PETITION TO LIST THE TUCSON SHOVEL-NOSED SNAKE (*CHIONACTIS OCCIPITALIS KLAUBERI*) AS AN ENDANGERED SPECIES

Center for Biological Diversity
Petitioner
December, 15 2004

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Ms. Gale Norton
Secretary of the Interior
Office of the Secretary
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

CC: Dale Hall
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Ms. Norton,

The Center for Biological Diversity hereby formally petitions to list the Tucson Shovel-nosed snake (*Chionactis occipitalis klauberi*) as threatened or endangered pursuant to the Endangered Species Act, 16 U.S.C. 1531 et seq. (ESA). This petition is filed under 5 U.S.C. 553(e) and 50 CFR 424.14 (1990), which grants interested parties the right to petition for issue of a rule from the Assistant Secretary of the Interior.

The petitioner also requests that Critical Habitat be designated concurrent with the listing, as required by 16 U.S.C. 1533(b)(6)(C) and 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553).

I. INTRODUCTION

As one of the most beautiful and interesting snakes of the upper Sonoran Desert, the Tucson Shovel-nosed snake is an important component of Arizona's natural heritage. Like other shovel-nosed snakes, the Tucson Shovel-nose is uniquely adapted to literally swim through sandy soils using its spade-shaped snout. In part related to this adaptation, the Tucson Shovel-Nose is dependent on very specific habitat requirements, including sandy soils found on level terrain of valley floors. Combined with a limited distribution, the narrow habitat requirements of the snake make it particularly vulnerable to habitat destruction from either agriculture or urban sprawl. Unfortunately, the snake's historic range includes portions of northern Pima County, northern and southwestern Pinal County, and southeastern Maricopa County—an area that has been heavily altered by historic agriculture and is rapidly being squeezed by urban sprawl from both Phoenix and Tucson. The Tucson Shovel-nosed snake needs the safety net of the Endangered Species Act to survive and continue to be a part of the unique biota of the upper Sonoran Desert.

II. NATURAL HISTORY

A. Taxonomy

The taxonomic history of shovel nosed snakes is described in detail in Klauber (1951). Shovel-nosed snakes, which occupy the southwestern U.S. and northwestern Mexico, were originally placed in the genus *Rhinostoma* (Hallowell 1854), but shortly changed to *Lamprosoma* (Hallowell 1856) and then *Chionactis* because the former name was preoccupied by a genus of Coleoptera (Cope 1860). They were later combined with the ground snakes in the genus *Sonora* (Van Denburgh and Slevin 1913). Based on differences in the nasal valve, angled abdomen, spadelike snout, fewer maxillary teeth, and hemipenial divergences, Stickel (1943) resegregated the shovel-nosed snakes from the ground snakes and revived *Chionactis* . This segregation has been accepted by the Catalogue of American Amphibians and Reptiles (Mahrdt et al. 2001). Two species and several subspecies of the shovel nosed snakes are currently recognized (Klauber 1951, Mahrdt et al. 2001). The Western Shovel Nosed snake (*Chionactis occipitalis*) is broadly distributed and currently includes four subspecies: 1.) Mojave Shovel-Nosed Snake (*Chionactis occipitalis occipitalis*), 2.) Colorado Desert Shovel-Nosed Snake (*Chionactis occipitalis annulata*), 3.) Tucson Shovel-nosed snake (*Chionactis occipitalis klauberi*), which is the subject of this petition, and 4.) Nevada Shovel-Nosed Snake (*Chionactis occipitalis talpina*) (Klauber 1951, Marhdt et al. 2001). The Sonoran Shovel-Nosed Snake (*Chionactis palarostris*) is more narrowly distributed in several known, disjunct population areas in northwestern Mexico and a single U.S. population in Organ Pipe Cactus National Monument, and includes two subspecies: 1.) Sonoran shovel-nosed snake (*Chionactis palarostris palarostris*), and 2.) Organ pipe shovel-nosed snake (*Chionactis palarostris organica*) (Klauber 1951, Mahrdt et al. 2001). Cross (1979), in an unpublished review, did not find unequivocal support for recognition of the four subspecies. However, Rosen (2003) concluded:

> "There is evidence of local variation and clines additional to that in the existing taxonomy, and some indication that the species is significantly locally adapted, and probably not panmictic (fully mixed via gene flow). Hence, the best and most reasonable

estimate we have for significant conservation units is in the existing taxonomy, and it is plausible to think that even smaller units are likely to be significant for the species."

As the only published materials on the taxonomy of the Western Shovel-nosed snake supports designation of four subspecies (e.g. Klauber 1951 and Mardt et al. 2001), including the Tucson Shovel-nosed snake, we adopt these designations for the purpose of this petition.

The Tucson Shovel-nosed snake intergrades with the Colorado Desert shovel-nosed snake over a substantial portion of its range (Rosen pers. comm.) Because of the markedly depleted population status of the Tucson Shovel-nosed snake and because intergrades of the subspecies preserve a portion of its genetic diversity, this proposal includes both intergrade and non-intergrade individuals in listing of the Tucson Shovel-nosed snake. This opens up significantly greater options for conservation.

B. Species Description

Shovel-nosed snakes (*Chionactis* sp.) are small (250-425 mm total length) colubrid snake with a shovel-shaped snout, an inset lower jaw, and coloring that mimics coral snakes (Mardt et al. 2001). Western Shovel-nosed snakes (*Chionactis occipitalis* ssp.) are characterized by a "conspicuous," dark head crescent, among other features (Table 1). They generally have >21 dark primary crossbands on the body and 4-14 pale brown bands on the tail. The dorsal ground color is creamy-white or yellow with the ventral surface generally lighter in color (Mardt et al. 2001). The Tucson Shovel-nosed snake is characterized most clearly by black or brown secondary bands that do not contact the ventral surface (Table 2), which is to say, the red bands tend to be suffused with dark pigment, making them appear brown or partly black.

Table 1. Diagnostic characteristics differentiating *Chionactis occipitalis* and *Chionactis palarostris*.

Character	***C. occipitalis***	***C. palarostris***
Snout	Longer, flat or concave	More truncated, convex
Dark parietal blotch	Crescent shaped	Rectangular
Primary crossbands	⩾21, don't cross venter	<21, encircle body
Secondary crossbands	Narrow	Broad

Table 2. Diagnostic characteristics differentiating four subspecies of *Chionactis occipitalis* from Mardt et al. (2001).

Character	***C.o. occipitalis***	***C.o. annulata***	***C.o. klauberi***	***C.o. talpina***
Ventral scale counts	♂146-165, ♀154-176	♂143-164, ♀153-178	♂141-151, ♀153-159	♂148-162, ♀157-176
Subcaudal scale counts	♂39-50, ♀37-48	♂40-57, ♀34-51	♂42-47, ♀38-43	♂44-51, ♀43-48
Body primary crossbands	25-41	18-35	23-29	23-29
Tail primary crossbands	6-14	4-12	7-11	6-13
Dark interspace maculations	Usually absent	Usually absent	Present	Present
Secondary crossbands	Absent	Present, red	Present, black or brown to purplish	Present, dark
Crossbands encircle body	Yes, anterior	Yes, anterior	No	Yes, posterior

C. Diet

The recorded diet of the Western Shovel-nosed snake (*Chionactis occipitalis*) consists of scorpions, beetle larvae, spiders, centipedes, and buried moth pupae (Mattison 1989, Rosen et al. 1996, SDCP 2004). The length of these invertebrates, found within the stomach of the Tucson shovelnose snake, typically raged from 0.16 inches to 1.26 inches (0.4 to 3.2 cm) (SDCP 2004). From these observations it also appears that hard-bodied prey, such as beetles, were not preferred (SDCP 2004, Glass 1972).

