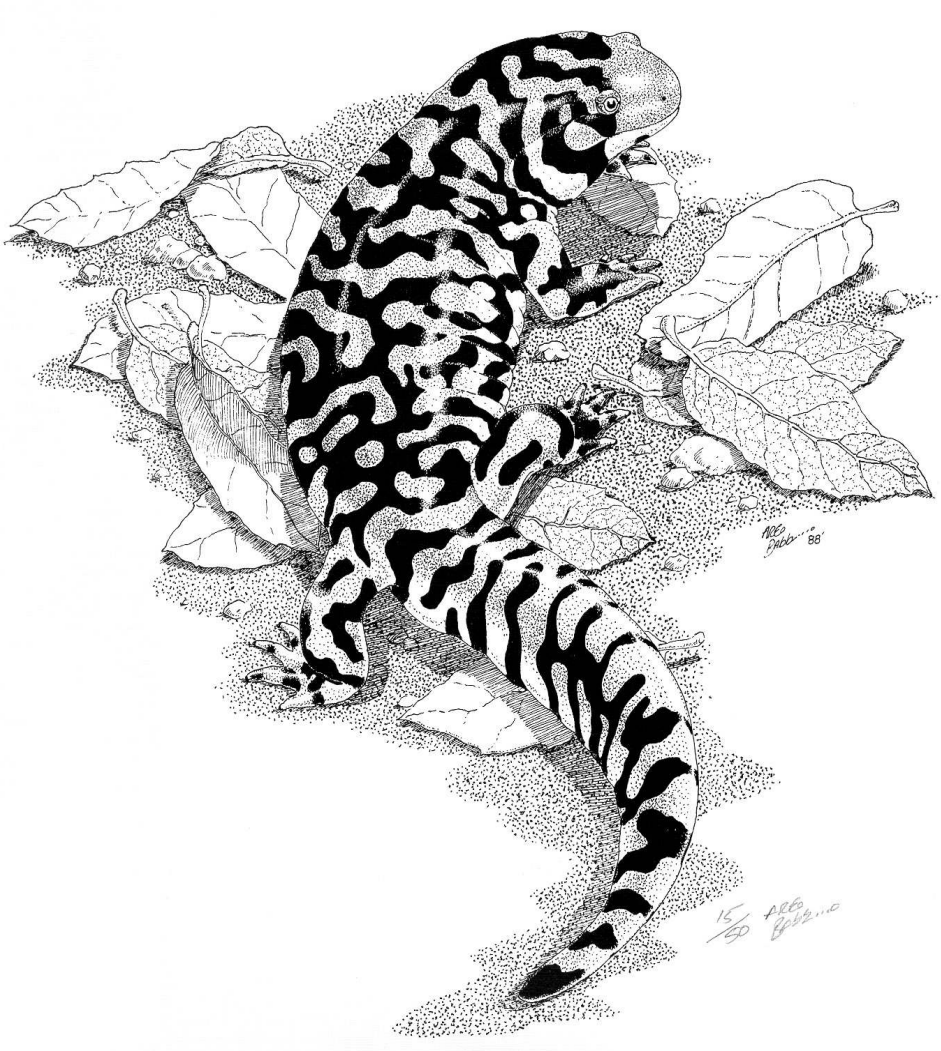
SONORA TIGER SALAMANDER RECOVERY PLAN



Ambystoma tigrinum stebbinsi
October 2002

SONORA TIGER SALAMANDER
(*Ambystoma tigrinum stebbinsi*)

RECOVERY PLAN

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Prepared for:
Region 2
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Approved: _____ Date: 9/24/02
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Concur: _____ Date: 9/16/02
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Literature citation of this document should read as follows:

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EXECUTIVE SUMMARY

Current Status: The Sonora tiger salamander is federally listed as endangered without critical habitat. As of this writing, the subspecies has been found in 53 ponds in the San Rafael Valley of Arizona.

Habitat Requirements and Limiting Factors: This salamander requires standing water from January through June for breeding and larval growth. Adult, metamorphosed salamanders inhabit adjacent grassland and oak woodland terrestrial habitat when not in ponds. Threats to Sonora tiger salamanders include the following: 1) restricted distribution, 2) disappearance of natural standing water habitat, 3) predation by non-native fish, bullfrogs, and crayfish, 4) genetic swamping by introduced, non-native barred tiger salamanders, 5) disease, 6) low genetic diversity, and 7) collection for bait or translocation by anglers.

Recovery Priority: 3 on a scale of 1 to 18. The priority is based on its being a subspecies (rather than a full species) with a high degree of threat and high recovery potential.

Recovery Objectives: 1) Reclassify from endangered to threatened status. 2) Delist.

Recovery Criteria: The Sonora tiger salamander may be reclassified to threatened status when approximately 90 percent of salamander's currently-occupied range and approximately 90 percent of current breeding ponds are protected and maintained to prevent habitat loss and degradation, predator introductions, barred tiger salamander introductions, and collection of salamanders for bait. Scientifically credible monitoring over a five year period must 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 Sonora tiger salamanders.

The Sonora tiger salamander will be considered for delisting when quantitative criteria in terms of number of breeding populations and amount, distribution, and type of available habitat are defined and met. Criteria will be based on research, continued monitoring, and population viability analysis. In addition, regulatory mechanisms and land management commitments must be implemented that provide for adequate long-term protection of the Sonora tiger salamander and its habitat. These commitments and mechanisms should address habitat maintenance and protection, management of non-native predators, disease transmission, introduction and collection of salamanders, interbreeding with non-native salamanders, and public education. Finally, the Sonora tiger salamander must be unlikely to need protection under the Endangered Species Act in the foreseeable future.

Actions Needed:

1. Maintain and enhance habitat where salamanders have been found, and create new habitat, if deemed necessary.

2. Control non-native predators (fish, bullfrogs, and crayfish) by enforcing and enhancing existing policies prohibiting the introduction and pond to pond transport of these taxa and by removing populations of non-native fish, bullfrogs, and crayfish.
3. Control introduction, transport, and collection of tiger salamanders in the San Rafael Valley by enforcing existing policies prohibiting these acts and by removing populations of barred tiger salamanders.
4. Create and enforce policies to minimize frequency of die-offs.
5. Monitor salamander populations and their habitat on public and, if permitted, private land, to observe threats as they arise and fulfill research objectives.
6. Conduct research to acquire demographic and dispersal information and develop a population viability analysis, better understand salamander disease, conduct genetic analyses, investigate reports of low pH, and determine distribution of crayfish and methods of crayfish removal.
7. Develop public education and information programs.
8. Practice adaptive management.

Total Cost of Recovery (minimum): $1,016,000

Costs, in thousands of dollars:

Year	Minimum Costs: ($000's)
2002	205
2003	283
2004	215
2005	150
2006	160
2007+	To be determined

Date of Recovery: If recovery criteria are met, reclassification to threatened status could be initiated in 2007.

TABLE OF CONTENTS

I. INTRODUCTION

The Sonora tiger salamander, *Ambystoma tigrinum stebbinsi*, was described by Lowe (1954), and subsequent field surveys and genetic analyses in the 1980's and 1990's reinforced the status of the Sonora tiger salamander as a distinct subspecies. Concerns about the threats posed by introduced fish and bullfrogs, frequent disease outbreaks, and genetic swamping by introduced barred tiger salamanders, *A. t. mavortium*, combined with the Sonora tiger salamander's restricted range and the fact that it is found almost exclusively in human-constructed and maintained ponds or cattle tanks, led to the Federal listing of the Sonora tiger salamander as endangered on January 6, 1997; no critical habitat was designated.

The Endangered Species Act (ESA) calls for preparation of recovery plans for listed species likely to benefit from the effort. This document establishes recovery goals and objectives, describes site-specific recovery actions recommended to achieve those goals, and estimates the time and cost required for recovery, as well as who should be responsible for implementation of recovery actions. A recovery plan is not self-implementing, but presents a set of recommendations endorsed by the U.S. Fish and Wildlife Service (USFWS). This plan was developed by the authors with the help of the Sonora Tiger Salamander Participation Team and the USFWS. The Participation Team consists of ranchers and residents of the San Rafael Valley (SRV), representatives of State and Federal agencies, and other concerned citizens that were appointed by the Regional Director of the USFWS's Region 2. The Participation Team prepared a report, included as Appendix A, that clarifies how recovery actions should be implemented to minimize social and economic impacts while still promoting the recovery of the Sonora tiger salamander.

Species Description and Taxonomy

The Sonora tiger salamander, *A. t. stebbinsi*, was described by Lowe (1954), who, along with Reed (1951), found the subspecies in ponds in the SRV, where most known Sonora tiger salamander populations exist. The SRV lies between the Huachuca and Patagonia mountains, is bordered by the Canelo Hills to the north, and extends from Santa Cruz County in Arizona south for approximately 30 km into Sonora, Mexico.

Sonora tiger salamanders begin their life as jelly-coated eggs laid in water. They hatch and grow as aquatic larvae with gills, and then either mature as gilled aquatic adults called branchiate adults, neotenes, or paedomorphs, or metamorphose into terrestrial salamanders without gills. Metamorphosed terrestrial Sonora tiger salamanders have a color pattern ranging from "a reticulate pattern with an irregular network of light coloration, often coupled with light spots, on a dark background color", to a pattern of large, well-defined light or yellow spots or transverse bars, some of which encroach on the dark venter (Jones *et al.* 1988). Metamorphosed Sonora tiger salamanders measure from about 45 to 150 mm snout to vent length (SVL). Branchiate adults are gray to olive on the dorsum, head, and tail, and off-white to yellow on the ventral side. They have three external gills on each side of their head, and measure between 65 and 165 mm SVL. Male and female adult salamanders can be distinguished by the presence of two black folds of tissue (cloacal folds) on the caudal side of a male's vent. Larvae are gray on the dorsum,

head, and tail, with little pigment on the ventral surface. They have external gills and hatch without legs, but grow hind and fore-limbs early in development.

Sonora tiger salamanders are one of three subspecies of tiger salamanders found in Arizona; the other two subspecies are Arizona tiger salamanders, *A. t. nebulosum*, and barred tiger salamanders, *A. t. mavortium*. Eggs, larvae, and branchiate adults of the three subspecies appear similar, except that larval and branchiate adult Arizona and barred tiger salamanders sometimes develop into a cannibalistic morph that has a wider head, enlarged vomerine teeth, and feeds preferentially on smaller conspecifics. Out of tens of thousands of salamanders observed in the SRV, only five have had the cannibalistic morph (Snyder and Collins, pers. obs.). Metamorphosed Arizona tiger salamanders have 11-50 irregularly shaped, yellow to olive spots and blotches, often with indistinct edges (Stebbins 1985), on a dark dorsal ground, with a similar pattern on the head and tail. Metamorphosed barred tiger salamanders have large, distinct, yellowish bars, spots, or transverse bars on a darkly grounded dorsum. Some of the spots or bars encroach on the dark venter. The reticulate pattern seen in Sonora tiger salamanders is not seen in Arizona or barred tiger salamanders, but many metamorphosed Sonora tiger salamanders do not have the reticulate pattern and are visually indistinguishable from barred tiger salamanders.

Sonora tiger salamanders possess genetic characteristics that in some respects resemble barred tiger salamanders and in other respects resemble Arizona tiger salamanders. A likely explanation for this pattern is a hybridization event between Arizona and barred tiger salamanders at some point in the distant past (Jones *et al.* 1995). Interviews with long-time residents of the SRV have provided anecdotal evidence of tiger salamanders in the valley during the early 1900's before the introduction of barred tiger salamanders for bait was likely to have taken place (Jones *et al.* 1988). This evidence, combined with the presence of *Ambystoma* fossils on the north side of the SRV and the San Pedro River, suggests that the Sonora tiger salamander is an endemic subspecies that evolved 'naturally,' and not as a result of human introductions of Arizona and barred tiger salamanders (Jones *et al.* 1995, Brattstrom 1955).

The rosy salamander, *Ambystoma rosaceum*, occurs in Durango, Chihuahua, and Sonora, Mexico, including the southern portion of the SRV in Mexico (Shannon 1951, Jones *et al.* 1995). Rosy salamander larvae are pinkish in color with dark patterning on the sides and back (Taylor 1981) and fewer gill rakers (9-15) than tiger salamanders in Arizona and Mexico (15-24) (Collins 1979). Metamorphed rosy salamanders are uniformly dark brown on the sides and back and lighter ventrally (Anderson 1961). Allozyme data suggest that interbreeding between *A. tigrinum* and *A. rosaceum* is rare or non-existent, even when their distributions overlap (Shaffer 1983).

Life History and Population Ecology

Breeding and Eggs

Sonora tiger salamanders begin breeding as early as January, and eggs can be found in ponds as late as early May (Snyder, pers. obs.). Breeding after monsoon rains in July and August is rare (Snyder, pers. obs.). Salamanders ready to breed have swollen, reddish vents. Terrestrial adults, which are often outside the pond during the rest of the year, return to ponds to breed, and

branchiate adults in the pond also breed. Although there is little data on breeding site fidelity for Sonora tiger salamanders, other *Ambystoma* species usually return to breed in the ponds where they were born (Shoop 1965, 1968, Shoop and Doty 1972, Douglas and Monroe 1981, Semlitsch 1981, Madison 1997, Madison and Farrand 1998). Courtship takes place under water, and is difficult to observe in the field. After fertilization, female tiger salamanders lay 200 to 2000 eggs (James Roth, pers. comm.), attaching them to aquatic vegetation, sticks, rocks, or substrate individually or in clumps of up to 50. Eggs take from 2-4 weeks to hatch; the colder the water, the longer the eggs take to develop. Sources of mortality for tiger salamander eggs include freezing, drying, and predation by adult salamanders (Holomuzki 1986) and introduced fish (Snyder 1998). Crayfish may prey upon salamander eggs. Transition probabilities from one life history stage to the next (*e.g.*, likelihood of an egg becoming a larva or a larva becoming an adult) have not been determined for Sonora tiger salamanders in the field.

Larvae

Following hatching, Sonora tiger salamander larvae can develop to the minimum size necessary to metamorphose in as little as two months. However, because many SRV sites with salamanders hold water all year, larvae often remain in the water longer before metamorphosing, or develop into branchiate adults instead of metamorphosing. Small tiger salamander larvae feed primarily on zooplankton (daphnids, copepods, bosminids, ostracods, *etc.*), but incorporate larger aquatic macroinvertebrates (chironomids, trichopterans, molluscs, zygopterans, *etc.*) into their diet as they grow (Collins and Holomuzki 1984). Sources of mortality for tiger salamander larvae include pond drying, disease (Jancovich *et al.* 1997), and predation by wading birds, introduced fish and bullfrogs (Snyder 1998), aquatic insects (Holomuzki 1986), and adult salamanders (Holomuzki 1986). Crayfish may prey upon larval salamanders, as well.

Branchiate Adults

Salamander larvae in permanent water often develop into branchiate adults that stay in the pond throughout their lives. SRV ponds that do not dry support up to several hundred branchiates (pers. obs.). Branchiate adult tiger salamanders prey on zooplankton and a variety of macroinvertebrates, and eat salamander eggs and larvae during the breeding season (Holomuzki 1986). Although branchiate adult Sonora tiger salamanders probably eat salamander eggs and larvae, they seldom develop into the cannibalistic morph. Branchiate adults can sometimes metamorphose into the terrestrial form in response to stressful events such as pond drying, but branchiates are often unable to complete metamorphosis or even die during the process (Roth, pers. comm.). Sources of mortality for branchiate adults include pond drying, disease (Jancovich *et al.* 1997), and predation by wading birds and larger introduced fish species (Snyder 1998). The lifespan of branchiate adult Sonora tiger salamanders in the field is not known, but Arizona tiger salamanders have survived as branchiates for up to 8 years in captivity (Roth, pers. comm.). The reason that branchiates have not been kept longer is that they eventually metamorphose, even after years as branchiates.

Metamorphosed Adults

When larvae are large enough (>45 mm SVL), they can metamorphose into terrestrial salamanders. The proportion of larvae that metamorphose depends heavily on pond permanence. In ponds that dry, all larvae that are large enough metamorphose. In ponds that do not dry, approximately 17 percent of larvae that are large enough metamorphose (Collins *et al.* 1988). The number of metamorphs in each population is difficult to estimate because most metamorphosed salamanders leave the pond after breeding, and we do not know what fraction of salamanders in the terrestrial environment return each year to breed. Outside the pond, metamorphosed tiger salamanders consume terrestrial insects and other macroinvertebrates. In the pond, metamorphosed individuals eat aquatic macroinvertebrates and terrestrial insects that fall in the water (Whiteman *et al.* 1994). Metamorphs often re-populate ponds following drying or disease outbreaks that kill most branchiate adults and larvae. Metamorphs are also the only life history stage that can disperse from pond to pond and establish new populations.

The ecology of Sonora tiger salamanders outside of ponds has been little studied, but other *Ambystoma* species spend much of their time in mammal burrows or buried in soft earth to avoid environmental extremes common on land (Shoop 1965, 1968, Shoop and Doty 1972, Douglas and Monroe 1981, Semlitsch 1981, Madison 1997, Madison and Farrand 1998). The dispersal patterns of Sonora tiger salamanders, which are critical for determining metapopulation dynamics, are also unknown. Radio-tracking of other *Ambystoma* species has shown that they frequently move up to 250 m from their breeding ponds (Shoop 1965, 1968, Shoop and Doty 1972, Douglas and Monroe 1981, Semlitsch 1981, Madison 1997, Madison and Farrand 1998). However, *Ambystoma* occasionally disperse longer distances. For example, Allison (pers. comm.) found two Arizona tiger salamanders in ponds between 1.5 and 2 km from the ponds where she found them the previous spring, and Sheridan Stone (Fort Huachuca Wildlife Office, pers. comm.) found 2 metamorphosed tiger salamanders (*A. t. mavortium*?) at sites 3-4 km from the nearest potential source population. In the SRV, Reed (1951) reported that newly created cattle ponds were colonized almost immediately by tiger salamanders, which he attributed to the ability of salamanders to disperse long distances. The above data suggest that only a small proportion of salamanders in a pond are likely to have dispersed from another pond, so salamanders in each pond are referred to as a population. If future data show that pond to pond movements are common, different terminology will be adopted. A lack of genetic variation within Sonora tiger salamanders has so far made it impossible to determine the degree of gene flow using genetic analysis, but sequencing of variable regions of nuclear DNA (microsatellites) may provide further insight into this question.

