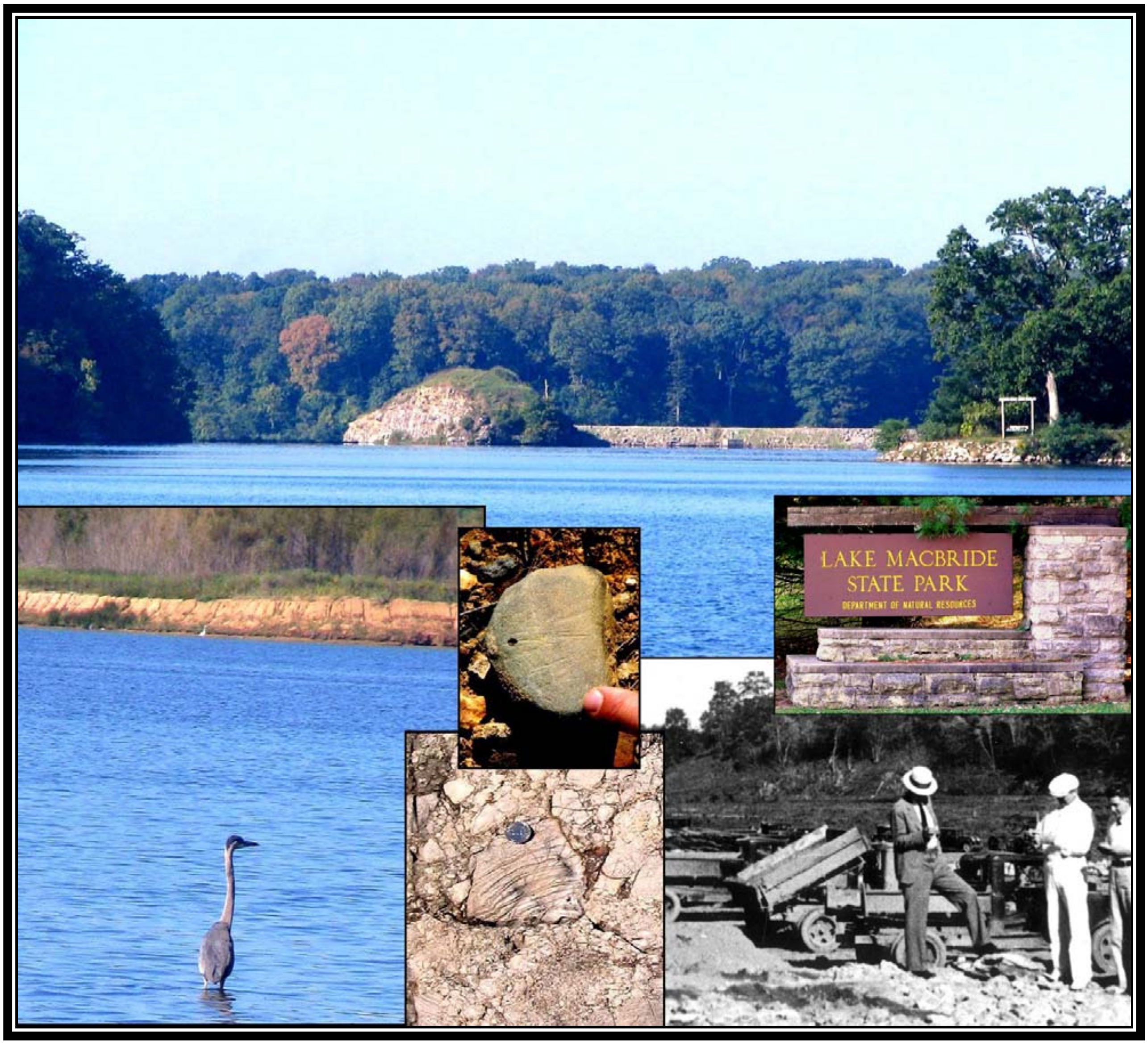
# THE NATURAL HISTORY OF LAKE MACBRIDE STATE PARK, JOHNSON COUNTY IOWA

edited by Raymond R. Anderson & Chad L. Fields




**Geological Society of Iowa**

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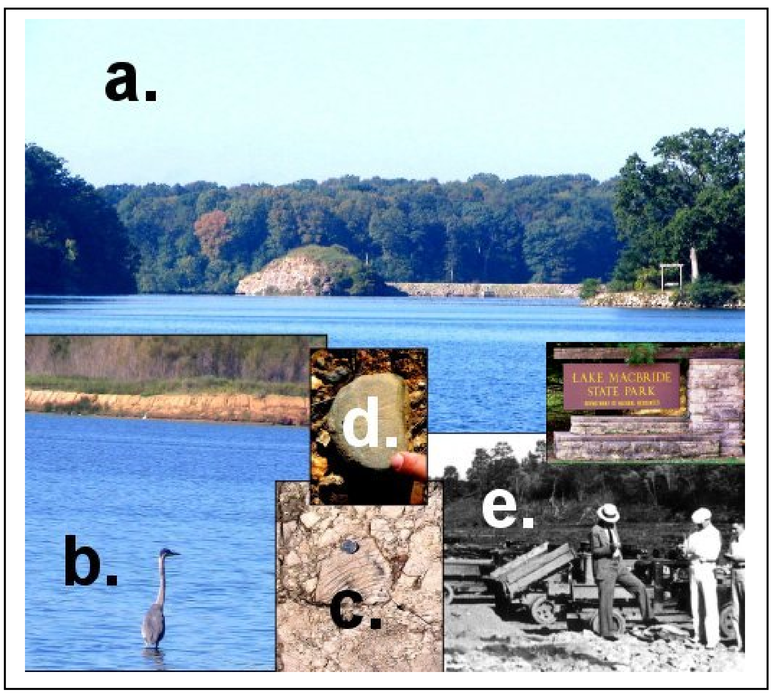