One aspect of the Tucson shovelnose snake's diet might be unique compared to other subspecies of western shovelnose snake. The Tucson shovelnose snake relies heavily on scorpions (*Vejovis spinigeris*) for a significant portion of its diet, and Glass (1972) suggested that *C. o. klauberi* may have developed a resistance to scorpion venom. However, captive specimens of other subspecies of *Chionactis occipitalis* have also been observed feeding on scorpions on several different occasions. The scorpion was most often seized by the base of the stinger. After the snake had a hold on the scorpion, on occasion it would back into the sand while holding the scorpion in its mouth. This aligned the scorpion properly to facilitate ingestion. After the scorpion was aligned, the snake would then begin to move the jaw opposite the side holding the stinger to begin to consume the prey. This was done in such a way that resulted in the scorpion being bent into a "U" shape. This would continue until the claws and stinger were all that remained to be consumed. At this point, both would be swallowed simultaneously (Norris and Kavanau 1966).

Aside from the consumption of scorpions, the Tucson Shovel-nosed snake "subdued prey by one of two means: striking and grasping with the mouth, or looping the anterior third of the body in a single loop over the prey and pressing it against the substrate, then seizing the prey with the mouth" (Glass 1972). When striking was used, the Tucson shovelnose snake often missed; however, this was not the case when the looping method was used (SDCP 2004).

From a study by Rosen et al. (1996) it is apparent that these snakes eat relatively frequently with the stomachs of 7 of 7 *C. o. annulata* containing food remains. This observation was further supported by the consumption of 5-8 crickets per week by each individual in a laboratory setting (Rosen et al. 1996). After a lapse in feeding of two to three weeks, the snakes begin to show marked decreases in weight (Rosen et al. 1996). From such high feeding demands it is predicted that these snakes would have to be actively feeding from at least April to October (Rosen et al. 1996), although they are rarely found crossing roads (the usual collecting/observation method) after early July.

D. Behavior of the snake

Shovel-nosed snakes exhibit a unique behavior described as "sand-swimming." The snake moves using a sideways swaying motion while it is either on or under the sand or loose soil (SDCP 2004, Stebbins 1985). During the day the snake will often rest under the sand surface below a creosote bush (*Larrea tridentate*); although, it can also be found under objects such as boards (SDCP 2004). A study performed by Norris and Kavanau (1966) determined that the burrowing behavior of *Chionactis occipitalis* was dependent on the period of time since last

activity and the temperature of the sand above it. During the winter months the snakes will hibernate in subsurface burrows. The Colorado Desert Shovel-Nosed snake has been found hibernating about three inches below the surface, near the top of south facing dunes (Shaw 1953). The burrows were approximately ten inches long and one and a half inches in diameter, with both ends of the burrow plugged with sand (Shaw 1953).

Although these species are very adept at burrowing and diving into loose sand, they will also attempt to escape by fleeing across the ground surface (Warren 1953), and their slender shape and stronger musculature allows them to crawl fast, for a small snake. The Western Shovel-nosed snake has also been observed attempting to climb creosote bushes when it is disturbed; (Warren 1953), and they frequently dive into pre-existing burrows if a threat appears.

When threatened, *Chionactis occipitalis* has been witnessed exhibiting a unique defensive balling behavior that had not previously been observed in this species (Mitchell 1978). After the snake had been repeatedly disturbed, it eventually coiled into a ball with its head underneath and on the outside (Mitchell 1978). According to Mitchell's account "this ball could be picked up, rolled over and knocked about without causing the snake to untwine." It has been suggested that this behavior makes it more difficult for predators to capture the snake in its burrow (Mitchell 1978).

E. Ecological Relations

Like other shovel-nosed snakes, the Tucson Shovel-nosed snake is a small, quick snake that apparently uses venom to capture arthropod prey (Rosen 2003). It occurs in flat, sandy arid areas of the high desert in southeastern Arizona. Little is known about its interactions with other species or role in the food chain. As a predator high in the food chain of small animals, however, it is likely that when the Tucson Shovel-nosed snake was, formerly, more abundant it exerted a considerable influence on populations of its arthropod prey, including scorpions. This would most likely be especially true within its specialized arid desert habitat areas with sandy soils.

F. Reproduction

Due to the relatively obscure nature of the Tucson Shovel-nosed snake, few studies have characterized the reproduction of this taxon. Other subspecies of Western Shovel-nosed snake (*Chionactis occipitalis*) have been found to be oviparous (Stebbins 1985; BISON-M 2000) with a clutch of 2 to 4 eggs laid in the summer (Goldberg 1997, SDCP 2004), and there is no doubt that the Tucson Shovel-nosed snake is similar. The breeding period for this species is believed to be from May-June, during which time reproductively active females have been found (Goldberg 1997). A lack of spermiogenic males and the occurrence of males with regressed testes during August-November likely indicate that breeding by *Chionactis occipitalis* does not continue into this period (Goldberg 1997). However, during the breeding period, only 25% of the females studied were found to be reproductively active, indicating that not all females of this species breed every year (Goldberg 1997).

In a study of the Colorado Desert Shovel-Nosed Snake (*Chionactis occipitalis annulata*), males have been shown to engage in combative behavior believed to be associated with their mating

period. The male combat is thought to serve many different functions; however, "the one considered most important to male fitness is priority access to sexually active females" (Goode and Schuett 1994). In combatant males, there is evidence to suggest a relationship between large size, winning, and access to sexually active females (Goode and Schuett 1994). Since combat behavior in snakes is often coincident with mating, Goode suggests that the mating season for these snakes is mid-spring.

G. Daily and Seasonal Activity

The daily activity of the Tucson shovelnose snake may vary depending on the time of year and the temperature. The Western Shovel-nosed snake has been observed to be active in the morning, "even on remarkably warm days" and just before sunset (Rosen et al. 1996). This species exhibits intense periods of surface activity during the time from 1900 hr – 2100 hr. This maximal activity peak occurs during the twilight time to just after dark, starting at a time when observation is barely possible without artificial light (Rosen et al. 1996). Activity seems to be highest after warm summer, or hot spring days, and with higher relative humidity (Rosen et al. 1996).

Seasonally, the Western Shovel-nosed snake, and the subspecies the Colorado Shovel-Nosed Snake, exhibit peaks in activity during May and early June (Goldberg 1997) with fewer snakes seen after the end of June (Goldberg 1997). The Tucson Shovel-nosed snake also displays a similar peak in activity, but collecting records suggest that the peak in activity might be slightly earlier in this subspecies, and demonstrate that activity ends more abruptly in late June-early July than is the case in subspecies found in lower, and more arid regions. These records show that peak activity begins in May, with decreasing activity in late June (Rosen 2003).

