

Recovery Plan for Sonoran tiger salamander (*Ambystoma mavortium tigrinum*)
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DRAFT AMENDMENT 1

We have identified best available information that indicates the need to amend recovery criteria for Sonoran tiger salamander (*Ambystoma mavortium tigrinum*) subsequent to completion of the 2002 Sonora Tiger Salamander Recovery Plan (Recovery Plan). In this proposed modification, we consider the adequacy of the existing recovery criteria, show amended recovery criteria by revising delisting criteria, and provide the rationale supporting the proposed recovery plan modification. The proposed modification is shown as an addendum that supplements the Recovery Plan, specifically the recovery criteria (p.13) of the existing Recovery Plan.

**For
U.S. Fish and Wildlife Service
Southwest Region
Albuquerque, NM**

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BACKGROUND INFORMATION

Recovery plans should be consulted frequently, used to initiate recovery activities, and updated as needed. A review of the recovery plan and its implementation may show that the plan is out of date or its usefulness is limited, and therefore warrants modification. Keeping recovery plans current ensures that the species benefits through timely, partner-coordinated implementation based on the best available information. The need for, and extent of, plan modifications will vary considerably among plans. Maintaining a useful and current recovery plan depends on the scope and complexity of the initial plan, the structure of the document, and the involvement of stakeholders.

An amendment involves a substantial rewrite of a portion of a recovery plan that changes any of the statutory elements. The need for an amendment may be triggered when, among other possibilities: (1) the current recovery plan is out of compliance with regard to statutory requirements; (2) new information has been identified, such as population-level threats to the species or previously unknown life history traits, that necessitates new or refined recovery actions and/or criteria; or (3) the current recovery plan is not achieving its objectives. The amendment replaces only that specific portion of the recovery plan, supplementing the existing recovery plan, but not completely replacing it. An amendment may be most appropriate if significant plan improvements are needed, but resources are too scarce to accomplish a full recovery plan revision in a short time.

Although it would be inappropriate for an amendment to include changes in the recovery program that contradict the approved recovery plan, it could incorporate study findings that enhance the scientific basis of the plan, or that reduce uncertainties as to the life history, threats, or species' response to management. An amendment could serve a critical function while awaiting a revised recovery plan by: (1) refining and/or prioritizing recovery actions that need to be emphasized, (2) refining recovery criteria, or (3) adding a species to a multispecies or ecosystem plan. An amendment can, therefore, efficiently balance resources spent on modifying a plan against those spent on managing implementation of ongoing recovery actions.

METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

U.S. Fish and Wildlife Service (USFWS) personnel associated with the Arizona Ecological Services Office (AESO) reviewed the best available information on the status and needs of the Sonoran tiger salamander. We reviewed and considered information found in the current Recovery Plan (USFWS 2002), the Sonoran Tiger Salamander 5-Year Review (USFWS 2007), pertinent published literature, and USFWS files. Following a review of the best available information, AESO personnel met with the Arizona Game and Fish Department to discuss development of quantitative delisting criteria. We intend to allow the Sonoran Tiger Salamander Participation Team, identified in the Recovery Plan, to provide peer review of the delisting criteria we have developed prior to finalizing the criteria.

ADEQUACY OF RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Endangered Species Act (ESA) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list." Legal challenges to recovery plans (see *Fund for Animals v. Babbitt*, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) have also affirmed the need to frame recovery criteria in terms of threats assessed under the five threat factors (ESA 4(a)(1)).

Recovery Criteria

The recovery objectives, downlisting criteria, delisting criteria, and recovery actions can be found on pages 13-21 in the existing 2002 Recovery Plan. The Recovery Plan contained delisting criteria that relied on future quantification of population metrics that would help us understand when recovery has been accomplished. It was determined at the time the Recovery Plan was developed, that there was inadequate information to quantify appropriate delisting criteria.

