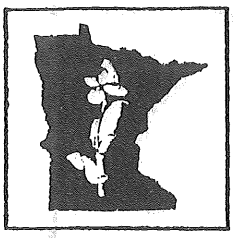
The 1980 Resource Inventory for the Kettle River Natural Area

Portions of
Sections 10, 15, 22 and 23
Township 41 North, Range 20 West
Barry Township
Sandstone Quadrangle
Pine County
Minnesota

Prepared by
The Scientific and Natural Areas Section
Division of Parks and Recreation
Minnesota Department of Natural Resources

January 1984



Scientific and Natural Areas

Scientific and Natural Areas serve:

Education - elementary through high school groups use such areas as outdoor classrooms.

Nature Observation - the public uses these areas to observe Minnesota's most unique or rare natural resources.

Protection Functions - Minnesota's rarest species or most unique features are protected for the citizens of today and tomorrow.

Recreation - the public uses such areas for informal, dispersed recreation.

Research - colleges are able to establish long term research projects secure in knowing the area will not be influenced by other management activities.

Genetic Storehouse - potentially valuable plants and animals are retained thereby offering potential for new medicines, resistance to plant diseases, and other unknown secrets.

Currently there are **34** Scientific and Natural Areas protecting undisturbed remnants of Minnesota's plant communities and plant and animal species. These areas encompass maple basswood forests, virgin prairies, orchid bogs, heron rookeries, sand dunes, and virgin pine stands, as well as many rare plant and animal species.

PREFACE

This report documents the information collected during a 1980 inventory of the Kettle River Natural Area. The inventory was designed to collect information on the physical and biological resources of the site, including its geology, soils, climate, water resources, flora and fauna. The land use history of the site was also investigated in an attempt to understand how such practices may have altered the resources of the natural area. Data supplied by this report will be used by evaluators to assess whether the site merits its designation as a Scientific and Natural Area (SNA) in accordance with the objectives and criteria established by the Program's Long Range Plan (Minn. Dept. of Nat. Res., Div. of Parks and Rec., SNA Section, 1980). This report will also be a valuable aid for individuals responsible for future management decisions as well as for scientists, educators and others interested in the area.

The inventory of the Kettle River Natural Area was part of a larger effort in which eleven natural areas in northwest, northeast and east-central Minnesota were surveyed. Inventory team members were: Lee Pfannmuller, SNA Planning Coordinator; Carmen Converse, Jane Cross-Cella, Sue Cutler, Ted Petron, Vicki Phelps and Marianne Severson, botanists; Tony Busche, Joel Jokela, Jim Lynch, Jim Pertz, Dan Scheneider and Jim Ziegler, zoologists; Larry Killien and Dianne Wade, land use history researchers; and Jim Strudell, geologist. Gerald Jensen, Supervisor, Scientific and Natural Areas Section, and Barbara Coffin, George-Ann Maxson, Welby Smith, Doug Wells and Henry Woolsey, Minnesota Natural Heritage Program, served as inventory

advisors. Several individuals and supporting institutions have given freely of both their resources and time, including the following: the Biology Department at Moorhead State University, in particular Dr. R. Pemble and Dr. T. Collins; Dr. E. Birney, Bell Museum of Natural History; Ron Huber, Science Museum of Minnesota; Gerald Wheeler, University of Minnesota; and Val Chandler, Minnesota Geological Survey. We are particularly indebted to Dr. G. Ownbey, University of Minnesota, who spent many long hours verifying literally thousands of plant specimens collected during the course of the summer inventory.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

DESCRIPTION OF STUDY AREA

The Kettle River natural area is a 306-hectare (756-acre) unit in west-central Pine County, approximately thirteen kilometers (8.1 miles) east of Hinckley, Minnesota. The tract is located within the Mille Lacs Landscape Region (Fig. 1), a gently rolling area dotted with small bogs and lakes. Second-growth forest, interrupted by an occasional hayfield, surrounds the natural area to the north and to the east. The Kettle River, a state-designated Wild and Scenic River, forms much of the southwest boundary while State Highway #48 marks the property's southern boundary.

Despite its relatively small size the Kettle River natural area encompasses a wide variety of landforms and habitats. Characterized by forests of silver maple and black ash, the floodplain of the Kettle River covers much of the southern third of the tract. Large sedge meadows are also common in this area. Two small lakes, which occupy former river channels, are testimony to the river's past meanderings. Next to one of the lakes is a small nesting colony of great blue herons.

North of the floodplain the Kettle River tract is a composite of well-drained uplands and rocky terraces and poorly-drained peaty lowlands. Aspen-birch forests dominate the uplands, although small stands of oak savanna and mixed northern forest are also present. Sandstone and basalt terraces are found throughout these well-drained areas; the two rock units are thought to be separated by the Douglas Fault, a geologic structure of statewide significance. More poorly drained low-lying sites, often situated between the rocky terraces, are

Figure 1. Kettle River Natural Area in relation to Minnesota's landscape regions. Adapted from T. Kratz and G.L. Jensen, an ecological geographic division of Minnesota (Unpublished, 1977).

dominated by mixed northern wetland forests, accompanied by large willow and alder thickets and scattered sedge meadows.

The flora and fauna of the tract are typical of woodlands of eastern Minnesota. Species observed on the property includes 3]3 vascular plants, 8 butterflies, 5 amphibians, 82 birds and 18 mammals. Several of these are noteworthy, including the rare plant species Poa paludigena (never before documented from Minnesota), Hydrocotyle americana, and Carex bromoides, rare butterflies Euphydryas phaeton borealis and Pieris napi oleracea, and two rare bird species, the bald eagle (Haliaeetus leucocephalus) and the sandhill crane (Grus canadensis tabida).

HISTORY OF PRESERVATION EFFORT

The Kettle River tract has remained largely undisturbed by human activity because of its rocky and swampy terrain. The property was purchased in the late 1960's by Dr. Ronald M. Christianson, a dentist in the town of Hinckley. Because Dr. Christianson wanted to ensure that the property remain in its natural state he nominated the site for Scientific and Natural Area (SNA) status in January 1974. In June of that same year the Commissioner's Advisory Committee recommended the tract's designation. After the Department of Natural Resources arranged a free lease with Dr. Christianson in 1975, the Kettle River SNA was officially established. Following its designation, Dr. Christianson donated most of the tract's present acreage to the state.

In the same year that the SNA was established, 1975, the Kettle River was incorporated into Minnesota's Wild, Scenic and Recreational Rivers System. As a result, part of the SNA is included within the area designated as a Wild and Scenic River (Fig. 2). The rules that govern the Kettle River SNA, however, are generally more restrictive than those that regulate the Wild and Scenic River.

LAND USE HISTORY

Most of the Kettle River Scientific and Natural Area has remained undisturbed for many years. However, human activities in the past have produced visible changes on the tract. The area's land use history was reconstructed through observations of these changes, interviews with local residents, and investigation of county records.

Of all the human activities on the tract, timber removal has probably had the most noticeable effect. Between 1840 and 1845 the large trees along the Kettle River were logged. Cut with hand saws and skidded to the river with oxen, the logs were floated to the town of Stillwater via the Kettle and St. Croix Rivers. Selective cutting of some 20,000 tons of maple (Acer saccharum) and elm (Ulmus americana) also took place in the winter of 1959. Conducted along the river on the south-western edge of the preserve (Fig. 2), this work was done by the U.S. Forest Service to demonstrate selective thinning. In addition to these large-scale logging operations, some trees have been removed from the property for firewood and fence posts. Fire-wood was removed from the west side of Section 23 from 1910 to 1955. During the Great Depression, most of the large cedar in the area was cut and sold for fence posts. Some of the most obvious visual signs of man's activity in an area are the routes by which he travels. The main thoroughfare near the Kettle River preserve is Minnesota Highway 48, situated along the preserve's south border (Figure 2). Construction records for the road only date back to 1934, when gravel was added to the existing roadbed. In 1940 the road was graded and the road ditch was created. In 1941 the road was graveled again. The

highway was tarred in 1942 and has since been maintained in that condition. The bridge (#5781) that crosses the Kettle River on highway 48 was built in 1971 and repaired 30 years later. A small vehicle access is located next to the river, just off the highway (Figure 2). It serves as a parking area for people using the river. In addition to the highway, a gravel township road abuts the property near its south end (Figure 2). This road connects some farms in the area to highway 48. While no roads presently cross the preserve, traces of old logging roads can be found. One, a winter sled road, entered the property from the gravel road and continued to the river (Figure 2). It was abandoned in 1959 and has since been overgrown with bushes and trees. Another logging road, also overgrown, once cut across the property just south of Nammacher's Lake. In addition, a foot path parallels the river for nearly the entire length of the tract (Figure 2). This path is used as a unting trail in the fall.

Agricultural use of the property and its effects on the land's quality have been very limited. Only one small area in the preserve shows signs of repeated mowing. This field, in the NW1/4 of the NW1/4 of Section 23, was mowed every year from about 1910 to the mid 1940's. The stacked hay was hauled out in the winter. It is also likely that many of the wet meadows on the tract were mowed during the dry years of the 1930's During that period, any area with grasses was usually cut for cattle feed. Lowlands were cut by hand with a scythe, and hay was stacked and left to be hauled out after the ground had frozen.

Like mowing, grazing has played a minor role in the tract's history. The only grazing that has taken place on the property was on the west side of Section 23 (Figure 2). This parcel of land was included in a neighbor's pasture to allow the cattle to drink from the natural springs on the preserve. Broken-down sections of the fence can still be found. Another fence is located along the northern boundary of the tract. The history of this fence is not known.

Two other unrelated events have left marks on the preserve. First, although no one has ever lived on the tract, two small buildings were located between Sections 10 and 15 (Figure 2). Used for overnight camping, the shacks were built by Orville Roberts and his brother when they were boys. The last of the structures was towed off the property in 1936. Second, an overhead electric line runs east-west along the north side of highway 48; its right-of-way crosses the preserve. Installed about 1940, the line carries electricity east from Hinckley to the Minnesota border. During August of 1980, the North Pine Electric Company of Finlayson cleared brush from the right-of-way under the power line using a Caterpillar tractor and brush roller. The company continues to clear brush periodically as needed.

Although the Kettle River Scientific and Natural Area has been used for many recreational activities, these have not left many visible signs on the land. Easy access along the river and the highway has allowed snowmobiling, camping, and hunting on the preserve. Because the property is adjacent to the Sandstone State Game Refuge, white-tail deer hunting has

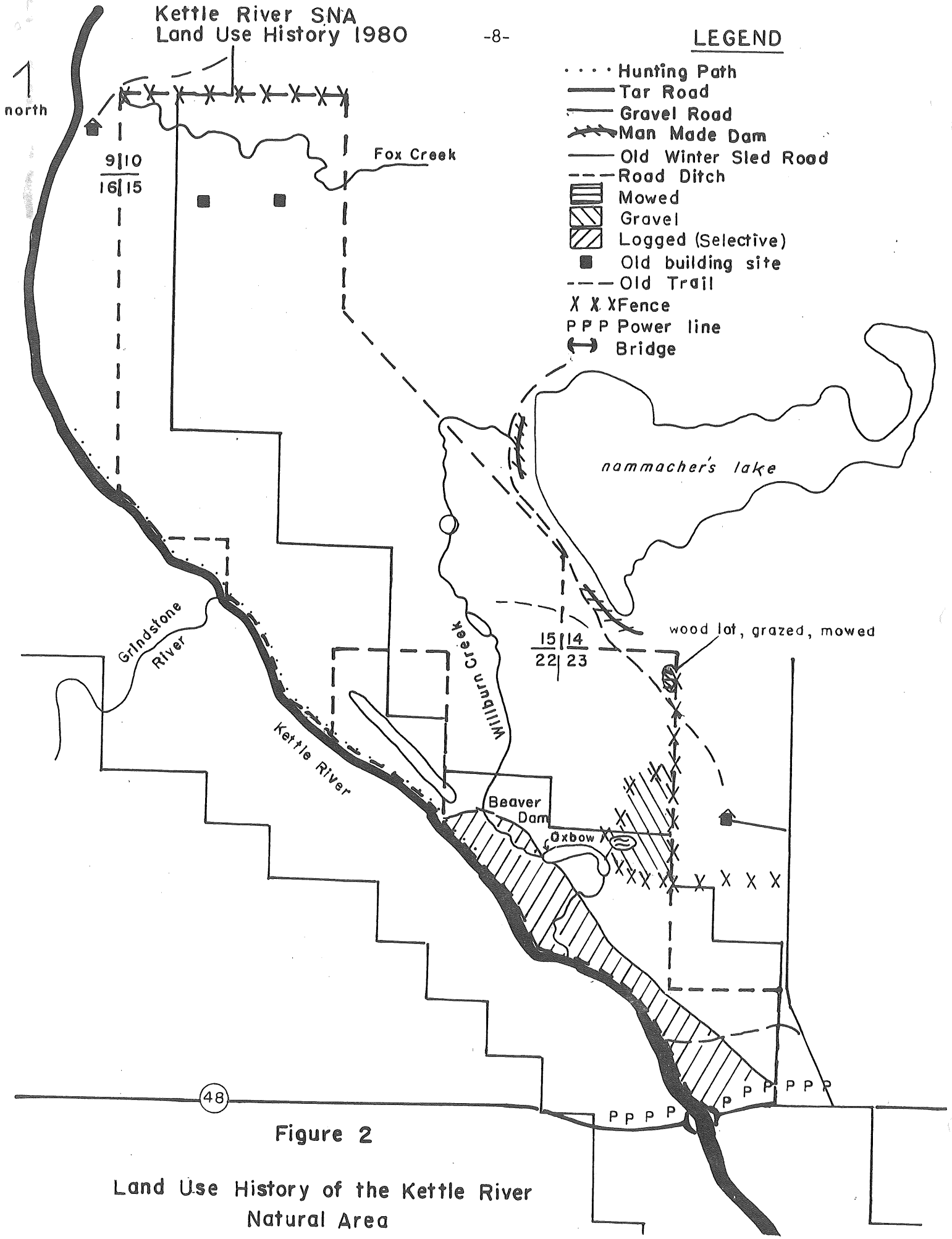


Figure 2

Land Use History of the Kettle River Natural Area

taken place during the bow season, and duck and grouse hunting have also occurred there. In past years the area was used for blueberry picking and possibly maple sugar harvesting.

In conclusion, it is remarkable that so much of the preserve has ramained undisturbed during the 120 years of European settlement. The search for land use history information has revealed that logging, grazing, and road-building have had the most visible impacts on the land. The effects of these and other land uses will be discussed in the remaining pages of this report.

PHYSICAL RESOURCES

OVERVIEW

This report on the physical resources of the study area has been broken down into separate sections on geology, soils, climate and water resources. Geology, generally referring to the study of the earth, forms the first section. It has been further subdivided into two separate parts dealing first with stratigraphy and structural geology, and second with geomorphology. The former discusses the composition and arrangement of the various geologic units underlying the tract, while the latter explains the topographic features of the area. The second major part of the report is devoted to soils. Simply defined, soil is the weathered surface of the earth, and essentially represents a transition from the geological to the biological realms of any area. Climate, the third main subdivision, relates to the long-term atmospheric characteristics of an area: principally temperature, precipitation and evapotranspiration. The final section, on water resources, discusses soil moisture, groundwater and surface water features, as well as seasonal variations in the water budget of the tract. In the discussion of these physical resources, particularly of geology, attention is given to historical as well as to purely descriptive aspects. A historical view not only aids understanding of the area, but also helps to identify unique physical features.

INTRODUCTION

Perhaps the most notable geologic feature on the Kettle River tract is the Douglas Fault, a major structure associated with the Midcontinent Rift System. The exact location of the fault is hidden by overlying glacial materials; nevertheless, the site seems to have the best surficial representation of the Douglas Fault in Minnesota. The northern part of the property is quite rocky, and sandstone outcrops are common due to erosion by glacial meltwaters. The southern portion of the tract is marked by a very steep bluff. The Kettle River has meandered extensively in the lowlands below this bluff, depositing alluvium and forming two narrow lakes.

STRATIGRAPHY AND STRUCTURAL GEOLOGY

Bedrock is found at or near the land surface over much of the lowlands of the Kettle River tract. On the uplands, depth to bedrock may be as great as thirty meters. The outcrops on the property are composed of two distinct rock units, the Chengwatana Volcanic Group and the Hinckley Sandstone. Both formations belong to the Keweenawan Sequence, a set of rock units from Minnesota, Wisconsin, Michigan and Ontario that are between 1400 and 600 million years old (Craddock, 1972b).

The older of the two geologic units is the Chengwatana Volcanic Group, which formed during the widespread extrusion of terrestrial lava flows, between 1.2 and 1.0 billion years ago (Halls, 1978). This volcanic sequence is an enormously thick accumulation of flows, over six kilometers thick in Minnesota (Hall, 1901). The sequence is predominantly basaltic in

composition and contains many individual flow units, which range from less than three to more than 300 meters thick. Outcrops of Chengwatana volcanics are found at two sites on the Kettle River property (Fig. 3): on a rock-cut terrace along Willburn Creek and in scattered outcrops on a steep grassy slope to the southeast. In both locations the rock is highly fractured, obscuring the structural features of the lava flows. The volcanic units strike N. 10°E. and dip 45°E. (Hall, 1901), although their altitude is not easily visible due to the fracturing.

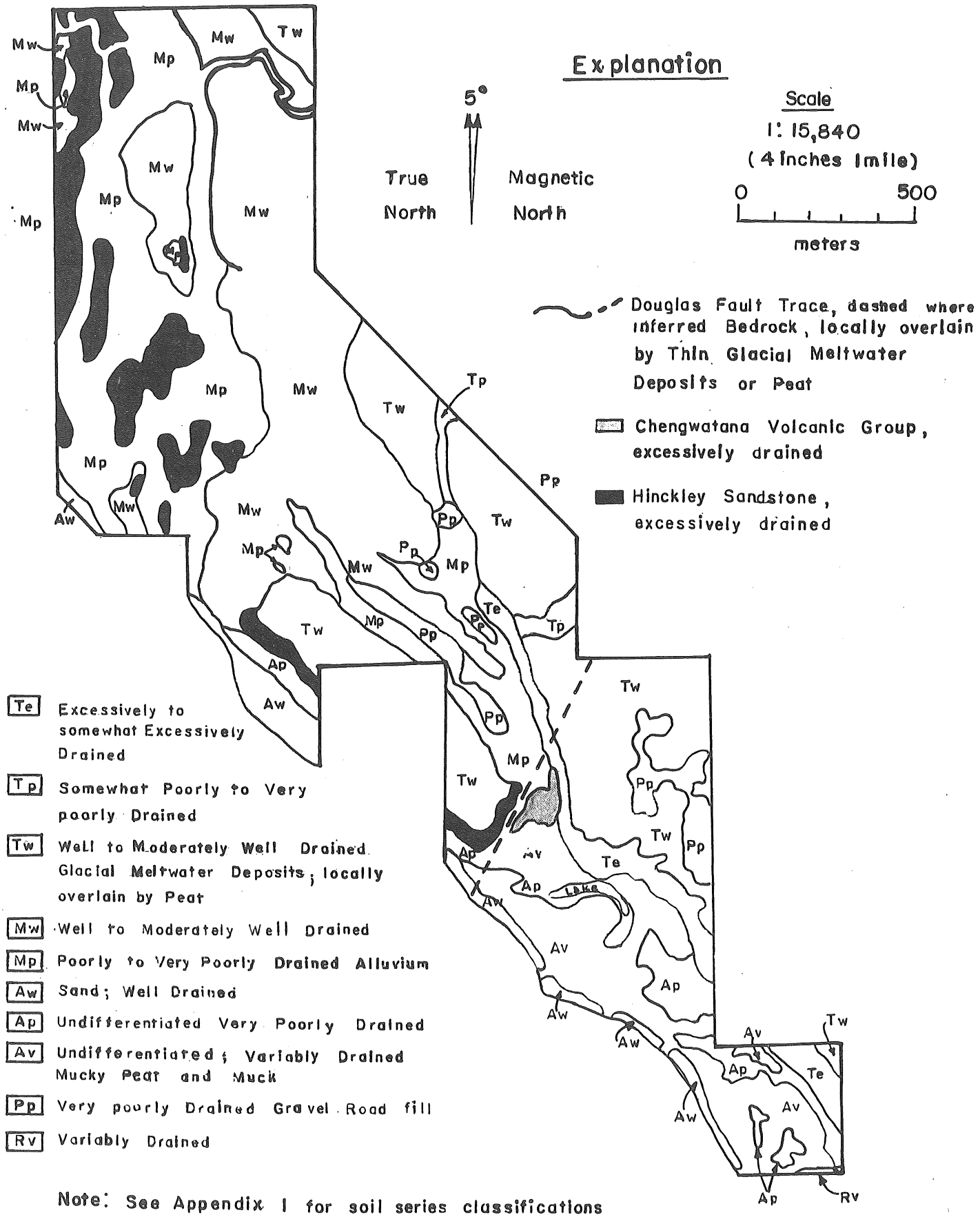
The Hinckley Sandstone, the other bedrock unit found on the tract, was formed in a sedimentary environment after the Keweenawan volcanic eruptions had ceased. It is exposed on rock-cut terraces and small escarpments throughout much of the northern and central parts of the Kettle River site (Fig. 3). These outcrops are medium- to very thick-bedded, and are nearly flat-lying. The sandstone is composed of medium- to coarse-grained quartz with a small percentage of altered feldspar grains. Sorting ranges from poor to moderate. The colors of the Hinckley outcrops vary from pale red to light pinkish or brownish grey (Tryhorn and Ojakangas, 1972).