**Key to Cover Photomosaic**

a. View of Lake Macbride looking southwest from the beach area shows the spillway framed between a rock bluff on the left and a rock knob on the right.
b. Heron (foreground) and egret (background) in Coralville Lake near Macbride dam.
c. Davenport breccia in breccis "dikes" along Coralville Lake north of Macbride dam.
d. Glacial erratic with prominent glacial stria in till exposed north of Macbride dam.
e. Equipment and workers constructing the original Lake Macbride dam in 1936.

# THE NATURAL HISTORY OF LAKE MACBRIDE STATE PARK, JOHNSON COUNTY IOWA

*edited by:*

**Raymond R. Anderson and Chad L. Fields**
Iowa Geological Survey
Iowa City, Iowa 52242-1319

*with contributions by:*

**Lynn Alex**
Office of the State Archaeologist
700 South Clinton Street Building
Iowa City, IA 52242-1030

**Leslie Ambrosino**
Consulting Archaeological Services
P.O. Box 686.
Creston, Iowa 50801

**Mark L. Anderson**
Office of the State Archaeologist
700 South Clinton Street Building
Iowa City, IA 52242-1030

**Raymond R. Anderson**
Iowa Geological Survey
Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

**Joe A. Artz**
Office of the State Archaeologist
700 South Clinton Street Building
Iowa City, IA 52242-1030

**Chad L. Fields**
Iowa Geological Survey
Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

**Daryl Howell**
Conservation & Recreation Division
Iowa Department of Natural Resources
Des Moines, IA 50319

**John Pearson**
Conservation & Recreation Division
Iowa Department of Natural Resources
Des Moines, IA 50319-0034

**Jonathan Sellars**,
Consulting Archaeological Services
P.O. Box 686.
Creston, Iowa 50801

**Stephanie A. Tassier-Surine**
Iowa Geological Survey
Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

**Brian J. Witzke**
Iowa Geological Survey
Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

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# INTRODUCTION TO THE NATURAL HISTORY OF LAKE MACBRIDE STATE PARK, JOHNSON COUNTY, IOWA

Raymond R. Anderson
Iowa Geological Survey
Iowa City, IA 52242

## The Park

One of Iowa's oldest and most scenic parks, Lake Macbride State Park encompasses 2,180 acres of rolling woodlands surrounding a multi-use lake. The park features fishing, picnicking, swimming, hiking, camping, boating and many other activities. The northern of the park's two units lies at the end of County Road F-16, 4 miles west of Solon. This unit includes a modern campground, boat ramps, beach (Fig. 1) and boat rental, picnic areas and the park office. The southern unit, located off County Road F-28 (Fifth Street in Solon) 3 miles west of Solon, offers a non-modern campground, boat ramps, picnic areas, a Frisbee golf course and a prairie.

Multi-use trails wind for miles around the lake, accessible via a five-mile scenic multi-use trail that runs from Solon to near the park entrance and very popular with bicyclists. All park trails offer opportunities for the best sights and sounds of Iowa. Bird watchers will thrill to the sight of nearly every native songbird in the region. During the spring and fall, shorebirds, water-fowl and ospreys are frequent visitors. During winter months, cross-country skiing and snowmo-biling are popular.

**Figure 1.** Beach and bathhouse at Lake Macbride State Park.

Lake Macbride State Park features two campgrounds. The modern campground in the northern unit of the park has 50 sites 37 with electrical hookups and 13 without, a shower and restroom and a trailer dump station. The non-modern campground in the southern park unit has 60 campsites and a non-flush restroom. This campground is located in a beautiful shaded setting near the lake. Both campgrounds have a playground nearby. Starting February 13, 2006, advance campsite reservations can be booked through the park reservation system. Half of the campsites are still available for self-registration on a first-come, first-serve basis.

Lake Macbride offers swimming as well as refreshments at the beautiful beach area. The Macbride beach is a great place for young and old to cool off on a hot summer day. Swimming is restricted to the designated beach area only.

Lake Macbride is an angler's delight! Good catches of walleyes, channel catfish, crappies and bluegill await the angler in the 812-acre artificial lake (Fig 2.). Walleyes, channel catfish and muskies are stocked annually. Lake Macbride may be the only lake in Iowa in which the prized Kentucky spotted bass can be caught. Good lake access is available for both shoreline and boat fishing.

There are seven boat ramps on the lake and one on Coralville Lake. Pontoons, motorboats, canoes and paddle boats are available for rent near the beach. The boat rental number is 319/624-2315. A 10 horsepower motor limit is in effect on Lake Macbride from May 21 through September 7. At all other times there is an unrestricted horsepower motor limit operated at a no-wake speed. Any size motor may be used on Coralville Lake. Pontoon docking spaces are available for rental, as are dry-storage spots for boats.