Sources of mortality for metamorphosed adults include extreme conditions in the terrestrial environment, disease (Jancovich *et al.* 1997), and predation by terrestrial predators and introduced fish and bullfrogs (Snyder 1998). The lifespan of metamorphosed Sonora tiger salamanders in the wild is not known, but metamorphosed Arizona tiger salamanders have survived 17 years in captivity (Roth, pers. comm.). Analysis of growth rings in toe bones (skeletochronology) of 150 Arizona tiger salamanders captured in the field revealed no

salamanders over 6 years old (Allison, unpublished), but it remains to be seen whether the same is true for Sonora tiger salamanders.

Distribution and Abundance

Dr. James P. Collins began surveying ponds with tiger salamanders in the SRV in 1979. Members of Dr. Collins' lab and employees of Arizona Game and Fish Department (AGFD) have continued surveys throughout the 1980's and 90's (*e.g.*, Collins *et al.* 1988, Abbate 1998). Because so few sites were sampled prior to the 1980's, it is impossible to determine the historical distribution of Sonora tiger salamanders. However, based on collections and observations of salamanders and the distribution of the plains grassland and adjacent Madrean evergreen woodlands (Brown 1994) in which the salamander has been found, the range of the subspecies and its occupied and potentially occupied habitat is thought to extend from the crest of the Huachuca Mountains west to the crest of the Patagonia Mountains, including the SRV and adjacent foothills from its origins in Sonora north to the Canelo Hills.

Surveys for the Sonora tiger salamander have been conducted on public land throughout the Arizona portion of the SRV. Surveys have also been conducted recently on the San Rafael Cattle Ranch. The number of ponds sampled is now well over 100, and tiger salamanders have been found in 53 ponds; 45 of these ponds have had salamanders within the last five years. The number of salamanders supported by each pond is difficult to determine, because metamorphosed salamanders can survive outside the ponds and we do not know what proportion of metamorphs breed each year. In some years, salamanders will be completely absent from a pond, only to return the following year to breed and produce many offspring.

Cattle ponds or tanks are the primary habitat for Sonora tiger salamanders, but there are several observations of unidentified salamanders away from cattle ponds. Salamanders suspected of being Sonora tiger salamanders were found in the Los Fresnos cienega in Mexico, 3 km south of the international boundary (Varela-Romero *et al.*, 1992). Tiger salamanders were also found in a cave and vertical mining shaft at the northwestern edge of the SRV (Tom Deecken, pers. comm.).

Because of the similarity between Sonora and barred tiger salamanders and the possibility that barred tiger salamanders have been introduced to ponds in SRV, genetic testing has been performed on salamanders from a number of SRV ponds to determine their identity. Genetic testing showed that some SRV ponds contain salamanders with genetic characteristics similar to barred tiger salamanders. Salamanders with these "*mavortium*-like" sequences are more common on the outskirts of the SRV and ponds close to Parker Canyon Lake, which, because of prior use of imported waterdogs as fish bait, is where we expect to find introduced barred tiger salamanders (Ziemba *et al.* 1998). Tiger salamanders have also been found in areas just outside the SRV, such as Fort Huachuca, Harshaw Canyon, Copper Canyon, and Coronado Memorial. Of these localities, genetic testing has only been performed on salamanders from the Fort, and with the exception of one pond within a kilometer of the SRV, salamanders on the Fort appear to be barred tiger salamanders (Andrew Storfer, University of Florida, pers. comm.).

Habitat Requirements

The most important habitat requirement for Sonora tiger salamanders is the availability of standing water for breeding from January through June. This gives the salamanders enough time to breed, grow as larvae, and metamorphose before the pond dries. Permanent bodies of water can be good breeding sites, except they often contain introduced fish and bullfrogs (Snyder 1998). Erosion and arroyo cutting in the late 19th and early 20th centuries caused the SRV to dry and natural standing water habitats to disappear (Hendrickson and Minckley 1984, Hadley and Sheridan 1995). As a result, ponds created by ranchers for watering their cattle are now almost the only suitable breeding sites remaining. However, there are still some springs on the San Rafael Cattle Ranch (Mike Pruss, pers. comm.), and possibly elsewhere, such as in Scotia Canyon, that may be suitable breeding sites.

Aquatic breeding habitats are used by all life stages; however, upland habitats are also used by terrestrial adults when not at the breeding ponds. Referring to conservation of the California tiger salamander, *A. californiense*, Petranka (1998) found that conservation of a 200-500 m radius of vegetation around a breeding pond would protect the habitat of most of the adult terrestrial population. In the SRV, however, aquatic and bank-line vegetation is missing from many ponds with salamanders, suggesting that these factors, although beneficial, are not necessary for the persistence of Sonora tiger salamanders. The SRV is a broad, open valley that forms the headwaters of the Santa Cruz and San Pedro rivers. The dominant terrestrial plant community in the SRV is plains grassland (Brown 1994). Typical grasses include, among others, plains lovegrass, *Eragrostis intermedia*, side-oats grama, *Bouteloua curtipendula*, and curly mesquite, *Hilaria belangeri.* Within the grasslands, stringers or groves of cottonwoods and other wetland plants grow along some drainages and at ponds and springs. Upslope, at the edges of the SRV, juniper and several species of oaks form patchy woodlands or savannas that gradually give way to pine-oak woodlands at higher elevation (Brown 1994). Sonora tiger salamanders are tolerant of a wide range of temperatures, with temperatures in ponds varying from less than 5^{o}C at the beginning of the year up to 30^{o}C during summer. Temperatures in the terrestrial environment range from below freezing to over 35^{o}C. Mammal burrows or loosened soils outside the pond likely provide refugia for metamorphosed salamanders in the terrestrial environment, enabling them to burrow underground to avoid extreme environmental conditions.

Present Status

More data are needed to make definitive statements about the long-term viability of Sonora tiger salamanders in the SRV. About half of the 53 Sonora tiger salamander populations have been discovered within the last five years, and only within the last five years were ponds with salamanders sampled consistently, making it difficult to determine trends in the proportion of ponds occupied by salamanders and suitability of those ponds for salamander breeding habitat. Also, more data on the ecology of Sonora tiger salamanders (*e.g.*, life-span, proportion of adults breeding each year, frequency and distance of dispersal events) are required to develop a suitable population viability analysis.

Despite the fact that Sonora tiger salamander populations face threats of introduced predators, disease, genetic swamping, restricted distribution, and habitat dependent on human management, there is little reason to assume *a priori* that Sonora tiger salamanders are in immediate danger of extinction. Salamander populations recovered following observed disease outbreaks (Collins, pers. obs.); only a few known populations have been eliminated by fish introductions (Snyder 1998), and ranchers have maintained many cattle ponds so that they hold water long enough to support salamanders but occasionally dry, eliminating fish and reducing bullfrog populations (Snyder 1998). Nevertheless, because Sonora tiger salamanders have such a restricted distribution, and because persistence of Sonora tiger salamander habitat depends directly on human management strategies, Sonora tiger salamanders will always be vulnerable to changes in land management and relatively small changes in environmental variables such as drying frequency, frequency of disease outbreaks, and frequency with which fish or non-native salamanders are introduced. Research on the ecology and viability of Sonora tiger salamander populations should assist in developing a management strategy to protect salamanders and their habitat that will ensure persistence of salamanders in the SRV. The genetic status of Sonora tiger salamanders is still being studied, but it appears that some (approximately 25 percent) SRV ponds with tiger salamanders contain at least some salamanders with sequences resembling barred tiger salamanders (Ziemba *et al.* 1998). The threat of genetic swamping by introduced barred tiger salamanders is one of the most difficult threats to assess because genetic testing is often required to distinguish between Sonora tiger salamanders, barred tiger salamanders, and (potentially) hybrids of the two subspecies.

Reasons for Listing

U.S. Fish and Wildlife Service (1997a) described seven threats to the Sonora tiger salamander which, when taken together, justified listing: (1) Sonora tiger salamanders have a restricted distribution and a limited number of breeding habitats, making them vulnerable to stochastic events, such as flooding or drought. (2) Most cienegas and standing water habitat presumably used historically by Sonora tiger salamanders for breeding have disappeared, and so today, salamanders in SRV are found almost exclusively in human-constructed cattle ponds or tanks that are small and often very dynamic habitats. (3) Many of the salamander's breeding ponds have been invaded by non-native fish and/or bullfrogs, which prey on salamanders and their larvae. Several salamander populations have been extirpated by fish introductions. (4) Sonora tiger salamanders are subject to frequent die-offs as a result of disease caused by an iridovirus that kills almost all salamanders and larvae in the pond at the time. (5) Low genetic heterozygosity for the subspecies might result in reduced fitness. (6) Barred tiger salamanders (*A. t. mavortium*) have apparently been introduced to the SRV and might interbreed with Sonora tiger salamanders, swamping out characteristics that differentiate the two subspecies. (7) Collecting Sonora tiger salamanders for bait or translocation by anglers might reduce population sizes, spread disease, and disperse non-native tiger salamanders. The reasons for listing are discussed in more detail below.

Restricted Distribution
At the time of listing in January of 1997, Sonora tiger salamanders reportedly had been found in 36 ponds since the early 1980's. Due to a thorough search of early survey records and continuing survey work in the SRV, the number of ponds where salamanders have been found has increased to 53, and more populations undoubtedly exist, particularly on unsurveyed private land. Salamanders have disappeared from a few ponds since surveys began in the late 1970's, but there is little indication that there is a general decline in the number of populations in the SRV. Furthermore, the density of ponds supporting salamander populations in the SRV is comparable to that in other regions supporting tiger salamanders. However, the restricted distribution of Sonora tiger salamanders makes them vulnerable to relatively small-scale environmental disturbances and land-use changes.

Habitat Loss
Prior to the 20th century, the SRV contained many more cienegas and vernal pools than it does today. Erosion and arroyo cutting in the late 19th and early 20th centuries caused the SRV water table to drop and natural standing water habitats to disappear (Hendrickson and Minckley 1984, Hadley and Sheridan 1995). However, at the same time natural standing water habitats were disappearing, cattle ponds were built. Many of the remaining springs and cienegas were converted into impoundments at this time, so most of the small standing water habitats remaining in the SRV are cattle ponds. Sonora tiger salamanders breed almost exclusively in these cattle ponds. The fact that Sonora tiger salamanders breed in human-constructed cattle ponds instead of natural habitats does not necessarily threaten persistence of the taxon. Sonora tiger salamanders have successfully bred in cattle ponds for decades, but salamanders are now dependent on humans to maintain the habitat. In particular, cattle ponds require occasional re-excavation because they fill with silt, and pond dams require occasional maintenance.

Cattle pond habitats are also vulnerable to extreme weather conditions. Long term drought could dry many of the ponds, and if ponds remained dry for several years, lack of breeding could lead to local extirpation of the salamander population. Cattle ponds can also wash out during storms or floods.

Predation by Introduced Species
There are reports of introduced fish in the SRV as early as the 1950's, and various introduced fish species now occur in SRV ponds, including mosquito fish (*Gambusia affinis*), green sunfish (*Lepomis cyanellus*), bluegill sunfish (*Lepomis macrochirus*), black bullheads (*Ameirus melas*), and largemouth bass (*Micropterus salmoides*). Bullfrogs (*Rana catesbeiana*) have been in the valley since at least the early 1970's. Laboratory and field experiments have shown that metamorphosed bullfrogs and all fish species listed above quickly eat salamander larvae, and adult Sonora tiger salamanders have been found in the stomachs of adult bullfrogs (Snyder 1998). In addition, whenever fish are introduced to a pond, the salamanders almost always disappear within the next few years, and do not reappear unless the fish are killed by pond drying (Snyder 1998). For some reason, adult bullfrogs have not maintained consistently high population densities in many SRV ponds, so the potential effect of bullfrogs on Sonora tiger

salamanders remains unclear (Snyder 1998). However, given the observation that bullfrogs eat salamanders and the effect of bullfrogs on other native western herpetofauna (*e.g.*, Rosen and Schwalbe 1996, Kupferberg 1997, Kiesecker and Blaustein 1997), bullfrogs should be considered a threat to Sonora tiger salamanders. Occasional drying of cattle ponds due to drought or siltation has limited the number of ponds occupied by fish and/or bullfrogs, because both taxa are vulnerable to drying. Crayfish are potential predators on salamanders as well, but have only been found in a few SRV ponds, and those did not contain salamanders (Pruss, pers. comm.). Crayfish are in many SRV streams, however, and if they are introduced to ponds with salamanders, they will probably harm Sonora tiger salamanders much as they have harmed other western herpetofauna (*e.g.*, Gamradt and Kats 1996, Fernandez and Rosen 1996).

Die-Offs

Sonora tiger salamander populations experience frequent die-offs (approximately 8 percent of populations are affected each year) in which almost all salamanders and larvae in the pond die. *Ambystoma tigrinum* virus (ATV) is the pathogen believed to be responsible for these die-offs (Jancovich *et al.* 1997). It is also possible that some die-offs might occur as a result of low pH (Pruss, pers. comm.). A copper smelter at Cananea, Sonora, less than 25 miles south of the border, may have released sulfur plumes resulting in acid precipitation (Platz 1989, Blanchard and Stromberg 1987), but currently there is no evidence to connect salamander die-offs with the copper smelter, and the smelter has not been operated since 1999. Although almost all the salamanders in the pond perish during die-offs, salamanders have been no less likely to breed in years following die-offs than in years not following die-offs (Snyder, pers. obs.). Presumably, metamorphosed salamanders outside the pond escape the effects of the die-off and are able to breed the following year.

Genetic Swamping

Sonora tiger salamanders also face the threat of genetic swamping by introduced barred tiger salamanders, which are often sold as large larvae or branchiate adults for fishing bait. Genetic analysis has suggested that barred tiger salamanders have been introduced to some SRV ponds, perhaps by anglers using salamanders as bait, or with the hope of establishing a population that could be harvested at a later date. Ponds in which introduced barred salamanders are most likely to occur are those that are most accessible, i.e. adjacent to roads on public lands, those that have a history of angling, and those near existing populations of barred salamanders. Salamanders with genetic characteristics similar to barred tiger salamanders have been found in six (Chamisa, Gypsy, Heidi, Inez, School Canyon East, and Whiner) out of 23 SRV ponds tested genetically (Ziemba *et al.*, 1998). Very low sample sizes (maximum of three individuals tested from these sites) make it impossible to determine what percentage of salamanders in these ponds had *mavortium*-like sequences and what percentage had *stebbinsi*-like sequences. Although the analysis of allozymes that was used could not determine whether there was any hybridization between the two subspecies, such hybridization is likely when the two subspecies co-occur. A microsatellite genetic analysis is under way to determine the extent of hybridization (Storfer, pers. comm.).

Collecting Salamanders for Bait
If large numbers of salamanders are collected for bait, it could threaten the persistence of Sonora tiger salamander populations. There are no data on the number of salamanders that are collected for bait, but illegal collection from the SRV has been reported (Collins and Jones 1987, Bob Hudson, pers. comm.). Given the popularity of salamanders as bait, it is reasonable to assume that illegal collection of salamanders will continue to occur.

Low Genetic Heterozygosity
Allozyme analysis has shown very little genetic variability in Sonora tiger salamanders (Jones *et al.* 1988, Jones *et al.* 1995, Ziemba *et al.* 1998). Low genetic variability is a concern because in populations with low heterozygosity, deleterious alleles are expressed more frequently, disease resistance might be compromised, and there is little capacity for evolutionary change in response to environmental change.

Current Management
Federal Regulations and Management
Federal listing under the ESA provided considerable protection to the Sonora tiger salamander and its habitat. Section 9 of the ESA prohibits take of any listed wildlife species, including the Sonora tiger salamander. The definition of "take" includes to harass, harm, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. "'Harm' in the definition of 'take' in the ESA means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering" (50 CFR 17.3). Harass is defined in the same regulation as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, and sheltering." Anyone who engages in a take could be found in violation of Section 9 of the Act. Such taking may occur only under the authority of the USFWS pursuant to Section 7 (through Federal interagency consultation if there is Federal involvement with a project) or through a Section 10(a)(1)(A) or (B) permit.

Because most of the land, cattle ponds, and salamander populations in the SRV are on Federal lands, most activities that might affect the salamander or its habitat are subject to Section 7 consultation. Federal agencies are required to consult with the USFWS on any discretionary actions they fund, authorize, or carry out that may affect listed species. As a result of these consultations, measures are built into proposed projects to protect the salamander and its habitat. For instance, 1997 and 1999 consultations between USFWS and the Coronado National Forest resulted in the development of cattle pond maintenance guidelines to minimize incidental take of salamanders associated with cleaning out ponds (U.S. Fish and Wildlife Service 1997b, 1999). The 1997 consultation also provided measures to reduce the possibility that salamanders might be unintentionally killed or moved among cattle ponds by fire suppression activities.

Other Federal regulations also play a part in the current management of the salamander. The National Forest Management Act of 1976 (16 U.S.C. 1600 et seq.) directs the U.S. Forest Service (USFS) to prepare programmatic-level management plans that will guide long-term resource management decisions. The goals of the Coronado National Forest Plan include a commitment to maintain viable populations of all native wildlife, fish, and plant species within the Forest's jurisdiction through improved habitat management (Coronado National Forest 1986a). The Plan's endangered species program includes participation in reaching recovery plan objectives for listed species, habitat coordination and surveys for listed species, and habitat improvement (Coronado National Forest 1986b). The Forest considers the salamander a sensitive species and a management indicator species (Coronado National Forest 1986a).

A population of salamanders in upper Garden Canyon of Fort Huachuca is suspected of being Sonora tiger salamanders. In accordance with Army Regulation 200-3, Fort Huachuca completed an Integrated Natural Resources Management Plan in 2001 and in 2002 will complete Endangered Species Management Plans (ESMPs) for all listed and proposed species and critical habitat, including the Sonora tiger salamander. Dr. James P. Collins has assisted in the development of the salamander ESMP (Jim Hessil, Fort Huachuca, pers. comm. 2002).

Several other Federal regulations affect management of salamander habitat. The National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. § 4321-4370a) requires Federal agencies to consider the environmental impacts of their actions. NEPA requires Federal agencies to describe a proposed action, consider alternatives, identify and disclose potential environmental impacts of each alternative, and involve the public in the decision-making process. Section 404 of the Federal Water Pollution Control Act of 1948 (33 U.S.C. 1251-1376), as amended, and Federal Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) are also applicable to management of wetlands inhabited by the salamander.