The Chengwatana Volcanic Group and the Hinckley Sandstone are separated by a small ravine of Willburn Creek in the central part of the Kettle River tract (Fig. 3). The Chengwatana basalt is exposed on the southeastern side of this ravine in a 7.5-meter high ledge and rock-cut terrace. On the opposite side of the ravine, about fifteen meters away, is a ten-meter high ledge exposing Hinckley Sandstone. The sandstone

is fractured, but not as extensively as the basalt. The contact between the two rock units is covered by cobbly glacial meltwater deposits in the ravine.

Aeromagnetic data from the area (Minn. Geological Survey, 1980) show a strong magnetic discontinuity along the ravine and indicate that the Hinckley Sandstone, and the other nonmagnetic Keweenawan sedimentary rocks beneath it, are over two kilometers thick northwest of the ravine (Chandler, 1980). This supports the conclusion by Hall (1901) that a major fault is located along this portion of Willburn Creek. This is the Douglas Fault, a high angle reverse fault that runs from east-central Minnesota into northern Wisconsin. The fault plane is nearly vertical and strikes N. 39^{o}E. along the ravine. Estimates of relative movement on the Douglas Fault are large, ranging from 2.5 to 3.5 kilometers (Craddock, 1972b). This ravine represents "the closest thing to a Douglas Fault exposure in Minnesota" (Morey, 1980). Such a "near-exposure", however, is much less precise than the only known exposures of the fault from Douglas County, Wisconsin.

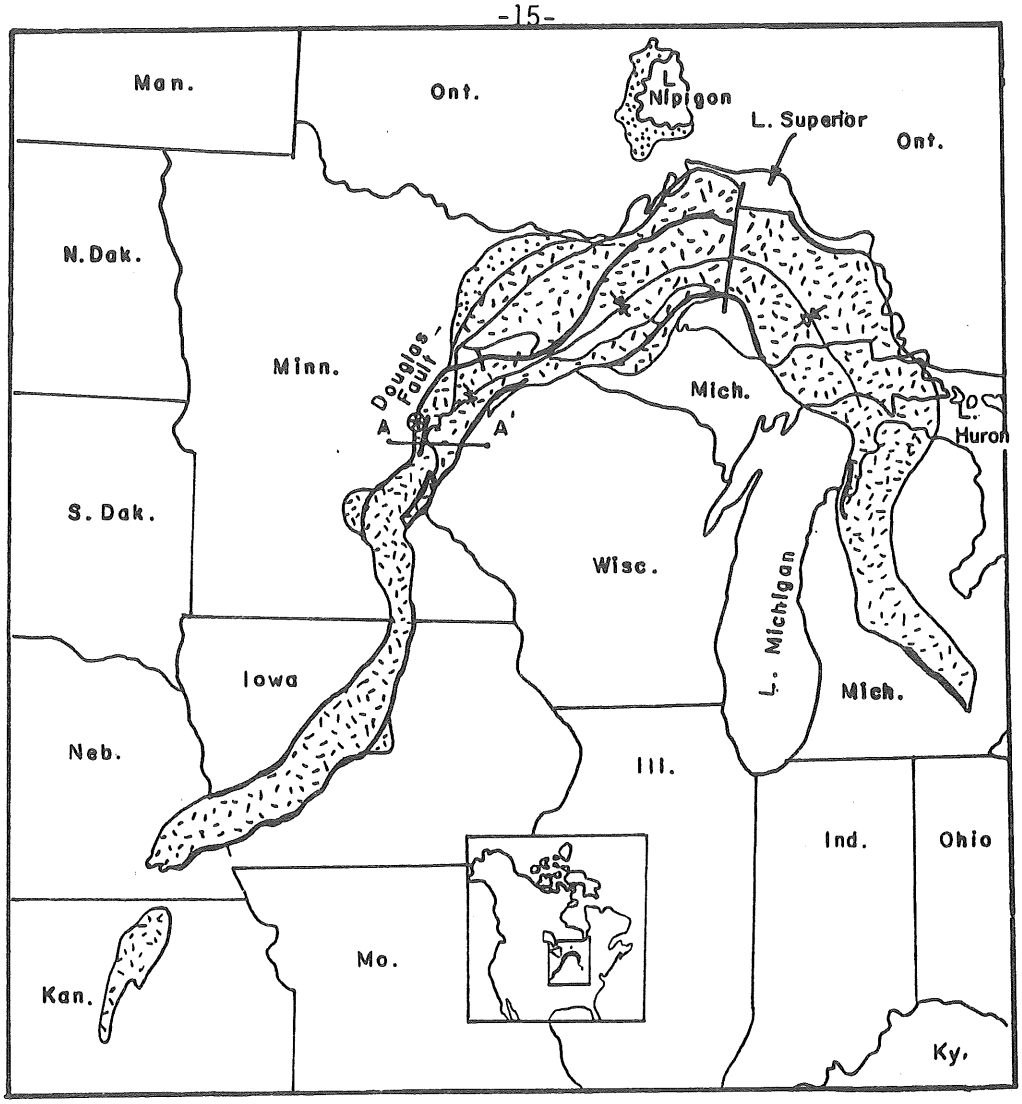
The Douglas Fault is an important structure because of its relationship to the development of the Midcontinent Rift System in Keweenawan time (Ocola and Meyer, 1973). This rift system is thought to have developed from the process of separation of lithospheric plates in the center of the North American continent. The extent of the Midcontinent Rift System is shown in Figure 4. Three lines of rifting, representing a triple junction of continental plates, are suggested: first, the line of separation



Note: See Appendix I for soil series classifications

Figure 3.

Surficial Geology and Soils of the Kettle River Natural Area



Explanation

- Keweenawan Volcanic Rocks
- Intrusive Rocks within the rift Zone
- Approximate Axis of Lake Superior Syncline
- Major Fault
- Kettle River Tract
- A——A' Line of Cross-Section, Figure 4 below

Scale
0 300
kilometers

Figure 4.

Generalized-Geologic Map of the Midcontinent Rift System, with post-Keweenawan deposits removed (modified from Halls, 1978).

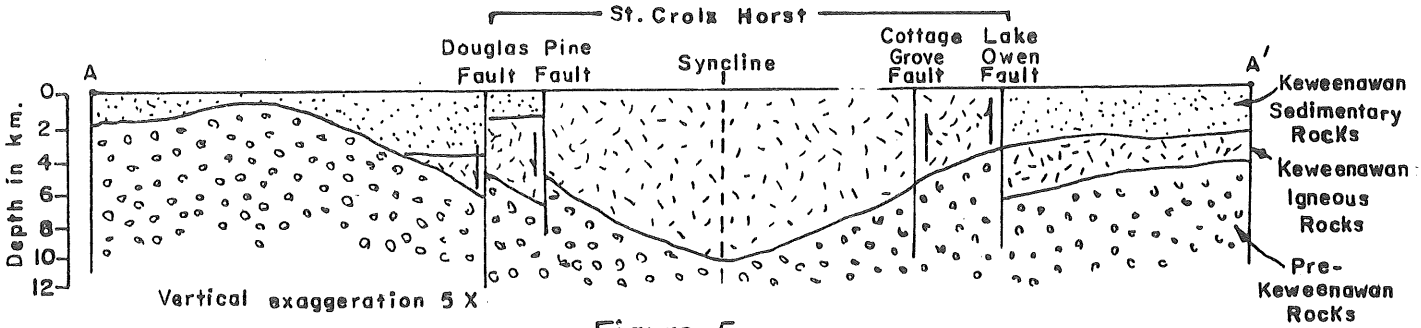


Figure 5.

Inferred Geologic Cross-Section across the St. Croix Horst (modified from Morey and Mudrey, 1972).

zone running from southeastern Michigan to Lake Superior; and finally, the line extending toward Lake Nipigon in Ontario (this last line of separation is more uncertain than the other two) (Franklin et al., 1980).

Halls (1978) states, "The Keweenawan rift may represent a preserved remnant of perhaps the oldest global rift system clearly analogous to those which have formed over the last 200 million years" (p. 122). The continental rifting that is now taking place in the Red Sea is considered to be the best modern example of the Keweenawan rift system. Both of these rift systems are elongate tensional features averaging sixty to seventy kilometers wide, and are characterized by extensive lava flows (Ocola and Meyer, 1973). The total volume of basalt flows associated with the Midcontinent Rift System, including the Chengwatana Volcanic Group, is over 400,000 cubic km. This is one of the earth's largest known such accumulations (Halls, 1978). Following these eruptions, the volcanic basin apparently began to subside and fill with sedimentary deposits such as the Hinckley Sandstone. The sediments seem to have been transported by streams and deposited in a delta-type environemnt under semi-arid conditions (Halls, 1978; Tryhorn and Ojakangas, 1972).

The Douglas Fault was active during this period of sediment accumulation. The fault forms the western boundary of a large uplifted block known as the St. Croix Horst, illustrated in Figure 5 along with several other important faults. Displacement along the fault did not occur within a short span of time; according to Craddock (1972a), "uplift of the horst was slow and incremental, and for millions of years the boundary faults (such

as the Douglas Fault) were the loci of low fault-line scarps" (p.423). Movements along the fault seem to have taken place both before and after the Hinckley desposition. Most of the activity, however, is thought to have occurred before the formation of the sandstone (Craddock, 1972a). This may explain why the Chengwatana rocks, which experienced much more fault activity, are more highly fractured than the Hinckley Sandstone along the Willburn Creek ravine. By 500 million years ago the activity of the Midcontinent Rift System, and more specifically, the Douglas Fault, had subsided. King and Zietz (1971) conclude that this midcontinent rift did not continue to separate and form a new ocean perhaps because "it did not persist long in geologic time, or, more probably, the crust in the area may or may not have been free to move apart except in a very limited way" (p. 2204).

A considerable amount of time passed between the formation of the Keweenawan rocks on the Kettle River tract and the deposition of the glacial materials that overlie them. The numerous glacial advances that have crossed the area during the past 60,000 years left a series of alternating layers of till (materials laid down directly by glacial ice), glacial meltwater deposits and lake sediments. These glacial deposits are up to thirty meters thick above the bedrock of the site. The most recent till deposit in the area came from the St. Croix Phase of the Superior Lobe of the Laurentian Ice Sheet. This lobe of ice advanced over the region from the northeast about 20,000 years ago (Wright, 1972).

Till from the Superior Lobe is found on the surface of the upland, in the eastern part of the tract, as well as on a low terrace near the river (Fig. 3). The till material is dense, hard, firm and brittle; it is predominantly composed of reddish brown sand and silt, and has five to twenty percent coarse fragments by volume (Lewis, 1978).

As the final retreat of the Superior Lobe from Minnesota took place, the Glacial Kettle River was formed and was directed across the Kettle River tract (see Geomorphology Section). The river's glacial meltwaters eroded pebbles, cobbles and boulders from the local sandstone and redeposited them as a thin covering over the bedrock. These glacial meltwater deposits are the uppermost geologic unit over most of the northern part of the property (Fig. 3). The composition of these sediments is silt and sand with a high (sixty to ninety percent) content of coarse sandstone fragments.

Moderately to highly decomposed organic matter has accumulated in shallow depressions on both the till and glacial meltwater deposits. This muck and mucky peat is most evident in a long, narrow lowland depression in the central part of the site, and in irregular depressions on the till upland (Fig. 3). Some unmapped, thin layers of organic matter have accumulated over the sandstone and glacial meltwater deposits on the northern part of the tract. On the sandstone this peat has filled in many of the vertical joints in the bedrock.

The uppermost geologic unit along the Kettle River and in much of the southern lowlands is alluvium left by the river (Fig. 3). Particle size of the alluvial deposits ranges from clay to sand; some levee sediments along the river consist almost totally of sand. Much of the alluvium is dark-colored due to its incorporation of organic particles.

GEOMORPHOLOGY

Total relief on the Kettle River property is greater than thirty meters. The lowest elevations are along the river, and the highest part of the area is on the eastern till uplands (Fig. 6). For its small size, the Kettle River tract is quite varied in its features. The landforms on the site are the result of three major processes: the movement of glacial ice, the action of glacial meltwaters and the action of present-day streams. Glacial ice, in the form of the Superior Ice Lobe, affected primarily the eastern, upland part of the property. Huge volumes of meltwater, carried by the Glacial Kettle River, eroded much of the lowland part of the tract to form several prominent escarpments, as well as erosional terraces. More recently, the actions of the modern Kettle River have affected the site, principally in the southeast. The fluvial processes of two smaller streams, Fox Creek and Willburn Creek, also have had some influence. Both of these creeks have been modified by the construction of beaver dams.

During the St. Croix Glacial Phase, the Superior Ice Lobe crossed the Kettle River tract. Leverett (1932) maps the eastern till upland of the site as part of the Beroun Moraine, a recessional feature of this phase. Yet this upland does not have the characteristic hilly topography of a moraine; instead, it is only gently rolling with irregularly shaped peat bogs (Fig. 3 and 6). The upland appears to be ground moraine, formed under an actively moving ice sheet.

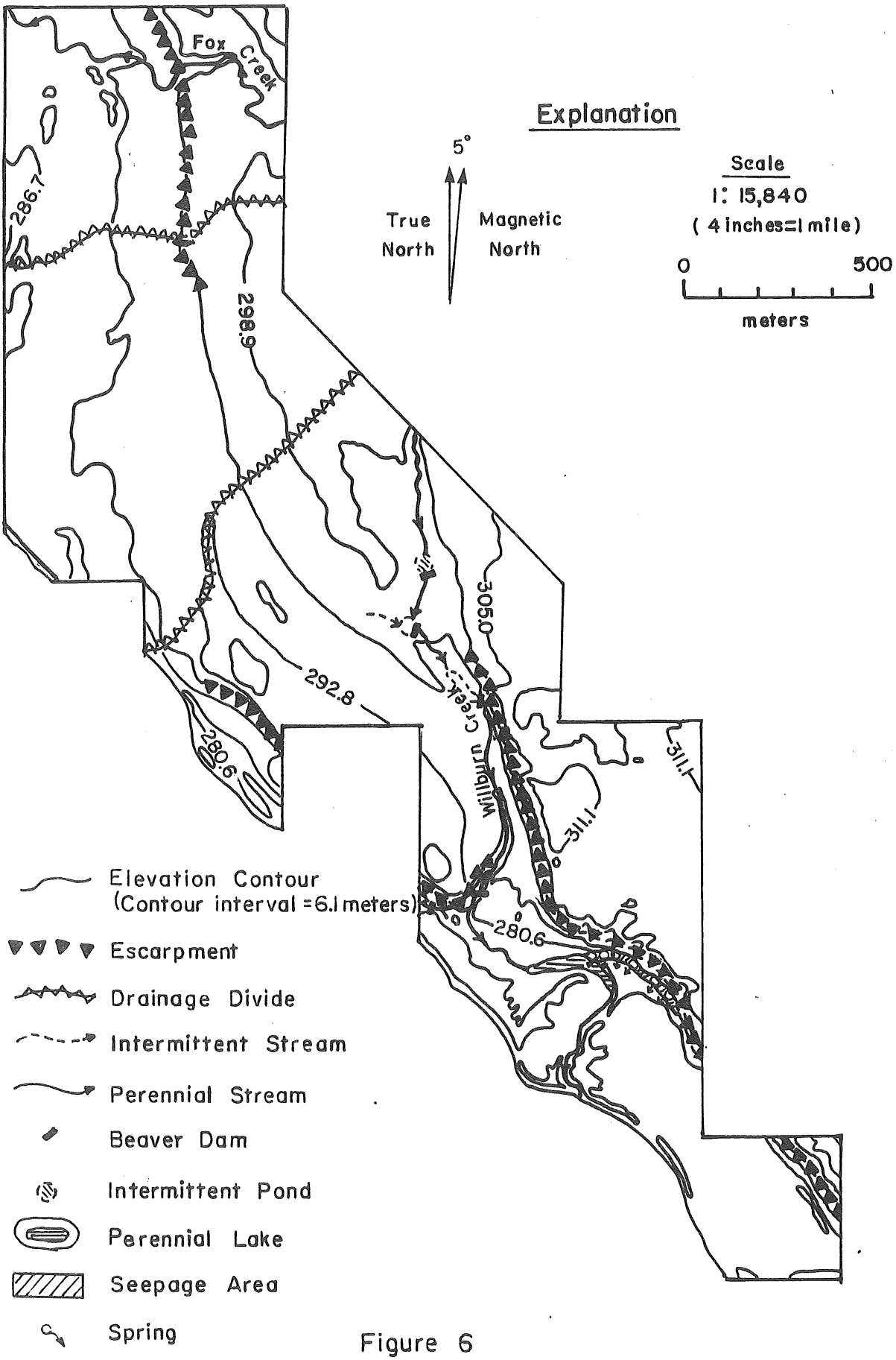


Figure 6

Geomorphology of the Kettle River Natural Area

The Superior Ice Lobe retreated from Minnesota for the last time about 12,000 years ago. As it withdrew to the northeast, into what is now the basin of Lake Superior, a large body of meltwater known as Lake Nemadji formed at its front. Lake Nemadji stood at an elevation of 323 meters and drained into the Moose River, a tributary of the Glacial Kettle River. The large volume of meltwater that drained out of Lake Nemadji and into the Glacial Kettle passed over the Kettle River tract. This tremendous flow of water continued until the formation of a new, lower outlet for the lake. This new outlet was the Brule River, which flowed southward into the Glacial St. Croix River and thus bypassed the former Kettle River drainage (Wright, 1972).

Erosion by the Glacial Kettle River is responsible for several features on the tract including three distinct escarpments. The most obvious feature is the steep (up to thirty meters high) escarpment in the southern half of the tract (Fig. 6). East and northeast of the oxbow lake, several small valleys have been cut into the escarpment. This high bluff gradually fades away to the north. Glacial meltwater tributaries may have entered the Glacial Kettle in this northern area, and thus precluded the formation of a steep escarpment.