H. Habitat Requirements

No systematic studies of habitat use by the Tucson Shovel-nosed snake have been conducted and only limited observational data is available (Rosen 2003). Rosen (2003) characterized macrohabitat features based on museum locations and more recent observations, but cautions that the accuracy of historic locations and ongoing habitat degradation may limit the precision of habitat descriptions. Rosen (2003) found that Tucson Shovel-nosed snake is a valley floor species found in more productive "creosote and mesquite" environments than is typical for other subspecies of Western Shovel-nosed snake, reflecting its geographic position in the higher desert areas lying between the Arizona Upland and Lower Colorado Valley portions of the Sonoran Desert.

Shovel-nosed snakes with their flattened head are adapted to moving through sand or soft soil. The Western Shovel-nosed snake is most closely associated with sandy soils, often including major sand dunes, whereas the Tucson Shovel-nosed snake occurs in a less arid region, which lacks major dunes, and is typically found on sandy loams with sparse gravel. Rosen (2003) summarizes:

> "The Tucson Shovel-nosed snake was found in Avra Valley primarily on Avra Valley Road, from 3 miles west of I10 to just west of Pump Station Road. It lived on sandy-

> loamy valley floor flats, probably with creosotebush, mesquite, and other shrubs. Its original distribution includes roughly equal parts of Marana and unicorporated Pima County. It was (or is) part of an extension of the lower Colorado Valley subdivision of the Sonoran Desert, up the Gila and Santa Cruz valleys, into eastern Pima County. There is evidence that this environment and its herpetofauna, is being severely degraded in central Arizona."

I. Distribution

The Tucson Shovel-nosed snake is found in northeastern Pima County and the adjoining extreme southern portion of Pinal County (SDCP 2004; Figure 1). The Sonoran Desert Conservation Plan (SDCP 2004) defines the historic distribution of the shovelnose snakes as follows:

> "The range of the western shovelnose snake in Arizona includes the Sonoran and Mohave deserts in the southwestern portion of the state. Its distribution is largely limited to valley floors below 2,200 feet (670 meters) with sand dunes, sandy loams, and very fine sandy loams (Lowe 1964). The subspecies *C. o. klauberi* has been found in the Avra Valley, in the north central part of the Tohano O'odham Nation, and the lower elevations of the Ajo region. Its distribution in Pima County is more patchy [sic] than the literature suggests (P. Rosen, pers. Com. 2000)."

The SDCP has also determined the present distribution of the Tucson Shovel-nosed snake to be:

> "West of Tucson northward along Avra Valley to Pinal County and perhaps touching the southeastern portion of Maricopa County. Its current distribution in Pima County is poorly known. Further research is needed to determine its current distribution and abundance. It is believed to have been eliminated from much of the Avra and Santa Cruz Valley areas and other parts of its range due to habitat loss from agricultural and urban development (P. Rosen, pers. Com. 1999). Most of its current range is believed to lie in southern Pinal County. The Tucson shovelnose snake only exists in lowland valley floors, a habitat that has diminished in suitability as a result of clearing for agriculture and development. Once soil is plowed for agriculture purposes, this species is not likely to return to the area, even under the best scenario."

Intergradation with *C. o. annulata* may begin at Casa Grande, and has been described to extend as far west as Gila Bend, north to Aguila, and south to Ajo" (Klauberi 1951).

We mapped the likely boundaries of the subspecies historic range based on Mardt et al. (2001) with modifications from Dr. Phil Rosen based on data he has collected on verifiable locations (Figure 1). Based on these sources, we also mapped the boundary between the intergrade and non-intergrade zones. Within this historic range, a majority of habitat is owned by private landowners and the state combined, followed by Nation lands, and the BLM (Table 3).

Table 3. Tucson Shovel-nosed snake habitat ownership based

on our habitat model (see below).

Landowner	**Acres**	**%**
BLM	203,421	16.1
Nation	218,293	17.3
Local or State Parks	7,670	0.6
Military	2,291	0.2
Natl. Parks	115,827	9.2
Other	5,181	0.4
Private	438,505	34.7
State Trust	272,238	21.5

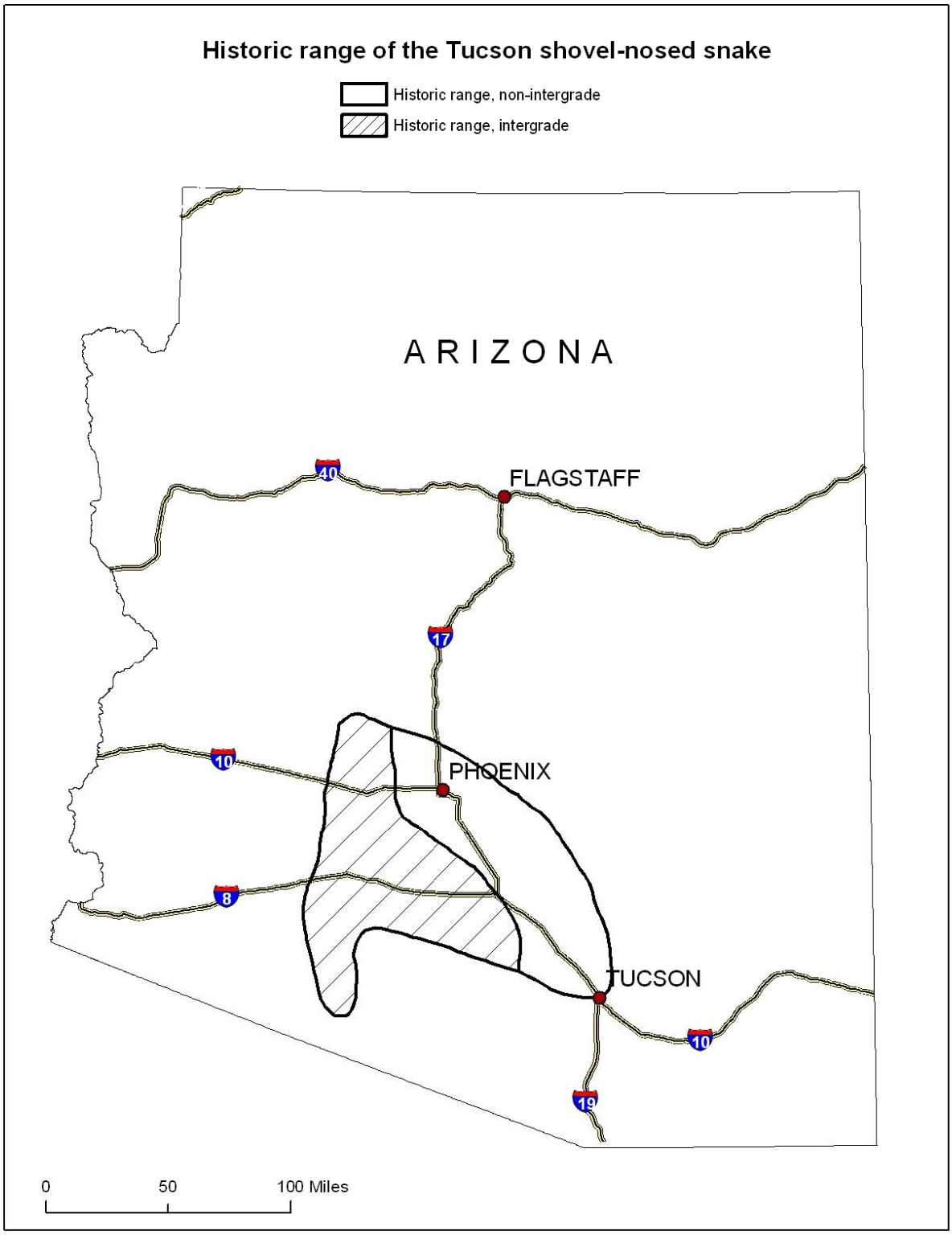

Figure 1. Historic range of the Tucson Shovel-nosed snake.

