

entered T 11/00
reviewed by V# 11/00
corrected by - F 11/00

A Herpetological Survey of

1292560

Wind Cave National Park, South Dakota

Transcription of reference info.

Brian E. Smith

U.S. Geological Survey/Biological Resources Division

Northern Prairie Science Center

8711 37th St. SE

Jamestown, ND 58401-7317

This report is the product of a project conducted by the Northern Prairie Science Center of the U.S. Geological Survey/Biological Resources Division, in cooperation with National Park Service personnel at Wind Cave National Park, South Dakota. Field work was completed between May 13 and August 31, 1996. The primary objectives of the project were to determine herpetofauna occurring on the park as a baseline for proposed controlled burning to be conducted in certain areas of the park, and to provide guidance and baseline data for continued herpetofaunal monitoring of the park by park personnel.

Entered.

B.bley: 14/019

A Herpetological Survey of Wind Cave National Park, South Dakota

Brian E. Smith

U.S. Geological Survey/Biological Resources Division

Northern Prairie Science Center

8711 37th St. SE

Jamestown, ND 58401-7317

Abstract

The herpetofauna of Wind Cave National Park was surveyed May-August of 1996. A variety of standard herpetological survey techniques were used, including drift fences, quadrats, calling surveys, visual encounter surveys, road cruises, and turtle traps. These techniques were compared and contrasted. For the common types of habitats found in Wind Cave National Park, and especially ponderosa pine forests, it was found that only visual encounter surveys and road cruises were effective in sampling herpetofauna. Turtle traps and calling surveys were found to be useful for certain specialized applications. The herpetofauna of the park is summarized in a series of species accounts.

Background

The herpetology of South Dakota is poorly known. The last review of the herpetofauna of the state was Over (1923), although Fishbeck and Underhill (1959) produced a checklist of South Dakota reptiles and amphibians. The Black Hills and surrounding area have received scant attention as well. The most recent study of the Black Hills was Peterson (1974), who reviewed the herpetofauna and made new collections. Smith and co-workers (1963a, b; 1964; Smith et al. 1966) completed various systematic and distributional studies on the herpetofauna of the area. Chiszar et al. (1994) reported on collections from the nearby Pine Ridge Reservation. Nearly all parts of South Dakota are in need of formal herpetofaunal surveys.

Originally, this study was envisioned as an opportunity to study the effects of controlled burning on herpetological communities. A controlled burn of the Rankin Ridge area of Wind Cave National Park (fig. 1) was planned for 1997, and the activities of the field crew were largely dictated by this project. The intent was to survey the area for herpetofauna during 1996, to provide a baseline with which post-burn data could be compared. Therefore, much of the field crew's efforts were expended surveying the Rankin Ridge area and an adjacent control area in Custer State Park, two sites which are dominated by ponderosa pine forest (*Pinus ponderosa*), which is atypical of much of Wind Cave National Park. Near the end of the 1996 field season the burn was cancelled, and further survey of the study and control plots were downscaled in favor of surveys of other parts of the park that had not been as extensively visited. For this reason, the survey of the park should be viewed as biased towards the herpetofauna of portions of the park dominated by ponderosa pine forest, although we examined much of the rest of the park as well.

Study Area

Wind Cave National Park covers an area of 11,449 hectares and is located in the southeastern Black Hills, in southwestern South Dakota. Elevations in the park range from about 1100 m to 1528 m, and the park encompasses a range of habitats from open prairie to forest dominated by ponderosa pine. About 3355 hectares of the park is forested and somewhat higher in elevation (from about 1200 m to 1528 m); the remainder (8094 hectares; both estimates from 1954 data, considerable encroachment of pine forest onto grasslands has occurred since then) is mostly mixed-grass prairie and ranges from about 1100 to 1300 m elevation. Towards the northwest, the park rises towards the higher elevations of the Black Hills. To the southeast are the lower elevations of the Great Plains.

The geography, topography, and geology of the Black Hills were described in detail by Froiland (1990), and the following discussion is taken from this source. Encircling the outer rim of the uplift of the Black Hills is a topographic feature called the Hogback Ridge. A portion of the eastern boundary of Wind Cave National Park runs just east of the crest of this ridge. One spring, Cat-Tail Spring, is found along the Hogback Ridge on this boundary of the park. Elevations in this area reach to about 1300 m. A sparse forest of ponderosa pine is found at higher elevations of the Hogback Ridge within the park. The inner (westernmost) edge of the Hogback Ridge is covered with mixed-grass prairie similar to that of the Red Valley (see below). The soils of the Hogback Ridge are mostly composed of sandstone.

To the west, covering about one third of the park, is the Red Valley, an area that abuts the western edge of the Hogback Ridge. The soils of the Red Valley are predominantly red sandstones. The Red Valley is covered with mixed-grass prairie. Three of the springs of Wind

Cave National Park are found in the Red Valley; Blacktail, Red Valley, and Boland Ridge Springs. In the Wind Cave area, elevations in the Red Valley range from about 1100 to 1220 m.

To the west of the Red Valley is another area, comprising about one third of the park, called the Minnekahta Plains. This is an area sandwiched between the Limestone Plateau (see below) and Red Valley that reaches its greatest width in the southern Black Hills (Froiland 1990). It is a rolling plain dominated by mixed grass prairie, but with scattered stands of ponderosa pine. In the Wind Cave area, elevations of the Minnekahta Plains range from about 1250-1310 m. It marks a transitional area from plains to mountainous topography, and the soils are predominantly red sandstone, shale, and limestone (Froiland, 1990). Four springs are found in the Minnekahta Plains on Wind Cave National Park: Gobbler, Limestone, Windy Point, and Parker Springs.

The Bison Flats Precipitation Catchment Pond is also located here.

Finally, a portion of Wind Cave National Park consists of a part of the Limestone Plateau, which seems to be fairly narrow in the southern Black Hills area. Nearly all of the Rankin Ridge burn area is within the Limestone Plateau. The soils of this region are limestone and various other types, and at Wind Cave National Park the area is dominated by ponderosa pine forest, with some interspersed mixed grass prairie. There are no springs within the Limestone Plateau portion of Wind Cave National Park.

The weather of Wind Cave National Park is typical of that of the Black Hills, which has a semi-arid continental weather pattern modified by the mountainous terrain (Froiland, 1990). Winters can be severe and cold, and temperatures can be warm in the summer. However, periods of warmer temperatures are not uncommon in the winter, and the Black Hills often are the warmest part of the Dakotas during the winter. The town of Hot Springs, located about 10

km south of the south entrance of Wind Cave National Park and at about 1060 m elevation, has recorded temperatures as low as -41°C and as high as 44°C . Between May 13 and August 31 of 1996, the lowest and highest temperatures recorded at the Wind Cave National Park weather station were 1°C , on May 21, and 34°C , on August 3, 4, 12, and 13, respectively. The growing season averages 142 days at Hot Springs. Severe thunderstorms are not uncommon, and several occurred on the park during the summer of 1996. The last freeze of 1996 was recorded on May 10 at Wind Cave National Park. Annual precipitation averages about 0.40 m on the plains to around 0.75 m at higher elevations, most of which falls as a result of thunderstorms between April and September. About 0.50-0.75 m of snow falls on the plains during the winter. The year of 1996 was one of the wettest ever recorded at Wind Cave National Park, and most of the springs and creeks were flowing at rates above normal. A significant rainfall event that lasted for six days, May 23-28, accounted for much of the water filling seasonal wetlands on the park during the active season. This seems to have been the most important weather event filling the large seasonal pond at Bison Flats and causing it to remain filled for longer than normal in 1996.

The Rankin Ridge burn area is one of the most rugged parts of Wind Cave National Park. Elevations here range from about 1300 to 1528 m, and many slopes are steep. There is virtually no permanent water in the area, although certain drainages hold small amounts of water at times, depending on rainfall and snowmelt. Some of these temporary wetlands had small breeding aggregations of chorus frogs (*Pseudacris triseriata*) during May and early June of 1996, and tadpoles and metamorphs were found in some areas. The burn area was bordered on the south by Beaver Creek, which in most years is an intermittent drainage. The year of 1996 was unusually wet, however, and Beaver Creek had heavy flow during the entire warm season. It

disappeared into a sinkhole at the southeastern edge of the Rankin Ridge burn area. Virtually all of the burn area was forested with ponderosa pine, but there were some small pockets of open prairie.

The control area for the original burn study was located on adjacent portions of Custer State Park. This area is similar to the Rankin Ridge burn area in elevation and topography, and is also heavily forested with ponderosa pine. The major difference between this area and the Rankin Ridge burn area is that more extensive wetlands exist on the control area than in the burn area. Highland Creek flows through the middle of the control site in Custer State Park, and some small wetlands occur in this area. A few wet meadows and small ponds were also found at this site. The largest pond in this area (the Section One Pond discussed on page 12) is <1 hectare in size. Broad-leaved cat-tails (*Typha latifolia*) were common emergents in these wetlands. One large area of prairie (ca. 2.5 km²) exists in this part of Custer State Park.

In general, water resources on Wind Cave National Park are sparse. There is one permanent creek, Highland Creek, and one creek which is usually intermittent, Beaver Creek. In addition to these creeks there are eight permanent springs on the park (fig. 2; Rahn and Gries, 1973). These springs are used as breeding habitat by chorus frogs and Woodhouses's toads (*Bufo woodhousii*) and they were carefully monitored for the duration of this study. One other major water resource was monitored in this study, a large seasonal pond on Bison Flats, near the Wind Cave National Park Visitor's Center (fig. 2). This was the most active amphibian breeding site on the park, and we have records of calling at this site for all the amphibians known to occur on Wind Cave National Park. Two more major water resources that we were aware of were two sewage treatment ponds nearby the Visitor's Center. These ponds contained a number of large larval

tiger salamanders (*Ambystoma tigrinum*). Some of these specimens may have been paedomorphs, but the ponds were not seined.

Methods

Reptiles and amphibians exhibit a diverse array of behaviors and life history strategies, and no single survey method is appropriate for all species. Therefore, our techniques combined a diversity of approaches. These are described below.