Arizona State Regulations

Collecting *Ambystoma* in the SRV is prohibited under Arizona Game and Fish Commission Orders 40 and 41, except under special permit. Furthermore, transport and stocking of live bullfrogs and fishing with live bait fish or *Ambystoma* within the range of this salamander in Arizona are prohibited (R12-4-316). Sale of live waterdogs at Parker Canyon Lake is prohibited under the same regulation. In the SRV, live crayfish can be used as bait, but only at the place of capture. Transported crayfish must be dead. The Sonora tiger salamander is included in AGFD's draft Wildlife of Special Concern in Arizona; however, this designation affords the species and its habitat no legal protection. State of Arizona Executive Order Number 89-16 (Streams and Riparian Resources), signed on June 10, 1989, directs State agencies to evaluate their actions and implement changes, as appropriate, to allow for restoration of riparian resources.

Ownership of the historic San Rafael Cattle Company Ranch in the center of the San Rafael Valley is currently divided between the Arizona State Parks Board (ASPB) and private owners.

The ranch originally covered approximately 8,700 hectares. In 1999 it was split into three sections: 1) The 6,850 hectare San Rafael de la Zanja Mexican land grant; 2) the 450 hectare "Upper 17" north of the land grant; and 3) 1,400 hectares south of the land grant and bordering the Mexican state of Sonora. The land grant and "Upper 17" are privately owned and operated as a working ranch. ASPB holds a conservation easement over the land grant, and The Nature Conservancy holds a conservation easement over the Upper 17. The conservation easement on the land grant prohibits subdivision of the affected property; sale, diversion or transfer of ground and surface waters; mining; stocking or transfer of non-native organisms; activities that use excessive amounts of water; planting of non-native vegetation; and includes other provisions to maintain the property in a relatively undisturbed condition. ASPB owns the 1,400 hectares between the land grant and the international border and operates it as a State Park. The park is closed to the public pending completion of visitor facilities planning and development.

Private Ownership and Management

As discussed above, ASPB and private parties are important land owners and managers in the center of the SRV. Most other lands in the range of the Sonora tiger salamander are owned by the Coronado National Forest. Fort Huachuca and Coronado National Memorial own and manage lands on the eastern edge of the salamander's range. Private inholdings occur throughout the valley, most notably in Mowry Wash, Adams Canyon, Meadow Valley, Campini Mesa, and lower Sunnyside Canyon. Many of the owners of these lands hold grazing permits on the Coronado National Forest and have a great influence on the management of the cattle ponds where the salamander breeds.

Sonora

In 1983, Jones *et al.* (1988) sampled 30 sites in northeastern Sonora and 26 sites along the eastern slope of the Sierra Madre Occidental and adjacent areas in northwestern Chihuahua. No *Ambystoma tigrinum* were found in Mexico; however, rosy salamanders, *Ambystoma rosaceum*, were located at one site in Sonora and 17 sites in Chihuahua. Salamanders suspected of being Sonora tiger salamanders have been collected from Los Fresnos cienega in the School Canyon drainage approximately 3 km south of the border (Varela-Romero *et al.* 1992). In Mexico, *Ambystoma tigrinum*, including the Sonora tiger salamander, is a species of Special Protection. This designation affords certain protections to the species (Secretaria de Desarrollo Urbano y Ecologia 1994).

II. RECOVERY

Recovery Objective

The objective of this Recovery Plan is the recovery and delisting of the Sonora tiger salamander. An interim objective is to downlist the species from endangered to threatened. Although Sonora tiger salamanders face a variety of threats, a relatively high density of ponds support Sonora tiger salamander populations, and there is no indication that the number of populations is declining, except in ponds where non-native fish have been illegally introduced. Consequently, downlisting criteria focus on monitoring and protecting existing Sonora tiger salamanders.

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 the salamander's currently-occupied range (lands managed by CNF, ASPB, 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 fish and crayfish, and are monitored to detect new threats, including introductions of predators and non-native salamanders.
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.

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

Downlisting and delisting criteria are designed to provide a basis for considering a change in the status of the Sonora tiger salamander, but would not trigger automatic downlisting or delisting. Such decisions are made by the USFWS through a rule-making process that involves public

review and comment. The recovery criteria will be revised by the USFWS as appropriate as new information pertinent to these topics becomes available. Revisions must be based on the best data available.

Step-Down Outline of Recovery Actions

1. Protect and enhance salamander habitat
    - 1.1. Develop guidelines for watershed use and maintenance
    - 1.2 Implement watershed use and maintenance guidelines
    - 1.3 Implement guidelines for cattle pond use and maintenance
    - 1.4. Develop cleaning and maintenance program for cattle ponds
    - 1.5. Enforce guidelines for cattle pond and watershed use and maintenance
    - 1.6. Enhance bank-line and aquatic vegetation at breeding ponds
    - 1.7. If necessary, develop and implement approaches to alleviate low pH in breeding ponds
    - 1.8. Develop cooperative agreements with willing land owners to protect salamander habitats on private lands
    - 1.9. If needed, build more ponds
    - 1.10. Develop self-sustaining cienega habitats that can support salamander populations
2. Control non-native predators (fish, bullfrogs, and crayfish)
    - 2.1. Explore with AGFD opportunities and mechanisms to minimize or eliminate introduction of crayfish.
    - 2.2. Enforce regulations prohibiting introduction of non-native predators to SRV ponds
    - 2.3. Remove non-native fish, crayfish, and bullfrog populations from SRV ponds
3. Control introduction, transport, and collection of tiger salamanders in SRV
    - 3.1. Enforce regulations preventing introduction, transport, and collection of tiger salamanders in SRV
    - 3.2. Remove non-native tiger salamander populations from SRV ponds
4. Develop and implement approaches to minimize frequency of die-offs
5. Monitor salamander populations and their habitat
    - 5.1. Prepare monitoring schedule and protocol
    - 5.2. Develop agreements with willing land owners to survey for and monitor populations on private lands
    - 5.3 Survey for salamanders on private lands pursuant to agreements developed in 5.2
    - 5.4. Develop interagency cooperation and data repository
    - 5.5. Conduct monitoring
    - 5.6. In coordination with Mexican officials, survey potential habitats in Sonora
6. Research
    - 6.1. Acquire demographic and dispersal information
        - 6.1.1. Determine age structure in adult salamanders
        - 6.1.2. Estimate female fertility and proportion of females breeding
        - 6.1.3. Acquire transition probabilities from one life history stage to the next

6.1.4. Acquire information on dispersal patterns through mark/recapture and radiotelemetry
6.1.5. Determine habitat use of terrestrial metamorphs via radiotelemetry
6.1.6. Develop a population viability analysis

6.2. Research spread and environmental triggers of disease
6.3. Conduct microsatellite analysis
6.4. Investigate extent and, if necessary, possible causes of low pH in ponds
6.5 Survey to determine crayfish distribution in the SRV
6.6. Research methods of crayfish removal

7. Public education
   7.1. Post and maintain signs
   7.2. Prepare brochures and make available to the public
   7.3. Participation Team meetings
8. Practice adaptive management in which recovery tasks are revised by USFWS in coordination with the Participation Team as pertinent new information becomes available

Narrative Outline for Recovery Actions

1. Protect and enhance salamander habitat. Protection and enhancement of habitat ensures that salamanders have suitable breeding sites and that metamorphs outside the pond are able to safely overwinter and disperse.
   1.1. Develop guidelines for watershed use and maintenance. Land use activities in watersheds and upland habitats should not pollute, lead to excessive sediment deposition, or prevent water from entering ponds. Also, to facilitate salamander dispersal and survival outside ponds, actions that excessively de-vegetate upland habitat should be prevented. Plains grassland and Madrean evergreen woodland communities (Brown 1994) within the range of the salamander should be maintained and protected.
   1.2 Implement watershed use and maintenance guidelines. Once developed, the guidelines should be implemented on public lands and, in the case of willing private landowners, on private lands.
   1.3 Implement guidelines for cattle pond use and maintenance. Current USFS guidelines for grazing and cattle pond use and maintenance (Appendix D, Attachment 2) are sufficient to protect salamanders from use associated with cattle ranching. These guidelines should be implemented on public lands and, in the case of willing private landowners, on private lands.
   1.4. Develop cleaning and maintenance program for stock ponds. Cattle ponds where salamanders have been found should be maintained so that in most years they hold water from January through July. Maintenance activities in ponds containing insufficient water may include removing sediment, reducing leakage, and maintaining dams. Occasional drying (once every few years) is acceptable, even desirable, since it eliminates fish and bullfrogs and forces a larger proportion of the salamander population to metamorphose.

1.5. Enforce guidelines for cattle pond and watershed use and maintenance. The USFS and ASPB should monitor cattle pond and watershed use and maintenance to ensure that guidelines are being followed.

1.6. Enhance bank-line and aquatic vegetation at breeding ponds. Grazing should be managed to maintain or increase aquatic and bank-line vegetation. Double tanks or trick tanks would allow for vegetated bank-lines and aquatic cover to grow and still allow cattle access to water. Double tanks or other actions implemented to increase vegetation cover should be conducted on an experimental basis to develop methodologies and ensure that salamander populations benefit.

1.7. If necessary, develop and implement approaches to alleviate low pH in breeding ponds. If survey results show that ponds experience low pH (*i.e.*, at least one pond per year with pH below 5), management actions should address this problem. If it is not possible to eliminate the source of low pH, ponds could be treated, with calcium carbonate, for example, to balance the pH.

1.8. Develop cooperative agreements with willing land owners to protect salamander habitats on private lands. If land owners are willing, salamander habitat on private lands should be protected in a manner similar to those on public land. State or Federal government agencies should attempt to provide support and assistance to land owners that improve private ponds to benefit Sonora tiger salamanders. Several stewardship and wildlife habitat improvement programs exist that might help meet these needs (see Appendix A).

1.9. If needed, build more ponds. If population viability analysis suggests more populations are needed in a certain part of their range, establish new habitats to facilitate dispersal of salamanders among breeding populations. New habitats should not facilitate dispersal and invasion by non-native aquatic species.

1.10. Develop self-sustaining cienega habitats that can support salamander populations. To establish habitats that do not require continual human maintenance and to create a greater diversity of available habitat, efforts should be made to restore cienega habitats that can support Sonora tiger salamander populations. This effort includes identifying suitable habitat, ensuring adequate waterflow and suitable vegetation, and removing or preventing the introduction of non-native predators. New ponds should not facilitate dispersal or establishment of non-native organisms that prey on Sonora tiger salamanders. This project should be coordinated with recovery efforts for other cienega species in the region. Initially, at least 3 such cienega habitats should be developed. These projects should be conducted in an experimental manner to determine methodologies for cienega restoration and how salamanders respond to these habitats. As methodologies for creating cienega habitats suitable for salamander breeding are developed, additional opportunities for cienega restoration in the SRV should be pursued.

2. Control non-native predators (fish, bullfrogs, and crayfish). If left unregulated, non-native predators could pose a serious threat to Sonora tiger salamanders.

2.1. Explore with AGFD opportunities and mechanisms to minimize or eliminate introduction of crayfish. It is currently legal to use live crayfish as bait in the

SRV, so long as they are used where they are captured. The Participation Team is concerned that current regulation may not be adequate to halt further introductions of crayfish. The Team and USFWS would work with AGFD to develop additional regulation as needed, as well as ensure adequate enforcement and outreach to minimize illegal introductions of crayfish in the SRV.

2.2. Enforce regulations preventing introduction of non-native predators to SRV ponds. It is currently illegal to transport live bullfrogs or bait fish within the Arizona range of the salamander. Fish and bullfrogs cannot be stocked without an aquatic stocking permit from AGFD, which considers the potential effects on endangered species before issuing permits. There should be adequate enforcement of these laws. Law enforcement agencies operating in the area, including USFS, USFWS, AGFD, ASPB, U.S. Border Patrol, and local law enforcement should be informed of these laws. Ranchers and landowners should be encouraged to report illegal activities that may adversely affect the Sonora tiger salamander. In coordination with AGFD and the land owner/manager, if needed to protect the salamander from non-native introductions and approved by the Arizona Game and Fish Commission and AGFD, ponds should be posted and enforced as "No Fishing".

2.3. Remove fish, crayfish, and bullfrog populations from SRV ponds. Non-native predators should be removed from ponds that contain or contained Sonora tiger salamanders. Predator removal should be conducted so as to minimize salamander mortality and effects on cattle and other animals that use the aquatic habitat. One possible method is simply to let ponds silt in and dry before re-excavating. If a pond is small, exhaustive sampling with a seine to remove predators is also feasible. Poison must be used with caution, because poison and agents of poison dispersal might affect cattle that use the pond and will almost certainly affect salamanders. If poison is administered to a pond used by cattle, the cattle must be protected, either by using a method not toxic to cows or by fencing the affected pond and providing an alternative water source. As many salamanders as possible must be removed before poisoning, and returned to the pond after the poison has dissipated or been neutralized. Methods for removing non-native fish and bullfrogs from cattle ponds have been developed at San Bernardino and Buenos Aires National Wildlife Refuges (Rosen and Schwalbe 2000, Schwalbe *et al.* 2000). Methods to remove crayfish need to be researched (see recovery action 6.6).

3. Control introduction, transport, and collection of tiger salamanders in SRV. Human use and transport of tiger salamanders threatens Sonora tiger salamanders because of the possibility of genetic swamping by introduced salamanders and over-collecting by bait harvesters.

3.1. Enforce regulations preventing introduction, transport, and collection of tiger salamanders in SRV. It is currently illegal to transport, introduce, or collect tiger salamanders in the Arizona range of the Sonora tiger salamander. There should be adequate enforcement of these laws. Law enforcement agencies operating in

the area, including USFS, USFWS, AGFD, ASPB, U.S. Border Patrol, and local law enforcement should be informed of these laws. Ranchers and landowners should be encouraged to report illegal activities that may adversely affect the Sonora tiger salamander.

3.2. Remove non-native tiger salamander populations from SRV ponds. If there are SRV ponds that contain only introduced barred tiger salamanders (verified by genetic testing over multiple years), the introduced salamanders should be removed. Removal must be repeated over a period of at least five years since metamorphosed salamanders in the terrestrial environment might return to breed. See section 2.3 for methods of removal and concerns about poisoning as a removal method.

4. Develop and implement approaches to minimize frequency of die-offs. Currently, researchers at Arizona State University, AGFD, and USFWS that study the Sonora tiger salamander scrub mud from nets, waders, and buckets, and soak them in a 10 percent bleach solution between each pond. Buckets are rinsed with water from each new pond to remove bleach that might poison salamanders. Policy should be made formalizing these guidelines for all researchers to follow. Policy should be modified as appropriate, given new information from disease research.

5. Monitor salamander populations and their habitat. Monitoring salamander populations should minimize threats posed to salamanders by factors such as introduced predators and extended habitat drying because monitoring will enable early detection and management of threats. Monitoring will also help identify other threats that may arise. Monitoring will also yield information about correlations between the state of salamander populations (*e.g.*, presence/absence, breeding/not breeding, diseased/not diseased) and environmental variables, such as pond drying, pH, and presence of aquatic and bank-line vegetation.

5.1. Prepare monitoring schedule and protocol. A protocol needs to be developed to identify all potential habitats in the salamander's range and to survey those habitats for the subspecies and non-native aquatic organisms. The protocol must enable monitors to create reproducible results about habitat characteristics, presence of introduced predators, and salamander status, while minimizing the spread of disease. A subset of ponds and cienega habitat with and without salamanders should be surveyed to assess the rate at which salamanders are appearing and disappearing from different habitat and which factors influence these metapopulation dynamics. Sampling should be conducted on an annual basis during the reproductive season and dry season. Every five years, a more thorough sampling should be conducted to determine the distribution of salamanders, fish, bullfrogs, and crayfish throughout the SRV.

5.2. Develop agreements with willing land owners to survey for and monitor populations on private lands. Private landowners in the SRV should be contacted and asked if surveys could be conducted on their lands for salamanders. Surveys should only be conducted in accordance with written agreements developed with willing private landowners. Agreements must respect private property rights and reflect the wishes of the landowner.

5.3 Survey for salamanders on private lands pursuant to agreements developed in 5.2. If landowners are willing, ponds on private lands should be checked for salamanders, and salamander populations on private lands should be monitored.

5.4. Develop interagency cooperation and data repository. Communication and coordination of monitoring efforts between agencies and other involved parties is essential. It is particularly important that a central data repository be established that can be accessed by all involved in research and management of Sonora tiger salamanders.

5.5. Conduct monitoring. Trained individuals should follow the monitoring protocol and schedule, recording information on a data sheet and depositing data in the central repository.

5.6. In coordination with Mexican officials, survey potential habitats in Sonora. Considering the proximity of Sonora tiger salamander populations to the Mexican border, it is likely that Sonora tiger salamander populations exist in Mexico. It would be useful to know the distribution and status of salamanders in Mexico so that conservation efforts could be coordinated.

6. Research. There is still a great deal of information to be learned about the basic ecology of the Sonora tiger salamander. This information will help managers to develop policies to ensure long term persistence of the salamander.

6.1. Acquire demographic and dispersal information

6.1.1. Determine age structure in adult salamanders. Age structure can be determined by counting bone rings in toe and arm bones or by marking and recapturing salamanders in a single pond over several years.

6.1.2. Estimate female fertility and proportion of females breeding. Fertility estimates can be obtained by counting eggs in previously preserved specimens. Proportion of females breeding can be obtained by counting the number of breeding females (*i.e.* those with red, swollen vents) in a pond and dividing by the estimated number of females in the population.

6.1.3. Acquire transition probabilities from one life history stage to the next. Probability of an egg becoming a larva and a larva becoming a branchiate or metamorphosed adult can be obtained by conducting intensive field surveys from when eggs are laid to when salamanders metamorphose, and determining the number of individuals at each life history stage through exhaustive sampling and mark/recapture.

6.1.4. Acquire information on dispersal patterns through mark/recapture and radiotelemetry. The likelihood of pond to pond dispersal can be determined by marking as many salamanders as possible in neighboring ponds and revisiting these ponds in following years to check for successful dispersers. Radio-telemetry would provide information about the directions of salamander dispersal and whether they have a preference for a certain environment through which to travel. Information provided by microsatellite DNA analysis may also provide insight into dispersal distances and potential barriers to gene flow.