III. POPULATION STATUS

Since the mid-1970's, the Tucson Shovel-nosed snake has severely declined (Rosen 2003). Rosen (2003) defines four historic and current populations within the core range of the Tucson Shovel-nosed snake:

> "As currently mapped, this taxon was known from the margin of the Arizona Upland in places where it has been severely impacted by suburban sprawl: Scottsdale region (probably extirpated by urban sprawl and agriculture), Florence region (uncommon, facing continued sprawl), Casa Grande region (severely impacted by agricultural development), and Avra Valley (also affected by agriculture and now, potentially, urban sprawl)."

Most of these areas have not been systematically surveyed and thus Rosen's rough characterizations of their status are the best information available.

The one area where surveys have occurred in recent years is the Avra Valley, where the last verifiable record of the species was in 1979 despite extensive collection by University of Arizona personnel throughout the 1980s and 1990s. After an extensive survey, Rosen (2003) and his associates failed to locate the species. The survey was conducted in areas where Tucson Shovel-nosed snakes had historically been observed up to 2-3 times per night through the mid-1970s, suggesting the snake has sharply and severely declined.

Rosen (2003) cautions that although it has declined severely, the Tucson Shovel-nosed snake may not be extirpated in Avra Valley. The study was conducted after a severe drought, and time constraints forced researchers to collect data in June, whereas a May collecting effort would be preferred (Rosen 2003). Fewer numbers of other species of snake were observed than would be expected based on the sampling effort, particularly in the most arid parts of the Avra Valley, where shovel-nosed snakes would be expected to be found (Rosen 2003). These factors prohibit concluding that the shovel-nosed snake has been extirpated from the Avra Valley. Moreover, Rosen (2004) reported the finding of a Tucson Shovel-nosed snake near Picacho, north of the Avra Valley, demonstrating that the species is not regionally extirpated. Rosen (2004) concludes that it would take at least three years of intensive survey to determine if the species is extirpated in the Avra Valley:

> "It would take at least 3 years of intensive sampling with no snakes found to support a conclusion that the species is extirpated in Marana, and the conclusions reached for Marana would be significantly clarified by knowledge of the species' status in the Santa Cruz Flats, where we now know it persists. A number of other species characteristic of the Lower Colorado Valley desertscrub, the habitat for the shovel-nosed snake, also appear to have declined markedly in the Avra Valley and Santa Cruz Flats in recent decades."

In addition to the above population areas, individual snakes "somewhat to strongly resembling" the Tucson Shovel-nosed snake are still seen, along with other individuals closer to the Colorado Desert Shovel-Nosed Snake (*Chionactis occipitalis annulata*) in an area of presumed subspecies

intergradation near Mobile in the Sonoran Desert National Monument (Rosen 2003). Such individuals may turn out to provide the only strong opportunity to preserve the genotype or unique genes of the Tucson Shovel-nosed snake (Rosen 2003).

IV. THE TUCSON SHOVEL-NOSED SNAKE IS ENDANGERED UNDER THE ESA

A. Present or threatened destruction, modification, or curtailment of habitat or range.

The Tucson Shovel-nosed snake has experienced substantial destruction of its habitat and range from agricultural and urban development, and much of its remaining habitat is threatened by urban sprawl from Tucson and Phoenix (SDCP 2004). Once an area has been plowed, or the soil has been compacted by urbanization or other factors, it is unknown whether habitat can ever be recovered and if so, how long it will take (SDCP 2004, Rosen personal communication). This is due in large part to the snake's habitat requirements of open sandy areas with fine, wind-blown sand (Mattison 1989, SDCP 2004), as well as to the generally lengthy period required for desertscrub to recover from un-natural disturbance, especially major disturbance to the soil surface, such as blading or plowing. These disturbances – once an area begins to return to desertscrub – are usually followed by periods with non-native weeds and urban insects (like cockroaches), followed by invasion by disturbance-tolerant native plants, and ultimately the addition of other native plants. However, full recovery of the vegetation after such disturbance has not been described, and even partial recovery of sensitive reptile and invertebrate groups has also not been observed (Rosen, personal communication). Post-disturbance recovery may be possible – certainly with enough time it must ultimately be – but whether it is practical or not remains in doubt. These facts highlight the importance of protecting existing habitat, particularly occupied habitat.

To determine the historic and current distribution of Tucson Shovel-nosed snake habitat, we developed a model of the snake's habitat with the cooperation of Dr. Phil Rosen. The models were developed and refined based on Dr. Rosen's professional knowledge of habitat conditions, the conditions at observed locations, and descriptions of habitat requirements from the literature. The models presented here are an extension of work with Dr. Rosen to model snake habitat by personnel working for Pima County's Sonoran Desert Conservation Plan and the town of Marana's Habitat Conservation Plan.

Historic habitat model

The habitat model used Geographic Information Systems (GIS) technology to map different landscape variables that were identified as components of the subspecies' habitat, including elevation, slope, vegetation and soil type. Each variable was classified into a range of values reflecting habitat suitability for the Tucson Shovel-nosed snake based on the field and lab experience of Dr. Phil Rosen and additional information taken from the habitat characteristics at known snake locations (Table 4).

Table 4. Model for Tucson Shovel-nosed snake. Ratings recommended by Dr. Phil Rosen.

