Snakes

Charles Conner, Phil Rosen and Peter Holm

Objectives

The snake monitoring is following the protocol established by Rosen (2000) and in communication with Rosen, but no formal NPS protocol has been established yet. The objectives as currently understood are (1) monitor snakes as one major element in the predator assemblage at ORPI that affects other monitored components, particularly lizards, rodents, and small birds (see below), (2) maintain the continuity of a notably long-running (1987-2006) monitoring record for snakes, which have only been so monitored at one or a few other sites worldwide, and (3) collect significant baseline information on natural history and demographics, which are largely unrecorded for most of the species present. At present, the ongoing monitoring is confined to one site, on which other intensive monitoring is ongoing for other EMP elements. Some additional monitoring data is available for Highway 85, Armenta Road, Armenta Ranch, and Pozo Nuevo, although some of this is quite limited in temporal scope and total effort.

Introduction

Snakes are a diverse component of Sonoran Desert communities. A total of 26 snake species have been recorded at OPCNM (Rosen and Lowe 1996). At OPCNM, snakes are abundant and are likely major predators of lizards, small mammals and of bird eggs and nestlings. Some species are predators of arthropods but their significance is unknown. They are also important predators on each other, and their predator importance makes them likely competitors for predatory mammals and raptorial birds. Snakes are likely abundant enough at ORPI that they also comprise a significant part of the diet of certain larger predators that would be leading candidates for top-down regulation of ecosystem structure, such as red-tailed hawks, coyotes, and foxes.

Snakes are conspicuous casualties of highway and even backcountry motor vehicle traffic. Between 1988 and 1991, Rosen and Lowe (1994) estimated that ca 1000 snakes were killed annually between Why and Lukeville on State Highway 85. The Organ Pipe shovel-nosed snake may be particularly vulnerable because its known range and habitat in the United States is close to Highway 85. Other threats to OPCNM snakes include poaching, especially of the rosy boa and shovel-nosed snakes, and climate change effects on species near their range limit (Rosen and Lowe 1996).

Long-term ecological studies of snakes are few. The most notable is reported by Fitch (1999, and many references therein) for 50 years of annual snake monitoring at the University of Kansas Natural History Reservation and adjacent lands. Snake monitoring at ORPI is a continuation of dissertation research initiated in 1987 by Rosen (2000). At 20 years in 2006, this is the longest running snake monitoring study in the Sonoran Desert, and all told, 1093 individual captures have been registered on the local monitoring site.

The primary reason snake monitoring was continued by the NPS was to provide additional information about predators that may be affecting lizards and rodents at the East Armenta EMP Site. Birds have also been monitored at this site and are the only other monitored group that includes some predator species. Rosen (2000) reported that trends in some snake species or groups were related to climate, prey populations, and predator populations during his study of this site in 1987-1998.

It would be preferable to have two or more additional snake monitoring sites, but overly dispersing the effort could also reduce the important details provided by the protocol described below. The East Armenta site has the benefit of being fairly ordinary and representative