**Figure 2.** The Lake Macbride Dam looking south towards the spillway. Lake Macbride is on the left, Coralville Lake is on the right.

## The Name

The name for Lake Macbride State Park came from a contest sponsored by a committee of the Iowa City Chamber of Commerce. The committee offered a prize of fifty dollars for the winning name, the only entry requirement being the suggested name accompanied by a letter of not more than two hundred words explaining why the name should be used. The judges who selected the winning name included representatives of the Iowa City Chamber of Commerce, the Lions Club, Kiwanis Club, Rotary, and the Women's Garden Club. By the deadline for entries, May 23, 1934, over six hundred entries were submitted, the majority from Iowa City and Cedar Rapids. The winning name was announced at the dedication of the park on Memorial Day, May 30, 1934. The fifty-dollar prize was awarded to Mrs. Onie Strub of the East Lucas township. Mrs. Strub suggested that the park be named after Thomas Huston Macbride, former University of Iowa President and professor, a prominent botanist, and an educational leader. The selection committee believed that Lake Macbride State Park would perpetuate his name.

## Topographic Map and Aerial Photos

The following pages include a topographic map of the Lake Macbride State Park area as well as several aerial photograph mosaics of the region.

The topographic map (Fig. 3) is a portion of the US Geological Survey's Ely 7.5 minute quadrangle map. The map, which features surface contours with a contour interval of 10 feet, shows all of Lake Macbride as it appears today, all of the lands of the State Park, and part of the Coralville Lake.

The first photo mosaic (Fig. 4) is a 1930s vintage composite of black and white aerial photographs. It shows the lake, as it was originally constructed in 1936, with the smaller dam and smaller lake. Also note the Iowa River is shown prior to the construction of the Coralville Dam and the impoundment of the Coralville Reservoir.

The second photo mosaic (Fig. 5) is composed of several 2002 color infrared aerial photographs, part of a statewide photo series. Color infrared, also known as "false color" uses special film and filters to produce an image from which all blue color is filtered out. The film assigns blue colors to things that we normally see as green, green colors to what we normally see as red, and red to objects that reflect near infrared wavelengths, normally invisible to our eye. In the color version of this photo (see pdf of guidebook on GSI website) healthy vegetation reflects highly in the infrared and so looks bright red, whereas water absorbs most infrared wavelengths and so appears dark or black. This photographic technique sees through haze very well and also shows variations in soils moisture in bare ground areas.

The third photo mosaic (Fig. 6) is a composite of standard color aerial images collected in 2005. The western area of Lake Macbride on this composite is the eastern edge of one of the composited photographs, and the sun angle created glare on the water when the image was collected.

## Enjoy your visit to Lake Macbride state park

The field trip leaders hope that you will enjoy your visit to Lake Macbride State Park and hope that you will return again to take advantage of the park's many assets. Please be safe and considerate of others. **Collecting of rocks and other natural materials is prohibited in the park, so only take pictures.**