Variable/Category	Value Rating
VEGETATION	
Scrub-Grassland - upland - Shrub-Scrub Disclimax (143.16)	1
Scrub-Grassland - xero-riparian - Shrub-Scrub Disclimax (143.16XR)	1
Sonoran Desertscrub – upland – Creosote-Bursage (154.11)	3
Sonoran Desertscrub – upland – Paloverde-Mixed Cacti (154.12)	1
Sonoran Desertscrub – upland – Agave-Burssage (154.15)	1
Sonoran Desertscrub – upland - Saltbush (154.17)	1
Sonoran Desertscrub - xero-riparian biome (154.10XR)	1
Sonoran Desertscrub - xero-riparian - Creosote-Bursage (154.11XR)	1
Sonoran Desertscrub - xero-riparian - Paloverde Mixed Cacti (154.12XR)	1
ELEVATION	
< 640 meters	3
640 - 670 meters	2
670 - 700 meters	1
> 700 meters	Mask
SOILS	
Sandy loam	3
Sandy clay loam	3
Clay loam	3
Loam	3
Silty clay loam	2
Clay	1
All others	Mask
SLOPE	
0 to 5%	1
> 5%	Mask

Each habitat variable was then mapped within the historic range of the snake using existing GIS data. For elevation and slope, a 30 m Digital Elevation Model was used (USGS, 1999). For vegetation, data from the Arizona Gap Analysis Project (GAP) was used (USGS 2001). This dataset used satellite imagery from 1990 to 1992 to determine and classify vegetation types in Arizona. Because this imagery could only determine vegetation types at the time of its collection, we used a digital version of the Biotic Communities of the Southwest by Brown and Lowe (1980) to determine historic vegetation prior to modification by urbanization and

agriculture. For soils, the "Soil Survey Geographic Database" (SSURGO) was used where available, which did not include the entire range of the snake (USDA, 1999). Because the snake avoids heavily graveled soils, soil scores were modified based on the presence of gravel with mapping units consisting of very gravelly soils (35 – 60% rock fragments) having 2.0 subtracted from their soil score and mapping units with gravelly soils (15 – 35% rock fragments) having 1.0 subtracted from their soil score.

The variables were then combined by summation into a single map of historic Tucson Shovel-nosed snake habitat that ranked areas from 0.0 to 10.0, with 10.0 being the most suitable habitat and zero being unsuitable (Figure 2). Because of a lack of soils data, approximately 22 percent of the snake's historic range could not be included in this model.

The performance of the historic habitat model was assessed by overlaying the previously observed snake locations upon the historic habitat model. Of 100 historic locations, 83 were found in areas that had a score of 8-10, indicating the model does a reasonable job of predicting Tucson Shovel-nosed snake habitat. Most of the locations in areas with a score of 8 or less were ones with relatively imprecise location descriptions that were near habitat with a high model score.

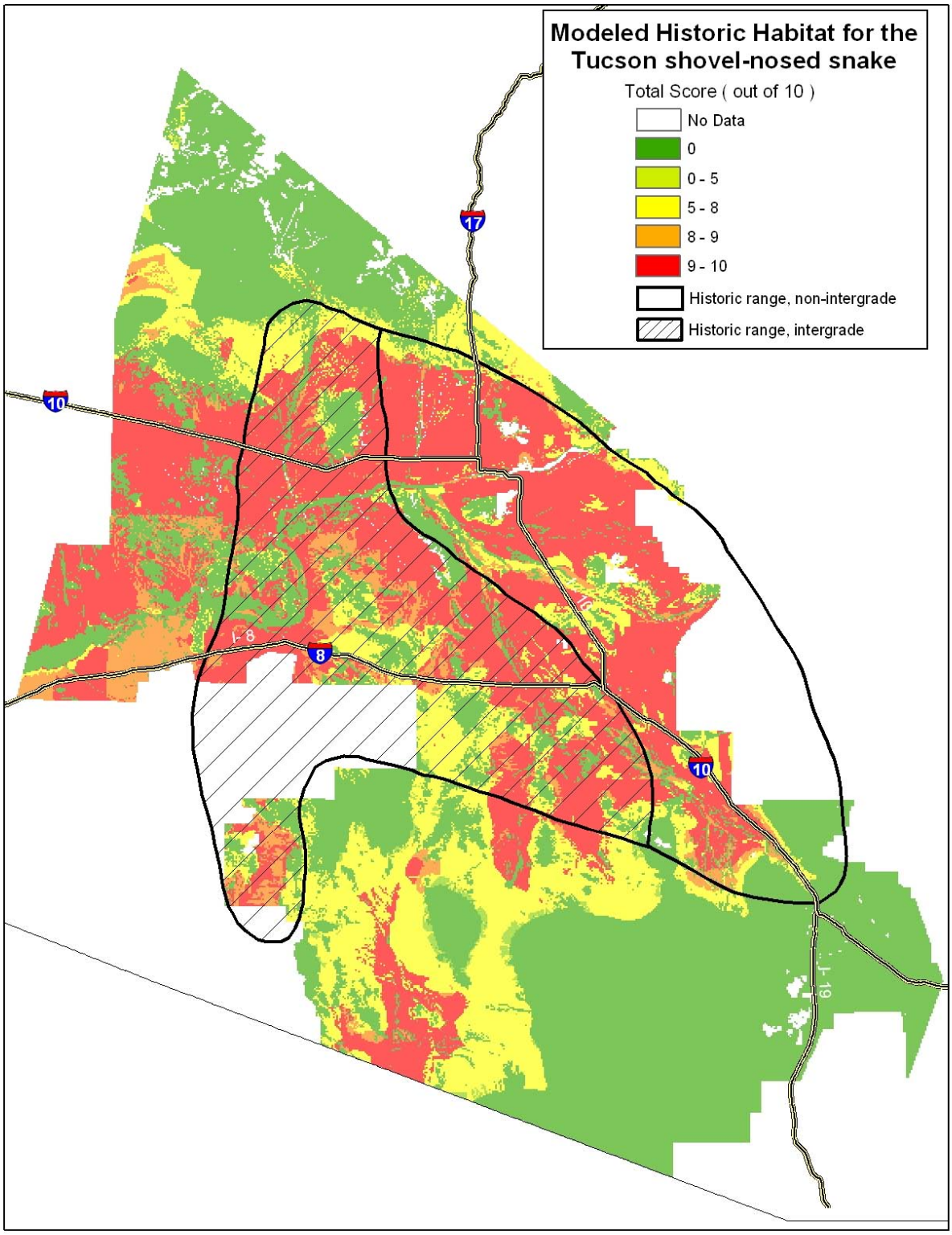

Figure 2. Model of Tucson Shovel-nosed snake habitat.

Remaining Habitat

To determine the extent of the snake's habitat historic that has been lost to urban or agricultural sprawl, we combined our model of snake habitat with a coverage of urban and agricultural areas developed by the Southwestern Regional Gap Analysis Project (SWReGAP)(USGS 2004), which used imagery current to 2001.

Within portions of the snake's range with available soils data, we documented extensive habitat loss (Table 5). Based on our model, we identified a total of 1,271,319 acres of potential habitat within the non-intergrade range of the Tucson Shovel-nosed snake. Of these, 914,015 acres (72%) have been converted to agriculture (33%) or urban sprawl (39%). Within the intergrade zone of the snake, we identified 1,330,865 acres of potential habitat, of which 424,694 (32%) acres have been lost to agriculture (28%) and urban sprawl (4%). Based on Rosen (2003), it is clear that the Tucson Shovel-nosed snake does not occupy all apparently suitable habitat, and thus even those areas identified by our model as suitable may not harbor the species. These results indicate the snake has lost significant portions of its habitat and range, particularly within the core non-intergrade portion of its range.

Table 5. Loss of Tucson Shovel-nosed snake habitat.

