Sonora Tiger Salamander
(Ambystoma tigrinum stebbinsi)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
Phoenix, Arizona

5-YEAR REVIEW
Sonora tiger salamander/*Ambystoma tigrinum stebbinsi*

1.0 GENERAL INFORMATION

1.1 Reviewers: Jim Rorabaugh

Lead Regional or Headquarters Office: Wendy Brown, Southwest Region, 505-248-6664

Lead Field Office: Steven Spangle, Field Supervisor, Arizona Ecological Services Field Office, 602/242-0210 x244

Cooperating Field Office(s): None

Cooperating Regional Office(s): None

1.2 Methodology used to complete the review:

This five year review was conducted by Jim Rorabaugh, U.S. Fish and Wildlife Service (USFWS), Arizona Ecological Services Office, with review by supervisors in that field office, as well as scientific staff and supervisors in the Division of Endangered Species in the USFWS Southwest Region, Albuquerque, NM. A recovery plan was recently developed for this subspecies (U.S. Fish and Wildlife Service 2002). That document, together with limited new information in the form of peer-reviewed literature and unpublished survey data, formed the basis for the review. No peer review of this document was sought for the following reasons: 1) the 5-year review resulted in a recommendation to leave the status unchanged, 2) most new information has undergone prior peer review, 3) survey data has not been peer-reviewed, but no population trends can be discerned from the data due to insufficient sample sizes, and 4) the level of public interest and/or scientific uncertainty or controversy is low. In the United States, the species occurs only within Arizona (one historical locality in northern Sonora, Mexico); hence, there are no cooperating Field or Regional Offices.

1.3 Background:

The Sonora tiger salamander and two plant taxa were petitioned for listing in a letter to the Secretary of Interior dated June 3, 1993. On April 3, 1995, we published in the Federal Register a 12-month finding and proposed rule to list these species. The Sonora tiger salamander was listed as endangered without critical habitat on January 6, 1997. A contractor was selected in July 1998 to prepare the recovery plan in close coordination with a recovery team, which was designated the Sonora tiger salamander Participation Team and met for the first time in October 1998. The draft recovery plan was made available for public review in the summer of 2000, and was finalized and signed in September 2002 by the Southwest Region's Regional Director and the Director of the Arizona Game and Fish Department (AGFD).

No listing decisions, status reviews, or recovery plan revisions have occurred regarding the Sonora tiger salamander since the signing of the recovery plan. Several biological opinions have been issued, Fort Huachuca (a land manager within the range of the subspecies) has finalized an Integrated Natural Resources Management Plan, monitoring of the species has occurred, some recovery actions have been initiated, and several peer-reviewed studies about the species have been published or are in review. The recovery plan described the baseline status of the subspecies in 2002. Documents and information since finalization of the recovery plan form the basis for this 5-year review, which focuses on changes in the species' status relative to the situation portrayed in the recovery plan.

1.3.1 FR Notice citation announcing initiation of this review: 71 FR 20714, April 21, 2006

1.3.2 Listing history

Original Listing
FR notice: 62 FR 665
Date listed: January 6, 1997
Entity listed: Sonora tiger salamander, *Ambystoma tigrinum stebbinsi*
Classification: Endangered, without critical habitat

Revised Listing, if applicable
FR notice: None
Date listed: None
Entity listed: None
Classification: None

1.3.3 Associated rulemakings: None

1.3.4 Review History: See background. The relevant documents reviewing the status of the subspecies are the final rule (62 FR 665) and the final recovery plan (September 2002)

1.3.5 Species' Recovery Priority Number at start of 5-year review: 3

1.3.6 Recovery Plan or Outline: Final recovery plan

Name of plan or outline: Sonora Tiger Salamander Recovery Plan
Date issued: September 2002
Dates of previous revisions, if applicable: None

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

__X_ ***Yes,*** *go to section 2.1.2.*
_____***No,*** *go to section 2.2.*

2.1.2 Is the species under review listed as a DPS?

____ ***Yes****, go to section 2.1.3.*
__X_ ***No****, go to section 2.1.4*

2.1.3 Was the DPS listed prior to 1996?

____ ***Yes****, go to section 2.1.3.1.*
____ ***No****, go to section 2.1.4.*

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____ ***Yes,*** *go to section 2.1.4.*
____ ***No****, go to section 2.1.3.2.*

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____ ***Yes****, go to section 2.1.4.*
____ ***No****, go to section 2.4., Synthesis.*

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ ***Yes****, go to section 2.4, Synthesis.*
__X_ ***No****, go to section 2.2., Recovery Criteria.*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan[1] containing objective, measurable criteria?

