woodland to the pine-fir belt (Hoffmeister 1986; Noel and Johnson 1993; AGFD 1997). Individuals of this species have also been observed in saguaro-paloverde desert scrub (Noel and Johnson 1993). Therefore, the home range requirements include at least one suitable day and night roost that is available and undisturbed during the summer, and access to suitable food plants.

Current and Potential Threats

General: Populations in Arizona appear to be highly variable (AGFD 1997). There is no evidence of a long-term decline or any clear trend. More potential roosts sites are available now than before mining occurred in the mountain ranges occupied by this species. Disturbance of roosts is a potential threat to individuals and local populations, but because this species is not concentrated in only a few roosts, it is unlikely that this disturbance would ever be significant enough to threaten the species (LCR MSCP 1999).

Pima County location, amount, and quality of protected habitat: Of the known records of this species from Pima County, 6 records are from Coronado National Forest land, 2 are from BLM land, 2 are from state lands, 1 is from Saguaro National Park, and 3 are from private land.

Existing and potential pest species: There are no known records of existing or potential harm to the Mexican long-tongued bat by predators or introduced pest species.

Threat mechanism: Current threats to this species include roost disturbance by humans and loss of forage plants (agave and saguaro flower nectar and pollen) (AGFD 1988).

Management Needs

General: Restrict human disturbances to roosts. In addition, studies to determine food habits, range, population densities, and migration and roosting patterns will augment current understanding of this species. Within the species' normal range, survey for and protection of roosts may be appropriate.

Current protective measures: None have been identified that would be likely to apply to this species in this area. Some caves and mines within this species range have been gated to keep out people but allow bats to enter, and this has met with mixed success (K. J. Kingsley, pers. obs.).

Sensitivity to human activities and densities: Mexican long-tongued bats, roosting primarily in the dimly lit entrances to caves, abandoned mine shafts, and even rock shelters, will readily fly into bright sunlight when disturbed (Hoffmeister 1986; AGFD 1997; K. J. Kingsley, pers. obs). Agave harvests in Mexico may also be adversely impacting this species, as it is believed to heavily utilize the nectar of agave and saguaro flowers as food source (AGFD 1988).

Corridor needs: Because Mexican long-tongued bats migrate seasonally between the southwestern United States and central Mexico is it assumed that they utilize migration corridors, and that some quality of the corridor is necessary for this species, but there is no specific information known that supports conclusions regarding corridor needs.

Key relationships: The Mexican long-tongued bat is found in the canyons of mixed oak-conifer forests, at elevations ranging from 4,000 to 6,000 feet, in mountain ranges surrounded by desert (AGFD 1997).

Migratory requirements: Specific migratory requirements are not known. It is presumed that food and shelter along the migration route are necessary.

Results of past mitigation activities: Gating roosts to keep out people has apparently met with mixed results, depending on gate design and other factors. Data on results of mitigation activities for this species are not known.

Existing monitoring and research programs: The Coronado National Forest requires bat surveys of mines that are likely to be disturbed by construction activities. An informal monitoring program has been conducted at Colossal Cave Mountain Park (Yeats n.d.).

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Allen's big-eared bat (*Idionycteris phyllotis*)

Status

Federal	Federal Species of Concern (former Category 2 candidate for federal listing) (AGFD 1998)
State	None
Other	California Natural Diversity Database (Global rank: G4, state rank: S2S3); California Species of Special Concern; Nevada Natural Heritage Program (Global rank: G4, state rank: SH); BLM Nevada Special Status Species. The Western Bat Working Group (1999) rates this species as "Red or High" in this area. "Based on available information on distribution, status, ecology, and known threats, this designation should result in these species being considered the highest priority for funding, planning, and conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment" (Western Bat Working Group 2000).
Rankings	G4 S2, S3

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated goals for this species.

Pima County Habitat Conservation Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: In Arizona, this species is monotypic; until recently, there have been too few specimens available to analyze for variation within the species (Hoffmeister 1986).

Classification: Order: Chiroptera; Family: Vespertilionidae; Genus: *Idionycteris;* Species: *phyllotis*.

Specific: *I. phyllotis* is also known by the following names: Allen's Lappet-browed bat, Mexican big-eared bat, *Corynorhinus phyllotis*, *Idionycteris mexicanus*, and *Plecotus phyllotis* (Hoffmeister 1986; AGFD 1997). In this document, this species will be referred to as Allen's big-eared bat, *Idionycteris phyllotis* (Jones et al. 1997).

Life History

Description: This average size for this species is 2 to 2.5 inches (5 to 6 cm) in length, with a wingspan ranging from 12 to 14 inches (30 to 35 cm). The coloration is tawny above with hairs dark at the base, and slightly lighter underparts. There is no fur on wings or tail membranes. Ears are large, 1.5 inch (40 mm) long, with 2 fleshy lobes, called lappets, projecting forward from base of ears. The ears are often protected by folding and coiling them into "rams' horns" which lay along the sides of the bat's neck. There are no glandular enlargements on muzzle, as in the closely related Townsend's big-eared bat (Noel and Johnson 1993; AGFD 1997).

Diet: This species has a fragile skull and jaw that suggests that it forages primarily on soft-bodied insects. Diet studies have determined that this species is primarily insectivorous; their main food includes small moths (Microlepidoptera, 6-12 mm in size), soldier beetles (Cantharidae), dung beetles (Scarabeidae), leaf beetles (Chrysomelidae), roaches (Blattidae), and flying ants (Formicidae). Food is gleaned from surfaces or pursued and seized in flight (AGFD 1997).

Reproduction: Little is known about reproduction in this species. In Arizona, females form maternity colonies in early summer with males possibly roosting solitary at this time. Young are born in mid to late June; they begin to fledge by the end of July. In Arizona, maternity roosts are known from the Kingman area and in the vicinity of Aravaipa Canyon (north end of the Galiuro Mountains) (AGFD 1997).

Behavior: *I. phyllotis* is an agile species, capable of highly maneuverable flights; able to hover and fly vertically, their movement is characterized by "swift, direct, flights from one place to another, interspersed with slower flights and occasional near hoverings, as if the bat were carefully seeking an exit" (Barbour and Davis 1969).

Roosts of this species are frequently associated with those of *Plecotus townsendii*, *Myotis californicus*, and *Myotis thysanodes*. *I. phyllotis* roosts in trees on the Coconino and Apache-Sitgreaves National Forests in northern Arizona (AGFD 1997), and in mines elsewhere. There is no information currently available on male or winter roosts although there a record of 1 individual observed in February 1992, in an adit in the vicinity of Union Pass, near Kingman (AGFD 1997). This species is known to roost in mines, in loose association with other bats (Hoffmeister 1986).

Distribution

Historic: There are no records of this species from Arizona before 1955 (Hoffmeister 1986). Allen's big-eared bats are known to range from the Colorado River Valley of Arizona to New Mexico and the central highlands of Mexico (from the Districto Federal, San Luis Potosi, Tamaulipas and Durango northward). Within the Arizona, this species is best known to occur at the higher elevations along the Mogollon Rim and adjacent mountain ranges. *I. phyllotis* is not known to inhabit the southwestern deserts of Arizona, but is known from north, east, south, and west of the deserts, and there are numerous records from mine tunnels in low desert areas of Mohave County (Hoffmeister 1986; AGFD 1997).

Present: In Arizona, most specimens for this species have been collected from the southern Colorado Plateau, the Mogollon Rim, and adjacent mountain ranges (AGFD 1997). Records of occurrence exist in the following counties: Mohave, Coconino, Yavapai, Gila, Graham, and Cochise

(Hoffmeister 1986). It is not yet known from Pima County (Figure 2), but *I. phyllotis* has been included as a hypothetically occurring but unverified species at Colossal Cave Mountain Park (Yeatts n.d.) and in the Rincon Mountains of Saguaro National Park (Davis and Sidner 1992). It is included in the SDCP because of the possibility that it may be found in Pima County, and because it is on the red list of the WBWG. A likely place to look for this species would be the San Pedro River and mine tunnels along the river side of the Catalina Mountains in northeastern Pima County (Planning Area 1).

Demographics

Density: No known information is currently available regarding density of natural populations.

Status: The population status of Allen's big-eared bat is not clearly known (AGFD 1997). The species may have only recently expanded into the Arizona deserts, based on a lack of records prior to 1955 (Hoffmeister 1986).

Trend: Populations trends are not known.

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations.

Age ratios: No known information is currently available regarding age ratios in natural populations.

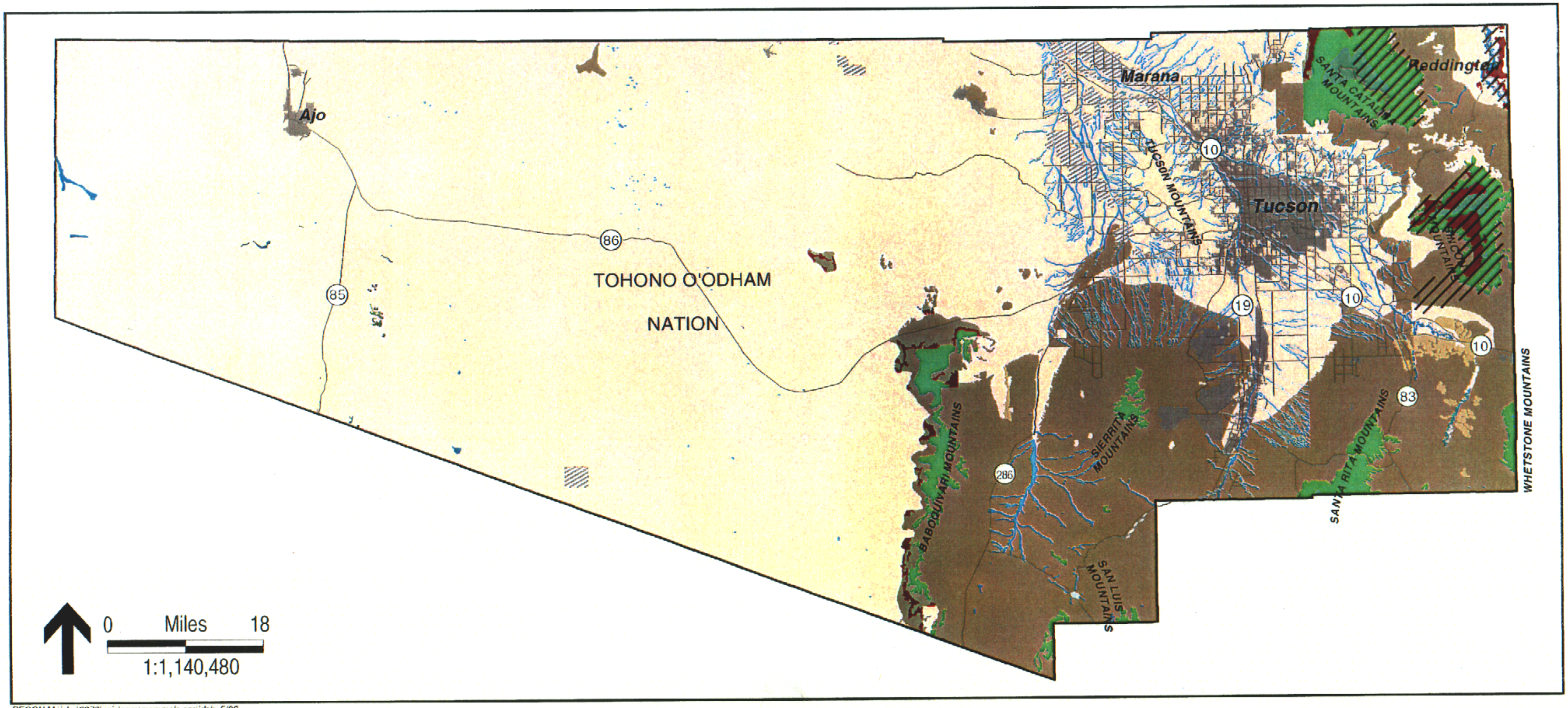
Significant Pima Co. populations or subpopulation basis in planning area: Allen's big-eared bat is not currently known to exist in Pima County although its presence is expected.

Habitat Requirements

Ability to use major land use categories: This species is known from ponderosa pine, pinyon-juniper, and riparian woodlands, as well as desert scrub. This species roosts in mine tunnels. Collection of this species most often occurs in areas near boulder piles, cliffs, rocky outcroppings, or lava flows (AGFD 1997a), and roosting probably occurs near such features (Czaplewski 1983). This species is also often netted along streams or over ponds where they may have been seeking insects, water, or both. The occurrence of these bats along streams or water sources dominated by mesquite, whitethorn (*Acacia constricta*), or agave (*Agave* spp.) may represent only the utilization of drinking water rather than preferred habitat (Hoffmeister 1986). Females are known to form maternity colonies in mine tunnels located in the low desert mountain ranges in Mohave County, Arizona (Hoffmeister 1986, LCR MSCP 1999).

Habitat trends in planning area: This species is easily disturbed at roost sites; disruption by humans can cause roost abandonment (AGFD 1997). There are numerous potential roost sites (inactive mines) that have not been adequately or recently examined, but are subject to natural collapse and also disturbance by recreationists.

Home range requirements: No information is currently known regarding seasonal migration patterns and winter roost locations (AGFD 1997). In Arizona, this species is known to roost in abandoned



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Allen's big-eared Bat
Potential Habitat and Vegetation Biomes

Potential Habitat
(based on assessment for this study)

Allen's big-eared Bat
(Idionycteris phyllotis)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 2

mine shafts, most often in ponderosa pine, pinyon juniper Mexican woodland, and riparian areas of sycamores, cottonwoods and willows; whereas the elevation range for this species spans from 2,600 feet to 9,800 feet, most individuals of the species occur between 3,500 and 7,500 feet (AGFD 1997). This species is known to be dependent on available water.

Current and Potential Threats

General: Many bat species are declining as a result of the loss of roosting and foraging habitat to urban expansion, agricultural development, and other factors. The availability of accessible surface water, suitable maternity roost sites, and food resources are limiting factors that could potentially threaten the overall health of populations of this and other bat species. Maternity colonies of this species are easily disturbed, often resulting in abandonment (AGFD 1997; LCR MSCP 1999).

Pima County location, amount, and quality of protected habitat: This species is currently not known from Pima County.

Existing and potential pest species: There are no known records of existing or potential harm to Allen's big-eared bat by predators or introduced pest species.

Threat mechanism: The only current threat to this species is considered to be roost disturbance by humans.

Management Needs

General: Protection of roost sites from disruptive human access is probably the only management need for this species. In addition, survey for roosts is a necessary component of protection.

Current protective measures: There are no agency-mandated recovery goals for the Allen's big-eared bat.

Sensitivity to human activities and densities: Allen's big-eared bat is sensitive to roost disturbance by humans.

Corridor needs: No information is known to exist on this species need for corridors.

Key relationships: *I. phyllotis* is found in ponderosa pine, pinyon-juniper, Mexican woodland and riparian locales with sycamores, cottonwoods, and willows at elevations ranging from 2,600 feet to 9,800 feet. It has been found in loose association with other species of mine-roosting bats, probably because they are all selecting the same roost characteristics (Hoffmeister 1986).

Migratory requirements: There are no known migratory requirements currently known for this species (AGFD 1997).

Results of past mitigation activities: No information is currently known to be available regarding results of past mitigation activities for this species.

Existing monitoring and research programs: No information is currently known to be available regarding existing monitoring and research programs for this species.

References

Arizona Game and Fish Department (AGFD). 1996a. Wildlife of special concern in Arizona. Public review draft. Phoenix, Arizona.

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Barbour, R. W., and W. H. Davis. 1969. Bats of America. University of Kentucky Press, Lexington, Kentucky.

Davis, R., and R. Sidner. 1992. Mammals of woodland and forest habitats in the Rincon Mountains of Saguaro National Monument, Arizona. Technical Report NPS/WRUA/NRTR-92/06 (CPSU/UA No. 47). National Park Service Cooperative National Park Resources Studies Unit, School of Renewable Natural Resources, University of Arizona.

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

Lower Colorado River Multi-Species Conservation Plan (LCR MSCP). 1999. Allen's big-eared bat (*Idionycteris phyllotis*). Species account. Obtained from http://www.lcrmscp.org/files.html.

Noel, D., and T. B. Johnson. 1993. Bats of Arizona. Special Heritage Edition of Arizona Wildlife Views, August. Arizona Game and Fish Department, Phoenix, Arizona.

Western Bat Working Group. 1999. Regional Priority Matrix. Obtained from www.batworkinggoups.org/wmatrix1.htm.

Yeatts, J. n.d. The abundant wildlife: bats. Colossal Cave Mountain Park web site: http://www.colossalcave.com/bats.html.

Western red bat (*Lasiurus blossevillii*)

Status

Federal	None
State	Wildlife Species of Special Concern in Arizona (AGFD 1996a, 1996b)
Other	Forest Service Sensitive (Region 3 and 5); Red or High Priority Species by Western Bat Working Group; Vulnerable Status 2 by SDCP
Rankings	G5 S2

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The western red bat was previously considered to be 1 of 4 subspecies of the widely distributed North American bat *Lasiurus borealis*. Currently it is considered a separate species. *Lasiurus blossevillii* (originally *L. b. teliotis*) is the only species of red bat that occurs in Arizona.

Classification: Order: Chiroptera; Family: Vespertilionidae; Genus: *Lasiurus;* Species: *blossevillii.*

Specific: *Lasiurus blossevillii* was originally known as *Lasiurus borealis teliotis.* In 1981, the genus *Nycteris* was used instead of *Lasiurus* by some scientists (Hall 1981). Currently, this species is recognized as *Lasiurus blossevillii* (Jones et al. 1997).

In this document, this species will be referred to as *Lasiurus blossevillii* or, in the case where earlier literature is cited, *Lasiurus borealis teliotis.*

Life History

Description: The western red bat is a medium-sized bat, forearm 1.5 to 1.7 inches (38 to 43 mm) long, weight 0.25 to 0.5 ounce (7 to 15 g); wings long, narrow and pointed, wingspan 11 to 13 inches (290-332 mm), ears short and rounded, 0.3 to 0.5 inches (11-13 mm) in length; interfemoral membrane (uropatagium) completely furred on the dorsal surface. Color ranges from bright orange to yellow-brown with white-tipped hairs; whitish patches near the shoulder; wing membranes black. Males are usually more brightly colored than females (AGFD 1996a).

Diet: This species is an insectivorous bat. Known forage includes moths, flies, bugs, beetles, cicadas, ground dwelling crickets, and hymenopterans (AGFD 1996a; Shump and Shump 1982).

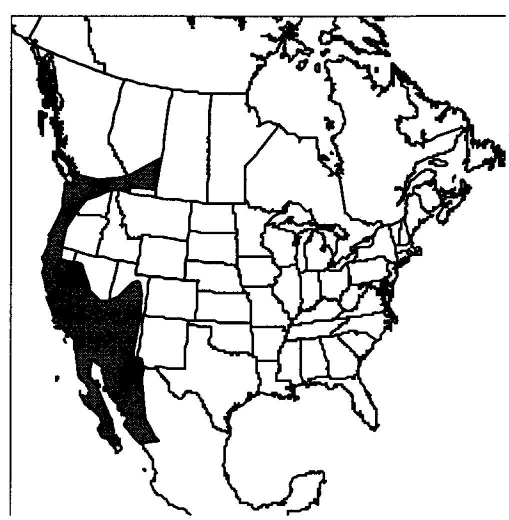
Reproduction: Mating occurs in August and October. Females store sperm until spring when fertilization occurs. Gestation, lasting approximately 60-70 days, yields a litter of 1 to 5 young from late May to mid-June. The average litter size is 2.3; this is higher than any other bat species. Lactation ensues for approximately 5 to 6 weeks, and young fledge between their third and fourth weeks (AGFD 1996a).

Behavior: Whereas the western red bat usually roosts alone, it migrates in groups and forages in close association with others. Males and females migrate at different times and occupy dissimilar summer ranges. The migratory and winter status of this species in Arizona is unknown (AGFD 1996a). Western red bats are believed to migrate altitudinally in the southern portion of their range (AGFD 1996a). They relocate to the southern portion of the range and/or hibernate in winter, occasionally emerging to feed on warm days (air temperatures 55-65 degrees Fahrenheit) (AGFD 1996a). This species responds to sub-freezing temperatures by raising metabolism to maintain body temperature above the critical low limit of –5 degrees Fahrenheit. The interfemoral membrane is wrapped over the body to provide 15% additional insulation.

This species is known to use thick foliage of trees or shrubs for day roosts. Roost sites range from a few feet to more than 40 feet high, with heavy shade above and open below to allow the bat to drop easily into flight (AGFD 1996a).

This species begins foraging activity 1 to 2 hours after dark and may forage well into the morning. Hunting may occur 600 to 1,000 yards from the roost site. The flight pattern associated with foraging behavior commences with slow, fluttering, erratic flight high in the air. Within 15 to 30 minutes, the individual may begin flying in straight lines or wide circles over the same ground between tree top level and a few feet above the ground (AGFD 1996a).

Distribution



Historic: Because of historic taxonomic confusion and possible overlapping ranges of the species of red bats, the exact extent of the historic range of this species is not clear. The total range of western red bat extends from extreme southern Canada through the United States east and west of the Great Plains south to Panama and South America. It is a summer resident in the southwestern United States. It is apparently only a summer resident in the southwestern United States (Barbour and Davis 1969; Shump and Shump 1982; AGFD 1996b). There are only 61 known records from Arizona, all between May 30 and September 30 (AGFD 1996b). There are apparently no known records of this species from the Lower Colorado River valley (Hoffmeister 1986; LCR MSCP 2000). The western red bat winters northward to Sonora and coastal California (Findley et al. 1975).

Present: In Arizona, the species is known to occur along riparian corridors with oaks, sycamores, and cottonwoods in the central and southeastern regions of the state (Figure 3).

Pima County records of the western red bat are summarized in the following table:

Date	Location	USGS Quad	Township	Ownership	Data Source

Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.

There are no Pima County records of the species in Hoffmeister (1986). It has not been found at Saguaro National Park, but its presence is expected (Davis and Sidner 1992).

Demographics

Density: No known information is currently available regarding density of natural populations. Populations fluctuate as this species is only a summer resident of Arizona.

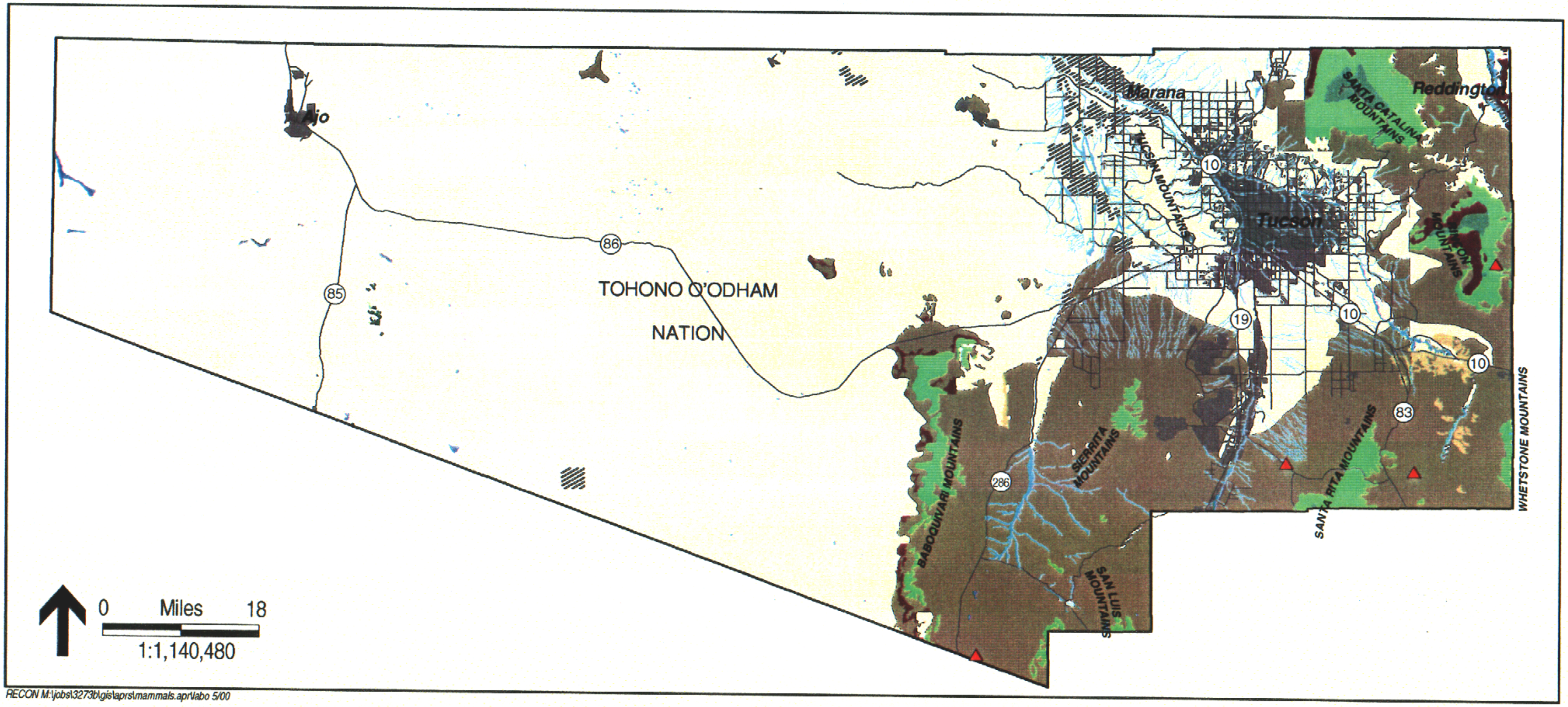
Status: The Western Bat Working Group (1999) considers this species a "Red or High" priority species, meaning that "Based on available information on distribution, status, ecology, and known threats, this designation should result in these species being considered for funding, planning, and conservation actions. Information about status, and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment."

Trend: Population trends are not currently known but appear stable (AGFD 1996b).

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations.

Age ratios: No known information is currently available regarding age ratios in natural populations.



Western Red Bat
Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)
- ▲ Western Red Bat (*Lasiuris blossevillii*)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 3

Significant Pima Co. populations or subpopulation basis in planning area: Too little is currently known about the distribution of this species in Pima County to determine whether any populations should be considered significant.

Habitat Requirements

Ability to use major land use categories: The western red bat is only known from broadleaf riparian deciduous forests and woodlands.

Habitat trends in planning area: The western red bat has been found to occur in walnuts, sycamores, and cottonwoods along central and southeastern riparian corridors at elevations ranging from 2,400 to 7,200 feet. This species roosts either independently or in limited family groups (including female and progeny) in thick foliage. Known roost sites include cottonwood trees (Chung-MacCoubrey 1999), several other tree species (Shump and Shump 1982), leafy shrubs and herbs (AGFD 1996c; Shump and Shump 1982). Roosting also may occur in saguaro cavities and in cave-like environments (AGFD 1996a), although this species rarely is recorded from caves and buildings. Additionally, the species has been found in the trees of fruit orchids (AGFD 1996a).

Home range requirements: This species seasonally migrates and summers in the southwestern United States. When in this area, it is only known from riparian areas. Size of home range and resources upon which this species depends are not known, beyond its requirement for suitable roost substrates and drinking water.

Current and Potential Threats

General: Current threats to this species are based on habitat loss and degradation of riparian areas and other broadleaf deciduous forests and woodlands (AGFD 1996a, 1996b; LCR MSCP 2000).

Pima County populations location, amount, and quality of protected habitat: Of the known records of this species from Pima County, 1 record is from state lands, 1 from BLM land, 2 from Coronado National Forest land, 1 from private land, and 1 is from Colossal Cave County Park. It is not known what portion of the population is represented by these records. It is assumed that the species is present in low numbers and in restricted areas (riparian deciduous forests and woodlands), but large areas of this habitat type in Pima County have not been adequately surveyed for this species.

Existing and potential pest species: There are no known records of existing or potential harm to the western red bat by predators or introduced pest species.

Threat mechanism: Current threats include habitat loss and degradation of riparian and other broadleaf deciduous forests and woodlands from the destruction of stream banks and accelerated erosion related to grazing, dam construction, water diversions, aquifer pumping, and pasture and cropland conversion (AGFD 1996b). Toxic chemicals may also negatively impact local populations of this and other bat species. While there is no recent evidence of this, historical evidence and implications exist (Clark 1988; Clark et al. 1995). Chemicals of concern include organochlorine pesticides (DDT, DDE, DDD), dieldrin, heptachlor-related chemicals, industrial polychlorinated biphenyls (PCBs), and heavy metals such as lead, cadmium, chromium, zinc, and mercury.

Management Needs

General: Adequate management strategies include developing efficient survey methods that address population status, life history, and roost selection, and protecting broad-leaf deciduous riparian areas with bank stabilization and regulation of livestock. Additionally, land acquisition and land owner education programs (most riparian habitat is privately owned) would also effectively bolster management efforts for this species (AGFD 1996b).

Current protective measures: No current protective measures are known to currently exist specifically for this species except that all bats are protected by the wildlife regulations of the state against direct taking. Pima County has a wash protection ordinance that prevents some destruction of habitat for this species. The federal Clean Water Act, in its Section 404, may also protect some of the habitat of this species.

Sensitivity to human activities and densities: Because habitat for this species occurs along riparian corridors, the success of this species is directly related to human activities and densities, many of which adversely impact riparian corridors. Increasing human population may deplete water resources upon which the habitat of this species depends.

Corridor needs: Because western red bats migrate seasonally between the southwestern United States and South America and, in Arizona, occur primarily in riparian regions, it is assumed that they travel along riparian corridors and that some level of quality of the riparian corridors is necessary for this species.

Key relationships: This species is found in broadleaf riparian deciduous forests and woodland habitats. The western red bat is associated with cottonwood and sycamore trees (AGFD 1996a; LCR MSCP 2000).

Migratory requirements: Specific migratory requirements are now known; however, it may be reasonable to assume that this species migrates along river and stream valleys with riparian deciduous woodland vegetation.

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for this species.

Existing monitoring and research programs: No information is currently known regarding existing monitoring and research programs for this species.

References

Arizona Game and Fish Department (AGFD). 1996a. *Lasiurus blossevillii.* Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department (AGFD). 1996b. Wildlife species of special concern in Arizona. Public review draft. Phoenix, Arizona.

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Lower Colorado River Multiple Species Conservation Plan. 2000. Western red bat species account. Obtained from http://www.lcrmscp.org/files.html.

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Western Bat Working Group. 1999. Regional Priority Matrix. Obtained from http://www.batworkinggroups.org/wmatrix1.htm (updated 11/22/99).

Yeatts, J. n.d. The abundant wildlife: bats. Colossal Cave Mountain Park web site: http://www.colossalcave.com/bats.html.

Western yellow bat (*Lasiurus xanthinus = ega*)

Status

Federal	None
State	Wildlife of Special Concern in Arizona (AGFD 1996); this species is on the Arizona Game and Fish Department's 1988 list of *Threatened Native Wildlife in Arizona* as a threatened species
Other	Forest Service Sensitive. The Western Bat Working Group rates this species as "Red or High" in this area. "Based on available information on distribution, status, ecology, and known threats, this designation should result in these species being considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment" (Western Bat Working Group 2000). Vulnerable Status 2 in SDCP.
Rankings	G5 S1 (AGFD 1998)

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: Taxonomic status of this taxon is uncertain. Some authors differ as to whether this species is distinct from *L. ega*. Jones et al. list it as *L. xanthinus*.

Classification: Order: Chiroptera; Family: Vespertilionidae; Genus: *Lasiurus;* Species: *xanthinus* or *ega*.

Life History

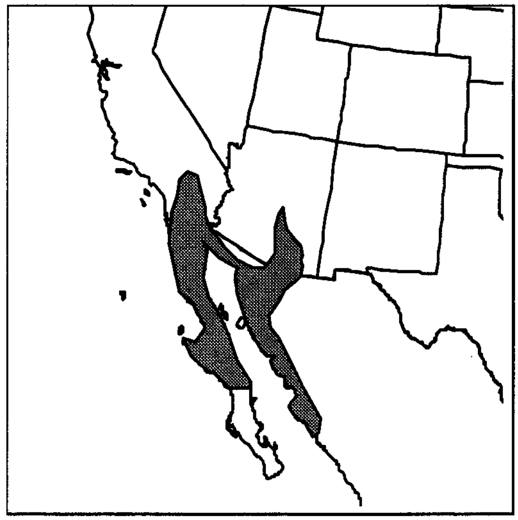
Description: The western yellow bat has an average wingspread of 13 to 14 inches (32-35 cm), and an average body length of 2.5 to 3 inches (6.25 to 7.5 cm) (Noel and Johnson 1993). Its fur is the yellowish color of dead palm fronds (K.J. Kingsley, pers. obs.).

Reproduction: Western yellow bats give birth to 1 or 2 young in June in roosts in vegetation. There are no known records of pregnant or lactating yellow bats from Arizona (Noel and Johnson 1993).

Behavior: This bat roosts in palm trees and riparian deciduous trees. They have been observed flying in straight lines with slow wing beats about 75 feet above the ground. They have been netted above water holes, but it is not clear whether they were drinking or foraging (Noel and Johnson 1993).

Diet: This bat is insectivorous. Little more is known about its diet.

Distribution



Historic: The historic range of this species is not well known. Specifically, it is not known from Arizona until recently (Noel and Johnson 1993), and it is not known whether it occurs in the small isolated populations of native fan palms in Arizona (M. Bogan, U.S. Geological Survey, University of New Mexico, pers. comm. to K. J. Kingsley, 16 Nov 1999).

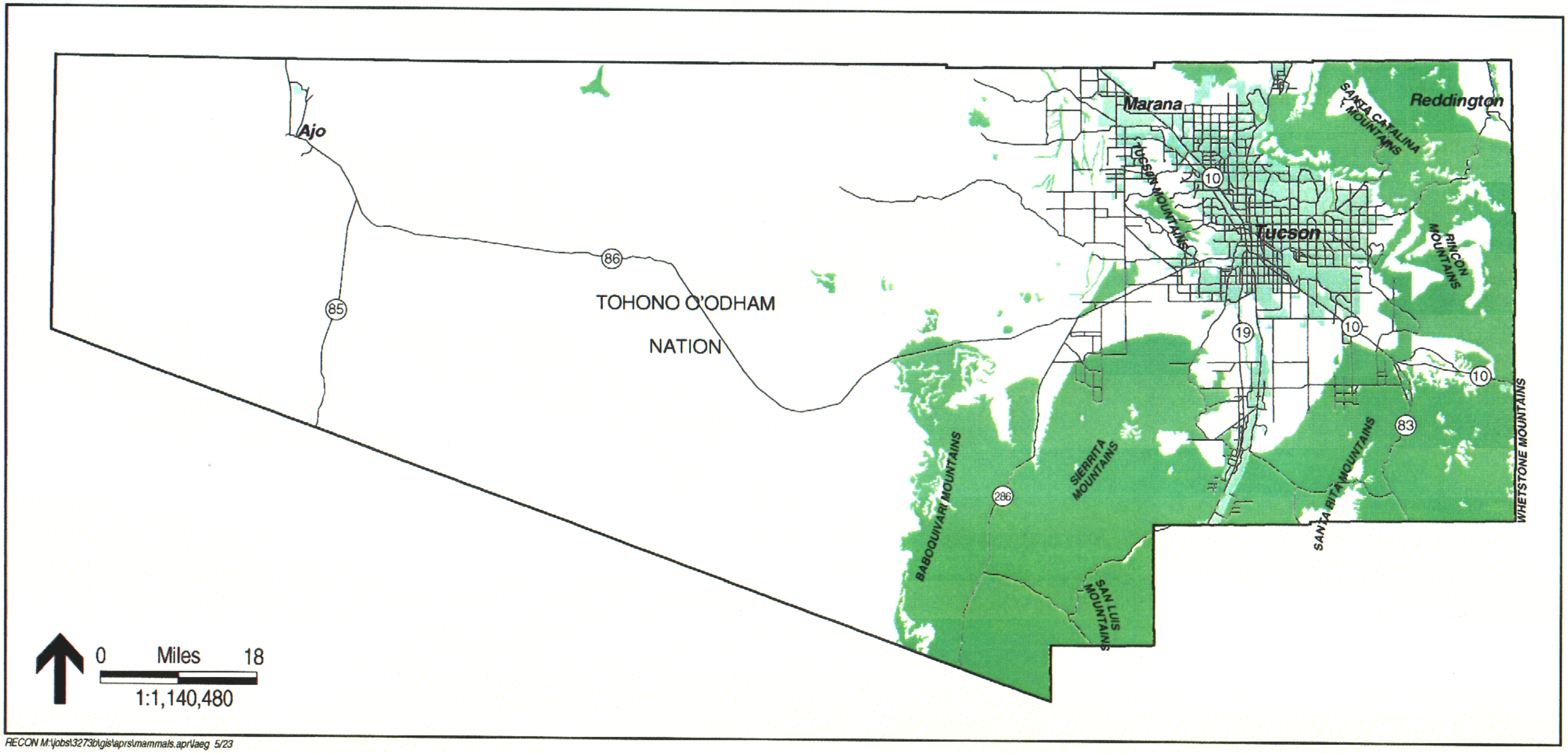
Present: This is a tropical species that barely enters the United States in southern Arizona, southern California, Texas, and New Mexico, and ranges south to Uruguay and Argentina (Noel and Johnson 1993). There are very few records of this species in the U.S., but some evidence appears to indicate that the species is increasing, primarily in urban areas (Noel and Johnson 1993; AGFD 1996). It is known to occur in association with Washington fan palms at Yuma, and in broad-leaved riparian areas along the Bill Williams River (Hoffmeister 1986, AGFD 1996). It is expected to occur at locations where palms have been planted along the Colorado River (Cockrum et al. 1996). The only record for the State of Nevada was from the Warm Springs National Wildlife Refuge along the Muddy River (Lund 2000). Yellow bats were reported along the Bill Williams River, where they roosted in native riparian trees, and at Lake Havasu City where they roosted in introduced palms (Brown 1996). Most known records of yellow bats from Arizona are from urban Tucson and Phoenix, where they are associated with planted fan palms (Hoffmeister 1986; Noel and Johnson 1993; AGFD 1996). They are said to be frequently encountered by tree trimmers in urban Tucson (R. Ward, pers. comm. to K. J. Kingsley, 1994). Figure 4 shows potential habitat in the eastern one-third of Pima County, with a much higher potential in higher elevations around Tucson.

Demographics

Density: No information is known to be available on the density of this species.

Status: This species is thought to be increasing in range and numbers, but insufficient information is available to determine this with certainty or to understand what this means (AGFD 1996). The WBWG considers this species a high priority species for study (WBWG 2000).

Trend: Population trends are not known, although records of this species appear to be increasing, this may be a result of better observation and reporting. Some authors (Noel and Johnson 1993; Fahey 1997) suggest that the species may be increasing. It is also possible that this species has declined in the Tucson valley as a result of historic loss of riparian woodland, and that the population has shifted to palm trees in the absence of riparian deciduous trees.



Western Yellow Bat Potential Habitat

Pima County Boundary
Major Road or Highway

Potential Habitat (GAP, 1994)
Low Value
Medium Value

Figure 4

Survival rates: No information is known to be available on this aspect of this species biology.

Reproduction rates: No information is known to be available on this aspect of this species biology.

Age ratios: No information is known to be available on this aspect of this species biology.

Significant Pima Co. populations or subpopulation basis in planning area: Most Pima County populations are likely to be associated with planted fan palms in urban Tucson. An ideal situation appears to be present at Agua Caliente Park, where hundreds to thousands of bats appear in the evening, many apparently flying out from roosts under dead palm fronds (K.J. Kingsley, pers. obs.). Only one known attempt was made to net bats at this park, and no yellow bats were caught (J. Tiburec, Bat Conservation International, pers. comm. to K. J. Kingsley, 30 Apr 2000). Yellow bats are rarely captured in mist nets (AGFD 1996).

Habitat Requirements

Ability to use major land use categories: This species is likely to be found primarily in association with planted fan palms (*Washingtonia filifera* and *W. robusta*) in residential and park areas. It is also found in riparian deciduous forests and woodlands.

Habitat trends in planning area: Apparently increasing, after massive historic losses of riparian woodland.

Home range requirements: This bat is known to roost in trees and it may need water.

Current and Potential Threats

General: Loss and degradation of riparian woodlands due to trampling of stream banks and increased erosion associated with grazing, construction of dams, water diversions, aquifer pumping, and pasture and cropland conversion, burning and removal of palm groves, and possibly pruning of urban palm trees (AGFD 1996). Toxic chemicals may adversely impact local populations of this and other bat species. There is no recent evidence of this, but historical evidence and implications exist (Clark 1988; Clark et al. 1995). Chemicals of concern include organochlorine pesticides (DDT, DDE, DDD), dieldrin, heptachlor-related chemicals, industrial polychlorinated biphenyls (PCBs), and heavy metals such as lead, cadmium, chromium, zinc, and mercury.

Pima County populations location, amount, and quality of protected habitat: There are no known records from protected habitat in Pima County. It has been stated to be probably present in Colossal Cave Mountain Park (Yeatts n.d.), and conditions at Agua Caliente Park appear ideal for this species, but this species has not been verified from either location.

Existing and potential pest species: None are known.

Threat mechanism: Loss roost sites resulting from historic loss of riparian deciduous woodland and current palm frond cutting.

Management Needs

General: Determination of the status and distribution of this species in Pima County is the highest priority need. A concerted effort should be made to determine whether it is present in any Pima

County owned and protected lands, or lands being considered for acquisition by the county. If the species proves to be present, management guidelines should be developed.

Current protective measures: None are specifically known for this species. All bats are protected by state law against direct harm.

Sensitivity to human activities and densities: No information is known to be available on this aspect of this species biology. It is known to inhabit urban Tucson, even occurring in downtown neighborhoods (K.J. Kingsley, pers. obs.).

Corridor needs: None are known for this species.

Key relationships: This species appears to be dependent upon fan palms and riparian deciduous woodland tree species (cottonwoods and willows).

Migratory requirements: None are known for this species.

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for this species.

Existing monitoring and research programs: No information is currently known regarding existing monitoring and research programs for this species.

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Lund, B. 2000. Slide shown at workshop on bats as part of the development of an adaptive management plan for the Clark County, Nevada, Habitat Conservation Plan and identified as a yellow bat by P. Brown, M. O'Farrell, L. Ball, and K. Kingsley, March 3.

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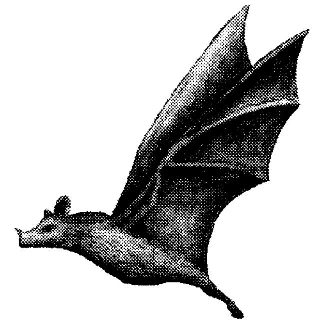
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuena)*

Status



Federal	Endangered (USFWS 1988)
State	Wildlife of Special Concern in Arizona (AGFD 1996); on the Arizona Game and Fish Department's 1988 list of *Threatened Native Wildlife in Arizona*, this species was listed as endangered
Other	Forest Service Sensitive (Region 3, 1990); Mexico: Threatened (AGFD 1995); Vulnerable Status 2 by SDCP
Rankings	G3 S2

Recovery Goals

Federal: Recovery Objective: Reclassification to threatened. Recovery Criteria: The U.S. Fish and Wildlife Service should review the status of the lesser long-nosed bat to determine if reclassification to threatened is warranted if all the following criteria are met:

- each major roost population in Arizona and Mexico is monitored for at least 5 years;
- the results of that monitoring show that population numbers are stable or increase over the higher set of population figures appearing in this recovery plan;
- sufficient progress has been made in the protection of roosts and forage plants from disturbance or destruction;
- no new threats to the species or its habitat have been identified or there are no increases to currently recognized threats; and
- the USFWS determines the species is no longer endangered (USFWS 1995).

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The name of the species has changed over time. It was named as a subspecies of *L. nivalis* by Hoffmeister (1957, cited in Hoffmeister 1986). Then it was elevated to species status, as *L. sanborni* in 1962 (Hoffmeister 1986). It was listed as an endangered species under Sanborn's long-nosed bat (*L. sanborni*), and a body of literature developed using those names. It was subsequently revised to *L. curasoae yerbabuena*, which is the currently recognized name (Jones et al. 1997). This is the only subspecies known from Arizona.

Classification: Order: Chiroptera; Family: Phyllostomidae; Genus: *Leptonycteris;* Species: *curasoae;* Subspecies: *yerbabuena.*

Life History

Description: *L. c. yerbabuena* is a medium-sized bat, forearm 51-56 mm. It is grayish to reddish brown with an elongated snout. This bat has a nose-leaf, no tail, and an interfemoral membrane that is reduced to a narrow band along each hind leg; this species has large eyes and reduced ears compared to other bats in Arizona (AGFD 1998). It is easily confused with the Mexican long-tongued bat, which has a visible tail enclosed in the interfemoral membrane.

Structural adaptations of the mouth of lesser long-nosed bat correspond to procuring nectar, their primary food source. The tongue is long and tipped with brush-like papillae that facilitate nectar lapping and teeth are modified, having lost the cutting and crushing cusps essential to successfully foraging on insects.

Diet: This species feeds on nectar and pollen from flowers of saguaro and organ pipe cactus in early summer possibly feeding on ripe cactus fruits near the end of the flowering season (AGFD 1988). In late summer and early fall, lesser long-nosed bats feed on agave. While feeding on nectar, they may initially ingest insects; they also ingest sugar water from hummingbird feeders at night (AGFD 1998; Cockrum and Petryszyn 1991); photos of species at hummingbird feeders near Saguaro National Park, R. Johnson, pers. comm. to K. Kingsley, 7 May 2000). It is believed that the northward migration of *L. c. yerbabuena* from Mexico may correspond to the sequential flowering of several forage species from south to north (AGFD 1998).

Whereas most other bats and rodents living in arid climates have kidneys adapted for water conservation and salt excretion, the lesser long-nosed bat does not, relying instead on nectar with its high water and low salt content. The nectar diet allows this species to rid itself of large amounts of water while retaining salts. In this way, lesser long-nosed bat can exist independent of free water (AGFD 1998).

Reproduction: Females migrate from central Mexico and arrive in Arizona in April. In late April to early May these already pregnant females gather in maternity roosts, some of which number in the hundreds to the thousands, in a few locales, even to the tens of thousands. In May, 1 young is born to each female. Maternity roost sites include caves, abandoned mines, and rock crevices (Cockrum et al. 1991). An abandoned adit in Copper Mountain, in Organ Pipe Cactus National Monument, Pima County, is home to the largest known maternity roost in North America (Tibbitts 1999). At night, young bats remain on the ceiling of the maternity colony while their mothers fly in search of suitable forage (Hoffmeister 1986). Offspring are usually flying by late June, with maternity roosts disbanding by the end of July (AGFD 1998). Adult males roost in their own separate colonies, that are smaller than those of the females, or with adult females and young at maternity sites (USFWS 1995). Few sites with adult males are not known from Arizona. In 1999, several males were netted in the Galiuro Mountains, and a male roost was suspected by not found (T. Snow, AGFD, pers. comm. to K. J. Kingsley, 12 Feb 2000).

Behavior: Lesser long-nosed bat is a non-hibernating seasonal migrating bat. As they cannot withstand extended exposure to cold temperatures, this species resides in Mexico from September/October, migrating to Arizona in the spring to deliver their offspring (AGFD 1998).

This bat can fly at speeds up to 14 mph, maneuvering easily to both hover near flowers and avoid hand and mist nets. This species can also be identified in roosting areas by a characteristic roaring sound emitted by their flying wings (AGFD 1998). Lesser long-nosed bats emerge from their daytime roosts at approximately 1 hour after sunset to search for food. Once they have foraged until their stomachs are extremely full (with the distended stomachs sometimes giving the appearance of pregnancy), they move on to night roosts, where they rest and groom. Grooming involves preening their fur, and removing and eating the sticking pollen. This pollen is highly nutritious and provides *L. c. yerbabuena* with proteins and nutrients not available from nectar (AGFD 1998). In total, Howell (1979) observed that this species spends about 6 hours per night foraging, alternating between 20 minutes flying and feeding and 20 minutes roosting on plants or rocks and grooming (AGFD 1998). At least 1 night roost is known from an inactive mine in the Chiricahua Mountains, where hundreds to thousands of lesser long-nosed bats congregated

Whereas both *L. c. yerbabuena* and the other nectar feeding bat in Arizona, *Choeronycteris*, both utilize the same plants for forage, there are seasonal differences in their migration patterns; *Choeronycteris* migrates northward later, relative to *L. c. yerbabuena,* feeding on agave flowers as it travels. Additionally, *Choeronycteris'* preference for columnar cacti is restricted to Mexico, during the winter months. While summering in Arizona, both species feed primarily on agave (AGFD 1998).

Distribution

Historic: The lesser long-nosed bat has been found in southern Arizona from the Picacho Mountains southwest to the Agua Dulce Mountains and southeast to the Chiricahua Mountains, in far southwestern New Mexico in the Animas and Peloncillo Mountains, and south from Arizona and New Mexico throughout the drier parts of Mexico, including Baja California. Occasionally, individuals have been reported outside of this range, for example there are records of individuals from the Phoenix area and the Bill Williams River during July and August. It is a seasonal resident in Arizona, usually arriving in early April and departing in mid-to-late September. However, it has been seen visiting hummingbird feeders in Tucson in January and February in recent years. It apparently resides in New Mexico only from mid-July to early September (USFWS 1995).

Present: There is no evidence to indicate that the range of the species has changed from its historic extent. However, some specific roosts are no longer used, and some are used by different numbers of bats than previously used them. Roost use may vary from year to year (USFWS 1995) for reasons that are not understood. Lesser long-nosed bats were driven out of Colossal Cave, apparently with great difficulty, after a long series of attempts culminating with the installation of an exhaust fan in 1966 that changed the roost conditions in the cave rendering it unsuitable (Cockrum and Petryszyn 1991). Most of the currently known roost sites are inactive mines. Within the known range of the species today, there are many more suitable roost sites (inactive mines) than there were when the only suitable sites were natural caves. Cockrum and Petryszyn compiled all known records of the species for the northwestern portion of its range, including Pima County. Their records from Pima County cover 2 pages of small type, and are not included here. Interested readers are referred to that source. According to HDMS and SWCA (2000), some have been detected along the eastern end of Pima County. Locations include the outlying areas of Santa Catalina, Rincon, and Santa Rita Mountains (Figure 5).

Demographics

Density: Populations fluctuate as this species is a seasonal resident of southern Arizona. Estimates of populations in maternity roosts range from 200 to 130,000 (USFWS 1995).

Status: There is a difference of opinion as to the status of this species. According to some authors (USFWS 1988; AGFD 1998), populations in Arizona are thought to have declined significantly. However, this is either contradicted by the available data (Cockrum and Petryszyn 1991) or at least not supported by data (USFWS 1995).

Trend: "If the most recent census numbers are correct, the lesser long-nosed bat has had a substantial increase in numbers since the status surveys of 1984-85. Its population sizes appear to be far larger (by 2 orders of magnitude in Arizona alone) than was known in 1985, and its numbers at some locations appear to be relatively stable from year-to-year. As mentioned previously, there is some question about the correctness of these numbers that requires additional investigation. We also do not know where these additional bats came from. Is this an actual increase in numbers resulting from successful recruitment of young to the adult population or is the increase the result of abandonment of other roosts and thus higher occupancy of the remaining roosts or were these bats always present but not located by earlier censuses? The Service cannot determine the answers, and the clear disagreement between scientists familiar with the species only adds to the uncertainty about the status of this species" (USFWS 1995:24).

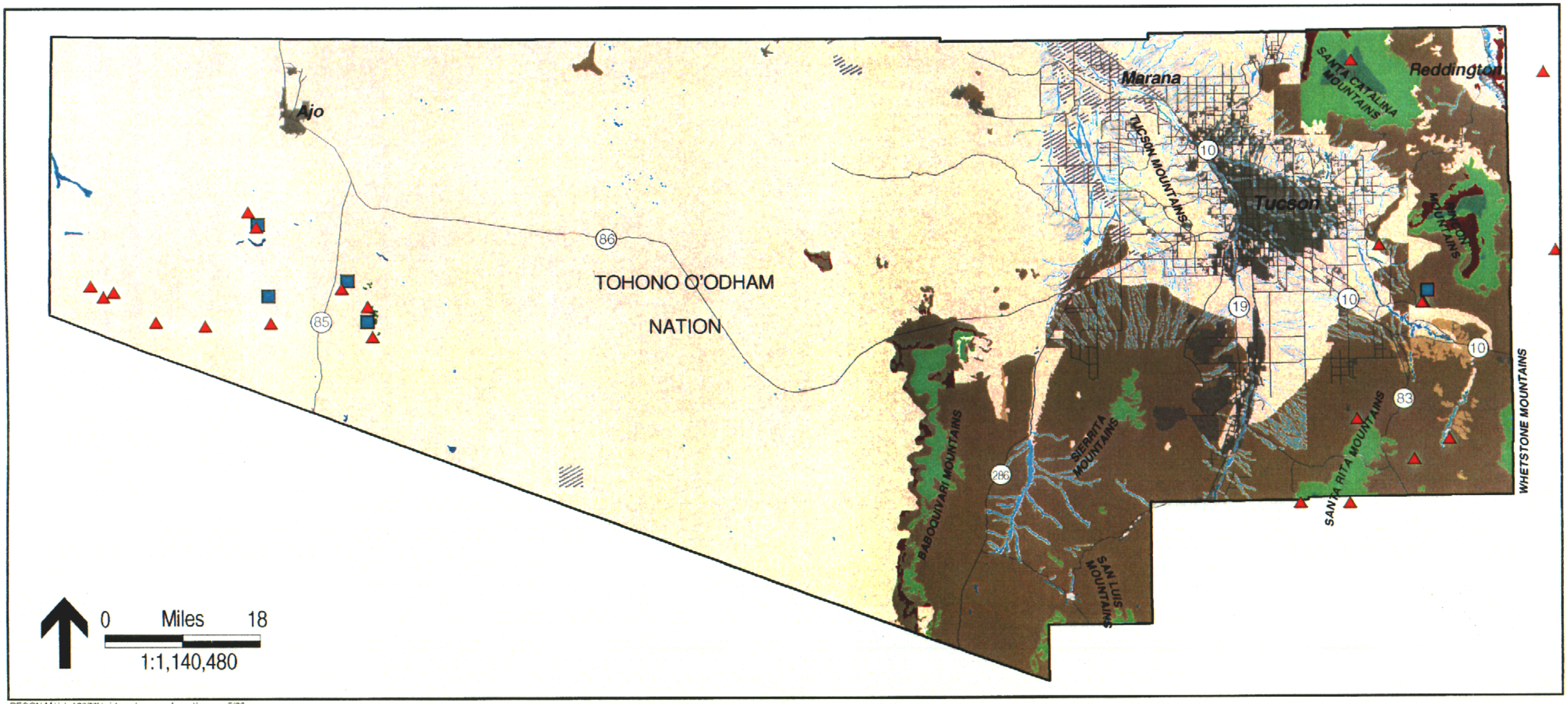
Survival rates: Longevity and sources of mortality have not been studied in this species (USFWS 1995).

Reproduction rates: It is not yet known whether adult females produce 1 or 2 young, in 1 or 2 pregnancies, per year. Current information suggests that most females bear only a single young per year and that timing of mating and parturition varies geographically (USFWS 1995).

Age ratios: No known information is currently available regarding age ratios in natural populations.

Sex ratios: Sex ratio at birth appears to be close to 1:1. Males and females often roost separately, and apparently only a few males migrate as far north as females do. Females roosts are known that number in the tens of thousands, whereas male roosts that have been studied contained 300 to 1,000 males (USFWS 1995).

Significant Pima Co. populations: Known major roosts sites in Pima County are described in the Recovery Plan (USFWS 1995). These are Bluebird Mine on the Cabeza Prieta National Wildlife Refuge, Copper Mountain Mine in Organ Pipe Cactus National Monument, Box Canyon Crevice in Saguaro National Park (only 1 or 2 bats in 1991), and Cave of the Bells, in Coronado National



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Lesser Long-nosed Bat
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)
▲ Lesser Long-nosed Bat
(Leptonycteris curasoae yerbabuenae)

Known Locations
(SWCA, 2000)
■ Lesser Long-nosed Bat
(Leptonycteris curasoae yerbabuenae)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 5

Forest. This species is also known from Colossal Cave Mountain Park, roosting in cracks and crevices in rocky cliffs (Yeatts n.d.).

Habitat Requirements

Ability to use major land use categories: The lesser long-nosed bat is known from Semidesert Grasslands and Sonoran Desert Scrub, Arizona Upland Subdivision at elevations below 3,500 feet from April until July up to Madrean Evergreen Woodland (oak transition regions) at elevations up to 5,500 feet from July until late September/early October (AGFD 1998). Lesser long-nosed bat appears to be the most dependent on the availability of inactive mines of the North American bat species. Most Arizona records are from inactive mines. Proximity to humans does not necessarily pose a threat to this species (USFWS 1995).

Habitat trends in planning area: All known roosts are protected by various means. Most are included in preserve areas.

Home range requirements: The home range requirements include at least 1 suitable day and night roost that is available during the summer, and access to appropriate food plants. Access to water is apparently not necessary, although this species is occasionally netted over water.

Current and Potential Threats

General: There is not general agreement as to what threats might affect this species. Most of the reasons for listing this species were either erroneous or not well supported by data (USFWS 1995). Probably the most significant threats are disturbance at roosts and loss of food plants. Lesser long-nosed bats are sensitive to disturbances in the roost, and we do not have a threshold level of effect that is tolerable and what is not (USFWS 1995). The long-term effects of losses of food plants (columnar cacti and agaves) is not known; however, there are large areas from which these plants are known, but the bats are not known (USFWS 1995).

Pima County location, amount, and quality of protected habitat: All known roosts in Pima County are protected by the various land management agencies. Large areas of potential food plants for this species are included within National Parks and Monuments and Wildlife Refuges.

Existing and potential pest species: There is no known information on existing or potential harm to the lesser long-nosed bat by pest species. Major bat predators include snakes in roosts, carnivores at roost entrances, and owls while the bats are foraging. Unlike many other bats, however, *L. curasoae* is not lunar-phobic (i.e., it does not reduce its foraging activity during the bright time of the lunar month), which suggests that it does not suffer strong selection pressure from nocturnal aerial predators (USFWS 1995).

Threat mechanism: Currently there is disagreement as to threat mechanism, if any, other that disturbance of roosts beyond some threshold and large-scale loss of food plants, which has not been demonstrated to have occurred (USFWS 1995).

Management Needs

General: Management "needs" and recovery actions are detailed in the Recovery Plan (USFWS 1995). In summary, these are:

- Continue protecting roost sites and evaluate the need for and implement protection for food plants.

- Monitor all major roosts in Arizona, New Mexico, and Mexico once a year.

- Continue surveying for additional roosts in the U.S. and Mexico.

- Develop and conduct a public education and information campaign in Arizona, New Mexico, and Mexico on the beneficial aspects of bats in general and the lesser long-nosed bat specifically.

- Conduct critical research on population census techniques, physical requirements for roosts, foraging ranges of roosts, reproduction and mating systems and other life history and habitat questions.

Current protective measures: Current protective efforts include gating of several caves and mine adits that are known to be used by this species, and monitoring of these sites. In addition, whenever projects that might affect roosts are planned on federal lands within the known range of this species, evaluation of effects, including surveys for roost sites, is required as part of the biological evaluation process.

Sensitivity to human activities and densities: Some evidence indicates that this species can tolerate some level of disturbance at roosts, but the threshold beyond which adverse impacts occur has not been determined (USFWS 1995).

Corridor needs: Because Lesser long-tongued bats migrate seasonally between the southwestern United States and Mexico, it is assumed that they utilize migration corridors, and that some quality of the corridor is necessary for this species. Specific corridors are not known, and may vary from year to year, or between fall and spring migrations. Some roosts for day and night use must be present within the migration corridor, and populations of forage plants along migration routes are necessary.

Key relationships: This species is a known pollinator of several agave species and columnar cacti, upon which it depends for food. It is often used as an example of mutualism, although, the importance of this species in pollinating plant species with which it is associated in Arizona as these plants is not clear because they also exist outside of the known range of lesser long-nosed bat (Cockrum and Petryszyn 1991; USFWS 1995; AGFD 1998).

Migratory requirements: See corridor needs (above).

Results of past mitigation activities: Current population estimates for this species suggest that there has been a substantial increase in numbers in the past 15 years. However, this apparent increase is not necessarily attributable to any specific efforts, as other factors may explain this apparent increase, including gross underestimation of the number of bats present in the 1980s. Specific effects of any mitigation activities are not determinable on the basis of available data.

Existing monitoring and research programs: Known recent efforts include studies of agave ecology (including fire relationships) on the Fort Huachuca military reservation, of foraging ecology in Sonora by researchers from Bat Conservation International, and of the effects of low-flying supersonic aircraft on the Barry M. Goldwater Air Force Range. Additionally, annual surveys of known roosts are conducted in Arizona and portions of Sonora by biologists from universities, federal and state agencies, and private organizations (USFWS 1995; AGFD 1998). At the developed Colossal Cave, there has been work accomplished to return parts of the cave to predisturbance conditions, to attract this species to use the cave as a maternity roost, as it did prior to the 1960s (AGFD 1998), but this has apparently not yet been successful (Yeatts n.d.).

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California leaf-nosed bat (*Macrotus californicus)*

Status

Federal	Species of Concern, former Category 2 Candidate (AGFD 1998)
State	Wildlife Species of Special Concern in Arizona (AGFD 1998); however, it was not included in the draft published in 1996 (AGFD 1996)
Other	USFS Sensitive: Region 3 (AGFD 1998). The Western Bat Working Group (WBWG) has designated populations of the California leaf-nosed bat in both the tropical/subtropical desert division of southern Arizona and southeastern California and the Colorado Plateau semidesert region of northern Arizona as red/high. The red/high designation is given to populations that are imperiled or are at high risk of imperilment. The WBWG recommends that red/high populations be given the highest priority for funding, planning, and conservation actions (WBWG 2000). Vulnerable Status 2 in SDCP.
Rankings	G4 S3S4

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: *Macrotus californicus* is 1 of 3 species of the family Phyllostomidae in Arizona. *M. californicus* is 1 of only 2 species within the genera *Macrotus*; it is the only species of this genus in Arizona (AGFD 1997).

Classification: Order: Chiroptera; Family: Phyllostomidae; Genus: *Macrotus;* Species: *californicus.*

Specific: This species was formerly recognized as a subspecies of *M. waterhousii.* Genetic studies and multivariate analysis of cranial characters by Davis and Baker (1974) illustrated that the 2 groups exist with a narrow area of overlapping range in southern Sonora; there is no evidence of hybridization. Therefore, *M. californicus* was elevated to species status and is generally recognized as a distinct species (Hoffmeister 1986; AGFD 1997).

Life History

Description: The California leaf-nosed bat is a bat with an erect, lanceolate nose-leaf. The ears are large, 1.16 to 1.52 inches (29.0-38.0 mm) long, and joined together near the base. The tail extends free past the edge of the uropatagium for 0.2-0.4 inch (5.0 to 10.0 mm). The forearm measures 1.88 to 2.25 inches (47.0-55.0 mm), and the wingspan is about 13.5 inches (35 cm). The color is brown (Noel and Johnson 1993; AGFD 1997).

Diet: This species consumes large flying insects, including grasshoppers, moths, and flying beetles; other appropriate food includes insect larvae, particularly lepidopterans. California leaf-nosed bat is capable of catching prey in flight, accomplishing this by hovering close to the ground or "gleaning" forage from vegetation within 3 feet of the ground (AGFD 1997). *M. californicus* seizes its prey from above, transporting it to a night roost to feed. This species may also feed on cactus fruits (Hoffmeister 1986).

Reproduction: Whereas males do not breed until their second year, females can breed during their first autumn season. Congregating in maternity roosts, females give birth during May and June. They nurse their progeny for 1 month at which point the young accomplish flight and begin to forage on their own. The nursing colonies are located near the roost entrances in locations with an average temperature of 90-95 degrees Fahrenheit. Some nursery colony sites are occupied year-round, but others are not (AGFD 1997). Males establish leks in mines or caves, with each male patrolling a specific area in flight. Females come to the lek and select a male, with which they mate.

Males and females roost separately. Roosting can occur by small groups at locations other than those of the maternity roost or at the same roost as the maternity roost but in a different area. Males join the females in late summer/early fall, fertilization takes place in the autumn, and males and females spend the winter together. Although fertilization takes place in the fall, embryological development is delayed through the winter until March when it continues normally. Maximum life expectancy for this species is greater than 15 years (AGFD 1997).

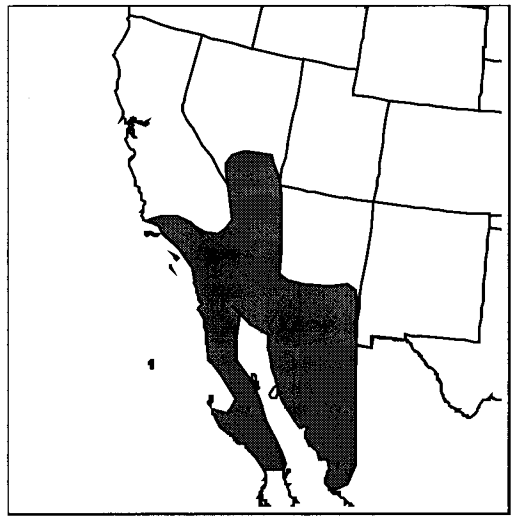
Behavior: Whereas this bat does not hibernate, it does regulate its body temperature to between 18 and 20 degrees Celsius when ambient temperatures drop to between 9 and 12 degrees Celsius. After a few hours of such extreme low temperatures, California leaf-nosed bats will die, unable to withstand sustained temperatures less than 26 degrees Celsius for longer than a few hours (AGFD 1997).

Foraging activity occurs during 2 periods: 1 to 3 hours after sunset (or sometimes immediately following sunset) and a 2-hour period ending at approximately half an hour before sunrise. Foraging time for a single bat totals approximately 1.75 hours, including time spent at night roosts eating larger prey. This species feeds year-round as it does not hibernate (AGFD 1997).

The vision of *M. californicus* is better, relative to other insectivorous bat species, and is at least as good as frugivorous and insectivorous bats that have been tested (AGFD 1997).

Finally, California leaf-nosed bat is well adapted to the desert, able to conserve water by concentrating urine. Lu and Bleier (1981) reported that some *M. californicus* individuals in captivity have lasted for at least 6 weeks without drinking water. Other sources, including Bell et al. (1986), argue that *M. californicus* is well adapted to temperate desert areas because they limit expending energy on thermal regulation. This is accomplished by existing in geothermally heated winter roost sites with a stable year-round temperature of approximately 29 degrees Celsius, an "energetically frugal pattern of foraging that relies on visual prey location," and detecting prey by the sounds they emit (Bell et al. 1986; AGFD 1997).

Distribution



Historic: This species is known from southern California, southern Nevada, across the southwestern half of Arizona (with 1 report from northwestern Mohave County) and southward to the southern tip of Baja California, northern Sinaloa, and southwestern Chihuahua, Mexico (AGFD 1997). The historic range of *M. californicus* does not include New Mexico; the species' occurrence there is "accidental" (BISON-M 2000).

Present: In Arizona, the species is known to occur in the Sonoran desert scrub from south of the Mogollon Plateau. There are some records from extreme southeastern and, in summer, extreme northwestern Mohave County. At some roosts, this species is a year-round resident; the winter range for *M. californicus* is nearly the same as the summer range (AGFD 1997). This is the species of bat most likely to be encountered in mines in southern Arizona (K. J. Kingsley, pers. obs.). Locations focusing on Pima County are shown in Figure 6.

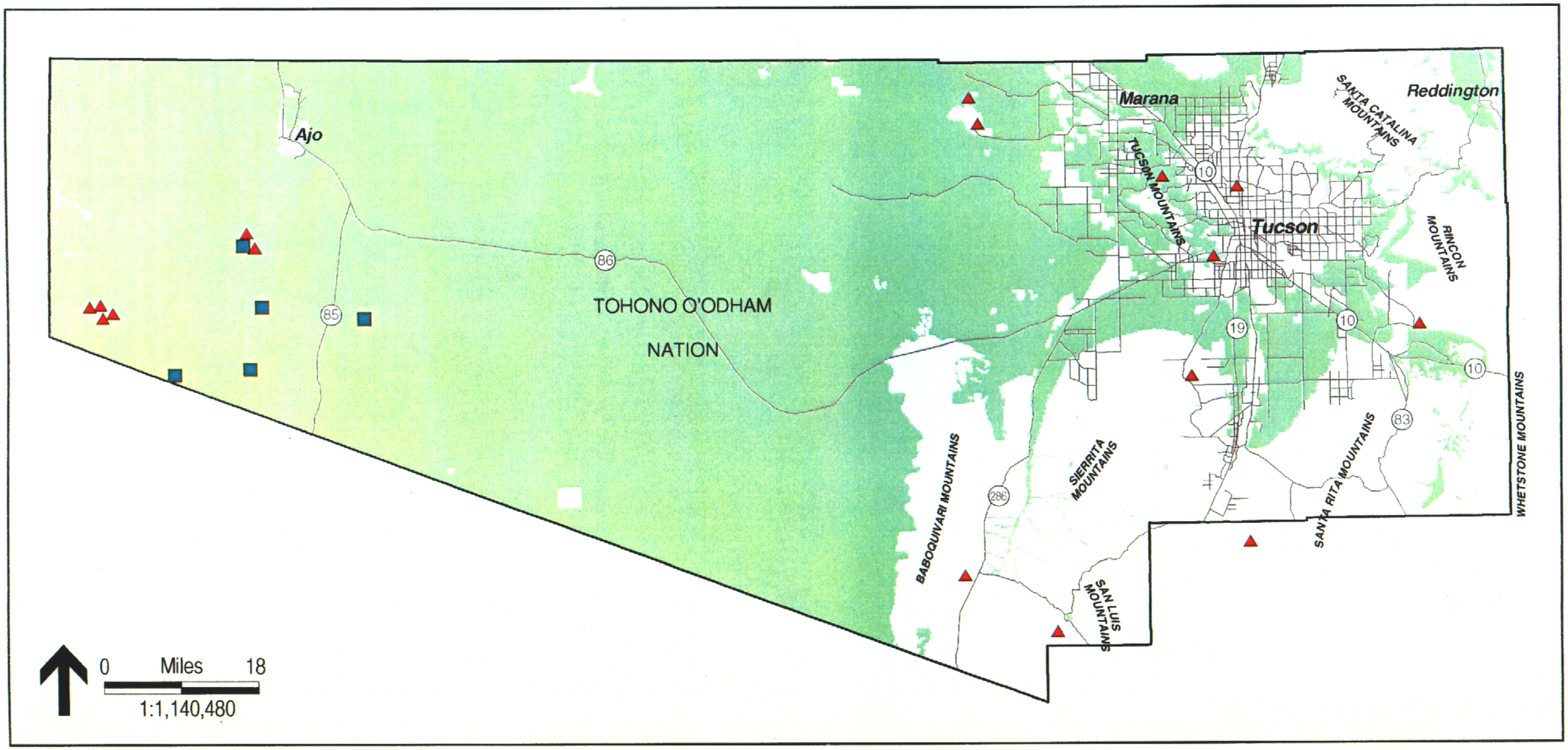
Pima County records are summarized in the following table:

Records of California Leaf-nosed Bat from Pima County

Date	Location	USGS Quad	Township	Ownership

Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.



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California Leaf-nosed Bat
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(SWCA, 2000)
California Leaf-nosed Bat
(Macrotus californicus)

Known Locations
(HDMS, 2000)
California Leaf-nosed Bat
(Macrotus californicus)

Potential Habitat
(GAP, 1994)
Low Value

Figure 6

Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.

SOURCE: AGFD 2000.

Demographics

Density: No known information is currently available regarding density of natural populations. This concept is probably not relevant or determinable for this species.

Status: No known information is currently available regarding status of natural populations. Overall, the status of this bat remains unknown (LCR MSCP 1999).

Trend: No information is available regarding trend in Pima County. Whereas there are more potentially suitable roosts available as a result of mining, many roosts are subject to disturbance.

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations.

Age ratios: No known information is currently available regarding age ratios in natural populations.

Sex ratios: No known information is currently available regarding sex ratios in natural populations. It is presumed that the sex ratio is 1:1, but because the 2 sexes sometimes occupy different roosts, and because most research on this species has been done at roosts, accurate data on sex ratios is not available.

Significant Pima Co. populations: Populations are known from inactive mines in most, if not all, of the mountain ranges in Pima County. All roosts should be considered significant, and all known roosts should be protected, while continued exploration investigates other potential roosts. Populations are known from within the Tucson Mountain Park and Colossal Cave Mountain Park (Yeatts n.d.; D. Carter, Pima Co. Parks Dept., pers. comm. to K. J. Kingsley, 7 May 2000).

Habitat Requirements

Ability to use major land use categories: The California leaf-nosed bat is known from caves, mines, and rock shelters, mostly in Sonoran Desert Scrub (AGFD 1997).

Habitat trends in planning area: *M. californicus* is sensitive to human disturbance at mine roosts. This disturbance may disorient the bat, adversely impact reproductive success, and even result in abandonment (AGFD 1997). Concerns include habitat destruction (mine closure dynamiting, bulldozing, or otherwise blocking access), or modification (changing air movement, humidity, temperature, or disrupting bat access) from partially obstructing or improper gating of abandoned mine areas. Additionally, closing mines for hazard abatement and renewing mineral extraction activity at formerly abandoned mine sites also threaten current colonies (AGFD 1997). Even placing a sign on a wire strung across a mine opening may have an impact on the mine's use by bats (K. J. Kingsley, pers. obs.).

Day roosts in mines usually occur within approximately 80 feet of the entrance and the bats prefer areas with abundant ceiling and flying space. In the colder areas of the range of *M. californicus*, roosts are chosen with temperatures equal to or exceeding 80 degrees Fahrenheit; the roosts are usually approximately 100 feet or more from the back of the entrance (Noel and Johnson 1993; AGFD 1997). Maternity roosts may be as far back in the tunnel as is physically possible (K. J. Kingsley, pers. obs.). Additionally, night roost sites, that may also include open buildings, cellars, bridges, and porches, are located in areas with overhead protection and sufficient flight approach (Noel and Johnson 1993; AGFD 1997).

Home range requirements: Basic requirements for this species include roost sites reasonably close to foraging sites. Some limited information indicates that this species forages primarily along washes. Their need for drinking water is not clearly understood, whereas this species is occasionally caught at mist nets over water, they may be either drinking or foraging for insects (K. J. Kingsley, pers. obs.).

Current and Potential Threats

General: The most important threat potentially affecting this species is usually considered to be human disturbance to roosts (AGFD 1997).

Pima County location, amount, and quality of protected habitat: Of the known records of this species from Pima County, 1 record is from Coronado National Forest land, 1 is from Organ Pipe Cactus National Monument, 2 are from BLM land, 1 is from state lands, 5 are from Cabeza Prieta National Wildlife Refuge, and 5 are from private land. However, this species is also known to be present in the Tucson Mountains Park (D. Carter, Pima County Parks Dept. pers. comm. to K. J. Kingsley, 7 May 2000) and Colossal Cave Mountain Park (Yeatts n.d.).

Existing and potential pest species: There are no known records of existing or potential harm to the California leaf-nosed bat by predators or introduced pest species.

Threat mechanism: This species depends for its survival on the roosts it uses, especially when nursing young and in winter. Disturbance may cause the bats to desert their roost and likely perish unless they can find another suitable roost. Also destruction or modification of the roost may make it unusable to the bats.

Management Needs

General: Restrict human disturbances to roosts. In addition, studies to determine home range, foraging areas and distances, and local and seasonal movement will augment current understanding of this species. Review of historical studies of roost site and disturbance are also necessary to fully comprehend the management needs of this species (AGFD 1997). Within the species' normal range, survey for and protection of roosts may be appropriate.

Current protective measures: Some caves and mines within this species range have been gated to keep out people but allow bats to enter. The effectiveness of this for this species has been variable, depending in large part on gate design.

Sensitivity to human activities and densities: *M. californicus* is sensitive to human disturbance at roost sites. This disturbance, including loud noises, may be disorienting to the bats, resulting in unsuccessful reproduction or roost abandonment (AGFD 1997). An increased human population will likely result in an increase in recreational visits to caves and inactive mines.

Corridor needs: As this is not a migratory species, no known migration corridor needs exist for this species. However, some evidence indicates that this species forages primarily along desert washes, and so foraging corridors may be a need.

Key relationships: The California leaf-nosed bat is found primarily in Sonoran Desert Scrub, both major divisions, at elevations below 4,000 feet, most occurring at elevations below 2,500 feet (AGFD 1997).

Migratory requirements: This is not a migratory species (AGFD 1997). However, it is not unusual for it to move between roost sites, and some roosts are used more at some seasons than at others (Hoffmeister 1986; K.J. Kingsley, pers. obs.).

Results of past mitigation activities: No information is currently available regarding long-term results of past mitigation activities. Some roosts have been gated at some locations, and the gates have had mixed results. Design of bat gates is a developing art, and more recent gates are better designed. Further research is necessary to establish an understanding of the effectiveness of bat gates. Mine warning signs placed so as to affect flight paths have apparently resulted in abandonment of some mines (K.J. Kingsley, pers. obs.).

Existing monitoring and research programs: AGFD has an active program of bat research and protection of important roosts. Organ Pipe Cactus National Monument also has an active program of bat research. No species-specific studies are known to be currently underway in this area.

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Merriam's mouse (*Peromyscus merriami*)

Status

Federal	None
State	Wildlife of Special Concern in Arizona (AGFD 1996)
Other	Vulnerable Status 1 by SDCP
Rankings	G5 S3

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This is a medium-sized mouse in the genus *Peromyscus*, which is one of the most abundant and diverse genera of rodents in North America. There are currently 18 recognized species in the genus in North America, north of Mexico (Jones et al. 1997). The species *merriami* is closely allied to the more widespread *P. eremicus*, and very difficult to distinguish from that species, with which it may be sympatric (Hoffmeister 1986).

Classification: Order: Rodentia; Family: Muridae; Genus: *Peromyscus;* Species: *merriami.* Two subspecies are currently recognized: *P. m. goldmani* which occurs only in southern Sonora and Sinaloa, Mexico, and the nominate subspecies *P. m. merriami*, which occurs in Sonora, Mexico and south-central Arizona. The species was described in 1896 by Mearns, based on a type specimen from Sonoyta, Sonora, and named after C. H. Merriam, one of the great pioneering mammalogists of the American Southwest (Hall 1981).

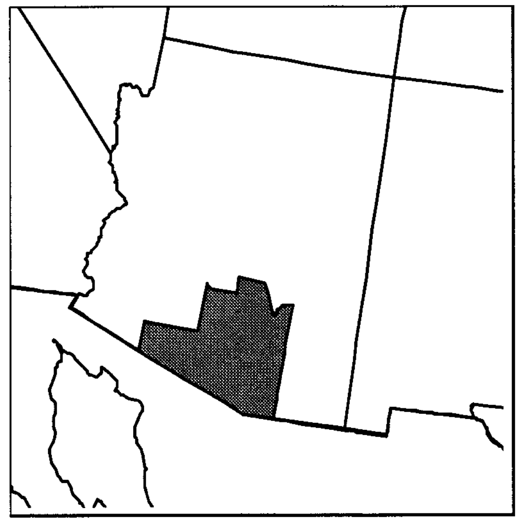
Life History

Description: Merriam's mouse has a pale gray body, faintly washed with tawny; the belly is cream-colored, and the tail is long, thinly haired and bicolored. There are 4 mammae. The head and body are 3.8 to 4.0 inches (97 to 102 mm) long, and the tail is 4.0 to 4.8 inches (102 to 122 mm) long (Burt and Grossenheider 1976). Merriam's mouse is very similar to the Cactus mouse (*P. eremicus*), and differs in having a slightly larger size, a ventrally curving baculum (as opposed to the dorsally curving baculum of *P. eremicus*) and a longer hind foot (Hoffmeister 1986). The braincase of *P. merriami* is more nearly flat than that of *P. eremicus*, and the average size is larger than *P. eremicus* where the 2 species occur together (Hall 1981).

Diet: There is no available information on the diet of Merriam's mouse.

Reproduction: Merriam's mice bear live young that are naked, blind, and totally dependent on maternal care. Birth can apparently occur at any month of the year. There are 2 to 4 young per litter (Hoffmeister 1986). No documented information is available on the number of litters per year.

Distribution



Historic: Merriam's mouse was found in the large mesquite forests along rivers throughout Pinal, Pima, and Santa Cruz counties in Arizona and into Sonora, Mexico. In Arizona it has been found in the south-central part of the state, from just north of Florence at the north, southeast of Tucson to the east, and Quitobaquito to the west (Hall and Kelson 1959; Hoffmeister 1986). In Pima County the species has been found in areas of Organ Pipe Cactus National Monument, Sabino Canyon, Arivaca, Baboquivari Mountains, San Xavier and Fort Lowell (Hoffmeister 1986).

Present: Most areas where Merriam's mice were historically present have been altered and recent records are lacking as to whether the species persists in these areas. These areas include the Santa Cruz River area (San Xavier) before the bosques were removed in the early part of the twentieth century for firewood (Phillips et al.1964), and at Wilmot Station southeast of Tucson where they were formerly taken in large numbers (BISON-M 2000). After more than 20 years of trapping efforts, a Merriam's mouse was collected at Organ Pipe Cactus National Monument in 1988, the first record from this area since 1907 (Petryszyn and Russ 1996), but it was not at the same location at which this species had been found previously. SWCA shows other known locations within Pima County, mostly on southeast and south-central areas (Figure 7).

Demographics

Density: There is no known information on density. Apparently this species was quite common in its appropriate habitat at one time (Hoffmeister 1986).

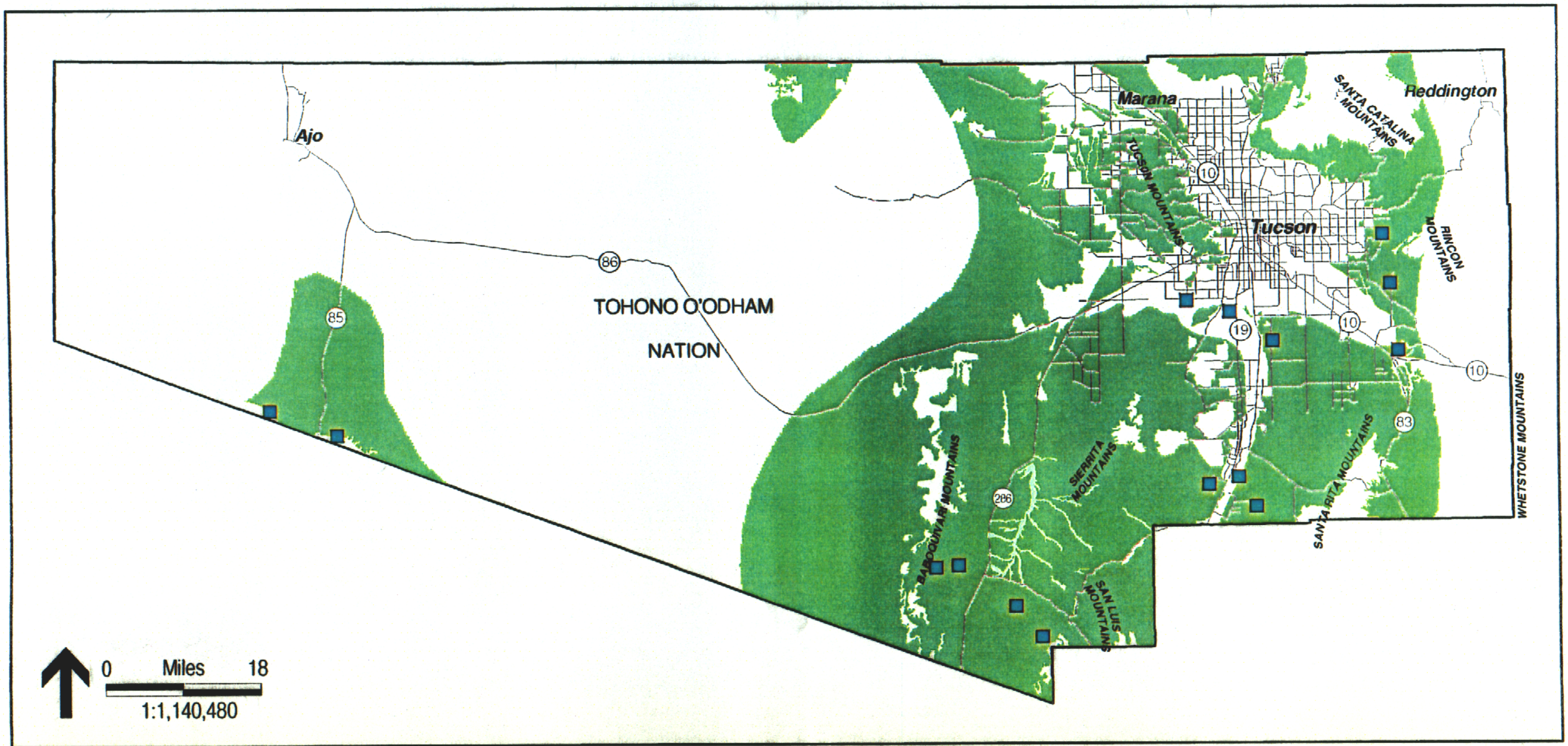
Status: Apparently this species has suffered severe declines caused by loss of habitat, but there are no known specific records based on recent trapping throughout its formerly known range to document this.

Trend: There is no known current or recent information on population trends. Based on loss of habitat, it appears that this species has been extirpated from much, if not all, of its former range in Pima County.

Survival rates: There is no known information on survival rates.

Reproduction rates: There are typically 2 to 4 young per litter.

Age ratios: There is no known information on age ratios.



Merriam's Mouse
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(SWCA, 2000)
Merriam's Mouse
(Peromyscus merriami)

Potential Habitat
(GAP, 1994)
Low Value
Medium Value

Figure 7

Sex ratios: There is no known information on sex ratios.

Significant Pima Co. populations: There is no current information on significant Pima County populations. As far as is known, there is only 1 record of this species from Pima County in the last 30 years.

Habitat Requirements

General: Merriam's mice are known primarily from heavy, forest-like stands of mesquite (bosques). They have also been found in thick stands of mesquite, cholla, prickly pear, paloverde, and grasses (Hoffmeister 1986).

Home range requirements: There is no information on the specific home range needs of this species.

Ability to use major land use categories: Merriam's mouse is believed to depend heavily on the presence of riparian woodland and dense mesquite forests, and it is unlikely they can persist where these are lacking.

Habitat trends in planning area: Human activities have altered many riparian areas and resulted in removal of large mesquites. Continued depletion of groundwater may kill many larger riparian trees and prevent establishment and regeneration of mesquite bosques. Few large mesquite bosques remain.

Current and Potential Threats

General: The greatest threat to Merriam's mouse is loss and degradation of mesquite-forest habitat.

Location, amount, and quality of protected habitat: Under current conditions, small mesquite bosques are present in Organ Pipe Cactus National Monument, Saguaro National Park, Buenos Aires National Wildlife Refuge, Empire-Cienega Natural Resource Conservation Area, Coronado National Forest, Cienega Creek County Park, and Colossal Cave County Park. It is not known whether this species persists in these areas. Only 1 specimen has been caught in more than 20 years of trapping efforts at Organ Pipe Cactus National Monument. Also, mesquite bosques remain on small parcels of private land along Tanque Verde Creek, Cienega Creek, Rincon Creek, and perhaps elsewhere, but there are no known recent records of trapping surveys having been done along any of these drainages.