6.1.5. Determine habitat use of terrestrial metamorphs. Radio-telemetry would also provide information about where terrestrial metamorphs live when they leave the pond, so that upland habitat could be identified for protection.

6.1.6. Develop a population viability analysis. Using the demographic and dispersal information gathered for the Sonora tiger salamander, a population viability analysis should be conducted that estimates the likelihood of extinction for Sonora tiger salamanders, assesses relative threats of various factors (fish, disease, habitat loss, *etc.*), and compares alternative management strategies. This Recovery Plan would be revised as needed based on the results of this analysis.

6.2. Research spread and environmental triggers of disease. There are a variety of ways that virus might move from one pond to another, and these dispersal mechanisms should be researched so that the spread of disease can be managed, if practical. Environmental conditions, such as low pH, might trigger disease outbreaks, so the conditions associated with disease should also be researched so that outbreaks can be minimized.

6.3. Conduct microsatellite analysis. Microsatellite analysis is needed to determine whether interbreeding has occurred between barred and Sonora tiger salamanders and whether there is any genetic variation and structure among Sonora tiger salamanders that needs to be preserved. Genetic analyses should be conducted at five year intervals to assess the spread of introduced barred tiger salamanders.

6.4. Investigate extent and, if necessary, possible causes of low pH in ponds. The pH in ponds containing salamanders needs to be monitored over the next several years to determine whether there are consistently low pH's or periodic drops in pH level. These data are particularly important in ponds experiencing die-offs. If low pH's are observed, researchers should attempt to correlate them with factors such as smelter output and weather patterns.

6.5. Survey to determine crayfish distribution. A one-year study of the distribution of crayfish in the SRV should be conducted. Surveys should be conducted in streams, ponds, and other water bodies on public lands and, with the permission of willing landowners, on private lands.

6.6. Research methods of crayfish removal. A thorough literature search and communication with experts should be carried out to determine effective methods of crayfish removal.

6.7. Investigate low genetic diversity and develop management recommendations. Genetic diversity among populations should be assessed, threats associated with low genetic diversity should be clearly identified, and a genetic management plan or other recommendations should be developed to alleviate those threats.

7. Public education

7.1. Post and maintain signs. General educational signs should be posted at the four major entrances to the SRV (Parker Canyon Lake, Canelo Pass, Montezuma Pass, Harshaw Road). Individual signs should be considered along pond access roads

for ponds that are visible from the road. If identified as "no fishing" areas in accordance with 2.2, ponds should be appropriately signed as such. These signs should inform the public about the Sonora tiger salamander and other sensitive species that use cattle pond and/or cienega habitat and the laws protecting the organisms and their habitat. Signs should be regularly inspected and maintained or replaced as needed.

7.2. Prepare brochures and make them available to the public. Interpretive brochures should be prepared and made available at offices of USFS, USFWS, Fort Huachuca, AGFD, and National Park Service at Coronado National Memorial. Brochures should also be available at Parker Canyon Lake, Patagonia Lake, and in the towns of Patagonia and Sonoita.

7.3. Coordinate implementation of recovery plan with Participation Team. The Participation Team should meet at least once annually to review progress in plan implementation; discuss issues, problems, and potential solutions; and to disseminate to interested parties new information on the ecology and status of the Sonora tiger salamander.

8. Practice adaptive management in which recovery tasks are revised by USFWS in coordination with the Participation Team as pertinent new information becomes available. The Participation Team should meet at least annually to review progress in implementing this recovery plan and to discuss the need for plan revision. Completion of a PVA and results of other research and management are expected to be insightful in regard to where our efforts should be focused to achieve a swift and cost-effective recovery of the salamander. New information may also warrant changes in the delisting or downlisting criteria. This recovery plan should be fully reassessed by the USFWS and Participation Team every three to five years or at any time it becomes apparent that the plan is not fulfilling its function to guide to recovery. The USFWS will depend heavily on input from the Participation Team in determining whether the plan needs revision.

Minimization of Threats to the Sonora Tiger Salamander Through Implementation of Recovery Actions

The final rule listing the Sonora tiger salamander evaluated threats to the species in terms of 5 listing factors. Implementation of the recovery actions would minimize these threats as follows:

Listing Factor 1: The present or threatened destruction, modification, or curtailment of its habitat or range. The historical habitats of the salamander have been largely lost or dramatically altered, and today the species breeds almost exclusively in cattle ponds that are small, often very dynamic, and require maintenance to ensure habitat persistence. Implementation of recovery actions 1.1-1.10 would protect upland habitats of terrestrial adult salamanders, protect the watersheds of breeding ponds, maintain and enhance cattle pond habitats, and reduce mortality and habitat degradation associated with periodic maintenance of cattle ponds. Self-sustaining cienega habitats would be restored to reduce the dependence of the salamander on artificial aquatic habitats that require maintenance. More cattle ponds would be constructed if deemed necessary to facilitate dispersal of salamanders and connectivity of populations.

Listing Factor 2: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes. Bait collectors and anglers may illegally capture salamanders and transport them to other areas. Such activities could adversely affect small populations and may spread disease. State and Federal law prohibit these activities, thus public education and law enforcement is needed to promote compliance. Recovery actions 2.2 and 3.1 call for coordination among law enforcement authorities and residents of the SRV to increase the awareness of this problem and facilitate adequate law enforcement. Recovery actions 7.1 and 7.2 aim to inform the public through signs and brochures about the Sonora tiger salamander and regulations to protect it.

Listing Factor 3: Disease or Predation. Introduced predaceous fish, bullfrogs, and crayfish threaten to eliminate the Sonora tiger salamander from portions of its range. The disease ATV causes dramatic die-offs of salamanders in breeding ponds. The disease can be spread by researchers or others working at cattle ponds in the SRV, or by anglers. Implementation of recovery actions 2.1 and 2.2 would provide regulations and enforcement to prevent introductions of non-native predators, and recovery actions 7.1 and 7.2 would provide the public with information about regulations and why non-native predators need to be controlled. Recovery action 2.3 calls for removing non-native predators from ponds that contain or contained Sonora tiger salamanders. Recovery action 4 calls for development and enforcement of disease prevention policies to be followed by researchers or monitors to ensure that ATV is not inadvertently introduced to salamander populations.

Listing Factor 4: The Inadequacy of Existing Regulatory Mechanisms. The listing of the Sonora tiger salamander put in place additional regulations to protect individuals of this species and aquatic habitats in the SRV, and provided other mechanisms to recover the species. The only additional regulatory mechanism identified herein to recover the salamander is described in recovery action 2.1, which calls for development of regulations to prevent use of live crayfish as bait in the SRV. Implementation of recovery actions 2.2 and 3.1 would provide the law enforcement to ensure compliance with these regulations, and actions 7.1 and 7.2 would provide public education to inform visitors to the SRV of these regulations and why they are needed.

Listing Factor 5: Other Natural or Manmade Factors Affecting Its Continued Existence. The barred salamander has been introduced to portions of the SRV and may hybridize with the Sonora tiger salamander. Barred salamanders are most likely introduced by anglers using them as bait or by bait collectors who wish to create a source for future collection. Recovery actions 2.2 and 3.1 call for enforcement of regulations that prohibit introduction, transport, and collection of any tiger salamanders in the SRV. Recovery actions 2.2 and 7.1 call for closing and signing ponds to fishing, if needed to protect salamanders. Implementation of recovery action 3.2 would remove non-native barred salamanders from SRV ponds. Recovery actions 7.1 and 7.2 would provide public education to inform visitors to the SRV of regulations concerning non-native salamanders and why such regulations are needed. An additional threat is isolation of small populations that increase the chances of extirpation or extinction from natural events such as catastrophic storms or drought. All of the recovery actions, when taken together, have the effect of increasing the likelihood that existing populations will persist, and that new populations will be established.

Recovery action 1.9 would result in construction of new breeding ponds if deemed necessary to facilitate salamander dispersal and connectivity of populations. Better connectivity would increase the likelihood that habitats would be recolonized if salamanders were extirpated due to drought or other catastrophes. Creation of self-sustaining cienega habitats capable of supporting Sonora tiger salamanders would provide a greater diversity of habitat types and habitats that do not require continual human maintenance. Greater habitat diversity reduces the chances that a catastrophic event would extirpate most populations or result in extinction.

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V. IMPLEMENTATION SCHEDULE

The implementation schedule outlines the tasks discussed in Part II and indicates task numbers, priorities, durations, estimated costs, and agencies that may be involved in implementing the task. If accomplished, these tasks should enable the Sonora tiger salamander to be delisted. The costs for each task are estimates, and actual budgets will have to be determined when each task is undertaken. Cost estimates do not commit funding by any agency.

Priorities in Column 3 of the implementation schedule are assigned as follows:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

Task duration in Column 4 indicates the number of years required to complete the task. A continuing task will continue to be conducted once implemented. An ongoing task is one that is already being conducted.

The following abbreviations are used to indicate the responsible agency in column 5:

ASPB	Arizona State Parks Board
ASU	Researchers at Arizona State University
AGFD	Arizona Game and Fish Department
FH	Fort Huachuca
FWS	United States Fish and Wildlife Service
IMADES	Instituto del Medio Ambiente y El Desarrollo Sustentable del Estado de Sonora
PT	Participation Team
TNC	The Nature Conservancy
CNF	United States Forest Service-Coronado National Forest

TBD= to be determined

IMPLEMENTATION SCHEDULE

Costs (thousands of dollars)

Task	Description	Priority	Duration	Responsible Party	FY 1	FY 2	FY3	FY 4	FY 5	Total
1.1	Develop guidelines for watershed use and maintenance	1	1 yr	PT, CNF, FH, ASPB	1	0	0	0	0	1
1.2	Implement watershed use and maintenance guidelines	1	Indefinite	PT, CNF, FH, ASPB	2	2	2	2	2	10
1.3	Implement guidelines for cattle pond use and maintenance	1	Indefinite	PT, CNF, FH, ASPB	2	2	2	2	2	10
1.4	Develop cleaning and maintenance program for cattle ponds	1	Indefinite	CNF, FH, ASPB	10	10	10	10	10	50
1.5	Enforce cattle pond and watershed use and maintenance guidelines	1	Indefinite	ASPB, CNF, FH	1	1	1	1	1	5
1.6	Enhance aquatic and bank-line vegetation	2	Indefinite	ASPB, CNF, AGFD, FWS	10	10	10	10	10	50
1.7	Control pH, if necessary	2	Indefinite	ASPB, CNF	TBD	TBD	TBD	TBD	TBD	TBD
1.8	Develop cooperative agreements with private landowners to protect habitat	1	Negotiable	PT, FWS, AGFD	10	10	10	10	10	50
1.9	Build new ponds, if needed	2	Indefinite	ASPB, CNF AGFD, FWS	TBD	TBD	TBD	TBD	TBD	TBD
1.10	Develop 3 self-sustaining cienegas as salamander habitat	3	5 yrs	ASPB, CNF, AGFD, FWS	20	20	20	20	20	100

Task	Description	Priority	Duration	Responsible Party	FY 1	FY 2	FY 3	FY 4	FY 5	Total
2.1	Explore with AGFD opportunities and mechanisms to minimize or eliminate introduction of crayfish	1	2 yrs	AGFD, FWS	5	5	0	0	0	10
2.2	Enforce regulations prohibiting non-native predator introduction	1	Ongoing	AGFD, FWS, ASPB. FH	5	5	5	5	5	25
2.3	Remove introduced predators	1	Indefinite	AGFD, FWS, CNF, ASPB, FH	10	40	40	10	10	110
3.1	Enforce laws prohibiting introduction, transport, & collection of tiger salamanders in SRV	1	Ongoing	AGFD, FWS, ASPB, FH	5	5	5	5	5	25
3.2	Remove introduced salamanders	1	Indefinite	AGFD, FWS, ASPB, FH	10	10	10	10	10	50
4	Develop approaches to minimize disease	2	1 yr	AGFD, FWS, ASU	3	0	0	0	0	3
5.1	Prepare monitoring schedule and protocol	1	1 yr	AGFD, FWS, ASU, CNF, PT	3	0	0	0	0	3
5.2	Develop agreements with willing land owners to survey on private property	2	Indefinite	AGFD, FWS	1	1	1	1	1	5
5.3	Survey for salamanders on private lands pursuant to agreements developed in 5.2	2	Negotiable	AGFD, FWS, ASU	5	5	2	2	2	16
5.4	Develop interagency cooperation and data repository	1	Indefinite	AGFD, ASU, FWS	5	5	2	2	2	16

Task	Description	Priority	Duration	Responsible Party	FY 1	FY 2	FY 3	FY 4	FY 5	Total
5.5	Conduct monitoring	1	Indefinite	AGFD, ASU, FWS	10	10	10	10	10	50
5.6	Survey potential habitats in Sonora	3	1 yr	AGFD, FWS, IMADES, ASU	0	0	15	0	0	15
6.1.1	Determine age structure	3	5 yrs	AGFD, ASU, FWS	5	5	5	5	5	25
6.1.2	Obtain estimates of female fertility and proportion of females breeding	3	5 yrs	AGFD, ASU, FWS	5	5	5	5	5	25
6.1.3	Acquire life history transition probabilities	3	5 yrs	AGFD, FWS, ASU	5	5	5	5	5	25
6.1.4	Mark/recapture studies of dispersal	3	5 yrs	AGFD, ASU, FWS	10	10	10	10	10	50
6.1.5	Radiotelemetry	2	5 yrs	AGFD, ASU, FWS	10	10	10	10	10	50
6.1.6	Develop PVA	1	1 yr	AGFD, FWS, ASU	0	0	0	0	20	20
6.2	Research spread & environmental triggers of disease	3	4 yrs	AGFD, FWS, ASU	10	10	10	10	0	40
6.3	Microsatellite analysis	2	2 yrs	FH, FWS, ASU, AGFD	10	10	0	0	0	20
6.4	Investigate low pH	2	5 yrs	CNF, AGFD, FWS	0	10	10	0	0	20

Task	Description	Priority	Duration	Responsible Party	FY 1	FY 2	FY 3	FY 4	FY 5	Total
6.5	Survey to determine crayfish distribution	3	1 yr	AGFD, FWS, CNF, FH, ASPB	0	0	10	0	0	10
6.6	Research crayfish removal	3	1 yr	AGFD, FWS, CNF, FH	0	0	10	0	0	10
6.7	Investigate low genetic diversity and develop management recommendations	3	2 yr	AGFD, FWS, ASU	10	10	0	0	0	20
7.1	Post and maintain signs	2	1 yr	CNF, ASPB, FH, AGFD	10	40	3	3	3	59
7.2	Prepare brochures and make them available to the public	2	1 yr	CNF, FH, ASPB, FWS, AGFD	10	0	0	0	0	10
7.3	Participation team meetings	1	5 yrs	PT, FWS, ASU	2	2	2	2	2	10
8.0	Practice adaptive management	1	Indefinite	PT, FWS, ASU	TBD	TBD	TBD	TBD	TBD	TBD
Totals [1]					**205**	**283**	**215**	**150**	**160**	**1013**

[1]Does not include TBD costs

Appendix A:
PARTICIPATION TEAM PLAN FOR IMPLEMENTING THE SONORA TIGER SALAMANDER (*Ambystoma tigrinum stebbinsi*) RECOVERY PLAN

Prepared by: The Sonora Tiger Salamander Participation Team

The purpose of this Participation Plan (Plan) is to describe the means to carry out the tasks/actions outlined in the implementation schedule of the Sonora Tiger Salamander Recovery Plan in a way that provides for timely recovery of the Sonora tiger salamander while minimizing social and economic effects. All parties, public and private, that might be affected by implementation of the Recovery Plan, were formally invited to participate as members of the Sonora Tiger Salamander Participation Team (Team) in the development of this Participation Plan. This diverse group of ranchers, scientists, agency representatives, and other stakeholders worked closely with the preparers of the Recovery Plan and the USFWS to mold recovery actions and define implementation techniques and responsibilities. In evaluating recovery actions, the first consideration was whether the proposed recovery action was necessary to recover the species; the second was to determine whether the same goal could be attained by another pathway with less economic and social impact on affected stakeholders.

The Team focused on those recovery tasks that were most likely to affect stakeholders. For instance, the Sonora tiger salamander is only known to occur in impoundments that are used primarily for watering livestock. Thus, these impoundments, or ponds, are not only critical for the survival of the salamander, but are also crucial components of viable livestock operations. Any recovery actions for salamanders in cattle ponds must also provide for continued use as a water source for livestock. At some sites, other considerations are also important, such as the mission of the Army at Fort Huachuca, the diverse mandates of the Coronado National Forest, and the management direction of Arizona State Parks Board (ASPB). These mandates, private property rights, and management needs are reflected in the recommendations made in this Participation Plan.

I. *Socio-Economic Setting*

The area impacted by the implementation of a recovery plan for the Sonora tiger salamander is referred to as the Lone Mountain/San Rafael Valley, consisting of approximately 331 square miles, straddling Santa Cruz and Cochise counties of southern Arizona. The area includes the eastern slopes of the Patagonia Mountains, the western slopes of the Huachuca Mountains, and the mesas and canyons between and south to the border. The following discussion of socio-economic conditions in

the SRV derive primarily from Hadley and Sheridan (1995), Orton (1996), Snider and Gum (1993), and U.S. Forest Service (1996)

Elevation ranges from almost 9,500 feet (Miller Peak in the Huachucas) to 4,500 feet at the center of the SRV. The area is a complex geomorphology of many small watersheds, but provides the headwaters for both the Santa Cruz and San Pedro rivers. Differing elevations and soil types within the area provide for a variety of vegetation zones, including plains grasslands, mixed cottonwood riparian habitat, evergreen woodlands, and ponderosa pine and mixed conifer forests.

Several theories exist about what human population existed in the SRV between 1450 and 1700 AD. The most widely held theory places Hohokam-Pima peoples in the area, living by hunting, fishing, gathering, and farming along the streams. It appears that the Sobaipuri people who occupied the upper Santa Cruz and San Pedro River valleys were probably a frontier population in the area, colonizing new territory in the 15th, 16th, and 17th centuries. By the end of the 17th century, the Spanish explorer Father Kino encountered the Sobaipuri in the area battling other indigenous people, which the Spanish identified as Janos, Jocomes, and Apaches. These groups were also hunters, gatherers, and part-time farmers who frequently shifted residences. By the early 18th century, most Janos and Jocomes had died out or been assimilated by the Apaches, who were, at least in the 18th century, the victors of intertribal warfare.