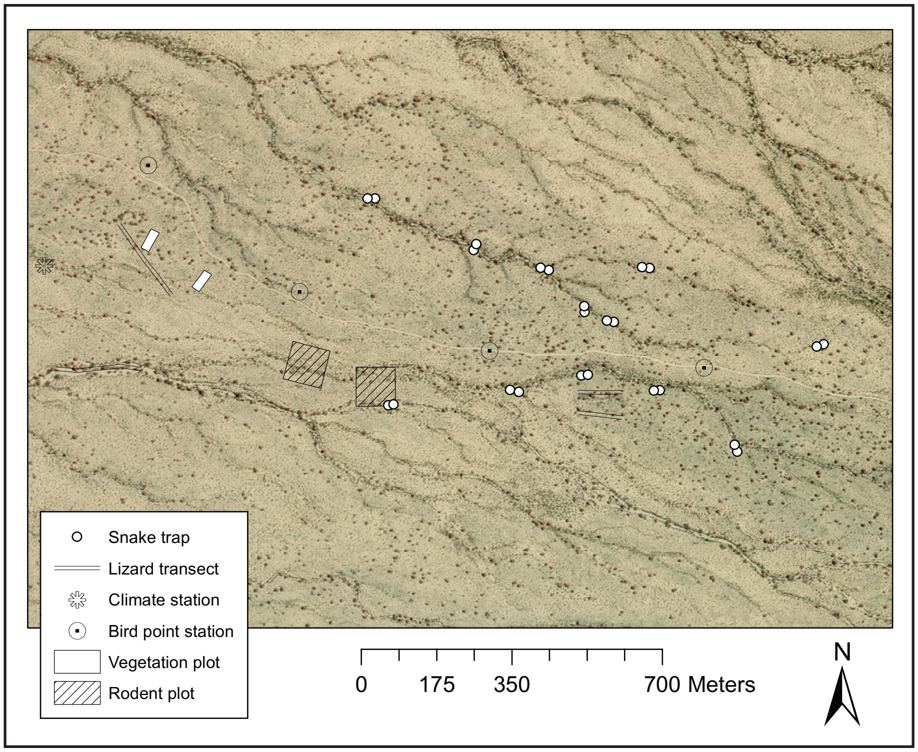

Figure 7-1. Snake monitoring study site map, Organ Pipe Cactus N.M.

while being accessible and support reasonably high diversity and abundance of snakes.

Methods

Snake monitoring at ORPI is conducted on an approximately 1km² study site adjacent to the East Armenta EMP site (Figure 7-1). Traps were installed in a variety of microhabitats, positioned so that they were likely to capture snakes and not expose captured animals to excessive heat. There are currently 12 trap stations (of the original 22), each consisting of 2 submerged buckets separated by a 12-18 m drift fence. Each drift fence consists of 3mm (1/8 inch) mesh hardware cloth, standing 75cm tall and sunk 15cm into the ground. At each end is a hardware cloth funnel trap, from which snakes enter and are trapped in a submerged plastic trash bucket with lid. The top 12cm of the bucket are above ground. Plywood boards, measuring approximately 30cm long and 25cm high are placed at the outer edges of the first funnel and at a 45° angle with the fence, to further guide animals into the funnel. Buckets are 75 or 110 liter capacity, with the entrances and screened vents approximately 50mm above ground, at minimum, to prevent flooding. The bucket lids are covered with a large piece of plywood to prevent overheating. Two false bottoms of screen (1 inch and 1/2 inch mesh) are installed to minimize predation within the trap buckets. Traps are checked once each day.

Each snake is permanently marked (with a unique, subcaudal scale clip), sexed, weighed, measured (including rattle segments), and examined for reproductive condition, food bolus, and injuries. Trap station, release time, and any pertinent notes such as banding pattern or color are also recorded. Snakes encountered outside traps are also processed. Snake traps are usually operated on 4 consecutive nights, once per month, from April to October. Monitoring has generally been scheduled to correspond to the dark moon phase and warm weather when possible. Snake monitoring also records species, age/size class, and trap location for all incidental captures of small mammals, lizards, amphibians, and large invertebrates. Data are recorded on field forms and later entered onto a spreadsheet.

All animals are released on site, with snakes being released into appropriately-sized burrows or other safe cover, or in the trap area at sunset. All necessary safety measures are taken when handling rattlesnakes and other biting animals. Trap entrances are blocked with the funnel edge boards when not in use, and the bucket lids are left slightly ajar, with sticks protruding just above the rim from the trap bottoms to facilitate the escape of any animals that may still get in.

Relative abundance was computed as the number of captures per trap night. Trap nights were computed as the number of nights multiplied by the number of traps. If traps were opened on mid-day Monday and closed on mid-day Friday, there would be 4 X 12 = 48 trap nights.

Results

Snake monitoring began in 1987 and has been conducted primarily by ORPI staff since 2000. There have been 3 known snake mortalities out of 365 captures between 2000 and 2005. One was eaten by another snake, one was apparently killed by ants, and one died during processing, presumably from excessive heat. Many animals other than snakes were also caught in the traps and some are killed. Most mortalities were due to predation, despite the use of false bottoms to separate animals of different sizes. There have been 45 documented lizard mortalities out of 2664 captures, 59 small mammal mortalities out of 1356 captures, 2 bird mortalities out of 4 captures, and 1 toad mortality out of 7 captures.

Monitoring activities for 2000-2005 are

Table 7-1. 2000-2005 sampling history at the snake study area, Organ Pipe Cactus N.M.