Existing and potential pest species: There are no identified pest species. However, near human habitation, feral cats may impact this species, and house mice may compete with it.

Threat mechanism: Loss of habitat through cutting of firewood or clearing for grazing or other development. Groundwater depletion in many places resulted in loss of formerly lush riparian areas with large mesquites or dense vegetation. Reestablishment and regeneration of suitable habitat for this species may be precluded by groundwater depletion.

Management Needs

General: Preservation of existing mesquite bosques and reestablishment of mesquite bosque habitat may benefit the Merriam's mouse, if it persists or can be reintroduced. A systematic program of trapping in apparently suitable habitat for this species is necessary to determine its current range and status.

Current protective measures: The Merriam's mouse has been designated as a Species of Special Concern by the State of Arizona (AGFD 1996). This status affords no specific protection. Some of its potential habitat lies within protected areas, where collecting and habitat destruction may be regulated.

Sensitivity to human activities and densities: There is no information on sensitivity to human activities. Of course, as human population has increased, and with it groundwater depletion and loss of mesquite bosques, this species has probably declined.

Corridor needs: There is no known information on corridor or dispersal needs. It is possible that this species requires large contiguous mesquite bosques along river corridors for its long-term survival, but this has not been demonstrated.

Key relationships: Merriam's mouse is apparently totally dependent on large mesquites. It may also require a mixture of other plants such as cacti, paloverde, and grasses.

Migratory requirements: The species is not known to migrate.

Results of past mitigation activities: No specific results are known, and no specific mitigation activities are known. This species has apparently disappeared from the Quitobaquito Springs area in Organ Pipe Cactus National Monument, where it was last found in 1907, despite more than 60 years of protection of the habitat.

Existing monitoring and research programs: There are no known monitoring and research programs for this species. A long-term program of trapping for small mammals is continuing at Organ Pipe Cactus National Monument (Peterson 1999).

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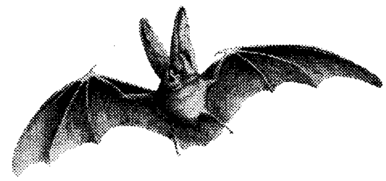
Pale Townsend's big-eared bat (*Plecotus townsendii pallescens*)

Status



Federal	Species of Concern (former Category 2 candidate) (AGFD 1998a)
State	Wildlife of Special Concern in Arizona (AGFD 1996)
Other	Vulnerable Status 2 in SDCP
Rankings	G4T4 S3S4 (AGFD 1998a)

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The scientific and common names of this bat have been changed several times over the past 50 years.

Classification: Order: Chiroptera; Family: Vespertilionidae; Genus: *Plecotus;* Species: *townsendii;* Subspecies: *pallescens.*

Synonymy: *Corynorhinus townsendii; Corynorhinus rafinesquii; Corynorhinus macrotus.*

P. townsendii is the currently recognized name. Pale Townsend's big-eared bat, lump-nosed bat, western big-eared bat, and long-eared bat have also been used as common names (AGFD 1998b), but the current common name is pale Townsend's big-eared bat (Jones et al. 1997).

Specific: This is 1 of 5 species in the genus *Plecotus* (excluding *Idionycteris phyllotis* which is sometimes included in the genus *Plecotus*). It is 1 of 3 species of *Plecotus* in North America and the only species of the genus in Arizona. This species is considered the most variable and progressive in the genus *Plecotus*. All Arizona populations are considered to be the subspecies *P. t. pallascens*, 1 of 5 subspecies in the species (AGFD 1998b).

Life History

Description: The pale Townsend's big-eared bat is a pale yellowish brown medium-sized bat, forearm 1/56 to 1.88 inches (39.0-47.0 mm), wingspan averaging between 11.5 and 12.5 inches (29 31 cm), and body length of 2 to 2.5 inches (5 to 7 cm). It has large, hairless ears, 1.2 to 1.6 inches

(30.0-39.0 mm) in length. It has a large glandular lump on each side of the nose (Noel and Johnson 1993; AGFD 1998b).

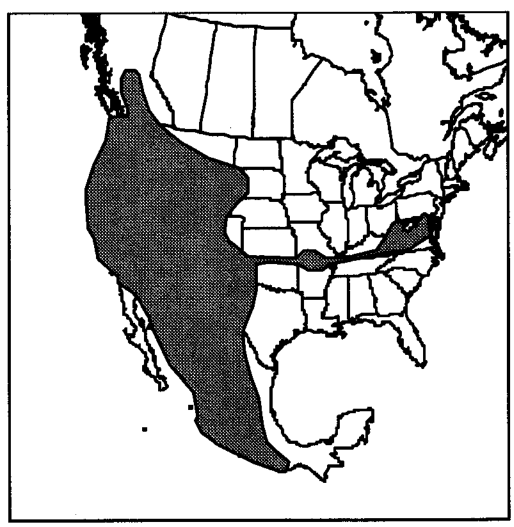
Reproduction: *P. t. pallescens* mates in October, but delayed fertilization occurs. One young is born per year. Dates of birth vary considerably throughout their range, with reports from late April to mid July. In Arizona most young are flying by the end of July. Females congregate in maternity colonies of 12 to several hundred individuals, usually in mines and caves. In Arizona, 5 and possibly 2 additional maternity colonies have been found with numbers in 1 of about 100 and in another of several 100s (AGFD 1998b).

Behavior: This species typically forages in darkness and is rarely seen at dusk. They forage for an hour or two, then rest in a night roost. They generally roost in caves or mines, occasionally in buildings. These bats prefer to hang from open ceilings at roost sites and do not use cracks or crevices. At maternity roosts these bats apparently prefer dim light near the edge of the lighted zone. In Arizona, emergence times and especially return times and patterns probably vary as they do elsewhere depending on insect activity and development stage of young (AGFD 1998b).

Winter roosts generally contain fewer individuals (usually singles or small groups and in Arizona occasionally as many as 50) than summer roosts. For hibernation they prefer roost sites with temperatures between about 12° and 0° C. These may be near entrances and in well-ventilated areas of the roost. The bats may arouse and move to other spots in the roost during the winter so as to be in areas of more stable cold temperatures. The ears are erectile and can be collapsed and rolled up while at rest and expanded to usual size when alert (AGFD 1998b).

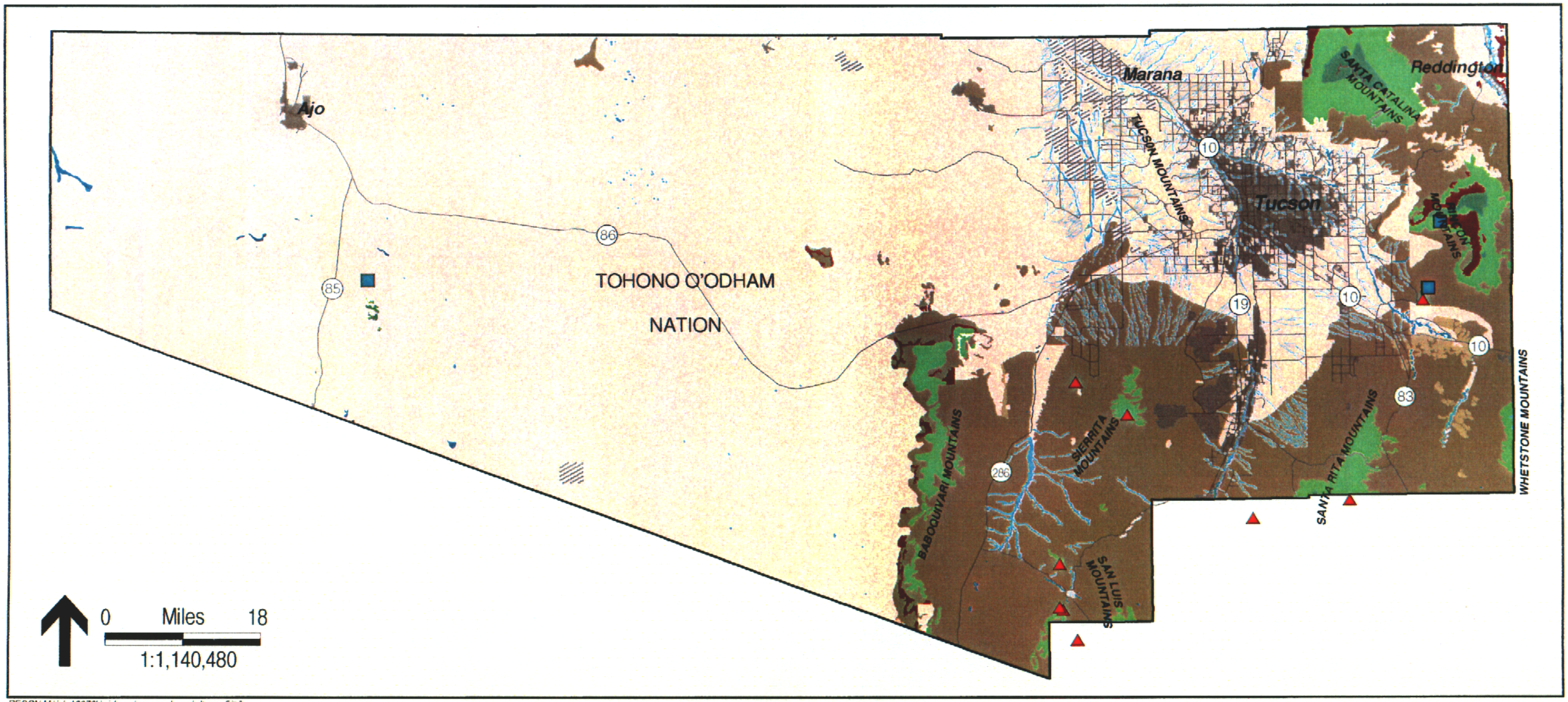
Diet: This bat feeds primarily on small moths that it catches in flight. It may also glean insects off of vegetation while it is in flight (Noel and Johnson 1993).

Distribution



Historic: This species is known from western North America from southern British Colombia south through the Pacific Northwest and southern California on the west and the Black Hills of South Dakota and West Texas on the east through the Mexican uplands to the Isthmus of Tehuantepec in southern Mexico. Isolated, presumable relictual, populations also exist in the Ozark Mountains of Oklahoma, Missouri, Arkansas, Kentucky, Virginia, and West Virginia (Hoffmeister 1986; Noel and Johnson 1993; AGFD 1998b).

Present: There is no evidence that the current range differs from the historic range. In Pima County, this species is frequently found, usually no more than one or a few at a time, in inactive mines and caves, and occasionally in buildings. It has been found in a wide variety of habitats from deserts to mountains, but is nowhere common (Hoffmeister 1986; Noel and Johnson 1993; AGFD 1998b) (Figure 8).



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Pale Townsend's Big-eared Bat
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)
▲ Pale Townsend's Big-eared Bat
(Plecotus townsendii pallescens)

Known Locations
(SWCA, 2000)
■ Pale Townsend's Big-eared Bat
(Plecotus townsendii pallescens)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 8

Demographics

Density: This species is rarely found in numbers greater than 10, but there are records of maternity colonies exceeding several hundred individuals (Hoffmeister 1986; Noel and Johnson 1993; AGFD 1998b).

Status: Unclear, though there have been losses/reductions of maternity colonies (AGFD 1998b).

Trend: The most populous colony in Arizona (Stanton's Cave in the Grand Canyon) disappeared in the 1970s shortly after the roost site was gated to protect archeological and paleontological remains. After the gate was modified in the mid 1980s several bat species (but not *P. townsendii*) were observed flying inside the site. Current status of these sites is unknown (AGFD 1998b). The population appears to be declining (AGFD 1996).

Drastic population declines for this species have occurred in California throughout the last 40 to 60 years. Among these declines are a 52% loss in the number of maternity colonies, a 44% decline in the number of roosts, a 55% decline in the number of animals, and a 32% decrease in the average size of remaining colonies in the state. The lower Colorado desert along the Colorado River, an area that experiences heavy recreational use, is 1 of 3 areas in California in which marked declines in the numbers of pale Townsend's big-eared bat colonies have taken place (Pierson and Rainey 1994, cited in LCR MSCP 1999). The overall population trend appears to be declining in Arizona, as well. Currently, there are only 13 verified maternity roosts in the state, representing 10 separate colonies, with a total population of about 1,000 adult females (Pierson and Rainey 1994, cited in LCR MSCP 1999). More than half of the known maternity roosts are in mines, and only 4 of these roosts contain 200 or more individuals. There may be losses or reductions of maternity colonies, which are easily disturbed; these disturbances often result in abandonment (AGFD 1996). In the absence of human disturbance, maternity colonies tend to remain stable over time (Pierson and Rainey 1994, cited in LCR MSCP 1999).

Survival rates: No information is known to be available on this aspect of the species biology.

Reproduction rates: No information is known to be available on this aspect of the species biology.

Age ratios: No information is known to be available on this aspect of the species biology.

Habitat Requirements

Ability to use major land use categories: This species is known to use caves, mines and buildings (generally abandoned or inactive) through a range of elevations and vegetation communities. It has been found in Sonoran Desert Scrub (both Arizona Upland and Lower Colorado River Valley subdivisions), Madrean Evergreen Woodland (oak woodland, oak/pine, and pinyon/juniper), and coniferous forests in Arizona.

Habitat trends in planning area: Apparently the most important limiting habitat element is roosts that are relatively free from disturbance. A large number of potentially suitable roosts were created by mining activities in the past two centuries. Many of these are gradually crumbling, and many are subject to exploration by people, some of whom disturb the bats either intentionally or unintentionally.

Home range requirements:. A suitable roost site appears to be the most important requirement. Water and abundant moths are also necessary. The foraging range is not well understood.

Current and Potential Threats

General: Disturbance of roosts appears to be the most important threat. Renewed mining, closure and sealing of abandoned mines naturally or for hazard abatement, and, possibly, the use of non-target pesticides are all considered threats (AGFD 1996). Historical alteration in the vegetation community along the Lower Colorado River is considered to have changed the available food supply for this species (LCR MSCP 1999), and similar conditions have occurred along the Santa Cruz River.

Pima County populations location, amount, and quality of protected habitat: This species is known to use Colossal Cave as a maternity roost (Yeatts n.d.). It has also been found in the Tucson Mountain Park (Hoffmeister 1986). This species is known from Organ Pipe Cactus National Monument (Organ Pipe Cactus National Monument 1999) and Saguaro National Park where a maternity roost of approximately 50 was present in 1992 (Davis and Sidner 1992).

Existing and potential pest species: None are known.

Threat mechanism: Disturbance of roosts and possible changes in foraging habitat.

Management Needs

General: Management needs for this species include:

- the development of consistent, effective monitoring methods;
- surveys to identify important summer and winter roost sites and foraging areas;
- surveys to locate, census, and monitor maternity colonies;
- protection of maternity and hibernaculum roosts using bat-friendly gates and weathering zone stabilization;
- buffer zones to protect maternity roosts from human access during roost occupancy; and (6) mitigation against or prevention of renewed mining activity near significant roosts and foraging areas (AGFD 1996, 1998b).

Current protective measures: Human access to some sites is limited by policy, procedure, and terrain. Some caves and mines known to have this species have been gated, but the extent to which this has occurred in Pima County is not known.

Sensitivity to human activities and densities: This species is said to be very sensitive to disturbance at its roost sites

Corridor needs: None are known for this species.

Key relationships: This species is dependent on caves and mines for roosts, and on moths for food.

Migratory requirements: None are specifically known for this species. It does use different roosts in winter and summer, so suitable roosts may be considered migratory requirements.

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for this species. The new gate at Stanton's Cave is purported to have improved conditions for this species (AGFD 1998b).

Existing monitoring and research programs: AGFD has an active program of bat research and protection of important roosts. Organ Pipe Cactus National Monument also has an active program of bat research. No species-specific studies are known to be currently underway in this area.

The following management recommendations were developed by the Idaho State Conservation Effort for the conservation of the pale Townsend's big-eared bat across its range in North America:

- evaluate all abandoned mines on public land, and publicly funded closures on private lands for bat habitat prior to closure;
- install bat gates for the protection of roost locations that support significant hibernacula and maternity colonies, where feasible;
- prohibit visitor access to hibernacula and maternity colonies during critical times of the year;
- designate caves or mines that are critical to the conservation of the pale Townsend's big-eared bat as Areas of Critical Environmental Concern (ACEC) and/or Research Natural Areas (RNA) on BLM and USFS managed lands;
- develop a list of all pale Townsend's big-eared bat roosts within potential pesticide spray blocks and survey potential spray blocks for additional roosts;
- establish 2-mile radius buffer zones around all known pale Townsend's big-eared bat roost sites in which no pesticide application will occur;
- maintain or improve riparian and wetland habitats within a 16 km (10 mile) radius of roost sites to achieve healthy and diverse structure; and
- strictly follow American Society of Mammalogists guidelines for roost entry procedures and limitations.

Research recommendations include examining the range of roost sites used by the species; evaluating forage habitat usage and develop baseline data on prey species; developing predictive roost site evaluation criteria; and determining direct and indirect effects of pesticide spraying (ISCE 1995, cited in LCR MSCP 1999).

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Arizona shrew (*Sorex arizonae*)

Status

Federal	Species of Concern (Former Category 2 Candidate) (AGFD 1998)
State	Wildlife Species of Special Concern in Arizona (AGFD 1996)
Other	Forest Service Sensitive (Region 3 and 5); Vulnerable Status 2 by SDCP
Rankings	G3 S2S3

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This shrew is known only from high mountain ranges of southeastern Arizona. It was previously mistakenly identified as either *S. merriami an S. monticollis* but appears to be a unique species.

Classification: Order: Insectivora; Family: Soricidae; Genus: *Sorex;* Species: *arizonae.*

Specific: This is a monotypic species that may be closely related to *S. oreopolus emarginatus* or *S. merriami.* It was described in 1977 from a type specimen taken in Miller Canyon, in the Huachuca Mountains, Cochise County, Arizona (AGFD 1997).

Life History

Description: The Arizona shrew is a small brownish gray mammal, with a body length of 2 to 2.5 inches (50-73 mm), and a total length of 3.6 to 4.5 inches. It may weigh between 0.06 and 0.1 ounce (1.9 and 2.9 gm). It has 5 toes on each foot. Its ears and eyes are small. Its tail is relatively long, greater than half (65%-95%) the body length and indistinctly bicolored. Its teeth are characterized by 5 upper unicuspids, without pigmented ridge and tines always present on medial sides of first upper incisors.

Diet: Arthropods, earthworms, slugs, etc. (AGFD 1997).

Reproduction: No known information is available about reproduction in the Arizona shrew, except that a lactating female was caught on 17 September 1992 (Van Pelt et al. 1994).

Behavior: No specific information is known on the behavior of the Arizona shrew, except that it was captured only at and after the peak of the summer rains, and it was speculated that these seasonal rains might trigger breeding and dispersal of Arizona shrews (Van Pelt et al. 1994). It is presumed that this species behavior does not differ especially from that of other shrews, which are extremely voracious predators during the active season of the year, and that there is a dormant season during times when conditions do not support activity.

Distribution

Historic: All records of the Arizona shrew are from high mountain ranges in southeastern Arizona and western New Mexico. In Arizona, they have been recorded from the Huachuca, Santa Rita, and Chiricahua Mountains. They were not captured in the Whetstone, Dragoon, or Rincon Mountains by biologists using techniques that have proven to be effective for capturing this species and working during seasons that this species was known to be active (Davis and Sidner 1992; Van Pelt et al. 1994). In New Mexico, they are known from the Animas Mountains, and they are also known from Chihuahua, Mexico, at 1 location (AGFD 1997).

Present: The present distribution is probably the same as the historic distribution, although Hoffmeister (1986) attributed 2 specimens to Pima County in the Santa Rita Mountains. However, on careful inspection, the cited capture sites are south of the county line in Santa Cruz County (Figure 9), and there is no suitable habitat for this species in the Santa Rita Mountains in Pima County.

Demographics

Density: No known information is currently available regarding density of natural populations.

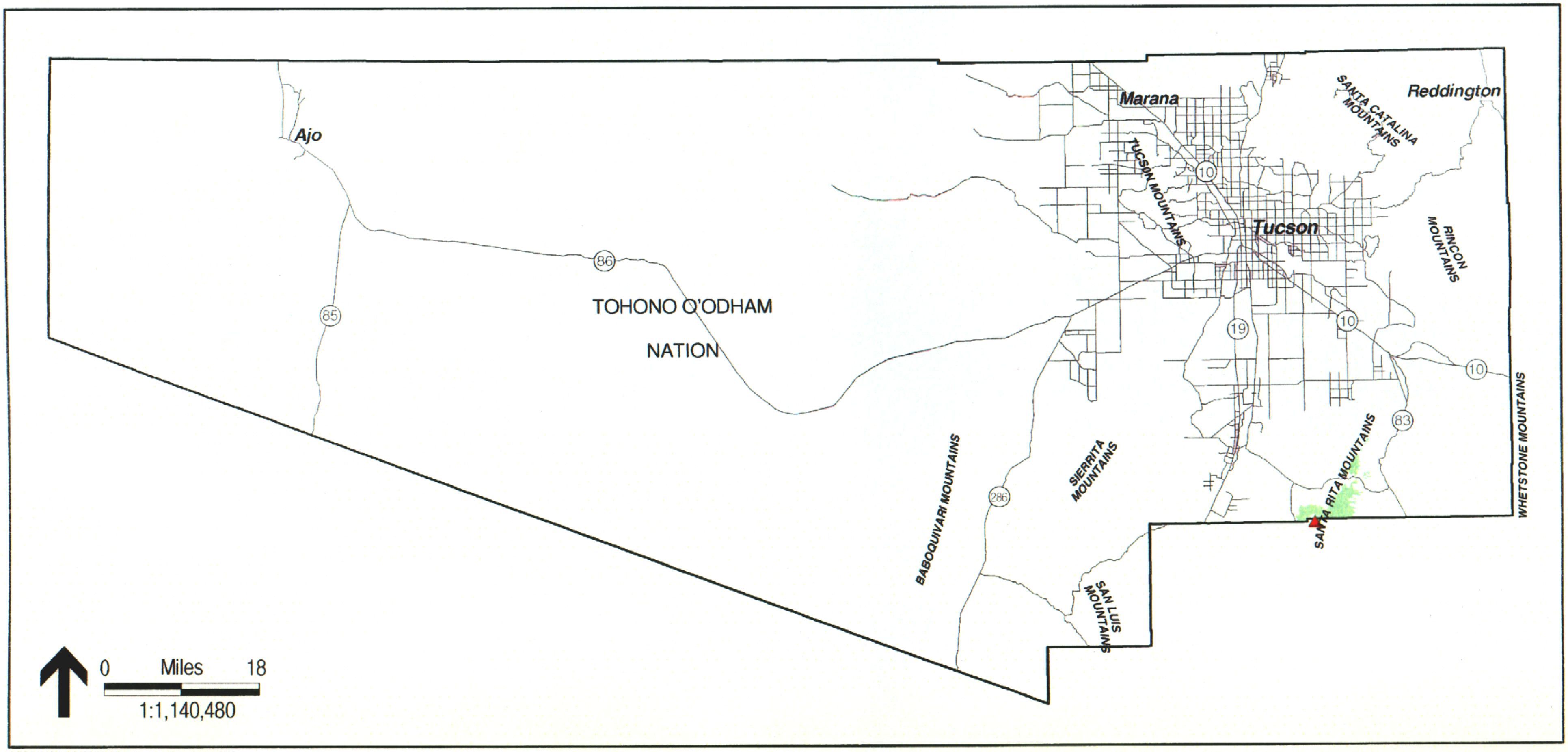
Status: Nothing is known of the status of this species. Recent (1992-1993) trapping efforts doubled the number of known specimens by using better techniques than had been previously used.

Trend: Population trends are not currently known.

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations.

Age ratios: No known information is currently available regarding age ratios in natural populations.



Arizona Shrew
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(HDMS, 2000)
Arizona Shrew
(Sorex arizonae)

Potential Habitat
(GAP, 1994)
Low Value

Figure 9

Significant Pima Co. populations or subpopulation basis in planning area: This species has not been recorded from Pima County. Previous records from the Santa Rita Mountains are from outside Pima County.

Habitat Requirements

Ability to use major land use categories: This species is known only from high elevation (above 5,675 feet [1,730 m]) locations in areas with downed woody debris, generally near surface water along drainages in mountain canyons (Van Pelt et al. 1994).

Habitat trends in planning area: Because there are no known records of the species within the planning area, no statements concerning habitat trends can be supported. All potentially suitable habitat within the planning area is within National Forest or National Park boundaries.

Home range requirements: Apparently this animal depends on downed woody debris, and it may also depend on water, but water by itself is not a sufficient condition for its presence (Van Pelt et al. 1994).

Current and Potential Threats

General: Fires may destroy the downed woody debris that is associated with locations at which this animal was captured (Van Pelt et al. 1994).

Pima County populations location, amount, and quality of protected habitat: No is known, this species is not known from Pima County. All potentially suitable habitat for this species is within Saguaro National Park or the Coronado National Forest.

Existing and potential pest species: No are known or have been speculated.

Threat mechanism: Destruction of some habitat elements (woody debris) by fire may be a threat.

Management Needs

General: More information is needed in order to formulate management needs for this species. Therefore, the most pressing management needs are for research efforts that will help to understand the habitat requirements for this species, its distribution, and human activities that may harm or benefit it.

Current protective measures: None are known specifically.

Sensitivity to human activities and densities: It is possible that human disturbance of the limited habitat of this species may harm it, but that has not been documented.

Corridor needs: None are known.

Key relationships: This species is associated with downed woody debris on the forest floor. It may also be associated with water.

Migratory requirements: None are known.

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for this species.

Existing monitoring and research programs: No information is currently known regarding existing monitoring and research programs for this species.

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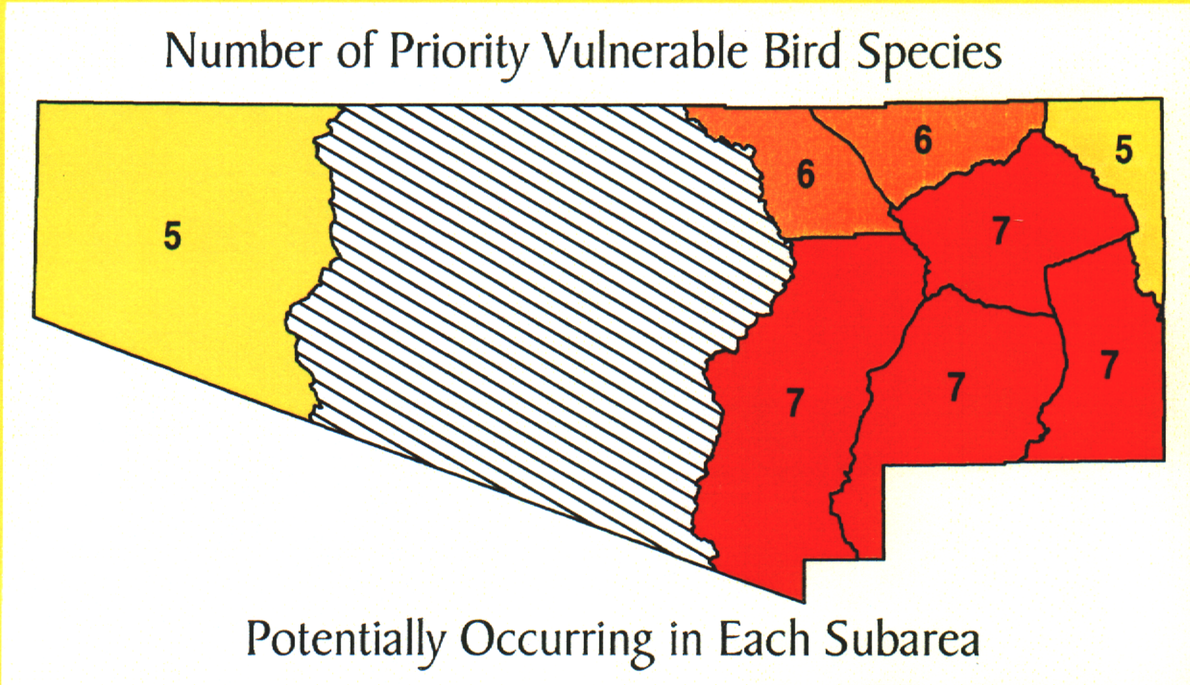

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Rufous-winged sparrow (*Aimophila carpalis*)

Status

Federal	Listed as a "migratory bird" under the Migratory Bird Treaty Act
State	None
Rankings	G4 S3

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The rufous-winged sparrow was first given the common name "Bay-winged Summer Finch" and the scientific name "*Peucaea carpalis*" by Coues in 1873, with the type specimen collected by Bendire in June, 1872, near Rillito Creek by Fort Lowell. It was listed as *Aimophila carpalis* in the American Ornithologists Union Checklists of 1886 and 1895. Several taxonomists have suggested placing this species in the closely allied genus *Spizella;* however, it remains in *Aimophila*, and a recent analysis indicates that this is appropriate (Lowther et al. 1999).

Classification: Order: Passeriformes; Family: Emberizidae; Genus: *Aimophila;* Species: *carpalis.* There are 3 recognized subspecies: *A. c. carpalis*, *A. c. bangsi*, and *A. c. cohaerens*. The subspecies present in Pima County is *A. c. carpalis*, which is larger and grayer above than the 2 southern (Mexican) subspecies (Lowther et al. 1999).

Life History

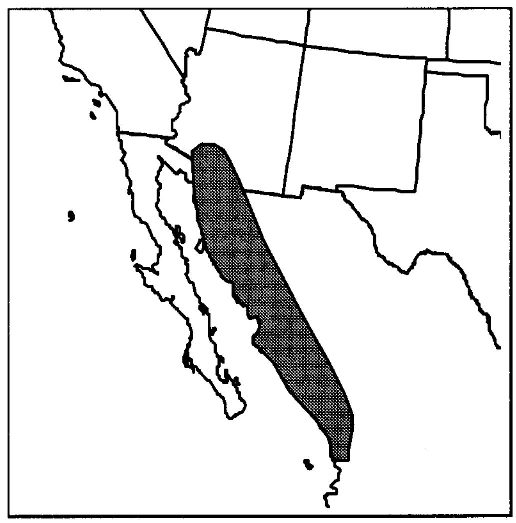
Description: The rufous-winged sparrow is a small (5.1-5.5 inches [13-14 cm], 15 g), distinctly marked sparrow. The adult has a gray head with black moustachial and malar stripes, narrow rufous postocular stripe, and rufous crown streaked with gray, often with a vague gray median stripe; grayish brown back streaked with dark brown; unstreaked pale gray underparts; dark brown wing-feathers edged buffy brown or rufous (on tertials), with 2 indistinct buffy white wing-bars, and rufous lesser wing-coverts (often concealed). The tail is long and rounded and the bill is distinctly bicolored, with the lower mandible orange-pink and the upper mandible dusky (except along cutting edges, which are the same color as the lower mandible). The sexes are similar and the adult plumages remain similar throughout the year. The juvenal plumage is similar but buffier, with distinct spotting or streaking on underparts, head streaked brown, less distinct facial pattern, and all dark bill (Lowther et al. 1999).

Diet: In Arizona during breeding season identified food items include small, green, inchworm-type caterpillars and blackish caterpillars and small (7-10 mm) grasshoppers. The bird also eats grass and weed seeds (Lowther et al. 1999).

Reproduction: The species is monogamous, with the pair bond maintained for life. The pair remains on the territory year-round. Territories appear to be maintained by song only; no physical encounters have been noted. Males are highly responsive to taped playbacks of their song, and will approach closely and sing. Incubation has been observed in the female only. The young are altricial and usually leave the nest between 7 and 10 days of age; they will remain with the parents for about 3 weeks or until hatching of eggs in a second brood (Lowther et al. 1999).

Behavior: Generally feeds by pecking at the ground and at the edges and bases of grass clumps, sometimes reaching or fluttering up to peck at grass clumps (Lowther et al. 1999).

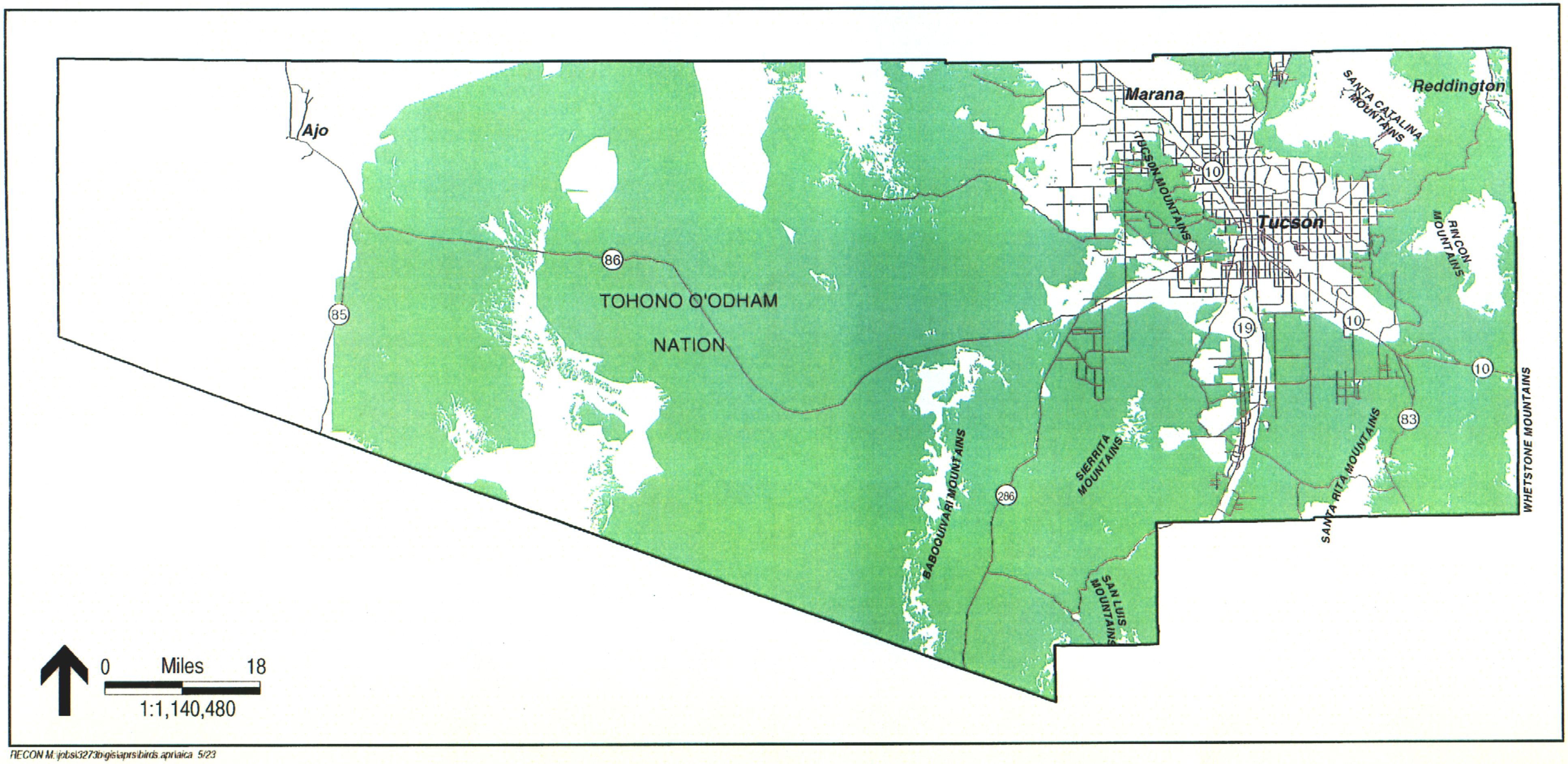
Distribution



Historic: Rufous-winged sparrows were found by Bendire near old Fort Lowell, Tucson, in "the early part of June," 1872. By 1884 the species had disappeared from the area. It was considered by the American Ornithologist's Union to be extirpated in Arizona due to overgrazing. The species reappeared, or was rediscovered, in the Tucson area in 1936 and has been recorded locally with some consistency (Phillips et al. 1964; Lowther et al. 1999).

Present: The rufous-winged sparrow is resident from south-central Arizona (Pinal County) south along the Pacific slope of Mexico through central Sonora to central Sinaloa. In Arizona, it is a resident in central and southern portions of eastern Pinal County (Red Rock, Oracle Junction), and in eastern two-thirds of Pima County (Figure 10) and western half of Santa Cruz County, including the Santa Cruz and Avra Valleys, and northern portion of the San Pedro River near Winkelman (Lowther et al. 1999). In Pima County specific locations include Saguaro National Park (east) and the Tucson area (Tucson Audubon Society 1999).

The Arizona Breeding Bird Atlas (Arizona Breeding Bird Atlas 2000) records bird locations only by U.S.G.S. 7.5-minute quadrangle names. Rufous-winged sparrows were recorded from 64 quadrangles in Pima County between 1993 and 1999. This represents the majority of quadrangles that have been surveyed in the county and shows a distribution that reaches almost throughout the county, wherever habitat conditions are appropriate. Most of the records are from the Altar and Avra Valleys and the Tohono O'odham Nation. Habitats in which this species was recorded and the proportion of the 64 records that were from each habitat are Arizona Upland Biome 73%, Lower Colorado River Biome 1.5%, Semidesert Grassland 6%, Sonora Savanna Grassland 3%, Urban/Agricultural (Parks) 1.5%, Sonoran Riparian Deciduous Forest and Woodlands 3%, and Sonoran Riparian Scrubland 8%. Several records were from residential, rural, and park situations,



Rufous-winged Sparrow Potential Habitat

Pima County Boundary
Major Road or Highway

Potential Habitat (GAP, 1994)
Low Value

Figure 10

indicating that this species may not be excluded by some level of human use and modification of the landscape.

Demographics

Density: Estimated breeding territory sizes range from 0.5 ha to 1.2 ha per pair. Density is extremely variable from year to year, depending upon timing and amount of rainfall (Lowther et al. 1999).

Status and trend: Because of extreme annual variation, status and trends are difficult to determine. However, early allegations that this species had been extirpated from the state indicate that at least for some period of time it was extremely rare, if present at all. In contrast, the number of records obtained during the 6 years of Arizona Breeding Bird Atlas research and the extent of the currently understood range suggest that the species is now fairly common and widespread.

Survival rates: No information is available on annual adult survival rate or on longevity (Lowther et al. 1999).

Reproduction rates: Clutches average 3-4 pale green or bluish white eggs. Nesting usually occurs in the early summer months. If the summer rains are sufficient there may be a second clutch after mid- to late July. The number of young reared per pair observed during a 4-year study varied from 1.1 to 2.7 (Lowther et al. 1999). In another study of 3 years' duration, annual production averaged 3.03 fledged young per pair.

Age ratios: Insufficient information is available to develop a life table (Lowther et al. 1999).

Sex ratios: Currently unknown (Lowther et al. 1999).

Significant Pima County populations: Most of the United States population of this species is in Pima County. Arizona Breeding Bird Atlas records indicate that this species is fairly widespread in appropriate habitat in Pima County and that there are no specific concentrations that should be deemed especially significant.

Habitat Requirements

General: Rufous-winged sparrows use flat or gently hilly Sonoran desert scrub and Sinaloan thorn scrub, characterized by scattered spiny trees and shrubs. Grasses are essential components. Hackberry (*Celtis* sp.), cholla species (*Opuntia* spp.), and paloverde (*Cercidium microphyllum*) almost invariably are present. Territories typically include some wash (riparian) habitat. Areas near Tucson where the species has been found include swales of tobosa grass, desert (dry) washes, riparian (flowing water) areas, farmland (brush and cleared areas along irrigation ditches) and deep-soil sites (spaced mesquite trees with many clumps of sacaton grass) (Lowther et al. 1999). Small numbers occur in oak savannahs at higher elevations.

Home range requirements: No information is available on home range requirements.

Ability to use major land use categories: Several Arizona Breeding Bird Atlas records were from residential, rural, and park situations, indicating that this species may not be excluded by some level of human use and modification of the landscape. However, most records are from apparently undisturbed areas. Lowther et al. (1999:3) stated: "Much of the land near Tucson is now unsuitable for rufous-winged sparrows because of urbanization, agriculture or grazing, but small populations do persist in some suburban areas."

Habitat trends in planning area: Despite some losses of habitat to urban development, the general trend is probably improving as a result of improved grazing management. Certainly the number of known locations has increased in the past 50 years, but the reasons for this apparent increase are not known.

Current and Potential Threats

General: Loss of habitat as a result of overgrazing and urban development is believed to have had the greatest effect on populations. Overgrazing in the desert habitats was alleged to have caused the local extirpation of the species in the 1880s from at least part of its range (Phillips et al. 1964). Apparent recovery of this species over the past 50 years may be related, at least in part, to improved grazing management.

Specific: Areas of continued overgrazing would require rest and restoration before they could become suitable habitat for this species. Development within the species habitat may impact the species, depending upon specifics of the development.

Location, amount, and quality of protected habitat: The species is known from Saguaro National Park, Buenos Aires National Wildlife Refuge, the Empire-Cienega Resource Conservation Area, and the Santa Catalina District of the Coronado National Forest. Information on the amount and quality of protected habitat for this species within those areas has not been determined.

Existing and potential pest species: Parasitism by brown-headed cowbirds was noted in as many as one-half of monitored nests at the time of the rufous-winged sparrow's discovery (1882) but has been reported infrequently since then. A study conducted in 1969 found rates of brood parasitism to be 7 cowbird eggs reared out of 90 sparrow nests (Lowther et al. 1999).

Threat mechanism: Loss of habitat through urban development or overgrazing.

Management Needs

General: Arizona Partners in Flight (a state, federal, and private partnership for conservation of native land birds) is developing a conservation plan for all of Arizona's breeding, winter and resident birds. In that plan, rufous-winged sparrow is recognized as a "priority species" and serves as one of the representative species for Lowland Grassland Priority Habitat (Lowther et al. 1999). Specific management needs, beyond protection of habitat from direct impacts of development and overgrazing, are not currently known.

Current protective measures: This species is protected under the Migratory Bird Treaty Act. The Migratory Bird Treaty Act makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird, including feathers, parts, nests, or eggs. Violations of the Migratory Bird Treaty Act are considered criminal offenses and can result in significant fines and imprisonment. In some cases, a conviction might also result in the forfeiture of equipment (vehicles, boats, airplanes, weapons, etc.) used during the commission of the crime (http://www.le.fws.gov/LE/Wildlife_Laws/MBTA/mbta.htm).

Sensitivity to human activities and densities: Insufficient information is available to support conclusions beyond that this species does not thrive in areas of dense human development and activity.

Corridor needs: No information is available to support conclusions or conjecture with regard to corridor needs.

Key relationships: Rufous-winged sparrows require flat or gently hilly desert grasslands, with scattered trees or shrubs, with grass of various species. They require seeds and arthropods for food. During hot hours in spring and summer, they forage in the deep shade portion of shrubs. When flushed by humans, rufous-winged sparrows generally fly to spiny shrubs or cacti (Lowther et al. 1999). More specific dependent relationships have not been demonstrated. This species is an occasional host of the brown-headed cowbird. There is no information on the kinds of predators that are likely to impact this species. Population fluctuations and survivorship appear to be closely tied to rainfall amounts and timing (Lowther et al. 1999).

Migratory requirements: Rufous-winged sparrows are nonmigratory, although individuals may move a short distance in winter months in search of food (Lowther et al. 1999).

Results of past mitigation activities: The apparent increase in this species may be at least partially due to improved grazing management; however, there are no systematic studies that correlate this species population with specific grazing management.

Existing monitoring and research programs: The Arizona Breeding Bird Atlas uses volunteers and professional staff to record the locations of all species of breeding birds in Arizona. It has resulted in an increase of understanding of the distribution of this species. Current monitoring studies of all birds are ongoing at several of the National Parks and Monuments, National Forests, Resource Conservation Areas, and National Wildlife Refuges; however, no species-specific monitoring is currently known.

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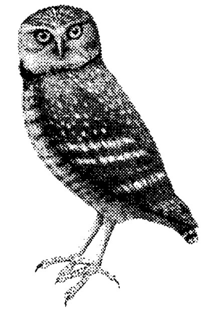
Burrowing owl (*Athene cunicularia hypugaea*)



Status

Federal	Listed as a migratory bird under the Migratory Bird Treaty Act
State	None
Other	Species of Special Concern in Utah; Vulnerable Status 2 by SDCP
Rankings	G4TU S4

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The burrowing owl has been variously placed in the monotypic genus *Speotyto* or *Athene.* It was placed in *Athene* by the American Ornithologists' Union in 1983, then moved to *Speotyto* in 1991 based on karyotypic evidence (Haug et al. 1993). It has since reverted back to *Athene* (BISON-M 2000).

Classification: Order: Strigiformes; Family: Strigidae; Genus: *Athene;* Species: *cunicularia.* There are up to 18 subspecies currently recognized that are geographically distinct and isolated (Clark et al. 1978), ranging from southern Canada through South America (Burton 1984). The subspecies occurring in Arizona is the western burrowing owl *A. c. hypugaea,* which occurs in North and Central America west of the eastern edge of the Great Plains (Haug et al. 1993).

Life History

Description: The burrowing owl is a small owl that measures from 7.5 to 10 inches (19 to 25 cm) in length and weighs about 5 ounces (150 g). The legs are long and sparsely feathered below the tibiotarsal joint. It has a round head with no ear tufts and a distinct oval facial ruff, framed by a broad, buffy white eyebrow-to-malar stripe on the interior part. The iris is usually bright lemon yellow. The wings are relatively long and rounded, with 10 brown and buffy white barred rectrices. The dorsum is brown; back, scapulars and crown profusely spotted with buffy white. The throat and undertail coverts are white; and the remainder of underparts of adults are buffy white with broad barring on both sides. Females are generally darker than males overall, particularly in worn plumage (Haug et al. 1993).

Diet: Burrowing owls are opportunistic feeders and take primarily arthropods, small mammals, and birds. Pellets collected in Arizona between June and August showed high proportions of scorpions, beetles, locusts and small rodents (Heteromyidae) (Haug et al. 1993).

Reproduction: The burrowing owl is predominantly monogamous, although pair bonds are not permanent in the western subspecies. Nests are constructed in preexisting holes from burrowing mammals or tortoises; owls are capable of digging their own burrows when holes are absent but rarely do so. Burrows are maintained by both adults by kicking backwards with their feet and digging with their beaks (Haug et al. 1993).

Behavior: Burrowing owls are primarily crepuscular in foraging habits but have been observed to hunt any time of the day or night. Insects are often taken during daylight and small mammals after dark. The owls hunt by walking, hopping, or running along the ground; flying from a perch; hovering, particularly over tall vegetation; and flycatching in the air. The prey is caught with the feet, but may be transferred to the beak for carrying or presentation to young (Haug et al. 1993).

Distribution

Historic: The historic range of the western burrowing owl (*Athene cunicularia hypugaea*) includes Arizona, California, Colorado, Idaho, Iowa, Kansas, Louisiana, Minnesota, Montana, North Dakota, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, South Dakota, Texas, Washington, Wyoming, Canada, and Mexico. Migratory populations breed in North America and may winter as far south as Guatemala or El Salvador (BISON-M 2000).

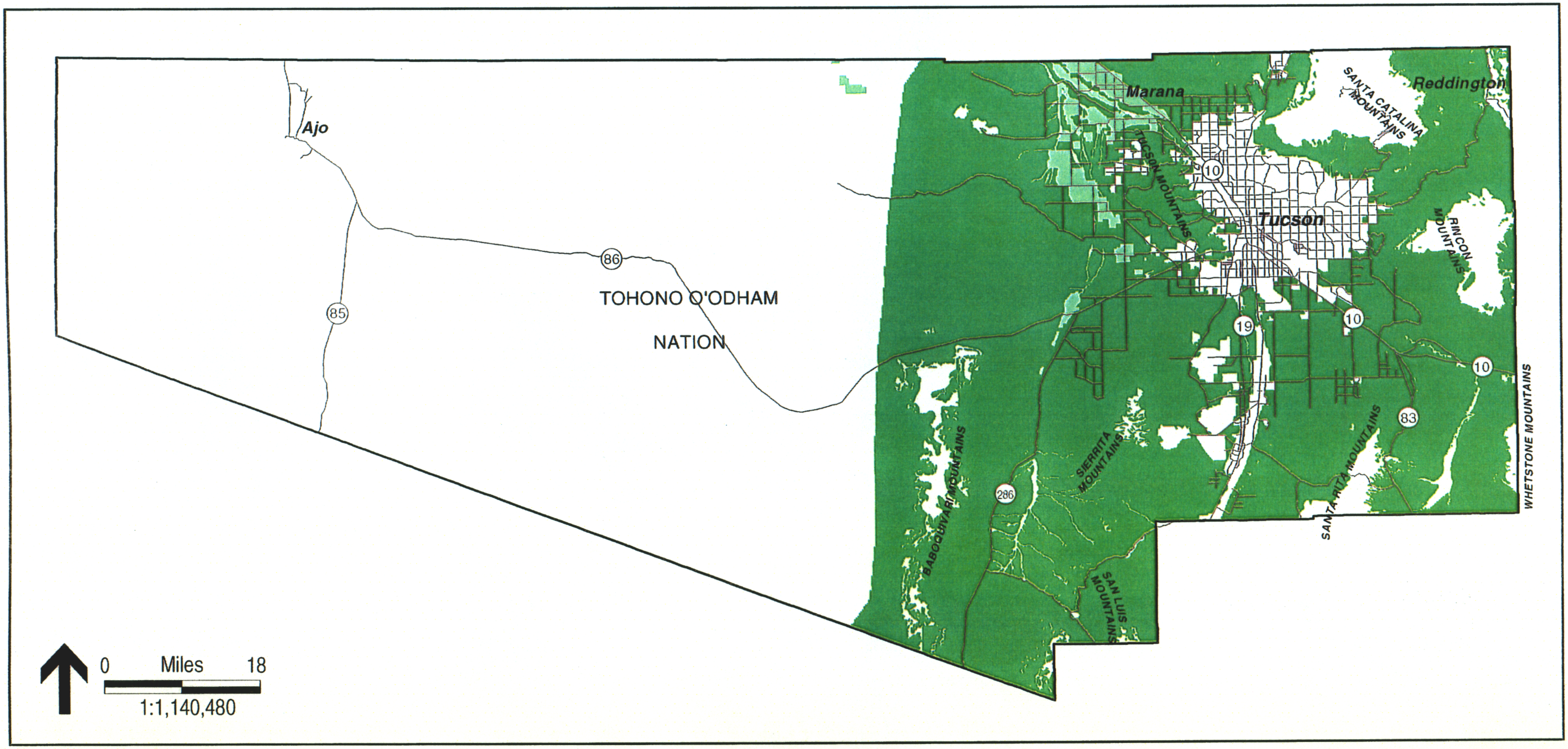
Present: In Arizona the burrowing owl has been recorded from Apache-Sitgreaves, Coconino, Coronado, Kaibab, Prescott and Tonto National Forests (BISON-M 2000).

The Arizona Breeding Bird Atlas (2000) records bird locations only by U.S.G.S. 7.5-minute quadrangle names. Burrowing owls were recorded from 5 quadrangles in Pima County between 1993 and 1999: Childs Mountain, Cat Mountain, Palo Verde Camp, Tucson SW, and west of Marana. Of the 5 records, 2 are from the Lower Colorado River Valley Subdivision of Sonoran Desert Scrub, and 2 records are from Urban/Agricultural areas (rural and cropland). The fifth did not have habitat descriptors recorded.

GAP mapping includes most lower-elevation areas in the eastern one-third of the county as potential burrowing owl habitat (Figure 11).

Demographics

Density: Burrowing owls may form loose nesting colonies; however, distances between nests have been found to vary greatly from 2,900 feet (900 m) in a colony in Idaho to less than 45 feet (14 m) in a colony in Texas (Haug et al. 1993). Nesting densities have been noted to vary from 8 pairs per



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Burrowing Owl Potential Habitat

Pima County Boundary

Major Road or Highway

Potential Habitat (GAP, 1994)

Low Value

Medium Value

Figure 11

square km in optimal habitat to 1 pair per 58 square km in poor habitat (LCR MSCP 1999). Nest burrows and territories are defended against conspecifics and other species, but feeding areas are not (Haug et al. 1993).

Status: Burrowing owls are uncommon residents of grasslands and open areas of desert scrub. They have declined in recent years (Tucson Audubon Society 1999), but no available information attempts to explain this purported decline.

Trend: Burrowing owls have declined in abundance throughout most of their range (Haug et al. 1993). In the western states, 54% of 24 jurisdictions reported burrowing owl populations decreasing, and there were no reported increases (LCR MSCP 1999).

Survival rates: No known information is available on survival rates for burrowing owls.

Reproduction rates: There is generally 1 brood per season which occurs from March to April. The female may re-nest if the first clutch is destroyed early in the season. Clutches consist of 7 to 9 round-ovate white eggs, averaging 0.25 inch (32 mm) long and about 1 inch (26 mm) broad. Eggs are incubated for 28 to 30 days. Young are born altricial and fledge at 44 days. Studied hatching successes ranged from 88.0% and 90.3% in Idaho to 64% and approximately 55% in California, for owls using artificial burrows. Fledging success has ranged from 4.9 to 2.9 fledged young per successful nest (Haug et al. 1993).

Age ratios: No known information is available on age ratios.

Sex ratios: No known information is available on sex ratios.

Significant Pima Co. populations: This bird is extremely rare in Pima County, so that all known populations should be considered significant and efforts should be made to locate more.

Habitat Requirements

General: Within their geographic range, burrowing owls inhabit open areas such as grasslands, pastures, coastal dunes, desert scrub, and the edges of agricultural fields. They also inhabit golf courses, airports, cemeteries, vacant lots, and road embankments, wherever there is sufficient friable soil for a nesting burrow (Haug et al. 1993).

Home range requirements: The presence of a nesting burrow (such as that of a badger, prairie dog, tortoise or other animal) seems to be the critical requirement for the western subspecies (Haug et al. 1993).

Ability to use major land use categories: Agricultural areas such as fields and croplands often provide optimal habitat for burrowing owls, as do moderately grazed areas. Urban development in these areas may result in a loss of habitat.

Habitat trends in planning area: Habitat for this species may be declining as agricultural lands are developed for urban use.

Current and Potential Threats

General: Predation is a major cause of mortality in burrowing owls. The dominant mammalian predators of burrowing owls are badgers (*Taxidea taxis*); other predators include opossums (*Didelphis virginiana*), weasels (*Mustela* spp.), skunks (*Mephitis* spp.), and domestic dogs and cats. Avian predators include Swainson's hawks (*Buteo swainsonii*), ferruginous hawks (*B. regalis*), merlins (*Falco columbarius*), prairie falcons (*F. mexicanus*), peregrine falcons (*F. peregrinus*), great horned owls (*Bubo virginianus*), red-tailed hawks (*B. jamaicensis*) and Cooper's hawks (*Accipiter cooperii*). Other observed causes of mortality include human disturbance through agricultural and construction activities, collisions with vehicles (the owls habitually sit and hunt on roads at night), and toxic chemicals such as insecticides and strychnine-laced grains (often dispersed for rodent and insect pest control in agricultural areas where birds nest). Also, a decline in the population of burrowing mammals may adversely affect owls through a lack of burrows (Haug et al. 1993).

Location, amount, and quality of protected habitat: No known habitat of this species is specifically protected for it in Pima County, and, to the best of our knowledge, it does not occur in areas that are protected except as a rare transient.

Existing and potential pest species: Burrowing owls have been reported suffering from body parasites such as lice (*Colpocephalum pectinatum*), sticktight fleas (*Echidnophaga gallinacea*), and human fleas (*Pulex irritans*). Several species of nest arthropods and fleas have been found in burrows (Haug et al. 1993). Many species of predators (listed above) are known to prey on burrowing owls.

Threat mechanism: Threats include loss of habitat through urban development in agricultural or rural areas; direct toxicity or loss of prey resulting from use of insecticides or rodenticides for pest management purposes in areas where burrowing owls breed; reduction in nest sites resulting from decreases in burrowing mammal population; and direct mortality from vehicular collisions.

Management Needs

General: Management measures that have been proposed for burrowing owls include protecting burrowing mammal populations to provide nesting habitat for burrowing owls; creating artificial burrows where natural burrows are destroyed or limited; providing artificial perches where limited for hunting and predator observation; and managing vegetation for foraging habitat through fire or grazing (LCR MSCP 1999). Pima County populations are especially important since there has been a decrease in populations within Pima County (Tucson Audubon Society 1999) as well as others throughout other Arizona lowlands (Phillips et al. 1964; Johnson et al. 1979; Witzeman 1997).

Current protective measures: This species is protected under the Migratory Bird Treaty Act. The Migratory Bird Treaty Act makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird, including feathers, parts, nests, or eggs. Violations of the Migratory Bird Treaty Act are considered criminal offenses and can result in significant fines and imprisonment.

Sensitivity to human activities and densities: Agricultural and residential development has reduced available habitat for burrowing owls. Chemical pest management in agricultural areas can result in either direct mortality or reduced productivity of owls. Increased vehicular traffic results in more collisions with owls. Scientific research involving digging up of burrows and nests causes destruction and abandonment of these sites. Human activities that reduce quality of prey habitat and thus lower food supplies result in poorer reproductive success in females (Haug et al. 1993).

Corridor needs: No specific information is known for corridor needs for this species.

Key relationships: The burrowing owl nests in desert valleys and grasslands and is often found in association with prairie dog colonies. However, there are no known prairie dog colonies in Pima County. Although it has not been specifically documented, it is most likely that this species depends on round-tailed ground squirrels in Pima County.

Migratory requirements: Most populations of the species are migratory to some extent. Whereas burrowing owls appear to be predominantly non-migratory in Florida, individuals banded in the Pacific Northwest have been found as far south as Mexico. Owls banded in the southern plains (Texas, Arizona, New Mexico, and Nevada) were recovered in the same states in which they were banded, suggesting short or no migration distances (Haug et al. 1993).

Results of past mitigation activities: No specific mitigation activities are known to have taken place in Pima County. The U.S. Fish and Wildlife Service has participated in and advocated construction of artificial nest burrows in other parts of the species range, and this has met with some success.

Existing monitoring and research programs: The Arizona Breeding Bird Atlas uses volunteers and professional staff to record the locations of all species of breeding birds in Arizona. It has resulted in an increase of understanding of the distribution of this species. Current monitoring studies of all birds are ongoing at several of the National Parks and Monuments, National Forests, Resource Conservation Areas, and National Wildlife Refuges; however, no species-specific monitoring is currently known, and this species is not known from any of these managed areas in Pima County, except as a rare fall and winter species on the Buenos Aires National Wildlife Refuge and a rare transient in Saguaro National Park.

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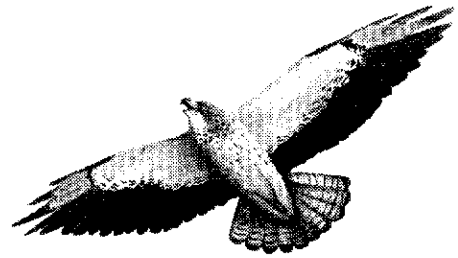
Swainson's hawk (*Buteo swainsoni*)

Status



Federal	Former federal Candidate, therefore a Species of Concern (AGFD 1998); protected by the Migratory Bird Treaty Act
State	Arizona Wildlife Species of Special Concern (AGFD 1996)
Other	Forest Service Sensitive (AGFD 1998); restricted from international trade by CITES
Rankings	G5 S3

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Swainson's hawk is a member of the subfamily Buteoninae (buzzard hawks) of the family Accipiteridae (hawks and eagles). The buteos are a diverse group of medium to large hawks that excel in the art of soaring (Dunne et al. 1988). They are recognizable by their broad tails and large, relatively rounded wings (NGS 1987). Twelve species of buteos breed in North America north of the Rio Grande (Dunne et al. 1988).

Classification: Order: Falconiformes; Family: Accipiteridae; Subfamily: Buteoninae; Genus: *Buteo;* Species: *swainsoni* (BISON-M 2000).

Specific: The Swainson's hawk was first collected by Dr. John Richardson in 1827 at Fort Carleson near Saskatoon, Saskatchewan, and was described as *Buteo vulgaris* (England et al. 1997). The bird was later re-described by C. L. Bonaparte and re-named (*Buteo swainsoni*) in honor of the British naturalist William Swainson who first illustrated the species (England et al. 1997). The Swainson's hawk is distinguished from most other buteos by long, narrow pointed (relative to other buteos) wings (NGS 1987). No recognized subspecies or geographic trends in morphology exist (England et al. 1997).

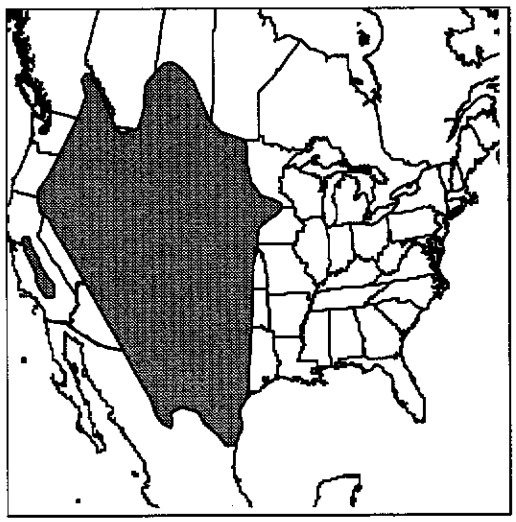
Life History

Description: The Swainson's hawk is a large, slim-winged, long-tailed buteo with a mixed bag of raptor traits (Dunne et al. 1988). The sexes are similar in appearance. This buteo is the most variable in terms of coloration of any raptor in Arizona (Glinski and Hall 1998). The only color patterns that seem consistent are the two-toned underwing, with the leading edge appearing lighter than the trailing edge, and the white patch on the throat and forehead. The species is adapted for hunting in the open country and has more pointed wings and a longer tail than the more familiar red-tailed hawk (Glinski and Hall 1998). In a soar, the bird somewhat resembles a Peregrine Falcon with its long pointed wings, but when it is gliding, the wings are crooked like those of an Osprey (Dunne et al. 1988). When soaring, the wings are held in a dihedral. Total length of males is 19 to 20 inches (48 to51 cm) and of females is 20 to 22 inches (51 to 56 cm), and the wingspan is 47 to 57 inches (119 to 144 cm) (England et al. 1997).

Diet: The diet of the Swainson's hawk includes small mammals, reptiles, insects and birds. This is a versatile predator that takes whatever is available. Grasshoppers are commonly fed upon by migrating Swainson's hawks (Glinski and Hall 1998).

Reproduction: Nest building begins within 7 to 15 days of arrival on the breeding grounds (England et al. 1997). In the southwest, the nest is usually composed of sticks and located in a saguaro cactus, a tree, a yucca or on a cliff (Davis 1997). Nests are typical of raptors: a bulky mass of sticks and twigs (England et al. 1997) lined with fresh leafy twigs, grass, hay, bark, and rarely cow dung (Bent 1964). The outside diameter of the nest is usually about 24 inches (60 cm) (Palmer 1988, cited in England et al. 1997). Usually 2 eggs are laid, but sometimes 3 or 4; incubation takes 28 to 35 days, and the young are semialtricial (Ehrlich et al. 1988). Young hatch asynchronously and fledging occurs approximately 30 days after hatching. Both the male and the female tend the young, which remain with the parents until migration (Ehrlich et al. 1988). One brood is normally reared per season (England et al. 1997). About 50% of nests are re-used (Ehrlich et al. 1988).

Distribution



Historic: Bent (1964) reported that in 1892 Bendire documented "on the arid wastes and table lands of southern Arizona, as well as in the sage and bunch grass districts of Nevada, Oregon, Washington and Idaho, Swainson's hawk is especially abundant, outnumbering, perhaps, all the other Raptores (raptors) of these regions combined." The historic range is believed to be essentially the same as the present range with the following exceptions: breeding populations have been extirpated from coastal southern and the central Coast Ranges in California, and have been essentially extirpated from the southern California Mohave Desert (Bloom 1980, cited in England et al. 1997). Swainson's hawks are migratory, and most of those that have been followed winter in Argentina, where they may be subject to stresses from insecticides (U.S. Department of Agriculture Forest Service 2000)

Present: Swainson's hawks breed throughout most of the western U.S., from northern Mexico to Alaska (NGS 1987). They are very rare fall visitors to the eastern U.S., winter chiefly in South America, and are casual visitors in southern Florida (NGS 1987). In Arizona, this species breeds throughout the state in suitable open grassland habitats and open desert scrub that sustains a grassland component (Glinski and Hall 1998). Migrating Swainson's hawks occur throughout the state in open country (Glinski and Hall 1998).

Arizona Breeding Bird Atlas records for this species in Pima County show that it was recorded in the following U.S.G.S. 7.5-minute quadrangles: Cumero Mountain, Fresno Wash, Las Guijas, Penitas Hills, Presumido Peak, The Narrows, Three Points, Tucson SE, West of Marana, West of Wahak Hotrontk, Wilbur Canyon.

GAP mapping includes the eastern and southeastern portions of Pima County as Swainson's hawk potential habitat (Figure 12).

Demographics

Density: There are at least 65 pairs in the state, 30 of which are located in the Hualapai Valley in northwestern Arizona (Glinski and Hall 1998). Sighting reports of nesting Swainson's hawks are more frequent in southeast Arizona than in other parts of the state and a survey of this portion of the state might document a considerable population (Glinski and Hall 1998). However, no known systematic survey, besides the Arizona Breeding Bird Atlas, has been done.

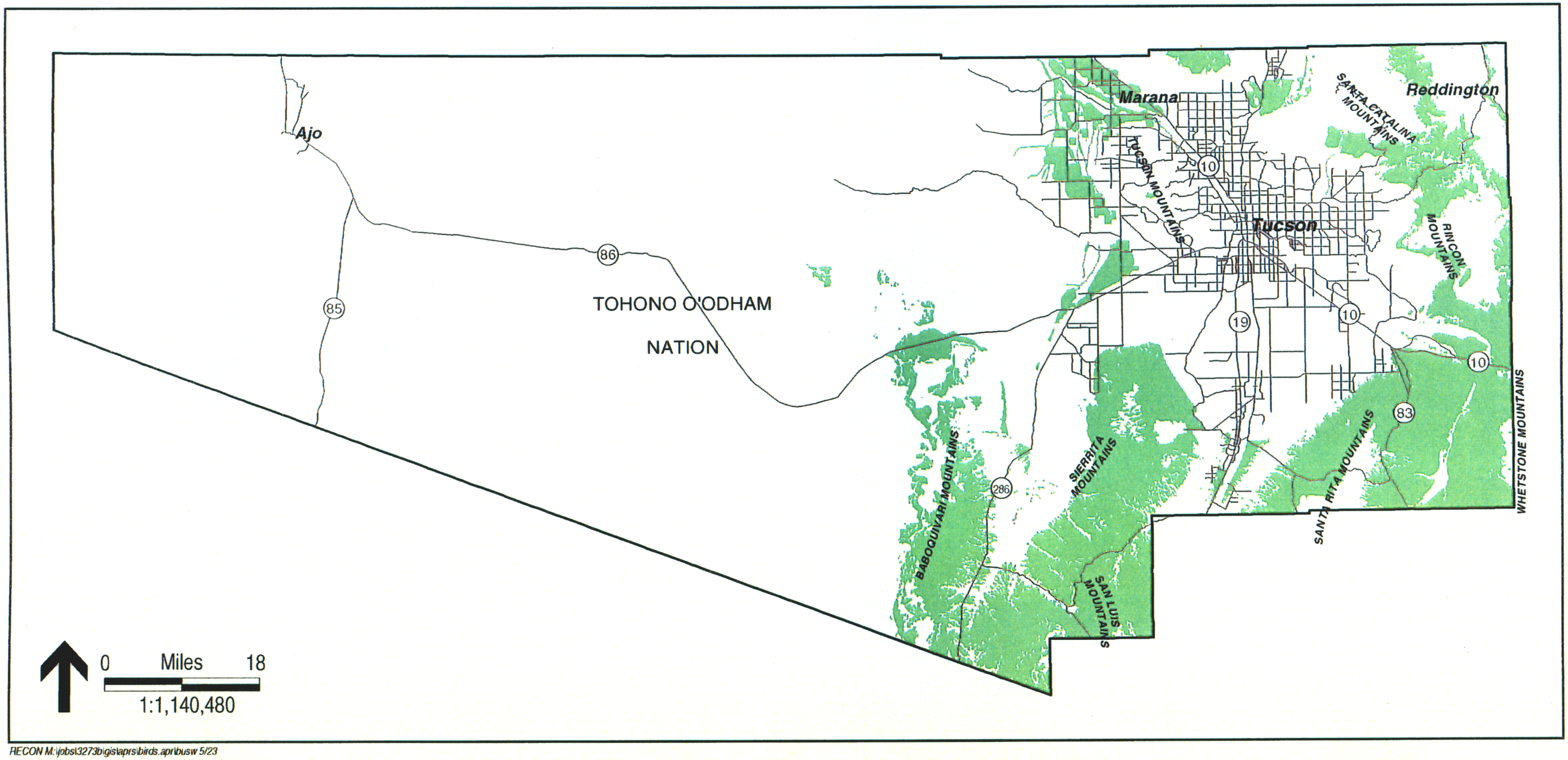
Status: The current status of this species is unclear (Ehrlich et al. 1988). The long-term survival of the Swainson's hawk is uncertain given the management of public lands for other resources and goals that may at times compete with the best interests of the species, and the lack of protection on private lands (Glinski and Hall 1998).

Trend: Although the nesting range has remained relatively stable, Swainson's hawks have suffered major declines in certain portions of their range, have expanded in others, and overall numbers are relatively high. Declines are well-documented in California, Oregon, and Nevada (Harlow and Bloom 1989). In Arizona, data are inadequate to determine trends (Bednarz 1988) and long-term survival of this raptor is uncertain (Glinski and Hall 1998).

Survival rates: Little information is available regarding age ratios in natural populations. In a study of nestlings banded throughout North America, 86 out of 410 survived at least 3 years and 19.8% of these were at least 10 years old when recovered (Houston and Schmutz 1995, cited in England et al. 1997). Banded birds more than 19 years old have been documented (England et al. 1997). Tens of thousands of wintering Swainson's hawks were reported killed on wintering grounds in Argentina by pesticide spray (BISON-M 2000).

Reproduction rates: Even minor disturbance can cause nest desertion (Ehrlich et al. 1988). As is often the case in asynchronous breeding, usually only one nestling survives to fledge the nest. There have been reports of fratricide (Parker 1976 and 1979 and Pilz and Seibert 1978, cited in Glinski and Hall 1998). Thirty percent of nest failure in agricultural shelter belts were due to hail and wind destruction of nests (Ehrlich et al. 1988). In some cases, expanding cultivation has increased breeding opportunities, especially in the northern Great Plains (Ehrlich et al. 1988).

Age ratios: No known information is currently available regarding age ratios in natural populations.



Swainson's Hawk Potential Habitat

Pima County Boundary
Major Road or Highway

Potential Habitat (GAP, 1994)
Low Value

Figure 12

Significant Pima Co. populations or subpopulations: Eleven records of potential, probable or confirmed breeding pairs have been documented in Pima County since 1993 (Arizona Breeding Bird Atlas 2000). Two of these records are confirmed breeding pairs, 1 on the Buenos Aires National Wildlife Refuge, 1 on the Tohono O'odham Indian Reservation. The others are not confirmed, but possible or probable breeding locations.

Habitat Requirements

Of 11 Arizona Breeding Bird Atlas records for Pima County, 1 was from Cultivated Woodlands - orchards, tree farms; 1 from Arizona Upland Biome - paloverde, ironwood, mesquite, catclaw acacia, saguaro, cholla, barrel cactus, prickly pear, creosotebush, jojoba, crucifixion-thorn; 4 from Semidesert Grassland - scattered sotol, agaves, burroweed, snakeweed, yucca; 3 from Sonoran Savanna Grassland - scattered mesquite, ironwood, paloverde; 2 from Sonoran Riparian Scrubland (dry wash) - mesquite, burrobush, arrowweed, desert broom, quailbush, saltcedar (tamarisk), seepwillow, desert-willow.

Home range requirements: Swainson's hawks nest in Grassland, Semidesert Grassland, and Savanna Grassland, either apart or intermixed with open desert scrub habitats (Glinski and Hall 1998). They forage exclusively in open plains and grasslands where visibility is good and there is reduced vegetative cover for greater prey access (Bechard 1982, cited in BISON-M 2000).

Ability to use major land use categories: Migrating Swainson's hawks are frequently seen in agricultural fields where they forage (Glinski and Hall 1998). They often can be seen resting on utility poles and fence posts. The importance of Arizona's watercourses to migrating hawks is uncertain, although migrating Swainson's hawks are regularly sighted in the valleys of the Gila and Santa Cruz Rivers, from central Arizona south to Mexico. (Glinski and Hall 1998). They are rarely seen in urban or suburban developed areas, woodlands, forests, or dense scrublands.

Habitat trends in planning area: The shift in occurrence of grasslands in the state has no doubt altered the breeding range (Glinski and Hall 1998). Historically, there likely were pockets of suitable Semidesert Grassland from Nogales north to Tucson and following the upper elevation limits of the Sonoran Desert to Phoenix, northwest toward Wickenburg, and then west past Aguila that sustained at least intermittent use by nesting Swainson's hawks (Glinski and Hall 1998). In some areas, the landscape is now dominated by brush instead of grass that grew there in the last century (Hastings and Turner, cited in Glinski and Hall 1998).

Current and Potential Threats

General: Habitat loss, degradation and fragmentation may contribute to the decline of this species (Bison-M 2000). Throughout their Arizona range, Swainson's hawks must contend with habitat loss through a continually expanding human population and associated development and recreation activities (AGFD 1998).

Pima County populations location, amount, and quality of protected habitat: Migratory birds passing through Pima County will encounter a mosaic of private, state and federal lands that offer varying resources and are subject to multiple use. Protected grassland habitats in Pima County include The Buenos Aires National Wildlife Refuge, the Empire Cienega Resource Conservation Area, and portions of Saguaro National Park (East Unit), Cienega Creek County Park, and Coronado National Forest, including the Santa Rita Experimental Range.

Existing and potential pest species: No information is available regarding predation of adults; however, predation of nestlings or fledglings by American crows, great horned owls, golden eagles, and predatory mammals has been documented (Dunkle 1977; Fitzner 1978; Woodbridge 1991—all cited in England et al. 1997).

Threat mechanism: Use of pesticides in areas of wintering hawk concentrations may significantly affect some North American breeding populations. Pesticides also reduce prey on wintering grounds (Woodbridge et al. 1995 and Goldstein et al. 1996, cited in Glinski and Hall 1998). Pollution and contaminants are alleged as threats to this species (Bison-M 2000). Direct mortality is caused by shooting, as the species is sometimes erroneously perceived as a pest, and it is often an easy target because it habitually perches on utility poles and fence posts along roads in open country.

Management Needs

General: The health of this species on its wintering grounds in South America remains uncertain (Glinski and Hall 1998), and alternative, less toxic pesticides and grasshopper baits should be tested in Argentina (England et al. 1997). Basic information is needed to document Swainson's hawk distribution on non-breeding grounds and to learn if the conversion of tropical rain forests and southern grasslands to pasture and farmland has affected their distribution (England et al. 1997). On the breeding grounds, research is needed to learn why populations and productivity have declined, especially in areas where apparently suitable habitat remains unoccupied (England et al. 1987). Increased effective law enforcement is necessary because many birds are shot while perched along roads (Ehrlich et al. 1988).

Current protective measures: Swainson's hawk does not receive any special federal or state protection, although it is generally protected by provisions of the Migratory Bird Treaty Act of 1918 (Glinski and Hall 1998).

Sensitivity to human activities and densities: Disturbance can cause nests to be abandoned (Ehrlich et al. 1988). Conversion of native grassland habitats and agricultural lands to urban development may further reduce resources for both migrating and nesting birds. Increased recreational traffic on roads in open country is likely to result in increase mortality due to shooting.

Corridor needs: During migration, Swainson's hawks rest and feed in grasslands and harvested fields, especially where grasshoppers are numerous, and often they perch on fence posts and telephone and power poles (England et al. 1997). The importance of Arizona's watercourses to migrating hawks is uncertain, although migrating Swainson's hawks are regularly sighted in the valleys of the Gila and Santa Cruz Rivers, from central Arizona south to Mexico (Glinski and Hall 1998).

Dispersal requirements: No specific dispersal requirements for this species are known.

Key relationships: Because the Swainson's hawk is an extremely versatile predator, no clear dependence on any particular prey species is noted. It is also versatile in selection of nest sites, so is not dependent on any particular tree species. However, it is closely tied to grasslands, if not dependent on them.

Results of past mitigation activities: No effective measures to mitigate for loss or degradation of foraging habitat have been demonstrated (England et al. 1997).

Existing monitoring and research programs: The U.S. Forest Service is working with Argentina's Institute of Agricultural Technology and other agencies to find solutions to the problem of pesticides and wildlife in Argentina's pampas (U.S. Department of Agriculture Forest Service 2000). Breeding bird surveys are conducted annually in Arizona by the USFWS. The Arizona Breeding Bird Atlas program has documented distribution of this and most other bird species in the state, and has increased knowledge of bird distribution.

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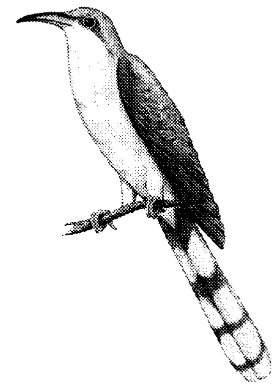
Western yellow-billed cuckoo (*Coccyzus americanus* ssp. *occidentalis*)

Status



Federal	Listed as a migratory bird under the Migratory Bird Treaty Act; petitioned for listing as endangered (February 8, 1998). USFWS has issued a notice of a 90-day petition finding, determining that the petition presented substantial information to indicate that the petitioned action may be warranted and initiating a 1-year status review process (USFWS 2000)
State	Wildlife of Special Concern, 1996 (BISON-M 2000)
Other	California Endangered; Nevada State Protected (LCR MSCP 1999); Vulnerable Status 2 by SDCP
Rankings	G5T3 S3

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The family Cuculidae has a worldwide distribution, and contains 29 genera and 142 species. Four genera are found in North America: *Cuculus*, *Crotophaga*, *Geococcyx*, and *Coccyzus*. The population of *Coccyzus americanus* that occurs west of the Pecos River, Texas, is *C. a. occidentalis*, distinguished from its eastern counterpart *C. a. americanus* by Ridgway in 1887, who cited a larger size for the western birds (Hughes 1999). One study, however, concluded that these morphological differences were not adequate for subspecies recognition. The subspecies is supported in a later study where small but statistically significant size differences between the eastern and western populations were found (Franzreb and Laymon 1993). Currently the issue stands unresolved pending further research and information. Ongoing genetic work may provide answers in the future (USFWS 2000).

Classification: Order: Cuculiformes; Family: Cuculidae; Genus: *Coccyzus;* Species: *americanus;* Subspecies: *occidentalis*.

Specific (to Pima County populations): The population of *Coccyzus americanus* that occurs in Arizona is the *C.a. occidentalis* subspecies.

Life History

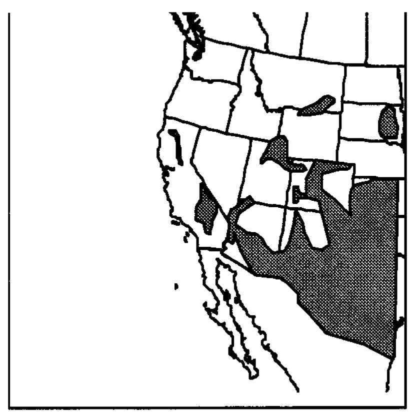
Description: The western yellow-billed cuckoo is a 10- to 12-inch (26 to 30 cm) long slender bird with relatively short, dark legs. The plumage is grayish brown on top and white below. The primary feathers on the wings are rufous (orange-brown) in color and there is a bold black and white pattern under the tail. The mandible of the bill is yellow. The plumage of both sexes is similar. Juveniles, which hold juvenal plumage well into the fall, have a much paler pattern on the tail and the bill may show little to no yellow (AGFD 1998). The "song sounds hollow and wooden, a rapid staccato kuk-kuk-kuk that usually slows and descends to a kakakowlp-kowlp ending" (Scott 1987).

Diet: The diet for the western yellow-billed cuckoo consists of hairy caterpillars, birds eggs, frogs, lizards, ants, beetles, wasps, flies, berries and fruit. The parents will feed their young by regurgitating insects (Ehrlich et al. 1988; Hughes 1999).

Reproduction: Both the male and female build the nest, often in willow or mesquite thickets (AGFD 1998), usually from 4 to 10 feet (1.2 to 3.0 m) above the ground but it can be as high as 35 feet (10.7 m) above the ground (BISON-M 2000). The nest is a stick platform, thinly lined with leaves, mesquite and cottonwood strips, grass and catkins with a little depression to hold the eggs. The nest is well concealed by the surrounding foliage (AGFD 1998). The female will lay 3 to 4 unmarked, pale greenish blue eggs. Incubation usually lasts 4 to 11 days with the eggs changing color to greenish yellow as they mature. The young hatch out of the eggs asynchronously and are born helpless and without feathers. The male will feed the first fledglings, while the female will feed the remaining young until they leave the nest in 7 or 8 days (Ehrlich et al. 1988).

Behavior: Breeding often coincides with outbreaks of cicadas, tent caterpillars, etc; prey abundance may lead to production of excess eggs and thus to brood parasitism, where excess eggs are laid in other birds nests. Clutch size estimates may be low in years of high prey abundance due to egg-dumping in other birds' nests (Ehrlich et al. 1988).

Distribution



Historic: In the west the species was said to have been widespread and locally common in California and Arizona, in a few river reaches in New Mexico, Oregon, and Washington; generally local and uncommon in scattered drainages of the arid and semiarid portions of western Colorado, western Wyoming, Idaho, Nevada and Utah; and probably uncommon and very local in British Columbia (USFWS 2000). Arizona populations are critical, including those in Pima County, since breeding populations throughout the West have been extirpated or greatly reduced (R. Johnson, pers. comm. to K. Kingsley, 3 May 2000). The species was extirpated in British Columbia in the 1920s, Washington in the 1930s, and Oregon in the 1940s and in the Sacramento Valley, California, where it was originally a common breeding bird, now less than 1% of the original breeding habitat remains (Laymon and Halterman 1987). In Arizona the species was a common resident in the (chiefly lower) Sonoran zones of southern, central, and western Arizona; scarce in the north-central part of the state, and very rare in the northeast (Phillips et al. 1964).

Present: The western yellow-billed cuckoo occurs in the Apache-Sitgreaves, Coconino, Coronado, Prescott, and Tonto National Forests of Arizona. The species nests primarily in the central and southern parts of Arizona. It has been extirpated from most lower elevation localities, especially the Colorado River valley (BISON-M 2000) and most of the Santa Cruz River in Pima County (Corman and Magill 2000). In Pima County yellow-billed cuckoos were found at the following areas in 1999: Cienega Creek (Empire Ranch, Davidson Canyon Confluence, and Upper Cienega Creek), Arivaca Creek and several sites in the Altar Valley (Corman and Magill 2000) (Figure 13). Other areas were surveyed for this species, with no success, and many potentially suitable areas were not surveyed, in part because they were on private property (Corman and Magill 2000). Breeding populations are known to occur on the west side of Topock Marsh and near the mouth of the Bill Williams River, Havasu National Wildlife Refuge, Imperial National Wildlife Refuge, and Picacho State Recreation Area (LCR MSCP 1999). Yellow-billed cuckoos have been recorded in the pecan groves in Green Valley and Sahuarita (Kingsley 1989). They have been recorded as rare transients in both units of Saguaro National Park (Southwest Parks and Monuments Association 1999). At the Buenos Aires National Wildlife Refuge, they are listed as uncommon in spring and summer (USGS 2000a). In the Santa Catalina Ranger District of the Coronado National Forest they are listed as rare transients in riparian habitat (USGS 2000b).

Demographics

Density: Densities vary greatly on a monthly and yearly basis; therefore, estimates made over a 1- to 2-year period must be assessed with caution (Hughes 1999). Also, density is often underestimated due to quiet demeanor and skulking behavior; birds are easily overlooked when silent (Hughes 1999). Individuals were counted on 3 plots in the Verde Valley, north-central Arizona, where 8.2, 19.8, and 26.5 pairs per 100 acres (40 ha) were found (Carothers et al. 1974). In the Green Valley pecan orchards, there were approximately 10 pairs per 100 acres (40 ha) (Kingsley 1989).

Status: Populations of the western subspecies of the yellow-billed cuckoo have decreased throughout their range (Corman and Magill 2000).

Trend: Populations appear to be extremely reduced from historic numbers, and a general decline in all areas seems to be occurring (AGFD 1998; Corman and Magill 2000).

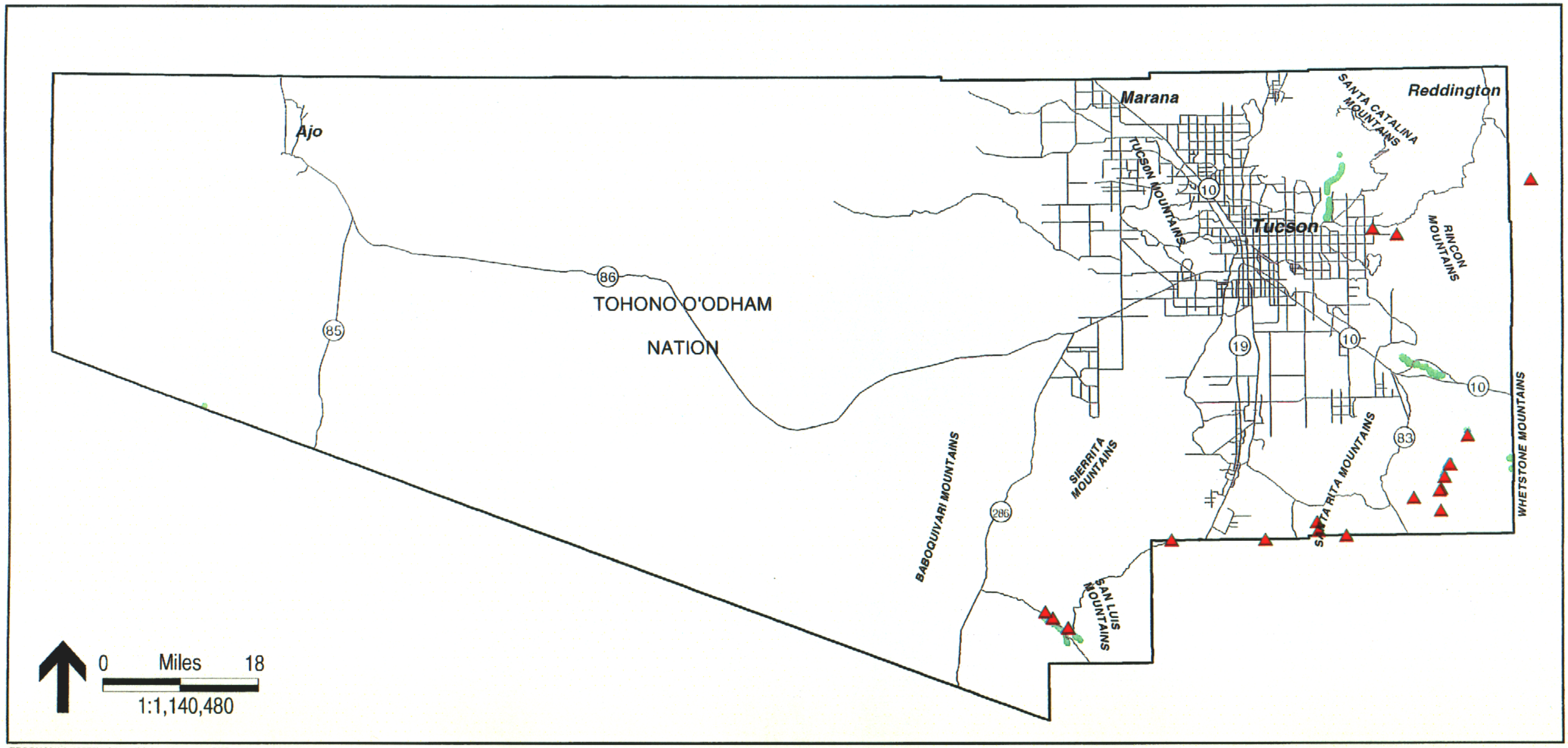
Survival rates: There is no information regarding survival rates (Troy Corman, AGFD, pers. comm. to Iris Rodden, SWCA, 25 Apr 2000).