The Spanish did not begin to settle in the area until the middle of the 17th century, when isolated ranching and mining operations began to appear. A military garrison was established in 1787 at “Santa Cruz” at the site of a Piman community referred to as Santa Maria Soamca. Santa Cruz was located along the Santa Cruz River about 5 miles south of the current U.S.-Mexico border. Using Santa Cruz as a base of operations, the Spaniards began a coordinated series of offensive raids on the Apaches and by the early 1800s, attacks by Apaches declined. Despite the efforts of the garrison soldiers, throughout the 18th century, stock raising in the SRV was a sporadic, dangerous, and precarious occupation.

In 1821, a resident of the presidio of Santa Cruz petitioned for grazing land at a place called La Zanja, to establish a ranch. The land was surveyed and years later, was finally granted, after four public auctions, to Don Ramon Romero and other associated residents. This eventually became what was known as the San Rafael Cattle Company. It appears that between 1825 and 1843, the parcioneros ran from 2,000 to 5,000 head of cattle on their grant. By 1843, the Apaches had driven off or killed all of the stock, with as many as 30 rancheros killed at one time at a place called "La Boca de la Noria", near the southern boundary of the ranch. In 1854, the area became part of the United States.

Between 1850 and 1870, the California gold rush, mining, cattle, military activities and travel between Tucson and Mexico brought activity to the area. Travelers, according to written accounts, were impressed with the beauty, fertility, abundance of trees, water, grass, and wildlife. Toward the end of the 19th century, the United States Army increased its presence with the establishment of Camp Moore at Calabases (1856), Fort Buchanan between Sonoita and Patagonia in 1857, Fort

Crittenden on Sonoita Creek in 1867, Camp Wallen on the Babocomari River in 1866-69, and Fort Huachuca in 1877. With increased protection, mining and settlement increased rapidly. The Apache Chief, Geronimo, surrendered in September 1886, which ended the Apache Wars and drastically reduced native American influence in the SRV and elsewhere in southeastern Arizona. By 1893, the valley was populated with ranches, homesteads, working mines, good wagon roads, and other signs of population.

Ranching in the SRV went through three major stages between the late 1800's and mid-20th century. The first stage was dominated by large landowners such as Colin Cameron on the San Rafael de la Zanja land grant, who attempted to extend control and drive smaller ranchers off the land. The second stage was a resurgence of small land holdings, particularly after the passage of the Forest Homestead Act and creation of the Huachuca Forest Reserve in 1906. The ranching population was at its highest in the first three decades of the 20th century. Drought and depression drove many ranchers off the land in the 1920's and 1930's and helped bring about the consolidation of the smaller operations into larger ranches (the third stage). Dry land farming was largely abandoned and cattle raising became the most important economic activity in the SRV and surrounding foothills. The San Rafael Cattle Ranch, a large parcel of private land in the center of the SRV, was recently sold by the Sharp family to The Nature Conservancy (TNC) and ASPB. ASPB has retained 1,400 hectares near the Mexican border, while TNC sold the remaining 7,300 hectares to a private individual (see pages 11-12 of the Recovery Plan).

The expansion and success of ranching activities in the valley brought about the development of many new sources of water, enabling the cattle to spread out and better utilize the forage. Water rights were recorded on cattle ponds and other waters for domestic and irrigation purposes on the San Rafael Cattle Company as early as 1822 and 1850. Across the valley, water rights were recorded on cattle ponds on the Lone Mountain Ranch and Bercich Cattle Company as early as 1884 and 1885 (Hadley and Sheridan 1995), indicating that cattle ponds were constructed with Fresno scrapers and mule teams. Later efforts in the 1950s used Forest Service equipment, with costs shared by the ranchers. Many ponds have been constructed as well as cleaned with private funds. Other water developments include pipelines for dispersing water from springs, and windmills and solar pumps for filling both steel rim and dirt tanks. The dirt tanks filled by pumped water and cattle ponds filled by captured run-off are most significant in this discussion, as they provide the habitat which has allowed for the continued existence of species such as the Sonora tiger salamander. This salamander is thought to have been reliant on natural cienegas, which no longer exist or are inhabited by non-native species with which the salamander can not coexist.

A review of developed waters on National Forest lands that are part of grazing permits within the Plan area shows 125 stock ponds, 35 developed springs, and 36 wells. Waters on private land have also been developed for livestock operations. For example, seven water developments on the Lone Mountain Ranch are used. The Sonora tiger salamander has been recorded at 53 of these waters. No comprehensive inventory of waters suitable for the species has been completed.

It is also significant to recognize that the maintenance and protection of these waters created for the use of cattle is dependent, at this point, upon the financial ability of the ranchers involved. Maintenance of windmills and solar pumps, cleaning of ponds and ditches that feed the ponds, and other items, such as reconstruction of dams and overflows blown out by floods, are very expensive and time consuming activities. These watering facilities and their maintenance are not only critical to the watering of livestock, but have become entwined in and critical to the existence of species such as the salamander. Some costs of maintaining cattle ponds can be estimated using cost figures for heavy equipment dispatched for fire suppression. These costs are as follows:

Item	Rate	Amount	Cost
Cat D8-K w/operator	$155/hour	24 hours	$3,720
Transport, 41 tons or more	$85/hour	8 hours	$680
Laborer	$10/hour	24 hours	$240
Government Paperwork	$500/tank	1 pond	$500
TOTAL			$4,460

Costs for maintenance of other water structures vary. These costs range from a rancher spending half of a day repairing a leaky pipe to hiring a pump maintenance company for one to two days to repair windmills or solar pumps. For replacement of fences around waters that further control livestock use, contractors can charge $3,000/ mile for materials, equipment, and labor. Ranchers grazing livestock on Forest lands are expected to cover most of these costs as part of their permit agreement with the Forest Service.

Cattle ranching remains the most significant factor in the SRV economy. In 1992, it was estimated that approximately 3,100 head of cattle were grazing on just the Forest Service portion of the valley. Revenues of approximately $780,000 were generated from these government permits. Eighteen jobs were directly supported by the ranches, with $216,450 in estimated employee compensation. Revenues of $18,200 were returned to Santa Cruz and Cochise counties by the Forest Service in lieu of taxes.

The direct financial implications of ranching are a small portion of the economic statistics of Cochise and Santa Cruz counties, as the population and number of ranches in the valley are very small by comparison to the totals in either county. The economic impact is also multiplied by the expenditures of the ranches and their employees in the towns adjacent to the valley.

The other significant economic factor that impacts towns adjacent to the valley (and less so the residents and landowners in the valley) is recreation and eco-tourism. An estimated 30,000 people used the developed recreation facilities at Parker Canyon Lake in 1992. Another estimated 7,500 to 10,000 visitors pursued other recreational activities on the Forest portion of the Valley. These activities included hunting, birdwatching, guided horseback and bicycle rides, and sight-seeing. Costs

for each visit include gas, lodging, and equipment. Using an average and conservative figure of $15/visit, recreational use on the Forest portion of the Valley generates $562,500 or more. The percentage of that amount going to local economies is not known. The impact of recreation on the valley, both in economics and landscape character, is also expected to increase with transfer of a portion of the San Rafael Cattle Company's ranch to the ASPB.

Other activities on the Forest also contribute to the local and regional economy. These activities include production of minerals and sale of forest products. Actual amounts generated are not known but should be considered quite limited compared to the contribution of ranching and recreation. For example, in 1998 less than 5 permits were issued by the Forest Service for forest products, primarily manzanita harvests.

Impacts of implementing the recovery plan on the above social and economical values of the Valley, particularly ranching and tourism, need to be considered both now and in the foreseeable future. Ranchers in the SRV are attentive to resource conditions and problems, and provide a continuity of oversight that can be an asset to wildlife managers and the recovery of the Sonora tiger salamander.

II. ***Participation Plan Preparation***

Participation Team members were appointed by the USFWS's Region 2 Regional Director, and include agency representatives and the public whose interests may be affected by actions deemed necessary to recover the Sonora tiger salamander. Initially, 64 individuals were invited by the Regional Director to serve on the Team. These individuals included local residents and ranchers (including all members of the SRV Association), and representatives of City, County, State and Federal agencies and governments that might be affected by Recovery Plan implementation. Twenty-two individuals accepted the invitation and were appointed to the Team, including thirteen local residents (primarily ranchers), two representatives of the AGFD, and single representatives from TNC, Southwest Center for Biological Diversity, Fort Huachuca, City of Sierra Vista, Grand Canyon University, the Coronado National Forest, and ASPB (Attachment 1). At the first meeting of the Team, members reviewed the list of those invited to serve on the Team and concluded it was a complete list. A USFWS representative acted in a support capacity and as a liaison between the Team and the USFWS Regional Director, but was not a member of the Participation Team. The preparers of the Recovery Plan (Dr. Jim P. Collins and Jon Snyder of Arizona State University) attended all of the Participation Team meetings and worked with Team members to address their concerns in regard to proposed recovery actions. Several other individuals received Participation Team mailings, but elected not to serve as Team members (Attachment 1). Only individuals appointed by the Regional Director received copies of interim draft Recovery Plans for review.

Participation Teams are components of Recovery Teams, and as such are exempt from the requirements of the Federal Advisory Committee Act, which otherwise would require that Team meetings be open to the public. In this case, the Team elected to have meetings open to anyone who wished to attend. Non-members were sometimes invited, and others occasionally came to the

meetings, but only those listed in Attachment 1 were regularly notified of upcoming meetings. Organization, structure, decision-making rules, and other process rules were determined by the Team members. The objective was to establish procedural rules that were fair and that would result in decisions and products representative of the diverse makeup of the Team. Sheridan Stone of Fort Huachuca served as Chairperson of the Team. Jim Rorabaugh of the USFWS prepared meeting notes. These notes were reviewed in draft form by Sheridan Stone and were modified as needed and approved by the Team at the following meeting. The Team decided to make decisions by majority rule, based on those present at the time a decision was made. Any Team member not agreeing with a decision could write a dissenting view which would become part of the decision-making record. No dissenting views were entered into the record.

This Participation Plan was compiled by the Team and Jim Rorabaugh. The Socio-Economic Setting was authored by Ann Patton, Lone Mountain Ranch, and Tom Deecken, Coronado National Forest. Much of the Plan was derived from the meeting notes.

III. *Alternatives Considered*

The Team considered all aspects of the proposed recovery program in determining areas of concern in regard to potential social or economic impacts. As discussed in Part I, Socio-Economic Setting, ranching and tourism are the primary social and economic values of the SRV, and these are the values primarily addressed herein. Ranching is of particular importance for the recovery of the salamander, because the only known breeding habitats of the salamander in Arizona are cattle ponds and impoundments. These ponds require periodic maintenance to remain useful as livestock waters and as habitat for the salamander. Maintenance is currently paid for by the ranchers. Without viable livestock operations, other means would be needed to maintain the ponds and prevent loss of key salamander habitats.

Recreation and tourism are important uses of lands managed by the Coronado National Forest, and to a lesser degree, lands at Fort Huachuca. The implementing regulations of the National Forest Management Act of 1976 require the following in all Forest Plans: "to the degree consistent with needs and demands for all major resources, a broad spectrum of forest and rangeland related outdoor recreation opportunities shall be provided". Thus, the Coronado National Forest is mandated to provide recreational opportunities for the public, but must temper recreational needs with other uses of public lands. The mission at Fort Huachuca is focused on intelligence and communications systems testing and training, but the Army provides recreational opportunities on their lands where such activities do not conflict with their mission. Recreation has a potential to adversely affect the recovery potential of the salamander, because the public uses some of the ponds as fishing holes, and off-road vehicle enthusiasts have been known to drive through ponds or drive on the edge of ponds, using them as challenging mud bogs. Fishing can result in the introduction of fish or non-native salamanders, or illegal capture and transport of Sonora tiger salamanders, with subsequent deleterious effects described in the Recovery Plan. Off-road vehicles can destroy salamander eggs and possibly salamanders, raise turbidity levels in the ponds, and possibly damage berms or water control structures.

Most of the Team's discussions centered around management of cattle ponds, and how various management alternatives might be applied to maximize benefits to both the salamander and ranching operations. This also included discussion of recreational activities, which the Team generally agreed needed to be controlled at ponds, both from the perspective of salamander recovery and to reduce vandalism of fences and other range improvements.

The Recovery Plan recommends various actions to protect and enhance habitats at and in the watersheds of cattle ponds (Task 1), to control the effects of non-native predators at cattle ponds (Task 2), and control introduction, transport, and collection of tiger salamanders in the SRV (Task 3). These tasks could affect social and economic values in the SRV, depending on how they are implemented. In many cases, the Recovery Plan does not specify how to implement these tasks, although subtasks provide some general guidance. In the following section, we discuss these tasks and subtasks, and provide details for how they might be funded and implemented on the ground in a manner that minimizes potential social and economic impacts, while providing for the recovery of the Sonora tiger salamander. Other tasks recommended in the Recovery Plan (create and enforce policies to minimize frequency of die-offs, monitoring of salamander populations and their habitat, and research) have much less potential to affect social or economic values so long as private property rights are considered and respected during implementation.

Federal agencies are required to use their authorities to carry out programs for the conservation of threatened and endangered species [section 7(a)(1) of the Endangered Species Act]. AGFD and ASPB have similar mandates to conserve species and natural resources. Thus, the burden of recovering the Sonora tiger salamander should fall to Federal and State agencies. Private landowners should be encouraged to participate in the recovery effort, and Federal and State assistance programs should be made available to assist landowners in Recovery Plan implementation.

IV. ***Recovery Task Implementation***

1. Protect and Enhance Habitat

1.1 Develop guidelines for watershed use and maintenance. The Recovery Plan recommends that "land use activities in watersheds and upland habitats should not pollute, lead to excessive sediment deposition, or prevent water from entering ponds. Also, upland habitat should remain vegetated to facilitate salamander dispersal and survival outside ponds." Grazing in accordance with Coronado National Forest standards and guidelines should provide adequate protection of watershed values in regard to potential grazing impacts. Mining, road construction, and other construction or development activities in the watersheds of ponds should not be permitted or should be designed so watershed values and flows into ponds are maintained, and pollution of ponds or excessive sedimentation of ponds does not result.

1.2 Implement watershed use and maintenance guidelines. Most lands upstream of ponds are managed by the Coronado National Forest, thus, the Forest will be primarily responsible for implementing this task. However, ASPB and Fort Huachuca should also implement the guidelines on their lands.

1.3 Implement guidelines for cattle pond use and maintenance. Guidelines for maintaining cattle ponds in a manner that minimizes impacts to the salamander, but is compatible with livestock operations, were developed by the USFWS and the Coronado National Forest. These guidelines, included herein as Attachment 2, should be followed during maintenance activities. Under ESA section 7 consultations, the Coronado National Forest is responsible for ensuring that the guidelines are followed on Forest lands; however, permittees typically conduct and fund maintenance activities. Maintenance activities are carried out by permittees as part of their livestock operations. If maintenance is not needed for livestock operations, but is conducted only to support salamander populations, that maintenance should not be the responsibility of the permittee. In these cases, maintenance should be conducted or funded by the Forest, the USFWS, or another management entity.

Under the guidelines, the Forest is responsible for determining presence/absence of salamanders, seining and holding of salamanders as needed, monitoring of "take" of salamanders, and reporting to the USFWS. These guidelines are also recommended for use on Fort Huachuca and private lands where salamanders occur. The section 7 biological opinions provide an exemption from the section 9 take prohibitions if the guidelines are applied voluntarily on private lands within Forest allotments. If applied on private lands, a private landowner could enter into an agreement with a permitted consultant, AGFD, the Coronado National Forest, or the USFWS to conduct presence/absence surveys, seining, and holding of salamanders. The agencies should be prepared to provide this service at no cost to the landowner.

1.4. Develop cleaning and maintenance program for cattle ponds. A pond cleaning and maintenance program should include annual work plans as well as long-term goals for continued maintenance. These programs will need to be developed in close coordination with livestock operators to ensure consistency with ranching operations. As discussed in 1.6., if pond maintenance is solely for the recovery of the salamander, the livestock operator should not be held responsible for funding that maintenance.

1.5. Enforce cattle pond and watershed use and maintenance guidelines. The Coronado National Forest, through its NEPA and permitting processes, will be primarily responsible for ensuring that cattle pond and watershed guidelines are carried out. Private landowners are encouraged to adopt these guidelines, as well. Various programs, discussed in Part V, herein, are available to assist private landowners in recovery task implementation.

1.6 Enhance bank-line and aquatic vegetation. Implementation of this task should be on a case-by-case basis, and will depend on the nature of the site, including existing cover, opportunities for trick tanks or double tanks, effects on livestock operations, availability of funding, and other considerations. An inventory of existing ponds within the range of the salamander should be made with the objective of identifying sites where bankline cover could be efficiently increased with minimal impacts or benefits to livestock operations. Private landowners and permittees should be encouraged to pursue enhancement of bankline cover, but Federal and State agencies should provide most of the support for these projects. Increased bank-line cover could be realized by complete or

partial fencing of cattle ponds. However, complete fencing would require installation of a trough for watering cattle. Troughs entail excessive maintenance, and if a valve malfunctions, several years worth of stored water can be lost. Partial fencing of ponds would allow vegetation to develop on the fenced portion of the pond and would provide access for cattle. But fencing strung through ponds corrodes very rapidly in the SRV (~4 years). The best option for increasing bank-line and aquatic vegetation is construction of double tanks or "trick tanks", described below.

Double Tanks or Trick Tanks: Ponds are sometimes constructed in pairs, with one pond immediately upstream of the other. In these cases, the upper pond acts as a silt trap. Where double tanks or ponds occur, one of the ponds could be fenced while leaving the other accessible to livestock. A second pond could also be constructed in some instances where only one pond currently exists. This option has the advantage of increasing the quality and quantity of potential salamander habitat, providing an opportunity to research the value of fenced versus unfenced ponds. It would also benefit livestock operations by providing a silt trap and longer life of the downstream pond. Bob Hudson of the Vaca Ranch has volunteered a pond on his ranch (lower Antelope Tank) as a site to experiment with use of double tanks.