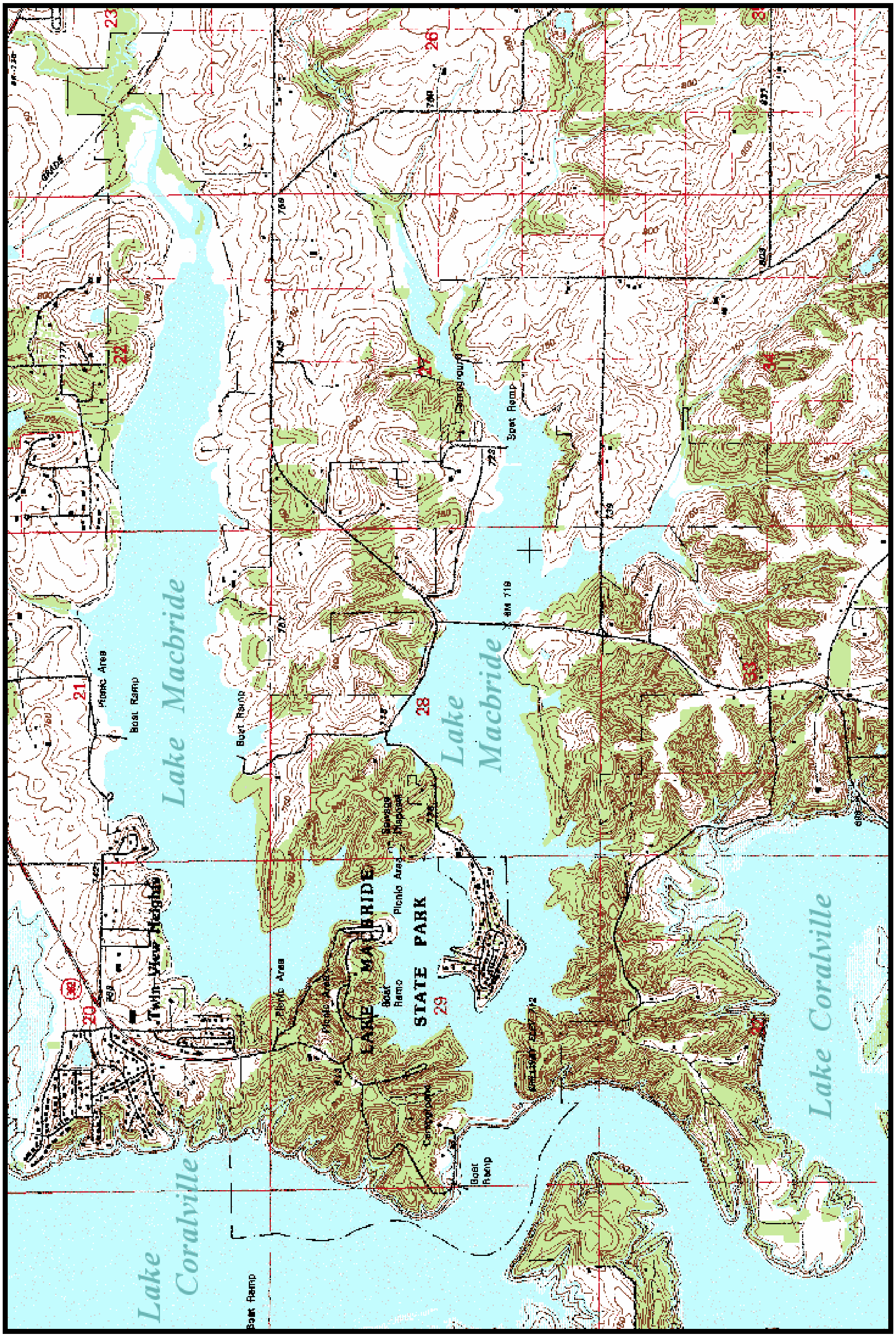


**Figure 3**. Portion of the U.S. Geological Survey 7.5 minute topographic map of the Ely Quadrangle that includes the Lake Macbride area.

**Figure 4**. Portion of the 1930s georectified aerial photography of Johnson County that includes the Lake Macbride area. From Iowa Department of Natural Resources Geographic Information System Library.

**Figure 5.** Poaration of 2002 color infrared aerial photography of Johnson County that includes the Lake Macbride area. From Iowa Department of Natural Resources Geographic Information System Library.

**Figure 6.** Poaration of 2005 color aerial photography of Johnson County that includes the Lake Macbride area. From Iowa Department of Natural Resources Geographic Information System Library.

# OVERVIEW OF THE QUATERNARY GEOLOGY OF LAKE MACBRIDE STATE PARK

Stephanie A. Tassier-Surine
Iowa Geological Survey
Iowa City, IA 52242-1319

## REGIONAL SETTING

Lake Macbride State Park is located within the Southern Iowa Drift Plain landform region of Iowa (Prior, 1991). The boundary with the Iowan Surface is located a few miles to the north-northeast (Fig. 1). The Southern Iowa Drift Plain was glaciated numerous times between 2.2 million and 500,000 years ago. Subsequent erosion and drainage development shaped the landscape of steeply rolling hills and integrated drainages that we see today. In contrast, the Iowan Surface is representative of a period of periglacial activity associated with the Wisconsin glacial maximum. Between 16,500 and 21,000 years ago a period of intense cold resulted in erosion and mass wasting (Bettis and Kemmis, 1992). Characteristic features of the Iowan Surface include a gently sloping landscape, an erosional remnant in the form of a stone line lag deposit, and colluviated materials on the land surface. The area around Lake Macbride State Park is characteristic of the features associated with the Southern Iowa Drift Plain.

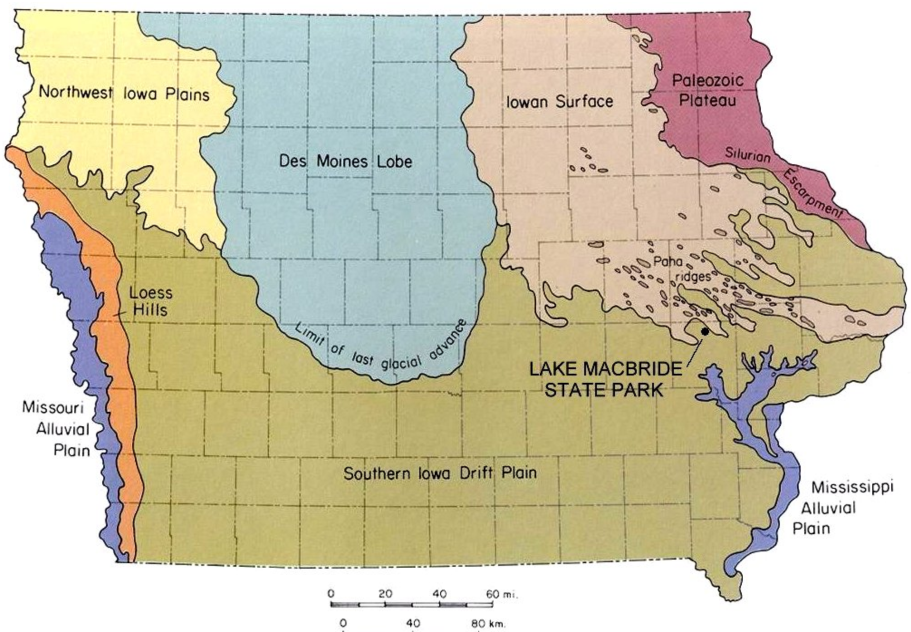


**Figure 1.** Landform regions of Iowa (Prior, 1991)

## REGIONAL STRATIGRAPHY

The Quaternary stratigraphy of east-central Iowa is dominated by Pre-Illinoian till deposits overlain by Wisconsin Episode loess. The deposits of the mid-continent represent one of the best records of continental glaciation, although they are incomplete due to a complex history of deposition, erosion and downcutting events. The basic stratigraphy for east-central Iowa is outlined below.