Start date	End date	Trap Nights	Start date	End date	Trap Nights
6/30/2000	7/7/2000	7	5/21/2003	5/25/2003	4
8/2/2000	8/6/2000	4	6/28/2003	7/3/2003	5
8/26/2000	9/3/2000	8	7/21/2003	7/28/2003	7
10/2/2000	10/6/2000	4	8/16/2003	8/21/2003	5
3/22/2001	3/27/2001	5	9/26/2003	9/30/2003	4
4/18/2001	4/23/2001	5	10/20/2003	10/24/2003	4
5/18/2001	5/23/2001	5	3/13/2004	3/16/2004	3
6/16/2001	6/20/2001	4	4/10/2004	4/15/2004	5
7/21/2001	7/25/2001	4	5/14/2004	5/18/2004	4
8/11/2001	8/15/2001	4	7/17/2004	7/21/2004	4
9/12/2001	9/17/2001	5	8/7/2004	8/12/2004	5
10/10/2001	10/13/2001	3	9/8/2004	9/14/2004	6
3/21/2002	3/23/2002	2	9/27/2004	9/29/2004	2
4/10/2002	4/13/2002	3	4/8/2005	4/11/2005	3
6/2/2002	6/6/2002	4	5/10/2005	5/13/2005	3
7/14/2002	7/18/2002	4	6/12/2005	6/15/2005	3
8/9/2002	8/11/2002	2	7/5/2005	7/9/2005	4
9/6/2002	9/11/2002	5	8/8/2005	8/13/2005	5
9/30/2002	10/3/2002	3	9/2/2005	9/6/2005	4
4/1/2003	4/4/2003	3	9/26/2005	9/29/2005	3
4/25/2003	4/29/2003	4			

Table 7-2. Relative abundance of snakes trapped on the snake study area, Organ Pipe Cactus N.M.. 1988-1998 data from Rosen (2000).

Scientific name	Species Code	Relative Abundance		Total Captures	
		2000-2004	1988-1998	2000-2004	1988-1998
Masticophis flagellum	Mafl	0.344	0.341	116	258
Hypsiglena torquata	Hyto	0.122	0.139	41	105
Crotalus atrox	Crat	0.128	0.106	43	80
Rhinocheilus lecontei	Rhle	0.083	0.114	28	86
Crotalus scutulatus	Crsc	0.033	0.074	11	56
Arizona elegans	Arel	0.098	0.033	33	25
Salvadora hexalepis	Sahe	0.065	0.041	22	31
Pituophis catenifer	Pica	0.030	0.032	10	24
Crotalus cerastes	Crce	0.039	0.025	13	19
Phyllorhynchus decurtatus	Phde	0.027	0.026	9	20
Micruroides euryxanthus	Mieu	0.006	0.026	2	20
Leptotyphlops humilis	Lehu	0.012	0.015	4	11
Phyllorhynchus browni	Phbr	0.009	0.008	3	6
Chilomeniscus cinctus	Chci	0.006	0.008	2	6
Lampropeltis getula	Lage	0.000	0.011	0	8
Chionactis palarostris	Chpa	0.000	0.001	0	1

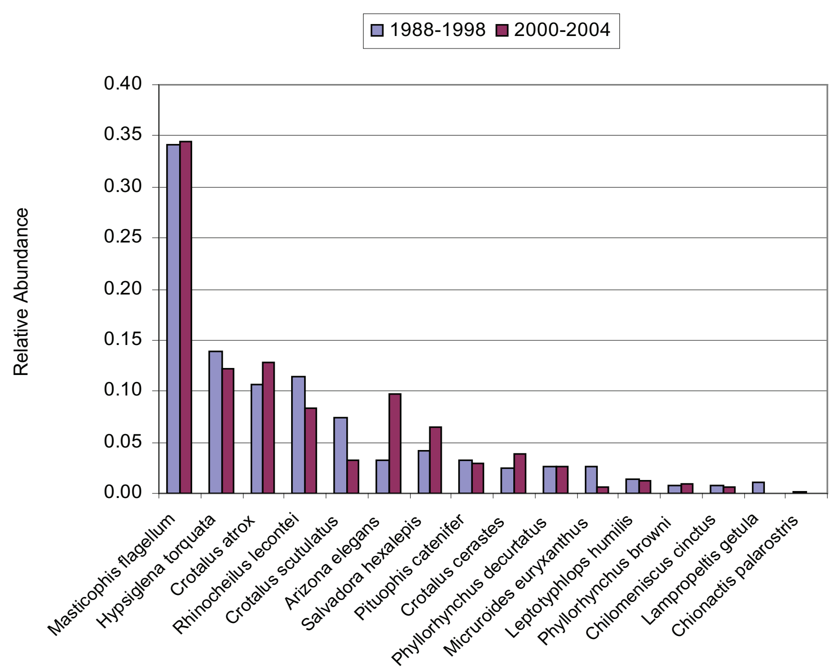

Figure 7-2. Relative abundance of snakes trapped on the snake study area, Organ Pipe Cactus N.M. 1988-1998 data from Rosen (2000).