Habitat	Habitat Zone	Acres	%
Agriculture	Intergrade	288,505	21.7
Developed	Intergrade	53,152	4.0
Mined	Intergrade	258	0.0
Old Agriculture	Intergrade	81,995	6.2
Water	Intergrade	784	0.1
Remaining good habitat	Intergrade	906,171	68.1
Agriculture	non-intergrade	340,302	26.8
Developed	non-intergrade	490,448	38.6
Mined	non-intergrade	83	0.0
Old Agriculture	non-intergrade	81,867	6.4
Water	non-intergrade	1,314	0.1
Remaining good habitat	non-intergrade	357,304	28.1
Agriculture	all	628,807	24.2
Developed	all	543,600	20.9
Mined	all	341	0.0
Old Agriculture	all	163,862	6.3
Water	all	2,099	0.1
Remaining good habitat	all	1,263,475	48.6

Analysis performed in conjunction with the creation of the Sonoran Desert Conservation Plan predicts that significant habitat losses for the species will continue. Using projections of future land development, SDCP (2004) estimated that development will result in loss of 43% of the snake's potential habitat (SDCP 2004). These are losses predicted to occur even with protections of the Sonoran Desert Conservation Plan. The population of Pima County is expected to increase from 889,000 to 1,200,000 (26%) by 2020 (SDCP 2004). No similar predictions are available for Pinal or Maricopa Counties, but similar population growth and habitat losses are likely. There are no indications that any significant portion of the known, extant range of the non-intergrade population will be protected from urbanization given present plans or trends.

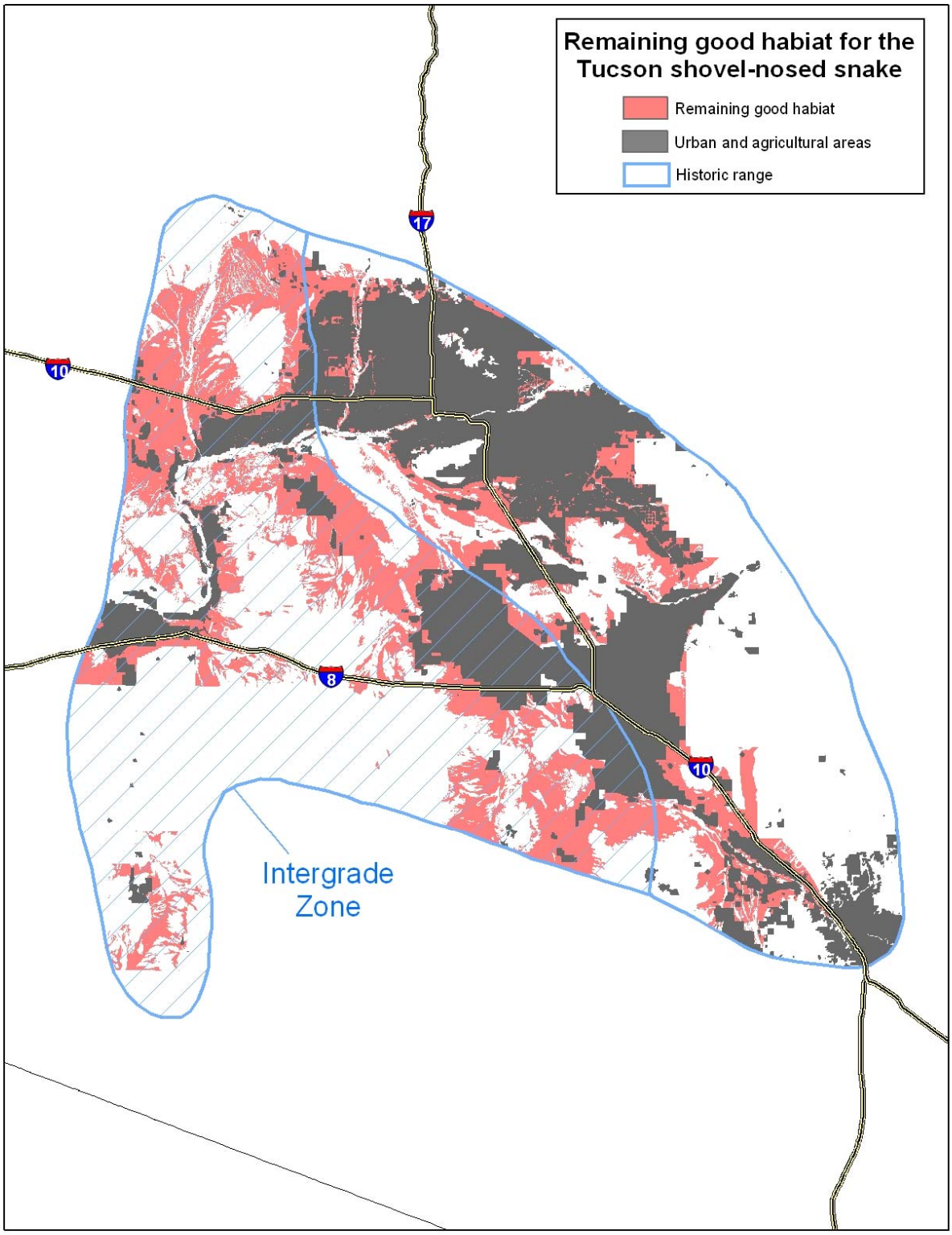

Figure 3. Loss of historic Tucson Shovel-nosed snake habitat.

Other potential threats to the Tucson Shovel-nosed snake's habitat include mining, off-road vehicles, which can crush snakes buried in the sand or compact soils used by the snake (SDCP 2004), construction of roads, which fragment snake habitat and are a source of snake mortality, and livestock grazing, which compacts soils, and may reduce prey of the snake by reducing and altering vegetation cover.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

While it is not believed that scientific and commercial collecting of this species is wide spread, this attractive species could be slightly impacted by collection, though only in limited areas. Although Arizona prohibits the commercial collection of reptiles, enforcement of this law is limited (SDCP 2004).

C. Disease or predation.

While snakes are often considered to be top predators, there is evidence to suggest that this species is also the prey of several other animals. In a study examining the diet of the Colorado Desert Sidewinder, *Chionactis occipitalis* was found to be a food item, occurring in the stomachs of 1.2% of the snakes examined (Funk 1965). In 1996, two adult *Chionactis occipitalis* were found impaled on an Ocotillo plant approximately six feet above the ground (Mahrdt and Banta 1996). It was determined that these snakes were the apparent prey of a loggerhead shrike (Mahrdt 1996). The remains of shovel-nosed snakes have also been found in pellets regurgitated by the Great Horned Owl (Rosen, personal communication).

D. Inadequacy of existing regulations.

The Tucson shovelnose snake is currently not afforded any state or federal protection and is not listed on any state or federal lists of species of concern. The snake, for example, is not listed on Arizona's "Wildlife of Special Concern" list. Even if the snake were listed, however, it would receive little protection because the list serves only to notify of the species' status, and does not require any conservation or management actions (AGFD 2001). Possible protections are provided by Pima County's multi-species conservation plan (SDCP 2004), which is currently being developed, a "habitat conservation plan" (HCP) being developed by the Town of Marana, creation of the Ironwood National Monument, or state land conservation efforts. For several reasons, however, none of these efforts ensure the survival and recovery of the Tucson Shovel-nosed snake.