Synthesis

The Recovery Plan described the baseline status of the subspecies in 2002, and the 2007 5-Year Status Review of the Sonoran Tiger Salamander focused on changes in the subspecies status relative to that portrayed in the Recovery Plan. The Sonora tiger salamander was described as the subspecies *stebbinsi* of the broad-ranging tiger salamander (*Ambystoma tigrinum*) by Lowe (1954) from specimens collected in the San Rafael Valley in southern Santa Cruz County, Arizona. The subspecies is currently recognized by Crother (2017) as the Sonoran tiger salamander (*Ambystoma mavortium stebbinsi*) and is found in the San Rafael Valley and adjacent slopes of the Huachuca and Patagonia mountains in southern Arizona along the international border with Mexico, but has not been verified to occur in Mexico. The geographic

area where the subspecies occurs may represent a relict grassland serving as a refugium for the species where tiger salamanders became isolated and eventually genetically distinct from the two ancestral subspecies. The non-native barred tiger salamander is considered an introduced species in the range of the Sonoran tiger salamander and the two subspecies are morphologically similar. The most important habitat requirement for Sonoran tiger salamander is the availability of standing water for breeding from January through June and aquatic habitats are used by all life stages. Aquatic sites currently inhabited by the Sonoran tiger salamander are almost exclusively human-constructed and maintained earthen ponds known as stock ponds. The 2002 Recovery Plan defines a population as all salamanders found at a discrete aquatic site, and we have no new information to define a population differently. Upland habitats are also used by terrestrial adults when not in aquatic sites. Current threats to Sonoran tiger salamanders include the following: 1) drying of aquatic habitat, 2) predation by non-native fish, bullfrogs, and crayfish, 3) genetic swamping by introduced, non-native barred tiger salamanders, 4) disease, and 5) low genetic diversity.

Significant research, monitoring, investigations, and implementation of recovery actions have occurred subsequent to completion of the 2007 5-Year Status Review of the Sonoran Tiger Salamander. Below, we summarize new information that has become available that has implications for considering downlisting and delisting criteria.

Taxonomy - The Introgression from introduced barred tiger salamander (*Ambystoma mavortium mavortium*) may be altering the gene pool of the Sonoran tiger salamander (*Ambystoma mavortium stebbinsi*). and introgression continues to be a concern. The Arizona Game and Fish Department and U.S. Geological Survey (USGS) has collected tissue samples and eDNA samples to develop genetic methods required to reliably distinguish the Sonoran tiger salamander from the non-native barred tiger salamander so that we can quantify the level of introgression. We are currently seeking funding to complete this project.

Dispersal distance - The Recovery Plan indicated that the longest movement of a terrestrial Sonoran tiger salamander was between 1.5 and 2 km. This was based on a marked salamander found in two different aquatic sites. A study is currently underway to look at movement of adult Sonoran tiger salamanders away from breeding ponds. To date, 10 terrestrial adults have been documented moving an average straight-line distance of 372.80 m (SD 245.87 m) and a maximum of just under 1 km from the aquatic site from which they were captured (C. Broska, pers. comm, 2019).

Distribution - From 2004 through 2013, Sonoran tiger salamanders were found in 69 of 159 aquatic sites sampled in southern Arizona. This represented an increase in number of sites occupied by the subspecies and primarily resulted from obtaining access to survey private lands beginning in 2009. In total, partners have been able to sample aquatic sites across 90% of the known range of the subspecies with 82% of all salamander detections occurring in aquatic sites on lands managed by the U.S. Forest service, 17% on private lands, and 1% on state park lands. Surveys of several stock ponds in northern Sonora, Mexico, during the 1980s, did not produce any salamander detections (Jones et al. 1988). In 2009, salamanders presumed to be Sonoran tiger salamanders were found and photo-documented at two stock ponds in the San Rafael Valley in Sonora (Rorabaugh et al. 2013). One of these sites is 0.85 km from the nearest known

Sonoran tiger salamander population in the U.S., which is within the known dispersal distance of the subspecies. Additional surveys during 2015–2018 revealed tiger salamander presence in 40 stock ponds south of the Arizona border in northern Sonora, Mexico, including the two sites where tiger salamanders were found in 2009 (B. Hossack, pers. comm., 2019; Hossack et al. 2016). It is yet unconfirmed that tiger salamanders at any of the sites in Sonora are the Sonoran tiger salamander subspecies, as identification must be verified by further genetic analysis of tissue and eDNA samples. We are in the process of obtaining funding to complete this research.

