

**AVRA VALLEY SNAKES: MARANA SURVEY REPORT FOR
TUCSON SHOVEL-NOSED SNAKE (*CHIONACTIS OCCIPITALIS KLAUBERI*)**

(Final Report on Shovel-Nosed Snake)

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**Figure 1. A juvenile Tucson Shovel-Nosed Snake from the Florence area. Photo by Erik Enderson.
The red bands may further darken to brown in the adult.**

Summary

Briefly, despite an intensive and productive June survey, we found no Tucson Shovel-Nosed Snakes in Avra Valley. They were last verified in Avra Valley in 1979, and could possibly be regionally extinct. We have two new records of the Ground Snake, one near Marana on the valley floor, and one in Marana at the Tortolita Mountains base. This survey has three significant limitations: it is limited to a single year; it follows a severe drought that appears to have markedly reduced populations of snakes to degrees that presumably vary among species; and it was initiated during the latter half of the seasonal activity cycle for the Tucson Shovel-Nosed Snake, after most of the year's activity had occurred. Notwithstanding these limitations, the conclusion that this taxon has severely declined since the mid-1970's in Avra Valley is inescapable. The entire taxon, *Chionactis occipitalis klauberi*, as currently recognized, may be threatened.

Introduction

The Western Shovel-Nosed Snake (*Chionactis occipitalis*, see Mardt et al., 2001a, b, &c; Klauber, 1951) is a small (10-14 inch long) harmless snake that uses venom to subdue its arthropod prey. It is colorfully banded as a coralsnake mimic, has a flattened head that allows it to move quickly (or even swim) through sand and soft soil, and is slender enough to be fast-moving on open ground (Fig. 1, on cover). Within the large snake family, the Colubridae, it is in a tribe, the Sonorini, that includes small, often specialized snakes. In our region, the Sonorini includes the Organ Pipe Shovel-Nosed Snake, the Banded Sand Snake, and the Ground Snake. Each of these lives on a characteristic kind of substratum (soil). The Western Shovel-Nosed Snake is the most arid-associated of these, and the most closely tied to sandy soils. It is most abundant in the great dunes of the Gran Desierto, Lower Colorado Valley, and Mohave Desert, where it can be the most abundant snake present. However, it also lives, or lived, east and northward into the margin of the Arizona Upland, near Ajo, Cave Creek, Florence, Picacho, and Marana.

The conservation status and taxonomy of the Western Shovel-Nosed Snake have not been recently treated in the published literature (white or gray), and there is considerable uncertainty about both. There are four described subspecies, but in an unpublished review, Cross (1979) did not provide unequivocal support for them as currently constituted. 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.

The study area for this project is the Avra Valley northwest of Tucson, Pima County, Arizona, and specifically in and immediately surrounding the expanding and growing town of Marana. This was a significant portion of the known range of the Tucson Shovel-Nosed Snake (*C. o. klauberi* Stickel [first described by William H. Stickel in 1941]; Fig. 1), a form characterized by dark pigment infusing the red cross-bands and other details of

coloration and scalation (see also Stebbins, 2003). As currently mapped, this taxon was known from the margin of the Arizona Upland, in places where it has been severely impacted by urban 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).

In addition to these sites, individual snakes somewhat to strongly resembling the Tucson Shovel-Nosed Snake are still seen, along with others characteristic of the Colorado Desert Shovel-Nosed Snake (*C. o. annulata*; Fig. 2) on the northeast fringe of the Tohono O'odham Nation, near Mobile in Sonoran Desert National Monument, and in the vicinity of Ajo. These populations are considered intermediate between the two subspecies, but there is no existing genetic data to support or reject this concept. However, in light of what is reported below, it may be that the genotype or unique genes of the Tucson Shovel-nosed Snake might only be significantly available for conservation in the area of Mobile.

Our objective here is to evaluate the status of the Tucson Shovel-Nosed Snake in the Marana region, as part of habitat conservation planning. As alluded to, our results are not encouraging, although some caveats about the adequacy of sampling need to be observed.



Fig. 2. An adult Colorado Desert Shovel-Nosed Snake (*Chionactis occipitalis annulata*) from near Sierra del Rosario, Sonora. Photo by P. C. Rosen.

Methods

We examined all museum records available to us, which included those from most major U.S. museum collections. On this basis, we plotted the known (verified) distribution of the Shovel-Nosed Snake in eastern Pima County (Fig. 3). Records came from Avra

Valley Road, from 3 miles west of Interstate Highway 10, to Pump Station Road, approximately 12 miles west of I10, and from U.S. highway 84 (now superseded by I10) from the area between Marana and Picacho Peak. The study area was defined as the Avra Valley, from Mile Wide Road on the south to Sasco Road at Red Rock, Pinal County, on

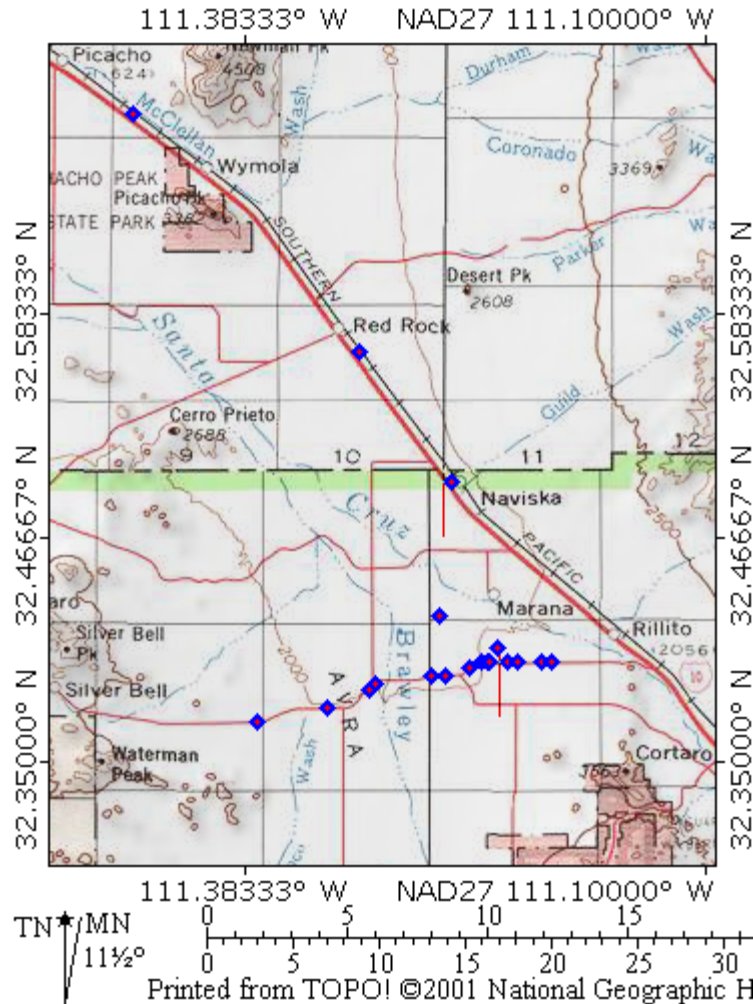


Figure 3. Distribution of Tucson Shovel-Nosed Snake (*Chionactis occipitalis klauberi*) in Avra Valley - Santa Cruz Flats region of Pima and Pinal counties, Arizona, based on plotable museum records, 1900-2003. Most records are on Avra Valley Road. Base image from TOPO! digital mapware.

the north, and from 2 miles east of the I10 Frontage Road to 2 miles west of Pump Station Road. The survey area was oriented in parallel to the orientation of the flats on the valley floor, (roughly parallel to I10), rather than strictly along a north-south axis.

We plotted all known (U.S. museum record vouchers) localities for the Avra Valley region on the 15-minute USGS topographical maps, and focused our sampling efforts near the known localities and in similar habitat. The habitat was level to very slightly sloping, fine to very-fine sandy-loamy desert below elevations of about 2100 feet or less.

We researched the seasonal activity cycle of this snake (see Klauber, 1931, 1939, 1951; Rosen et al., 1995) to supplement our existing experience, and also plotted the dates for museum records available to us for the region closer at hand, which pertains most nearly to the Tucson Shovel-Nosed Snake and our study area (Fig. 4). Results indicated that the Shovel-Nosed Snake in this region, in Avra Valley and similar environments, displays a peak of observed activity (primarily based on roadway appearances) during May, with significant, though decreasing activity through late June. There is residual activity in early July and almost no observed activity after that. This is in contrast to Klauber's (1951) observations in the "Colorado Desert" and Mohave Desert of southern California, where May and June showed similar activity levels and late summer activity was at 38% of the spring peak, contrasting sharply with Fig. 4 (ca. 11%) and with the Sonoran Shovel-Nosed Snake at Organ Pipe (Rosen et al., 1995; 11%), though it is higher in Yuma County (26%; personal observation).