Reproduction rates: Rates are likely regulated by both food and habitat availability, and thus tend to fluctuate in response to these factors (Hughes 1999).

Age ratios: No information is available on age ratios (Troy Corman, AGFD, pers. comm. to Iris Rodden, SWCA, 25 Apr 2000).

Sex ratios: No information is available on sex ratios (Troy Corman, AGFD, pers. comm. to Iris Rodden, SWCA, 25 Apr 2000).

Significant Pima Co. populations: The species has been found at Cienega Creek, Arivaca Creek, the San Pedro River, the Tanque Verde Wash, Rincon Creek, and the Green Valley pecan orchards. Many areas of potentially suitable habitat have not been surveyed recently, most of which are on private property (Corman and Magill 2000).



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Western Yellow-billed Cuckoo
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(HDMS, 2000)
Western Yellow-billed Cuckoo
(Coccyzus americanus occidentalis)

Potential Habitat
(GAP, 1994)
Low Value

Figure 13

Habitat Requirements

Home range requirements: Yellow-billed cuckoos have been found in mature Sonoran Riparian Deciduous Forest, Cottonwood-Willow Series, and Sonoran Riparian Scrub, in well-developed mesquite bosques (Corman and Magill 2000). Areas where cuckoos have been found in recent years comprised at least 37 acres (15 ha) including 7 acres (3 ha) or more of closed canopy, with canopy heights of 16 to 100 feet (5 to 30 m) and understory height of 3 to 20 feet (1-6 m) (Hughes 1999). Active cuckoo nests found in Arizona during the 1998 and 1999 seasons ($n = 6$) were found in Arizona alder (1), tamarisk (1), Fremont cottonwood (2), and Goodding willow (2). More detailed and specific information is being compiled by AGFD (Corman and Magill 2000).

Ability to use major land use categories: In Arizona, the western yellow-billed cuckoo will use streamside cottonwood, willow groves and large mesquite bosques for migrating and breeding. The quality of the habitat appears to matter more than the actual amount of habitat; greater numbers of breeding birds were found in the dense riparian woodlands along Arivaca Creek than in areas along Cienega Creek where the vegetation is less dense (B. Wooldridge, SWCA, pers. comm. to Iris Rodden, SWCA, 25 Apr 2000). This species may be rarely observed as a transient in desert and urban settings (AGFD 1998).

Habitat trends in planning area: Following a major historic decline, tall, dense riparian woodland is beginning to come back along portions of the Santa Cruz River, Cienega Creek, and the San Pedro River (K. Kingsley, pers. obs.). Some of this known to be used by yellow-billed cuckoos (Corman and Magill 2000). Essentially all riparian woodland is protected by various local and national ordinances and regulations, and very little active destruction is likely to occur in the future. However, this habitat type is dependent upon either surface or shallow subsurface water, which is subject to multiple demands by a growing human population, and groundwater depletion may continue to occur.

Current and Potential Threats

General: The primary threat to this species survival is the continued loss, degradation, and fragmentation of mature cottonwood-willow riparian habitat. Major threats to this habitat type include reclamation, flood control, and irrigation projects; habitat loss due to urbanization and agricultural activities; and the continued invasion of nonnative saltcedar into riparian areas. Exposure to pesticides and other contaminants on wintering and breeding grounds, as well as livestock grazing and off-road vehicle use within riparian habitats, also continue to threaten this species survival (LCR MSCP 1999). As the quality of the habitat decreases through competition with exotic plant species, or inappropriate grazing, the number of western yellow-billed cuckoos that can be supported decreases (Magill and Halterman 1999). There is evidence that pesticide use (DDT) adjacent to the breeding grounds and in the wintering grounds may cause eggshell thinning (Laymon and Halterman 1987). It has also been observed that the species is frequently killed by flying into television towers, airport ceilometers, and tall buildings during nocturnal migration (Howell et al. 1954).

Location, amount, and quality of protected habitat in Pima County: Suitable habitat for this species is known to occur on the Empire-Cienega Resource Conservation Area, Cienega Creek County Park. However, much potentially suitable habitat for this species in on private property and has not been surveyed.

Existing and potential pest species: Invasive exotic plant species such as saltcedar (*Tamarix ramosissima*) have altered native riparian habitat and may render it less suitable for the western yellow-billed cuckoo. However, saltcedar only forms dense stands in areas of managed and damaged rivers that are unsuitable for maintenance and regeneration of native riparian vegetation, so it is not possible to blame the saltcedar for declines in habitat quality (Stromberg and Chew, in press).

Threat mechanism: Degradation and fragmentation of riparian woodlands, specifically mature cottonwood-willow riparian habitat, and failure of these to regenerate because of flood management practices. Threats to remaining populations in central and southern Arizona are stated as: degradation and loss of riparian habitat from vegetation clearing, stream diversion, water management, agriculture, urbanization, overgrazing, and recreation (BISON-M 2000). Depletion of groundwater has dried many riparian areas and resulted in the loss of riparian vegetation.

Management Needs

General: Management of riparian habitat known to support cuckoo populations is considered necessary. AGFD conducts surveys to determine cuckoo status, and use of or dependence on additional areas of potential habitat (AGFD 1998). A long list of detailed recommendations is presented in a recent report (Corman and Magill 2000). These are summarized as: expand the survey effort to encompass all major riparian habitat types and include areas within potentially suitable habitat that were not thoroughly surveyed; conduct nest searching and monitoring studies; land management agencies need to promote regeneration of riparian habitat; management activities require cooperation, coordination, and funding.

Current protective measures: This species is protected under the Migratory Bird Treaty Act. The Migratory Bird Treaty Act makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird, including feathers, parts, nests, or eggs. Violations of the Migratory Bird Treaty Act are considered criminal offenses and can result in significant fines and imprisonment.

Pima County has a wash protection ordinance that prevents some destruction of habitat for this species.

The federal Clean Water Act, in its Section 404, may also protect some of the habitat of this species.

Sensitivity to human activities and densities: There is no information regarding impacts of disturbance at nest and roost site, or human/research impacts (Hughes 1999).

Corridor needs: Contiguous well-developed riparian corridors may be beneficial but have not been demonstrated to be necessary. Corridors to connect isolated breeding areas are probably unnecessary for a highly mobile migratory species such as this.

Key relationships: Mature cottonwood-willow riparian habitat is utilized by this species for breeding and source of primary prey items, particularly tent caterpillars.

Migratory requirements: Western yellow-billed cuckoos are strictly a summer resident in Arizona (Magill and Halterman 1999). The migratory habits and routes of this species are poorly known and need further study; however, it is likely that riparian corridors play a role since food sources such as caterpillars are found there (Hughes 1999).

Results of past mitigation activities: There is no information on the results of past mitigation activities.

Existing monitoring and research programs: Arizona Game and Fish Department is actively involved in a program of monitoring and research (Corman and Magill 2000).

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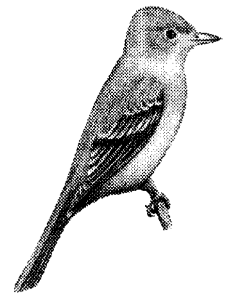
Southwestern willow flycatcher (*Empidonax traillii extimus*)



Status

Federal	Endangered (USFWS 1995)
State	Wildlife of Special Concern in Arizona (AGFD 1996)
Other	Vulnerable Status 2 in SDCP
Rankings	AGFD 1998

Recovery Goals

Federal: A recovery plan for this species is in development and is not yet available. Currently, the Recovery Team is compiling data from researchers throughout the range and developing recovery strategies (Paradzick et al. 2000).

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The southwestern willow flycatcher is a small bird in the flycatcher family.

Classification: Order: Passeriformes; Family: Tyranidae; Genus: *Empidonax;* Species: *traillii;* Subspecies: *extimus.*

Specific: There are 11 species in the genus *Empidonax* in North America, 6 breed in Arizona. *E. t. extimus* is 1 of 4 subspecies of *E. traillii,* and it is the only subspecies likely to breed in southern Arizona (AGFD 1997), but other subspecies, especially *brewsteri,* are known to occur regularly as migrants (G. S. Mills, pers. comm. to K. J. Kingsley, 8 May 2000).

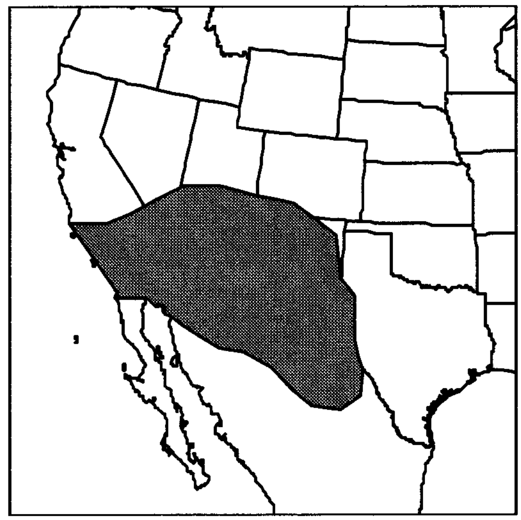
Life History

Description: The southwestern willow flycatcher is a small bird, approximately 5.75 inches (15 cm) long. The body is brownish olive to grayish green on the upper parts with a pale olive breast, pale yellow belly, and whitish throat, and two white wing bars. An eye ring may be faint or absent. The bill is relatively large, the maxilla dark and the mandible usually entirely yellow or pale orange, and it often has a dusky tip. Both sexes are alike. The species is most easily identified by its vocalizations (AGFD 1997).

Reproduction: Males sing repeatedly from exposed perches while on territories and occasionally on migration. Breeding season is May through July, with the birds usually arriving on their breeding grounds in late April or early May. The pair forms and builds a compact cup-shaped nest of shredded bark, cattail tufts, and grasses, and lines it with fine grasses and feathers. A clutch of 3 or 4 eggs is laid. Usually only 1brood is raised per year, but occasionally 2 broods may be raised. Brown-headed cowbirds are said to frequently parasitize nests, laying their own eggs, which hatch sooner than their hosts' eggs. Baby cowbirds may outcompete their nest mates, and push them out of the nest (AGFD 1997).

Behavior: This is a neotropical migratory bird that is present in Arizona from April through August or September. It is a highly territorial bird that uses vocalization to advertise its territory. The territorial call is unique and easily recognized by trained observers. The bird will respond to taped calls, and this method is used to survey for this species (Sferra et al. 1997; Paradzick et al. 2000).

Distribution



Historic: Southwestern willow flycatchers are known from southern Nevada, southern Utah, southern California, most of Arizona and New Mexico, western Texas, and possibly southwestern Colorado (breeding birds from Colorado are apparently not clearly this subspecies). They winter in Mexico, Central America, and/or northern South America (AGFD 1997).

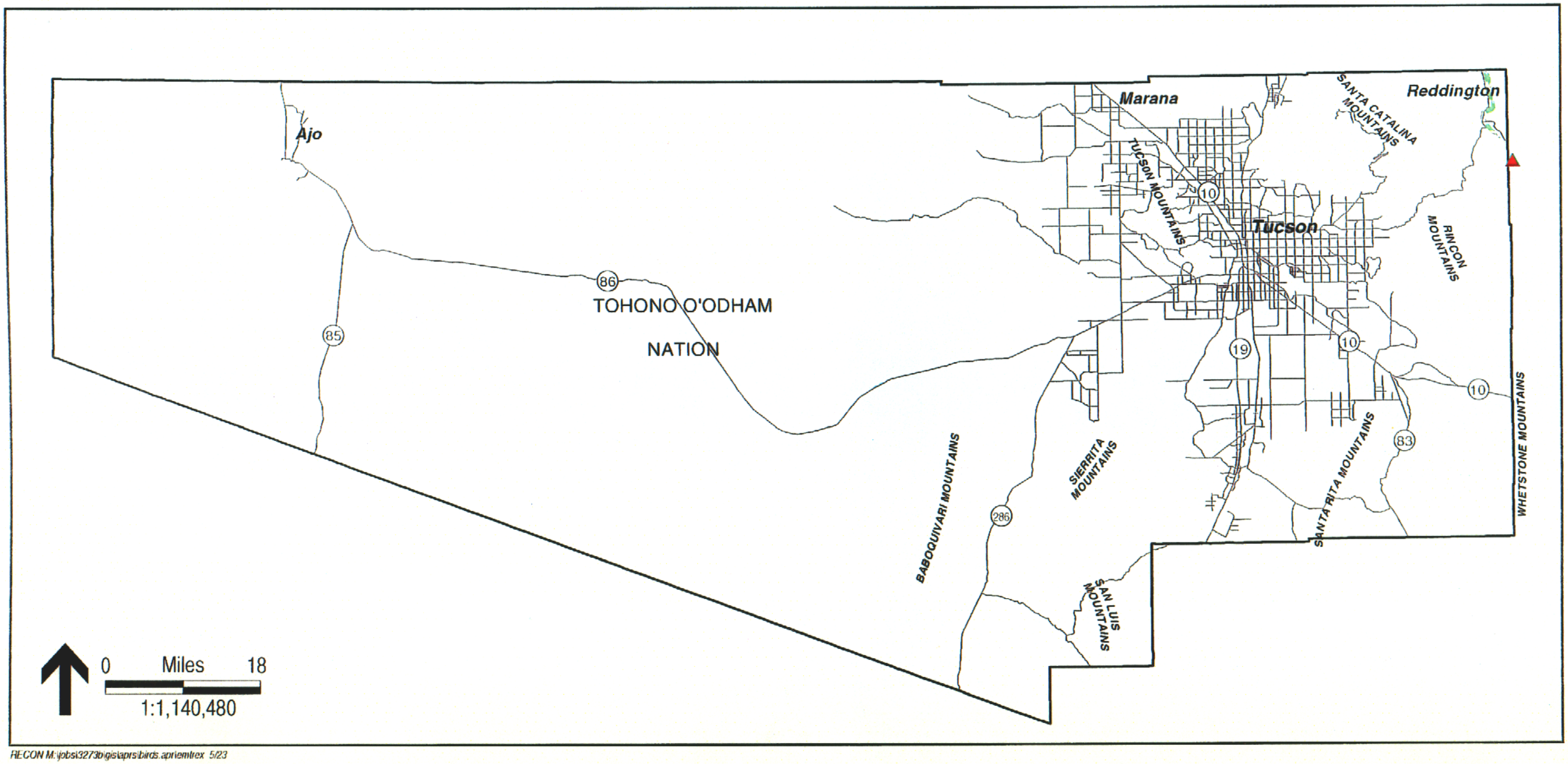
Present: The geographic range has probably not changed significantly, although there are undoubtedly many local areas from which this species has been extirpated, and it has suffered severe declines in numbers. On the other hand, it has recently expanded into new areas, such as the Grand Canyon (Brown 1991). In Arizona, willow flycatchers were documented along 12 drainages. The major concentrations at elevations less than 1115 m occurred near the confluence of the Gila and San Pedro Rivers, Roosevelt Lake, Alamo Lake, Topock Marsh, the lower Grand Canyon, the Gila River, and Camp Verde. Three high elevation sites were also documented, 2 on the Little Colorado River near Greer and 1 on the San Francisco River near Alpine (Paradzick et al. 2000).

There are no records of this species from Pima County available in the HDMS database. It is likely that migrants of this and other subspecies of willow flycatcher may occasionally pass through this area, but there are no known breeding records for Pima County (Figure 14). This species is included in this volume solely because some members of the Scientific and Technical Advisory Team feel that it might someday become established in the County, and/or that some birds may have been overlooked.

Demographics

Density: Density of this species is extremely variable. This species uses fairly specific habitat patches, which vary in size and quality (Paradzick et al. 2000).

Status: Extreme population reductions are alleged to have occurred since the 1800's because of habitat loss, although quantitative data are lacking (USFWS 1995; AGFD 1997).



Southwestern Willow Flycatcher Known Locations and Potential Habitat

Pima County Boundary

Major Road or Highway

Known Locations (HDMS, 2000)

▲ Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

Potential Habitat (GAP, 1994)

Low Value

Figure 14

Trend: There is not sufficient information to base a conclusion on trend. The trend throughout the state has been a sizeable decrease in populations during the early 1900s (Phillips et al. 1964). There has been a recent large increase in the number of known individuals, but much, if not all, of this increase is likely due to an increase in survey efforts. Some sites that have been surveyed repeatedly for several years have shown an increase in individuals, and some have shown declines (Paradzick et al. 2000).

Survival rates: No known specific information is available on this aspect of the species biology.

Reproduction rates: Of 327 nests monitored in Arizona in 1999, 73 were depredated, and 10 of 227 nesting attempts had cowbird parasitism documented. Nest predators were common king snakes, Cooper's hawks, a gopher snake, and a yellow-breasted chat (Paradzick et al. 2000).

Age ratios: No known information is available on age ratios in this species.

Significant Pima Co. populations or subpopulation basis in planning area: This species is not known to occur in Pima County, except possibly as a migrant, and then only occasionally.

Habitat Requirements

Ability to use major land use categories: Nesting willow flycatchers were found in 3 main riparian habitat types in Arizona. All nests found above 2,100 m were in dense stands of Geyer willow. Low-elevation sites were characterized by two vegetation types: (1) mixed native/exotic associations and (2) monotypic exotic habitat dominated by dense stands of tamarisk forming a nearly closed canopy (Paradzick et al. 2000). A large proportion of seemingly suitable habitat remains unoccupied.

Habitat trends in planning area: Apparently suitable habitat is not known to be present in Pima County.

Home range requirements: There is not sufficient information to support hypotheses about home range requirements for this species.

Current and Potential Threats

General: Extreme population reductions were alleged to have occurred, but there are no known quantitative data to support this contention. Historic habitat loss is alleged to be the cause of these population reductions (USFWS 1995; AGFD 1997). Current alleged threats include: fluvial geomorphic changes and corresponding modification of vegetation, overgrazing, cowbird parasitism, fire, predation, and human disturbance. Actual data on these threats from Arizona are very limited and not very conclusive. A large fire in 1996 at PZ Ranch in Pinal County resulted in some loss of birds and habitat, but the long-term results are not known. At some high elevation sites, grazing by livestock and elk apparently damaged some habitat, and livestock may benefit cowbirds. Human disturbances documented were limited to nest disturbance by researchers, and the available information is somewhat contradictory and is not conclusive. In 3 years of studies, approximately 20% of all nests with known outcome were lost to predation (Sferra et al. 1997).

Pima County populations location, amount, and quality of protected habitat: There is no known habitat for this species in Pima County.

Existing and potential pest species: Brown-headed cowbirds are often named as a pest for this species. Cowbird parasitism was documented at 10 of 237 nests studied in 1999 in Arizona (Paradzick et al. 2000). Cowbird parasitism may be a recent trend related to human activity, especially the raising of livestock, which has happened throughout much of the western United States (R. Johnson, pers. comm. to K. Kingsley, 7 May 2000). Earlier records of cowbird parasitism showed no brood parasitism of this species in Arizona (Bent 1942).

Threat mechanism: Loss of habitat in some portions of the range; also nest parasitism is said to be a problem in some parts of the range (USFWS 1995).

Management Needs

General: The highest priority is for protection of occupied and potential willow flycatcher habitat. Riparian areas with little or no survey effort need to be identified and surveys conducted. Further research is needed to develop a better understanding of habitat characteristics (Paradzick et al. 2000).

Current protective measures: Coordinated surveys and research studies for this species have been done each year since 1993 involving AGFD, USFWS, and private consultants. The species and its habitat are protected under the Endangered Species Act, local riparian conservation ordinances, and public land management agency policies.

Sensitivity to human activities and densities: There is very limited understanding of this aspect of this species' biology. Some are known to have nested adjacent to roads and bridges and to have endured nest monitoring studies (K.J. Kingsley, pers. obs.).

Corridor needs: There is no specific information available on this aspect of this species' biology. It may be reasonable to assume that southwestern willow flycatchers require somewhat intact riparian corridors for migration, but this has not been demonstrated by data, and the ability of this species to colonize apparently isolated areas of habitat has been documented (Sferra et al. 1997; Paradzick et al. 2000).

Key relationships: Willow flycatchers at low elevations in Arizona appear to be closely tied to tamarisk: 95% of nests studied in 1999 were in tamarisk (Paradzick et al. 2000).

Migratory requirements: Although this species is known to be migratory, migratory requirements are not known.

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for this species. Some ongoing studies are being done under the rubric of mitigation, but they are not known to be actually studying the results of mitigation activities. Cowbird trapping and livestock removal has apparently met with some success in portions of this species range, but have met with inconclusive results in Arizona (Sferra et al. 1997).

Existing monitoring and research programs: Surveys and monitoring studies have been done under the coordination of the AGFD and USFWS since 1993, and a series of annual reports is prepared (Sferra et al. 1997; Paradzick et al. 2000; and others not cited).

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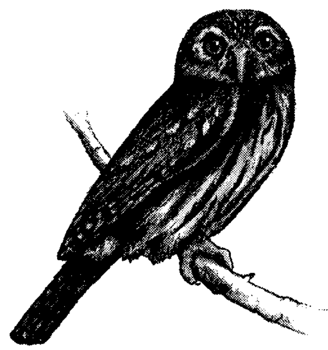
Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*)

Status



Federal	Endangered (USFWS 1997)
State	Wildlife Species of Special Concern in Arizona (AGFD 1996, 1998)
Other	Forest Service Sensitive; Threatened in Mexico (AGFD 1998); Vulnerable Status 1 by SDCP
Rankings	G5T3 S1

Recovery Goals

Federal: A Recovery Plan is in the process of being developed.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The taxonomy of the genus *Glaucidium* is a topic of some debate among authorities at the species and subspecies level (Cartron et al. 2000a). Molecular analyses are currently or recently in progress and results have not yet been published, that may resolve some of the taxonomic difficulties. The currently accepted taxonomy is as stated below.

Classification: Order: Strigiformes; Family: Strigidae; Genus: *Glaucidium;* Species: *brasilianum;* Subspecies: *cactorum.*

Specific: This is the only subspecies that occurs in Arizona, and may be the only subspecies in the United States, depending on the outcome of taxonomic studies (Cartron et al. 2000a).

Life History

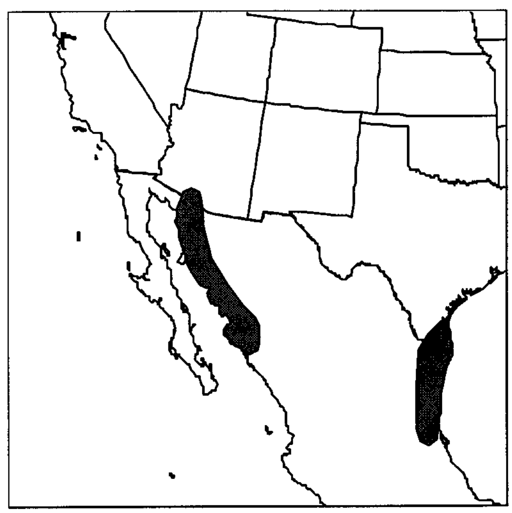
Description: The cactus ferruginous pygmy-owl is a small bird, averaging 6.5 inches (16.5 cm) in length and weighing 2.5 ounces (70 g). The owl is gray-brown or rufous (reddish) brown in color. The head is small, compared to some other owls, and it lacks ear tufts. The eyes are yellow. The crown is finely streaked with flecks of buff. The tail is relatively long compared to those of other owls. There are subtle differences in coloration and size between the sexes (females are larger than males), and juveniles have somewhat different plumage from adults (Cartron et al. 2000a).

Diet: Cactus ferruginous pygmy-owls have been recorded feeding on birds, small mammals, lizards, and insects. The proportion of each apparently depends on what is available at the time (Cartron et al. 2000a).

Reproduction: This owl typically nests in a natural cavity or abandoned woodpecker holes in trees or large columnar cacti (saguaros in Arizona). No lining material is added. Cactus ferruginous pygmy-owl eggs are white and almost spherical. They are laid at irregular intervals of 32 to 39 hours, and clutch sizes range from 3 to 7 eggs. Most of the incubation is done by the female, although recent information indicates that the male may perform some incubation duties. A second clutch may be laid if the first one fails. Hatching is asynchronous, over a period of several days, each hatchling emerging about 20 to 26 hours apart. During the first week, the female remains with the young in the nest, leaving only to obtain food, or dispose of wastes. Intense competition for food takes place between nestlings, and some may kill others. Young remain on the nest for between 21 and 30 days, then remain near it for approximately 2 months, being fed by both parents until they learn to fend for themselves. They eventually disperse. The adults apparently maintain the pair bond (Cartron et al. 2000a).

Behavior: Cactus ferruginous pygmy-owls are highly territorial, and call loudly and monotonously from perches within the territory. They respond to tape recordings of their calls, and that is the method the USFWS uses as the basis for the protocol for conducting surveys for this species (USFWS 2000; Richardson et al. 2000). Behavioral studies have been under way for several years, including the use of radiotelemetry for following birds, but the results of these studies have not yet been published. The cactus ferruginous pygmy-owl is an opportunistic predator and may cache prey remains in a tree, cavity, or ball of mistletoe (Cartron et al. 2000a).

Distribution



Historic: The historical distribution and decline of the species was described by Johnson et al. (2000). All evidence indicates that the species was at the edge of its range in Arizona, and that most of its range is in Mexico, Central, and South America. The exact limits of distribution of each subspecies are not clearly resolved. Most evidence indicates that the species was historically found primarily, if not exclusively, in riparian areas. Baseline information is limited, and most of the early bird studies were fairly concentrated along rivers. It is possible, although not certain, that the species occurred primarily along rivers and may have also occupied desert scrub. Records of the species extend along the southern Arizona river valleys, as far north as New River, north of Phoenix, west to Agua Caliente on the Gila River, and east to (possibly) the confluence of the San Francisco and Gila Rivers. At one time, it was common in the Phoenix area.

Present: The currently known range is reviewed by Richardson et al. (2000). Multiple surveys have been conducted throughout much of the species range since 1993. However, much of the land within the potential range is privately owned and has not yet been surveyed, or has not been surveyed due to funding and personnel constraints. The currently known distribution is in several areas:

1. Most of the cactus ferruginous pygmy-owls detected were in the Northwest Tucson and Southern Pinal County areas, mostly in the bajadas of the Tortolita Mountains, in low-density urban areas and Sonoran desert scrub.

2. One owl was detected in the Tucson Mountains in 1998 in Sonoran desert scrub, while a large population has been detected just east of this range (Figure 15).

3. Cactus ferruginous pygmy-owls have been documented from Organ Pipe Cactus National Monument since the 1940s, and owls have been detected every year since 1993, except 1994. Nesting was documented in 1998 and 1999 in Sonoran desert scrub.

4. Several owls have been found on the Tohono O'odham Nation in Sonoran desert scrub (see Figure 15).

5. Several owls have been found in the Altar Valley in Sonoran desert scrub and desert scrub/desert grassland transition areas.

Exact locations are closely guarded secrets by agencies and not available to the public.

Demographics

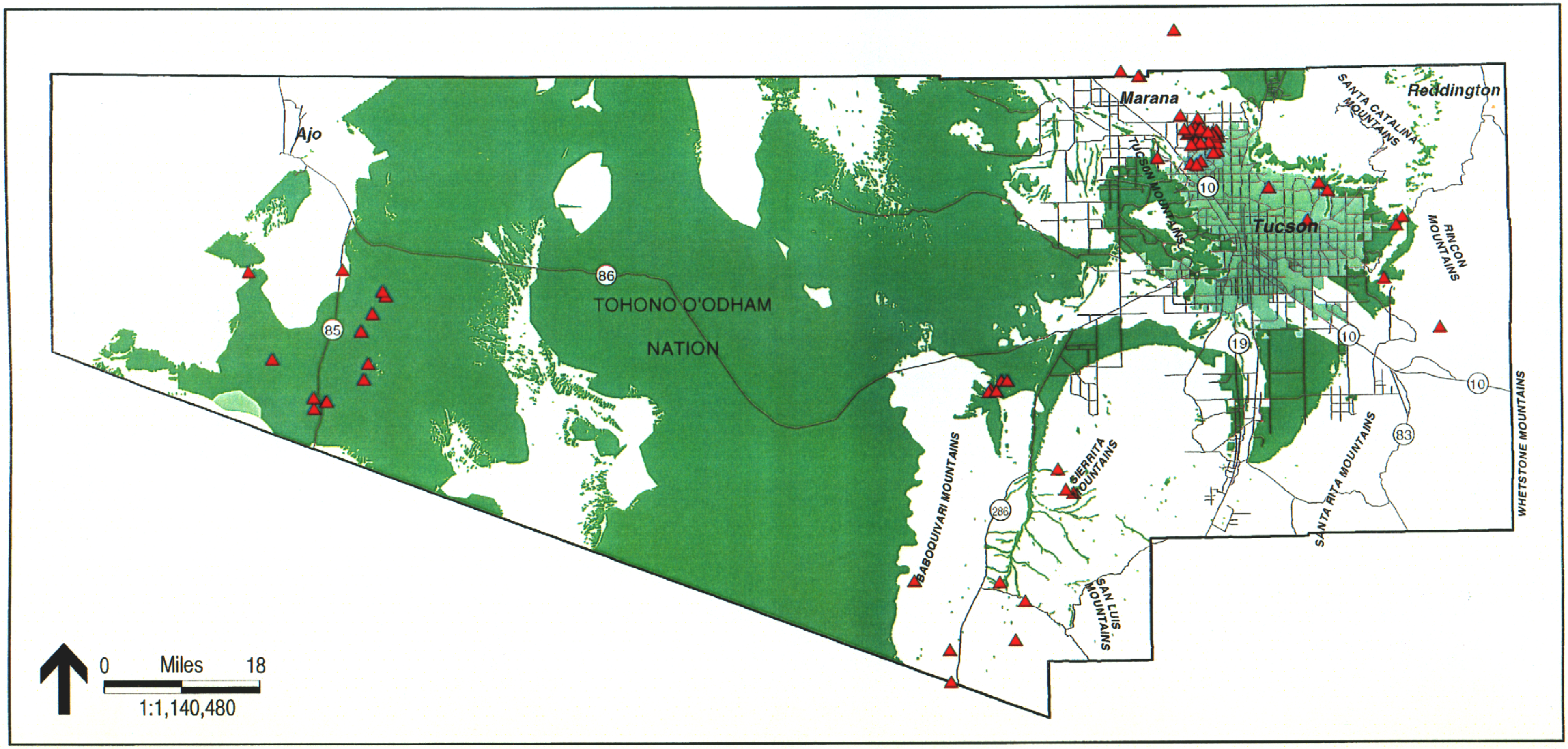
Density: No known information is currently available regarding density of natural populations. Density is apparently so variable, and the species so widely dispersed, that it is not appropriate to evaluate density, except to state that they are very sparse.

Status: Status is uncertain at present. New detections are being made each year as a result of increases surveys. The results of population surveys do not yet allow for an estimate of population size (Richardson et al. 2000).

Trend: Population trends are not currently known. There has been a historical decline that has been attributed to the loss of riparian areas throughout the species range in Arizona (Johnson et al. 2000). Between 1971 and 1988, fewer than 20 credible cactus ferruginous pygmy-owl sightings were recorded. No persistent breeding population was known anywhere in the state (Johnson e al. 2000; Richardson et al. 2000). In the past 7 years, with systematic surveys over a wide area of the state, with several breeding pairs located and a total of 78 individual owls detected in 1999 (Richardson et al. 2000). However, it would not be appropriate to base any estimate of trend on this limited data set.

Survival rates: No known information is currently available regarding survival rates in natural populations. Some information is anticipated to become available as a result of ongoing radiotelemetry and banding studies.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations. Some information is anticipated to become available as a result of ongoing radiotelemetry and banding studies



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Cactus Ferruginous Pygmy Owl
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(HDMS, 2000)
Cactus Ferruginous Pygmy Owl
(Glaucidium brasilianum cactorum)

Potential Habitat
(GAP, 1994)
Low Value
Medium Value

Figure 15

Age ratios: No known information is currently available regarding age ratios in natural populations. Some information is anticipated to become available as a result of ongoing radiotelemetry and banding studies

Significant Pima Co. populations: All known individuals are considered significant. The areas with known populations are outlined above.

Habitat Requirements

Ability to use major land use categories: Current information allows only the description, in general terms, of the habitat areas where cactus ferruginous pygmy-owls have been bound in Arizona. So far, there is insufficient data to determine specific habitat needs. Also, owls have been found over an unexpectedly high range of vegetation types, which makes it difficult to identify what specific habitat characteristics are selected by the owls. Most of the known owls detected since 1993 were found in an area that is a mixture of private, state, and BLM lands. Residential occupancy ranges from scatter ranches on hundreds of acres to six residences per acre. Livestock grazing and recreational use occur in the area (Richardson et al. 2000). Other areas that are relatively more pristine, with fewer human residences and less intensive human activities have fewer or even no records of cactus ferruginous pygmy-owls. Whereas most people would agree that intensive human development is probably inimical to the species, some degree of development may be beneficial.

Habitat trends in planning area: Because it is not possible to determine specific habitat needs, it is inappropriate to draw conclusions on habitat trends in the planning area.

Home range requirements: Estimates are based on extremely limited information, and suggest that the home range may vary with weather conditions. Estimates of territory size in Arizona have ranged between 0.01 and 4 ha. In Organ Pipe Cactus National Monument, territories appear to be linear along washes (Cartron et al. 2000a). Presumably, a suitable home range must include a nest hole, prey species at some density, and some as yet poorly understood configuration of vegetation, which may vary between individual owls or subpopulations.

Current and Potential Threats

General: Threats were defined as historic loss of riparian habitat, and current threats are usually summarized as "development" and "other potential impacts." The species was listed as endangered because of historical and current evidence suggesting a significant population decline had occurred in Arizona and that the owl was nearly extirpated. Loss and alteration of the owl's habitat was identified as the primary threat to the remaining population (USFWS 1997).

Specific causes of human-related deaths of individual owls are not well known, but were speculated to include casualties caused by pest control, pollution, collision with cars, TV towers, and glass windows, electrocution by power lines, and cat predation. One cactus ferruginous pygmy-owl was known to have collided with an automobile window, although it survived, it showed signs of injury. In Texas, 2 owls were known to have been killed by a domestic cat. In Arizona, children were observed shooting pellet or BB guns near a nest site (Cartron et al. 2000a).

Pima County populations location, amount, and quality of protected habitat: The currently understood distribution of the cactus ferruginous pygmy-owl has been summarized through

1999 (Richardson et al. 2000). Most of the county has not been adequately surveyed. Of 78 individual birds detected in 1999, 39 were in Northwest Tucson, 8 in Organ Pipe Cactus National Monument, none in the Silverbell and Tucson Mountains, 10 on the Buenos Aires National Wildlife Refuge, and 21 in the Altar Valley (except the NWR). There is insufficient information available to evaluate habitat quality. Specific site location information is closely guarded by AGFD and USFWS and not available to independent researchers or the interested public.

Existing and potential pest species: There has been some speculation that the introduced house sparrow and European starling may compete for nest cavities with cactus ferruginous pygmy-owls, but this has not been substantiated. Several species of native birds have also been mentioned as potential competitors for nest cavities and raiders of prey caches (Cartron et al. 2000a).

Threat mechanism: Historic habitat losses, current habitat losses and alterations, reduction in prey density, competition have all been mentioned. Also, the possibility of natural fluctuations of a species at the edge of its range has been raised (Johnson et al. 2000). There is an inherent risk of extinction in small populations due to stochastic variation in demographic parameters, sex ratio, genetic diversity, environmental conditions and disease (Cartron et al. 2000b).

Management Needs

General: Scientific understanding of management needs is lacking. Specific recommendations have been made to increase and intensify surveys and to centralize information. Specifically called for are conducting surveys within a range of housing development patterns and sites with other types of human activities to clarify the levels and design of human activities tolerated by cactus ferruginous pygmy-owls (Richardson et al. 2000; Cartron et al. 2000b). Due top a lack of biological information, land managers are having difficulty developing management guidelines. A long list of research needs is presented as the conclusion to the only significant peer-reviewed document on this species biology (Cartron et al. 2000b).

Current protective measures: This species is protected against "take" by the Endangered Species Act. Critical Habitat has been designated, most of which is not known to be occupied or suitable for this species. Development of property within the Critical Habitat, and to a lesser degree throughout most of the species historic and known range in Arizona has been limited by the "recommendation" that property be surveyed for this species (USFWS 2000). Some individuals are known from protected lands, including Organ Pipe Cactus National Monument and Buenos Aires National Wildlife Refuge. The AGFD and USFWS closely guard information on the location of known individuals, and do not release this information to the interested public. A permit is required to conduct surveys for this species, and, at least theoretically, it may be considered a violation of the ESA to conduct surveys, or even play a tape of the owl's territorial call, without a permit.

Sensitivity to human activities and densities: There is insufficient information to base conclusions on this, and this is one aspect of the species biology for which additional research is called for (Richardson et al. 2000; Cartron et al. 2000b).

Corridor needs: None are positively known. It has been speculated that loss of more-or-less continuous riparian corridors may have been the cause of the species decline in Arizona.

Key relationships: This species is dependent on woodpeckers, such as the Gila woodpecker, for nest holes in Arizona (Cartron et al. 2000a).

Migratory requirements: None are specifically known. Although it has been stated that the species is not migratory (USFWS 1997), limited evidence suggests that this is not entirely true (Cartron et al. 2000a, 2000b).

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for this species. There has been some limited success with artificial nest boxes in Texas (Proudfoot et al. 2000) but this has not been the case in Arizona, so far (Richardson et al. 2000).

Existing monitoring and research programs: The number of surveys for this species has increased greatly in recent years, and the number of surveyors with permits has also increased greatly. Active research programs are under way by AGFD, USFWS, and other agencies. The Recovery Team is actively participating in and directing some research.

To date, Pima County has made the largest financial commitment among all governmental entities, and is the only local governmental entity funding the comprehensive study of the species. Pima County contractors in 1999 surveyed more land for this species than all government agency efforts combined had ever done. The County funded a genetics study to compare DNA of Arizona and other populations and to evaluate the genetic health of the Arizona population. The study is ongoing and a report has not yet been drafted. Telemetry and habitat analysis studies are being done by AGFD under contract to Pima County. Results of those studies are not yet available. Studies in Mexico and Pima County have been funded by the U.S. Fish and Wildlife Service for the 2000 survey season. The Recovery Plan is expected to call for new and continued research studies. All of these studies are expected to contribute valuable information to the understanding of this species (Pima County 1999).

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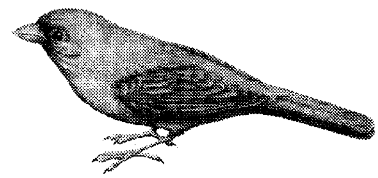
Abert's towhee (*Pipilo aberti*)

Status



Federal	Listed as a "migratory bird" under the Migratory Bird Treaty Act
State	None
Other	Vulnerable Status 1 by SDCP, probably should have been Status 2
Rankings	G5 S5

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The species was first described in 1852 by Spencer Baird, who named it for Lt. James William Abert, U.S. Army (1820-1897), who reputedly obtained the specimen during a survey of "New Mexico." The actual location of the origin of this type specimen is postulated by the American Ornithologists' Union to be Gila Bend, Maricopa County, south-central Arizona (Tweit and Finch 1994).

Classification: Order: Passeriformes; Family: Emberizidae; Genus: *Pipilo;* Species: *aberti.* Subspecies designations are varied and unclear. In 1946 the species was divided (based on plumage differences) into a paler western population (*P.a. dumeticolus*) which included California, Colorado River and Virgin River populations, specifically excluding the Bill Williams River and its tributaries in western Arizona (van Rossem 1946). By implication the remainder of the species range was assigned to the darker *P.a. aberti.* This subspecies distribution was later revised (1983) with the range of the western subspecies expanded eastward to the Gila River near Phoenix and to the Bill Williams at the Big Sandy Wash, and designated as the nominate subspecies *P.a. aberti* Baird. An eastern subspecies, *P.a. vorhiesi* Phillips, was postulated for the upper Santa Cruz River near Tucson and east on the Gila and San Pedro Rivers above their junction. Intermediate populations are variable in plumage (Tweit and Finch 1994). The subspecies that occurs in Pima County is *P.a. vorhiesi.*

Life History

Description: Abert's towhee is a large sparrow with gray-brown upperparts. There is little or no contrast between crown and back. The breast, flanks, and belly are pinkish brown. The crissum is dark rust. There is black on the lores, malar region, chin, and extreme anterior forehead surrounding a pale bill, giving the appearance of a black mask around the bill. The male and female plumages are identical (Tweit and Finch 1994).

Diet: Abert's towhee primarily eats insects and seeds. Beetles and ants are important foods year-round, many caterpillars are consumed in the fall, winter and spring, and grasshoppers and cicadas in the summer. Seeds are usually taken from plants in the family Chenopodiaceae (Tweit and Finch 1994).

Reproduction: Abert's towhee is monogamous and the pair-bond is lifelong. In the early part of the year (February to April), the female constructs a bulky cup nest of leaves, grasses and bark in trees and shrubs at 4 to 7 feet (155 cm to 224 cm) high, often with a southeast orientation. Second broods are common, and are started about 9 weeks after the start of a successful first nest. If a nest is not successful, the pair may attempt to renest as often as 6 times. Clutch size ranges from 1 to 5 pale blue eggs with dark mottles that average 0.9 inch (24 mm) in length and 0.7 inch (18 mm) in width. Incubation takes 14 days, and the young remain in the nest for 12 to13 days. The fledglings remain with the parents for another 4 to 5 weeks before becoming independent (Tweit and Finch 1994).

Behavior: Abert's towhee is a shy and wary bird that spends most of the non-breeding season foraging on the ground for insects and seeds or perching on low shrubs or tree branches. The species usually forages by scratching at the ground or loose leaf litter, but has also been observed finding insects in bark crevices up to 8 feet (2.5 m) above the ground (Tweit and Finch 1994). During extremely hot summers the species restricts its activity to the cooler parts of the day: early morning and late afternoon (Erlich et al. 1988). During breeding season the pair will sing duets to each other, and territories will be aggressively defended against conspecifics. Abert's towhee will aggressively interact with other species at food sources to displace them (Tweit and Finch 1994).

Distribution

Historic: This species is resident from southeastern California, southern Nevada, southwestern Utah, central Arizona, and southwestern New Mexico south to northeastern Baja California and northern Sonora (Tweit and Finch 1994; BISON-M 2000).

Present: Since the mid-1970s the range of Abert's towhee has expanded from the upper Santa Cruz to Nogales, up Sonoita Creek, up Oak Creek nearly to Sedona, and from the upper San Pedro into Mexico. The species has also been found utilizing exotic shrubs along irrigation ditches and suburban backyards in Phoenix and Tucson. The range of the species has contracted in other areas, and Abert's towhees have completely disappeared from some areas of Utah. In Arizona, loss of native riparian habitat has fragmented the species range, and invasive species such as saltcedar (*Tamarisk* sp.) has reduced the suitability of much existing habitat (Tweit and Finch 1994), although the species may be abundant in saltcedar-dominated habitats (K. Kingsley, pers. obs.; G. S. Mills, pers. obs.). In Pima County, Abert's towhees are common along brushy washes and the effluent-dominated portion of the Santa Cruz River, and they may be present in urban backyards, especially those that are along washes (K. Kingsley, pers. obs.) (Figure 16).

The Arizona Breeding Bird Atlas (Arizona Breeding Bird Atlas 2000) records bird locations only by U.S.G.S. 7.5-minute quadrangle names. Abert's towhees were recorded from 32 quadrangles in Pima County between 1993 and 1999. Habitats in which this species was recorded and the proportion of the 32 records that were from each habitat are: Sonoran Riparian Scrubland 35%, Sonoran Riparian Deciduous Forest and Woodlands 27.5%, Arizona Upland Biome 12.5%, Urban/Agricultural (Rural) 10%, Lower Colorado River Biome 7.5%, Sonoran Savanna Grassland 2.5%, Altered Riparian 2.5%, and Residential 2.5%.

Demographics

Density: Mated pairs maintain permanent territories about 3.75 to 5 acres (1.5 to 2 ha) in size in optimum habitat. The mean territory size in the lower Colorado River valley is 3 acres (1.22 ha), and only 2 acres (0.8 ha) on the San Pedro River (Tweit and Finch 1994).

Status: Status is very difficult to define because it apparently varies in different portions of the range.

Trend: The species appears to be declining in "many or most parts of its range, apparently in response to vanishing riparian habitat" (BISON-M 2000). On the other hand, apparently this species is adapting well to human influences and anthropogenic habitat, at least in some portions of its range (K. Kingsley, pers. obs.).

Survival rates: The maximum recorded age for a banded bird was 8 years 7 months (Tweit and Finch 1994).

Reproduction rates: Annual fecundity averages 14.05 eggs per female, with annual productivity averaging 2.8 fledglings per pair. Up to 6 clutches may be laid in a year, some of them containing only 1 egg (Tweit and Finch 1994).

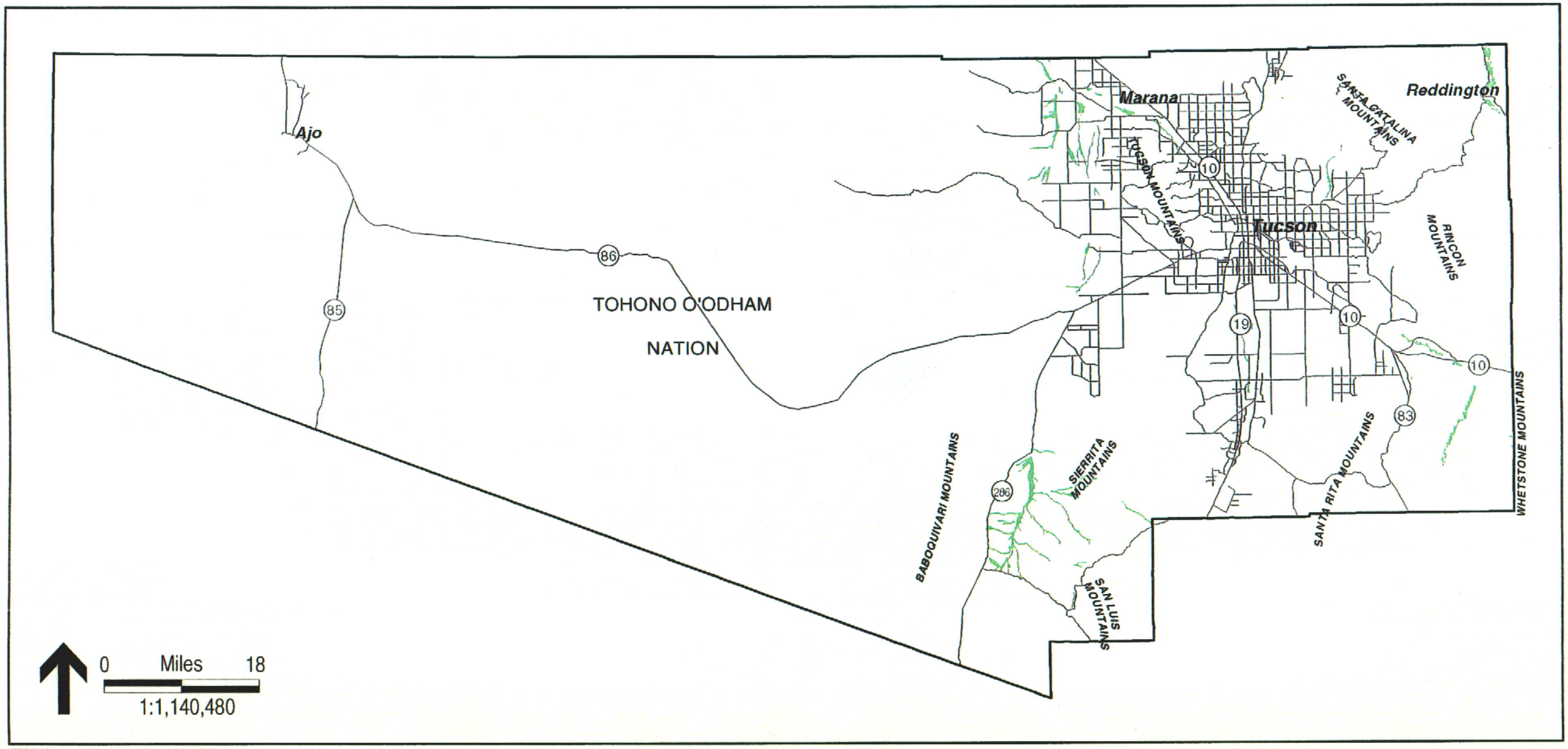
Age ratios: There is no known information on age ratios.

Sex ratios: There is no known information on sex ratios.

Significant Pima Co. populations: Abert's towhees are found in all known low-elevation riparian sites in Pima County. The population along the effluent-dominated portion of the Santa Cruz River may be at a greater density than at other locations for this species (K. Kingsley, pers. obs.). However, no density studies are known that would permit comparison.

Habitat Requirements

General: Abert's towhee prefers Sonoran Riparian Deciduous Woodland and Riparian Scrubland, with a dense understory of shrubs. Much of this habitat has been altered and fragmented, and Abert's towhee is now found in remnants of riparian woodland and scrubland, marshes, and areas



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Abert's Towhee Potential Habitat

Pima County Boundary
Major Road or Highway

Potential Habitat
(GAP, 1994)
Low Value

Figure 16

with exotic vegetation, including saltcedar in the lower Colorado River valley and in mixed exotic-native habitat in the Phoenix, and Tucson areas (Tweit and Finch 1994). They are also found in Sonoran and Chihuahuan Desert Scrub habitats, usually near washes (BISON-M 2000).

Home range requirements: There is no specific information on home range requirements of this species.

Ability to use major land use categories: This species appears to be well adapted to urban development in at least some portions of its range. However, density in urban areas may be less than in optimal natural areas.

Habitat trends in planning area: Human activities such as development, agriculture, grazing, and depletion of groundwater has destroyed much of Arizona's native riparian habitat. It has been estimated that only about 5% to10% of this native habitat remains today (Johnson 1979; Tweit and Finch 1994). Continuation of these activities may imperil remaining habitat for this species. Invasive exotic species also are alleged to pose a growing threat to this habitat; however, this has not been demonstrated and may not be true because this species apparently thrives in *Tamarix*-dominated habitats (G. S. Mills, pers. obs.; K. Kingsley, pers. obs.).

Current and Potential Threats

General: Much riparian habitat has been lost through the clearing of land for agriculture, development or grazing, or through groundwater depletion that has lowered the water table. Exotic species such as saltcedar have become established in many remaining riparian areas and may have reduced habitat quality for Abert's towhee. After removal of cattle from the San Pedro Riparian National Conservation Area, spring densities of Abert's towhees in cottonwood-willow habitat almost doubled (Tweit and Finch 1994).

Location, amount, and quality of protected habitat: Specific measures for the protection of the habitat of this species are unknown. However, Pima County's wash protection ordinance probably benefits this species by protecting its habitat. This species is known from Saguaro National Park, Organ Pipe Cactus National Monument, Buenos Aires National Wildlife Refuge, the Empire-Cienega Resource Conservation Area, Coronado National Forest, the Santa Cruz River Park, Tucson Mountains Park, Cienega Creek Park, Agua Caliente Park, and many urban parks. Insufficient information is available at present to evaluate the specific amount of habitat for this species that is protected.

Existing and potential pest species: Cowbirds are sometimes parasites of Abert's towhee nests. Because Abert's towhee eggs are larger than those of cowbirds, Abert's towhee is probably not a good host for the cowbird. Cowbirds usually select host nests that contain eggs smaller than their own. Cowbird nestlings do not appear to thrive in Abert's towhee nests, possibly starving to death due to competition from the much larger towhee nest mates (Tweit and Finch 1994).

Threat mechanism: Destruction of riparian habitat through development, agriculture, grazing or groundwater depletion. There have been no known studies performed on the effects of pesticides or other contaminants in areas where Abert's towhees are present (Tweit and Finch 1994).

Management Needs

General: Protection of native riparian habitat is needed for the conservation of Abert's towhee. Management programs that benefit the endangered southwestern willow flycatcher may also benefit Abert's towhee in portions of their sympatric range.

Current protective measures: This species is protected under the Migratory Bird Treaty Act, despite the fact that it is sedentary. The Migratory Bird Treaty Act makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird, including feathers, parts, nests, or eggs. Violations of the Migratory Bird Treaty Act are considered criminal offenses and can result in significant fines and imprisonment.

Pima County has a wash protection ordinance that prevents some destruction of habitat for this species.

The federal Clean Water Act, in its Section 404, may also protect some of the habitat of Abert's towhee.

Sensitivity to human activities and densities: There is no known specific information available on this subject. This species may survive and even thrive in urban and suburban backyards under some circumstances.

Corridor needs: There is no known information available on corridor needs of this species.

Key relationships: Abert's towhee is considered a riparian obligate species (Johnson et al. 1987; Tweit and Finch 1994), but the specific type of riparian association upon which it is obligate is not defined and may vary from xeroriparian to hydroriparian. The dependency appears to be more on vegetation density and structure than on species of vegetation or presence of water (K. Kingsley, pers. obs.).

Migratory requirements: The species is essentially sedentary, although it is classified as a "Migratory Bird" under the federal Migratory Bird Treaty Act.

Results of past mitigation activities: Removal of cattle from the San Pedro Riparian National Conservation Area resulted in almost doubled spring densities of Abert's towhees in cottonwood-willow habitat (Tweit and Finch 1994).

Existing monitoring and research programs: No specific monitoring and research programs for this species are currently known. However, this species is one that is frequently observed in studies of riparian birds within its range. In Pima County, habitat for this bird is included in a recently completed study of the effluent-dominated portion of the Santa Cruz River (K. Kingsley, unpublished notes), and is also included in the annual Christmas Count sponsored by the Audubon Society and Fish and Wildlife Service Breeding Bird Surveys, as well as continuing monitoring surveys at Organ Pipe Cactus National Monument (1998).

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Johnson, R. R., L. T. Haight, and J. M. Simpson. 1987. Endangered habitats versus endangered species: a management challenge. Pp. 89-96 *in* S. A. Laymon, ed. Management and preservation of endangered birds in riparian ecosystems. Western Birds 18:89-96.

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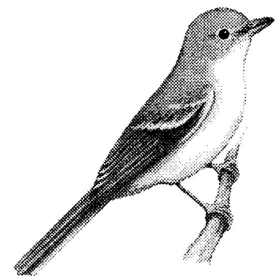
Bell's vireo (*Vireo bellii*)



Status

Federal	Listed as a migratory bird under the Migratory Bird Treaty Act
State	None
Other	Endangered in the State of California
Rankings	G5T4 S4

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: Vireos occur only in the Western Hemisphere, from Canada to Argentina and the West Indies. There are 38 species worldwide with 12 reported in North America. *Vireo bellii*, Bell's vireo, was named by John James Audubon in 1844 for John G. Bell, a taxidermist who accompanied Audubon on his Missouri River expedition of 1843 (Terres 1980).

Classification: Order: Passeriformes; Family: Vireonidae; Genus: *Vireo;* Species: *bellii.* There are 4 recognized subspecies: *V. b. bellii*, which breeds from east Colorado to South Dakota; *V. b. medius,* which breeds from southwest Texas south to Durango; *V. b. arizonae*, which breeds from southern Nevada, southwest Utah, and northwest and central Arizona south to southeast California (the lower Colorado River Valley) and southern Sonora, Mexico; and *V. b. pusillus,* the least Bell's vireo, which breeds in southwest California and northwest Baja California. The subspecies present in Pima Co. is *V. b. arizonae*, Arizona Bell's vireo (Brown 1993).

Life History

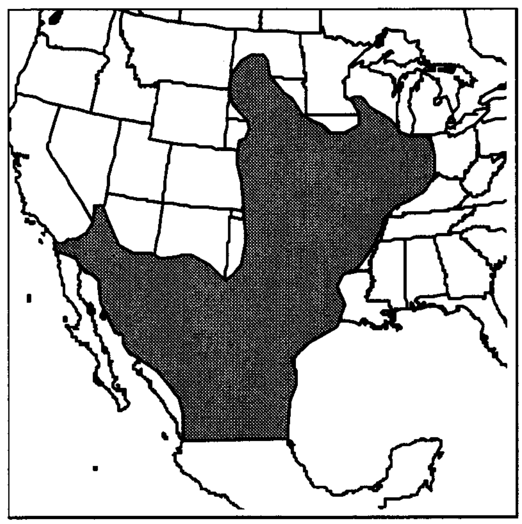
Description: Bell's vireo is a small bird, with a length of 4.5 to 5.0 inches (115 to 125 mm) and weight from 7 to 10 g. Its short, rounded wings make it's tail look long. It has a short, straight bill, somewhat compressed at the base. Males and females have similar plumage throughout the year. The plumage color varies; it is generally drab gray to green above, and white to yellow below; the breast is unstreaked. There is a faint white eye ring. There are 2 pale wing bars, and the lower bar is more prominent. The juvenal plumage resembles that of adults in worn summer plumage—essentially white and gray but whiter below with more distinct wingbars (Brown 1993).

Diet: Bell's vireo is almost entirely insectivorous in the breeding season, occasionally consuming small (<1%) amounts of fruit. One study found caterpillars (Lepidoptera) made up 15.9%, of the species diet, with stinkbugs (Pentatomidae), 9.3%; bees and wasps (Hymenoptera) 6.4%; and weevils (Rhynchophora) 6.1% (Brown 1993). Primary winter foods are unknown (Brown 1993).

Reproduction: Breeding activities usually commence in April in Arizona and California (in May farther north) and continue through July. Pairs are generally monogamous although polygyny and polyandry occur with some individuals. Early courtship activities are violent, with the male attacking and pursuing the female prior to copulation. Clutches consist of 3-5 eggs, white with scattered brown spots, about 0.7 inch in length (18 mm) and 0.5 inch in width (13 mm). Eggs are incubated for 14 days by both parents. The young are born helpless and without feathers and continue to be tended by both parents. Fledglings leave the nest in 11 to 12 days (Ehrlich 1988). Most pairs produce only 1 brood per season, but second broods have been reported and appear to be normal in the Lower Colorado River Valley and along the Colorado through Grand Canyon, Arizona (Brown 1993).

Behavior: Bell's vireo forages primarily by gleaning prey from a substrate, but will also remove prey from a substrate while hovering or capture prey during aerial pursuit. While foraging the bird hops between branches; it is rarely reported on the ground (Brown 1993).

Distribution



Present: Bell's vireo is widespread in central and southwest United States and northern Mexico. It breeds from southern California to southern Nevada, Utah, northwest and southern Arizona and New Mexico; and from Texas north to North Dakota, east to Ohio, and south to Tennessee, and in the northern half of Mexico. The winter range is not well known. Records have been reported from southern Baja California and southern Sonora south along west coast of Mexico and Central America to Honduras and casually to northern Nicaragua. It has also been reported from the east coast of Central America from Veracruz south to Honduras. There are scattered winter records from extreme southern California, southern Arizona, southern Texas, Louisiana, and southern Florida (Brown 1993).

The subspecies present in Pima County, Arizona Bell's vireo, breeds from southern Nevada, southwest Utah, and northwest and central Arizona south to southeast California (the lower Colorado River Valley) and southern Sonora, Mexico (Brown 1993).

The Arizona Breeding Bird Atlas (Arizona Breeding Bird Atlas 2000) records bird locations only by U.S.G.S. 7.5-minute quadrangle names. Bell's vireos were recorded from 99 quadrangles in Pima County between 1993 and 1999. This represents the majority of quadrangles that have been surveyed in the County, and shows a distribution that reaches almost throughout the County, wherever habitat conditions are appropriate. Habitats in which this species was recorded and the proportion of the 99 records that were from each habitat are Sonoran Riparian Scrubland 42%, Sonoran Riparian Deciduous Forest and Woodlands 21%, Arizona Upland Biome 17%, Interior Riparian Deciduous Forest and Woodlands 7%, Urban/Agricultural (Rural) 4%, Semidesert Grassland 3%, Lower Colorado River Biome 1%, Sonora Savanna Grassland 1%, Marshes, Cienegas, Ponds 1%, Urban/Agricultural (Parks) 1%, and Urban/Agricultural (Residential) 1%. Several records are from residential, rural, and park situations, indicating that this species may not be excluded by some level of human use and modification of the landscape.

Historic changes: A slight range expansion to include eastern Indiana has been observed in recent decades, and in Grand Canyon, Arizona, the range has expanded 145 miles (232 km) up the Colorado River. Breeding populations in north and central California have been extirpated, and the species has been nearly extirpated in the lower Colorado River Valley (Brown 1993). Locations for Bell's vireo in Pima County are shown in Figure 17.

Demographics

Density: The breeding territories of males have been observed to range from 0.1 to 1.3 ha in Kansas, and 0.2 to 1.6 ha and 0.3 to 1.3 ha in 2 separate studies in California (Brown 1993).

Status and trend: The Arizona Bell's vireo has been declining along the lower reaches of the Colorado River and along the lower reaches of the Gila, Santa Cruz, and Salt rivers. It has remained common throughout its range at higher elevations. Since the late 1960s, the Arizona Bell's vireo has been expanding its range eastward along the Colorado River into Grand Canyon National Park (LCR MSCP 1999).

Survival rates: The oldest known banded individual was 6 years and 11 months old. Studies have found only 8% to 15% of adults live longer than 4 years, and there is some data indicating that mortality in the first year of life may be as high as 76%, and 56% mortality per year for adults (Brown 1993).

Reproduction rates: Annual reproductive success in 2 studies of California populations (where cowbirds were removed) ranged from 1.90 to 3.38 fledglings per breeding pair.

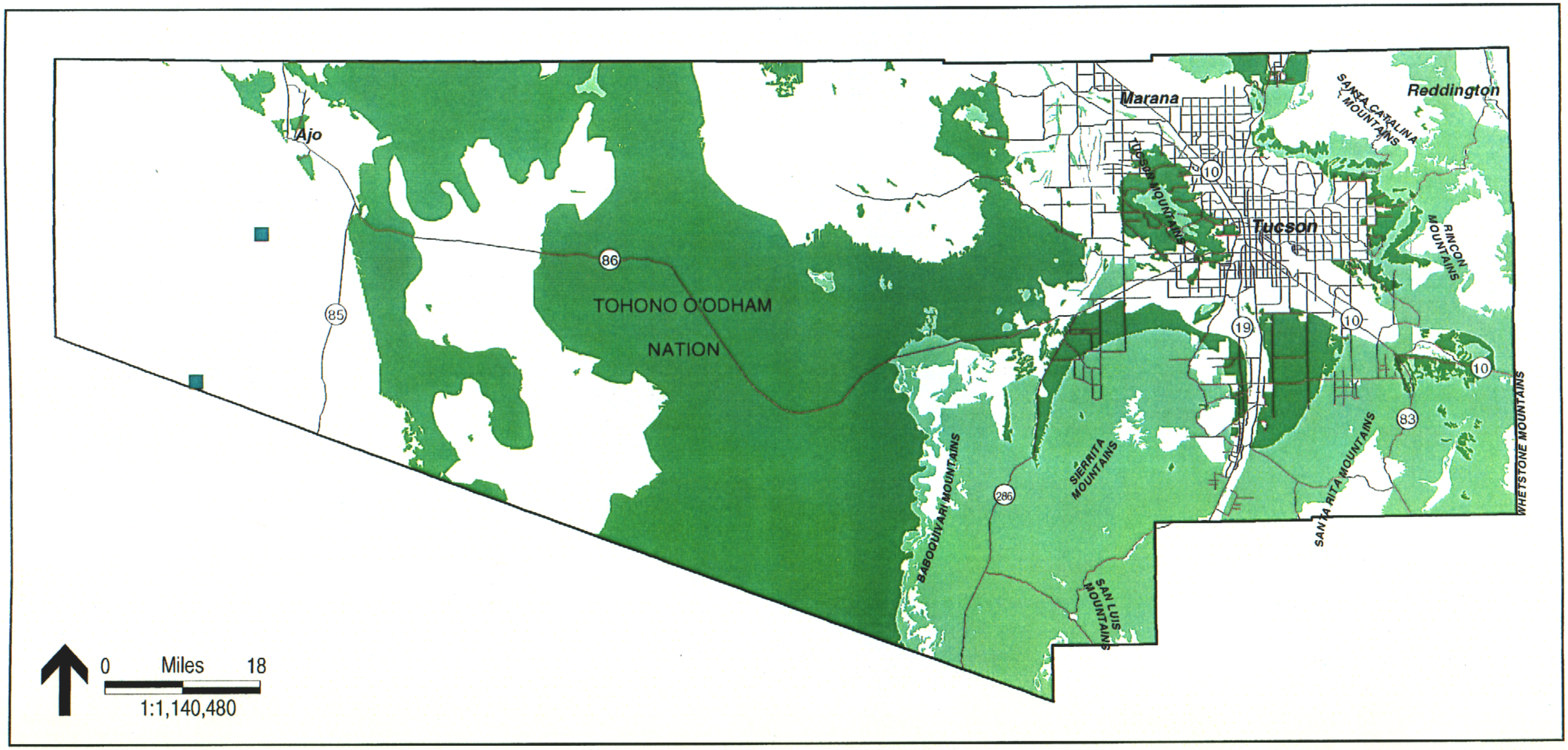
Age ratios: There is no readily available information on age ratios.

Sex ratios: Observed male to female sex ratios in California from 1980 to 1992 ranged from nearly 50:50 (1980) to 61:39 (1988); however, it has been noted that males are easier to detect than females (Brown 1993).

Significant Pima Co. populations: No especially significant populations are known in Pima County.

Habitat Requirements

General: Bell's vireo prefers dense, low, shrubby vegetation in riparian areas. Characteristically it is found in dense shrubland or woodland along lowland stream courses, with willows (*Salix* spp.), mesquite (*Prosopis* spp.), and seepwillows (*Baccharis glutinosa*) being characteristic plant species (BISON-M 2000). It is known to be a habitat generalist in riparian scrubland dominated by the introduced shrub tamarisk (*Tamarix ramosissima*) along the Colorado River in Grand Canyon, Arizona; it is a specialist in native seepwillow and mesquite habitats of the lower Colorado River Valley, Arizona, where tamarisk is rarely used (Brown 1993).



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Bell's Vireo
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations (SWCA, 2000)
Bell's Vireo *(Vireo belli)*

Potential Habitat (GAP, 1994)
Low Value
Medium Value

Figure 17

Home range requirements: Home range requirements of this species are assumed to be similar to territory size (Brown 1993).

Ability to use major land use categories: Bell's vireo primarily uses native riparian woodlands and shrublands, and it can also use areas altered by tamarisk.

Habitat trends in planning area: Depletion of groundwater has resulted in the drying of many riparian areas and the loss of vegetation there. However, because the species is common and widespread along many smaller upland riparian areas, which have been much less affected by groundwater depletion, the loss of riparian habitat along larger watercourses has probably not greatly decimated the overall County population. Some habitat improvement has occurred along the effluent-dominated portion of the Santa Cruz River (K. Kingsley, pers. obs.).

Current and Potential Threats

General: Current threats to this subspecies within the study area include the continued loss and degradation of habitat due to urbanization, water projects, flood control projects, agriculture, livestock grazing, introduced competitors, exotic invasive plants, off-road vehicles, and nest parasitism by brown-headed cowbirds (LCR MSCP 1999).

Specific: No specific threats to this species within and unique to Pima County are known.

Location, amount, and quality of protected habitat: Currently most suitable habitat is protected from direct destruction by wash protection ordinances and policies. This species occurs in Saguaro National Park, Organ Pipe Cactus National Monument, Buenos Aires National Wildlife Refuge, Tucson Mountain Park, Cienega Creek Park, Colossal Cave Park, portions of the Santa Cruz River Park, and elsewhere throughout the county, wherever suitable habitat exists. However, without surveys, it is not possible to determine the precise location, amount, and quality of protected habitat for this species is present.

Existing and potential pest species: Bell's vireo is frequently used as a host by brown-headed cowbirds (*Molothrus ater*). Rates of parasitism can be as high as 70% of all nests in a area being affected (BISON-M 2000). Female cowbirds will lay 1 egg per day in vireo nests, and may simultaneously remove or destroy 1 or more vireo eggs or young. Cowbird nestlings out-compete vireo nestlings for food and parental care so that vireo nestlings are often neglected and die. Success of the parasite is usually low, since vireos typically respond to the presence of cowbird eggs by abandoning the nest (Brown 1993) or occasionally by building a second floor of nest over the cowbird eggs (Ehrlich 1988).

Threat mechanism: Loss of riparian habitat and parasitism by brown-headed cowbirds.

Management Needs

General: The management priority for the Arizona Bell's vireo should be the return of healthy stands of cottonwood-willow habitat that provide this riparian-obligate subspecies with the breeding habitat it requires. Activities such as revegetation of disturbed riparian areas, control of invasive exotic plants, reduction of cattle grazing in riparian areas, and limiting off-road vehicle traffic fall in to this category. Trapping and removal of cowbirds where rates of brood parasitism are high may increase productivity of Bell's vireo (LCR MSCP 1999).

Current protective measures: This species is protected under the Migratory Bird Treaty Act. The Migratory Bird Treaty Act makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird, including feathers, parts, nests, or eggs. Violations of the Migratory Bird Treaty Act are considered criminal offenses and can result in significant fines and imprisonment.

Habitat protection is afforded by the various county and local wash protection ordinances and by Section 404 of the federal Clean Water Act.

Sensitivity to human activities and densities: Bell's vireo responds to the presence of humans with an alarm call. Males may reduce the frequency of their song in the presence of a human observer (Brown 1993). Further information on the response of Bell's vireo to human activities is not known. Bell's vireo appears to tolerate human activity as long as suitable habitat is present. The species nests successfully in areas of suitable habitat in high-density residential areas in Tucson (G. S. Mills, pers. comm. 2000).

Corridor needs: There is no known information on corridor requirements.

Key relationships: Bell's vireo is a riparian-obligate and requires dense riparian habitat to persist and breed. However, the species of plants that make up that habitat vary throughout the species range. It requires insects for its diet, but appears to be an opportunistic gleaner. It has an adverse relationship with the brown-headed cowbird.

Migratory requirements: Bell's vireo leaves the northernmost limits of its breeding range in August or September, although southern populations (such as in southern Arizona) may depart as late as November. The species overwinters primarily along the Pacific coast of southern Mexico. Spring migrants begin to return to the breeding range from early to mid-March (Brown 1993).

Results of past mitigation activities: No mitigation activities that were specifically directed at this species are known. Conservation and reestablishment of riparian habitat has undoubtedly benefited this species, but no specific documentation of this is known.

Existing monitoring and research programs: No specific monitoring and research programs for this species are currently known. However, this species is one that is frequently observed in studies of riparian birds within its range. In Pima County, habitat for this bird is included in a recently completed study of the effluent-dominated portion of the Santa Cruz River (K. Kingsley, unpublished notes), and is also included in the annual Christmas Count sponsored by the Audubon Society and Fish and Wildlife Service Breeding Bird Surveys, as well as continuing monitoring surveys at Organ Pipe Cactus National Monument (OPCNM 1998).

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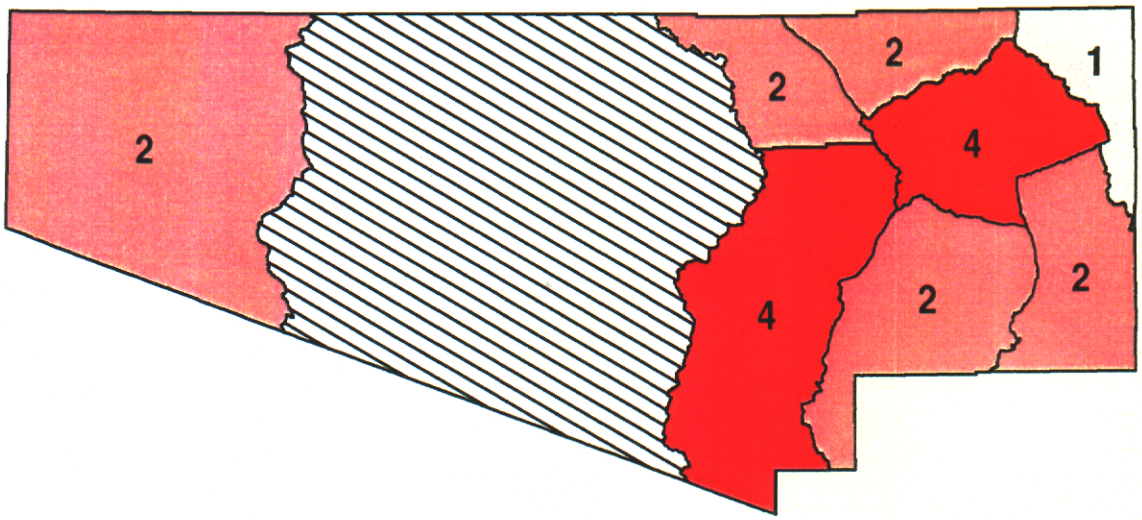
Number of Priority Vulnerable Reptile Species



Potentially Occurring in Each Subarea

REPTILES

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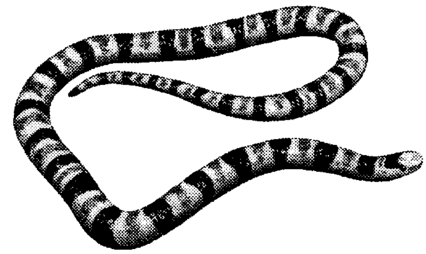
Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*)

Status



Federal	No status for species or subspecies
State	No status for species or subspecies
Other	No status for species or subspecies; Vulnerable Status 1 by SDCP
Rankings	G5, S5 for western shovel-nosed snake (*Chionactis occipitalis*)

Recovery Goals

Federal: There are no federal agency-mandated recovery goals for this species.

State: There are no state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Tucson shovel-nosed snake is 1 of 4 subspecies of the western shovel-nosed snake (Stebbins 1985; BISON-M 2000). This is the easternmost subspecies of the species. The species is distributed in Arizona, California, Nevada, Sonora, and Baja California del Norte.

Classification: Order: Squamata; Family Colubridae; Genus: *Chionactis*; Species: *occipitalis*; Subspecies: *klauberi*. The genus *Chionactis* has 2 species in North America, *C. occipitalis* and *C. palarostris*. Both species have subspecies that are covered in these species accounts and included in the SDCP. *C. occipitalis* has 4 subspecies that occur in the U.S.: *C. o. occipitalis*, the Mohave shovel-nosed snake; *C. o. annulata*, the Colorado Desert shovel-nosed snake; *C.o. talpina*, the Nevada shovel-nosed snake; and *C. o. klauberi*, the Tucson shovel-nosed snake.

Specific: The Tucson shovel-nosed snake is distinguished from the other subspecies by black or brown secondary bands between the primary bands and usually fewer than 152 ventral scales in males and fewer than 160 in females (Stebbins 1985).

Life History

Description: The adult Tucson shovel-nosed snake is 10 to 17 inches (25 to 42 cm) long. Markings vary considerably between individuals and between subspecies. Tucson shovel-nosed snakes have a cream-colored, whitish or yellowish body with approximately 21 or more black or brown bands across the back, reaching almost to the belly or encircling the body. Between these bands are black or brown smaller bands. The snout is flattened and shaped somewhat like a shovel (Stebbins 1985).

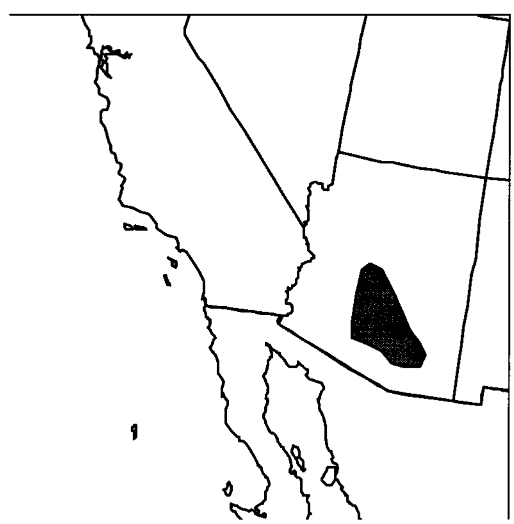
Diet: The western shovel-nosed snake eats insects (adult and larval stages), spiders, scorpions, centipedes, and buried moth pupae (Stebbins 1985), and it is likely that, in this respect, this subspecies does not differ from the species. In captivity, this species was observed to eat crickets, scorpions, coleopteran and lepidopteran larvae, silverfish, termites, immature grasshoppers, small native cockroaches (*Arenivaga* sp.), spiders, and earwigs. Food animals accepted ranged from 4 to 32 mm in length, and soft-bodied prey were preferred over hard-bodied prey such as beetles (Glass 1972).

Reproduction: The western shovel-nosed snake is oviparous (Stebbins 1985; BISON-M 2000), and has a clutch of 2 to 4 (occasionally up to 9) eggs laid in summer (Stebbins 1985).

Behavior: This species nests in an underground burrow, which it digs (BISON-M 2000). It moves by a swimming, sideways swaying motion under or on the surface of sand or loose soil (Lowe 1964; Stebbins 1985). The western shovel-nosed snake usually rests by day buried under a creosotebush (*Larrea tridentata*), although it may occasionally be found under surface objects such as boards. It roams above and below the ground surface at night (Stebbins 1985). It flees from bright light, such as that of a lantern or flashlight, and from the disturbance of collectors and observers (Warren 1953). It typically explores an area of some 10 or 15 square feet next to the bush and may climb the bush in search of food or when frightened. If approached by a collector, the snake may flee in a more-or-less direct route to another bush or climb the nearest bush (Warren 1953). Males engage in combat with each other (Goode and Schuett 1994), as do those of many other snake species.

Feeding behavior of captive snakes was observed by Glass (1972). Snakes subdued prey by one of two means: striking and grasping with the mouth, or looping the anterior third of the body in a single loop over the prey and pressing it against the substrate, then seizing the prey with the mouth. Missing was common when striking was used, but not when looping was used.

Distribution



Historic: The range of the western shovel-nosed snake in Arizona includes the Sonoran and Mohave deserts in the southwestern portion of the state, within which its distribution is limited chiefly to dunes and similar areas having fine sand without rocks (Lowe 1964). This species has been found in an area from northern Pima County across southwestern Pinal County into southern Maricopa County (Stebbins 1985). In Pima County, it has been found in the Avra Valley, and elsewhere in valley fill areas with sandy soils, and probably on the Tohono O'odham Nation.

Present: The Tucson shovel-nosed snake is distributed from south of Tucson northward along Avra Valley to Pinal County and Maricopa County. Its current distribution in Pima County is poorly known. Further research is needed to determine its current distribution and abundance. It was recently found in Organ Pipe Cactus National Monument

(Rosen and Lowe 1996). It is believed to have been eliminated from much of the Avra Valley area and other parts of its range due to habitat loss from agricultural and urban development (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). Most of its current range is believed to lie in southern Pinal County (Figure 18). The Tucson shovel-nosed snake only exists in lowland valley floors, a habitat that has diminished in suitability as a result of clearing for agriculture and development.

Demographics

Density: Information on density of this species is extremely limited. Much information about the abundance of this and other snakes is based on nocturnal road surveys. That information may be questionable when used to determine density, because such surveys may be biased. Roads might be attractive or repulsive to this and other snakes, or snakes may be most easily observed along roads because they are conspicuous on the cleared surface. This species moves rapidly across roads and away from lights of a car (Warren 1953). Therefore, nocturnal road surveys may be inadequate to assess the density or relative abundance of this species. One herpetologist reported observing 68 Tucson shovel-nosed snakes in May, 1998, 32 of which were alive and 36 dead (Desert Snakeman 1998). That author did not indicate the number of miles driven to find this number of snakes nor the areas where they were found. However, this is a large number of individuals of what is sometimes considered to be a fairly rare species.

Tracks of this species are distinctive in sand (Warren 1953), and might be useful to determine density. Warren (1953) reported one individual collector finding 12 *Chionactis occipitalis* in an area of about 100 square yards in sand dunes east of Palm Springs, California (the subspecies there is *occipitalis*). He pointed out that the number of *Chionactis* found dropped off "tremendously" only a quarter of a mile in any direction from this site. This indicates that density of this species is extremely variable and depends on factors that are not known.

Pitfall trapping is also a useful method for locating this snake. This was the most abundant snake found in pitfall arrays in Mixed Riparian Scrub (Xeroriparian), Creosotebush (Lower Colorado Desert), and Sonoran Desert Scrub (Arizona Upland) and it was also present in Mesquite Bosque (Floodplain Woodland) (Jones 1988). However, this report was for a limited number of pitfall arrays spread over a very wide range of western Arizona, and it is not possible from his data to determine the effort and results from Pima County or which subspecies were involved.

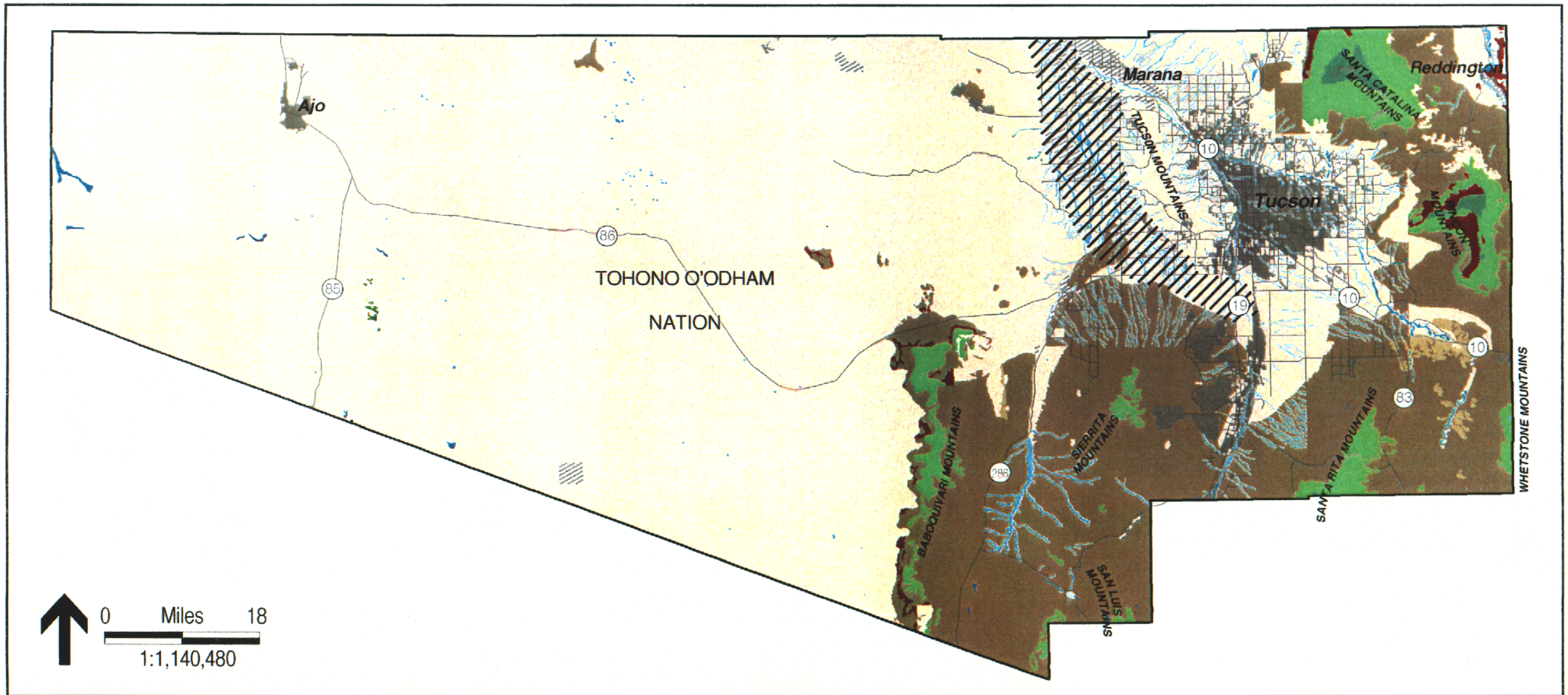
Status: The current status of this species is not well known. It has probably been extirpated from some of the areas in Pima County that it formerly inhabited, as human land uses have become incompatible with the species.

Trend: The population trend for this species is not known. Although it has probably been extirpated from part of its former range, there has been relatively little new agricultural and urban development within its range in recent years. However, high speed automobile traffic results in road kill, which is considered by some to be a problem for this species. Traffic has undoubtedly increased on all roads within its range as the human population has increased.

Survival rates: No information is available on survival rates of this species.

Reproduction rates: The species is reported as laying 1 clutch of 2 to 4 eggs (perhaps as many as 9) during the summer (Stebbins 1985).

Age ratios: No information is available on age ratios of this species.



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Tucson Shovel-nosed Snake
Potential Habitat and Vegetation Biomes

Potential Habitat
(based on assessment for this study)

- Tucson Shovel-nosed Snake *(Chionactis occipitalis klauberi)*

- Pima County Boundary
- Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 18

Sex ratios: No information is available on sex ratios of this species.

Significant Pima Co. populations: More information is needed to thoroughly document the distribution of this species in the County.

Habitat Requirements

General: The western shovel-nosed snake is known from the Lower Sonoran life zone, in areas with sand and loose soil. It consistently occurred on open, sandy sites and was present in Mixed Riparian Scrub (Xeroriparian), Creosotebush (Lower Colorado Desert), and Sonoran Desert Scrub (Arizona Upland) and it was also present in Mesquite Bosque (Floodplain Woodland) (Jones 1988). It is absent or infrequent in rocky desert terrain. It is most abundant in flat and sparsely vegetated areas with fine, wind-blown sand, such as dunes, washes, sandy flats, loose soil, and rocky hillsides having sandy gullies or pockets of sand among rocks (Lowe 1964; Stebbins 1985). Associated vegetation includes creosote, desert grasses, desert forbs, cactus, and mesquite (Warren 1953; Stebbins 1985).

Home range requirements: No specific information is available on home range requirements. However, limited literature suggests that males use combat to force dispersal (Goode and Schuett 1994) and that density may be extremely variable within apparently suitable habitat (Warren 1953). In areas with high density, foraging tracks of one snake on one evening may be concentrated in an area of some 10 or 15 square feet next to a creosotebush (Warren 1953).

Ability to use major land use categories: Apparently this species is only able to use relatively undisturbed desert lands with loose sandy soil.

Habitat trends in planning area: More information is needed on the specific distribution of this species to determine trends. Current environmental regulations and land ownership may protect at least some of the suitable habitat for the western shovel-nosed snake within public lands and on the Tohono O'odham Nation.