A smaller escarpment, probably also formed by the Glacial Kettle River at some stage, is found in the north-central portion of the tract (Fig. 6). This feature is an abrupt three-meter high sandstone scarp. Vertical joints and large fallen sandstone blocks have formed small caves at several points along its length.

The third sandstone escarpment is up to twenty meters high and lies closer to the Kettle River. This bluff is on the western edge of the large isolated terrace in the middle of the property (Fig. 6). South of this terrace, the sandstone scarp curves northeastward, paralleling the ravine that marks the Douglas Fault (see Stratigraphy and Structural Geology Section).

Low north-south trending ridges and terraces occur throughout the northern and central parts of the property (Fig. 6). Most of these represent valley outwash that was produced by the scouring and deposition of the southward flowing glacial river. The outwash terraces are part of the glacial river channel, and were abandoned at a higher level after the discharge of the Glacial Kettle River was reduced. Many of the terraces in the northern part of the site are bedrock surfaces eroded by the Glacial Kettle. The sandstone on these rock-cut terraces often has deep vertical joints. The basalt terrace, located adjacent to the fault, and the low till-covered terrace near the river (Fig. 3), also represent erosional terraces.

The Kettle River is now much reduced in both drainage area and size from the time when it drained Lake Nemadji. Upstream from the Kettle River tract it now drains approximately 2300 square km (Helgeson et al., 1973). Channel width adjacent to the site ranges from thirty to sixty meters. The river does not meander extensively, nor does it follow an entirely straight-line course. However, considerable meandering of the Kettle River has occurred in the recent past over the lowlands in the southern part of the site. Two small lakes in this area occupy

former river channels (Fig. 6). One is an oxbow lake that transmits the flow of Willburn Creek; the other is an elongate lake, located at the foot of the large escarpment in the south-eastern corner of the property. Another fluvial landform is the natural levee that parallels most of the river bank (Fig. 6). The levee is two to three meters high and 25 to 75 meters wide. Such levees form during flood stages of the river. When the water, carrying a high sediment load, moves out onto the floodplain its rate of flow suddenly drops. At lower rates of flow it deposits the heaviest particles, commonly sand. This deposition occurs on the floodplain immediately adjacent to the river channel. The natural levee thus formed along the Kettle is occasionally broken where several drainageways, particularly Willburn Creek, enter the river.

Two creeks cross the Kettle River tract. The more northerly of these is Fox Creek, in drainage basin 35068 (Fig. 6). This stream drains about fifteen square km of forest and farmland to the northeast (Minnesota Department of Natural Resources, Division of Waters, Watershed Mapping Project, 1980). The creek has cut down through the sandstone to form creekside ledges up to ten meters high. Its bed material is largely sand and cobbles derived from the bedrock. The channel is two to three meters wide in a creekplain fifteen to forty meters wide.

Most of the property is within drainage basins 35067 and 35070 of the Kettle River. Basin 35067 encompasses a small section of the northern part of the tract, and has no noticeable stream (Fig. 6). In the central part of the site, a major share of the surface drainage passes through Willburn Creek. This

This stream has a drainage basin of about four square km of predominantly farmland to the east (Minn. Dept. of Nat. Res., Div. of Waters, Watershed Mapping Project, 1980). The water it brings into the property is outflow from Nammacher Lake (see Water Resources Section). In the stretch in which Willburn Creek crosses the glacial deposits, its c haracteristics are much like those of Fox Creek, described above. After passing through the ravine that marks the Douglas Fault, Wilburn Creek enters the alluvial floodplain, where it divides. Part of the remaining creek meanders southeastward to the oxbow lake, and thence into the Kettle River (Fig. 6); the other part flows westward into a lake that is outside of the study area. That portion of the property that is southeast of the oxbow lake contains no outstanding drainageways.

Beaver dams have modified both Fox Creek and Willburn Creek. Five old dams are shown along the latter stream in Figure 6. It is uncertain exactly when any of these dams were constructed, although they surely did not originate prior to the 1920's. All five have created small impoundments that still contain intermittent ponds. On Fox Creek, near the point where it enters the property, a beaver dam was built about 1970.

SOILS

The soils of the Kettle River tract are not highly developed. Due to the cold climate and the tundra environment near the glaciers, soil development was very slow until the final retreat of the ice from Minnesota about 11,500 yeats ago. The

tundra was followed by spruce forest, and more recently by pines and northern hardwoods (Wright, 1972). In this relatively warm environment, soil development has accelerated; nevertheless, the role of parent material in determining soil type is still predominant. The soils of the site are best described in terms of bedrock-, till-, meltwater sediment-, alluvium-, and peat-derived soils, which correspond to the surficial geology (Fig. 3).

Soils have developed very slowly on the bedrock outcrops. Weathering has been more intensive on the basalt exposures than on the sandstone exposures. This can be attributed to the greater age, more extensive fracturing, and less resistant minerals of the volcanic rock.

The soils derived from till and glacial meltwater deposits (Fig. 3) are strongly acidic in their upper horizon and become neutral at depth. The decrease in acidity with depth indicates the downward movement of carbonates in the soil. Other soluble ions, such as calcium, magnesium, sodium, potassium, sulfate and chloride, are also extensively leached.

The solum, or principal zone of active soil-forming processes, is up to one meter deep in the soils developed from glacial deposits. The solum is divided into an upper horizon that has been leached and a lower horizon where some of the leached materials have been redeposited. Organic matter, clay and some iron, in addition to soluble salts, are among those materials leached from the upper horizon. Much of the leached clay, in particular, has been redeposited in the lower part of the solum. Below the solum the weathering processes have been largely non-biological. The lower horizons of the more poorly

drained soils usually have mottling, an indication of intermittent waterlogging and poor aeration.

In the till-derived soils (Fig. 3), the texture is that of a fine sandy loam, with a low to moderate content of coarse fragments. The upper solum is dark brown and grey due to the incorporation of organic matter. Colors become more reddish brown in the lower soil horizons.

The soils derived from glacial meltwater deposits (Fig. 3) have a coarse sand to fine sandy loam texture, with a high content of coarse fragments. Like the till-derived soils, their colors shift from dark brown and grey in upper horizons to reddish brown at depth.

Most of the alluvium on the Kettle River tract (Fig. 3) was deposited so recently that distinct soil horizons have not yet developed. In some places, a thin surface layer of muck or mucky peat can be found. Incipient mottling also can be observed in the poorly drained and older alluvial soils.

In addition to the alluvium floodplain, the escarpments on the tract (Fig. 6) have poorly developed soils. Soils on such steep slopes have high surface runoff and therefore less water available to infiltrate the subsurface. In addition, the soils on the escarpments are continually subject to downslope creeping and sliding.

The peat-derived soils on the property (Fig. 3) consist of shallow (.75-meters deep) layers of organic matter over loamy sand. The organic material in such peat varies from moderately to highly decomposed. Most of the peat is slightly acidic, and gradually becomes neutral at increasing depth (Lewis, 1978).

Ash from forest fires is found in many of the soils on the tract, especially in the north. The Great Hinckley Fire swept the site in 1894, and more recent fires have occurred in the north during the 1940's and again about 1960 (see Land Use History Section). The soils of the Kettle River property have been practically undisturbed by human activity. A small exception is those soils disturbed by powerline and road construction activities along Highway #48 (see Land Use History).

CLIMATE

The Kettle River site has a typical moist continental climate with wide seasonal temperature extremes. Average daily maximum and minimum temperatures in January are -7°C. and -19°C., respectively; in July they are 28°C. and 13°C. The average date of the last spring frost is 18 May, and the average earliest fall frost is 21 September (University of Minnesota, Agricultural Experiment Station, 1980).

The average annual precipitation on the area is 739 mm. About fifteen to twenty percent of this amount comes as snowfall from November through March. Precipitation, in the form of rainfall, usually increases in the spring and peaks in June, July or August. Much of the summer rainfall results from heavy thunderstorms. Precipitation commonly decreases in the fall (Helgeson et al., 1973).

The average annual evapotranspiration in the area is estimated at 488 mm. The evapotranspiration rate increases rapidly in the spring from a winter level near zero, and normally peaks in July. Like precipitation, evapotranspiration diminishes in the fall (Helgeson et al., 1973).

WATER RESOURCES

Soil permeability on the Kettle River property is moderately slow to moderately rapid. The bedrock terraces are rather permeable due to the presence of fractures. Despite the ability of water to infiltrate at a moderate rate, much of it remains near the land surface. The drainage of the site ranges from excessive to very poor (Fig. 7). The excessively drained areas include the escarpments and the rock-cut terraces.

Even on the sandstone terraces, however, very poorly drained seasonal ponds and shallow peat can be found in some of the rock fractures. The upland ground moraine, with the exception of the peat bogs, is basically well drained. The low topography of the remainder of the site is the main factor responsible for its poor drainage. The valley outwash varies from well to poorly drained, while the alluvial lowlands are mostly very poorly drained (Fig. 7). The seasonal high water table in these lowlands and in the bogs is at or near the land surface. On the till upland, however, the seasonal high water table is 1.5 meters below the surface. The direction of groundwater flow is to the west, toward the Kettle River (Helgeson et al., 1973). Some groundwater travels through subsurface layers of permeable glacial deposits on the upland. At various points along the base of the high southeastern bluff this groundwater flows out in seepage areas. The most noticeable seepage, which includes several small springs, occurs near the oxbow lake (Fig. 6).

The Kettle River adjacent to the site is estimated to have an average discharge of about seventeen cubic meters per second. The maximum discharge has been over 300 cubic meters per second and the minimum discharge less than three cubic meters per second (U.S. Dept. of the Interior, U.S. Geological Survey, 1978). The river and its two tributary creeks flood occasionally. Flooding in both April 1965 and July 1972 raised Fox Creek about two meters above its baseflow level.

Nammacher Lake, a reservoir on Willburn Creek just east of the tract, moderates the flow in that stream. A six-meter high filled embankment was constructed in 1972. The impoundment

covers thirty to forty hectares, and averages five meters deep with a maximum depth of fifteen meters. The level crest of the reservoir is at 307.75 meters elevation. The spillway passes to Willburn Creek via a .5-meter diameter metal pipe (Minnesota Department of Natural Resources, Division of Waters, Dam Safety Section, 1971).

The annual water budget shows a period of moisture accumulation from October to April. Most of this water is stored above ground as snow and ice; an average of 81 days annually have more than .15 meters of snow cover. From late November until mid-April the soil is typically frozen, preventing groundwater recharge and leading to a slight decline in the water table during late winter. Stream flow in winter is sustained at reduced levels by seep and spring discharge as well as by lake and bog storage. The normal yearly low flows of the Kettle River, Fox Creek and Willburn Creek occur in February or March. Snowmelt, thawing and substantial rainfall in April and May recharge soil moisture and groundwater, and increase surface runoff. During this period flooding is most likely to take place. In the spring, water usually accumulates in the very poorly drained areas (Fig. 7). Except when rainfalls are excessive, both water levels and streamflow gradually recede through the summer. As during the winter, stream discharge is sustained by groundwater discharge. Reduced evapotranspiration rates in the fall eliminate the moisture deficit of late summer. Water levels and streamflow increase at this time, but not to the extent observed in the spring (Helgeson et al., 1973).

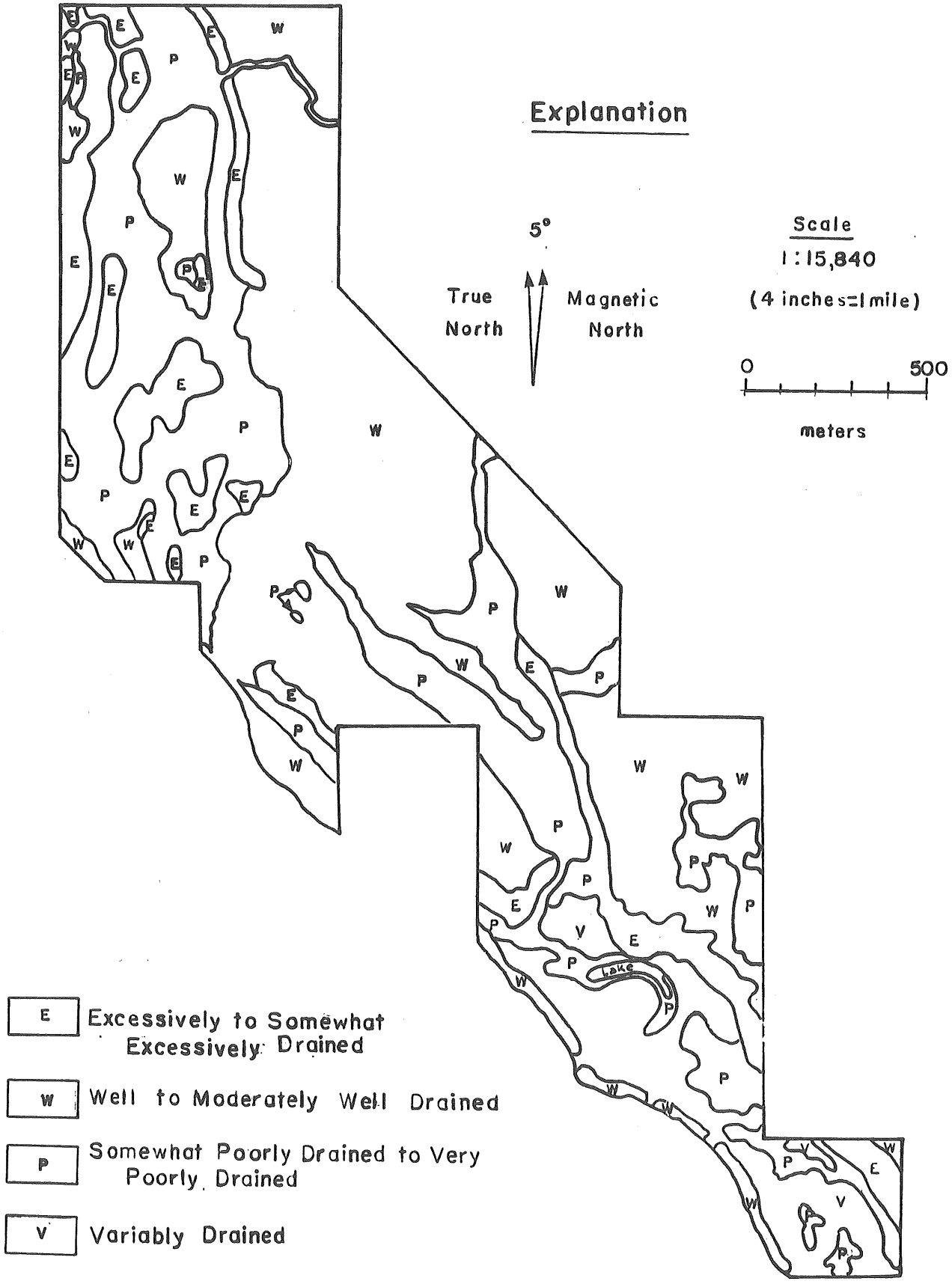


Figure 7

Soil Drainage of the Kettle River Natural Area

BIOLOGICAL RESOURCES

OVERVIEW

The description of the biological resources of the Kettle River natural area has been broken into two separate sections. The first section is devoted to vegetation. Reflecting the combined influences of all the physical factors discussed earlier, the vegetation of the Kettle River tract provides the primary energy source for all living organisms. The primary purpose of this portion of the report is to delineate and describe all the plant communities on the natural area as well as to identify and describe any rare or sensitive plant species. The section begins with a brief overview of the present vegetation, followed by a short discussion of the presettlement vegetation. Next, the vegetative and physical characteristics are thoroughly described for each cover type, including those areas that have been disturbed. Finally, special attention is given to the status of rare plant species found on the tract. A note is also made of other rare species that may occur on the natural area and which should be searched for during future field work.

The second section of the biological resources report describes many of the zoological components of the tract. Five groups of animals -- butterflies, amphibians, reptiles, birds, and mammals -- were surveyed during the 1980 inventory. Clearly, such a survey does not represent a complete inventory of all the animal species on the site. Several factors were responsible for the selectivity of the zoological studies. First, restraints of time, manpower, and equipment simply precluded a study of all

the animals present on the tract. Second, those animals chosen for study are those for which the most information regarding biology and distribution is available. Finally, the animals chosen include most of the more visible species. As such, these species are more easily inventoried and can serve as valuable indicator species for those organisms not studied. Following a brief introduction, the animals that were surveyed are discussed in four sections (butterflies, reptiles and amphibians, birds and mammals). Each section describes the inventory methodology and then presents the survey results. Special attention is given to any rare or unusual species occurring on the tract.

VEGETATION

INTRODUCTION

The vegetation of the Kettle River natural area is largely defined by the tract's physical characteristics such as soil drainage, soil composition, slope and susceptibility to river flooding. These combined physical factors, along with the recent effects of human and natural disturbances, are responsible for the rather distinct cover types on the tract. For example, along the well-drained escarpment in the southern half of the area, aspen-birch communities predominate. In contrast, the poorly-drained central and northern lowlands support a variety of wetland communities including sedge meadows, cattail marshes, shrub thickets and mixed coniferous-deciduous wetlands. The well-drained terraces that interrupt these wet lowlands support stands dominated by varying combinations of aspen, paper birch and red pine. Finally, the alluvial soils of the Kettle River floodplain are covered by a variety of lowland hardwoods, including basswood, green ash, black ash, American elm and silver maple. Before describing these communities in detail, the area's original presettlement vegetation will be discussed briefly, followed by a short description of the field methods used during the 1980 inventory.

ORIGINAL VEGETATION

The present vegetation of the Kettle River natural area is, in part, a reflection of the human and natural modifications that have taken place since the area was originally settled. In an attempt to understand what the magnitude of these modifications may have been, it is important to know how the vegetation appeared prior to settlement. Tools for reconstructing the past vegetation are available in the records of the General Land Survey office. These records, which constitute the field notes of the men who originally surveyed Minnesota during the late 1800's, provide detailed information regarding the presettlement vegetation of the Kettle River area.

As the men surveyed each township, they walked along the section lines, marking the mile and half-mile intervals by recording tree species, diameter at breast height (dbh), and distance from the survey corner to the nearest tree (the "bearing tree"). Theoretically, the only criteria for selecting bearing trees was that each had to have a minimum dbh of five inches (Fedkenheurer, 1975). As the surveyors travelled through the townships, they also recorded the locations of uplands, swamps, streams, roads and lakes. Although there are several problems in the use of survey notes for determining past vegetation, including fraud, bias, and species name duplication, the records remain a valuable source of information regarding the nature of the vegetation prior to settlement by Europeans (Fedkenheurer, 1975). The original survey notes for the general vicinity of the Kettle River tract have therefore been transcribed and plotted in Figure 8.