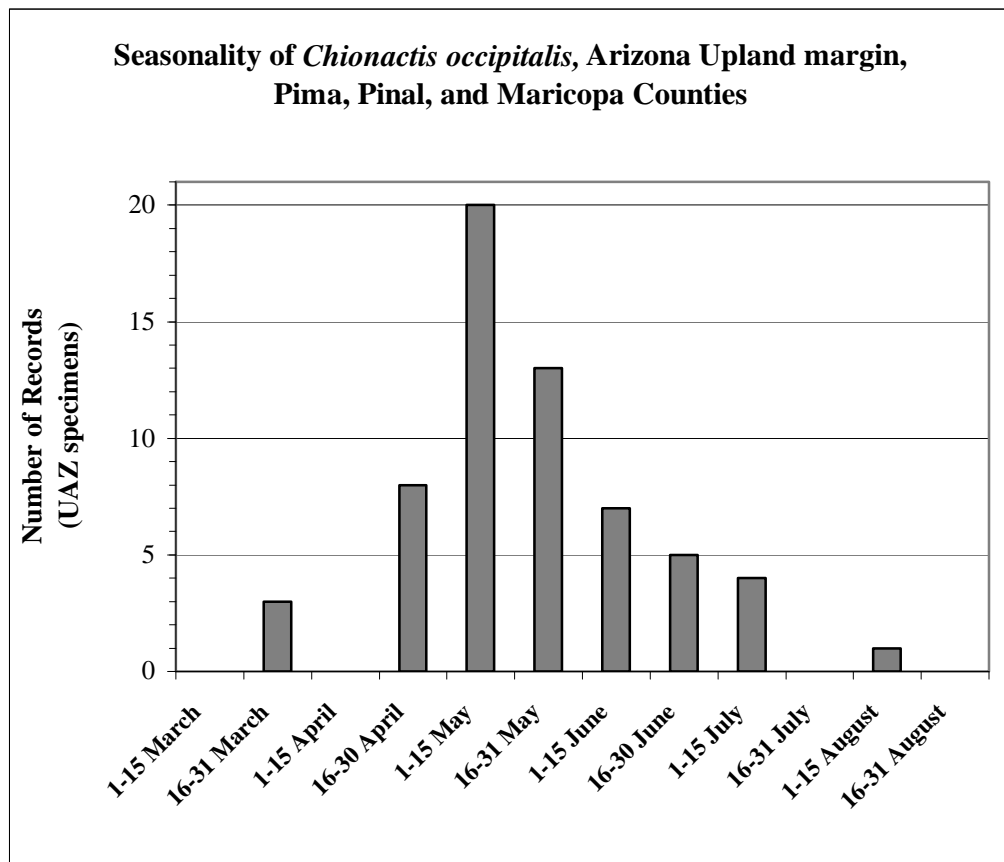


Figure 4. A rough measure of seasonality of observed activity of Shovel-Nosed Snakes in a general region ecologically like that occupied by the Tucson Shovel-Nosed Snake. Data courtesy of George L. Bradley, University of Arizona Herpetology Collection.

In the Arizona Upland, most snakes show increased activity during the July-early September monsoonal rains, and snake collectors respond with increased effort. There has been no shortage of people looking for snakes, and no shortage of records for those months for almost all species except the Shovel-Nosed Snakes. The summer rains seem

to “turn them off,” for reasons that might include hardening of the substratum after rains. Since summer rains are infrequent in Klauber’s main study region, and because we have strong evidence from both experience and the museum records, it is clear that the Tucson Shovel-Nosed Snake is not mobile enough to be reliably road-collected July-September.

For this reason, we rushed to start the sampling at the earliest possible date, which in our case were the rather late dates of May 31-June 4, 2003. Winter rains were good enough to produce a moderate spring bloom in the study region, and snake activity was expected to be good, based on previous work. However, preceding years, and particularly 2002, were times of major regional drought, with widespread observations of reduced reptile populations. As expected for a bloom year, substantial snake activity was observed throughout most of June; but similarly, total numbers observed were somewhere around 1/3 or less than expected at population densities prevailing during the 1980’s and 1990’s.

To ensure that shovel-nosed snake activity was occurring and observable in this year, during the June dates we sampled in Avra Valley, we also made three trips to the Mobile area, Maricopa County, Arizona, to “calibrate” our Avra Valley results to a site with known abundance of Shovel-Nosed Snakes near the Arizona Upland. We did observe two Western Shovel-Nosed Snakes during that time, even though the total effort (see Appendix 2) was far less than that for the core study area.

Results and Discussion

I. Jurisdictional Boundaries



Figure 5. Distribution of the Tucson Shovel-Nosed Snake in relation to the Marana town limits, based on historic localities backed up by museum specimen vouchers.

Museum records (Fig. 5) were primarily confined to Avra Valley Road because that was the principal paved road that was surveyed in Avra Valley prior to the decline of the Tucson Shovel-Nosed Snake. An additional record was obtained from Bing Wong's place west of the airport, and one that apparently was from just south of Nelson on Silverbell Road. The I10 corridor (original as U.S. highway 84) yielded only one record in Marana, and two in Pinal County – one near Redrock and one south of Picacho. The paucity of records along the I10 corridor has three likely causes: (1) the habitat substratum along the corridor is primarily silty and clayey, and thus not optimal for the species, which likely occurs or occurred on sandier soils nearby; (2) heavy traffic volume in the corridor made it unattractive to collectors, and difficult to survey due to high speed traffic flow; and (3) much habitat along the corridor has been severely degraded.

On Avra Valley Road, Shovel-Nosed Snakes were found both inside and outside the current Marana town limits. Nearly half the original records were clearly from unincorporated Pima County lands.

II. Habitat and Geography

The distribution of records along Avra Valley Road, the only suitable transect prior to the decline, shows a concentration of records in the east-central portion of the valley, on sandy flats outside the primary floodplain of Brawley Wash. This may be partly an artifact of the timing of desert conversion relative to the onset of scientific sampling.

Sampling began in the mid-late 1950's by Dr. Charles H. Lowe and his graduate students at the University of Arizona, with a peak during the 1960's era when Robert L. Bezy, in particular, and others were making major collections there and elsewhere in Arizona. After the 1960's, and especially starting in the late 1970's, traffic increased on Avra Valley Road, and collectors began to concentrate on the road stretches west of the growing population centers, that is, from Anway Road or Pump Station Road west to Silver Bell Mine or town site.

I assume that there was always significant road hunting along this stretch, because International Biological Programme (IBP) and other herpetological activity were substantial in the 1960's and early 1970's in the area of Pump Station and Avra Valley Roads. This western stretch was extensively hunted during the 1980's, as well as in the 1990's, and the lack of Shovel-Nosed Snake records west of Pump Station Road, as well as in the first 3 miles west of I10 on Avra Valley Road, are not artifacts of collecting effort: those are near the actual limits of the population during the 20th century. However, few workers road-hunted on unpaved roads prior to recent years, so the paucity of records north and south of Avra Valley Road must be considered an artifact.

To the south, there was fairly intensive work along Mile Wide Road, with no records of shovel-nosed snakes. Furthermore, the land rises above 2100 feet elevation within about 4-6 miles south from Avra Valley Road, and this is about the elsewhere-observed upper elevation limit for *Chionactis occipitalis* in the Sonoran Desert. Thus, it is likely that

most of the original population was north of Mile Wide Road, and probably north of Manville Road. The population undoubtedly extended northward, down the Santa Cruz flats to Casa Grande and beyond. An examination of the downstream records also indicates they were in the mid-valley flats environment, and thus also heavily subject to decimation by advancing agriculture (and now, housing development).

In Avra Valley, U.S.G.S. topographic maps from the 1950's show agriculture largely confined to the "Cortaro Farms", which was the area west of I10 (then U.S. 84) from roughly Rillito and Tangerine Road to Hardin Road, north and east of the Santa Cruz River. Presumably the "cortaros" (cutters) removed the "marana" (mesquite thicket) to make way for these farms.

Regardless, a comparison of the 1954 15-minute Cortaro quadrangle with the 1967 7.5-minute Marana quadrangle suggests that the population area from Sanders Road to about three miles west of I10 was developed from desert to agriculture between 1954 and 1966, with many canals, wells, field-edge roads appearing in the interim. Thus, the abundant records of shovel-nosed snakes from this area came during and shortly after the agricultural expansion.

West of there, along Avra Valley Road near Brawley Wash (between Sanders and Trico Roads), the 1959 Silver Bell Peak quadrangle indicates that agricultural development was already widespread. It seems to have been earlier in this area, and this probably can partly account for the scarcity of shovel-nosed snake records (2 total) in this stretch. However, many areas close to the Brawley Wash have hard, adobe-like soils, and this may originally also have contributed to the snake's apparent rarity near there.

Further west, we have a slightly greater number of records (4 total), extending about 2 miles up the lower bajada from the valley floor flats (defined here as the level ground deposited by north-south arroyos perpendicularly to the flow pattern on the bajada). Given the heavy attention given the Silver Bell bajada, the lone bajada record suggests this environment was only occupied by the fringe of a valley floor-centered population.

Limited data on habitat was obtained during this study (Table 1). Most available records are from museum records, which are accurate to less than ± 0.1 miles, and often to about ± 1 mile. In Avra Valley, habitat destruction after the dates of collection has been substantial, making habitat characterization somewhat more difficult, and it has not been attempted here in detail. As such, habitat and soils cannot be judged precisely using the available data, but a very good general characterization of macrohabitat is possible, and Table 1 provides a first approximation of what the *Chionactis occipitalis* habitat is like as the species approaches its upper elevational limit near the Arizona Upland. This differs from what might be expected further west and lower down, where sandy soils and sand dunes may be the usual habitat. Here, in the higher desert, there is a tendency for the species to use productive creosote-mesquite floodplain environments (Rosen et al., 1995), but also apparently to occur in open creosotebush desert (Table 1). Soils are primarily soft, sandy loams, with sparse gravel, although one of the Mobile Road soil samples had much fine particulate material.