Drift fences: We set up five drift fences apiece in the control area and in the Rankin Ridge burn area. Placement of the fences was determined at random as follows. South Dakota State Highway 87 runs north and south through both the burn area and the control area. A mileage along this road was determined at random to hundredths of a mile using a random numbers table. We drove to this spot using the odometer in our field vehicle, estimating hundredths of a mile. From this point, a direction and distance in meters was chosen at random. For the burn area, the road ran along the west edge of the plot, and we always walked due east the specified distance. For the control area, the road ran through the middle of the plot, and a direction (east or west) was chosen at random. Depending on the distance, we then used either a 50-m measuring tape and compass or a Global Positioning System to determine our walking distance and direction. Final site selection for drift fence placement was double-checked using 7.5' topographic maps (U.S. Geological Survey) in an attempt to match local topography with that indicated by the map.

Drift fences were modified from Jones (1981). See Appendix 1 for detailed construction information. This type of fence is non-directional and samples herpetofauna moving in any direction through the area. Drift fence arms were 7.65 m long. The arms were haphazardly

placed, depending on local topography, but each of the three arms were always separated from the others by an angle of 120°. Two funnel traps were placed at the end of each arm, one on either side of the fence. See Appendix 1 for information on constructing funnel traps. Pitfall traps were not used. The funnel traps were numbered and camouflaged using downed limbs and leaves. Each fence was 0.76 m high, except fences 4 and 5 on the burn area, fence 4 on the control area, and one arm of fence 5 on the control area, which were 0.61 m high. We found that the shorter fences were superior to the taller fences in high winds, which were frequent in the study area. High winds tended to loosen the anchoring of the arms on the taller fences, necessitating frequent repairs. The shorter fences needed less maintenance. Although bison (*Bison bison*), antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), and elk (*Cervus elaphus*) were common, the fences never suffered obvious damage from these ungulates. The fences were maintained for varying times, but all were constructed between May 30 and June 9, and removed on August 21 and 22. They were open continuously during this time. They were checked on a variable schedule, but never at intervals longer than three days.

Transects: Strip transects are a type of quadrat sampling technique in which the quadrats are long and thin (Jaeger and Inger, 1994). Quadrat sampling techniques have been used in many herpetological studies (Jaeger and Inger, 1994), but I am not aware of their use in a habitat thought to be as herpetologically depauperate as ponderosa pine forest or open prairie. The current study provided an opportunity to evaluate the effectiveness of strip transects as a systematic sampling technique in a habitat that is presumably not rich in herpetofauna. For this study, transects were placed randomly within the study plots using the same methodology as

drift fences (above). A compass direction (N, S, E, W, NW, NE, SW, SE) was picked at random, and a 50-m tape was stretched to its length from the starting point. Potato rakes, marked at one meter, were then used by two workers, one on either side of the tape, to remove all cover objects from the transect. Any herpetofauna encountered were captured. The area uncovered was 100 m² for each transect, potentially providing a measure of absolute abundance. Twenty transects were planned for the control and burn areas, but they were discontinued after fifteen transects were completed at each site, since reptiles and amphibians were never captured using this technique.

Visual encounter surveys (VES): These are surveys in which a group of experienced herpetologists spends a certain (often predetermined) amount of time turning cover objects searching for herpetofauna in a given area (Crump and Scott, 1994). There are several major problems with the technique, including (usually) a lack of randomness in placement of VES, lack of knowledge of the exact area covered by investigators during the search, and biases introduced by observers, since many herpetologists avoid "bad" areas or cover objects during a search and when determining starting points of VES. The technique provides no absolute measure of density, but it can be useful as a general descriptor of herpetofaunal abundance, and it can be the most productive method employed in survey work, in terms of number of specimens captured per unit of effort (Busby et al., 1994). We randomized the starting point for VES by conducting VES in conjunction with transects. Following completion of transects, we walked 100 m from the center of the transect in one of eight randomly picked directions as above to pick a starting point for the survey. The crew then went in separate directions and haphazardly searched the area, avoiding the just-completed transect and areas within 50-m of the transect.

Biases are introduced through several causes: We picked cover objects that looked "good" to overturn, and we avoided "bad-looking" habitat during searches. The area covered varied significantly: If a large proportion of the immediate area was prairie, then we covered substantially more area than we would have if the surroundings were forested or had significant rock cover. I do not believe it is possible to accurately estimate areal coverage during such a survey, and we made no attempt to do so. We conducted several VES following the cessation of use of the transect technique. For these VES, we began the survey at the point randomly picked for the transect starting point. When the decision was made to cancel the controlled burn, we stopped surveys on the control area, and concentrated on finishing surveys on Wind Cave National Park. Fifteen VES were conducted on the control area and 20 were completed on the burn area.

VES were always conducted for two person-hours, and they were all conducted with the same three-person crew. If reptiles or amphibians were sighted, we attempted to capture, sex, and measure all specimens. For escapees, it was always possible to positively identify the species, since the herpetofauna of the area is relatively depauperate and was easily learned by the field crew. All captured specimens were measured and released at the site of capture, except rattlesnakes. These were captured and removed, measured and sexed (using sexing probes) in the laboratory, and returned to the site of capture the following day or later the same day.

Turtle trapping: Standing water is not abundant on Wind Cave National Park, which contains no large, permanent ponds that seem to be suitable turtle habitat. One pond, the "Section One Pond," in the control area on Custer State Park, about 1 km north of the northern boundary of Wind Cave National Park (middle of Section 1, R5E, T5S), appeared to provide

suitable turtle habitat. Three turtle traps were placed in this pond, from July 27 to August 15, and every turtle captured was marked with a unique mark by notching the shell using a triangular file. The turtle traps were 1.83 m long, with 3.81 cm mesh, and they were 0.76 m in diameter (Memphis Net and Twine Co., 2481 Matthews Ave. Memphis, TN 38108). They were baited using perforated cans of sardines suspended within the trap, hanging in the water (Conant and Collins 1991: 18). At the same time, we also trapped at three sites on Beaver Creek, where common snapping turtles (*Chelydra serpentina*) had been spotted on trails and roadways.

Road cruising: This method has often been used to collect snakes, and we found that it works well to sample at least some anurans. There are two main paved roads in the park, South Dakota State Highway 87 (SD 87) and U. S. Highway 385 (US 385). In addition, two unpaved roads, National Park Service Roads 5 and 6 (NPS 5 and 6), exist on the park. Another unpaved road, Custer County Road 5 (CCR 5), is used to access the southeastern entrance of the park, via CCR 101, which connects to US 385. We travelled one route, varied only by the direction in which it was driven on any given night. Described in a clockwise fashion, this route ran from the Visitor's Center, north on US 385 to SD 87, thence north to NPS 5. We turned on NPS 5 and headed east and south to NPS 6, which we then travelled north to the entrance of Custer State Park and returned to NPS 5. We then took NPS 5 to CCR 5 to CCR 101, which heads south and west to US 385. Occasionally, we travelled CCR 101 east (through Buffalo Gap) to its junction with South Dakota State Highway 79 and then returned on CCR 101 to US 385. We then took US 385 north, back to the Visitor's Center. We alternated driving this route clockwise and counterclockwise on alternate nights. When specimens were encountered, they were sexed, measured, and immediately re-released at the site of capture. Snakes were returned to the

laboratory for sexing (using sexing probes) and measurement, and returned to the same spot the next evening. The route was about 72 km (45 miles) long, and usually took 2-2 1/2 hours to drive, depending on the number of specimens captured during a drive. This route is well illustrated on the Black Hills Southeast Trails Illustrated topographic map (1993, revised 1995; Trails Illustrated, Evergreen, CO 80439-3746).

Surveys of springs and precipitation catchment ponds: Soils of the Limestone Plateau are porous, and water falling as precipitation in this region drains quickly into the soil, as does water entering this region in streams flowing out of the Precambrian core of the Black Hills (Rahn and Gries, 1973). Water from both sources re-emerges at springs throughout the Black Hills, where the underground water encounters the relatively impermeable soil of the Spearfish formation (Rahn and Gries, 1973). The Spearfish formation is a primary component of the soils of the Red Valley (Froiland, 1990), and Wind Cave National Park has several permanent springs. These springs are a primary water source that could be used by reptiles and amphibians on Wind Cave National Park. Only Woodhouse's toads and chorus frogs were common at any of the springs, however. Several of the springs had breeding choruses of both species at various times during the active season. Chorus frog tadpoles were frequently observed. We visited the springs regularly, about once every two weeks or more often for most springs. Cat-Tail and Limestone Springs were a long distance from roads, and they were monitored about once a month.

Early in the season we attempted to conduct visual encounter surveys at night at each of the springs. We visited the springs on a rotating basis, surveying one or two each night, but we found that VES resulted in equivocal data, for reasons discussed below (see "Results"). After eight VES conducted at four springs and catchment ponds, VES were abandoned as a

quantitative method of investigating the anuran fauna at the springs. Following termination of regular VES, we conducted a modified VES at each spring. For these VES, a three-person crew spent forty minutes, or two person-hours, looking for choruses, adults, eggs, or tadpoles, but without counting or measuring the specimens observed. These searches resulted in presence/absence data for various life history stages. Visual encounter surveys were conducted for shorter periods of time at very small springs, such as Parker and Gobbler Springs. These springs were completely surveyed in less than two person-hours.

Precipitation catchment ponds on Wind Cave National Park are generally very ephemeral. The soils appear to be very permeable, presumably due to the extensive cave system for which the park was established. These ephemeral ponds were used by Plains spadefoots (*Scaphiopus bombifrons*) and chorus frogs. A single male Great Plains toad (*Bufo cognatus*) was heard calling at one such pond one night. Only one ephemeral pond, the Bison Flats Pond, was of significant size and longevity as to be an important resource for chorusing and breeding for several species. The rain event of May 23-28 resulted in exceptionally intense breeding activity at this pond, and was the single most important event of the spring for amphibians breeding at this pond. The Bison Flats Pond was already large by this time, but greatly increased in size and depth during these six days. On the evenings of May 29 and 30, a large multi-species chorus was found at the Bison Flats Pond. On these two evenings, all anurans known from the park were found chorusing at this pond. We monitored this pond very closely throughout the summer, using the same techniques and schedule as that used for the permanent springs. We used Bison Flats Pond to verify calling activity each night that calling anurans were censused anywhere on the park.

