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**FAUNAL SURVEY OF
AGATE FOSSIL BEDS NATIONAL MONUMENT**

**A Report
to the**

**National Park Service
United States Department of the Interior
Midwest Region
Omaha, Nebraska**

by

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EXECUTIVE SUMMARY

Introduction

"The preservation of natural resources and processes in the National Park system may be the most important legacy the Park Service can provide American conservation"¹ (Williams 1992). A primary step to the preservation of natural resources is establishing baseline criteria on species currently using the park to breed, forage or as a migration route, as well as their distribution and relative abundance by habitat. Recently, the National Park Service (NPS) and the National Biological Survey (NBS) issued a mandate to assemble baseline inventory data describing the current status of natural resources under their stewardship and monitor these resources in order to detect or predict changes. This information is also needed to provide reference information for comparison with other, more altered environments (Williams 1992). One of many NPS units in need of such baseline information was Agate Fossil Beds National Monument (AGFO).

This study involved the inventory of all existing bird, mammal, reptile and amphibian species and the determination of their residency status, density and/or abundance indices and distribution by habitat at AGFO. Objectives of this project were to: 1) meet the current mandate of the NPS and the NBS to conduct faunal inventories, 2) document the existence of any threatened or endangered species or species out of their normal range, 3) compare inventory results with species cited in the literature as existing in Sioux county, 4) recommend a monitoring plan for future inventories using methods that detected the highest number of species and produced repeatable density or abundance indices with the least amount of time and effort, and 5) provide resource managers with management recommendations to reduce anthropogenic influences on the natural ecosystems of AGFO.

Agate Fossil Beds located in the western panhandle of Nebraska, covers 965 ha in Sioux County. The five major habitat types are upland and lowland prairie, riparian/wetlands, rocky

¹ Williams, G. 1992. Natural Resources Inventory and Monitoring Guideline. NPS-75. 37 pp.

bluffs and cottonwood/willows. Faunal inventories were conducted between September 1992 and August 1994. Inventory methods were selected for their acceptance by the scientific community and their relative ease of implementation and subsequent replication. Birds were surveyed using transects, point counts and road surveys; herptiles with active search transects, coverboards, auditory surveys and a drift fence; small mammals with live, pitfall and snap trap grids and/or transects and mistnets and large mammals with Tomahawk traps, scent post stations and road surveys. Non-structured opportunistic sampling was important in detecting transient, migratory and low density species.

Results/Discussion

Overall, 92 bird, 30 mammal, 16 reptile and 6 amphibian species were detected at AGFO. One Bald eagle, recently classified as threatened, was seen flying over the monument. Range extensions included three reptiles (Northern water snake, Western smooth green snake, Western milk snake) and 1 amphibian (Great Plains toad), which are known to occur in Nebraska but have not been recorded in Sioux county. The majority of person hours was spent surveying mammals, followed by reptiles, amphibians and birds. The wetland/riparian habitat had the greatest number of total species with 23 breeding bird, 16 mammal, 9 reptile and 4 amphibian species. The combined habitats of upland and lowland prairie had 15 breeding bird, 22 mammal, 8 reptile and 4 amphibian species. The rocky bluff habitat harbored 13 breeding bird, 12 mammal, 4 reptile and 1 amphibian species. Seven species of breeding bird and 8 mammal species were recorded in the cottonwood/ willow habitat. Four summer and/or permanent resident bird, 11 mammal, 3 reptile and 1 amphibian species, that have been cited in the literature as existing within the vicinity of Sioux county were not detected during the survey.

The proposed monitoring plan for AGFO consists of: 1) bird transects run once in June in the upland and lowland prairies, rocky bluffs and riparian/wetlands, 2) bird point counts run once for 10 minutes each in June in the cottonwood/willow area, 3) a small mammal live trap grid consisting of 49 Sherman live traps maintained for 6 consecutive nights in June in upland

prairie, 4) small mammal live trap transects each consisting of 25 Sherman live traps maintained for 6 consecutive nights in June in the rocky bluffs, lowland prairie and riparian/ wetlands, 5) a small mammal live trap transect consisting of 10 Sherman live traps maintained for 6 consecutive nights in June in the cottonwood/willows, 6) a small mammal snap trap transect maintained for 3 consecutive nights in June in the riparian/ wetlands, 7) herptile active search transects run once in June or July in all habitat types. The implementation of this monitoring plan would require 3-4 weeks of effort by 2 people each year data were required and would provide sufficient data to detect major shifts in faunal diversity.

Although the restoration of Monument lands to "pre-settlement" conditions is one of the long term goals for AGFO, it is suggested that the majority of Monument grounds be maintained as a late successional grassland community since early successional (grazed) grasslands are well represented on adjacent, private lands. Grasshopper sparrows, Harriers, Dickcissels, Harvest mice and Voles would benefit from the preservation of the mature grasslands in the Monument. Restoration of natural disturbances characteristic of "pre-settlement" conditions could be implemented on a small scale using Black-tailed prairie dogs and fire. A prairie dog town may also attract burrowing owls, a declining species, which need established burrows for nesting and Spotted and Swift lizards which prefer open sandy prairie with sparse vegetation and burrows for cover. Fire, in general, has been shown to increase plant productivity and plant species diversity. Selective burning every 3-5 years would create a habitat type favored by Upland sandpipers and Sharp-tailed grouse. The control of exotic plants, smooth brome and canadian thistle, are also suggested as management options to help restore Agate Fossil Beds to "pre-settlement" conditions.

TERRESTRIAL VERTEBRATES OF AGATE FOSSIL BEDS NATIONAL MONUMENT, NEBRASKA

Jennifer L. Graetz¹, Robert A. Garrott¹ and Scott R. Craven¹

Abstract.-A survey of terrestrial vertebrates was conducted at the Agate Fossil Beds National Monument, Nebraska during the fall of 1992 and the summers of 1993 and 1994. The residency status, density and/or abundance indices and distribution by habitat were determined for all detected species of birds, mammals, reptiles and amphibians. Overall, 92 bird, 31 mammal, 16 reptile and 6 amphibian species were recorded in approximately 1064 person hours. Birds were surveyed using transects, point counts and road surveys; mammals with live, pitfall and snap traps, mistnets, scent post stations and road surveys and herptiles with auditory surveys, active search quadrats, coverboards and a drift fence. A threatened Bald eagle, and range extensions of the Northern water snake, Western smooth green snake, Western milk snake and Great plains toad, were documented on Monument grounds. Four summer and/or permanent resident bird, 11 mammal, 3 reptile and 1 amphibian species were identified as potentially present; known to occur in the vicinity of Cook county but not detected during the survey. A monitoring plan consisting of avian censuses, reptile transects, live trap grids and transects and snap trap transects is proposed. The reintroduction of the Black-tailed prairie dog, use of fire and the control of exotic plants, smooth brome (*Bromus inermis*) and canadian thistle (*Cirsium arvense*), are suggested as management options to help restore Agate Fossil Beds to "pre-settlement" conditions.

Introduction

Agate Fossil Beds National Monument (AGFO), located in the sandhills prairie region of Western Nebraska, was established in 1965 to preserve Miocene mammal fossils present in the rocky bluffs. In addition, the Monument is a refuge for animal and plant species characteristic of a late successional mixed grass prairie ecosystem (Risser et al. 1981); a rarity in an area managed for cattle

¹ Department of Wildlife Ecology, University of Wisconsin, Madison, 53706.

production (Potvin and Harrison 1984). Recent attention focused on habitat loss and subsequent declines in floral and faunal diversity (Wilson 1988, Brown et al. 1994) has prompted the National Park Service (NPS) and the National Biological Survey (NBS) to mandate that all lands under their stewardship be inventoried and monitored on a periodic basis (Williams 1992). This baseline data are needed to monitor changes within and outside of park lands and to use for comparison with other, more altered environments (Haug 1983, Williams 1992, Anonymous 1991). Since its establishment, no comprehensive wildlife inventory has been conducted at AGFO.

This study involved the inventory of all existing bird, mammal, reptile and amphibian species and the determination of their residency status, density indices for selected species, abundance indices and distribution by habitat at AGFO. Objectives of this project were to: 1) meet the current mandate of the NPS and the NBS to conduct faunal inventories, 2) document the existence of any threatened or endangered species or species out of their normal range, 3) compare inventory results with species cited in the literature as existing in the vicinity of Sioux county, 4) recommend a monitoring plan for future inventories, using methods that detected the highest number of species and produced repeatable density or abundance indices with the least amount of time and effort (Buckman and Sickie 1983) and 5) provide resource managers with recommendations which could be used to restore AGFO to its "pre-settlement" condition; a long-term goal for AGFO (Bennett et al. 1990).

Study Area

AGFO covers approximately 965 ha in Sioux County, Nebraska. It is located 96 km north of Scotts Bluff. Elevation within the monument varies from 4,400 meters in the Niobrara river bed to 4,500 meters in the rocky bluff regions. The average annual rainfall for 1993 and 1994 was 63.6 cm. A 9.5 km stretch of the Niobrara river winds through the center of the Monument. The five major habitat types are: 1) Upland prairie, which is the dominant habitat (712.4 ha), 2) lowland prairie, adjacent to the riparian/wetlands (107.4 ha), 3) riparian/wetland areas in and immediately

surrounding the Niobrara River (77.8 ha), 4) rocky bluffs (65.9 ha) and 5) cottonwood/willow habitats (1.39 ha; Figure 1).

Dominant plant species in the upland prairie include several grama grasses (*Bouteloua* spp.), needle and thread grass (*Stipa comata*), smooth brome (*Bromus inermis*), lemon scurfpea (*Psoralea lanceolata*), blackroot sedge (*Carex filifolia*) and low lupine (*Lupinus pusillus*). The riparian/wetland area is dominated by bulrush (*Scirpus validus*), yellow iris (*Iris pseudoacorus*), broad-leaved cat-tail (*Typha latifolia*), and willows (*Salix* sp.). Common plants in the lowland prairie are prickly poppy (*Argemone polyanthemos*), tumbling mustard (*Sisymbrium altissimum*), russian thistle (*Salsola iberica*), missouri milk vetch (*Astragalus missouriensis*), white sweet clover (*Melilotus albus*), indian ricegrass (*Oryzopsis hymenoides*) as well as grasses found in the upland prairie habitat. The rocky bluffs are sparsely vegetated with species such as sunflowers (*Helianthus* spp.), plains prickly pear (*Opuntia macrorhiza*), Nebraska sedge (*Carex nebraskensis*), soapweed (*Yucca glauca*) and plains phlox (*Phlox andicola*; Taylor and Taylor 1988, Graetz and Feller unpubl. data).