Table 1. Habitat variables for *Chionactis occipitalis* at or near the upper end of its ecological and elevational distribution. Road localities from near Mobile were provided by Robert Bezy and Erik Enderson. Soil characterizations in the field were made by Rosen or Julia Fonseca. ORPI (Organ Pipe Cactus National Monument) samples were collected by Rosen; the Avra Valley sample was collected by Verma Miera.

Taxon, Locality, & Field reading of soil type	Sample Date	Collector	Field Characterization	% Gravel	% Course sand	% Fine sand, silt, and clay	Vegetation
ORPI, Pozo Nuevo swale	12-May-91	PCR	fine sandy loam	11%	21%	68%	creosote swale
ORPI W bdry nr Pozo Nuevo	11-May-91	PCR	very fine sandy loam	13%	50%	37%	creosote-mesquite floodplain
Mobile #1, 0.1 mi E Mobile	28-Jun-03	PCR, JF	loamy sand	5%	46%	49%	desert bosque
Mobile #2, 1.0 mi W Mobile	28-Jun-03	PCR, JF	sandy loam	1%	39%	59%	xeroriparian
Mobile #3, 1.2 mi W Mobile	28-Jun-03	PCR, JF	sandy loam	1%	31%	67%	creosote flat
Mobile #4, 2.9 mi W Mobile	28-Jun-03	PCR, JF	sandy loam	11%	34%	55%	creosote flat
Mobile #5, 5.3 mi W Mobile	28-Jun-03	PCR, JF	gravelly-sandy loam	34%	18%	48%	creosote flat
Mobile #6, 5.6 mi W Mobile	28-Jun-03	PCR, JF	gravelly-sandy loam				creosote flat
Mobile #7, 7.2 mi W Mobile	28-Jun-03	PCR, JF	silty-sandy loam	4%	11%	85%	creosote flat
Mobile #8, 8.0 mi W Mobile	28-Jun-03	PCR, JF	gravelly-sandy loam	21%	17%	62%	creosote flat
Avra Valley Rd at Sanders	15-Apr-95	PCR, VM	sandy loam	3%	41%	56%	creosote-mesquite flat
MEAN			sandy loam with sparse gravel	10.4%	31.0%	58.6%	productive desert and creosote flats
N				10	10	10	
S.E.				3.3%	4.3%	4.2%	
MIN				1.4%	11.0%	37.2%	
MAX				34.1%	50.0%	85.0%	

III. Snakes in Avra Valley in 2003

We observed 81 individual snakes of 17 species, all on level valley floor desert, in the Marana region of Avra Valley (Table 2; see Appendix 1; Fig. 6). That is a full complement – every expected or reasonably possible native species, with the lone exception of the Shovel-Nosed Snake. We made three "calibration runs" to the area of Mobile, AZ, during the heart of our Avra Valley sampling, and observed two shovel-nosed snakes (along with 2 Spotted Leaf-Nosed Snakes, 2 Long-Nosed Snakes, and a Coachwhip), thus adding to our sense that we were doing the right thing at the right time.

In addition, in Avra Valley, we observed 5 snakes of a species (the Banded Sand Snake) that is morphologically, ecologically, and behaviorally similar to the shovel-nosed snake; the differences are that it (1) typically lives in rich desert ("Arizona Upland") rather than arid desert ("Lower Colorado Valley"), (2) moves less, (3) is generally rarely found on roads (except under heavy sampling - adding to the evidence that our efforts were right on), and (4) was only first recorded on the floor of Avra Valley around 1983.

The last verifiable record of the Shovel-Nosed Snake in Avra Valley was in 1979 near Avra Valley Road and Sanders Road junction (in present-day Marana). Thus, it is possible that a species replacement is occurring in Avra Valley. The Banded Sand Snake was undoubtedly present on the bajadas of all the mountains, and on the Santa Cruz River along the east side of Tucson Mountains. It was probably present in the center of Avra Valley (near Trico Road – Silverbell Road junction) on the sandy ridge separating the Santa Cruz floodplain from that of the Brawley-Los Robles-Blanco Wash. Until there were paved roads there, collecting would have been limited. Thus, the population could have been poorly known but present.

We observe that a second reptile species, the Desert Horned Lizard, which was originally present in Avra Valley, also became rare in the observational record starting in the early 1970's (last record 1991). Prior to this decline, museum records indicate it was about 1/5th as abundant as the Regal Horned Lizard. I have 28 records of horned lizards from Avra Valley in the appropriate region during our 2003 survey (they were out around dusk eating ants), as well as 8 more observations of my own during 1992-1998, and all of these are Regal Horned Lizards. In addition, others on the survey team observed some dozens of horned lizards in Avra Valley in recent years, also all Regal Horned Lizards. This species pair is a close analogy to the Shovel-Nosed Snake – Banded Sand Snake pair. The horned lizard of the Arizona Upland has remained abundant, and even may have increased in abundance; the horned lizard of the Lower Colorado Valley has decreased in observed abundance.

Verbal reports from the 1960's reveal that some snake collecting was done in this area where we found the Banded Sand Snakes on roads, and at least one Shovel-Nosed Snake was collected, though it apparently was not cataloged into the collection (R. L. Bezy, personal communication). This adds to the evidence that the Banded Sand Snake may have increased in abundance, as appears to be the case. Additionally, verbal records indicate that the Shovel-Nosed Snake was reasonably abundant and reliably found, with up to 2-3 being observed per night of road driving, during the 1970's (C. R. Schwalbe, personal communication). This confirms the severe decline of the Shovel-Nosed Snake.

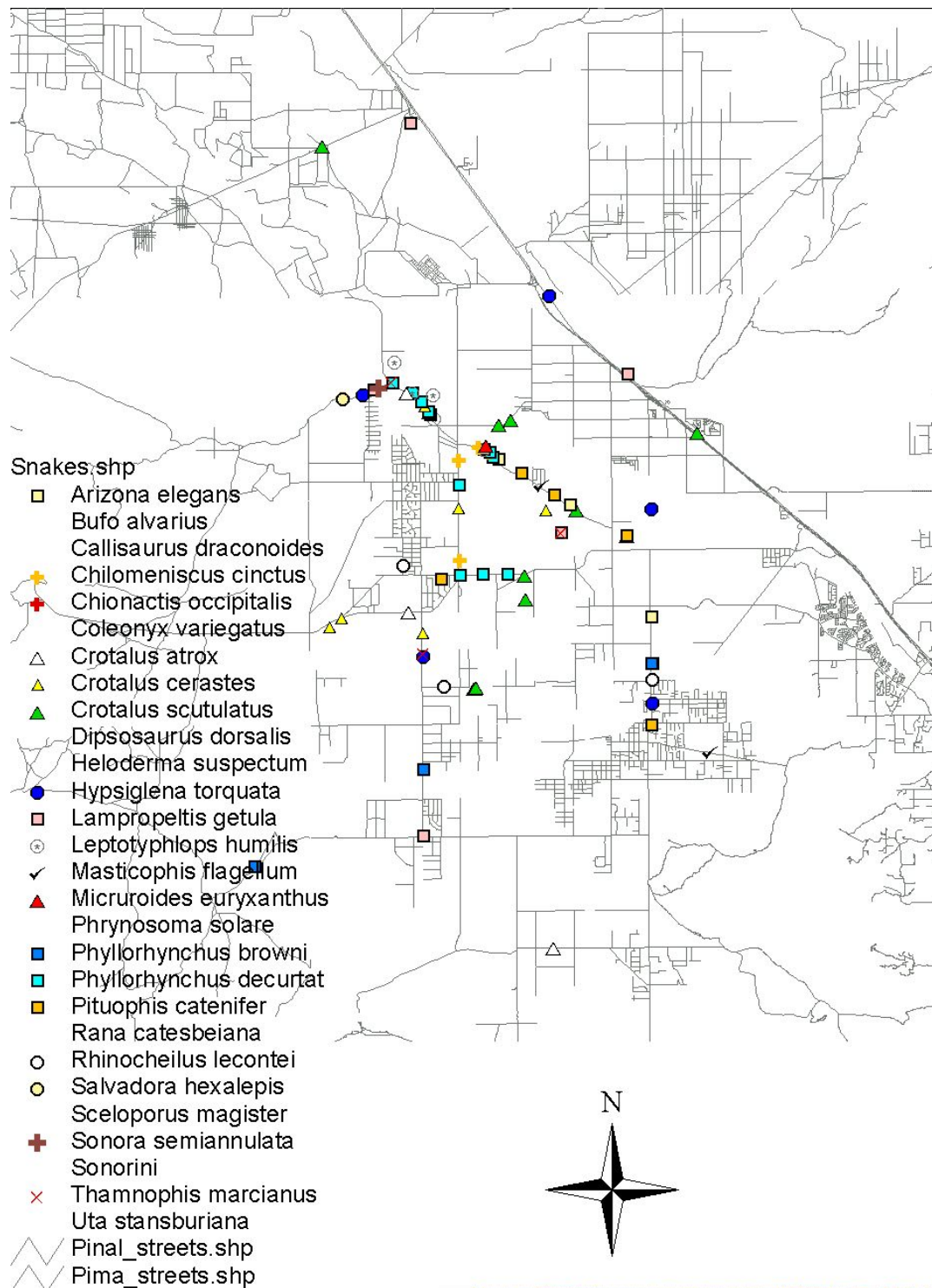


Figure 6. Snake records from Avra Valley survey, Pima and Pinal counties, Arizona, May 31-June 30, 2003, superimposed on the road grid.