Sonoran Desert Conservation Plan. The snake is being considered for protection under the Sonoran Desert Conservation Plan (SDCP), which is currently being developed by Pima County and could eventually provide some protection for the snake in a small portion of its range, assuming it is ever found again on the land covered by the SDCP. Before we consider the potential protection provided the Tucson shovelnose snake by the SDCP, however, it is important to note that under the Endangered Species Act, when determining whether a species meets the requirements of a threatened or endangered species, the Fish and Wildlife Service is not to consider draft, planned, or future management actions, but instead only the current management and status of the species. In numerous cases, the U.S. Fish and Wildlife Service has

been forced by judicial action to reverse decisions not to list species because they relied on promised management actions, including decisions over the Barton Spring's salamander, Queen Charlotte goshawk, jaguar, Alexander Archipelago wolf and coho salmon. This is not merely a legalistic technicality. There is a good reason for considering only current management and status. States, Federal agencies and private interests can easily promise to protect and recover species in order to avoid or delay a listing that they consider potentially controversial. Whether they fulfill the promises of the Plan and whether this fulfillment will result in recovery of the snake can only be determined with time. For these reasons, the Sonoran Desert Conservation Plan (SDCP), which is expected to take effect in mid 2005 (sonorandesert.org), is largely immaterial to determining whether the Tucson Shovel-nosed snake merits listing under the Endangered Species Act.

A draft of the SDCP was released January 13, 2004. The SDCP identifies 55 priority vulnerable species that require special management, including the Tucson Shovel-nosed snake. Based on mapping of high potential habitat for 41 of the priority species for which there was sufficient information, SDCP (2004) identified a "biologically preferred alternative reserve system" that corresponds with areas where high potential habitat of 3 or more species overlaps. Within this reserve system, the SDCP allocates lands to one of several categories, including multiple use management areas, important riparian areas, biological core management areas, scientific research areas, special species management areas, agricultural in-holdings, and critical landscape connections. Within these various land designations, the SDCP specifies broad goals that call for emphasizing restoration of native vegetation and preservation of 75-90% of habitat. Although protecting such habitat is a laudable goal, the SDCP does not require that such habitat be protected and provides no regulatory framework to ensure that such protection will actually occur.

Even if the SDCP took effect immediately and included strong regulatory provisions to enforce is goals, however, the protections provided the Tucson Shovel-nosed snake would be inadequate. The majority of its current range is outside the SDCP, in Pinal County, and even within Pima County, a significant portion of the snake's habitat will not be protected under the plan. Based on our habitat model, only 16% of the snake's habitat in its core range and 9% of its habitat in the intergrade zone is within Pima County. Of this habitat, 16% is not covered by the Plan because it is within urban jurisdictions and thus at risk of development and 50% occurs on Nation lands where its management is uncertain. Of the area that is included, SDCP (2004) predicts 43% of potential habitat will likely be lost to development and that 43% of priority conservation areas are likely to be lost. These are some of the highest proportions for any of the species covered by the SDCP, likely because of the snake's utilization of flat, low-lying areas that are also desirable for development. This overlap makes the snake particularly sensitive to future development.

The SDCP is also unlikely to ensure the Tucson Shovel-nosed snake's future because most of the lands covered by the Plan and the snake's habitat in Pima County are not under County jurisdiction. Of Tucson Shovel-nosed snake habitat identified by the SDCP in Pima County, only 17% is under county jurisdiction. The remaining areas are private, Federal, State, City, and Nation lands. To achieve the goals of the SDCP would require the cooperation of agencies at each level listed above. This is reflected in the draft Plan, which states:

> "Over all, the biologically preferred alternative provides substantial coverage for the majority of the PVS used in the development of the alternative. However, inasmuch as the biologically preferred alternative includes federal, state and incorporated lands, this represents the potential coverage if all of these entities implement these management actions consistent with the intent of the PMCMSP in their own management efforts."

Success of the SDCP is thus dependent on an assumption that all agencies with jurisdictions covering the lands included in the plan would act in ways consistent with the guidelines set forth in the plan. Such an assumption is highly uncertain and fails to qualify as an existing regulatory mechanism that is enforceable and effective.

Finally, the SDCP allocates the majority of the Tucson Shovel-nosed snake's habitat to the least protective land designation: "multiple use management areas." Of known Tucson Shovel-nosed snake habitat calculated using our model, we estimate that 65% within the snake's core range and 58% within its range where it intergrades with the Colorado Desert shovel-nosed snake are within the multiple use designation. According to the Plan:

> "Land use and management goals within these areas will focus on balancing conservation, restoration and enhancement of natural communities with other uses compatible with the maintenance of biological values. Land uses appropriate for these areas must be consistent with maintaining open space, natural vegetation and wildlife use values… Land-use changes within Multiple use Management areas should retain at least 75 percent of the land in natural vegetation and in a configuration that achieves actual conservation of the native species that may occupy that landscape."

Thus, within a majority of the Tucson Shovel-nosed snake's range in Pima County, the SDCP allows for destruction of 25% of its habitat and fragmentation of a greater amount. This level of habitat loss is assuming that the Plan will be effective at protecting other lands, which, as discussed above, is questionable.

In sum, the SDCP does not qualify as an existing regulatory mechanism, and does not guarantee protection of most Tucson Shovel-nosed snake habitat because it is out of the county, not under county jurisdiction, or simply not protected by the Plan. Given the Tucson Shovel-nosed snake's perilous status and ongoing threats, the species requires immediate protection.

Town of Marana Habitat Conservation Plan. The Town of Marana issued a draft preliminary HCP on September 10, 2004, which considered impacts to the Tucson Shovel-nosed snake (CH2MHILL 2004). The HCP reports that the Town has grown from 6,400 acres with 1,512 people in 1977 to 75,263 acres and 17,000 people today. The Town is expected to grow to 40,000 people in 10 years with up to 48,937 acres of development planned in the next 25 years.

A Tucson Shovel-nosed snake was last observed in Marana at Sanders Road and Avra Valley Road in 1979. Surveys in 2003 failed to locate the snake, but Rosen (2003) cautioned that the survey was conducted late in the season during the continuing period of intense drought conditions, meaning Tucson Shovel-nosed snakes still may occur in Marana. In addition, Rosen

(2004) reported the verified collection of a Tucson Shovel-nosed snake near Picacho, demonstrating they're not regionally extirpated.

Similar to us, the Town of Marana developed a model of habitat in cooperation with Dr. Phil Rosen, predicting a total of 15,626 acres of habitat within town limits. Of this, the HCP predicts that 13,712 acres (88%) will be lost to urban sprawl in the next 25 years, 8633 acres in high density development and 4,996 acres in low density housing. The HCP notes: "once suitable habitat with relatively undisturbed soil conditions is graded for development its potential value to this species is lost."