Methods

Faunal inventories were conducted during October 16-29, 1992, June 1-July 30, 1993, June 2-July 24, 1994 and April 22-24, 1994. Methods were selected based on their acceptance by the scientific community and their relative ease of implementation and subsequent replication. Habitat types were determined using aerial photographs, topographic maps and plant guides. All transects, trapping grids, scent stations etc. were placed near easily accessed points such as park and habitat boundaries and trails to facilitate follow-up surveys. For aesthetic reasons and to avoid vandalism, traps, scent stations, coverboards and the drift fence were placed out of sight from visitors. The UTM coordinates of most survey locations are listed in Appendix 1 and approximate locations of all survey sites are mapped in Appendices 2 and 3. The residency status of a species was defined as one or more of the following: 1) A permanent resident, 2) a summer or winter resident, 3) a spring or fall migrant or 4) transient, present for only a short duration during the summer (birds only). Detailed methodology has been organized by faunal groups.

Four 1000 meter strip transects were established to determine density and diversity indices of breeding bird species in the four primary habitats: upland prairie, lowland prairie, riparian/wetland and rocky bluffs (appendix 2). Each transect was run a total of 5 times, three times in 1993 and two times in 1994 during the peak breeding season (mid-June to mid-July), between 6:00 and 9:00 a.m. Transects were walked slowly at a speed of 1.5 to 1.7 km per hour (Emlen 1977) and all visual and auditory detections were recorded out to a fixed boundary of 50 meters on each side of the transect (Verner 1985, Bibby et al. 1992). The strip width of 50 meters on each side was chosen to maximize the detection of bird calls and songs (Emlen 1977, Emlen and DeJong 1981, DeJong and Emlen 1985). Standardized density indices, defined as the mean number of each species detected per 10 ha by habitat type during the 5 transect runs were calculated to facilitate comparisons of bird abundance between habitats. Shannon-Wiener diversity indices of bird communities were calculated using the mean number of species and individuals detected over the 5 transect runs for each habitat type (Krebs 1989).

Additional bird species were surveyed using point counts (Reynolds et al. 1980), colony counts (Bibby et al. 1992) and road surveys (nocturnal and diurnal; Bibby et al. 1992, Appendix 2). Twelve points in the riparian and 6 in the upland prairie areas were surveyed in 1992 by recording all visual and auditory cues for 10 minutes at a predetermined area. Since Cliff swallows are a flocking species and therefore not accurately censused using transects (Bibby et al. 1992), abundance indices were determined by counting all colonies and the number of active nests per colony. Diurnal road surveys involved driving the road bisecting the Monument twice in the spring of 1994, stopping every 800 m for 5 minutes to record all species detected and the associated habitat. Spotlight surveys were conducted to detect nocturnal species five times during each July, 1993 and 1994 and three times in October, 1992. Surveys were conducted by slowly driving the roads going through the center of the Monument, the ranger residence road and around the parking lot next to the visitor's center from an hour after sunset until 11:00 p.m.

Small mammals were surveyed using live and pitfall traps arranged in grids and transects (Raphael and Rosenberg 1983, Dueser and Porter 1986) and with snap trap transects (Galindo-Leal 1990) and with mist nets (Cox and Franklin 1989, Appendices 2 and 3). Four, 1.44 ha live-trap grids were maintained from June through July, 1993 and 1994 in upland prairie. Each grid contained 49 long Sherman live traps (7x9x49 cm), spaced at 20m intervals in a 7x7 pattern and 5 pitfall traps (36 oz. coffee cans), one each in the center of each quadrant and one in the center of the grid. Long traps were used to avoid injuring the tails of Kangaroo rats which were relatively common on the Monument. Traps were set for three consecutive nights every second or third week. Live traps were kept open during the day for 2, 3-day trapping periods in July 1994 to survey diurnal species such as Thirteen-lined ground squirrels. Linear transects varied by year, consisting of 10 to 25 live, and a maximum of 10 pitfall traps, at 10 or 20 meter intervals. In the fall of 1992, 3 transects were maintained in the upland prairie, 2 in the rocky bluff (live traps only) and riparian/wetlands and 1 in the cottonwood/willow area for 2, 3-day trapping periods. In June of 1993, 1 transect each was maintained in the riparian/wetland and rocky bluff areas (live traps only) for 1, 6-day trapping period. In July of 1994, the riparian transect was maintained for 1, 6-day trapping period. Pitfall traps were not used in the rocky bluff transects due to the difficulty of digging holes in that area. Trap spacing was increased to 20 meters in 1993 and 1994 because of the low densities of small mammals as indicated by the fall 1992 trapping data. Sherman traps were baited with peanut butter and rolled oats in the fall of 1992 and the summer of 1994 and sunflower seeds were used during the summer of 1993. A small piece of polyester batting (Kaufman et al. 1983) was added to the live and pitfall traps as bedding and insulation for trapped mammals. Each individual captured was marked with an ear tag. Fingernail polish was used for species with ears too small for tagging. All animals were released at the capture site immediately after marking. A snap trap transect consisting of 25 traps at 20 meter intervals was maintained for 3 nights in the riparian area in 1994 in an attempt to capture species reluctant to enter live traps (Beacham and Krebs 1980, Boonstra and Rodd 1984). Standardized capture rates, expressed as the number of individuals per 100 trap nights, were

calculated as abundance indices. Bats and owls were surveyed with mist nets erected at foraging sites (Harvey 1992). One net was maintained over the Niobrara river for five nights in July, 1994. Nets were opened from 9:00 until 12:00 p.m. and checked every half hour.

Medium and large mammals were surveyed using two sizes of Tomahawk live traps (60x17.5x17.5 cm, 40x12.5x12.5 cm, Day et al. 1980), scent post stations (Roughton and Sweeny 1982) and spotlight surveys (Appendices 2 and 3). In 1992, small Tomahawk traps were run for 22 trap nights in the rocky bluff, 22 in the riparian/wetland and 8 in the cottonwood/willow habitats. Additionally, large Tomahawk traps were run for 57 trap nights in the riparian/wetland and 28 in the upland prairie habitats. In 1993, small Tomahawks were run for 70 trap nights in the rocky bluffs and large Tomahawks for 140 in the riparian/wetlands. Tunafish, anise oil and canned dog food were used as bait. Standardized capture rates, expressed as the number of individuals per 100 trap nights, were calculated as abundance indices. In the fall of 1992, 2 scent posts were run for 2 nights in upland prairie, 3 for 2 nights in lowland prairie and 4 stations for 2 nights in riparian/wetland areas. During the summer of 1993, 5 stations were run for 6 nights in the rocky bluffs, 6 for 4 nights in the upland prairie habitat and 4 for 4 nights in the riparian/wetland area. All scent post stations were baited with a plaster disk impregnated with a fatty acid scent (Roughton 1982). Spotlight surveys were conducted to detect nocturnal species on the same evenings as the bird nocturnal surveys.

Amphibians and reptiles were sampled with a drift fence and pitfall traps (Corn 1990), active search quadrats (Jaeger and Inger 1994), auditory surveys (Zimmerman 1990) and coverboard transects (Grant et al. 1992, Appendix 3). The drift fence was placed near the edge of the wetland in an attempt to capture individuals migrating to and from this breeding location. The 1x15 m fence and pitfall traps located at each end were checked every other day from June 6 through July 30, 1993. Standardized capture rates, expressed as the number of individuals per 100 trap nights were calculated as abundance indices for pitfall trap data. Ten, 10x10 m quadrats were searched in rocky bluff areas during peak sunlight hours when lizards such as the Eastern short-horned and Spotted lizards and Striped swifts are most active (Hudson 1985). Standardized detection rates, expressed as

the number of individuals per hectare, were calculated as density indices for quadrat data. Ten auditory surveys, 4 each in June and July, 1993 and 1994 and twice in April 1994, were conducted in the riparian/ wetland habitat to detect frogs and toads. All calls were recorded one half hour before and one hour after sunset. Three coverboard transects, consisting of 11, 1.5x.75 m plywood boards spaced at 20 meter intervals, were checked for herptiles every other day, three times each during the morning, afternoon or evening, from June 30 through July 20, 1994. Two transects were placed in the riparian/wetland habitat and one in lowland prairie. Auditory surveys were used to detect frogs and toads calling in the wetland/riparian areas. All unique calls were recorded one half hour before and one hour after sunset, twice in late April 1994, as well as four times each during the summers of 1993 and 1994.

In addition to the "active" survey methods described, all faunal sightings as well as road kills, skulls, nests and tracks encountered opportunistically during fieldwork, were recorded by habitat type. The AGFO staff and adjacent landowners supplied additional sighting information for the Monument. Species richness, defined as the sum of all species in each faunal group, was calculated by habitat as a reference point for future inventories. Field guides (Hudson 1985, Jones et al. 1983, Peterson 1990, Ford 1959) were searched for any summer and/or permanent resident bird, mammal, reptile or amphibian species historically known to occur in the vicinity of Sioux county but not detected during the current inventory.

Results

Approximately 1064 person hours were spent on Monument grounds during the baseline inventory. Of this, 692 person hours were spent conducting 20 bird transect runs, 18 bird point counts, colony counts, 13 spotlight surveys, 5 mist net nights, 10 active search quadrats, 10 auditory surveys, 27 coverboard transect runs, 54 drift fence nights, 3931 Sherman live, 438 pitfall, 122 small Tomahawk, 225 large Tomahawk and 75 snap trap nights and 88 scent post nights. Approximately 372 hours were spent locating and setting up survey locations, setting traps, preparing scent post sites, etc., ordering equipment, preparing data sheets, conducting preliminary analyses and driving

and walking to and from survey locations. The majority of person hours was spent surveying mammals (530), followed by reptiles and amphibians (88) and birds (74). Overall, 92 bird, 30 mammal, 16 reptile and 6 amphibian species were detected at AGFO. These numbers reflect species observed, captured, heard or positively identified by sign at least once during the 2-year period. One Bald eagle, recently classified as threatened, was seen flying over the monument. Range extensions included three reptiles and 1 amphibian, a Northern water snake, Western smooth green snakes a Western milk snake and a Great Plains toad, which are known to occur in Nebraska but have not been recorded in Sioux county (Hudson 1985). A Great egret and two White-tailed kites were detected in the Monument east and north respectively, of their "normal" breeding range. Since both species were present for only a brief period, they were recorded as transients (Peterson 1990). Relative abundance categories, defined in Appendix 4, were listed by habitat type for all bird (Appendix 5), mammal (Appendix 6) and herptile (Appendix 7) species detected during the inventory. Detailed results are presented below by faunal groups.