Results and Discussion

Efficacy of survey techniques: Survey techniques can be thought of as providing data of a hierarchical nature, herein ordered from most to least informative. The most informative survey techniques provide data on the absolute abundance of organisms on a study plot; i. e., how many organisms are there for a given unit of area? With an appropriately randomized design, these data can be generalized to a larger area or region of interest. Less informative are survey techniques that provide numbers per unit of time or trap unit. Such data do not provide density estimates, and can be more difficult to generalize to larger regions outside of the study area. The least informative survey techniques are those resulting in simple presence/absence estimates. These techniques result in data that can be used solely to indicate presence of a species at a locality at the survey time. The absence of a species during such a survey is more problematic. It is possible that the species is absent, but it is also possible that the survey was conducted at a time when the species would not be expected, such as outside of the breeding season in anurans, or at a time of the day during which the species is usually inactive, such as during the day for nighttime-calling anurans. For reptiles and amphibians, survey techniques are not well-developed, and it is imperative that many techniques are used with several species and evaluated at many sites. In this study, we attempted to use all the well-known techniques available to survey the area. Herein I offer comments on these techniques as applied at Wind Cave National Park, and give suggestions as to which of these techniques might be of most use in instituting a standardized monitoring program at Wind Cave National Park.

Drift fences: These are expensive and time-consuming to construct. Fences such as the type we used in this study cost about \$100 in materials in April of 1996. Once funnel traps were

constructed, installation took about one-two hours for an experienced three-person field crew to install. Portage time to the sites could be significant, depending on proximity of the sites to roads. Additional time was spent on maintenance, which varied greatly from one site to another. Fences set in the open were the most expensive in terms of maintenance costs. High winds, which are frequent at Wind Cave National Park, shake the arms of the fence enough that re-trenching is frequently needed. The shorter 0.61 m fences needed less repairs of this nature. Fences set in the forest or in protected areas also needed less maintenance. I would recommend use of the 0.61 m fences in open habitat and 0.76 m fences in wooded habitat or protected areas. Surprisingly, heavy rains did not seem to damage the fences. Ungulates on the park also never damaged the fences, although damage from ungulates was anticipated. Drift fences have never been tested in the laboratory, but I have assumed that 0.61 m and 0.76 m fences are high enough that the herpetofauna of Wind Cave National Park cannot climb over the fence.

In order for a census technique to be effective, it must be possible to capture herpetofauna using the technique. In this regard, drift fences on Wind Cave National Park were nearly a complete failure. Two herpetological specimens were collected on the burn and control areas combined during the entire summer. Drift fences were open for 758 fence-nights. Therefore, capture rate during this study was 0.0026 captures/fence-night. The specimens collected were one chorus frog on July 26 and one redbelly snake (*Storeria occipitomaculata*) on July 7. Low trap success could be due to a number of factors: 1) Herpetofauna are rare on the sites; 2) Herpetofauna avoid the fences; 3) Herpetofauna avoid capture when the fences are encountered; 4) The herpetofauna are very selective in their use of habitat within the area, and they did not use the habitats in which fences were placed; and 5) The fences are improperly constructed. The

type of fence used in this study has been used in many studies, and it is unlikely that herpetofauna actively avoid the fences or avoid capture when encountering the fences, or that the fences were improperly built. Since both VES and strip transects also indicate a very depauperate herpetofauna on these sites, and since this fauna seems to be highly localized to certain habitat types (most notably, near water resources), it seems most likely that the lack of captures on drift fences is reflective of small population sizes and habitat specificity. It is possible that fences in the prairie portions of the park might be more productive.

Transects: Quadrats have proved effective in assessing density, species diversity, and relative abundance of some amphibians (Lloyd et al., 1968; Scott, 1976; Inger, 1980; Jaeger 1980a, b; Lieberman, 1986; and Mathis, 1990), and it is the only technique we used that could have provided a measure of absolute density of herpetofauna on Wind Cave National Park. Unfortunately, this was not possible, since no specimens were captured in 35 transects. It is likely that the technique would eventually result in some density estimate, but it may require so many strip transects as to be prohibitively costly. After the site is located, a three-person crew can conduct one transect in about one hour, and we could complete two or three transect/VES tandems a day, depending on the walk required to reach the sites. However, this technique is ineffective in the pine forests of Wind Cave National Park. Transects placed in prairie habitat might be quite unproductive as well. We completed a few transects in small prairies on the Rankin Ridge area, and there was very little cover in such areas.

Visual encounter surveys: This was the only technique that proved even marginally effective in capturing herpetofauna during this study. Most VES resulted in no captures, but a few resulted in locality records. Herpetofaunal populations are certainly sparse on both the

control area in Custer State Park and in the burn area in Wind Cave National Park. At Wind Cave National Park, we observed or captured a total of six specimens in 40 person-hours of work (0.15 specimens/person-hour). The data are listed in Appendix 2. In the control area, the numbers were slightly higher; eight specimens in 28 person-hours of work (0.29 specimens/person-hour). These data are inflated, however, by turtles observed at a single VES (number 12), which was conducted alongside the Section One Pond (see page 20). If this site is excluded, then the numbers of herpetofauna observed on the control area are virtually identical to those on the burn area, at 0.15 specimens/person-hour.

The major drawback of this technique is the difficulty of quantifying the search area. As mentioned above, the area covered by such a search cannot be reliably estimated. When cover is lacking, a significant area is walked searching for suitable cover items. If many cover items are present, then a much smaller area is covered. When cover items are overturned, they are of only certain sizes. For example, two prairie rattlesnakes (*Crotalus viridis*) were discovered after hearing the sound of rattling under a rock that was much too large to overturn (two individuals were inferred from the differing rattle pitches). Currently, there is no method known that can convert VES data into density (rather than abundance) data, but if this is not of concern, VES can provide an abundance estimate for herpetofauna at Wind Cave National Park. Using a well-trained crew, and using the same crew each time (to avoid between-crew variance), a reasonable estimate of relative numbers might be obtained that might be useful in any monitoring plan instituted on this park or any other in the northern Great Plains. It is important that the search area be randomly placed in order to arrive at a statistically defensible estimate of abundance for an area. It is also necessary to stratify the sample, if more than one habitat type is to be

searched. For this study, VES were conducted only in ponderosa pine forest, and we did not stratify by habitat.

Turtle trapping: This is a highly effective technique for turtles in ponds, but it may be poor at censusing turtles in streams. Common snapping turtles were observed along Beaver Creek, but 17 trap-nights of effort along this stream resulted in no captures. We conjectured that the odor of the bait was diluted by stream flow. In contrast, trapping at Section One Pond was highly effective in capturing large numbers of painted turtles (*Chrysemys picta*). Thirty-three trap nights resulted in 52 captures of 40 painted turtles. Most of these turtles (35) were caught in the first three nights; 23 the first night alone. Figure 3 shows the cumulative number of turtles trapped. From this graph, I would estimate the total number of turtles in the Section One Pond at near 40.

Road cruising: In terms of specimens captured per effort expended, this was probably the most productive method used in this survey. We travelled 1236.0 km (768.2 miles) of roadway during 19 road cruises throughout the summer. We captured 32 specimens of reptiles and amphibians, an average of 1.63 specimens per road cruise. Many of these (12 individuals, 11 of which were toads) were collected on August 9, an evening characterized by cloudy conditions and a light rain during half of the cruise. Woodhouse's toads (25), prairie rattlesnakes (6), and a Great Plains toad were collected at Wind Cave National Park using this technique, but chorus frog, Great Plains toad, Plains spadefoot, and Woodhouse's toad choruses were heard during road cruises conducted during the calling season (May-June and occasionally later for Plains spadefoots and chorus frogs). Other snake species (eastern yellowbelly racers, *Coluber*

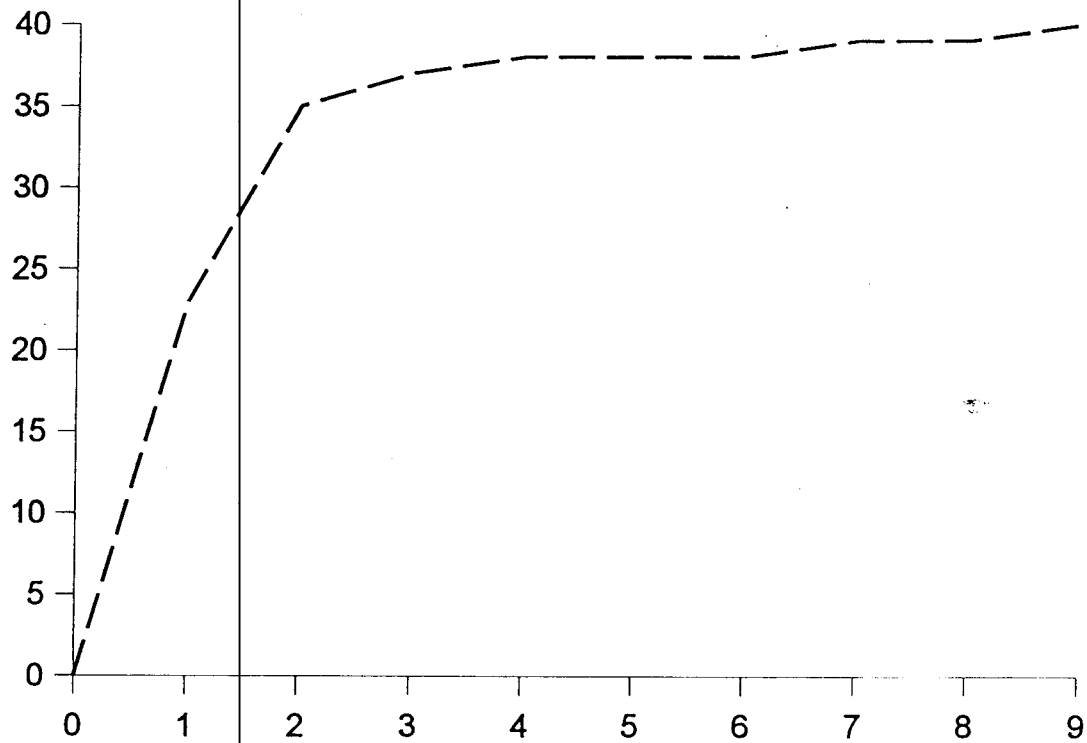


Figure 3: Cumulative number of turtle captures at the Section One Pond, Custer State Park, South Dakota, between July 27 and August 15. The x-axis is trap-night number, the y-axis is the cumulative number of turtles trapped. Re-captures are not included in this figure, and the traps were not left open all nights during this period.

constrictor; bullsnakes, *Pituophis melanoleucus*; smooth green snakes, *Opheodrys vernalis*; and western Prairie garter snakes, *Thamnophis radix*) were encountered on roads in the vicinity.

