HABITAT ASSOCIATIONS AND DISTRIBUTION OF AMPHIBIANS AND REPTILES AT MIDDLE FORK SAVANNA, LAKE COUNTY ILLINOIS

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INTRODUCTION

Oak savannas were once a dominant feature of the northeastern Illinois landscape (Nuzzo, 1985; Packard, 1986). With the post-settlement suppression of wildfire and the subsequent increase in agricultural use, and the recent rapid urbanization of much of the area, savannas have become rare.

Middle Fork Savanna is located at the western edge of the community of Lake Forest, in the southeastern part of Lake County, Illinois (Figure 1). It has been referred to as one of the two best remaining examples of tallgrass savanna in the world (The Nature Conservancy, 1988). This community type, called "rich savanna, midwest type" is assigned a ranking of G1, or globally endangered (Chapman, 1988). In large part because this community type is so rare, little is known about the associated wildlife. For northeastern Illinois amphibians and reptiles, information has been published on related community types such as dry-mesic forest, woodland, northern flatwoods, and sand savanna (Mierzwa, in press), but until this study nothing has been available on open sites on mesic or wet soils.

We initiated this study primarily to provide baseline information on the herpetofauna and to help formulate suggestions for planning and prioritizing site management. We agree with Bogan et al. (1988), who stated that "in the absence of reliable information, land stewards may end up managing for a relatively small portion of the total fauna, primarily those that are rare or endangered, highly visible or popular, pests, or those of importance to hunters and trappers." Only a few northeastern Illinois natural areas have been thoroughly inventoried prior to the initiation of management or restoration work. Middle Fork Savanna is unusual in having baseline information available for mammals (Byers et al., 1986), birds (Apfelbaum and Bowles, 1986; Sullivan, 1993), reptiles and amphibians (this report), leaf litter beetles (Keesy, 1987), vascular vegetation (Apfelbaum et al., 1987), and lichens and bryophytes (Christy and Apfelbaum, 1987), as well as a description of the types and quality of plant communities (Brown and Schennum, 1980). We also accumulated some information on small mammals and fishes in the course of our study (Appendices C and D).

A secondary goal of this study is to provide quantified data on amphibian and reptile utilization of the oak savanna ecosystem, which has not yet been well studied, and on differential use of the various components of that ecosystem, including woodlands, savannas, grasslands, and wetlands. This component of the study evolved to include a preliminary look at amphibian metapopulation dynamics.

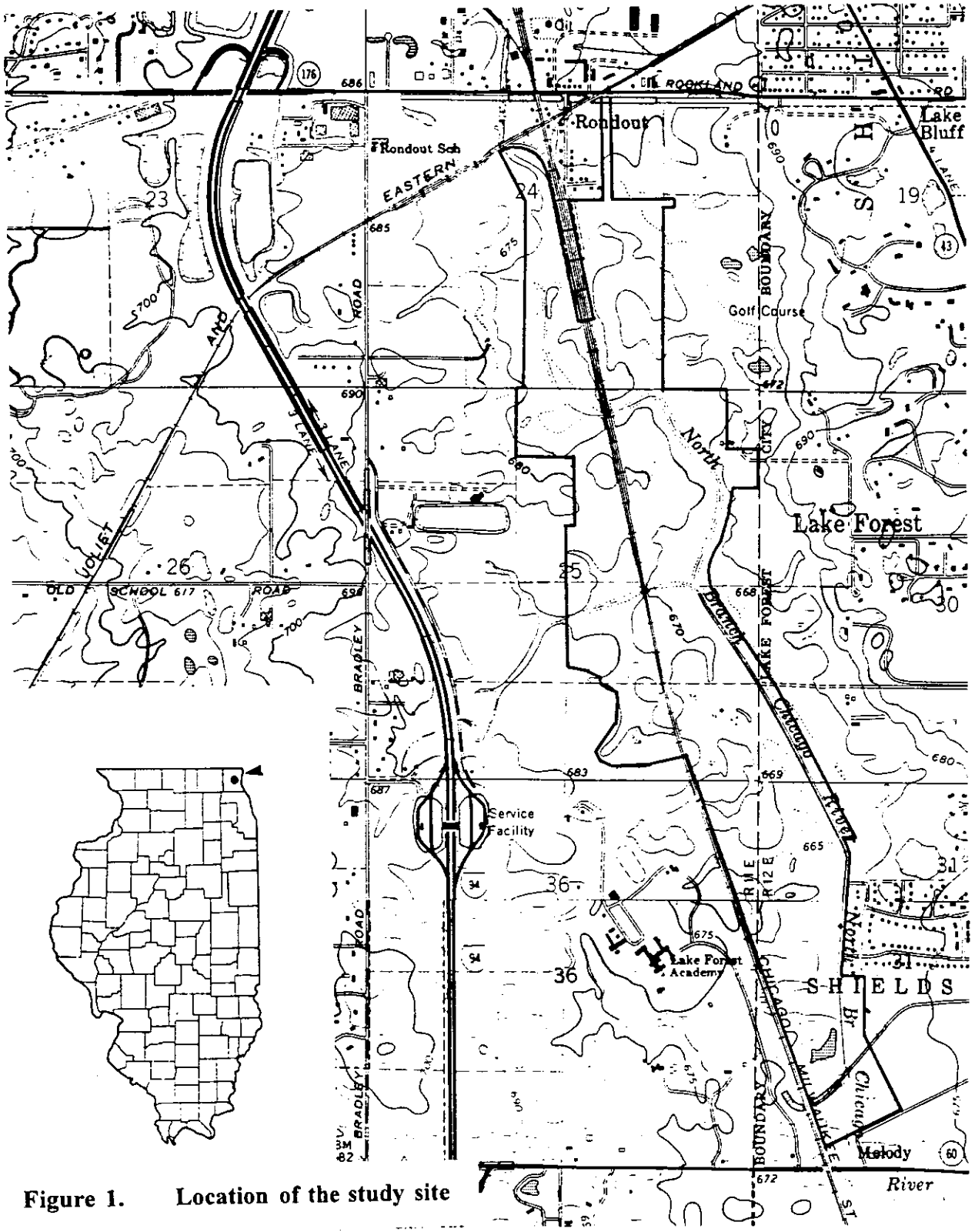

Figure 1. Location of the study site

METHODS AND MATERIALS

Middle Fork Savanna is a large and complex site; it is probably not possible to thoroughly inventory the entire area in any one field season. Therefore, we have chosen to concentrate sampling efforts in representative examples of several key plant communities, on the assumption that most of the resident small animal species will be observed in this way. Searches did take place over much of the site, but at a lesser level of effort than in the primary areas.

Each sampling method has inherent bias; that is, each method is more likely to catch some species than others. The best results are usually obtained when a variety of sampling methods are utilized concurrently. For this study, we used drift fences, cover objects, random searches, and seines.

Drift fences are an effective technique for collecting a variety of small animals. They are in operation 24 hours a day, so are able to collect nocturnal or crepuscular species or those which are active only under certain weather conditions. They sometimes capture secretive species which are difficult to collect by other methods and provide quantifiable data which can be easily compared from one site to another. However, drift fences require an initial investment in materials and are time consuming to install. They also are not effective at capturing some species, such as tree frogs or other arboreal forms, or large snakes which can easily go over the fence.

Our drift fences are a modified version of the system described by others (Heyer et al., 1994; Karns, 1986; Campbell and Christman, 1982; Vogt and Hine, 1982). We use 15.2 meter (50 foot) lengths of aluminum flashing either 51 cm (20 inches) or 61 cm (24 inches) high, with one edge buried about 10 cm (four inches) in the ground. The fence forms a barrier to small animals moving through the area. Animals tend to follow the base of the fence and enter a funnel trap placed at either end. Funnel traps are constructed from cylinders of aluminum window screen. A 20 cm (eight inch) outside diameter plastic funnel with a 2.5 cm (one inch) central opening is installed at one end. The opposite end of the funnel trap is closed, but can be easily opened to remove animals. Funnel traps are covered to prevent dessication. We usually place a pitfall trap at the midpoint of each fence, but at this site we did this at only one location to minimize damage to the herbaceous layer.

We installed drift fence arrays at three locations along a roughly south-southeast to north-northwest transect. Each array consisted of two drift fences positioned at a 90 degree angle approximately 15.2 meters (50 feet) from a midpoint (Figure 2). The southern array was near the center of a high-quality savanna; the central array was near the southern edge of a small woodland; and the northern array was in a wet and mesic prairie opening. The drift fence sites are described in greater detail below.

Cover objects are another effective means of locating secretive species, especially small snakes (Fitch, 1992). Animals hide under logs, boards, and other objects to avoid predation or to thermoregulate. A large trash pile located just north of the savanna included many boards, pieces of sheet metal and other flat objects. At the beginning of the study, some boards were already in suitable locations; we spread additional pieces of wood and metal around the vicinity of the trashpile, and then turned them to check for animals during each visit. We also checked an existing collection of boards and debris located outside the preserve boundaries, just off the Interstate 94 service road.

While walking between drift fence and cover object locations, we conducted random searches for animals out foraging or otherwise in the open (Karns, 1986). We also regularly searched areas which tend to support concentrations of amphibians and reptiles, such as wetland margins. Random searches took place over much of Middle Fork Savanna, with the exception of the northern end of the site.

Seines and dipnets were used to sample amphibian larvae in ponds and marshes. Seines were used in open water areas, and dipnets in heavily vegetated wetlands where it was not possible to pull a seine.

Sampling took place in spring, summer, and fall in a wide variety of weather conditions. Visits were made at temperatures from just above freezing to over 30 degrees C, and in clear, partly cloudy, and cloudy conditions as well as during sustained rainfall. We visited the site two to three times a week during April and May, and at least once a week during June, July, September, and October. The minimum time required to check all drift fences and intervening sample sites was two hours, but some trips were considerably longer.

DESCRIPTION OF THE STUDY SITE

Middle Fork Savanna is located in southeastern Lake County, Illinois. The site is long and narrow, stretching approximately 4.4 km (2.7 miles) from Route 176 on the north to Route 60 on the south, but is only 1.1 km (0.7 miles) wide at the widest point. The preserve is bisected by a raised embankment with railroad tracks heavily used by Amtrak and freight trains. The Middle Fork of the North Branch of the Chicago River flows through the preserve, forming part of the eastern boundary. Much of the land to the east is in residential use, although some open land remains. On the west the preserve is bordered largely by successional fields and cropland along Interstate 94. During our study, one of these parcels was in the process of being graded for future construction.

Geology and soils

The bedrock underlying the site is Silurian dolomite. There are no outcrops and the depth from the surface to bedrock has not been measured. Therefore the geology which influences Middle Fork Savanna is that created by the Pleistocene glaciations, the most recent of which was the Wisconsinan. The actual site is underlain by Lake Border Groundmoraine; to the east is the Blodgett Moraine and, to the west, the Deerfield Moraine (Willman, 1971). Paschke and Alexander (1970) mapped individual soils based on air photos and some field work. The Montgomery silty clay, a lacustrine sediment, is the most common single soil type and apparently formed under a standing wetland. The remainder of the soils probably arrived as sediments from glacial outwash. Resulting differences were caused by type and frequency of vegetation cover.

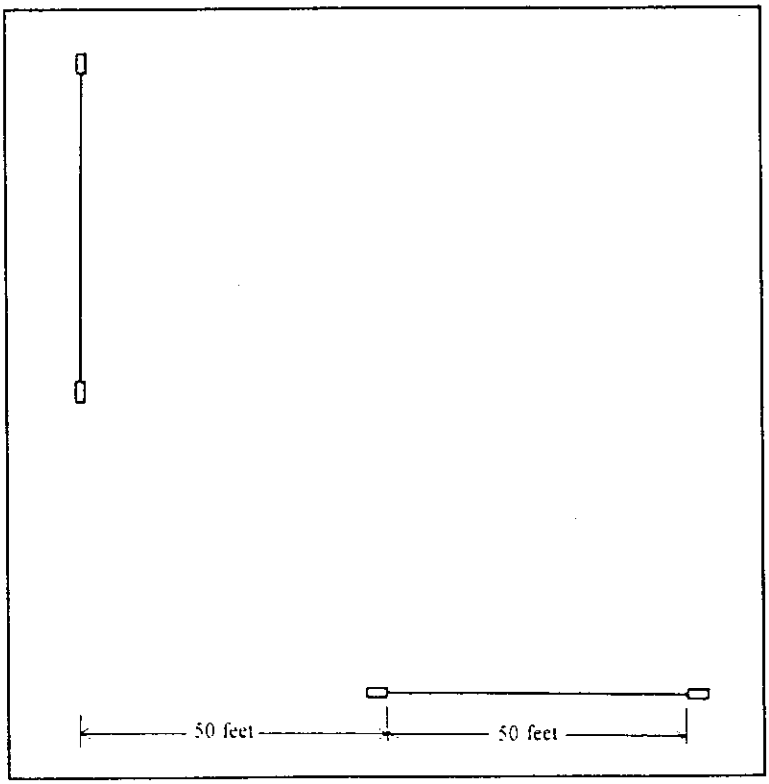

Figure 2.

Above: photo of savanna drift fence array

Below: plan view of a typical array layout

Table 1. Soil types present at Middle Fork Savanna, from Fehrenbacher, et al. (1984).

Soil No.	Soil name	Soil Assoc.	Developed under:	Hydrology/ Comments
103	Houghton muck		Wetland	Usually saturated
153	Pella silty clay	12	Prairie	Poorly drained
228	Nappanee silt loam	45	Woodland	Somewhat poorly drained/Fine, calcareous
232	Ashkum silty clay loam	14	Prairie	Poorly drained/Fine textured
320	Frankfort silt loam	45	Transitional	Somewhat poorly drained/Fine, calcareous
330	Peotone silty clay loam	14	Prairie	Poorly drained/Fine textured
465	Montgomery silty clay	19	Wetland/grass	Impermeable subsoils/Lacustrine sediments
696	Zurich silt loam	41	Woodland	Moderately well drained/Calcareous
981	Wauconda & Frankfort	41/45	Woodland	Wauconda: somewhat poorly drained, nearly level
982	Aptakisic & Nappanee	45	Woodland	Aptakisic: somewhat poorly drained, calcareous

Vegetation

A countywide presettlement vegetation map by Moran (1978) showed much of the area around the upper reaches of the Middle Fork of the Chicago River as savanna, with a narrow band of marsh along parts of the stream itself. Some prairie was present in the region, but true forest was restricted to a band along the east bank of the Des Plaines River and to the vicinity of the Lake Michigan bluffs.

Hutchison (1988) mapped presettlement vegetation for the immediate vicinity of Middle Fork Savanna. He also showed the low areas bordering the river as marsh and wet prairie, with isolated groves of oaks on islands of higher ground. Most of the remainder of the land within and near the present preserve boundaries was shown as savanna, and the map includes surveyor's descriptions of the landscape such as "scattering timber." The only mention of prairie is for an area in the northern part of the preserve, but small grassland openings would have been common among the oaks.

The present-day preserve is a mosaic of oak groves, native and non-native grasslands, and wetlands. The quality of the wooded areas varies considerably. The highest quality savanna remnant is very open, has been referred to as one of the best black-soil savanna remnants in the world (The Nature Conservancy, 1988), and has been burned as recently as 1985 (Apfelbaum et al., 1987). Other groves are badly overgrown with weedy shrubs, and some have lost much of the herbaceous understory. Some areas described by Brown and Schennum (1980) as retaining prairie openings are now so badly overgrown that they are nearly impossible to walk through.

Prairie remnants of excellent quality also persist (Brown and Schennum, 1980), but these typically do not exceed a few acres in size, and the largest is badly overgrown with shrubs. Much larger expanses of successional field are present, including former cropland and pasture.

Wetlands are well interspersed through the site, and vary in size, hydroperiod, and quality. Several wetlands within the area of former pasture have been drained by installation of tiles and now hold water for only a few days or weeks after heavy rainfall.

We prepared a simplified cover type map (Figure 3) to help relate our sample sites to the surrounding landscape. Preparing a detailed map would have involved extensive aerial photo interpretation and subsequent ground-truthing, and may have detracted from our field time searching for animals. To save time, we have grouped structurally similar cover types. All wooded communities are mapped as a unit, as are all grasslands, and all wetlands. A more detailed cover type map showing woodland, savanna, mesic prairie, wet prairie, marsh, successional field, and other communities, would be useful to future researchers.

As stated above, we positioned our drift fence arrays to sample some of the best remaining examples of savanna, woodland, prairie, and wetland. Locations of the drift fence arrays, board arrays, and other sample sites described below are shown in Figure 4.

Savanna drift fence array

The most southerly drift fence array was installed near the center of the high-quality savanna located in the northeast corner of section 36, T44N, R11E, and the northwest corner of section 31, T44N, R12E. This savanna is dominated by bur oak, *Quercus macrocarpa,* and white oak, *Quercus alba* (Apfelbaum et al., 1987), with lesser numbers of other oak species present. Canopy cover was measured by densiometer (Forest Densiometers, Bartlesville, Oklahoma) on September 4, 1993, along a series of transects through the entire savanna grove. The mean of 21 readings was 30 percent canopy cover. A dense herbaceous layer was present through the late summer and fall months, reaching a peak height in excess of one meter. This area is classified as mesic and wet-mesic savanna (S. Packard, pers. comm.), and is on predominantly clay and silt-clay soils. A large semi-permanent marsh with a densely vegetated border and an open water center is located 28 meters (92 feet) to the north of the drift fence location.