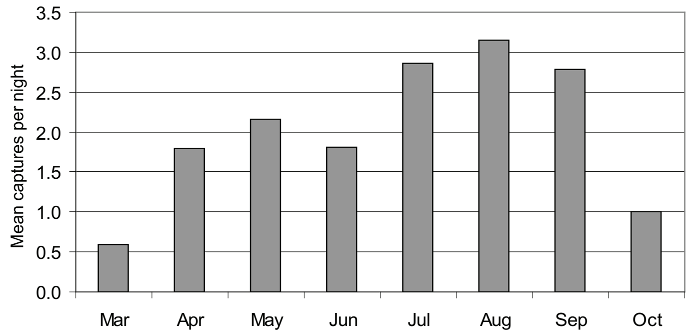

Figure 7-3. Mean snake captures per trap night by month on the snake study area, Organ Pipe Cactus N.M.

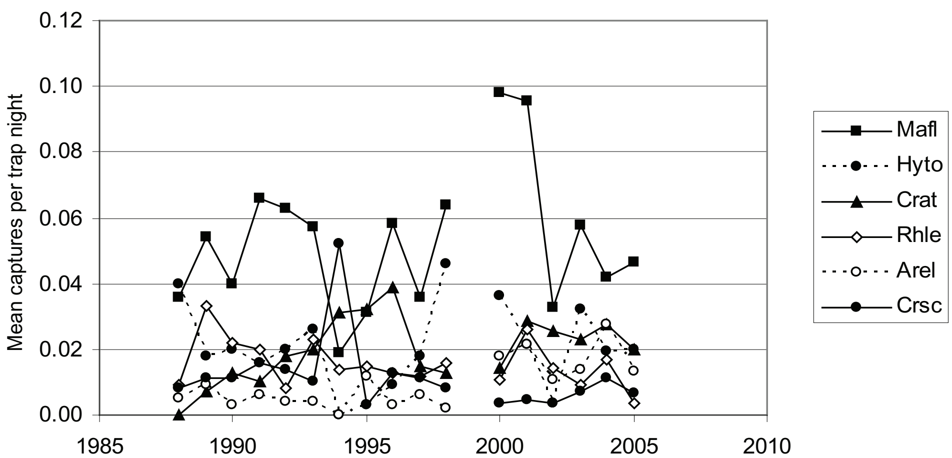

Figure 7-4, Mean snake captures per trap night for six common species on the snake study area, Organ Pipe Cactus N.M. 1988-1998 data are adjusted differently; see Rosen (2000).

summarized in Table 7-1. A total of 14 species of snakes have been recorded at the study site (Table 7-2). Changes in the relative abundance of some species between the periods1988-1998 and 2000-2004 are apparent in Figure 7-2. Species apparently declining are *Crotalus scutulatus*, *Micruroides euryxanthus*, and *Lampropeltis getula*, while increasing are *Arizona elegans*, *Salvadora hexalepis*, and possibly *Crotalus cerastes* and *Rhinocheilus lecontei*.

Overall, the composition of the snake community at the study site appears relatively similar between the two periods. No marked decline in overall snake abundance, as indicated by captures per trap night, is evident over the duration of this monitoring record.

Discussion

Monthly variation in capture rate (Figure 7-3) suggests that activity is depressed during the pre-monsoon drought in June, although dry springs have markedly depressed snake capture rates and normal and wet springs probably have capture rates similar to summer rates. Sampling would be optimized by limiting the trapping period to April through September (or early October if warm conditions persist). It would not be an efficient use of human resources to sample snakes during cooler months when few or no captures would be obtained.

By far, the species caught with the greatest frequency was *Masticophis flagellum*, no doubt due to its unique character as a widely ranging and active predator as well as its abundance. Many individuals of this species have been caught repeatedly over the years, with some surprising distances having been covered.

Figure 7-4 provides a glimpse at possible long-term trends. The 2002 decline likely reflects a decrease in activity during severe drought, as well as a population decline that seems to have persisted for most species in the year or two immediately after the drought.