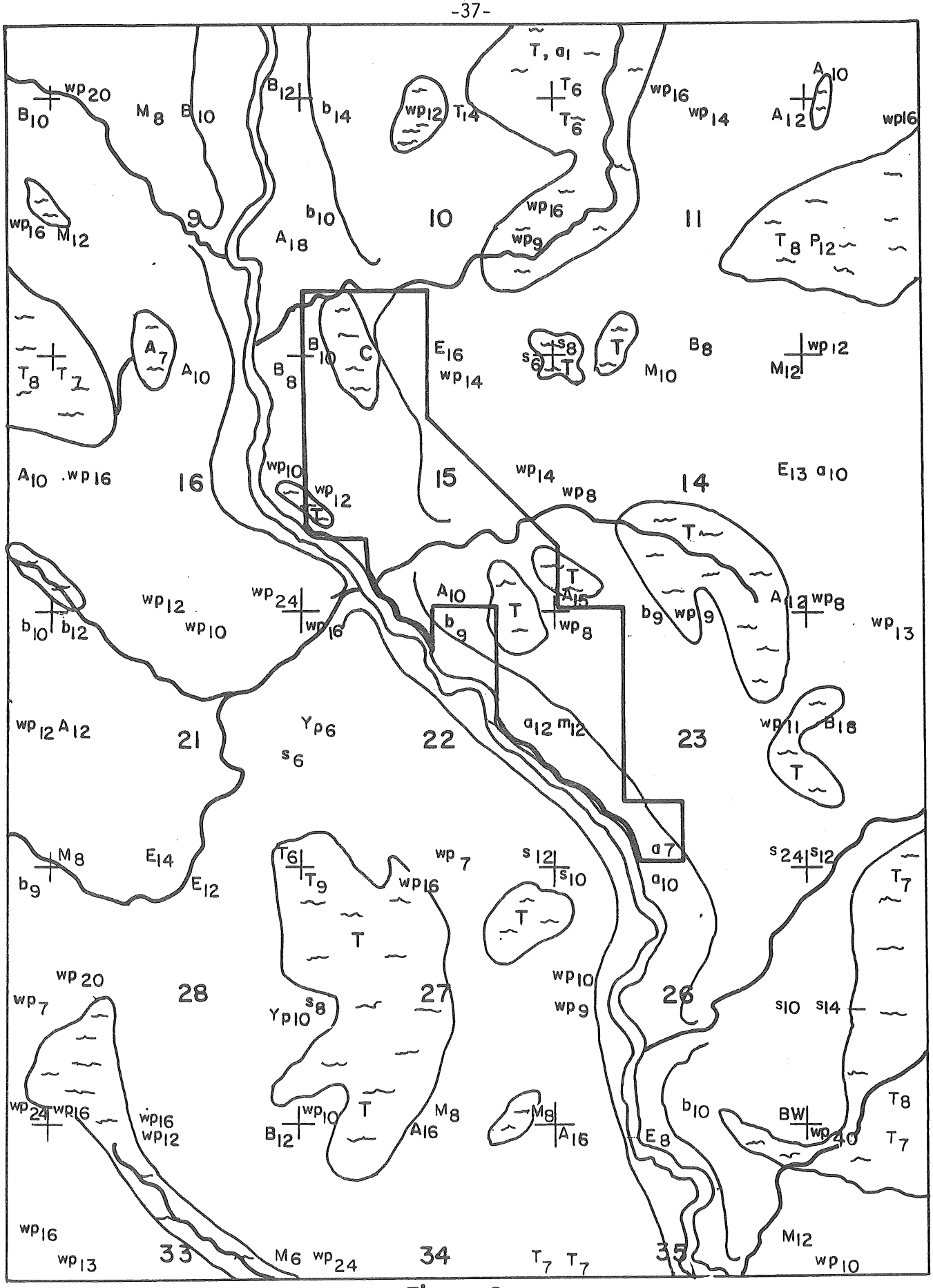


Figure 8

The Original Vegetation of Kettle River SNA area. Adapted from the U.S. General Land Office Survey Notes, 1851.

Explanation

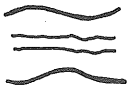

River

Creek

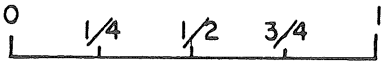
SNA Boundary


Swamp

Tamarack Swamp


River bottom

Scale
1: 31680
2 inches = 1 mile



23 Section Numbers

wp_{14} White Pine 14" diameter breast height

A Aspen

a Ash

al Alder

B Birch

b Balsam Fir

c Cedar

E Elm

M Maple

T Tamarack

S Spruce

wp White Pine (Pinus strobus)

yp Yellow Pine (Pinus resinosa)

The transcription of the survey notes has been carried one step further by Francis J. Marschner (1930) and James Trygg (1967). Both men have used the records to develop comprehensive maps of the state's original vegetation. By examining Figure 8, as well as the maps prepared by Marschner and Trygg, a general description of the original vegetation of the area can be prepared.

According to the land surveyor's notes from 1851, the Kettle River area had soils that were "unfit for cultivation". The soils were evaluated as poor on both well drained and poorly drained sites. The well-drained terraces and areas east of the escarpment had mixed northern forests. Hardwood species in these forests included aspen, birch (Betula papyrifera?), maple (Acer rubrum?), and sometimes ash (Franxinus pennsylvanica?). Pines included are red pine, (Pinus resinosa), white pine (Pinus strobus), and probably jack pine (Pinus banksiana). Balsam fir (Abies balsamea) and spruce (Picea sp.) were sometimes associated with the above species. Hazelnut (Corylus sp.) was a common shrub.

Many of the poorly-drained areas supported tamarack (Larix lariciana) and cedar swamps (Thuja occidentalis). Spruce (Picea mariana?), black ash (Fraxinus nigra), balsam, and alder were also common in these areas, especially in the central and northwestern areas of the tract.

There is less information about the riverbottom vegetation of the southern area of the tract. Elm (Ulmus americana), ash (Fraxinus nigra?), and basswood (Tilia americana) grew in the vicinity, and probably also grew in these wetlands. The maple recorded in this area may have been silver maple (Acer saccharinum).

The original vegetation of the Kettle River tract has been described by Trygg as "Original Pine Lands". This is a very general description, yet acceptable based on the surveyor's notes because 36% of the bearing trees (Figure 8) are white pine. Of the twelve species used as markers, white pine clearly dominates. However, it is difficult to determine if white pine was actually more dominant in the plant communities than other species. Surveyors also often evaluated local timber value, perhaps leading to the notation of pine more frequently than other equally prevalent tree species.

Marschner, on the other hand, designated two cover types for the natural area. The west half of the tract is located in the "River-Bottom Forest" cover type, characterized by the species birch, aspen, balsam fir, alder, and maple, with a few scattered pines. The remaining portion of the tract lies in what Marschner describes as a nearly pure stand of white pine.

Since the first surveyors recorded their observations, the original vegetation of the Kettle River area has been altered by several human and natural disturbances. Such disturbances have included logging, grazing, mowing, recreational activities, fire, flooding and storms. Tree stumps in the riverbank floodplain, for example, indicate that the area was logged in the past. Most of the larger trees that were located near the river were probably logged at one time. Logging probably also occurred in the coniferous forests which once covered the northern half of the tract. Large stands of the dense alder growth in this area may delineate areas that formerly supported tamarack and cedar stands. Aspen and red pine may also dominate burned or logged areas. Alder thickets, young red pine and aspen are now common at Kettle River, suggesting that much of the tract has been disturbed.

Charred stumps and pieces of wood are further evidence of disturbance. Although the northwest portion shows the most recent signs of fire, the entire area was burned by the Hinkley fire of 1894 (see Land Use History Section).

Besides fire, natural disturbances affecting the tract have included flooding and wind damage. The southern part of the tract is frequently flooded in the spring and early summer. Heavy rains at other times may cause rather sudden flooding in the lowlands. Extensive wind damage was not noticeable in the summer of 1980, although there were reports of a recent large red pine windfall.

Due to the soil's poor suitability for cropland, agricultural use has been limited to grazing and mowing. These activities have largely been confined to the site's eastern upland. Marsh hay may have been periodically harvested from sedge meadows. Introduced or "weedy" species are present in small numbers in these areas, as well as along riverbanks and trails on the tract.

Together, these human and natural disturbances have modified the original or presettlement vegetation of the Kettle River natural area. Perhaps the most significant change over the past 120 years has been the virtual elimination of white pine in the uplands and tamarack and cedar in the lowlands.

METHODS

An intensive effort to describe the present vegetation of the Kettle River natural area was undertaken during the course of the 1980 inventory. The work proceeded in two directions. The first was an attempt to document the variety of vascular plants growing within the natural area. Work began in June and proceeded through early September. Throughout this period the tract was

visited at regular intervals. During each visit, portions of the tract were searched systematically so that each cover type in the area was adequately covered. Flowering and fruiting plants were collected and pressed. Pertinent data regarding the habitat, location, associated species and relative abundance for each specimen were recorded. The vascular plants collected during the field survey are presented in Appendix II. Voucher specimens have been deposited at the University of Minnesota herbarium, st. Paul campus. A detailed account of the rare species identified on the tract will be presented below, following the discussion of the Kettle River plant communities.

The second direction in which the vegetation field work proceeded during the inventory was to collect data that would enable the researchers to identify and describe the plant communities of the natural area. Communities were initially identified by preparing a cover type map with the use of aerial photos, color-infrared photos and soil maps. The map was then ground-truthed in order to accurately refine and revise the mapping units. Within each major community, a permanent 20 x 20 meter study area, or releve plot, was established. Species composition and homogeneity, along with soil type and topography, were the major criteria for selecting each plot.

After the plot was chosen, the releve method of vegetation analysis (Heitlinger, 1979) was used to gather supporting data for describing major community groups. Supporting data included sociability, cover abundance, and height classifications for each species identified. DBH (diameter at breast height) measurements for all trees within the plot were recorded as well as the total number of saplings. These field measurements were used to calculate

the relative density and relative basal area for each tree species. These, in turn, were combined to obtain an Importance Value (i.v.) to be weighted against a maximum value of 200 (Curtis, 1959) (Table 1). Physical features of the releve site, such as soil characteristics, site moisture, topographic position, and evidence of disturbance, were also recorded in order to give a complete description of each community. From these releve data, community descriptions were prepared; they are found in this report. However, the original releve data are on file at the SNA office for further reference. The information derived from releve data was used to classify the different vegetation types on the Kettle River tract. A classification scheme developed by the Minnesota Natural Heritage Program (1980a) provided guidelines for designating communities and the different cover types within the communities. In the body of this report (and in the legend for Figure 9), the communities have been grouped under general headings (e.g. Aspen-Birch group) where they occupy similar sites or share dominant species.

The result of the field methods outlined above was the preparation of a vegetation cover type map for the natural area (Figure 9). Each of the communities delineated on the map will be described in detail in the following pages.

TABLE I

MAJOR TREE SPECIES, KETTLE RIVER 1980

Importance Value = I.V./dbh (cm)
(By Map Code - see Figure 9)

Tree Species	BB	LS1	AB1	BO	LF4	LF3	AB2	RP	LF1
Abies balsamea					11/19.1				
Acer negundo									7/12.7
Acer rubrum	16/12.7		19/16.5				9/7.6		
Acer saccharinum						190/27.9			
Betula lutea					20/17.8				
Betula papyrifera	10/10.2	22/17.8	43/12.7		10/17.8		149/7.6	58/10.2	
Fraxinus nigra	15/12.7	26/10.2			98/12.7				17/15.2
Fraxinus pennsylvanica			5/10.2						32/20.3
Juglans cinerea	73/15.2								
Larix laricina		66/24.1			46/25.4				
Picea mariana		15/12.7							
Pinus resinosa							17/14.0	100/12.7	
Populus grandidentata							9/12.7	42/17.8	
Populus tremuloides	4/12.7	13/10.2	106/15.2				16/10.2		
Quercus macrocarpa				200/10.2					43/20.3
Tilia americana	63/12.7		5/10.2		15/25.4				101/22.9
Ulmnus Americana	17/12.7		19/10.2			10/8.9			

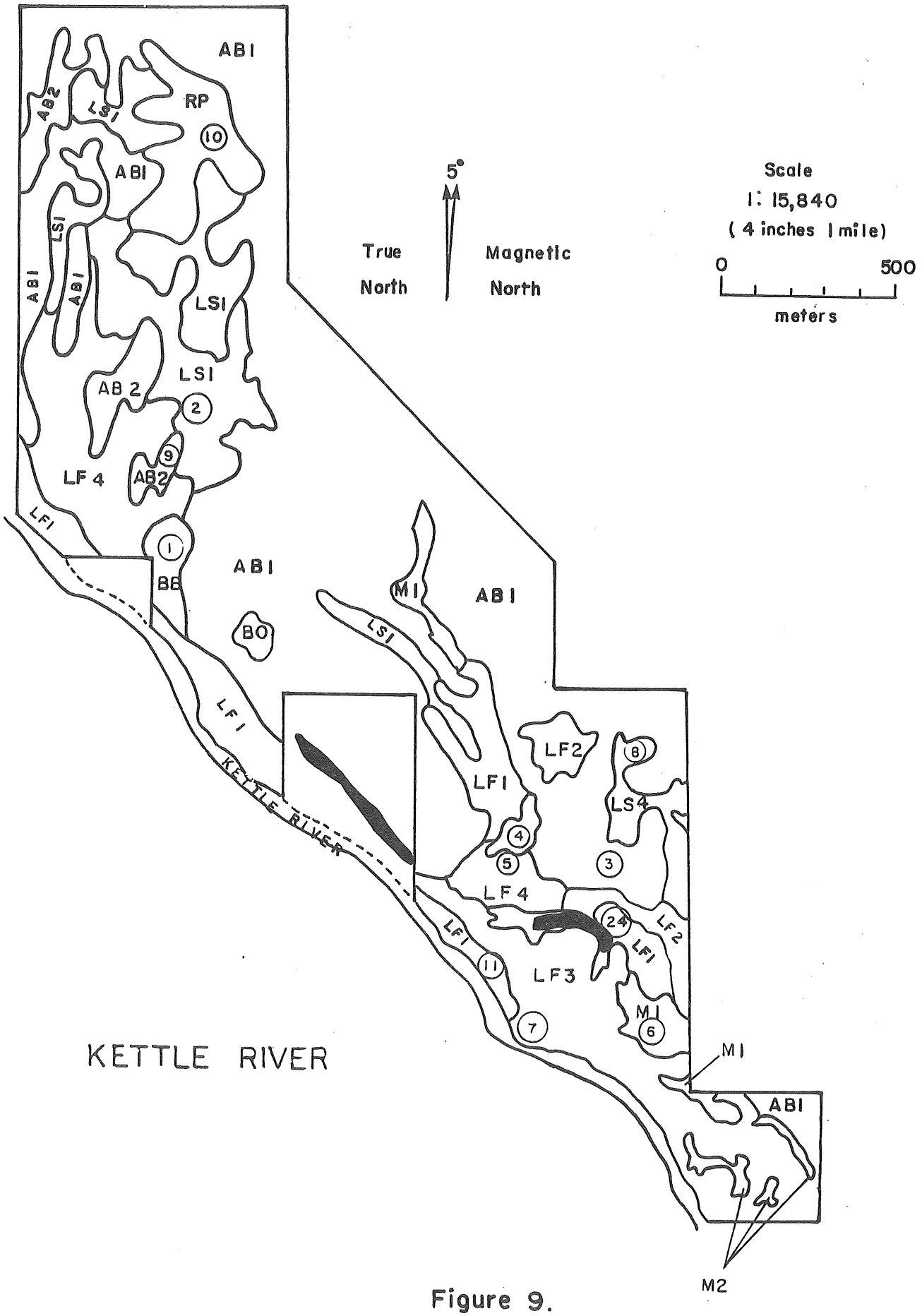


Figure 9.

Plant Communities of the Kettle River Natural Area

LEGEND FOR FIGURE 9

Aspen-Birch Group

- ABI Trembling Aspen
- AB2 Paper Birch

Lowland Forest Group

- LF1 Basswood-Green Ash-Bur Oak
- LF2 Black Ash-Basswood-American Elm
- LF3 Silver Maple Floodplain
- LF4 Black Ash-Tamarack

Lowland Shrub Group

- LS1 Alder
- LS2 Willow

Sedge Meadows and Marshes

- M1 Sedge Meadow
- M2 Bulrush-Cattail Marsh

Other Communities

- BB Basswood-Butternut
- BO Bur Oak Savannah
- RP Red Pine-Paper Birch-Largetoothed Aspen

ASPEN - BIRCH GROUP: 155.2 Hectares, 50.7% of Study Area

The Aspen-Birch group is very extensive on the natural area: collectively, its two communities cover over half of the tract. The group consists of two communities, Paper Birch and Trembling Aspen. The latter is a very heterogeneous community consisting of four different cover types: Trembling Aspen-Paper Birch, Trembling Aspen-Paper Birch-Hazel, Trembling Aspen-Hazel, and Trembling Aspen-Juneberry. Releve data, which provide detailed information on community composition, were taken for the Paper Birch Community (Releve 9) and for the Trembling Aspen-Paper Birch-Hazel cover type of the Trembling Aspen community (Releve 3). The major points of the releve data are described below, along with general descriptions of the other cover types.

The Aspen-Birch communities occur most often along and to the east of the site's escarpment, which is very steep in the south, fades in the center of the tract, and again becomes very prominent in the north. The rather large terrace in the west-central part of the tract, as well as the drier portions of the rock outcrops in the northwest, are also dominated by Aspen-Birch woods.

In addition to the Paper Birch and Trembling Aspen communities, the Kettle River tract supports some pure stands of either large-toothed or trembling aspen. These stands are often found as small pockets in the Trembling Aspen Community or in the Red Pine-Largetoothed Aspen-Paper Birch Community. Because they are very small and blend into the surrounding communities, these pockets are not described below as separate communities.

Trembling Aspen (ABl): 145.4 Hectares, 47.5% of Study Area

Cover Types: Trembling Aspen - Paper Birch
Trembling Aspen - Paper Birch - Hazel
Trembling Aspen - Hazel
Trembling Aspen - Juneberry

The four cover types within the widespread Trembling Aspen Community differ mainly in the density and composition of the shrub layer and in the relative dominance of paper birch. Releve data were taken only for the Trembling Aspen-Paper Birch-Hazel cover type (see below). Although the cover types are not delineated in Figure 9, their locations are documented in SNA files. In all four cover types, trembling aspen is the dominant tree; paper birch is codominant in the Trembling Aspen-Paper Birch and Trembling Aspen-Paper Birch-Hazel cover types. In contrast, paper birch is found only as an incidental or associated species in the Trembling Aspen-Hazel and Trembling Aspen-Juneberry cover types. The shrub layer is least dense in the Trembling Aspen-Paper Birch cover type; shrub layer density is greater (although usually not over 50% cover) in the other three cover types. Dominant shrub species are indicated by the cover type names: Trembling Aspen-Paper Birch-Hazel and Trembling Aspen-Hazel are characterized by a shrub layer consisting largely of beaked hazel (Corylus cornuta), while the juneberry (Amelanchier sp.) dominates this layer in the Trembling Aspen-Juneberry type.

The Trembling Aspen-Paper Birch-Hazel stand described by Releve 3 in the southwestern part of the tract occurs on a more moist and fertile soil than that found in similar woods in other parts of the tract. The site is located east of the escarpment.

Trembling aspen (importance value = i.v.=106) dominates the stand, and paper birch (i.v.=43) is an associate at the 10 to 20 meter height class. There are several standing-dead paper birch and aspens of varying sizes in the stand. Red maple, green ash, and basswood are found in the releve plot as incidental species. Hardwood species occur as both saplings and seedlings. These include American elm, green ash, black ash, bur oak, red maple, and hawthorne.

Cover in the shrub layer is moderate, averaging from 30 to 50 percent. The shrub layer includes many species in addition to the hardwood saplings listed above. These include Corylus cornuta, Corylus americana, Cornus racemosa, Cornus rugosa, Amelanchier sp., and Rubus sp. These species also contribute to the groundlayer.

The herbaceous ground cover of the releve plot is typical of these woods. Pteridium aquilinum, Aster macrophyllus, Aralia nudicaulis, and Amphicarpa bracteata are very common and evenly distributed. Galium triflorum and Desmodium canadense are also present.