Other than the cost of technicians to perform the work, road cruises are not expensive. At 15 miles/gallon, and gasoline costs estimated at \$1.30/gallon, gasoline cost about \$4.00/night, and a technician to do the survey for three hours each night would cost \$25.53 (GS-4 level).

Technician costs will vary, depending on the amount of specimens captured and processed on any given cruise. Vehicle costs also vary, depending on the type used. It is difficult to assess the technique in terms of the quality of the data, also. Most importantly, it is likely that only certain species are amenable to censusing in this manner, and there are likely to be many inherent biases. As an example, anuran species heard during road cruises included chorus frogs, Plains spadefoots, Great Plains toads, and Woodhouse's toads. Only Woodhouse's toads and Great Plains toads were observed on the road, however. Stops near springs and precipitation catchment ponds can be included on road cruises so as to conduct calling amphibian surveys (NAAMP, 1996) concurrently with road cruises. Capture rates on gravel versus paved roads were not compared, although reptiles and amphibians were collected on both types of road surfaces. The effect of time of day was also not assessed, although some live snakes were found on roads during late afternoon and morning hours. Generally, road cruises were begun about a half hour after sundown. Moonlight and weather were also not considered, but it is commonly thought that moonless or cloudy nights with some rain are most conducive to successful road cruises.

Suggestions for a Monitoring Program

Amphibians and reptiles are often major components of many different ecosystems, and monitoring of these groups can be incorporated into existing resource management plans on any national park. Starting a herpetological monitoring program will require decisions on the amount of resources to be committed to such a program, basic knowledge of the herpetofauna of the area, and study of herpetological monitoring techniques that may prove useful. For Wind Cave National Park, we now have basic knowledge of both the herpetofauna found on the park and techniques that seem useful in monitoring these herpetofauna. It is likely that these techniques can be adapted for use in many parts of the northern Great Plains. Herein I make suggestions to guide the development of a monitoring program.

Visual encounter surveys: These can be used anywhere on the park, and they seem to be one of the few techniques that is useful in censusing the terrestrial herpetofauna. A two person-hour VES is recommended; less time spent on each survey might result in unproductive surveys. A three-person crew is recommended because this keeps the time spent surveying to a reasonable length (40 minutes for such a crew). A four-person crew would be sufficient as well, but increasing crew size causes increased expense, increases a supervisor's duties, and increases the observer variance. It is important that the crew membership have some stability: A well-coordinated crew that has worked together in the past results in more reliable observations. It is important that the starting points of VES be randomized. Visual encounter surveys are inexpensive and simple to operate.

Calling amphibian surveys: During this study, only the spring sites and Bison Flats Pond were surveyed using this technique. These sites can continue to be surveyed, especially those

sites that are near roadways, such as Blacktail, Red Valley, and Boland Ridge Springs, and Bison Flats Pond. The method is relatively easy, but requires knowledge of the calls of the various species. Audio tapes can be made to train volunteers or employees on the calls made by the anurans of Wind Cave National Park.

By consulting maps of the water resources of Wind Cave, other areas of the park can be added. Surveys of springs will probably only be useful in monitoring chorus frogs and Woodhouse's toads, since these are the only two species that have been found at these springs. More extensive surveys would be necessary to successfully monitor rare or seldom-observed species, such as Plains spadefoots and Great Plains toads.

Calling surveys would require a formal design incorporating knowledge of all the seasonal wetlands on the park. Continuing surveys of spring sites and Bison Flats Pond would be inexpensive and simple; more extensive surveys would require some planning and consultation with a professional herpetologist. Timing of surveys is also fairly simple, in that Bison Flats Pond can be monitored closely for chorus frog activity as soon as temperatures rise above freezing during the spring. Since chorus frogs call sooner and for longer than any other anurans at Wind Cave National Park, except possibly Plains spadefoots, surveys can begin as soon as chorus frogs are noted at Bison Flats Pond. Bison Flats Pond can also be used as a validation site.

Plains spadefoots present special problems, since they are explosive breeders that have a short and variable breeding period. They may be present but unnoticed due to their peculiar life history. These problems are not unique to Wind Cave, and development of techniques useful in monitoring these anurans is an area of current research.

Finally, presence of calling anurans does not indicate successful reproduction. What it indicates are sites at which successful reproduction may occur. To be certain of reproductive success, ponds at which calling anurans have been heard should be marked and followed throughout the active season. Presence of egg masses, tadpoles, and metamorphs gives a better indication of successful recruitment during any given year. Identification of tadpoles and metamorphs is very difficult, even for trained professionals, and this part of a monitoring program will necessitate some training in identification of such life stages or consultation with an herpetologist.

Road cruising: Road cruises are an important ancillary method of monitoring various species of snakes and some anurans. Although only prairie rattlesnakes were encountered during nighttime road cruises, we encountered smooth green snakes (*Opheodrys vernalis*), bullsnakes (*Pituophis melanoleucus*), eastern yellowbelly racers (*Coluber constrictor*), and Plains garter snakes (*Thamnophis radix*) on roads in the vicinity of Wind Cave National Park or on the park itself when we were engaged in other activities.

The biases of sampling herpetofauna using road cruises are not well known. Since prairie rattlesnakes are common on the park and are nocturnally active, then nocturnal road cruises probably preferentially sampled this species. Bullsnakes were commonly found during the day on roads within Wind Cave National Park, and road cruising during the day may have been an effective technique of sampling this species. Woodhouse's toads are large enough to be easily seen on the road by the typical observer and are commonly found far from water. It is not surprising that they are also well-represented in road cruising samples. However, other anurans, such as Plains spadefoots, share these characteristics, and were not found during this study on

road cruises. Perhaps this indicates that this species is not common on the park, but it is difficult to draw any conclusions. Certainly, small amphibians that are hard to see and subject to rapid dessication are probably not well-sampled by road cruises.

At any rate, night-time road cruises at Wind Cave National Park were effective in sampling prairie rattlesnakes and Woodhouse's toads, and they should be effective at monitoring the relative abundance of these species and possibly diurnal species of snakes as well. Individuals on nighttime calling surveys should certainly scan the roads for herpetofauna while conducting their survey route. Road cruising may be the only way to discover certain rare snakes that are known from the park or vicinity, such as smooth green snakes, pale milk snakes (*Lampropeltis triangulum multistriata*), and Plains hognose snakes (*Heterodon nasicus nasicus*). Herpetofauna were encountered on both gravel and paved roads. Not enough specimens were collected to comment upon weather conditions, but it is suspected that cloudy weather and light rain stimulate herpetofaunal activity. The temperature should at least be above 9° C, the coldest air temperature at which any anurans were heard to chorus. In seventeen years of experience, I have repeatedly noticed reduced activity during periods of full or nearly full moon, and road cruises conducted on such evenings are generally uneventful. The main expense of road cruising is the observer's time.

Drift fences: These are somewhat expensive and are time-consuming to construct. Also, without proper training, they are commonly poorly built and ineffective. They also require high maintenance. During this study, most maintenance was required as a result of wind damage, and I recommend shorter (0.61 m) fences for exposed areas. Surprisingly, ungulates did not cause much damage to the fences, but this may not be the case if fences are placed on the mixed-grass

prairie portion of the park, where ungulates are more common. Drift fences were also very ineffectual in this study, but this could be due to the fact that ponderosa pine forests seem to typically have low numbers of reptiles and amphibians. Capture rates might be higher in the mixed grass prairie or closer to water sources. Drift fences have been shown to be an effective means of sampling herpetofauna in a number of studies, and they should be a part of any systematic plan to sample the herpetofauna of any given area. I would recommend conducting training sessions for construction of these fences, and also that serious thought be put into providing sufficient resources to operate a number of fences, should this technique be used. Constructing a drift fence would require a significant input of time and money so as to assure that the traps are properly built and maintained. Without such a serious commitment, drift fences should not be considered as part of a monitoring program at Wind Cave National Park.

Other techniques: The transect technique evaluated in this study was completely ineffectual at sampling herpetofauna, it was somewhat time-consuming to set up, and required fairly detailed measurements. It is possible that it might be an effective technique in certain specialized habitats on Wind Cave National Park, but it seems unlikely to yield much data. Turtle traps placed in Section One Pond on Custer State Park were extremely effective, but no turtle habitat appears to exist on Wind Cave National Park. If such habitats are found or created on the park, turtle traps are relatively inexpensive and can be easily deployed with minimal training. At this point, I see no purpose in incorporating this technique as part of any ongoing monitoring effort.

Recommendations: A fairly simple monitoring strategy can be put into place on Wind Cave National Park. Visual encounter surveys can be conducted throughout the park during the active

season (usually April-September, but weather can alter this time frame somewhat). Since many VES have already been conducted in the Rankin Ridge area, early efforts might be concentrated in other areas of the park. Although only two common species seem to use the spring sites, these sites can be followed yearly. As soon as chorus frogs are heard in the spring, workers can head to any of the springs at night (usually an hour or two after sunset) to check for chorusing activity. These springs can then be followed throughout the active season for successful reproduction (calling individuals, tadpoles, and metamorphs observed; see Appendix 3). The Bison Flats Pond should be closely monitored for reproductive activity, since it is very close to the Visitor's Center and maintained the largest and most diverse breeding populations observed in 1996. A worthwhile addition to this scheme would be periodic nighttime road cruises, which should help to monitor the Woodhouse's toad and prairie rattlesnake populations, and the consideration of daytime road cruises. A more serious effort would involve the installation of drift fences and the institution of a systematic anuran calling survey, which could incorporate a representative sampling of the temporary wetland sites known to exist on Wind Cave National Park. A professional herpetologist should be consulted should these latter steps be added to the monitoring project. Data forms that were used for various types of surveys by the field crew during 1996 are printed in Appendix 4.