__X_ ***Yes****, continue to section 2.2.2.*

____ ***No****, go to section 2.3., Updated Information and Current Species Status.*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

__X_ ***Yes,*** *go to section 2.2.2.2.*
____ ***No****, go to section 2.2.3.*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

_____ ***Yes****, go to section 2.2.3.*
__X__ ***No****, go to section 2.2.3.*

The downlisting and delisting criteria, taken together address all 5 of the listing factors. Furthermore, amelioration of threats, as defined in the 5 factors, is described in the section of the recovery plan entitled "Minimization of Threats to the Sonora Tiger Salamander Through Implementation of Recovery Actions". However, there is some new information regarding existing threats.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

Downlisting Criteria
The Sonora tiger salamander should be proposed for downlisting when both of the following criteria have been met:

1. Approximately 90 percent of salamander's currently occupied range (lands managed by Coronado National Forest, Arizona State Parks Board, Fort Huachuca, and cooperating private landowners) and approximately 90 percent of current breeding ponds are protected in accordance with recovery actions 1.1 through 1.5, are free from introduced

[1] Although the guidance generally directs the reviewer to consider criteria from final approved recovery plans, criteria in published draft recovery plans may be considered at the reviewer's discretion.

fish and crayfish, and are monitored to detect new threats, including introductions of predators and non-native salamanders.

Analysis
Data are insufficient to properly determine: 1) current occupied range, 2) current percentage of breeding ponds protected in accordance with recovery actions 1.1 through 1.5, and 3) current percentage of breeding ponds free of introduced fish and crayfish. An estimated 300 stock tanks (potential breeding sites) occur within the range of the salamander, of which 139 were surveyed by AGFD during 2001-2006. These surveys have revealed presence of introduced fishes at four sites within the range of the subspecies. Four species were detected, including largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochinus*), green sunfish (*Lepomis cyanellus*), and mosquitofish (*Gambusia affinis*). Crayfish (*Orconectes virilis*) occur on the eastern periphery of the subspecies' range in Merritt and Bear canyons, and possibly at Parker Canyon Lake, but have not been observed in sites currently or previously occupied by Sonora tiger salamanders. Non-native fishes (green sunfish and mosquitofish) were found this year in the Santa Cruz River (D. Duncan, USFWS, pers. comm. 2006); surveys by AGFD since 2001 have revealed non-native fishes in Parker Canyon, and several non-native fish species also occur at Parker Canyon Lake within the range of the subspecies. In addition, surveys at Rancho Los Fresnos, Sonora, have revealed widespread presence of green sunfish and crayfish, and localized presence of black bullhead (*Ictalurus melas*) within the range of the subspecies.

Recovery actions 1.1-1.5 are mostly not implemented. Guidelines for cattle pond use and maintenance (1.3) have been largely implemented on public lands, but not on private lands. Watershed use and maintenance guidelines have not been developed (1.1), implemented (1.2), or enforced (1.5). A formal stock pond cleaning and maintenance plan (1.4) has not been developed or implemented; however, ranchers and the Forest Service address maintenance as needed in association with allotment management plans and annual operating plans. Enforcement of guidelines for cattle pond watershed use and maintenance (1.5) has not occurred. In summary, criterion 1 for downlisting has not yet been fully met.

2. Scientifically credible monitoring data resulting from monitoring protocols identified in recovery action 5.1, collected over a consecutive five year period, and reviewed by the Participation Team, indicate that the number of Sonora tiger salamander populations is not in decline and that there are no new factors that threaten the persistence of the Sonora tiger salamander metapopulation.