Birds

The average densities of 36 bird species detected during the transect counts are summarized by habitat in Table 1. These species are a reflection of the summer and/or permanent resident bird communities at AGFO. The top 3 most common species for each habitat type are as follows: 1) Upland prairie; Grasshopper sparrows, Western meadowlarks and Horned larks, 2) lowland prairie; Western meadowlarks, Grasshopper sparrows and Red-winged blackbirds, 3) riparian/wetland; Red-winged blackbirds, Marsh wrens and Northern rough-winged swallows and 4) rocky bluffs; Western meadowlarks, Rock wrens and Lark sparrows. The greatest percentage of the total number of species for each habitat type was recorded on the first run of the transect as Figure 2 illustrates (21/31 riparian/wetland, 6/10 upland prairie, 5/11 lowland prairie and 7/8 rocky bluffs). The density indices (average total number of individuals per transect/10 ha $\pm$ S.E.) of the bird communities were 7.2 ± 1.3 in the rocky bluffs, 18 ± 2.1 in the riparian/wetland area and 4.6 ± 1.1 in both the upland and lowland prairie types. Shannon-Weiner diversity indices of bird communities are presented in Figure

3 by habitat type (1.4 for upland and lowland prairie, 2.0 for rocky bluff and 2.6 for wetland/riparian habitats).

Seventy three bird species detected by point, colony, road counts, and/or opportunistically, or by Park service personnel or adjacent landowners, are listed by habitat in Table 2. Twenty-three were classified as migrants, 2 as migrants and summer residents, 10 as winter residents, 28 as summer residents, 8 as permanent residents and 2 as transients. Sandhill cranes, Canada geese and Mallards located in the riparian/wetlands were the most common migrants. A great horned owl and common nighthawks were the only species detected during the spotlight surveys. Six colonies and 405 active nests were detected during the Cliff swallow colony counts.

Mammals

The density indices, defined as captures per 100 trap nights, obtained by live, pitfall or snap traps of 17 mammal species are summarized by habitat type in Table 3. Pitfall traps in the upland prairie in 1992 and Sherman live traps in the riparian/wetlands were unsuccessful and therefore not listed in the table. The number of species captured in each habitat by trap type were: 1) Upland prairie; 9 species captured with Sherman live and 4 with pitfall traps, 2) rocky bluffs, 7 species captured with Sherman live and 2 with small Tomahawk traps, 3) riparian/wetlands; 4 species captured with Sherman live, 3 with snap traps, 2 with pitfall and 2 with large Tomahawk traps and 4) cottonwood/willow; 5 species captured with Sherman live, 2 with pitfall and 2 with small Tomahawk traps. Deer mice and Ord's kangaroo rats were the two most common rodents in the upland prairie, rocky bluff and cottonwood/willow habitats. The riparian/wetlands were dominated by Deer mice, masked shrews and Striped skunks. Desert cottontails were abundant in the cottonwood/willow habitat. Trapping grids generated abundance indices for 10/11 total species trapped in the upland prairie habitat. Figure 4 summarizes the number of new species that were detected during each of the 3, 3-day trapping periods for the grid on which the greatest number of species was trapped in 1994. By the end of the second 3-day period, 7 of the eight total species and 14 of the 16 total individuals were captured on this grid.

The number of sightings and/or sign detected by habitat for 20 mammal species are summarized in Table 4. Seven species were recorded at scent post stations as well as detected opportunistically by sight, scat and tracks. Spotlight surveys detected 6 species, 5 of which were also detected using live traps or opportunistically by sight and/or tracks. No bats (or owls) were captured in the mist net. Most species (18) were recorded using no formal survey methods. The most common species detected by sight or sign were Desert cottontails, Eastern moles, White-tailed and Mule deer. Predatory species identified were the Coyote, Mink, Swift fox, Red fox and a Long-tailed weasel.

Reptiles and Amphibians

The number of sightings and/or sign detected by habitat for 6 amphibian and 16 reptile species are summarized in Table 5. Three frog species, the Northern leopard frog, Western chorus frog and Bullfrog were recorded while conducting auditory surveys. Woodhouse's toads were captured in the pitfall traps and a Western plains garter snake along the fence of the drift fence. Woodhouse's toads and Prairie rattle snakes were recorded on the spotlight surveys. Most species (18) were recorded using no formal survey methods; walking the bird transects and to and from trapping, drift fence and scent post locations. No species were detected underneath the coverboards but Western plains garter snakes were found basking on top of the boards in the early morning. Eastern short-horned lizards were the only species detected on the active search quadrats in the rocky bluff habitat. The most common species detected by sight and/or sign were Woodhouse's toads, Prairie rattle snakes and Western chorus frogs.

Species Richness by Habitat

The species richness of each faunal group is illustrated in Figure 3 by habitat. The wetland/riparian habitat, covering 8.06% of the total area, had the greatest number of total species with 23 breeding bird, 16 mammal, 9 reptile and 4 amphibian species. The combined habitats of upland and lowland prairie, covering 84.96% of the area, had 15 breeding bird, 22 mammal, 8 reptile and 4 amphibian species. The rocky bluff habitat, which made up 6.83% of the area harbored 13

breeding bird, 12 mammal, 4 reptile and 1 amphibian species. Seven species of breeding birds and 8 mammal species were recorded in the cottonwood/willow habitat, which accounted for only 0.14% of the total area.

Potentially Present Species

Four summer and/or permanent resident bird (Peterson 1990, Ford 1959), 11 mammal (Jones et al. 1983), 3 reptile and 1 amphibian (Hudson 1985) species, known to occur in the vicinity of Cook county but not detected during the current inventory are listed in Table 6. Some of these species may exist on Monument grounds but were undetected due to their secretive nature (Olive-backed pocket mouse, Small-footed myotis) or low densities (Gray fox, Spotted ground squirrel). Bison, Black-tailed prairie dogs and River otters do not exist on Monument grounds because of local extinction or extirpation as a result of hunting, trapping and/or poisoning (Jones et al. 1983). Burrowing owls and Black-footed ferrets are also not present due to their close association with Black-tailed prairie dog colonies (Peterson 1990, Fagerstone and Biggins 1986). Spotted lizards and striped swifts may not be present since their preferred habitat of "blow-outs" caused by grazing is not represented inside Monument boundaries.

Discussion

From the sparsely vegetated rocky bluffs to the floral and faunal rich riparian zones, AGFO supports the majority of species characteristic of the Northern great plains. The number of species detected (92 birds, 31 mammals, 16 reptiles and 6 amphibians) are comparable to the baseline inventory results obtained at the more habitat diverse Scotts Bluff National Monument also located in the Nebraska Panhandle (96 birds, 28 mammals, 8 reptiles and 4 amphibians, Cox and Franklin 1989). However, the baseline faunal inventory data gathered from this study represents just the first step toward the development of a complete inventory and monitoring program at Agate Fossil Beds National Monument.

A monitoring program, implemented on a routine basis, could be used to detect changes in species abundance and faunal community composition due to intrinsic and extrinsic factors (Williams

1992). The continued suppression of "pre-settlement" disturbances such as fire and grazing (Anderson 1982, Collins and Barber 1985) inside park boundaries could result in the displacement of species which prefer early successional grasslands with floral and faunal species characteristic of late successional grassland ecosystems (Hudson 1985, Kantrud and Kologiski 1982, Kruger 1984, Curtis 1987, Sexton and Gillespie 1979, Sietman et al. 1994). Extrinsic factors such as the habitat destruction on wintering grounds (Hecht and Cockburn 1990) and herbicide and pesticide runoff upstream (Peek 1986) could cause declines in long-distance migrant bird and permanent resident bird and mammal species (Risser et al. 1981, Terborgh 1992) and amphibian species (Duellman and Trueb 1994) that use Monument grounds. A monitoring program could also provide scientific evidence with which to evaluate the effectiveness of management plans designed to restore the Monument to "pre-settlement" conditions (Williams 1992).

Monitoring Plan

Realistically, all the methods used during the baseline inventory would not be cost-effective to implement for routine monitoring (Glenn 1994). The methods recommended are those which generated repeatable density or abundance indices with the least amount of time and effort for the greatest number of summer and/or permanent resident species from each faunal group for each habitat type. These qualities are attractive to agencies with limited funding, personnel and time to conduct follow-up monitoring (Haug 1983, Buckman and Sickle 1983). Destructive or removal sampling was kept at a minimum at the request of Park Service personnel (Rapier pers. comm.). A detailed description of the proposed monitoring plan has been summarized below. All described survey locations are listed in Appendix 1.

Birds

- A) Upland and lowland prairie, rocky bluffs, riparian/wetlands: The 4 standardized bird transects should be run once during the second week of June.
- B) Cottonwood/willow: 3 points at 50 meter intervals should be established using the small mammal transect location. Each point should be run once for 10 minutes the second week of

June. Density indices, defined as the number of birds detected per 10 ha, should be calculated for temporal comparisons.

- * 4 person hours, 1 per transect
- * No equipment required assuming availability of binoculars

Mammals

- A) Upland prairie: Grid 4 should be maintained in the upland prairie habitat for 6 consecutive nights in June using only Sherman live traps.
- B) Rocky Bluffs : The first transect listed should be run for 6 consecutive nights in June using 25 Sherman live traps at 20 m intervals.
- C) Riparian/wetlands: The first transect listed should be run for 6 consecutive nights in June using 25 Sherman live traps at 20 m intervals and the snap trap transect (25 snap traps at 20 m intervals) should be run for 3 consecutive nights.
- D) Cottonwood/willows: This transect should be run for 6 consecutive nights in June using 10 Sherman live traps at 10 m intervals.
- E) Lowland prairie: A transect consisting of 25 Sherman live traps at 20 m intervals should be established at the starting point of the bird transect in this habitat. Live traps should be maintained for 6 consecutive nights in June. Abundance indices of individuals, defined as captures per 100 trap nights should be calculated for temporal comparisons. All traps should be baited with peanut butter and rolled oats.

- * 72 person hours to set and check traps
- * 50 Sherman live traps, 25 Museum Special snap traps and 2 ear tag applicators initially required; 2-3 kg each peanut butter and rolled oats, 1 kg polyester batting and 50-60 ear tags needed per year

Reptiles and Amphibians

- A) Upland and lowland prairie, rocky bluffs and riparian/wetlands: Active search transects as described by Jaeger and Inger (1994) should be used to standardize the numerous (18)

opportunistic sightings of herptile species. These transects should be established using the bird transect locations and run once in June or July.

B) Cottonwood/willow: An active search transect should be established and run once in June or July using the small mammal transect in this habitat type. Density indices of individuals, defined as the number of individuals detected per ha should be calculated for temporal comparisons.