Species Accounts

The taxonomy and common names used in the species accounts follow Conant and Collins (1991). Subspecific epithets are at times controversial and are subject to fairly rapid taxonomic revision, but they are used here where necessary for completeness. The term "successful reproduction" is used for anurans observed chorusing with eggs and/or tadpoles and metamorphs

found later in the season. This designation only identifies the sequence of chorusing--eggs and/or tadpoles found--metamorphs found, and does not imply the subsequent success of these metamorphs. The time sequence of these events is given for each species for which it is definitely known. Some species that were not found on the park are discussed, either because they might eventually be found on the park or are known from the vicinity. A checklist of species occurring or likely on the park is given in Appendix 5.

Amphibians

Ambystoma tigrinum melanostictum (blotched tiger salamander): This subspecies seems to be common on Wind Cave National Park, but can be difficult to observe. Large numbers of larval salamanders live in the sewage treatment ponds nearby the Visitor's Center. Adults can sometimes be found living in black-tailed prairie dog (*Cynomys ludovicianus*) towns, and they can be observed at night by shining a light into the entrance of prairie dog burrows. Occasionally the salamanders will be visible near the mouth of the burrow. In most towns we visited, we found few salamanders; e. g., 6 salamanders in 138 holes at one site, 2 salamanders in 171 holes at another site. At two other towns in the area, we found no salamanders despite checking over 100 holes at each town. At Bison Flats, surveys on May 17 and June 10 revealed several salamanders, with 45 occupied holes out of 150 checked on May 17, and 43 occupied holes out of 169 checked on June 10. We found several salamanders active at burrow entrances each night that we found calling frogs of any species at Bison Flats Pond (Appendix 3). Often, there were more than one salamander per hole. During a survey conducted on August 4, after the pond had dried, only 2 occupied holes were found out of 171 that were checked. I believe that the adult salamanders that lived in the prairie dog holes used the precipitation catchment pond as

breeding habitat, and either left or became less active when the pond dried. The first larvae were found in the pond on June 24, and the pond was totally dry by July 23. Average time to maturity in the Okoboji wetlands in northwestern Iowa is ten weeks (Lannoo, 1996), and it is doubtful that any of the Bison Flats larvae could have grown to maturity in the short period of time between our first observations of hatchlings and the drying of the pond. Reproduction, therefore, probably was unsuccessful in 1996. It would be very interesting to examine prairie dog burrows around the Bison Flats Pond during the months of May to July, to see whether the congregation of adult salamanders found in this prairie dog town in 1996 was an isolated event, or one that is repeated on a yearly basis. It might even be possible to easily monitor this population throughout the years in such a manner. Untrained observers can easily spot the salamanders, and short walk-through surveys after dark are simple to conduct at this site. Prairie dog control efforts should take into account possible effects on reptiles and amphibians using the towns as retreats.

Bufo cognatus (Great Plains toad): These appear to be rare on Wind Cave National Park. A small breeding chorus was heard at the Bison Flats Pond on May 29 and 30, and a single individual was briefly heard calling in the vicinity of Parker Spring on June 5. Another was observed on NPS 5 on August 9. Tadpoles and metamorphs of this species were not found. The highest elevation at which this species has been collected in the Black Hills is 1190 m (Peterson, 1974). Bison Flats is at about 1260 m elevation, and the area around Parker Spring is nearly 1310 m in elevation. Much of Wind Cave National Park is probably too high in elevation to support this species. Great Plains toads were more common in the surrounding lowlands (unpublished data).

✓
Bufo woodhousii (Woodhouse's toad): This toad is fairly common, and breeding choruses were heard at several sites (see Appendix 3). Reproduction was apparently successful at many sites, including Gobbler Spring, Bison Flats Pond, Blacktail Spring, and Red Valley Spring. Of these sites, only Bison Flats Pond had substantial numbers of metamorphs. Very few were found at the other sites. Active choruses were found at Red Valley West Spring, Blacktail Spring, Bison Flats Pond, Parker Spring, and Boland Ridge Spring. This toad was also common on road cruises. It appeared to the field crew that they were more active on moonless or cloudy nights and in light rain, but these differences were not notable enough to draw definite conclusions. This species does not call continuously once the calling season begins. Choruses are found sporadically, probably stimulated by weather events. Johnson and Batie (1996) and Bowers et al. (in press) have analyzed calling behavior in relation to weather in Woodhouse's toads, but their data are equivocal, other than to note that Woodhouse's toads call at air temperatures around 20°C. Woodhouse's toads were also common in lowland areas surrounding Wind Cave National Park.

✓
Pseudacris triseriata (chorus frog): Individuals of this species in the Wind Cave area may be either *Pseudacris triseriata triseriata* or *P. t. maculata*, or possibly hybrids between these two subspecies. These subspecies are not readily distinguishable in the field (James Platz, Creighton University, personal communication), and I have not assigned the individuals at Wind Cave to a subspecific designation. The taxonomy of this species is unsettled, and future name changes should be expected (James Platz, personal communication). This frog is ubiquitous and abundant on Wind Cave National Park. It was found in virtually all temporary and permanent sources of water, even in small puddles lasting less than a few weeks. Chorusing was heard at

all springs except Cat-Tail Spring. Reproduction did not appear to have been successful at Boland Ridge Spring, Parker Spring, Windy Point Spring, Limestone Spring, and Cat-Tail Spring, but at most of these springs, numbers of metamorphs were found in nearby intermittent pools. Once again, very large numbers of metamorphs were found at Bison Flats Pond. The calling season lasted from May 13 to June 6, and began a few weeks earlier (Dave Kenney, Wind Cave National Park, personal communication). Eggs were first noticed on May 29, at Blacktail Spring. Tadpoles were first noticed on May 29, at Red Valley Spring, and metamorphs were first observed on June 24, at Bison Flats Pond. Calling males were also occasionally found outside of the regular calling period, during periods of wet and cool weather. These choruses did not appear to result in successful reproduction. We also infrequently found frogs abroad during the summer under small rocks and pieces of debris. These were all single males. This species seems to be the first one to call in the spring in many areas of North Dakota and South Dakota, and they should be used as a guide to the start of chorusing activity among all the anurans of Wind Cave National Park. When chorus frogs start calling, it is likely that other species will be actively chorusing within days to a few weeks, and nighttime calling surveys can begin. Chorus frogs were the only species noted to call during the day. They were not observed during road surveys, but they would be very difficult to spot on roads due to their small size.

~~*Rana catesbeiana*~~ (**bullfrog**): This species was noted one mile north of Hot Springs by Smith et al. (1966). We found it in downtown Hot Springs, in Hot Brook near the thermal springs. It is likely that this species would not survive anywhere on the park, since it generally requires larger bodies of water and warmer water than is found on the park. However, it has been implicated in population declines of other anurans (Moyle, 1973; Bury and Luckenbach, 1976; Hammerson,

1982; Hayes and Jennings, 1986; Fisher and Shaffer, 1996), and discovery of any bullfrogs on Wind Cave National Park should be treated with alarm. There is no evidence that it occurs naturally in the area, and the population at Hot Springs is probably introduced. Accidental and intentional introductions of this species are common, and it would not be unusual should someone attempt an introduction at Wind Cave at some time.

***Rana pipiens* (northern leopard frog):** This species was found at localities alongside SD 87, from the north entrance to Wind Cave National Park for about two miles north into Custer State Park. The species was also found at various sites in the Black Hills, and also in Buffalo Gap National Grassland and at Badlands National Park. Likely habitat of this species exists along Beaver Creek and at two ponds located along the (unnamed) main canyon off of which the canyon to Limestone Spring forks, south of the mouth of this latter drainage (R5E, T6S, SW 1/4 Sec. 15). These latter ponds were searched on August 28, but no northern leopard frogs were found. Observations of this species on Wind Cave National Park would be significant. The species is most easily observed in the Dakotas during daytime searches along ponds and intermittent streams late in the active season, from early to mid-August through the beginning of October.

***Scaphiopus bombifrons* (Plains spadefoot):** This species can be very difficult to observe. It is an opportunistic breeder, congregating in temporary pools after heavy rains in the spring and summer, and larvae may develop and leave ponds within one month (Smith, 1956). It has been reported to call and breed only at temperatures above 11°C (Smith, 1956). We found a multi-species chorus at Bison Flats Pond on May 29 and 30 that included this species, chorus frogs, Great Plains toads, and Woodhouse's toads. From this date onward through the summer, Plains

spadefoots were found sporadically throughout the park, but they are exceedingly difficult to monitor because they are opportunistic breeders. It is unknown whether they are common or rare on the park. Park personnel should record any choruses or specimens found. New monitoring techniques, perhaps automated data recorders, will need to be developed to adequately survey and monitor this species.

Turtles

~~Chelydra~~ *Chelydra serpentina* (common snapping turtle): This species has been observed in the vicinity of Beaver Creek in past years (Dave Kenney, personal communication) and during our survey. We were not successful in trapping this species on Wind Cave National Park. This species is generally common and ranges widely throughout the eastern United States.

~~Chrysemys~~ *Chrysemys picta bellii* (western painted turtle): This species is common in the vicinity of Wind Cave National Park where suitable habitat exists. I have observed it on Wind Cave National Park, along NPS 6 near the Custer State Park border. However, the field crew found no suitable habitat anywhere on Wind Cave National Park. The species seems to require permanent ponds of a reasonable size (perhaps as small as 1/4 hectare), and no such ponds exist on the park. The species is not found at spring sites. There are probably very few western painted turtles on the park, and any found might be transient. The individual I saw on Wind Cave National Park was found within 1 km of a large pond on Custer State Park.