Woodland drift fence array

A drift fence array was installed in the southern part of a moderate quality woodland located approximately 600 meters (1968 feet) north-northwest of the first array. This woodland is dominated by white oak, *Quercus alba.* A limited number of densiometer readings were taken in the immediate vicinity of the drift fences; estimated tree canopy cover in this area is 60%. A dense but patchy shrub cover, consisting largely of honeysuckle (*Lonicera* sp.) and buckthorn (*Rhamnus cathartica*) is present, with about 50% cover. Some areas are so overgrown with shrubs that they are nearly impassable. Other areas are relatively open, and retain some herbaceous growth. The drift fences were located about 15.2 meters (50 feet) north of a large marsh.

Prairie drift fence array

A third drift fence array was located within a prairie opening about 300 meters (984 feet) north-northwest of the second array. Brown and Schennum (1980) called this the "largest continuous set of prairie communities of all the Lake Forest properties in question" and "the best example of a mesic to wet-mesic prairie in the entire region." One drift fence was installed in mesic prairie, while the second fence of the array was within wet prairie. Clusters of shrubs (mostly gray dogwood, *Cornus racemosa*) are common, fragmenting the prairie into a series of small openings. The nearest standing water was a man-made ditch about 25 meters (82 feet) south of the drift fence array. A small, shallow pond was located approximately 50 meters (164 feet) northwest of the drift fences.

Savanna edge board array

Boards, sheet metal, and other cover objects were spread randomly through an area just north of the high quality savanna. A large debris pile is present at this location, and many of the objects were already in place at the start of the study. Others were removed from the debris pile and placed in more suitable locations nearby.

Most of the boards were between the fence marking the northern edge of the high quality savanna and a pond and marsh complex. A few additional cover objects, mostly sheet metal, were located just northwest of the pond, which we refer to as the "windmill pond" because a non-functional windmill is located within its basin.

Widely scattered oaks are present throughout this area, with approximately five to ten percent estimated canopy cover, and an understory of predominantly non-native pasture grasses. This study site is bordered by railroad tracks on the west, and by open pasture on the north and east. Cover objects were turned on nearly every visit, usually while walking between the savanna and woodland drift fences.

Tollway service road board array

Another accumulation of boards, including several full sheets of plywood, were found adjacent to the Interstate 94 service road during the 1991 site visits. These are located on private land approximately 500 meters (1640 feet) west of the preserve boundaries, but they were checked occasionally during 1993. The surrounding area is predominantly successional field ranging from relatively open to densely overgrown with shrubs. Very few large trees are present in this area, and we noted several very small prairie remnants nearby. Wetlands are present in the vicinity, but tend to be smaller and more ephemeral than those in the eastern part of the study area.

Wetlands

Numerous wetlands are present throughout the study area, ranging from large semi-permanent marshes and wet prairies to man-made ditches. Several of these wetlands, identified in Figure 5, were sampled for amphibian larvae during the spring and early summer of 1993. Wetlands are described below. Not all wetlands on the site are described; only those visited on a fairly regular basis are included on this list.

- Wetland A is a large and deep man-made borrow pit. No amphibians, either adult or larval, were noted in the pond, probably due to the high concentration of presumably introduced fish. Bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) were observed near the shore.

- Wetland B is an ephemeral cattail (*Typha* sp.) marsh within a large successional field. It is located along a trail a short distance south of the Concord Street entrance to the preserve.

- Wetland C is a small shrub swamp grading into wet prairie, and is located just south of the high quality savanna.

- Wetland D is a very small, shallow, and ephemeral marsh within the high quality savanna. In years of normal precipitation it may not hold water long enough to allow amphibian metamorphosis.

- Wetland E is a large and diverse marsh with some bordering wet prairie, and is located near the drift fence array within the northern part of the high quality savanna. Cattails and sedges border a central area of open water. This may be the only permanent natural marsh on the preserve. Purple loosestrife (*Lythrum salicaria*) has invaded the periphery of this wetland and has become dense in places.

- Wetland F, the "windmill pond," is located just north of the high quality savanna. A dense cluster of cattails is present along the eastern margin, but otherwise aquatic vegetation is sparse. When full, the pond covers a considerable area, but water levels fluctuate tremendously due to the presence of a drain tile near the north end of the pond, where the tile runs under the non-functional windmill. Typically, the pond fills after rainfall and then drains down to a small, shallow central pond within a few days or weeks. The pond never dried completely in 1993.

- Wetland G is a large marsh within the southern end of a white oak woodland. The woodland drift fences were installed just north of this wetland. A large open water center is present, bordered by cattails and purple loosestrife. Several cottonwoods (*Populus deltoides*) grow along the ephemerally inundated margins of the wetland. Parts of the marsh are bordered by wet prairie.

- Wetland H is a small man-made ditch draining into the middle fork of the Chicago River. It divides a large pasture from prairie openings, and is bordered by a wire fence and numerous cottonwoods and weedy shrubs. The wetland is located just south of the prairie drift fence array.

- Wetland I is a small and shallow marsh grading into wet prairie, and is located a short distance to the north of the prairie drift fence array. Even though this wetland probably does not hold water past June in a normal year it maintains an open water center.

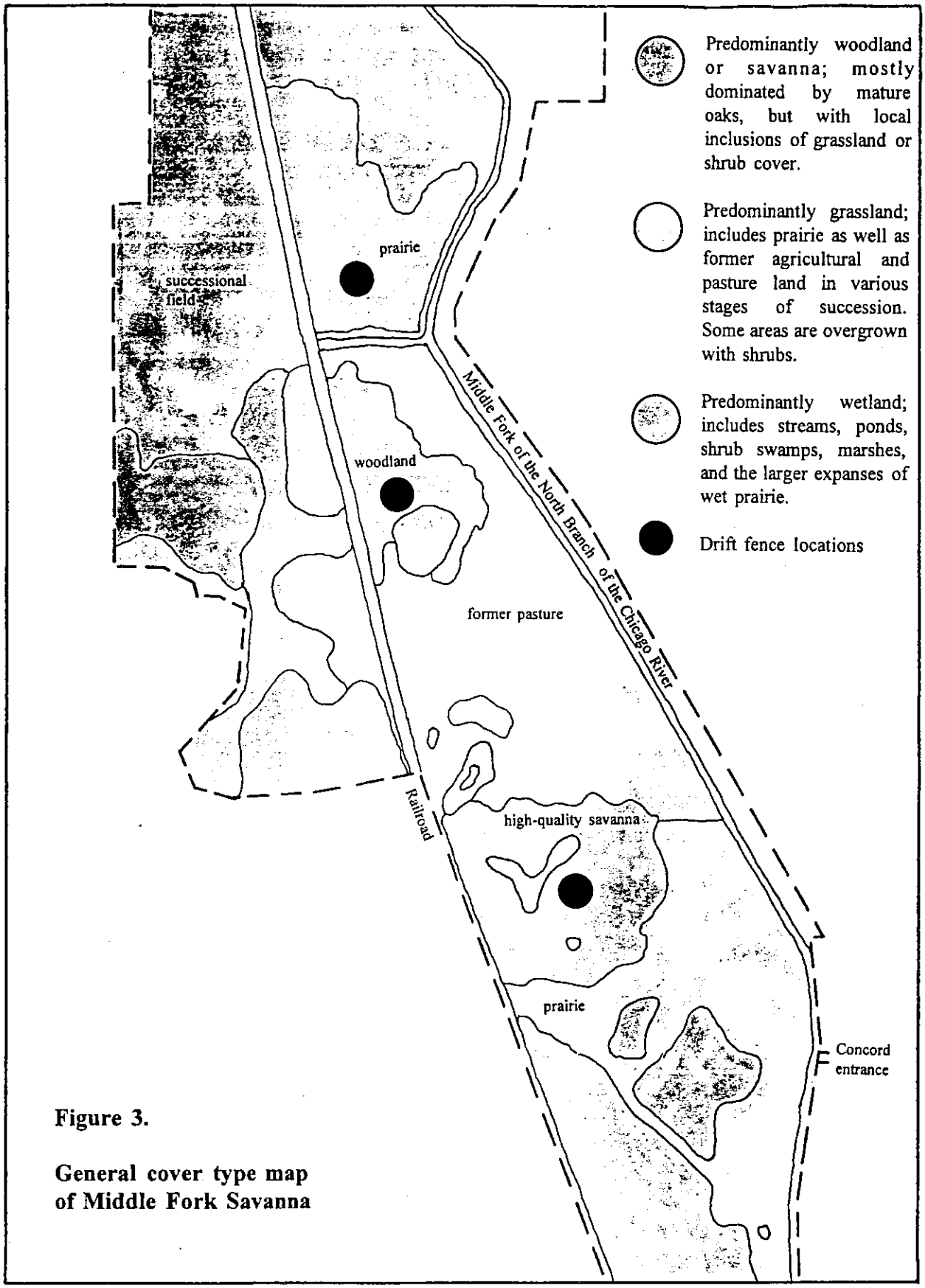

Figure 3.

General cover type map of Middle Fork Savanna

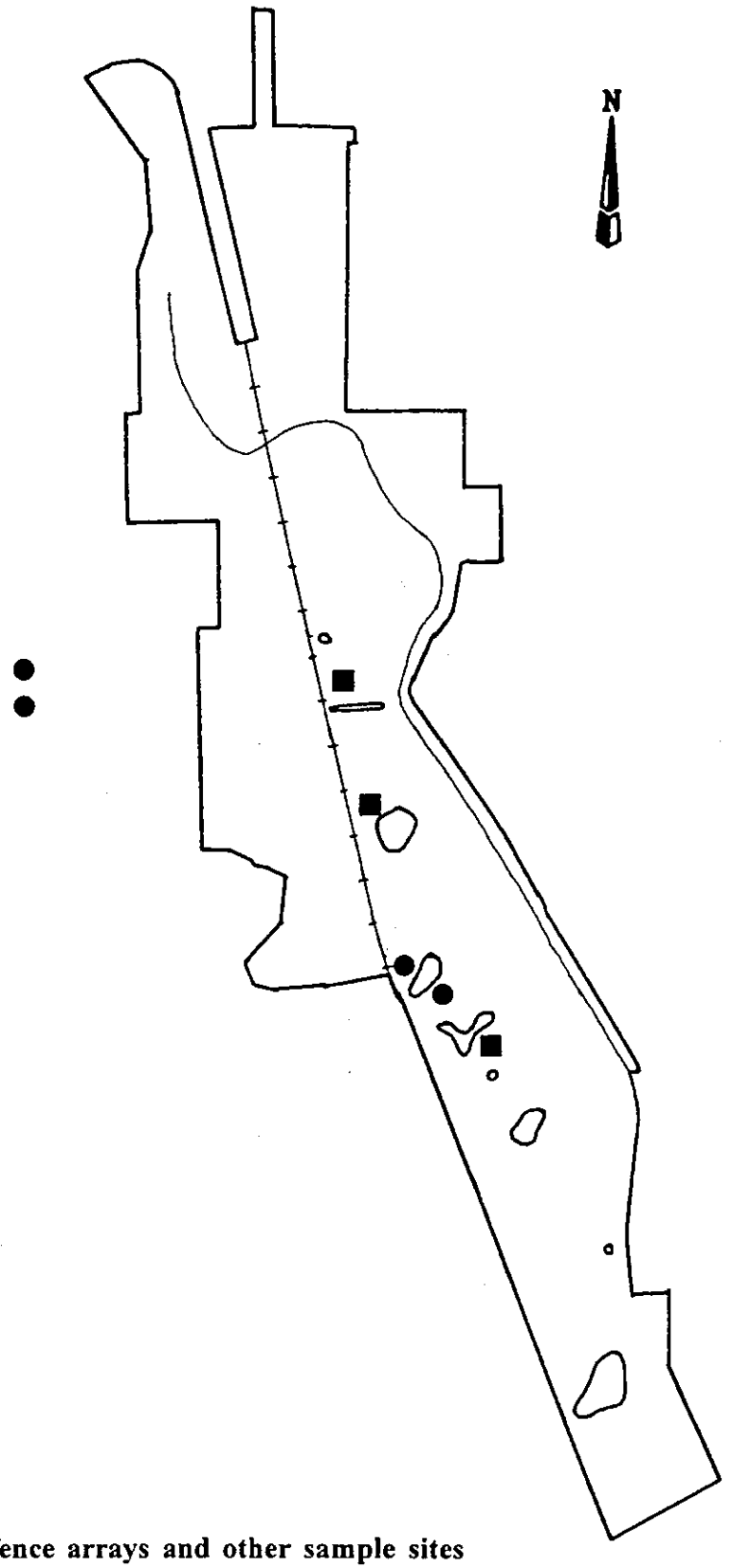

Figure 4.

Locations of drift fence arrays and other sample sites

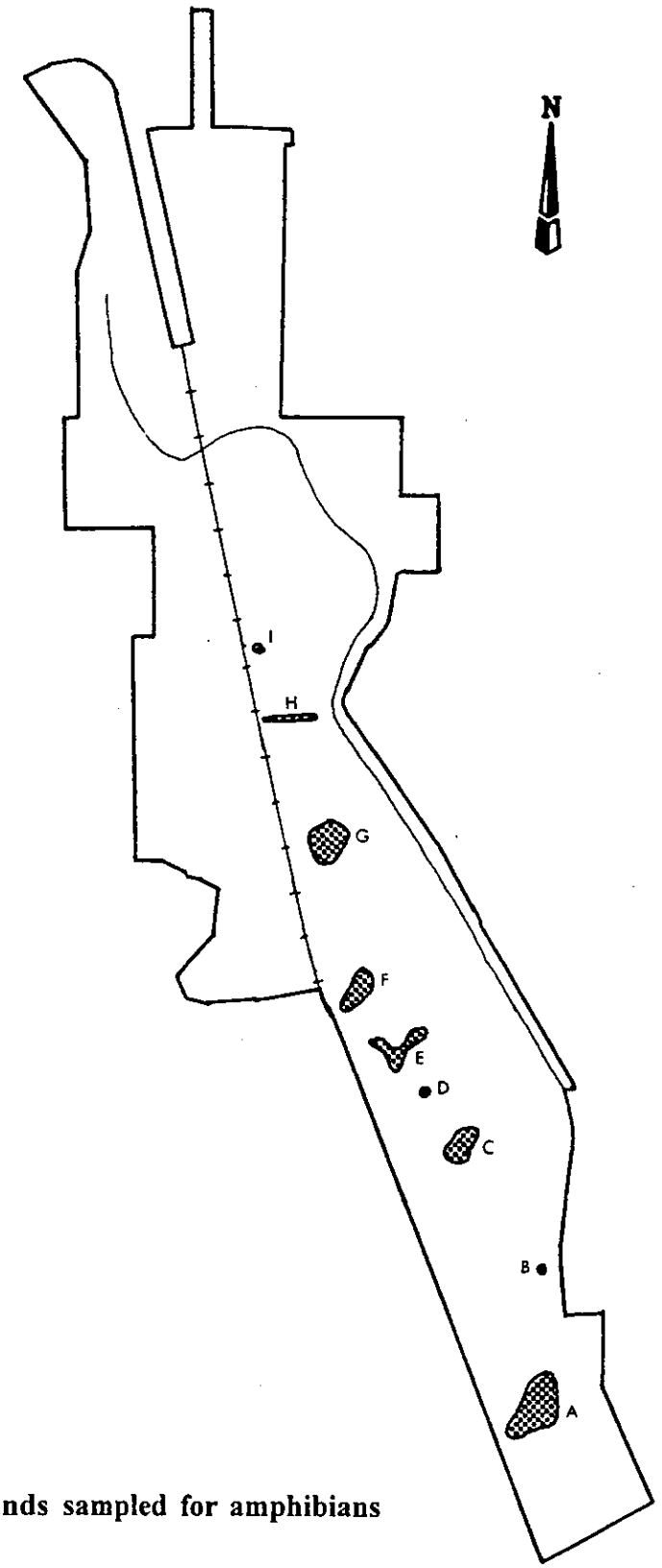

Figure 5. Wetlands sampled for amphibians

RESULTS

Thirteen species of amphibians and reptiles were collected or observed at Middle Fork Savanna, including two species of salamander, four species of frogs, three species of turtles, and four species of snakes (Table 2).

A total of 430 individual amphibians and reptiles were captured or observed. Salamanders made up 34 percent of the total catch, frogs 39.2 percent, turtles 1.9 percent, and snakes 6.9 percent. The most abundant species was the blue-spotted salamander, *Ambystoma laterale*, which made up 28.0 percent of the total. When the species abundance data for Middle Fork Savanna are graphed on a rank abundance plot, they approximate a log normal distribution (chi-square goodness of fit test; $P > .30$; Pielou, 1975), which has been described as indicative of a "large, mature and varied natural community" (Magurran, 1988).

Captures by sample site are shown in Table 3. The savanna, woodland, and prairie columns include both drift fence and random captures. The savanna edge column represents mostly captures under boards and other cover objects, but includes some random observations. Other columns record mostly random observations.

The prairie and woodland sample sites were most productive both in number of species and number of individuals, but this is somewhat deceptive. At both locations, drift fences captured large numbers of juvenile amphibians dispersing from nearby wetlands. These animals passed through the sampled areas, but most of them continued on for unknown distances, and the sample sites do not necessarily represent optimal habitat. Also, mortality is usually relatively high for juvenile amphibians. Numbers were lower at the savanna drift fence sample site, but the majority of the captures were of adult animals, most of them likely to be permanent residents of the surrounding community.