- * 5 person hours, 1 per transect

- * No equipment required

The implementation of this monitoring plan would require 3-4 weeks of effort by 2 people each year data were required and would provide sufficient data to detect major shifts in faunal diversity.

Management Recommendations

The restoration of Monument lands to "pre-settlement" conditions is one of the long term goals for AGFO (Bennett et al. 1990). Natural disturbances such as large and small scale grazing (Bison, Prairie dogs), burrowing and fire were common factors present throughout the evolution of grassland communities (Anderson 1982, Collins and Barber 1985 and Risser et al. 1981) and could be re-established on the Monument. However, the reintroduction of Bison would be impractical due to the small size of the Monument. The majority of Monument grounds should be maintained as a late successional grassland community since early successional (grazed) grasslands are well represented on adjacent, private lands (Kirsch et al. 1978). Grasshopper sparrows, Harriers, Dickcissels, Harvest mice and Voles (Owens and Myres 1973, Duebbert and Lokemoen 1977, Kantrud and Kologiski 1982 and Risser et al. 1981) would benefit from the preservation of the mature grasslands in the Monument. Restoration of natural disturbances could be implemented on a small scale (100-150 ha) using prairie dogs and fire to create a mosaic of "pre-settlement" habitat types.

The Black-tailed prairie dog, a small mammal grazer and burrower, controlled on adjoining rangelands, would be a good candidate for reintroduction at AGFO. The burrow system created

would result in a whole new "microhabitat" in the monument. The diversity of the vegetation in prairie dog towns has been shown to be higher than in adjoining grassland (Bonham and Lerwick, 1976; Coppock et al., 1983) due to the invasion of annual and short-lived perennial plant species (Curtis 1987). A prairie dog town may also attract Burrowing owls, a declining species, which need established burrows as nest sites and Spotted and Swift lizards which prefer open sandy prairie with sparse vegetation and burrows for cover. Unfortunately, one Black-footed ferret would require a population of at least 800 prairie dogs in order to survive, therefore a reintroduction could not be feasible at AGFO (Fagerstone and Biggins 1986).

Fire could also be beneficial to both animal and plant communities. Selective burning every 3-5 years would create a habitat type favored by Upland sandpipers (Kirsch and Higgins 1976) and Sharp-tailed grouse (Sexton and Gillespie 1979). In general, fire has been shown to increase plant productivity (Hulbert 1969; Rice and Parenti 1978; Towne and Owensby 1984; Mentis and Tainton 1984) and plant species diversity (Adams et al. 1982; Anderson 1982; Walker and Peet 1984; Kruger 1984) in many grassland systems.

The removal of exotic species is an additional management option to consider if restoration to pre-settlement conditions is a goal. Exotics inhibit the growth of native species by competing for light and nutrients (Curtis 1987). Based on preliminary research, the relative percent cover of smooth brome, an introduced pasture grass, is approximately 20 % (Graetz unpubl. data 1993) in the upland prairie habitat. Removal would require plowing and periodic cultivation with a spring-tooth harrow in order to expose and subsequently kill the rhizomes before reseeding with native prairie plants (Smith and Smith 1980). Although this seems like a labor-intensive process, it could be done on a small scale in order to minimize disturbance to animal communities. The Canadian thistle (*Cirsium arvense*), an exotic that grows in the wetland/riparian area, could be controlled by mowing, pulling plants by hand each year or with a spot herbicide application (Damrosch 1988).

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Table 1. Density indices (birds/10 ha) to summer and permanent resident bird species determined from standardized transects established in each major habitat type at Agate Fossil Beds National Monument, Nebraska.

Common name <i>Scientific name</i>	Habitat Types			
	Upland Prairie	Lowland Prairie	Riparian/Wetland	Rocky Bluffs
Wood duck			1	
✓ <i>Aix sponsa</i>				
Blue-wing teal			.2	
✓ <i>Anas discors</i>				
Virginia rail			1.2	
✓ <i>Ballus limicola</i>				
Killdeer			6.2	
✓ <i>Charadrius vociferus</i>				
Wilson's phalarope			.8	
✓ <i>Phalaropus tricolor</i>				
Common snipe			.8	
✓ <i>Gallinago gallinago</i>				
Ring-necked pheasant			.2	
✓ <i>Phasianus colchicus</i>				
American kestrel		.4		
✓ <i>Falco sparverius</i>				
Prairie falcon	.2			
✓ <i>Falco mexicanus</i>				
Red-tailed hawk			.2	
✓ <i>Buteo jamaicensis</i>				
Swainson's hawk				.2
✓ <i>Buteo swainsoni</i>				
Belted kingfisher			.6	
✓ <i>Ceryle alcyon</i>				
Mourning dove	.6	.4	1.6	2.2
✓ <i>Zenaida macroura</i>				
Common nighthawk	.4		.2	.2
✓ <i>Chordeiles minor</i>				
Eastern kingbird		.6	2.6	
✓ <i>Tyrannus tyrannus</i>				
Say's phoebe	.4			1.2
✓ <i>Sayornis saya</i>				
Horned lark	1.2		.2	3.6
✓ <i>Oremophila alpestris</i>				
Barn swallow			.2	
✓ <i>Hirundo rustica</i>				

Table 1. (continued)

Common name <i>Scientific name</i>	Habitat Types			
	Upland Prairie	Lowland Prairie	Riparian/Wetland	Rocky Bluffs
Bank swallow			.4	
✓ <i>Icteria riparia</i>				
✓ <i>N. rough-winged swallow</i> <i>common</i>	.4		17.6	
✓ <i>Stelgidopteryx serripennis</i>				
House wren			.4	
✓ <i>Troglodytes aedon</i>				
✓ <i>Marsh wren</i> <i>common</i>			12.2	
✓ <i>Cistothorus palustris</i>				
✓ <i>Rock wren</i> <i>common</i>		.2		3.8
✓ <i>Salpinctes obsoletus</i>				
✓ <i>Brown thrasher</i>			.8	
✓ <i>Toxostoma rufum</i>				
✓ <i>Gray catbird</i>			.6	
✓ <i>Dumetella carolinensis</i>				
✓ <i>Loggerhead shrike</i>				.2
✓ <i>Vanius ludovicianus</i>				
✓ <i>Yellow warbler</i>			2.4	
✓ <i>Dendroica petechia</i>				
✓ <i>Common yellowthroat</i>		.2	6.6	
✓ <i>Geothlypis trichas</i>				
✓ <i>Common grackle</i>			2.4	
✓ <i>Quiscalus quiscula</i>				
✓ <i>Red-winged blackbird</i>		3.8	17.4	
✓ <i>Agelaius phoeniceus</i>				
✓ <i>Western meadowlark</i> <i>common</i>	7.2	12	5.2	6.4
✓ <i>Sturnella neglecta</i>				
✓ <i>Brown-headed cowbird</i>		.4	3.6	1.6
✓ <i>Molothrus ater</i>				
✓ <i>Lark sparrow</i> <i>common</i>	.8	.2	1	6
✓ <i>Chondestes grammacus</i>				
✓ <i>Grasshopper sparrow</i> <i>common</i>	11	7.6	2	.2
✓ <i>Ammodramus savannarum</i>				
✓ <i>American goldfinch</i>	.2		4.4	
✓ <i>Carduelis tristis</i>				
✓ <i>Lark bunting</i>		.2		1.6
✓ <i>Calamospiza melanocorys</i>				

Table 2. Number of bird sightings (using point counts or opportunistically) detected by habitat in approximately 1060 person hours during the summers of 1993 and 1994 and the fall of 1992, at Agate Fossil Beds National Monument, Nebraska. Residency status defined as M=spring or fall migrant, P=permanent resident, S=summer resident, W=winter resident and T=transient, present only a short duration.

Common name Scientific name	Residency Status	Habitat Types				
		Riparian Wetland	Upland Prairie	Lowland Prairie	Rocky Bluffs	Cottonwood Willow
Snow goose ✓ <i>Chen caerulescens</i>	M	1				
Canada goose ✓ <i>Branta canadensis</i>	M	110				
Mallard ✓ <i>Anas platyrhynchos</i>	S/M	S-1/M-38				
Shoveler ✓ <i>Anas clypeata</i>	M	14				
Bufflehead ✓ <i>Bucephala albeola</i>	M	4				
Ring-billed gull ✓ <i>Larus delawarensis</i>	M	1	2			
Black tern ✓ <i>Chlidonias niger</i>	S	6				
Great blue heron ✓ <i>Ardea herodias</i>	S	5				
Great egret ✓ <i>Asmerodius albus</i>	T	1				
Sandhill crane ✓ <i>Grus canadensis</i>	M	>5000				
Sora ✓ <i>Porzana carolina</i>	S	1				
American avocet ✓ <i>Recurvirostra americana</i>	S	1				
Killdeer ✓ <i>Charadrius vociferus</i>	M		2	5		
Common snipe ✓ <i>Gallinago gallinago</i>	M	5		3		
Greater yellowlegs ✓ <i>Tringa melanoleuca</i>	M	2				
Lesser yellowlegs ✓ <i>Tringa flavipes</i>	M	1				

Table 2. (continued)

Common name <i>Scientific name</i>	Residency Status	Habitat Types				
		Riparian Wetland	Upland Prairie	Lowland Prairie	Rocky Bluffs	Cottonwood Willow
Solitary sandpiper	M	1				
✓ <i>Tringa solitaria</i>						
Upland sandpiper	S		1			
✓ <i>Bartramia longicauda</i>						
Wild turkey	P		1			
✓ <i>Meleagris gallopavo</i>						
Ring-necked pheasant	P		1	1		
✓ <i>Phasianus colchicus</i>						
Sharp-tailed grouse	P	5	1			
✓ <i>Pedioecetes phasianellus</i>						
White-tailed kite	T	2				
✓ <i>Elanus leucurus</i>						
Northern harrier	M/S	M-4	M-3/S-1			
✓ <i>Circus cyaneus</i>						
Cooper's hawk	M					1
✓ <i>Accipiter cooperii</i>						
American kestrel	M		1			1
✓ <i>Falco sparverius</i>						
Red-tailed hawk	W	1	1		1	3
✓ <i>Buteo jamaicensis</i>						
Swainson's hawk	S		1		1	2
✓ <i>Buteo swainsoni</i>						
Rough-legged hawk	W		1			2
✓ <i>Buteo lagopus</i>						
Bald eagle	W		1			
✓ <i>Haliaeetus leucocephalus</i>						
Golden eagle	S		1			
✓ <i>Aquila chrysaetos</i>						
Turkey vulture	S		1			
✓ <i>Cathartes aura</i>						
Short-eared owl	W		2			
✓ <i>Asio flammeus</i>						
Great horned owl	P	1	1			3
✓ <i>Bubo virginianus</i>						
Barn owl	S				3	
✓ <i>Tyto alba</i>						