Successional changes throughout the Aspen-Birch communities of the Kettle River area will probably be similar to those that are apparent in the Releve #3 site. Hardwoods will probably replace these pioneer woods. Succession is, in fact, already occurring; the dominant canopy species (aspen and birch) are present only in the tallest height classes and are not reproducing as seedlings or saplings. The sapling layer is instead dominated by hardwoods and shrubs. The resulting competition for dominance will occur between the shrub and the hardwood species.

Paper Birch (AB2): 9.8 Hectares, 3.2% of Study Area

The second member of the Aspen-Birch Group is the Paper Birch Community. In the Kettle River study area, pure paper birch stands often occur as small pockets in mixed aspen woods. In addition to these pockets, there are also three large stands in the northwest corner of the tract. These stands appear to dominate infertile sites on the area, particularly on the steep escarpments and sandstone terraces.

Releve #9 describes one of the three larger paper birch stands. Much of the releve plot has large exposed blocks of sandstone with vertical joints. As much as 60% of the ground surface is exposed rock and another 20% is covered only with a thin carpet of mosses and lichens. The little vegetation that is present is found growing in shallow soil on rock surfaces or, more often, in crevices between large rock fragments.

Paper birch (importance value = i.v.=149) is the dominant tree species. It does not grow past ten meters in height. It often grows in the crevices, which results in a patchy distribution throughout the stand. Other tree species and saplings are infrequent. Red maple, trembling aspen, large-toothed aspen, and red pine are part of the canopy layer from five to ten meters, while butternut and Prunus pennsylvanica are in the two to five meter or sapling height class. Generally the impression of this site is one of exposed rock contrasting with the many white trunks of the paper birch.

The shrubs which are present are sparsely and only slightly more evenly distributed than the trees. The smaller shrub species are most common on drier areas and include Diervilla lonicera,

Vaccinium Angustifolium, Vaccinium myrtilloides, and Apocynum androsaemifolium. More moist sites include some of the taller shrubs, principally Alnus rugosa, Ilex verticillata, and Ribes glandulosum.

Crevices provide the physical habitat for most of the herbaceous species. The fern Polypodium virginianum grows on the crevice walls, and Viola incognita, Maianthemum canadense, and Carex disperma grow in small clumps at the base of the crevices. Pockets of humus on the rocks nourish other species, particularly Pteridium aquilinum and Polygonum cilinode.

The young, vigorous paper birch stand described by Releve 9 probably was established after a fire crossed the area. There is no significant regeneration of birch except by suckers. Probable succession of this stand would be to sparse shrubs or perhaps eventually to a forest dominated by aspen, birch, and pine.

This site is similar in species composition to other pure paper birch stands in the area. The major difference is in the low density of shrubs and groundcover, which increase on sites having a thicker soil layer.

LOWLAND FOREST GROUP: 78.9 Hectares, 25.8% of Study Area

Basswood-Green Ash-Bur Oak (LF1)=21.7 Hectares, 7.1% of Study Area

The Lowland Forest Communities on the Kettle River Study area are best represented by the vegetation along the natural levees (Figure 9). This area of sandy loam soils is high enough to escape all but the most severe flooding. The Basswood-Green Ash-Bur Oak Community, described by Releve #11, is a good example of this levee community. Basswood (i.v.=101) dominates; bur oak (i.v.=43) and green ash (i.v.=32) are associates. Only basswood occurs at all noted height classes, ranging up to 20 meters in height. Its prevalence in the understory is largely due to basal suckering rather than to sapling or seedling regeneration. Black ash, bur oak, and green ash all occur at the 10 to 20 meter height class. American elm, green ash, and bur oak propagate in the understory. Other understory trees include Crataegus, boxelder, hackberry, and Prunus virginiana. All are occasional in the sparse shrub layer.

The upper stratum of the groundcover is dominated by an extensive cover of Matteuccia struthiopteris and Laportea canadensis. The lower stratum is dominated by Hydrophyllum virginianum, Carex sprenglii and Anemone quinquefolia, all of which are evenly distributed throughout the plot. Patches of bare soil are common. This stand appears successionally stable, and the canopy species appear to be replacing dead trees.

Black Ash-Basswood-American Elm (LF2)=6.4 Hectares, 2.1% of Study Area

A second type of lowland forest is the Black Ash-Basswood-American Elm Community; it is more poorly drained than the Basswood-Green Ash-Bur Oak Community described just above. These poorly drained woods border Wilburn Creek and beaver ponds that interrupt the creek. Although this community is quite wet, it is still more adequately drained than the deciduous-coniferous swamp to the south or the alder thickets to the northwest. Black ash, basswood, silver maple, and American elm are the most common species. Bur oak and all minor understory trees of the levee are absent; they are replaced by occasional tamarack, balsam fir, and black spruce, as well as by saplings of the dominant species.

Silver Maple Floodplain (LF3)=27.5 Hectares, 9.0% of Study Area

The Silver Maple Floodplain, exemplified by Releve #7, is found only in the southern half on the tract. During flood-stage, standing water covers the predominantly sandy soil of this area. The water enters the floodplain through channels interrupting the levee. On the releve site, a dry channel is visible, extending southwest towards the river. Water marks on tree trunks and large areas of bare soil indicate that standing water at flood stages has prevented the establishment of herbaceous species.

Silver maple (i.v.=190) dominates the stand. American elm (i.v.=10) is the only other species found with any regularity in the community. Many silver maple seedlings and some American elm seedlings cover the ground, including some of the more barren areas where no herbaceous species grow. This regeneration insures the successional stability of silver maple as the continued dominant of this stand, even though many of the largest trees appear old and several that are dead.

There is no shrub layer because of periodic flooding. Groundcover, except for the silver maple and American elm seedlings, is limited to an area of slightly better drainage. The most common herbaceous species in this area are Laportea canadensis, Pilea pumila, and Impatiens capensis; all grow profusely in large clumps elsewhere on the floodplain. Other herbaceous species include Cinna arundinacea, Leersia virginica, Minulus ringens, and Carex lupulina.

Other floodplain sites are also dominated by silver maple, but may exhibit increased numbers of herbaceous species or a prevalence of sedge species in the understory.

Black Ash-Tamarack (LF4)=23.3 Hectares, 7.5% of Study Area

Two stands, codominated by black ash and tamarack, are found on the natural area. The first is located in the northwest corner of the study area, and the second is near the oxbow lake to the south (Figure 9). In these areas, the water table is often so close to the surface that water is visible in small surface depressions.

The swamp described in Releve #5 is located in the Black Ash-Tamarack stand near the oxbow lake. Despite dry weather in 1980, the site had a very moist ground surface at the time of the study.

Black Ash codominates the stand (i.v.=98) with tamarack (i.v.=46). These two species, along with basswood (i.v.=15), occupy the 20 to 35 meter height class. The tamarack in the releve plot has a large average dbh of 25 cm. This large size, combined with the exceptional height of the canopy species, indicates either rapid growth or longevity of the tamarack at this site. Other tree species approaching this height class include balsam fir (i.v.=11), and yellow birch (i.v.=20). This is the only community at Kettle River in which yellow birch is common. Of all of the tree species in this stand, only black ash appears to be regenerating vigorously. Signs of regeneration in other species in the releve plot include: balsam fir, black spruce, and American elm saplings; basswood, and paper birch suckers; and some seedlings, although only those of black ash are significant in number.

Horizontal strata are poorly defined because tree species are not of a uniform age in this stand. As a result, the stand visually appears more open than would be expected from data collected.

Alnus rugosa, Acer spicatum, Cornus rugosa, and a variety of saplings comprise the shrub layer, which is uneven both in its horizontal and vertical distribution.

Groundcover of the stand, as well as that further to the north, exhibits a high amount of species diversity. The hummocky ground layer is richly carpeted with mosses and liverworts. Other herbaceous species include groups of Maianthemum canadense and Anemone quinquefolia distributed evenly over the site. Common species growing in clumps include Circaea alpina, Coptis groenlandicum, and Viola pallens. Numerous ferms and other species including Cirsium muticum, Clintonia borealis, Geum rivale, and Cypripedium calceolus are plants which form a group unique to swamps of this type.

This stand may be successionally stable. Balsam fir and black spruce are regenerating in the understory, and openings created by deadfall may be populated by shade intolerant tamarack or by moderately shade tolerant yellow birch. It is also possible that black ash will assume even more than its current dominance because of its vigorous seedling propagation. American elm and basswood, also present in the understory, will possibly become more important.

Releve #5 differs in several respects from the second stand to the northwest. Swamps interrupt the rocky land in the northwestern stand, creating a less homogeneous terrain than in the area of the releve site. In this stand, rock terraces may act as barriers to separate similar communities. For example, black ash sometimes dominates the woods, often nearly excluding coniferous

species. In other parts of the rocky area, especially on the borders with alder thickets or pine woods, large specimens of cedar and tamarack are found. Groundcover in this rocky site is less diverse than at the Releve 5 site; grasses and sedges replace most other species.

OTHER FORESTED COMMUNITIES

Lowland Shrub Group: 43.8 hectares, 14.3% of Study Area

Two lowland shrub communities are found at Kettle River: the Alder Community, consisting of three cover types described below, and the Willow Community. In both, the canopy is dominated by the shrub after which the community is named, and the groundlayer is dominated by grasses and sedges. Releve data were taken for one cover type within the Alder Community and for the Willow Community; the other ocver types are described below in general terms.

Alder Community (LS1): 38.9 hectares, 12.7% of study area.

Cover types: Speckled Alder-Red Osier Dogwood-Willow
Speckled Alder-Willow
Speckled Alder

The three cover types within the Alder Community are either dominated by speckled alder (Alnus rugosa) or codominated by Alnus rugosa and other shrub species. (The extent of each cover type is shown on maps in SNA files.) The community occurs almost exclusively north of the tract's basalt terrace (see Geology section) and is found either as dense stands or as a narrow band bordering the Willow Community. Poorly drained organic soils underlie most of the stands. The Alder-Dogwood-Willow cover type consists of two large stands in the northern half of the site, while the Alder-Willow cover type is represented by one stand in the drier northwest corner of the tract, near the Alder stand. The dense and uniform Alder cover type is made up of this one very large stand in the north central part of the tract, as well as one smaller stand that winds through the Aspen-Birch and Deciduous Wetland Communities further south.

Releve 2 illustrates a dense thicket of the Alder cover type. The ground here is covered with Sphagnum peat, and has occasional moist depressions. Alnus rugosa, the dominant species, grows so densely at 2 to 5 meters in height that it is often difficult to penetrate. None of the tree species

found in the thicket are as important in characterizing the community as the alder.

There are six canopy species on the releve plot, eleven trees in all. The presence of the two large tamaracks, two black ash and a single black spruce tree can be explained by the fact that the releve site is less than fifty meters from the edge of the Black Ash-Tamarack Community. Bur Oak, represented by four young trees (average dbh 11.4 cm) would be the most likely choice for future canopy succession other than to Deciduous Wetland. The remaining trees, trembling aspen and paper birch, are not as abundant nor as healthy as the oaks in this stand.

Salix, primarily Salix discolor, is the only associated shrub growing as tall as alder. In the lower shrub canopy species of Salix, Rubus, Vaccinium, and Ribes are present in significant numbers along with Spiraea tomentosa and Ilex verticillata. Prevalent herbaceous species include Calamagrostis canadensis, Carex leptalea, Carex intumescens, and Onoclea sensibilis.

This stand seems fairly stable and will probably continue to regenerate in the near future, delaying possible succession to a mixed northern wetland forest or oak-alder community. The existing alder thickets may themselves be products of succession following fire or logging of earlier cedar stands.

Other alder communities in the tract vary both in their terrain and the density of shrub growth. Small alder-dominated thickets at times occur in the flowing water of streams or springs. They are also common at the base of very steep slopes. This is especially noticable in the center of the area, where a northeast-facing slope and a southwest facing slope, both supporting Aspen-Birch cover, form a trough. At the east end of this trough is a beaver dam, behind which is a small pond. At the east end of this trough is a beaver dam, behind which is a small pond. At the west end, immediately at the base of the slope, is an alder thicket.

Alder density also varies throughout the tract. Alder often borders willow communities. Associated species may include three species of willow growing either with alder or as clumps in a central sedge-grass meadow. These willow species are Salix amygdaloides, Salix pyrifolia and Salix petiolaris. Spiraea tomentosa, Spiraea alba and Cornus stolonifera also grow in widely separated clumps in the central meadow. Trees are rare in the center of these sites, but tamarack, black spruce and black ash are found on the thicket edges.

Willow Community (LS2): 4.9 hectares, 1.6% of study area

The Willow Community occurs on the tract most often in combination with the alder thickets just described, or with Scirpus and Carex. The largest observed Willow Community does not occur in the central lowlands, but rather in a low area on the uplands east of the escarpment. As described by releve #8, it accurately represents the smaller willow communities in other areas.

Salix petiolaris and Salix pyrifolia dominate the releve site. Most willows occur in scattered groups at the lower end of the .5 to 5 meter height classes. Clumps of Spiraea tomentosa and Alnus rugosa grow at the same level. The height class below one meter is dominated by a dense growth of Carex rostrata. Scirpus cyperinus is also important, growing in dense patches. At the ground level, the moist organic soil is completely covered by wet Sphagnum.

Other groundcover species are widely scattered, except for Lycopus uniflorus and Impatiens capensis, both of which grow in small groups. All others are most often found growing singly. A group of species characteristic of this community includes Scutellaria lateriflora, Scutellaria epilobiifolia, Thelypteris palustris, Dryopteris cristata, Triadenum fraseri and Campanula aparinoides.

This community is intermediate between an alder-willow thicket and a sedge-willow meadow, both also found in the natural area. The former has already been described and the latter is evident in the large sedge meadow in the south. In

this meadow, Salix forms large clumps but does not become dominant. In the future this site may increase its shrub density, particularly of alder, with the absence of fire.

SEDGE MEADOWS AND MARSHES: 8.2 hectares, 3.7% of study area

Sedge meadows and marshes represent another vegetation type found on areas of poorly drained soil. Their distribution throughout the tract is rather uneven. Most of the larger areas are to the south, although many meadows also occur to the north in the Willow and Alder Communities already discussed. These lowland shrub and meadow communities are often similar, particularly in their ground cover composition.

Sedge Meadows (M1) = 6.7 hectares, 2.2% of study area

The Sedge Meadow Community described in releve #6 is unique in the tract because of its large size and homogeneity. It is the largest meadow in the tract, covering nearly 3 hectares. It is located at the base of the steep eastern escarpment and extends to the Silver Maple Floodplain to the southwest, and to the deciduous swamps to the north. It is poorly drained and is influenced by river flooding, as revealed by its alluvial soil. The dominants in the releve plot are Carex rostrata, below 1.5 meters, and Potentilla palustris, below .5 meters.

The ground is very wet, and is thickly covered with peaty material derived from the sedges. Water saturates this spongy groundwater, and standing water is visible in depressions. The high water table, along with the presence of Potentilla palustris, Sagittaria laterifolia and Acorus calamus indicates this site's affinity to a marsh, characterized by water above the soil most of the year.

This meadow as a whole shows limited species diversity. Willows form occasional thickets, and other herbaceous species are either scattered in the meadow or found on the edges. These include Galium tinctorium, Sium suave,

Bidens cernua, Bidens frondosa and Scirpus spp.. Shrub prevalence will probably increase under drier conditions. However, continued flooding will maintain the sedge meadow.

Other southern meadows are smaller and even more marshlike than the large meadow. Because of the flooding effects, these meadows differ in species composition from the large meadow of releve #6. In the smaller meadows sedges are found in closer association with alder thickets and willows.

Bulrush Cattail Marsh (M2) = 1.5 hectares, 0.5% of Study Area

The presence of standing water most of the year and the dominance of Typha and Scirpus, rather than sedges, distinguishes a marsh from a sedge meadow. Marshy areas are evident surrounding small beaver-dam ponds and adjacent to the Oxbow Lake. Releve #24, a transect along the Oxbow Lake edge, includes species encountered in marshes, and is a limited reference for these communities (releve data are filed at the SNA office). However, the best characterization of the Marsh Community at Kettle River is from a marsh just south of the sedge meadow that was described above (releve #6).

The marshes on the Kettle River tract typically are dominated by Scirpus spp., Typha spp., Acorus calamus, Sagittaria latifolia and Sparganium eurycarpum. Plant distribution in marshes is related to water depth. Typha spp., Sparganium eurycarpum, Lemna minor, Ranunculus flabellaris, and Equisetum fluviatile are associates in the deepest sites. In intermediate water levels, Acorus calamus, Potentilla palustris and Leersia oryzoides are more common. Shallow water or the muck on the edge of the marsh is occupied by Bidens cernuua, Bidens frondosa, Eleocharis spp., Impatiens biflora, Poa palustris and Iris versicolor. Sedges such as Carex critina and Carex tenera may be found on the marsh edges. The presence and frequency of these species varies with the amount of water in the marsh, its size, and the cover type of the adjacent community.

Such marshes will probably succeed to sedge meadows if increasingly dry conditions and the accumulation of organic matter prevail. Burning, drought or more permanently increased water levels could disrupt this succession. The marshes described most likely will remain stable because the periodic flooding of the river results in seasonal rather than permanent fluctuation in water levels.

Basswood-Butternut (BB): 4.3 hectares, 1.4% of study area

The example of a moderately drained forest is found in a rocky area in the northwest corner of the tract. Many hardwood species grow in this site, including black ash, red maple, elm, paper birch, aspen, and butternut. Occassional large specimens of white pine grow in this rocky area. The canopy is often open and the shrubs Rosa sp., Rubus sp., Ribes sp., Vaccinium sp., Corylus sp., Ledum groenlandicum and Alnus rugosa are common in the variably drained open areas.

Releve #1 describes a butternut-dominated stand found in this area. The soil layer is poorly developed and the trees are clustered along the site's periphery. Basswood (i.v. = 63) dominates the stand and occurs with trembling aspen (i.v. = 4) and black ash (i.v. = 15) at the 10 to 20 meter height class. Basswood is important in the understory only because of its vegetative basal suckering. The 5 to 10 meter height class is variably populated with the codominant butternut (i.v. = 73), black ash, red maple (i.v. = 16), American elm (i.v. = 17) and paper birch (i.v. = 10). Butternut and black ash are the most significantly regenerating species in the understory. Only one aspen occurs on the releve plot, although there are several standing dead aspen and birch trees.

The shrubs are mainly found on a dry area encircled by the trees. Corylus cornuta, Corylus americana, Prunus americana, and Rubus sp. are found in the uniformly diverse shrub layer. The groundcover of the dry, more exposed areas includes Amphicarpa bracteata, Cornus canadensis, and Aralia racemosa. More shaded, moist areas contain groups of Osmunda cinnamomea, Circaea alpina,

and Thalictrum dasycarpum. Cypripedium calceolus was observed in another butternut stand nearby.

From core samples, the age of some of the trees has been figured at 30 years. This, combined with the open canopy and small size of the trees, indicates that this stand may have resulted from selective cutting. It also may have succeeded an aspen-dominated community present after fire. The stand is presently undergoing succession, and hardwoods and hazelnut will probably become increasingly dominant.

Bur Oak Savanna (BO): 2.4 hectares, 0.8% of study area

Small areas of Oak Savanna, each covering less than one hectare, are scattered throughout the Aspen-Birch Communities of the tract. The eastern escarpment and the western terraces are sites where the community is most frequently found.