Population trends and interactions - Completion of a 10-year (2004–2013) monitoring program coordinated by the Arizona Game and Fish Department generated data sufficient to estimate (1) trends in breeding site occupancy by the Sonoran tiger salamander, (2) trends in occupancy of introduced predators, and (3) probability of co-occurrence between Sonoran tiger salamanders and invasive predators (Hossack et al. 2017). Hossack et al. (2017) found that occupancy of Sonoran tiger salamanders increased, annually, by 2.2% over the 10-year monitoring period even though drought persisted during the monitoring period and invasive predators were commonly present at sites occupied by Sonoran tiger salamanders. Of the 159 aquatic sites included in the study, 16% of sites were dry every time they were sampled, and an additional 33% of sites were dry at least once during the study. Across all years, distance to the nearest sampled pond averaged 1.02 km and the average distance to all other surveyed ponds was 12.4 km. Salamander occupancy of wet ponds averaged 59.2% annually. Presence of invasive predators (fish or American bullfrogs) in a given pond reduced probability of salamander presence by 23%. Predatory fish were detected at five sites surveyed and had no salamanders. American bullfrogs, a predator and competitor of the salamander, were detected during 55% of all surveys when water was present. American bullfrogs were found to co-occur with salamanders at 25 of 69 sites at least once during the study (USFWS files). Of the 25 sites that had surveys with both salamanders and American bullfrogs present, 92% of the sites also had only American bullfrogs present at some point during the study. American bullfrogs were detected at an additional 15 sites that were never occupied by salamanders during the study. Occupancy of salamanders and invasive predators both declined dramatically following the 5th consecutive year of drought. However, salamander occupancy recovered quickly after return to non-drought conditions, while occupancy of invasive predators remained suppressed.

Invasive bullfrogs - A single effort to control American bullfrogs within the range of the Sonoran tiger salamander took place near the end and after completion of the 10-year monitoring program. From 2010-2012, and in 2015, the Coronado National Forest (CNF) surveyed, monitored, and eliminated American bullfrogs within a six-mile radius of Peterson Ranch Pond in Scotia Canyon. Thirty-six lentic and seven lotic sites were surveyed and all life stages of bullfrogs were removed from 24 lentic sites. American bullfrogs were not detected in 19 sites including all of the lotic sites. Fourteen sites had 10 or fewer bullfrogs removed, and the remaining 10 sites accounted for 98% of the total bullfrogs removed. In 2016 and 2017, the CNF conducted a related effort to determine the current status of American bullfrogs within approximately two-thirds of the known range of the Sonoran tiger salamander. Of 163 aquatic sites surveyed, 32% were dry. Of the wetted sites, American bullfrogs were detected in 35% of the sites, and 32% of sites showed signs of likely American bullfrog breeding (Hall 2018). Six of the 24 sites where American bullfrogs had been removed within 6 miles of Scotia Canyon were re-occupied by bullfrogs, but at much lower levels (Hall 2018).

Pathogens - During the 10-year monitoring program, dead salamanders were reported in <1% of sampling events. Dead salamanders found were presumed to indicate evidence of disease outbreaks including that caused by the *Ambystoma tigrinum* virus (ATV). No disease testing was conducted on any dead salamanders found. Outbreaks of ATV can wipe out an entire population very quickly, so it is possible that sites where salamanders disappeared during some years could have experienced disease outbreaks. Also of note, a new pathogenic chytrid fungus, *Batrachochytrium salamandrivorans* (Bsal), was described in 2013 after observations of unusual mortality among fire salamanders (*Salamandra salamandra*) in Europe (Spitzen-van der Sluijs et al. 2013; Martel et al. 2013). Bsal has not yet been detected in the U.S. Susceptibility to Bsal varies among salamander species, but is not known to be lethal to the Ambystomidae family that includes the Sonoran tiger salamander (Martel et al. 2014). The USGS is currently testing tiger salamanders found along the US Mexico border for Bsal (E. Muths, pers. comm 2018).