Analysis
In 2001, the AGFD initiated a monitoring protocol that involves visiting a random sample of 10 stock tanks once and an additional 10 stock tanks that are visited twice. Each stock tank is sampled for Sonora tiger salamanders. Notes on introduced species are also taken. We are in receipt of trip reports documenting what was found during the following trips: 24-26 April 2006, 6-9 March 2006, 6-9 February 2006, 10-13 January 2006, 13-15 June 2005, 3-5 May 2005, 7-10 March 2005, 23-26 February 2004, 5-8 May 2003, 10-13 March 2003, 7-10 February 2003, 4-7 February 2003, late May 2002, early May 2002, March 2002, late June 2001, early June 2001, and April 2001. During these surveys, sampling was conducted at 139 tanks. Sonora tiger salamanders were found at 37 (27 percent) of these tanks, which were sampled from 1-7 times

each. At 23 of 29 tanks where salamanders were found, and which were sampled more than once, salamanders were not found on at least one visit.

The 2001 and 2002 data were not collected entirely consistent with protocols used from 2003-2006. At least five years of data collected in accordance with the current protocol are needed to begin to assess trends (D. Cox, AGFD, pers. comm. 2006). Hence, trend analysis cannot be conducted to assess whether criterion 2 has been met. Five years of data according to protocols will have been collected after the field season in 2007, at which time trend analysis may be possible. No new threats to the salamander or its habitat are known. In summary, criterion 2 for downlisting has not been fully met.

Delisting Criteria

The Sonora tiger salamander should be proposed for delisting when all of the following criteria have been met:

1. Number of breeding populations and amount, distribution, and type of available habitat are adequate to support viable populations of Sonora tiger salamanders in the long term. A population viability analysis (PVA), as described in the Narrative Outline, should provide the information to quantify these variables.

Analysis

We do not know whether the number of breeding populations and amount, distribution, and type of available habitat are adequate to support viable populations in the long term because a PVA has not been completed. Nor do we have adequate data to determine the number of populations on the landscape at any one time. This criterion has not been met.

2. Regulatory mechanisms and land management commitments that provide for adequate long-term protection of the Sonora tiger salamander and its habitat, such as those priority tasks described in the step-down narrative, have been implemented. These commitments and mechanisms should address management of non-native predators, disease transmission, introduction and collection of salamanders, interbreeding with non-native salamanders, public education, and other issues as described in the step-down narrative or identified in subsequent revisions of this plan.

Analysis

We have implemented field protocols to minimize the likelihood of disease transmission, and a pilot project was initiated in 2006 to test techniques for eliminating non-native predators from a localized area of the San Rafael Valley. However, we have yet to address other topics in the criterion.

3. The Sonora tiger salamander is unlikely to need protection under the Endangered Species Act in the foreseeable future.

Analysis

As the recovery plan is largely yet to be implemented, and we do not know the status or trends in salamander populations, we cannot conclude that the Sonora tiger salamander is unlikely to need protection under the Endangered Species Act in the foreseeable future.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history: There have been several new publications relevant to Sonora tiger salamander biology. Most have focused on diseases; however, Pitman (2005) examined upland use by terrestrial adult California tiger salamanders (*Ambystoma californiense*). This is a related species and may provide some implications for management of upland sites as habitat for terrestrial Sonora tiger salamanders. Pitman (2005) excavated burrows and found tiger salamanders at a mean distance of 356 m, but as far away as 510 m, from the nearest breeding pond in gopher burrows, riprap, and in rocks associated with gopher burrows. He suggests upland habitats should be protected and managed for healthy small mammal populations within 500 m of breeding sites.

Davidson *et al.* (2003) documented chytridiomycosis, caused by the pathogen *Batrachochytrium dendrobatidis*, in Sonora tiger salamanders from the San Rafael Valley. This disease has been implicated in global decline of frogs and toads; however, Davidson *et al.* found that none of the infected Sonora tiger salamanders died from the disease. Individuals appeared to vary in their susceptibility to the disease, and salamanders appeared to recover from the infections.