Table 2. Reptiles and amphibians observed on the Avra Valley floor during road-cruising survey for the Tucson Shovel-nosed Snake during May 31-June 30, 2003. DOR is "dead on road", and LOR is "live on road".

Taxon	English Name	Number Observed					Total
		DOR	LOR	shed skin	track on sand	found while walking	
Snakes							
<i>Arizona elegans</i>	Glossy Snake	3	1				4
<i>Chilomeniscus cinctus</i>	Banded Sand Snake	4	1				5
<i>Chionactis occipitalis</i>	Western Shovel-nosed Snake	0	0	0	0	0	0
<i>Crotalus atrox</i>	Western Diamondback	3	2			2	7
<i>Crotalus cerastes</i>	Sidewinder	3	2		1		6
<i>Crotalus scutulatus</i>	Mohave Rattlesnake	3	4			3	10
<i>Hypsiglena torquata</i>	Night Snake	3	2				5
<i>Lampropeltis getula</i>	Common Kingsnake	3	2	1			6
<i>Leptotyphlops humilis</i>	Western Blind Snake	3	2				5
<i>Masticophis flagellum</i>	Coachwhip (Red Racer)	1					1
<i>Micruroides euryxanthus</i>	Sonoran Coralsnake	1					1
<i>Phyllorhynchus browni</i>	Saddled Leaf-nosed Snake	1	3				4
<i>Phyllorhynchus decurtatus</i>	Spotted Leaf-nosed Snake	9	3				12
<i>Pituophis catenifer</i>	Gopher Snake	4	2				6
<i>Rhinocheilus lecontei</i>	Long-nosed Snake	1	2				3
<i>Salvadora hexalepis</i>	Western Patch-nosed Snake	1					1
<i>Sonora semiannulata</i>	Ground Snake	1					1
<i>Thamnophis marcianus</i>	Checkered Garter Snake	1	1			2	4
All Snake Species		45	27	1	1	7	81
Lizards and Toads							
<i>Callisaurus draconoides</i>	Zebra-tailed Lizard		1			1	2
<i>Cnemidophorus tigris</i>	Tiger Whiptail		1				1
<i>Coleonyx variegatus</i>	Western Banded Gecko	6	24				30
<i>Dipsosaurus dorsalis</i>	Desert Iguana		1				1
<i>Heloderma suspectum</i>	Gila Monster	1					1
<i>Phrynosoma solare</i>	Regal Horned Lizard	18	7			2	27
<i>Sceloporus magister</i>	Desert Spiny Lizard					2	2
<i>Uta stansburiana</i>	Side-blotched Lizard	1				1	2
<i>Bufo alvarius</i>	Sonoran Desert Toad	2	4				6
<i>Rana catesbeiana</i>	American Bullfrog					3	3
All Lizards and Toads		28	38	0	0	9	75

IV. Potential Conservation Areas

Based on our sampling of the snake assemblage as a whole, the best potential conservation area in Marana proper, in Avra Valley (i.e., not including on the Tortolita bajada or in Tortolita Mountains), are the sections of land west of Sanders Road and north of Avra Valley Road, along Silverbell Road to the village of Nelson (sections 5, 6, 7, and 8 in T11S, R11E).

Although it is possible the Tucson Shovel-nosed Snake is now extirpated in the Avra Valley and Santa Cruz Flats, to those involved in the survey it appeared that sufficient habitat for it remained in Marana, unincorporated Pima County, and southern Pinal County (in the area of Red Rock to Picacho Peak). Further, the findings of this study unequivocally demonstrate a major decline in this important population area for this taxon. The taxon is thus clearly threatened throughout its currently known range, and is likely to be a focus of conservation efforts, or at least contention.

Therefore, a set of areas that seem to hold the best potential for conservation of the Tucson Shovel-nosed Snake in the region of Marana (Fig. 7) is offered in an annotated list. The objective is to familiarize the reader with what is left of the valley floor in the area, where these snakes, other reptiles, amphibians, plants, and mammals characteristic of the valley floor might still be preserved in some measure, along with the natural landscape.

Area 1. Silverbell Ridge. This is an area of slightly elevated, sandy ground projecting northward into the confluence of Santa Cruz River and Brawley Wash. Its southern end yielded the greatest concentration of Tucson Shovel-Nosed Snake museum records, and it still supports a high diversity of reptiles. This ridge contains the best valley floor snake diversity within the current Marana town limits.

Area 2. Brawley Flats. This area contains the least-disturbed tract of desert lands left within the distributional area of the Tucson Shovel-Nosed Snake in Pima County. Parts of this area are included in the planned Biological Reserve of the Sonoran Desert Conservation Plan. Sampling here in 2003 was of limited effectiveness, apparently because the foregoing drought severely affected most reptile populations – with the apparent exception of the Regal Horned Lizard. This area is in various stages of recovery from disturbance, as well as re-disturbance by wildcat housing development that is often heavily damaging to the land.

Area 3. Magee – Avra Roads Desert Flats. This area adjoins the Brawley Flats (Area 2), and also contains relatively undisturbed tracts of desert lands within the former (or present) distributional area of the Shovel-Nosed Snake. Part of this area is included in the Biological Core of the Sonoran Desert Conservation Plan. Sampling here in 2003 was of limited effectiveness, as in Area 2. Parts of this area have rich, sandy, productive desert flats with a mix of mesquite, blue paloverde, creosotebush, saltbush, and smaller shrubs. However, these areas are also being affected by unplanned development, as well as local overgrazing.

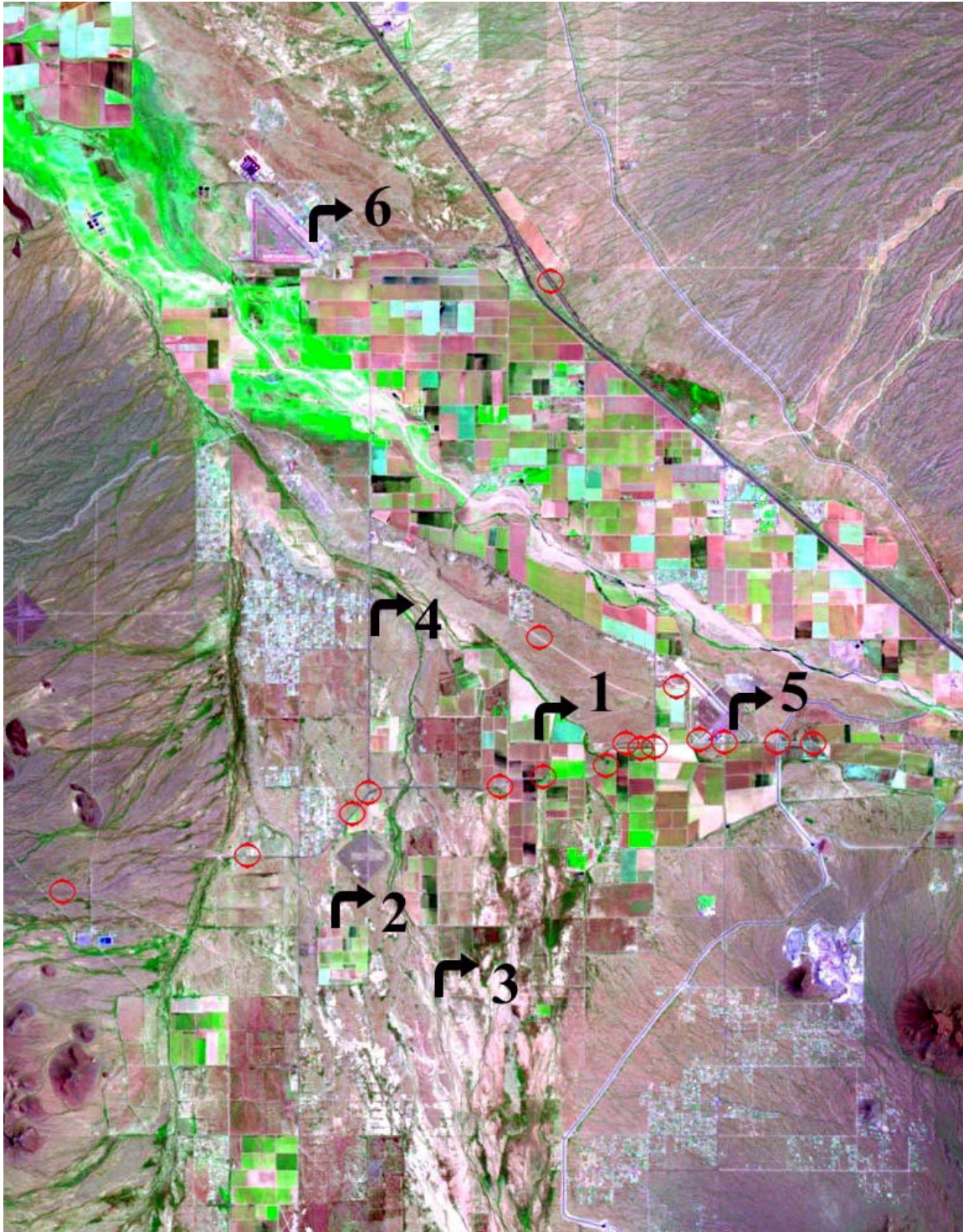


Figure 7. Museum records and potential conservation areas mapped onto a 1993 aerial image of the northern Avra Valley. The habitat associations at museum localities for the Tucson Shovel-nosed Snake (red ovals) may be inferred, although agricultural expansion (green – active; reddish – recovering) has obliterated desert habitat formerly occupied by snakes. Arrows point toward potential conservation areas, with numbers corresponding to discussion in the text. Base image source: University of Arizona A.R.T. lab, School of Renewable Natural Resources.