Current and Potential Threats

General: Loss of habitat to agricultural and urban development is likely to impact this species in portions of its range. Off-road vehicle activities are likely to adversely affect this species. Road building is likely to have destroyed and possibly fragmented some habitat. Increased traffic probably increases road kills.

Specific: This subspecies has probably suffered significant losses of habitat due to agricultural and urban development in the Avra Valley. It also is impacted by highway traffic within its habitat, and it may be affected by scientific and commercial collecting.

Location, amount, and quality of protected habitat: Currently not known. The distribution of this species needs to be more accurately determined before conclusions can be drawn. It was recently found at Organ Pipe Cactus National Monument, which is a protected habitat, but most records are of individuals killed on the Highway 85 (Rosen and Lowe 1996). Highway mortality may significantly affect local populations of snakes.

Existing and potential pest species: There is no known evidence of any pest species that affects this species. It is possible that invasion of its habitat by non-native plants, such as red brome, bufflegrass, or black mustard may be detrimental to this species by reducing or eliminating open ground.

Threat mechanism: Habitat loss due to agricultural and urban development; off-road vehicle activity, including military activity, may compact soil or crush buried snakes; increased highway traffic may cause direct mortality. Collection by herpetologists and illegal commercial collectors may cause local population losses and disrupt habitat.

Management Needs

General: Protection of habitat from development and disturbance by off-road vehicle activities, and enforcement of laws against commercial collection are necessary to protect this species. Speed limits or other road use limitations (such as seasonal restriction of use after dark) may help protect snakes (Rosen and Lowe 1996).

Current protective measures: Some of this species' habitat is protected within Organ Pipe Cactus National Monument and Saguaro National Park. Arizona prohibits commercial collection of reptiles, but enforcement is limited.

Sensitivity to human activities and densities: High density development that requires mass grading within its habitat is likely to be detrimental to this species. Off-road vehicles and highway use may be an important cause of mortality.

Corridor needs: None are specifically identifiable. This species is capable of crossing roads, including paved highways, although road kill may be a significant cause of mortality in some locations.

Key relationships: This species is found in a variety of habitat types including Mixed Riparian Scrub (Xeroriparian), Creosotebush (Lower Colorado Desert), and Sonoran Desert Scrub (Arizona Upland) and it was also present in Mesquite Bosque (Floodplain Woodland) (Jones 1988). In much of its range, the western shovel-nosed snake is associated with creosotebush, which it may use as escape cover and as a foraging substrate (Warren 1953). Glass (1972) made observations that strongly suggested that this subspecies may have a physiological resistance to scorpion (*Vejovis spinigeris*) venom, and contrasted scorpion capture behavior of this subspecies with that of *C.o. occipitalis* described by other authors. This suggests that scorpions may be a significant part of this subspecies' diet, and that subspecies may differ in behavior and physiology.

Migratory requirements: None are known for this species.

Results of past mitigation activities: None have been clearly demonstrated for this species. Enforcement of the law against commercial collecting of reptiles has probably had some benefit for this species, which is an attractive animal that may be of value in the illegal reptile trade.

Existing monitoring and research programs: Organ Pipe Cactus National Monument continues a long-term study of all vertebrate species, but snakes are not consistently reported on (Pate 1999). No other specific studies are currently known.

References

Arizona Game and Fish Department (AGFD). 1998. Status designations: biological elements of Arizona. Report dated 28 April compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

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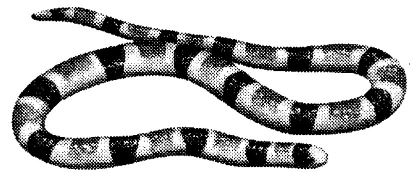
Organ Pipe shovel-nosed snake (*Chionactis palarostris organica*)

Status



Federal	No status for species or subspecies
State	No status for species or subspecies
Other	No status for species or subspecies; Vulnerable Status 1 by SDCP
Rankings	G3T3 S2

Recovery Goals

Federal: There are no federal agency-mandated recovery goals for this species.

State: There are no state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Organ Pipe shovel-nosed snake (*Chionactis palarostris organica*) is a subspecies of the Sonoran shovel-nosed snake, a species with its primary range in Mexico. Only this subspecies extends its range into the United States, and only into a small portion of western Pima County.

Classification: Order: Squamata; Family: Colubridae; Genus: *Chionactis*; Species: *palarostris;* Subspecies: *organica.* The family Colubridae contains over 1,500 species worldwide. The genus *Chionactis* has 2 species in North America, *C. occipitalis* and *C. palarostris*. Both species have subspecies that are covered in these species accounts and included in the SDCP.

Specific: The subspecies occurs only in Sonora, Mexico and Pima County, Arizona (Lowe 1964; Stebbins 1985; BISON-M 2000). It was named after Organ Pipe Cactus National Monument, where it was first collected.

Life History

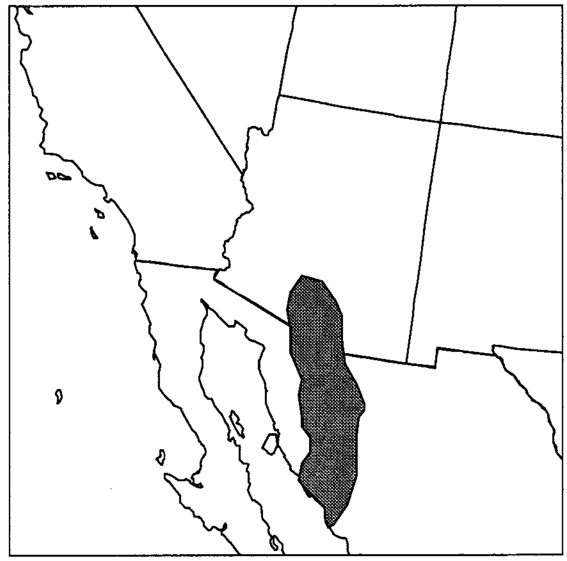
Description: The adult Sonoran shovel-nosed snake is 10 to 17 inches (25 to 42 cm) long and has black, white to yellow, and red bands that mostly encircle the body, resembling the western coral snake. Red bands are saddle-shaped and in Arizona are roughly the same width as the black bands. In Sonora, the red saddles may be 2 or 3 times wider (Stebbins 1985).

Diet: The only information available on the diet of this species is that it eats invertebrates (Stebbins 1985). The congeneric Tucson shovel-nosed snake probably has a very similar diet, but there may be some specific differences, possibly because of preferred substrate differences.

Reproduction: The Organ Pipe shovel-nosed snake is oviparous (Stebbins 1985; BISON-M 2000), and 4 eggs have been found in a female (Stebbins 1985).

Behavior: This species nests in an underground burrow (BISON-M 2000).

Distribution



Historic: The known range of Organ Pipe shovel-nosed snake includes Sonora from the Magdalena area and El Pocito (41 miles south of Hermasillo), and Arizona from Organ Pipe Cactus National Monument and along the Sonoyta-Ajo road to about 25 mi. (40 km) north of the Mexico border, from sea level to 2,500 feet elevation (Stebbins 1954).

Present: In Arizona, most, if not all, of the range of this snake is in Organ Pipe Cactus National Monument. The published record states: "The Organ Pipe shovelnosed snake is known to occur in the United States only in ORPI. . . . all other confirmed records are from the road surface of Route 85" (Rosen and Lowe 1996:36) (Figure 19). The Heritage Data Management System has one record of this species from private property "Sonoyta Valley: North of Lukeville" in 1949, which may now be within Organ Pipe Cactus National Monument. However, this species may also occur on the Cabeza Prieta Wildlife Refuge and the Tohono O'odham Nation in western and central Pima County (Stebbins 1954, 1985; Lowe 1964; P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Demographics

Density: The only available information on density is from records along Route 85 through Organ Pipe Cactus National Monument (Rosen and Lowe 1996). This species was one of the most common species observed along that road during the 4-year period 1987-1991.

Status: Other than occasional observations along roads, nothing is known of the status of this species.

Trend: No information is available regarding trends for this species.

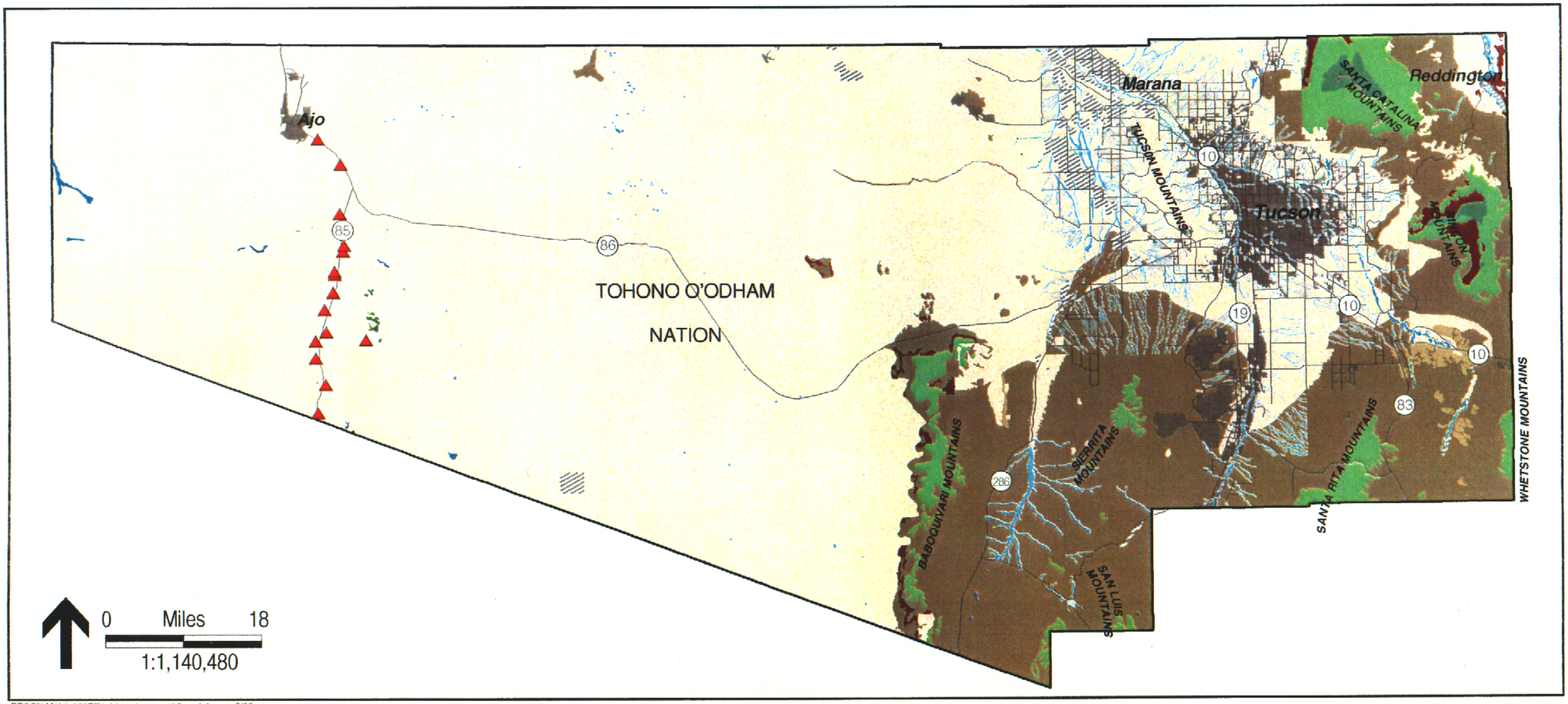
Survival rates: No information is available regarding survival rates of this species.

Reproduction rates: No information is available regarding reproduction rates of this species.

Age ratios: No reliable information is available regarding age ratios of this species.

Sex ratios: No reliable information is available regarding sex ratios of this species.

Significant Pima Co. populations: The entire U.S. population of this species is in Pima County. The documented distribution is within or immediately adjacent to Organ Pipe Cactus National Monument, but other populations may occur and should be located and identified.



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Organ Pipe Shovel-nosed Snake
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

- Organ Pipe Shovel-nosed Snake
  (Chionactis occipitalis klauberi)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 19

Habitat Requirements

General: The Organ Pipe shovel-nosed snake is found in a very limited portion of the Paloverde-Cacti-Mixed Scrub Series of the Arizona Upland subdivision of the Sonoran Desert Scrub biome. It frequents more rocky soils on bajadas and valley bottoms, and hillier terrain than *C. occipitalis* (Lowe 1964; Shaw and Campbell 1974; Stebbins 1985; Rosen and Lowe 1996).

Home range requirements: No information is available on the home range requirements of this species.

Ability to use major land use categories: No specific information is available on the ability of this species to use major land use categories. It is reasonable to conjecture that this species would not survive in areas of significant land disturbance, and may suffer significant mortality from traffic on paved roads.

Habitat trends in planning area: Most of this species' habitat in the planning area is probably well protected within Organ Pipe Cactus National Monument.

Current and Potential Threats

P. Rosen (pers. comm. to D. Scalero, 4 Mar 1999) believes that the primary threat to the Organ Pipe shovel-nosed snake is road kill. The importance of this to the population within Pima County cannot be accurately estimated, but it may be significant (Rosen and Lowe 1996). No existing or potential pest species that may affect this species are known.

Management Needs

General: Protection of habitat from development and disturbance by off-road vehicle activities, and enforcement of laws against commercial collection may be necessary to protect this species. Speed limits or other road use limitations (such as seasonal restriction of use after dark) may help protect snakes (Rosen and Lowe 1996).

Current protective measures: Most, if not all, of this species' habitat is protected within Organ Pipe Cactus National Monument. Arizona and the National Park Service prohibit commercial collection of reptiles, but enforcement is limited.

Sensitivity to human activities and densities: Off-road vehicles and highway use may be an important cause of mortality. Vehicle use within the species' range may increase with increased human population.

Corridor needs: None are specifically identifiable. This species is capable of crossing roads, including paved highways, although road kill may be a significant cause of mortality in some locations.

Key relationships: This species is found only in a limited portion of Sonoran Desert Scrub (Arizona Upland), in bajada or valley-bottom terrain (Rosen and Lowe 1996). No specific key relationships are known for it.

Migratory requirements: None are known for this species.

Results of past mitigation activities: None have been clearly demonstrated for this species. Enforcement of the law against commercial collecting of reptiles has probably had some benefit for this species, which is an attractive animal that may be of value in the illegal reptile trade. Enforcement of speed limits along Route 85 may be beneficial to this species.

Existing monitoring and research programs: Organ Pipe Cactus National Monument continues a long-term study of all vertebrate species, but snakes are not consistently reported on (Pate 1999). No other specific studies are currently known.

References

Arizona Game and Fish Department (AGFD). 1998. Status designations: biological elements of Arizona. Report dated 28 April 1998 compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

Biota Information System of New Mexico (BISON-M). 2000. Sonoran shovelnose snake (*Chionactis palarostris organica*). Version 1/2000 species account developed by New Mexico Department of Game and Fish, Santa Fe, New Mexico.

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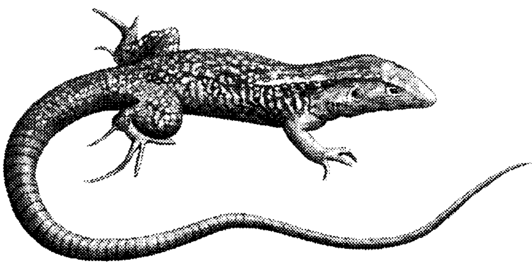
Giant spotted whiptail (*Cnemidophorus burti stictogrammus*)

Status



Federal — Designated as a Species of Concern by USFWS (AGFD 1998)

State — No AGFD status for species or subspecies (AGFD 1998); the canyon spotted whiptail (*Cnemidophorus burti*) is listed as threatened in New Mexico by NMDGF (BISON-M 2000); this is the only subspecies in New Mexico

Other — The canyon spotted whiptail (*Cnemidophorus burti*) is listed as Sensitive by USFS Region 3 Forester (AGFD 1998; BISON-M 2000); the canyon spotted whiptail (*Cnemidophorus burti*) is listed as Sensitive by BLM New Mexico State Office (BISON-M 2000); Vulnerable Status 2 by SDCP

Rankings — G4T4 S3

Recovery Goals

Federal: There are no federal agency-mandated recovery goals for this species.

State: There are no state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This whiptail lizard is one subspecies of the canyon spotted whiptail (*Cnemidophorus burti*). The species was described by Taylor in 1936, who designated the type locality near La Posa, 10 miles northwest of Guaymas, Sonora, Mexico (Lowe 1964; Degenhardt et al. 1996). *C. burti* is the largest *Cnemidophorus* species that occurs in the United States. The genus name *Cnemidophorus* means "thread carrier" referring to the long tail. The genus has 14 species in the western U.S. (Stebbins 1985). There are 4 subspecies of *Cnemidophorus burti* (Degenhardt et al. 1996), with two in Arizona, *C. b. xanthonotus* and *C. b. stictogrammus*. *C. b. xanthonotus* is limited to a small portion of western Pima County and a few isolated populations in Pinal and Maricopa Counties. It is treated in another species account in this document. Not all workers agree on the taxonomy of the subspecies (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Classification: Order: Squamata; Family: Teidae; Genus: *Cnemidophorus;* Species: *burti;* Subspecies: *stictogrammus.*

Synonymy: This subspecies has also been called *Cnemidophorus sacki stictogrammus* (AGFD 1997).

Specific to Pima County populations: The subspecies *C. b. stictogrammus* is known to occur in eastern Pima County.

Life History

Description: This is a slender, fast-moving lizard. The adult size for the species is 3.5 to 5.5 inches (8.7 to 13.7 cm) snout-vent length, with a tail generally longer than the snout-vent length. The medial and upper surfaces of the neck, legs, and feet are dark grayish green to bluish, with green or pale spots, and a reddish brown to reddish orange color on the head and neck. The tail is brown in adults and reddish or orange in young. Large males may have no stripes (Stebbins 1985; AGFD 1997).

Diet: Giant spotted whiptails eat arthropods, primarily insects and spiders (Stebbins 1985; AGFD 1997; BISON-M 2000).

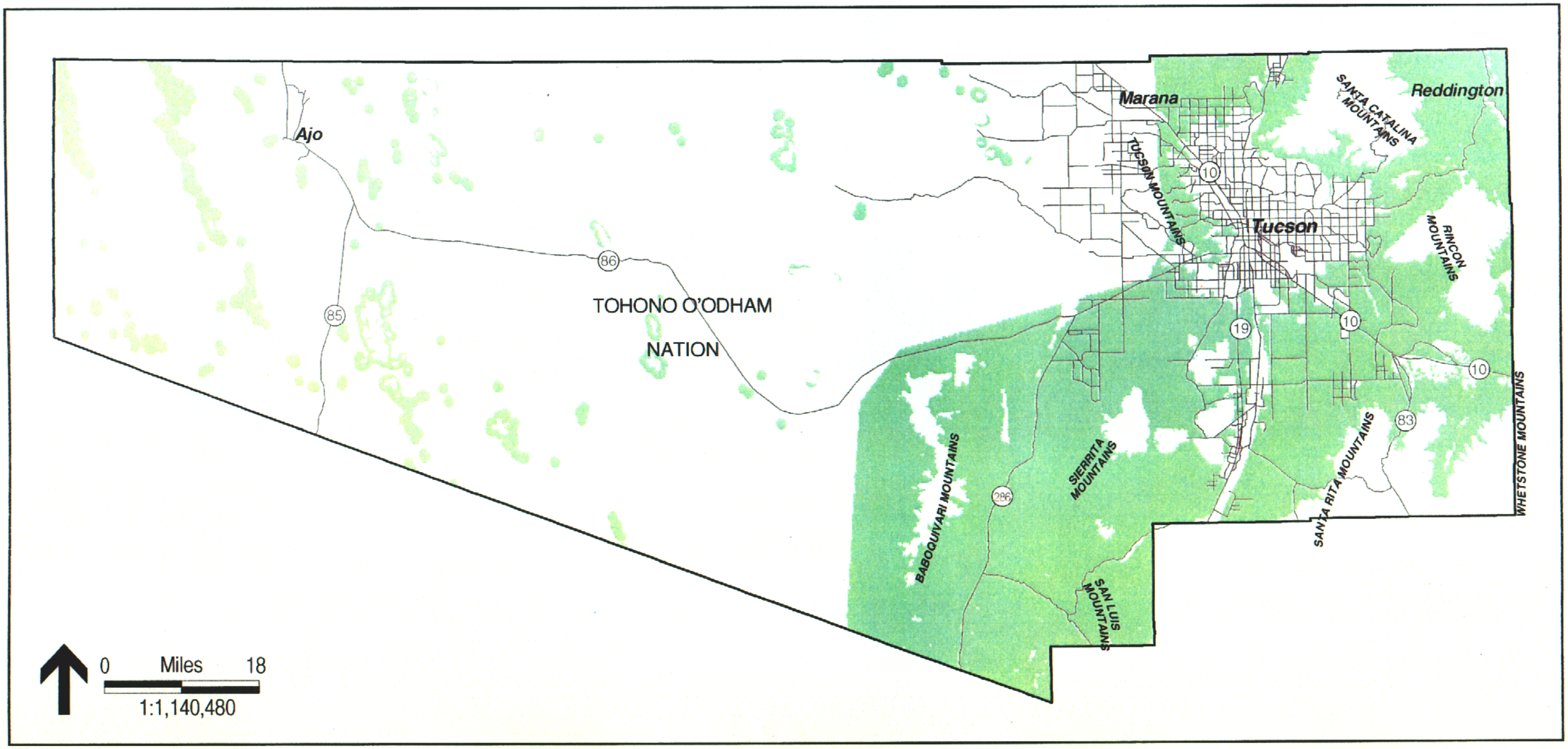
Reproduction: Giant spotted whiptails are oviparous, breeding in May through July. Clutch size average 4.33 eggs (range 3 to 5). There may be more than one clutch per year (Goldberg 1987).

Behavior: The giant spotted whiptail is diurnal from spring through early autumn, and hibernates in winter. Lizards emerge from hibernation in April or early May, depending on yearly climatic conditions (Goldberg 1987). This lizard forages by nosing in leaf litter among herbaceous vegetation. The primary defense mechanism is escape, and individuals quickly seek cover in piles of debris and rocks when disturbed (BISON-M 2000).

Distribution

Historic: The historic range of the giant spotted whiptail includes Arizona and New Mexico (BISON-M 2000). Its range in Arizona extends from the Baboquivari and Pajarito Mountains on the west, to Guadalupe Canyon in extreme southwestern New Mexico. It includes the Santa Cruz and San Pedro river basins in the south-central part of the state, from the Santa Catalina Mountains near Oracle southward to the Yaqui River basin and the Rio de la Concepcion in Sonora (Lowe 1964). The distribution pattern suggests that this may be a relict species that was once more widely distributed, but has survived climate change only by being restricted to specific limited habitats, in this case, relatively mesic canyons, riparian areas, and grasslands.

Present: In Pima County, the giant spotted whiptail has been recorded from the Santa Catalina, Santa Rita, and Baboquivari Mountains (AGFD 1997). GAP mapping includes these mountain ranges, as well as other areas, as potential giant spotted whiptail habitat (Figure 20). It was formerly



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Giant Spotted Whiptail Potential Habitat

Pima County Boundary
Major Road or Highway

Potential Habitat (GAP, 1994)
Low Value

Figure 20

common in Sabino Canyon, but has apparently declined in abundance. It has been extirpated from the Santa Cruz River valley (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Demographics

Density: There are no known data available on the density of this subspecies.

Status: This subspecies has a very limited distribution, although it is the most widespread subspecies of the species (AGFD 1997).

Trend: Populations are said to be "apparently stable" (AGFD 1997), although Rosen stated that the subspecies had been extirpated from at least part of its range and had declined in other parts (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Survival rates: No specific information is available on survival rates in this subspecies. There may be a relationship between survival and weather conditions as has been found in the other Arizona subspecies of this species (Rosen and Lowe 1996).

Reproduction rates: No specific information is available on reproduction rates in this subspecies. There may be a relationship between reproduction rates and weather conditions as has been suggested for the other Arizona subspecies of this species (Rosen and Lowe 1996).

Age ratios: No specific information is available on age ratios in this subspecies.

Sex ratios: No specific information is available on sex ratios in this subspecies. This species has males and females, presumably in similar numbers, unlike some species of this genus that consist entirely of females (Cole and Dessauer 1994).

Significant Pima Co. populations: Because the known distribution of this subspecies is so limited, all populations in Pima County should probably be considered significant.

Habitat Requirements

General: Giant spotted whiptails are found in lower Sonoran (chiefly riparian areas) and upper Sonoran life zones (Lowe 1964), in mountain canyons, arroyos, and mesas in arid and semi-arid regions, entering lowland desert along stream courses. It is found in dense shrubby vegetation, often among rocks near permanent and intermittent streams, and in grassy areas within riparian habitats (Degenhardt et al. 1996; AGFD 1997), through an elevation range of near sea level to around 4,500 feet (1,370 m).

Home range requirements: Giant spotted whiptails depend on a mosaic of open spaces and cover while foraging (BISON-M 2000).

Ability to use major land use categories: Giant spotted whiptails use rangeland, mixed rangeland, water, and streams and canals (BISON-M 2000).

Habitat trends in planning area: Apparently this subspecies has lost some ground, specifically along the Santa Cruz River (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Current and Potential Threats

General: Giant spotted whiptails could be impacted by uncontrolled wildfire or by overgrazing of the riparian vegetation in its limited habitat. In New Mexico, habitat alteration and overcollecting represent the only major perceived threats to the species (BISON-M 2000).

Location, amount, and quality of protected habitat: Giant spotted whiptails occur in the Coronado National Forest, in Sabino Canyon Recreation Area (Goldberg 1987; BISON-M 2000).

Existing and potential pest species: None have been specifically mentioned, although it is possible that invasive non-native grasses, such as red brome and bufflegrass, may increase incidence and severity of fires in the limited habitat of this subspecies.

Threat mechanism: Direct loss of individuals by collecting, and loss of habitat resulting from all factors that cause degradation of riparian habitat.

Management Needs

General: Distribution, population, habitat and life history studies are needed (AGFD 1997).

Current protective measures: Arizona prohibits commercial collection of reptiles, but enforcement is limited.

Sensitivity to human activities and densities: Loss of habitat may occur as a result of draw down of groundwater and other factors related to human activities that impact riparian habitats.

Corridor needs: No known information is available on corridor needs of this subspecies. It is apparently found in several disjunct populations and may be a relict of another climatic era that has survived in isolated refugia.

Key relationships: No known information is available on key relationships of this subspecies.

Migratory requirements: No known information is available on migratory requirements of this subspecies. It probably does not migrate.

Results of past mitigation activities: There have been no known past mitigation activities.

Existing monitoring and research programs: There are no known monitoring and research programs for this subspecies.

References

Arizona Game and Fish Department (AGFD). 1998. Status designations: biological elements of Arizona. Report dated 28 April compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, Arizona.

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Cole, C. J., and H. C. Dessauer. 1994. Unisexual lizards (genus *Cnemidophorus*) of the Madrean Archipelago. Pp. 267-273 *in* L. F. Debano, P. F. Ffolliott, A. Ortega-Rubio, G. J. Gottfried, R. H. Hamre, and C. B. Edminster, tech. coords. Biodiversity and management of the Madrean Archipelago: the Sky Islands of southwestern United States and northwestern Mexico. Sept. 19-23, Tucson, Arizona. General Technical Report RM-GTR-264. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

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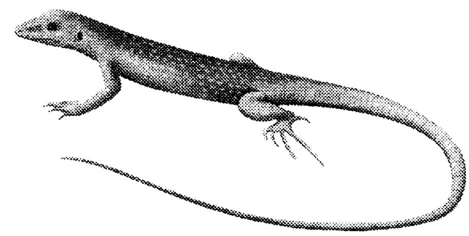
Red-backed whiptail (*Cnemidophorus burti xanthonotus*)

Status



Federal	Designated as a Species of Concern by USFWS (AGFD 1998)
State	No AGFD status for species or subspecies (AGFD 1998); the canyon spotted whiptail (*Cnemidophorus burti stictogrammus*) is listed as threatened in New Mexico by NMDGF (BISON-M 2000)
Other	The canyon spotted whiptail (*Cnemidophorus burti*) is listed as Sensitive by USFS Region 3 Forester (AGFD 1998; BISON-M 2000); the canyon spotted whiptail (*C. b. stictogrammus*) is listed as Sensitive by BLM New Mexico State Office (BISON-M 2000); Vulnerable Status 1 by SDCP
Rankings	G4T2 S2

Recovery Goals

Federal: There are no federal agency-mandated recovery goals for this species.

State: There are no state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This whiptail lizard is one subspecies of the canyon spotted whiptail (*Cnemidophorus burti*). The species was described by Taylor in 1936, who designated the type locality near La Posa, 10 miles northwest of Guaymas, Sonora, Mexico (Lowe 1964; Degenhardt et al. 1996). *C. burti* is the largest *Cnemidophorus* species that occurs in the United States. The genus name *Cnemidophorus* means "thread carrier" referring to the long tail. The genus has 14 species in the western U.S. (Stebbins 1985). There are 4 subspecies of *Cnemidophorus burti* (Degenhardt et al. 1996), with 2 in Arizona, *C. b. xanthonotus* and *C. b. stictogrammus*. *C. b. stictogrammus* is widespread and is treated in another species account in this document. Not all workers agree on the taxonomy of this subspecies, but Rosen believes that *C. b. xanthonotus* is distinct and not an intermediate morph (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). The subspecific epithet refers to the red back.

Classification: Order Squamata, Family Teidae, Genus *Cnemidophorus,* Species *burti,* Subspecies *xanthonotus.*

Synonymy: This subspecies has also been called *Cnemidophorus sacki xanthonotus* (AGFD 1997).

Specific to Pima County populations: The subspecies *C. b. xanthonotus* is found in a portion of western Pima County, and there are other known populations in Maricopa County.

Life History

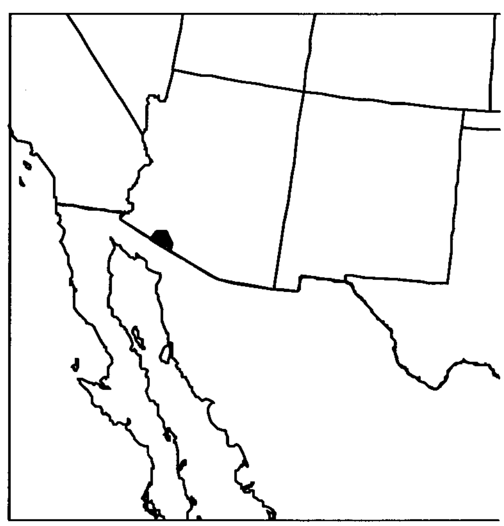
Description: This is a slender, fast-moving lizard. The adult size for the species is 3.5 to 5.5 inches (8.7 to 13.7 cm) snout-vent length, with a tail generally longer than the snout-vent length. The medial and upper surfaces of the neck, legs, and feet are dark grayish green to bluish, with green or pale spots, and a reddish brown to reddish orange color on the back that may obscure the other markings. Smaller individuals have 6 stripes and sometimes a vertebral stripe, with a reddish brown to reddish orange dorsal field (AGFD 1997), that ends abruptly on the upper sides (Stebbins 1985).. Large males may have no stripes (Stebbins 1985).

Diet: Red-backed whiptails eat arthropods, primarily insects and spiders (Stebbins 1985; AGFD 1997; BISON-M 2000). More specific information is not available for this subspecies.

Reproduction: Red-backed whiptails are oviparous, breeding in June and July. Three to 7 eggs per clutch are laid and 1 to 4 offspring are produced per clutch (AGFD 1997; BISON-M 2000). There may be more than 1 clutch per year, as in *C. b. stictogrammus* (Goldberg 1987), but this has not been demonstrated for this subspecies.

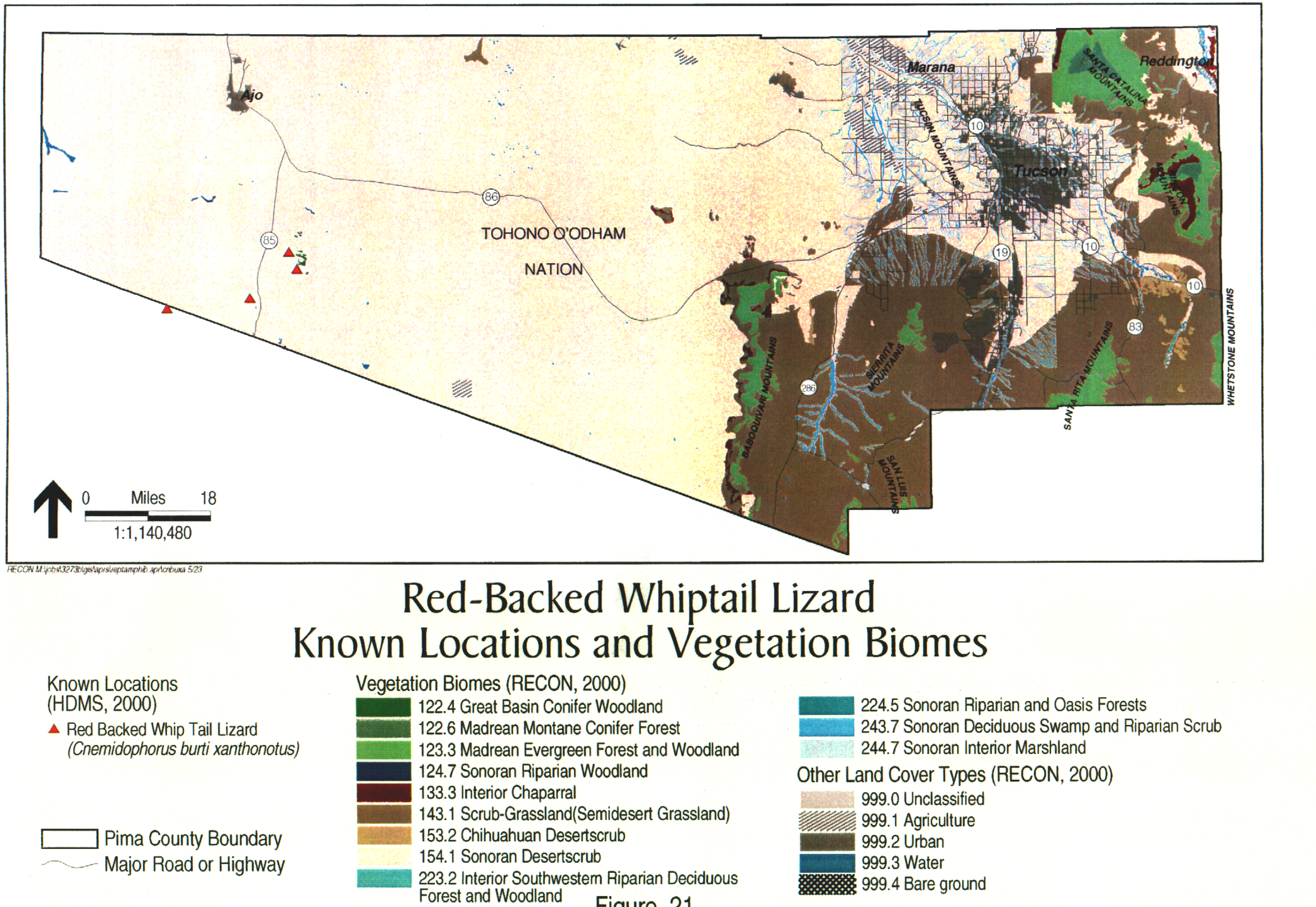
Behavior: Red-backed whiptails are is diurnal from spring through autumn, and hibernate December through February. This lizard forages by nosing in leaf litter among herbaceous vegetation. The primary defense mechanism is escape, and individuals quickly seek cover in piles of debris and rocks when disturbed (BISON-M 2000).

Distribution



Historic: The historic range of the red-backed whiptail includes some of the mountain ranges of western Arizona. Its distribution in Sonora, Mexico, is not known (Stebbins 1985). The distribution pattern suggests that this may be a relict species that was once more widely distributed, but has survived climate change only by being restricted to specific limited habitats, in this case, relatively mesic canyons in desert mountain ranges.

Present: The total range of the subspecies includes the southwest-central border of Arizona in Pima County and northern Sonora (AGFD 1997), although specific information on its distribution in Sonora is apparently not available. The subspecies is known from Ajo, Dripping Springs, Puerto Blanco Mountains, in Organ Pipe Cactus National Monument in Pima County (AGFD 1997) (Figure 21), the Table Top Mountains and Javelina Mountain in south-central Pinal County, and to the Sierra Estrella in Maricopa County (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999; Stebbins 1985; BISON-M 2000). It may occur on other isolated mountain ranges within this geographic range, including some on the Tohono O'odham Nation, but no known records are available. The largest known population is in the Ajo Mountains at Organ Pipe Cactus National Monument (Rosen and Lowe 1996).



Red-Backed Whiptail Lizard
Known Locations and Vegetation Biomes

Figure 21

Demographics

Density: There are no data available on the density of this subspecies. Detailed lizard density studies at Organ Pipe Cactus National Monument have failed to obtain information on this species because it was not found on the study plots (Rosen and Lowe 1996; Connor and Rosen 1999), except once (OPCNM 1998).

Status: This subspecies has a very limited distribution (AGFD 1997).

Trend: Information is insufficient to determine population trends. AGFD (1977) reports that populations are apparently stable in Arizona (AGFD 1997), although they appear to be very sensitive to the effects of drought and show decline in drought years, with greater sensitivity to aridity than other lizards (Rosen and Lowe 1996). Connor and Rosen (1999) have concluded that the Ajo Mountains population has apparently suffered a long-term decline (several years) related to a period of drought in the late 1980s, but possibly involving other factors.

Survival rates: No specific information is available on survival rates in this subspecies. There is likely to be a relationship between survival and weather conditions (Rosen and Lowe 1996).

Reproduction rates: No specific information is available on reproduction rates in this subspecies. There is likely to be a relationship between reproduction rates and weather conditions (Rosen and Lowe 1996).

Age ratios: No specific information is available on age ratios in this subspecies.

Sex ratios: No specific information is available on sex ratios in this subspecies. This species has males and females, presumably in similar numbers, unlike some species of this genus that consist entirely of females (Cole and Dessauer 1994).

Significant Pima Co. populations: Because the known distribution of this subspecies is so limited, all populations in Pima County should probably be considered significant.

Habitat Requirements

Habitat for the subspecies in Arizona includes juniper-oak woodland down to the desert edge, among dense shrubby vegetation near and on the banks of semi-arid permanent springs and arroyos, and in canyons (Lowe 1964; Stebbins 1985; AGFD 1997; BISON-M 2000). Within Pima County, known habitat includes areas with productive rocky slopes from approximately 2,000 to 4,000 feet elevation (e.g., Ajo Mountains) (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). Jones (1988) found it in Semidesert Grassland.

Home range requirements: *Cnemidophorus burti* depends on a mosaic of open spaces and cover while foraging (BISON-M 2000). Requirements for this subspecies are not known, but probably do not differ from the other subspecies.

Ability to use major land use categories: Red-backed whiptails are known only from relatively undisturbed canyon areas in wilderness or rangeland.

Habitat trends in planning area: Habitat trends appear to be generally stable.

Current and Potential Threats

General: This species might be impacted from uncontrolled wildfire or by overgrazing of the riparian vegetation in its limited habitat (BISON-M 2000) and it might be especially sensitive to global climate change (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Location, amount, and quality of protected habitat: Most of the known range of this subspecies occurs in Organ Pipe Cactus National Monument and is protected. However, it is possible that this species is present in other mountain ranges outside the monument in Pima County, but there are no known records.

Existing and potential pest species: None have been specifically mentioned, although it is possible that invasive non-native grasses, such as red brome and bufflegrass, may increase incidence and severity of fires in the limited habitat of this subspecies.

Threat mechanism: This species appears to be more sensitive to the effects of drought, and show decline in drought years, with greater sensitivity to aridity than other lizards (Rosen and Lowe 1996). It is possible that global climate change may threaten this lizard (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Management Needs

General: Monitoring and general research studies of populations (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). Protection of relatively mesic canyon habitats in the isolated mountain ranges in which this subspecies occurs may be beneficial in ensuring survival through at least short-term climate change.

Current protective measures: Most of the known range of this subspecies is within Organ Pipe Cactus National Monument, which protects the habitat and prohibits collecting or killing.

Sensitivity to human activities and densities: No known information is available on sensitivity to human activities and densities for this subspecies.

Corridor needs: No known information is available on corridor needs of this subspecies. It is apparently found in several disjunct populations, and may be a relict of another climatic era that has survived in isolated refugia.

Key relationships: No known information is available on key relationships of this subspecies.

Migratory requirements: No known information is available on migratory requirements of this subspecies. It probably does not migrate.

Results of past mitigation activities: There have been no known past mitigation activities.

Existing monitoring and research programs: Organ Pipe Cactus National Monument has been conducting lizard surveys for several years at specific locations. This species is rarely found during this surveys (Rosen and Lowe 1996; OPCNM 1998; Connor and Rosen 1999). Studies on the distribution, population, habitat, and life history studies are suggested (AGFD 1997).

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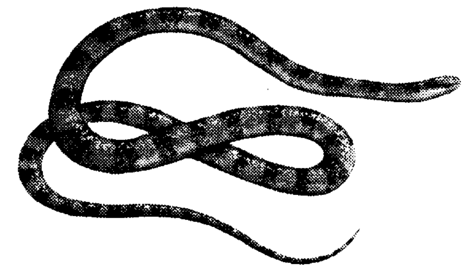
Ground snake (valley form) (*Sonora semiannulata*)

Status



Federal	None (AGFD 1998)
State	None (AGFD 1998)
Other	Vulnerable Category 1 by SDCP
Rankings	G5, S5 for the species in Arizona and New Mexico (AGFD 1998; BISON-M 2000)

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This monotypic species was described by Baird and Girard in 1853, based on the holotype collected by J. H. Clark two years earlier. The type locality was originally designated as Sonora, Mexico, but later changed to the vicinity of the Santa Rita Mountains in Pima and Santa Cruz counties, Arizona (Degenhardt et al. 1996). The high level of polymorphism in *S. semiannulata* resulted in numerous synonyms applied to this snake (Degenhardt et al. 1996). Some populations of this species (including those in Colorado) were formerly known as *S. episcopa* (BISON-M 2000).

Classification: Order: Squamata; Family: Colubridae; Genus: *Sonora* (after the state in Mexico); Species: *semiannulata* (Latin: half-ringed).

Specific: The valley form of *Sonora semiannulata* may or may not be a subspecies, but is at least a morph that is different from the morph found in the Willcox area (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). Stebbins (1954) identified *S. s. semiannulatua* as a subspecies occurring in the Santa Rita Mountains based on scale count.

Life History

Description: The ground snake is a small species that may reach about 18 inches (45 cm) total length. The species is highly polymorphic. Dorsal color is brownish, orange, reddish, or gray. Patterns include plain, cross-banded, longitudinally banded (red or orange if present), or a combination (Stebbins 1985; Degenhardt et al. 1996). Plain, striped, and cross-banded individuals sometimes occur at the same locality (Stebbins 1985).

Diet: *S. semiannulata* is carnivorous. The diet includes eggs, adult vertebrates, and arthropods (arachnids, chilopods, and adult and larval insects) (Stebbins 1985; BISON-M 2000). Scorpions, centipedes, and black widows are commonly found in stomach and fecal samples (Degenhardt et al. 1996).

Reproduction: *S. semiannulata* is oviparous and breeds twice annually, in spring to early summer and autumn (Degenhardt et al. 1996; BISON-M 2000). Sexual maturity is reached between 1.5 to 2.5 years old (Degenhardt et al. 1996). Clutches generally contain 3 to 9 eggs, of which and 3 to 7 offspring result from each reproductive effort. Gestation period is 29 to 60 days (Degenhardt et al. 1996; BISON-M 2000).

Behavior: This species is probably chiefly nocturnal and requires warm nighttime temperatures for activity and loose soil for burrowing (BISON-M 2000). Individuals typically thermoregulate under warm rocks or less often near their den entrance (Degenhardt et al. 1996). This species is most active April through October, especially in summer (Degenhardt et al. 1996; BISON-M 2000). It hibernates or aestivates in underground den. *S. semiannulata* is preyed on by other colubrids and elapids (kingsnakes, patchnose snakes, and coral snakes). The ground snake's primary defense mechanism is hiding (BISON-M 2000).

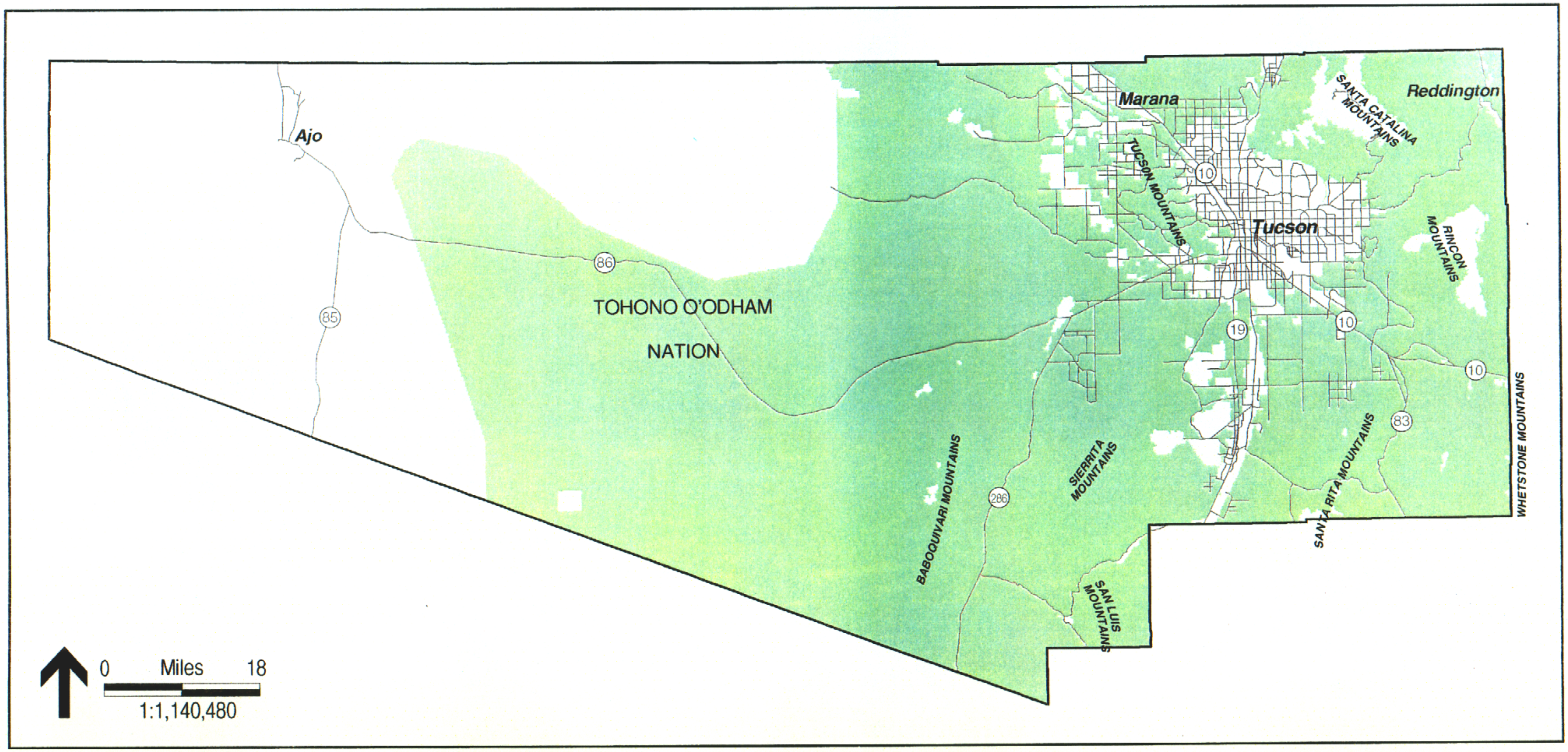
Distribution

Historic: *S. semiannulata* is known to occur in New Mexico, Arizona, Colorado, Utah, Texas, and Chihuahua and Sonora, Mexico at elevations from 2000 to 5500 feet (BISON-M 2000). The valley form is known only from an undetermined limited area in Pima County.

Present: The range of *S. semiannulata* includes grassland areas of the central United States from southeastern Colorado to southwest Missouri, south and west into northern Mexico. It ranges across the deserts of west Texas, New Mexico, Mexico, Arizona, Nevada, and California. Apparent isolated populations exist in eastern Oregon and western Idaho, Baja California, northern Utah, and northern Kansas (Stebbins 1985; Degenhardt et al. 1996). Scattered localities occur from the southern half and northwestern quarter of Arizona (lowe 1964). In Pima County, small numbers of this form occur in many small populations on the Tohono O'odham Nation, its eastern border between Marana and Eloy, and rarely around Tucson (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). The AGFD Heritage Data Management System does not track this species. Figure 22 shows the GAP potential habitats within Pima County.

Demographics

Density: The valley form of *S. semiannulata* is rare around Tucson. Many small populations occur in Pima County that appear to be scattered among populations of the more common forms (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). However, a form of ground snake is common in specific habitats within the Sulphur Springs Valley (BISON-M 2000).



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Ground Snake(Valley Form) Potential Habitat

Pima County Boundary
Major Road or Highway

Potential Habitat (GAP, 1994)
Low Value

Figure 22

Status and trend: Because this species is apparently not tracked by HDMS, little information may exist on the valley form. No specific information is available to support a conclusion on its status or trend. Dr. P. Rosen believes the form is declining (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999).

Survival rates: No specific information is available on this aspect of this species biology.

Reproduction rates: No specific information is available on this aspect of this species biology.

Age ratios: No specific information is available on this aspect of this species biology.

Sex ratios: No specific information is available on this aspect of this species biology.

Subpopulation basis in planning area: It is possible that the population within the planning area is genetically distinct from other populations.

Significant Pima Co. populations: Insufficient information is available to determine significance of any specific population.

Habitat Requirements

Generally, terrestrial habitats (BISON-M 2000) including grassland islands within mountain seas (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). This species occupies plains, valley, and foothill habitats (Lowe 1964; Degenhardt et al. 1996). It has been found mostly near mountains with higher slopes and areas with poorly drained soils, and speculation is that this is because subsurface moisture is required for the species and its prey (Stebbins 1985; Degenhardt et al. 1996). Vegetation may be scant (Great Basin sagebrush plains and creosote desert), or dense (lower Colorado River thickets of mesquite, arrowweed, and willow communities). The species ranges from prairies through desert communities, thornscrub, and pinyon-juniper woodland to the pine-oak zone (Stebbins 1985). Specifically, Tobosa desert grassland over silty, loamy clay soils on the Tohono O'odham Nation (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). In New Mexico, the species has been found in lava fields, sandy areas, loose and rocky soil with a southwest aspect and on talus slopes between 41% and 70% (22 to 35 degrees), rocky outcrops and rimrock, and desert pavement (BISON-M 2000).

Home range requirements: Insufficient information is available to support conclusions as to this animal's home range requirements.

Ability to use major land use categories: This species has been found in urban and residential areas, rangeland, herbaceous rangeland, barren land, sandy areas other than beaches, and bare exposed rock (BISON-M 2000).

Habitat trends in planning area: Insufficient information is available to support conclusions on this.

Current and Potential Threats

General: The valley form of *S. semiannulata* is being impacted by habitat destruction (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). However, it has been found in abandoned buildings and farm structures (such as barns, sheds, and silos) often enough to be considered tolerable to, or possibly benefiting from human association (BISON-M 2000). *S. semiannulata* is sensitive to control compound DRC-1339, so determined by Animal Damage Control (BISON-M 2000).

Location, amount, and quality of protected habitat: This species is known to occur in Coronado National Forest (BISON-M 2000), and Saguaro National Park (Doll et al. 1989). Only 1 record is known from Organ Pipe Cactus National Monument, out of records for 2, 077 snakes (Rosen and Lowe 1996). These records are for the species, not necessarily for this putative unique form. Distribution of the form is not known.

Existing and potential pest species: None are known.

Threat mechanism: Direct destruction of habitat has been alleged, but not specified or documented.

Management Needs

General: The most pressing need is for identification and delineation of the habitat of this form and determination of actual threats to it. This may be followed by development of specific management policies and methods.

Current protective measures: None are specifically known.

Sensitivity to human activities and densities: In New Mexico, the species has been found to tolerate or benefit from human influences, such as farm outbuildings (barns, silos, and sheds), and abandoned buildings (BISON-M 2000). No specific information is available on the valley form of this species.

Corridor needs: No known information is currently available on this aspect of the biology of this species.

Key relationships: No known information is currently available on this aspect of the biology of this species.

Migratory requirements: No known information is currently available on this aspect of the biology of this species.

Results of past mitigation activities: No known information is currently available on this aspect of the biology of this species.

Existing monitoring and research programs: No known programs are specifically directed at this species. Numerous amateur and professional herpetologists maintain their own records of the species they encounter, generally in an informal way, and they may have information of use in understanding the distribution, biology, and conservation needs of this form.

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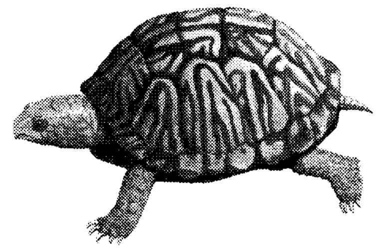
Desert box turtle (*Terrapene ornata luteola*)

Status



Federal	None
State	None
Other	Determined subject to special protection in Mexico; protected from international trade by CITES; Vulnerable Status 2 by SDCP
Rankings	G5T4 S3S4

Recovery Goals

Federal: There are no federal agency-mandated recovery goals for this species.

State: There are no state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The desert box turtle is 1 of 2 subspecies of the western box turtle, *Terrapene ornata*. The subspecies *T. o. luteola* was described by Smith and Ramsey in 1952 based on a type specimen collected by W. E. Smith 17 miles south of Van Horn, Culberson County, Texas (Ward 1978). The species is widespread in the grasslands of the Great Plains of North America, from southern Wisconsin to southeastern Wyoming and southward to the Gulf Coast of western Louisiana and Texas.

Classification: Order: Testudines; Family: Emydidae; Genus: *Terrapene;* Species: *ornate;* Subspecies *luteola.*

Specific (to Pima County populations): The subspecies *T. o. luteola* is the only subspecies in Arizona.

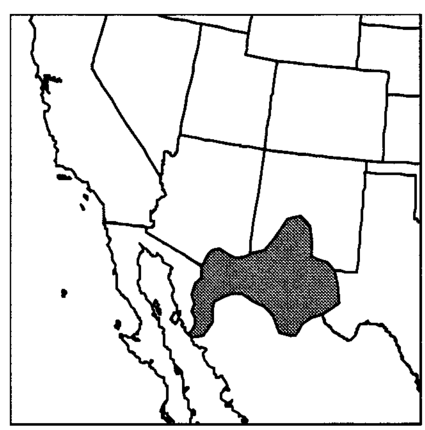
Life History

Description: This chiefly terrestrial turtle is from 4 to 5.75 inches (10 to 15 cm) in carapace length. The plastron has a single hinge in front and can be drawn tightly against the carapace. The carapace is high and round, and is typically marked with pale radiating lines or a series of black or dark brown dots on a yellow field. The plastron may have similar markings. The markings become less distinct as age advances and are eventually lost. This subspecies can be distinguished from the other subspecies (the ornate box turtle, *T. o. ornata,* which does not occur in Arizona) by its having no dorsal markings as an old adult, and younger individuals having 11 or more light radiating lines on the second costal scute, whereas *T. o. ornata* has a maximum of 9 or 10 (Degenhardt and Christianson 1974). The shells of older individuals are uniform straw color or pale greenish brown. The first nail on each hind foot turns inward on males. The iris and spots on forelimbs are reddish (yellowish in females), and the head is sometimes greenish. Females grow larger than males (Stebbins 1985; Degenhardt et al. 1996).

Diet: Box turtles eat beetles and other insects, often from cow dung (Stebbins 1985). The diet also includes other arthropods, molluscs, annelids, and carrion (BISON-M 2000). Plant food includes berries, melons, tender shoots, and leaves (Stebbins 1985). Blair (1976:100) reported the ornate box turtles he studied (*T. o. ornata*) as being "wholly omnivorous," and described one as feeding on a dead roof rat, and another with feathers in its mouth. He listed items consumed as including: snails, beetles, a stick insect, mulberries, persimmons, fruit and blades of a prickly pear cactus, and cow dung. Water was provided by prickly-pear cactus and drinking from ponds.

Reproduction: Box turtles breed in both the spring and autumn, producing clutches of 2 to 8 eggs (the mean is 4.7) that are generally laid between May and July (Stebbins 1985; BISON-M 2000). Incubation lasts 59 to 70 days, but may extend to 125 days in cool weather. Eggs probably require soil moisture for development (BISON-M 2000). Sexual maturity is attained at about 100 mm carapace length, at roughly 7 to 8 years of age. Gravid desert box turtle females were x-rayed and found to contain fewer eggs than that reported for the species (range 1 to 4, the mean is 2.7). Clutch size was correlated with body size of the female. Sex of *Terrapene* species is not determined genetically but depends on the temperature at which the egg was incubated, with lower incubation temperatures producing more males (Degenhardt et al. 1996).

Behavior: Box turtles seek shelter under boards, rocks, and other objects or in self-made burrows (Stebbins 1985). When threatened, the turtle withdraws the body inside the shell and closes it with the hinged plastron. It snaps its jaws and produces copious urine to discourage most predators (Degenhardt et al. 1996). This species hibernates in winter and is active from March through November, and activity is stimulated by rainfall (Stebbins 1985). It may be observed on roads in the cool hours of the morning or evening, or immediately following rainstorms (Degenhardt and Christiansen 1974). The species is primarily terrestrial, but is also found using quiet waters (BISON-M 2000). Individuals of desert box turtles are active well before sunrise, basking and then foraging until mid-morning when they retreat to their burrows. They are rarely found at night (Degenhardt and Christiansen 1974). Many burrows known to be used by box turtles are excavations of kangaroo rats. Although primarily terrestrial, individuals observed in New Mexico were described to be excellent swimmers (Degenhardt et al. 1996).



Distribution

Historic: The desert box turtle ranges from south-central New Mexico south to central Chihuahua and Sonora, Mexico, and from western Texas across New Mexico to the eastern base of the Baboquivari Mountains at elevations from sea level to about 6600 feet (2010 m) (Stebbins 1985).

Present: There is no evidence to indicate that the range of the species has changed, although local populations may have changed in number in some areas (Rosen et al. 1996) and it is possible that there have been some local extirpations.

The range of the desert box turtle in Pima County is not well known, but it probably occurs throughout the Plains Grassland and Semidesert Grassland areas from the eastern county line to the Baboquivari Mountains (Figure 23). The Heritage Data Management System does not track this species.

Demographics

Density: No specific studies of density of desert box turtles are known. For a population of *T. o. ornate,* Blair (1976) estimated that in the 5-year period 1952-1956, the number of turtles recorded on a 4.05 ha tract ranged from 32 to 44, or 0.53 to 0.89 per ha. Limited information indicates that the Western box turtle is uncommon on rocky slopes, rare in desert scrub, common in mesquite-dominated bajadas, abundant in bajada grasslands, grassland flats, mesquite-dominated flats, and uncommon along the agricultural edge of the Sulphur Springs Valley, Cochise County, Arizona (BISON-M 2000). Rosen et al. (1996:70) described it as "seen in numbers in several areas of the SSV, which, together with the San Bernardino Valley, is the species core in Arizona. During routine summer field work we often saw 2-3 per day. They were found in far greater numbers, especially at the hills east of Pearce, prior to severe highway mortality in the 1960s-1980s. Box turtles are not common north of Sunsites. Although we didn't record them in Chihuahuan desertscrub in the SSV, they occur in and near sacaton bottoms in desertscrub at the lowest elevations of the San Bernardino Valley." In Pima County, they are rarely encountered by casual visitors to the area (K. Kingsley, pers. obs.)

Status: The subspecies is apparently secure in New Mexico, but is uncommon or restricted in Arizona (BISON-M 2000), and local populations may have declined (Rosen et al. 1996).

Trend: Accurate information on trend of this species in Pima County is not known.

Survival rates: Individuals of natural populations of *T. ornata* may live up to 30 years (Degenhardt et al. 1996). Blair reported maximum longevity of 32 years, and complete population turnover in 32 years. No other information is known, and no specific information for this subspecies is known.

Reproduction rates: Two to seven offspring are produced per reproductive effort (BISON-M 2000).

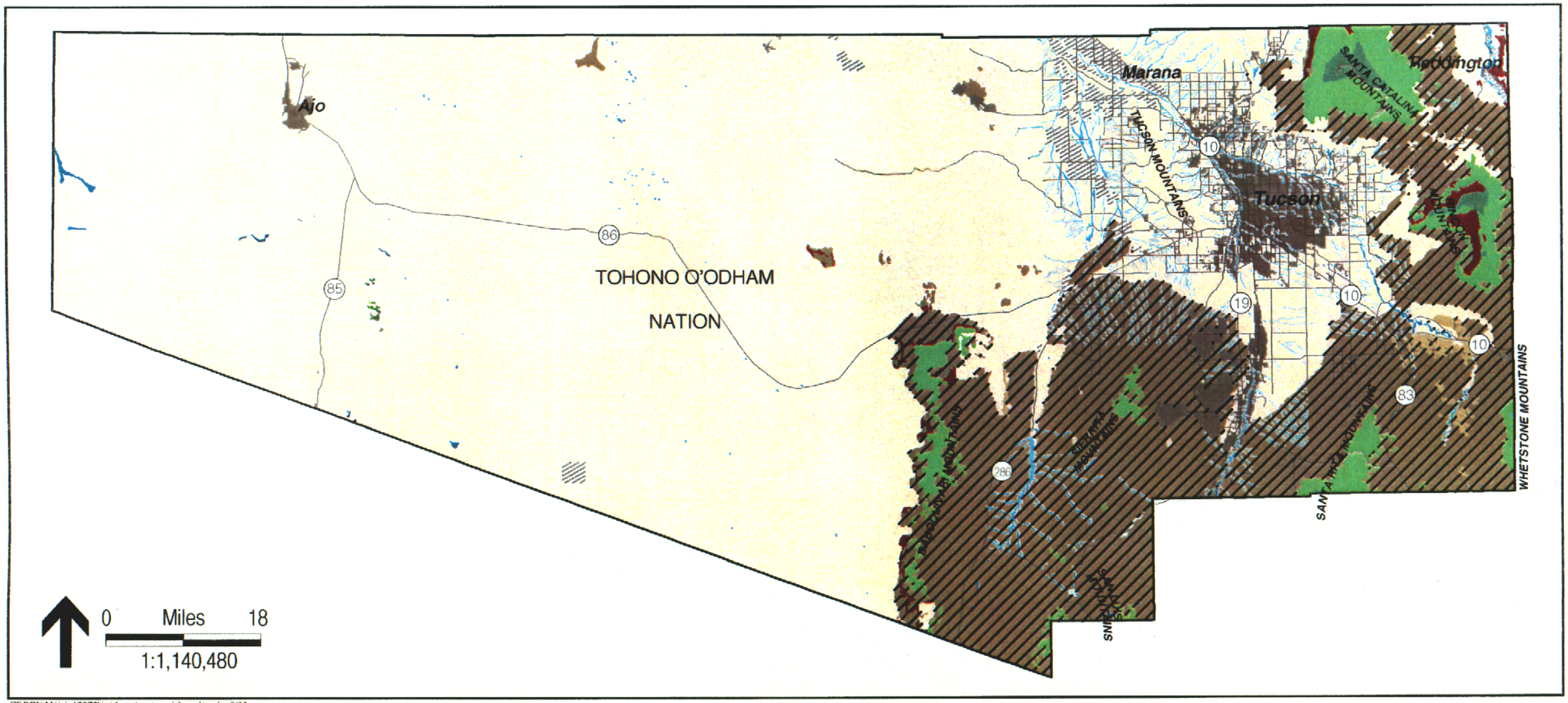
Age ratios: No specific information on age ratios is known.

Sex ratios Around 1960, the sex ratio of a *T. o. ornata* population in Kansas was 1.00M:1.69F (BISON-M 2000). No specific information on the desert box turtle is known.

Significant Pima Co. populations: Distribution of this animal in Pima County is not well known, but it has been observed in grasslands of the Empire-Cienega Resource Conservation Area, and in the valley of the Santa Cruz River near Sahuarita, and the Altar Valley. Pima County is the westernmost edge of this species range.

Habitat Requirements

General: The western box turtle is primarily a prairie turtle that inhabits arid and semi-arid treeless plains and rolling grass and shrub land across much of its range where soils are sandy. It also occurs in open woodland with herbaceous understories (Stebbins 1985; BISON-M 2000). In some parts of its range, the western box turtle is associated with prairie dog towns (BISON-M 2000).



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Desert Box Turtle
Known Locations and Vegetation Biomes

Potential Habitat
(based on assessment for this study)

Desert Box Turtle
(Terrapene ornata luteola)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 23

Home range requirements: This species apparently requires moist soil that is not compacted (BISON-M 2000). In his study of *T. o. ornata*, Blair (1976) estimated home range as being a maximum of 137 m diameter.

Ability to use major land use categories: Desert box turtles are found in land use and land cover associations that include rangeland, herbaceous rangeland, water, streams and canals, wetland, barren land, and sandy areas other than beaches (BISON-M 2000). It has also been found in the pecan orchard in Sahuarita (K. Kingsley, pers. obs.). However, this species is rarely observed in Pima County, and its exact habitat requirements are not known.

Habitat trends in planning area: No information is available on this; however, it is probably reasonable to surmise that improved grazing management of grasslands results in improved habitat conditions for this species, and that residential development of grasslands is detrimental to this species.

Current and Potential Threats

General: The desert box turtle is sensitive to highway traffic and collecting (Rosen et al. 1996; BISON-M 2000). It may also have been affected be Compound DRC-1339 used by Animal Damage Control and has apparently been caught in leghold traps as well (BISON-M 2000). Automobiles were a significant cause of mortality for 2 populations studied over time, and prairie fires were also mentioned as a cause of mortality in Kansas (Blair 1976).

Location, amount, and quality of protected habitat: Western box turtles are known to occur on the Coronado National Forest (BISON-M 2000), Empire-Cienega Resource Conservation Area, and Buenos Aires National Wildlife Refuge.

Existing and potential pest species: Ectoparasites of *T. ornata* include both fly larvae in some parts of the range and chigger mites in other areas (BISON-M 2000). It is not known whether this is a problem in Pima County. It is possible that invasive non-native grasses, such as red brome, Lehmann lovegrass, and bufflegrass, may increase the incidence of fires which could cause significant mortality in local populations of this species.

Threat mechanism: Road mortality and possibly collecting (Rosen et al. 1996), residential development (subdivisions) in this species limited habitat. Grass fires may also cause mortality (Blari 1976).

Management Needs

General: Encourage or support further study (Rosen et al. 1996). The range, population ecology, and threats to this species in Pima County are not well known.

Current protective measures: Commercial collection is prohibited by state law. Any collection is prohibited on the Buenos Aires National Wildlife Refuge.

Sensitivity to human activities and densities: No specific information on this subject is known; however, there is probably increasing threat of loss to road mortality and collecting as the human population of the area increases.

Corridor needs: No known information is available on this species need for corridors.

Key relationships: No key relationships are known for this species in this area. In some parts of its range, the western box turtle may be associated with prairie dog towns (BISON-M 2000).

Migratory requirements: No known information is available on this species' migratory requirements.

Results of past mitigation activities: No known information is available on past mitigation activities for this species.

Existing monitoring and research programs: No known information is available on monitoring and research programs for this species.

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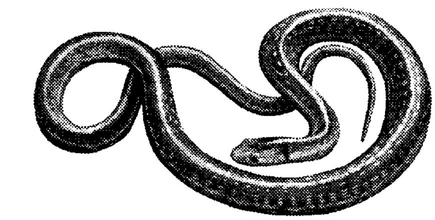
Mexican garter snake (*Thamnophis eques megalops*)

Status



Federal	Species of Concern by USFWS (AGFD 1998)
State	Wildlife of Special Concern in Arizona by AGFD (AGFD 1998); Endangered by New Mexico Department of Game and Fish (BISON-M 2000)
Other	Sensitive by USFS Region 3 Forester (AGFD 1998); Sensitive by New Mexico State BLM Office (BISON-M 2000); Threatened in Mexico (AGFD 1998); Vulnerable Category 2 by SDCP
Rankings	G4T3 S2S3

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The type locality of *T. e. megalops* is designated as Tucson, Pima County, Arizona, and was described by Kennicott in 1860 (Degenhardt et al. 1996). Three subspecies of *T. eques* exist, but only one subspecies, *T. e. megalops*, occurs in Arizona (AGFD 1998) and New Mexico (Stebbins 1985; BISON-M 2000).

Classification: Order: Squamata; Family: Colubridae; Genus: *Thamnophis* (Greek means "shrub" plus "snake"), Species: *eques* (derivation uncertain, possibly from the Greek for "equal" or "horse"); Subspecies: *megalops* (Greek means "big eyes").

Life History

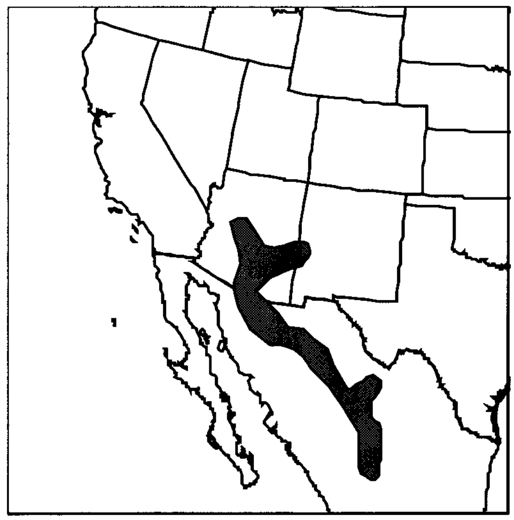
Description: The Mexican garter snake has a relatively stout body with a total length of18.0 to 40.0 inches (45.7 to 101.6 cm). Individuals are brown to greenish brown with a yellow-white dorsal stripe flanked by stripes on the third and fourth scale rows in the anterior region. Large brown blotches are on the back of the head that are separated from the corner of the mouth by light-colored crescents (AGFD 1998).

Diet: *T. e. megalops* primarily eats native frogs (including leopard frogs), toads, fishes, and small mammals (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999; AGFD 1998; Degenhardt et al. 1996; BISON-M 2000).

Reproduction: *T. e. megalops* bears up to 25 live young (AGFD 1998). Males reach sexual maturity at 2 years of age and females at 2 to 3 years. Adult females are larger than males. Gravid females typically move several meters from water to warmer microenvironments where young are born between early June and early July. Only about half of all females in population bear young in any one year (Degenhardt et al. 1996).

Behavior: *T. eques* is active during the warmest season and forages around vegetated watercourses that provide shelter. When threatened, it flattens the head and body and strikes repeatedly (Degenhardt et al. 1996).

Distribution



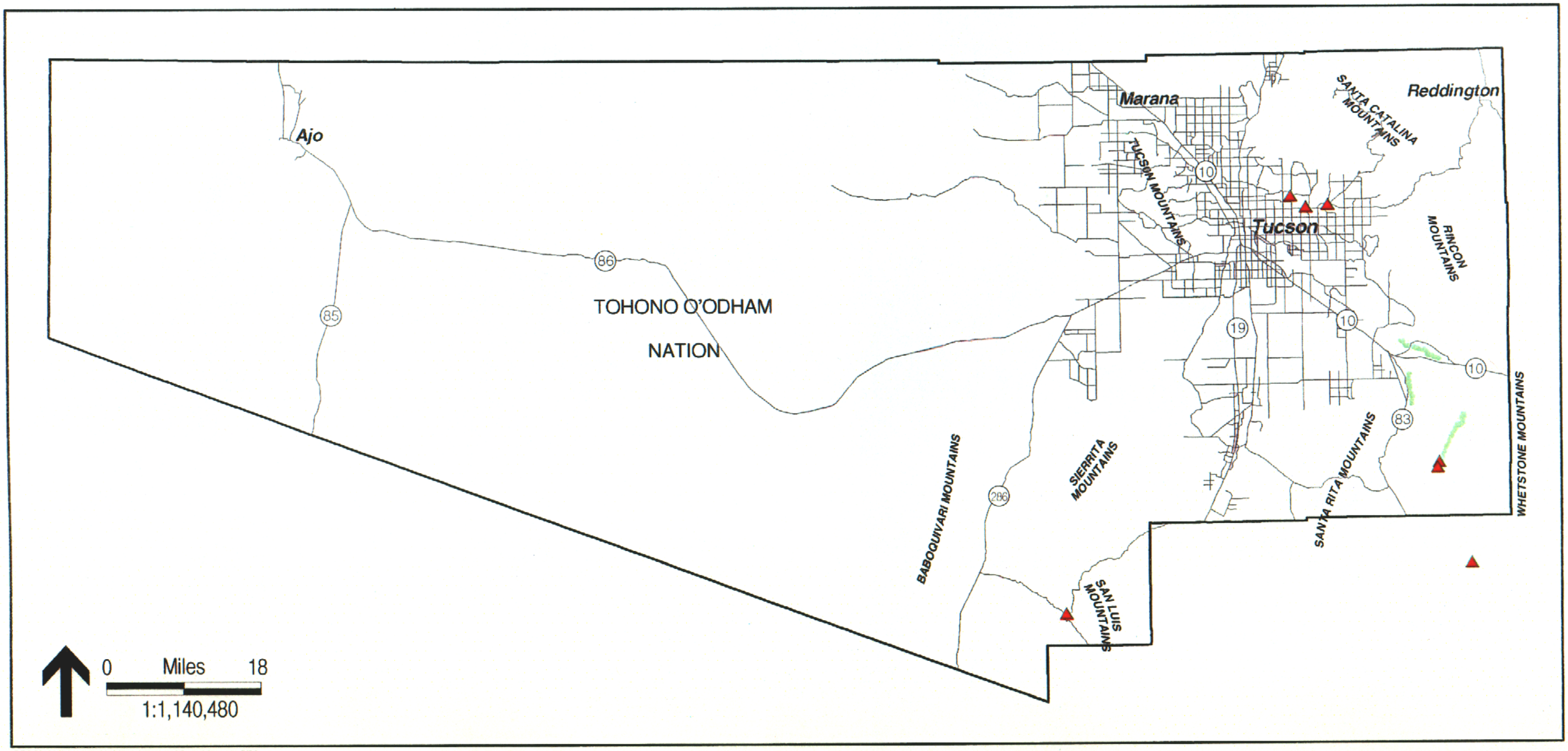
Historic: The historic range of the Mexican garter snake includes Arizona, New Mexico, and Mexico (BISON-M 2000). Southern Arizona to Oaxaca, Mexico (AGFD 1998), but is extirpated from the Colorado River near Yuma (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999), the apparent western limit of this snake's historic range.

Present: Central, south-central, and southeastern Arizona to Oaxaca, Mexico (AGFD 1998). In Arizona, this subspecies ranges from the southeast corner of the state from the Santa Cruz Valley east and generally south of the Gila River. Records after 1980 include the San Rafael Valley and Sonoita grasslands areas, Arivaca, the Agua Fria, Verde, Salt, and Black rivers, and Oak Creek (AGFD 1998). *T. e. megalops* is extirpated from the Santa Cruz and Rillito rivers, and Tanque Verde and Pantano washes in the Tucson area (Rosen and Schwalbe 1988; P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). In a rangewide survey in 1988, this species was found in Lower and Upper Sonoran Life Zones, at elevations from 1,739 to 6,152 feet (530 to 1875 m), within 50 ft (15 m) of permanent water where lush vegetation grew. They are known to occur in Sonoran Riparian Forests and Woodlands, and ponds and cienegas (Rosen and Schwalbe 1988). HDMS locations and potential GAP habitats within Pima County are shown on Figure 24. The AGFD HDMS has the following records as of March 2000.

Date	Location	USGS Quad	Township	Ownership

Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.



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Mexican Garter Snake
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(HDMS, 2000)
▲ Mexican Garter Snake
(Thamnophis eques megalops)

Potential Habitat
(GAP, 1994)
Low Value

Figure 24

Demographics

Density: Mexican garter snakes occur at high densities at a few locations (not in Pima County) in appropriate habitat, but those densities are highly variable throughout the species range. Most populations were thought to consist of fewer than 50 individuals (Rosen and Lowe 1988).

Status: In New Mexico, *T. e. megalops* is very rare and/or very limited in its distribution and needs special consideration. Concerns for this snake are based on low numbers, limited distribution, and restricted range. Habitat restoration, enhancement, and maintenance, and control of exotic species such as bullfrog are essential if Mexican garter snake will recover in New Mexico (BISON-M 2000). In Arizona, declines have been demonstrated in association with habitat loss and bullfrog predation (Rosen and Schwalbe 1988). In 1988 it was estimated that there were fewer than 10,000 individuals of this species in Arizona (Rosen and Schwalbe 1988).

Trend: Populations decreased historically with several local extirpations since 1950 as habitat is modified and exotic predators are introduced (AGFD 1998). Current information is not sufficient to determine whether or not this trend is continuing.

Survival rates: Insufficient information is available to evaluate.

Reproduction rates: Females apparently bear a single clutch per breeding season, with an average clutch size of 13.6 (range 7 to 26). However, only about half of the females in population bear young in any one year (Rosen and Schwalbe 1988; Degenhardt et al. 1996).

Age ratios: The observation that only about half of all females in population bear young in any one year suggests that population age ratios may be distributed evenly. A disproportionate number of large snakes were found on the San Bernardino National Wildlife Refuge, and it was concluded that this was because the large bullfrog population at the site was consuming most of the smaller individuals (Rosen and Schwalbe 1988).

Sex ratios: Sex ratios appear to differ from 1:1. Adult females comprised only 26% of the field records compiled by Rosen and Schwalbe (1988).

Significant Pima Co. populations: A population of approximately 600 Mexican garter snakes was estimated for Cienega Creek (Rosen and Schwalbe 1988). No other Pima County locations were found for this snake, which was historically common in the Santa Cruz River and tributaries.

Habitat Requirements

In Arizona, habitat for *T. e. megalops* is chiefly cienegas within desert grassland to elevations of 8,500 feet (AGFD 1998) and from 3,000 to 6,000 feet (910 to 1830 m) in New Mexico (BISON-M 2000). However, habitat occasionally includes desert and lower oak woodland habitats. This subspecies also occurs in and adjacent to streams in valley floors and generally open areas, but not in steep mountain canyon stream habitats (AGFD 1998). In New Mexico, *T. e. megalops* frequents stream habitats generally characterized by shallow, slow moving, and at least partially vegetated water bodies, such as springs (BISON-M 2000). In general, this species requires intact riparian vegetation communities along permanent water that is free from bullfrogs.

Home range requirements: In general, this species requires intact riparian vegetation communities along permanent water that is free from bullfrogs.

Ability to use major land use categories: *T. e. megalops* is found in aquatic habitats surrounded by land use/land cover associations that include rangeland, shrub and brush rangeland, forest land, mixed forest land, water, streams and canals, barren land, and transitional areas (BISON-M 2000).

Habitat trends in planning area: Following massive historical declines of the habitat for this species, habitat destruction has apparently slowed or ceased, leaving remnants of suitable habitat. Some restoration efforts have occurred, and it is possible that the Mexican garter snake may become reestablished in some areas from which it had been extirpated.

Current and Potential Threats

General: "Mexican Garter Snake historical localities in the Phoenix and Tucson areas have all been devastated by urbanization, introduction of bullfrogs and predatory fishes and removal of dense vegetation" (Rosen and Schwalbe 1988:25). Lowering of water table, destruction, degradation, and fragmentation of habitat, predation by introduced bullfrogs and predatory fishes, and direct mortality are all considered threats to this species (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999; AGFD 1998; BISON-M 2000). In New Mexico, the range of *T. e. megalops* corresponded to an area that has been highly modified by humans chiefly for agriculture. Such modification of habitat has undoubtedly impacted this snake adversely. The specific impacts to New Mexico habitat that threaten this snake are dewatering, overgrazing, modification of stream morphology, siltation, arroyo cutting, and the introduction of exotic species (BISON-M 2000).

Location, amount, and quality of protected habitat: Populations occur on USFS (Coronado National Forest), BLM, ASLD, Pima County, and private land (AGFD 1998). Probably the best available habitat and the highest population levels (possibly the only remaining relatively secure population in the county) is along Cienega Creek, much of which is protected from development and severe overgrazing.

Existing and potential pest species: Non-native predators are known to include bullfrogs, fishes, and may include crayfish (Rosen and Schwalbe 1988; AGFD 1998; P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999; BISON-M 2000).

Threat mechanism: Habitat loss through water depletion and diversion and severe overgrazing, combined with introduced predators.

Management Needs

General: Management of introduced species, water, and riparian cover are needed. Lakes should not be located proximate to refugia for *T. e. megalops* (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). Studies of distribution, habitat, populations, and life history are suggested (AGFD 1998). In New Mexico, management practices that adversely affect *T. e. megalops* include irrigation, channelization, and the introduction of exotic species (BISON-M 2000), presumably predaceous sport fishes.

Current protective measures The New Mexico Department of Game and Fish manages for this snake by regulating the method and season of take and the amount, age, and sex of individuals, and by regulating disturbance of the species (BISON-M 2000). Take is restricted in Arizona.

Sensitivity to human activities and densities: Historic development and activities have eliminated most of the habitat and extirpated most local populations of this species.

Corridor needs: This is probably a metapopulation species that has multiple local populations, formerly connected by contiguous rivers and streams. The conditions that would foster maintenance of local populations and connections between them have been eliminated as a result of human activities. Artificial maintenance of local populations and gene flow may be necessary.

Key relationships: The best-known key relationships are adverse for this species and involve non-native species. Healthy populations of this species are found in association with leopard frogs (*Rana* sp.) and the fish genera *Gila* and *Poeciliopsis* (Rosen and Schwalbe 1988).

Migratory requirements: See above under corridor needs.

Results of past mitigation activities: An attempt at bullfrog suppression has been occurring for many years on the San Bernardino National Wildlife Refuge, but results of that effort on this species are not known. No other mitigation activities are known.

Existing monitoring and research programs: No specific current monitoring and research programs are known. Observations of this species may be included in more generalized studies.

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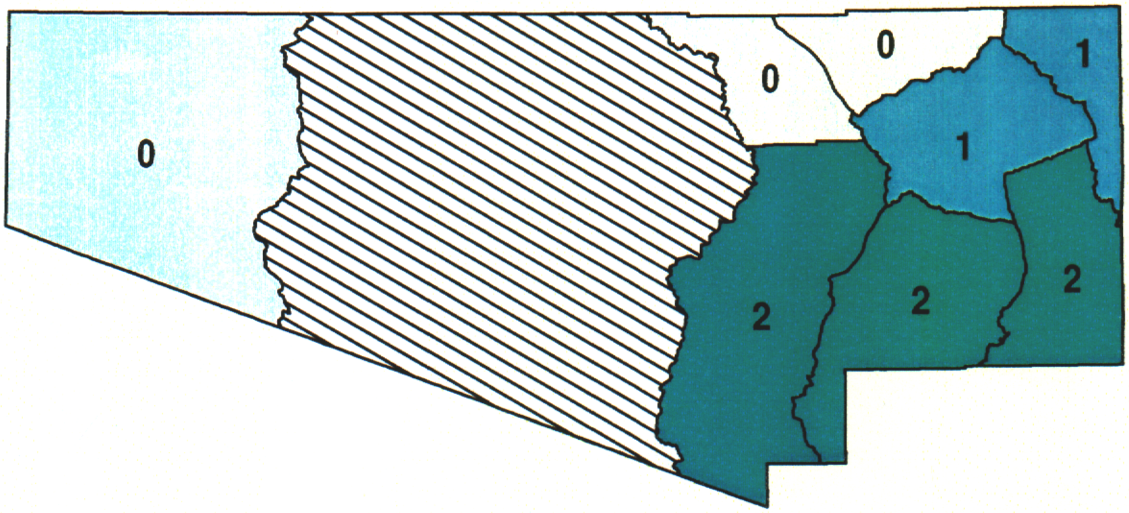
Stebbins, R. C. 1985. A field guide to western reptiles and amphibians. Houghton-Mifflin, Boston, Massachusetts.

Number of Priority Vulnerable Amphibian Species



Potentially Occurring in Each Subarea

AMPHIBIANS

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Chiricahua leopard frog (*Rana chiricahuensis*)

Status

Federal	Priority 2 Candidate for ESA list by USFWS (USFWS 1999)
State	Wildlife of Special Concern in Arizona (AGFD 1996), Endangered on New Mexico (BISON-M 2000)
Other	Forest Service Sensitive, Threatened in Mexico (AGFD 1998); Vulnerable Status 1 by SDCP
Rankings	G3 S3

Recovery Goals

Federal: There are no agency-mandated goals for this species at this time.

State: There are no agency-mandated goals for this species at this time.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The type specimen of *Rana chiricahuensis* was collected by James Platz in 1971 approximately 6 km west of Portal, in Cochise County, Arizona on the Coronado National Forest (AGFD 1997). *R. chiricahuensis* is considered by some lumper taxonomists as a member of the *Rana pipiens* complex. The genus *Rana* is represented in the Old World and New World. The *R. pipiens* complex may have diverged recently. Approximately 20 species occur in North America, with 6 in Arizona. Populations in isolated aquatic communities differ in pattern and coloration from each other (AGFD 1997). Some populations in New Mexico and Arizona that are currently classified as *R. chiricahuensis* are probably species that have not yet been described. *R. chiricahuensis* is a close relative of the Ramsey Canyon leopard frog (*R. subaquavocalis*) found only in Ramsey and Brown canyons in the Huachuca Mountains, Cochise County, Arizona. The mating call of *R. chiricahuensis* is similar to the calls of 3 Mexican species with which it is taxonomically aligned (*R. montezumae*, *R. dunni*, and *R. megapoda*) (BISON-M 1997).

Classification: Order: Salientia; Family: Ranidae; Genus: *Rana;* Species: *chiricahuensis.* No subspecies of *R. chiricahuensis* have yet been described, but the Mogollon Rim/White Mountains form will soon be distinguished by J. E. Platz as a distinct species from those in southeastern Arizona (Sredl 1997).

Life History

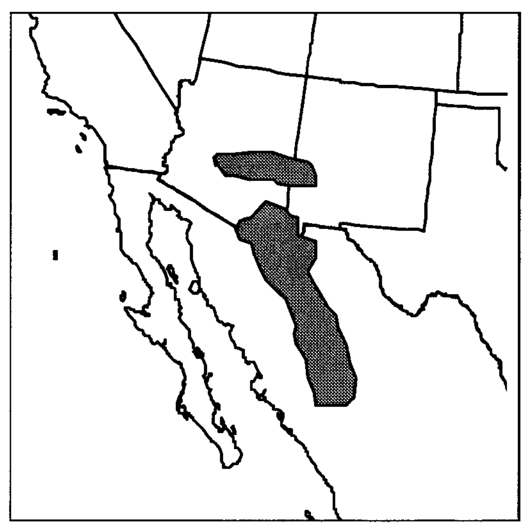
Description: Eggs are black and white and strongly demarcated between the animal and vegetal poles. Tadpoles are darkly pigmented with darkly blotched tails. Adults are distinguished from other leopard frogs by their unique thigh pattern that includes prominent, white-tipped tubercles on a dark field. Generally, adults are stout-bodied, medium-sized frogs with many dorsal spots, no spots on the head, and poorly defined or discontinuous dorsolateral folds (BISON-M 1997).