Further study has occurred on the *Ambystoma tigrinum* virus (ATV) that routinely kills large numbers of Sonora tiger salamanders and other *Ambystoma* salamanders throughout western North America and southern Canada. Collins *et al.* (2003) found that infected salamanders from the San Rafael Valley had survival and growth rates lower than infected Arizona tiger salamanders (*A. t. nebulosum*) from the White Mountains, Arizona. Brunner *et al.* (2004) found dispersing, infected metamorphosed Arizona salamanders at the end of an epidemic and provides indirect evidence that these individuals can return the next season to re-infect the breeding population. ATV is usually lethal within 2-3 weeks, but larval and adult Arizona salamanders can recover from ATV and carry sublethal infections for more than five months. These recovered individuals may become carriers that can then re-infect other individuals. Larval Arizona salamanders are ten times more likely to recover from ATV than are metamorphosed animals (Brunner *et al.* 2004). ATV is transmitted via direct contact among salamanders, feeding on infected tissues, and in water with high viral titers. No other hosts of the disease are known in the range of the Sonora tiger salamander, and ATV quickly degrades in pond water and mud in the absence of salamander hosts.

As discussed in 2.3.1.3 below, barred tiger salamanders (*Ambystoma tigrinum mavortium*) have been apparently introduced into the range of the Sonora tiger salamander. Collins *et al.* (2003) noted isolation of ATV from salamanders obtained from a Phoenix bait supplier, suggesting that use of salamanders as bait

is a mechanism for dispersal and spread of this disease. Jancovich *et al.* (2005) sequenced ATV from various locales in North America and concluded that the emergence of salamander ATV throughout the western U.S. is likely the result of a single introduction and recent spread. They suggest that the disease may have originated with sport fishes, such as rainbow trout or largemouth bass, which have been widely introduced in the western U.S. The disease may have started as a fish ranavirus and then switched to salamanders. However, they also provide evidence that the disease could have been spread via waterdogs used as bait.

Docherty *et al.* (2003) described iridovirus and ranavirus mortality events in two subspecies of *A. tigrinum* in North Dakota and Utah, and spotted salamanders (*A. maculatum*) from Maine. No other amphibian species appeared to be affected, but the authors suggested challenge assays were needed to determine fish and amphibian host ranges. The iridovirus infections were consistent with a sudden onset of viremia with viral inclusions in almost all organs. This is in contrast to ATV infections in Arizona, which is a viral skin disease.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends: No new information. Collection of such data is recommended in the recovery plan.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.): In regard to the threat of introgression with the introduced barred salamander, the recovery plan cited Ziemba *et al.* (1998) who found salamanders with genetic characteristics similar to the barred tiger salamander at six stock tanks in the southeastern portion of the San Rafael Valley, and suggested hybridization was occurring. The authors used allozyme sequences. Since the recovery plan was finalized, Storfer *et al.* (2004) used mitochondrial DNA sequences and analysis of microsatellite loci to demonstrate the presence of a barred tiger salamander haplotype. They concluded that either 1) there has been incomplete lineage sorting from a shared ancestor, or 2) there has been ongoing or sporadic introgression of barred tiger salamander DNA into Sonora tiger salamander populations. The authors further suggested that the most likely explanation for the presence of barred tiger salamander DNA was introduction of barred tiger salamanders as bait. All six of the tanks are near a highway and Parker Canyon Lake, a popular fishing site. Recovery action 3.2 recommends removal of non-native salamanders from tanks that do not also contain Sonora tiger salamanders. Adaptive management should be considered for mixed populations of Sonora and barred tiger salamanders, including eliminating such populations due to the threat of introgression (Tom Jones, AGFD, pers. comm. 2007).

Andrew Storfer and others have submitted a manuscript for publication about inbreeding and population structure in the Sonora tiger salamander. The authors studied genetic variation and population structure based on microsatellite analysis

of 276 salamanders from about half of the known localities. They found generally low allelic diversity, heterozygosity significantly lower than expected, and evidence of recent bottlenecks. A high degree of genetic subdivision was found among populations, as well. In conclusion, the genetic data suggest most populations are small and inbred (Andrew Storfer, Washington State University, pers. comm. 2007).

2.3.1.4 Taxonomic classification or changes in nomenclature: No new information.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.): We have not found Sonora tiger salamanders at Rancho Los Fresnos, Sonora, during three survey trips to that area (see U.S. Fish and Wildlife Service 2006a&b). Populations may have contracted in the area due to presence of non-native species, which were not found when salamanders were detected there in 1990 (Varela-Romero *et al.* 1992). AGFD reported salamanders at Kunde Tank in the Redrock Canyon area north of the San Rafael Valley, which have tentatively been identified as *Ambystoma tigrinum stebbinsi* using genetic markers (D. Cox, AGFD, pers. comm. 2006). This finding would represent a range extension of approximately 6.8 miles north of the nearest known locality. Whether the subspecies dispersed to or was purposely introduced to this locality is unknown.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): Note 2.3.1.5 in regard to invasion of non-native predators at Rancho Los Fresnos. Drought during recent years may have reduced surface waters and potential breeding sites for the salamander and its non-native predators, but there has been no quantitative analysis of that phenomenon. Heavy rains in the summer of 2006 filled most stock tanks within the range of the species. No other new information is available.