The difference in use of the savanna and savanna edge sample areas, which are in close proximity to each other, implies that individuals of at least some species are moving about to locate and utilize optimal habitat. Amphibians are generally more common within the savanna, while most snakes were captured in the more open edge areas where sunlight is readily available.

Captures were made regularly throughout the spring, summer, and fall at the savanna and savanna edge sample sites. At the woodland sample site, most reptile captures were made in the spring and fall, when more sunlight was able to penetrate the tree canopy, while most amphibian captures took place in a series of late summer and fall pulses as juveniles left nearby wetlands. At the prairie sample site, very few animals were captured in the spring, when ground cover was sparse, but reptile captures increased sharply in summer as vegetation became dense and remained high through the fall. Amphibian captures were almost entirely in late summer and fall as juveniles left nearby wetlands, but very few adult amphibians were captured.

Table 2. Amphibians and reptiles collected at Middle Fork Savanna

Species	1993	1991	Total	% of total
Blue-spotted salamander *Ambystoma laterale*	121	1	122	28.0
Tiger salamander *Ambystoma tigrinum*	24	0	24	6.0
American toad *Bufo americanus*	56	0	56	13.0
Western chorus frog *Pseudacris triseriata*	84	0	84	20.0
Bullfrog *Rana catesbeiana*	1	0	1	0.2
Northern leopard frog *Rana pipiens*	26	0	26	6.0
Snapping turtle *Chelydra serpentina*	2	0	2	0.5
Blanding's turtle *Emydoidea blandingii*	0	1	1	0.2
Painted turtle *Chrysemys picta*	5	0	5	1.2
Smooth green snake *Opheodrys vernalis*	11	1	12	2.8
Plains garter snake *Thamnophis radix*	0	1	1	0.2
Common garter snake *Thamnophis sirtalis*	87	1	88	20.5
Redbelly snake *Storeria occipitomaculata*	8	0	8	1.9
TOTAL	**425**	**5**	**430**	**100**

Table 3.

Amphibians and reptiles collected or observed at Middle Fork Savanna, by sample site

	Savanna	Savanna edge	Open pasture	Wood-land	Prairie	Borrow pit	Concord entrance	Shrub swamp	West preserve	Tollway	Total	%
Blue-spotted salamander	22	15	2	45	32	-	-	2	2	1	122	28.4
Tiger salamander	6	15	-	-	-	-	-	-	3	-	24	5.6
American toad	3	-	-	11	38	-	4	-	-	-	56	13.0
Western chorus frog	34	-	1	34	14	-	-	1	-	-	84	19.5
Bullfrog	-	-	-	1	-	-	-	-	-	-	1	0.2
Northern leopard frog	1	1	4	7	1	-	12	-	-	-	26	6.0
Snapping turtle	-	-	-	2	-	-	-	-	-	-	2	0.5
Blanding's turtle	-	-	-	-	-	-	-	-	-	1	1	0.2
Painted turtle	-	-	-	-	-	5	-	-	-	-	5	1.2
Smooth green snake	-	5	-	-	2	-	-	-	-	5	12	2.8
Plains garter snake	-	-	-	-	-	-	-	-	-	1	1	0.2
Common garter snake	6	36	1	5	31	-	-	-	2	7	88	20.5
Redbelly snake	-	3	-	-	3	-	-	-	-	2	8	1.9
Total											430	100.0

DISCUSSION

Concepts traditionally applied to the study of wildlife habitat utilization in wooded ecosystems break down when applied to savannas. Forests are usually thought of as cohesive units, even though the best old-growth examples are heterogenous as a result of light gap succession and plant community responses to soil moisture variations and other factors. Large, unfragmented tracts of continuous forest are believed to have the highest wildlife species carrying capacity (Schroeder et al, in press; Patton, 1992). Edge effect is a negative, something which allows unwanted or exotic species to invade.

The savanna ecosystem follows different rules. The savanna is one gigantic edge. It is often a mosaic of small oak groves interspersed with grasslands and wetlands. This spatial variability is further complicated by temporal variability. Over a time frame of hundreds or thousands of years, the oaks advance and retreat with changes in fire frequency or climate cycles. According to Anderson et al. (in press), "savannas were probably unstable, fire-dependant communities whose species composition and abundance changed relatively rapidly as a function of varied fire frequency." This dynamic ecosystem is populated by adaptable animals which require, prefer, or are able to tolerate a mosaic of sunlight and shade, and move about within the habitat to suit their needs.

Equally relevant is the Curtis-Packard debate on the true characteristics of savanna. Curtis (1959), working in Wisconsin, held that a savanna is a transition community, essentially a prairie with trees, inhabited by a mix of species from the two component communities. Packard (1986) believes that oak savanna is actually a distinctive and unique community, with its own characteristic set of species which have now become rare along with good examples of the community. Some of these characteristic plant species did not seem to "fit" into any other community type.

Similarly, a few amphibian and reptile species have no clear habitat association, at least within the Chicago region. Unfortunately, these species have become so rare today within the region that it will be extremely difficult to understand habitat needs. For example, the western ribbon snake (*Thamnophis proximus*) may be associated with particular types of savanna-wetland complexes. However, only two northeastern Illinois populations are known to exist, one at Braidwood Dune and Savanna Nature Preserve in Will County, and one at Chain O' Lakes State Park in Lake County. The species apparently was more common in the 1850s, when Robert Kennicott collected them near his home in what is now Glenview, in northern Cook County (Mierzwa, 1985).

At Middle Fork Savanna, amphibians and reptiles are interspersed among the sunlight and shade mosaic associated with mixed oak groves and grasslands. None of the prairie openings are large enough to support a true grassland fauna. Species usually associated with savannas, such as the common garter snake and redbelly snake, intermingle with prairie species like the smooth green snake. Because of the greater availability of sunlight, prairie openings and extremely open portions of savannas (5-10 percent canopy cover) support by far the greatest densities of snakes on the site.

Terrestrial amphibians tend to be concentrated in areas with at least a partial tree canopy. The relationship between tree canopy cover, density of herbaceous vegetation, and distribution of amphibians is not yet well understood. The Middle Fork Savanna amphibian assemblage includes habitat generalists (American toad, western chorus frog) as well as species with more precise habitat needs (blue-spotted salamander, tiger salamander, northern leopard frog).

Because they have an aquatic larval stage and a terrestrial or semi-aquatic adult stage, amphibians are constrained by both aquatic and terrestrial habitat requirements. Two species which utilize very different terrestrial communities as adults may return to the same pond to breed. Competition between larval amphibians can be intense (Wilbur, 1972), and growth and survival rates are often dependent on the density of larvae in the pond, and on the relative abundance of various species.

At Middle Fork Savanna, potential constraints on amphibian larvae include hydroperiod, density of aquatic vegetation, interspecific competition, and predation. Some wetlands simply do not hold water long enough in most years for most species to reach metamorphosis. American toads and western chorus frogs transform as early as mid-June, well before other local species, and are able to utilize relatively ephemeral wetlands. Blue-spotted salamanders and northern leopard frogs generally leave the ponds by early July. Tiger salamanders require ponds which hold water until late July or early August, and bullfrog tadpoles must overwinter, so require permanent ponds.

Tiger salamander larvae often exceed 127 mm (5.0 inches) inches in total length by the time they are ready to leave the ponds, and they are voracious predators on larvae of other amphibians, as well as on smaller individuals of their own species. In ponds which hold water long enough to support tiger salamanders but have little or no aquatic vegetation for cover, like the windmill pond, there is little left alive except tiger salamanders by early summer. In densely vegetated wetlands, like the one within the high-quality savanna, a full complement of amphibian species are able to survive to metamorphosis because numerous hiding places are available.

We sampled nine different wetlands at Middle Fork Savanna for amphibian larvae. The level of effort and the methods varied considerably between wetlands, so we do not claim to present a complete inventory of each wetland. Our samples were generally sufficient to capture at least the relatively common species in each wetland, so are useful for comparison of the various wetlands. Some wetlands, including the ones within the savanna (wetland E), the woodland (wetland G), and the windmill pond (wetland F) were sampled thoroughly and on multiple occasions with both seines and dipnets, so our data should be relatively complete for those sites. Results of larval samples are presented in Table 4.

Table 4. Larval amphibians by wetland

Wetland	Ambystoma laterale	Ambystoma tigrinum	Bufo americanus	Pseudacris triseriata	Rana pipiens
A					
B			●	●	●
C	●			●	
D				●	
E	●	●		●	●
F		●	●		
G	●			●	●
H			●		
I				●	

Additional wetlands support breeding amphibians but were not sampled. For example, we did not look at any of the wetlands west of the railroad tracks, or any in the extreme northern part of the site, in any detail.

The interspersion of numerous wetlands within the savanna mosaic provides a fascinating opportunity for the study of amphibian metapopulation dynamics. Bowles et al. (1993), citing Gilpin and Hanski (1991), defined metapopulations as consisting of "interacting populations that persist in spatially and temporally variable environments where the probability of local extinction is high .... for metapopulations to persist, local populations must avoid simultaneous extinction by reacting independently to landscape-level disturbances and colonizing newly formed habitats."

As we stated above, many amphibians are dependent for breeding on wetlands which vary considerably in hydroperiod. Ephemeral wetlands may persist long enough to allow metamorphosis of larvae only during years with high spring and early summer precipitation; during periods of extended drought, such wetlands may be a population sink. Longer lasting, more stable wetlands are more reliable, but may contain more predators.

Studies in southern Indiana have shown that some amphibian species tend to maintain relatively stable population sizes, while others fluctuate considerably (Cortwright, 1993). At Middle Fork Savanna, a few more dry years might have resulted in the local extirpation of bullfrogs and northern leopard frogs; both species evidently had low population sizes at the beginning of our study. The higher than normal rainfall of 1993 allowed the northern leopard frog, and the other amphibian

species utilizing temporary ponds, to enjoy unusually successful reproductive seasons. Throughout the summer and fall we observed juvenile amphibians dispersing from breeding ponds into surrounding habitat. As a result of successful dispersal, some species may breed in additional wetlands in future years.

Amphibians at Middle Fork Savanna will continue to be affected by short term variations in climate. However, restoration of wetlands and adjacent terrestrial habitat will increase the odds of long term survival for most species by providing more stable aquatic habitat and removing barriers between existing islands of good quality habitat, thus facilitating repopulation of some areas and genetic interchange between others.

All of the amphibian and reptile species we located at Middle Fork Savanna were already known from nearby areas, and most are common in suitable habitat. However, several additional species are so far noticeable by their absence. Green frogs (*Rana clamitans*), milk snakes (*Lampropeltis triangulum*), and brown snakes (*Storeria dekayi*) all are relatively common within a few miles of the study area. We are not at this time willing to rule out their presence; the only conclusive statement that can be made is that they are not abundant. Rarely if ever are all species of amphibians and reptiles present on any site located in the first full year of study. Temporal fluctuation in apparent abundance is a well documented phenomenon (Morrison, 1988), and may be related to variations in levels of surface activity or to actual changes in numbers of individuals. The unusually cool and wet weather of the 1993 field season almost certainly resulted in substantial departures from what is considered normal behavior for many species. Salamanders were active on the surface all summer, a rarity under normal conditions. Basking opportunities were severely limited for turtles and snakes because of frequent cloudy and rainy weather. Observations of massasaugas (*Sistrurus catenatus*) were down considerably from previous years at the nearest known Lake County site (T. Anton, pers. comm.) which is 6.5 km (4 miles) away. We did not locate a milk snake at Middle Fork Savanna, but for the first time in a decade we did not see one anywhere else in northeastern Illinois, either. In general, amphibians were easier to observe than in most years. Reptiles varied from species to species and from site to site; we noticed little difference in our ability to collect common garter snakes (*Thamnophis sirtalis*). Some small, secretive snakes were collected in larger than normal numbers, but other species, including some of the larger snakes and most turtles, were rarely seen.

We urge future researchers to be cautious in interpreting our quantitative data. We captured large numbers of juvenile amphibians because even small wetlands held water long enough to allow metamorphosis, and cool, wet weather permitted frequent surface activity. Sampling in the future is unlikely to yield such high amphibian numbers. This will not indicate a decline, but merely a return to more typical densities.

One of us (KSM) first visited Middle Fork Savanna in April of 1991. The second and third animals observed on that trip were a Blanding's turtle (*Emydoidea blandingii*) and a plains garter snake (*Thamnophis radix*). Neither has been seen on the site since. Plains garter snakes are common in parts of Lake County, but they are similarly elusive at nearby Ryerson Conservation Area, where

multiple specimens were observed in two of five years, but none were seen the other three years despite intensive field work (Mierzwa, unpublished field notes).

Some of the missing species may be present on site, but are so uncommon that a larger sample size will be necessary to locate a specimen. Alternatively, a population could be localized in an area of the preserve which was not sampled, or in a restricted microhabitat. We expect that at least one or two of the missing species will turn up in subsequent years. Site restoration may expedite this process; at Glacial Park in McHenry County, the total number of amphibians and reptiles captured has increased each of seven years as degraded savannas, grasslands, and wetlands are restored to health (Mierzwa, 1993a).

The alternative explanation for the absence of certain species is less palatable; some species may already have been lost to stochastic extinctions. This has probably happened to some extent at most midwestern natural areas.

Theories of island biogeography are well known to most biologists (MacArthur and Wilson, 1963, 1967). Natural areas in northeastern Illinois are often a different sort of island, surrounded by a sea of suburban development, or agricultural land. Newmark (1986) stated that National Parks in the less developed western U.S. function as islands, even though the mammalian fauna he was writing about is typically more mobile than the herpetofauna.

We prefer to avoid any discussion of species diversity, since the various methods usually employed can be confusing and provide little useful information. We will focus instead on species richness (the total number of species present on the study area) and equitability (the evenness, or relative distribution of individuals among the various species).

The amphibian and reptile species richness of Middle Fork Savanna is within the normal range for a preserve of its size and type. Several authors have pointed out the relationship between preserve size and species richness, including Newmark (1986) for mammals, Seagle (1986) for birds, and Mierzwa (1993) for amphibians and reptiles. At approximately 200 hectares (500 acres), Middle Fork Savanna is large enough to support most, but not all, of the full species complement. Any additional land acquisition should focus on ensuring the long term survival of the biodiversity already present, since adding enough area to significantly increase species richness would be very expensive.

While preserve size may be the single most important factor influencing species richness, it is not the only one. Schroeder et al. (in press) mention tract shape, adjacent habitat types and land use, water quality, and level of disturbance as important considerations. The number of natural community types within a site is probably related both to preserve size and number of species.

A circular, square, or otherwise compact preserve shape is generally considered optimal (Carroll, 1992). The long, narrow shape of Middle Fork Savanna is of some concern from a species richness standpoint, especially because of the presence of a high railroad embankment which effectively bisects and further narrows the site, making colonization or movement between different parts of the site more difficult. For example, the former pasture may reduce the survival of juvenile amphibians attempting to disperse from one wooded area to another. Since the pasture is continuous from the railroad to the river, there is no easy way for small animals sensitive to sunlight, wind, and lower humidity to bypass this barrier. Adjacent land use is another concern; rapid suburban growth of surrounding regions implies that the preserve will eventually become an island of open space surrounded by mowed lawns, pavement, and other by products of development. Altered hydrology within the watershed, in particular, can have far reaching effects. While other preserves, including Old School Forest Preserve and Shaw Prairie exist nearby, gene flow between the various areas of open space is already restricted or cut off for all but the most mobile animals. We observed juvenile leopard frogs attempting to disperse from private land just west of Middle Fork Savanna during rainfall, and heading straight for Interstate 94. It is unlikely that very many made it across.

In heavily populated areas a certain amount of human disturbance is inevitable. Even when public use is restricted to passive recreational activities like hiking or bird watching, some stress may be placed on resident small animals. This becomes more serious when animals are harassed, removed, or destroyed. During our study, we regularly encountered three local children who were busily collecting every small frog and snake they could find. Fortunately they were not particularly efficient junior herpetologists, but a number of animals were removed from the preserve and kept as pets. We suspect that our admonitions to take only a few were ignored as soon as we had left.

Finally, our experience has shown that species richness is higher at sites with a medium or large stream or river (third order or larger) or a lake, because these features support an assemblage of turtles and other aquatic and semi-aquatic species which would otherwise not be present. The lack of such a major water body at Middle Fork Savanna is a constraint on the maximum possible number of species.

Water quality may be another constraint. We observed no amphibians or reptiles in the river, although snapping turtles are almost certainly present at times, and most of the fish noted were species characteristic of degraded conditions (see Appendix D). The headwaters of the Middle Fork originate in or run through commercial and industrial areas north and northwest of the preserve. Stormwater runoff from associated paved areas, and possibly direct inputs of effluent, could contribute to lowered water quality. Chemical analysis of water samples taken in the northern part of the preserve could be used to determine the seriousness of any problem.

Evenness, or equitability, is another frequently used measure. Disturbed communities are often dominated by one or a few adaptable species. In theory, higher quality sites have a more equitable distribution of individuals among a number of species. In practice, some species are far more abundant than others, and in any community several are usually quite rare. Our 1993 data are affected by the abundance of juvenile amphibians, so any analysis of equitability must be done with care. Since our relative abundance data approximate a log-normal distribution, we must assume that

any effects of human disturbance on the herpetofauna of the site have not been excessive. We do find the abundance of common garter snakes striking; this species is usually the most common snake at localities in the Chicago region, but rarely does it outnumber other types of snakes by such a wide margin in such a large, high-quality preserve. It will be interesting to monitor changes in the snake community as restoration progresses.