Area 4. Trico-Brawley Flats and North Silverbell Ridge. Parts of this area contain high quality mesquite and creosotebush environments, although much of the area is recovering from disturbance or is being affected by semi-suburban sprawl.

Area 5. Marana Airport Desert Flats. This area has been identified from the 1993 aerial photo of the survey region, and appears to still have some habitat potential that is probably within the area occupied by the Tucson Shovel-Nosed Snake. It was not effectively sampled during the 2003 work.

Area 6. Red Rock–Picacho Desert Flats. This area is north of the Pinal County line, running between I10 and Pinal Air Park. It contains the largest blocks of relatively intact desert lands within the former (or present) distributional area of the Tucson Shovel-Nosed snake in Avra Valley and Santa Cruz Flats. The area is difficult of access, but runs from Pinal Air Park Road, northeast across Sasco Road, then swings north around the west side of Picacho Peak State Park, and north nearly to Picacho. It has not been significantly surveyed north of Red Rock, and the sampling done in 2003 was of limited effectiveness, apparently because the foregoing drought severely affected most reptile populations in this desert environment – with the apparent exception of the Regal Horned Lizard. This area has the highest potential to yield records of the Tucson Shovel-Nosed Snake in this region.

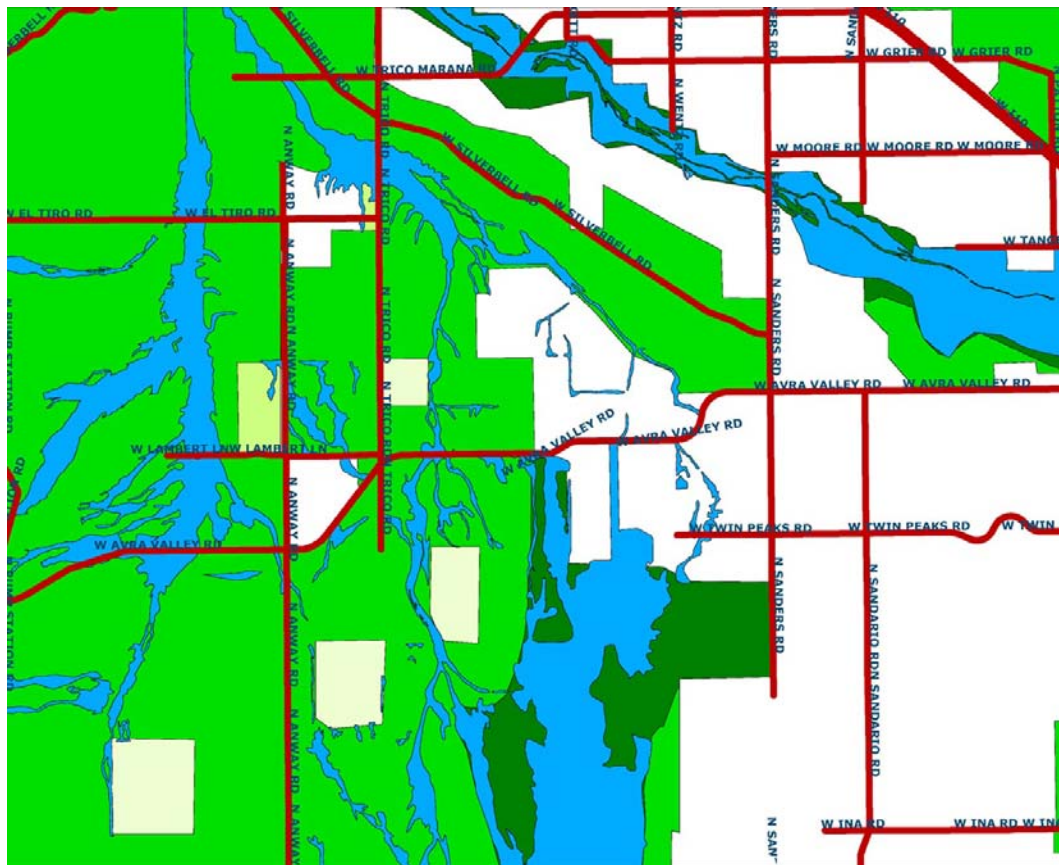


Figure 8. Sonoran Desert Conservation Plan reserve lands designation for the Avra Valley survey region. Dark green - Biological Core; bright green - Multiple Use Management; blue - Important Riparian Area; white – outside of reserve). Source: Pima County MapGuide (website), 9-1-03.

Conclusions

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 unincorporated 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.

There can be no reasonable doubt that the Tucson shovel-nosed snake has severely declined in Avra Valley (including Marana) since the 1960's and 1970's. (1) There are no museum records since 1979; (2) University of Arizona herpetology personnel continued activity in Avra Valley during the 1980's; (3) we have worked Avra Valley intensively off and on since 1991; (4) our June 2003 survey was effective but yielded no shovel-nosed snakes; and (5) we have no reliable reports of observations of shovel-nosed snake in Avra Valley since 1979. All this evidence is consistent and conclusive. The question is whether the species is extinct in Avra Valley or not.

It appears to us that habitat suitable for the Tucson shovel-nosed snake remains in Avra Valley, including in Marana. Examples are around the airport; north of Twin Peaks Road between Tucson Mountains and Sanders Road; northwest of Avra Valley Road and Sanders Road between Silverbell Road and the agricultural fields southwest of the Brawley Wash diversion channel; and the large area south of Avra Valley Road to about 2 miles south of the Magee Road alignment, from Pump Station and Anway Roads east across the Brawley flats to Avra Road or Sander Road.

We looked in this area and failed to find evidence of Shovel-Nosed Snakes. The habitat is fragmented; some of it has been impacted by plowing at some past time; much of it has been degraded by the incision of Brawley Wash, with attendant erosional loss of vegetation and sandy soil; and the entire area may also have been impacted by changes leading to loss of arid Lower Colorado Valley desert conditions and enhancement of less arid Arizona Upland desert conditions. All these findings point toward a possibility that the shovel-nosed snake is extinct in the region.

Against this conclusion, are the following points: (1) our survey was in June, while peak activity is in May; (2) although spring 2003 was productive in Avra Valley, and snake activity was substantial, the foregoing, severe drought apparently caused major reductions in snake populations, and the total numbers we saw were low; (3) the number of snakes observed in the most arid parts of Avra Valley, where Shovel-Nosed Snakes would most likely be if they still exist, was very low, and appeared to reflect the drought effects more strongly than other areas closer to agriculture, on bajadas, and near low-density human populations. Thus, the survey was not ideal, and does not permit a conclusion that the Shovel-Nosed Snake is gone from Avra Valley. Certainly it has sharply declined, is now very rare if it is present, and, if it is present, would be likely to disappear without special efforts at recovery.

Ground Snake Findings

During our sampling we found a single Ground Snake, on the Blanco Wash bottom at Silverbell Road (not in Marana proper, but close enough to verify that the Avra Valley population still exists). We also received a 2003 photo voucher of this species from the base of the Tortolita Mountains within Marana town limits. Thus far, we have conducted little survey for this species in Marana outside areas most likely to yield Shovel-Nosed Snakes. The 2003 records indicate that further sampling may reveal viable populations of the Ground Snake in and near Marana.

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APPENDIX 1. Reptiles and amphibians observed in Avra Valley and on Mobile Road, Arizona, during surveys for the Western Shovel-nosed snake, May 31-June 30, 2003.