The site described in releve #4 is unique in that it is found on a small terrace composed of highly fractured basalt near Willburn Creek (Fig. 9). The only significant tree species is bur oak (i.v. = 200). The oaks are scrubby (average dbh = 10.2 cm) and are so scattered that they form no cohesive canopy layer. As a result, the understory grows in nearly full sunlight. Only Prunus virginiana grows as tall as the oaks. The very rocky, excessively drained soil supports large patches of Rubus pennsylvanicus and Rubus strigosus. Less common are Corylus cornuta and Cornus racemosa, growing sparsely in areas in more soil development. The major groundcover species include Corylus cornuta, Diervilla lonicera, Rubus strigosus, Helianthus giganteus, Pteridium aquilinum and Solidago juncea. These species, growing in patches, demonstrate the high exposure of this site.

Introduced or "weedy" species in the stand include Poa pratensis, Achillea millefolium Trifolium pratense and Trifolium repens. These indicate the proximity

of cultivated fields to the east, or the possible past grazing of this slope (see Land Use History Section). Introduced species also occur in other open areas, particularly to the east of the main escarpment. They are not abundant in the savannas and are less common in the woods.

Other small areas (not delineated in Figure 9) of Oak Savanna are found along the escarpment, and are similar to the site described by the releve plot in their scattered oak distribution and excessively drained soil. The groundcover, predominantly grasses, usually has a greater cover density than any other vegetation layer. Ironwood, Amelanchier Spp., Ribes cynosbati and Apocynum androsaemi-folium are sometimes associated with these areas, but do not form dense thickets. On some well-drained terraces in the western part of the tract, shrubs are encroaching rapidly upon the oak openings. Corylus cornuta seems particularily successful in its invasion. These oak openings are much less exposed than the escarpment savannas. They are surrounded by aspen woods, grow on a much more gradual slope and cover smaller areas.

The Oak Savanna Community may have originated following fire or grazing. The savannas on the basalt terrace and the main escarpment will probably persist because of the excessive drainage and exposure of those sites. Those savannas on the western terrace will rapidly be replaced by oak-shrub communities, perhaps followed by upland hardwood forests.

Red Pine - Paper Birch - Large toothed Aspen (RP): 11.6 hectares, 3.8% of study area

The mixed northern forest of large-toothed aspen, paper birch and red pine is found on well drained, infertile sites often continuous with Aspen-Birch woods. Smaller stands are found in the rocky, northwestern part of the Kettle River study area. The largest area is in the extreme northern part of the tract, where the terrain consists of large, uneven sandstone blocks with vertical joints.

Releve #10 describes a site dominated by red pine (i.v. = 100), with a small average dbh of 12.5 cm, ranging from 15 to 20 meters in height. The pines are evenly distributed throughout the stand. Large-toothed aspen (i.v. = 42) is also found in the 10 to 20 meter height class while paper birch is present only in the 5 to 10 meter height class. Of the three trees, only paper birch is regenerating.

A humus layer covers a sandy loam soil too meager to support any significant shrub community. The groundcover includes species similar to an Aspen-Birch woods. Amphicarpa bracteata, Aster macrophyllus, Pteridium aquilinum and Maianthemum canadense are all common and evenly distributed in the community.

This stand appears to have originated after fire as shown by the equal age of the trees. The presence of pine and paper birch as sapling-sized trees in the canopy probably demonstrates the extremely dry conditions of the site more than indicating any successional stability. Much of the red pine in the vicinity shows considerable porcupine damage, perhaps leading to its decline.

RARE PLANTS

There are three rare plant species currently known to occur in the Kettle River SNA: Carex bromoides, Hydrocotyle americana, and Poa paludigena. Of these, Carex bromoides is the most widespread. It has been found by Dr. Gerald Wheeler at several locations along the Kettle River, and it occurs frequently in the low, wet alluvial woods in the SNA. According to Dr. Wheeler, however, this is the only location in Minnesota where the species has been found in such abundance.

Hydrocotyle americana was collected in a silver maple floodplain forest in the NW¼SW¼ of Section 23. It is not known how extensively this species occurs in the SNA. Previous to this collection, H. americana had been recorded only four times in Minnesota; three times along the St. Croix River in Washington and Chisago Counties, and once at an unknown location in Houston County.

Poa paludigena was collected in a black ash swamp in the SW¼NW¼ Section 23. The extent of its occurrence in the SNA is also unknown. Its documentation here is important because this is the first and only record of this species occurring in Minnesota. It is considered rare wherever it occurs, and has been proposed for review by the U.S. Fish and Wildlife Service for threatened status throughout its range.

ANIMALS

INTRODUCTION

A total of 113 animal species were reported on the Kettle River tract during the 1980 inventory. Of these, 82 species were birds, 18 were mammals, 8 were butterflies, and 5 were amphibians. Although most of the species observed are typical of Minnesota's east-central forests, a few are unusual, including the bald eagle, sandhill crane, and two rare butterflies. Further discussion of these species will follow.

The high diversity of birds on the tract reflects both the varied habitat available and the ease of observing and identifying birds. The larger mammals, too, are relatively easy to see and identify, but observation of small mammals is limited to trapped specimens, and their identification can be difficult. These difficulties also apply to inventory of butterflies, reptiles and amphibians. Thus, the low diversity of the latter three groups is probably due mainly to logistical problems with survey timing and methodology rather than to actual lack of diversity.

BUTTERFLIES

METHODS

An inventory of butterflies[1], designed to document species composition, was conducted on the Kettle River natural area during the 1980 inventory. From

[1]The term butterfly, in this document, refers both to the true butterflies (Papilionoidea) and to the skippers (Hesperioidea).

the second week of June until the last week of August a group of three zoologists visited the site weekly. The objective on each visit was to cover all habitat types, emphasizing those areas where flowering plants were in bloom.

A standard twelve-inch butterfly net was used to capture the insects. Careful notes were taken on the activity of the specimen, the technical location from which it was collected, its habitat, the plant species it was visiting, and the relative abundance of the butterfly on the preserve that day. Specimens were released, except when identification required a prepared specimen or when a voucher specimen was desired.

Identification of butterflies was accomplished by using the following references: Ehrlich and Ehrlich (1961), Howe (1975), Klots (1951), and McCabe and Post (1977). Specimens were verified by Ron Huber (Zoology Assistant, Science Museum of Minnesota) and vouchers were deposited at the Science Museum of Minnesota.

DISCUSSION

Eight butterfly species representing five families were identified on the Kettle River natural area during the 1980 inventory. Table 1 lists all the species, recorded in phylogenetic order. Habitat types, butterfly activity, observed flight dates and a rough estimate of frequency were also recorded; this information is available in the files of the Scientific and Natural Areas Program.

The butterflies observed on the tract are predominantly typical of wet meadows and mixed hardwood forests. With the exception of Euphydryas phaeton borealis and Pieris napi oleracea, all are thought to be relatively common in wet forest environments like Kettle River. Euphydryas phaeton borealis and Pieris napi oleracea, however, are both considered rare (Huber, 1979). The first species, E. p. borealis, occurs only where the larval food plant turtlehead, Chelone glabra, grows. On the Kettle River tract the species was collected in a wet meadow typical of those in which turtlehead is commonly found. The second species, Pieris napi oleracea, if found in cool, moist deciduous or mixed

DISCUSSION

Eight butterfly species representing five families were identified on the Kettle River natural area during the 1980 inventory. Table 1 lists all the species, recorded in phylogenetic order. Habitat types, butterfly activity, observed flight dates and a rough estimate of frequency were also recorded; this information is available in the files of the Scientific and Natural Areas Program.

The butterflies observed on the tract are predominantly typical of wet meadows and mixed hardwood forests. With the exception of Euphydryas phaeton borealis and Pieris napi oleracea, all are thought to be relatively common in wet mixed forest environments like Kettle River. Euphydryas phaeton borealis and Pieris napi oleracea, however, are both considered rare (Huber, 1979). The first species, E. p. borealis, occurs only where the larval food plant turtlehead, Chelone glabra, grows. On the Kettle River tract the species was collected in a wet meadow typical of those in which turtlehead is commonly found. The second species, Pieris napi oleracea, is found in cool, moist deciduous or mixed coniferous woods. The larvae feed on plants of the family Brassicaeae, represented by two species on the natural area (see Appendix II). As a result of the destruction of habitat, along with strong competition by an introduced species, Pieris rapae, Pieris napi's range has been severely reduced.

The low diversity of butterflies on the Kettle River tract is, in part, a reflection of the late field season as well as the difficulty of sampling in dense forest environments. Because the field season did not begin until the second week of June, many species that are active in May and early June were not encountered. In addition, spring sampling is important in forest tracts where the majority of plants flower early in the season. Successful capture of butterflies was also difficult in the dense understory of most habitats.

Table 1. Butterflies of the Kettle River Natural Area

Species			Monthly Abundance[1]		
Family	Scientific Name	Common Name	June	July	August
Papilionidae	*Papilio glaucus* Linnaeus	Tiger Swallowtail	F	-	-
Pieridae	*Pieris napi oleracea* Harris	Mustard White	F	F	-
Apaturidae	*Asterocampa celtis* Boisduval and LeConte	Hackberry Butterfly	-	F	-
Nymphalidae	*Limenitis arthemis* Drury	White Admiral	C	C	-
	Nymphalis antiopa Linnaeus	Mourning Cloak	F	F	-
	Euphydryas phaeton Drury	Baltimore	-	F	-
Satyridae	*Lethe eurydice* Johansson	Eyed Brown	A	A	-
	Cercyonis pegala nephele Kirby	Wood Nymph	-	C	-

[1]Abundance estimates are derived from sightings during the time spent in the field and are only a relative index of the actual populations. Symbols used to indicate abundance are as follows:

1-5: Actual number sighted
F: Few (5-20)
C: Common (20-50)
A: Abundant (> 50)

REPTILES AND AMPHIBIANS

METHODS

A survey of reptiles and amphibians was also conducted on the Kettle River natural area to document species composition. Drift fences were the primary collection technique utilized. Animals were also hand captured whenever they were encountered on the area.

Two drift fences, each approximately 12 meters in length, were established in lowland areas on the tract.[2] The fences were constructed of .5-meter high galvanized flashing which was sunk about 10 cm into the ground. Buckets that served as drop receptacles were placed at various intervals along the fence as well as at each end. Presumable, animals moving through the area would be diverted along the fence and into one of the containers. The fences were in operation for several days in mid-August with no success. Although the drift fences produced no results, a considerable amount of time was spent on the natural area and any reptiles and amphibians observed while on the area were hand captured.

Reptiles and amphibians collected during the inventory were retained as voucher specimens. The animals were identified in the lab using Conant (1975). Information recorded for each specimen included the date, location, collector, method of capture and habitat type. Voucher specimens were tagged and preserved in a 10% Formalin solution.

DISCUSSION

Five amphibian species were collected and recorded on the Kettle River natural area during the 1980 inventory (Table 2). All the specimens were caught by hand; the drift fences were not successful in collecting any specimens. The first species, the American toal (Bufo americanus), was collected in an upland

---

[2]The locations of the drift fences have been mapped and are available in the SNA files.

Table 2. Amphibians of the Kettle River Natural Area

Scientific Name	Common Name
Bufo americanus	American toad
Hyla sp.	Gray tree frog
Rana clamitans	Green frog
Rana pipiens	Leopard frog
Rana sylvatica	Wood frog

aspen-birch stand on 5 June 1980. Observed on numerous occasions throughout the summer, the toad is believed to be quite abundant on the tract. Two additional species, the northern leopard frog (Rana pipiens) and the wood frog (Rana sylvatica), were collected seven and five times respectively. Both species were abundant on the Kettle River floodplain where open water can be found throughout the spring, summer and fall. The fourth species, the green frog (Rana clamitans), was collected twice on 31 July 1980. Observed along the shore of the Kettle River, these were the only two green frogs observed throughout the course of the inventory. Finally, one gray treefrog (Hyla sp.) was found on 24 June 1980 in an upland aspen - red pine stand. The specimen may have been either H. versicolor or H. chrysoscelis. Because of the difficulty in distinguishing the two species, Dr. John Schmidt, University of Minnesota, was asked to examine the specimen. Dr. Schmidt was the first to locate H. chrysoscelis in Minnesota and has done extensive field work with many Minnesota amphibians. Unfortunately, the Kettle River specimen could not be conclusively assigned to either species.

BIRDS

METHODS

An inventory of birds was conducted on the Kettle River natural area to document species composition and to provide an index of abundance for each species on the area. The IPA (Indices Ponctuels d'Abondance) or Point Count Method (Robbins, 1979) was used to census bird populations during the summer breeding season. The Point Count Method provides information on species composition and abundance for large, diverse tracts of land, such as Kettle River, and the results can be compared to censuses taken in different habitats or different locations.

The Point Count Method is dependent on the establishment of a series of points throughout the area. While keeping time and manpower constraints in mind,

an attempt was made to sample all major habitat types. Thirteen circular bird stations, each with a 50 meter radius, were dispersed throughout the various habitat types on the Kettle River tract.[3] When selecting the stations, care was taken to avoid overlapping the sampling areas of adjacent stations.

During the census a trained observer stood at each designated station for ten minutes and recorded on a map all birds heard or seen within the 50 meter radius. Symbols were used to denote the means of identification (sight, song or call) and the sex of the species. While travelling between stations, time was used to search out questionable species and to record any incidental bird observations. Each bird point was censused six times for a total of 60 minutes during the month of June and the first week of July. Scheduling required that the Kettle River tract be censused on two consecutive days during the season. The twelve census dates for the study area were: 9 and 10 June, 13 and 16 June, 19 and 20 June, 24 and 25 June, 30 June and 2 July, and 7 and 8 July 1980. To reduce the chance of personal bias, each census point was visited only two times by the same observer. In addition, the starting point was rotated for each visit so that each bird station would be sampled at different times. The censuses were conducted in the early morning during peak bird activity and only when weather conditions were favorable.

To supplement the bird counts, incidental bird sightings were recorded whenever the researchers were on the area. Since many additional hours were spent on the Kettle River tract, this increased the chances of encountering uncommon bird species that may not have been recorded during the breeding census.

Census data were analyzed to give an index of abundance for each species. Each singing male, occupied nest or family of birds out of the nest counted as one pair, while a bird seen or heard calling counted as one half of a pair

(Robbins, 1979). The highest of the six counts for each species at a particular station was used as a population index. An index of abundance was then calculated for each species by dividing the combined count at all stations by the number of sampling points.

Species were listed taxonomically and assigned to one of four abundance categories based on their index value. The four categories are as follows:

Category	Index Value (Average # pairs/station)
Abundant	greater than 1.0
Common	0.5 to 1.0
Uncommon	0.1 to 0.5
Very Uncommon	less than 0.1

Species only recorded once during the breeding census were not placed in an abundance category, but were listed along with the other species and with the date of their observation. All birds recorded as incidentals were treated in a similar manner. When positive evidence of nesting was observed (e.g. observations of nests or young) those details are also included in the table.

DISCUSSION

The high diversity of bird species observed on the Kettle River tract is an indication of the variety of habitats found there. Several of the species are unusual and are recognized by the Minnesota Natural Heritage Program as meriting special consideration on the part of planners, biologists and developers. The bald eagle (Haliaeetus leucocephalus) is classified as a threatened species by the federal government. It was seen flying over the Kettle River in July of 1980, but was not observed nesting on the area. This nearest known nesting site for the bald eagle is in Chisago County, in the Goose Creek Natural Area of St. Croix Wild River State Park. However, future investigations may reveal closer breeding sites.

Table 3. Birds of the Kettle River Natural Area

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE[1]	REMARKS
Gavia immer	Common Loon	*	Species only heard once during census on 24 June 1980.
Podilymbus podiceps	Pied-billed Grebe	*	Species only seen once. Recorded as an incidental on 30 June 1980 on small inland lake.
Ardea herodias	Great Blue Heron	Uncommon	Rookery in SW¼ NW¼ Sec. 23, 18 nests.
Butorides virescens	Green Heron	*	Species only seen once. Recorded as an incidental on 8 July 1980.
Botaurus lentiginosus	American Bittern	*	Species only heard and seen once. Recorded as an incidental on 8 July 1980.
Branta canadensis	Canada Goose	*	Species only seen once. Recorded as an incidental on 9 June 1980. Observed flying overhead.
Anas platyrhynchos	Mallard	*	Species only seen once. Recorded as an incidental on 9 June 1980. Observed flying overhead.
* Aix sponsa	Wood Duck	Uncommon	Species only seen once during census on 20 June 1980.

Table 3. Cont

	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
	Accipiter striatus	Sharp-shinned Hawk	*	Species only seen once. Recorded as an incidental on 28 July 1980. Nesting in silver maple tree in SE¼ NE¼ of Section 22 T41N, R20W.
	Butio platypterus	Broad-winged Hawk	Uncommon	Nest with young observed in July in SE¼ SW¼ of Section 23, T41N, 220W.
*	Haliaeetus leucocephalus	Bald Eagle	*	Species only seen once. Recorded as an incidental on 28 July 1980. Flying over inland lake.
	Pandion haliaetus	Osprey	*	Species only seen once. Recorded as an incidental on 25 July 1980. Flying over Kettle River.
	Bonasa umbellus	Ruffed Grouse	*	Species reported as an incidental on two occasions, 10 June and 13 June, 1980.
	Phasianus colchicus	Ring-necked Pheasant	*	Species only seen once during census on 24 June 1980.
*	Grus canadensis	Sandhill Crane	*	Species only seen once. Recorded as an incidental on 2 July 1980 along Kettle River shoreline.
	Porzana carolina	Sora	*	Species only heard once during census on 13 June 1980.

Table 3. cont.

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
Porzana carolina	Sora	*	Species only heard once during census on 13 June 1980.
Charadrius vociferus	Killdeer	*	Species reported as an incidental on two occasions, 5 June and 24 June, 1980.
Philohela minor	American Woodcock	*	Species reported as an incidental on numerous Occasions.
Capella gallinago	Common Snipe	*	Species reported as an incidental on two occasions, 10 June and 19 June, 1980.
Actitis macularia	Spotted Sandpiper	*	Species only seen once. Recorded as an incidental on 24 June 1980.
Larus argentatus	Herring Gull	Uncommon	
Zenaida macroura	Mourning Dove	*	Species only heard once during census on 30 June 1980.
Coccyzus americanus	Yellow-billed Cuckoo	*	Species only heard once during census on 7 July 1980.
* Bubo virginianus	Great Horned Owl	*	Species only seen once Reported as an incidental on 9 July 1980.

Table 3. Cont.

	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
*	Strix varia	Barred Owl	*	Species only seen once during census on 25 June 1980.
	Chordeiles minor	Common Nighthawk	*	Species only seen once. Recorded as an incidental on 9 July 1980.
	Chaetura pelagica	Chimney Swift	Very Uncommon	
	Archilochus colubris	Ruby-throated Hummingbird	Very Uncommon	
	Megaceryle akyon	Belted Kingfisher	*	Species only heard and seen once during census on 30 June 1980.
*	Dryocopus pileatus	Pileated Woodpecker	Uncommon	
*	Melanerpes erythrocephalus	Red-headed Woodpecker	Uncommon	
*	Sphyrapicus varius	Yellow-bellied Sapsucker	*	Species only heard and seen once during census on 7 July 1980.
*	Dendrocopos villosus	Hairy Woodpecker	Uncommon	

Table 3. cont.

	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
	Tyrannus tyrannus	Eastern Kingbird	*	Species only seen once during census on 19 June 1980.
*	Myiarchus crinitus	Great Crested Flycatcher	Abundant	
	Sayornis phoebe	Eastern Phoebe	Uncommon	
	Empidonax minimus	Least Flycatcher	Common	
	Contopus virens	Eastern Wood Pewee	Common	
*	Iridoprocne bicolor	Tree Swallow	Very Uncommon	
	Stelgidopteryx ruficollis	Rough-winged Swallow	*	Species only heard and seen once. Recorded as an incidental on 28 July 1980.
	Hirundo rustica	Barn Swallow	*	Species reported as an incidental on numerous occasions.
	Cyanocitta cristata	Blue Jay	Common	
	Corvus brachychynchos	Common Crow	Common	

Table 3. Cont.