1.7. Control pH, if necessary. The need for this task would be clarified after more research to determine the degree to which low pH occurs and whether or how it is correlated with salamander die-offs. If acidic conditions are a problem, this action is probably best addressed by eliminating the source of the low pH. However, this may not be possible or feasible (*i.e.* if low pH is a result of natural processes, or caused by atmospheric emissions from copper smelters in Mexico). Treatment with calcium carbonate, as suggested in the Recovery Plan, or other measures that would not adversely affect salamander breeding habitat or the value of the ponds as water sources for cattle, may be prudent to counteract low pH levels. Implementation of these measures should be the responsibility of the landowner/manager. Private landowners are encouraged to work with State and Federal biologists to correct low pH in their ponds. As discussed in Part V, Federal and State assistance programs could be made available to help private landowners address this problem.

1.8. Develop cooperative agreements with private land owners to protect habitats. This action is an extension of previous actions that involve Federal and State cooperation and assistance to private landowners. See Part V for further information on government assistance programs.

1.9. Build more ponds, if needed. The need for this task would be clarified after completion of a PVA (task 6.1.6). Construction of new ponds would need to take into account numbers and distribution of breeding sites needed for viable populations of salamanders, whether new ponds may facilitate dispersal of non-native organisms, and how new ponds would affect livestock operations. In general, new ponds have the potential for benefitting livestock operations through better distribution of livestock. But new ponds may not be justified from the perspective of cattle operations alone. Because maintenance of ponds on Forest allotments is generally the responsibility of the permittee, the cost of maintenance should not be greater than potential benefits to a livestock operation, or if ponds are built solely for salamanders, construction and maintenance costs should be the responsibility of the management agency. In either case, construction of new ponds on Forest lands

should be closely coordinated with the permittee. Construction of new ponds may not be a viable option unless water rights issues and other legal concerns can be resolved.

1.10. Develop self-sustaining cienegas as salamander habitat. This task could most efficiently be implemented by restoring more natural cienega conditions to former cienegas that have been altered by impoundments, diversions, channel incisement, and other habitat alteration. Examples of such sites include springs in upper Scotia Canyon, (new) Bog Hole Reservoir, and possible sites on the former San Rafael Cattle Ranch (now owned by ASPB and a private party). The upper Scotia Canyon site is currently owned by the Lone Mountain Ranch, but is expected to be exchanged to the Coronado National Forest in 2002. Elimination of bullfrogs, re-routing or closure of the road through the canyon, followed by rehabilitation of eroded portions of the road, and restoration of the several impoundments to more natural cienega conditions could provide excellent habitat for the Sonora tiger salamander and other sensitive species, such as Huachuca water umbel, Huachuca springsnail, Mexican garter snake, and leopard frogs (*Rana chiricahuensis* or *R. subaquavocalis*). Restoration plans and funding are in place for Bog Hole (a cooperative AGFD, Forest Service, and USFWS effort), which includes removal of non-native fish and reintroduction of native fishes. The project could also include reintroduction of Sonora tiger salamanders. On the former San Rafael Cattle Ranch, restoration of Heron Springs or other sites may be possible. Funding for these activities should be the responsibility of land managers and State and Federal wildlife agencies.

2. Control non-native predators (fish, bullfrogs, and crayfish).

2.1. Explore with AGFD opportunities and mechanisms to minimize or eliminate introduction of crayfish. Use of live crayfish as bait is currently legal in the SRV and other areas of Arizona, although they must be used at the place of capture. The Team and FWS will work with AGFD to step up public outreach about current regulations and to aggressively enforce current regulations. The Team also believes AGFD should be encouraged to develop rules prohibiting possession of crayfish or their use as live bait within the range of the Sonora tiger salamander. Anglers, other recreationists, and other publics would have the opportunity to comment through the rule making process.

2.2. Enforce policies preventing introduction of non-native predators to SRV ponds. Arizona Game and Fish Commission Order 40 prohibits the transport and use of live bait fish within the range of the Sonora tiger salamander. Transport and release of live bullfrogs is prohibited by Commission Order 41. Allowing fishing encourages illegal stocking of game and bait fish, crayfish, and barred salamanders. A risk assessment should be conducted to identify cattle ponds in which populations of salamanders are most at risk from introduction of non-native predators by anglers. The Coronado National Forest and USFWS should develop a proposal to AGFD to cooperatively pursue posting these high risk cattle ponds as “No Fishing”. If approved by the Commission, posted portions of the Coronado National Forest would be added to the list of closed fishing areas in Commission Order 40. Fort Huachuca, which controls on-post access for taking aquatic wildlife, should also post high risk ponds as “No Fishing”. USFWS and Coronado National Forest have developed protocols for avoiding or minimizing introduction of non-native predators during fire suppression activities (U.S.

Fish and Wildlife Service 1997b). These protocols should be followed throughout the range of the salamander.

2.3. Remove fish, crayfish, and bullfrog populations from SRV ponds. Methods to implement this task include allowing a pond to dry out, seining, gigging of bullfrogs, or using chemicals to kill non-native fish. If chemicals are used, cattle should not be allowed to water at the pond until the chemicals and their carriers have dispersed, or treatment should occur when cattle are using another pasture. Elimination of fish needs to be approved by AGFD, and if it occurs on Federal lands, the Federal land manager will need to complete an environmental review, including a NEPA process, and possibly public involvement. Appropriate State and County regulations will also need to be followed. Some ponds that support fish are used by the public as fishing holes. Anglers that use these sites should be informed and allowed to have input into any decisions to control non-native fish.

3. Control introduction, transport, and collection of tiger salamanders in the SRV.

3.1. Enforce policies preventing introduction, transport, and collection of tiger salamanders in SRV. The efficiency of existing law enforcement authorities could perhaps be increased by cooperative efforts and better awareness by law enforcement officials of existing regulations concerning bait fish, and collection, transport, and release of live bullfrogs and salamanders. A coordination meeting among law enforcement agencies and officials from the Forest Service, Fort Huachuca, AGFD, USFWS, ASPB, and the Border Patrol should be organized to find ways to better facilitate detection and enforcement of illegal wildlife activities, including those relevant to Sonora tiger salamanders. A Memorandum of Understanding may be appropriate among agencies to define agency roles and procedures in cases of suspected illegal activities.

Ranchers and landowners are potentially the most important presence in the SRV to notice suspected illegal activities, such as illegal collection, transport, or release of salamanders, crayfish, and fish, and use of live fish or salamanders as bait. The AGFD's Operation Game Thief allows ranchers and others to call 1-800-352-0700, toll free, to report potentially illegal activities. AGFD's toll free Operation Vandals (1-800-VANDALS or 1-800-826-3257) responds to reports of wildlife or habitat vandalism.

3.2. Remove non-native tiger salamander populations from SRV ponds. Elimination of non-native salamander populations should be accomplished with chemicals or seining while larval and branchiate salamanders are present. If the pond is allowed to dry, many salamanders will metamorphose and return to breed the next year. Because an unknown portion of the population of any one pond includes terrestrial metamorphs, repeated visits in subsequent years will likely be necessary to ensure the population is eliminated. If chemicals are used, cattle should not be allowed to water at the pond until the chemicals and their carriers have dispersed, or treatment should occur when cattle are using another pasture. Elimination of salamanders needs to be approved by AGFD, and if it occurs on Federal lands, the Federal land manager will need to complete an environmental review, including a NEPA process, and possibly public involvement.

V. *State and Federal Programs to Assist Land Owners and Managers in Recovery Plan Implementation*

Implementation of recovery tasks will, in some cases, require considerable funds and resources. A variety of programs are available to fund these tasks. Programs are typically targeted for specific types of projects, and may be limited to certain categories of applicants (i.e. private party or government agency). Included here is a list of programs that may be useful in implementing the Sonora tiger salamander recovery plan. It is not an exhaustive list, but is meant to provide some guidance to land owners and managers on available funding sources. In addition to these government programs, private foundations and individuals offer grants that could be used to fund recovery tasks. An annual directory, entitled "Environmental Grantmaking Foundations" contains information about 800 foundations. It is available from the Resources for Global Sustainability, Inc., P.O. Box 3665, Cary, NC 27519-3665 (phone: 800-724-1857, rgs@environmentalgrants.com).

1. USFWS Programs:

A. **Endangered Species Act Section 6 Funds**: These are funds provided to AGFD to implement recovery actions, survey and monitor of sensitive species, candidate assessment, and other related actions. Recent initiatives have provided additional funding to AGFD for habitat conservation planning and agreements. Safe Harbor Agreements provide an exemption from the take prohibitions in the ESA if a private land owner voluntarily develops habitat or allows habitat to develop for threatened or endangered species. Habitat Conservation Planning Grants are grants administered by AGFD to assist non-Federal land owners and managers who wish to voluntarily develop and implement habitat conservation plans, which are part of the application package for a permit from USFWS to take listed species incidental to other activities. The funds may be used on private, State, or Federal lands.

B. **Partners for Fish and Wildlife**: This program provides technical and financial assistance to willing private landowners who want to improve fish and wildlife habitat on their property. The program is open to private individuals, tribes, counties, and State government. Contact Marty Jakle, USFWS, Phoenix (602/640-2720, marty_jakle@fws.gov)

C. **North American Wetlands Conservation Act**: Designed primarily to implement the North American Waterfowl Management Plan, but may have some application for Sonora tiger salamanders. Proposals are 4-year plans of action supported by an Act grant and partner funds to conserve wetlands and wetland-dependent fish and wildlife through acquisition (including easements), enhancement, restoration, and other eligible activities. Grants may be used to enhance or restore habitats on private, State, or Federal lands. A 1:1 non-Federal match is required. Contact Coordinator, North American Wetlands Conservation Council, USFWS, 4401 North Fairfax Drive, Room 110, Arlington, Virginia 22203 (703/358-1784, fax: 703/358-2282). Electronic mail address is r9arw_nawwo@mail.fws.gov; the internet address is http://www.fws.gov/rpnawwo/nawcahp.html.

2. Natural Resource Conservation Service Programs:

A. **Conservation Reserve Program**: A voluntary program that offers annual rental payments and cost-share assistance to establish long-term resource conservation. The program provides up to 50 percent of participant costs to establish target management practices on private lands. Could be used to help establish riparian buffers and cienegas on private lands. Contact Frank Toupal, NRCS, Tucson (520/670-6602, ext. 226).

B. **Wildlife Habitat Incentives Program (WHIP)**: Provides technical assistance and cost-share (up to 75 percent) to help establish and improve fish and wildlife habitat, primarily on private lands. Contact Frank Toupal, NRCS, Tucson (520/670-6602, ext. 226).

C. **Wetlands Reserve Program**: A program that can be used to cost-share (NRCS pays up to 75 percent) restoration of privately-owned wetlands or former wetlands on rangelands or farmlands. Contact Frank Toupal, NRCS, Tucson (520/670-6602, ext. 226).

3. AGFD Programs:

A. **Stewardship Program**: Provides technical management assistance, including use of heavy equipment, materials, and labor; or reimbursement of materials and labor, to enhance wildlife habitat and populations. Projects can occur on private or public lands. Contact AGFD's Stewardship Program Coordinator, Tucson (520/628-5376).

4. U.S. Forest Service Programs:

A. **Bring Back the Natives**: This initiative is a national effort by the Department of Interior's Bureau of Land Management and Department of Agriculture's Forest Service in cooperation with the National Fish and Wildlife Foundation to restore health of entire riverine and aquatic systems and their native species. In turn, national, State, and local partners make their own matching contributions to accomplish improved habitat and water quality. Three programs are available through the Forest Service: 1) *Rise to the Future* is a program to enhance fisheries and aquatic resources, 2) *Every Species Counts* conserves sensitive flora and fauna, and helps recover endangered species, and 3) *Get Wild* targets protection and improvement of riparian and wetland habitats and associated species. Forest Service funds must be matched with labor and materials. Contact Tom Deecken, Coronado National Forest, Sierra Vista Ranger District, 5990 S. Highway 92, Hereford, Arizona, 85615, (520/378-0311). Bring Back the Natives funds can also be obtained through the National Fish and Wildlife Foundation (see below).

5. National Fish and Wildlife Foundation:

Challenge Grants: Proposals are funded for habitat protection and restoration, species conservation and applied conservation, applied research and policy development, education, and training for natural resource professionals. Requires a 1:1 non-Federal match in the form of funds, contributed goods and service, or lands. Projects can occur on private or public lands, and invasive exotic species management is an area of emphasis for the Foundation's wildlife and habitat grants. Contact National Fish and Wildlife Foundation, 1120 Connecticut Ave NW, Suite 900, Washington, D.C., 20036 (202/857-0162, projects@nfwf.org).

6. Arizona Department of Water Resources

Arizona Water Protection Fund. The purpose of the fund is to protect water of sufficient quality and quantity to maintain, enhance, and restore rivers and associated riparian habitats, including fish and wildlife dependent on those habitats. In fiscal year 1998, approximately $5,000,000 was available. Contact Ms. Irmalisa Horton, Arizona Department of Water Resources, 500 North Third Street, Phoenix, Arizona 85004, (602/417-2460).

VI. Conclusion

The Recovery Plan, especially the Implementation Schedule, as discussed above, presents a wide array of activities, significant expenditure of funds, and long-term commitments by participating individuals and organizations. For downlisting and eventual removal of the Sonora tiger salamander from the endangered species list to occur, these actions must achieve on-the-ground results. They must also be realistic and flexible. Cost for the most part will be borne by the State and Federal wildlife management agencies and public land managing agencies of the SRV in conjunction with willing private land cooperators. Private property rights will be respected. On public lands, activities shown in the Implementation Schedule must also complement the social and economic setting of the Valley, while achieving the needed biological results. Cooperation among all interested parties must be stressed at all times. While the Recovery Plan focuses on the Sonora tiger salamander, it should be an integral component of the many efforts in the SRV that maintain the health of both its human residents and the array of wildlife and plants living there. For the Recovery Plan to work, a cooperative effort among the many private and public interests in the SRV that considers the diverse values and uses of the area must be forged and maintained.

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Attachment 1: **Sonora Tiger Salamander Participation Team**

Bud and Carol Bercich
San Rafael Valley, Arizona

Matt Chew
Arizona State Parks
Phoenix, Arizona

Tom Deecken
Sierra Vista Ranger District
Coronado National Forest
Hereford, Arizona

Glen Goodwin
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Earl and Georgie Hardy
Patagonia, Arizona

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Sonny and Nancy McCuistion
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George Michael
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City of Sierra Vista
Sierra Vista, Arizona

Jim and Ann Patton
Lone Mountain Ranch
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Tim Snow, Mike Pruss[1]
Arizona Game and Fish Department
Tucson, Arizona

Peter Robbins
Little Outfit Ranch
San Rafael Valley, Arizona

Roy Averill-Murray, Mike Sredl[1]
Nongame Branch
Arizona Game and Fish Department
Phoenix, Arizona

Emily Stevens
Patagonia, Arizona

Sheridan Stone (Team Chairperson)
Fort Huachuca Wildlife Office
Fort Huachuca, Arizona

Kieran Suckling, Executive Director
Southwest Center for Biological Diversity
Tucson, Arizona

Peter Warren
The Nature Conservancy, Arizona Chapter
Tucson, Arizona

US Fish and Wildlife Service Liason (not a voting member):

Jim Rorabaugh (compiles meetings notes which are edited and approved by Chairperson)
US Fish and Wildlife Service
Phoenix, Arizona

Recovery Plan Preparation Team (not Participation Team members)

Dr. James P. Collins
Jon Snyder
Department of Zoology
Arizona State University
Tempe, Arizona

[1] Tim Snow and Roy Averill-Murray are the current AGFD Participation Team representatives.

Not Team members, but requested to remain on the mailing list for meeting notes:

Al Anderson, Conservation Chair
Huachuca Audubon Society
Sierra Vista, Arizona

Edwin and Elke Grose
Patagonia, Arizona

John Hendrickson
Tucson, Arizona

Steve and Byrd Lindsey
Elgin, Arizona

Ozzie Rodriguez
Patagonia, Arizona

Frank Toupal, Wildlife Biologist
Natural Resources Conservation Service
Tucson, Arizona

Attachment 2

STOCKPOND MANAGEMENT AND MAINTENANCE PLAN
for the
SONORA TIGER SALAMANDER
in the
SAN RAFAEL VALLEY
and
SURROUNDING AREAS

Coronado National Forest
Sierra Vista Ranger District

The Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*) was listed as endangered in 1997. It has been recorded from at least 40 sites in the San Rafael Valley, in nearby Mexico, and in 3 other watersheds on the periphery of the San Rafael Valley. All but 4 of these records are from stock ponds maintained for livestock.

Stock ponds provide needed water for livestock and wildlife in the upper San Pedro and Santa Cruz watersheds. These waters are very important sites for breeding activities and year-long occupancy of the Sonora tiger salamander. Cleaning out these tanks on a periodic basis is necessary for continued access to water for wildlife and livestock. However, maintenance and other uses of these waters could impact the salamander negatively, as well as benefit it.

The following guidelines for management and maintenance of stock ponds on National Forest lands in Sonora tiger salamander habitat incorporate terms and conditions of a biological opinion on Forest Plans, as amended (U.S. Fish and Wildlife Service 1998).

1. Personnel education programs, minimization of project impacts, and well defined operational procedures (including pre-project surveys for salamanders) shall be implemented.

   a. Livestock permittees within the range of the species shall be informed yearly that:

      (1) Take of salamanders is prohibited under the Endangered Species Act;

      (2) Permittees are required to notify the Forest at least 30 days prior to initiating maintenance, dredging, or cleaning out of stock tanks; and

      (3) If permittees comply with the guidelines contained in this pond management and maintenance plan, they will be covered by the incidental take statement for actions on any lands within their Forest allotments, including private, state, forest, or other lands.

   b. The Forest shall insure that:

      (1) Prior to any surface-disturbing activities at stock tanks on National Forest land within the range of the Sonora tiger salamander, the presence/absence of the salamander shall be determined by a qualified biologist approved by the Forest. If salamanders are not encountered during seining of the pond, the salamander will be considered absent. If salamanders are observed in the water or can be captured with a dip net, seining is not necessary.

(2) Individuals authorized by the Forest to maintain, dredge, or clean out stock tanks occupied by Sonora tiger salamanders shall be informed of the legal and sensitive status of the species and shall have a copy of these guidelines.

(3) New surface disturbances and clearing of vegetation during work at stock tanks shall be minimized to the extent practical.