## Pre-Illinoian Episode

Early glacial studies in Iowa outlined a two-tiered stratigraphy for the entire state, consisting of the 'Kansan' and 'Nebraskan' till sheets. Subsequent work completed in the 1970's and 1980's, based on both stratigraphic studies and laboratory analysis, led to the recognition of a much more complex glacial stratigraphy for Iowa (Boellstorff 1978a, 1978b; Hallberg 1980a, 1980b, 1986). Boellstorff identified seven tills in western Iowa and eastern Nebraska, and Hallberg recognized at least six tills in eastern Iowa. As a result, the Kansan-Nebraskan terminology was abandoned in favor of the term Pre-Illinoian.

In east-central Iowa two Pre-Illinoian formations are recognized and differentiated based primarily on clay mineralogy, the Wolf Creek and older Alburnett formations (Hallberg, 1980a). The Wolf Creek Formation is distinguished due to its much higher percentage of expandable clay minerals. The Wolf Creek is further subdivided into three members based on carbonate (calcite-dolomite) ratios, sand fraction lithology and particle-size data. Oldest to youngest, the members are the Winthrop, Aurora and Hickory Hills till members. The Alburnett Formation consists of multiple members identified in outcrop and core, but no conclusive analytical method has been found to differentiate them. Multiple Alburnett Formation tills are only identified if more than one is found at a locality. Otherwise, it is difficult to identify which till member is at a given site if only one is present. Both Pre-Illinoian till formations may also have fluvial materials associated with them and are commonly separated by paleosols.

## Illinoian Episode

Illinoian Episode till was deposited in Iowa between 300,000 and 130,000 years ago (Hallberg, 1980b). These materials are only present in the southeastern portion of the state including Lee, Des Moines, Louisa, Muscatine and Scott counties. Illinoian age tills in Iowa are composed of the Kellerville member of the Glasford Formation. They are primarily distinguished by the clay mineral composition and the abundance of Pennsylvanian lithologies in the sand-size fraction through cobble-size clasts. When compared with Pre-Illinoian tills, Illinoian tills have a much higher percentage of illite in the clay mineral fraction and a much lower calcite-dolomite ratio.

## Wisconsin Episode

Several formations in east-central Iowa are associated with the Wisconsin time period. Two Wisconsin Episode eolian (wind-blown) deposits are identified in the region- the Peoria Formation and the older Pisgah Formation. A weakly expressed interstadial soil, the Farmdale Geosol, is commonly formed in the upper part of the Pisgah Formation. These loess and eolian sand deposits mantle the uplands and older terrace deposits throughout the state.

The most widespread materials of the Wisconsin Episode in east-central Iowa are the Peoria and Pisgah formation loesses. These materials were deposited between 12,500 and 30,000 years ago (Bettis, 1989) and blanket much of the state.

The name Pisgah Formation was proposed by Bettis (1990) and replaces materials previously referred to as the basal Wisconsin sediment or the basal Wisconsin loess. The Pisgah Formation has an equivalent stratigraphic position with the Roxana Silt of Illinois and the Gilman Canyon Formation of Nebraska. The Pisgah Formation was deposited approximately 24,000 to 30,000 years ago (Bettis, 1989) and may include loess, colluvium, or slope deposits. It typically overlies the Sangamon Geosol and has the Farmdale Geosol formed in its surface. The Farmdale Geosol is a weakly developed interstadial soil that consists mostly of organic matter accumulation.

The Farmdale Geosol and Pisgah Formation are overlain by the Peoria Formation. The Peoria was deposited from 25,000 to 12,500 years ago and may be composed of either a silt or sand facies. These wind-blown sediments accumulated during and after the Last Glacial Maximum. The Peoria occurs throughout Iowa and ranges in thickness with proximity to the source. Loess is the thickest near the Iowan Surface and near local valley sources (Iowa River). The Peoria Formation materials are most commonly uniform, oxidized, yellow-brown, silt loam. The upper portion is typically leached, but in thicker sections the lower portion can be unleached and may contain gastropods.

Multiple Wisconsin terrace deposits have also been identified in east-central Iowa. Esling (1984) placed these into three sets of deposits: the Early Phase High Terrace (EPHT), the Late Phase High Terrace (LPHT) and the Low Terrace (LT). These deposits are all the result of erosion of the surrounding uplands.

EPHT deposits have a well-expressed Sangamon Geosol and are mantled by both the Pisgah and Peoria formation loesses. These terrace deposits are older than 40,000 years B.P., but are younger than Illinoian age (Esling, 1984). The LPHT is only mantled by Peoria Formation materials and is 12,500 to 25,000 years old. LT deposits are not mantled by Wisconsin eolian materials and accumulated between 21,000 and 10,000 years ago.