Taxon	Obs Type	Locality	UTM-E (NAD 27)	UTM-N (NAD 27)	Date	Obs.
<i>Arizona elegans</i>	DOR	Sandario Rd., 1.8 mi (rd) S Avra Valley Rd.	479675	3581979	19-Jun-2003	GLB
<i>Arizona elegans</i>	DOR	Silver Bell Rd., 0.7 mi (rd) SE Trico Rd.	472529	3589224	27-Jun-2003	GLB
<i>Arizona elegans</i>	LOR	Silver Bell Rd., 1.0 mi (rd) SE Trico Rd.	473170	3588792	18-Jun-2003	GLB
<i>Arizona elegans</i>	DOR	Silver Bell Rd., 1.4 mi (rd) NW Sanders Rd.	476200	3586798	23-Jun-2003	GLB
<i>Bufo alvarius</i>	DOR	Anway Rd, 3.8 mi N Manville Rd	NA	NA	29-Jun-2003	RLB
<i>Bufo alvarius</i>	LOR	Mile Wide Rd at 2.8 mi (rd) W Sandario Rd	474988	3567782	6-Jun-2003	PCR
<i>Bufo alvarius</i>	LOR	Picture Rocks Rd., ca 0.5 mi (rd) W Sandario	478615	3576667	18-Jun-2003	GLB
<i>Bufo alvarius</i>	LOR	Safford and Wasson Rds.	NA	NA	7-Jun-2003	PCR
<i>Bufo alvarius</i>	LOR	Silverbell Rd, 1.8 mi W Trico-Marana Rd	NA	NA	6-Jun-2003	RLB
<i>Bufo alvarius</i>	DOR	Silverbell Rd, 1.9 mi E Pump Station Rd	NA	NA	6-Jun-2003	RLB
<i>Bufo alvarius</i>	LOR	Trico Marana Rd 0.8 mi E of Luckett Rd	NA	NA	16-Jul-2003	MA
<i>Callisaurus draconoides</i>	LOR	Magee Rd., 0.1 mi E Anway Rd	469999	3579041	9-Jun-2003	PCR
<i>Callisaurus draconoides</i>	DOR	Mobile Rd., 14.4 mi (rd) W Mobile	NA	NA	28-Jun-2003	PCR
<i>Callisaurus draconoides</i>	Live	Powerline Rd., state land	475162	3586630	26-Jun-2003	PCR
<i>Chilomeniscus cinctus</i>	DOR	Silverbell Rd, 0.6 mi E Trico Rd	472321	3589319	6-Jun-2003	RLB
<i>Chilomeniscus cinctus</i>	DOR	Silverbell Rd, 0.6 mi ESE Trico Rd	472321	3589319	7-Jun-2003	RLB
<i>Chilomeniscus cinctus</i>	DOR	Silverbell Rd, 1.0 mi ESE Trico Rd	472790	358911	29-Jun-2003	RLB
<i>Chilomeniscus cinctus</i>	DOR	Trico Rd at Brawley Wash	471466	358-8755	25-Jun-2003	DJC
<i>Chilomeniscus cinctus</i>	LOR	Trico Rd 0.5 mi N Avra Valley Rd	471458	358-4459	4-Jun-2003	DJC
<i>Chionactis occipitalis</i>	DOR	Mobile Rd, (Hwy 238) 7.2 mi WSW Mobile	370950	3654181	9-Jun-2003	RLB
<i>Chionactis occipitalis</i>	LOR	Mobile Rd., 15.6 mi (rd) W Mobile	358572	3651759	28-Jun-2003	PCR
<i>Cnemidophorus tigris</i>	LOR	Silverbell Rd, 0.4 mi W Trico Rd	NA	NA	29-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR	Anway just S of Avra Valley Rd	469849	3581883	16-Jun-2003	DJC
<i>Coleonyx variegatus</i>	DOR	Anway Rd., 1.4 mi (rd) S Avra Valley Rd.	469847	3580260	28-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	Avra Valley Rd. at Silver Bell Rd.	478067	3584874	8-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	I-10 Frontage Rd. (W side), 0.7 mi (rd) S Marana interchange	480619	3590795	7-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	Mobile Rd (Hwy 238) 23.0 mi WSW Mobile	NA	NA	18-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR	Mobile Rd (Hwy 238) 25.8 mi WSW Mobile	NA	NA	18-Jun-2003	RLB
<i>Coleonyx variegatus</i>	DOR	Mobile Rd., 7.3 mi (rd) W Mobile School	NA	NA	28-Jun-2003	PCR
<i>Coleonyx variegatus</i>	LOR	Moore Rd., 0.5 mi (rd) E Silver Bell Rd.	478869	3588920	7-Jun-2003	GLB
<i>Coleonyx variegatus</i>	DOR	Sandario Rd. at Anthony Rd.	479681	3578276	26-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	Sandario Rd., 1.1 mi (rd) S Avra Valley Rd.	479666	3583115	10-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	Sasco Rd, 1.6 mi (rd) SW I-10	467276	3602993	8-Jun-2003	PCR
<i>Coleonyx variegatus</i>	LOR	Sasco Rd, 1.8 mi (rd) SW I-10	466853	3602795	8-Jun-2003	PCR
<i>Coleonyx variegatus</i>	DOR	Silver Bell Rd., 0.2 mi (rd) NW Sanders Rd.	477730	3585973	10-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	Silver Bell Rd., 0.5 mi (rd) SE Trico Rd.	472234	3589342	6-Jun-2003	GLB
<i>Coleonyx variegatus</i>	DOR	Silver Bell Rd., 0.8 mi (rd) NW Sanders Rd.	476878	3586344	23-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR	Silver Bell Rd., 1.55 mi W Trico Rd.	469751	3591407	18-Jun-2003	PCR
<i>Coleonyx variegatus</i>	LOR	Silver Bell Rd., 2.2 mi E of Trico Rd.	474514	3587958	18-Jun-2003	PCR
<i>Coleonyx variegatus</i>	LOR	Silverbell Rd W of Trico	470539	3590403	18-Jun-2003	DJC
<i>Coleonyx variegatus</i>	LOR	Silverbell Rd, 0.3 mi W Trico-Marana Rd	NA	NA	16-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR	Silverbell Rd, 0.5 mi E Trico-Marana Rd	NA	NA	16-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR	Silverbell Rd, 0.6 mi W Sanders	NA	NA	16-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR	Silverbell Rd, 0.8 mi W Sanders	NA	NA	16-Jun-2003	RLB

<i>Coleonyx variegatus</i>	DOR Silverbell Rd, 0.9 mi NW Trico-Marana Rd	NA	NA	6-Jun-2003	RLB
<i>Coleonyx variegatus</i>	DOR Silverbell Rd, 1.0 mi W Sanders Rd	NA	NA	16-Jun-2003	RLB
<i>Coleonyx variegatus</i>	DOR Silverbell Rd, 1.0 mi W Sanders Rd	NA	NA	29-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR Silverbell Rd, 1.2 mi E Trico Rd	NA	NA	8-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR Silverbell Rd, 1.6 mi W Sanders Rd	NA	NA	6-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR Silverbell Rd, 2.1 mi W Sanders Rd	NA	NA	29-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR Silverbell Rd, 2.8 mi W Sanders	NA	NA	16-Jun-2003	RLB
<i>Coleonyx variegatus</i>	LOR Silverbell Rd, 4.1 mi E Trico Rd	NA	NA	6-Jun-2003	RLB
<i>Coleonyx variegatus</i>	DOR Trico Rd., 0.7 mi (rd) S Silver Bell Rd.	471454	3588460	18-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR Trico Rd., N side of Brawley Wash	471452	3589011	18-Jun-2003	GLB
<i>Coleonyx variegatus</i>	LOR Twin Peaks Rd., 2.4 mi E Sandario Rd	483318	3582464	7-Jun-2003	PCR
<i>Crotalus atrox</i>	LOR Avra Valley Rd., 0.5 mi (rd) W of Anway Rd	469233	3582266	29-Jun-2003	PCR
<i>Crotalus atrox</i>	VIS Magee Rd arroyo E of Trico	472036	3578942	18-Jun-2003	DJC
<i>Crotalus atrox</i>	VIS Magee Rd arroyo E of Trico	472040	3578954	19-Jun-2003	DJC
<i>Crotalus atrox</i>	DOR Mile Wide Rd at 2.6 mi (rd) W Sandario Rd	475323	3567782	6-Jun-2003	PCR
<i>Crotalus atrox</i>	LOR Pump Station Rd, .7 mi S Silverbell Rd	NA	NA	10-Jun-2003	EFE
<i>Crotalus atrox</i>	DOR Silver Bell Rd., 1.1 mi (rd) W of Trico Rd.	470182	3590875	9-Jun-2003	PCR
<i>Crotalus atrox</i>	DOR Silverbell Rd, 0.5 mi SW Aguirre Rd	469221	3591707	29-Jun-2003	RLB
<i>Crotalus cerastes</i>	LOR Anway Rd, 5.4 mi N Manville Rd	469836	3581356	29-Jun-2003	RLB
<i>Crotalus cerastes</i>	DOR Avra Valley Rd., 0.6 mi (rd) E Pump Station Rd.	465829	3581669	27-Jun-2003	GLB
<i>Crotalus cerastes</i>	LOR Avra Valley Rd., 0.9 mi (rd) E Pump Station Rd.	466325	3582021	27-Jun-2003	GLB
<i>Crotalus cerastes</i>	track Powerline Rd., state land	475162	3586630	26-Jun-2003	PCR
<i>Crotalus cerastes</i>	DOR Silver Bell Rd., 1.3 mi (rd) NW Trico Rd	469984	3591140	5-Jun-2003	PCR
<i>Crotalus cerastes</i>	DOR Trico Rd., 1.9 mi (rd) N Avra Valley Rd.	471422	3586727	27-Jun-2003	GLB
<i>Crotalus scutulatus</i>	LOR El Paso Gasline Rd., 0.1 mi (rd) W Avra Valley Rd.	474249	3583811	29-Jun-2003	PCR
<i>Crotalus scutulatus</i>	LOR I-10 Frontage Rd. (W side), 1.6 mi (rd) S Marana interchange	481716	3589863	7-Jun-2003	GLB
<i>Crotalus scutulatus</i>	VIS Magee Rd arroyo E of Trico	472085	3579017	18-Jun-2003	DJC
<i>Crotalus scutulatus</i>	VIS Magee Rd arroyo E of Trico	472085	3579017	19-Jun-2003	DJC
<i>Crotalus scutulatus</i>	VIS S of Avra Valley Rd and W of Sanders	474267	3582793	18-Jun-2003	DJC
<i>Crotalus scutulatus</i>	DOR Sanders Rd., 0.3 mi (rd) N Avra Valley Rd.	478620	3585458	6-Jun-2003	GLB
<i>Crotalus scutulatus</i>	LOR Sasco Rd, 2.5 mi (rd) SW I-10	465699	3602332	8-Jun-2003	PCR
<i>Crotalus scutulatus</i>	DOR Silver Bell Rd., 1.1 mi (rd) NW Sanders Rd.	476489	3586599	21-Jun-2003	GLB
<i>Crotalus scutulatus</i>	DOR Trico Marana Rd at Santa Cruz River Bridge	473706	3590508	31-May-2003	PCR
<i>Crotalus scutulatus</i>	LOR Trico-Marana Rd. 1/2 mi W Santa Cruz River	473195	3590295	8-Jun-2003	PCR
<i>Dipsosaurus dorsalis</i>	LOR Pima-Pinal County line, 0.05 mi E of Trico Rd	471561	3596267	8-Jun-2003	PCR
<i>Heloderma suspectum</i>	DOR Silverbell Rd, 0.8 mi ESE Trico Rd	472576	3589215	29-Jun-2003	RLB
<i>Hypsiglena torquata</i>	DOR Anway Rd, 4.8 mi N Manville Rd	469840	3580331	29-Jun-2003	RLB
<i>Hypsiglena torquata</i>	DOR East I-10 frontage Rd., 3.8 mi (rd) N Marana exit	475423	3595825	31-May-2003	PCR
<i>Hypsiglena torquata</i>	LOR Sandario Rd. at Anthony Rd.	479681	3578276	7-Jun-2003	GLB
<i>Hypsiglena torquata</i>	DOR Silver Bell Rd., 0.4 mi (rd) NW Sanders Rd.	479695	3586610	23-Jun-2003	GLB
<i>Hypsiglena torquata</i>	LOR Silverbell Rd, 0.2 WSW Cocio Rd	467331	3591621	16-Jun-2003	RLB
<i>Lampropeltis getula</i>	LOR Anway Rd., 0.02 mi (rd) N Manville Rd.	469809	3572619	29-Jun-2003	PCR
<i>Lampropeltis getula</i>	shed Field Corner Tank, state land	475827	3585609	26-Jun-2003	PCR
<i>Lampropeltis getula</i>	LOR Gasline Rd SW of Saguaro Powerplant	469498	3603287	8-Jun-2003	PCR
<i>Lampropeltis getula</i>	DOR Marana	478726	3592412	26-Jun-2003	PCR
<i>Lampropeltis getula</i>	DOR Sandario Rd., 0.6 mi (rd) S Avra Valley Rd.	479681	3579951	27-Jun-2003	GLB
<i>Lampropeltis getula</i>	DOR Silver Bell Rd., 0.2 mi (rd) WSW Los Robles Wash	467810	3591813	10-Jun-2003	GLB
<i>Leptotyphlops humilis</i>	DOR Silver Bell Rd., 0.4 mi (rd) E Los Robles Wash	468721	3592990	19-Jun-2003	GLB
<i>Leptotyphlops humilis</i>	LOR Silver Bell Rd., 0.5 mi (rd) SE Trico Rd.	472546	3589231	10-Jun-2003	GLB