Table 2. (continued)

Common name <i>Scientific name</i>	Residency Status	Habitat Types				
		Riparian Wetland	Upland Prairie	Lowland Prairie	Rocky Bluffs	Cottonwood Willow
Mourning dove	P					1
✓ <i>Zenaidura macroura</i>						
Common flicker	M		1			
✓ <i>Colaptes auratus</i>						
Downy woodpecker	P					2
✓ <i>Picoides pubescens</i>						
Western kingbird	S		1			
✓ <i>Tyrannus verticalis</i>						
Western wood pewee	S					1
✓ <i>Contopus sordidulus</i>						
Horned lark <i>common</i>	W		16			
✓ <i>Empidonax alpestris</i>						
White-throated swift	M	2				
✓ <i>Aeronautes saxatalis</i>						
N. rough-winged swallow	S				1	
✓ <i>Stelgidopteryx serripennis</i>						
Cliff swallow	S				6 colonies	
✓ <i>Hirundo pyrrhonota</i>						
American crow	P					1
✓ <i>Corvus brachyrhynchos</i>						
Black-capped chickadee	W	1				4
✓ <i>Parus atricapillus</i>						
Marsh wren <i>common</i>	S					2
✓ <i>Cistothorus palustris</i>						
Brown thrasher	S					1
✓ <i>Toxostoma rufum</i>						
Mountain bluebird	S				1	
✓ <i>Sialia currucoides</i>						
American robin	P	1	8			1
✓ <i>Turdus migratorius</i>						
Loggerhead shrike	S		2			2
✓ <i>Lanius ludovicianus</i>						
Cedar waxwing	M					2
✓ <i>Bombycilla cedrorum</i>						
Yellow-rumped warbler	M					1
✓ <i>Dendroica coronata</i>						

Table 2. (continued)

Common name Scientific name	Residency Status	Habitat Types				
		Riparian Wetland	Upland Prairie	Lowland Prairie	Rocky Bluffs	Cottonwood Willow
Common yellowthroat	S					1
<i>Geothlypis trichas</i>						
Yellow-headed blackbird	S	1				
<i>Xanthocephalus xanthocephalus</i>						
Red-winged blackbird <i>common</i>	M		150		1	
<i>Agelaius phoeniceus</i>						
Bobolink	S	1				
<i>Dolichonyx oryzivorus</i>						
Brown-headed cowbird	S		1			
<i>Molothrus ater</i>						
European starling	W	1	25			17
<i>Sturnus vulgaris</i>						
Orchard oriole	S					1
<i>Icterus spurius</i>						
Slate-colored Junco	W	2				1
<i>Junco hyemalis</i>						
Pine siskin	W	2				66
<i>Carduelis pinus</i>						
Blue grosbeak	S					1
<i>Quiraca caerulea</i>						
Lazuli bunting	S					1
<i>Passerina amoena</i>						
Rufous-sided towhee	S	2				2
<i>Pipilo erythrophthalmus</i>						
Savannah sparrow	M	2				
<i>Passerculus sandwichensis</i>						
Song sparrow	M	1				2
<i>Melospiza melodia</i>						
American tree sparrow	W	14				11
<i>Spizella arborea</i>						
Chipping sparrow	M				7	
<i>Spizella passerina</i>						
White-crowned sparrow	M					2
<i>Zonotrichia leucophrys</i>						
Field sparrow	M					3
<i>Spizella pusilla</i>						

Table 2. (continued)

Common name <i>Scientific name</i>	Residency Status	Habitat Types				
		Riparian Wetland	Upland Prairie	Lowland Prairie	Rocky Bluffs	Cottonwood Willow
American goldfinch <i>Carduelis tristis</i>	S			9		1
Dickcissel <i>Spiza americana</i>	S		1	1		1
Lark bunting <i>Calamospiza melanocorys</i>	S	8	1			

Table 4. Number of mammal sightings and/or sign detected by habitat in approximately 1064 person hours during the summers of 1993 and 1994 and the fall of 1992, at Agate Fossil Beds National Monument, Nebraska.

Common name Scientific name	Habitat Types			
	Upland Prairie	Rocky Bluffs	Riparian Wetlands	Cottonwood Willow
✓ Meadow vole <i>Microtus pennsylvanicus</i>	1			
✓ Desert cottontail <i>Sylvilagus audubonii</i>	13	10		6
✓ Eastern Cottontail <i>Sylvilagus floridanus</i>	1			
NO ✓ Blacktail jackrabbit <i>Lepus californicus</i>	1 skull			
✓ Bushy-tail woodrat <i>Neotoma cinerea</i>		2 burrows		
✓ Eastern mole <i>Scalopus aquaticus</i>	>25 burrows			1 carcass
✓ Northern pocket gopher <i>Thomomys talpoides</i>				1 skull
✓ Striped skunk <i>Mephitis mephitis</i>	1 tracks			
✓ White-tailed deer <i>Odocoileus virginianus</i>	11	2	9	6
✓ Mule deer <i>Odocoileus hemionus</i>	9			
✓ Coyote <i>Canis latrans</i>	4	4		
✓ Mink <i>Mustela vison</i>			3	
✓ Beaver <i>Castor canadensis</i>			5	
✓ Raccoon <i>Procyon lotor</i>		1	4	
✓ Muskrat <i>Ondatra zibethicus</i>			3	
✓ Porcupine <i>Erethizon dorsatum</i>				1
✓ Swift fox <i>Vulpes velox</i>	1			

Table 4. (continued)

Common name <i>Scientific name</i>	Habitat Types			
	Upland Prairie	Rocky Bluffs	Riparian Wetlands	Cottonwood Willow
Red fox <i>Vulpes vulpes</i>	1			
Badger <i>Taxidea taxus</i>	2 holes		1	
Long-tailed weasel <i>Mustela frenata</i>	1			

Table 3. Abundance indices of mammal species, defined as captures per 100 trap-nights, by habitat, year and trap type at Agate Fossil Beds National Monument, Nebraska. Sherman small mammal live traps used unless otherwise indicated.

Common name Scientific name	Habitat Type: Upland Prairie					Rocky Bluffs		Riparian Wetlands				Cottonwood Willow		
	Year:	92	93	94		92	93	92	93	94		92		
	Trap Type:	Live	Live	Live	Pitfall	Live	Live	Live	Pitfall	Live	Pitfall	Pitfall	Snap	Live Pitfall
Trap Nights:		120	1372	1764	120	120	75	120	138	150	30	60	75	60 30
✓ Deer mouse <i>Peromyscus maniculatus</i>		3.34	0.51	3.4	0.84	10.84	2.67	10					2.67	23.3
✓ Ord's kangaroo rat <i>Dipodomys ordii</i>		7.14 ^a /2.5	1.02	0.79	0.84	13.64 ^b /1.84	2.67							12.5 ^c
✓ Western harvest mouse <i>Reithrodontomys megalotis</i>		0.84		0.28		1.67		2.5						6.67
✓ Plains harvest mouse <i>Reithrodontomys montanus</i>						2.5								
✓ Plains pocket mouse <i>Perognathus flavescens</i>		1.67	0.48	0.28	0.84									1.67 6.67
✓ Silky pocket mouse <i>Perognathus flavus</i>				0.06		0.84		0.84						3.34
✓ Hispid pocket mouse <i>Perognathus hispidus</i>			0.07	0.17										
✓ Northern grasshopper mouse <i>Onychomys leucogaster</i>			0.15	0.23		2.5								
✓ Masked shrew <i>Sorex cinereus</i>					0.84			1.67	6.67		1.45			
✓ Prairie vole <i>Microtus ochrogaster</i>				0.62									1.33	
✓ Meadow vole <i>Microtus pennsylvanicus</i>													2.67	

Table 3. (continued)

	Habitat Type: Upland Prairie					Rocky Bluffs		Riparian Wetlands				Cottonwood Willow			
	Year:	92	93	94		92	93	92	93	94		92			
Common name	Trap Type:	Live	Live	Live	Pitfall	Live	Live	Live	Pitfall	Live	Pitfall	Pitfall	Snap	Live	Pitfall
Scientific name	Trap Nights:	120	1372	1764	120	120	75	120	138	150	30	60	75	60	30
Desert cottontail <i>Sylvilagus audubonii</i>														25 ^f	
Bushy-tail woodrat <i>Neotoma cinerea</i>						4.55 ^b	1.43 ^c								
Plains pocket gopher <i>Geomys bursarius</i>				0.05								1.67			
Striped skunk <i>Mephitis mephitis</i>								5.26 ^d		.71 ^e					
Raccoon <i>Procyon lotor</i>								1.75 ^d							
Thirteen-lined ground squirrel <i>Spermophilus tridecemlineatus</i>		1.62	0.51	1.02											

^aLarge Tomahawks traps used (28 trap nights)^bSmall Tomahawks traps used (22 trap nights)^cSmall Tomahawks traps used (70 trap nights)^dLarge Tomahawks traps used (57 trap nights)^eLarge Tomahawks traps used (140 trap nights)^fSmall Tomahawks traps used (8 trap nights)

Table 5. Number of reptile and amphibian sightings and/or sign detected by habitat in approximately 1064 person hours during the summers of 1993 and 1994 and the fall of 1992 at Agate Fossil Beds National Monument, Nebraska.

Common name <i>Scientific name</i>	Habitat Types		
	Upland Lowland Prairie	Rocky Bluffs	Riparian/Wetland
Northern leopard frog			7
<i>Rana pipiens</i>			
Western chorus frog	1		15
<i>Pseudacris triseriata triseriata</i>			
Bullfrog			1
<i>Rana catesbeiana</i>			
Woodhouse's toad	25	1	9
<i>Bufo woodhousii woodhousii</i>			
Great plains toad	2		
<i>Bufo cognatus</i>			
Barred tiger salamander	1		
<i>Ambystoma tigrinum mavortium</i>			
Bullsnake	6	1	
<i>Pituophis catenifer melanotenus sayi</i>			
Prairie rattlesnake	15	1	10
<i>Crotalus viridis viridis</i>			
Western milk snake	1		
<i>Lampropeltis triangulum gentilis</i>			
King snake	1		
<i>Lampropeltis species</i>			
Western smooth green snake	2		
<i>Ophedrys vernalis blanchardi</i>			
Blue racer	4		
<i>Coluber constrictor foxii</i>			
Eastern yellow-belly racer	6		1
<i>Coluber constrictor flaviventris</i>			
Western plains garter	1		5
<i>Thamophis radix</i>			
Wandering garter	2	1	1
<i>Thamophis elegans vagrans</i>			
Red-sided garter			2
<i>Thamnophis sirtalis parietalis</i>			
Western hognose	1		
<i>Heterodon nasicus</i>			

Table 5. (continued)

Common name <i>Scientific name</i>	Habitat Types		
	Upland Lowland Prairie	Rocky Bluffs	Riparian/Wetland
Northern water snake ✓ <i>Nerodia sipedon sipedon</i>			1
Eastern short-horned lizard ✓ <i>Phrynosoma douglassii brevirostre</i>	2	30/ha ^a	
Snapping turtle ✓ <i>Chelydra serpentina</i>			2
Western spiny softshell ✓ <i>Aplousoma spinifera harwegi</i>			1
Western painted turtle ✓ <i>Chrysemys picta bellii</i>			1

^aDetected during active searches of 10, .01 ha quadrats

Table 6. Species historically recorded in the vicinity of Sioux county but not detected during the baseline inventory conducted from the fall of 1992 through the summer of 1994 at Agate Fossil Beds National Monument, Nebraska. Bird species are summer and/or permanent residents.