2.3.1.7 Other: None

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range: No substantial new information regarding the nature of threats to habitat or range is available. As noted above, the subspecies was not found at Rancho Los Fresnos, Sonora, which may be due to presence of non-native predators not present when Sonora tiger salamanders were found at this site in 1990.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes: No new information.

2.3.2.3 Disease or predation: New information is summarized in 2.3.1.1 above regarding disease. This new information confirms that ATV can be spread via use of locally obtained waterdogs as fish bait.

2.3.2.4 Inadequacy of existing regulatory mechanisms: No new information.

2.3.2.5 Other natural or manmade factors affecting its continued existence: As discussed in 2.3.1.3, the work of Storfer *et al.* (2004) confirms the presence of barred tiger salamander DNA in the range of the Sonora tiger salamander; likely the result of introduction of barred tiger salamanders as bait in the Parker Canyon Lake area. In the 2002 recovery plan, we suspected this was the case, but Storfer's work strengthens the argument that hybridization with and genetic swamping by barred tiger salamanders is a real threat to the Sonora tiger salamander. Using microsatellites, Storfer (pers. comm. 2007) also found that Sonora tiger salamanders are typically inbred with low genetic diversity. Low genetic variability had previously been documented via analysis of allozymes, and was identified as a threat in the recovery plan.

2.4 Synthesis

Surveys conducted by AGFD demonstrate that Sonora tiger salamanders are found at relatively few sites (37 of 139 stock tanks sampled during 2001-2006), consistent with the findings of the recovery plan. As described in the recovery plan, these sites are all impoundments created as livestock waters that require periodic maintenance. The historical habitats of the subspecies have either disappeared or are occupied by non-native fishes with which Sonora tiger salamanders cannot coexist. Not enough years of survey data are available to assess population trends, but we expect that the first such analyses will be possible towards the end of 2007. There is an unconfirmed range extension of about 6.8 miles to the north, but the subspecies may be precluded from habitats at the southern portion of its range (Rancho Los Fresnos) by introduced, non-native predators. New information is available about mechanisms of transmission, survivorship, human-caused vectors, persistence in the absence of salamanders, and other aspects of ATV. This information does not dramatically change our understanding of the magnitude of this threat, but does significantly advance our knowledge of the disease. Chytridiomycosis was found in Sonora tiger salamanders, but this amphibian disease does not appear to affect survivorship, and salamanders can recover. In summary, no new information is available suggesting significant changes in the status of or threats to the Sonora tiger salamander since the recovery plan was issued in 2002.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist:
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X_ No change is needed

3.2 New Recovery Priority Number: No change.

Brief Rationale: Recovery Priority 3, which is based on the Sonora tiger salamander being a subspecies with a high degree of threat and high recovery potential. Threats, particularly invasion and spread of non-native, predatory species, but also disease and drought, are significant. However, the recovery plan lays out a feasible strategy to address the threats, leading to a high recovery potential.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The recovery plan implementation schedule with its prioritized tasks is still the appropriate guiding document for recommended future actions; however, see Section **2.3.1.3** regarding recommended adaptive management and mixed populations of Sonora and barred tiger salamanders. The primary impediment to recovery has been lack of funding to implement recovery actions, and because of that, relatively little progress has been made in implementing recommended recovery actions. We intend to seek funding from grants and foundations in coming years to initiate comprehensive recovery.

5.0 REFERENCES

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Personal Communications (provided information used in the review):

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF THE SONORA TIGER SALAMANDER

Current Classification: Endangered with no critical habitat

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Jim Rorabaugh

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Acting Debra T. Bills Date 6/19/07

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Fish and Wildlife Service

Approve D. Mullon Date 4 Oct. 2007