SPECIES ACCOUNTS

Blue-spotted salamander *Ambystoma laterale*

The blue-spotted salamander is a medium-sized (to 150mm total length), black or dark gray salamander with scattered blue spots or flecks concentrated on the lower sides, and scattered in lesser amounts on the dorsolateral and ventral surfaces. Only diploid *Ambystoma laterale* are known from Lake County, Illinois. Polyploid members of this species complex are known from other parts of the range, but this subject is complex and beyond the scope of this paper. See Lowcock et al., (1987), for a detailed explanation.

The blue-spotted salamander is a northeastern species, with a modern range extending well into Canada and nearly to Hudson Bay (Conant and Collins, 1991; Cook, 1984). Chicago region localities are near the southwestern extreme of the range (Smith, 1961), except for two relict populations in eastern Iowa (Christiansen and Bailey, 1991). Within Illinois, blue-spotted salamanders are currently known only from Lake, Cook, Will, DuPage, McHenry, and Winnebago Counties (Mierzwa, 1987).

During the Wisconsinan glaciation, blue-spotted salamanders presumably inhabited the boreal forest which existed not far south of the ice sheet (Pielou, 1991; Lowcock, 1989). During the subsequent hypsithermal, Illinois populations may have been fragmented by the encroaching grasslands.

In Illinois, blue-spotted salamanders are considered a characteristic species of northern flatwoods (White, 1978), and they probably reach their greatest abundance in that habitat. A population in a northern flatwoods/dry-mesic forest community at Ryerson Conservation Area is thought to exceed 2500 breeding individuals at a single large pond (Mierzwa, 1986). *Ambystoma laterale* also are common in mesic forest, although suitable breeding ponds tend to occur less frequently in the better drained soils of that community, and in oak woodlands. Individuals are somewhat less common in floodplain forests, oak savannas, and young successional forests.

The original habitat is well illustrated by examining a west to east transect from the Des Plaines River to the Middle Fork Savanna study site. Blue-spotted salamanders are well known from MacArthur Woods. Breeding success in a floodplain forest oxbow pond is apparently limited by fish predation, and individuals are difficult to find near the river. Moving east, salamanders become fairly common in the sugar maple *(Acer saccharum)* and basswood (*Tilia americana*) dominated mesic forest. However, the breeding ponds are within the northern flatwoods areas east of the mesic forest. Adults disperse in all directions from these ponds, thus utilizing a variety of wooded community types. In and near the mesic forest blue-spotted salamanders occur sympatrically with

the spotted salamander, *Ambystoma maculatum*, which is restricted to relatively humid and undisturbed forests (Vogt, 1981).

No information is available on the private land east of St. Mary's Road, but salamanders presumably occur there. At Middle Fork Savanna, blue-spotted salamanders are still common, although at somewhat lower densities than in extensive forests. Here the spotted salamander has dropped out of the fauna and been replaced by the tiger salamander, *Ambystoma tigrinum*, a characteristic inhabitant of savannas and woodlands in northeastern Illinois (Mierzwa, in press).

At Middle Fork Savanna, blue-spotted salamanders are common and widespread. Breeding is known to occur in at least three ponds. All adult specimens were taken within tree cover, and most were in the high-quality savanna. A few adults were collected in the woodland and in some of the degraded wooded areas, and juveniles were common over much of the site. Dispersing juveniles were routinely collected up to 50 meters (164 feet) outside the tree line, and a few were found up to 150 meters (492 feet) from the nearest tree. It is not known whether these animals were able to survive long enough to reach the next area of suitable habitat.

Occurrence in the high-quality savanna extends the known habitat utilization to 30 percent canopy cover. Previously, adult blue-spotted salamanders had been found in the Chicago region only in a range of 50-100 percent canopy cover. The presence of a dense herbaceous layer and the wet soil conditions within the savanna may partially explain the relatively high density of salamanders there.

Larval blue-spotted salamanders were common only in wetlands with dense submerged and emergent vegetation. In open wetlands, only the much larger larvae of tiger salamanders were found. Tiger salamander larvae are voracious predators.

Tiger salamander ***Ambystoma tigrinum***

Tiger salamanders are large (to at least 330mm total length), stout-bodied salamanders with dull yellow spots or blotches scattered over a black ground color. Spots are usually present all over the body on adult specimens, but the heaviest concentration is usually on the lower sides. Newly metamorphosed juveniles are olive green for the first few days after leaving the water, with noticeable gill stubs. The quickly darken, but may not gain their pattern for several weeks.

Tiger salamanders are found nearly coast to coast in the United States. At present six subspecies are recognized (Conant and Collins, 1991), although ongoing genetic work has raised some questions on the true relationships of the group (Shaffer, pers. comm.). The tiger salamander species complex is centered in Mexico, and the eastern and western forms are thought to represent two separate invasions from Mexico, or to have been separated at some point during the glacial past and subsequently reestablished secondary contact (Routman, 1993). In any case, tiger salamanders are probably southwestern in origin, and after the Wisconsinan glaciation may have re-populated the Chicago region later than the cold adapted blue-spotted salamander. The spread of tiger salamanders most likely followed the arrival of oak dominated woodlands approximately 10,000 years ago (Pielou, 1991; Delcourt and Delcourt, 1991).

Tiger salamanders are currently widespread and relatively common in Illinois. Smith (1961) described their habitat as "...permanent ponds, either prairie or woodland...small forest edge ponds are probably preferred." Today tiger salamanders are thought to be a characteristic savanna and woodland species, at least within the Chicago region (Mierzwa, in press). They occur in very open areas where other salamander species are not present, and are occasionally found at considerable distances from trees. In large expanses of true forest, for example at MacArthur Woods and Ryerson Conservation Area, tiger salamanders are generally absent.

American toad ***Bufo americanus***

This is the familiar toad of the Chicago region, stout bodied and covered with warts. Color may be brown, tan, gray, or brick red, usually with a few small dark spots on the dorsal surfaces. Large paratoid glands are present behind the head. Chicago region specimens are assigned to the subspecies *Bufo americanus americanus.*

American toads are widely distributed in the eastern U.S. exclusive of the southeastern coastal plain. The range extends as far north as Hudson Bay and as far west as eastern Kansas. A wide variety of habitat types are utilized, including prairie, savanna, woodland, floodplain forest, and a variety of disturbed situations. While American toads are habitat generalists and are not necessarily characteristic of any one habitat type, they must have been present in nearly all presettlement savannas.

Breeding takes place during late April and early May in marshes, vernal ponds, floodplain oxbow ponds, and various ephemeral bodies of water, including flooded tire ruts. The call is a prolonged, melodic trill. The tadpoles grow rapidly and leave the water before any other amphibian except the western chorus frog.

Adult toads are largely independent of standing water except for breeding, and we observed individuals in widely scattered parts of Middle Fork Savanna. Savanna, woodland, and prairie drift fences all captured toads, and random observations were made in successional fields. Breeding areas include the shallow vegetated fringes of the windmill pond, the ditch between our woodland and prairie drift fences, and an ephemeral wetland a short distance south of the Concord entrance. At least during 1993, toads seemed to avoid the larger, longer lasting wetlands preferred by most other amphibians.

Western chorus frog ***Pseudacris triseriata***

Western chorus frogs typically display a pattern of dark brown longitudinal stripes over a tan ground color, although they may be darker at low temperatures and in early spring often appear to be a near uniform dark brown. They are small, seldom exceeding 37mm (1.45 inches) in length, and have minute toe pads. *Pseudacris triseriata* is one of the most frequently heard early spring frogs in northeastern Illinois.

Western chorus frogs are widely distributed, with a range extending from western New York to extreme eastern Colorado, with disjunct populations in parts of Arizona and New Mexico. Northeastern Illinois populations are assigned to *Pseudacris triseriata triseriata.*

Western chorus frogs are most common in predominantly grassland areas, being largely replaced by spring peepers (*Pseudacris crucifer*) in the more heavily forested eastern part of the range. In Illinois, the western chorus frog is abundant and tolerant of disturbance. Numerous populations persist within suburban areas.

Western chorus frogs inhabit prairies, savannas, woodlands, northern flatwoods, and a variety of disturbed situations. They may be present in forested areas, but tend to be much less common. Breeding takes place from late March through May in marshes, vernal ponds, or other shallow, temporary bodies of water.

Chorus frogs are common at Middle Fork Savanna, and are found throughout the preserve. Almost all of the wetlands on the site are used for breeding, including some too ephemeral for other amphibians to utilize. During the summer, adults were sometimes seen foraging for insects in dense herbaceous vegetation immediately after rainfall.

Bullfrog ***Rana catesbeiana***
This is our largest local frog, reaching a length of at least 150mm (6.0 inches). Bullfrogs are smooth-skinned, with partially webbed hind feet. They may be olive green or dark green, sometimes with indistinct darker mottling. The lack of dorsolateral folds is a distinguishing character.

Bullfrogs are widespread from the Atlantic coast to the foothills of the Rocky Mountains, and have been introduced to many localities farther west. They may be more common in Illinois today than in presettlement times because of the availability of farm ponds, borrow pits, and other man-made permanent ponds and lakes. Permanent water is a prerequisite for the bullfrog, since the tadpole spends up to two full years in the aquatic form before metamorphosis (Smith, 1961). In addition to the previously mentioned artificial water bodies, bullfrogs inhabit large rivers, lakes, and large permanent ponds. Adults are semi-aquatic, and seldom wander far from the water.

We observed only one bullfrog at Middle Fork Savanna during this study. A juvenile was captured in a funnel trap at the woodland drift fence. Another ranid frog, probably another juvenile bullfrog, was observed at the edge of the windmill pond but could not be approached closely enough to confirm the identification. The relative scarcity of permanent wetlands at Middle Fork Savanna probably constrains the size of the bullfrog population. However, the lack of bullfrog sightings at the large man-made (or at least deepened) pond near the southern end of the site is puzzling. Bullfrogs are able to co-exist with fish at other Chicago region localities.

Northern leopard frog ***Rana pipiens***
This is the familiar spotted frog of much of North America, although few who have observed leopard frogs in the wild or dissected one in high school biology class are aware that they actually comprise a complex of cryptic sibling species. Only one form, the northern leopard frog, occurs in Lake County. This medium sized ranid (usually 51-108mm, or 2.0 to 4.25 inches, in length) may be green, tan, or brown, with numerous large dark spots. The spots are most often oval or round, but may be irregular in shape, and almost always have a thin white outline. A pair of raised dorsolateral folds are prominent.

Northern leopard frogs are found from New England to Oregon, and well into Canada. To the south they are replaced by other, related species. In northeastern Illinois, the range of the northern leopard frog extends only as far south as Kankakee County, where it overlaps with that of the plains leopard frog, *Rana blairi*.

Northern leopard frogs declined drastically in numbers during the late 1960's and early 1970's. In Wisconsin, the decline has been attributed at least in part to an outbreak of *Aeromonas*, or redleg, a contagious bacterial disease (Vogt, 1981). *Aeromonas* outbreaks are now hypothesized to be associated with other, sometimes unidentified sources of sublethal stress; the bacteria is always present but under ordinary circumstances is not harmful (Carey, 1993). Leopard frog populations have since rebounded well in Lake and McHenry Counties, Illinois, where substantial wetland acreage has been set aside. The species has not fared as well in some other states, particularly those which allow large scale collecting by biological supply houses.

Northern leopard frogs are characteristic of sedge meadows, wet prairies, and other areas of dense, damp herbaceous vegetation. They also occur within savannas and woodlands, as long as some herbaceous cover is present. Although northern leopard frogs are most abundant in sunlit openings, in northeastern Illinois they reach maximum abundance in predominantly savanna regions. Breeding takes place in marshes, vernal ponds, and vegetated margins of lakes, but the remainder of the active season leopard frogs will wander considerable distances from standing water. Morning dew on grass is reportedly used for rehydration (Feder and Burggren, 1992).

Although *Rana pipiens* is not restricted to savannas, it is noteworthy that the range extends only a short distance south of the Northeastern Morainal Division of Schwegman (1973). In much of the Grand Prairie Division, *Rana blairi*, a species associated with true grasslands, is the only leopard frog (Brown and Morris, 1990).

At the beginning of our 1993 study, northern leopard frogs were not conspicuous at Middle Fork Savanna. We heard only a few males calling during the late April peak breeding season, and observed only a couple of adult animals. However, the higher than normal precipitation during much of 1993 resulted in unusually high larval survival rates, and by late summer sightings of juvenile leopard frogs were routine. By fall the young leopard frogs had reached nearly adult size, although the number of frogs observed per unit of time had gradually decreased.

Major leopard frog breeding areas include the wetlands near our savanna and woodland drift fences. Substantial numbers of tadpoles were seined from these two marshes. Large numbers of metamorph leopard frogs were observed along trails south of the Concord entrance, implying that one or more of the wetlands near this area are also important. Additional areas frequently utilized by juveniles or adults include much of the former pasture and the periphery of several marshes.

Snapping turtle ***Chelydra serpentina***

This large (up to 300mm, or 11.8 inches, carapace length) turtle is seldom seen because of its aquatic and bottom dwelling habits. It is distributed throughout the U.S. east of the Rocky Mountains.

Snapping turtles inhabit rivers, lakes, permanent ponds and marshes. They seldom leave the water except to lay their eggs.

Snapping turtles are very tolerant of habitat disturbance and pollution, and are one of the few reptiles still inhabiting the Chicago River. Although we did not actually observe them in the Middle Fork within the study area, they most likely do occur there.

Both of our 1993 observations were at the marsh not far from our woodland drift fences. We watched and photographed one subadult snapping turtle foraging among the cattails in shallow water. We also found the remains, including the entire carapace, of a much larger snapping turtle which had been dead for some time. Since this marsh went nearly dry in 1993, in spite of higher than normal rainfall, it must be a secondary habitat for snapping turtles at Middle Fork Savanna. We suspect that the permanent man-modified pond near the southern end of the property harbors a larger population, although it would be necessary to use turtle traps to confirm this.

Blanding's turtle ***Emydoidea blandingii***

The Blanding's turtle is a large (up to 240mm, or 9.45 inches, carapace length) semi-aquatic species with a high-domed shell and a conspicuous yellow chin and throat. Although Blanding's turtles are at present moderately common in extreme northeastern Illinois, they are listed as a Category 2 species (under consideration for protection, but in need of further study) by the U.S. Fish and Wildlife Service and are included on the Illinois watch list. Recent population studies have demonstrated that Blanding's turtles do not become reproductively active until 14 to 20 years of age, and that individual turtles may reach an age well in excess of 60 years (Congdon et al., 1993). As a result, mortality or loss of juvenile or adult turtles becomes significant at a lower level than with most other species of reptiles.

Blanding's turtles usually inhabit permanent marshes or ponds, showing a preference for hemi-marshes with a mosaic of vegetated and open water areas (Ross and Anderson, 1990). Although most often found in shallow water, it is not unusual to observe adult Blanding's turtles on land. Population densities tend to be relatively low; the largest known northeastern Illinois population is at Chain O' Lakes State Park, where Rowe and Moll (1991) captured and marked a total of 42 Blanding's turtles at two widely separated wetland complexes.

The inclusion of *Emydoidea blandingii* on the Middle Fork Savanna species list is based on an April, 1991 sighting of a single basking adult just southwest of the current preserve boundaries. Marshes near our savanna and woodland drift fences provide better Blanding's turtle habitat, but dense emergent vegetation complicates attempts at observation. On several occasions in 1993 we were unable to approach unidentified turtles in these wetlands closely enough to get a good look through screening vegetation. We suggest the careful use of turtle traps in these wetlands in the future.

Restoration of wetlands will provide additional habitat for this species, and may allow expansion of what appears to be a small population.

Painted turtle ***Chrysemys picta***

This is easily the most conspicuous northeastern Illinois turtle, well known because of its habit of basking on logs or other exposed objects. Thin yellow and red stripes on the head and forelegs serve as useful identifying marks, and are usually visible through binoculars. Painted turtles in the Chicago region are considered intergrades between the midland and western subspecies, *Chrysemys picta marginata* x *C. p. bellii* (Smith, 1961).

Painted turtles are fully aquatic, rarely leaving the water except to lay eggs in late May or early June. On sunny spring and summer mornings it is not unusual to see basking painted turtles lined up on every available floating log, sometimes even climbing on top of each other.

The relative lack of permanent water at Middle Fork Savanna limits the numbers of this species. We observed painted turtles only at the man-modified pond near the southern end of the preserve, where up to five individuals were observed basking simultaneously on the bank and nearby logs. Painted turtles may occasionally be found in other wetlands.

Smooth green snake ***Opheodrys vernalis***

The small (to 565mm, or 22.25 inches, total length), harmless smooth green snake feeds primarily on insects. It is described well by its common name; adults are unmarked light green above and white below. No subspecies are currently recognized.

The range extends from New England to northeastern Montana and adjacent Canada, with numerous disjunct populations scattered as far southwest as Utah and New Mexico. In Illinois, smooth green snakes are found in the glaciated portion of the state where grasslands were once common. This was once one of the most common snakes in northeastern Illinois. Seibert (1950) and Seibert and Hagen (1947) reported 182 green snakes per hectare in southeastern Cook County. With the continued loss of habitat and the dramatic increase of pesticide and herbicide use in the post World War II period, green snake populations were decimated. Minton (1972) reports finding dead green snakes within two weeks after cropdusters sprayed a field in Indiana.