Lizards and Snakes

Lizards: No lizards have ever been reported from Wind Cave National Park, and we did not hear of any sightings despite interviewing many employees and volunteers at the park. One

resident of Hot Springs reported lizards just south of town, but the field crew was not able to find this population. It is not likely that any lizards exist on the park.

✓*Coluber constrictor flaviventris* (eastern yellowbelly racer): This was the second most commonly observed snake at Wind Cave National Park. It is diurnal and extremely fast. It is not likely to be observed on roads at night, and easily escapes during the day. All our observations of this species were during the day, in the mixed-grass prairie. Most of our observations were made in the course of walking to and from field sites. This species is known as a lizard feeder in many parts of its range. A road-killed specimen collected at Wind Cave National Park was found to have eaten grasshoppers.

✓*Crotalus viridis viridis* (prairie rattlesnake): This is the only venomous snake found on the park, and it is the most common snake on the park. We found it in all habitats, and it appears to be fairly common in the campground, Visitor's Center, and employee housing. We observed the species at all times of the day, and it was particularly common on road cruises. Potentials for visitor and employee contacts with this species are high. Fortunately, bites from this species are rarely fatal, and both hospitals in Hot Springs appear to be well-equipped and familiar with the treatment for bites from this species. All bites from this species should be treated as potentially life-threatening, especially if they are delivered to small adults or children. Emergency procedure should be to immediately transport the victim to one of the two hospitals in Hot Springs. However, most of the time this species is docile and will avoid encounters with humans and other large animals. They will rarely bite unless molested or surprised.

There is probably at least one, and possibly several, prairie rattlesnake den sites on the park. These are frequently shared with other snake species and are very important resources for the

snakes, since suitable den sites can be rare in the habitat. Some of these den sites may be associated with Wind Cave, and employees should take caution when exploring little-known cavities in the area, especially during the spring and fall.

Regarding prairie rattlesnakes found nearby areas frequented by visitors and employees, park policy has been to remove such snakes to a safe distance and release them. It is not at all clear that this is an effective policy, but no research has been done on the efficacy of this procedure. It is possible that these snakes may return to the area in which they were captured, or they may become disoriented and more likely to die. There is a great need for research on locomotor and navigational skills of rattlesnakes on national parks, since re-location is a common strategy on parks when venomous snakes are encountered nearby areas frequented by visitors and employees.

***Heterodon nasicus nasicus* (Plains hognose snake):** This species was not found by the field crew in 1996. However, it seems to be rare in much of its range, and it may occur on the park. The species exhibits the peculiar behavior of "playing dead" (rolling onto its back and lying motionless) when disturbed, and one park employee recalled a snake caught in years past that exhibited this behavior. Since the behavior is unique to the hognose snakes, and this species is the only hognose snake in the area, it seems likely that the employee was describing this species. Any observation of this species on Wind Cave National Park would be of interest.

***Lampropeltis triangulum multistriata* (pale milk snake):** This is the northwesternmost subspecies of the wide-ranging milk snake. This snake appears to be very rare at Wind Cave National Park. One specimen was brought to us which was found dead in the laundry room of one of the seasonal employee's apartment complexes on July 12. Another specimen had been

found in the same area, sometime during the last 10 years (Kevin Jackson, Wind Cave National Park volunteer, personal communication).

Opheodrys vernalis (smooth green snake): This snake ranges widely throughout the northeastern United States, but is restricted to the Black Hills in western South Dakota. It was also not found on Wind Cave National Park, but a road-killed specimen was collected on SD 87 0.7 road miles north of the north entrance to Wind Cave National Park in Custer State Park the evening of August 18. This is close enough to Wind Cave National Park that the species might occur in the Rankin Ridge area. Peterson (1974) found this species to be common in the Black Hills.

Pituophis melanoleucus (bullsnake): This is a common non-venomous snake at Wind Cave National Park. It is diurnal, and was never collected on night-time road cruises, but it was often encountered during the day, and was occasionally seen during VES. Again, most observations were fortuitous. It was found throughout the park. It feeds on rodents, and is common near human habitations. It is generally common throughout its range.

Storeria occipitomaculata pahasapae (Black Hills redbelly snake): This is the only taxon of herptile endemic to the Black Hills. It was not found on the park, but a specimen was collected at a drift fence in pine forest along SD 87 in Custer State Park on July 5, about one mile north of Wind Cave National Park. If found on the park, it is likely to be in the vicinity of Rankin Ridge. Although an endemic, it is not thought to be especially rare (Peterson, 1974; Douglas Backlund, South Dakota Natural Heritage Program, personal communication).

Thamnophis elegans vagrans (wandering garter snake): It seemed unusual that garter snakes of any species (except for a single western Plains garter snake, described below) were

never found on spring sites, despite considerable time spent during day and night on the springsites and at Bison Flats Pond by the field crew. *Thamnophis elegans vagrans* was common along streams and the wetlands on the Custer State Park border area within the first two miles north of the north entrance to Wind Cave National Park along SD 87. This is a common and widespread snake of the western United States, but enters South Dakota only in the Black Hills region.

✓*Thamnophis radix haydenii* (western Plains garter snake): This seems to be the most common garter snake in the plains surrounding the Black Hills (unpublished data), but it is rare on Wind Cave National Park. Only a single specimen was found, on August 13 at Red Valley West Spring.

✓*Thamnophis sirtalis parietalis* (red-sided garter snake): This species of garter snake is also common on Wind Cave National Park and Custer State Park, in the same habitat as described above for the wandering garter snake. It is a common and wide-ranging snake of the eastern United States.

Acknowledgments

The contributions of many were instrumental to the success of this project. Of course, field assistants Jason Kolbe and R. Scot Ferguson were invaluable, and much of the data I owe to them. Dave Kenney, former resource manager at Wind Cave National Park, originally suggested this study. Martha Jakobek was instrumental in leading us to field sites and sharing her knowledge of the area. Ross Rice assisted us in many ways during our visit to Wind Cave, and served as a gracious host. Many other employees and the numerous volunteers working at the park were also of great help, willingly sharing their knowledge of the biotic resources of the

park. They also reported many sightings of reptiles and amphibians throughout the area during the summer of 1996. These employees and volunteers were too numerous to mention here, but especially helpful was Kevin Jackson, whose ten years of volunteer experience at the park and an interest in herpetology helped us to fill in many gaps in species distributions at the park.

Discussions with Dorothy Bowers were helpful in formulating some of my ideas during the writing of this paper, although the opinions expressed herein are my own. Help from Tamara Lawson was instrumental in compiling the data and revising the final draft. Douglas Johnson and Diane Larson, of the Northern Prairie Science Center, provided guidance and support throughout the project. Products and companies mentioned in the text are not necessarily endorsed or recommended by the writer nor by the government of the United States.

Literature Cited

- Bowers, D. G., D. E. Andersen, and N. H. Euliss, Jr. In press. Anurans as indicators of wetland condition in the Prairie Pothole Region of North Dakota: An Environmental Monitoring and Assessment Program (EMAP) Pilot Project. *In* M. J. Lannoo, ed., Status and Trends of Midwestern Amphibians. University of Iowa Press, Iowa City, Iowa.
- Bury, R. B., and R. A. Luckenbach. 1976. Introduced amphibians and reptiles in California. *Biological Conservation* 10:1-14.
- Busby, W. H., J. R. Parmalee, C. M. Dwyer, E. D. Hooper, and K. J. Irwin. 1994. A survey of the herpetofauna on the Fort Riley Military Reservation, Kansas. Reports of the State Biological Survey of Kansas, Report No. 58. 79 pp.
- Chiszar, D., D. Featherman, R. Fuerst, and H. M. Smith. 1994. Observations on the herpetofauna of the Indian reservations of southwestern South Dakota. *Bulletin of the Chicago Herpetological Society* 29:269-270.
- Conant, R., and J. T. Collins. 1991. *A Field Guide to Reptiles and Amphibians: Eastern and Central North America*, 3rd Ed. Houghton Mifflin Company, New York. 450 pp.
- Crump, M. L., and N. J. Scott, Jr. 1994. Visual encounter surveys. Pp. 84-92 *in* Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L.-A. C. Hayek, and M. S. Foster, eds. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press, Washington, D.C. 364 pp.
- Fishbeck, D. W., and J. C. Underhill. 1959. A checklist of the amphibians and reptiles of South Dakota. *Proceedings of the South Dakota Academy of Science* 38:107-113.

- Fisher, R. N., and H. B. Shaffer. 1996. The decline of amphibians in California's Great Central Valley. *Conservation Biology* 10:1387-1397.
- Froiland, S. G. 1990. *Natural History of the Black Hills and Badlands*. The Center for Western Studies, Sioux Falls, South Dakota. 225 pp.
- Hammerson, G. A. 1982. Bullfrogs eliminating leopard frogs in Colorado? *Herpetological Review* 13:115-116.
- Hayes, M. P., and M. R. Jennings. 1986. Decline in ranid frog species in western North America: Are bullfrogs (*Rana catesbeiana*) responsible? *Journal of Herpetology* 20:490-509.
- Inger, R. F. 1980. Densities of floor-dwelling frogs and lizards in lowland forests of southeast Asia and Central America. *American Naturalist* 115:761-770.
- Jaeger, R. G. 1980a. Density-dependent and density-independent causes of extinction of a salamander population. *Evolution* 34:617-621.
- , 1980b. Fluctuations in prey availability and food limitation for a terrestrial salamander. *Oecologia* 44:335-341.
- , and R. F. Inger. 1994. Quadrat sampling. Pp. 97-102 in Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L.-A. C. Hayek, and M. S. Foster, eds. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press, Washington, D.C. 364 pp.
- Johnson, D. H., and R. D. Batie. 1996. Surveys of calling amphibians in North Dakota. Internet WWW Page at URL: <http://159.189.96.215/resource/distr/herps/amsurvey/amsurvey.htm>.