AMENDED RECOVERY CRITERIA

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the species is no longer at risk of extinction and may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from an endangered species to a threatened species. The term “endangered species” means any species (species, sub-species, or DPS) which is in danger of extinction throughout all or a significant portion of its range. The term “threatened species” means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Revisions to the Lists, including delisting or downlisting a species, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the Act. Section 4(a)(1) requires that the Secretary determine whether a species is an endangered species or threatened species (or not) because of threats to the species. Section 4(b) of the Act requires that the determination be made “solely on the basis of the best scientific and commercial data available.” Thus, while recovery plans provide important guidance to the USFWS, States, and other partners on methods of minimizing threats to listed species and measurable objectives against which to measure progress towards recovery, they are guidance and not regulatory documents.

Recovery criteria should help indicate when we would anticipate that an analysis of the species’ status under section 4(a)(1) would result in a determination that the species is no longer an endangered species or threatened species. A decision to revise the status of or remove a species from the Federal Lists of Endangered and Threatened Wildlife and Plants, however, is ultimately based on an analysis of the best scientific and commercial data then available, regardless of whether that information differs from the recovery plan, which triggers rulemaking. When changing the status of a species, we first propose the action in the *Federal Register* to seek public comment and peer review, followed by a final decision announced in the *Federal Register*.

We provide delisting criteria for the Sonoran tiger salamander, which will supplement the existing criteria as follows:

Downlisting Recovery Criteria

Downlisting criteria will remain the same as in the Sonora Tiger Salamander Recovery Plan (USFWS 2002, p. 13).

Delisting Recovery Criteria

In addition to meeting the downlisting criteria provided in the 2002 Recovery Plan, the Sonoran tiger salamander may be considered for delisting when the following criteria have been met:

1. Maintain populations at a level that demonstrates at least 60% annual occupancy in at least 80% of all 159 currently known available aquatic breeding sites averaged over each 10-year period for 30 years. All potential aquatic sites that can support Sonoran tiger salamanders shall be spatially distributed throughout the range of the subspecies to maintain a 1 km overall average distance from each site to the next nearest site, and a 12 km overall average distance from each site to all other sites.

Justification: Trend data shows that Sonoran tiger salamander occupancy of known sites has increased annually over a 10-year period despite documented ongoing effects of two of the main threats identified in the original Recovery Plan: predation by and competition with non-native aquatic species and drying of aquatic habitat caused by ongoing long term drought. Long term trends in occupancy in all known aquatic salamander habitats, based on annual surveys using standardized protocols, are a measurable metric to gauge success of recovery of the subspecies. The salamander demonstrated increased occupancy over a ten-year period when very few actions took place to address known threats to the subspecies. Therefore, it is reasonable to expect the current occupancy level to be maintained over the long term and to improve if threats are addressed. Over the past 10 years, salamanders exhibited an average occupancy level of 60% across the known range (Hossack et al. 2017), which suggests this could indicate a stable population level despite environmental fluctuations. This 60% annual occupancy is therefore used in the criterion to describe the minimal level of occupancy across 80% of breeding sites to attain delisting, above. Maintaining or increasing occupancy in at least 80% of all known aquatic sites that can support Sonoran tiger salamanders will reduce the effects of disease, predation, and potential increase of drought. It is reasonable to expect that an average 20% of aquatic sites will continue to be dry during the breeding season each year throughout the range of the salamander. Although effects of disease remain unknown, maintaining occupancy at a majority of sites may decrease the effects of disease outbreaks on the subspecies as a whole. Having aquatic sites distributed throughout the landscape allows for wetted sites to persist even when some sites dry each year. Maintaining connectivity between aquatic sites would increase the likelihood that these habitats would be recolonized if salamanders were extirpated due to disease, predation, or drying. The 1 km and 12 km distances are derived from recent research on dispersal and current distribution of aquatic sites that could potentially support breeding of the salamander, as discussed above, to allow for adequate connectivity among potential breeding sites. If newly found tiger salamander populations in Sonora, Mexico, are determined to be Sonoran tiger salamanders, it will also improve our understanding of the status of the subspecies.

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 in the Recovery Plan, have been implemented. These

commitments and mechanisms should address management of non-native predators in perpetuity, 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.