Bettis and Ludvigson (1988) mapped the outcrops along the Coralville Reservoir shoreline. Both EPHT and LPHT deposits were noted, as well as Pennsylvanian and Devonian bedrock. Limited areas of Pre-Illinoian till were identified, but there are likely more that are obscured by colluvial materials. A modified map of their work is shown in Figure 2.

Although a landscape feature and not a deposit, the Iowan Surface developed during Wisconsin time, between about 16,500 and 21,000 years ago (Bettis and Kemmis, 1992). The Iowan Surface developed during the coldest part of the Wisconsin Episode resulting in a period of extensive erosion in northeast Iowa. Much erosion of the Pre-Illinoian tills and associated paleosols occurred. In many areas a lag deposit of coarser material was left at the surface and is referred to as a stone line. The Iowan Surface is the dominant landform region of northeast Iowa (Fig. 1).

A portion of the Johnson County Surficial Geologic Map (Tassier-Surine et al., 2004) produced as part of the STATEMAP program is shown in Figure 3 and illustrates the location of Lake Macbride State Park and its relation to the Iowan Surface boundary. The Iowan Surface is located approximately two miles to the northeast of Stop 4. The unit bordering the Iowan Surface to the south contains eolian sand and silt. The majority of Lake Macbride State Park is mapped as 'Thick Loess' and is described as being a uniform silt without the presence of sand. This unit ranges in thickness from five to fifteen meters. These thick deposits are the result of the close proximity to both the Iowan Surface and the Iowa River valley.

## QUATERNARY EXPOSURES WITHIN LAKE MACBRIDE STATE PARK

The Quaternary exposures at Lake Macbride State Park are typical of what would be expected on the Southern Iowa Drift Plain. The basic stratigraphy consists of Peoria Formation loess overlying the Sangamon Geosol formed in Pre-Illinoian till. The Pisgah Formation deposits and the Farmdale Geosol may also be present, but were not identified at the exposure we will visit. They have been identified in other areas surrounding the Coralville Reservoir, but it is not clear whether they were never deposited or subsequently eroded at this location. Bettis (1989) reports that Pisgah materials range from one to three feet in thickness in the Coralville Reservoir area.

To access Stop 4, we will walk northwest from the Coralville boat ramp along the east shore of the Coralville Reservoir. Along the way, we will see several Quaternary deposits.