(4) Maintenance, dredging, and cleaning of occupied stock tanks shall not occur from January 1 through May 31.

(5) Oil, fuel, and other equipment fluid shall be stored away from occupied stock tanks in secure containers. Any leaks shall be cleaned up and properly disposed of as soon as they occur.

(6) If salamanders or larvae are present prior to dredging or cleaning out of stock tanks and a qualified biologist believes seining of salamanders and larvae out of the tank would reduce mortality and injury, then the tank shall be seined and animals held in suitable tanks, aquaria, or holding ponds and returned to the tank after construction is complete if, in the judgement of the qualified biologist, the tank contains enough water to support the salamanders.

(7) During maintenance activities, the amount of underwater objects (logs, rocks, etc.) for salamander cover and egg deposition shall be maintained or increased.

(8) Vegetation cover at tanks occupied by salamanders shall be retained or increased through (but not limited to) the use of partial fencing, construction of water lots, double tanks, or alternative waters such as wells and pipelines.

(9) Except as needed in emergency situations to abate immediate fire threat of loss of life or property, no water shall be drafted from stock tanks known to be occupied by Sonora tiger salamanders. Other water sources, such as Parker Lake, wells, and water tenders shall be considered before drafting water from occupied stock tanks.

(10) In non-emergency situations, water shall be drafted from stock tanks within the range of the salamander only if other sources of water are not available or reasonably accessible, and only if the tanks are not occupied by salamanders, pursuant to guideline 2. b.

(11) An objective of fire suppression activities shall be protection of occupied Sonora tiger salamander habitat, including the watersheds of those habitats.

(12) All occupied tanks and apparently suitable tanks (free of non-native predators) within the range of the Sonora tiger salamander shall be retained in public ownership.

2. Actions shall be taken to ensure that the spread of neither non-native predators nor disease is facilitated by project activities.

a. If water is drafted from a stock tank within the range of the salamander, it shall not be refilled with water from another tank, Parker Lake, or other sources of water that may support fish, salamanders, or bullfrogs.

b. As opportunities arise, the Forest shall work with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service in the development of interpretive materials for users of the Forest that

includes information about legal protection of the salamander and prohibitions on use of live baitfish, crayfish, and waterdogs, and transport of live bullfrogs in the San Rafael Valley.

3. The Forest shall monitor incidental take resulting from the proposed projects and report to the U.S. Fish and Wildlife Service the findings of that monitoring.

   a. The Forest shall submit annual monitoring reports to the Arizona Ecological Services Field Office by December 31 of each year beginning in 1997. These reports shall briefly document for the current calendar year the effectiveness of salamander mitigation measures, activities that occurred in the calendar year that were subject to these terms and conditions, the numbers and locations of salamanders encountered, general conditions of salamanders, and the number of salamanders, larvae, and eggs taken. The report shall make recommendations for modifying or refining these terms and conditions to enhance Sonora tiger salamander protection and reduce needless hardship on the Forest, and its contractors and permittees.

The anticipated take associated with the drafting of water from stock tanks for fire suppression, stock tank maintenance, trampling by cattle, and pre-project surveys is:

1. A total of 20 salamanders, eggs, and larvae per year in the form of direct mortality or injury resulting from drafting water from stock tanks for fire suppression.

2. A total of 20 salamanders and larvae per year in the form of direct mortality or injury resulting from stock pond maintenance.

3. A total of 10 salamanders, eggs, and larvae per year resulting from trampling by cattle.

4. A total of 100 salamanders and larvae per year in the form of harassment as animals are temporarily moved from harm's way during stock tank maintenance.

5. A total of 200 salamanders and larvae per year in the form of harassment during pre-project surveys of tanks to determine presence/absence of salamanders.

Appendix B: Public and Peer Reviews

The availability of the draft recovery plan for public review was advertised in the Federal Register on June 16, 2000. A memorandum announcing the availability of the draft plan was sent to 78 private and public persons, organizations, and agencies on June 19, 2000. The draft plan was made available on USFWS's Phoenix Field Office's website, and hard copies of the plan were mailed to anyone requesting one. Independent peer review was also solicited from two herpetologists that are familiar with tiger salamander conservation and recovery planning. The Service accepted public and peer comments through August 15, 2000. Three comment letters were received, all of which are reproduced herein. Comment letters were received from the two peer reviewers (Dr. Cecil Schwalbe, Research Ecologist, U.S. Geological Survey, Western Ecological Research Center, Sonoran Desert Field Station, University of Arizona, Tucson, Arizona; and Samuel Sweet, Associate Professor, Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, California), and from Duane Shroufe, Director, Arizona Game and Fish Department, Phoenix, Arizona.

The Participation Team met on October 19, 2000, to review the comment letters and revise the recovery plan as needed in response to those comments. Discrete comments are identified in each letter and numbered by comment letter and comment number. Because not all members of the Participation Team were able to meet and discuss comments, a draft final plan that included comments and responses to comments was distributed for final review by Team members in May 2001. Comments received by the Team were incorporated into a revised final draft and sent to the Team for a final review in November 2001. Additional minor revisions were made in response to Team comments on the November 2001 draft and are reflected herein.

Comment Letter #1

United States Department of the Interior

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

U.S. GEOLOGICAL SURVEY
Western Ecological Research Center
Sonoran Desert Field Station
125 Biological Sciences East
University of Arizona
Tucson, Arizona 85721

August 15, 2000

Jim Rorabaugh
U.S. Fish and Wildlife Service
Ecological Services State Office
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Dear Mr. Rorabaugh:

Thank you for the opportunity to review the Sonora Tiger Salamander Recovery Plan Draft (April 2000). My review comments are enclosed.

The draft plan is well written and thorough. My comments are mostly minor, but I expanded in areas in which I had specific knowledge or expertise. I did not specifically mention it in the attached comments, but I agree with the draft plan that much research is needed before an acceptable population viability analysis can be made. Thus, delisting will have to wait until those requisite data can be collected and analyzed and all the delisting criteria can be met.

If you have any questions about my review, please contact me.

Sincerely,

Cecil R. Schwalbe, Ph.D.
Research Ecologist

Enc.: Review draft comments

Cc: Judd Howell, USGS WERC

Review of Sonora Tiger Salamander Recovery Plan Draft (April 2000)

Cecil R. Schwalbe, Ph.D.
U.S. Geological Survey, Western Ecological Research Center

August 14, 2000

Overall the draft recovery plan is a well-written, informative, and useful document. It is appropriate that Dr. James Collins and his student Jon Snyder drafted this plan, since Dr. Collins is recognized as the leading authority on *Ambystoma tigrinum* in the Southwest. With input provided by Jim Rorabaugh of the U.S. Fish and Wildlife Service and members of the Participation Team, the draft plan utilizes many of the people available with extensive knowledge of this taxon and its management.

The respective sections of the draft recovery plan are thorough. I have offered specific comments on sections as appropriate. One of the most important tasks in the recovery of the Sonora tiger salamander is Task 1.10, the development of three self-sustaining cienegas as salamander habitat (see additional comments below).

As mentioned several times in the draft plan and Appendix D, cooperation with private landowners and grazing permittees should be encouraged whenever possible. There are many parallels in trying to recover the Sonora tiger salamander and the Chiricahua leopard frog, which is currently proposed for listing as a threatened species. Managing cattle ponds to benefit Sonora tiger salamanders should also benefit Chiricahua leopard frogs (*Rana chiricahuensis*) in the San Rafael Valley (SRV), especially by ridding ponds of non-native aquatic predators.

Specific comments follow by page number.

1-1

Page 5, Distribution and Abundance section, third paragraph: It might be useful to some readers to clarify why we might expect to find salamanders with *mavortium*-like sequences close to Parker Canyon. Up to this point in the draft recovery plan, no mention has been made of the use of salamander larvae for fish bait. (See other comments under *Arizona State Regulations*, page 11).

1-2

Page 11, Arizona State Regulations: For the record, it would be useful to include in this section that the sale of waterdogs as bait at Parker Canyon Lake has been prohibited since the mid to late 1980s. This prohibition was an attempt by Arizona Game and Fish Department to protect the genetic integrity of the Sonora tiger salamander in the San Rafael Valley. I cannot remember the exact date when the sale was prohibited, but it should be in AGFD records. While working for AGFD, I recall having to conduct an analysis of the potential economic impact on waterdog vendors of prohibiting sale for use at Parker Canyon Lake. The economic impact was slight as I remember; fishermen at Parker Canyon Lake did not use many waterdogs.

Page 16, Narrative Outline for Recovery Actions 2.3 Remove fish, crayfish, and bullfrog populations from SRV ponds (see also page 41 in Appendix D): This is likely to be one of the more difficult recovery actions to accomplish, especially for crayfish and bullfrogs, because of their amphibious nature. Removing predators from ponds already containing Sonora tiger salamanders will be complicated. For ponds in the SRV not containing Sonora tiger salamanders, some methods we have developed for removing bullfrogs could be applicable.

1-3

Phil Rosen and I are in the second year of a 4-year effort to conserve the Chiricahua leopard frog at Buenos Aires National Wildlife Refuge in the Altar Valley, Arizona. The initial part of that project entails surveying for and removing bullfrogs and non-native fishes from former cattle ponds on the refuge. Some of the research includes developing effective methods of removing predators and establishing new populations of leopard frogs. We have found that fish are easiest of the introduced predators to remove, either by poisoning or drying the ponds. In most cases we have had to use a combination of techniques to eliminate bullfrogs, including manually removing the frogs (hand capture, spearing, netting, trapping, or shooting), drying the ponds (using seasonal drought combined with pumping the tanks dry), or poisoning the tadpoles and frogs.

In several cases we have had to temporarily use hardware-cloth fencing (with eaves to prevent the frogs from climbing out) to contain the frogs while we caught, shot, or poisoned them). The fencing has effectively allowed us to contain the bullfrogs in the stock tank while pumping the water into the adjacent sediment trap (or into aboveground storage tanks for wildlife and livestock), thus creating a new pond immediately for use by wildlife (including breeding by native anurans). This removal of bullfrogs or crayfish will be more easily accomplished in ponds in pastures that are in restoration. A similar system is discussed under "Double Tanks or Trick Tanks" on page 39. Such a system (now augmented by a new well and a concrete leopard frog pond and aboveground metal cattle tank) is currently being used in the conservation of the Chiricahua leopard frog on the Magoffin Ranch in Cochise County.

This year we measured the efficacy of last year's bullfrog removal efforts and will submit that information for publication this winter. We have also used exclosure fences to successfully keep bullfrogs out of Chiricahua leopard frog breeding sites, but that is difficult to do on a long term basis. This year a student, Dennis Suhre, has been marking bullfrogs and we have measured dispersal as great as two miles up and down drainage and at least 0.75 miles across drainages for individual frogs.

1-4

Page 18, 6.1.4: Acquire information on dispersal patterns through mark/recapture and radiotelemetry: The information provided by the microsatellite DNA analysis may also provide information about dispersal distances and potential barriers to gene flow.

1-5 Page 20, Anderson 1961 citation: change "rosacum" to "rosaceum".

1-6 Page 20, Brattstrom 1955 citation: change "29" to "**29**" to be consistent with other journal volume numbers.

1-7 Page 20, Collins 1979 citation: change "Copeia **1979**" to "Journal of Herpetology **13**"

1-8 Page 22, Reed 1951 citation: change "Miscelannea" to "Miscellanea".

1-9 Page 27, Implementation Schedule 3.2: The initial cost of removing introduced predators may be underestimated by a factor of 2 or 3, depending on how many ponds have to be rid of bullfrogs or crayfish. I estimate it cost us approximately $15K to remove bullfrogs from 3 large, perennial stock tanks last year at Buenos Aires National Wildlife Refuge. That cost entailed fencing, pumping, seining endangered fish out of one of the ponds before we could finish drying it, then poisoning the last 5,000 gallons or so of water with swimming pool chlorine to kill the last bullfrog tadpoles and cause the last few, very wary bullfrogs to bolt from the drying pond.

Poisoning the pond would not have been necessary if there had been time to completely dry out the pond before the onset of the summer rains. However, we believe that poisoning might often be necessary to kill amphibious pests such as crayfish and bullfrogs and their tadpoles, which might survive in damp earth until it rains again. Antimycin might be useful also in killing bullfrogs and crayfish, since those animals do not sense that toxin; both bullfrogs and crayfish crawl out of waters poisoned with rotenone.

1-10 The cost for removing aquatic predators should decrease in subsequent years as the major source ponds of the predators are eliminated. However, an intensive monitoring (surveillance) program is necessary to detect and eliminate immigrant predators before they can reproduce and re-establish populations.

1-11 Page 40, section 1.10. Develop three self-sustaining cienegas as salamander habitat. I thoroughly support this task. Restoring valley-bottom perennial wetlands is the only way populations of Sonora tiger salamanders (or Chiricahua leopard frogs) will become self-sustaining. If the introduced aquatic predators present in most of these valley-bottom wetlands cannot be eliminated or controlled, we will be locked into intensive management of the affected species forever. In the past, these perennial wetlands provided refugia for aquatic species during periods of drought. Now, when these native species are forced to retreat to those wetlands, they face potentially severe predation, sometimes almost certain extirpation.

Comment Letter #2

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
2221 WEST GREENWAY ROAD, PHOENIX, AZ 85023-4399
(602) 942-3000 • WWW.AZGFD.COM

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DIRECTOR
DUANE L. SHROUFE
DEPUTY DIRECTOR
STEVE K. FERRELL

August 15, 2000

David L. Harlow
Field Supervisor
U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Dear Mr. Harlow,

Thank you for the opportunity to review and comment on the draft Recovery Plan for the Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*). The Arizona Game and Fish Department (Department) commends the participation team and others involved, in the preparation of this document. We are especially appreciative of the efforts of Jim Rorabaugh, for organizing and coordinating this complex process to completion.

Department staff from the Nongame Branch and our Tucson Regional office have been active participants throughout the planning process, thus we have relatively few comments on the draft plan. We are supportive of the recovery plan, and respectfully offer the following comments to help the U.S. Fish and Wildlife Service (Service) produce an equitable and effective plan.

Page 12, Section II (Recovery): Downlisting Criteria

2-1

1) The draft plan states that " The Sonora tiger salamander will be considered for downlisting when both of the following criteria have been meet:". "Considered" should be deleted from this statement. If the criteria agreed upon by the participation team and the Service are met, then the salamander should be downlisted. Current wording could allow a Service biologist or others, to impede or circumvent downlisting due to personal preferences, despite the recommendations of the participation team. In essence, there should be no additional stipulations (no surprises), beyond those criteria originally negotiated by the participants in good faith. Downlisting criteria should only be modified with the consent of cooperating agencies and other participants.

2-2

2) The requirement of a 90% occupation rate, of currently occupied ponds, is arbitrary and biologically unsupported. An accurate percentage can only be determined after acquiring additional data (e.g. dispersal patterns, age structure, survivorship, natural population fluctuation trends, recruitment, proximity of nearby occupied ponds) and upon completion of a population viability analysis (PVA) or similar predictive model. We recommend noting in the recovery plan,

that this frequency is ephemeral, until better data is available. Only public lands should be considered in this percentage, as private lands are "private" and more complex to coordinate conservation management.

2-3 The Service should also produce a list of all currently occupied ponds, and include it in the recovery plan to provide participants and others with a mechanism to measure success. This list could be restricted in distribution, or specific localities assigned number codes to protect the sites from vandalism or illegal collection.

2-4 3) It is unlikely that all illegally stocked populations of fish, bullfrogs, and crayfish can be completely removed from ponds also inhabited by salamanders. We recommend the Service recognize the difficulties of complete eradication in the plan, and allow for a small percentage of infested ponds to exist. Cooperating agencies and other participants should collectively decide upon an acceptable percentage of "sacrificial" tanks, based on the best available information or a PVA.

2-5 4) When appropriate, the cooperating agencies and other participants should discuss and evaluate the monitoring results over any 5 year period, then decide whether the population trend throughout the species' range is stable. These same individuals should also help evaluate whether a "new factor" could potentially threaten the species and prevent downlisting.

Page 12, Section II (Recovery): Delisting Criteria

2-6 1) See comments in number 1 that also apply to delisting.

2-7 2) The delisting criteria listed, should be clear, achievable, and measurable; no generic descriptions. Without this level of detail, cooperating agencies and other participants will have difficulty in planning management activities, measuring success, and initiating delisting. Expending the effort to provide this level of detail now, will save precious time, money, and conflict in the future. Participants and affected individuals need to know precisely where the bar is set for delisting.

2-8 3) It is unnecessary, and in some cases impossible, to complete all the listed recovery actions before delisting can be achieved. We recommend re-evaluating the priorities, particularly the second and third level, and decide which are critical to achieve delisting. Those criteria should be clearly outlined in the delisting section. Many of the criteria referenced could be accomplished under a less restrictive, less costly, Conservation Agreement after delisting occurs.

2-9 4) Statement number 3 should be deleted as a criteria for downlisting. This statement is a "catch-all", "what-if" statement that allows subjective, non-data based opinions to influence decisions. If the recovery criteria are sound and clearly stated, this statement becomes unnecessary.

General comments

2-10 1) Self sustaining cienegas should only be developed, if supported by the outcome of the PVA (e.g. size, location) and necessary to support downlisting or delisting.

2-11 2) Survey results for populations of salamanders in Mexico should not negatively impact, or create additional criteria, for downlisting or delisting efforts in Arizona.

2-12 3) The pace and success of the recovery actions listed in the plan, will be largely dependent upon funding availability. We encourage the Service to aggressively seek funding for all the criteria outlined in the recovery plan.

2-13 4) Department representatives Mike Sredl and Mike Pruss, have been replaced by Mike Demlong (Amphibians and Reptiles Program Manager) and Tim Snow (Region V Nongame Specialist) as Department representatives.

We look forward to continuing our partnership with the Service in conserving sensitive species in Arizona. If you have any questions regarding these comments please contact Mike Demlong (602-789-3504).