Justification: Criterion two is identical to the original delisting criterion #2 in the 2002 Recovery Plan. Non-native predatory fish are known to completely decimate salamander populations, but have not persisted in aquatic sites occupied by the salamander as they did prior to ongoing drought conditions. Likewise, American bullfrogs have not completely replaced salamanders from aquatic sites, although they have likely increased in presence throughout the range of the salamander since the 1990s. The effects of non-native aquatic species have likely been mitigated by sites drying periodically due the long term drought, and drying of sites is included as a potential tool in the Recovery Plan for managing non-native predators. Effects of disease and introgression remain largely unknown. Because the Sonoran tiger salamander has a very limited distribution, it is important that habitat is protected and threats are addressed across the majority of its range. Criterion 2 is derived from downlisting criteria that require monitoring of the subspecies and its habitat as well as address threats of aquatic habitat destruction, predation by nonnatives, control of introduced salamanders, and die-offs from disease across approximately 90 percent of salamander's currently-occupied range. The delisting criteria expand upon the downlisting criteria to continue to address these threats across the entire range of the subspecies.

Rationale for Amended Recovery Criteria

These delisting criteria now provide the general public with a way to understand when recovery has been achieved. These delisting criteria reflect the recovery strategy for this subspecies outlined in the Recovery Plan that is currently being implemented by the existing Sonoran Tiger Salamander Participation Team. Recovery criteria linked to threat abatement are necessary. Determining whether a species is an endangered species or a threatened species evaluates not only the absolute numbers of individuals, size of their habitats, or other demographic and habitat measures, but also the stressors and threats attributed to five threat factors (ESA 4(a)(1)) that cause a species to be at risk of extinction. The ESA 4(a)(1) factors that cause a species to be an endangered species or a threatened species must be reduced, eliminated, or mitigated in order to recover such species, and "threats-based" criteria are required to reflect when threats have been ameliorated to a level and extent that allows for the ecological requirements of the species to be met. Populations can increase to respectable sizes and even be growing because of recovery efforts that reduce or eliminate the threats acting on the species, to sufficient levels. However, if the threats continue unabated, return once protections are removed or once conservation measures are terminated, the species' condition is likely to degrade again. For this reason, recovery criteria are necessary to assess threat abatement as well as population condition.

The USFWS uses a recovery concept based on the conservation biology principles of resiliency, redundancy, and representation ("3Rs") to identify the conditions needed for species recovery. Briefly, the USFWS defines the 3 Rs as follows: resiliency describes the ability of the species to withstand stochasticity; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. Shaffer and Stein (2000) defines the 3Rs as follows: Resiliency encompasses population-specific attributes that increase long-term persistence in the fact of

disturbance and can also address related issues regarding threats abatement and recovery of ecologically effective populations. Redundancy requires establishing multiple populations in each ecological setting to spread extinction risk and to increase species viability. Representation requires the protection of populations across the full range of ecological settings of a species range, meeting the ESA's geographic representation mandate. (Shaffer and Stein 2000). Below we justify the masked bobwhite delisting criteria in the context of the 3Rs and threats, which when combined with the explanations above, provide support for the delisting criteria.

Resiliency is met by maintaining or exceeding current occupancy of Sonoran tiger salamanders at sites throughout its historical range so that populations are able to withstand effects associated with disturbances such as variations in rainfall, nonnative species invasions, (environmental stochasticity), and random fluctuations in populations (demographic stochasticity). Any increase in occupancy above that needed to downlist the Sonoran tiger salamander will provide greater resiliency of the Sonoran tiger salamander subspecies.

Redundancy is met by maintaining or increasing the number of sites occupied by the Sonoran tiger salamander established under the delisting criteria. Aquatic sites occupied by salamanders are spread throughout the range of the subspecies and the current spatial distribution will be maintained or improved.

Representation is met by maintaining diversity within the populations of Sonoran tiger salamanders that occur within the historical range. We consider all salamander populations to be a single representative unit as threats to the subspecies currently act on all populations similarly throughout the range. A spatial distribution of populations located an average distance to the nearest population of 1km or less allows for increased genetic diversity across a range of environmental conditions. This allows Sonoran tiger salamander populations to adapt to changing conditions that enhances the viability of the subspecies.

ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS (*if applicable*)

No additional site-specific recovery actions are necessary for this subspecies; therefore, this is not applicable.

COSTS, TIMING, PRIORITY OF ADDITIONAL RECOVERY ACTIONS (*if applicable*)

No additional site-specific recovery actions are necessary for this subspecies; therefore, this is not applicable.

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