In Illinois, green snakes are a prairie species, probably reaching maximum abundance in mesic to wet conditions. Populations persist on many of the prairie and sedge meadow remnants of Lake County. Wooded areas are generally avoided, although we have recently confirmed green snake use of very open savanna situations in McHenry County (Mierzwa, in preparation).

Our green snake sightings at Middle Fork Savanna were centered on three areas: the prairie remnant where we installed one of our drift fence arrays; the former pasture just north of the savanna, where we discovered a clutch of five *Opheodrys vernalis* eggs; and the successional field complex adjacent to the Interstate 94 service road, outside of and to the west of the preserve boundaries. We are aware of much larger green snake populations in the immediate vicinity, for example, at the prairie white-fringed orchid site near Route 137 and I-94. The Middle Fork Savanna population may have been reduced in size either by encroachment of woody vegetation or by past chemical use associated with agricultural operations. As fire is returned to the ecosystem and grasslands are restored, the green snake population should gradually increase in size.

Plains garter snake ***Thamnophis radix***

Although garter snakes may be confusing at first glance, several distinct characters can aid identification. Only two species are commonly encountered in northeastern Illinois. The plains garter snake is the more brightly colored of the two, with an orange mid-dorsal stripe and thin yellow lateral stripes contrasting with a dark brown, olive brown, or nearly black ground color. The lateral stripes are unbroken or broken irregularly by encroachment of dark pigment, and are on the third and fourth scale rows counting up from the wide ventral scutes.

Plains garter snakes are a great plains species, occurring from the formerly prairie regions of Illinois and southern Wisconsin west to northeastern New Mexico and Montana. Disjunct populations exist as far east as Ohio, presumably relics of a hypsithermal prairie peninsula expansion (Smith, 1947). Illinois populations are assigned to *Thamnophis radix radix*.

Plains garter snakes are very much a grassland species, characteristic of mesic prairie, and tend to be replaced by *Thamnophis sirtalis* in areas with trees or other woody vegetation. Both species are tolerant of human disturbance, and may coexist in open successional fields and suburban vacant lots.

When one of us (KSM) first visited Middle Fork Savanna in April, 1991, one of the first animals captured was a plains garter snake. The specimen was taken under a board in a relatively open successional field adjacent to the Interstate 94 service road, outside of the preserve boundaries. Although we have not observed *Thamnophis radix* since at Middle Fork Savanna, we believe that it is present within the preserve in low numbers. At several other preserves in Lake County, including Ryerson Conservation Area, we have been able to locate plains garter snakes only sporadically. Often several specimens are observed in a few days, and then none are seen for up to several years.

Plains garter snakes are moderately common along the south facing embankment of Route 137 two miles directly north of the study site. It is noteworthy that Hutchison (1988) shows prairie to the north of Middle Fork Savanna. Because of the prevalence of savanna and wetland conditions at Middle Fork Savanna, we suspect that *Thamnophis radix* has always been the less common of the two garter snakes there. As brushclearing, controlled burning, and grassland restoration proceed, sightings of this species may become somewhat more frequent.

Common garter snake ***Thamnophis sirtalis***

This garter snake is duller in coloration than the preceding species, with dull tan or whitish stripes over a brown, olive brown, or nearly black ground color. The lateral stripes, which are on the second and third scale rows, are distinctly broken into a series of dashes on the front third of the body. The common garter snake also has a larger head, clearly distinct from the neck, and tends to be more aggressive. Large specimens will often attempt to bite when handled. Occasional individuals may exceed one meter (3.28 feet) in length, although most are much smaller.

Thamnophis sirtalis is found from coast to coast, with a number of recognized subspecies. Local specimens are referred to the Chicago garter snake, *Thamnophis sirtalis semifasciata*, and are characterized by the broken lateral stripe.

Common garter snakes are so adaptable, and are found in so many human modified areas, that the original habitat associations are often obscured. Most Chicago region records are from areas which formerly were savanna, and even today this is the only garter snake in most wooded areas. The common garter snake often co-exists with the white-footed mouse (*Peromyscus leucopus*), another inhabitant of areas near woody vegetation, while *Thamnophis radix* is more often associated with the deer mouse (*Peromyscus maniculatus*).

We observed common garter snakes on most of our visits to Middle Fork Savanna, and the site supports one of the densest populations of this species that we have seen in Lake County. Specimens were found in most parts of the site, but were easiest to collect under boards in the large debris pile near the windmill pond. We also captured quite a few common garter snakes in our prairie drift fences, suggesting that woody encroachment has advanced to a stage favoring savanna species over those typical of prairie.

Redbelly snake *Storeria occipitomaculata*

This is our smallest local snake, reaching a maximum length of only 311mm (12.25 inches). There are two color phases, one tan to reddish brown and one dark gray. A wide, light mid-dorsal stripe may or may not be present. The underside is bright orange-red. Three light spots are present just behind the small head.

Redbelly snakes occur through most of the eastern U.S., but there is an apparent gap in the range approximating the former prairie peninsula (Conant and Collins, 1991). In Illinois they are most common in the Northeastern Morainal Division, where they are associated with savannas and open woodlands. In McHenry County we have collected them on gravel hill prairies. They are secretive and easily overlooked, and tend to be surface active mostly in the early spring and again in the fall.

At Middle Fork Savanna we collected redbelly snakes under boards around the fringes of the former pasture, in our prairie opening drift fences, and under boards and rocks along the Interstate 94 service road. The species is moderately common by northeastern Illinois standards.

OTHER AMPHIBIANS AND REPTILES KNOWN FROM THE VICINITY

Salamanders

The spotted salamander, *Ambystoma maculatum*, is known from Ryerson Conservation Area and MacArthur Woods. It is restricted to the immediate vicinity of mesic forests, and is sensitive to any drop in humidity caused by thinning of the tree canopy (Vogt, 1981). Spotted salamanders are sometimes confused with the superficially similar tiger salamander, but there is no suitable spotted salamander habitat at Middle Fork Savanna. The eastern newt, *Notophthalmus viridescens*, was reported from a locality south of Deerfield Road and east of the Des Plaines River by Pope (1964), based on a 1942 capture of a single individual. Recent efforts to locate the species there have been unsuccessful, and no Lake County records are available for recent decades. Newts require permanent water with dense vegetation, a habitat type which is very limited in extent at Middle Fork Savanna.

Frogs

The cricket frog, *Acris crepitans*, was once among the most abundant amphibians in northern Illinois, and it almost certainly occurred historically at Middle Fork Savanna. Sometime during the 1970s cricket frogs disappeared throughout the northern part of the range of the species, and only a very few populations are presently known from the Chicago region. The spring peeper, *Pseudacris crucifer*, is fairly common at Ryerson Conservation area. It occasionally is found in savannas, but is characteristic of more heavily wooded situations. Gray treefrogs, *Hyla versicolor* complex, are documented from Highland Park by old museum specimens and reportedly once occurred in parts of the Des Plaines River valley. The two forms, the diploid *Hyla chrysocelis* and the tetraploid *Hyla versicolor*, can be distinguished only by pulse rate of the breeding call or by chromosome counts or measurement of cell size. There are no recent records from southeastern Lake County, and it is not known which form historically occurred there. *Hyla chrysocelis* is still common in the Fox River Valley, and *Hyla versicolor* is known from DuPage and Will Counties. Apparently suitable habitat is present at Middle Fork Savanna, but even where tree frogs are common they tend to be sporadically distributed. The absence of green frogs, *Rana clamitans*, from Middle Fork Savanna samples to date is somewhat surprising. This species is common at many other Lake County savanna-like sites. The rarity of permanent wetlands within the preserve boundaries is probably the limiting factor, since green frog tadpoles require a full year before metamorphosis. If green frogs are present on the site but are too rare to be readily sampled, they should become more conspicuous as drain tiles are broken or removed and wetlands restored.

Turtles

The musk turtle, *Sternotherus odoratus*, occurs sporadically in rivers throughout northeastern Illinois. It has not been reported from the vicinity of Lake Forest, but is a bottom dweller and thus easily overlooked. The spiny softshell turtle is common in the Des Plaines River. Although considered characteristic of backwater sloughs on larger rivers, there is a slight chance that one or more individuals could ascend the Chicago River drainage from time to time. A variety of non-native turtles, including sliders, *Trachemys scripta*, box turtles, *Terrapene* sp., and others, are likely to be observed eventually because of the proximity of residential areas and the all too common

human habit of releasing unwanted animals. With the probable exception of the slider, non-native turtles are unlikely to survive for long.

Lizards

The five-lined skink, *Eumeces fasciatus*, formerly occurred in Waukegan and Glenview. There are no records since before 1900, and the species is presumably extirpated in northeastern Illinois. Five-lined skinks may once have inhabited savannas in this region.

Snakes

The fox snake, *Elaphe vulpina*, is common in prairie and savanna regions through most of Lake County, but there have been very few records from the southeastern quarter of the county and none near Lake Forest. It is uncertain whether this is due to closer proximity to urbanization or to the more heavily wooded nature of parts of the region. The milk snake, *Lampropeltis triangulum*, may occur at Middle Fork Savanna, and should not be ruled out without extensive sampling. Milk snakes are known from nearby Shaw Prairie, from Ryerson Conservation Area, and Wadsworth Savanna, among other Lake County sites. The habitat at Middle Fork Savanna appears to be nearly ideal, and the lack of 1993 specimens may be due to unusually wet weather during the peak activity season in May. Milk snakes are highly fossorial at most other times of the year (Henderson et al., 1980). Brown snakes, *Storeria dekayi*, are often found at savanna and woodland sites in the Chicago region, and their presence should not yet be ruled out. At some other savannas multiple years of sampling have been necessary to locate this species. Brown snakes are common at Ryerson Conservation Area and at several other localities east of the Des Plaines River, but are apparently more sporadically distributed and less common in the Chicago River drainage. Kirtland's snake, *Clonophis kirtlandii*, is a rare (Illinois threatened and federal Category 2) fossorial snake originally described by Robert Kennicott from specimens collected near Glenview in the 1850's. The species still occurs at the type locality, but the few localities north of that point are considered questionable. The clay soils and numerous crayfish burrows at Middle Fork Savanna appear to offer suitable habitat, but at the present time it is unclear whether the range of Kirtland's snake extends this far to the north. Because of the tendency to inhabit crayfish burrows and the sedentary lifestyle, Kirtland's snakes are often difficult to locate. Graham's crayfish snake, *Regina grahamii*, is known from only a few northeastern Illinois localities. The northernmost of these is a permanent marsh in Green Oaks, at the southern end of O'Plaine Road. Two specimens were collected in the early 1980's at this locality, which is only a little over 3.3 km (2.0 miles) north of Middle Fork Savanna. The Green Oaks wetland is now nearly surrounded by residential development, and recent efforts to locate specimens have been unsuccessful. Some wetlands at Middle Fork Savanna are similar in structure to the one in Green Oaks, but the lack of permanent water in most years may result in a lack of suitable habitat. The massasauga, *Sistrurus catenatus*, has been thoroughly studied at Ryerson Conservation Area (Anton, 1993). Massasaugas were once reported as far northeast as Duffy Road at Interstate 94 (Bushey, 1978), but there have been no further reports from that area (Beltz, 1992). Massasaugas are thought to require a water table which is seasonally close to the surface for hibernation, the proximity of somewhat drier upland areas for summer habitat, and the presence of some trees or shrubs to provide shade for thermoregulation in an otherwise relatively open environment (Mierzwa, 1993b). While parts of Middle Fork Savanna fit this description, there have been no reports of

Massasaugas from the area. Venomous snakes generally do not escape human notice for long, and their presence tends to be reported in the local press. Most likely, massasaugas either were never present at Middle Fork Savanna, or they were extirpated during the early settlement of Lake County.

SITE MANAGEMENT PRIORITIES

Controlled burning and clearing of non-native vegetation

Middle Fork Savanna includes natural communities of exceptional quality. It also has suffered from a variety of human disturbances, resulting in a fragmented landscape with savannas, prairies, and wetlands partially isolated by former pasture and agricultural land. One of the priorities of site management must be to restore a functional ecosystem, by enhancing the quality of the surviving communities and restoring the intervening disturbed areas.

As in most savanna and woodland complexes, the encroachment of woody vegetation is a serious problem in parts of Middle Fork Savanna. In many areas the tree and shrub canopy has grown in, resulting in a dense, nearly impenetrable woodland. Under these conditions, the herbaceous understory disappears, and characteristic savanna and grassland animals become scarce.

Clearing of shrubs and the return of fire are critical to the long-term survival of many of the small animal species now present at Middle Fork Savanna. Studies at other savanna restoration sites, for example at Glacial Park in McHenry County (Mierzwa, 1993a) have shown that some amphibians and reptiles repopulate restored prairies and savannas with amazing rapidity. Cropland nearly devoid of life, when planted to prairie and burned once, has been utilized by several species in as little as two to three years. Savannas cleared of shrub thickets have been repopulated from adjacent areas within a year. Some incidental mortality to small animals does occur from controlled burning, but no amphibian and reptile species have been lost from sites burned for several years, and many species appear to actually increase in abundance within a few years of the onset of management.

Many parts of Middle Fork Savanna are in need of clearing and burning. We generally concur with Brown and Schennum's (1980) prioritization of areas for restoration. The prairie openings around our northernmost drift fences are of great importance, since they probably provide a refuge for some grassland species, such as smooth green snakes, which do not persist for long as encroachment of woody vegetation advances. This area must be maintained in an open state until nearby pasture and successional field can be restored to prairie, so that grassland species can disperse as additional habitat becomes available. This area is recommended for priority clearing and burning. The nearby woodlands retain a partial herbaceous layer, and the shrub thickets are still incomplete, so these are also convenient targets for restoration. We also suggest investigating the possibility of removing the cottonwoods and shrubs along the ditch just south of the prairie opening. These, in combination with the ditch, act as an effective barrier to both small animals and researchers. At present, it is necessary to climb onto the adjacent railroad embankment to walk from the pasture to the prairie.

Purple loosestrife control

Some of the most diverse wetlands within the preserve boundaries are threatened by encroachment of purple loosestrife *(Lythrum salicaria)*. Field work at sites with extensive monotypic growths of this plant (for example, Powderhorn Prairie) have indicated that few amphibians or reptiles remain in the affected wetlands. Diverse wetlands with a mosaic of various vegetation types and patches of open water usually support the highest concentrations of amphibians.

Two wetlands in proximity to drift fence arrays, one in the high quality savanna and one at the southern edge of the woodland, retain central open water areas and diverse assemblages of breeding amphibians and aquatic invertebrates. Efforts to control and eventually eradicate purple loosestrife in and around these wetlands are recommended in the immediate future. Any application of herbicides should be done with care, preferably after most larval amphibians have left the ponds in mid to late July.

Wetland restoration

A series of wetlands in the former pasture north of the savanna have been drained by past installation of tiles. These wetlands flood after heavy rain, but usually drain within a few days. Destroying or plugging these drain tiles, which empty into the river, will rapidly restore breeding habitat for some amphibians able to use temporary water, such as the western chorus frog and the American toad. The largest wetland, closest to the savanna and marked by a small windmill, did not dry completely in 1993 but fluctuated wildly in size and depth. This wetland, once stabilized, will likely hold water long enough to be used by additional amphibians. Restoration of this series of wetlands will add habitat diversity to the monotypic former pasture, which may currently act as a significant barrier to amphibians and effectively isolate woodlands on the northern and southern ends of the preserve.

Prairie restoration

Restoration of prairies in areas currently dominated by exotic grasses or forbs will play an important long-term role in maintaining populations of some grassland animals. We have been amazed at how quickly reptiles and amphibians will repopulate former agricultural fields planted in prairie grasses. At Glacial Park, in McHenry County, we captured many more salamanders, frogs, and snakes than we had expected in a two year old dry prairie restoration (Mierzwa, 1994). Restoration of prairie at the former pasture could help reduce habitat fragmentation, since we have observed heavy amphibian and reptile use only along the fringes of this nearly monotypic grassland.

Stream restoration

If it is possible to achieve and maintain acceptable levels of water quality, physical restoration of parts of the Middle Fork could provide a habitat not presently available on the site. Grading of gentle banks and restoration of at least some of the bordering marsh which once was present (Hutchison, 1988) could improve both the aesthetics and the habitat value of the stream. Unfortunately, adjacent land uses limit the possible extent of restoration.

General comments on site management

We disagree with some of the management suggestions made by Sullivan (1993b). While we do agree that substantial diversity remains on the site, some species are not faring well. Middle Fork Savanna is aesthetically pleasing and it retains plant communities that have been lost elsewhere, but it can be improved. Patches of exceptionally high quality woodland, savanna, and prairie are separated by expanses of Eurasian weeds, while native vegetation is being shaded out by aggressive exotic shrubs. The present day fauna of Middle Fork Savanna represents the survivors of decades of habitat manipulation and fragmentation.

Islands of biodiversity are scattered through the site (Collins, 1992), but significant barriers to small animal movement exist. These barriers take different forms, depending on the species trying to move about. A monotypic pasture is a major barrier to a salamander in need of high humidity, a shrub choked woodland is a barrier to a sun-loving reptile, and a steep-sided man-made ditch or railroad embankment is a barrier to nearly anything small and unable to fly.