- Jones, K. B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. *Southwestern Naturalist* 26:107-115.
- Lannoo, M. J. 1996. *Okoboji Wetlands: A Lesson in Natural History*. University of Iowa Press, Iowa City, Iowa. 156 pp.
- Lieberman, S. S. 1986. Ecology of the leaf litter herpetofauna of a Neotropical rain forest: La Selva, Costa Rica. *Acta Zoológica Mexicana* 15:1-72.
- Lloyd, M., R. F. Inger, and F. W. King. 1968. On the diversity of reptile and amphibian species in a Bornean rain forest. *American Naturalist* 102:497-515.
- Mathis, A. 1990. Territoriality in a terrestrial salamander: The influence of resource quality and body size. *Behaviour* 112:162-175.
- Moyle, P. B. 1973. Effects of introduced bullfrogs, *Rana catesbeiana*, on the native frogs of the San Joaquin Valley, California. *Copeia* 1973:18-22.
- North American Amphibian Monitoring Project. 1996. North American Amphibian Monitoring Program, Calling-Amphibian Surveys. Internet WWW page at URL: <http://www.im.nbs.gov/amphib/naampcall.html>. Last updated 2 February 1996.
- Over, W. H. 1923. *Amphibians and reptiles of South Dakota*. University of South Dakota Bulletin Number 10. 34 pp.
- Peterson, C. R. 1974. A preliminary report on the amphibians and reptiles of the Black Hills of South Dakota and Wyoming. M. S. Thesis, University of Illinois at Urbana-Champaign. 59 pp.
- Rahn, P. H., and J. P. Gries. 1973. Large springs in the Black Hills, South Dakota and Wyoming. South Dakota Geological Survey Report of Investigations No. 107. 46 pp.

- Scott, N. J., Jr. 1976. The abundance and diversity of the herpetofaunas of tropical forest litter. *Biotropica* 8:41-58.
- Shaffer, H. B., and J. E. Juterbock. 1994. Night driving. Pp. 163-166 in Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L.-A. C. Hayek, and M. S. Foster, eds. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press, Washington, D.C. 364 pp.
- Smith, H. M. 1956. *Handbook of Amphibians and Reptiles of Kansas*, 2nd ed. University of Kansas Museum of Natural History Miscellaneous Publication 9. 356 pp.
- , 1963a. The identity of the Black Hills population of *Storeria occipitomaculata*, the red-bellied snake. *Herpetologica* 19:17-21.
- , 1963b. New distributional records of amphibians and reptiles from South Dakota and Wyoming. *Herpetologica* 19:147-148.
- , 1964. The taxonomic status of the Black Hills population of smooth greensnakes. *Herpetologica* 19:256-261.
- , R. Mixter, and T. Spangler. 1966. The bullfrog and other reptiles and amphibians in western South Dakota. *Journal of the Ohio Herpetological Society* 5:106-107.

Appendix 1

Procedure for Building Funnel Traps and Drift Fences

Jason Kolbe and R. S. Ferguson

U.S. Geological Survey/Biological Resources Division

Northern Prairie Science Center

8711 37th St. SE

Jamestown, North Dakota 58401-7317

Materials:

Steel fence posts; 48"; 12 posts per drift fence. These are usually known at lumber yards as electric fence stakes.

Aluminum flashing (aluminum valley tin); 24" or 30" high. Flashing comes in 50' rolls; 1.5 rolls are needed per fence. We do not recommend using galvanized steel because of its excessive weight. We have found that 24" fencing is more stable in high winds than 30" fencing, although the taller fencing might be more desirable for two reasons: It can be sunk further into the ground, and it may better prevent reptiles and amphibians from climbing over the fence and escaping the traps. We believe that 24" fencing is high enough to trap most snakes encountered at Wind Cave National Park. If trapping of snakes is not necessary, then 24" fencing should be sufficient for trapping other reptiles and amphibians.

Wire screening; 36" wide. Approximately 33 funnel traps can be made from a 100' roll of screening. We recommend aluminum window screening, but other types can be used.

Aluminum window screening is easy to work with, disposable, and recyclable. Some workers make traps of hardware cloth, which is sturdier, but more difficult to work with and transport.

Tools:

Potato rakes

Sharp shooter shovel (narrow spade, sometimes called a tile spade)

Shovels

Tape measure

Hammer (or small sledge)

Tin snips

Wire (heavy gauge)

Pliers

Duct tape

Stapler

Compass

Large nail

Gloves

Funnel traps:

We found it helpful to cut a pattern out of the wire screening for the cylinder portion (1 per trap) and end funnels (2 per trap) of the funnel traps. The dimensions for the cylinder are 27" X 36", and the diameter of the circle for the end funnels is 11". After the patterns are cut, assembly begins with the cylinder. Starting with the 27" X 36" piece of screening lying flat, fold it lengthwise without creasing the middle. It should be in the shape of an exaggerated teardrop.

Staple every three inches or so along the edge. After the stapling is complete, fold the stapled edge over twice. Each fold should be about an inch wide. The cylinder portion of the trap is now complete. Next, take the two 11" diameter circular pieces of screening and make one cut straight into the center of each circle (5.5" cut). Now fold each circle so it overlaps and forms a funnel or conical shape. Make sure the base of the funnel is close to the same size as the diameter of the cylinder ends. When the desired funnel shape is obtained, staple it several times to maintain this shape. Next, cut off the tip of the funnel, leaving a hole just large enough for the largest species you expect to capture. Staple around the cut off end so there are no gaps in the funnel. Insert the funnel into an end of the cylinder with the funnel pointed inward. Staple the base of the funnel to the end of the cylinder leaving no gaps between the cylinder and funnel. Repeat this step for the other funnel. It may be necessary to cut a hole in only one funnel, depending on the intended use.

When animals are captured using this design, it is necessary to pop the staples out of the seam and reach in to capture the specimen. The traps can then be re-stapled and used again. This type of material does not last long, but they lasted throughout the field season at Wind Cave National Park. They can be made and recycled as necessary, and are inexpensive and easy to build. Very large (>2 m) snakes have been captured in traps of this design (Brian E. Smith, unpublished data). The traps can also be collapsed around the specimen if necessary. These traps have not been used with venomous snakes, but it seems likely that collapse of the trap will be necessary to remove such species from these traps.

Drift fence:

After the drift fence sites are selected, determine where the focal point will be for the three (triradiate) arms of the fence. Choose a direction for the first arm; it is important to imagine where the other two arms will be and to avoid potential obstacles (e.g., rocks, trees, etc.). This trap style is meant to be non-directional, so orientation of the arms is not important. If the site is on a hillside, avoid parts of the slope with fluctuations in gradation. If the grade fluctuates substantially, it may be necessary to dig deep trenches or to cut and angle the aluminum flashing. When the three arm directions are roughly laid out, use a compass to obtain the proper angle of 120 degrees between each arm. It is helpful to position stakes out from the focal point in the direction of each arm. Then position the stakes in a straight line out from each pointer stake at a distance equal to the length of each fence arm (7.65 m or 25'). Using the end stakes as a guide, rake a guide path for the trench from the focal point to the end stake of each arm using a potato rake. Clear away all grass, leaves, rocks, and other debris to facilitate the digging. Next, dig a 6"-8" trench from the focal point to the end stake of each arm. A narrow spade (tile spade or sharpshooter) is especially helpful in digging this trench. Remove all rocks and pay special attention to make sure that the trench is straight.

Next, make three holes for each of the four stakes to be woven into the three arms of the fence (4 stakes for each arm of the fence). These stakes should be at regular intervals, but leave an extra 2-3' at the focal point end to overlap with the adjoining arms of the fence. We used a very large nail to puncture holes in the flashing, and then just pushed the stakes through the holes. With aluminum flashing, it is then possible to "weave" the 48" metal stakes through the fence, as if one were knitting. The small holes this process creates can be covered with duct tape after the

fence is erected. Alternatively, two stakes can be placed at each position and then wired together at the top of the fence or through the fence to hold it upright, but this technique requires twice as many stakes. The point of the stakes is simply to hold the fence up in strong winds. It is important that snakes cannot climb over the fence using the stakes as anchors, so keep this in mind while building the fence. We believe that the weaving technique will thwart attempts to scale the fence by snakes.

Next, position the fence with its woven stakes in the center of the trench, remembering to leave an extra 2-3' at the beginning of each arm to overlap with adjacent arms. Pound the stakes into the ground and then slide the fence down as close to the bottom of the trench as possible. Repeat this procedure for the other two arms making sure that the fence arms overlap enough so that no gaps will be present. Then tape the arms together with duct tape where they adjoin so that no gaps are present in the flashing where each separate piece joins each arm. When all fence arms are in the ground, fill in the trenches on both sides of each arm so that no gaps can be seen under the fence. It is also helpful to wire the three focal point stakes tautly together to reinforce the central part of the fence. In addition, we strung guide wires from stakes and/or the ends of the fence arms as needed for support, but remember that snakes can use these wires to climb the fence, depending on placement of the wires.

Finally, place one trap at the end of each side of the fence for each arm (six funnel traps total). Weigh the ends of the funnel traps down with dirt, rocks, leaves, etc., and cover the trap with lighter debris to provide shade. Make sure that there is not a gap between the funnel trap and the fence. It may be more likely that reptiles and amphibians will crawl into a small darkened hole, so it is a good idea to make funnel traps seem as "natural" a crevice as possible.

It is important to use one trap on either side of the fence. A single trap placed at the end of a fence can be avoided if animals simply go around the edge of the fence, never entering the funnel.

Remember that none of these techniques are standardized and that they have never been tested under controlled conditions, so modify them for your own situation as necessary. A well-trained and physically fit crew of three can pack all of these materials into any fence site over any terrain for as many miles as required. Once at the site, fences can be assembled in ninety minutes to two hours. We (Smith, Kolbe, and Ferguson) have installed from 2-4 fences a day, depending on the hike required to reach each site.

Data:

We took the following data for each fence:

Compass direction of each arm (aspect).

Slope of each arm.

Canopy cover at the end of each arm and at the center of the array.

Number of each funnel trap.

General habitat at each fence. This could be expanded to a general vegetation survey at each site.