Diet: Adults and juveniles eat a variety of foods that include arachnids, crustaceans, and aquatic and terrestrial insects, while larvae eat periphyton, algae, organic debris, and plant tissue (BISON-M 1997; AGFD 1997).

Reproduction: The mating call of *R. chiricahuensis* differs in frequency and pulse rate from other members of the *R. pipiens* complex in the U.S. Breeding season at higher elevations, above 5,900 feet (1,800 m), is late May through August, and at lower, warmer sites, below 5,900 feet (1,800 m) is mid February through June, with sporadic breeding into autumn (AGFD 1997; BISON-M 1997). Some populations at thermally stable sites may be reproductively active year-round. Moreover, the hatching to metamorphosis period appears to be shorter at such sites (2 to 3 months) compared to cooler sites (8 to 9 months). Eggs are typically attached to vegetation in shallow water near the shoreline of ponds and streams. Depending on temperature, the larval period may last only 3 months in some populations while tadpoles overwinter in other populations. Reproductive maturity is generally 2 to 3 years from metamorphosis (BISON-M 1997).

Behavior: Chiricahua leopard frogs are nocturnally active during the active season, resting during the day among vegetation surrounding their aquatic habitat. When startled, individuals jump into the water. Individuals may wander farther from the banks during the nocturnal period, but are also found on floating mats of vegetation. Life history and behavioral studies are needed (AGFD 1997).

Distribution



Historic: Historical distribution of this species is difficult to ascertain because it was formerly considered just another *Rana pipiens*, and so classified by observers before it was described as a separate species in 1979. Positive historical records are known from over 114 sites in southeastern Arizona, where it occupied most large rivers and lakes, as well as many small tributaries and ponds. From 1990 to 1994, 265 potential sites, including 87 of the 114 known historical sites were surveyed, and Chiricahua leopard frogs were found in 12 historical and 51 previously unknown sites (Sredl and Howland 1994). Data reviewed in 1995 suggested that *R. chiricahuensis* was expatriated from nearly 50% of its historical occurrences in the U.S. (BISON-M 1997).

Present: The total range includes montane regions in central and southern Arizona, southwestern New Mexico south into the Sierra Madre Occidental to western Jalisco, Mexico, at elevations from 3,500 to 8,400 feet (1,066 to 2,450 m). Two disjunct distributions exist within central and southeastern Arizona, from montane central Arizona east and south along the Mogollon Rim to montane areas of west-southwestern New Mexico, and southeastern montane areas of Arizona into Sonora (AGFD 1997) and Chihuahua, Mexico (BISON-M 1997). The 2 distributions likely represent distinct species that have not yet been formally distinguished (Sredl 1997). In New Mexico, the species is most abundant in the Gila, Tularosa, and San Francisco river drainages. Such areas within the Gila National Forest may support the largest metapopulations remaining in New Mexico (BISON-M 1997). Elevational range of the central and eastern Arizona distribution is 3,500 to 8,040 feet (1,068 to 2,452 m), and 1,219 to 4,023 feet (372 to 1,227 m) near the Arizona-Mexico border. Distribution studies are needed (AGFD 1997). In Pima County, *R. chiricahuensis* has been found at 6 sites, outlined in the table below (AGFD 2000) (Figure 25).

Date	Location	USGS Quad	Township	Ownership

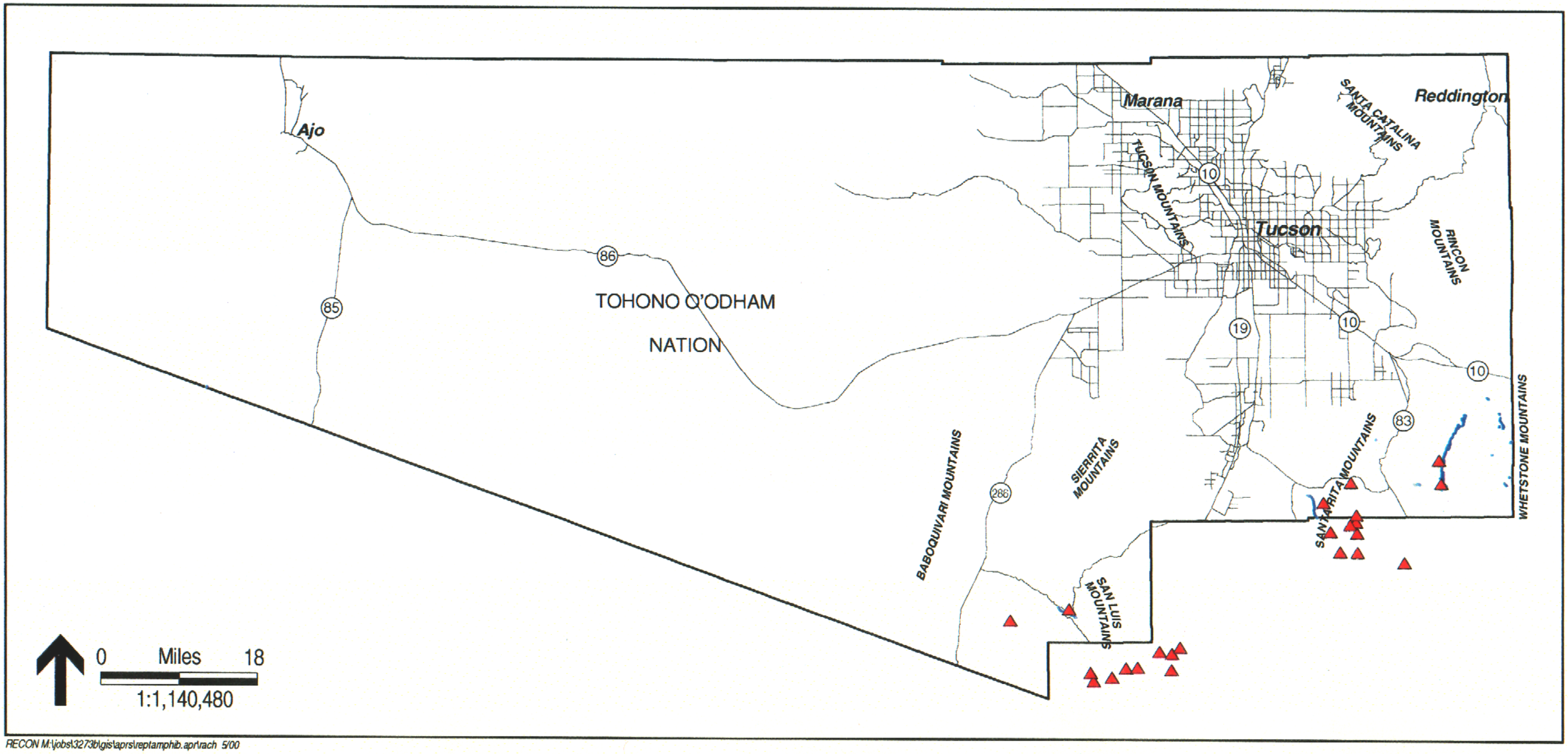
Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.

Demographics

Density: Demographic information is limited to a single study in Cochise County, Arizona. In 1994, the Lincoln-Peterson population estimates (±95% CI) for individuals with greater than 55 mm snout-vent length were 59 ± 39 at Headquarters Windmill Tank and 24 ± (no error estimate) at Monkey Tank, both in the Chiricahua Mountains (Sredl 1997).

Status: The southeastern form of *R. chiricahuensis* (*sensu* Sredl 1997) occurs in Arizona south of the Gila River in Cochise, Santa Cruz, Pima, and Graham counties, in stock tanks, rivers, and streams at elevations from 1061 to 2012 m (3480 to 6600 ft). Natural lotic systems contain 53% of known localities, livestock tanks contain 45%, and 2% (2 localities) are in artificial reservoirs. Approximately 79% of known localities are in the San Simon, San Pedro, and Santa Cruz river drainages. Such drainages are the major watersheds that drain northward into the Gila River. Approximately 21% are in the headwaters of the Rio Concepcion and Rio Yaqui, both of which flow southward into Mexico (Sredl 1997). The southeastern form of *R. chiricahuensis* are found primarily in Cochise County (49% of localities), Santa Cruz County (30%), Graham County (17%), and the remainder (3%, or 6 sites) in Pima County. Sredl (1997) conducted 656 presence/absence surveys south of the Gila River. Frogs were detected at 17 of the 84 historic sites surveyed, and found at 44 new sites. The 17 historic sites that were not surveyed included 4 on National Wildlife Refuges, 6 on Coronado National Forest, 6 on privately owned land, and 1 on military land. Sredl (1997) stated that 61 extant sites for the southeastern form exist. Major river drainages with extant sites include the San Pedro (36), Santa Cruz (10), Rio Concepcion (8), Rio Yaqui (4), and San Simon (3).



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Chiricahua Leopard Frog
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(HDMS, 2000)
Chiricahua Leopard Frog
(Rana Chiricuahensis)

Potential Habitat
Perennial streams and intermittent streams where Chiricahua Leopard Frog has a high potential for occurrence

Figure 25

Seventy-nine percent of extant sites are on Coronado National Forest (48), state land (5), National Wildlife Refuge (1), and private land (7).

Trends: The population status is precarious, with substantial losses occurring throughout the range for a variety of reasons, some unknown, along the Mogollon Rim and in the White Mountains (AGFD 1996). Population studies are needed (AGFD 1997).

During a 1989 study, *R. chiricahuensis* was absent from 33 of 36 known localities in Arizona. The population trend in 1991 was noted to be declining (decreasing numbers and/or increasing threats). By 1994, *R. chiricahuensis* populations were declining rapidly throughout their range from reasons unknown. The decline was especially evident in Arizona and New Mexico, chiefly at stock pond habitats. Some of the pond declines may have been associated with anoxic conditions during winter.

Fifty historic collection sites in New Mexico were sampled in 1995. Thirty-three of the sites had been occupied within the previous 11 years, but individuals were found at only 6 of the sites. Twenty-two new sites were also surveyed, and individuals were found at 5 of the sites. In 1996, *R. chiricahuensis* was not found at any of 8 known localities on the Gray Ranch in southern Hidalgo County, New Mexico (BISON-M 1997).

A mark-recapture study was conducted in 1994 at Horsefall Canyon, Cochise County (Sredl 1997). Initial criteria for site selection included a high degree of geographic closure, relatively natural or minimally modified habitat, and a sufficient number of frogs to yield adequate captures and recaptures. The study area contained 2 earthen stock tanks on the northwest side of the Chiricahua Mountains, just south of Chiricahua National Monument. The Headquarters Windmill Tank (HW) is at the confluence of Horsefall Canyon and Pinery Creek. Water is supplied to the tank from spill-off from a metal drinker supplied by a windmill. Frogs were found in both the drinker and the tank. Monkey Tank (MT) is approximately 1.6 km (1 mi) up Horsefall Canyon from HW. Elevations of the tanks are 5800 and 6080 feet, and are surrounded by Madrean evergreen woodland upland vegetation. Average annual rainfall is 500 mm (19.63 in). Sampling began in May 1994. A huge die-off that occurred in June 1994 was possibly caused by hydrogen sulfide poisoning. A high detritus load in the pond, combined with a low water level, high water temperature, and low levels of dissolved oxygen, produced an environment attractive to sulfur-producing bacteria. The event reduced the population of 60 to 80 adult frogs to less than 10 (Sredl 1997).

Survival rate: Although the maximum lifespan of *R. chiricahuensis* is unknown, the species may have a longer maximum lifespan than *R. yavapaiensis*, which was determined to be 3 years (Collins et al. 1996). Life span may reach 14 years in nature (Center for Biological Diversity 1997).

Reproduction rate: No known information on reproduction rate is available. Reproduction rate probably varies with locality and conditions from year to year.

Age ratio: No known information on age ratio is available. The concept is not effectively applicable to this species, because 2 individuals may produce dozens to hundreds of offspring under favorable conditions.

Sex ratio: In 1994, Sredl (1997) found 14 males and 20 females at HW, and 16 males and 10 females at MT. Neither sample differed significantly from a 1:1 ratio ($p > 0.30$ and $p > 0.23$ for HW and MT, respectively).

Significant Pima Co. populations: All existing Pima County populations should probably be considered significant. Additional surveys should be conducted to determine the full extent of the range of this species in Pima County.

Habitat Requirements

The Chiricahua leopard frog is an aquatic and riparian species (BISON-M 1997). Habitat includes a variety of water sources including rocky streams with deep, rocky pools, overflow pools and oxbows of rivers, permanent springs, ponds, and wetlands at elevations from 3,500 to 8,040 feet in central and eastern Arizona, and from 1,219 to 4,023 feet in southeastern Arizona (AGFD 1997, 1996). It also occurs in thermal springs and seeps, stock tanks, wells, and mainstream river reaches (BISON-M 1997). Adjacent upland communities include oak and pine-oak woodland, chaparral, grassland, and desert. Habitat studies are needed to more precisely define the habitat of the species and habitat requirements (AGFD 1997). Although 1 population is known to occur in an aboveground water tank with no natural habitat in the vicinity, ideal habitat includes permanent water (during breeding season, and at least muddy conditions otherwise for survival), aquatic heterogeneity (deep pools with nearby shallow areas), undercut banks (retain moisture during drought), overhanging terrestrial vegetation, and abundant aquatic vegetation (BISON-M 1997).

Home range requirements: Known habitat requisites are detailed above. Home range requirements beyond these are not known.

Ability to use major land use categories: The Chiricahua leopard frog uses agricultural land, water, streams and canals, lakes, and unforested wetlands. While habitat destruction and modification may affect *Rana* populations, the overall decline of *R. chiricahuensis* has not been connected to this factor, at least in Hidalgo County, New Mexico. The disappearance of ranid frogs in Hidalgo County exhibits a regional pattern that is not associated with changes in land use (BISON-M 1997).

Habitat trends in planning area: After a major historical decline in suitable habitat, potentially suitable habitat is being preserved and restored on a small and local scale.

Current and Potential Threats

General: Existing and potential pest species such as introduced fishes, crayfish, and bullfrogs are possibly displacing Chiricahua leopard frog (AGFD 1997, 1996, 1988, BISON-M 1997). Population fragmentation, habitat loss resulting from water diversion, groundwater pumping, pollution (AGFD 1996, 1988), and anoxia represent other potential threats. Among populations monitored during a study in 1989, population size and duration of reproductive events differed markedly. Theoretically, larger populations should be less susceptible to extinction, and populations with a longer reproductive period should be more stable. However, neither factor appeared correlated with the types of mortality observed. Sites with the greatest declines were associated with the type of aquatic habitat (flowing or still water), rather than population size or patterns of water temperature fluctuations. Pond populations exhibited adult-form mortality, while stream populations did not. Interestingly, pond habitats had not been altered conspicuously, nor were bullfrogs or introduced predatory fishes observed. Moreover, the declines could not be attributed to acidification, based on pH data gathered during the study. Introduction of pollutants and toxicants into pond sites does not support the declines because other amphibian species persisted, although differential susceptibilities among amphibian species have been documented. The cause of declines is best explained by the novel parasite/pathogen and catastrophic event hypotheses. The pond sites are used by cattle that may serve as vectors for the introduction of parasites or pathogens. Short-term catastrophes cannot be rejected at this time because the pond sites were visited bi-monthly at best. The winter and spring of 1989 were unusually dry and may have dramatically contributed to the declines observed, but no other catastrophes were noted during the study. The oxygen depletion hypothesis perhaps provides the best explanation of adult-form mortality. Tadpoles of *R. muscosa* survived a winterkill in high elevation lakes in the Sierra Nevada because their gills better removed existing oxygen from the water than those of adults. The tadpoles have a hemoglobin with a higher oxygen affinity than adults, and their standard metabolic rate decreased in response to lower oxygen levels, while adult metabolism remained constant during the same period. At some sites in New Mexico, *R. chiricahuensis* adults overwintered in mud on the bottom of tanks while tadpoles were more active and did not overwinter. Hydrogen sulfide gas was abundant, indicating anaerobic conditions in the mud. Anaerobic conditions in winter can be caused by a reduction in primary productivity, low levels of winter and spring runoff, high nutrient load in runoff resulting from heavy tank use by cattle (causing a bloom of anaerobic decomposers and subsequently attenuated oxygen deficit), and drought causing mortality of aquatic vegetation, invertebrates, and vertebrates that provided additional organic matter for anaerobic decomposers that in turn, led to further oxygen deficits. Because *R. chiricahuensis* evolved in and are adapted to natural habitats, they may be able to use artificial ponds under certain conditions, and unable to cope in other conditions, such as anoxia resulting directly and indirectly from drought and coupled with the cumulative effects of habitat alteration (BISON-M 1997).

Current data cannot adequately or exclusively support the bullfrog and other introduced predator hypotheses, because declines have occurred both at sites with and without introduced predators. Crayfish compete for vegetation, and salamanders feed on ranid eggs and tadpoles. Declines of *Rana* populations at some Arizona sites are correlated with the occurrence of tiger salamanders and crayfish. Habitat alteration affects ranid populations, but the overall decline of *R. chiricahuensis* in New Mexico has not been linked to this factor. Commercial exploitation is no longer testable because the putative condition no longer exists. Post-metamorphic death syndrome (PMDS) has been implicated as the cause of periodic die-offs at sites in Arizona and extirpations at sites in New Mexico. The cause of PMDS is unknown but may be facilitated by a multitude of environmental factors. Cadmium, and possibly arsenic, from copper smelters have apparently affected some *R. chiricahuensis* populations in southern Arizona. These elements may be a causal factor in PMDS. However, pH data at 5 *R. chiricahuensis* populations does not suggest that declines are attributable to acidification, although water acidity may affect growth and development of larvae.

The global phenomenon of increased ultraviolet • radiation resulting from holes in the atmospheric ozone layer is a possible cause of amphibian declines worldwide. The eggs of some amphibian species have a lower resistance to ultraviolet radiation damage than other species, and can impair development. However, no data are available for *R. chiricahuensis* (BISON-M 1997).

In 1998, *R. yavapaiensis* specimens from Big Spring were analyzed and red-leg disease was eliminated from causes of death. Rather, the disease was identified as chytrid fungus. This diagnosis led to further analysis of other specimens collected form die-off sites. The fungus was found in dead specimens collected from Cienega Creek in Pima County. Apparently, chytrid fungus originated in Australia, moved to Central and South America, and is now in Arizona. The vector has not been identified (M. Sredl, personal communication, 10 February 2000).

In summary, there are probably several or many threats that may affect frog populations, some are known, some are not known, some act independently and others synergistically.

Location, amount, and quality of protected habitat: Most of the known locations on public land are protected to some degree. However, there is little or no evidence that habitat protection is effective for protecting populations of this species.

Existing and potential pest species: The introduced crayfish (*Oronectes virilis*) is having major negative affects on native populations of aquatic invertebrates, Chiricahua leopard frog (*Rana chiricahuensis*), and Sonoran mud turtles (*Kinosternon sonoriense*) (BISON-M 2000), probably contributing to the statewide decline of *R. chiricahuensis* in Arizona (AGFD 1997). Bullfrogs are known to compete with and consume this species, and few, if any, locations support both species.

Threat mechanism: Massive historical habitat loss and isolation of local populations has disrupted the metapopulation structure of this species. Multiple threats impact local populations, and without a healthy metapopulation structure, recovery of local populations in not possible (Sredl and Howland 1994).

Management Needs

General: Stabilize and enhance Mogollon Rim and White Mountain populations, renovate appropriate sites, including removal of non-native predators, for establishment of new populations at historically occupied sites, establish new breeding populations via translocation of wild frogs or the release of captive bred or reared frogs, monitor populations and evaluate management actions (AGFD 1996). Factors to assure available quality habitat include (1) maintenance or development of permanent water sources within a metapopulation area, while preventing further groundwater pumping, (2) development and maintenance of heterogeneous habitats that include cover, shelter, breeding microhabitats, (3) increase depth, duration, and surface area of water to increase mean annual oxygen levels, (4) prevent overgrazing to recover bank vegetation and to increase water quality, (5) prevent introduction of non-native predators and eradicate such species whenever possible, (6) prevent overcollection by museums, and (7) prevent pollution, especially from agricultural and industrial sources (BISON-M 1997).

Although the southeastern form of *R. chiricahuensis* (*sensu* Sredl 1997) has declined, the number and distribution of extant populations and land management status combine to make this population the second-most stable and manageable leopard frog in Arizona (Sredl 1997).

Current protective measures: Arizona implemented a closed season for *R. chiricahuensis* (AGFD 1997), and implemented a year round, open season on bullfrogs, and set an unlimited bag and possession limit for dead bullfrogs across the entire state, except for 3 western counties. The regulations will simplify efforts to pressure bullfrog populations in specific areas to favor native species. The preliminary effects are encouraging, but data are insufficient to determine whether bullfrog control might augment recruitment in *R. yavapaiensis* and other species (BISON-M 1997).

Sensitivity to human activities and densities: Most of the apparent impacts to *R. chiricahuensis* are directly or indirectly associated with human activities, but precise quantification or qualification is difficult.

Corridor needs: In New Mexico, conservation of *R. chiricahuensis* should focus first on protection and management of 1 or more core populations, and then on protection and management of surrounding suitable natural or artificial sites. Surrounding sites should serve as buffers that help stabilize metapopulations over the long term. Surrounding artificial sites could be managed to support satellite populations, or sinks/sources for metapopulations. Such a measure may be critical when natural habitats and dispersal corridors are irreversibly degraded. However, the level of management required to achieve such a goal might be difficult. Both invertebrate and vertebrate natural and introduced predators are commonly attracted to permanent water sources, and can often rapidly invade new aquatic habitats (BISON-M 1997).

Natural dispersal corridors in Arizona have effectively been eliminated by a variety of human activities. Facilitated dispersal (relocation) is recommended (Sredl and Howland 1994).

Key relationships: No specific key relationships are known for this species.

Migratory requirements: Migration is not known for this species.

Results of past mitigation activities: No specific past mitigation activities are known for this species.

Existing monitoring and research programs: AGFD maintains an active program of research and monitoring for all frogs in the state; however, it has only one active full-time person for this program.

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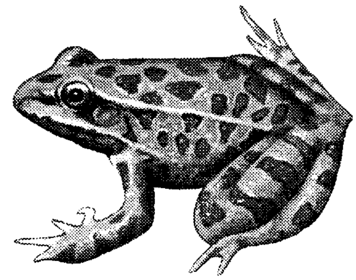
Lowland leopard frog (*Rana yavapaiensis*)

Status



Federal Species of Concern (former Category 2 candidate for listing) by USFWS (AGFD 1998)

State Wildlife of Special Concern in Arizona by AGFD (AGFD 1996, 1998); Endangered by NMDGF (BISON-M 1997)

Other Sensitive by USFS Region 3 Forester; Rare in Mexico (AGFD 1998); Vulnerable Status 2 by SDCP

Rankings G4 S4

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The type specimen of *Rana yavapaiensis* was collected by James Platz in 1971 in Tule Creek, Yavapai County, Arizona (AGFD 1997). *R. yavapaiensis* is considered by some lumper taxonomists as a member of the *Rana pipiens* complex. The *R. pipiens* complex may have diverged recently. The genus *Rana* is represented in the Old World and New World. Approximately 20 species occur in North America, with 6 in Arizona. Populations in restricted aquatic communities differ in pattern and coloration (AGFD 1997).

Classification: Order: Anura; Family: Ranidae; Genus: *Rana;* Species: *yavapaiensis*. This species was formerly considered *Rana pipiens*. No subspecies have been described.

Life History

Description: This is a medium-sized frog. The dorsal field color of adults is a light gray-green, green, tan, or brown, with dark brown spots and no halos. Adults can be distinguished from other leopard frogs by their prominent dorsolateral folds that are discontinuous posteriorly and deflected medially in the sacral area. The supralabial stripe diffuses anterior to the eye, the venter is cream-colored, and yellow pigment on the groin often extends posterior to the venter and to the ventral portions of the legs (AGFD 1997).

Diet: Adults eat small invertebrates and rarely, small vertebrates. Larvae eat algae, plant tissue, organic debris, and probably small invertebrates (AGFD 1997).

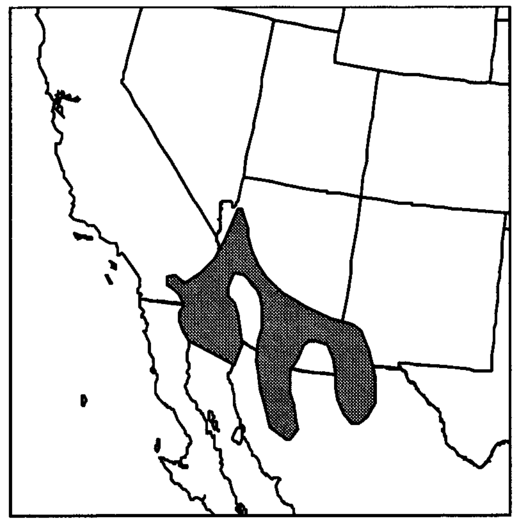
Reproduction: In Arizona, *R. Yavapaiensis* breeds February through April, and occasionally into Autumn (AGFD 1997; BISON-M 1997).

Behavior: This frog is usually found near water, and jumps into water when it is frightened.

No additional information is known to be available specifically on its behavior.

Distribution

Historic: The total range of *R. yavapaiensis* included lower elevations of the lower Colorado River and its tributaries in Nevada, California, Arizona, New Mexico, northern Sonora and extreme northeast Baja California, Mexico. This frog occurred in the Colorado River near Yuma in extreme southwestern Arizona, in west, central, and southeastern Arizona south of the Mogollon Rim, and the Virgin River drainage in extreme northwestern Arizona (AGFD 1997). However, this frog has been extirpated from New Mexico since 1985 (BISON-M 1997), from southwestern Arizona, probably from California, and possibly from Nevada (AGFD 1997).

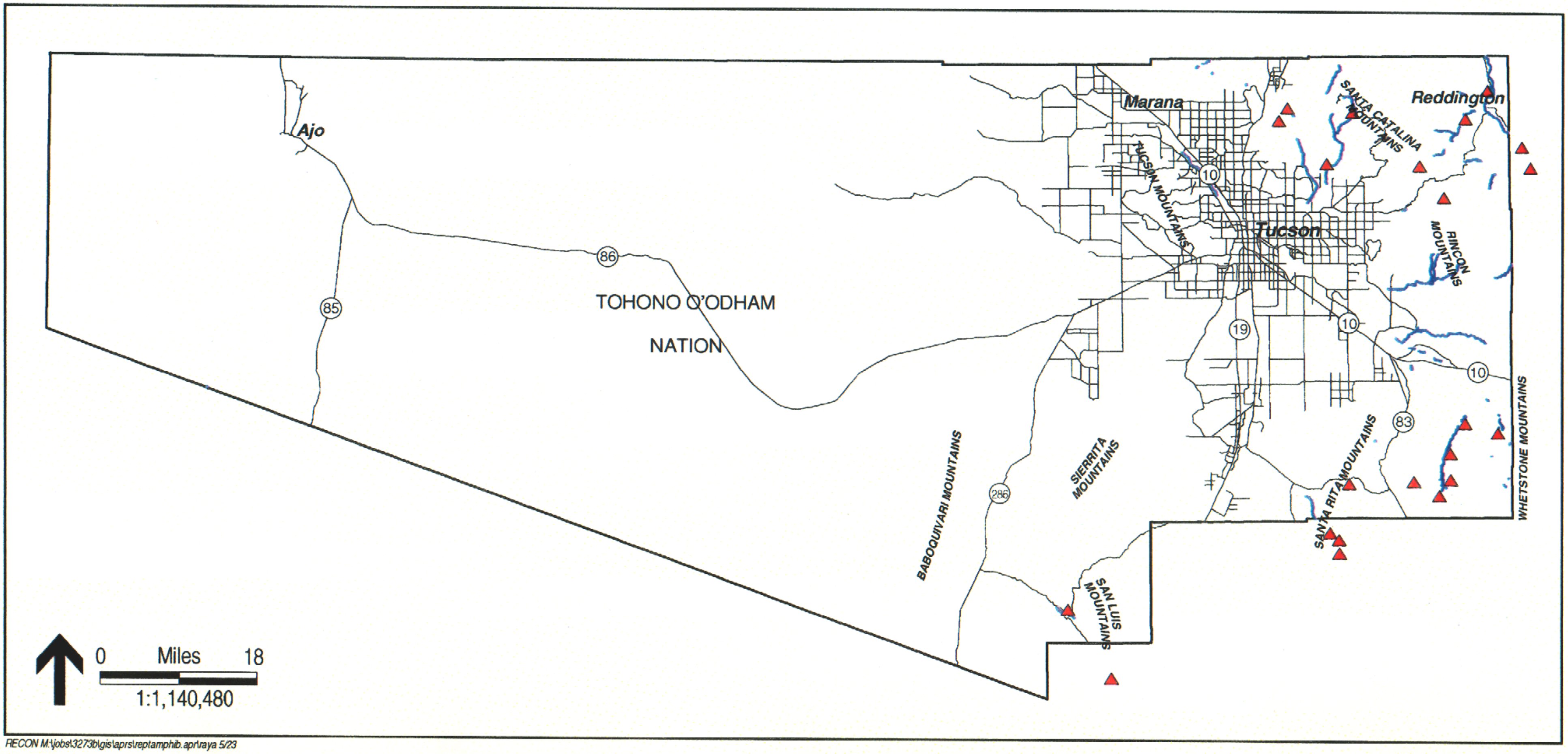


Present: *R. yavapaiensis* currently occurs in south-central, central, west-central, and extreme northwestern Arizona (AGFD 1988), south and west of the Mogollon Rim (AGFD 1996). *R. yavapaiensis* was found in 5 canyons in the Rincon Mountain District of Saguaro National Park, Pima County during 1996 and 1997 surveys (Swann and Schwalbe 1998). *R. yavapaiensis* currently occur at 10 to 20 sites primarily in eastern Pima County, but the present range has been greatly reduced (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). There have been recent changes (losses) of populations, and a thorough recent survey of the County has not been done. It is known to be present in Cienega Creek County Park (K. J. Kingsley, pers. obs.) (Figure 26).

Demographics

Density: Mark-recapture studies were conducted at a total of 6 sites in Arizona from 1991 to 1996 (Sredl 1997). However, data were gathered annually only at Big Spring in Graham County. The Lincoln-Peterson population estimates (±95% CI) at that site indicate a decline: 313 ± 111 in 1991; 443 ± 111 in 1992; 156 ± 37 in 1993; 134 ± 85 in 1994; 92 ± 25 in 1995; and 70 ± 47 in 1996. The large confidence intervals may have resulted from low capture probabilities. Data were collected on frogs at Alamo Canyon in the Santa Catalina Mountains in Pima County in 1991 and 1992. Population estimates were 41 ± 46 and 41 ± 49, respectively (Sredl 1997).

Status: *R. yavapaiensis* was apparently extirpated from New Mexico as of 1995 (BISON-M 1997), probably extirpated from California, and possibly from Nevada (AGFD 1997). In Arizona, central populations appear healthy, but die-offs have occurred. *R. yavapaiensis* has disappeared from most of the lower Gila and lower Colorado river drainages, but the specific causes have not been



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Lowland Leopard Frog
Known Locations and Potential Habitat

Pima County Boundary
Major Road or Highway

Known Locations
(HDMS, 2000)
Lowland Leopard Frog
(Rana yavapaiensis)

Potential Habitat
Perennial streams and intermittent streams where Leopard Frogs have a high potential for occurrence

Figure 26

identified. Declines have also occurred in south-central and southeastern Arizona (AGFD 1996). Data on Arizona populations suggest that metapopulations are highly variable. Such variability is accentuated by catastrophic climatic and epizootic events that result in unstable metapopulations (BISON-M 1997).

Trend: The trend of the *R. yavapaiensis* population was described as declining by USFWS in 1994, defined as decreasing numbers and/or increasing threats (BISON-M 1997). It is questionably stable in central Arizona, declining in southeastern Arizona, and extirpated from southwestern Arizona (AGFD 1997). The Alamo Canyon population in the Santa Catalina Mountains was extirpated probably as a result of drought (Phil Rosen, personal communication, 03-04-99).

Survival rates: *R. yavapaiensis* apparently has a maximum life span of 3 years, based on skeletochronology (Collins et al. 1996). Population data were gathered annually from 1991 to 1996 at Big Spring in Graham County, and from 1991 to 1993 at Tule Creek in Yavapai County. Although subject to interpretation, the average annual JOLLYAGE adult survivorship estimates (±95% CI) suggest stability at Big Spring (0.92 ± 0.32 in 1991, 0.55 ± 0.25 in 1992, 0.63 ± 0.41 in 1993, 0.78 ± 0.36 in 1994, 0.90 ± 0.46 in 1995, and 0.71 ± 1.33 in 1996), while any trend at Tule Creek is unclear because of inadequate data (1.82 ± 4.05 in 1991, 0.25 ± 0.60 in 1992, and 3.92 ± no estimate in 1993). Juvenile survivorship estimates (±95% CI) also suggest stability at Big Spring (0.39 ± 0.19 in 1991, 0.09 ± 0.11 in 1992, 0.81 ± 0.41 in 1993, 0.84 ± 0.50 in 1994, 0.54 ± 0.27 in 1995, and 0.31 ± 0.65 in 1996), while any trend at Tule Creek is unclear, again because of inadequate data (1.09 ± 2.47 in 1991, 0.26 ± 0.73 in 1992, and 0.36 ± 0.36 in 1993). The large confidence intervals may have resulted from low capture probabilities (Sredl 1997).

Reproduction rates: Data were gathered annually from 1991 to 1996 at Big Spring in Graham County, and from 1991 to 1993 at Tule Creek in Yavapai County. The average annual JOLLYAGE recruitment estimates (±95% CI) suggest a net decline at Big Spring (279 ± 2506 in 1991, -58 ± 3214 in 1992, 43 ± 343 in 1993, 70 ± 436 in 1994, 12 ± 387 in 1995, and 13 ± 46 in 1996), while any trend at Tule Creek is unclear because of inadequate data (111 ± 5172 in 1991, 447 ± 2746 in 1992, and 226 ± no estimate in 1993). The large confidence intervals may have resulted from low capture probabilities (Sredl 1997).

Age ratios: Assuming that snout-vent length (SVL) corresponds closely to age and cohort class, a general pattern of oscillation in Arizona is apparent. Using data from Big Spring as an example, SVL ± 1 sd was highest in April 1993 (63.4 ± 8.47, indicating mostly subadults and adults), decreased in June and July (54.6 ± 11.14 and 53.1 ± 13.49, respectively, reflecting the breeding effort of metamorphosing frogs), and increasing slightly overall in October (58.6 ± 11.52, resulting from rapid growth of new recruits) (Sredl 1997). From both surveys (1991 and 1992) at Alamo Canyon in Pima County, the range of SVL values suggests a heterogeneous mix of newly metamorphosed individuals and reproductive adults. However, studies suggest that the Reed Spring population in Gila County was reduced to 1 cohort during the same period (Sredl 1997).

Sex ratios: Three of the six populations surveyed between 1991 and 1996 (Reed Spring in Gila County, and Thicket Spring and Tule Creek in Yavapai County) had ratios that did not differ significantly from 1:1. However, significantly more females were found in at least one year in the remaining 3 populations (Alamo Canyon in Pima County, Barnhardt Mesa in Gila County, and Big Spring in Graham County) (Sredl 1997). Sredl (1997) stated that incorrect sexing and sexually dimorphic capture probability are possible sources of the bias.

Significant Pima County populations: Pima County contains 29 of the known 316 (9.2%) of *R. yavapaiensis* localities in Arizona (Sredl 1997). Cienega Creek probably has the largest current population of this species in the County (K.J. Kingsley, pers. obs.).

Habitat Requirements

General: This species is generally restricted to permanent waters south and west of the Mogollon Rim, below 5500 feet elevation and chiefly below 3000 feet. This frog apparently prefers small to medium streams over ponds, stock tanks, and other aquatic habitats (AGFD 1988, 1996; BISON-M 1997). Populations typically occur in aquatic systems with surrounding Sonoran Desert Scrub, Semidesert Grassland, or Madrean Evergreen Woodland upland vegetation communities at elevations from 800 to 5500 feet (244 to 1678 m) in Arizona (AGFD 1997). In New Mexico, lowland leopard frogs were associated with vegetation that includes Arizona sycamore (*Platanus wrightii*), seepwillow (*Baccharis glutinosa*), other trees and shrubs, and various forbs and graminoid plants. *R. yavapaiensis* often concentrates near deep pools associated with root masses of large riparian trees (BISON-M 1997).

Home range requirements: Large pools are essential for adult survival and reproduction, and small pools and marsh habitats probably enhance survival of juveniles (BISON-M 1997).

Ability to use major land use categories: This species is not known to occur in areas of intensive development by people.

Habitat trends in planning area: After major historic losses, potentially suitable habitat for this species appears to be increasing or remaining stable. Most currently occupied locations appear to be in stable or improving condition (K.J. Kingsley, pers. obs.).

Current and Potential Threats

General: Some die-offs have occurred, but specific causes have not been positively identified. *R. yavapaiensis* is threatened by a multitude of human impacts in aquatic habitats, and introduction of predatory fishes (AGFD 1988). Threats include disease, flooding, alteration of riparian habitat by livestock grazing (BISON-M 1997; Sredl 1997), introduction of non-native predatory fishes (bass, sunfish, and catfish) and bullfrogs (AGFD 1996; BISON-M 1997), human use of aquatic habitats, and the invasion of the introduced Rio Grande leopard frog (*R. berlandieri*) in the lower Gila and Salt rivers.

Location, amount, and quality of protected habitat: All known currently occupied habitat in Pima County receives some level of protection.

Existing and potential pest species: Non-native predators and competitors include bullfrogs, Rio Grande leopard frogs, crayfish, predatory fish, and disease organisms. Introduced predators of leopard frogs may exert a strong, negative influence on leopard frog populations through predation on egg masses, tadpoles, and post-metamorphic individuals. Tadpoles evolved in the absence of visual predators such as bass and sunfish may be more active than tadpoles at sites where such predators occur. Relatively higher activity levels may make tadpoles more vulnerable to predation. Catfish forage in benthic habitats and in vegetation that increases the likelihood of detecting tadpoles and egg masses. Populations of *R. yavapaiensis* that coexist with bullfrogs in southeastern Arizona have declined, and bullfrog predation has been identified as a major factor (BISON-M 1997). Lowland leopard frogs can probably coexist in streams with low densities of bullfrogs, but need a flooding regime (e.g. the lower San Pedro River, and Rillito Creek and Tanque Verde Creek) (P. Rosen, pers. comm. to D. Scalero, 4 Mar 1999). The latter point seems to conflict with the threat identified by Sredl (1997) and BISON-M (1997). In 1998, *R. yavapaiensis* specimens from Big Spring were analyzed and red-leg disease was eliminated from causes of death. Rather, the disease was identified as chytrid fungus. This diagnosis led to further analysis of other specimens collected form die-off sites. The fungus was found in dead specimens collected from Cienega Creek in Pima County. Apparently, chytrid fungus originated in Australia, moved to Central and South America, and is now in Arizona. The vector has not been identified (M. Sredl, AGFD, pers. comm. to B. Pavlick, SWCA, 10 Feb 2000).

Threat mechanism: Multiple threats and threat mechanism have been described above.

Management Needs

General: Monitor the status of remaining populations, monitor the range expansion of *R. berlandieri*, determine the effects of *R. berlandieri* on *R. yavapaiensis*, and manage appropriately (AGFD 1996). Suggested projects include population and metapopulation studies, dispersal abilities, habitat reservations, and translocation effectiveness (AGFD 1997). The results of microhabitat use by different age classes of *R. yavapaiensis* illustrates the importance of instigating land management practices that will create or maintain a variety of habitats for highly aquatic amphibians. Adult *R. yavapaiensis* need large pools for survival and reproduction, whereas juveniles need small pools and marsh habitats to enhance their survival (BISON-M 1997).

Current protective measures: Arizona implemented a closed season for *R. yavapaiensis* (AGFD 1997), and implemented a year round, open season on bullfrogs, and set an unlimited bag and possession limit for dead bullfrogs across the entire state, except for 3 western counties. The regulations will simplify efforts to pressure bullfrog populations in specific areas to favor native species. The preliminary effects are encouraging, but data are insufficient to determine whether bullfrog control might augment recruitment in *R. yavapaiensis* and other species (BISON-M 1997). Habitats known to be currently occupied by this species are protected by a variety of land management agencies and regulations.

Sensitivity to human activities and densities: No known information is specifically available about this. It may be reasonable to expect that as human population of the area increases, groundwater depletion leading to loss of surface water habitat may occur.

Corridor needs: Like the Chiricahua leopard frog, the lowland leopard frog appears to be a classic metapopulation species whose avenues of connection between local populations have been significantly impacted by human activities and their consequences. This species probably requires dispersal corridors consisting of streams and adjacent riparian habitat in reasonably good condition, without insurmountable interruptions or barriers.

Key relationships: No specific key relationships are known for this species.

Migratory requirements: See above under corridor needs.

Results of past mitigation activities: None are known specifically for this species or its habitat.

Existing monitoring and research programs: AGFD maintains an active program of research and monitoring for all frogs in the state; however, it has only one active full-time person for this program.

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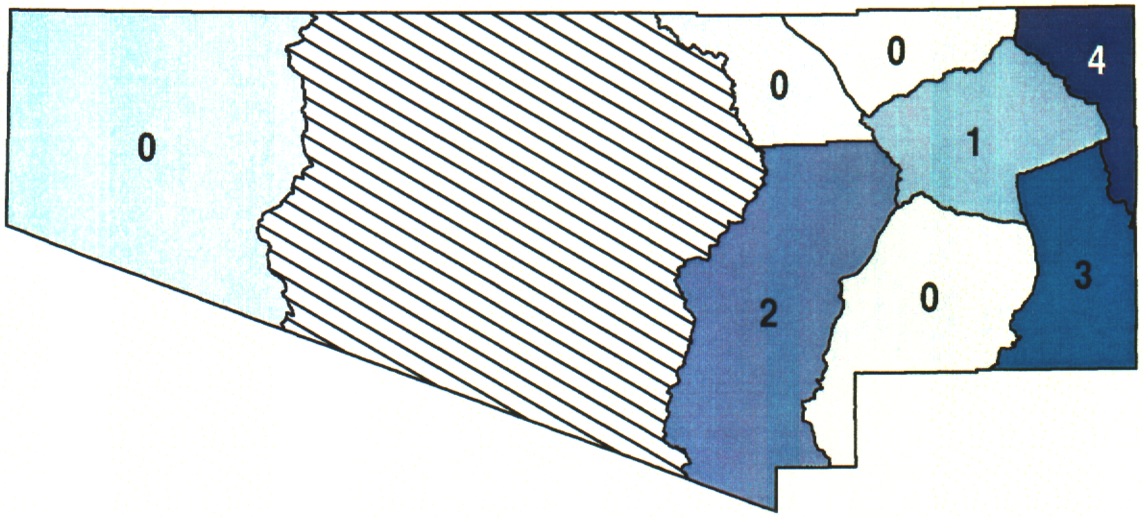
Number of Priority Vulnerable Fish Species

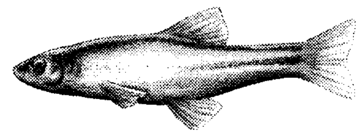


Potentially Occurring in Each Subarea

FISH

Longfin dace (*Agosia chrysogaster*)

Status



Federal	Former candidate for Category 2 listing (1994), now Species of Concern (AGFD 1998)
State	None
Rankings	G4 S3S4

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The longfin dace is a small minnow.

Classification: Order: Cypriniformes; Family: Cyprinidae; Genus: *Agosia*; Species: *chrysogaster.*

Synonymy: The species has been known by the names: *Agosia metallica*, *Hyborhynchus siderius*, *Zophendum siderium* (AGFD 1997).

Specific: This is the only species of *Agosia* in Arizona.

Life History

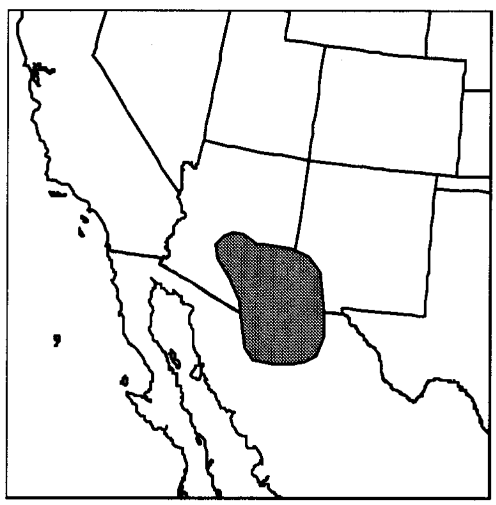
Description: The longfin dace is a small, silvery fish that is usually found in schools in water with a sandy substrate. The body of the longfin dace is fusiform, with small scales. Adults rarely exceed 2.6 inches (6.5 cm), standard length. There are approximately 70 to 90 scales in the lateral line. The head is thick and blunt, and the mouth is small, subterminal, oblique; overhung by a bluntly rounded snout; the mouth terminates posteriorly at a point under the nares. The back and upper sides are silvery gray to olive, sides sometimes with golden flecks; the lower sides and abdomen are whitish, and the peritoneum black. A diffuse, dusky lateral stripe originates at the upper corner of the opercle, terminating in a black spot at the base of the caudal fin (Sublette et al. 1990, cited in AGFD 1997).

Diet: Longfin dace are omnivorous and opportunistic, with food selection apparently determined by availability. In Sycamore Creek, Maricopa County, Arizona they were noted to be primarily herbivorous, whereas in Aravaipa Creek the preferred diet was baetid mayflies except when algae was abundant, which then made up 53% of the diet. When resources are abundant they prefer to feed exclusively in daylight (Fisher et al. 1981).

Reproduction: The reproductive season for the longfin dace is variable from year to year yet fairly prolonged. Nests and reproductive behaviors have been observed from February through August in various streams. The timing of spawning may be in response to summer rains. Nests occur in shallow, 2 to 4 inches (5 to 20 cm) of water with a slight current, over sandy bottoms. Nests range from 5.9 to 9.8 inches (15 to 25 cm) in diameter, and are 1.6 to 2.4 inches (4 to 6 cm) deep. As many as 25 nests may be within a square meter. Nests in marginal areas (along current or over muddy substrates) are usually smaller in size (less than 5.9 inches [15 cm] in diameter). Hatching occurs in less than 4 days, and newly hatched fry remain in the nest depressions for a short time, then disperse to the stream margins (Minckley and Barber 1971).

Behavior: Longfin dace generally feed during the day; however, when food is scarce they will feed continuously (Fisher et al. 1981). In response to the onset of a flooding event the fish will move directly into the current, then move laterally as the intensity of turbulence increases. The dace remain in the margins of the current, and move back into the channel as discharge declines; they are rarely caught in flood pools or backwaters (Minckley and Barber 1971; Rinne 1975). In response to drought longfin dace generally do not bury themselves into the substrate, but rather retreat in side pools or under algal mats or tiny logs and stones during the day, and can move around and feed in as little as a few millimeters of water at night (Minckley and Barber 1971).

Distribution



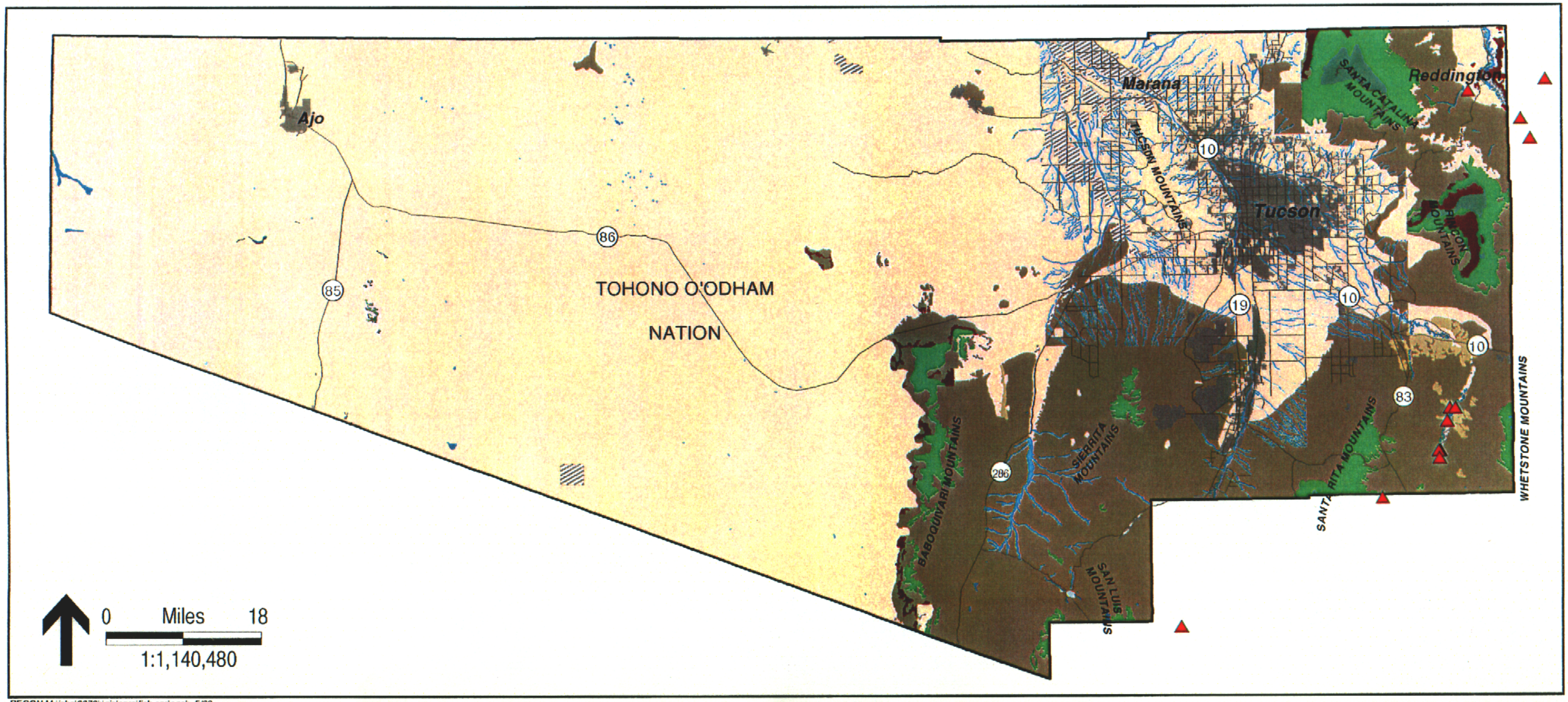
Historic: The longfin dace was historically found throughout Arizona, New Mexico and Mexico (BISON-M 2000).

Present: The longfin dace currently found in a broad area that consists of disjunct populations. It is known to be present in the Bill Williams and Gila River drainages in Arizona; south into Sonora, Mexico (coastal streams and Rio Yaqui basin), the Rio Sinaloa, Mexico, and perhaps farther south. It is native to the Gila River basin (including the San Francisco River), the Bill Williams, Yaqui, Magdalena, and Sonoyta drainages and has been introduced into the Virgin River basin, Arizona, Zuni and Mimbres rivers and Rio Grande basin, New Mexico (AGFD 1997; BISON-M 2000). Distribution has increased in the mountainous areas, probably due to climactic trends (AGFD 1997).

The Arizona Game and Fish Department HDMS has 6 records for the longfin dace in Pima County (Figure 27). Of these, 5 were in various portions of Cienega Creek in Springwater Canyon and 1 was from Buehman Canyon south-southeast of Cocklebur Tank (AGFD 2000).

Demographics

Density: There is no readily available information on density.



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Longfin Dace
Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)

▲ Longfin Dace *(Agosia chrysogaster)*

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 27

Status: There is no readily available information on status.

Trend: Overall, this species is declining throughout its range. The population located in the Gila River basin, however, remains stable (BISON-M 2000).

Survival rates: There is no readily available information on survival rates.

Reproduction rates: There is no readily available information on reproduction rates.

Age ratios: There is no readily available information on age ratios.

Sex ratios: There is no readily available information on sex ratios.

Significant Pima Co. populations: The largest population in Pima County appears to be in Cienega Creek. This species is abundant in Cienega Creek County Park (K. J. Kingsley, pers. obs.).

Habitat Requirements

General: The habitat of the longfin dace ranges from clear, cool mountain brooks at higher elevations to small, intermittent low-desert streams with a sand or gravel substrate (BISON-M 2000). Plant communities are varied (AGFD 1997).

Home range requirements: Longfin dace tend to occupy relatively small streams (AGFD 1997). Shifting of streams or deposition of sand into channels as a result of flooding is beneficial to longfin dace; just as strong annual flows lead to population declines (Minckley and Barber 1971).

Ability to use major land use categories: The longfin dace requires small, sandy-bottomed streams. Areas where the species has been recorded tend to be remote or protected areas, implying that water sources near human habitation may no longer be suitable habitat (AGFD 1997).

Habitat trends in planning area: The species is alleged to be declining in number, possibly as a result of the loss of suitable habitat (AGFD), although currently occupied locations appear to be in stable or improving condition (K. J. Kingsley, pers. obs.).

Current and Potential Threats

General: Loss of extensive areas of formerly occupied or suitable habitat has occurred historically.

Specific: Loss of small, sandy stream habitat will negatively impact this species. Flood control programs and groundwater depletions may contribute to the drying-out of suitable stream habitat.

Location, amount, and quality of protected habitat: Most currently known habitat in Pima County is believed to be protected within parks, preserves, or special management areas. Habitat for this species may expand beyond existing locations during high water periods.

Existing and potential pest species: Longfin dace are known to be vulnerable to 5 species of native parasites. The most dangerous parasite appears to be *Ichthyophthirius multifiliis*, of which epizootic outbreaks appear to be common in streams throughout Arizona. Other parasites found on longfin dace include: *Myxobolus macrocapsularis*, *Rhabdochona decaturensis*, *Rhabdochona* sp., and *Lernaea cyprinacea* (Mpoame and Rinne 1983).

Threat mechanism: Loss of stream habitat through water management practices or high water consumption; also, natural flood events can decimate local populations.

Management Needs

General: Protection of existing occupied habitat should continue, and transplantation to recovered potentially suitable habitat may be appropriate. Invasion of non-native fishes should be prevented, and existing populations of non-natives (if any) in this species habitat should be eliminated.

Current protective measures: All known habitat for this species in Pima County is under some form of protection.

Sensitivity to human activities and densities: Activities that affect water quantity or quality will impact this species. Flood control projects, dams, and drawdown of the water table may dry up small streams and channels that support populations of longfin dace.

Corridor needs: The species is not known to require corridors, as such, but does require intact stretches of streams. Long-term metapopulation dynamics probably requires at least occasional connection between isolated local populations.

Key relationships: None are specifically known.

Migratory requirements: The species has no known patterns of migration; flood events, however, will disperse or displace the species to downstream to other locations. It appears to be, or to have been, a classic metapopulation, and connection of local populations at some unknown frequency is probably necessary for long-term health of the species.

Results of past mitigation activities: Activities that protected or restored natural riverine systems with small, shallow creeks and channels will probably have benefited this species; however, no long-term studies that support this notion are known.

Existing monitoring and research programs: There are no known existing research and monitoring programs specifically studying this species.

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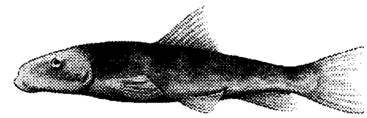
Desert sucker (*Catostomus clarki*)

Status



Federal	Former candidate for Category 2 listing (1994), now Species of Special Concern (1996)
State	None
Rankings	S3S4 G3G4

Recovery Goals

Federal: There are no agency-mandated recovery goals for this species.

State: There are no agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The type specimen (*Catostomus clarki*) was described from the Santa Cruz River, Gila basin (Baird and Girard 1854).

Classification: Order: Cypriniformes; Family: Catostomidae; Genus: *Catostomus*; Species: *clarki*.

Synonymy: The species has been known by the names: *Minomus clarkii*, *Pantosteus arizonae*, *Pantosteus (Notolepidomyzon) arizonae*, *Pantosteus clarki*, *Catostomus (Pantosteus) clarki*, and *Catostomus insignis* x *Pantosteus clarki*.

Life History

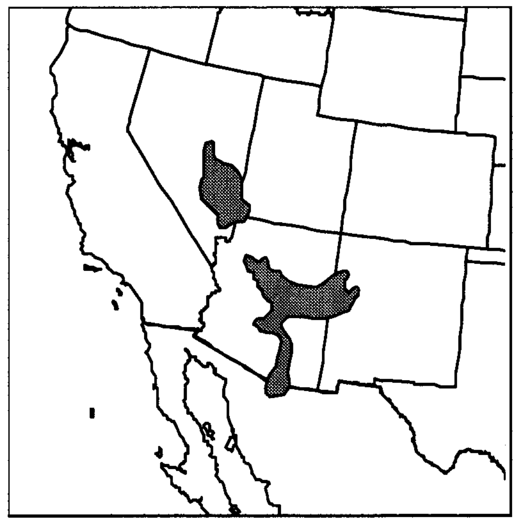
Description: This is a medium sized catostomid fish, attaining adult size of 4 to 11 inches (10 to 28 cm) in standard length. It has large lips with small papillae evenly dispersed over the lower lip; and jaws with cartilaginous scraping edges. The scales in the lateral line have been recorded ranging from 61 to 104. There are 8 to 12 dorsal rays (usually 10 or 11) and 8 to 12 pelvic rays that are 9 or 10 inches (22.8 to 25.4 cm) long. There is usually a small flap of skin present at the base of each pelvic fin. Coloration ranges from silvery tan to dark greenish above, and is silvery to yellowish below (AFGD 1997).

Diet: Chironomid fly larvae are the primary food of juveniles. As an adult, this species is primarily herbivorous, scraping *aufwuchs* from stones as well as ingesting plant detritus. Large amounts of sand and silt occasionally found in the gut suggest that it also feeds in the interstitial sediment of rubble-boulder substrates. Filamentous green algae is thought to be a primary food source; animal components of the *aufwuch* that are also ingested include Chironomidae, Ephemeroptera, Simuliidae, and Pyralididae, all of which are typical inhabitants of riffles (Fisher et al. 1981; Bestgen et al. 1987; BISON-M 2000). When resources are abundant they prefer to feed at crepuscular peaks (Fisher et al. 1981).

Reproduction: Desert suckers spawn in the spring to early summer on riffles (AFGD 1997; LCR MSCP 1999).

Behavior: After hatching, juveniles gather in quiet pools along the bank. Individuals move to swifter water as they mature beyond juveniles (BISON-M 1999).

Distribution



Historic: The historic range of the desert sucker includes Arizona, New Mexico, Nevada, Utah, and Mexico.

Present: The desert sucker occurs in suitable habitats of the lower Colorado River downstream from the Grand Canyon, generally including tributary streams of the Gila River drainage upstream of Gila, Arizona, along with the Virgin River basin of Utah, Arizona, and Nevada including the pluvial White River and Meadow Valley Wash. In Arizona, the Desert sucker has been recorded in the Apache-Sitgreaves National Forest (BISON-M 2000) and Aravaipa Creek (LCR MSCP 1999). Its range has decreased rapidly in southern Arizona (AGFD 1997).

The Arizona Game and Fish Department HDMS have no records for the desert sucker in Pima County. Of the 3 HDMS records from near to the county line (all from the San Pedro River), 2 are from Cochise County and 1 is from Graham County (Figure 28).

Demographics

Density: There is no readily available information on density.

Status: There is no readily available information on status.

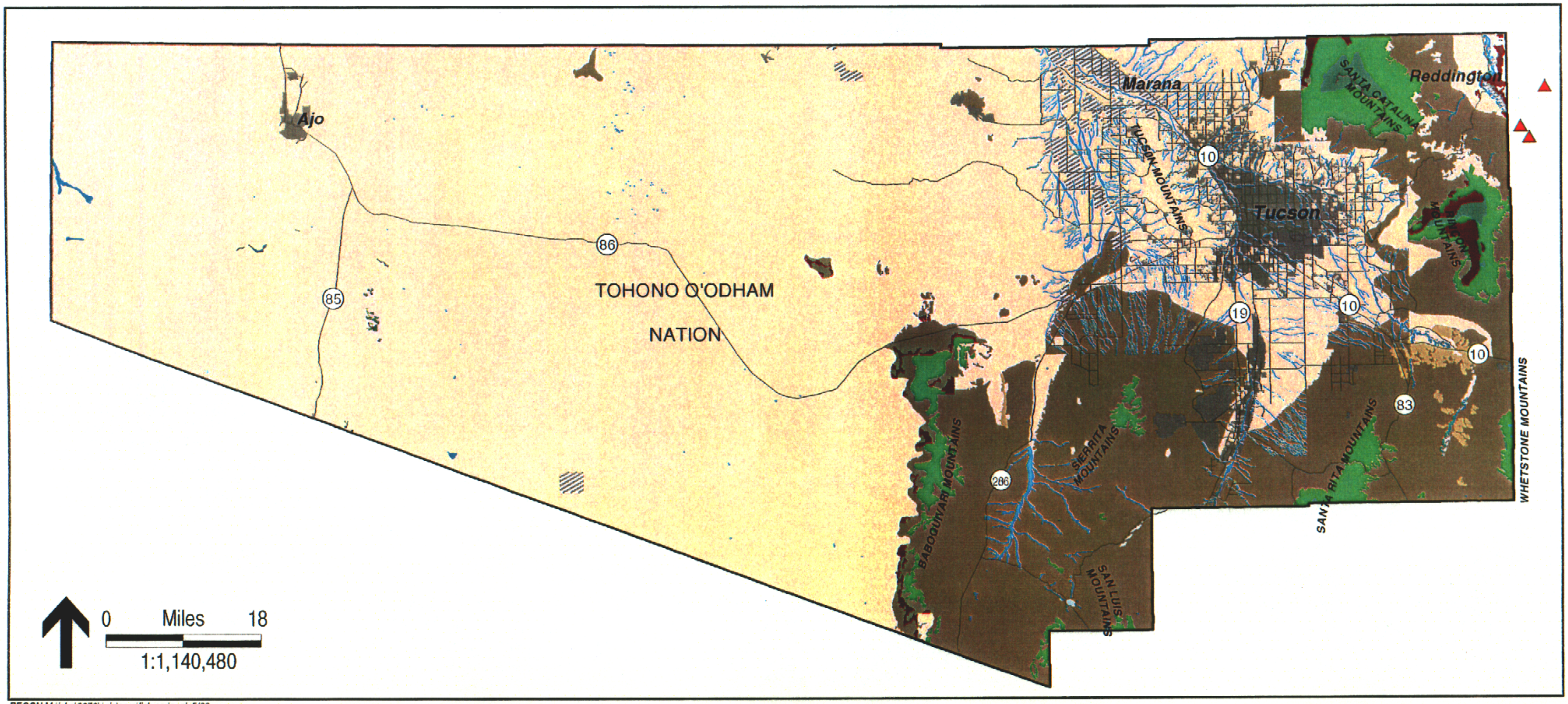
Trend: Populations of desert sucker are declining, although its distribution is still widespread. The decline is due mainly to the impacts of water development projects on the amount and quality of habitat (LCR MSCP 1999).

Survival rates: There is no readily available information on survival rates.

Reproduction rates: There is no readily available information on rates of reproduction.

Age ratios: There is no readily available information on age ratios.

Sex ratios: There is no readily available information on sex ratios.



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Desert Sucker
Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)
- ▲ Desert Sucker *(Pantosteos clarkii)*

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 28

Habitat Requirements

General: The desert sucker is found in rapids and flowing pools of streams, primarily over bottoms of gravel-rubble with sandy silt in the interstices. It can tolerate a wide range of water temperatures, from 50 to 70 degrees Fahrenheit (10 to 21 degrees C). Water depth is generally less than 1 foot (0.3 m) (BISON-M 2000). In some southeastern Arizona streams, desert suckers are reported to be restricted to specific pool type habitats (i.e., about 80% cover, cobble and gravel substrate, and no silt or mud substrates) (LCR MSCP 1999).

Habitat usage information for the desert sucker is life-stage specific. Larval desert suckers utilize backwaters, embayments, and some pools. As juveniles, desert suckers move into faster flowing habitats like riffles and rapids. As desert suckers mature into adults they move from juvenile habitats (riffles, etc.) into deeper pools and pool-like areas.

Home range requirements: The desert sucker requires rapids and flowing pools of streams, with gravel-rubble bottoms that have sandy silt in the interstices.

Ability to use major land use categories: The lack of records from Pima County suggests that there may be little or no suitable habitat for the desert sucker under current conditions. If long-term improvement to habitat in the San Pedro River is made, then it is possible that this species may become established there.

Current and Potential Threats

General: Loss, fragmentation or modification of habitat from water development projects, stream diversions, and aquifer pumping is a major threat to the species. There has been much habitat degradation occurring in tributaries outside of the 100-year floodplain of the mainstem Colorado River (LCR MSCP 1999). Invasion of non-native fishes either from stock or domestic livestock watering tanks upstream or the Gila River downstream is an equal or greater threat. The Red Shiner is present in the Gila River and has been suggested as a potential competitor for native species. This species has recently (1990) been reported in the lower reaches of Aravaipa Creek (BISON-M 2000). At early life stages, the desert sucker may be preyed upon by nonnative fish in some areas. Hybridization with other sucker species is also a threat to desert suckers at some locations (LCR MSCP 1999).

Location, amount, and quality of protected habitat: There is no known habitat for this species in Pima County

Existing and potential pest species: Desert suckers are known to be vulnerable to 6 species of native parasites. The most dangerous parasite appears to be *Ichthyophthirius multifiliis*, of which epizootic outbreaks appear to be common in streams throughout Arizona. Other parasites found on desert suckers include *Myxobulus oblongus*, *Ornithodiplostomum ptychocheilus*, *Clinostomum marginatum*, *Isoglaridacris bulbocirrus*, and *Rhabdochona decaturensis* (Mpoame and Rinne 1983).

Threat mechanism: Loss of stream habitat through water management practices and/or depletion of groundwater. Also, natural flood events can decimate local populations.

Management Needs

General: Aravaipa Creek canyon area must have its upstream aquifer protected. Over-appropriation or use of the headward Sulphur Springs Valley aquifer must be guarded against. Maintenance of flow in this stream is highly critical because of the habitation of shallow riffle areas by 5 of the 7 remaining native Cypriniform fishes (including desert suckers). In the event of reduction in flow, intermittent surface flow could result (BISON-M 2000).

A winter snagging season for anglers currently (1994) exists for this sucker below Stewart Mountain Dam on the lower Salt River. This management action was taken as a measure to encourage harvest of the species, as many die during the extremely low winter water flows (AFGD 1997).

Current protective measures: There are no current protective measures for this species.

Sensitivity to human activities and densities: Activities that affect water quantity or quality may impact this species. Flood control projects, dams, and drawdown of the water table may dry up small streams and channels that support populations of desert suckers.

Corridor needs: Corridor needs of the desert sucker are not known.

Key relationships: None are specifically known.

Migratory requirements: Desert suckers are known to be relatively sedentary and migrational or seasonal movements do not occur (Bestgen et al. 1987); however, desert suckers have been reported to exhibit seasonal movement in Aravaipa Creek, Arizona, a small, low-elevation stream (LCR MSCP 1999).

Results of past mitigation activities: Activities that protected or restored natural riverine systems with small, shallow creeks and channels are presumed to have benefited this species, but that has not been demonstrated with known data.

Existing monitoring and research programs: There are no known research and monitoring programs at this time.

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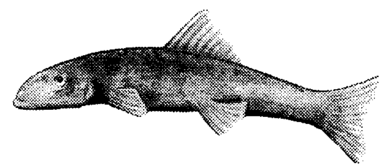
Mpoame, M., and J. N. Rinne. 1983. Parasites of some fishes native to Arizona and New Mexico. Southwestern Naturalist 28(4):399-405.

Sonora sucker (*Catostomus insignis*)

Status



Federal	Former candidate for Category 2 listing (1994), now Species of Special Concern (1996)
State	None
Other	Endangered in Mexico
Rankings	S3 G4

Recovery Goals

Federal: There are no agency-mandated recovery goals for this species.

State: There are no agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The type specimen (*Catostomus insignis*) was described from the San Pedro River, probably near mouth of Babacomari River, Cochise County, Arizona (BISON-M 2000).

Classification: Order: Cypriniformes; Family: Catostomidae; Genus: *Catostomus*; Species: *insignis*.

Synonymy: The species has been known by the names *Minomus insignis, Catostomus insigne, Catostomus gila,* and *Catostomus insignis* x *Pantosteus clarki.*

Life History

Description: This is a large catostomid fish, attaining adult size of 8 to 31 inches (20 to 79 cm) in standard length. Its lower lip is about 3 times as thick as its upper lip. There are 10 to 11 rays in the dorsal fin. The body is sharply bicolored, olive brown above and deep yellow below. The scales on the upper half of the body have dark spots forming faint dashed lines. Weights of Sonora suckers range from 4 ounces to 4 pounds (AGFD 1997).

Diet: The Sonora sucker is an omnivore, feeding in early morning and late evening on the *aufwuchs* assemblage of shallow pools. A significant component of the diet is macroinvertebrates, particularly *Ephemeroptera*, with some coarse sand occasionally ingested (BISON-M 2000).

Reproduction: Sonora suckers spawn from February to early July (AFGD 1997). Eggs are deposited in riffles and fall into the interstices between gravels and incubate (BISON-M 2000).

Distribution

Historic: The historic range of the Sonora sucker includes Arizona, New Mexico, and Mexico (BISON-M 2000).

Present: The Sonora sucker is native to the Gila and San Francisco drainages (except in extreme headwaters). It was introduced unsuccessfully into the Rio Hondo drainage, apparently during the 1960s. The status of the species is stable in the San Francisco and Gila River. In Arizona, the Sonora sucker has been recorded in the Apache-Sitgreaves and Coconino National Forests in Arizona, and is widespread in the Gila and Bill Williams river basins of Arizona (BISON-M 2000).

The Arizona Game and Fish Department has no records for the Sonora sucker in Pima County. There is one record from Graham County: in Redfield Canyon in the Galiuro Mountains, on private land, northeast of the eastern boundary of Pima County (Figure 29).

Demographics

Density: There is no readily available information on density.

Status: There is no readily available information on status.

Trend: Populations of Sonora sucker are declining, although its distribution is widespread, especially in the Gila and Bill Williams river basins of Arizona. Populations are stable in the San Francisco and Gila River drainages (BISON-M 2000).

Survival rates: There is no readily available information on survival rates.

Reproduction rates: There is no readily available information on rates of reproduction.

Age ratios: There is no readily available information on age ratios.

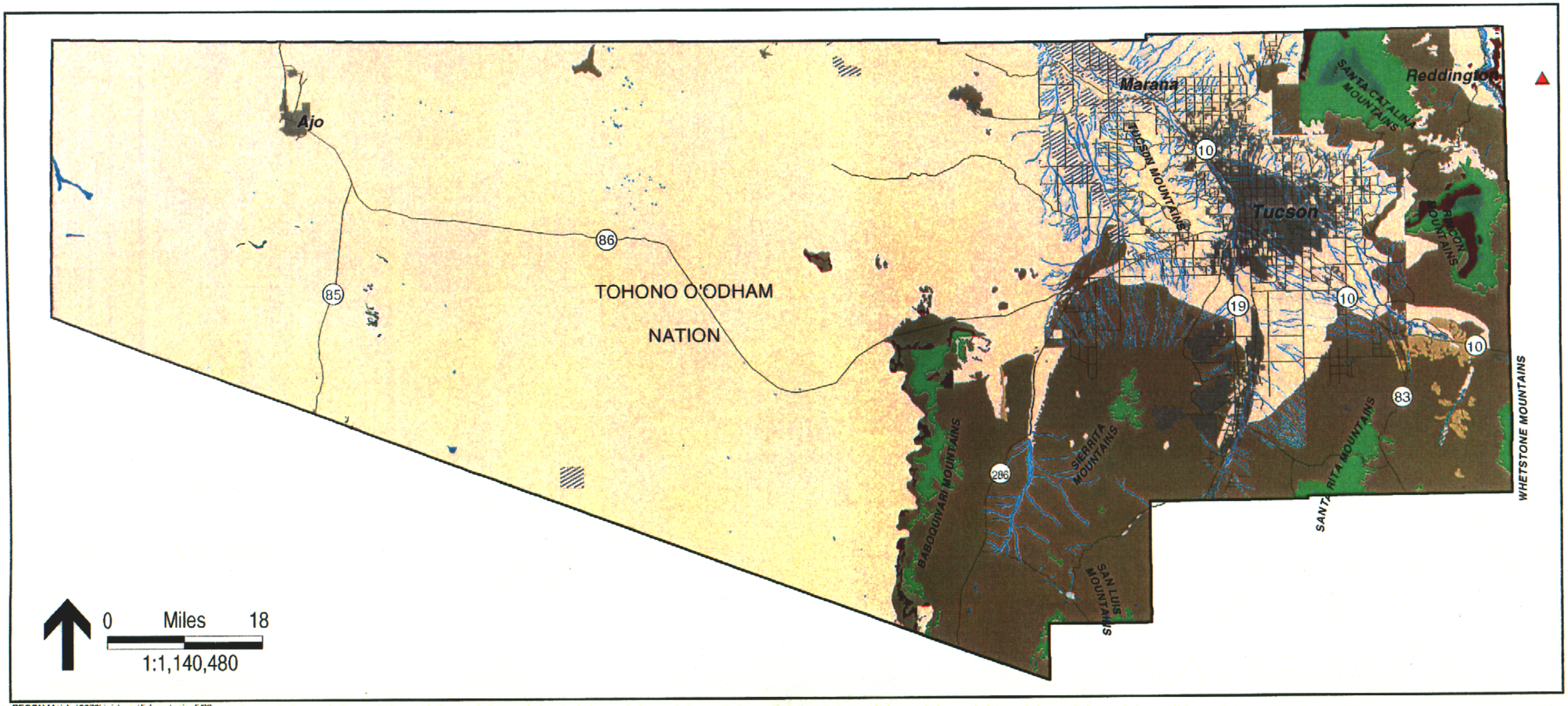
Sex ratios: There is no readily available information on sex ratios.

Habitat Requirements

General: The Sonora sucker requires lentic and pool habitats, with gravel-rubble bottoms. It is found in a variety of habitats from warm water rivers to trout streams (BISON-M 2000).

Home range requirements: Permanent water appears to be important for the survival of this species.

Ability to use major land use categories: The lack of records from Pima County suggests that there may be little or no suitable habitat for the Sonora sucker.



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Sonora Sucker
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)
▲ Sonora Sucker
(Pantosteos insignus)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 29

Current and Potential Threats

General: Loss, fragmentation or modification of habitat from water development projects, stream diversions, and aquifer pumping is a threat to the species. Invasion of non-native fishes either from stock or domestic livestock watering tanks upstream or the Gila River downstream is an equal or greater threat. The red shiner is present in the Gila River and has been suggested as a potential competitor for native species. It has recently (1990) been reported in the lower reaches of Aravaipa Creek (BISON-M 2000).

Location, amount, and quality of protected habitat: The species is not known to be present in Pima County.

Existing and potential pest species: Sonora suckers are known to be vulnerable to 10 species of parasites. The most dangerous parasite appears to be *Ichthyophthirius multifiliis,* of which epizootic outbreaks appear to be common in streams throughout Arizona. Other parasites found on desert suckers include *Myxobulus catostomi, M. discrepans, M. nodularis, Ornithodiplostomum ptychocheilus, Clinostomum marginatum, Ligula intestinalis, Isoglaridacris bulbocirrus, Neoechinorhynchus* sp., *and Rhabdochona decaturensis* (Mpoame and Rinne 1983).

Threat mechanism: Loss of stream habitat through water management practices or high water consumption; also, natural flood events can decimate local populations.

Management Needs

General: Aravaipa Creek canyon area must have its upstream aquifer protected. Over-appropriation or use of the headward Sulphur Springs Valley aquifer must be guarded against. Maintenance of flow in this stream is highly critical because of the habitation of shallow riffle areas by 5 of the 7 remaining native Cypriniform fishes (including Sonora suckers). In the event of reduction in flow, intermittent surface flow could result (BISON-M 2000).

Current protective measures: There are no current protective measures for this species.

Sensitivity to human activities and densities: Activities that affect water quantity or quality may impact this species. Flood control projects, dams, and drawdown of the water table may dry up small streams and channels that support populations of Sonora suckers.

Corridor needs: Corridor needs of the Sonora sucker are not known.

Key relationships: The Sonora sucker requires rivers or streams that have deep and quiet, rocky or gravelly pools. They are intolerant of lake conditions created by dams.

Migratory requirements: This species tends to be relatively sedentary (Bestgen et al. 1987).

Results of past mitigation activities: Activities that protected or restored natural riverine systems with small, shallow creeks and channels will have benefited this species.

Existing monitoring and research programs: There are no known research and monitoring programs at this time.

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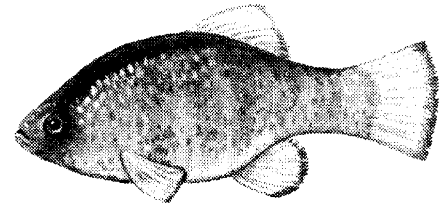
BISON-M (Biota Information System of New Mexico). 2000. Sonora sucker (*Catostomus insignis*). Version 1/2000 species account developed by New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Mpoame, M., and J. N. Rinne. 1983. Parasites of some fishes native to Arizona and New Mexico. Southwestern Naturalist 28(4):399-405.

Desert pupfish (*Cyprinodon macularius macularius*)

Status



Federal	Endangered (USFWS 1986)
State	Wildlife of Special Concern in Arizona (AGFD 1996)
Other	Forest Service Sensitive (AGFD 1998); Vulnerable Status 1 by SDCP
Rankings	G1 T1 S1

Recovery Goals

Federal: A recovery plan has been developed for this species (USFWS 1993). It identifies downlisting criteria for this species, which, if met, would result in this species being listed as threatened. Delisting of this subspecies is not considered feasible. The recovery plan incorporates a 3-tiered approach to reintroductions and recovery. Arizona is to establish fixed numbers of populations in each of 3 tiers. Tier 1 contains naturally occurring populations that must be protected and replicated. Arizona has no natural populations remaining. Tier 2 populations are to be reestablished in habitats that receive a high degree of protections and will require only minor management activity, as defined in the recovery plan. Arizona is to establish 10 Tier 2 populations in the lower and middle Gila River and its tributaries. Tier 3 populations may be established in natural or semi-natural habitats that may experience major management actions. Arizona is to establish a minimum of 45 Tier 3 populations. At least 45 populations must remain established in Arizona throughout a 10-year period, although it is not necessary for an individual Tier 3 population to persist the entire 10 years (USFWS 1993).

State: There are no known state agency-mandated recovery goals for this species. The AGFD is an active cooperator in the federal recovery plan (Weedman and Young 1997).

Pima County Habitat Conservation Plan Goals

Pima County currently has no known habitat for this species in conservation areas and lands owned or controlled by the County. However, potential habitat may exist in County lands, and the County will evaluate these and cooperate with the Recovery Team for this species in transplanting this species to County lands, if the Recovery Team and the County agree that such is appropriate.

If populations are transplanted to Pima County lands, the County and the Recovery Team will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: There are 12 species of *Cyprinodon* in North America, 1 species in Arizona. There are 2 subspecies are *C. m. macularius*, which was once widespread, and *C. m. eremus* which is known only from Quitobaquito Spring in Organ Pipe Cactus National Monument (AGFD 1995).

Classification: Order: Cyprinodontiformes; Family: Cyprinodontidae (Greek means "carp"); Genus: *Cyprinodon;* Species: *macularius* (Latin means "spotted").

Life History

Description: The desert pupfish is a small fish, approximately 2 inches (5 cm) long, with a thick, smoothly rounded body shape and narrow, vertical dark bars on the sides. Breeding males are blue on the tops and sides, and have yellow to orange (sometimes red-orange) tail fins. Females and juveniles have tan to olive colored backs and silvery sides. Both sexes often have an eye-like spot on the dorsal fin, and, rarely, a second spot at the base of the tail fin (Minckley 1973).

Diet: Desert pupfish are essentially omnivorous, and known to consume small invertebrates, mosquito larvae, detritus, algae, and small bits of aquatic vegetation (AGFD 1995). In softer substrates, they dig small pits in search of food and then aggressively defend the pits (Minckley 1973). Desert pupfish are very effective at consuming mosquito larvae, and would probably be extremely effective in mosquito control operations if they were available (Legner and Warkentin 1989).

Reproduction: Males are aggressively territorial. Females choose mates, and the eggs are laid apparently randomly within the territory. The male's territorial behavior protects the eggs against predators. Hatching occurs within a few days. Growth of young is rapid, sexual maturity may be reached in 6 weeks under favorable conditions (Minckley 1973). Pupfish seldom live longer than a year (Minckley 1973).

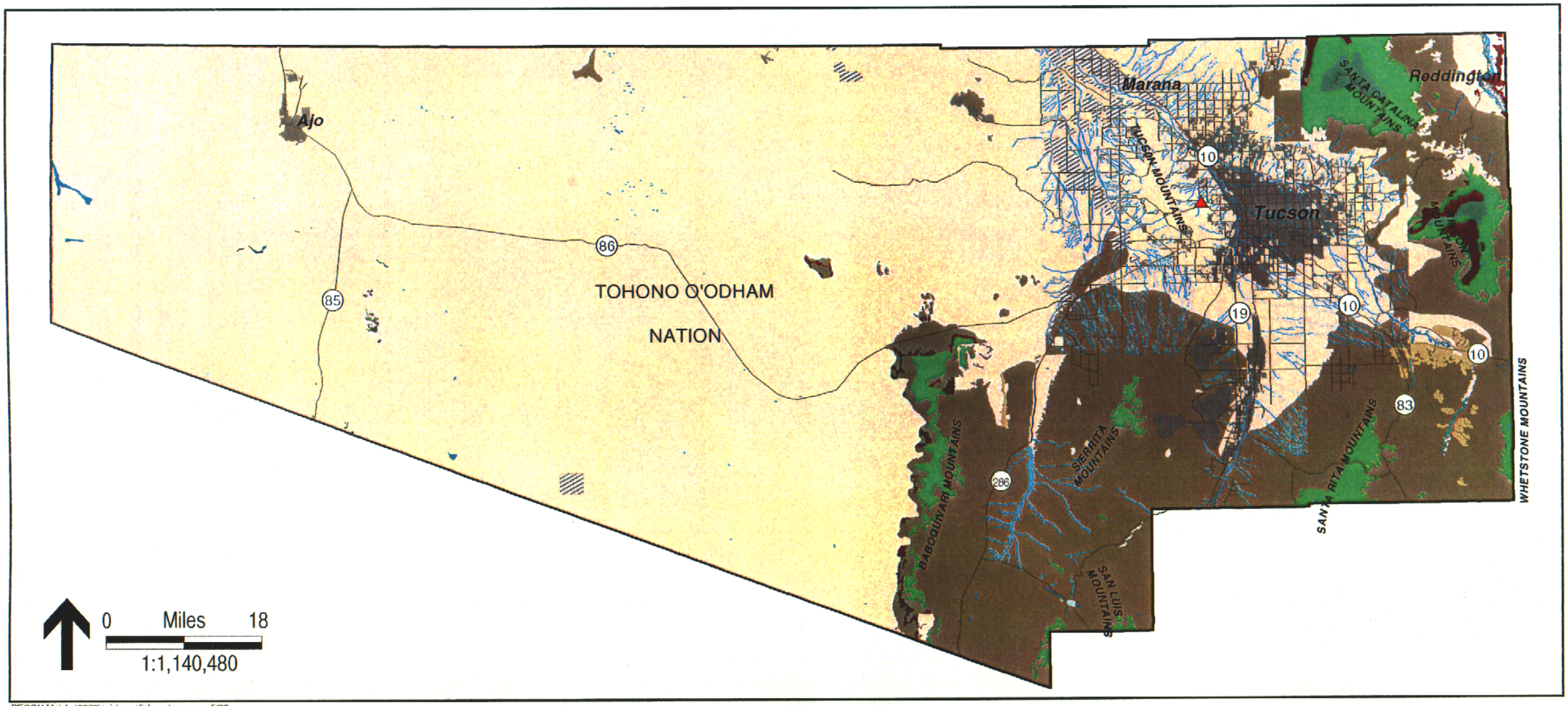
Behavior: Beyond reproductive and territorial behavior, little information is readily available.

Distribution

Historic: The historic range of this species range includes the lower Gila River basin in Arizona and Sonora, Mexico, including the Gila, Santa Cruz, San Pedro, and Salt rivers as well as the lower Colorado River in Arizona, California, and adjacent Mexican states from the vicinity of Needles downstream to the Gulf of California (Minckley 1973; USFWS 1993; AGFD 1995; Weedman and Young 1997). Historically, the desert pupfish went through cycles of expansion and contraction of populations as a result of natural climatological variation (Weedman and Young 1997). Desert pupfish were found in a variety of different habitats including cienegas, springs, headwater streams, and margins of large rivers.

Present: Presently, the only remaining natural populations are found in a few sites in the Salton Sea drainage in California, and the Colorado Delta in Baja California and Sonora, Mexico (Minckley 1973; USFWS 1993; Weedman and Young 1997). Reintroductions of *C. m. macularius* have been made at 15 sites in Arizona, with stock primarily from Santa Clara Slough, Sonora, Mexico. Only 1 remained extant in 1997 (Weedman and Young 1997).

The only known existing desert pupfish in Pima County are at the International Wildlife Museum in the Tucson Mountains (AGFD 2000) (Figure 30).



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Desert Pupfish
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

▲ Desert Pupfish
(Cyprindodon macularius macularius)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 30

Demographics

Density: No known information is currently available regarding density of natural populations. Density undoubtedly varied from place to place and season to season within the species' natural range.

Status: Desert pupfish distribution began to decline concurrent with modern settlement of the Southwest, until the species became extinct in Arizona. No known natural populations are present in Arizona, and reintroductions have not met with success (Weedman and Young 1997).

Trend: The species is extinct in Arizona and the Recovery Plan for reintroductions has not met with success and appears to be unlikely to succeed, although the agencies are still trying. Genetic integrity of stock is questionable because of hybridization of stocks (Weedman and Young 1997). The future does not look good for this species.

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations. Most adult fish are presumed to reproduce, and annual turnover of the population is expected (Minckley 1973).

Age ratios: No known information is currently available regarding age ratios in natural populations.

Significant Pima Co. populations: This species does not occur in Pima County, except in captivity. However, it is possible that it may be introduced, or reintroduced to some locations as part of the Recovery Plan.

Habitat Requirements

Ability to use major land use categories: This fish requires water, but has a very broad range of tolerance for water quality and temperature. They have the ability to withstand extreme water temperatures up to 113 degrees Fahrenheit (45 degrees Celsius), low dissolved oxygen concentrations, and salinity twice that of seawater (AGFD 1995).

Habitat trends in planning area: New water bodies (stock ponds, ornamental ponds) have been created in the area, and efforts are being made to protect and enhance streams and cienegas. These may create potentially suitable reintroduction sites for the species.

Home range requirements: Water, within broad condition parameters, free of non-native fish and with abundant invertebrate prey species is necessary for survival of this fish.

Current and Potential Threats

General: Loss of habitat and introduction of non-native predators and competitors have resulted in loss of this fish from most of its range.

Pima County populations location, amount, and quality of protected habitat: Strictly speaking, no actual habitat remains in Pima County, because the species is not present. Potentially suitable habitat for reintroduction is included in Cienega Creek Park, the Empire-Cienega Resource Conservation Area, Bingham Cienega, Arivaca Cienega and Creek, and possibly other locations.

The extent of potentially suitable habitat in these locations is not specifically known, and the only effective way to determine it is to introduce the fish and determine what habitat they use.