	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
	Parus atricapillus	Black-capped Chickadee	Abundant	
*	Sitta carolinensis	White-breasted Nuthatch	Common	
*	Troglodytes aedon	House Wren	Uncommon	
	Troglodytes troglodytes	Winter Wren	Uncommon	
	Cistothorus platensis	Sedge Wren	Very Uncommon	
	Dumetella carolinensis	Gray Catbird	Common	
	Turdus migratorius	American Robin	Uncommon	
	Hylochichla mustelina	Wood Thrush	Abundant	
	Catharus guttatus	Hermit Thrush	Uncommon	
	Catharus fuscescens	Veery	Abundant	
	Bombycilla cedrorum	Cedar Waxwing	Uncommon	
	Sturnus vulgaris	Starling	*	Species only heard once during census on 30 June 1980.
	Vireo olivaceus	Red-eyed Vireo	Abundant	

Table 3. Cont.

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
Mniotilta varia	Black-and-White Warbler	Uncommon	
Vermiuora chrysoptera	Golden-winged Warbler	Common	
Vermivora ruficapilla	Nashville Warbler	Common	
Dendroica petechia	Yellow Warbler	Uncommon	
Dendroica fusca	Blackburnian Warbler	*	Species only heard and seen once during census on 9 June 1980.
Dendroica pensylvanica	Chestnut-sided Warbler	Abundant	
Seiurus auro capillus	Ovenbird	Abundant	
Seiurus noveboracensis	Northern Waterthrush	*	Species only seen only. Recorded as an incidental on 29 July 1980.
Oporonis philadelphia	Mourning Warbler	Abundant	
Geothlypis trichas	Common Yellowthroat	Abundant	
Wilsonia canadensis	Canada Warbler	Common	
Setophaga ruticilla	American Redstart	Common	

Table 3. cont.

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	REMARKS
Passer domesticus	House Sparrow	*	Species only seen once during census on 13 June 1980.
Agelaius phoeniceus	Red-winged Blackbird	Common	
Icterus galbula	Northern Oriole	Uncommon	
Quiscalus quiscula	Common Grackle	Uncommon	
Molothrus ater	Brown-headed Cowbird	Abundant	
Piranga olivacea	Scarlet Tanager	Uncommon	
Cardinalis cardinalis	Cardinal	*	Species only heard once. Recorded as an incidental on 19 June 1980.
Pheucticus ludovicianus	Rose-breasted Grosbeak	Common	
Passerina cyanea	Indigo Bunting	Uncommon	
Spinus tristis	American Goldfinch	*	Species only seen once. during census on 7 July 1980.
Pipilo erythrophthalmus	Rufous-sided Towhee	Uncommon	
Zonotrichia albicollis	White-throated Sparrow	Abundant	
Melospiza georgiana	Swamp Sparrow	Uncommon	
Melospiza melodia	Song Sparrow	Common	

The greater sandhill crane (Grus canadensis tabida) is classified as threatened by the Minnesota Natural Heritage Program. Its populations declined radically in the late 1800's as the state's prairies were plowed, and only since 1950 have its numbers begun to increase (Minnesota Natural Heritage Program, undated). The recent increase is attributed partly to protection of some of the wetlands which form its breeding habitat (Minnesota Natural Heritage Program, undated). However, wetlands in the state are still disappearing rapidly, and as a result this species deserves attention. A survey of sandhill crane populations on 1978 (Henderson, 1979) produced positive evidence of 87 breeding pairs with 46 young in Minnesota; the actual total is estimated at 150 to 300 breeding pairs with 150 to 300 young in the state. Although the sandhill crane was not observed nesting on the Kettle River tract, the preserve may form an important part of its habitat: one breeding pair was observed in 1977 in Clover Township, Section 6, about 7 miles northeast of the Kettle River Tract, and more recently an adult (probably breeding) was seen in Munch Township, Section 11, about three miles south of the tract.

During the 1980 inventory, a great blue heron rookery of 18 nests was observed on the south shore of the Oxbow Lake in the SW¼NW¼ Section 23 (Figure 10, Table 4). All of the nests are built in silver maple trees (Acer saccharinum). This colony should be observed annually to record its size and breeding success. In addition, further investigation should be directed at confirming a 1977 report from Fish and Wildlife personnel describing a rookery of about 12 nests in the S½SE¼ Section 26, on the east side of the Kettle River. This observation was made from a plane, and should be checked from the ground. If it is not found, the location may have been mistaken, or the colony may have moved in the intervening three years.

A final observation of special interest is the large number of cavity nesting birds on the Kettle River site. Ten of the 82 species observed always

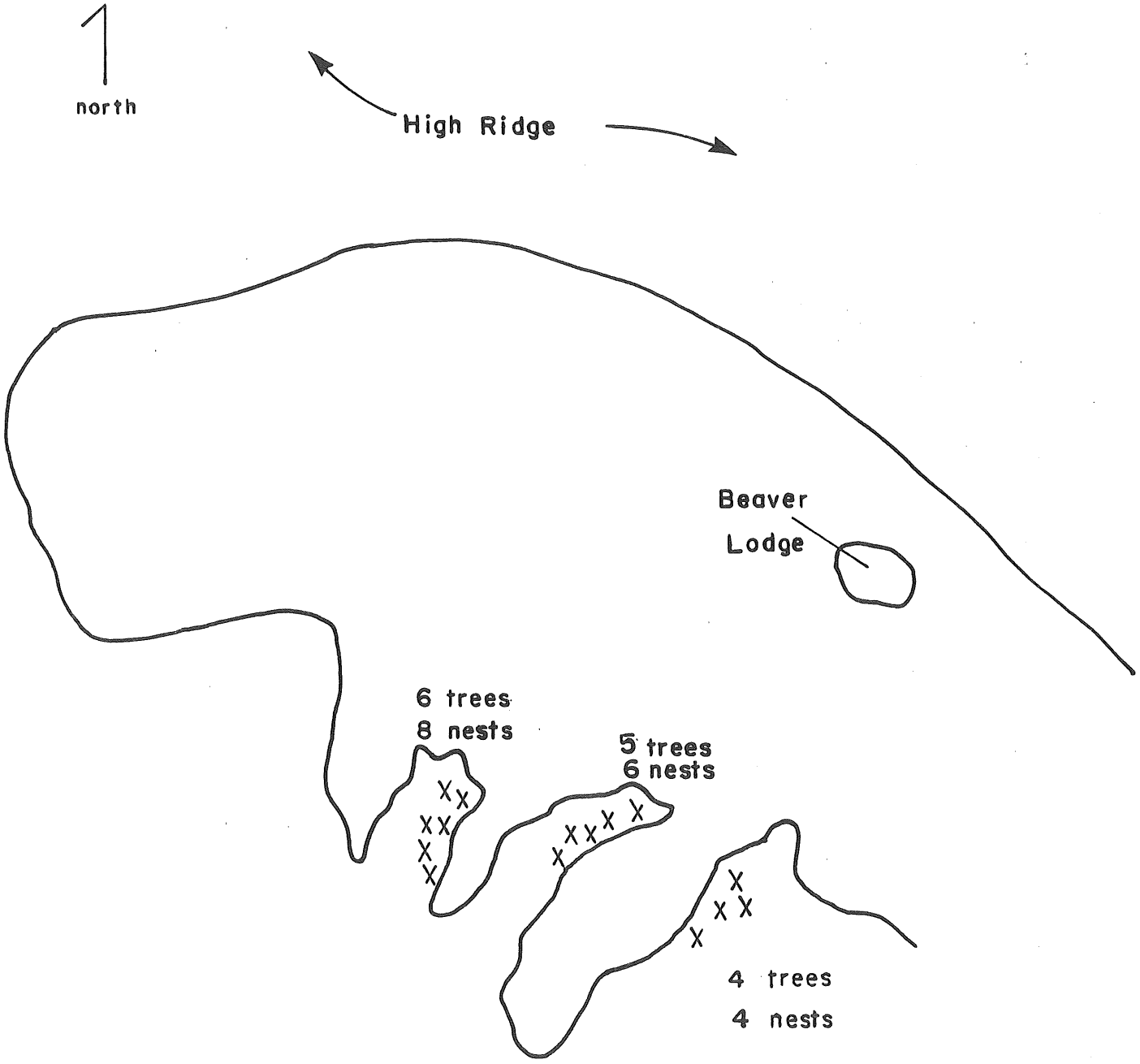


Figure 10

Kettle River Great Blue Heron Colony

or usually nest in tree cavities, including owls (2 species), woodpeckers (4 species), the great crested flycatcher, tree swallow, white breasted nuthatch, and house wren. This variety of cavity-nesters may indicate large numbers of standing dead trees on the tract, especially in the lowland forests where large elms, maples and basswood are relatively common.

The northern waterthrush (Seiurus noveboracensis) was observed incidentally on the tract in July 1980. It is visually very similar to the Louisiana waterthrush, a peripheral species in Minnesota classified as rare by the Natural Heritage Program. Since the Louisiana waterthrush has been recorded on similar habitats nearby (e.g. the St. Croix Natural Area), it may also occur on the Kettle River Tract. Future field workers should attempt to verify the sighting, and if the Louisiana waterthrush is found, to determine its status here.

MAMMALS

METHODS

An inventory of large and small mammals was also conducted to document species composition on the Kettle River natural area. Small mammal populations were sampled during a summer trapping session, while large mammals were recorded by visual observations only. A short trapping session was carried out from 28 July to 1 August. Two areas were trapped for three nights (28 July to 31 July) while a third area was only trapped for two nights (31 July to 1 August) because of difficulties reaching the area. An attempt was made to sample all major habitat types on the Kettle River tract while keeping time and manpower constraints in mind.

Three traplines were set consisting of Museum special snap traps and Sherman live traps. The ratio of snap traps to live traps was approximately

Table 4. Kettle River Great Blue Heron Colony

Tree Species	Status	DBH (cm)	# Nests Supported
1. Acer saccharinum	live	65.3	1
2. Acer saccharinum	live	70.4	2
3. Acer saccharinum	live	54.6	1
4. Acer saccharinum	live	53.3	1
5. Acer saccharinum	dead	53.3	1
6. Acer saccharinum	dead	52.6	1
7. Acer saccharinum	live	74.9	1
8. Acer saccharinum	dead	93.2	2
9. Acer saccharinum	live	56.1	1
10. Acer saccharinum	live	80.0	2
11. Acer saccharinum	live	49.8	1
12. Acer saccharinum	live	57.2	1
13. Acer saccharinum	dead	63.0	1
14. Acer saccharinum	live	63.8	1
15. Acer saccharinum	dead	60.7	1

ten to one. Two lines of 100 traps each and one line of 90 traps (total no. of traps = 290) were distributed throughout the Kettle River tract.[4] The traps were laid down in a pattern of ten museum specials followed by one Sherman live trap. The distance between consecutive traps was 8-10 meters and the total length of a line was approximately 1000 meters. Traps were baited with a mixture of peanut butter, liver and bacon grease. In addition to the traplines, two conibear traps were set along an inland lake in an attempt to capture larger species such as mink (Mustela vison), woodchuck (Marmota monas) or muskrat (Ondatra zibethica).

All traps were checked and rebaited each morning of the trapping session. Dead captures were assigned a number corresponding to the trap number and retained. Specimens badly damaged by scavengers were disposed of. For these specimens, information on species and sex was obtained if possible, and in some cases, measurements were taken prior to disposal of the specimen. Live captures were identified by species and sex and retained only if the animal was in poor condition or if the species was not well documented on the area. An attempt was made to save skins and/or skulls from all members of the family Soricidae so that positive species identification could be made.

In the lab, collected specimens were identified to species (if possible) and measured. Measurements included weight (grams), total body, tail, ear and hind foot length (millimeters). Other information recorded included the date and location of the capture, type of trap, and the sex and age (immature or adult) of the specimen.

Whenever possible, two of each species caught were prepared as voucher specimens and deposited in the collection at the Bell Museum of Natural History, University of Minnesota. Skulls were kept to provide a means of positive

---

[4]Maps showing locations of traps and traplines plus descriptions of vegetation types traversed are available in the SNA files.

identification. A catalogue of species and a trapping journal also accompanied the vouchers to the museum. Copies of the catalogue and journal have been retained for the SNA files. Reproductive information, including measurements of tests and embryos, was obtained for voucher specimens and recorded in the catalogue. Mammals not prepared as vouchers were kept frozen and donated to supporting institutions.

In addition to trapping, drift fences were used to simultaneously collect reptiles, amphibians and small mammals. As described earlier, two drift fences were established in lowland areas on the Kettle River site. The drift fences were only in operation for a few nights in mid-August.

To supplement the trapping data, incidental mammal sightings were recorded whenever possible. Many additional hours were spent on the natural area and this increased the chances of encountering uncommon species or larger mammals that could not be effectively trapped. Mammal signs or tracks were also recorded as evidence of an animals presence on the area. To increase the chances of locating tracks, a scent station was established along the shore of an inland lake. A commercial muskrat lure was displayed at the station and checked every morning during the trapping session. A set of tracks was found on 31 July 1980, but were too obscure to identify.

Incidental mammal sightings were recorded with the date, location and details of the observation. These incidentals were added to the existing list of species for the Kettle River tract.

DISCUSSION

The results of the 1980 mammal inventory are presented in Table 5. The table indicates the method of identification (trapping, drift fence or sighted/sign) for each species and the number recorded under each method. Overall, a total of eighteen species were recorded on the Kettle River tract.

Table 5. MAMMALS OF THE KETTLE RIVER NATURAL AREA

Species Scientific Name	Common Name	METHODS Trapping Number	METHODS Drift Fence	INCIDENTALS Sighted	INCIDENTALS Track/Sign
Sorex cinereus	Masked shrew	2	1		
Sorex sp.		3			
Blarina brevicauda	Shorttail shrew	2			
Sylvilagus floridanus	Eastern cottontail			1	
Tamias striatus	Eastern chipmunk			2	
Marmota monax	Woodchuck			1	
Sciurus carolinensis	Eastern gray sq.			1	
Tamiasciurus hudsonicus	Red squirrel			5	
Castor canadensis	Beaver				2
Peromyscus maniculatus	Deer mouse	2			
Peromyscus leucopus	White-footed mouse	8			
Peromyscus sp.		85			
Cleithrionomys gapperi	Boreal Redback Vole	15			
Microtus pennsylvanicus	Meadow Vole	12			
Zapus hudsonius	Meadow jumping mouse	1			
Neozapus insignis	Woodland jumping mouse	1			
Zapus or Neozopus sp.		6			
Erethizon dorsatum	Porcupine				1
Ursus americanus	Black bear				1
Procyon lotor	Raccoon				1
Odocoileus virginianus	Whitetail Deer			4	1

The results of the small mammal trapping are summarized by the total number of each species caught. One hundred thirty-seven animals were captured during the three night trapping effort (786 trap nights). This represents a trapping success of 17.4%. In addition, one Sorex cinereus was captured in the drift fence, but was not included in the calculation of trapping success.

Of the one hundred thirty-seven small mammals captured, forty-three individuals were positively identified to the species level. For these species, specimens and skulls have been deposited at the Bell Museum. For the remaining ninety-four individual specimens, identification is certain only to the generic level. However, specimens of the genera Peromyscus, Zapus, and Neozapus can only belong to species already documented on the area (Peromyscus leucopus, P. maniculatus, Zapus hudsonius, and Neozapus insignis). On the other hand, the specimens of Sorex which were identified only to genus level may include undocumented species. Unfortunately, despite the attempt to save all Sorex skins and skulls, some specimens were too badly damaged to be retained for identification purposes.

The predominant genera caught on the natural area during the trapping session were all members of the family Cricetidae: Peromyscus, Clethrionomys and Microtus. The four species that represent these genera accounted for 86% of the total number of specimens captured. The population of Peromyscus was particularly high; Peromyscus spp. were encountered in all of the major habitats that were sampled.

Other species documented during the trapping session included the following: Sorex cinereus, Blarina brevicauda, Zapus hudsonius, and Neozapus insignis. Although less abundant in numbers, these species add to the overall diversity of small mammal populations at Kettle River.

Ten additional mammal species were recorded as incidentals on the natural area (Table 4). Beaver, (Castor canadensis), black bear (Ursus americanus), raccoon (Procyon lotor) and porcupine (Erethizon dorsatum) were each documented on the area solely on the basis of tracks and other signs of their presence. For example, three small beaver dams along Willburn Creek (Fig. 4) show signs of continued upkeep by beaver. At the southwest end of the long inland lake, in Section 22, there is an active beaver lodge constructed in the roots of an upturned tree. The depth of the water near the lodge was increased with the help of another dam at the southwest end of the lake. Trembling aspen, the predominant tree species along the upland ridges, provides an abundant food resource and also supplies building material for the beaver.

Fresh black bear tracks were found on 29 July, 1980 along the south shore of the Oxbow Lake in Section 23. Plaster casts have been made of the tracks and they are presently being stored at the SNA office. Raccoon tracks were also found near the Oxbow Lake and were numerous along the Kettle River. Extensive diggings found along the sandy river bank were also thought to be the result of raccoon activity.

Evidence of porcupine activity on the tract was also common. Debarked red pines were visible on an upland red pine paper birch ridge in the NW¼ of Section 15. This open sandstone ridge may also provide a suitable den site for porcupines.

Other species observed on the tract include the woodchuck, eastern cottontail (Sylvilagus floridanus) gray squirrel, (Sciurus carolinensis) red squirrel (Tamiasciurus hudsonicus) eastern chipmunk (Tamias striatus) and white-tail deer, (Odocoileus virginianus). The red squirrel and white-tail deer were seen frequently.

MANAGEMENT RECOMMENDATIONS

The Kettle River SNA does not appear to require any particular management

work at this time. It is adequately posted as an SNA, and does not seem to be suffering from any significant overuse or abuse.

REFERENCES

Chamberlain, Leon M. 1977. Soil Survey of Anoka County, Minnesota. U.S. Dept. of Agriculture, Soil Conservation Service.

Chandler, Val. 13 November 1980. Personal communication. Minn. Geological Survey.

Chase, Clement G., and Todd H. Gilmer. 1973. Precambrian Plate Tectonics: The Midcontinent Gravity High. Earth and Planetary Science Letters, Vo. 21, 70-78.

Conant, R. 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Boston: Houghton Mifflin Co.

Craddock, Campbell. 1972a. Keweenawan Geology of East-Central and Southeastern Minn.: In P.K. Sims and G.B. Morey, ed., Geology of Minn: A Centennial Volume. Minnesota Geological Survey, 416-424.

Craddock, Campbell. 1972b. Late Precambrian, Regional Geologic Setting. In P.K. Sims and G.B. Morey, ed., Geology of Minn.: A Centennial Vol. Minn. Geological Survey, 281-291.

Curtis, John T. 1971. The Vegetation of Wisconsin. Madison: Univ. of Wisconsin Press.

Ehrlich, Paul R. and Anne H. Ehrlich. 1961. The Butterflies. Dubuque, Iowa: Wm. C. Brown and Co.

Fedkenheuer, A. W. 1975. Past and Present Forest Communities of St. Croix State Park, Minnesota and their Use in Determining Ecomanagement Direction. Ph.D. Thesis, Univ. of Minnesota.

Franklin, J.M., W.H. McIlwaine, K.H., Poulsen, and R.K. Wanless. 1980. Stratigraphy and Depositional Setting of the Sibley Group, Thunder Bay District, Ontario, Canada: Canadian Journal of Earth Sciences, 17: 633-651.