We prefer the sweeping, long-term and landscape level view expressed by Collins (1992). We are more interested in what once existed, and can be partially restored with proper management. The ultimate goal should be to manage the site toward the best available estimate of the presettlement condition. A wealth of presettlement vegetation information is available for Middle Fork Savanna and for Lake County, at a variety of scales and levels of detail (Moran, 1978; Hutchison, 1988; Westerman, no date), based on both General Land Office and immediate post-settlement surveys. With this information, we can be confident that savanna was once common here, but that no true forest was present closer than MacArthur Woods, more than a mile to the west. If the savanna and woodland groves of Middle Fork Savanna are allowed to succeed to closed canopy forest, as Mendelson et al. (1992) have proposed for other sites, the result will be a depauperate community which has lost most of the savanna animals but not gained new species to replace them. Even if the amphibians characteristic of mesic forest are able to survive in such a situation, they will be unable to cross interstate highways and residential subdivisions to colonize the area.

Perhaps it is not possible to reconstruct every detail. For example, while it is technically possible to restore the vast marshes along the river through construction of weirs and planting of native vegetation, it may not be politically or economically feasible because parts of the watershed remain in private ownership. However, management for the original ecosystem, to the extent possible, will allow most of the resident animals to thrive. Manage for a particular species or subset of species, and some other group will suffer. Finally, the savanna is not a static ecosystem, and it should not be managed as one. To successfully manage a dynamic ecosystem, one must have a four dimensional view of the landscape.

We especially disagree with Sullivan's proposal to leave some buckthorn in place. Even an intensive effort to eradicate all non-native shrubs will require years on a preserve as large and complex as this one. Native shrubs, adapted to fire, will likely do well in some parts of the preserve. For example, hazel (*Corylus americana*), a species frequently mentioned by the early surveyors, has become much more widespread at Glacial Park as savannas have been cleared and burned. Yes, a few species of animals may become less common as non-native shrubs are eventually brought under control. There

are plenty of other preserves in the area with extensive growths of non-native shrubs, but there are no other high-quality savannas.

Since Sullivan (1993b) clearly states that he prefers the *status quo*, we assume that his management suggestions are meant to maintain the species assemblage which is currently present. We wonder what the species mix would look like under what Packard (1993) describes as "a natural burn regime." Amphibians and reptiles, unlike birds, cannot easily immigrate into a site isolated by surrounding highways and development. However, our extensive experience at other northeastern Illinois preserves in the process of restoration leads us to expect that even if additional species cannot easily be gained, some of those already present in low numbers will become more common as restoration progresses. The result will be a more stable community with less risk of stochastic extinctions, and better species evenness.

Any assessment of potential animal reintroductions must wait at least several years, until restoration has progressed considerably. If species have been lost, the causes of the loss must be addressed before expending scarce resources on translocations. Only one large scale amphibian reintroduction has been attempted in northeastern Illinois to date; in 1993 cricket frogs, *Acris crepitans*, were translocated to an historical locality in Glacial Park (Mierzwa, 1994). The results of that effort will not be known until at least mid 1994. We are aware of a few amatuer efforts to move small numbers of reptiles, but these remain undocumented and most are likely to fail because the perpetrators did not fully understand complex habitat needs and were unfamiliar with the concept of minimum viable population size (Lacy, 1992). The success rates of translocations in other parts of the country have been low (Dodd and Seigel, 1991). We have addressed the issue of translocation elsewhere in greater detail (Mierzwa, 1994), but in general we urge caution, extensive research, and detailed documentation before making a decision on any movement of animals.

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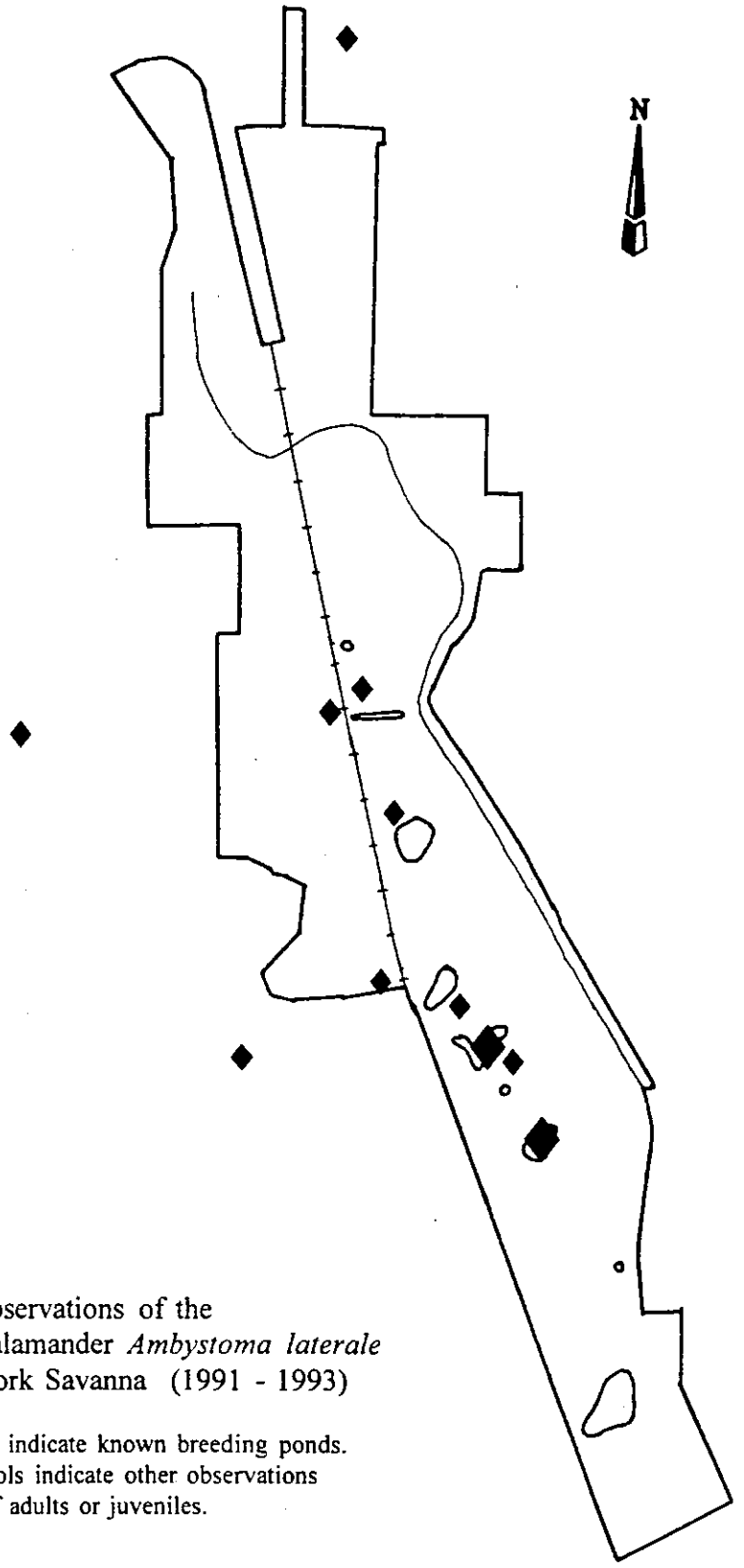
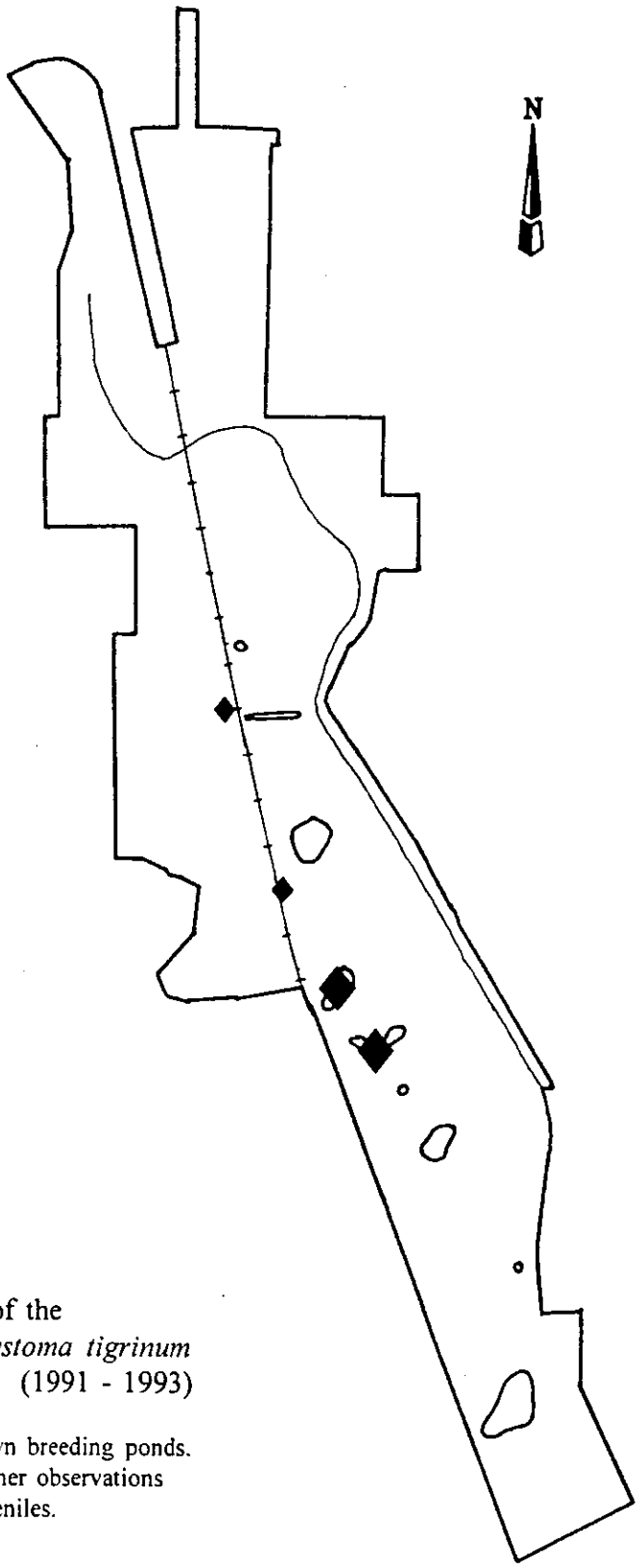
APPENDIX A - DISTRIBUTION MAPS
AMPHIBIAN AND REPTILE OCCURRENCES
AT MIDDLE FORK SAVANNA



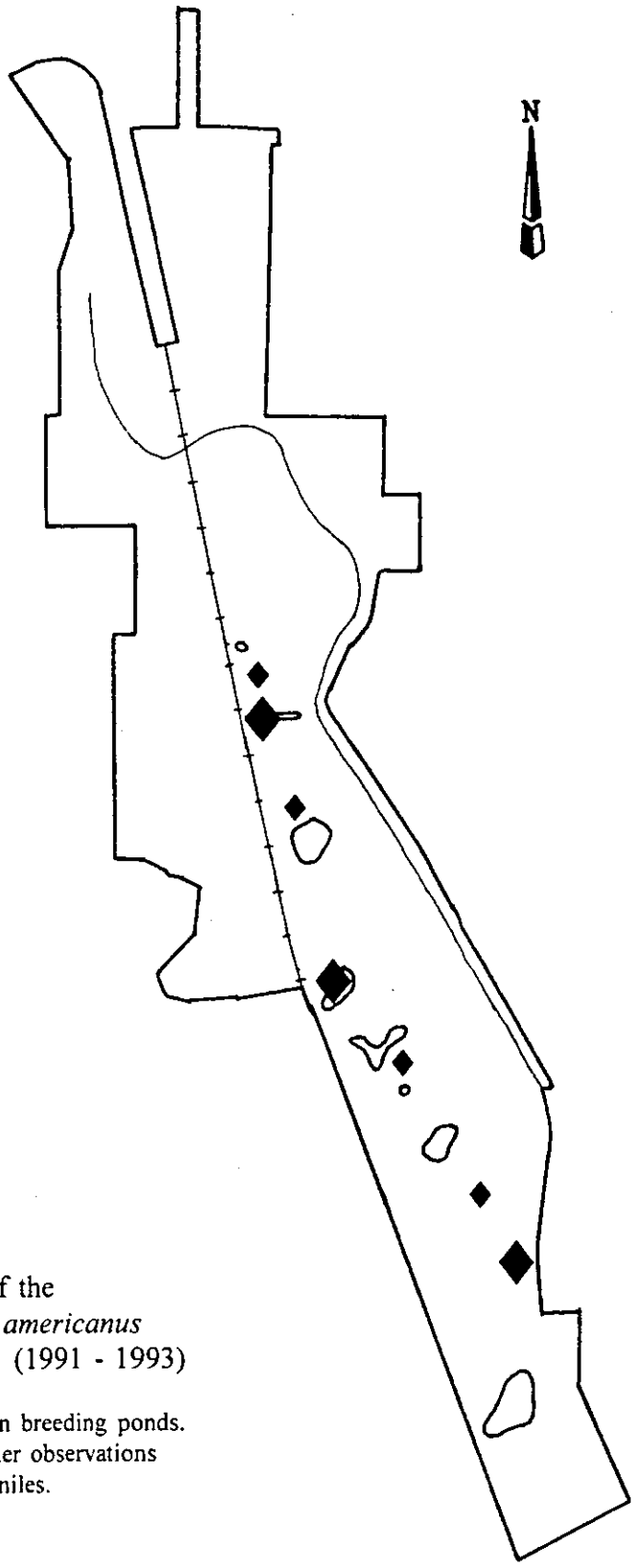
Observations of the
Blue-spotted salamander *Ambystoma laterale*
at Middle Fork Savanna (1991 - 1993)

Large symbols indicate known breeding ponds.
Small symbols indicate other observations
of adults or juveniles.



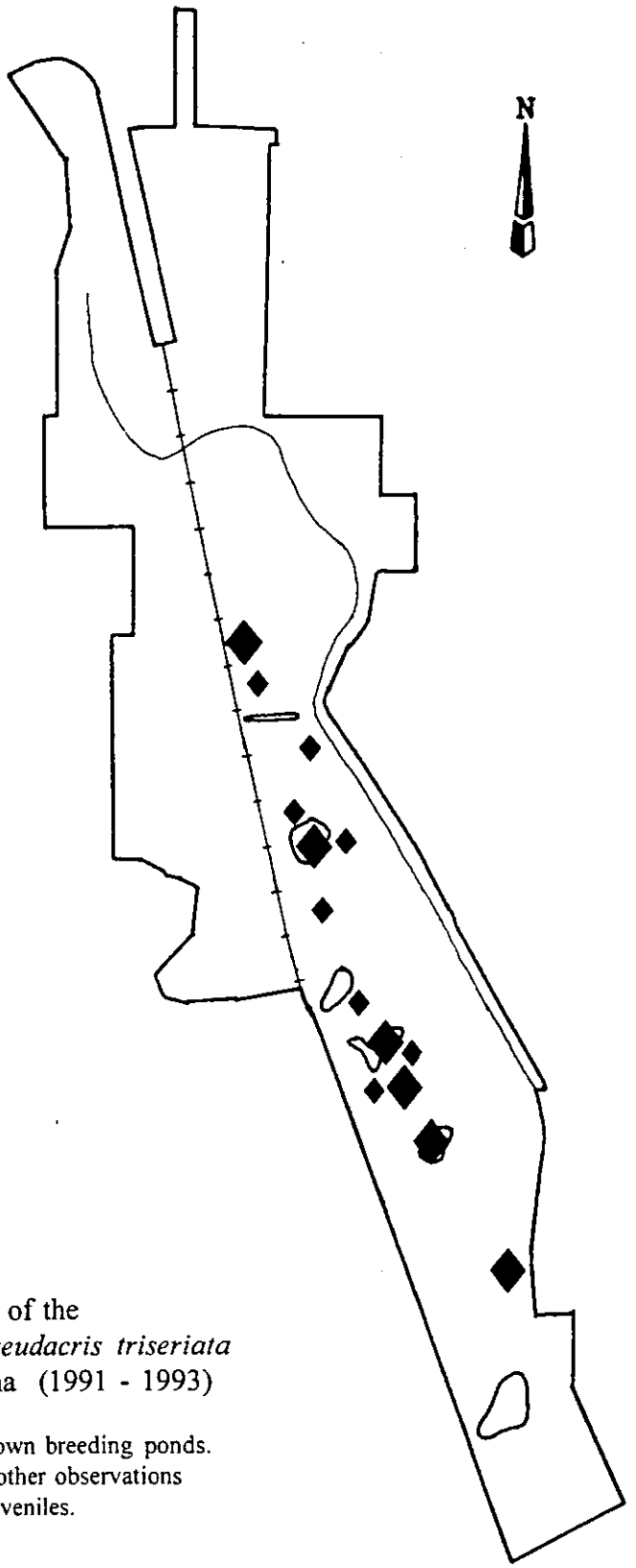
Observations of the
Tiger salamander *Ambystoma tigrinum*
at Middle Fork Savanna (1991 - 1993)

Large symbols indicate known breeding ponds.
Small symbols indicate other observations
of adults or juveniles.