Existing and potential pest species: Largemouth bass, mosquitofish, Tilapia, and red shiners outcompete desert pupfish for available resources, disrupt reproduction, or actively feed on pupfish. The bullfrog is a predator of the desert pupfish (USFWS 1993).

Threat mechanism: Loss or contamination of habitat and competition and predation by non-native species.

Management Needs

General: Continued evaluation of potential reintroduction sites and support for reintroduction efforts, including removal of non-native species would be necessary to reestablish this species in Pima County.

Current protective measures: Maintenance of a small number of refugia populations and evaluation of potential reintroduction sites is occurring (Weedman and Young 1997).

Sensitivity to human activities and densities: Land use practices such as livestock grazing, mining, timber cutting, road maintenance, and recreation may affect this species through increased erosion, intensified flood events and decreased groundwater tables resulting in loss of stream flow. Effluent from wastewater treatment facilities and runoff may degrade water quality. These threats may impact both existing populations and habitats proposed for re-establishment. Release of pet exotic fish into waters occupied by this species might result in loss of pupfish. All of these factors are likely to be related to human population size and densities.

Corridor needs: Historically, most nodes of desert pupfish were probably connected, at least occasionally, during periods of natural climatic variation. This type of connection is probably necessary in evolutionary time for the genetic health of the species.

Key relationships: No beneficial key relationships are known. Key adverse relationships exist with exotic predators and competitors, as discussed above.

Migratory requirements: None are known.

Results of past mitigation activities: Past mitigation activities, in the form of attempts at reestablishing populations, have not been very successful (Weedman and Young 1997).

Existing monitoring and research programs: No information is currently known regarding existing monitoring and research programs for this species, other than repeated attempts at reintroducing the species and trying to determine why they are not successful (Weedman and Young 1997).

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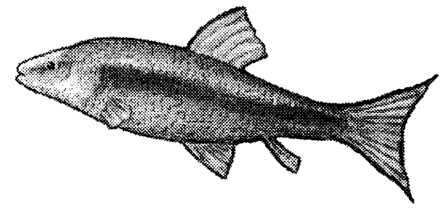
Gila chub (*Gila intermedia*)

Status



Federal	Listed as a Candidate by USFWS (AGFD 1998); petitioned for listing as endangered
State	Wildlife of Special Concern in Arizona (AGFD 1996)
Other	State Endangered in New Mexico (AGFD 1997); USDA Forest Service Sensitive, Region 3; Listed Endangered in Mexico (AGFD 1998)
Rankings	G2 S2

Recovery Goals

Federal: There are no known agency-mandated recovery goals for this species.

State: There are no known agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Gila chub is a member the minnow family (Cyprinidae). The genus *Gila* is widespread throughout North America (Hubbs 1940, 1941 and Miller 1946, cited in Weedman et al. 1996) with numerous species in the North American Southwest classified as threatened, endangered, or rare (R. Johnson, pers. comm. to K. Kingsley, 3 May 2000).

Classification: Order: Cypriniformes; Family Cyprinidae (Minnows), Genus *Gila*, Species *intermedia*. *G. intermedia* is most closely related to *Gila robusta* (Rinne 1969, cited in AGFD 1997). Eight species are known from Arizona (Minckley 1973) and *Gila intermedia* is 1 of 5 that are endemic to the Colorado River Basin (Weedman et al. 1996).

Specific: The Gila chub was first described as *Gila gibbosa* based on collections acquired by John H. Clark during the U.S. and Mexican Boundary Survey. The type locality and type specimen are unknown (AGFD 1997). The specific epithet *gibbosa* became invalid following a later synonymization because it was an erroneous homonym (Rinne 1969, 1976, cited in Weedman et al. 1996). Thus, the officially recognized original description is *Tigoma intermedia* (Girard 1856, cited in Weedman et al. 1996). The nomenclature was changed numerous times since the original description, and at one time the Gila chub was considered a subspecies of *Gila robusta*. Synonyms used for this taxon and their authors include the following:

- *Gila gibbosa* (Baird and Girard 1854)

- *Tigoma intermedia* (Girard 1856)
- *Tigoma gibbosa* (Girard 1856, 1859; Jordon et al. 1930)
- *Gila nigra* (Cope and Yarrow 1875;)
- *Squalius intermedius* (Jordon and Gilbert 1883)
- *Squalius niger* (Jordon and Gilbert 1883)
- *Squalius lemoni* (Smith 1884)
- *Leuciscus intermedius* (Evermann and Rutter 1895; Gilbert and Scofield 1898; Meek 1904)
- *Richardsonius gibbosus* (Snyder 1915)
- *Gila robusta intermedia* (Miller 1945, 1946, 1961; LaRivers 1962; Beckman 1963; Sigler and Miller 1963; Uyeno and Miller 1965; Barer and Minckley 1966; Miller and Lowe 1967; Cole 1968; Minckley and Alger 1968; Minckley 1969)
- *Gila intermedia* (Koehn 1965; Minckley and Deacon 1968; Rinne and Minckley 1970; Stout et al. 1970; Minckley 1971, 1973; Rinne 1976; Minckley et al. 1986).
- *Gila intermedia* is the most recently recognized description accepted by the American Fisheries Society (Robins et al. 1991, cited in Weedman et al. 1996).

Life History

<u>Description</u>: The Gila chub is a small-finned, deep-bodied, chunky and dark colored minnow (Weedman et al. 1996). Females are typically larger than males and attain lengths up to approximately 9.8 inches (25 cm); males are rarely greater than 5.9 inches (15 cm) in length (Rinne and Minckley 1991, cited in AGFD 1997). The scales are large, thick, and broadly overlap, and usually have prominent growth rings. The lateral-line scales are almost always fewer than 80. Dorsal fin-rays are usually 8 or fewer (rarely 9); anal fin-rays are 8 or fewer; and pelvic fin-rays number 8 or 9. An abrupt, soft, and fatty nuchal hump sometimes develops in large females of some populations. The total vertebrae vary from 38-45, but are usually fewer than 42. Diffuse lateral bands are rarely present and there is no basicaudal spot. Breeding males are red or orange on the lower cheek and posterior parts of lips, paired fin bases, and on the ventro-lateral surfaces including the caudal peduncle (Minckley 1973).

The Gila chub is similar in appearance to the roundtail chub, *Gila robusta*, but can be distinguished by having a chunkier body type. In addition, the length of head measured from terminus to posterior edge of operculum divided by the minimum depth of caudal peduncle is usually less than 3.0 (ADFG 1997).

<u>Diet:</u> Gila chubs are omnivores and primarily eat terrestrial and aquatic insects. At larger sizes they become pisciverous and have been found to consume speckled dace, *Rhinichthys osculus*. They probably consume other small fish as available. Larger adults feed during evening and early morning hours. Juveniles will feed throughout the day on insects and algae, both filamentous and diatomaceous (AGFD 1997).

<u>Reproduction:</u> Gila chubs probably mature in their second to third year and reproduction occurs primarily from late spring into summer (AGFD 1997). Gila chubs are oviparous (egg-laying) and spawning typically occurs from late spring into summer (Minckley 1973). Spawning is most likely sporadic over the reproductive season (Rinne and Minckley 1991, cited in Weedman et al. 1996) and may be related to temperature and other site-specific conditions. In some cases, spawning occurs throughout the year (Griffith and Tiersch 1989, cited in Weedman et al. 1996). Spawning is believed to occur over beds of submerged aquatic vegetation or root wads (Minckley 1973). Actively breeding fish become fire-red along the ventro-lateral surfaces and the eyes become yellow to yellow-orange (Minckley 1973).

Distribution

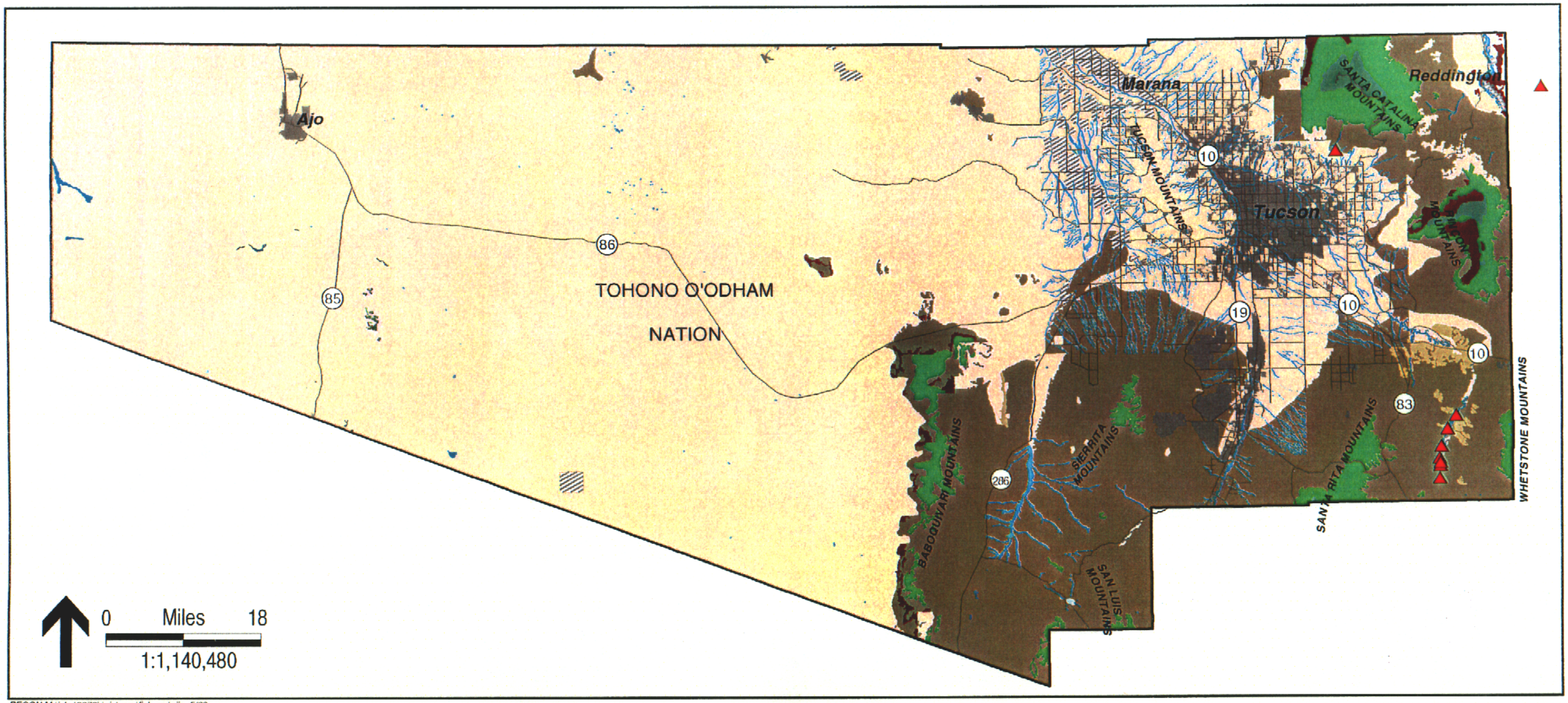
Historic: The Gila chub's historic range likely included suitable habitat throughout the entire Gila River basin except the Salt River drainage above Roosevelt Lake. Records include rivers, streams, and stream-fed tributaries in Arizona, New Mexico, and northern Sonora, Mexico. In Arizona, occupied habitats included suitable cienegas and small tributaries as well as artificial habitats such as Buckeye Canal (Weedman et al. 1996).

Present: The Gila chub is currently known from the following drainages: Santa Cruz River (Cienega Creek, Sabino Canyon, Sheehy Spring), Middle Gila River (Eagle, Bonita and Harden Cienega Creeks and San Carlos and Blue Rivers), San Pedro River (Bass, O'Donnell and Redfield Canyons, Babocomari River and Turkey Creek), Agua Fria River (Silver and Sycamore [rare] Creeks), Verde River (Spring and Walker Creeks). Gila chub populations were extirpated from Monkey Spring (Santa Cruz River), and Fish and Cave Creeks (Salt River). The species is currently considered extirpated from New Mexico (AGFD 1997). The AGFD Heritage Database Management System includes only 8 records for Pima County, all of which occupy the Santa Cruz River watershed, and 1 record for Graham County. Of 24 populations of Gila chub documented, 8 occurred in Pima County in the following locations: Cienega Creek, Binghamton Pond, Redfield Canyon, Sabino Canyon and the Santa Cruz River (Weedman et al. 1996) (Figure 31).

Demographics

Density: Density estimates for this species are irrelevant, because it occurs in a dynamic system. Populations expand and contract both seasonally and over time as climactic events affect aquatic habitat (AGFD 1997). Additional survey work needs to occur in all known Gila chub habitat before population specific distributions and abundances can be determined (Weedman et al. 1996).

Status: Populations of Gila chub have slowly been disappearing (ADFG 1997). According to Weedman (1996), 24 populations of Gila chub exist in isolated Gila River basin streams or cienegas in central and southern Arizona and northern Sonora, Mexico. Of these, 9 are of unknown status, 6 are considered unstable and threatened, 8 are considered stable but threatened, and only 1 is considered stable and secure (Weedman et al. 1996). The Redfield Canyon population was considered stable but threatened at the time of the last survey (Griffith and Tiersch 1989, cited in Weedman), and the Sabino Canyon population was considered unstable and threatened due to the presence of green sunfish (*Lepomis cyanellus*) (Dudley and Matter 2000). An attempt was made to eliminate this introduced predator in 1999, but not all green sunfish were eliminated from Sabino Creek (K. Kingsley, pers. obs.). Few recent surveys have been conducted in other portions of the species historic range, and further studies are needed to accurately document Gila chub distribution and abundance. Qualitative and quantitative abundance of Gila chub within most streams is basically undocumented.



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Gila Chub
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

▲ Gila Chub
(Gila intermedia)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 31

Trend: By 1973, populations of Gila chubs had declined throughout their range (Minckley 1973). The species is believed to be extirpated from New Mexico (BISON-M 2000). In Arizona, some populations appear to be declining although available data are insufficient to verify a trend (Weedman et al. 1996). One population (Turkey Creek) is known to have recently disappeared (Weedman et al. 1996).

Survival rates: In Sabino Canyon, researchers found that no Gila chub under 40 mm were observed anywhere in the canyon where they were sympatric with green sunfish, although they were observed in portions of the canyon that were not occupied by green sunfish (Dudley and Matter 2000). This indicates that survival rates in populations with introduced predators are very low. Information regarding survival rates of other populations is currently lacking.

Reproduction rates: No known information regarding reproductive rates and success is available.

Age ratios: The characteristic sexual dimorphism of Gila chub makes age and growth analysis difficult. In a study at Redfield Canyon, researchers found that 4 age groups comprised the populations and annual growth declined rapidly after the first year (Griffith and Tiersch 1989, cited in Weedman et al. 1996). An extinct population at Monkey Spring displayed unusual growth patterns with much larger scales, and marked size disparity between sexes with males being much smaller and with other body feature differences (Weedman et al. 1996). This information underscores the need for study of additional populations, both to provide knowledge regarding general age ratio patterns, and to elucidate unique characteristics in individual populations.

Significant Pima Co. populations or subpopulations: A large portion of the current geographic range known to be occupied by this species is contained within Pima County. However, remaining populations of Gila chub within Pima County are isolated remnants of a formerly widespread species. The only population currently considered secure and stable occurs within Pima County in Cienega Creek (Weedman et al. 1996). Two other known populations occur in Pima County: the Redfield Canyon population in the San Pedro drainage, which is considered stable but threatened, and the Sabino Canyon population, which is considered unstable and threatened (Weedman et al. 1996). Few studies have been conducted on these disjunct populations; however, there is some evidence to suggest that populations may differ from one another in terms of growth patterns (Weedman et al. 1996). Further analysis is necessary to determine the validity and importance of this hypothesis, and the importance of maintaining the genetic integrity of separate populations.

Habitat Requirements

Home range requirements: Gila chubs are normally found in small headwater streams, cienegas and springs, or marshes of the Gila River basin. They utilize diverse habitat types based on the season and age of the fish. Adults have been collected from deep pools with heavily vegetated margins and undercut banks. Juveniles have been collected from riffles, pools and undercut banks of runs (AGFD 1997). Gila chubs have an affinity for deeper pools in slow velocity water and are almost always associated with cover such as undercut banks, root wads, and instream debris piles (BISON-M 2000). In larger stream systems they utilize heavily vegetated backwaters for cover and feeding. The limit of their elevational range is unknown (AGFD 1997).

Ability to use major land use categories: Gila chub are restricted to streams, cienegas and springs or marshes with adequate cover and food supply, and they fail to flourish in water that is colonized by non-native aquatic species.

Habitat trends in planning area: Pima County actively promotes riparian restoration of river corridors and floodplains. Current and future plans to accomplish this goal include acquisition of flood-prone lands to prevent future development and degradation, and restoration of aquifers that once supported free-flowing streams. These projects should increase potential habitat for this species and secure sites for reintroduction, if necessary, in the future. Nonetheless, steps such as removal of non-native species and construction of suitable slow water habitats such as those that existed historically and are preferred by Gila chub may be necessary to ensure that these sites are suitable for survival of Gila chub.

Current and Potential Threats

General: The U.S. Fish and Wildlife Service is currently seeking information regarding the Gila chub in order to determine if the species should be proposed as either threatened or endangered or if it should be removed from the candidate list. Preliminary information indicates that alteration of habitat and introduction of non-native predators has caused significant declines in Gila chub populations throughout their former range. In August 1999, the Center for Biological Diversity filed a lawsuit against Bruce Babbitt and USFWS, seeking protection for the Gila chub and the Chiricahua leopard frog under the ESA. The suit followed a petition filed in June 1998 to list both species, which USFWS declined to process because both species were already candidates for listing.

Suitable aquatic areas in Pima County have been significantly reduced and widespread alteration of hydrologic regimes within watersheds has taken place in the last century. Many watercourses that likely supported Gila chub at one time no longer have perennial flows, rather they convey water only during storm events. Many watercourses have become channelized through increased flooding intensity and no longer offer microhabitats necessary for the Gila chub to meet its life cycle requirements. Increased growth and development within the county may continue this trend of dewatering of potential habitat if management measures are not implemented.

Pima County populations location, amount, and quality of protected habitat: Sabino Canyon and Redfield Canyon are protected by the U.S. Forest Service. A portion of Cienega Creek at the Empire Ranch is managed by the BLM as a natural area. This species is not yet known from Cienega Creek County Park, which may provide suitable habitat if Gila chubs are transplanted there.

Existing and potential pest species: The inability of Gila chub populations to reproduce successfully and thrive after the introduction of green sunfish was documented at Sabino Canyon by Dudley and Matter (2000). Pima County water bodies have been colonized by a wide array of other non-native species that may contribute to the decline of the native fishes. These may include the following: introduced plants such as saltcedar (*Tamarix ramosissima*), which alter hydrology and change habitat characteristics; invertebrates such as the Asian clam (*Corbicula fluminea*) and crayfish (*Orconectes* sp.); amphibians such as the eastern bullfrog (*Rana catesbiana*); and numerous other non-native fish such as smallmouth bass (*Micropterus dolomieu*) (Weedman 1998). Additionally, parasites introduced incidentally with nonnative species may jeopardize Gila chub populations (USFWS 1983).

Threat mechanism: Loss or degradation of habitat due to water diversion and groundwater depletion, dam and reservoir construction, increased peak flood discharges, and increased sedimentation; and negative interactions with competitive and predatory non-native fishes (Weedman et al. 1996).

Management Needs

General: All existing Gila chub populations must be identified, protected, and monitored for recruitment using standardized techniques, preferably biannually in the spring breeding season and in late autumn (Vives 1990, cited in Weedman et al. 1996). Control of non-native species in streams and other aquatic habitats that support Gila chub is vital to their survival. Gila chubs currently co-exist with green sunfish (*Lepomis cyanellus*) in several streams; however, they have been extirpated from at least one location by largemouth bass (*Micropterus salmoides*). Research on methods of mitigating impacts from non-native species is needed. Land management activities that affect watersheds, alter stream flow characteristics or affect the amount of perennial water in streams may be detrimental to populations of Gila chub, especially those activities that increase erosion and degrade stream banks (AGFD 1997). In areas that have been modified, steps should be taken to restore aquatic habitat where necessary.

Current protective measures: Portions of O'Donnell Creek, Redfield Canyon and Bass Canyon outside of Pima County are included in the Canelo Hills and Muleshoe Preserves, which are managed by the Nature Conservancy (TNC). Fall Fish Count volunteers formerly monitored several populations annually (Cienega Creek, Sheehy Spring, Sabino Canyon and Silver Creek). BLM Phoenix District is currently proposing translocations from Silver Creek to nearby perennial streams in the Agua Fria headwaters (ADFG 1997). Habitat restoration projects are ongoing at Empire-Cienega Ranch.

Sensitivity to human activities and densities: Historically, the Gila chub populations were dramatically reduced or extirpated as a result of degradation of habitat related to land alterations, water withdrawals, and introduction of non-native species. Continued human population growth in the area may result in further groundwater depletion, contamination of existing habitats with introduced fish and other non-native species, and pollution of the water by human, livestock, and chemical wastes and by increased siltation.

Corridor needs: Dispersal corridors within rivers and streams must be available for this species to become reestablished within former portions of its range. Currently, Gila chub populations are effectively isolated by ephemeral reaches of stream or in-channel structures that impede movement and harbor predatory non-natives (Weedman et al. 1996). Adequate cover and habitat features preferred by the Gila chub will allow the species to move through the watershed. Removal of aggressive non-native fish and other species such as crayfish and bullfrogs within these corridors may be necessary for any level of success. Many existing populations are separated by very long stretches of normally dry watercourses with no perennial flow. Establishment of suitable corridors in these areas is problematic.

Key relationships: Historically, Gila chub were commonly found in association with Gila topminnow, desert sucker, Sonora sucker, longfin dace, and speckled dace. The plant community that characterizes habitat where this species is found is broadleaf riparian vegetation consisting of cottonwood, willow, ash, alder, sycamore, walnut, and *Baccharis* spp. in association with submerged aquatic vegetation typical of cienega/marsh habitats (ADFG 1997). A major cause of decline of Gila chub populations is the introduction of non-native species, discussed above.

Migratory requirements: The movement patterns of adults and larvae are poorly understood at present and research is needed to understand this. In a study at Sabino Creek, young-of-the-year Gila chub were abundant in upstream reaches of the creek that were devoid of green sunfish, but were absent in downstream areas occupied by the green sunfish, which suggests that young life stages of Gila chub do not persist in sections of the creek occupied by green sunfish (Dudley and Matter 2000). Thus, the presence of non-native fish in Pima County streams may hinder the movement of young Gila chub to portions of the stream and thus prevent natural translocation or re-establishment of populations.

Results of past mitigation activities: Gila chubs are known to have been stocked into 3 streams in Arizona: Garden Canyon, Larry Creek, and Lousy Canyon. The Garden Canyon population was extirpated prior to 1995. The populations at Larry Creek and Lousy Canyon have not been monitored and the success of the stocking and establishment of the population is unknown (Weedman et al. 1996). An attempt was made to remove green sunfish from Sabino Creek in 1999, but the ultimate success of this is unknown. Green sunfish were present in Sabino Creek on 27 April 2000 (K. Kingsley, pers. obs.).

Existing monitoring and research programs: The Nature Conservancy conducts annual monitoring at Canelo Hills and Muleshoe Preserves, and the Bureau of Land Management conducts annual monitoring on populations of Gila chub within their lands (D. Duncan, USFWS, pers. comm. to P. Titus, SWCA, 11 Apr 2000).

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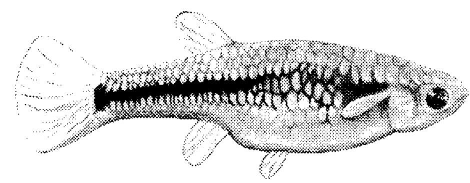
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)

Status



Federal	Listed as Endangered (1967)
State	Wildlife of Special Concern in Arizona
Other	Forest Service Sensitive, USFS Region 3, 1998; Threatened in Mexico (1995); Vulnerable Status 1 by SDCP
Rankings	G3T3 S2

Recovery Goals

Federal: Recovery Plan approved 1984; Revised Recovery Plan 1998, not formally approved. "The interim goal for recovery of Gila topminnow is ensuring their survival in the U.S. through protection of habitats currently occupied by natural populations and maintenance of refugia stocks of each natural population. Concurrent with these activities, recovery should be aggressively pursued through reestablishing populations on federal and other lands wherever possible" (Weedman 1998:16).

State: No specific state recovery goals are known.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The species was first described as *Heterandria occidentalis* from collections taken by Mr. John H. Clark on the U.S. and Mexican Boundary Survey under Lieutenant Colonel J. Graham. The type locality is the Santa Cruz River, near Tucson, Arizona (AGFD 1995). The species was redescribed by Hubbs and Miller in 1941 as *Poeciliopsis occidentalis* (Weedman 1998).

Classification: Order: Cyprinodontiformes; Suborder: Cyprinodontoidei; Family: Peociliidae; Genus: *Poeciliopsis*; Species: *occidentalis*; Subspecies: *occidentalis*. The genus name is from the Greek *poecilio,* which means "variegated, many-colored, varied," and *opsi,* which means "appearance." Of the 19 species that are described within the genus (Weedman 1998), the Sonoran topminnow (*Poeciliopsis occidentalis*) is the only species that occurs in Arizona (AGFD 1995). The specific epithet is from the Latin *occidens,* which means "quarter of the setting sun," meaning west.

Specific: The Sonoran topminnow includes 2 subspecies: the Gila topminnow (*Poeciliopsis o. occidentalis*) and the Yaqui topminnow (*P. o. sonorensis*). The Gila topminnow is the only subspecies that occurs within Pima County (AGFD 1995).

Synonymy: Other names this species has been known by are: *Heterandria occidentalis, Girardinus occidentalis, Girardinus sonoriensis, Poecilia occidentalis, Mollienisia occidentalis,* and *Arizonichthys psammophilus* (AGFD 1995).

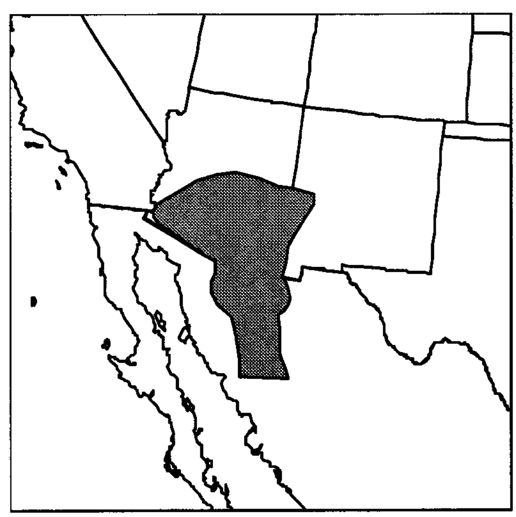
Life History

Description: The Gila topminnow is a small fish that is generally tan- to olive-colored, with darker dorsal coloration and a light to whitish ventral coloration. A dark band is present along both sides of the body. Scales on the dorsum are darkly outlined and extend as black speckles to the upper belly and pre-pectoral area. The dorsal profile is slightly curved and the body is somewhat elongated. The caudal fin is rounded to almost square. The fins are characterized by rays that are outlined with melanophores and lack dark spots. Breeding males are blackened with varying degrees of golden coloration in the pelvic, pectoral, and caudal fins and in the front of the body along the midline. Orange coloration is present at the base of the gonopodium (AGFD 1995). Males are smaller than the females and rarely measure more than 1 inch (2.5 cm) standard length; the females sometimes reach lengths of 2 inches (5 cm) or more, but are usually 1.2 to 1.8 inches (3.0 to 4.5 cm.) standard length (Minckley 1973).

Diet: Gila topminnows are omnivorous, consuming by engulfing almost anything smaller than they are. They likely utilize a broad spectrum of foods such as detritus and amphipod crustaceans, but feed voraciously on aquatic insect larvae, especially mosquitoes, when abundant (AGFD 1995).

Reproduction: The Gila topminnow is ovoviparous; that is, fertilization occurs internally, eggs develop inside the mother, and live young are produced. Females are able to carry 2 broods simultaneously, with one that is far more advanced than the other, and also have the ability to store sperm packets for delayed fertilization. The reproductive season normally lasts from April through November, but young may be produced year-round in some thermally stable springs. During breeding, some males become dark black and exhibit aggressive breeding behavior, while others will not become black but still attempt to mate inconspicuously with females. The typical brood size ranges from 10-15 young, with larger broods produced during the summer. Young that are produced early in the breeding season may reach sexual maturity in a few weeks to several months (AGFD 1995). An individual's life span is approximately 1 year, depending on the season in which it was born (Minckley 1973).

Distribution



Historic: Weedman (1998) cited reports that the Gila topminnow was once the most common fish in the Gila River Basin, but that there was a well-documented decline of the species once the basin was settled by modern man. Historically the subspecies was found in most perennial springs and streams, and along the vegetated margins of rivers within the Gila River drainage in Yavapai, Gila, Pinal, Maricopa, Graham, Greenlee, Cochise, Pima, Santa Cruz and Yuma Counties (AGFD 1995). By 1994, the Gila topminnow was restricted to 10 known populations in widely separated, isolated locations (Weedman and Young 1997). A separate forthcoming report in the SDCP series will detail the loss of one specific population and provide additional information on the history of this species in Pima County.

Present: Currently, 14 naturally occurring localities are known to support Gila topminnows within the United States (Weedman 1998). As of 1997, 18 populations that were reintroduced to wild locations remained; 7 of these were secure enough that they should persist into the foreseeable future (Weedman and Young 1997). Additionally, 12 captive populations were known to persist in 1997 (Weedman 1998). AGFD Heritage Database Management System records include 16 occurrences within Pima County. Most are from Cienega Creek, within the Empire-Cienega Resource Conservation Area. This appears to be the only reasonably secure population in the county. This species has apparently not yet become established (or re-established) downstream from there at the County park (D. Duncan, pers. comm to K. Kingsley, 19 Apr 2000). Two (transplanted) locations were in the Rincon Mountains, and 2 were within the Santa Catalina Mountains, but these have died as a result of loss of water from their habitat (Weedman and Young 1997). One captive population is at the International Wildlife Museum in the Tucson Mountains. One record is from Peck's Canyon in the Arivaca Creek drainage. Other known locations of Gila topminnow within Pima County, Arizona, presented by HDMS are shown on Figure 32.

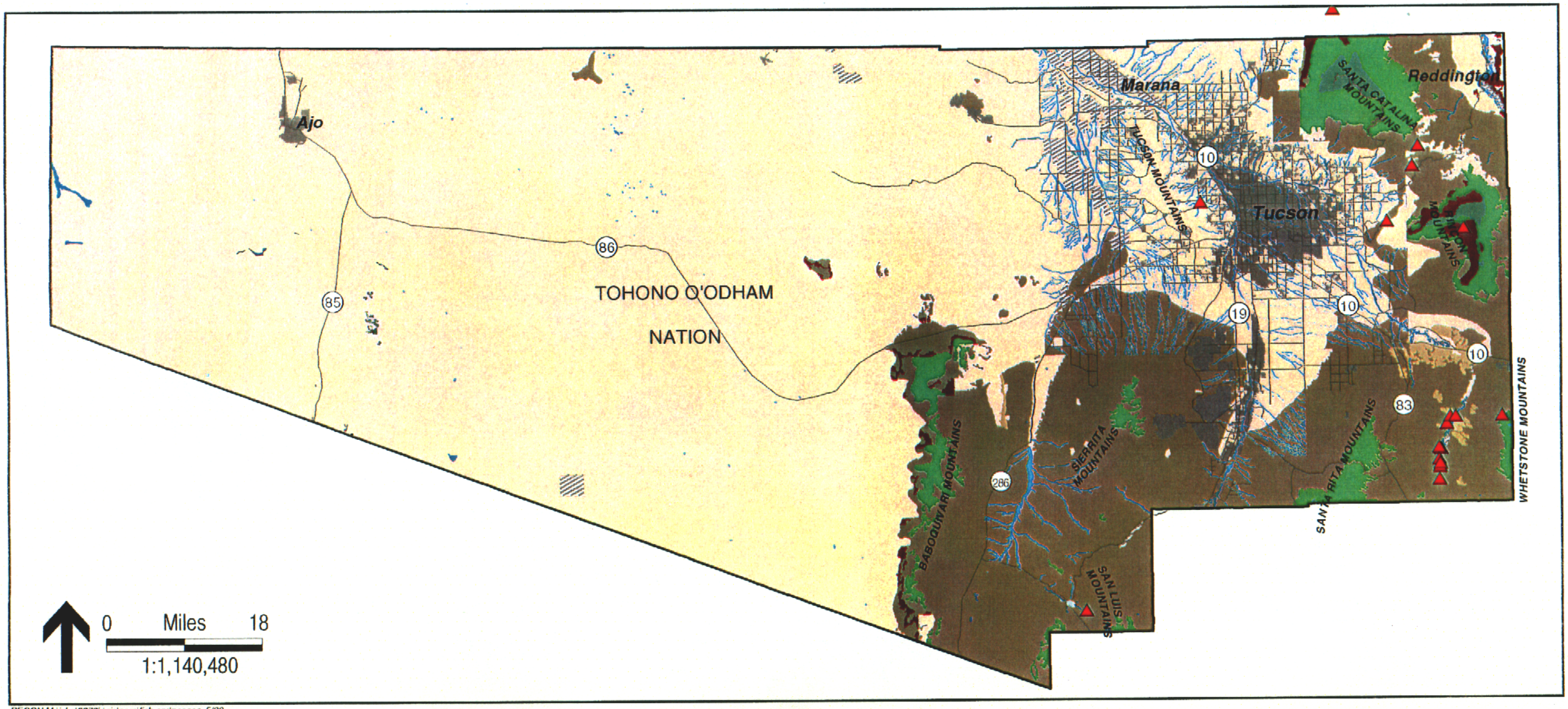
Demographics

Density: Before human settlement, Gila topminnows likely formed an almost continuous population at low elevations throughout the Gila River and its tributaries (Weedman 1998). Natural populations of Gila topminnows that were monitored from 1992-1997 ranged from just 2 individuals to estimates of over 1,000 individuals (Weedman 1998).

Status: In Arizona, the species currently occurs in the Gila River drainage, particularly in the upper Santa Cruz River, Sonoita and Cienega creeks and the middle Gila River (Weedman 1998). Naturally occurring populations in New Mexico were extirpated by the 1950s; however, a population has been reintroduced into a pond in Grant County (BISON-M 2000). The species also occurs throughout Rio de la Concepcion and Sonora in northern Sonora, Mexico, where the species is listed as threatened (Weedman 1998).

Trend: The Gila topminnow was once a widespread and abundant fish in southern Arizona that has steadily declined to a small number of disjunct populations. Management activities involving translocations or reintroductions began in 1936 when fish were stocked into Arivaca Creek (Weedman and Young 1997). Miller (1961) documented the extirpation of Gila topminnow from Arivaipa Creek just 2 years after the introduction of the mosquitofish (*Gambusia affinis).* Several existing populations are currently threatened by the existence of exotic predatory fish (Sharp Spring, Bylas Spring, Sonoita Creek, Redrock Canyon, Santa Cruz River, Fresno Canyon) (AGFD 1995). The security of the currently existing natural occurrences is variable and only 3 are considered relatively secure (BISON-M 2000). According to Weedman (1998), more than 350 Gila topminnow stockings to wild and captive localities have been executed. These included 206 reintroductions at 178 wild locations and 141 captive sites. Successfully re-established populations represent approximately 8% of these efforts (Weedman and Young 1997).

Survival rates: Competitive and predatory interactions with introduced fish species, especially mosquitofish, have greatly reduced the range and abundance of the Gila topminnow. The rapid replacement of topminnow by introduced mosquitofish has been impressively documented at many localities. However, in some diverse habitats the 2 fishes have been able to co-exist for many years. In most instances, replacement occurs through direct predation by mosquitofish on young



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Gila Topminnow
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)
▲ Gila Topminnow
(Poeciliopsis occidentalis occidentalis)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
122.4 Great Basin Conifer Woodland
122.6 Madrean Montane Conifer Forest
123.3 Madrean Evergreen Forest and Woodland
124.7 Sonoran Riparian Woodland
133.3 Interior Chaparral
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223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
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244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
999.0 Unclassified
999.1 Agriculture
999.2 Urban
999.3 Water
999.4 Bare ground

Figure 32

and small Gila topminnow, and shredding of the fins of larger topminnows which leads to increased risk of infection. Populations of Gila topminnow historically expanded into intermittent waters during wet years and then retreated to headwater springs and perennial reaches of streams during drier years. Their high fecundity and long reproductive season allowed them to rapidly expand into new habitat. The life span of this species is approximately 1 year, but it appears to be linked to sexual maturation which is dependent upon time of year in which they were born (AGFD 1995).

Reproduction rates: Brood size and the onset of breeding in topminnows can be influenced by several factors including food abundance, photoperiod, temperature, predation upon the population and female size (Weedman 1998). Sex ratios in stabilized populations nearly always favor females, varying from 1.5 to 6.3 per male (Schoenheer 1974, cited in Weedman 1998). Under optimum laboratory conditions, Gila topminnow can produce 10 broods per year at intervals of 7-14 days, and can produce up to 10 broods after being isolated from males (Schultz 1961, cited in Weedman 1998). During peak breeding season up to 98% of female are pregnant (Minckley 1973).

Age ratios: Information on age ratios is not available. Because the Gila topminnow is an ovoviviparous annual fish, ages are only adult and juvenile.

Significant Pima Co. populations: The only known currently viable population of this species in the wild in Pima County is in Cienega Creek on the Empire-Cienega Resource Conservation Area.

Habitat Requirements

General: The basic habitat requirement for the Gila topminnow is water that is permanent and free from non-native predators. Beyond that, habitat requirements of Gila topminnows are broad. The subspecies historically occupied headwater springs and vegetated margins and backwater areas of intermittent and perennial streams and rivers. Topminnows can withstand water temperatures from near freezing to 90-100 degrees Fahrenheit (32-38 degrees Celsius) (AGFD 1995). Weedman (1998) cited reports that Gila topminnows can live in a fairly wide range of water chemistry conditions, with pH's ranging from 6.6 to 8.9, dissolved oxygen readings from 2.2 to 11 mg/l, salinities from tap water to sea water and that topminnows can temporarily tolerate almost total loss of water by burrowing into mud for 1 to 2 days. Preferred habitats contain dense mats of algae and debris, usually along stream margins or below riffles, with sandy substrates sometimes covered with organic muds and debris (Minckley 1973).

Home range requirements: Gila topminnows probably do not fit the classic concept of "home range." Their natural habitat is one of dynamic streams that change so much over the course of a topminnow's life that a home range would be inappropriate.

Ability to use major land use categories: Gila topminnows are restricted to springs, cienegas, permanent and interrupted streams, and margins of large rivers (Weedman 1998).

Habitat trends in planning area: After a severe, long-term decline, efforts are being made to halt the decline and restore some habitat. The BLM has been involved in stream restoration efforts within the Empire-Cienega Resource Conservation Area. Pima County has engaged in an apparently successful stream restoration effort in its Cienega Creek Park. Gila topminnows have not become established there from the upstream population, but may be transplanted in the near future (D. Duncan, pers. comm. to K. Kingsley, 19 Apr 2000). Also, Pima County actively promotes riparian restoration of river corridors and floodplains. Current and future plans to accomplish this goal include acquisition of flood-prone lands to prevent future development and degradation, and restoration of aquifers that once supported free-flowing streams. These projects should increase potential habitat for this species and secure sites for reintroduction, if necessary, in the future.

Current and Potential Threats

General: The revised recovery plan (Weedman 1998) identifies the following factors as affecting the ability to delist the species in the foreseeable future:

- irrevocable loss of habitat or contamination by mosquitofish;
- habitat alteration;
- habitat destruction;
- non-native species introductions; and
- limited existing mechanisms and resources to alleviate the above threats.

Pima County populations location, amount, and quality of protected habitat: The population on the Empire-Cienega Resource Conservation Area receives mandated legal protection against detrimental practices by the BLM. Potential reintroduction sites exist within the Santa Cruz River and Cienega Creek drainages and at a spring in Agua Caliente Park, although the latter is populated by non-native fish that would need to be removed prior to translocation of Gila topminnow.

Existing and potential pest species: The inability of Gila topminnow populations to survive and thrive after the introduction of mosquitofish has been well documented. Pima County water bodies have been planted with a wide array of other non-native species that may reduce their suitability to support the Gila topminnow. These include introduced plants such as saltcedar (*Tamarix ramosissima*) and water primrose (*Ludwigia peploides*) which alter hydrology and change habitat characteristics; invertebrates such as the Asian clam (*Corbicula fluminea*) and crayfish (*Orconectes* sp.); amphibians such as the bullfrog (*Rana catesbiana*); and numerous additional non-native fish such as smallmouth bass (*Micropterus dolomieu*) and green sunfish (*Lepomis cyanellus*) (Weedman 1998).

Threat mechanism: Habitat alteration and destruction, and introduction of predaceous non-native fish, principally mosquitofish, are the main reasons for decline of the Gila topminnow (Weedman 1998). Introduction of other non-native species including crayfish and bullfrogs have likely contributed to the decline of this species as well.

Management Needs

General: Swift and decisive action is needed in order to prevent extinction. Protection of remaining natural and lasting reintroduced populations are necessary. The revised recovery plan for the Gila topminnow (Weedman 1998) identifies the following actions:

- reintroduction and protection of populations throughout the historic range and monitoring of both natural and re-introduced populations should be continued;
- a protocol for managing populations including protection of genetic integrity should be developed and implemented;

- further studies of the life-history, genetics, ecology and habitat of Gila topminnow and interactions with non-native species should be conducted; and

- the public and resource managers should be informed and educated regarding the subspecies.

AGFD (1995) recommends that land management activities such as mining, grazing, fuel-wood cutting, logging, etc., should be evaluated in relation to site-specific characteristics, as these activities can have either a positive or negative effect on Gila topminnow populations due to timing, intensity or other activity-related factors.

Current protective measures: Endangered status for this species implements federal protection under the Endangered Species Act. Portions of Cienega Creek have been acquired and established as a Resource Conservation Area by the BLM. A Memorandum of Understanding was signed in 1981 between the USFWS, AGFD, and USFS allowing coordination for the reintroduction of Gila topminnow on Forest Service administered lands. Gila topminnows are currently being held in several refugia, with isolation of genetic stocks from different sources or origin, for potential reintroduction to suitable habitats (AGFD 1995). It may be appropriate to reintroduce Gila topminnow to Cienega Creek County Park (D. Duncan, USFWS, pers. comm. to K. Kingsley, 19 Apr 2000).

Sensitivity to human activities and densities: Land use practices such as livestock grazing, mining, timber cutting, road maintenance, and recreation may affect this species through increased erosion, intensified flood events and decreased groundwater tables resulting in loss of stream flow. Effluent from wastewater treatment facilities and runoff may degrade water quality. These threats may impact both existing populations and habitats proposed for reestablishment (Weedman 1998). Release of pet exotic fish into waters occupied by this species can result in loss of topminnows. All of these factors are likely to be related to human population size and densities.

Corridor needs: The current recovery plan recommends that, until further genetic studies are completed for the Gila topminnow, each existing population of Gila topminnow should remain separate (Weedman 1998). Corridor planning should also include prevention of non-native species movement into habitats occupied by Gila topminnow populations.

Key relationships: No beneficial key relationships are known. Key adverse relationships exist with exotic predators and competitors, as discussed above.

Migratory requirements: Because populations of Gila topminnow historically expanded into intermittent waters during wet years and then retreated to headwater springs and perennial reaches of streams during drier years, future planning should attempt to incorporate this facet of the species life history. However, it must be approached with caution so as to prevent or reduce mixing of genetic stocks and the introduction of predators and diseases.

Results of past mitigation activities: Since 1981, AGFD, BLM, USFWS, and USFS have cooperated in an effort to recover the Gila topminnow by reintroducing populations into formerly occupied habitats. The failure of many re-introduction efforts have been attributed to poor site selection (Weedman and Young 1997). Results of habitat restoration efforts are not known. Proposed fish barriers (for exotics) and other mitigation activities designed to offset potential adverse effects of the Central Arizona Project have not yet been built, so no conclusion regarding results can be made.

Existing monitoring and research programs: AGFD continues a monitoring and reintroduction program partially funded through Section 6 of the Endangered Species Act (Weedman 1998).

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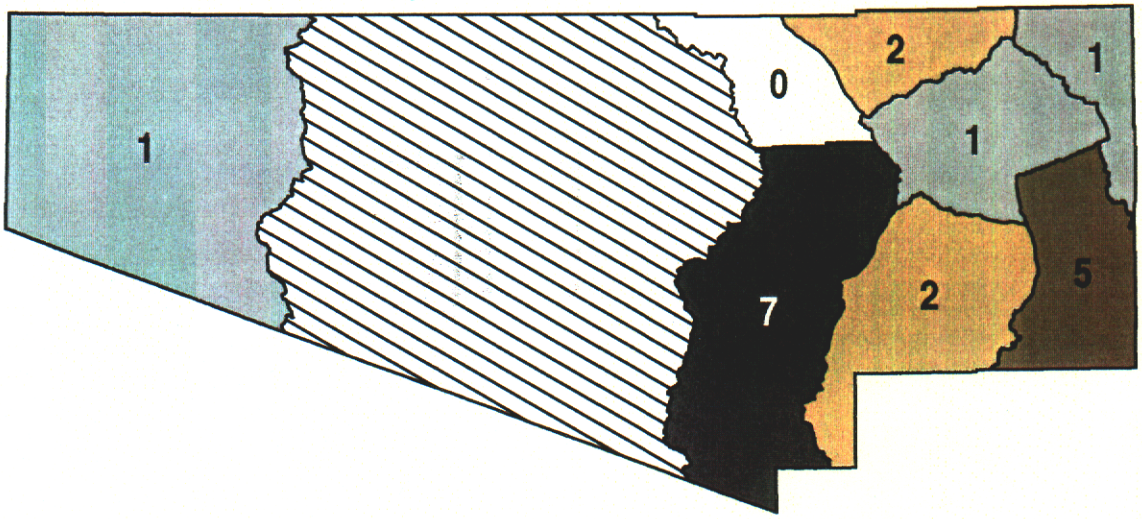
Number of Priority Vulnerable Invertebrate Species



Potentially Occurring in Each Subarea

INVERTEBRATES

Arkenstone Cave pseudoscorpion (*Albiorix anophthalmus*)

Status

Federal	None
State	None
Other	Vulnerable Status 1 by SDCP
Rankings	G1S1

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This is an eyeless cave-dwelling pseudoscorpion that is known only from Arkenstone Cave in Colossal Cave Mountain Park. It was described in 1999, and it is probably found nowhere else in the world. Pseudoscorpions are small arachnids (arthropods related to spiders and scorpions) that lack tails and have appendages that function as pinchers. They are small (mostly less than 0.2 inch [5 mm] long), secretive animals that usually live in leaf letter, moss, manure, under loose bark, or under stones. Over 200 species are known from the United States, but there are very few active students of this group (Levi and Levi 1990). More than 26 species are cavernicolous (meaning they have been found in caves) and several are troglobites (animals especially adapted for live in caves, that have reduced or lost eyes and pigment, and enlarged sensors for touch, and that never leave the cave environment) (Muchmore 1992).

Classification: Order: Pseudoscorpiones; Family: Ideoroncidae; Genus: *Albiorix* (Greek = white digging tool, referring to the chelae [claws]); Species: *anopthalmus* (Greek = without eyes).

Specific: *Albiorix anopthalmus* was described by Muchmore and Pape (1999) from specimens collected in Arkenstone Cave, Colossal Cave Mountain Park, Pima County, Arizona.

Life History

Description: This pseudoscorpion is a small (about 0.1 inch [3 mm] long) light tan creature with a gray dorsal stripe. It has extensible grasping organs called palps that are light brown and resemble a scorpion's pincers. It has no eyes, no tail, and eight legs. A very detailed description is given in Muchmore and Pape (1999).

Diet: These creatures have been observed feeding on small insects called psocids (booklice) that apparently feed on feces of crickets and/or mold on cricket feces. The pseudoscorpions are suspected of also preying on other small invertebrates in the cave (Muchmore and Pape 1999).

Reproduction: Very little information is available. The annual population peaks in April. Young are present all year, at it is assumed that breeding occurs all year. No young were ever observed with a female (Muchmore and Pape 1999).

Behavior: This animal is a minute predator that lives in permanent darkness and preys on scavenging invertebrates. They move about in the cave, with population concentrations varying from month to month. They depend on tactile and chemoreceptive sensory structures. When exposed to light, they scurry to the underside of some piece of debris. They are located almost exclusively on the undersides of pieces of rock debris on the floor of the cave. They make silk chambers, similar to known pseudoscorpion brood nests, in which the adults, and presumably young, find shelter (no young have been recorded in a brood nest, yet) (Muchmore and Pape 1999).

Distribution

Historic and present: Arkenstone Cave is the only known location for this species (Muchmore and Pape 1999) (Figure 33).

Demographics

Density: This species is found only in a very small part of the cave. Populations fluctuate following an apparent annual cycle. The most individuals that were ever counted were 35, including both adults and nymphs (Muchmore and Pape 1999).

Status: The entire world of this species consists of a small portion of a cave. Within those confines, the population exhibits some resilience and mobility, and the ability to recover from perturbations (Muchmore and Pape 1999).

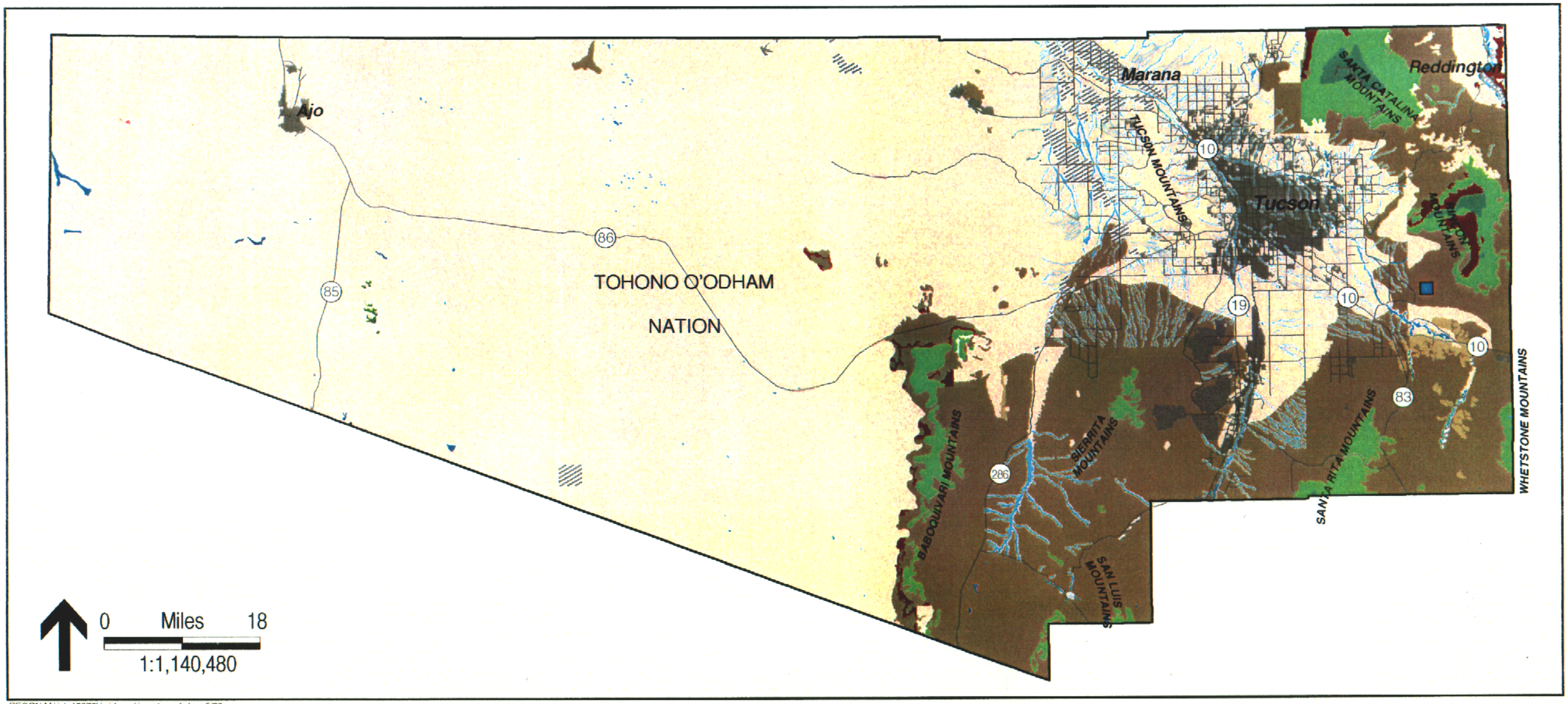
Trend: There is no information on long-term trend. The species exhibits annual cycles in population size. In 5 years of observations, no significant fluctuations in the overall observable population were noted (Muchmore and Pape 1999).

Survival rates: No known information is currently available regarding survival rates in populations.

Reproduction rates: No known information is currently available regarding reproduction rates.

Age ratios: Based on 804 observations, 49% of the population was adult.

Significant Pima Co. populations or subpopulation basis in planning area: This species is only known from one location.



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Pseudoscorpion
Known Locations and Vegetation Biomes

Known Locations
(SWCA, 2000)

- Pseudoscorpion
  (Albiorix anophthalmus)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 33

Habitat Requirements

Ability to use major land use categories: This species is only found in one cave.

Habitat trends in planning area: Apparently stable, the cave is within Colossal Cave Mountain Park. There are no plans to alter the entrance or any part of the cave, or to permit a significant increase in visitation to the cave by recreational cavers. Within the cave itself, the habitat of this animal is subject to some changes by flooding, but the population is expected to recover (Muchmore and Pape 1999).

Home range requirements: This species requires a relatively pristine, undisturbed cave environment with a healthy population of crickets and psocids.

Current and Potential Threats

General: No specific threats apply to this animal. Its only known location is within a county park, and managers of the park are well aware of the importance of this cave.

Pima County populations location, amount, and quality of protected habitat: The entire known habitat of this species is protected.

Existing and potential pest species: None are known for this species in this area. In Texas, similar species are alleged to be threatened by the introduced fire ant (*Solenopsis invicta*), (Elliott 1992a, 1992b; USFWS 1998) but this species has not yet become established in Pima County.

Threat mechanism: From fire ants: direct predation or competition. In other areas that have unique cave fauna, threats include:

- direct destruction of the caves, or of the drainage areas bringing water into caves;
- pollution of the cave or of water carried into the cave by natural drainage;
- loss of habitat for animals that spend part of their lives in the cave and part outside, but are the primary source of nutrients within the cave environment (these are called trogloxenes);
- disturbance by recreational cavers; and
- scientific studies and collecting.

Management Needs

General: The most useful management approach for this species is to limit human access to the cave and determine the area around the cave that should be preserved in its natural state in order to secure the habitat of this animal and those upon which it depends. Guidelines for creating and maintaining cave preserves have been developed (Sasowsky et al. 1997; Elliott 1998; White and Kingsley 1999) and should be applied appropriately to this cave. Conservation of cave fauna is becoming an increasingly important issue of concern in the U.S. (Culver et al. 2000).

Current protective measures: Arkenstone Cave is within Colossal Cave Mountain Park and is managed for protection.

Sensitivity to human activities and densities: Intensive use by recreational cavers may disrupt the habitat of this species. Trampling or other disruption of the aboveground plant community may impact this species indirectly by impacting the trogloxenic crickets that import nutrients to the cave ecosystem.

Corridor needs: None.

Key relationships: This species is totally dependent upon crickets (*Ceuthophilus* sp.) that forage outside the cave and rest within it. The cricket feces provide nutrient input to the cave ecosystem. The feces and/or molds growing on them provide food for scavengers, especially the psocid *Psyllipsocus ramburii*, which are fed upon by the pseudoscorpion. Arkenstone Cave appears to be one of the most biologically significant caves in the world (R. B. Pape, pers. comm. to K. Kingsley, 2 Mar 2000).

Migratory requirements: None.

Results of past mitigation activities: No past mitigation activities are known.

Existing monitoring and research programs: A program of study of the fauna of Arkenstone Cave has been ongoing since 1990.

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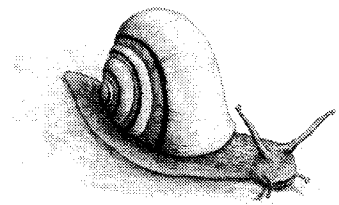
Talus snails (*Sonorella* species)

Status



Federal	One species, *S. eremita,* was proposed for listing as an endangered species, but the proposal to list was withdrawn following a conservation agreement guaranteeing no disturbance of the species habitat (USFWS 1999); several species not known from Pima County are Candidate species or Species of Concern
State	None
Other	Vulnerable Status 1 by SDCP, for the species discussed here
Rankings	Most of these species should be G1 or G2 S1 or S2

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for these species.

State: There are no known state agency-mandated recovery goals for these species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for these species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for these species based on research into the requirements of the species.

Taxonomy

General: The talus snail, genus *Sonorella,* includes 79 described species and inhabits the Madrean Archipelago and adjacent regions. Taxonomic understanding is limited and evolving, and some of the ideas on *Sonorella* taxonomy advanced by previous authors may not be correct. Assignment to specific taxa has been based on location and microanatomy of the genitalia, but more modern techniques have been recently applied and are changing our understanding of species, phylogeny, and biogeography (McCord 1994).

Classification: Order: Stylommatophora; Family: Helminthoglyptidae; Genus: *Sonorella.*

Specific: Approximately 30 described species or local populations are recorded from Pima County, Arizona. Because taxonomic understanding is currently evolving, it is not possible to accurately state exactly how many are species or subspecies (McCord 1994).

Those taxa that are known from locations outside Coronado National Forest, Saguaro National Park, Organ Pipe Cactus National Monument, Buenos Aires National Wildlife Refuge, or the Tohono O'odham Nation are recommended for inclusion in the Sonoran Desert Conservation Plan. These are *S. ambigua ambigua, baboquivariensis baboquivariensis, b. berryi, b. depressa, eremita,* *imperatrix, imperialis, magdalensis, meadi, pupela, rinconensis, sabinoensis buehmanensis, s. tucsonica, sitiens sitiens, tortilliata,* and *xanthenes.*

Life History

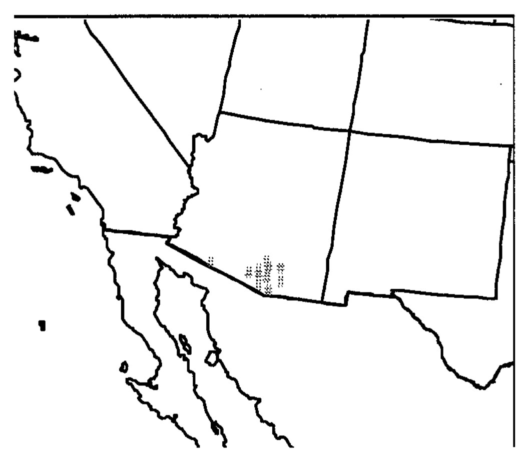
Description: *Sonorella* snails are small (less than 1 inch [2.5 cm] diameter) snails with globose-depressed, umbilicate shells that are generally glossy, opaque pinkish buff, fading to nearly white around the umbilicus, and having shoulder bands that are some darker shade of brown. The spire is very low and conoidal. There may be approximately 4.5 whorls. The aperture is rounded, oblique, and slightly wider than high. The top of the animal's head is gray, the body cream or light gray colored. Anatomy, especially of the genitalia, is complex (Bequaert and Miller 1973; AGFD 1997).

Diet: Nothing is known of the diets of most of the species. A few have been observed feeding on plants, with no further description. A mountain species that was studied intensively (*S. odorata*) was found to consume fungi (Gilbertson 1965).

Reproduction: Snails of this genus are fully functioning hermaphrodites that mate with both sets of genitalia simultaneously. Nothing is known of their reproductive behavior or fecundity in natural conditions.

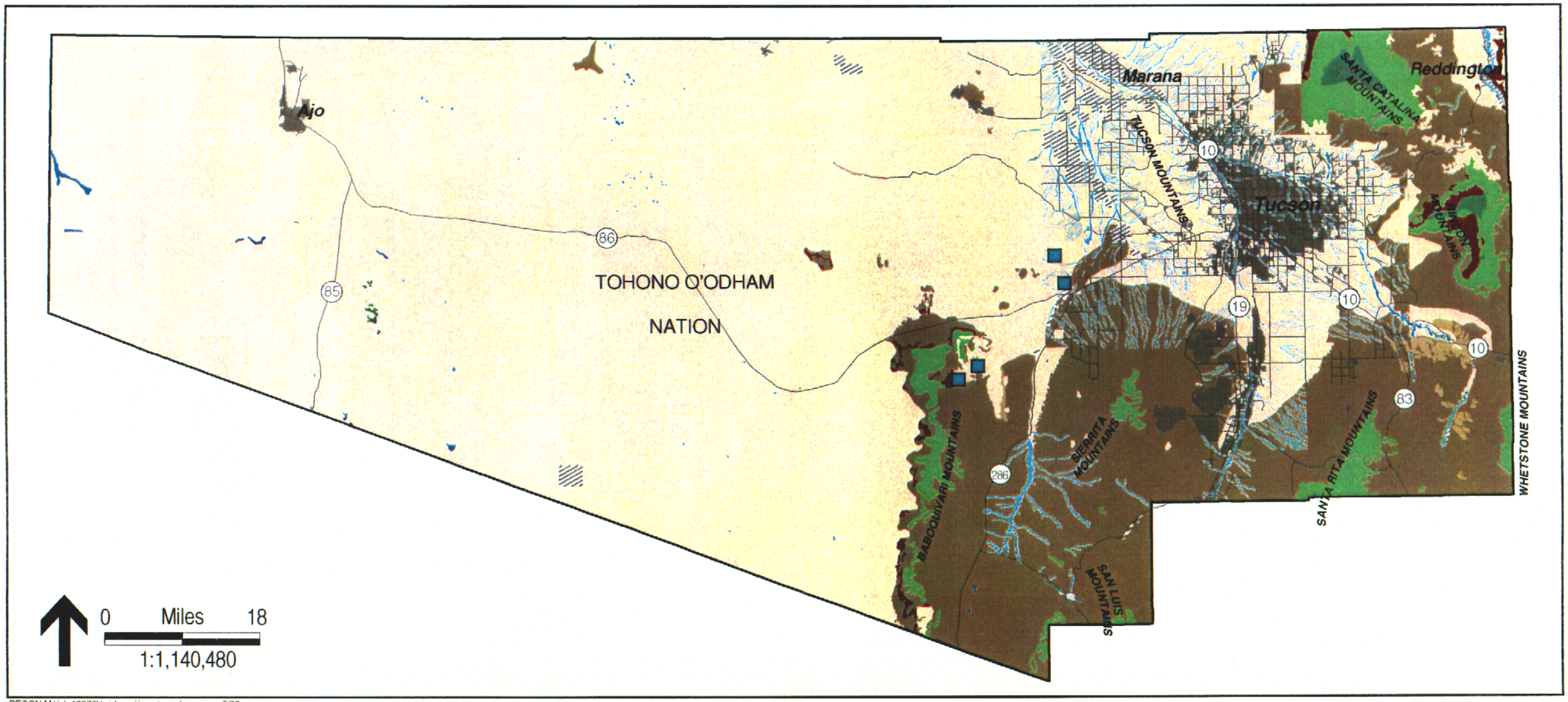
Behavior: Snails of this genus spend most of the year in a dormant state in cracks and crevices between, and under, rocks. They emerge only under very specific weather conditions, feed and mate and then return to their hiding places. Some may be active only on one or a few days each year, some may not be active for more than a year. There is no information available on how long they can survive periods of dormancy (Pilsbry and Ferris 1915, 1918; Bequaert and Miller 1973; Terkanian 1999).

Distribution



Historic: All available evidence supports the hypothesis that all of the localized taxa are relicts of previously widespread taxa isolated by repeated episodes of isolation and dispersal during repeated climate changes in the distant past (McCord 1994; Terkanian 1999). The known historic distribution of the *Sonorella* species of Pima County recommended for inclusion in the Sonoran Desert Conservation Plan is listed in the following table.

Present: Current distribution is probably not different from historic distribution, but there has been no known systematic search effort in approximately 30 years, and some species may be extinct. Some that were described by Pilsbry and Ferris in 1915 and 1918 were not relocated by Miller in the 1960s and 70s (Bequaert and Miller 1973). The total range of most of the known species is less than the land occupied by one moderate-sized house (Figures 34-49).



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Talus Snail *(Sonorella ambigua ambigua)*
Known Locations and Vegetation Biomes

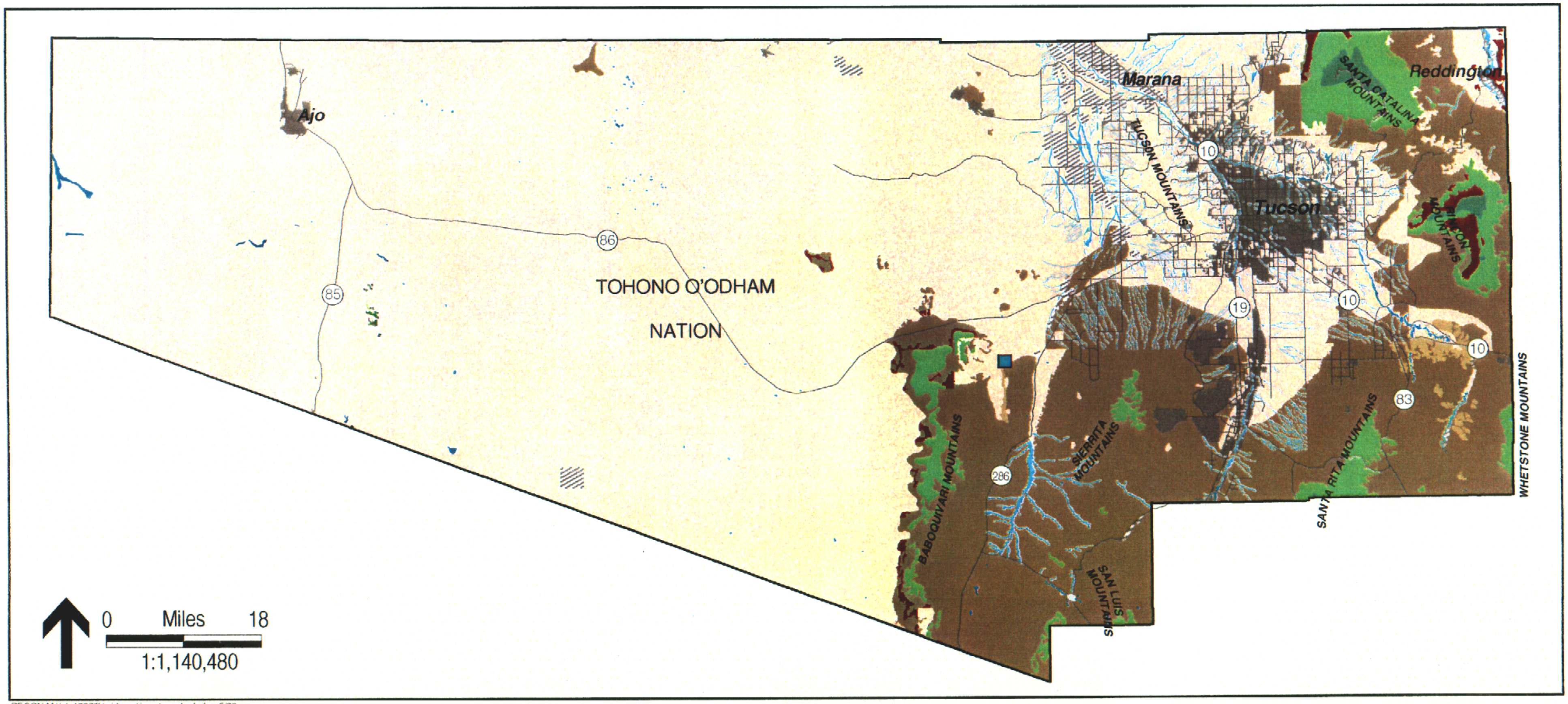
Known Locations (SWCA, 2000)
- Talus Snail *(Sonorella ambigua ambigua)*

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 34



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Talus Snail (*Sonorella baboquivariensis baboquivariensis*) Known Locations and Vegetation Biomes

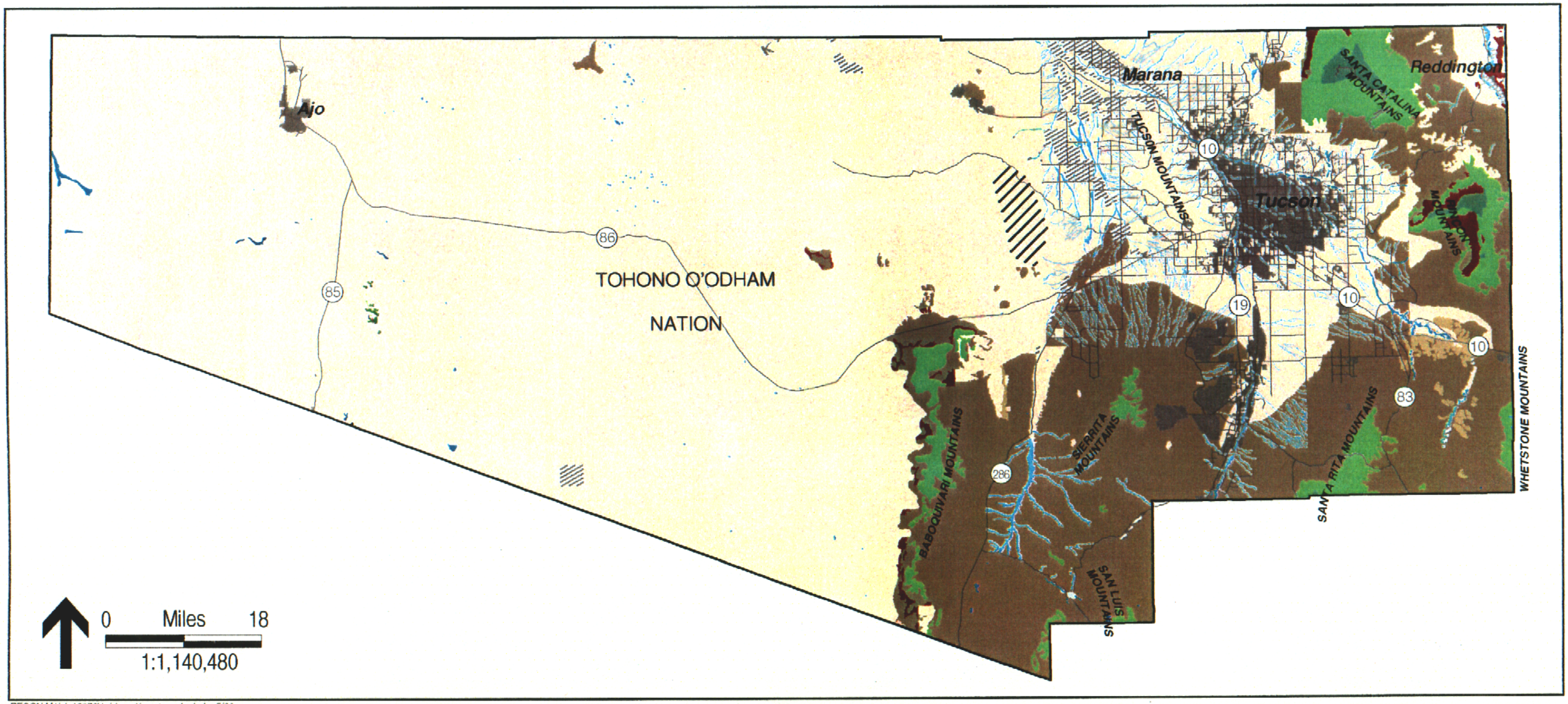
Known Locations (SWCA, 2000)
- Talus Snail (*Sonorella baboquivariensis baboquivariensis*)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 35



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Talus Snail *(Sonorella baboquivariensis berryi)* Potential Habitat and Vegetation Biomes

Potential Habitat
(based on assessment for this study)

Talus Snail
(Sonorella baboquivariensis berryi)

Pima County Boundary

Major Road or Highway

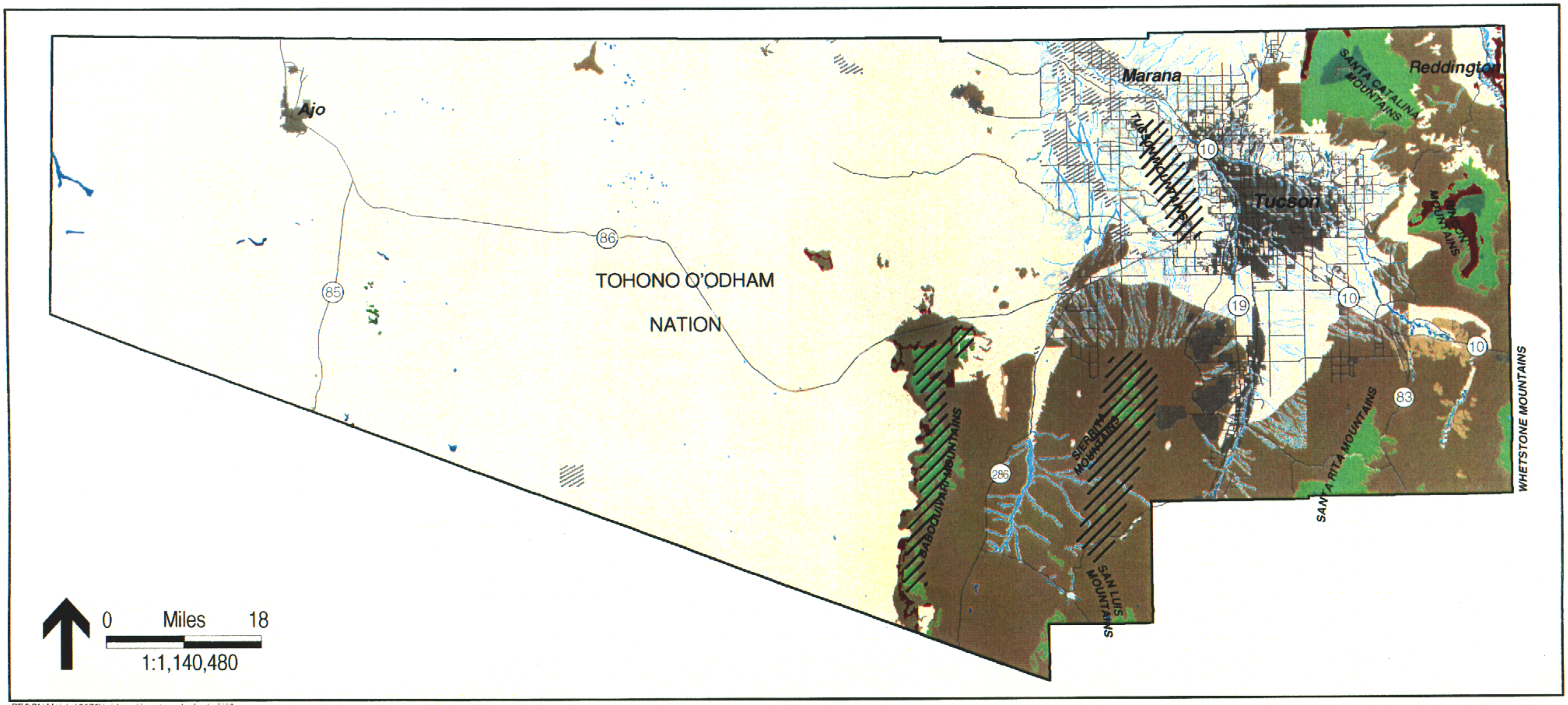
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 36



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Talus Snail *(Sonorella baboquivariensis depressa)*
Potential Habitat and Vegetation Biomes

Potential Habitat
(based on assessment for this study)

Talus Snail *(Sonorella baboquivariensis depressa)*

Pima County Boundary

Major Road or Highway

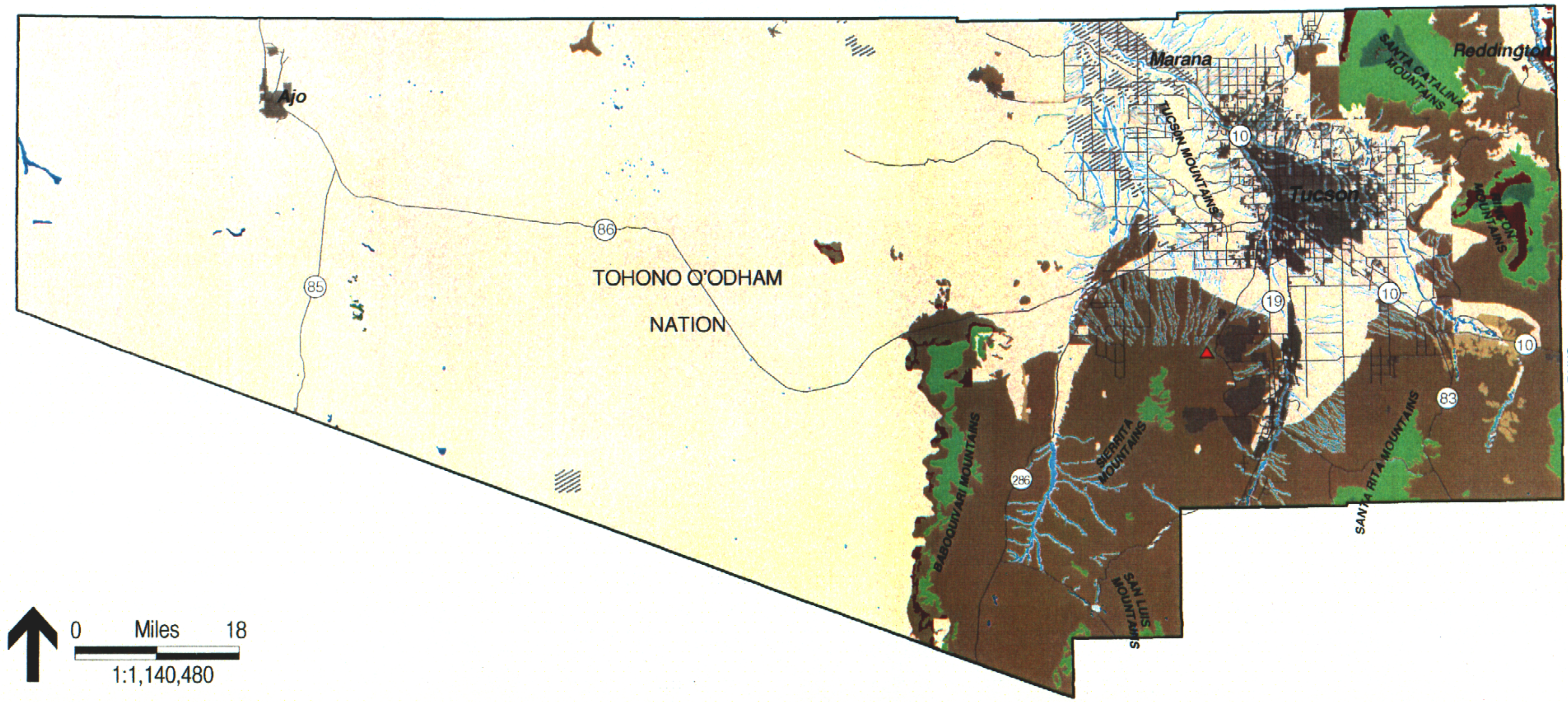
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 37



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San Xavier Talus Snail *(Sonorella eremita)* Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)

▲ San Xavier Talus Snail *(Sonorella eremita)*

Pima County Boundary

Major Road or Highway

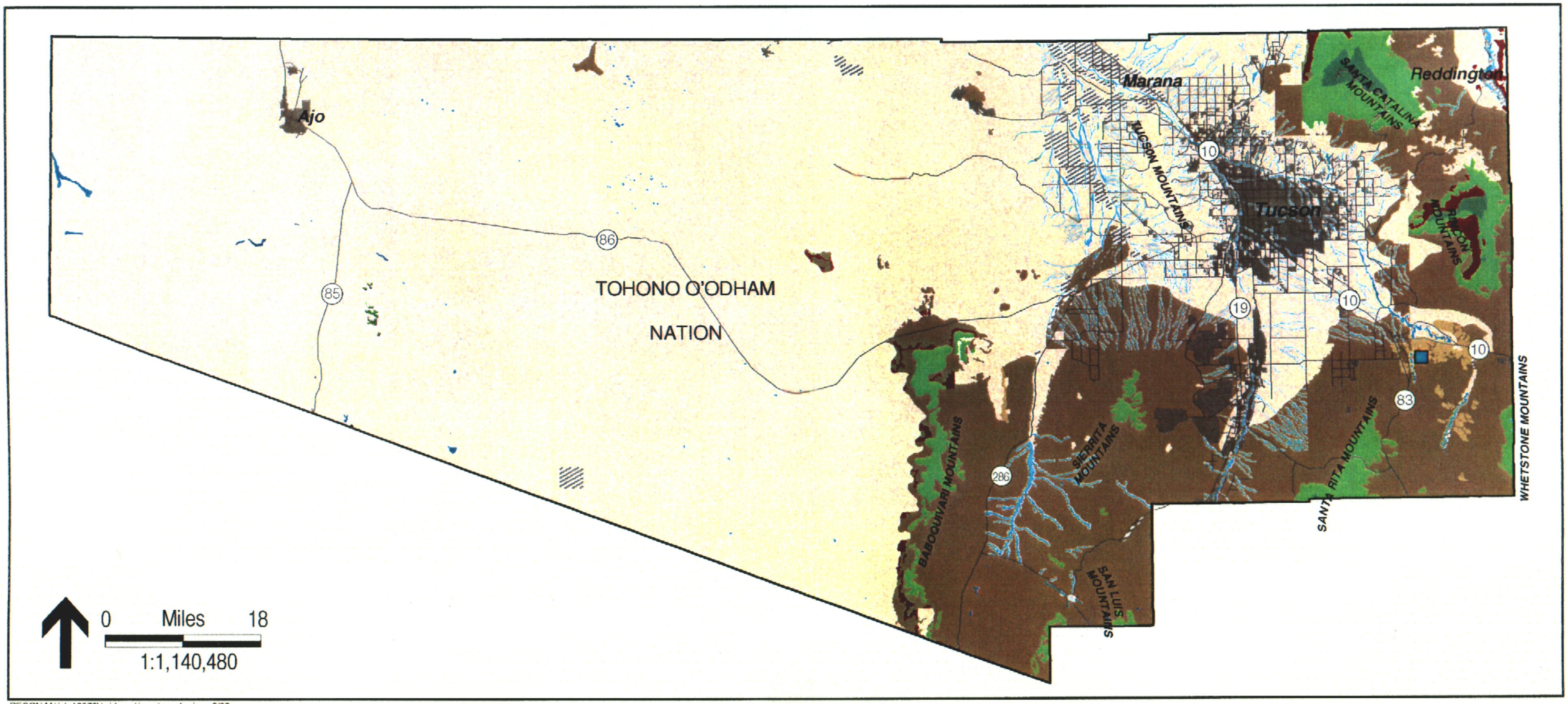
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 38



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Talus Snail *(Sonorella imperatrix)* Known Locations and Vegetation Biomes

Known Locations (SWCA, 2000)

- Talus Snail *(Sonorella imperatrix)*

Pima County Boundary

Major Road or Highway

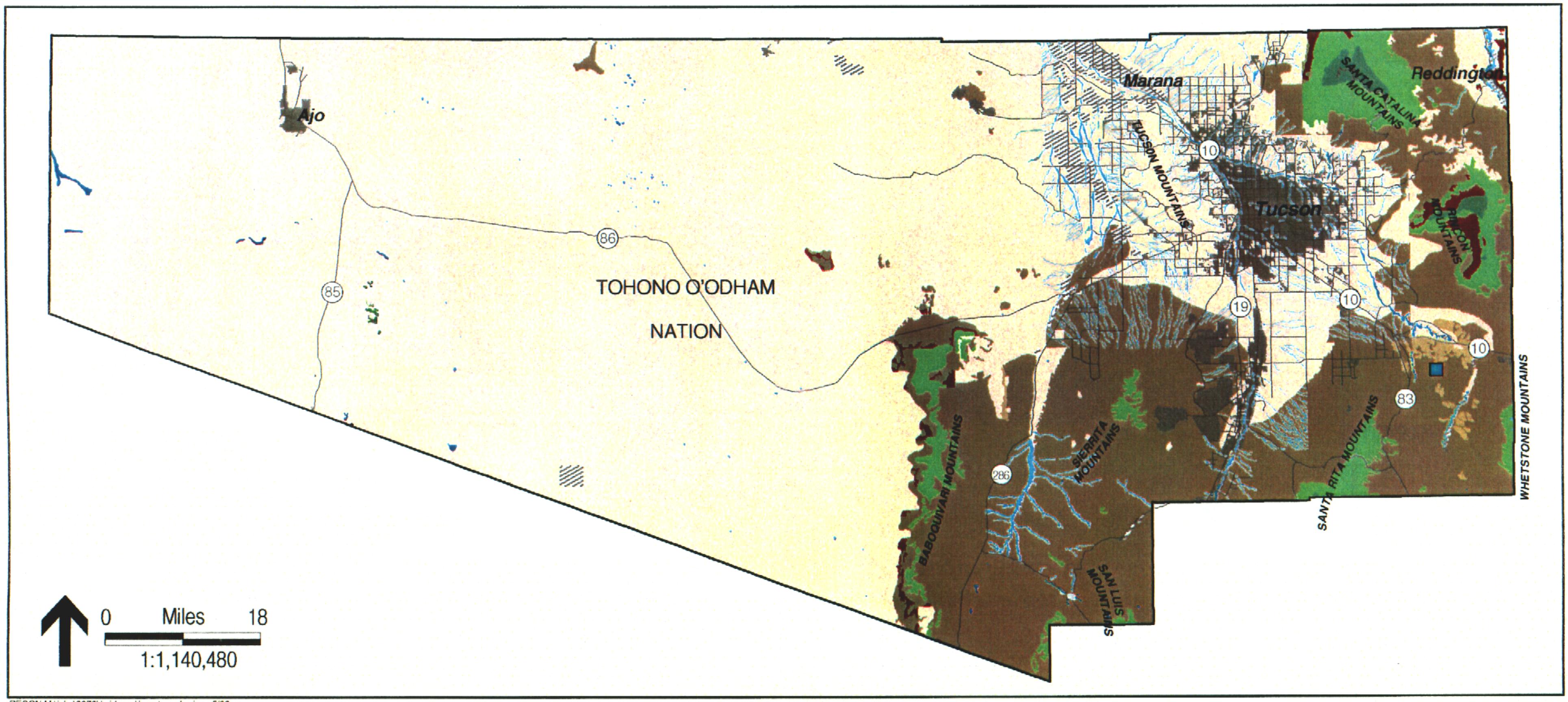
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 39



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Talus Snail *(Sonorella imperialis)*
Known Locations and Vegetation Biomes