<i>Leptotyphlops humilis</i>	DOR	Silver Bell Rd., 0.9 mi (rd) E Los Robles Wash	469467	3591690	17-Jun-2003	GLB
<i>Leptotyphlops humilis</i>	DOR	Silver Bell Rd., 0.9 mi (rd) W Trico Rd.	470413	3590547	19-Jun-2003	GLB
<i>Leptotyphlops humilis</i>	LOR	Silver Bell Rd., 1.5 mi (rd) SE Los Robles Wash	470390	3591600	10-Jun-2003	GLB
<i>Masticophis flagellum</i>	DOR	Mobile Rd., 6.2 mi (rd) W Maricopa	393447	3660379	28-Jun-2003	PCR
<i>Masticophis flagellum</i>	DOR	Picture Rocks Rd., 1.4 mi W of Saguaro National Park	482149	3576114	30-Jul-2003	MA
<i>Masticophis flagellum</i>	DOR	Silver Bell Rd., 2.2 mi (rd) NW Sanders Rd.	474991	3587613	26-Jun-2003	GLB
<i>Micruroides euryxanthus</i>	DOR	Silver Bell Rd., 0.3 mi (rd) E Trico Rd.	472630	3589390	26-Jun-2003	GLB
<i>Phrynosoma solare</i>	DOR	Anway Rd., 0.7 mi (rd) S Avra Valley Rd.	469844	3581095	9-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Avra Valley Rd. at Trico Rd	471451	3583730	6-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Avra Valley Rd., 0.3 mi (rd) E Trico Rd.	471991	3583856	29-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Avra Valley Rd., 0.8 mi (rd) W Garvey Rd	471801	3583866	9-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Avra Valley Rd., 1.0 mi (rd) E Anway Rd.	471175	3583353	29-Jun-2003	PCR
<i>Phrynosoma solare</i>	Live	Brawley Wash, 0.35 mi (air) S Magee Rd.	473045	3578474	9-Jun-2003	PCR
<i>Phrynosoma solare</i>	Live	Gasline Rd SW of Saguaro Powerplant	471649	3600487	8-Jun-2003	PCR
<i>Phrynosoma solare</i>	LOR	Gasline Rd., 2.6 mi (rd) S Sasco/Red Rock Rd	471651	3600492	30-Jun-2003	PCR
<i>Phrynosoma solare</i>	LOR	Gasline Rd., 2.7 mi (rd) S Sasco/Red Rock Rd	471794	3600297	30-Jun-2003	PCR
<i>Phrynosoma solare</i>	LOR	Gasline Rd., 5.6 mi (rd) S Sasco/Red Rock Rd.	472384	3597612	30-Jun-2003	PCR
<i>Phrynosoma solare</i>	LOR	Magee Rd., 0.3 mi E Anway Rd	470076	3579043	9-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Mannville Rd, 0.6 mi W Anway Rd	NA	NA	29-Jun-2003	RLB
<i>Phrynosoma solare</i>	DOR	Mannville Rd, 1.1 mi W Anway Rd	NA	NA	29-Jun-2003	RLB
<i>Phrynosoma solare</i>	DOR	Manville Rd., 0.6 mi E Anway Rd.	470786	3572601	29-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Manville Rd., 1.0 mi E Anway Rd.	471297	3572605	29-Jun-2003	PCR
<i>Phrynosoma solare</i>	LOR	S of Avra Valley Rd and Trico Rd	473188	3583094	2-Jun-2003	DJC
<i>Phrynosoma solare</i>	LOR	S of Avra Valley Rd and Trico Rd	473053	3584292	2-Jun-2003	DJC
<i>Phrynosoma solare</i>	DOR	Silver Bell Rd. at Aguirre Rd.	468613	3592136	20-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Silver Bell Rd., 0.3 mi (rd) E Los Robles Wash	468631	3592127	26-Jun-2003	GLB
<i>Phrynosoma solare</i>	DOR	Silver Bell Rd., 0.5 mi (rd) E Los Robles Wash	469067	3591826	24-Jun-2003	GLB
<i>Phrynosoma solare</i>	DOR	Silver Bell Rd., 0.7 mi W Trico Rd.	470542	3590402	18-Jun-2003	PCR
<i>Phrynosoma solare</i>	DOR	Silver Bell Rd., 1.8 mi (rd) E Los Robles Wash	470520	3590437	24-Jun-2003	GLB
<i>Phrynosoma solare</i>	DOR	Silverbell Rd W of Trico	470539	3590403	18-Jun-2003	DJC
<i>Phrynosoma solare</i>	DOR	Silverbell Rd, 0.5 mi E Trico-Marana Rd	NA	NA	16-Jun-2003	RLB
<i>Phrynosoma solare</i>	LOR	Silverbell Rd, 6.5 mi W Sanders	NA	NA	16-Jun-2003	RLB
<i>Phrynosoma solare</i>	DOR	Silverbell Rd, between Trico and Trico-Marana Rd	NA	NA	6-Jun-2003	RLB
<i>Phrynosoma solare</i>	DOR	Trico at Pinal Air Park Rd	471474	3596376	8-Jun-2003	PCR
<i>Phyllorhynchus browni</i>	LOR	Anway Rd, 1.8 mi N Manville Rd	469820	3575502	29-Jun-2003	RLB
<i>Phyllorhynchus browni</i>	LOR	IRFO, 3.7 mi W IRFO entrance at Manville Rd	462543	3571373	6-Jun-2003	PCR
<i>Phyllorhynchus browni</i>	DOR	Sandario Rd., 0.5 mi (rd) S Emigh Rd	479676	3579962	24-Jun-2003	GLB
<i>Phyllorhynchus browni</i>	LOR	Silverbell Rd W of Trico	469471	3591687	18-Jun-2003	DJC
<i>Phyllorhynchus decurtatus</i>	LOR	Avra Valley Rd E of Trico Rd	473515	3583855	4-Jun-2003	DJC
<i>Phyllorhynchus decurtatus</i>	DOR	Avra Valley Rd., 0.6 mi (rd) E of Trico Rd.	472445	3583870	28-Jun-2003	GLB
<i>Phyllorhynchus decurtatus</i>	LOR	Gas line Rd, 2.9 mi W. Anway Rd	NA	NA	18-Jun-2003	EFE
<i>Phyllorhynchus decurtatus</i>	DOR	Mobile Rd (Hwy 238) 1.2 mi WSW Mobile	379468	3657444	18-Jun-2003	RLB
<i>Phyllorhynchus decurtatus</i>	DOR	Mobile Rd., 4.4 mi (rd) W Mobile School	374479	3655976	28-Jun-2003	PCR
<i>Phyllorhynchus decurtatus</i>	DOR	Silver Bell Rd., 0.3 mi (rd) E Los Robles Wash	468631	3592127	26-Jun-2003	GLB
<i>Phyllorhynchus decurtatus</i>	DOR	Silver Bell Rd., 0.9 mi (rd) SE Los Robles Wash	469492	3591688	30-Jun-2003	GLB
<i>Phyllorhynchus decurtatus</i>	DOR	Silver Bell Rd., 1.0 mi (rd) SE Trico Rd.	472909	3588885	21-Jun-2003	GLB
<i>Phyllorhynchus decurtatus</i>	DOR	Silver Bell Rd., 1.6 mi (rd) SE Los Robles Wash	470173	3590888	30-Jun-2003	GLB
<i>Phyllorhynchus decurtatus</i>	DOR	Silver Bell Rd., 1.9 mi (rd) SE Los Robles Wash	470244	3590736	30-Jun-2003	GLB
<i>Phyllorhynchus decurtatus</i>	LOR	Silverbell Rd, 0.8 mi NW Trico-Marana Rd	469864	3591286	6-Jun-2003	RLB