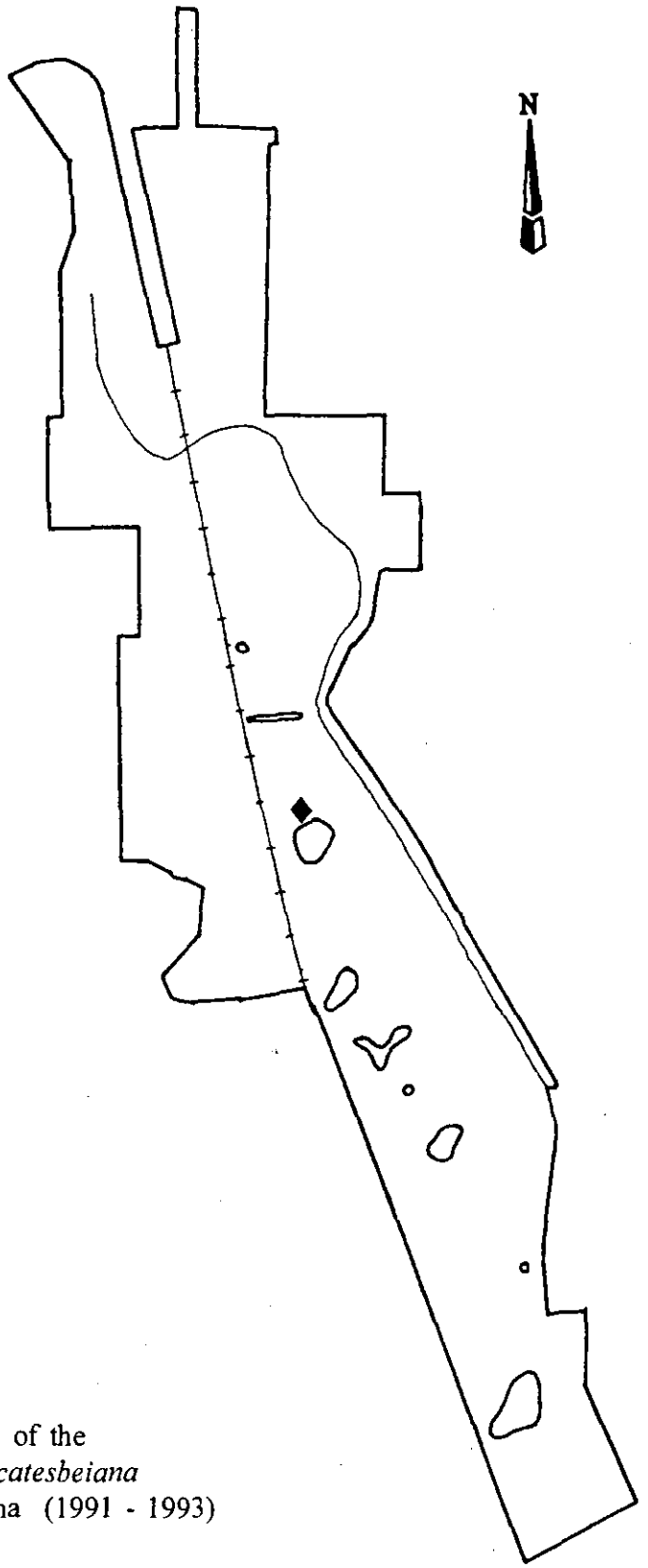
Observations of the
American toad *Bufo americanus*
at Middle Fork Savanna (1991 - 1993)

Large symbols indicate known breeding ponds.
Small symbols indicate other observations
of adults or juveniles.

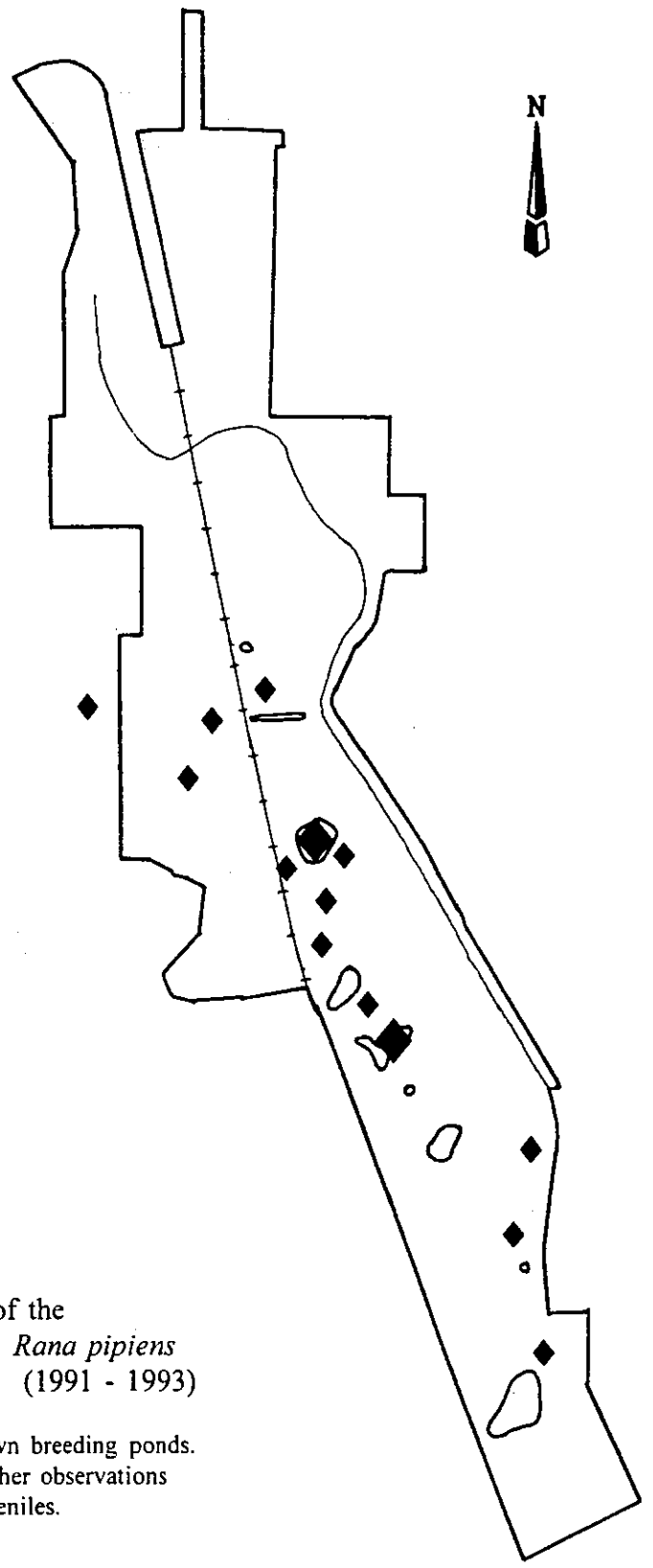


Observations of the
Western chorus frog *Pseudacris triseriata*
at Middle Fork Savanna (1991 - 1993)

Large symbols indicate known breeding ponds.
Small symbols indicate other observations
of adults or juveniles.

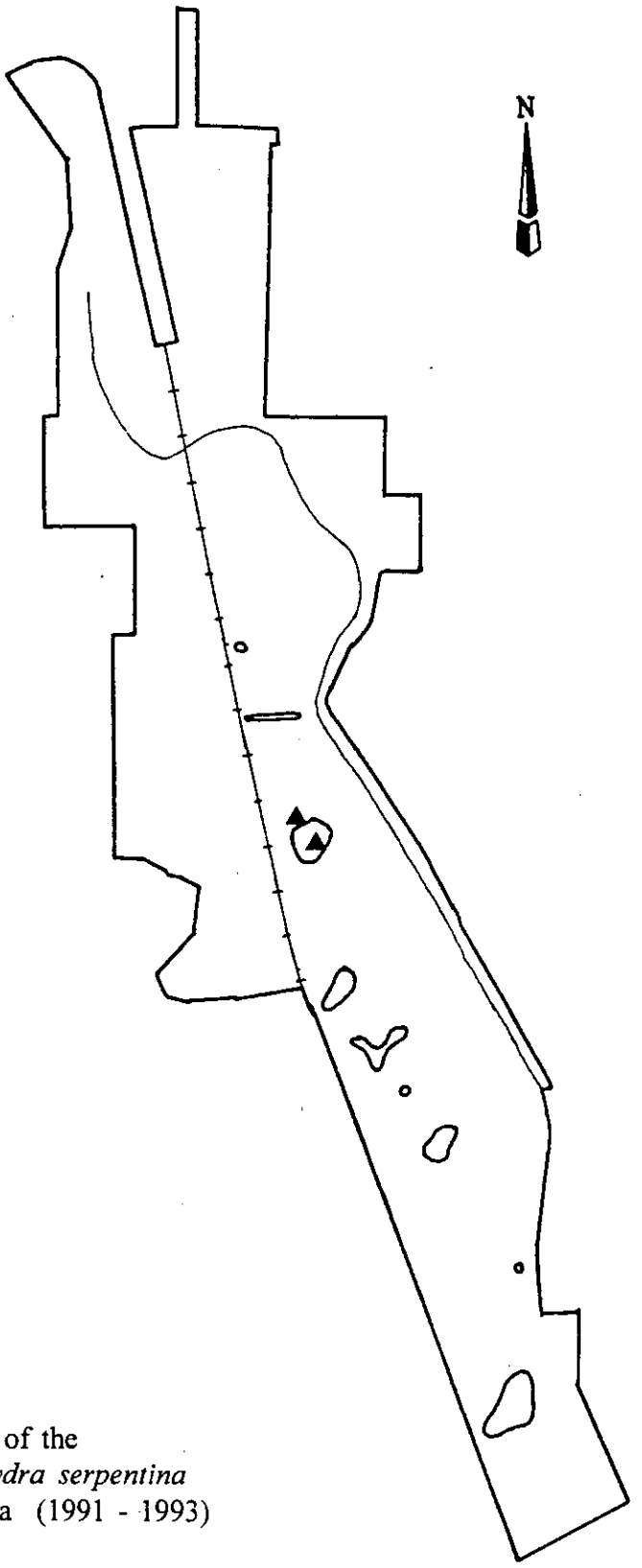


Observations of the
Bullfrog *Rana catesbeiana*
at Middle Fork Savanna (1991 - 1993)

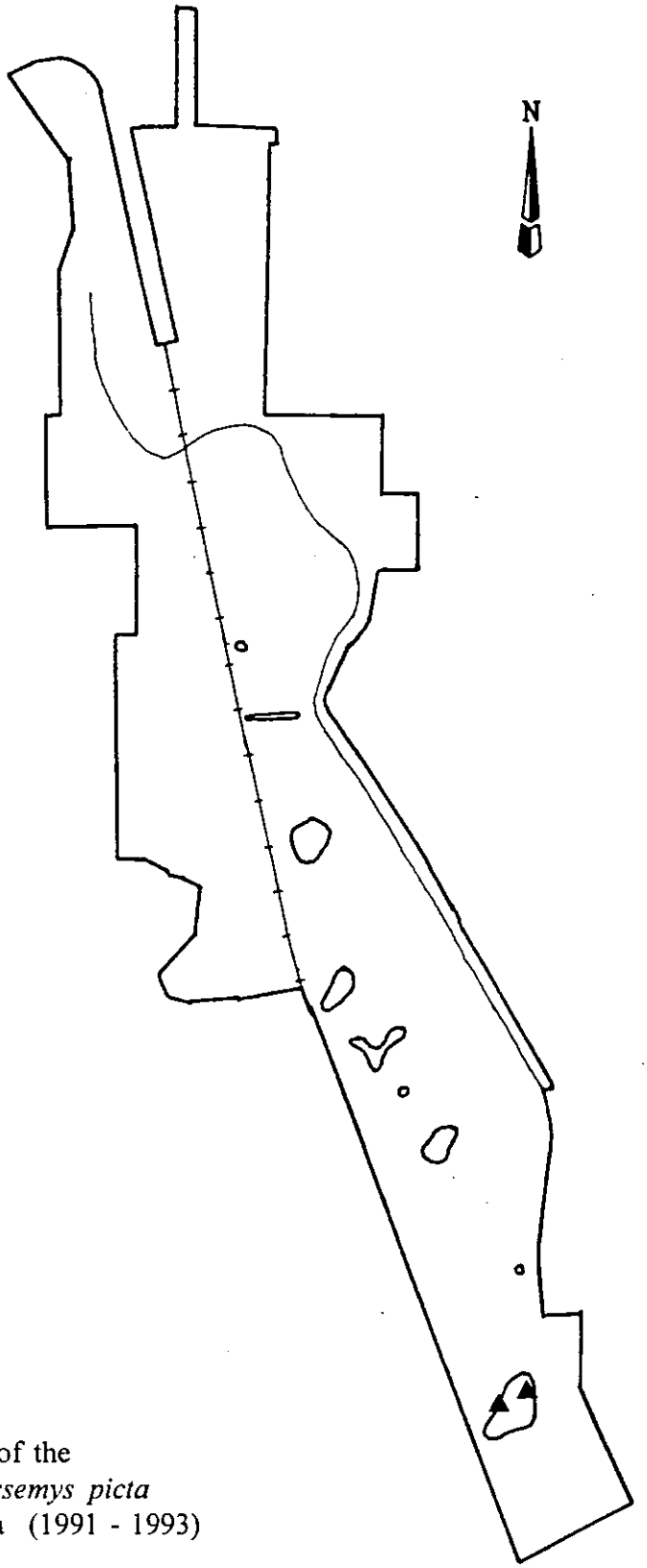


Observations of the
Northern leopard frog *Rana pipiens*
at Middle Fork Savanna (1991 - 1993)

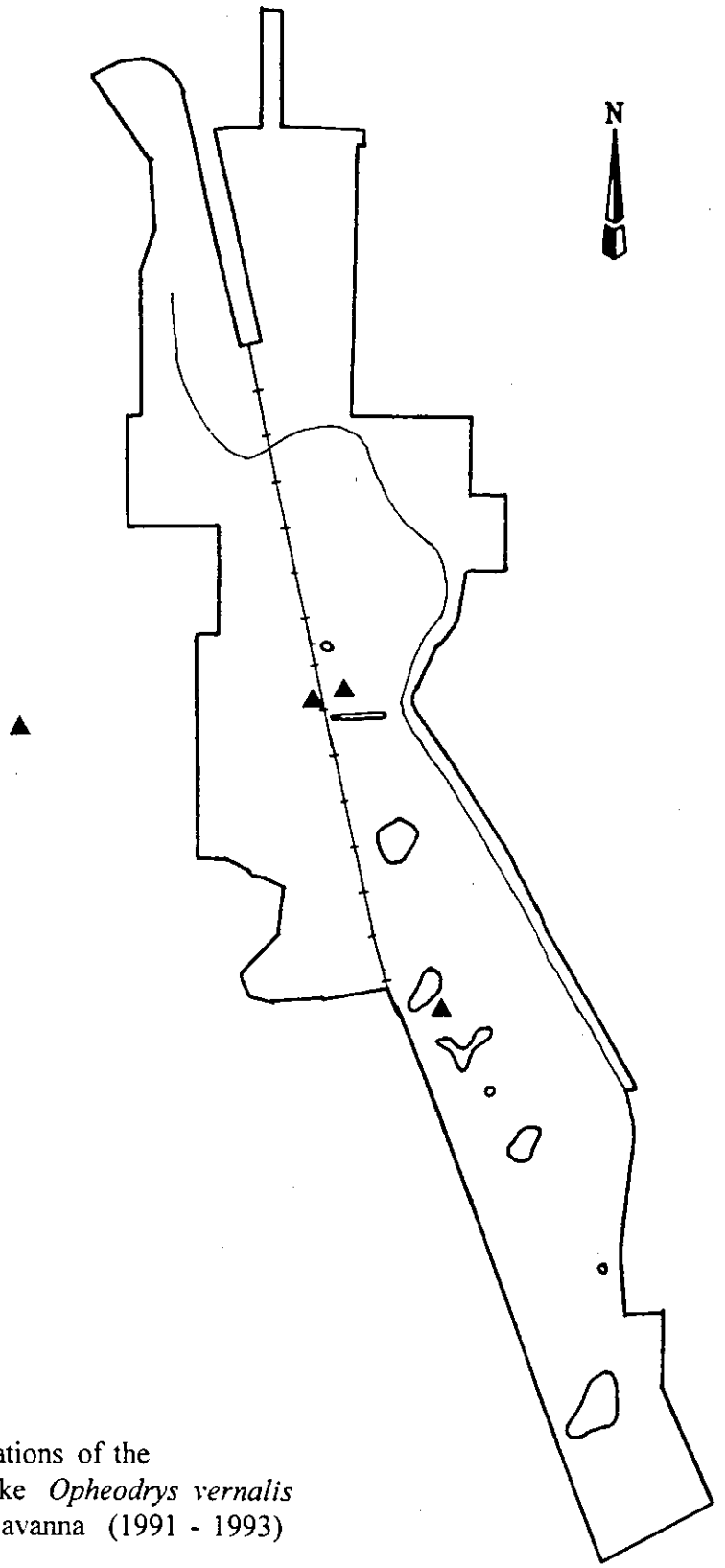
Large symbols indicate known breeding ponds.
Small symbols indicate other observations
of adults or juveniles.