Known Locations (SWCA, 2000)
- Talus Snail *(Sonorella imperialis)*

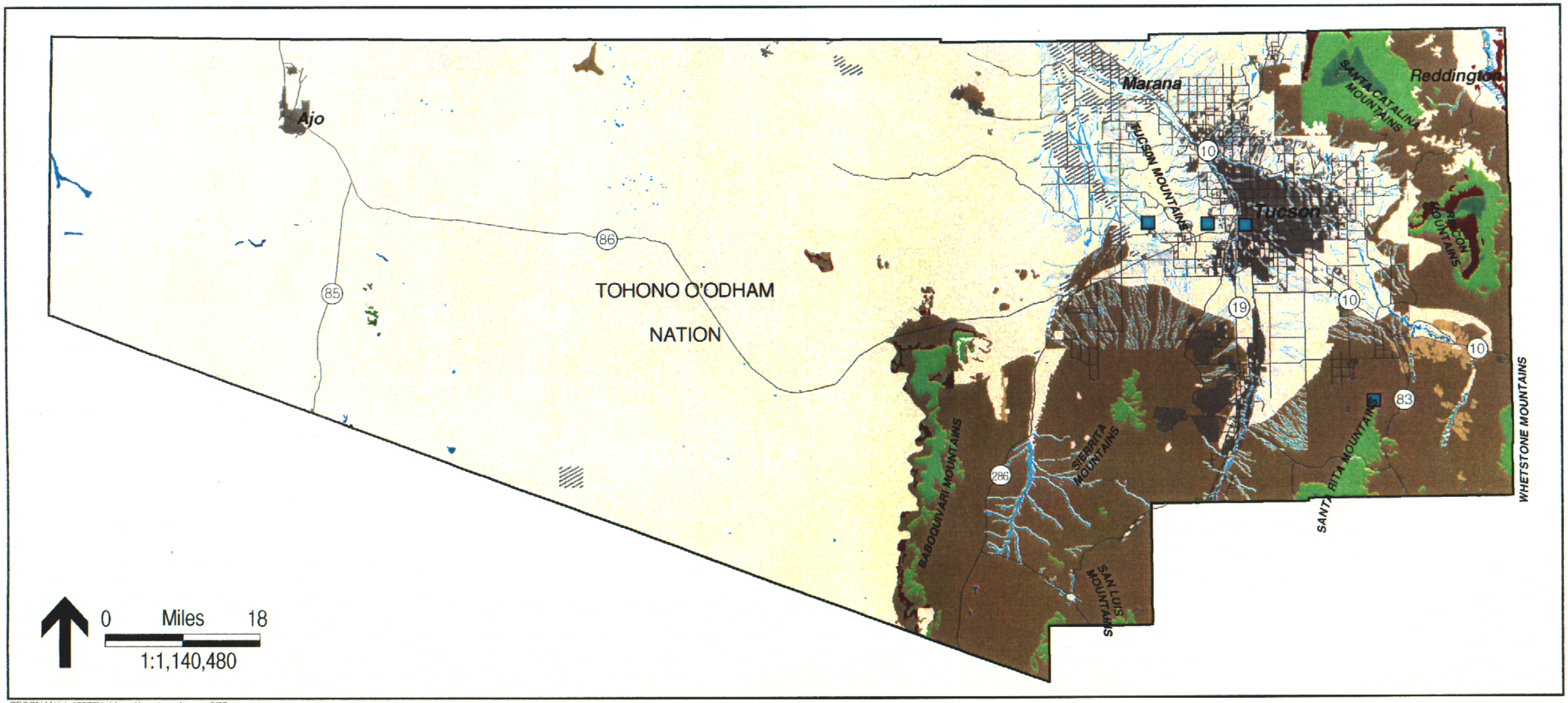
Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Pima County Boundary

Major Road or Highway

Figure 40



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Talus Snail *(Sonorella magdalensis)* Known Locations and Vegetation Biomes

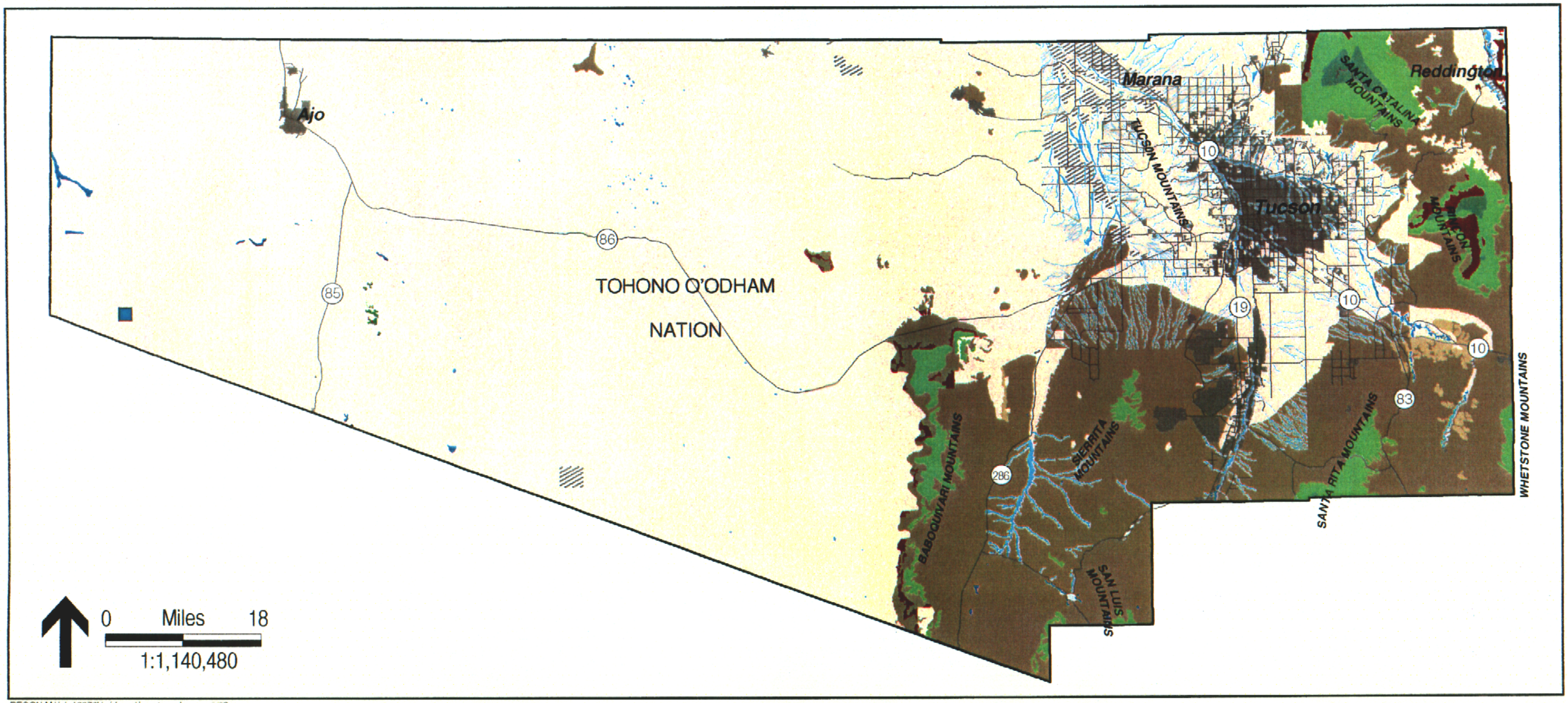
Known Locations (SWCA, 2000)
- Talus Snail *(Sonorella magdalensis)*

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 41



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Talus Snail *(Sonorella meadi)*
Known Locations and Vegetation Biomes

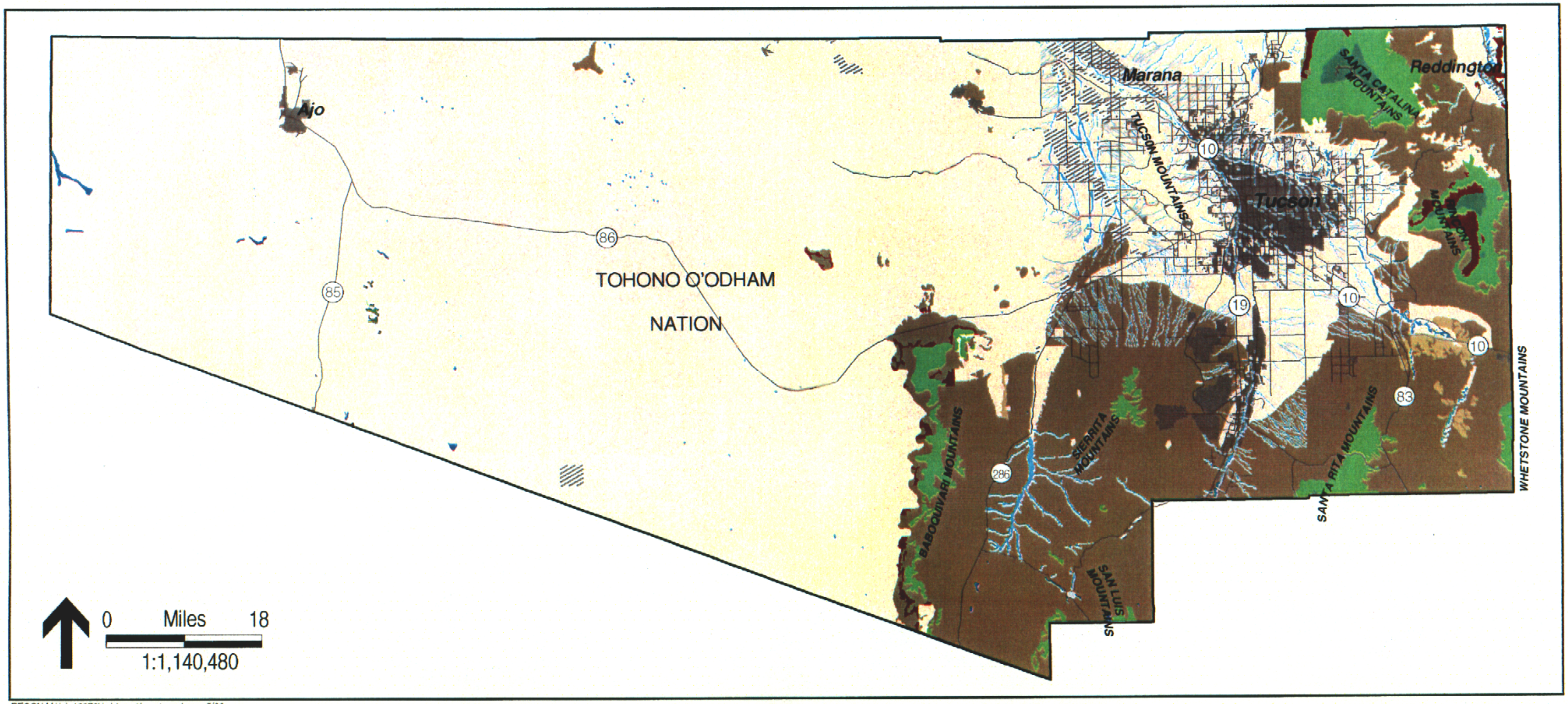
Known Locations (SWCA, 2000)
- Talus Snail *(Sonorella meadi)*

- Pima County Boundary
- Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 42



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Talus Snail *(Sonorella pupela)*
Vegetation Biomes

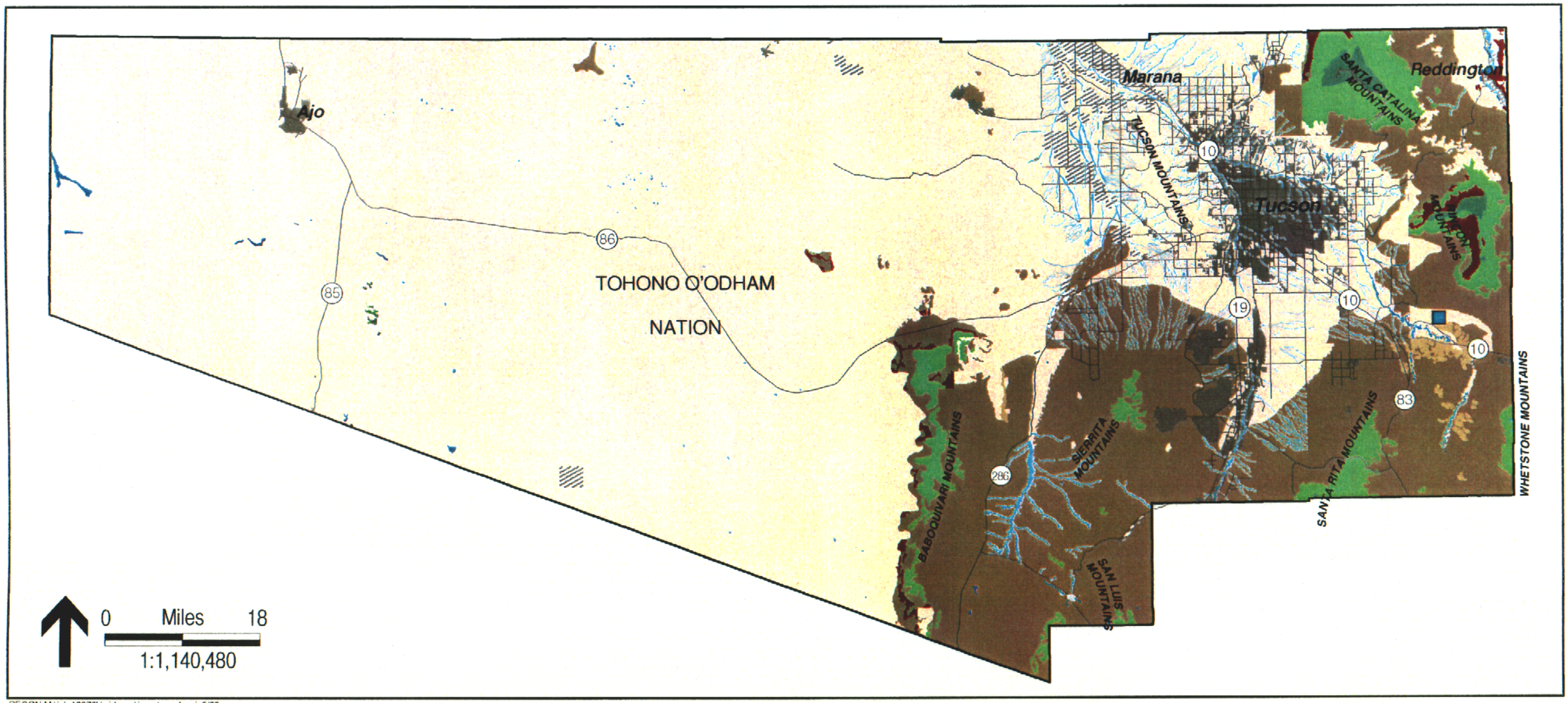
Potential Habitat Unknown
(Insufficient information
for mapping available.)

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 43



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Talus Snail *(Sonorella rinconensis)*
Known Locations and Vegetation Biomes

Known Locations
(SWCA, 2000)

- Talus Snail
  (Sonorella rinconensis)

Pima County Boundary
Major Road or Highway

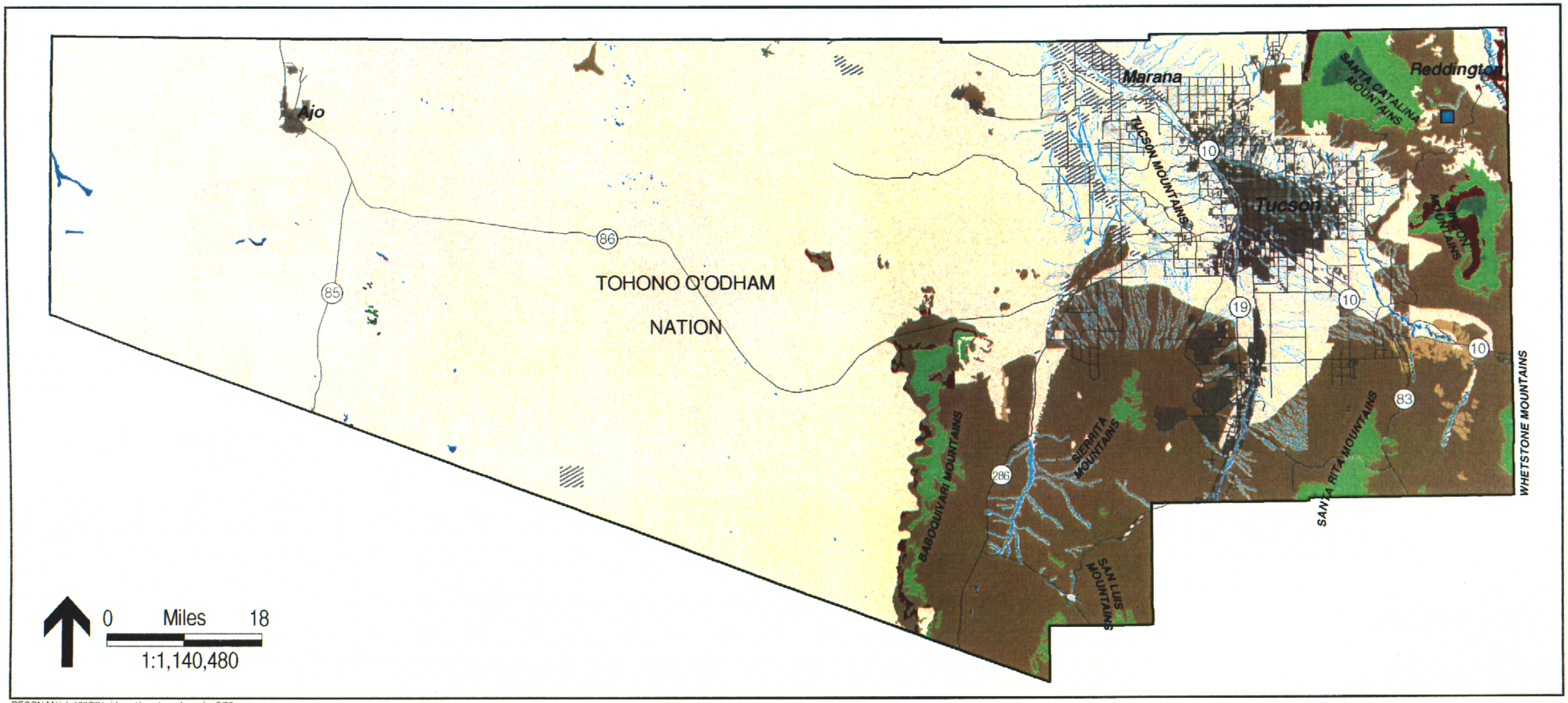
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 44



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Talus Snail *(Sonorella sabinoensis buehmanensis)*
Known Locations and Vegetation Biomes

Known Locations
(SWCA, 2000)

- Talus Snail *(Sonorella sabinoensis buehmanensis)*

Pima County Boundary
Major Road or Highway

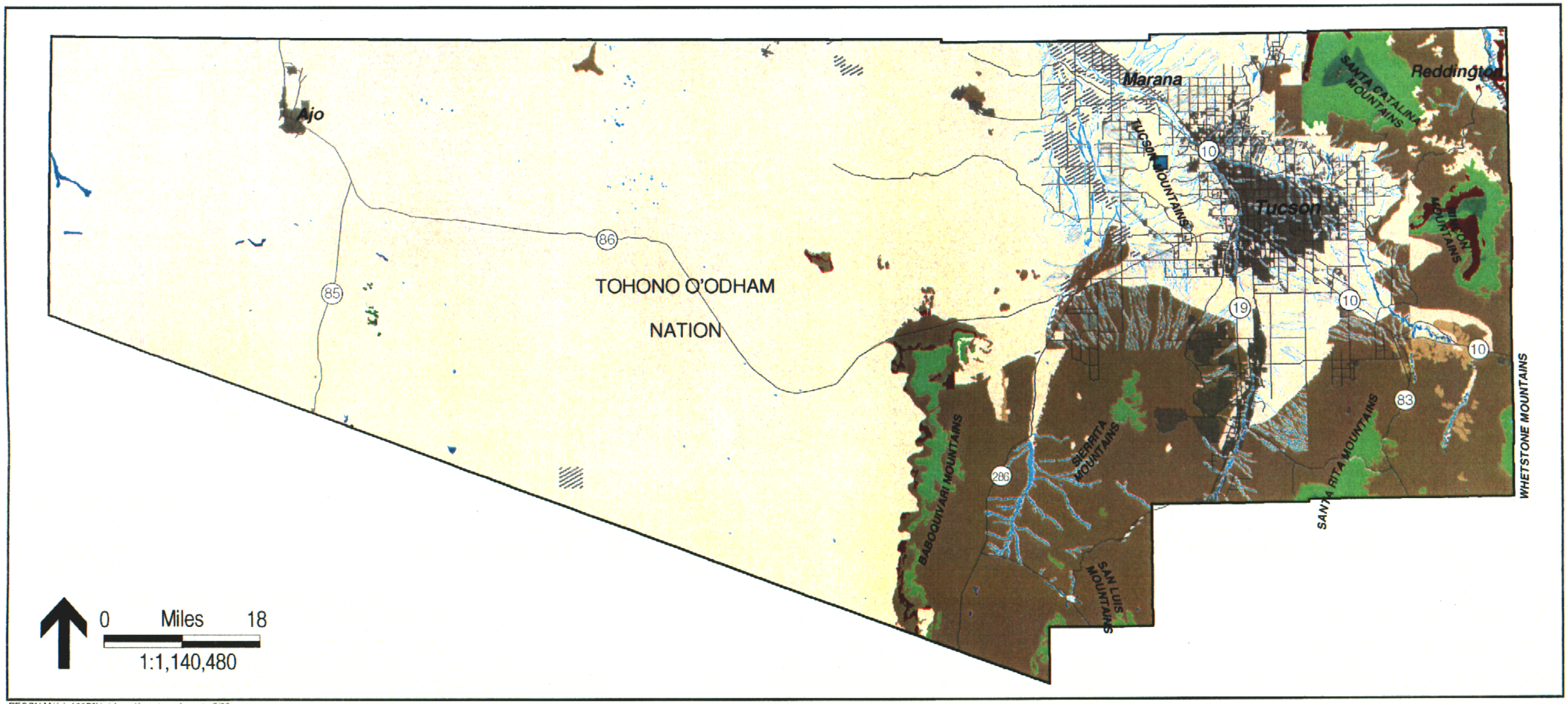
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 45



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Talus Snail *(Sonorella sabinoensis tucsonica)*
Known Locations and Vegetation Biomes

Known Locations (SWCA, 2000)

- Talus Snail *(Sonorella sabinoensis tucsonica)*

Pima County Boundary

Major Road or Highway

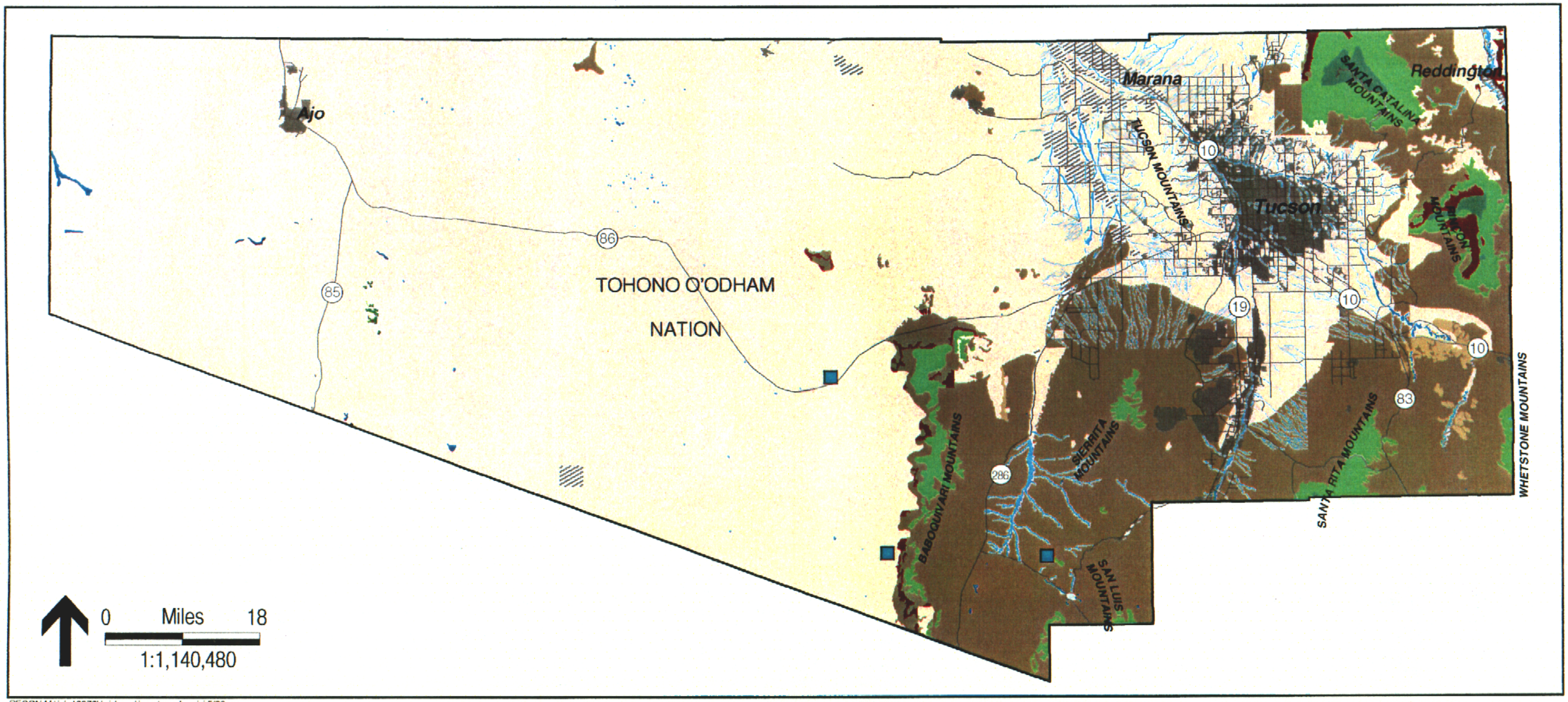
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 46



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Talus Snail *(Sonorella sitens sitens)*
Known Locations and Vegetation Biomes

Known Locations
(SWCA, 2000)

- Talus Snail
  (Sonorella sitens sitens)

Pima County Boundary
Major Road or Highway

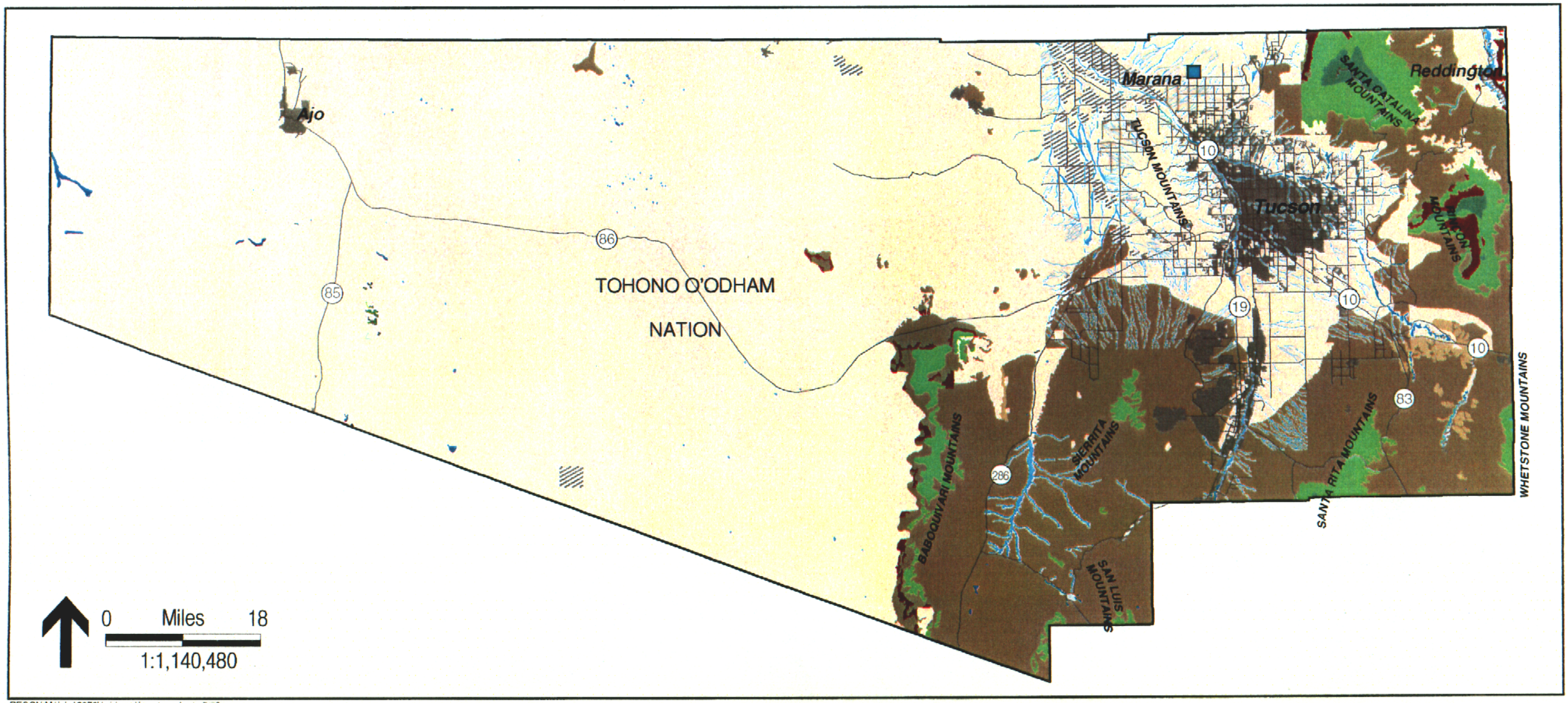
Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 47



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Talus Snail *(Sonorella tortillita)*
Known Locations and Vegetation Biomes

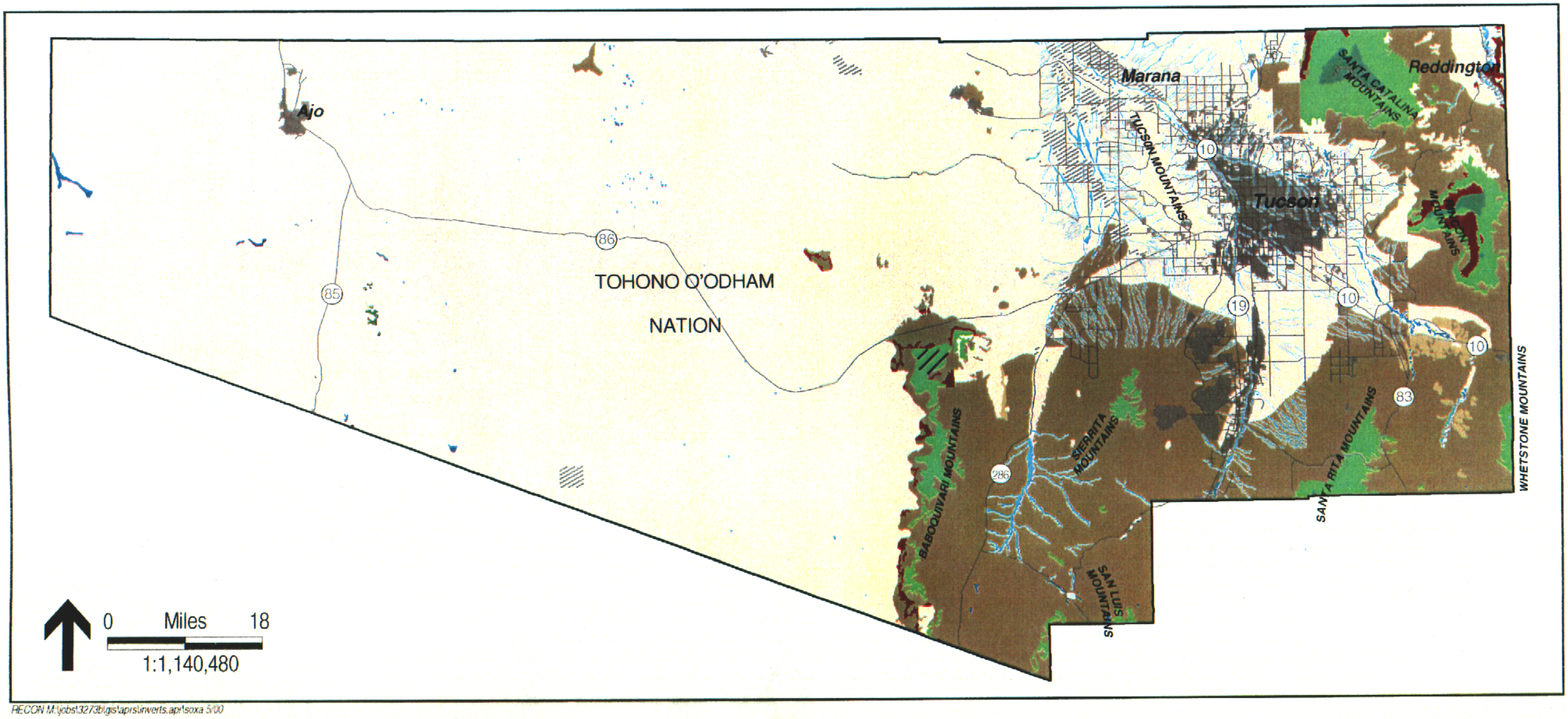
Known Locations (SWCA, 2000)
- Talus Snail *(Sonorella tortillita)*

Pima County Boundary
Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 48



Kitt Peak Talus Snail *(Sonorella xanthenes)*
Potential Habitat and Vegetation Biomes

Potential Habitat
(based on assessment for this study)

Kitt Peak Talus Snail
(Sonorella xanthenes)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 49

SONORELLA OF PIMA COUNTY

Species	Type locality	Range and Elevation (ft)	Owner/Management
Sonorella ambigua ambigua	Cababi Mts ca 75 mi W of Tucson (aka Ko Vaya Hills)	Cababi Mts (Ko Vaya Hills), 2,500 Roskruge Mts., 2,650-2,900 Quinlan Mts. at Kitt Peak, 5,500-6,300 Coyote Mts, 3,400-4,000 Robles HIlls, Comobabi Mts., hills 5 mi W of Kom Vo, 2,000 Santa Rosa spur of Nariz Mts., 2,280	Mostly on Tohono O'odham Nation lands
Sonorella baboquivariensis baboquivariensis	Baboquivari Mts. E side of range at head of Thomas Cyn 1.5 mi S of Baboquivari Peak	Baboquivari Mts. East side N side of Saucito Mt., 4,300	Tohono O'odham, private?, and USFWS?
Sonorella baboquivariensis berryi	Roskruge Mts. E side, small hill N of road	Roskruge Mts. E side, not relocated	BLM or State?
Sonorella baboquivariensis depressa	Baboquivari Mts. "Sycamore" = Brown Canyon	Baboquivari Mts. Sierrita Mts. Tucson Mts., 4,250	?
Sonorella eremita	NW end of San Xavier Hill, Mineral Hill Group	NW end of San Xavier Hill, Mineral Hill Group, 3,850	Private
Sonorella imperatrix	Empire Mts., 1.5 mi N of Total Wreck Mine	Empire Mts N section, W side of large peak, 1.5 mi No of Total Wreck Mine, 4,900	?
Sonorella imperialis	Empire Mts. uncertain	Empire Mts. along road to Forty-nine Mining Camp, N slope of mountain in gulch running N, S section of range, 4,800	
Sonorella magdalensis, S. tumamocensis, S. sitiens arida, and *S. linearis* are all synonyms	Sonora, Mexico above Magdalena	Cerro Colorado, 4,100 (*S. sitiens arida*) Roskruge Mts. Tucson Mts., 3,300 Santa Rita Mts., 5,500-5,800 (*S. linearis*) Tumamoc Hill, 2,750 (*S. tumamocensis*) also Sonora, Mexico, and Santa Cruz Co.	
Sonorella meadi	Agua Dulce Mts., canyons S and W of Agua Dulce Pass	Agua Dulce Mts., 1,600 Bates and Granite Mts.?	BLM? and NPS

SONORELLA OF PIMA COUNTY

Species	Type locality	Range and Elevation (ft)	Owner/Management

Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.

SONORELLA OF PIMA COUNTY (cont.)

Species	Type locality	Range and Elevation (ft)	Owner/Management
Sonorella rinconensis	Rincon Peak	Rincon Mts. Posa Quemada Canyon, 2 to 3 mi NE of Colossal Cave, 3,700 Rock slide on S side of the Tucson-Benson Hwy (of 1917), near the cave on Shaw's Ranch (now Posta Quemada Ranch), 3,500 1 to 2 mi SW of former ranch buildings, 2 to 3 mi N of new Tucson-Benson Freeway, S bank of Pantano Wash, 3,200 E bank of Agua Verde Creek, 3,300 Base of N facing limestone cliffs, ca 0.25 mi S of Posta Quemada Ranch	Private, State, and County, some locations may be included in Colossal Cave Mountain Park
Sonorella sabinoensis buehmanensis	Buehman Canyon near Korn Kobb Mine	Santa Catalina Mts. Buehman Canyon, near Korn Kobb Mine, 3,450 and elsewhere in Buehman Canyon	USFS and TNC?
Sonorella sabinoensis tucsonica	Tucson Mts.	N section of Tucson Mts., 2,300	Private?, NPS, or County?
Sonorella sitiens sitiens	Las Guijas Mts. NW end of range, above Las Guijas Mine	Las Guijas Mts., 4,000 Quijotoa Mts, near Ventana Comobabi Mts Cabai Mts (Ko Vaya Hills), 2,700 SW section of Baboquivari Mts., Chutum Vaya Cyn, 3,500 also Pajarito Mts. in Santa Cruz Co., 4,000	Mostly Tohono O'odham
Sonorella tortillita	Tortolita Mts. E side of Hog Canyon, Pinal Co.	Tortolita Mts., Ruelas Canyon, 3,050	Private?
Sonorella xanthenes	Kitt Peak, Quinlan Mts.	Ravines on N slope of Kitt Peak, 5,500-6,700	?

SOURCE: Bequaert and Miller 1973.

***SONORELLA* OF PIMA COUNTY (cont.)**

Species	Type locality	Range and Elevation (ft)	Owner/Management

Sensitive Information – Not available for public review.

Information obtained from and available in existing public documents is available from Pima County upon request. All requests for access to HDMS information should be forwarded to the Arizona Game & Fish Department.

SOURCE: Bequaert and Miller 1973.

Demographics

Density: No known information is currently available regarding density of natural populations.

Status: No known information is available about the current status of any of these species.

Trend: Population trends are not currently known.

Survival rates: No known information is currently available regarding survival rates in natural populations.

Reproduction rates: No known information is currently available regarding reproduction rates in natural populations.

Age ratios: No known information is currently available regarding age ratios in natural populations.

Significant Pima Co. populations or subpopulation basis in planning area: Because of their extreme rarity and total dependence on extremely limited habitat, all populations should be considered significant and they should be located (or relocated).

Habitat Requirements

Ability to use major land use categories: Apparently all *Sonorella* species live in isolated, undisturbed areas of rocks, generally, or exclusively, limestone, mostly, if not exclusively, on north-facing or trending slopes, usually near hilltops or in rocky canyons (Pilsbry and Ferris 1915, 1918; AGFD 1997; Terkanian 1999).

Habitat trends in planning area: One location, for *Sonorella eremita*, was disturbed by a road and the construction of microwave relay towers. It is subject to a conservation agreement that precludes additional disturbance of the remaining habitat (USFWS 1998).

No information is currently available about the condition or trends of the habitat of the other species that occur in Pima County.

Home range requirements: Limestone rocks with cracks or talus formations appear to be necessary for most species. No additional information about requirements for any of them is available.

Current and Potential Threats

General: The total known and likely range of many of these species is smaller than a moderate size house, and is isolated from any other potential habitat. Relatively minor perturbations of the habitat may result in changes that impact the snails. These species are thought to be particularly sensitive to potential global climate change (Terkanian 1999).

Pima County populations location, amount, and quality of protected habitat: Unknown, with the exception of that of *S. eremita*, which is protected by a conservation agreement. Some locations are within land that is protected in one form or another, but not specifically for these animals, and current conditions of the populations are unknown.

Existing and potential pest species: None are currently known for these animals, and none are likely to be problematic.

Threat mechanism: Minor to major disruption of habitat by road building, development, or other land uses.

Management Needs

General: Locating, examining, and documenting the currently existing populations and determining the most appropriate methods of management are the most pressing needs.

Current protective measures: Some populations are within protected lands, and most are difficult of access.

Sensitivity to human activities and densities: Minor disturbance of the land may result in major problems for these animals. Dirt carried by erosion may fill crevices necessary for survival, and erosion may be exacerbated by human activities. Curious people attempting to observe these snails have inflicted conspicuous damage to the habitat of *S. eremicus* (K. J. Kingsley, pers. obs.). Populations are extremely small, but their sizes are unknown. Any collection or disturbance is likely to be problematic.

Corridor needs: None are known, and the concept is probably irrelevant for these species.

Key relationships: There may be key interdependencies with some species of fungi. Limited information on this was developed of *S. odorata* (Gilbertson 1965).

Migratory requirements: None are known, and the concept is probably irrelevant for these species.

Results of past mitigation activities: No information is currently known regarding results of past mitigation activities for these species.

Existing monitoring and research programs: No information is currently known regarding existing monitoring and research programs for these species.

References

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Bequaert, J. C., and W. B. Miller. 1973. The mollusks of the arid Southwest. University of Arizona Press, Tucson, Arizona.

Gilberton, L. H. The biology of the snail *Sonorella odorata* Pilsbry and Ferris (Gastropoda: Pulmonata). Unpublished M.S. thesis, University of Arizona.

McCord, R. D. 1994. Phylogeny and biogeography of the land snail, *Sonorella*, in the Madrean Archipelago. Pp. 317-324 *in* L. F. Debano, P. F. Ffolliott, A. Ortega-Rubio, G. J. Gottfried, R. H. Hamre, and C. B. Edminster, tech. coords. Biodiversity and management of the Madrean Archipelago: the Sky Islands of southwestern United States and northwestern Mexico. USDA Forest Service General Technical Report RM-GTR-264, Fort Collins, Colorado.

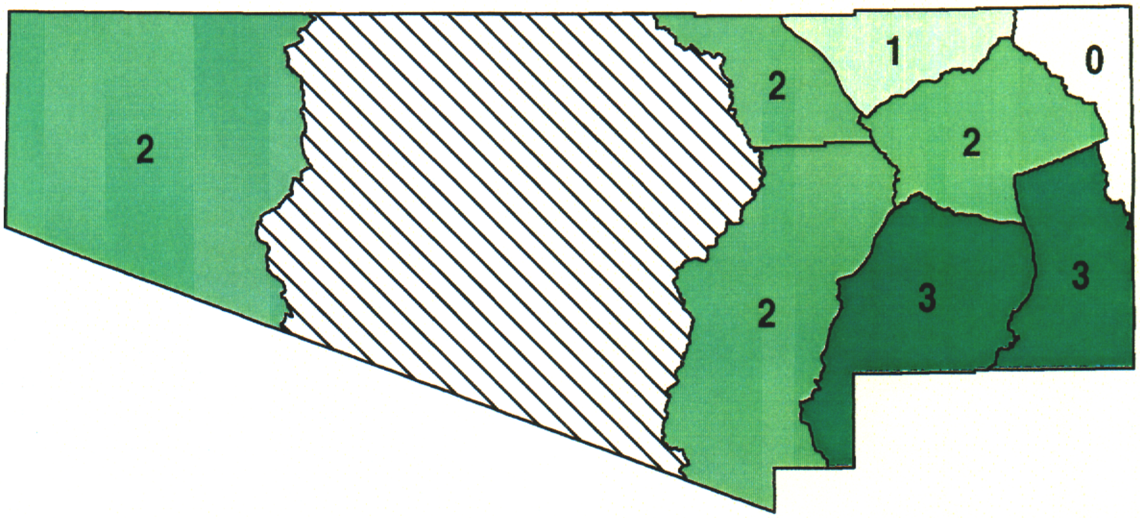
Pilsbry, H. A., and J. H. Ferris. 1915. The Dragoon, Mule, Santa Rita, Baboquivari, and Tucson Ranges, Arizona. Part VII of Mollusca of the southwestern states. *In* Proceedings of the Academy of Natural Sciences of Philadelphia 67:363-418.

Pilsbry, H. A., and J. H. Ferris. 1918. The Santa Catalina, Rincon, Tortillita, and Caliuro Mountains and The mountains of the Gila headwaters. Parts IX and X in Mollusca of the southwestern states. *In* Proceedings of the Academy of Natural Sciences of Philadelphia 70:282-333.

Terkanian, B. 1999. Conservation plans for the San Xavier Talussnail, *Sonorella eremita*. *In* Proceedings of the Invertebrates in Captivity Conference. Sonoran Arthropods Studies Institute, Tucson, Arizona.

U.S. Fish and Wildlife Service (USFWS). 1998. Endangered and threatened wildlife and plants; withdrawal of proposed rule to list the San Xavier talussnail (*Sonorella eremita*) as endangered. Federal Register 63:53620-53623.

Number of Priority Vulnerable Plant Species



Potentially Occurring in Each Subarea

PLANTS

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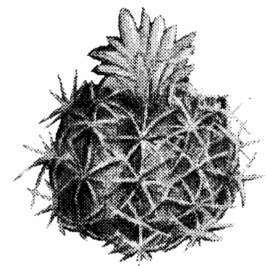
Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*)

Status



Federal	Listed as endangered by USFWS on September 23, 1993
State	Arizona Native Plant Law, Highly Safeguarded
Other	Forest Service Sensitive; protected from international trade by CITES; Vulnerable Status 1 by SDCP
Rankings	G4 S2

Recovery Goals

Federal: Recovery goals and a recovery plan are not yet available; critical habitat has not been designated.

State: None designated.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Pima pineapple cactus is a member of the cactus family. The genus *Coryphantha* was separated from the genus *Mammillaria* based on the presence of tubercle grooves, straight spines, and the position of the flowers at the base of the young tubercles (Benson 1969:194-196). This genus consists of cacti with solitary or branching stems that are cylindrical or subglobose in shape and 1 to 18 inches (2.5-46 cm) tall and 1 to 7 inches (2.5-18.5 cm) in diameter. Flowers and fruits appear on new growth at the apex of a stem or branch, developed in a special area at the base of the upper side of a tubercle distant from the spine-bearing part of the areole and connected with it by a narrow isthmus that persists for many years as an elongate groove on the tubercle. There are "some 30-40" species that range from southern Alberta to central Mexico, with 15 in Canada and the United States (Benson 1982:809) and 6 in Arizona (Benson 1969:194-196).

Classification: Family: Cactaceae (cactus family); Genus: *Coryphantha;* Species: *scheeri*; Variety: *robustispina* (new combination in Benson 1969).

Specific: *Coryphantha scheeri* var. *robustispina* was first described as *Mammillaria robustispina* (Engleman 1856) based on the type specimen that was collected by A. Schott in 1856 on the south side of "babuquibari" (i.e., Baboquivari) Mountains in Sonora, Mexico (Benson 1969:194-196). Since then, it has been reclassified and renamed several times. Synonyms used for this taxon and their authors are:

- *Mammillaria robustispina* Schott
- *Cactus robustispinus* Kuntze

- *Coryphantha robustispina* Britton & Rose
- *Coryphantha muehlenpfordtii* (Poselger) Britton & Rose var. *robustispina* W.T. Marshall
- *Coryphantha scheeri* (Kuntze) L. Benson var. *robustispina* (Schott) L. Benson
- *Mammillaria brownii* Toumey
- *Cactus brownii* Toumey

Benson (1982) lists 4 varieties of *Coryphantha scheeri* with different but partially overlapping distributions. The following names used for habitat types are those used by Benson. *C. s.* var. *scheeri* in the Chihuahuan Desert of New Mexico, Texas, and Mexico from Chihuahua to Zacatecas; *C. s.* var. *valida* in southeastern Arizona [an apparent error—no *C. s. valida* are known from southeastern Arizona as indicated in Benson (1982)] east to Texas and Chihuahua, Mexico, in Desert Grassland, Texan and Mexican grasslands, and Chihuahuan Desert; *C. s.* var. *uncinata* in the Chihuahuan Desert in the vicinity of El Paso, Texas, and *C. s.* var. *robustispina* in the Arizona Desert (upper edge), Desert Grassland, and the lower edge of Southwestern Oak Woodland in south central Arizona and northern Sonora. The name *Coryphantha* means "top flower" and refers to the position of the flower on the stem. The name *scheeri* is after a botanist named Scheer. The variety name *robustispina* refers to the very large hooked spines.

Life History

Description: *Coryphantha scheeri* var. *robustispina* is a succulent perennial that is hemispherical or cylindroid in shape and up to 4.0-18 inches (10.0-46.0 cm) tall and 3.0-7.0 inches (8.0-18.0 cm) in diameter. The spines are very stout and are straw-colored when young, but blacken with age (EES 1992). Each spine cluster has 1 strong central spine that is usually curved or hooked at the abruptly narrowed tip. There are 6 radial spines in young plants, and these increase to 10 to 15 in older plants. The spines vary from 0.76-0.92 inch (19.0-23.0 mm) long and the upper ones are more slender than the lower ones. The areoles are densely covered with deciduous woolly fibers that disappear at maturity. The tubercles are grooved along their upper surface. The stems can branch by developing basal offsets (clones) from the oldest tubercles (Roller 1996a:10). The plant may occur in clusters which are formed either by producing basal offsets, or when seeds germinate at the base of the mother plant. The flowers are bright silky yellow, or rarely white, with coral edges and have a narrow floral tube. The fruit is green, ellipsoid, succulent, and sweet. The seeds are brown or black and finely veined or netted (AGFD 1994).

Reproduction: Reproductive growth occurs during the summer rainy season. Flower buds appear in mid-May and the timing appears to be related to photoperiod. Flowering occurs 5 to 7 days after the first summer rains of at least 3 mm and continues through the monsoon season (Roller 1996a:10). Pollinators include both native insects and European honeybees. The species can self-pollinate; however, seed production is reduced by self-pollination (Roller 1996b). It appears that at least some seeds roll off the mother plant, land at its base, and germinate, forming clusters of a mother with offspring. Long-distance dispersal mechanisms are unknown, but observations of ground squirrels, jackrabbits, and some birds feeding on fruits and the presence of viable seeds in jackrabbit droppings provide some indication of possible mechanisms.

Distribution

Historic: Because there is no evidence to the contrary, we assume that the historic range of *Coryphantha scheeri* var. *robustispina* is roughly the same as the present range.

Present: *Coryphantha scheeri* var. *robustispina* inhabits southeastern Arizona and north-central Sonora. In southeastern Arizona, the known range lies within Santa Cruz and Pima Counties and is generally bounded to the east by the Santa Rita Mountains, to the west by the Baboquivari Mountains and does not extend to the north past the south side of Tucson (AGFD 1994) (Figure 50). There are outlier populations in the Vail area and just south of Interstate 10 and west of Highway 83, north of Mt. Fagan (Mima Falk, USFWS, pers. comm. to K. Kingsley, 1 May 2000). Of the 64 records of occurrence for this variety in the AGFD Heritage Data Management System records, 60 are from Pima County. These records do not represent all locations known to various individuals and agencies, but indicate the general known distribution of the plant. Distribution of this variety in Mexico is not well known, and it is possible that a different variety is found there (M. Falk, USFWS, address to Scientific and Technical Advisory Committee, 13 Apr 2000).

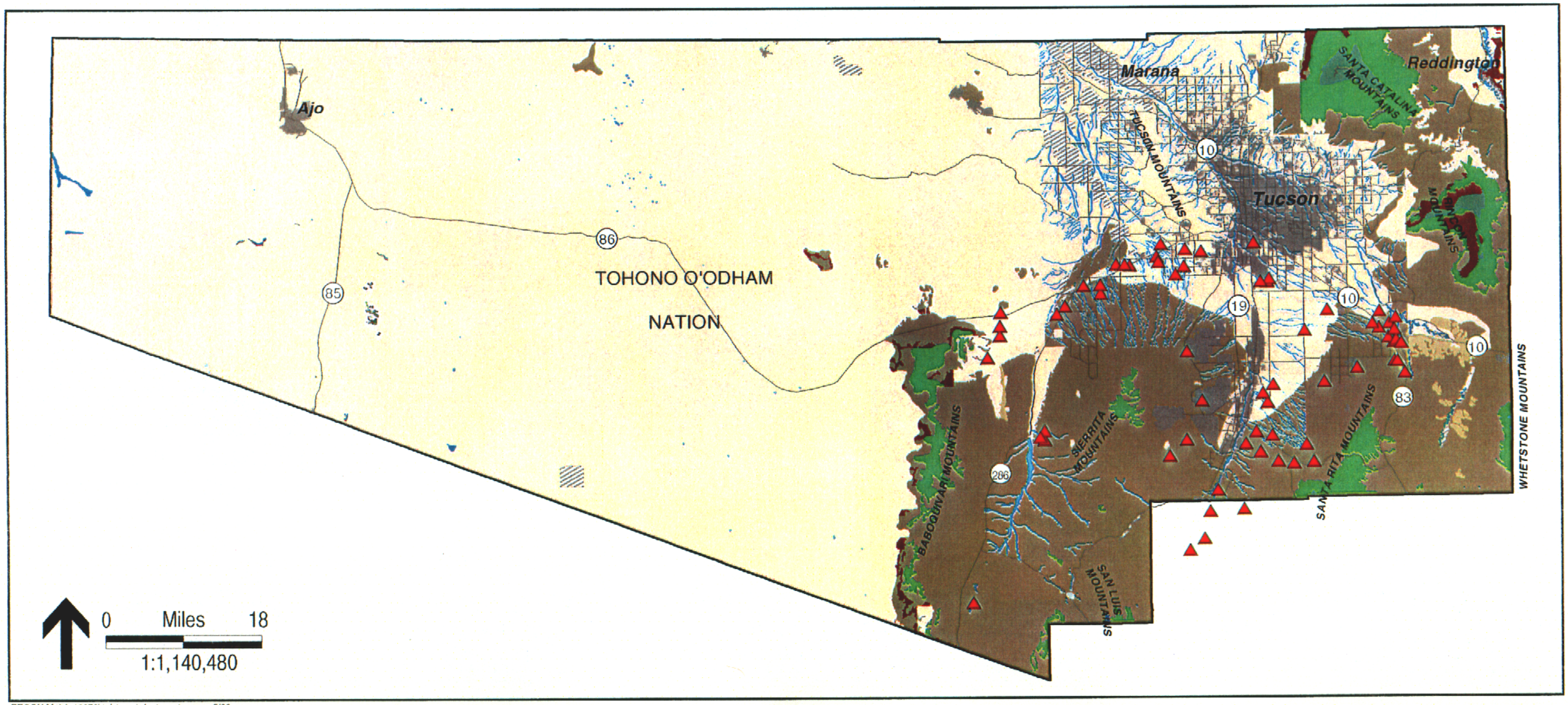
Demographics

Density: *Coryphantha scheeri* var. *robustispina* is not common or abundant within its habitat, but is sparsely distributed where found, although relatively dense populations occur locally (K. Kingsley and B. Pavlick, pers. obs.). It is difficult to estimate population density accurately because the species is well camouflaged within its habitat, and is difficult for even well-trained, experienced observers to find consistently (Roller 1996a:10). Density estimates for areas near the Sierrita Mountains of Arizona range from a low of 0.12 plant per ha to a high of 0.54 plant per ha (0.05 to 0.2 per acre) (Mills 1991).

Status: There are 64 records of occurrence for this species in the AGFD Heritage Data Management System. Of these, many may have been affected by development or degradation of habitat, or are on land that may be developed. Only about 10% to 20% of the geographic range of the variety is estimated to have been surveyed (M. Falk, USFWS, address to Scientific and Technical Advisory Committee, 13 Apr 2000).

Trend: The USFWS determined that this species should be listed as Endangered, citing the amount of habitat loss that had occurred and was likely to continue to occur throughout the range of this species, the amount of habitat modification, the scarcity of plants, and the difficulty in protecting an area large enough to maintain a viable population as factors contributing to the need to list this species as endangered (USFWS 1993). Populations of Pima pineapple cactus are believed to be on a downward trend due to loss and degradation of habitat (AGFD 1994).

Survival rates: Little is known regarding the survival rates of natural populations. In combined laboratory and shadehouse experiments, 47% of 160 planted seeds were established at the end of the first year of growth, and establishment was 30% lower than seed germination (Roller 1996b).



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Pima Pineapple Cactus
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

▲ Pima Pineapple Cactus
(Coryphantha scheeri var. robustispina)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 50

Reproduction rates: Adult cacti produced an average of 7 flowers and 5 fruits, and 71% of the flowers achieved fruit set through pollination (range 41-82%). The mean number of seeds in a pooled sample was 89, with a range of 24 to 131. Seed viability under controlled conditions was relatively high with an average germination of 89%. No seed dormancy mechanisms were apparent and seed longevity appeared to last beyond 21 months (Roller 1996b).

Age ratios: No information is currently available regarding age ratios in natural populations.

Significant Pima Co. populations or (sub)populations: Pima County encompasses the majority of this variety's known range.

Habitat Requirements

Ability to use major land use categories: *Coryphantha scheeri* var. *robustispina* cannot be associated with specific and narrow habitat descriptions (EES 1992). It has been found mostly along ridges in Semidesert Grassland and alluvial fans in the Arizona Upland Subdivision of Sonoran Desert Scrub as described by Brown (1994). It occurs from approximately 2,300 to 5,000 feet (702 to 1,525 m) in elevation, and is usually found on flat ridgetops with little slope and in soils that are mostly rocky loams (AGFD 1994). It is present in Arizona Desert (upper edge), Desert Grassland, and the lower edge of Southwestern Oak Woodland (Benson 1982).

Although little information is available regarding specific habitat requirements, the limited range and sparsely distributed populations of this cactus suggest specialized needs that may be revealed by further research. Some observers think that this cactus appears to be found most often on degraded, historically and/or currently overgrazed grassland in association with kangaroo rat mounds (R. Schmaltzel, pers. comm. to K. Kingsley, 22 Feb 2000; K. Kingsley, pers. obs.), although others disagree with the observation of association with kangaroo rats (B. Pavlick, pers. obs.). Probably the most consistent observation is that the cactus is found most often in "open" areas not associated with dense grass cover. This may be true, or an artifact of the ease with which it can be found in "open" areas.

Habitat trends in planning area: Portions of the range of this species were developed by agricultural, urban, and mining activities, including prehistoric and historic development, prior to the species being listed as Endangered. Therefore, it is not possible to determine the impact of this development on this species. Areas that are within the species' range have been proposed for development since the species was listed as Endangered. Of 632 Section 7 consultations done by the U.S. Fish and Wildlife Service in Pima County between 1984 and 1999, 12 determined that the proposed projects "may affect" this species, and 1 was determined likely to jeopardize the continued existence of the species. In all known "may affect" cases, mitigation (in the form of transplanting cacti to other locations) was done, but long-term follow-up has not yet determined the effects of mitigation. It is assumed that all transplanted plants are lost (M. Falk, USFWS, address to Scientific and Technical Advisory Committee, 13 Apr 2000). An extension of the Central Arizona Project was planned that included creation of a reservoir (Tucson Aqueduct Reservoir Site) that would have entailed the loss of approximately 640 acres of "habitat" with an unspecified number of plants (AGFD 1994). This plan resulted in the only jeopardy opinion, and has not yet been developed. In the long term, however, it is reasonable to conclude that some portion of the range of this species is likely to be developed and subsequently lost.

Pima County's mountain parks and natural preserves will be expanded with the development of the Sonoran Desert Conservation Plan through the design and implementation of a comprehensive open space park and preserve system that meets endangered species compliance standards for the region. It is anticipated that this will include habitats that include known populations of this species and incorporate room for expansion of these populations.

Current and Potential Threats

General: The final listing as Endangered by USFWS identified the following factors as all affecting the species:

- present or threatened destruction, modification, or curtailment of habitat or range;
- overutilization (of the plant) for commercial recreational, scientific, or educational purposes;
- disease and predation; and
- inadequacy of existing regulatory mechanisms.

Pima County populations location, amount, and quality of protected habitat: The majority of the species known range is in Pima County (AGFD 1995). Lands occupied by Pima pineapple cactus are administered or owned by Coronado National Forest, BLM (Phoenix District), Bureau of Reclamation, Buenos Aires National Wildlife Refuge, Tohono O'odham Nation, Arizona State Lands Department, and many private landowners. The species is sparsely distributed within a limited range, very little of which (<5 to 10%) is federal land (AGFD 1994). Most of the land within the species' known range is private or state land.

Existing and potential pest species: Pima pineapple cactus appears to have been damaged by the larval stage of a moth in the family Phycitidae (Phillips et al. 1981). The effect of this damage is unknown (USFWS 1993). An unidentified beetle eats the plant and lays eggs in the plant. Larva consume the plant from the inside out. This appears to be the proximate cause of death of many plants, but whether it is the ultimate cause is unknown. Competition with non-native grasses, such as bufflegrass, Lehmann's lovegrass, and red brome, may be a problem for this species. The introduction and spread of Lehmann's lovegrass has affected up to 75% of Pima pineapple cactus habitat (USFWS 1993) and altered historical fire regimes (Roller 1996a:10, 1995). Individual Pima pineapple cactus plants appear to exhibit less vigor in community types characterized by higher fire frequencies and continuous stands of Lehmann's lovegrass (Roller 1996a:10).

Threat mechanism: Speculation includes direct loss of individuals, loss or degradation of habitat by trampling or grazing by livestock, recreation, and agricultural or land development; poaching; and competition with non-native plants. However, the only threat that has been clearly documented to impact this species is direct disturbance of land with this species on it.

Management Needs

General: AGFD (1994) identified the following key management needs:

- livestock management needs to be improved;
- education needs to be provided to the public regarding Arizona Native Plant Law and cactus theft;

- additional surveys need to be conducted to better delimit the range, particularly in Mexico;
- further research is needed to determine if transplantation is successful as a mitigation measure;
- demographic monitoring should be initiated to determine if existing populations are stable; and
- several preserves that are large enough to sustain viable populations should be set aside.

Current protective measures: The USFWS Final Rule listing this variety as Endangered implements federal protection under the Endangered Species Act. At the time of the listing, USFWS determined that designation of critical habitat was not prudent for the species due to the threat of illegal collection (USFWS 1993). Protection for plants under the ESA is somewhat limited when they occur on private land. The Arizona Native Plant Law protects the species as a "Highly Safeguarded Species" requiring a permit for collection and salvage. *Coryphantha scheeri* var. *robustispina* is included in Appendix II of CITES, which requires that a permit be obtained for export from the country of origin.

Sensitivity to human activities and densities: Earth disturbing activities associated with rapidly growing human populations are occurring throughout the range of the species and are the most significant cause of habitat loss and fragmentation (USFWS 1993). Extensive residential development within the known range has fragmented habitat and may continue to do so. The effect of such fragmentation on this species, which apparently has a naturally fragmented distribution, is not clear. Other human activities that may have reduced habitat for Pima pineapple cactus include mining, agricultural practices including grazing, and off-road vehicle use.

Corridor needs: No specific corridor needs are known. Dispersal corridors may be necessary for the successful establishment of new populations of the species; however, characteristics of appropriate corridors are unknown and long-distance dispersal mechanisms are unknown.

Dispersal requirements: Dispersal mechanisms are currently unknown. Dispersal can take place by both sexual and asexual reproduction; however, suitable habitat must be available for new populations to become established. Because little is known regarding specific habitat requirements for this species, potential dispersal routes and establishment sites are impossible to assess without further research. Protection of habitats that are characteristic for this species and within the known range to the extent possible will ensure future management options.

Key relationships: Pima pineapple cactus is found primarily in Lower Sonoran Desert Scrub and Semi-desert Grassland dominated by white-thorn acacia (*Acacia constricta*), velvet mesquite (*Prosopis velutina*), thread snakeweed (*Gutierrezia microcephala*), triangle-leaf bursage (*Ambrosia deltoidea*), and various other cacti and grasses (EES 1992). Roller (1996b) documented the collection and ingestion of fruit by the greater roadrunner (*Geococcyx californianus*) and activity around individual plants by rodents and lagomorphs. These animals may be important for dispersal of seeds, but effective seed dispersal has not been demonstrated, and the seed dispersal mechanism remains unknown. Visitors to Pima pineapple cactus flowers include native insects and European honeybees (Roller 1996a:10, 1996b). The potential effects of the recent loss of feral European honeybees and the arrival and establishment of Africanized honeybees on populations of both native plants and their native pollinators are unknown.

Results of past mitigation activities: Large Pima pineapple cacti seem to survive transplantation well if proper methods are followed (Mills 1991; Roller 1996a:10). However, long-term monitoring is limited or non-existent and the USFWS considers transplanted individuals as lost (M. Falk, USFWS, address to Scientific and Technical Advisory Team, 13 Apr 2000). In a salvage operation at a land-development project just north of Green Valley, transplant survivability of plants that were moved to a monitored shadehouse setting was successful if the roots were trimmed and hardened off before replanting (Roller 1996a:10). Long-term studies of survival of transplanted cacti and populations have not been done but are under way as part of the requirements of a Section 7 consultation (K. Kertell, pers. comm. to K. Kingsley, 11 Jan 2000). The Natural Resources Conservation Service conducted a program of control of the shrub *Euryops multifidus*, which had been introduced by the Soil Conservation Service and had become naturalized on the Santa Rita Experimental Range. This probably had a beneficial effect on Pima pineapple cactus habitat (M. Falk, USFWS, pers. comm. to K. Kingsley, 1 May 2000).

In a prescribed burn conducted at Buenos Aires National Wildlife Refuge that sought to control non-native grasses, Pima pineapple cacti surrounded by a firebreak survived and produced fruits (AGFD 1994). Again, long-term studies have not been done on the effects of this mitigation activity on individuals and the population.

Existing monitoring and research programs: Monitoring efforts are in progress on a small transplanted population (K. Kertell, pers. comm. to K. Kingsley, 11 Jan 2000). Other similar efforts may be in progress, but these are unknown. A 4-year study of the demography and natural history of this species is currently under way by research staff of the Arizona-Sonora Desert Museum, with support from the National Fish and Wildlife Foundation. The population on the Coronado National Forest has been monitored for the last 4 years and will continue to be monitored (M. Falk, USFWS, pers. comm. to K. Kingsley, 1 May 2000).

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Gentry indigo bush (*Dalea tentaculoides*)

Status

Federal	Species of Concern, former Candidate C2 (AGFD 1998)
State	Arizona Native Plant Law, Highly Safeguarded
Other	Forest Service Sensitive; protected from international trade by CITES; Vulnerable Status 1 by SDCP
Rankings	G1 S1

Recovery Goals

Federal: There are no agency-mandated recovery goals for this species.

State: There are no agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species

Taxonomy

General: *Dalea tentaculoides* was described by Gentry in 1950. The type specimen was collected from Sycamore Canyon, Pajarito Mountains, Santa Cruz County, Arizona (Kearney et al. 1960).

Classification: Family: Fabaceae; Genus: *Dalea*; Species: *tentaculoides.*

Specific: There are 36 species of *Dalea* in Arizona (Kearney et al. 1960). However, the taxonomy is unclear. "*Dalea tentaculoides* is a distinctive member of the genus, with no closely related species" (AGFD 1997).

Life History

Description: The Gentry indigo bush is a shrubby, erect, perennial herb, growing from a woody root crown, up to 6.6 feet (2.0 m) high but usually less. Older plants have numerous hairless stems 12.0 to 20.0 inches (30.0 to 50.0 cm) tall. Stems branch from near the base, and are covered with pustulate tubercles. Young branches are green, turning brown with age. The compound leaves are 1.2 to 2.4 inches (3.0 to 6.0 cm) long with 9 to 17 pairs of leaflets; the upper leaves are smaller with 3 to 8 pairs of leaflets. Leaflets are hairless, with midribs not obvious, and are notched at the tips, dotted with small punctate glands below. Flowers are sessile and 0.24 inch (6.0 mm) long, bracts persistent and 0.12 to 0.2 inch (3.0 to 5.0 mm) wide. The inflorescences are spiked, flowers are borne in oblong clusters, petals are rose-purple, borne above middle of the stamen tube. Sepals, floral bracts, and branches bear elongate, tentacle-like glands. Seeds are 0.06 inch (1.5 mm) long (AFGD 1997).

This is the only *Dalea* that has elongate, tentacle-like glands on the calyx and floral bract. It is easily confused with, and misidentified as, *D. versicolor* and *D. greggii*. *D. pulchra* has gray-green, hair-covered leaflets. Each leaf has 2 to 4 pairs of leaflets, and the inflorescence is spherical. *D. sessilis* and *D. versicolor* (Now [1994] *D. versicolor sessilis*) are spring blooming, with 4 to 9 pairs of curved (smaller than *D. tentaculoides*) leaflets per leaf. *D. versicolor* has blister bumps on the calyx (AFGD 1997).

Reproduction: This plant can grow back vigorously (resprout) when buried by flooding; multiple stems arising from under the ground make it difficult to determine the number of individuals. The largest plants in 1991 were found in the lee of obstructions (boulders, trees) that protected the plants from severe flooding effects. The largest clumps in Sycamore Canyon are found on the lee side of trees and boulders. These plants survived severe flooding in 1990 (AFGD 1997).

Behavior: The Gentry indigo bush may be bifloral, flowering from April through June and then again from September through October, following the winter and summer rains. The flowers are smaller at the second flowering, looking more like a globe (AFGD 1997).

Distribution

Historic: The Gentry indigo bush was found in southern Arizona, and may extend into Mexico.

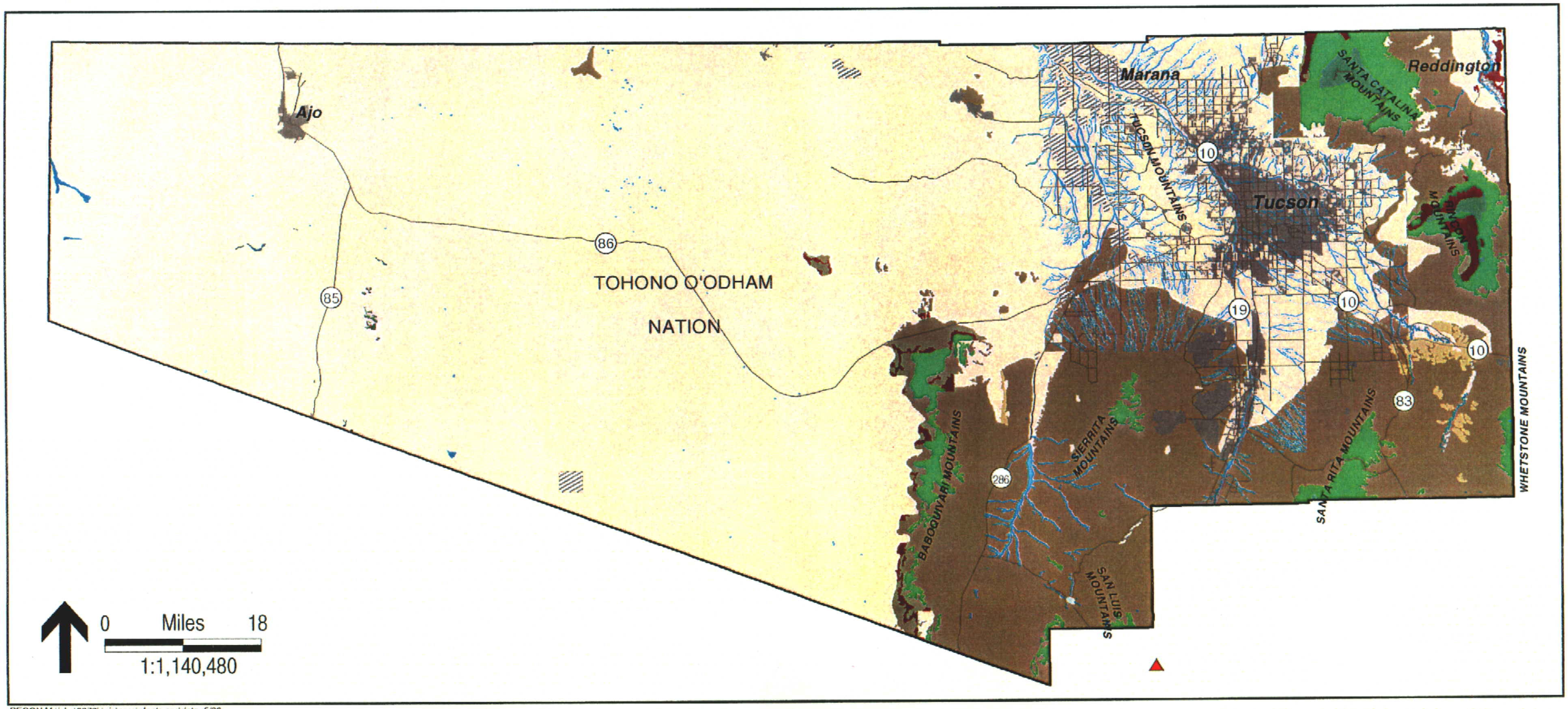
Range within Arizona: The Gentry indigo bush is only known in the Sycamore Canyon drainage in the Atascosas Mountains, Pajarito Mountains, Santa Cruz County, and Baboquivari Mountains (in the 1930s), and was recorded in 1965 in Mendoza Canyon, Pima County. There are 8 or 9 historical, non-specific sites, not relocated (AFGD 1997).

This species is not known from Pima County (Figure 51), but not all of the potentially suitable habitat has been searched, and some locations in Pima County have been mentioned as possible locations for transplanting this species.

Demographics

Density: The population size varies year to year (impacts from trespassing cattle and flooding, 1990). The species can rebound rapidly by root sprouting (AFGD 1997).

Status and Trend: In Sycamore Canyon (1981), only 1 population containing over 100 plants was found. In 1989, problems with fence maintenance of Goodding Research Natural Area allowed extensive livestock utilization of the Sycamore Canyon population (1990). The fence was subsequently repaired and improved. The single known population in Sycamore Canyon, Atascosas Mountains, increased from 1291 to 1389 individuals (between 1990 and 1991). The study plot, however, showed higher mortality than recruitment, with the population dropping from 148 to 118 individuals. Despite the drop, mortality was very low for the larger size classes. There was significant growth of last year's individuals; hence, the number of large individuals nearly quadrupled. The number of inflorescences produced increased greatly. In early 1993,



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Gentry Indigobush
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

▲ Gentry Indigobush
(Dalea Tentaculoides)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 51

severe flooding occurred. When plot was surveyed in June, 1993, 20 to 30 individuals was observed although many were completely covered by sand (AFGD 1997).

The species is no longer found in Mendoza Canyon (Gori 1994), although the specimen collected in 1965 from that location has detailed locality information (AFGD 1997).

Survival rates: There is no readily available information on survival rates.

Reproduction rates: There is no readily available information on reproduction rates.

Age ratios: There is no readily available information on age ratios.

Sex ratios: There is no readily available information on sex ratios.

Significant Pima Co. populations: The species is not recorded as occurring in Pima County.

Habitat Requirements

General: The Gentry indigo bush is found along canyon bottom on cobble terraces that are subject to occasional flooding. Historic collection records indicate possible growth on rocky hillsides. The species often occurs in disturbance prone environments (AFGD 1997).

Home range requirements: The Gentry indigo bush requires a substrate of sandy, gravelly loam of rhyolite parent material. It is found in the Oak-juniper Woodland and Madrean Evergreen Woodland plant communities, and is associated with the species: *Platanus wrightii, Fraxinus velutina, Juglans major,* and *Quercus* spp. Exposure may be shaded or unshaded. The plant has been recorded from elevations ranging from 3,600 to 4,400 feet (1,098 to 1.342 m) (AFGD 1997).

Ability to use major land use categories: The Gentry indigo bush is found in the Oak-juniper Woodland and Madrean Evergreen Woodland plant communities.

Habitat trends in planning area: Because the species is not known from the planning area, it is not appropriate to discuss habitat trends in the planning area.

Current and Potential Threats

General: The greatest threats to this species are alleged to be watershed degradation due to overgrazing by livestock, plants being eaten by livestock, and trampling by recreationists or livestock (AFGD 1997).

Location, amount, and quality of protected habitat: The largest known population grows in Sycamore Canyon, in the Atascosas Mountains, Santa Cruz County.

Existing and potential pest species: There is no readily available information on pest species.

Threat mechanism: The greatest threats to this species are alleged to be watershed degradation due to overgrazing by livestock, plants being eaten by livestock, and trampling by recreationists or livestock (AFGD 1997).

Management Needs

General: Fence maintenance is needed to protect sensitive populations from livestock trampling and depredation, or trampling from recreationists (AFGD 1997).

Current protective measures: Following problems with fence maintenance of Goodding Research Natural Area (1989) that allowed extensive livestock utilization of the Sycamore Canyon population, the fence was subsequently repaired and improved (AFGD 1997). There are no other known current protective measures.

Sensitivity to human activities and densities: The species is sensitive to livestock grazing and foot traffic that tramples plants (AFGD 1997).

Key relationships: The Gentry indigo bush requires a substrate of sandy, gravelly loam of rhyolite parent material. It is found in the Oak-juniper Woodland and Madrean Evergreen Woodland plant communities.

Results of past mitigation activities: Goodding Research Natural Area was extended to include more of the Gentry indigo bush population (AFGD 1997), but results are not certain.

Suggested monitoring and research programs: Seed collections for future reintroduction; additional surveys (particularly east side of Baboquivaris) are needed in potential habitat. Monitoring of the whole drainage (Sycamore Canyon population) is recommended to better understand the plant's adaptation to disturbance (AFGD 1997).

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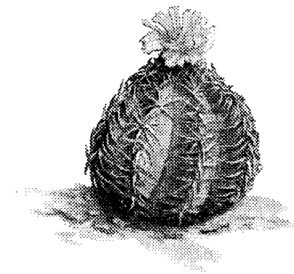
Nichol's Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholii*)

Status



Federal	Listed as Endangered by USFWS on October 26, 1979 (44 FR 61927)
State	Arizona Native Plant Law, Highly Safeguarded
Other	Protected from international trade by CITES; Vulnerable Status 1 by SDCP
Rankings	G4 S2

Recovery Goals

Federal: An approved Recovery Plan has been prepared (USFWS 1986). Critical habitat has not been designated.

State: There are no known state agency recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

Classification: Family: Cactaceae (cactus family); Genus: *Echinocactus;* Species: *horizonthalonius;* Variety: *nicholii.*

Nichol's Turk's head cactus is a member of the cactus family. The genus *Echinocactus* consists of heavily spined barrel-shaped cacti that grow to 6 feet (2 meters) tall. Benson (1982) states that there are 12 and possibly more species occurring in the U.S. and Mexico, but that the status (meaning taxonomic status) of the extraterritorial species has not been fully evaluated. More recently Chamberland (1996) stated that there are 6 described species in the genus, growing in the southwestern U.S. and Mexico. Both authors agree that there are only 2 species that occur in Arizona, *E. polycephalus* and *E. horizonthalonius.* Both of these species are further subdivided into 2 varieties. The only variety of *E. horizonthalonius* found in Arizona is var. *nicholii.* The variety was named as a new taxon in Benson's 1969 book *The Cacti of Arizona.* The type locality is said to be southwest of Silver Bell, Silver Bell Mountains, 2,800 feet elevation, in Pima County (Benson 1969). The first specimen of *Echinocactus horizonthalonius* var. *nicholii* was collected by Forrest Shreve from Pima County in 1918; however, it was not recognized as a distinctive variety until relatively recently (Benson 1969). Several varieties have been named under *E. horizonthalonius* but are not recognized by most cactus specialists (USFWS 1986). Chamberland (1995:13) stated: "The Sonoran Desert plants tend to grow taller, and have been described as *E. horizonthalonius* var. *nicholii* L. Benson. However, the distinction of this variety is obscured by the variability present in the Chihuahuan Desert populations."

The name *Echinocactus* is from the Greek *Echinos* meaning hedgehog and *cactus* meaning a spiny plant (Chamberland 1995), the variety name is after A. A. Nichol, formerly of the University of Arizona and Arizona Game and Fish Department (Benson 1982). No source for the common names is available; however, "Turk's Head" probably refers to a fancied resemblance of this cactus at some stage of growth to a hat worn by someone from Turkey. There is apparently no synonymy for the scientific name. Other common names for this plant include blue barrel (Earle1980; Chamberland 1995), eagle's-claw (Chamberland 1995), eagle claw cactus, and Nichol Turk's head cactus (ESIS 1996).

Life History

Description: Nichol's Turk's head cactus is a small, blue-green to gray-green barrel cactus with a single stem. Individuals are up to 18 inches (45.0 cm) tall and 8 inches (20.0 cm) in diameter. Seedlings often sprout at the base of a mother plant and may give the impression of small clumps. Small individuals are more-or-less spherical, and as the individuals grow, they develop a longer, twisted shape. Plants may have 7 to 13 prominent ribs, but usually have 8. There are generally 3 central spines on each areole, 1 of which is black, curves sharply downward, and is a distinguishing character for this variety. The remaining central spines are red at the tips and gray at the base and curve upward. These central spines are approximately 1 inch (2.5 cm) long. There are 5 radial spines on each areole, which are approximately 3/4 inch (1.9 cm) long. The flowers are pink, magenta, to bright purple and are 2 to 3 inches (5.0 to 7.0 cm) long. The fruit is wooly and white. The seed is black and longer (0.13-0.17 inch [0.33-0.43 cm]) than broad (0.5 inch [1.25 cm]) (AGFD 1994).

Reproduction: Nichol's Turk's head cactus produces offspring by sexual reproduction. Flowering occurs in late April to mid-May. The number of flowers produced appears to depend on a combination of summer and winter rainfall patterns, with the range of 6 to 10 (ESIS 1996). Apparent pollen disseminators include bees, butterflies and ants. Fruit matures from May to June. Each fruit contains 50 to 100 seeds, resulting in an average of 200 seeds per plant each year. Seeds produced in one year are released as the next year's new flower opens and dislodges the old fruit. Seeds are thought to be dispersed by birds and along rills by rainwater. Germination occurs in mid-summer. Seed viability is quite high, even after 20 years (ESIS 1996).

Distribution

Historic: *Echinocactus horizonthalonius* is widely distributed in the Chihuahuan desert of west Texas. During the Pleistocene, the range of *Echinocactus horizonthalonius* may have extended from the Chihuahuan Desert region into the Sonoran Desert region during a period of relatively high temperatures and low rainfall (Yatskievych and Fischer 1984). If so, return of pluvial conditions might have fragmented its distribution into disjunct populations, enabling the Sonoran Desert plants to diverge from the typical form (Yatskievych and Fischer 1984). That is, this variety may be a relict population of a once more widespread parent taxon. Because there is no evidence to the contrary, we assume that the historic range of *Echinocactus horizonthalonius* var. *nicholii* is roughly the same as the present range.

Present: Nichol's Turk's head cactus occurs in Pima and Pinal Counties, Arizona and Sierra del Viejo, Sonora, Mexico. In Arizona the range extends from the Vekol Mountains in southwestern Pinal County south to the Waterman Mountains in Pima County (Figure 52) and including the Silver Bell Mountains (AGFD 1994 and HDMS records). It occurs only on limestone-derived soils, in rocky soil or soils composed largely of talus chips, and appears to be limited by soil (ESIS 1996). It occurs through an elevation range of 2,400 to 4,100 feet (732 to 1,250 m). It is known from Planning Units 6B and 7, in sites depicted on the Waterman Peak, Silver Bell East, and Silver Bell West 7.5-minute U.S.G.S. quadrangle.

Demographics

Density: Density varies with slope and exposure, with density higher on rocky terraces than on alluvium. On alluvium, plants are more robust and at greater density in open, exposed areas than in areas with shade plants such as trees and shrubs. In one study, density was found to range from 2.3 to 8.6 plants per 1000 square meters (ESIS 1996).

Status: The Silver Hill Mine on Waterman Peak has a robust population that numbers approximately 10,00 plants; 1500 to 1660 of those plants were tagged and mapped as part of Section 7 consultation (AGFD 1994). Research on this population continues intermittently (B. Schmaltzel, pers. comm. to K. Kingsley, 19 Apr 2000). Reliable data on the status of other populations are not available.

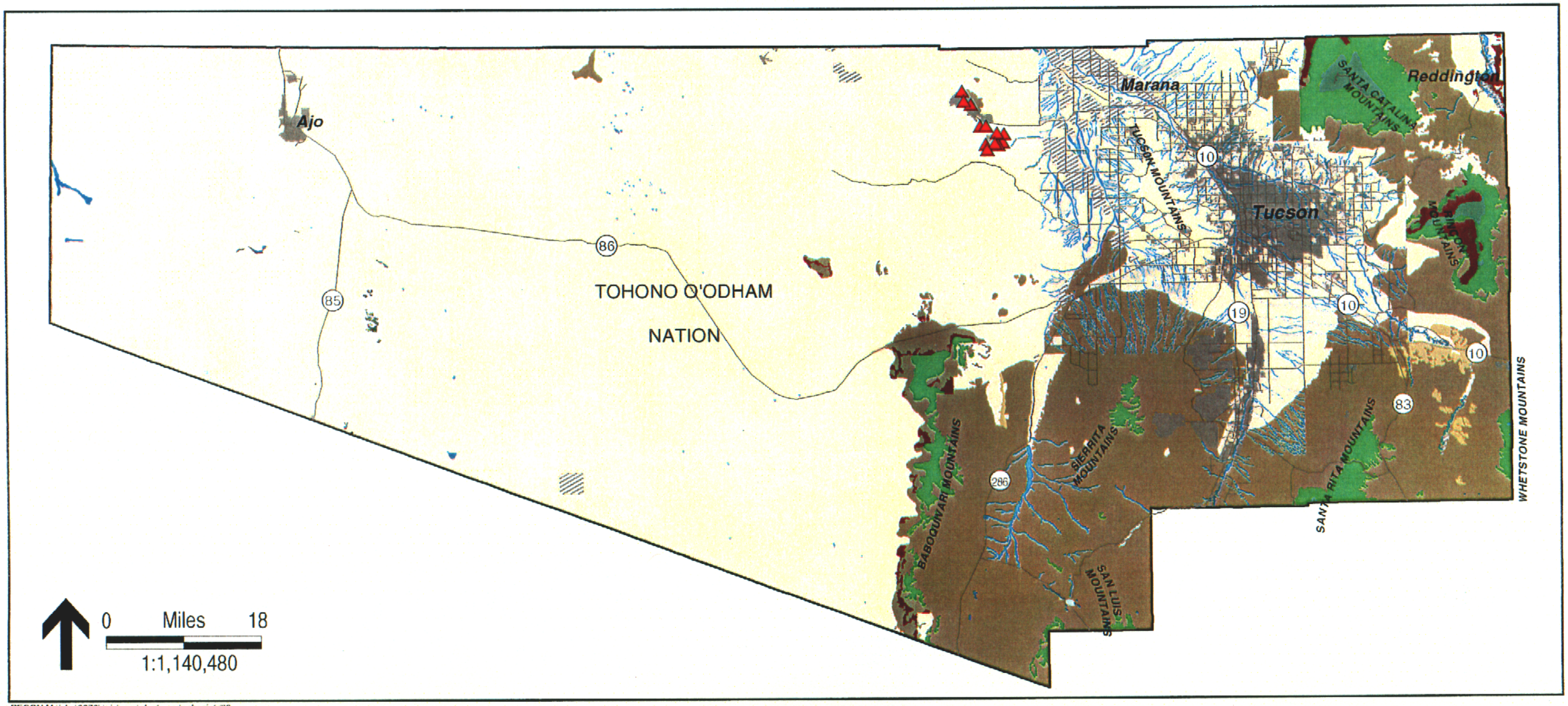
Trend: One observer has noted older size classes diminishing in monitoring plots at Waterman Peak (AGFD 1994). Reliable recent data on the overall trend are not available.