<i>Phyllorhynchus decurtatus</i>	DOR	Silverbell Rd, 1.0 mi ESE Trico Rd	472790	358911	16-Jun-2003	RLB
<i>Phyllorhynchus decurtatus</i>	DOR	Trico Rd at Avra Valley Rd intersection	471463	3583834	18-Jun-2003	DJC
<i>Phyllorhynchus decurtatus</i>	DOR	Trico Rd., 1.3 mi (rd) S Silver Bell Rd.	471464	3587686	18-Jun-2003	GLB
<i>Pituophis catenifer</i>	DOR	Anway Rd, 1.9 mi N. Avra Valley Rd.	NA	NA	18-Jun-2003	EFE
<i>Pituophis catenifer</i>	DOR	Avra Valley Rd W of Trico Rd	470634	3583661	4-Jun-2003	DJC
<i>Pituophis catenifer</i>	DOR	Sandario Rd., 0.3 mi (rd) N Picture Rocks Rd.	479649	3577317	17-Jun-2003	GLB
<i>Pituophis catenifer</i>	DOR	Sanders Rd., 0.3 mi (rd) N Avra Valley Rd.	478620	3585458	26-Jun-2003	GLB
<i>Pituophis catenifer</i>	LOR	Silverbell Rd, 1.9 mi NW Sanders Rd	475543	3587259	8-Jun-2003	RLB
<i>Pituophis catenifer</i>	LOR	Silverbell Rd, 3.0 mi NW Sanders Rd	474145	3588192	8-Jun-2003	RLB
<i>Rana catesbeiana</i>	Live	Farm Pond	473128	3595115	8-Jun-2003	PCR
<i>Rana catesbeiana</i>	Live	Park Link Jct. N Tank	468166	360681	8-Jun-2003	PCR
<i>Rana catesbeiana</i>	Live	Pond	474617	3595533	8-Jun-2003	PCR
<i>Rhinocheilus lecontei</i>	LOR	Magee Rd., 0.5 mi (rd) E Anway Rd	470754	3579046	9-Jun-2003	PCR
<i>Rhinocheilus lecontei</i>	DOR	Mobile Rd., 4.7 mi (rd) W Maricopa	395453	3660509	28-Jun-2003	PCR
<i>Rhinocheilus lecontei</i>	DOR	Mobile Rd., 4.85 mi (rd) W Maricopa	39545	366050	28-Jun-2003	PCR
<i>Rhinocheilus lecontei</i>	LOR	NW of Avra Valley Rd and Trico Rd	469019	3584292	2-Jun-2003	DJC
<i>Rhinocheilus lecontei</i>	DOR	Sandario Rd. at Magee Rd.	479681	3579286	23-Jun-2003	GLB
<i>Salvadora hexalepis</i>	DOR	Silver Bell Rd., 1.2 mi (rd) W Los Robles Wash	466512	3591452	19-Jun-2003	GLB
<i>Sceloporus magister</i>	Live	Levee of Field Corner Tank, state land	475827	3585609	26-Jun-2003	PCR
<i>Sceloporus magister</i>	Live	Powerline Rd., state land	475162	3586630	26-Jun-2003	PCR
<i>Sonora semiannulata</i>	DOR	Silver Bell Rd., 0.2 mi NW Los Robles Wash	468048	3591920	5-Jun-2003	PCR
<i>Sonorini</i>	track	Powerline Rd., state land	475162	3586630	26-Jun-2003	PCR
<i>Thamnophis marcianus</i>	DOR	Anway Rd., ca 0.9 mi (rd) S Avra Valley Rd.	469838	3580461	9-Jun-2003	PCR
<i>Thamnophis marcianus</i>	Vis	Field Corner Tank, state land	475827	3585609	26-Jun-2003	PCR
<i>Thamnophis marcianus</i>	Vis	Field Corner Tank, state land	475827	3585609	26-Jun-2003	PCR
<i>Thamnophis marcianus</i>	LOR	Silverbell Rd at Aguirre Rd	468595	3592142	8-Jun-2003	RLB
<i>Uta stansburiana</i>	VIS	S of Avra Valley Rd and W of Sanders	474376	3582962	18-Jun-2003	DJC
<i>Uta stansburiana</i>	DOR	Silverbell Rd, 5.4 mi E Aguirre Rd	NA	NA	16-Jun-2003	RLB

APPENDIX 2. Sampling effort (number of times each road segment was cruised looking for shovel-nosed snakes, and total miles) in the Avra Valley region and near Mobile, in Arizona, 2003.

Road Segment	5/31	6/2	6/4	6/5	6/6	6/7	6/8	6/9	6/10	6/16	6/17	6/18	6/19	6/20	6/21	6/23	6/24	6/25	6/26	6/27	6/28	6/29	6/30	sum
I10 Frontage Marana to Pinal line	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
I10 Frontage Marana to Redrock area	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4
I10 Frontage south fr Marana exit	0	0	0	2	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
Cochie Canyon Rd	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4
Adonis-Grier Rd (E of I10)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Trico Marana Rd	1	0	0	0	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5
Luckett Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardin Rd	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Barnett Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Postvale Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sanders Rd N of Silverbell Rd	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	4
Sanders Rd bet. Avr Val Rd & Silverbell	0	0	0	2	4	3	4	0	2	2	2	2	2	0	2	3	2	0	3	0	0	1	3	37
Silverbell Rd fr Sanders to ca. Blanco Wash	0	0	0	1	12	10	8	1	2	4	2	5	2	1	3	3	2	2	3	2	1	4	3	71
Back Rds nr Sanders and Avr Val Rd jct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Pump Station Rd	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Pipeline Rd	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
El Paso Rd - Garvey Rd	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	5
Tres Arroyos-El Tiro-Cocio Rd neighborhood	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Trico Rd	1	1	2	0	0	0	0	1	0	0	0	4	1	1	1	1	0	2	1	3	1	1	1	22
Avra Valley Rd betw I10 & Sanders	1	2	2	2	0	0	0	0	0	2	0	4	2	1	0	0	0	2	0	0	0	1	0	19
Avra Valley Rd betw Sanders & Pump Station	1	2	2	2	0	0	0	0	0	2	0	3	3	1	1	1	0	2	1	0	0	1	0	22
Avra Valley Rd for shorter stretch	1	0	0	0	2	1	2	2	2	0	0	2	2	0	2	2	2	0	2	5	5	3	2	37
Anway Rd	0	1	0	0	0	0	0	2	0	0	0	6	2	0	0	0	0	2	0	4	2	3	0	22
Magee Rd & other interior rds S of Av Val Rd	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Missile Base Rd	0	0	2	0	0	0	0	2	0	2	0	2	2	0	0	2	0	2	0	0	0	0	0	14
Avra Rd-Magee Rd-Via Cielo Vista	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Clayton-Sanders S of Avra Valley Rd	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Emigh-Sanders-Magee Rd block	0	0	0	1	1	1	2	0	1	0	1	1	0	0	1	1	1	0	1	0	0	0	0	12
Sandario Rd	0	0	0	1	2	1	2	0	2	0	2	2	2	0	2	2	2	0	2	2	2	0	2	28
Twin Peaks Rd W of Sandario	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Twin Peaks Rd E of Sandario	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
back roads E or W of Avra Valley Airport	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Airline-Lambert-Portland neighborhood	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sidewinder Lane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orange Grove Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manville Rd	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4
Mile Wide Rd	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
Reservation Rd	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
Pinal Air Park Rd	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sasco Rd	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Rds betw Pinal Air Park and Sasco	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4
Mobile Rd	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0	0	3	0	0	11
TOTAL MILES (cruising)	61	50	50	61	165	204	160	159	36	84	53	314	89	66	59	50	36	50	104	56	127	117	97	2249