Birds	Mammals
Long-billed curlew <i>Numenius americanus</i>	White-tailed jackrabbit <i>Lepus townsendii</i>
Vesper sparrow <i>Pooecetes gramineus</i>	Black-tailed prairie dog <i>Cynomys ludovicianus</i>
Burrowing owls <i>Athene cunicularia</i>	Small-footed myotis <i>Myotis leibii</i>
Brewer's blackbird <i>Euphagus cyanocephalus</i>	Olive-backed pocket mouse <i>Perognathus fasciatus</i>
	Spotted ground squirrel <i>Spermophilus spilosoma</i>
	Eastern spotted skunk <i>Spilogale putorius</i>
Reptiles	Gray fox <i>Urocyon cinereoargenteus</i>
Spotted lizards <i>Holbrookia maculata maculata</i>	River otter <i>Lutra canadensis</i>
Striped swifts <i>Sceloporus undulatus garmani</i>	Black-footed ferret <i>Mustela nigripes</i>
Northern many-lined skinks <i>Eumeces multivirgatus multiviragatus</i>	Pronghorn <i>Antilocapra americana</i>
Amphibians	Bison <i>Bison bison</i>
Spadefoot toad <i>Scaphiopus holbrookii</i>	

30/38

738
342

92/199

16/19

6/7

38
 38
 246
 134
 38
 38
 246
 134
 38
 38
 246
 134

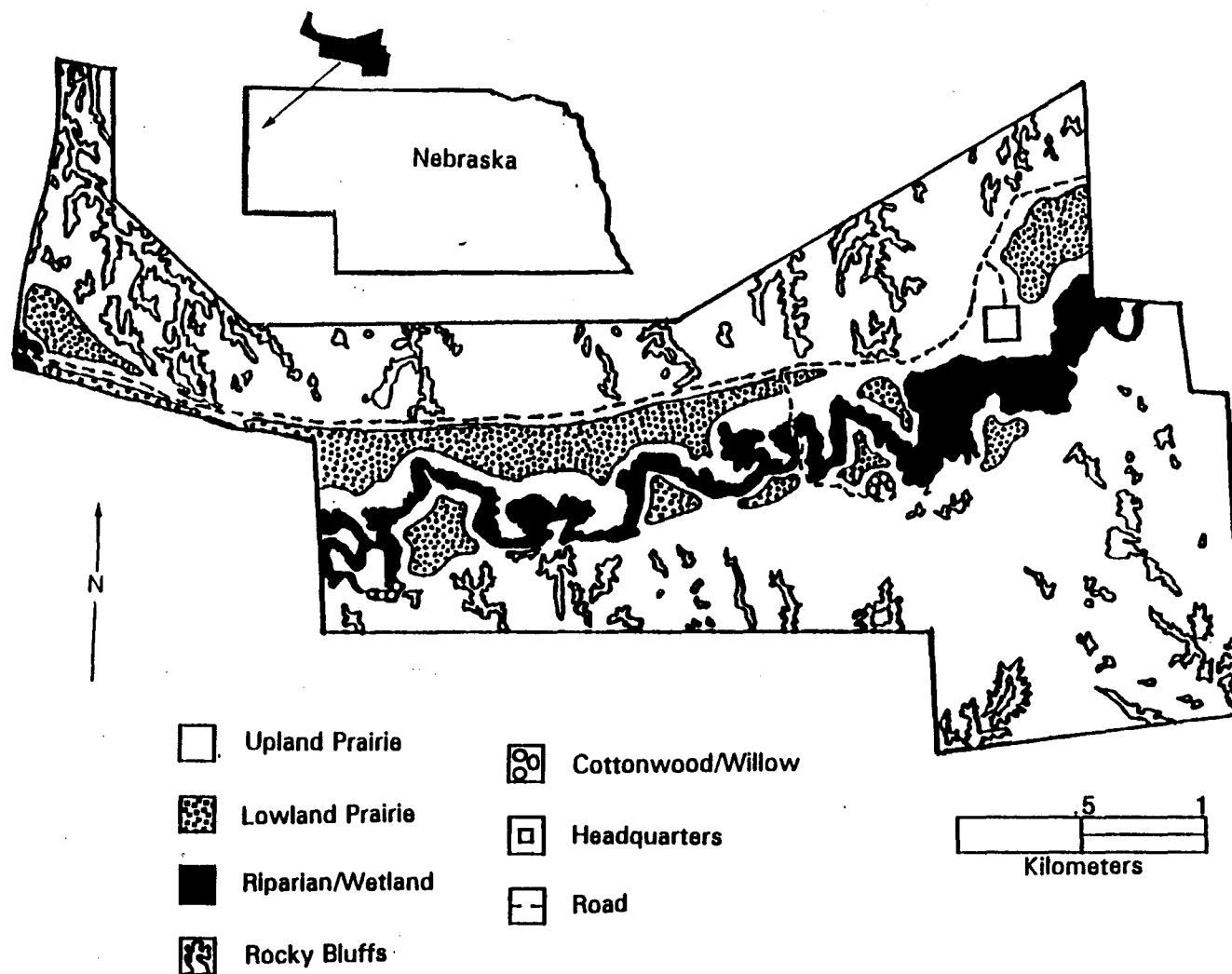


Figure 1. The five major habitat types at Agate Fossil Beds National Monument, Nebraska.

Figure 2. Percentage of the total number of bird species recorded from five consecutive runs of standardized transects established in each major habitat at Agate Fossil Beds National Monument, Nebraska. Results determined from data collected the second week of June, 1993 and 1994; three runs per transect the first year and two the second.

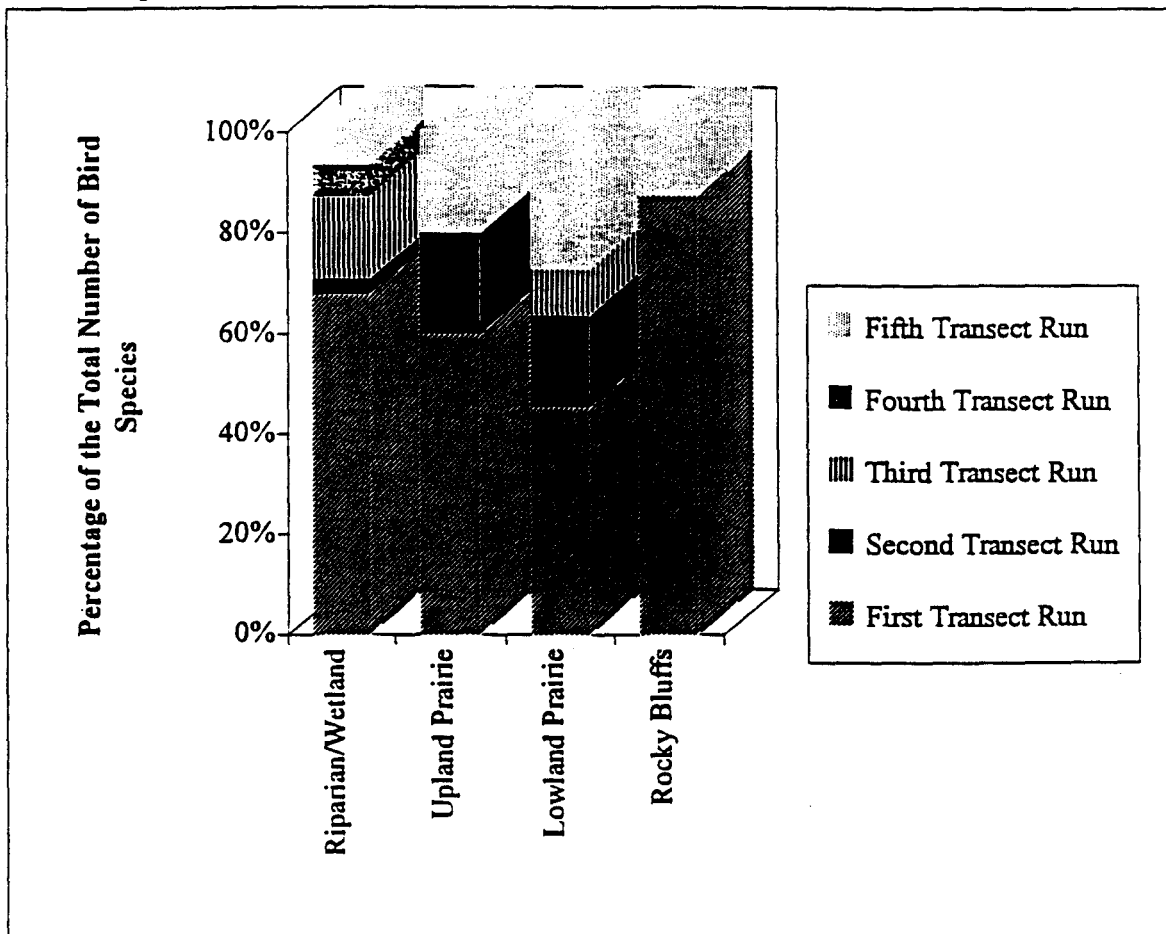


Figure 3. Shannon diversity indices of bird communities determined from standardized transects established in each major habitat at Agate Fossil Beds National Monument, Nebraska. Indices determined from data collected the second week of June, 1993 and 1994; three runs per transect the first year and two the second.