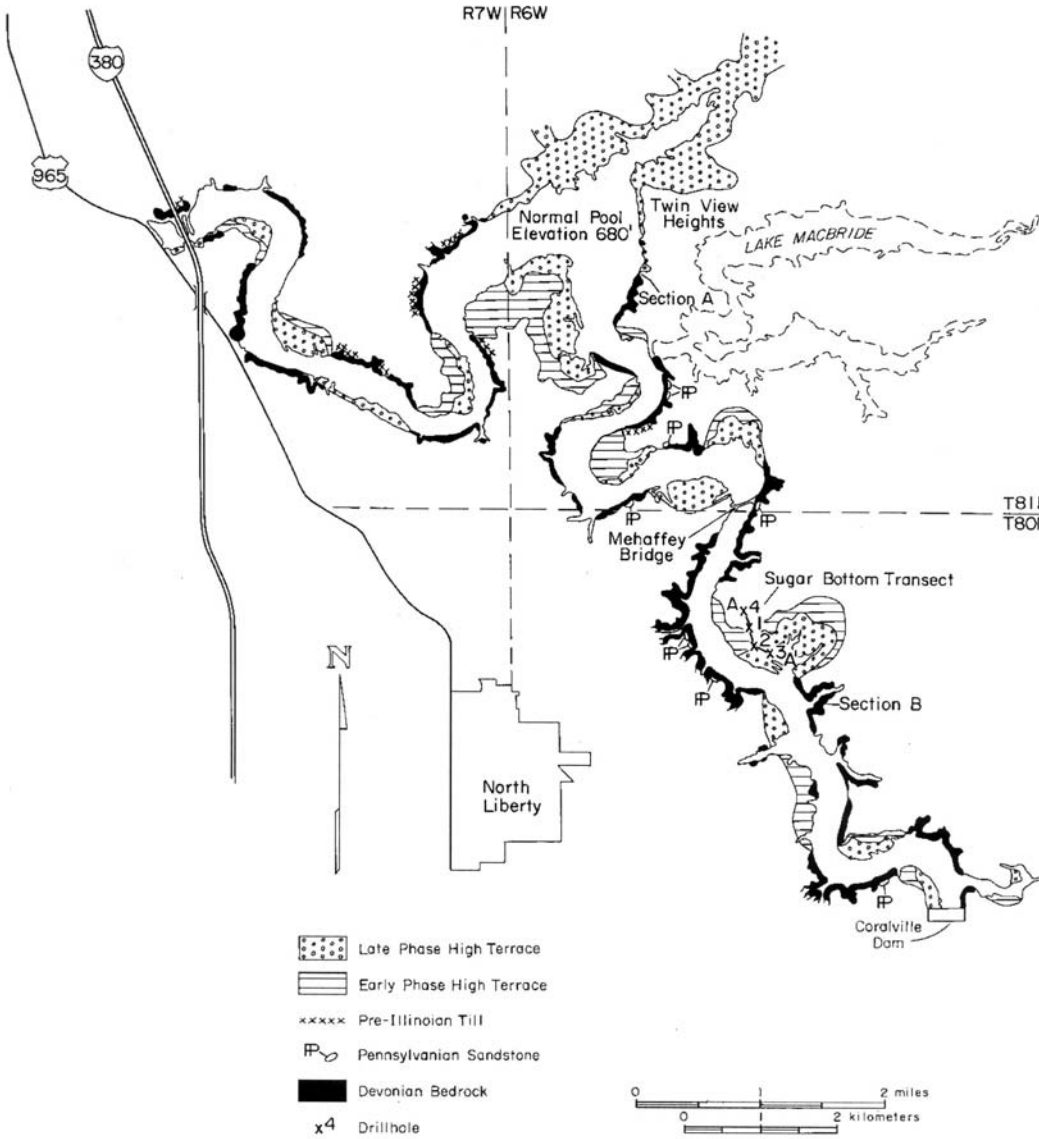


**Figure 2**. Map showing Coralville Reservoir shoreline deposits. Units include EPHT, LPHT, Pennsylvanian and Devonian bedrock and Pre-Illinoian till. Modified from Bettis and Ludvigson, 1988.

Pre-Illinoian till is intermittently present along the path we will walk along the shore. In some areas the Sangamon Geosol formed in Pre-Illinoian till is visible as a reddish clay loam with pebbles. In other areas the only indication of the till is the presence of glacial erratics face scattered on the bedrock surface. Striated glacial erratics (Fig. 4) may be found on the ground surnear the till outcrop. The striations form as erratics entrained in the base of the glacier grind along the bedrock surface.

There were multiple Pre-Illinoian glacier advances between 2.2 million and 500,000 years ago. However, due to the extensive weathering and soil formation it cannot be determined which formation is present. Clay mineralogy and carbonate ratios are two of the diagnostic features

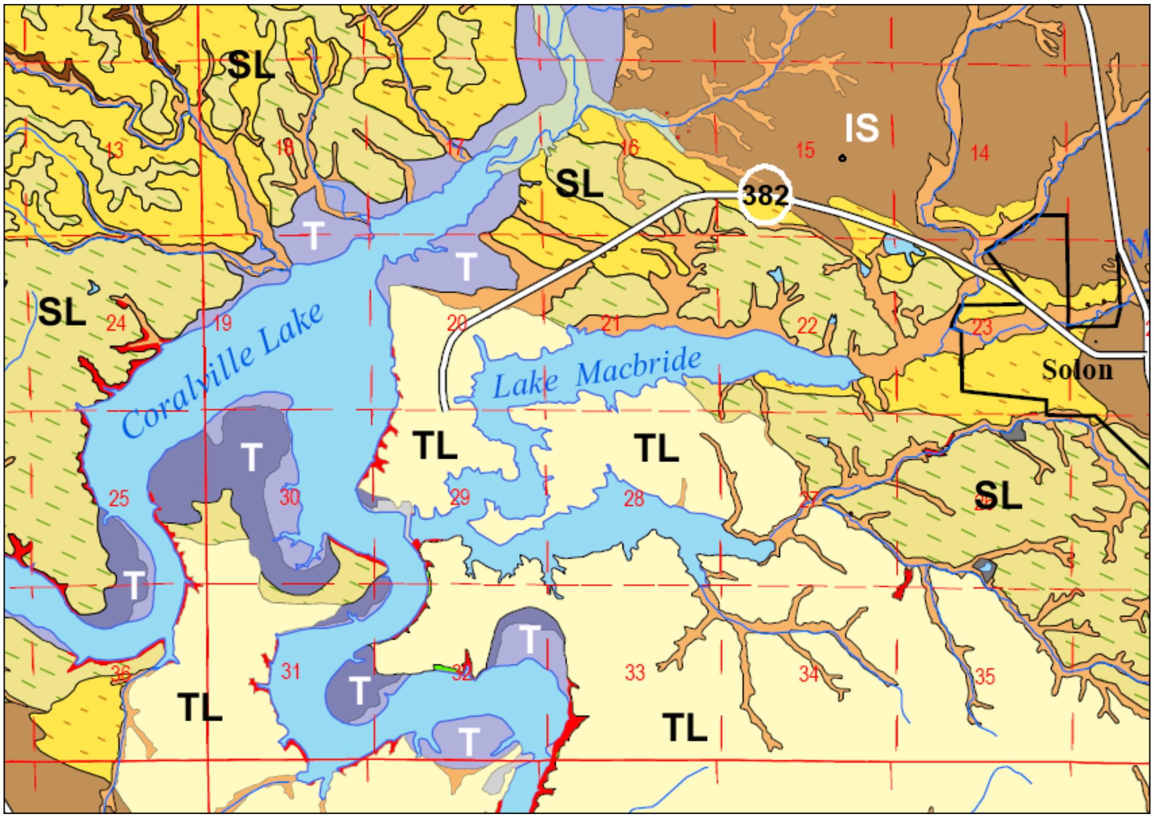


**Figure 3.** Surficial geologic materials surrounding Lake Macbride State Park (modified from Tassier-Surine et al., 2004). Units include the following: IS- Iowan Surface; TL- thick loess (up to 40'); SL- dashed area includes eolian sand (bordering Iowan Surface) and thinner loess; T- terrace deposits- darker color is EPHT and lighter color is LPHT. Thin dark areas along the shore are bedrock outcrops.