Sincerely,

Duane L. Shroufe
Director

DLS:BDT:md

cc: Bruce D. Taubert, Wildlife Management Division Assistant Chief
Terry B. Johnson, Nongame Branch Chief
Gerry L. Perry, Region V, Supervisor

Comment Letter #3

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO

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SANTA BARBARA, CALIFORNIA 93106-9610

3 August 2000

Mr. Jim Rorabaugh
U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Re: AESO/ES *A.t.s.* RP

Dear Mr. Rorabaugh:

I have had the chance to review the draft Sonora Tiger Salamander Recovery Plan, and am providing my comments herein. As a general observation, the draft plan accurately highlights both what is known and what is not yet known about the population biology and ecology of this animal, and in my view succeeds in making interim recommendations for its management. I am less comfortable with proposing detailed recovery criteria at this stage, given the major holes in the picture, but I understand that the principle of adaptive management can be applied at least in theory. In my experience such flexibility tends to be far easier to promise in advance than to achieve once a recovery plan is approved.

3-1

I approached my evaluation from two perspectives: (a) experience here in California with the development and implementation of recovery plans for the arroyo toad and red-legged frog; and (b) lessons from the ongoing bitter saga of the emergency listing of the Santa Barbara County DPS of the California tiger salamander. I would be the first to say that I have no field experience with the Sonora tiger salamander, nor any independent appreciation of the complex political, social or economic factors that are undoubtedly involved. I do not subscribe to the view that "an expert is somebody from somewhere else", and ask your indulgence in advance should I misconstrue some biology or cause fainting spells among stakeholders.

With that disclaimer, I have two central comments. First, I am very surprised that there seems to have been no systemic attempt to define the potential range of *A. t. stebbinsi*, nor a preliminary analysis of the distribution of known and potential breeding sites. Perhaps this has been done, but if so, it really should be a core element of the recovery plan. Second, the extensive focus on breeding habitat, while obviously important, must not obscure the need for a hard look at management practices in upland areas used by metamorphosed salamanders.

3-2

3-3

3-4 On the first point, it would seem to be a simple matter to assess air photos of the entire San Rafael Valley to locate all potential breeding sites; are there 60, 100, 300? What fraction of the existing sites has been surveyed? If there are problems with introgression

3-5 from *A. t. nebulosum* and *A. t. mavortium*, where are the natural entry corridors, and where are introductions most likely to have occurred? Are there patterns in the

3-6 distribution of either known or potential breeding ponds that could inform management options? Using the subset of ponds that have been surveyed, can you develop a

3-7 preliminary model that has some predictive power and is thus testable? Lacking data of this sort, I do not see how a comprehensive recovery plan can be achieved. For one thing, you are in the dark about status; for another, the exercise of evaluating good, bad and indifferent breeding sites might tell you something you'd like to know.

I am aware that such work can be problematic; here in California we have landowners who consider review of topographic maps and air photos as trespassing. However, the core issues surely differ between states; in Arizona, stock ponds are assets essential to ranching, whereas they are liabilities in California as former ranching operations are bought up and converted to vineyards. Beyond the presumably shared distaste for "government snooping", we have significant section 9 problems here that I doubt are matched in Arizona. Sensitivities of private landowners aside, I do feel that some assessment of the potential range and potential number of breeding ponds inhabited by *A. t. stebbinsi* should be a component of the Recovery Plan.

My second point mimics an emerging issue in California: it is too easy to focus on the salamander breeding sites, do good things there, and go home satisfied while the animals go extinct. Beyond the obvious role of breeding ponds, the larger issue should also be

3-8 clear, that even minor decreases in the survivorship of mature salamanders can far outweigh the significance of variation in the survivorship of eggs or larvae. This is simply applied population biology. We know that natural variation in climate, episodic disease outbreaks, and "accidents" can significantly affect survivorship and recruitment in individual ponds, or regionally, on a year-to-year basis. Further, studies of transition probabilities are highly dependent on these factors, and a very considerable body of information may have to be collected before there is much confidence in population viability estimates, unless the answers are very bad. What we **can** say with some confidence from first principles is that survivorship patterns in metamorphosed animals, whether mature or immature, can have a disproportionate effect on viability. In-pond measures take on very different meanings if, for example, the average mature salamander breeds once in its lifetime vs. twice, etc.

3-9 The draft recovery plan is explicit in several places in acknowledging that little is known about terrestrial habitat requirements of *A. t. stebbinsi*, and is correct in calling for much more research on this topic. My hope is that the final plan will make this point even more forcefully.

It is clear that construction of stock tanks has at least compensated for loss of cienaga habitat, and very likely increased both the distribution and the numbers of *A. t. stebbinsi*.

3-10 However, the hard possibility remains that current grazing practices are directly or

indirectly having a negative effect on survivorship of metamorphosed tiger salamanders, whether by soil compaction and vegetation removal in the vicinity of breeding ponds, by alteration of plant communities regionally, or by trickledown effects on small mammal community structure, population densities, or the like. You simply don't know, beyond having the assurance that the animals have coexisted locally with livestock operations for something approaching two centuries. Unfortunately, this probably isn't enough under the ESA. Without knowledge of the age structure of the terrestrial component of the population no one can say if there are imminent problems or not.

Brad Shaffer and Peter Trenham's work on *A. californiense* illustrates this dilemma. It appears that very few females in their populations survive to breed twice, and as a direct result most of the breeding sites in their study area constitute sinks. This picture would change dramatically if the 'average' female lived 6 years and bred twice, as opposed to five years, breeding once. It is hard to reconcile the apparently miserable survivorship of adult *Ambystoma* in this study with a knowledge of the recurrence interval of long-term droughts in coastal California; if Shaffer and Trenham are correct, *Ambystoma californiense* should be extinct. I have no reason to question their analyses, and am very concerned that there is some factor as yet unknown which has dramatically reduced the survivorship probabilities of terrestrial tiger salamanders in the historic past. Put another way, we may have simply been lucky up to now that we've not had a **real** drought of the duration we know to be possible from dendrochronological evidence.

3-11

My recommendation is thus that the final plan include a discussion of this "invisible" component of the salamander's life history, structured so as to make the point that a focus on ponds alone can be illusory. To use a local datum, humans are more aquatic than are metamorphosed *A. californiense*, if you add up time in the shower vs. time in the breeding pond.

These are my chief concerns with the draft recovery plan. They are issues of focus, and should not be construed to detract from what is otherwise a very complete document. In particular, I commend the authors of the plan for foresight regarding such forehead-slappers as the use of occupied stock ponds as emergency fire reservoirs, and the various ways in which exotic predators and competitors may come to be in a pond. The protocol on decontamination of survey equipment is likewise an essential feature, and it should be written into any permits issued for work at these sites. Also, many of the practical recommendations contained in the plan are both relevant to management and feasible, and they are sufficiently detailed as to lead to realistic chances of implementation. Also, it is impressive that a stakeholder group has been brought into the recovery process, and that they have generated some specific and workable proposals. This is unique in my experience, and I am sure was a difficult process for all concerned.

3-12

To me, the Participation Team Plan looks to be the core of a formal Habitat Conservation Plan under which Incidental Take Permits could be issued for participating landowners; is this the goal?

Thank you for the opportunity to review this draft, and I hope that my criticisms will be regarded as constructive. I would be happy to remain in the loop as the plan is revised and implemented, as I forsee some overlap in challenges between this undertaking and the development of a comparable document for the California tiger salamander.

Sincerely,

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Appendix C: Response to Comments

Comments from reviewers were addressed as follows:

Comment Letter #1: Dr. Cecil Schwalbe, U.S. Geological Survey

Comment 1-1: The Distribution and Abundance section was revised as suggested.

Comment 1-2: The Plan was revised to note that sale of live waterdogs at Parker Canyon Lake is prohibited.

Comment 1-3: In part 2.3, the Plan was revised to note that methods for controlling non-native predators have been developed at Buenos Aires and San Bernardino National Wildlife Refuges. We included citations from this work.

Comment 1-4: We revised section 6.1.4 as requested.

Comment 1-5: We revised the citation as requested.

Comment 1-6: We revised the citation as requested.

Comment 1-7: We revised the citation as requested.

Comment 1-8: We revised the citation as requested.

Comment 1-9: We roughly estimated the number of ponds in the SRV that would need to be treated for non-native predator removal (22) and multiplied by $5,000. Costs in section 3.2 of the Implementation Schedule were revised, as requested, using this estimate.

Comment 1-10: We revised section 3.2 of the Implementation Schedule to reflect an initial extensive effort to remove non-native predators, followed up by a lesser effort in subsequent years.

Comment 1-11: No changes in the Plan needed in response to this comment

Comment Letter #2: Duane Shroufe, Arizona Game and Fish Department

Comment 2-1: The commenter requests that language in the downlisting criteria be revised to say that the salamander will be downlisted (instead of will be considered for downlisting) when the criteria are met. Recovery Plans are not decision documents, rather they are advisory in nature. Decisions to downlist a species are made via a rulemaking process that includes evaluation of the five listing factors and public comment on a draft downlisting proposal (50 CFR 424). In evaluating the five listing factors, the Service would use the downlisting criteria in the Plan, but other factors may also be important. Because of this, the requested change cannot be made. However, the language has been

revised to indicate that the salamander should be proposed for downlisting when the downlisting criteria have been met.

Comment 2-2: In reference to the downlisting criteria, the commenter refers to a "requirement of a 90% occupation rate, of currently occupied ponds". However, criterion 1 actually refers to habitat protection at "ponds on approximately 90 percent of the salamander's currently-occupied range". It is true that the 90 percent figure is not derived from any data about the salamander. However, as much as possible, downlisting and delisting criteria should be quantitative. The Participation Team believed 90 percent was a reasonable figure, given the land ownership within the range of the salamander (management may not be possible on some private lands). However, to set this figure lower might leave salamander populations overly vulnerable to some threats, particularly invasion by non-native predators. Because 90 percent is a best guess of the Team, we have included the following language on page 21, part 8, in regard to adaptive management: "New information may also warrant changes in the delisting or downlisting criteria." In response to input from the Participation Team on the May 2001 final draft, we have also added that approximately 90 percent of the current ponds also be protected before downlisting would be proposed.

Comment 2-3: The Team will work to develop a list of all ponds currently occupied by the salamander. This list will be available to Team members, which should help facilitate management for the salamander. However, we believe that distribution of the list outside of the Team, including making it an attachment to the Plan, should be discouraged because it might facilitate collection of salamanders or vandalism.

Comment 2-4: The Plan does not require or recommend, either as downlisting or delisting criteria, complete removal of all illegally stocked fish, bullfrogs, and crayfish from ponds inhabited by salamanders. Downlisting criterion #1 recommends that approximately 90 percent of currently occupied ponds be protected in accordance with recovery actions 1.1-1.5, are free from introduced fish and crayfish, and are monitored to detect new threats. In regard to possible downlisting, the "acceptable percentage of 'sacrificial' tanks" referred to by the commenter, is 10 percent (from downlisting criterion #1). This percentage may be adjusted based on a PVA or other new information (see page 20, part 8).

Comment 2-5: In response to this comment, downlisting criterion #2 has been revised to include review of the five-year monitoring data by the Participation Team, and to clarify that monitoring data used to evaluate population trend should be collected over a five-year period.

Comment 2-6: The introductory sentence to the delisting criteria was revised to indicate the salamander "should be proposed for delisting", rather than "will be considered for delisting".

Comment 2-7: The Participation Team and the Service agree that delisting criteria should be clear, achievable, and measurable. Lack of detail in the delisting criteria reflects an absence of some key information about the salamander necessary to adequately define under what conditions viable populations of salamanders could be maintained in the long term. As indicated in delisting criterion

#1, a PVA should help clarify when population viability has been achieved. We have revised page 21, section 8, to include a process for the Participation Team to review new information and to work with USFWS to revise downlisting and delisting criteria as needed based on results of a PVA or other new information.

Comment 2-8: The Team and USFWS agree with the commenter that it may not be necessary to complete all recovery actions before delisting can be proposed. However, based on our current understanding of the recovery needs of the salamander, regulatory mechanisms and land management commitments, such as those recommended in the Implementation Schedule, are needed to remove threats to an extent that listing is no longer needed. The Team and USFWS reevaluated task priorities in the Implementation Schedule. Priority for task 6.1.5 was changed from 3 to 2 (see response to comment 3-9, below), and in response to your comments suggesting the importance of a PVA, the priority for task 6.1.6 was elevated from 3 to 1. Agreements among landowners, land managers, the Service, and/or AGFD could help ensure that priority tasks are accomplished (addressed in part in task 5.2).

Comment 2-9: Delisting criterion #3 is not quantifiable by itself; however, as noted by the commenter, whether or not this criterion was met would emerge from an evaluation of delisting criteria #1 and #2, and an assessment of the five listing factors. This criterion is necessary due to the uncertainties at this time in what is needed to maintain viable populations of salamanders in the long-term. As new information is collected, including the results of a PVA, the delisting criteria may be revised to be more quantifiable, which may include deleting criterion #3, as suggested by the commenter.

Comment 2-10: Self-sustaining cienegas would provide a habitat type for the salamander different than the cattle ponds it currently inhabits. Because different habitat types respond to environmental stressors differently, providing a diversity of habitat types for the salamander may help populations persist in the long-term. Also, cattle ponds require periodic maintenance. If the salamander is found in other habitats, it will be more likely to persist if resources for cattle pond maintenance become limiting at some point in the future. Dr. Schwalbe noted in his comment letter, "restoring valley bottom perennial wetlands is the only way populations of Sonora tiger salamanders (or Chiricahua leopard frogs) will become self-sustaining." However, the need for self-sustaining cienegas and other recommendations in the Plan will be reevaluated as new information, including results of a PVA, become available (see page 20, part 8).

Comment 2-11: The delisting and downlisting criteria do not specifically refer to possible populations of Sonora tiger salamanders in Sonora, although at the top of page 12, presence of tiger salamanders suspected of being *Ambystoma tigrinum stebbinsi* at Los Fresnos, Sonora, is mentioned. Because the Plan currently does not recognize the occurrence of the subspecies in Sonora, discovery of populations there could only bolster the status of the salamander. If *A. t. stebbinsi* is confirmed in Sonora, no changes in the delisting or downlisting criteria are likely to result. However, in that case, a recovery task to work with the Mexicans on conservation of the salamander and its habitat may be

an appropriate addition to the Step-Down Narrative and Implementation Schedule. This could involve a revision to task 5.6.

Comment 2-12: USFWS will work with its partners to aggressively seek funding for and to implement all recovery tasks in the Implementation Schedule.

Comment 2-12: Changes in AGFD representation have been noted in section IV, "List of Contacts" and in Attachment 1 of the Participation Plan.

Comment Letter #3: Dr. Samuel Sweet, University of California, Santa Barbara, California

Comment 3-1: The section on adaptive management, page 21, part 8, has been revised to better define the roles of the Participation Team in recovery plan review and reassessment. This section also now indicates that the Team should meet at least annually. The Participation Team is the best forum to track implementation of the Plan and to assess its progress or need for change.

Comment 3-2: We have added a description of potential and occupied range of the salamander in the first paragraph under Distribution and Abundance on page 5. Although we believe most potential breeding habitats have been surveyed, we have included in task 5.1, page 18, identification and survey of all cattle pond within the range of the salamander.

Comment 3-3: Under part 1.1 of the narrative outline we have added the statement: "Plains grassland and Madrean evergreen woodland communities (Brown 1994) within the range of the salamander should be maintained and protected."

Comment 3-4: See response to comment 3-2 and task 5.1, page 18.

Comment 3-5: We have added a sentence under "Genetic swamping" on page 9 that describes where introductions or colonization of barred salamanders are most likely to occur within the range of the Sonora tiger salamander.

Comments 3-6 and 3-7: The breeding habitat requirements of the Sonora tiger salamander appear to be rather simple, and are described in "Habitat Requirements" on page 6. We believe this descriptive model is adequate to identify potential breeding sites. Patterns of distribution should emerge from extensive surveys proposed under task 5, pages 18-19. Investigation of dispersal patterns (task 6.1.4) and development of a PVA (task 6.1.6) should provide further insight into colonization and extirpation rates, and why some apparently suitable ponds are unoccupied.

Comment 3-8: We agree that small changes in the survivorship of adult salamanders can translate into relatively large changes in population viability. However, adult, breeding salamanders occur both as terrestrial metamorphs and as aquatic branchiates. Thus, the salamander is able to hedge its bet against catastrophes in either the uplands (such as wildfire) or in aquatic habitats (such as drought or disease outbreaks). If aquatic populations are devastated, breeding by terrestrial salamanders can still

occur. If the terrestrial population is wiped out, breeding by branchiates can still occur. Nevertheless, we recognize the need to maintain and conserve both aquatic and upland habitats. We have added language regarding conservation of upland habitats (see response to comment 3-3).

Comment 3-9: Task 6.1.5 calls for determining the habitat use of terrestrial metamorphs. We have changed the priority of this task from 3 to 2. Data about habitat use in the uplands will also be derived from task 6.1.4, "acquire information on dispersal patterns through mark/recapture and radiotelemetry".

Comment 3-10: We recognize that livestock grazing has some adverse effects to the Sonora tiger salamander and its habitat, as well as beneficial effects. We have attempted to address adverse effects by recommending the use of the cattle pond management and maintenance guidelines provided in Attachment 2, enhancement of bank-line and aquatic vegetation at breeding ponds (task 1.6), development of cooperative agreements with willing landowners to protect salamander habitats on private lands (task 1.8), and maintenance of plains grassland and Madrean evergreen woodland upland communities (task 1.1). We believe that current Forest Service grazing regulations are adequate to prevent deterioration of vegetation communities, soil conditions, and watersheds as a result of livestock grazing activities. However, we will continue to evaluate the extent and condition of salamander habitats and causes for any observed habitat deterioration (task 5.1). The results of this work may warrant changes in recovery tasks.

Comment 3-11: Unfortunately we do not have the type of age-specific survivorship and fecundity data for the Sonora tiger salamander that exists for *Ambystoma californiense.* We do not know if adult survivorship or fecundity is a limiting factor for *stebbinsi.* We also do not know the effect of long-term drought, but suspect that under such conditions, many of the ponds where *stebbinsi* occurs would likely dry up, perhaps extirpating the salamander from portions of its range. Development of a PVA, including research necessary to generate data for the PVA, is proposed under task 6.1. This work should provide insight into aspects of salamander life history and identification of those factors most important to population viability.

Comment 3-12: The purpose of the Participation Plan is to describe the means to carry out the tasks in the Implementation Schedule in a way that provides for timely recovery while minimizing social and economic effects. Although not a purpose of the Participation Plan, it could provide, along with the Recovery Plan itself, some guidance to those developing Habitat Conservation Plans in support of an application for an incidental take permit for non-Federal activities.

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