Hall, C.W. 1901. Keweenawan Area of Eastern Minnesota. Geological Society of America Bulletin, Volume 12, 313-342.

Halls, H.C. 1978. The Late Precambrian Central North American Rift System--A Survey of Recent Geological and Geophysical Investigations. In Neumann, E.R., and I.B. Ramberg, ed., Tectonics and Geophysics of Continental Rifts. D. Reidel Publ. Co., Dordrecht, Holland, 111-123.

Heitlinger, Mark. 1979. Vegetation Analysis for 1979 SNA-DNR Inventory. Unpub. report, revised 1980 by L.A. Pfannmuller.

Helgeson, J.O., G.F. Lindholm, W.L. Broussard and D.W. Ericson, 1973. Water Resources of the Kettle River Watershed, East-Central Minnesota. U.S. Geological Survey Hydrologic Investigations Atlas HA-437.

Howe, W.H. 1975. The Butterflies of North America. Garden City, New York: Doubleday, Inc.

Huber, R. 1979. Minnesota Butterflies - Uncommon Species. Unpub. Report.

King, E.R., and Zietz, I. 1971. Aeromagnetic Study of the Midcontinent Gravity High of Central U.S. Geological Society of America Bulletin, Volume 82, 2187-2208.

Klots, A.B. 1951. A Field Guide to Butterflies. Boston: Houghton Mifflin Co.

Leverett, Frank. 1932. Quaternary Geology of Minnesota and Parts of Adjacent States. .S. Geological Survey Professional Paper 161.

Lewis, Royce R. 1978. Soil Survey of Carlton County, Minnesota. U.S. Dept. of Agriculture, Soil Conservation Service.

Marschner, F.J. 1930. The Original Vegetation of Minnesota. Published 1964 by Soil Conservation Service, U.S. Dept. of Agric., St. Paul, Minnesota.

McCabe, T.L. and R.L. Post. 1977. Skippers of North Dakota. Dept. of Entomology, Ag. Exp. Station, North Dakota State Univ.

McCormick, Gerald William. 1978. Till Genesis and Soils in East-Central Minn. M.S. Thesis, University of Minnesota.

Minnesota Department of Natural Resources, Division of Parks and Recreation, Scientific and Natural Areas Section. 1980a. Long Range Plan.

Minnesota Department of Natural Resources, Division of Parks and Recreation, Scientific and Natural Areas Section. 1980. Minnesota's Landscape Regions.

Minnesota Department of Natural Resources, Division of Waters, Dam Safety Section, 1971. Various communications relating to Nammacher Lake.

Minnesota Department of Natural Resources, Division of Waters, Watershed Mapping Project. 1980. Watershed divide maps.

Minnesota Department of Transportation, Highway Division. 1980. Construction Project Log Record, Trunk Highway 48.

Minnesota Geological Survey. 1980. Aeromagnetic Map of Minn., Sandstone Southeast Quadrangle, Total Magnetic Intensity Anomaly.

Minnesota Natural Heritage Program. 1980a. Plant Community Classification, 8 August 1980 Draft.

Minnesota Natural Heritage Program. 1980b. Status sheet for Brus canadensis tabida (Greater Sandhill Crane).

Mooney, Harold M., Campbell Craddock, Paul R. Farnham, Stephen H. Johnson and Gary Volz. 1970. Refraction Seismic Investigations of the Northern Midcontinent Gravity High. Journal of Geophysical Research. 75(26):50-508b.

Morey, G.B. 1972. Petrology of Keweenawan Sandstones in the Subsurface of Southeastern Minnesota. In P.K. Simms and G.B. Morey, ed., Geology of Minn.: A Centennial Vol. Minn. Geological Survey, 436-449.

Morey, G.B., and M.G. Mudrey, Jr. 1972. Keweenawan Volcanic Rocks in East-Central Minnesota. In P.K. Simms and G.B. Morey ed., Geology of Minn.: A Centennial Vol. Minn. Geological Survey, 425-430.

Morey, G.B. 17 November 1980. Personal Communication. Associate Director, Minn. Geological Survey.

Ocola, Leonidas C., and Robert P. Meyer. 1973. Central North American Rift System: Structure of the Axial Zone from Seismic and Gravimetric Data. Journal of Geophysical Research, 78(23):5173-5194.

Robbins, C.S. 1979. Census Techniques for Forest Birds: In Management of Southern Forests for Nongame Birds, U.S.D.A. Forest Service, Southeastern Research Station.

Trygg, J. 1967. Composite Map of U.S. Land Surveyors' Original Plats and Field Notes.

Tryhorn, A.D., and Richard W. Ojakangas. 1972. Sedimentation and Petrology of the Upper Precambrian Hinckley Sandstone of East-Central Minn. In P.K. Simms and G.B. Morey, ed., Geology of Minn.: A Centennial Vol. Minn. Geological Survey, 431-435.

U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service. 1969, 1975. Aerial photographs.

U.S. Department of Agriculture, Soil Conservation Service. Various dates. Soil surveys and soil survey interpretations.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1977. Climate of Minnesota. Climatography of the U.S., No. 60.

U.S. Department of the Interior, U.S. Geological Survey. 1961. Sandstone Quadrangle: 15-minute series topographic map.

U.S. Department of the Interior, U.S. Geological Survey. 1978. Water Resources Data for Minnesota, Water Year 1977. U.S.G.S. Water Data Report MN-77.

University of Minn., Agricultural Experiment Station. 1980. Minn. Soil Atlas, Stillwater Sheet: Misc. Report 171-1980.

Wright, H.E., Jr. Quarternary History of Minnesota. In P.K. Simms and G.B. Morey, ed., Geology of Minn.: A Centennial Vol. Minn. Geological Survey,

Wright, H.E. Jr., and W.A. Watts. 1969. Glacial and Vegetational History of Northeastern Minnesota. Minnesota Geological Survey Special Publication 11.

APPENDICES

Appendix I. Soil Series Classifications

Map Symbol on Figure 2	Soil Series Name	Soil Family Placement in U.S. Soil Conservation Service Class.
Ap	Wet Alluvium	Unclassified
Av	Alluvium	Unclassified
Aw	Sandy Alluvium	Unclassified
Mp	Wet Stony Land	Unclassified
Mw	Stony Land	Unclassified
Pp	Histosols	Histosols, Undifferentiated
Rv	Unnamed	Unclassified
Te	Steep Gravel Escarpments	Unclassified
Tp	Ronneby	Aeric Fragiaqualfs, coarse-loamy, mixed, frigid
Tw	Milaca	Typic Fragiochrepts, coarse-loamy, mixed, frigid

APPENDIX II. PLANT SPECIES LIST

ACERACEAE
- Acer negundo L.
- Acer rubrum L.
- Acer saccharinum L.
- Acer spicatum Lam.

ALISMATACEAE
- Alisma subcordatum Raf.
- Sagittaria latifolia Willd.

ANACARDIACEAE
- *Rhus radicans L.

APIACEAE
- *Cicuta maculata L.
- Cryptotaenia canadensis (L.) DC.
- Heracleum maximum Bartr.
- *Hydrocotyle americana L.
- Osmorhiza claytoni (Michx.) Clarke
- Sanicula gregaria Bickn.
- Sanicula marilandica L.
- Sium suave Walt.
- Zizia aurea (L.) Koch.

APOCYNACEAE
- Apocynum androsaemifolium L.

AQUIFOLIACEAE
- Ilex verticillata (L.) Gray.

ARACEAE
- Acorus calamus L.
- Arisaema triphyllum (L.) Schott.
- Calla palustris L.
- Symplocarpus foetidus (L.) Nutt.

ARALIACEAE
- Aralia hispida Vent.
- *Aralia nudicaulis L.
- Aralia racemosa L.

ARISTOLOCHIACEAE
- Asarum canadense L.

ASCLEPIADACEAE
- Asclepias exaltata L.
- Asclepias incarnata L.

ASTERACEAE
- Achillea millefolium L.
- Anennaria neodioca Greene.
- Artemisia serrata Nutt.
- Aster lateriflorus Willd.

*Aster macrophyllus L.
Aster puniceus L.
Aster simplex Willd.
Aster unbellatus Mill.
Bidens cernua L.
Bidens frondosa L.
Cirsium muticum Michx.
Crepis tectorum L.
Erigeron philadelphicus L.
Eupatorium maculatum L.
Eupatorium perfoliatum L.
*Eupatorium rugosum Houtt.
Helianthus giganteus L.
Helianthus strumosus L.
Hieracium canadense Michx.
Lactuca canadensis L.
Petasites palmatus (Ait.) Gray.
Petasites vitifolius Greene.
Prenanthes alba L.
Rudbeckia laciniata L.
Senecio aureus L.
Solidago canadensis var. scabra (Muhl.) T. & G.
Solidago flexicaulis L.
Solidago juncea Ait.
Taraxacum officinale Weber.
Traopogon dubis Scop.

BALSAMINACEAE
Impatiens capensis Meerb.

BERBERIDACEAE
*Caulophyllum thalictroides (L.) Michx.

BETULACEAE
Alnus rugosa (DuRoi.) Spreng.
Betula lutea Michx.
Betula papyrifera Marsh.
Carpinus caroliniana Walt.
Corylus americana Walt.
Corylus cornuta Marsh.
Ostrya virginiana (Mill.) K. Koch.

BORAGINACEAE
Myosotis scorpioides L.

BRASSICACEAE
Arabis divaricarpa Nels.
*Cardamine bulbosa (Schreb.) BSP.

CAMPANULACEAE
Campanula aparinoides Pursh.
Campanula rotundifolia L.

CAPRIFOLIACEAE
Diervilla lonicera Mill.
Linnaea borealis L.
Lonicera canadensis Marsh.

Lonicera dioica L. var. glaucescens (Rydb.) Butters.
*Lonicera oblongifolia (Goldie.) Hook.
Sambucus pubens Michx.
Symphoriocarpos albus (L.) Blake.
Viburnum lentago L.
Viburnum rafinesquianum Schult.
Viburnum trilobum Marsh.

CARYOPHYLLACEAE
Stellaria aquatica (L.) Scop.
Stellaria longifolia Muhl.

CELASTRACEAE
Celastrus scandens L.

CONVOLULACEAE
Convolvulus sepium L.

CORNACEAE
Cornus canadensis L.
Cornus racemosa Lam.
Cornus rugosa Lam.
Cornus stolonifera Michx.

CRASSULACEAE
Penthorum sedoides L.

CUCURBITACEAE
*Echinocystis lobata (Michx.) T. & G.

CUPRESSACEAE
Thuja occidentalis L.

CYPERACEAE
Carex arcta Boott.
Carex bromoides Willd.
Carex critina Lam.
Carex disperma Dew.
Carex emoryi Dew.
Carex interior Bailey
Carex intumescens Rudge.
Carex lacustris Willd.
Carex leptalea Wahlenb.
Carex lupulina Willd.
Carex pensylvanica Lam.
Carex retrorsa Schwein.
Carex rostrata Stokes.
Carex sprengelii Spreng.
Carex tenera Dew.
Carex tuckermanii Dew.
Eleocharis acicularis (L.) R. & S.
Scirpus atrocinctus Fern.
*Scirpus atrovireus Willd.
Scirpus cyperinus (L.) Knuth
Scirpus rubrotinctus Fern.
Scirpus validus Wahl.

DIOSCOREACEAE
Dioscorea villosa L

EQUISETACEAE
Equisetum arvense L.
Equisetum fluviatile L.
Equisetum sylvaticum L.

ERICACEAE
Epigaea repens L.
*Gaultheria procumbens L.
Ledum groenlandicum Oeder.
Monotropa uniflora L.
Pyrola elliptica Nutt.
Vaccinium angustifolium Ait.
Vaccinium myrtilloides Michx.

FABACEAE
Amphicarpa bracteata (L.) Fern.
Desmodium canadense (L.) DC.
Desmodium glutinosum (Muhl.) Wood.
Lathyrus venosus Muhl.
Trifolium pratense L.
Trifolium repens L.
Vicia americana Muhl.

FAGACEAE
Quercus macrocarpa Michx.

GENTIANACEAE
Gentiana andrewsii Griseb. var. andrewsii

GERANIACEAE
Geranium maculatum L.

HYDROPHYLLACEAE
Hydrophyllum virginianum L.

HYPERICACEAE
Triadenum fraseri (Spach.) Gl.

IRIDACEAE
Iris versiclolr L.

JUGLANDACEAE
Juglans cinerea L.

LAMINACEAE
Agastache scrophulariaefolia (Willd.) Kuntze.
Lycopus uniflorus Michx.
Melampyrum lineare Desr.
Mentha arvensis L.
Monarda fistulosa L.
Prunella vulgaris L.
Scutellaria epilobiifolia Hamilt.
Scutellaria lateriflora L.
Stachys tenuifolia Willd.

LEMNACEAE
Lemna minor L.

LILIACEAE
Clintonia borealis (Ait.) Raf.
Lilium superbum L.
Maianthemum canadense Desf.
Smilacina racemosa (L.) Desf.
Smilacina stellata (L.) Desf.
Smilax hispida Muhl.
Smilax lasioneura Hook.
Streptopus roseus Michx.
Trillium cernuum L.
Uvularia grandiflora Sm.

LOBELIACEAE
Lobelia inflata L.

LYCOPODIACEAE
Lycopodium clavatum L.
Lycopodium obscurum L.

MENISPERMACEAE
Menispermum canadense L.

MORACEAE
Humulus lupulus L.

NYMPHAECEAE
Nuphar variegatum Engelm.
Nymphaea odorata Ait.

OLEACEAE
Fraxinus nigra Marsh.
Fraxinus pennsylvanica Marsh. var. subintegerrima (Vahl.) Fern.

ONAGRACEAE
Circaea alpina L.
Circaea quadrisulcata (Maxim.) Franch. & Sav.
Epilobium angustifolium L.
Epilobium glandulosum Lehm.
Epilobium leptophyllum Raf.
Oenothera biennis L.

OPHIOGLOSSACEAE
Botrychium virginianum (L.) Sw.

ORCHIDACEAE
Cypripedium calceolus L. var. parviflorum (Salisb.) Fern.

OSMUNDACEAE
Osmunda cinnamomea L.
Osmunda claytoniana L.
Osmunda regalis L.

OXALIDACEAE
Oxalis stricta L.

PAPAVERACEAE
*Sanguinaria canadensis L.

PINACEAE
Abies balsamea (L.) Mill.
Larix laricina (DuRoi.) K. Koch.
Picea glauca (Moench.) Voss.
Picea mariana (Mill.) BSP.
Pinus resinosa Ait.
Pinus strobus L.

POACEAE
*Agrostis hyemalis (Walt.) BSP.
Agrostis scabra Willd.
Bromus ciliatus L.
Calmagrostis canadensis (Michx.) Beauv. var. canadensis
Cinna latifolia (Trev.) Griseb.
Danthonia spicata (L.) Beauv.
*Elymus virginicus L.
Glyceria canadensis (Michx.) Trin.
Glyceria grandis S. Wats.
Glyceria striata (Lam.) Hitchc.
Hystrix patula Moench.
Leersia oryzoides (L.) Sweet.
Leersia virginica Willd.
Muhlenbergia mexicana (L.) Trin.
Panicum boreale Nash.
Panicum columbianum Nash.
Panicum lanuginosum Ell. var. fasciculatum (Torr.) Fern.
Panicum leibergii (Vasey) Scribn.
Panicum linearifolium Scribn.
Panicum oligosanthes Schultea. var. Scriberianum (Nash.) Fern.
Phalaris arundinacea L.
Poa paludigena Fern. & Wieg.
Poa palustris L.
Poa pratensis L.

POLYGONACEAE
Polygonum cilinode Michx.
Polygonum coccineum Muhl.
Polygonum punctatum Ell.
Polygonum sagittatum L.
Rumex orbiculatus Gray.

POLYPODIACEAE
Adiantum pedatum L.
*Athyruium filix-femina (L.) Roth.
Cystopteris fragilis (L.) Bernh. var. Mackayi Lawson.
Dryopteris cristata (L.) Gray.
Dryopteris spinulosa (Mull.) Watt. var. spinulosa
Gymnocarpium dryopteris (L.) Newm.
*Matteccia struthiopteris (L.) Todaro.
Onoclea sensibilis L.
Polypodium virginianum L.
Peteridium aquilinum (L.) Kuhn.
Thelypteris palustris Schott.

PORTULACEAE
Claytonia virginica L.

PRIMULACEAE
Lysimachia ciliata L.
Lysimachia thrysiflora L.
Trientalis borealis Raf.

RANUNCULACEAE
Actaea rubra (Ait.) Willd.
Anemone canadensis L.
Anemone quinquefolia L.
Aquilegia canadensis L.
Caltha palustris L.
Clematis virginiana L.
*Coptis groenlandica (Oeder) Fassett.
Ranunculus abortivus L.
Ranunculus flabellaris Raf.
Ranunculus pensylvanicus L.
ranunculus recurvatus Poir.
Ranunculus septentrionalis Poir.
Thalictrum dasycarpum Fisch. & Ave'-Lall.
Thalictrum dioicum L.

RHAMNACEAE
Ceanothus americanus L.

ROSACEAE
Agrimonia gryposepala Wallr.
Amelanchier sanguinea (Pursh.) DC.
Crataegus chrysocarpa Ashe.
Fragaria virginiana Duschesne.
Geum rivale L.
Potentilla palustris (L.) Scop.
Potentilla simplex Michx.
Prunus pensylvanica L.f.
Prunus serotina Ehrh.
Prunus virginiana L.
Pyrus melanocarpa (michx.) Willd
Rosa blanda Ait.
Rubus allegheniensis Porter.
Rubus flagellaris L.
Rubus occidentalis L.
Rubus pensilvanicus Poir
Rubus strigosus Michx.
Spiraea alba DuRoi.
Spiraea tomentosa L.

RUBIACEAE
Galium boreale L.
Galium tinctorium L. var. tinctorium
Galium trifidum L.
Galium triflorium Michx.

RUTACEAE
*Zanthoxylum americanum Mill.

SALICACEAE
Populus grandidentata Michx.
Populus tremuloides Michx.
Salix bebbiana Sarg.
*Salix discolor Muhl.
Salix gracilis Anderss.
Salix pyrifolia Anderss.
Salix rigida Muhl.
Salix serissima (Bailey) Fern.

SANTALACEAE
*Comandra unbellata (L.) Nutt.

SAXIFRAGACEAE
Mitella diphylla L.
Ribes americanum Mill.
Ribes cynosbati L.
Ribes glandulosum Grauer.
Ribes hirtellum Michx.
Saxifraga pensylvanica L.

SCROPHULARIACEAE
Castilleja coccinea (L.) Spreng.
Chelone glabra L.
Gratiola neglecta To-r.
Mimulus glabratus HBK.
Mimulus ringens L.
Pedicularis canadensis L.
Pedicularis lanceolata Michx.
Veronica americana (Raf.) Schw.
Veronica scutellata L.

SPARGANIACEAE
Sparganium chlorocarpium Rydb.
Sparganium eurycarpum Engelm.

TILIACEAE
Tilia americana L.

TYPHACEAE
*Typha latifolia L.

ULMACEAE
Celtis occidentalis L.
Ulmus americana L.

URTICACEAE
Boehmeria cylindrica (L.) Sw.
Laportea canadensis (L.) Wedd.
Pilea pumila (L.) Gray.
Urtica gracilis Ait.

VERBENACEAE
Verbena hastata L.

VIOLACEAE
Viola cucullata Ait.

Viola incognita Brainerd
Viola pallens (Banks) Brainerd.
Viola pubescens Ait.
Viola sororia Willd.

VITACEAE
*Parthenocissus inserta (Kerner) K. Fritsch.
*Vitis riparia Michx.

*Species observed but not collected.