For more information, see:

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L.-A. C. Hayek, and M. S. Foster, eds. 1994.

Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians.

Smithsonian Institution Press, Washington, D. C. 364 pp.

See especially pp. 109-117. We used the Jones-style array depicted in figure 11B, page 112.

Appendix 2: Visual Encounter Survey Data;

Wind Cave National Park

VES number	Location*	Species collected
1	13 6 22 750 E, 48 32 440 N	
2	13 6 21 950 E, 48 28 670 N	<i>Bufo woodhousii</i> (female)
3	13 6 22 660 E, 48 31 000 N	
4	13 6 22 040 E, 48 29 300 N	<i>Pseudacris triseriata</i> (female)
5	13 6 23 380 E, 48 29 000 N	<i>Crotalus viridis</i> (two specimens not sexed)
6	13 6 23 820 E, 48 28 400 N	
7	13 6 21 960 E, 48 28 690 N	
8	13 6 24 890 E, 48 25 980 N	
9	13 6 22 600 E, 48 27 500 N	
10	13 6 22 380 E, 48 26 760 N	<i>Pituophis melanoleucus</i> (juvenile)
11	13 6 22 180 E, 48 29 000 N	<i>Coluber constrictor</i> (shed skin only)
12	13 6 23 560 E, 48 30 260 N	
13	13 6 22 750 E, 48 29 630 N	
14	13 6 22 610 E, 48 27 470 N	
15	13 6 23 210 E, 48 32 160 N	<i>Thamnophis</i> species (escaped)
16	13 6 22 640 E, 48 27 660 N	
17	13 6 22 980 E, 48 27 200 N	
18	13 6 22 340 E, 48 29 140 N	
19	13 6 22 080 E, 48 28 180 N	
20	13 6 23 840 E, 48 30 140 N	

*--Locations given in Universal Transverse Mercator (UTM) system. System used was accurate to +/- 15 m, and eastings and northings are rounded to the nearest 10 m.

Appendix 3: Springsite Phenologies

In this appendix are compiled phenologies for each spring visited and for Bison Flats Pond. For each table, the following activities are recorded: Calling (an active chorus present); tadpoles present, and metamorphs present. These activities and life stages are recorded for each species present at each spring. Several of these are summarized in the tables below, but some springs were not active enough to warrant inclusion in a table. These springs, and certain species at some springs, are discussed below. If the calling--tadpoles--metamorphs sequence is not complete for any species at the following springs, I have assumed reproductive failure at the site for 1996.

Date	Calling	Tadpoles	Metamorphs
29 May	XXXX		
30 May	XXXX		
22 June		XXXX	
24 June		XXXX	
1 July			XXXX
8 July			XXXX
23 July			XXXX

Bison Flats Pond: Phenology of *Bufo woodhousii*.

Date	Calling	Tadpoles	Metamorphs
29 May	XXXX		
30 May	XXXX		
22 June		XXXX	
24 June		XXXX	
1 July			XXXX

Bison Flats Pond: Phenology of *Scaphiopus bombifrons*.

Date	Calling	Tadpoles	Metamorphs
13 May	XXXX		
14 May	XXXX		
15 May	XXXX		
21 May	XXXX		
24 May	XXXX		
26 May	XXXX		
27 May	XXXX		
28 May	XXXX		
29 May	XXXX		
30 May	XXXX		
2 June	XXXX		
22 June		XXXX	
24 June		XXXX	XXXX
1 July			XXXX
8 July			XXXX
23 July			XXXX
12 August			XXXX

Bison Flats Pond: Phenology of *Pseudacris triseriata*.

Also noted calling at Bison Flats Pond were *Bufo cognatus*, on May 29 and 30. Successful reproduction was not noted in this species at Wind Cave National Park in 1996.

Date	Calling	Tadpoles	Metamorphs
14 May	XXXX		
16 May	XXXX		
22 May	XXXX		
24 May	XXXX		
29 May	XXXX	XXXX	
3 June	XXXX	XXXX	
1 July		XXXX	
16 July		XXXX	
13 August		XXXX	XXXX

Blacktail Spring: Phenology of *Pseudacris triseriata*.

Also successfully reproducing at Blacktail Spring was *Bufo woodhousii*, which was heard calling May 29, with metamorphs found July 16 and August 13.

Date	Calling	Tadpoles	Metamorphs
16 May	XXXX		
21 May	XXXX		
24 May	XXXX		
29 May	XXXX		
3 June	XXXX	XXXX	
5 June		XXXX	
24 June		XXXX	
1 July		XXXX	
8 July		XXXX	
16 July		XXXX	
13 August		XXXX	

Boland Ridge Spring: Phenology of *Pseudacris triseriata*.

Successfully reproducing at Boland Ridge Spring was *Bufo woodhousii*, with choruses found on May 16 and May 29, and metamorphs on August 13.

Date	Calling	Tadpoles	Metamorphs
14 May	XXXX		
16 May	XXXX		
29 May	XXXX		
3 June	XXXX		
8 July			XXXX
13 August			XXXX

Red Valley Spring: Phenology of *Bufo woodhousii*.

Date	Calling	Tadpoles	Metamorphs
14 May	XXXX		
16 May	XXXX		
21 May	XXXX		
24 May	XXXX		
29 May	XXXX	XXXX	
3 June		XXXX	
24 June		XXXX	
1 July		XXXX	
8 July		XXXX	
16 July		XXXX	
13 August		XXXX	

Red Valley Spring: Phenology of *Pseudacris triseriata*.

No other anurans were found at this spring.

Other Springs

Several other springsites were not visited as intensely or had considerably less activity than those discussed above. Anuran phenologies at these springs are briefly described below.

Cat-Tail Spring: No anurans were found breeding at this spring in 1996. However, *Pseudacris triseriata* choruses, tadpoles, and metamorphs were found in temporary pools within 15 m of the spring.

Gobbler Spring: *Pseudacris triseriata* were found chorusing in the spring and nearby drainage on May 15, May 17, and June 6. Tadpoles were found July 16. *Bufo woodhousii* were found nearby the spring at various times, and metamorphs were found July 16. On August 21, a visit to the spring revealed that it had been recently cleaned and all debris removed. *Ambystoma tigrinum* larvae were abundant in the spring pool. It is not clear whether reproduction was successful for *P. triseriata* at this site.

Limestone Spring: A small chorus of *Pseudacris triseriata* was found on May 14. No anurans were found at the spring during visits on June 6 and July 16. Reproduction was not successful for any anurans at this spring in 1996.

Parker Spring: *Pseudacris triseriata* were chorusing at this spring on May 16, and this species plus *Bufo woodhousii* were found chorusing at this site on June 4. Nothing was found during a follow-up visit on July 16, and a single larval *Ambystoma tigrinum* was found on August 21. Reproduction was not successful for any anurans at this spring in 1996.

Windy Point Spring: One *Pseudacris triseriata* was found calling at this spring on May 14. No anurans were seen during follow-up visits on June 6 and July 16. Reproduction was not successful at this spring in 1996.

Appendix 4: Sample Data Forms

This appendix consists of several data forms used by the field crew at Wind Cave National Park. The first two forms, "Systematic Sampling Survey" and "Visual Encounter Survey" can be used for VES and transects. The third form, "Road Survey Data Sheet", was developed during the field season for road cruises. This is a two-page form, with data on the specimens encountered entered on the second page. This second page can be copied to the back of the first for field use.

SYSTEMATIC SAMPLING SURVEY

OBSERVERS

DATE/TIME

/

GENERAL LOCALITY

SPECIFIC LOCALITY

HABITAT TYPE

SEARCH TYPE

HABITAT DESCRIPTION

SLOPE/ASPECT

/

CANOPY

WEATHER

TEMPERATURE

air

water at surface

water

cm deep

SPECIES OBSERVED

APPROXIMATE AREA SEARCHED

ENDING TIME

VISUAL ENCOUNTER SURVEY

Date

Observer(s)

General locality

Specific locality

Weather

Air temp

Habitat description

Slope/aspect

/

Canopy

Begin time

End time

No.	Species	Sex	SVL	Weight	Substrate	Location	Activity	Time
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								

ROAD SURVEY DATA SHEET

Date:

Observers:

Start time:

Odometer reading:

Weather conditions (temperature, moon phase, general description):

Route:

End time:

Odometer reading:

Weather conditions (temperature and general description):

Comments:

Species encounter data

Species	Sex	SVL	TL	Encounter data (location, habitat, substrate, activity)

Appendix 5

Checklist of Amphibians and Reptiles of Wind Cave National Park, South Dakota

Salamanders

Ambystoma tigrinum melanostictum (blotched tiger salamander): Apparently common park-wide.

Frogs

Bufo cognatus (Great Plains toad): Rare in grasslands.

Bufo woodhousii (Woodhouse's toad): Common park-wide.

Pseudacris triseriata (chorus frog): Abundant park-wide, more common in grasslands.

~~*Scaphiopus bombifrons*~~ (Plains spadefoot): Status unknown. Found in pine forest and grasslands.

Turtles

~~*Chelydra serpentina*~~ (common snapping turtle): Status unknown. Found at Beaver Creek.

~~*Chrysemys picta bellii*~~ (western painted turtle): Infrequent, possibly transient. Common in all habitats in vicinity. No suitable breeding habitat appears to exist on the park.

Snakes

Coluber constrictor flaviventris (eastern yellowbelly racer): Common park-wide. Apparently more common in grasslands.

Crotalus viridis viridis (prairie rattlesnake): Common park-wide.

~~*Heterodon nasicus nasicus*~~ (Plains hognose snake): Rare. Probably found only in grassland.

~~*Lampropeltis triangulum multistriata*~~ (pale milk snake): Rare. Habitat preferences unknown.

Pituophis melanoleucus (bullsnake): Common park-wide.

Thamnophis elegans vagrans (wandering garter snake): Common along streams and wetlands. Not found at spring sites.

Thamnophis radix haydenii (western Plains garter snake): Rare, found only in grasslands near water.

Thamnophis sirtalis parietalis (red-sided garter snake): Common along streams and wetlands. Not found at spring sites.