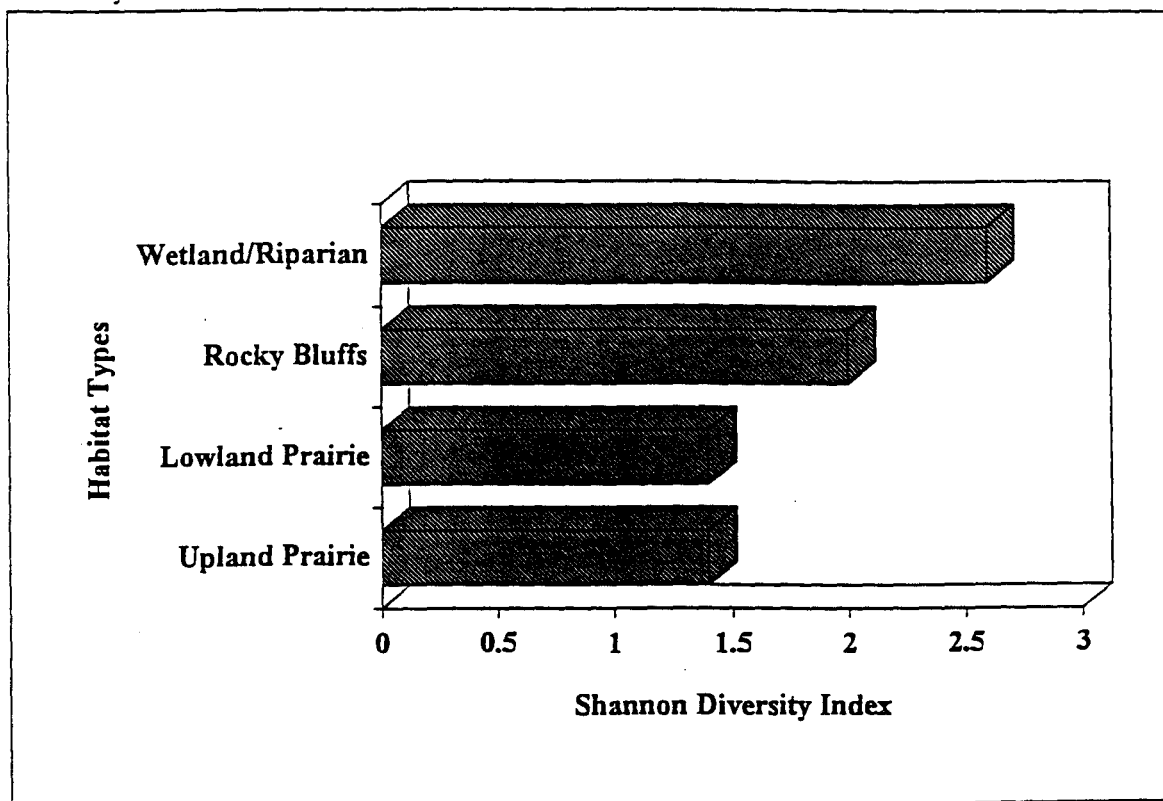


Figure 4. Number of new small mammal species recorded for each of three, 3-day trapping periods on one of four live-trap grids at Agate Fossil Beds National Monument, Nebraska. Grid was maintained in upland prairie from June through July, 1994. Trapping periods were separated by 7 to 8 day intervals.

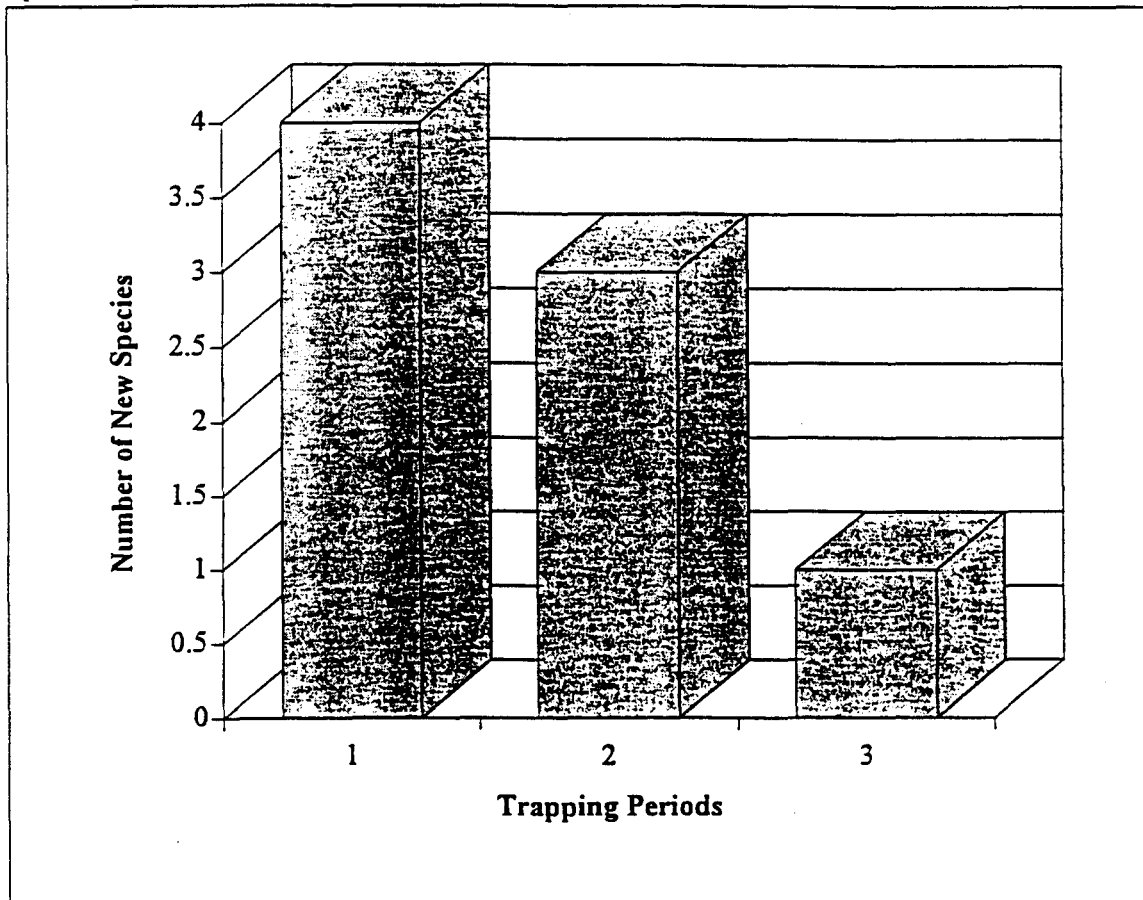
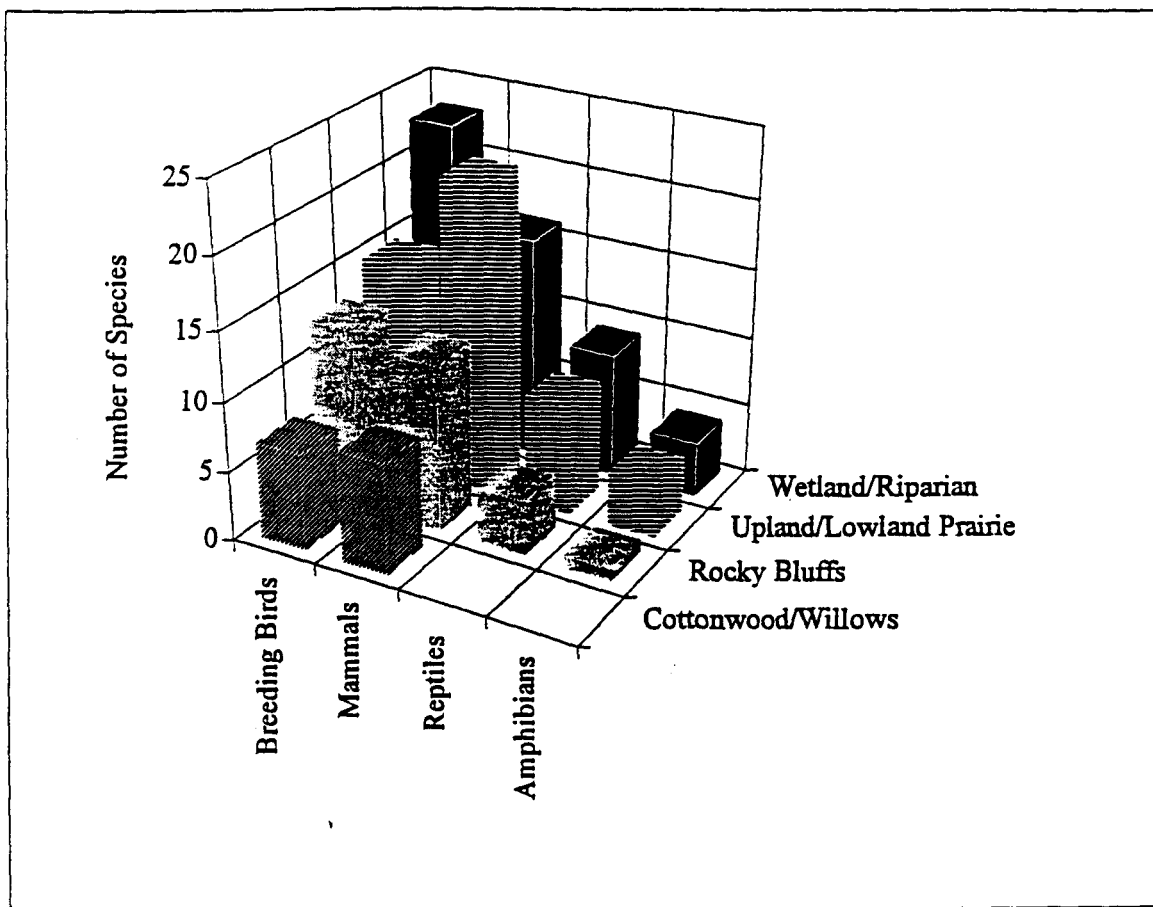


Figure 5. Wildlife species richness of faunal groups in each major habitat at Agate Fossil Beds National Monument, Nebraska. Based on data collected during the fall of 1992 and the summers of 1993 and 1994 using all described methods. Bird species represent summer and/or permanent residents.