Relative abundance has remained fairly constant. Some snakes have shown an apparent increase in abundance, most notably *Arizona elegans* and *Salvadora hexalepis*. *Crotalus cerastes* may also have increased, and the three species that may be increasing are ones found widespread and abundant in the hyperarid quarters of the Lower Colorado Valley and Gran Desierto west and southwest of ORPI.

Species seeming to decline on the site were *Crotalus scutulatus*, *Micruroides euryxanthus*, and *Lampropeltis getula*. The reason that *C. scutulatus* may be declining is not clear: although it is not common in the arid deserts, as suggested above, neither is *C. atrox*, which did not decline. However, both *M. euryxanthus* and *L. getula* are generally associated with relatively mesic conditions, especially in arid lands, and the first has never been found in the arid Lower Colorado Valley Sonoran Desertscrub.

Monitoring results for 2000-2005 are surprising in showing relatively stable rates of observed snake activity and abundance comparable to those seen in 1987-1998. As the drought has extended, and in some years deepened, snake populations have not collapsed, but have remained as a relatively stable predator group. Nonetheless, the results suggest the drought may be having an impact on species abundance patterns by favoring relatively more arid-associated (and presumably arid-adapted) species. These kinds of results are essential for comparison to less natural, more impacted areas such as Tucson and Avra Valley, where unstable snake communities may be expected, and where species losses have been noted (Rosen 2003).

A special case of interest is *Crotalus cerastes*, which is rarely caught in the traps but is by far the most commonly seen snake on the sandy dirt road (Armenta Road) that cuts through the study area. *Crotalus cerastes* prefers the loose sandy substratum encountered along the road, especially the edges, and can frequently be found sidewinding or crawling along the interior road edges at night, presumably hunting for prey. This behavior could be resulting in an increased number of mortalities, as Law Enforcement and other vehicle traffic have climbed dramatically in recent years.

Recommendations

Life history and natural history data

A substantial set of baseline data has been collected for snakes at this Sonoran Desert site. The use of unique marks allows the accumulation of individual life history data including growth, reproductive condition, injuries, and movement. The East Armenta EMP site and snake study area is the only site where rodents, birds, snakes, lizards, large invertebrates, and, on 2 occasions, vegetation have been monitored. It is a unique opportunity to examine interactions between species and trophic groups because no other EMP site has a snake trap array. Even though this suite of monitoring elements is limited to one site, the results should contribute to our understanding of desert ecosystems and provide valuable material for interpretation. The necessary analyses have not yet been conducted with recent data (see Rosen, 2000 for results of his analysis of the 1987-1998 data). To realize the value of this information the data will either have to be analyzed by NPS or provided to others for analysis.

Highway mortality

Rosen and Lowe (1994) estimated that approximately 1000 snakes were killed per year between Why and Lukeville. If resources are available, the monument could employ a combination of trap stations and road surveys for snakes to provide information specifically designed to quantify the amount and distance from highway of road mortality impacts. This design would also establish a broader and thus firmer basis for estimates of predation pressure that are probably essential to interpreting monitoring trends in other groups, notably lizards and small mammals.

Sidewinder mortality on Armenta Road
Conduct evening road surveys of sidewinders along the Armenta Road for comparison with data collected in the 1990s by Rosen to determine if increased traffic is having an impact.

Acknowledgements
Field assistance was provided by Ami Pate, Mónica Hernández, Brian Barns, and Adam Hinkle.

Literature Cited

Fitch, H.S. 1999. A Kansas Snake Community: Composition and Changes over 50 Years. Krieger Publishing Company. 165pp.

Rosen, P.C. 2000. A monitoring study of vertebrate community ecology in the northern Sonoran Desert, Arizona. PhD. Dissertation. University of Arizona. Tucson. 307pp.

Rosen, P.C. 2003. Avra Valley snakes: Marana survey report for Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*). Final Report to Town of Marana on Shovel-Nosed Snake. 23 pp.

Rosen, P.C., and C.H. Lowe. 1994. Highway mortality of snakes in the Sonoran Desert of southern Arizona. Biol. Cons. 68:143-148.

Rosen, P.C., and C.H. Lowe. 1996. Ecology of the amphibians and reptiles at Organ Pipe Cactus National Monument, Arizona. Technical Report No. 53, Cooperative Park Studies Unit, The University of Arizona, Tucson. 136pp.