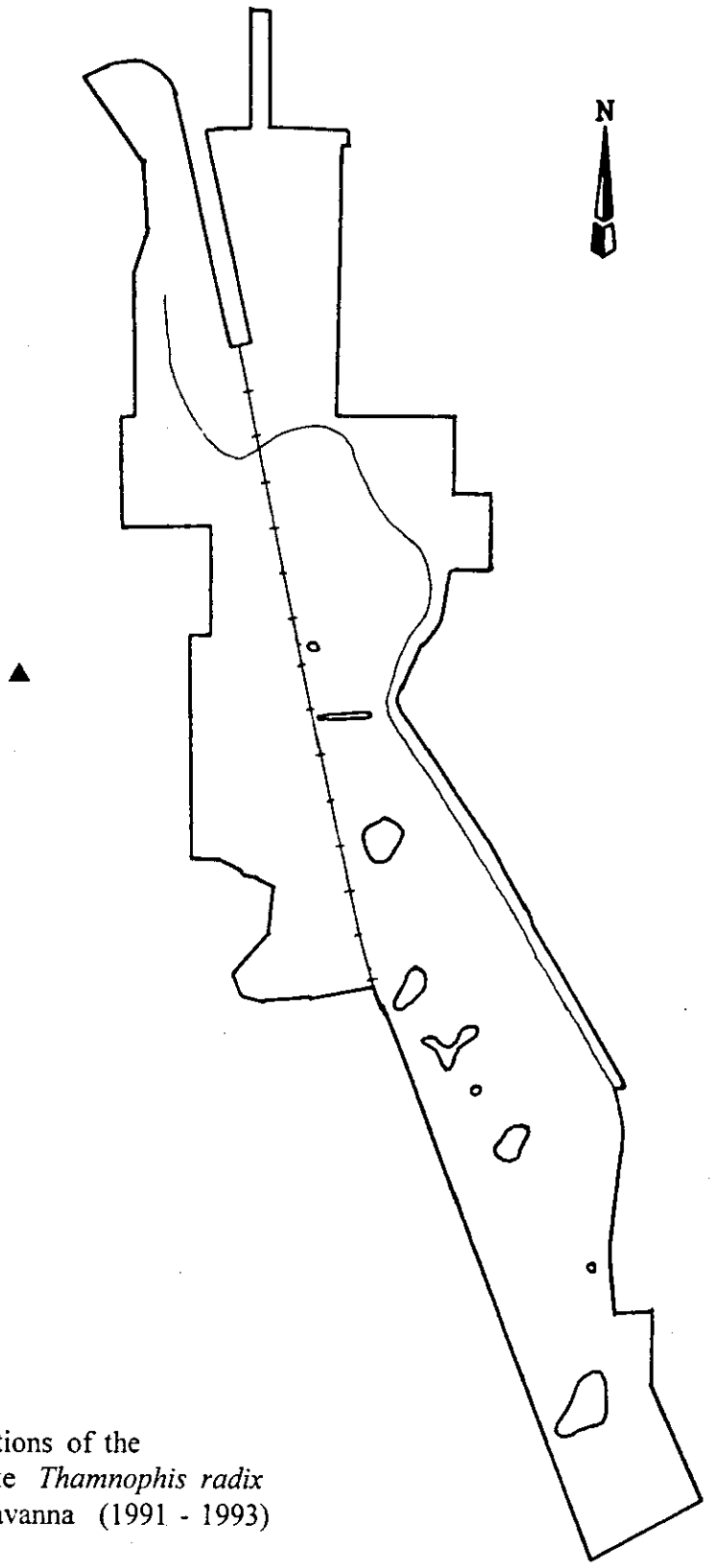
Observations of the
Snapping turtle *Chelydra serpentina*
at Middle Fork Savanna (1991 - 1993)



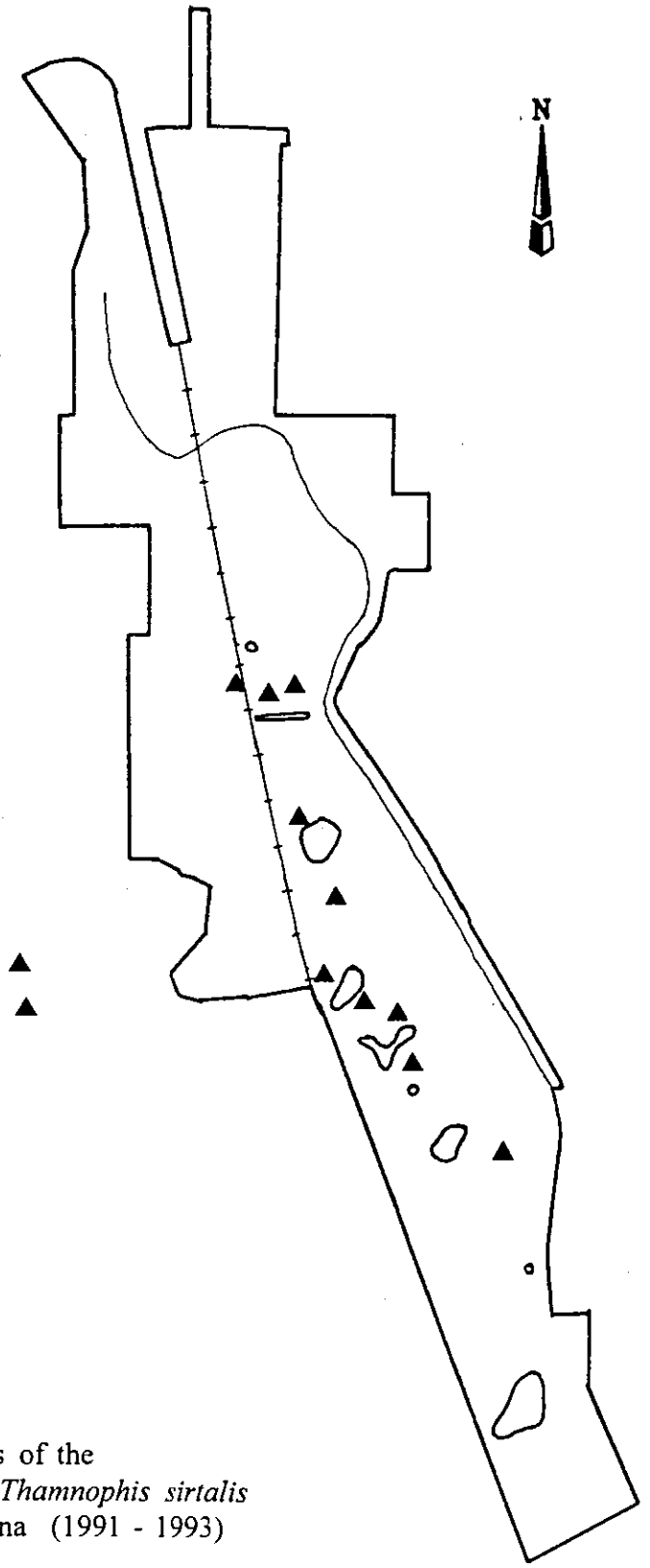
Observations of the
Painted turtle *Chrysemys picta*
at Middle Fork Savanna (1991 - 1993)



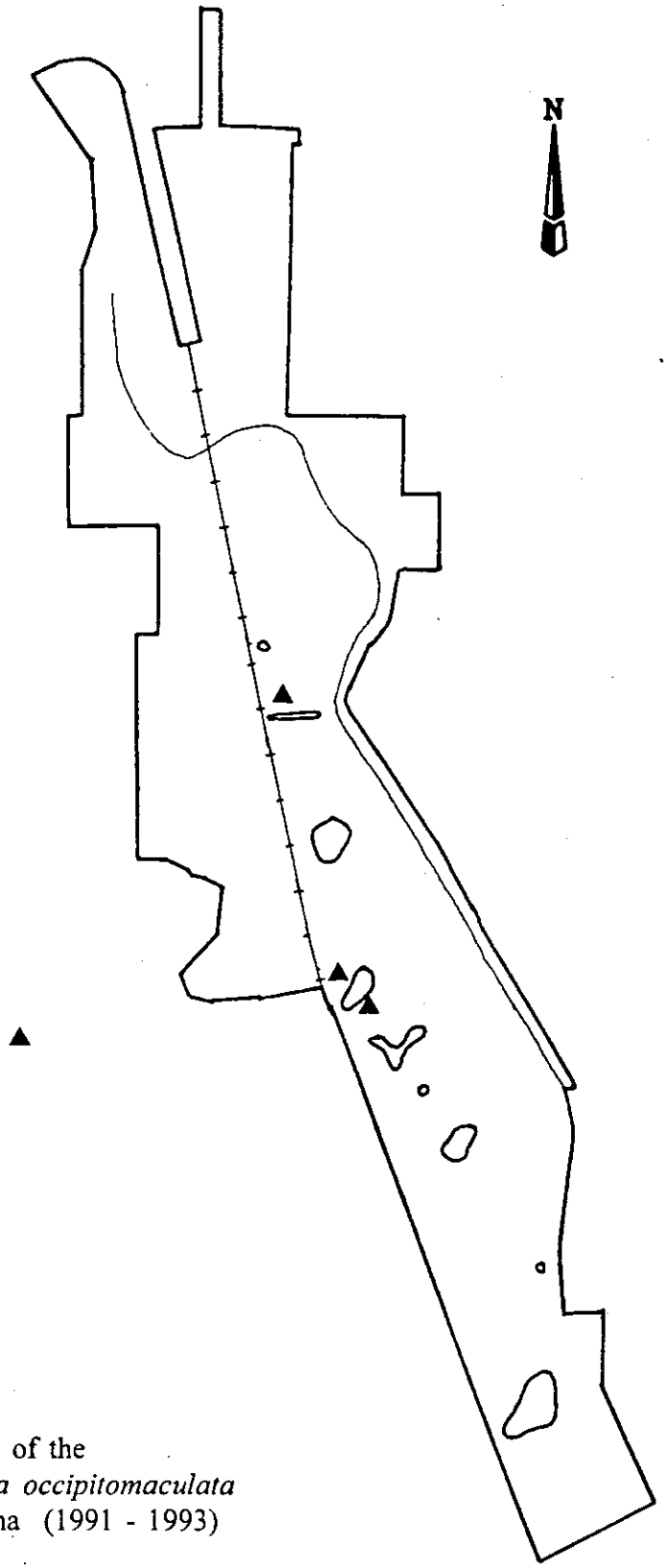
Observations of the
Smooth green snake *Opheodrys vernalis*
at Middle Fork Savanna (1991 - 1993)



Observations of the
Plains garter snake *Thamnophis radix*
at Middle Fork Savanna (1991 - 1993)



Observations of the
Common garter snake *Thamnophis sirtalis*
at Middle Fork Savanna (1991 - 1993)



Observations of the
Redbelly snake *Storeria occipitomaculata*
at Middle Fork Savanna (1991 - 1993)

APPENDIX B - MUSEUM SPECIMENS AND PHOTO VOUCHERS
MIDDLE FORK SAVANNA

Table B-1. Preserved specimens to be deposited at the Field Museum of Natural History

Blue-spotted salamander, *Ambystoma laterale*	3
American toad, *Bufo americanus*	1
Western chorus frog, *Pseudacris triseriata*	2
Northern leopard frog, *Rana pipiens*	1
Smooth green snake, *Opheodrys vernalis*	1
Common garter snake, *Thamnophis sirtalis*	1

Table B-2. Photographic vouchers of Middle Fork Savanna animals

Blue-spotted salamander	*Ambystoma laterale*
Tiger salamander	*Ambystoma tigrinum*
American toad	*Bufo americanus*
Western chorus frog	*Pseudacris triseriata*
Bullfrog	*Rana catesbeiana*
Northern leopard frog	*Rana pipiens*
Snapping turtle	*Chelydra serpentina*
Smooth green snake	*Opheodrys vernalis*
Common garter snake	*Thamnophis sirtalis*
Redbelly snake	*Storeria occipitomaculata*

APPENDIX C - INCIDENTAL MAMMAL OBSERVATIONS MIDDLE FORK SAVANNA

MAMMALS

Previous mammal information on Middle Fork Savanna is limited to reports of random sightings by Brown and Schennum (1980), and the results of an intensive and detailed but brief sampling effort by Byers et al. (1987) which focused on small mammals.

We made no special effort to sample mammals, but in the course of an entire spring, summer, and fall study of amphibians and reptiles we captured numerous small mammals in our drift fences, observed many others under boards, logs, and other cover objects, and observed either individuals or sign of several larger species. These observations are reported below. Nomenclature follows Jones et al (1986). Other references include Hoffmeister (1989) and Mumford and Whitaker (1982).

Our overall impression is that the density of those species of small mammals likely to be preyed upon by hawks, owls, large snakes, and other mammals is relatively high.

The most significant sighting is that of the long-tailed weasel (*Mustela frenata*), an Illinois watch list species. While this elusive predator is known from other Lake County sites, including Ryerson Conservation Area, it is seldom observed. On two occasions in April of 1991 we flushed a long-tailed weasel from hiding while turning boards to look for snakes. The animal was under a large piece of plywood immediately adjacent to the Interstate 94 service road, west of and outside the present preserve boundaries. During the summer of 1993, we observed, from a distance, what may have been another weasel at the northern edge of the high-quality savanna, but high grass obscured visibility.

Table C-1. Mammals observed at Middle Fork Savanna during 1993.

Masked shrew	*Sorex cinereus*	4	
Northern short-tailed shrew	*Blarina brevicauda*	14	
Eastern cottontail	*Sylvilagus floridanus*	1	
Woodchuck	*Marmota monax*	3	
Eastern chipmunk	*Tamias striatus*	2	
White-footed mouse	*Peromyscus leucopus*	2	
Meadow vole	*Microtus pennsylvanicus*	11	
Muskrat	*Ondatra zibethicus*	1	
Meadow jumping mouse	*Zapus hudsonius*	1	
Raccoon	*Procyon lotor*	3	
Coyote	*Canis latrans*	-	(tracks)
Long-tailed weasel	*Mustela frenata*	1	
White-tailed deer	*Odocoileus virginianus*	14	

Additional species reported by Brown and Schennum (1980):

Striped skunk	*Mephitis mephitis*

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APPENDIX D - INCIDENTAL FISH DATA
MIDDLE FORK OF THE NORTH BRANCH
OF THE CHICAGO RIVER
AT MIDDLE FORK SAVANNA

FISH

A single fish sample was taken in the Middle Fork of the Chicago River on 5 May, 1993. A 6 x 15 foot seine was used to sample an approximately 100 meter long section of the stream just above the Concord Avenue bridge. Water was at higher than normal levels at the time of sampling, but there had been no significant rain for at least several days and turbidity appeared to be within normal levels.

Most of the fish captured were immediately preserved in 10% formalin and returned to the lab for sorting. One juvenile largemouth bass, a game species, was identified and released. Results are given below.

Nomenclature follows Robins et al. (1991). Other references include Smith (1979).

Table D-1. Fish captured at Middle Fork Savanna during 1993.

Golden shiner	*Notemigonas crysoleucas*	8
Fathead minnow	*Pimephales promelas*	202
White sucker	*Catostomus commersoni*	5
Black bullhead	*Ameiurus melas*	1
Green sunfish	*Lepomis cyanellus*	5
Largemouth bass	*Micropterus salmoides*	1

Index of Biotic Integrity (IBI)

The Index of Biotic Integrity (IBI) was developed to help assess the quality of water resources. It is believed that fish and other aquatic organisms respond to a wide range of factors, including water quality and habitat structure. Biological monitoring can often assess the combined effects of a wide variety of impacts, rather than measuring specific variables in isolation (Karr, 1991). IBI can also be useful for monitoring temporal trends.

IBI measures attributes of fish communities, including species richness and composition, trophic composition, and abundance and condition, and evaluates the sample site against what might be expected at a relatively undisturbed site of a similar size (Karr et al., 1986; Karr, 1991). Thus, IBI combines 12 attributes (or metrics) into one number which indicates the relative quality of an aquatic ecosystem. Criteria for metrics 1-5, which vary with stream order and geographic region, follow Hite and Bertrand, 1989. Criteria for metrics 6-12 are identical to those given in Karr et al. (1986).

An IBI score was calculated from the single Middle Fork sample. Within the study area, the Middle Fork is a second order stream. Known past impacts include channelization, resulting in straight sided banks and relatively homogenous aquatic habitat. Water quality may also have suffered from runoff of unknown pollutants, since the headwaters of the Middle Fork flow through commercial areas. Downstream at the Lake-Cook County line (the nearest IEPA ambient water quality

monitoring station) the Middle Fork is rated as "partial support/minor impairment" (Illinois Environmental Protection Agency, 1990).

Using IBI and Macroinvertebrate Biotic Index (MBI) data, Hite and Bertrand (1989) mapped the Middle Fork of the Chicago River as a Grade D, or Limited Aquatic Resource, stream. Our IBI score of 30 is at the top end of this range, bordering on Grade C, or moderate aquatic resource. This may reflect the location of our sample site close to the headwaters of the stream, above the source of most urban runoff, and the consistently higher than normal level and flow rate of the stream during much of 1993, which should have diluted any pollutants which were present. Silver and ammonia nitrogen have been cited as significant pollutants in the headwaters of the North Branch (Northeastern Illinois Planning Commission, 1978).

Omnivores (fathead minnow and golden shiner, both species typical of moderately degraded urban streams) dominated our sample. However, metrics indicative of extreme degradation (percent hybrids and percent diseased individuals) scored well, implying that whatever water quality problems do exist are not especially severe.

Table D-2. IBI results - Middle Fork of the Chicago River at Concord Ave. bridge - 5 May, 1993

	Metric	sample value	metric score
1.	Number of species	6	3
2.	Number of darter species	0	1
3.	Number of sunfish species	1	3
4.	Number of sucker species	1	1
5.	Number of intolerant species	0	1
6.	% green sunfish	2.3	5
7.	% omnivores	95.9	1
8.	% insectivores	0	1
9.	% piscivores	0.5	1
10.	No. individuals in sample	219	3
11.	% hybrids	0	5
12.	% diseased	0	5
	IBI Score		30

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