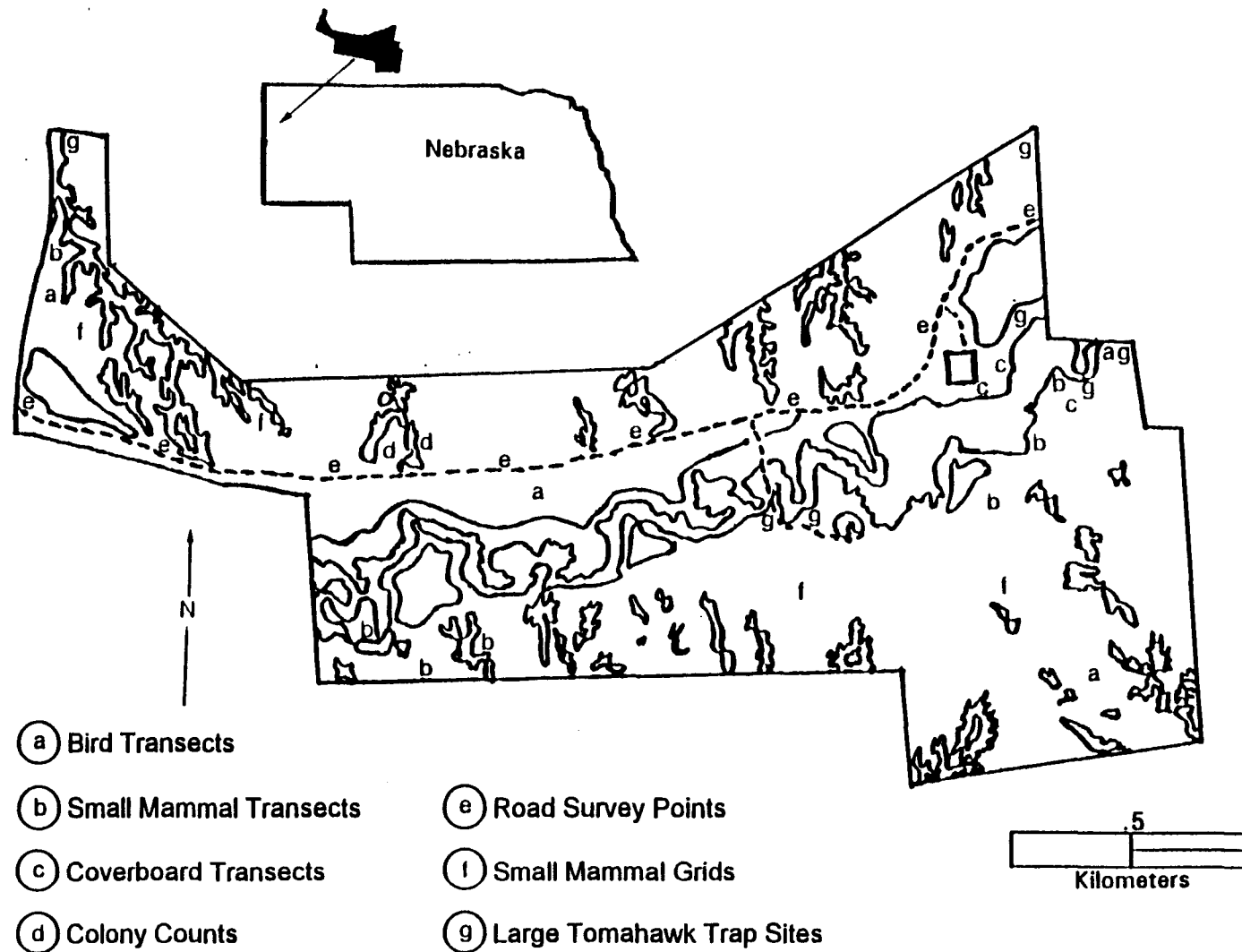


Appendix 1. UTM coordinates of all bird and coverboard transects, trapping transects and grids, drift fence, colony counts, herp quadrats, scent post, Tomahawk trap, auditory survey and mist net locations at Agate Fossil Beds National Monument, Nebraska.

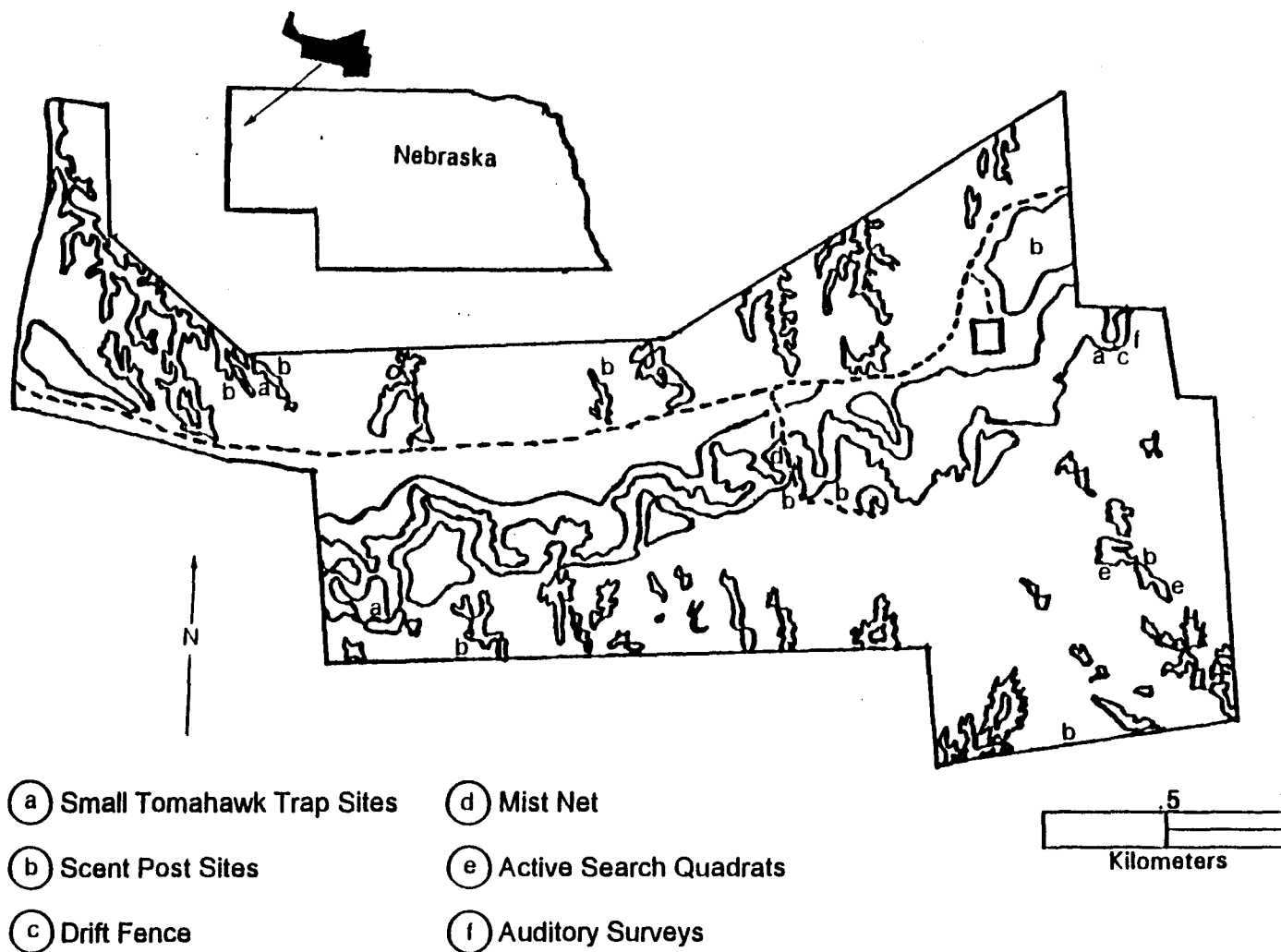
Survey Method	UTM Coordinates			
Bird Transects	Start		Finish	
Upland Prairie	604.8 4695.9		604.3 4696.7	
Lowland Prairie	602.8 4697.2		601.9 4697.1	
Rocky Bluffs	600.7 4697.4		599.7 4697.9	
Riparian/Wetlands	604.7 4697.7		604.2 4697.2	
Small Mammal Transects				
Upland Prairie	604.4 4697.1		604.3 4697.2	
	601.5 4697.3		601.4 4696.3	
Rocky Bluffs	599.7 4697.9		600.2 4697.8	
	601.7 4696.3		601.7 4696.4	
Riparian/Wetlands-Live	604.6 4697.5		604.8 4697.4	
	604.6 4697.5		604.5 4697.4	
Snap	604.6 4697.5		604.4 4697.3	
Cottonwood/Willows	601.3 4696.4		601.3 4696.5	
Spotlight Surveys	599.5 4697.5		604.6 4698.3	
Coverboard Transects				
Riparian/Wetlands	604.5 4697.6		604.6 4697.7	
	604.5 4697.5		604.4 4697.4	
Lowland Prairie	604.7 4697.4		604.9 4697.3	
	Approximate Locations			
Colony Counts	601.4 4697.4	600.3 4697.4	600.4 4697.4	
	1	2	3	4
Road Survey Points (8)	599.5 4697.5	600.2 4697.2	601 4697.2	601.8 4697.2
	5	6	7	8
	602.5 4697.3	603.3 4697.5	604 4697.7	604.6 4698.3

Appendix 1. (continued)

Survey Method	UTM Coordinates							
	Approximate Locations							
Small Mammal Grids (four corners)	1		2		3		4	
Grid 1	600.1	4697.5	600.2	4697.5	600.1	4697.6	600.2	4697.6
Grid 2	600.9	4697.4	600.9	4697.5	601	4697.4	601	4697.5
Grid 3	603.2	4696.4	603.2	4696.5	603.3	4696.4	603.3	4696.5
Grid 4	604	4696.4	604	4696.5	604.1	4696.4	604.1	4696.5
Large Tomahawk Trap Sites								
Riparian/Wetlands	604.9	4697.5	603.2	4697.1	604.6	4697.5	603.2	4696.9
Upland Prairie	604.3	4697.8	604.5	4698.5	599.8	4698.7		
Small Tomahawk Trap Sites								
Rocky Bluffs	600.7	4697.4	600.6	4697.4				
Riparian/Wetlands	604.6	4697.5						
Cottonwood/Willow	601.3	4696.4						
Scent Post Sites								
Upland Prairie	602.5	4697.6	601.5	4696.3	604.6	4695.7		
Lowland Prairie	604.4	4697.8						
Riparian/Wetlands	603.2	4696.9	603.3	4696.9				
Rocky Bluffs	600.7	4697.4	604.6	4696.5	600.9	4697.4		
Drift Fence	604.7	4697.5						
Mist Net	603.2	4697.2						
Active Search Quadrats	604.7	4696.6	604.8	4696.7				
Auditory Surveys	603.2	4697.2	604.6	4697.5				



Appendix 2. Approximate locations of bird, small mammal and coverboard transects, colony counts, road survey points, small mammal grids and large Tomahawk trap sites at Agate Fossil Beds National Monument, Nebraska.



Appendix 3. Approximate locations of small Tomahawk trap, scent post, drift fence, mist net, active search quadrats and auditory survey sites at Agate Fossil Beds National Monument, Nebraska.