To mitigate the loss of most remaining habitat in the Town of Marana, the draft preliminary HCP proposes two possible strategies. "Strategy A" calls for mitigating all habitat loss through direct purchase of land or development rights with the ratio of purchased to destroyed habitat increased with decreasing suitability and connectivity of the habitat. "Strategy B" calls for surveys for a period of five years, during which development is limited in suitable Tucson Shovel-nosed snake habitat. If the snake is found in a given property, the Developer will be forced to mitigate any habitat loss similar to above. If no Tucson Shovel-nosed snakes are found within five years, no mitigation will be required.

Similar to above, the draft preliminary HCP should not be considered in the context of listing the Tucson Shovel-nosed snake because its provisions, implementation, and effectiveness are all uncertain. Of the two strategies, Strategy A clearly will protect more habitat and is thus better for the Tucson Shovel-nosed snake. Both strategies, however, allow for substantial habitat loss, severely limiting survival and recovery of the Tucson Shovel-nosed snake in the Avra Valley. The HCP argues that Tucson Shovel-nosed snake habitat within the Town's boundaries is a small percentage (3%) of all habitat in the County, implying that its loss would be inconsequential. The HCP, however, fails to analyze the landscape consequences of the loss of most Tucson Shovel-nosed snake habitat in Avra Valley in terms of contiguity and gene flow among populations of Tucson Shovel-nosed snake. It also failed to consider the impact of the loss in the context of past and ongoing losses of habitat elsewhere in the snake's range.

Habitat within the town of Marana is part of the habitat for the Avra Valley population region for the Tucson Shovel-nosed snake, which is one of only two well-documented population centers for the core (non-intergrade) form, the other being near Florence in Pinal County. Loss of the Avra Valley and Florence population areas would represent near complete loss of the known non-intergrade populations. The Marana HCP only includes a portion of the Avra Valley population area, and even this portion receives only limited protection under the HCP, at best.

It may be of interest to note that the sole reason for inclusion of the Tucson Shovel-nosed snake in the Town of Marana HCP was the expectation that this snake might likely be listed under the Endangered Species Act.

In sum, the Town of Marana HCP is at this time only a preliminary draft that proposes strategies that allow for the substantial loss of habitat and potentially populations.

State Lands. According to our habitat model, 21.5% of the Tucson Shovel-nosed snake's habitat occurs on Arizona state lands. Arizona currently has no regulations or programs to protect the Tucson Shovel-nosed snake on their lands and the Federal Enabling Act for Arizona and state constitution limit conservation on state lands by requiring that use of the lands maximize the economic value of state lands to benefit schools. The Arizona state constitution, for example, states:

> "Said lands shall not be sold or leased, in whole or in part, except to the highest and best bidder at a public auction… All lands, lease-holds, timber, and other products of land, before being offered, shall be appraised at their true value, and no sale or other disposal thereof shall be made for a consideration less than the value so ascertained" (Arizona State Constitution, Article 10, Sections 3 and 4).

In order to incorporate conservation into state land management, the Arizona legislature passed the "Arizona Preserve Initiative" in 1996 (HB 2555). The initiative established a process by which state lands can be leased or purchased for conservation purposes. The legality of the law, however, is in question because of the constitutional requirement to maximize economic value. Sale of state land at Tumamoc Hill for conservation purposes to Pima County, for example, was recently canceled because of legal protests (Arizona Daily Star, April 22, 2003). Even if there weren't these legal hurdles, however, the Arizona Preserve Initiative provides little protection for the snake because it only allows for the lease and purchase of state land. It does not require such purchase or lease to conserve the snake's habitat, nor are there plans in the works to do so. No other protections are provided the snake on state lands.

Bureau of Land Management. Sixteen percent of the Tucson Shovel-nosed snake's modeled habitat is found on BLM lands, almost entirely within the intergade zone of the snake. The Bureau of Land Management currently has no regulations to protect the Tucson Shovel-nosed snake, does not survey for the snake or its habitat, or consider impacts on the species during project-specific analysis.

BLM lands are secure from development or agriculture. Primary threats are off-road vehicles, roads, livestock grazing, and mine leasing. The extent of these threats and their impact on the Tucson Shovel-nosed snake have not been studied, but it is likely that they are impacting the species to some degree, particularly off-road vehicle use, which has been growing exponentially in recent years.

Nation Lands. The Tohona O' odham Nation controls 17% of the Tucson Shovel-nosed snake's habitat with somewhat less than half of this habitat found in the core range of the snake. Management of Tucson Shovel-nosed snake habitat on Nation Lands is uncertain. The Nation generally does not share information about the distribution or management of species on their lands. Potential threats on Nation lands include development, off-road vehicle use, and heavy livestock grazing that may have especially severe impacts on valley floor environments normally utilized by shovel-nosed snakes.

E. Other natural or anthropogenic factors

Because of the Tucson Shovel-nosed snake's apparently precarious status, severe weather, particularly prolonged drought, has the potential to negatively impact Tucson Shovel-nosed snake populations, even contributing to local extirpation. Rosen (2003) observed that one potential reason they did not locate any Tucson Shovel-nosed snakes in the Avra Valley and observed reduced numbers of other reptiles was prolonged drought.

Additionally, whereas drought could contribute to final extinction of the subspecies, either climate change or habitat modification that resulted in permanently wetter environmental conditions could also lead to further declines of this arid-adapted species, particularly under prevailing conditions in which only fragments of the original distribution remain occupied.

V. RECOMMENDATIONS FOR RECOVERY

In the immediate future, the most critical action to ensure the survival and recovery of the Tucson Shovel-nosed snake is identifying and protecting remaining occupied and suitable habitat. This will require conducting intensive surveys to determine where remaining populations occur, followed by purchase or zoning regulation of habitat to ensure its preservation. Listing of the Tucson Shovel-nosed snake will facilitate these activities by requiring surveys to avoid take and by making Section 6 funding available for survey and research.

Following identification of existing populations and habitat, a plan needs to be developed to protect suitable, but unoccupied habitat that is essential to the recovery of populations and ensures the contiguity of existing populations. Designation of critical habitat and development of a recovery plan will facilitate both of these things.

VI. REQUEST FOR DESIGNATION OF CRITICAL HABITAT

The Secretary shall designate critical habitat concurrent with determination that a species in endangered or threatened as required by the ESA (16 U.S.C. 1533(a)(3A)). The Center for Biological Diversity requests critical habitat designation concurrent with species listing. Critical habitat should include all existing habitat of the Tucson Shovel-nosed snake and agricultural areas with potential for recovery and determined to be important to the survival and recovery of the species. Populations of the Tucson Shovel-nosed snake are becoming more fragmented and isolated due to loss and degradation of habitat, and local extirpations. In order to conserve the species, populations must be able to expand and connect with other populations.

VII. CONCLUSION

The Tucson Shovel-nosed snake is a beautiful and unique member of the fauna of the upper Sonoran Desert. Because of its dependence on sandy-loamy soils in flat valley bottoms, the Tucson Shovel-nosed snake has experienced a severe and dramatic loss of its habitat with likely but poorly studied impacts on populations. Efforts are under way to conserve Sonoran Desert habitats in portions of the Tucson Shovel-nosed snake's range. These efforts, however, come too

little and late. The Tucson Shovel-nosed snake clearly merits listing as a threatened or endangered species under the Endangered Species Act.

Sincerely,

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