Survival rates: Differences in fecundity and survival exist between plants inhabiting rocky terraces versus those in alluvial habitats, with those at higher elevations with more rocks and moisture having denser populations (USFWS 1986; ESIS 1996). Shaded plants grow, flower and survive at lower rates than plants that inhabit open microhabitats (USFWS 1986). Limiting factors include extent of limestone soils, exposure to freezing temperatures, amount of open unshaded habitat, and availability of safe sites for seedling establishment (ESIS 1996; USFWS 1986). Soil erosion is an important survival factor because half-buried plants do not grow well and rodents eat plants that have washed out or been injured (ESIS 1996).

Reproduction rates: Population dynamics are slow for this cactus and the turnover rate is low (ESIS 1996).

Age ratios: Growth rates are uniform within local populations but differ between populations (USFWS 1986; ESIS 1996). In general, the mean age is 9.5 to 13+ years and maximum age varies from 24 to 39 years in the populations that have been studied, although plants up to 69 years old have been reported (ESIS 1996). Young plants made up from 48% to 80% of the studied populations (ESIS 1996).

Significant Pima Co. populations or subpopulation basis in planning area: All of the 12 occurrences recorded by the HDMS database are in Pima County. Of these, 6 are on private lands, 4 are on Bureau of Land Management lands, and 2 are on Arizona state lands. The Waterman Peak population is possibly the largest and best studied and therefore may be considered most significant.



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Nichol's Turk's Head Cactus
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

▲ Nichol's Turk's Head Cactus
(Echinocactus horizonthalonius var. nicholii)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 52

Habitat Requirements

Nichol's Turk's head cactus inhabits talus-strewn Carboniferous and Devonian limestone slopes in the Upland Division of Sonoran Desert Scrub, 2,400 to 3,600 feet (732 to 1,098 m) in elevation on north-, west- and south-facing slopes (AGFD 1994) although the elevation range may be slightly broader, from 2,460 to 4,100 feet (750 to 1,250 m) (ESIS 1996). It is restricted only to limestone-derived soils. It is generally found in open vegetation characterized by few trees and scattered low shrubs. At lower elevations it is found in gravely substrates and at higher elevations it is found in rocky areas.

Ability to use major land use categories: This species grows only in the Arizona Upland Division (Paloverde-Mixed Cacti Series) of the Sonoran Desert Scrub biome.

Habitat trends in planning area: Habitat is not increasing. Because of protections afforded by this species status as Endangered, significant loss of habitat on federal land is not expected to occur. However, because this plant occurs on a mixture of federal, state, private, and Tohono O'odham Nation land, some loss of habitat due to human actions should be considered possible. Part of the range of this species has been proposed for protection within proposed Pima County mountain parks and natural preserves. If these parks and preserves are created and managed as proposed, loss of the majority of this species' habitat will be prevented.

Current and Potential Threats

General: The final listing as Endangered by USFWS identified mining of limestone deposits, off-road vehicle use, and collection as factors affecting the species (USFWS 1986). Any modification of the habitat, such as by clearing, introduced invasive plants, severe grazing pressure, or off-road vehicle traffic would probably have a negative impact on the species (ESIS 1996).

Pima County populations location, amount, and quality of protected habitat: Much of the species known range is in Pima County. Lands occupied by Nichol Turk's head cactus are administered or owned by the following entities: the Bureau of Land Management Tohono O'odham Nation, Arizona State Lands Department, and private landowners (AGFD 1994).

Existing and potential pest species: Packrats (*Neotoma* sp.) eat the plants after washout or injury. Birds eat the seeds and ants attack the nectaries (ESIS 1996). The effects of these native animals on individual plant survival and population dynamics are unknown. Non-native invasive grasses may become a problem for this species, through competition for space and water in a very limited suitable habitat.

Threat mechanism: Alteration of suitable habitat by human activities including mining, recreation, and unauthorized collection are considered as major threats (USFWS 1986). In addition, seed collection by commercial cactus nurseries may be a serious problem, because collection methods can damage the central meristem of this cactus and prevent further growth and reproduction (ESIS 1996).

Management Needs

General: According to the Recovery Plan for *Echinocactus horizonthalonius* var. *nicholii* (USFWS 1986), the following actions are needed:

- Studies on ecology and population biology including soil need, water needs, effects of small herbivores, determination of pollinators, life history requirements, and demographic trends and application of this information into management plans.

- Searches for other populations in suitable habitat within the known range in Arizona and recently discovered range in Sonora, Mexico.

- Implementation of a Habitat Management Plan and designation of an Area of Critical Environmental Concern.

- Development of propagation techniques to provide nursery stocks both to reduce collection and for use in reintroduction efforts.

- Development of public awareness, appreciation, and support for the preservation of Nichol's Turk's head cactus.

Current protective measures: The endangered status implements federal protection under the Endangered Species Act. Critical habitat has not been designated for the species. The Arizona Native Plant Law protects the species as a "Highly Safeguarded Species" requiring a permit for collection. *Echinocactus horizonthalonius* var. *nicholii* is also protected from collection and trade by CITES and the Lacey Act.

Sensitivity to human activities and densities: Human activities alleged to affect this species include direct impacts from collection, off-road vehicle use, hiking and camping, surface mines, highway and railroad construction, and soil compaction by heavy equipment (ESIS 1996).

Corridor needs: No specific corridor needs are known. Dispersal corridors may be necessary for the successful establishment of new populations of the species; however, characteristics of appropriate corridors are unknown. There is no evidence that corridors are an appropriate consideration for this species, and establishment of new populations of this species should be considered highly unlikely because it is limited to a very specific and uncommon habitat and has likely filled the available suitable space.

Key relationships: Nichol's Turk's head cactus is associated with Paloverde-Cactus (*Cercidium-Opuntia*) shrub communities. Dominant species in this community include *Cercidium microphyllum*, *Ambrosia deltoidea*, *Krameria grayi*, *Encelia farinosa*, *Opuntia phaecantha*, *Carnegiea gigantea*, *Fouquieria splendens*, and *Opuntia acanthocarpa* (AGFD 1994).

Dispersal requirements: Currently known means of dispersal include distribution of seeds by birds and along rills by rainwater, and falling at the base of the mother plant. Because this plant is extremely substrate limited, management for establishment of new populations may not be appropriate. Protection of sites currently occupied by this species is probably the only appropriate management option.

Results of past mitigation activities: Long-term effects of past mitigation efforts are unknown. Possible decline in older size classes and lack of observations of small plants (AGFD 1994) may be a temporary natural phenomenon, or may indicate a problem.

Existing monitoring and research programs: Recovery efforts by the BLM have included the development of a Habitat Management Plan and establishment of a monitoring plot in the Waterman

Mountains which has been studied for several years (ESIS 1996). A study was done by The Nature Conservancy, funded in part by the Arizona Department of Agriculture and Horticulture, of populations of this species on the Tohono O'odham reservation (B. Schmalzel, pers. comm. to K. Kingsley, 19 Apr 2000).

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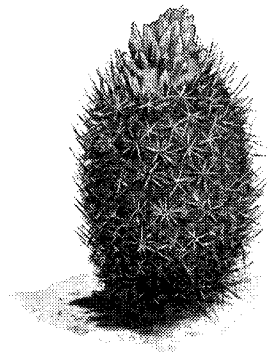
Yatskievych, G., and P. C. Fischer. 1984. New plant records from the Sonoran Desert. Desert Plants 5:180-185.

Acuña cactus (*Echinomastus [=Sclerocactus] erectocentrus* var. *acuñensis*)

Status



Federal	Federal Candidate List
State	Arizona Native Plant Law, Highly Safeguarded
Other	Forest Service Sensitive; Bureau of Land Management Sensitive; protected from international trade by CITES; Vulnerable Status 1 by SDCP
Rankings	G3 S1

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Acuña cactus is a member of the cactus family (Cactaceae). Until recently, the genus was called *Echinomastus*, but recently it was changed to *Sclerocactus* (Kartesz 1994). Apparently not all taxonomists accept this revision (e.g., Pinkava 1995), and most of the literature available refers to this species as in *Echinomastus* or one of the early genera to which it was assigned. In this document, this species will be referred to as *Echinomastus erectocentrus* var. *acuñensis* for convenience, but readers should be aware that the accepted name may become *Sclerocactus*, and that this variety may be sunk.

Three species of *Echinomastus* occur in Arizona (AGFD 1997). These are *E. erectocentrus*, *E. intertexta*, and *E. johnsonii*. The genus consists of cacti with branched or unbranched stems that are ovoid to cylindroid and 2 to 15 inches (5.0-37.5 cm) tall and 1 to 5 inches (2.5-12.5 cm) in diameter. Flowers and fruits appear on new growth of the current season near the apex of the stem or branch, each on the side of the tubercule in a felted area distant from the spine-bearing portion of the areole and connected by the isthmus running the length of the tubercle, the area persisting and forming an elongate and narrow scar (Benson 1969).

Classification: Family: Cactaceae (cactus family); Genus *Echinomastus*, meaning "spiny stem"; Species: *erectocentrus;* Variety: *acuñensis*. *Echinomastus erectocentrus* has 2 varieties: the Acuña cactus (*E. e.* var. *acuñensis*) and the needle-spined pineapple cactus (*E. e. erectocentrus*). Both varieties occur in Pima County but occur in different and widely separated portions of the county.

Specific: The Acuña cactus was first described as *Echinomastus erectocentrus* by W. T. Marshall based on the type specimen, which was collected by William Supernaugh on January 2, 1951 at Organ Pipe Cactus National Monument. Benson described the species as *Neolloydia erectocentra* var. *acuñensis* (1969); however, later descriptions and most current usage have reverted to the Marshall's original name *Echinomastus erectocentrus*, with 2 recognized varieties. The type locality is OPCNM, Pima County, Arizona (AGFD 1997). Acuña cactus presumably derives its common and variety names from the Acuña Valley, which was likely named for an early settler (CASA 2000).

Other names used for this taxon and their authors are:

- *Echinomastus erectocentrus* Britton and Rose
- *Thelocactus erectocentrus* W. T. Marshall
- *Mammillaria childsii* Blanc
- *Echinocactus krausei* Hildmann
- *Theocactus drausei* Kelsey and Dayton
- *Neolloydia erectocentra acuñensis* (Coulter) L. Benson
- *Sclerocactus erectocentrus* (Coulter) N.P. Taylor

Life History

Description: The Acuña cactus has solitary stems that usually range from 3 to 9 inches (7.5-22.5 cm) tall and 3 to 4 inches (7.5-10.0 cm) wide and are gray-green in color (Benson 1969; AGFD 1997). The tubercles are about 0.5 inches (1.25 cm) long vertically (Benson 1969) and a groove extends from areole to the base of each tubercle (AGFD 1997). The spines are distinctive: the radial spines are in clusters of 11 to 15 and are up to 1 inch (2.5 cm) long with reddish to yellowish coloration and dark tips; the central spines are 0.75 to 1.5 inches (1.9-3.4 cm) long and straight (not hooked) (AGFD 1997). The upper central spines ascend and converge, giving the appearance of a "red-headed crew cut" (Phillips et al. 1982). The flowers are 2 inches (5.0 cm) or more long. Flowers are variable in color, but often pink to purple. The fruits are pale green, become tan when dry, and are .5 inch (1.25 cm) long. The fruits bear papery scales and dehisce by splitting. The seeds are rough and black (AGFD 1997).

Reproduction: Flowering takes place from March to mid-April (AGFD 1997). Flowering is correlated with plant size and, presumably, age. Plants less than 40 mm tall rarely produce flowers and plants over 90 mm tall almost always produce flowers. This species is self-incompatible and pollinated by at least eleven species of bees. Fruit set and seed set do not appear to be limited by pollinator abundance and fruit set is high; however, water availability appears to limit flower production. The primary germination period is during the summer monsoon (Johnson 1992).

Distribution

Historic: Benson (1969) recorded the geographic range of this variety as western Pima County to the Sand Tank Mountains of Maricopa County and to Pinal County near Florence, and northern Sonora, Mexico. The U.S. range supports only widely separated disjunct populations (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000).

Present: Five populations of Acuña cactus are currently known, 4 of these are in the U.S. and 1 is in Sonora, Mexico (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000). The U.S. populations include 1 at OPCNM; 1 near a mine pit on private land at Ajo, Arizona; 1 northeast of Ajo, Arizona, on Bureau of Land Management lands; and 1 east of the jail in Florence, Arizona (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000) (Figure 53). Only a very small part of the species potential range has been surveyed.

Demographics

Density: Recently monitored populations number from 40 individuals (Arcadis Geraghty & Miller, Inc. and SWCA, Inc. 1997) to populations that number greater than 300 individuals (OPCNM 1998). Because the species is difficult to detect, and grows in small, widely scattered populations, some populations may be undetected.

Status: If illegal collecting continues to occur and continues to target plants that are critical to population stability, population decline is likely to occur (OPCNM 1998).

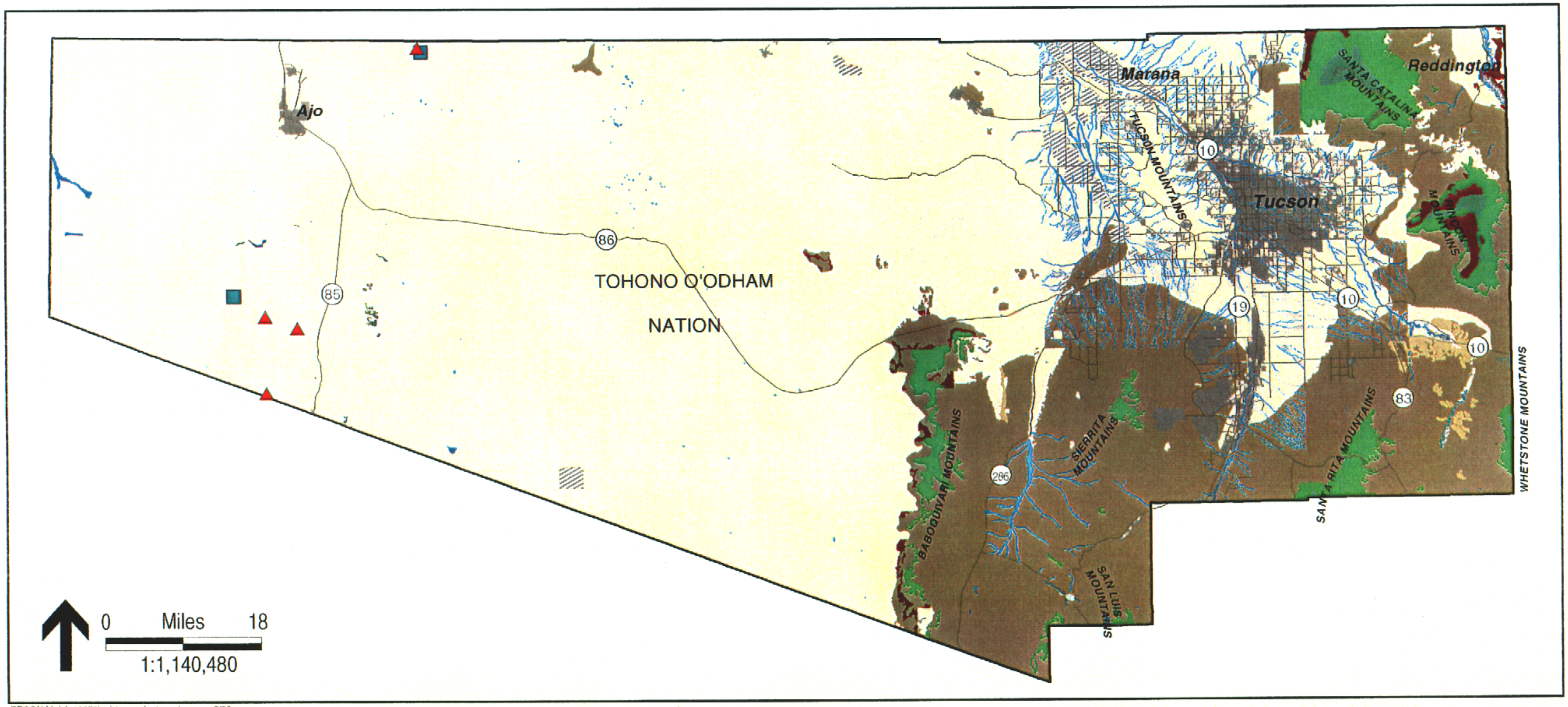
Trend: Populations located within OPCNM appear to be relatively stable according to AGFD (1997), but the BLM population is declining due to the combined effects of livestock and an expanding burro (*Equus asinus*) populations (OPCNM 1999). Illegal collection and decline in habitat quality are the causes for the decline of a population on public lands jointly managed by the BLM and Arizona State Lands Department (OPCNM 1999). The Ajo population is almost gone due to historic impacts associated with mining (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000).

Survival rates: Little information is available regarding the long-term survival of individuals or populations of Acuña cactus; however, data from annual monitoring at OPCNM documented that highest mortality occurred in the 1-10 mm size ratio (OPCNM 1998). Data are insufficient to determine the longevity of individuals within populations, and rates of mortality within each size class, or variations, if any, between populations. The presumption that the population on OPCNM is "healthy" or stable is not supported by data (OPCNM 1999).

Reproduction rates: Once an individual attains maturity and begins to flower, flowering in the same individual almost always occurs annually and fruit set is high (Johnson 1992). In the OPCNM population, limited data suggest recruitment has been low during most years, but punctuated by episodes of good or abundant recruitment. The primary germination period is during the summer monsoon season (OPCNM 1998). Fruit seed production may be influenced by plant size, rainfall, individual variability in ovule number, and seed predators (Johnson 1992). The Desert Botanical Garden in Phoenix, Arizona documented low seed viability in a study of seeds from plants grown in a shadehouse at OPCNM (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000).

Age ratios: Age ratios for Acuña cactus are unknown at present. Annual monitoring at OPCNM documented that the highest number of individuals are within the 0-10 mm size class. Very few individuals were greater that 150 mm (OPCNM 1998).

Significant Pima Co. populations or subpopulations: All known U.S. populations should be considered significant.



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Acuna Cactus
Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)
- ▲ Acuna Cactus (*Echinomastus erectocentrus var. acuensis*)

Known Locations (SWCA, 2000)
- ■ Acuna Cactus (*Echinomastus erectocentrus var. acuensis*)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)
- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)
- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 53

Habitat Requirements

Ability to use major land use categories: Acuña cactus is restricted to well-drained knolls and gravel ridges between major washes (Phillips et al. 1982) and generally occurs at elevations from 1,300 to 2,000 feet (397-610 m) (AGFD 1997). Substrates include granite (Phillips et al. 1982) and limestone hills and flats (Benson 1982) and bright red to white andesite (AGFD 1997). Known populations are located in open exposures (AGFD 1997). Johnson (1992) reported that distribution of individuals at OPCNM may be influenced by variations in soils. Though little information is available regarding specific habitat requirements, the rarity of this cactus suggests specialized needs that may be revealed by further research. It apparently has only been found in relatively pristine desert areas, and does not survive substrate disturbance.

Habitat trends in planning area: Most of the known U.S. habitat is within OPCNM. Of the 4 populations in Arizona, 1 occurs on private land, 2 occur on federal land, and 1 occurs on a mixture of state, federal, and private land.

Current and Potential Threats

General: This species is very susceptible to poaching, and numerous individuals have been illegally removed from OPCNM population study plots (OPCNM 1998). Preliminary data from studies at OPCNM suggests that degraded sites may cause high mortality of new germinants and seedlings; however, further evidence is needed to validate this hypothesis. In addition, undocumented populations may potentially be adversely affected by military activities, grazing and/or land development.

Pima County populations location, amount, and quality of protected habitat: Two of the known U.S. populations are located solely on federal lands and are currently secure, although poaching continues. However, populations on private lands and hitherto undocumented populations may be at risk. Otherwise, the location, amount, and quality of protected habitat for this species are impossible to assess at present because too little information regarding the distribution of the species is known.

Existing and potential pest species: In studies conducted at OPCNM, the opuntia borer, *Moneilema gigas* LeConte (Coleoptera), typically killed plants by consuming the fleshy interior severing the root and stem. Furthermore, fruits and seeds were sometimes damaged by moth larvae (Johnson 1992).

Threat mechanism: Loss of individuals by poaching and physical destruction by uprooting and/or crushing.

Management Needs

General: Because this subspecies is very difficult to detect, it may be more common and widespread than is currently known. Only a very small portion of its potential range has been surveyed. Extensive surveys for Acuña cactus and further research on the ecology and life cycle requirements could provide information necessary for effective management of the species.

Current protective measures: As a candidate for listing under the Endangered Species Act, no specific protection under the Act is implemented. However, federal agencies are alerted to its status and limited in performing actions that may adversely affect the species. The largest Pima County populations are located on federal lands and are currently managed for conservation of the subspecies; however, extensive surveys for this species may reveal hitherto unknown populations that are lacking protection.

Sensitivity to human activities and densities: Poaching is an ever-present risk that has not been quantified and threatens existing populations, even those at OPCNM. Off-road vehicular traffic, grazing, and land development have the potential to alter habitats or cause direct mortality, but there is no documented evidence of this.

Corridor needs: None have been identified or are likely to be.

Key relationships: In a study of the OPCNM population, Johnson (1992) found that some mature individuals that did not flower contained larvae of the opuntia borer, *Moneilema gigas,* which commonly infests *Opuntia fulgida* and *O. engelmanii* (Crosswhite and Crosswhite 1985). The most abundant, robust and consistent pollen vectors for both *Echinomastus* and *Echinocereus* during the study were *Diadasia rinconis* and *Megachile palmensis*, though numerous other native bee species also visited the flowers, and one individual European honeybee was documented visiting a flower during the study. The potential effects of the recent loss of European bees and the arrival and establishment of Africanized honeybees in Pima County, Arizona, on populations of both native plants and their native pollinators is still unknown and needs to be evaluated.

In the past 3 years at OPCNM, frequent uprooting has been noted and is correlated with high mortality (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000). The cause of the uprooting is unknown but is assumed to be the act of wildlife (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000).

Dispersal requirements: The mechanism of dispersal is unknown. Ants are known to invade the fruits and carry off the seeds, but it appears the seeds are simply "lost" from the population rather than dispersed (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000).

Results of past mitigation activities: Plants that were found uprooted or "tipped over" at OPCNM were taken to a shadehouse and potted. These plants survived to produce flowers and fruit, but cannot be replanted in their native habitat because of the rocky nature of the substrate and the Acuña cactus' shallow root system (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000). No other mitigation activities are known.

Existing monitoring and research programs: The population of Acuña cactus that occurs on OPCNM has been monitored annually for growth, reproduction and mortality since 1988 and monitoring will continue on an annual basis (S. Rutman, National Park Service, pers. comm. to P. Titus, 28 Apr 2000).

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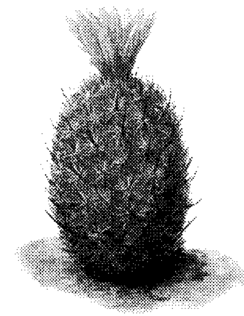
Needle-spined pineapple cactus (*Echinomastus [=Sclerocactus] erectocentrus* var. *erectocentrus*)

Status



Federal	Former federal Candidate 2 List; therefore a Species of Concern
State	Arizona Native Plant Law, Salvage Restricted
Other	Forest Service Sensitive; Vulnerable Status 1 by SDCP
Rankings	G3 S3

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The needle-spined pineapple cactus is a member of the cactus family (Cactaceae). Until recently, the genus was called *Echinomastus*, but recently it was changed to *Sclerocactus* (Kartesz 1994). Apparently not all taxonomists accept this revision (e.g., Pinkava 1995), and most of the literature available refers to this species as in *Echinomastus* or one of the early genera to which it was assigned. In this document, this species will be referred to as *Echinomastus erectocentrus* var. *erectocentrus*, for convenience, but readers should be aware that the accepted name may become *Sclerocactus* and that this variety may be sunk.

Three species of *Echinomastus* occur in Arizona (AGFD 1997). These are *E. erectocentrus*, *E. intertexta*, and *Echinomastus johnsonii*. The genus consists of cacti with branched or unbranched stems that are ovoid to cylindroid and 2 to 15 inches (5.0-37.5 cm) tall and 1 to 5 inches (2.5-12.5 cm) in diameter. Flowers and fruits appear on new growth of the current season near the apex of the stem or branch, each on the side of the tubercule in a felted area distant from the spine-bearing portion of the areole and connected by the isthmus running the length of the tubercle, the area persisting and forming an elongate and narrow scar (Benson 1969).

Classification: Family: Cactaceae (cactus family); Genus: *Echinomastus*, meaning "spiny stem"; Species: *erectocentrus;* Variety: *erectocentrus,* referring to the erect character of the central spine in each areole.

Specific: *Echinomastus erectocentrus* var. *erectocentrus* was first described in 1896 as *Echinocactus erectocentrus* by Coulter from a specimen collected by Evans near Benson in Cochise

County, Arizona. Since then, the taxon has been renamed several times. Other names used for this taxon and their authors are:

- *Echinocactus horripilus* Lemaire var. *erectocentrus* Weber
- *Echinomastus erectocentrus* Britton and Rose
- *Thelocactus erectocentrus* W. T. Marshall
- *Mammillaria childsii* Blanc
- *Echinocactus krausei* Hildmann
- *Theocactus drausei* Kelsey and Dayton
- *Neolloydia erectocentra erectocentra* (Coulter) L. Benson
- *Sclerocactus erectocentrus* (Coulter) N.P. Taylor

The type specimen was lost, so a neotype was designated by Benson (1969) based on a specimen collected from east of the junction of U.S. 80 and the road to Sonoita, Pima County, Arizona, which he named in a new combination as *Neolloydia erectocentra* var. *erectocentra.* Three species of *Echinomastus* occur in Arizona (Benson 1982). The species *E. erectocentrus* is divided into 2 varieties: the acuña cactus (*E. e.* var. *acunensis*) and the needle-spined pineapple cactus (*E. e.* var. *erectocentrus*). Dr. Donald Pinkava of Arizona State University believes *E. e.* var. *acuñensis* may be indistinct from var. *erectocentrus* (AGFD 1997). Apparently the varieties have been sunk, and there are no recognized valid varieties of the species *Sclerocactus erectocentrus* (Kartesz 1994). Needle-spined pineapple cactus likely derives its common name from the needle-like appearance of the central spines.

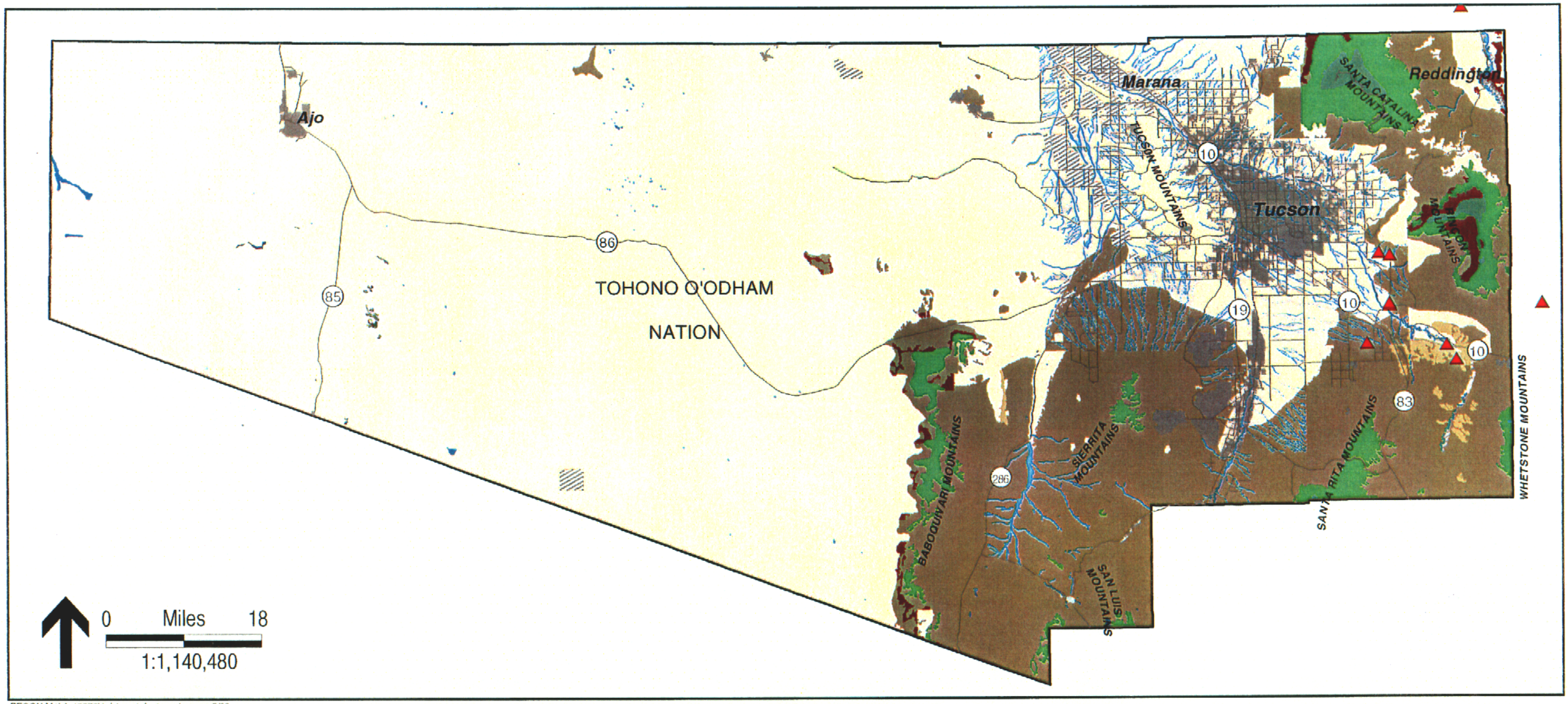
Life History

Description: The needle-spined pineapple cactus is a succulent perennial that is characteristically a single stem, 4 to 6 inches (10-15 cm) tall (although occasionally to 12 to 15 inches [30-37 cm]) and 3 to 5 inches (7.5-13 cm) wide. The plant has tubercles that are about 0.25 inch (0.6 cm) long and are borne on longitudinal ridges. There are 1 or 2 central spines, distinguishing this variety from *E. e. acunensis*, which has 2 or 3 central spines. The central spines are 0.5 to 0.86 inch (1.2-2.2 cm) long, pointed upward, and have reddish brown tips. The radial spines number 11 to 15 per cluster, and are about 0.5 or 0.63 inch (1 to 1.5 cm) long and are white to red-tinged. The flowers are pink, 1.5 inches (3.8 cm) long and 1.5 to 1.8 inches (3.8-4.5 cm) wide, and have bright red stigma lobes. The fruit is green when young and tan when dry and is 0.4 inch (1.0 cm) long and 0.3 inch (0.8 cm) wide (AGFD 1997).

Reproduction: Flowering occurs in April. No known additional information is available regarding the reproductive biology of this species.

Distribution

Historic: Benson (1969:192) described the range as "Southeastern Arizona from southeastern Pima County to western Cochise County." However, his map (p. 190) shows three localities in eastern Pinal County and 1 in eastern Cochise County.



Needle-spined Pineapple Cactus Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)

▲ Needle-Spined Pineapple Cactus *(Echinomastus erectocentrus var. erectocentrus)*

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 54

Present: Although some available literature indicates that *Echinomastus erectocentrus* var. *erectocentrus* occurs only in Pima and Cochise counties, Arizona in areas south and east of Tucson (AGFD 1997), the Heritage Database Management System (HDMS) database contains 2 records from Pinal County, both of which are located along the San Pedro River in the eastern-most part of the county. In addition, HDMS contains 7 Pima County records (Figure 54) and 1 Cochise County record. This species is scattered in a few locations, apparently disjunct from each other. However, large areas of the potential range between known locations have never been searched adequately to find this species.

Demographics

Density: No known information is currently available regarding density of natural populations. The plant is generally widely scattered where it occurs (K. Kingsley, pers. obs.).

Status: There are 10 records of occurrence for this species in the HDMS database. Of these, 5 records are located on state lands and 5 are located on private lands. All of these sites may be developed in the future. It is not known what proportion of the population is represented by these records.

Trend: Population trends of the needle-spined pineapple cactus are unknown at present.

Survival rates: No information is currently available regarding survival rates in natural populations.

Reproduction rates: No information is currently available regarding reproduction rates in natural populations or information that is specific to propagation of this species. This species is considered difficult to propagate and is not common in cultivation (USFWS 2000).

Age ratios: No information is currently available regarding age ratios in natural populations.

Significant Pima Co. populations or subpopulation basis in planning area: Pima County encompasses much of the known range of this variety. Of the 7 HDMS records for Pima County, 4 are located on private lands and 3 occupy state lands. All of these are located within the eastern portion of the county, within Planning Areas 2, 3 and 4. A population is known to exist at Colossal Cave County Park.

Habitat Requirements

Ability to use major land use categories: The needle-spined pineapple cactus has been found on alluvial fans and hills on southern and western exposures, generally from 3,000 to 4,600 feet elevation (915-1403 meters). Substrates consist of alluvial soils with rock and gravel over sandstone conglomerate, and limestone outcrops. It appears *E. e. erectocentrus* may grow over a wider range of substrates than *E. e. acuñensis* (AGFD 1997).

Habitat trends in planning area: Portions of the known range of this cactus have been affected by agricultural, urban, and mining activities, including prehistoric and historic development. Areas that are within the remaining range of this species are subject to potential development and a variety of other land use activities including grazing and other forms of agriculture, and recreational use. At present it is not possible to determine the effects of these activities on this species. Known populations are near disturbed areas; 1 population is divided by Interstate 10 (AGFD 1997). It is reasonable to conclude that some portion of the range of this species is likely to be lost as a result of various land use activities. However, the species is distributed over a fairly large area of undeveloped or minimally developed land, and so little is known of its specific requirements that it is not possible to determine habitat trends with accuracy.

Current and Potential Threats

General: Illegal collection for the cactus trade and urbanization are management factors of concern for the needle-spined pineapple cactus (AGFD 1997). Road development, overgrazing, and off-road vehicle use may also impact this species.

Pima County populations location, amount, and quality of protected habitat: Much of the species known range is in Pima County (AGFD 1997). Lands within the range of needle-spined pineapple cactus are administered or owned by the following entities: Coronado National Forest, Bureau of Land Management, Arizona State Lands Department, private landowners, and Pima County. It is known to occur in Colossal Cave County Park, and it may occur in Cienega Creek County Park.

Existing and potential pest species: There are no known records of potential damage to needle-spined pineapple cactus by insects, herbivores, or competition with non-native species. It is possible that invasive non-native grasses such as Lehmann lovegrass and red brome could create conditions that would foster fires that may be detrimental to this species, but no known studies demonstrate this.

Threat mechanism: Speculation includes loss or degradation of habitat by trampling by livestock and vehicles and poaching; however, these potential threats have not been clearly documented (AGFD 1997).

Management Needs

General Probably the most pressing management need for protection of this species is acquisition of more information about the species through further research. In particular, additional surveys need to be conducted to better delimit the range, demographic studies should be initiated to determine if existing populations are stable, and studies of the reproductive biology are needed to allow effective management. Resolution of taxonomic uncertainty, with general agreement as to the appropriate name and taxonomic status of this entity would be helpful.

Current protective measures: The Arizona Native Plant Law protects the species as "Salvage Restricted" requiring a permit for collection. *Echinomastus erectocentrus* was originally listed in Appendix II of CITES in 1975, and later uplisted to Appendix I in 1983; thus requiring that a permit be obtained for export from the country of origin. Evidently the only recent legal exports were seeds grown in cultivation (USFWS 2000).

Sensitivity to human activities and densities: Trampling and construction are alleged problems for populations of *Echinomastus erectocentrus* var. *erectocentrus* (AGFD 1997). Although no data were found to verify this statement, the limited number of known populations and small range suggests a risk of vulnerability to degradation and/or loss of habitat. In addition, the lack of information regarding range, specific habitat requirements, life cycle requirements, and demographics makes effective management of this species problematic.

Corridor needs: No specific corridor needs are known. Dispersal corridors may be necessary for the successful establishment of new populations and maintenance of existing populations of the species; however, characteristics of appropriate corridors are not known. Known distribution suggests that populations are naturally isolated from each other.

Key relationships: The needle-spined pineapple cactus inhabits the Arizona Upland Subdivision of the Sonoran Desert Scrub and Semidesert Grassland. Dominant associated species are *Larrea tridentata*, *Cercidium microphyllum*, *Fouquieria splendens*, *Yucca angustissima*, *Opuntia phaeacantha*, *Prosopis velutina*, *Coryphantha* ssp., *Zinnia pumila*, *Allionia incarnata*, *Dyssodia* spp., *Psilostrophe cooperi*, *Aristida purpurea*, and *Erioneuron pulchellum*. There is no known information concerning pollinators or disseminators of this subspecies, which might provide important information about the life cycle requirements and limited range of this cactus. Some herbivores and frugivores likely consume the flowers and fruits, and some animals may disperse seeds; however, documentation is lacking.

Results of past mitigation activities: No known specific mitigation efforts are currently under way or have been documented in the past.

Existing monitoring and research programs: An informal study of this species is underway at Colossal Cave Park (R. Schmaltzel, pers. comm. to K. Kingsley, 19 Apr 2000). No other known monitoring efforts or studies are currently under way.

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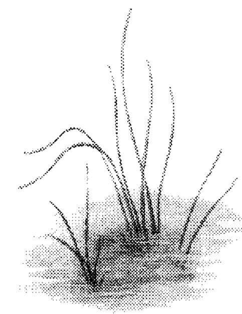
Huachuca water umbel (*Lilaeopsis schaffneriana recurva*)

Status



Federal	Listed As Endangered by USFWS (62 FR 3, January 6, 1997)
State	Arizona Native Plant Law, 1993, Highly Safeguarded
Other	Forest Service Sensitive, USFS Region 3, 1990; Vulnerable Status 1 by SDCP
Rankings	G4T2 S2

Recovery Goals

Federal: Recovery goals and a recovery plan are not yet available. Critical habitat was designated by USFWS on July 12, 1999, and included a total of 83.9 km of streams or rivers in Cochise and Santa Cruz counties, Arizona.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: This species was first described by A. W. Hill as *Lilaeopsis recurva* based on the type specimen, which was collected by Pringle on 19 May 1881 (Hill 1926). The type locality is found along the Santa Cruz River in Pima County near Tucson, Arizona. The genus *Lilaeopsis* (Greene) contains approximately 20 species and is well developed in the temperate zones of North America, South America, Australia, and New Zealand (AGFD 1997). Six or seven species are recognized in North America (Affolter 1980).

Classification: Family: Apiaceae (parsley family); Subfamily: Apiaceae; Genus: *Lilaeopsis*; Species: *schaffneriana*; Subspecies: *recurva*.

Specific: Hill applied the name *Lilaeopsis recurva* to the type specimen, and the name prevailed until Affloter (1985) revised the genus and applied the name *Lilaeopsis schaffneriana recurva* to plants found west of the continental divide.

Life History

Description: Herbaceous semi-aquatic perennial with tiny 3- to 10-flowered umbels that arise from nodes of creeping shallow (0.4-0.8 inch [1.0-2.0 cm]) underground rhizomes which run along the bottom of still ponds. Cylindrical hollow leaves that are pale green in color and typically borne 2 or 3 per node, having septa at irregular intervals. Generally 0.04-0.12 inch (1.0-3.0 mm) in diameter, however, length varies depending on microhabitat. When growing above water in wet soil near streams, stems are often 1.2-2.0 inches (3.0-5.0 cm) tall (too weak to support leaves) but may be up to 8.0 inches (20.0 cm). Inflorescence peduncles are typically 0.4-2.8 inch (1.0-7.0 cm) long and always shorter than leaves. Flowers are 0.04-0.08 inch (1.0-2.0 mm) wide with tiny maroon-tinted petals and are borne below leaves. Fruits are globose, 0.06-0.08 inch (1.5-2.0 mm) in diameter, and slightly longer than wide (AGFD 1997).

Reproduction: Flowering has been observed March through October (Warren et al. 1991) and fruiting observed May through September. Three to ten very small flowers are borne on an umbel. The pollinator or pollination mechanism of this species is not known. The fruits are globose, 0.06-0.08 inch (1.5-2 mm) in diameter, and usually slightly longer than wide (Affolter 1985). The species reproduces sexually through flowering and asexually from rhizomes, the latter probably being the primary reproductive mode (USFWS 1997). It also disperses when clumps are dislodged (AGFD 1997).

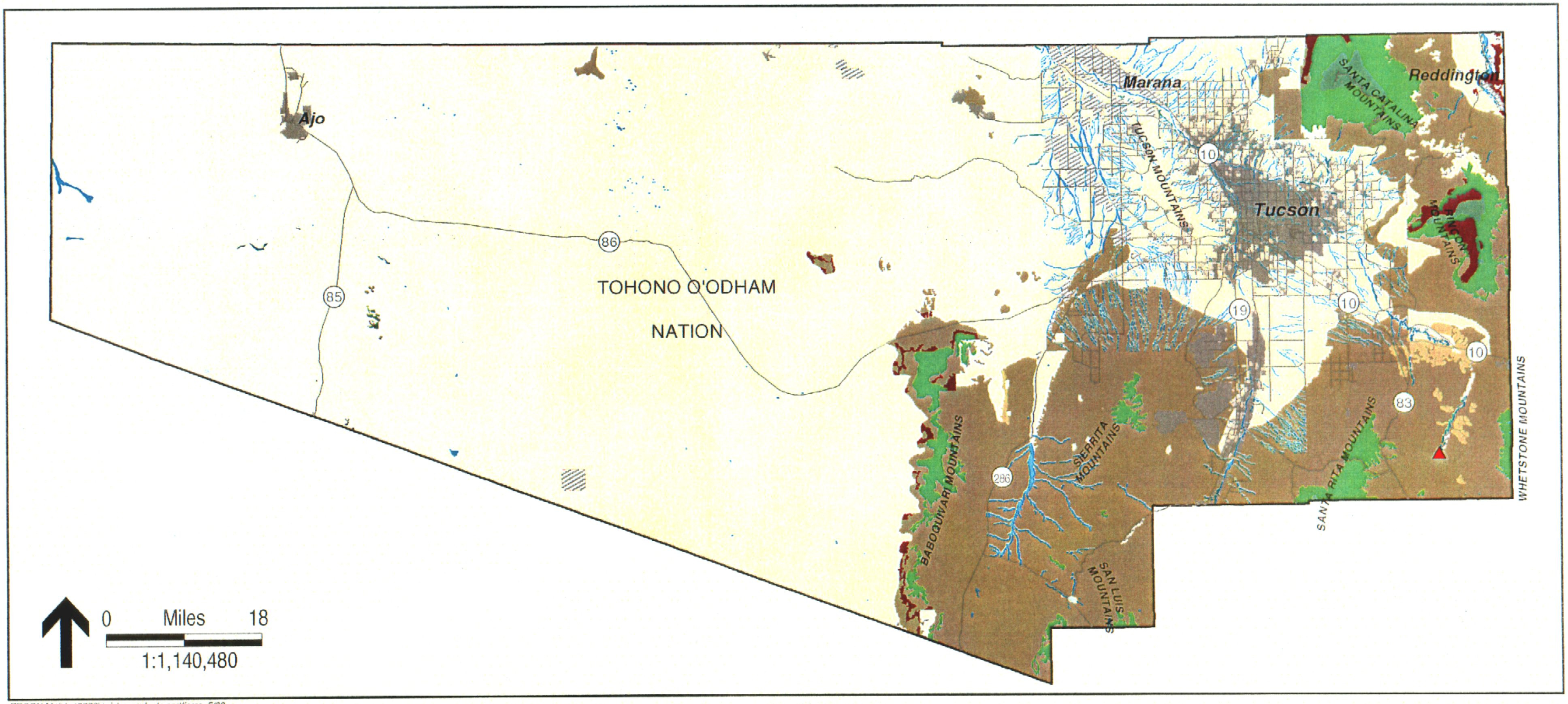
Distribution

Historic: Historically in Pima County: Tucson, along the Santa Cruz River; Cochise County: Huachuca Mountains, San Pedro area, Saint David (extirpated), San Bernardino Valley/Black Draw; Santa Cruz County: Sonoita Creek, Canelo Hills/Turkey Creek, San Rafael Valley. There are 20 locations historically for this species in Tucson, none of which are currently suitable. A population at House Pond on the San Bernardino National Wildlife Refuge was extirpated during pond reconstruction in the 1970s. A population at Saint David was presumed extirpated due to channel erosion.

Present: Disjunct locations are known in Pima, Santa Cruz, and Cochise counties, and Sonora Mexico. This species has been documented from 26 sites west of the continental divide; but has been extirpated from 6 of these sites. The 20 extant sites occur in the following 4 watersheds: San Pedro River, Santa Cruz River, Rio Yaqui, and Rio Sonora. All sites are between 3,500 and 6,500 feet (1,148-2,133 m) elevation (USFWS 1999). The only population in Pima County for which the Heritage Data Management System has records is in Empire Gulch, a tributary of Cienega Creek, which is managed by the BLM as part of the Empire-Cienega Resource Conservation Area (Figure 55). It is possible, even likely, that this species also occurs downstream in one or more locations along Cienega Creek, and it may eventually become established within Cienega Creek County Park. It may also be possible to reestablish populations in the effluent-dominated portion of the Santa Cruz River and in the portion of the San Pedro River within Pima County.

Demographics

Density: This species follows a very typical metapopulation structure, with each drainage constituting a segment of the metapopulation. Clusters within each drainage are local populations that typically come and go as conditions change. The size of populations and density of Huachuca water umbel plants fluctuate in response to both flood cycles and changing site characteristics.



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Huachuca Water Umbel
Known Locations and Vegetation Biomes

Known Locations
(HDMS, 2000)

▲ Huachuca Water Umbel
(Lilaeopsis schaffneriana var. recurva)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 55

Although the extent of occupied habitat can be estimated, the number of individuals in each population is impossible to determine because of the intermeshing nature of the creeping rhizomes and the predominantly asexual mode of reproduction. A population of Huachuca water umbel may be composed of one or many individuals (USFWS 1997).

Status: Listing of this species as endangered and designation of critical habitat should at least stabilize the decline. Management of existing habitat, such as in the San Pedro River National Riparian Conservation Area may improve this species status.

Trend: This species has been extirpated from a significant portion of its historical range (USFWS 1999). Huachuca water umbel populations have been observed to expand and contract depending on the presence of "refugia" where this species can escape the effects of scouring floods in a watershed that has an unaltered hydrograph and a healthy riparian community that stabilizes the channel. This species can rapidly expand a population under ideal conditions. However entire patches can be lost due to flooding or may be greatly reduced due to competition with other species (USFWS 1997).

Survival rates: As is true of density determinations, survival of individuals is impossible to assess because of the intertwining nature of rhizomes and predominance of asexual reproduction.

Reproduction rates: Reproduction rates are difficult to detérmine because individual populations fluctuate widely between specific sites, seasons, and years. Pollinators, or the pollination mechanism, of this species are not known but may exist and be necessary for continued existence of the species. However, Affloter (1985) suspects other members of the genus *Lilaeopsis* self-pollinate, and seed germination has been observed from plants grown in greenhouse conditions without known access to pollinators (Warren et al. 1991).

Age ratios: No information is available on age ratios.

Significant Pima Co. populations or subpopulations: Four Huachuca water umbel populations occur in the Santa Cruz River watershed, but only 1 is known from Pima County. These probably represent very small remnants of larger populations that may have occurred in the past. Tucson area populations have been extirpated along with the habitat and species assemblages with which they once occurred. Currently the only population in Pima County for which records are available is in Empire Gulch, a tributary of Cienega Creek, within the BLM Empire-Cienega Resource Conservation Area. Surveys of the entire Cienega Creek and its tributaries may reveal other populations (USFWS 1999).

Habitat Requirements

General: Huachuca water umbel requires perennial water, gentle stream gradients, small- to medium-sized drainage areas, and (apparently) mild winters, although it can recover from freezing. It is usually found in water depths from 2.0 to 6.0 inches (5.0 to 15.0 cm), but occasionally to 10.0 inches (25.0 cm) deep. It grows in submerged sand, mud and/or silt (AGFD 1997), but usually requires some organic component (Mima Falk, USFWS, pers. comm. to K. Kingsley, 1 May 2000). This plant grows in cienegas (marshy wetlands), at elevations of 4,000-6,500 ft. (1,220-1,982.5 m). Plants may be found in both unshaded and shaded sites (USFWS 1999).

Ability to use major land use categories: This species only occurs in water, specifically in ponds and cienegas, or streams with slowly moving water, within Sonoran desert scrub, grassland or oak woodland, and conifer forest. It formerly occurred also at lower elevations, as in the Santa Cruz River at Tucson.

The physical and biological habitat features essential to the conservation of Huachuca water umbel include, which were defined as constituent elements of critical habitat:

- a riparian plant community that is fairly stable over time and not dominated by nonnative plant species,
- a stream channel that is relatively stable but subject to periodic flooding,
- refugial sites, and
- a substrate that is permanently wet or nearly so, for growth and reproduction of the plant (USFWS 1999).

Habitat trends in planning area: Pima County actively promotes riparian restoration of river corridors and floodplains. Current and future plans to accomplish this goal include acquisition of flood-prone lands to prevent future development and degradation, and restoration of aquifers that once supported free-flowing streams. These projects should increase potential habitat for this species and provide sites for reintroduction, if necessary, in the future. Management of the Empire Cienega Resource Conservation Area by the BLM and Cienega Creek County Park actively protects and rebuilds potentially suitable habitat for this species. Use of effluent to maintain water flow in the Santa Cruz River may ultimately result in development of suitable habitat for this plant. It appears that loss of suitable habitat has stopped, and restoration has begun.

Current and Potential Threats

General: Wetland habitats are rare and some people believe they are declining in the southwest. Historic watershed degradation included impacts associated with livestock grazing, development, and diversion of water. Some of these may continue to deteriorate habitat for this species, or keep it unsuitable for re-establishment. Individual plants or entire populations can be destroyed when flooding is too frequent or intense, although an intermediate level of flooding frequency may reduce competition from other plant species (USFWS 1999).

Pima County populations: location, amount, and quality of protected habitat: Riparian areas in Pima County have been significantly reduced and widespread alteration of hydrologic regimes within watersheds has taken place in the last century. The Santa Cruz River, which historically supported Huachuca water umbel, no longer has perennial flows, except where sewage effluent is available, and suitable habitat for this species is not known to be present currently. Increased growth and development within the county may continue this trend of dewatering of potential habitat if management measures are not implemented.

Existing and potential pest species: Huachuca water umbel populations have undergone a reduction in size due to competition when habitat is aggressively colonized by other wetland species, both native (e.g., cattails [*Typha* spp.], and nonnative (e.g., water cress [*Rorippa nasturtium-aquaticum*]. *Arundo donax* is also a species of concern in some areas (Mima Falk, USFWS, pers. comm. to K. Kingsley, 1 May 2000). Crayfish (probably *Orconectes* sp.) were observed in a patch of Huachuca water umbel in the San Pedro River (K. Kingsley, pers. obs. 30 Apr 2000). These introduced omnivores may be detrimental to this species.

Threat mechanism: Loss of wetland aquatic habitat that results from drawdown of groundwater, alteration of the watershed, development overgrazing; trampling and grazing by livestock; diversion of water and de-watering of habitats; and flash flooding. Also, overcrowding by other plants may result in reduction of local populations of this species.

Management Needs

General: Perennial water flow and excessive erosion are key management issues. Huachuca water umbel populations are restricted to wetland habitats that are rare in the southwest United States and adjacent Mexico. Protection should include habitats that are affected by watershed degradation due to livestock grazing and development; trampling and grazing by livestock; diversion of water and dewatering of habitats; and flash flooding. Protective measures should include procurement of instream flow rights and management of watersheds to reduce flood intensity. Rural and urban development, road building, chaining, agriculture, mining, fire, and other land disturbances that degrade the watershed can adversely affect Huachuca water umbel.

Current protective measures: Endangered status for this species implements federal protection under the Endangered Species Act (USFWS 1997). Designation of critical habitat (all of which is located within Santa Cruz and Cochise County) prohibits destruction or adverse modification of critical habitat by any activity funded, authorized or carried out by any federal agency (USFWS 1999). Designation of the San Pedro Conservation Area was accomplished by legislation that states that the BLM is charged with conservation, protection and enhancement of the riparian area, which includes populations of Huachuca water umbel. Friends of the San Pedro River docents are given training to identify and monitor species on the San Pedro. Management of the Empire-Cienega Natural Resource Conservation Area may protect this species there. Coronado National Forest monitors all of their known populations and has protective measures such as livestock exclosures in place in critical habitat. Populations on Fort Huachuca are monitored and recreational use is excluded.

Sensitivity to human activities and densities: Historically, Huachuca water umbel populations have been greatly reduced or extirpated as a result of land alterations, water withdrawals, and alteration of watershed dynamics.

Corridor needs: Dispersal corridors along rivers may be necessary for this species to become re-established in areas from which it has been extirpated, and intact rivers may assist in re-establishment of this plant.

Dispersal requirements: Dispersal can take place by both sexual and asexual reproduction along stream corridors; however, suitable habitat, which at present is severely limited, must exist for new populations to become established.

Key relationships: A primary constituent of designated critical habitat for this species (USFWS 1999) includes a riparian plant community that is relatively stable over time and in which non-native species do not exist or are at a density that has little or no adverse effect on resources available to Huachuca water umbel. The health of Huachuca water umbel populations may serve as an indicator of habitat conditions for other sensitive species that occupy the same community. These include Canelo lady's tresses (*Spiranthes delitescens*), Huachuca spring snail (*Pyrgulopis thompsonii*), Gila chub (*Gila intermedia*), Sonora tiger salamander (*Ambystoma tigrinum stebbensii*), Chiricahua leopard frog (*Rana chiricahuensis*), and Mexican garter snake (*Thamnophis eques*) (Warren et al. 1991). The pollinator or pollination mechanism of this species is not known. If another species is necessary for pollination, then conservation of that species will be necessary in order to maintain viable populations of Huachuca water umbel.

Results of past mitigation activities: Introductions of Huachuca water umbel into ponds have reportedly been successful; however, in some cases an initial period of colonization was followed by competition with other plants around the perimeter of the ponds which corresponded to a decrease in the population (USFWS 1999).

Existing monitoring and research programs: A monitoring program is continuing on the San Pedro Riparian Conservation Area. Other monitoring may be in progress, but is not currently known. This will be filled in after conversations with agencies and organizations.

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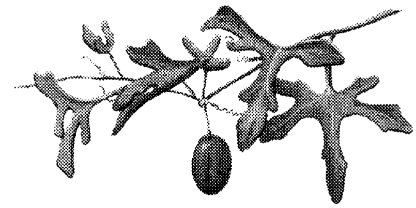
Tumamoc globeberry (*Tumamoca macdougalii*)

Status



Federal None. This species had been listed as endangered, but was found to be more abundant and widespread than thought at the time of listing. The USFWS listed the globeberry as endangered under the ESA in 1986 based on the known presence of only 30 isolated populations in Pima County, Arizona, and 5 populations in Sonora, Mexico (51 FR 15906). In 1988 and 1989, the Bureau of Reclamation conducted surveys required by Section 7 of the ESA to determine the impact of a Central Arizona Project canal and pipeline on the globeberry. These surveys determined that the species occurred across a more extensive range and was less habitat-specific than previously thought. Finding few threats of extinction in its newly identified habitat, the USFWS removed the Tumamoc globeberry from the endangered species list in 1993 (58 FR 33562) (Noecker 1998).

State Arizona Native Plant Law: Salvage Restricted

Other Forest Service Sensitive; Bureau of Land Management Sensitive; Vulnerable Status 2 by SDCP

Rankings:

Recovery Goals

Federal: There are no known federal agency-mandated recovery goals for this species.

State: There are no known state agency-mandated recovery goals for this species.

Pima County Habitat Conservation Plan Goals

Pima County will allow no net unmitigated loss or fragmentation of habitat for this species in conservation areas and lands owned or controlled by the County.

Pima County will develop, through an adaptive management plan, appropriate detailed and quantifiable population and/or habitat goals for this species based on research into the requirements of the species.

Taxonomy

General: The Tumamoc globeberry is a vine in the cucumber family.

Classification: Family: Cucurbitaceae. Genus: *Tumamoca* (named after Tumamoc Hill in Tucson, Arizona, which is the type locality); Species: *macdougalii* (after the collector of the type specimen).

The Tumamoc globeberry was first collected by David T. Macdougal on July 31, 1908, on Tumamoc Hill west of Tucson, Arizona, where the Carnegie Institute Desert Laboratory was located. The specimen was sent to John N. Rose at the U.S. National Herbarium, who described the new genus and species in honor of the type locality and of the collector (FWIE 2000).

Specific: *T. macdougalii* is the only known species in the genus.

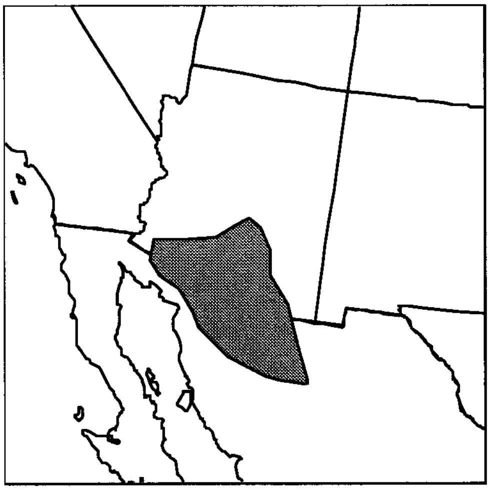
Life History

<u>Description:</u> The Tumamoc globeberry is a perennial dioecious or monoecious vine with grasping tendrils. It arises each summer rainy season from a cluster of tuberous roots that are united into a woody crown with a short stem. The slender annual stems have many nodes. Each node along the stem produces 1 tendril, 1 leaf, 1 male flower raceme, and 1 female flower bud. Leaves vary widely in size and shape. Most are rounded in outline, divided into 3 lobes; these lobes are about 0.8 to 1.6 inches (2.0 to 4.0 cm) long, with secondary lobes. The leaves have tiny pustule-like hairs. The flowers have pale yellow petals that are united below their middle, 0.4 to 0.6 inch (1.0 to1.5 cm) long. Round, green fruit (that give the common name to the plant), about size of a seedless grape, striped like watermelon when young, develop and turn red after 4 to 5 weeks. They contain 2 to several large seeds, 0.28 to 0.32 inch (7.0-8.0 mm) long that are 4-sided (FWIE 1996; AGFD 1997).

<u>Reproduction:</u> Aboveground growth, including stems, leaves, flowers, and fruits, occurs during a brief season following the start of summer rains. Most flowers appear in August, fruits appear August to September. Local *Tumamoca* distribution in the Tucson area indicates inactive dispersal, with several plants, apparently parents and offspring, clustered under a tree. In Mexico and on the Tohono O'odham Nation, the young are *not* found near the parent (AGFD 1997).

Experiments on the pollination ecology of *T. macdougalii* indicate that its pollen is self-compatible. Fruits are, however, not produced without pollination. Fruit set is highest with cross-pollination and, at least at one site, lowest when flowers are left to natural pollination. This indicates the species has difficulty attracting and utilizing pollinators and may explain how populations are able to maintain monoecious, all female, and all male plants (FWIE 1996).

<u>Behavior (phenology):</u> This vine is almost always found in the shade of and supported by a tree, usually mesquite, blue paloverde, or ironwood. It is dormant during winter and early spring. Some growth can occur in April-June (depending on tuber size), but most growth is in response to summer rains. The slender, leathery leaves produced during the early summer drought (termed "drought leaves") expand to more than twice their previous size. After substantial summer rains flower racemes produce 15 to17 male flowers as long as soil moisture is adequate. During times of drought the average is 3 to 6 per raceme. The vine can grow to over 10 feet (3 m) in a few weeks, producing dozens of leaves and flowers. The fruit mature and turn bright red, and are fed upon by birds. The aboveground growth is killed by the first frost, usually in November. As winter progresses, the plant withers, leaving a shriveled vine and white-gray woody stem above ground. It overwinters as a subterranean tuber with no living parts above ground (FWIE 1996; AGFD 1997).



Distribution

<u>Historic:</u> At the time of its discovery, and for many years thereafter, this vine was thought to be very rare and very limited in its distribution. Over time, with acquisition of effective search images and application of extensive and intensive efforts by field crews working primarily for consultants doing surveys for a plant that was initially considered a critically endangered species, *T. macdougalii* was found to be more abundant and widespread than had been thought.

Present: The range of *T. macdougalii* covers some 31,000 square miles of Sonoran Desert from just southeast of Guaymas, Sonora, Mexico, to Tucson, Arizona, west to Organ Pipe Cactus National Monument and north to Pinal County, Arizona (FWIE 1996). Figure 56 shows Pima County locations of Tumamoc globeberry.

Demographics

Density: Density of natural populations is extremely variable, with the plant being patchily distributed in the landscape. *T. macdougalii* is not uniformly or randomly distributed throughout the available habitat. Instead, the distribution is highly contagious (i.e., clumped), consisting of discrete isolated populations of one to several hundred plants that cover areas of less than 1 acre to about 400 acres (FWIE 1996). Populations throughout the range are separated by considerable expanses of apparently suitable, but unoccupied habitat with individuals clumped within populations. Estimating the abundance of the species by searching small areas and extrapolating to the entire range is impossible without an extremely large sample size (FWIE 1996).

Status: This plant was formerly listed as endangered. It was delisted because it was determined that the original information upon which the listing was based was in error, and the plant was more abundant and widespread than thought at the time of listing. However, portions of the range in Mexico have become converted to bufflegrass, which apparently is incompatible with this species, and losses of populations in Mexico are feared (Mima Falk, pers. comm. to K. Kingsley, 24 Apr 2000).

Trend: Population trends are not currently known, some of the study areas in Mexico have suffered losses attributed to bufflegrass invasion. Some local populations have apparently decreased and even been eliminated, but others have increased during the same time period (FWIE 1996).

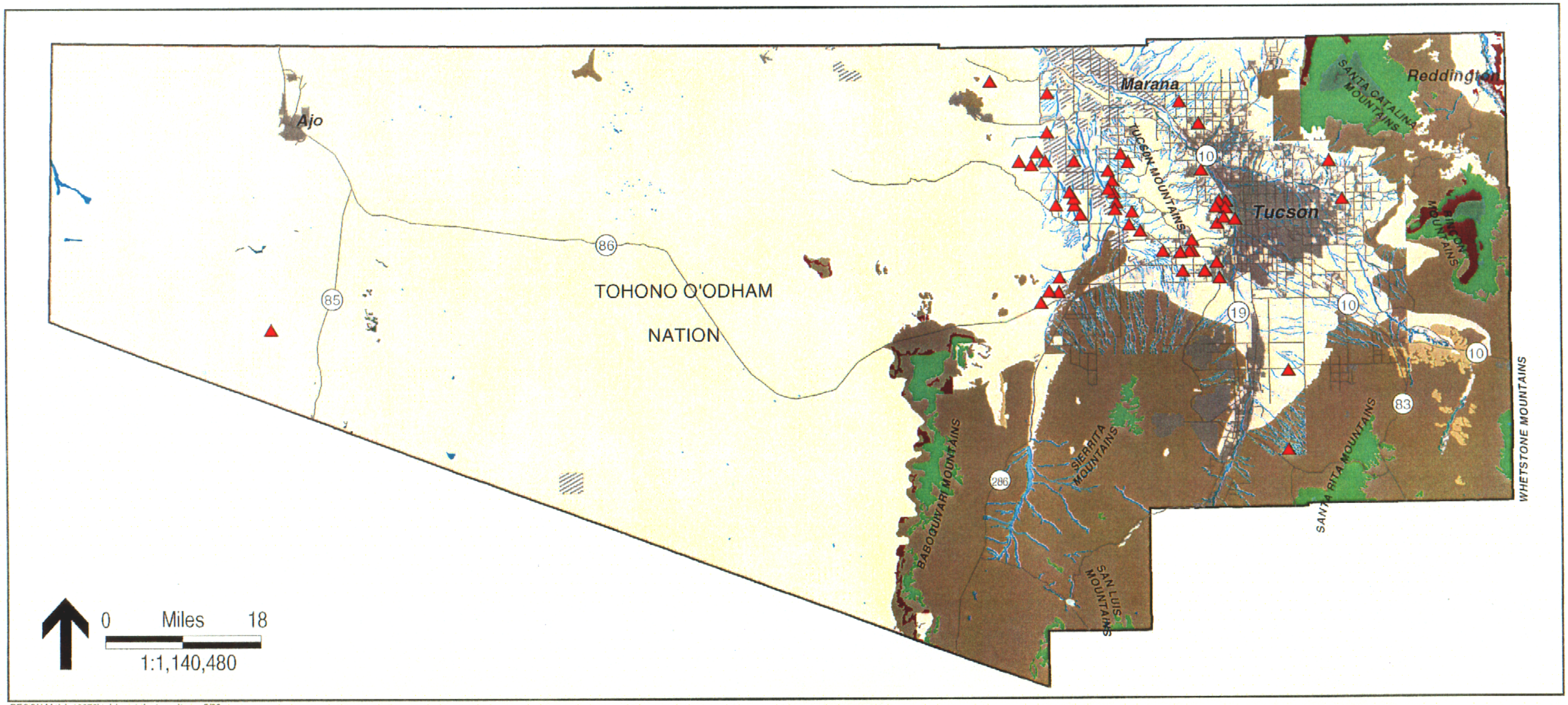
Survival rates: The seedlings of any given growing season are produced from the fruits of previous years. It is not known how long the seeds may survive in the soil. Seedlings have a very low survival rate.

Reproduction rates: Insufficient information is available to support conclusions on reproduction rates. Apparently reproduction rates are extremely dependent on amount and timing of rainfall and vary greatly from year to year and place to place (FWIE 1996).

Sex ratios: Tumamoc globeberry is facultatively dioecious and self-compatible, while expressing towards androecy (07). The ratio of male to female functions in the species is undoubtedly linked to the favorability of the precipitation regime. Female flower production is significantly negatively correlated with both tuber weight and length of longest stem. Plants may be predominantly one sex when small and then become increasingly more the opposite as they age (FWIE 1996).

Age ratios: Plants may live 25 years or more, but the number of plants in each increasing size class decreases dramatically. Presumably plant size is related to age (FWIE 1996).

Significant Pima Co. populations or subpopulation basis in planning area: Several populations in Pima County are considered significant because they have been studied for many years. Most of these are along the CAP Canal right-of-way or in preserves created as part of the CAP construction process, but 1 population is in Sabino Canyon and it has been studied since 1984 (AGFD 1997).



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Tumamoc Globeberry
Known Locations and Vegetation Biomes

Known Locations (HDMS, 2000)

- ▲ Tumamoc Globeberry (*Tumamoca macdougalii*)

Pima County Boundary

Major Road or Highway

Vegetation Biomes (RECON, 2000)

- 122.4 Great Basin Conifer Woodland
- 122.6 Madrean Montane Conifer Forest
- 123.3 Madrean Evergreen Forest and Woodland
- 124.7 Sonoran Riparian Woodland
- 133.3 Interior Chaparral
- 143.1 Scrub-Grassland(Semidesert Grassland)
- 153.2 Chihuahuan Desertscrub
- 154.1 Sonoran Desertscrub
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
- 224.5 Sonoran Riparian and Oasis Forests
- 243.7 Sonoran Deciduous Swamp and Riparian Scrub
- 244.7 Sonoran Interior Marshland

Other Land Cover Types (RECON, 2000)

- 999.0 Unclassified
- 999.1 Agriculture
- 999.2 Urban
- 999.3 Water
- 999.4 Bare ground

Figure 56

Habitat Requirements

The species is capable of occupying a wide range of habitats from halophytic coastal scrub communities on clayey saline hardpans only a few hundred feed from the Gulf of California shoreline to rocky loamy soils derived from weathered granite at nearly 3000 ft. elevation in south central Arizona. Southeast of Guaymas, it occurs in a halophytic coastal scrub community on extremely salty hardpans; at Kino Bay it occurs in coastal scrub on salty sand of old barrier dunes; in Tucson it is found on hot, dry, south-facing slopes of basalt and along desert washes. The largest population known is found in creosotebush desert scrub on gravelly loams primarily derived from weathered granites (FWIE 1996). Biotic communities in which it has been found include Arizona Upland and Lower Colorado Valley, Plains of Sonora and Central Gulf Coast subdivisions of Sonoran Desert Scrub Biotic Community; and the Sinaloan Thornscrub Biotic Community (AGFD 1997).

Ability to use major land use categories: This species is usually found in essentially undisturbed soil. However, several plants have been found in man-modified microhabitats. One group was found on an embankment created 2 or 3 decades ago to serve as a firing range backdrop (FWIE 1996).

Habitat trends in planning area: Large areas of potentially suitable habitat within the species; range have not been adequately explored. Much of the species' range in the U.S. is on protected land or land that is not likely to be developed. However, some development has occurred within the species range, and it is likely that some habitat has been lost.

Home range requirements: Because this plant has been found over such a wide range of conditions, precise requirements are poorly understood. Populations in Avra Valley and the Tucson basin are between 2,000 and 2,680 feet elevation. Thirteen populations are found on the lower slope of small mountains and hills, but none occur on the bedrock-dominated mountain slopes. No populations have been found in the floodplains of any major drainageway such as the Rillito River, Brawley, Wash, or the Santa Cruz River, although many populations are adjacent to or within the floodplains of minor washes (FWIE 1996).

The plants are always found climbing among shrubs and trees, which provide shade and elevated humidities for delicate seedling and juvenile plants, and support for the larger adult vines. The problem of survival on a wide variety of soil types may be circumvented by requiring germination and establishment to occur beneath a nurse plant, where the soil environment is highly modified by shade of the nurse plant and organic material from decaying vegetation. Clusters of 50-100 plants have been found beneath the canopy of a single nurse plant. The plants do not appear to be more abundant or vigorous in association with any particular host species. Observed 'nurse plants' include foothills paloverde (*Cercidium microphyllum*), creosotebush (*Larrea tridentata*) blue paloverde (*Cercidium floridum*), whitethorn acacia (*Acacia constricta*), saguaro (*Carnegiea gigantea*), prickly pear (*Opuntia phaeacantha*), ironwood (*Olneya tesota*), triangleleaf bursage (*Ambrosia deltoidea*), buckhorn cholla (*Opuntia acanthocarpa*), chainfruit cholla (*O. fulgida*), barrel cactus (*Ferocactus wislizenii*), range ratany (*Krameria parviflora*), ocotillo (*Fouquieria splendens*), and desert willow trees (*Chilopsis linearis*) (FWIE 1996).

Current and Potential Threats

General: Threats include urbanization, farming, overgrazing, recreation, habitat conversion, javelina (eating tubers), off-road vehicle use, and pesticides (AGFD 1997). The factor that really seems to be responsible for the rareness of the plant is a faulty mechanism of seed dispersal combined with a lack of pollinators. The main factors affecting survival are:

1) intensity and seasonal distribution of summer precipitation;

2) intensity, duration, and seasonal distribution of droughts;

3) date and intensity of first hard frost;

4) local predation pressure, varying from minor stem clipping to partial or complete excavation; and

5) anthropogenic habitat alteration (FWIE 1996).

Pima County populations location, amount, and quality of protected habitat: Most of the known range of this species encompasses land owned or managed by some governmental agency, but most of the known records are from locations that were surveyed prior to some development process. Therefore, it is not possible to accurately determine the extent of protected habitat with information currently available.

Existing and potential pest species: Javelina consume the roots and may destroy the plants in the process. A leaf-mining insect is known to consume some leaf tissue. Rabbits clip growing stems (FWIE 1996).

Threat mechanism: Physical destruction of plants, and failure to reproduce.

Management Needs

General: Maintenance of at least some of the range of this species in relatively pristine condition is probably necessary for its survival. Limited management options are possible for this species because many of the factors affecting it are beyond human control.

Current protective measures: Large areas that are known to be within the species range and that are known to have the species present are under management control of a variety of government agencies. Some preserves have been created and surrounded with hog wire fences to keep out javelinas. Many plants were transplanted from the CAP right of way, placed in preserves, and monitored for many years. Monitoring is very difficult, confounded by the difficulties of relocating plants once discovered, of distinguishing them from neighbors only a few millimeters away, and of accounting for dormant plants (FWIE 1996; K. J. Kingsley, pers. obs.).

Sensitivity to human activities and densities: Distribution of this species makes it difficult to determine its sensitivity to human activities and densities. Most known populations are on relatively undisturbed desert land, and it is considered a climax species. There is little or no evidence that it is affected by grazing. It is clearly affected by any activities that significantly disrupt the soil or remove trees and other vegetation.

Corridor needs: None are known.

Key relationships: The pollinator(s) have not been identified yet but are believed to be 1 or more moth species (FWIE 1996). The highly contagious (i.e., clumped) distribution suggests very strongly that seeds are inefficiently dispersed. Some obscure environmental parameter may be responsible, but this seems unlikely. It has been suggested that the original disperser was a bird species which is now, at least locally extinct, and that this is responsible for the contagious distribution (FWIE 1996). Several species of birds have been mentioned as seed consumers (AGFD 1997), but the effectiveness of them as seed dispersers has not been demonstrated.

It is believed that nurse plants are necessary to provide support for the delicate vine and provide a means of displaying mature fruits to potential seed dispersers. They may also moderate soil conditions, enabling *T. macdougalii* to grow in a wide variety of soil types. However, there is no indication that certain species are better nurse plants (FWIE 1996).

Migratory requirements: None are known. Seed dispersal agents may be a limiting factor for at least some populations.

Results of past mitigation activities: Long-term monitoring studies have been done of several populations that received some form of mitigation treatment, either avoidance or transplantation. Transplantation has had mixed results, and their interpretation is confounded by inadequate controls and the difficulties inherent in monitoring this species (FWIE 1996).

Existing monitoring and research programs: Continued monitoring is occurring for some known populations by USFWS and contractors, and by the U.S. Forest Service.

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APPENDIX A

SPECIES PER SUBAREA

This list includes only the 56 species for which species accounts were prepared. Assignment to subareas is based on HDMS records, other published records, or personal observations, including review of the maps included in the species accounts document that show known locations. Potential is based on the personal observation that the subarea contains habitat characteristics that are associated with known locations of the species, but there are no known records of the species from that subarea. It is possible that some potential distribution of some species has not been included, and /or that some records have been overlooked. This information is summarized in a table at the end of this document.

SUBAREA 1- MIDDLE SAN PEDRO

Quads: Campo Bonito, Peppersauce Wash, Kielberg Canyon, Mt. Bigelow, Buehman Canyon, Redington, Piety Hill, Soza Canyon, Mica Mountain, Happy Valley, Rincon Peak, Galleta Flat West

MAMMALS		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	known
Allen's Big-eared Bat	*Idionycteris phyllotis*	potential
Western Red Bat	*Lasiurus blossevillii*	potential
Lesser Long-nosed Bat	*Leptonycteris curasoae*	known
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	potential
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	potential
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
REPTILES		
Desert Box Turtle	*Terrapene ornata luteola*	potential
AMPHIBIANS		
Lowland Leopard Frog	*Rana yavapaiensis*	known
FISH		
Longfin Dace	*Agosia chrysogaster*	known
Desert Sucker	*Catostomus clarkii*	potential
Sonora Sucker	*Catostomus insignus*	potential
Gila Chub	*Gila intermedia*	potential
INVERTEBRATES		
Talus Snail	*Sonorella sabinoensis buehmanensis*	known
PLANTS	NONE KNOWN	

PLANNING UNIT 2 CIENEGA-RINCON

Quads: Tanque Verde Peak, Mica Mountain, Vail, Rincon Peak, Galleta Flat West, Mount Fagan,The Narrows, Mescal, Helvetia, Empire Ranch, Spring Water Canyon, Apache Peak, Mt. Wrightson, Sonoita, Elgin, Mustang Mountains

MAMMALS		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	known
Allen's Big-eared Bat	*Idionycteris phyllotis*	potential
Western Red Bat	*Lasiurus blossevillii*	known
Lesser Long-nosed Bat	*Leptonycteris curasoae*	known
California Leaf-nosed Bat	*Macrotis californicus*	known
Merriam's Mouse	*Peromyscus merriami*	known
Pale Townsend's Big-eared Bat	*Plecotus townsendii*	known
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Swainson's Hawk	*Buteo swainsoni*	known
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	known
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	potential
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
REPTILES		
Desert Box Turtle	*Terrapene ornata luteola*	known
Mexican Garter Snake	*Thamnophis eques megalops*	known
AMPHIBIANS		
Chiricahua Leopard Frog	*Rana chiricahuensis*	known
Lowland Leopard Frog	*Rana yavapaiensis*	known
FISH		
Longfin Dace	*Agosia chrysogaster*	known
Gila Chub	*Gila intermedia*	known
Gila Topminnow	*Poeciliopsis o. occidentalis*	known
INVERTEBRATES		
Arkenstone Cave Pseudoscorpion	*Albiorix anopthalmus*	known
Talus Snails	*Sonorella imperatrix*	known
	Sonorella imperialis	known
	Sonorella rinconensis	known
	Sonorella magdalensis	potential
PLANTS		
Pima Pineapple Cactus	*Coryphantha scheeri robustispina*	known
Needle-spined Pineapple Cactus	*Echinomastus e. erectocentrus*	known
Huachuca Water Umbel	*Lilaeopsis schaffneriana recurvata*	known

PLANNING UNIT 3 UPPER SANTA CRUZ

Quads: San Xavier Mission, Tucson SW, Tucson SE, Vail, Samaniego Peak, Twin Buttes, Sahuarita, Corona de Tucson, Mount Fagan, Batamote Hills, Esperanza Mill, Green Valley, Helvetia, Empire Ranch, Cerro Colorado, Saucito Mtn, Amado, Mt. Hopkins, Mt. Wrightson, Arivaca, Murphy Peak

MAMMALS		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	known
Western Red Bat	*Lasiurus blossevillii*	known
Lesser Long-nosed Bat	*Leptonycteris curasoae*	known
California Leaf-nosed Bat	*Macrotis californicus*	known
Merriam's Mouse	*Peromyscus merriami*	known
Pale Townsend's Big-eared Bat	*Plecotus townsendii*	known
Arizona Shrew	*Sorex arizonae*	potential
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Swainson's Hawk	*Buteo swainsoni*	known
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	known
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	potential
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
REPTILES		
Desert Box Turtle	*Terrapene ornata luteola*	known
Giant Spotted Whiptail	*Cnemidophorus burti stictogrammus*	known
AMPHIBIANS		
Chiricahua Leopard Frog	*Rana chiricahuensis*	known
Lowland Leopard Frog	*Rana yavapaiensis*	known
FISH	NONE KNOWN	
INVERTEBRATES		
Talus Snails	*Sonorella eremita*	known
	Sonorella magdalensis	potential
PLANTS		
Pima Pineapple Cactus	*Coryphantha scheeri robustispina*	known
Gentry Indigobush	*Dalea tentaculoides*	potential
Tumamoc Globeberry	*Tumamoca macdougalii*	known

PLANNING UNIT 4. MIDDLE SANTA CRUZ

Quads: Oro Valley, Mt. Lemmon, Mt. Bigelow, Avra, Jaynes, Tucson North, Sabino Canyon, Agua Caliente Hill, Piety Hill, Cat Mountain, Tucson, Tucson East, Tanque Verde Peak, San Xavier Mission, Tucson SW, Tucson SE, Vail

MAMMALS		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	known
Allen's Big-eared Bat	*Idionycteris phyllotis*	potential
Western Yellow Bat	*Lasiurus xanthinus*	known
Lesser Long-nosed Bat	*Leptonycteris curasoae*	known
California Leaf-nosed Bat	*Macrotis californicus*	known
Merriam's Mouse	*Peromyscus merriami*	known
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Burrowing Owl	*Athene cunicularia*	known
Swainson's Hawk	*Buteo swainsoni*	known
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	known
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
REPTILES		
Desert Box Turtle	*Terrapene ornata luteola*	potential
Giant Spotted Whiptail	*Cnemidophorus burti stictogrammus*	known
Ground Snake	*Sonora semiannulata*	known
Mexican Garter Snake	*Thamnophis eques megalops*	known
AMPHIBIANS		
Lowland Leopard Frog	*Rana yavapaiensis*	known
FISH		
Gila Chub	*Gila intermedia*	known
INVERTEBRATES		
Talus Snails	*Sonorella magdalensis*	known
PLANTS		
Pima Pineapple Cactus	*Coryphantha scheeri robustispina*	known
Tumamoc Globeberry	*Tumamoca macdougalii*	known

PLANNING UNIT 5 TORTOLITA FAN

Quads: Desert Peak, Tortolita Mts., Oracle Junction, Oracle, West of Marana, Marana, Ruelas Canyon, Oro Valley, Mt. Lemmon, Avra, Jaynes, Tucson North

MAMMALS	NONE KNOWN	
Mexican Long-tongued Bat	*Choeronycteris mexicana*	potential
Western Red Bat	*Lasiurus blossevillii*	potential
Western Yellow Bat	*Lasiurus xanthinus*	potential
Lesser Long-nosed Bat	*Leptonycteris curasoae*	potential
California Leaf-nosed Bat	*Macrotis californicus*	potential
Pale Townsend's Big-eared Bat	*Plecotus townsendii*	potential
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Burrowing Owl	*Athene cunicularia*	known
Swainson's Hawk	*Buteo swainsoni*	known
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
REPTILES		
Tucson Shovel-nosed Snake	*Chionactis occipitalis klauberi*	known
Ground Snake	*Sonora semiannulata*	potential
AMPHIBIANS	NONE KNOWN	
FISH	NONE KNOWN	
INVERTEBRATES		
Talus Snails	*Sonorella tortillita*	known
	Sonorella sabinoensis tucsonica	known
PLANTS		
Tumamoc Globeberry	*Tumamoca macdougalii*	known

PLANNING UNIT 6A ALTAR VALLEY

La Tortuga Butte, Cocoraque Butte, Brown Mtn. Cat Mountain, San Pedro, Three Points, San Xavier Mission SW, San Xavier Mission, Kitt Peak, Palo Alto Ranch, Stevens Mtn., Samaniego Peak, Baboquivari Peak, Fresno Wash, Penitas Hills, Batamote Hills, Aguirre Peak, Mildred Peak, Las Guijas, Cerro Colorado, Saucito Mtn., Caponera Peak, Presumido Peak, Wilbur Canyon, Arivaca, Murphy Peak, Sasabe, Cumero Mountain, Bartlett Mountain.

MAMMALS		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	known
Western Red Bat	*Lasiurus blossevillii*	known
California Leaf-nosed Bat	*Macrotis californicus*	known
Merriam's Mouse	*Peromyscus merriami*	known
Pale Townsend's Big-eared Bat	*Plecotus townsendii*	known
Lesser Long-nosed Bat	*Leptonycteris curasoae*	potential
Western Yellow Bat	*Lasiurus xanthinus*	potential
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Burrowing Owl	*Athene cunicularia*	known
Swainson's Hawk	*Buteo swainsoni*	known
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	known
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
REPTILES		
Desert Box Turtle	*Terrapene ornata luteola*	known
Giant Spotted Whiptail	*Cnemidophorus burti stictogrammus*	known
Mexican Garter Snake	*Thamnophis eques megalops*	known
Tucson Shovel-nosed Snake	*Chionactis occipitalis klauberi*	known
AMPHIBIANS		
Chiricahua Leopard Frog	*Rana chiricahuensis*	known
Lowland Leopard Frog	*Rana yavapaiensis*	known
FISH		
Desert Pupfish	*Cyprinodon m. macularius*	captive
Gila Topminnow	*Poeciliopsis o. occidentalis*	captive
INVERTEBRATES		
Talus Snails	*Sonorella ambigua ambigua*	known
	Sonorella b. baboquivariensis	known
	Sonorella baboquivariensis berryi	known
	Sonorella b. depressa	known
	Sonorella magdalensis	known
	Sonorella sitiens sitiens	known
	Sonorella xanthenes	known
PLANTS		
Pima Pineapple Cactus	*Coryphantha scheeri robustispina*	known
Tumamoc Globeberry	*Tumamoca macdougalii*	known

Planning Unit 6B Avra Valley

Quads: Greene Reservoir, Friendly Corners, Gap Tank, Silver Bell West, Silver Bell East, West of Marana, Marana, Waterman Peak, West of Avra, Avra, Jaynes, La Tortuga Butte, Cocoraque Butte, Brown Mtn., Cat Mountain

MAMMALS		
California Leaf-nosed Bat	*Macrotis californicus*	known
Lesser Long-nosed Bat	*Leptonycteris curasoae*	known
Mexican Long-tongued Bat	*Choeronycteris mexicana*	potential
Western Red Bat	*Lasiurus blossevillii*	potential
Western Yellow Bat	*Lasiurus xanthinus*	potential
Pale Townsend's Big-eared Bat	*Plecotus townsendii*	potential
BIRDS		
Rufous-winged Sparrow	*Aimophila carpalis*	known
Burrowing Owl	*Athene cunicularia*	known
Swainson's Hawk	*Buteo swainsoni*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	potential
REPTILES		
Tucson Shovel-nosed Snake	*Chionactis occipitalis klauberi*	known
Ground Snake	*Sonora semiannulata*	potential
AMPHIBIANS	NONE KNOWN	
FISH	NONE KNOWN	
INVERTEBRATES	NONE KNOWN Some *Sonorella* snails which may or may not be previously described species may be present in the area.	
PLANTS		
Nichol's Turk's Head Cactus	*Echinocactus horizonthalonius var. nicholii*	known
Tumamoc Globeberry	*Tumamoca macdougalii*	known

Planning Unit 8 Western Pima County

Quads: Aguila Mtns. SE, Okie Well, East Pass, Midway SW, Deadman Gap, Hat Mountain SW, Tom Thumb, Granite Mts. North, West of Growler Peak, Growler Peak, Childs Mtn., Ajo North, Burro Gap, Coffeepot Mtn., Granite Mts. South, Saguaro Gap Well, Temporal Pass, Chico Shunie, Ajo South, Sikort Chuapo, Gakolik Mtns., Antelope Hills, North of Agua Dulce Mts., Palo Verde Camp, Bates Well, Armenta Well, Gunsight, Hotason Vo, O'Neill Hills, Agua Dulce Mts., Pozo Nuevo Well, Kino Peak, Tillotson Peak, Mount Ajo, Gu Vo, West of Quitobaquito Springs, Quitobaquito Springs, West of Lukeville, Lukeville, Diaz Peak, Pia Oik, South of Lukeville, Blankenship Well, Menagers Lake.

MAMMALS		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	known
Lesser Long-nosed Bat	*Leptonycteris curasoae*	known
California Leaf-nosed Bat	*Macrotis californicus*	known
Pale Townsend's Big-eared Bat	*Plecotus townsendii*	known
Merriam's Mouse	*Peromyscus merriami*	known
Western Red Bat	*Lasiurus blossevillii*	potential
Western Yellow Bat	*Lasiurus xanthinus*	potential
BIRDS		
Burrowing Owl	*Athene cunicularia*	known
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	known
Abert's Towhee	*Pipilo aberti*	known
Bell's Vireo	*Vireo belli*	known
Rufous-winged Sparrow	*Aimophila carpalis*	potential
REPTILES		
Organ Pipe Shovel-nosed Snake	*Chionactis palurostris organica*	known
Redback Whiptail	*Cnemidophorus burti xanthonotus*	known
AMPHIBIANS	NONE KNOWN	
FISH	NONE KNOWN	
INVERTEBRATES		
Talus Snail	*Sonorella meadi*	known
PLANTS		
Acuña Cactus	*Echinomastus erectocentrus acuñensis*	known
Tumamoc Globeberry	*Tumamoca macdougalii*	known