**Figure 4.** Striated glacial erratic near Stop 4. Striations indicate abrasion with the bedrock surface.

used to distinguish between the two Pre-Illinoian formations, but these analyses are not possible with oxidized materials.

Peoria Formation loess is present at the top of the section along most of the path we will follow. Although only five to twenty feet is exposed along the path, the Peoria Formation silt may exceed 35 feet in thickness in the park and surrounding area. The thickest exposed sequence is near the Fisheries Station. Historical reports suggest that this material was quarried for use in the building of the original dam (see Anderson p.71, this guidebook). The loess at the Fisheries Station is a uniform oxidized light brown silt loam. The upper portion is leached and the lower part of the section is unleached with gastropods. This is typical of the loess deposits in the area (Tassier-Surine et al., 2004).

Based on GEOSAM drilling records (http://gsbdata.igsb.uiowa.edu/geosam/), loess thickness ranges from 25 to 40 feet within the park. Till

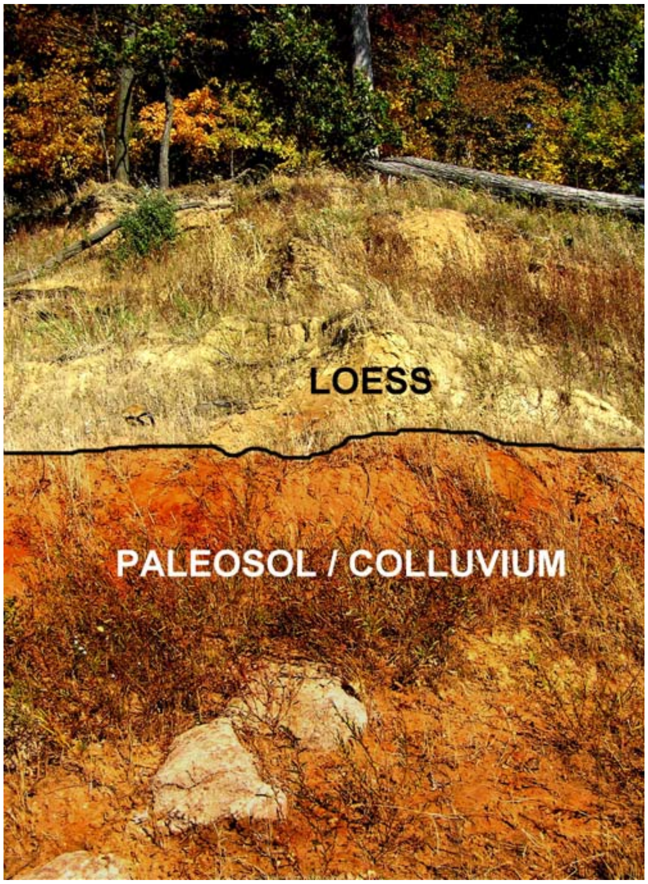


**Figure 5.** Outcrop along the path to Stop 4. Approximately ten feet of Peoria Formation loess overlies paleosol formed in colluvium. Devonian bedrock is exposed at the base of the section.

thickness ranges from 5 to 35 feet in the park (65' at the University of Iowa Recreation Area). The thickness of Peoria Formation silt (up to 40') is typical for landscape positions near river valleys.

There are several places along the path to see good exposures of Quaternary materials. Two basic sequences are present, one for valley deposits, and one for upland exposures. Closest to the boat ramp, Peoria Formation silt overlies older fine-grained alluvium with a paleosol formed in its surface. Secondary carbonate concretions are also common in this area. Some colluvial deposits are present, but the Pisgah and Pre-Illinoian formation materials are absent. Bettis (1989) mapped this area as EPHT (Fig. 2).

Farther along the trail, the bedrock elevation increases and till or till-derived colluvial materials become visible (Fig. 5). In this area the Peoria Formation loess is light brown, oxidized, unleached silt loam with few gastropods. The underlying material is five to ten feet thick and is a reddish-brown clay loam to silt loam with few pebbles and sand. A paleosol is formed in its upper surface. These materials are either colluvium or older alluvium overlying bedrock. Glacial erratics are located near the bedrock surface indicating that some of the material is till-derived colluvium or a remnant lag deposit where the till has been eroded.

At Stop 4, we will see a section more typical of upland deposits on the Southern Iowa Drift Plain. Pre-Illinoian till with the Sangamon Geosol formed in its upper part is overlain by Peoria Formation silt. The till is oxidized and leached clay loam with pebbles. Joints and mottling are present in some areas. The Sangamon Geosol is present as a reddish brown clay loam formed in the till surface. The upper part of the paleosol may be a colluvial mixing zone. No stone line is observed. The till and paleosol are mantled by approximately ten feet of Peoria Formation silt. The Peoria is oxidized, leached, light brown, uniform silt loam. The Pisgah Formation and Farmdale Geosol are not present.

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# BEDROCK GEOLOGY OF LAKE MACBRIDE STATE PARK AND MACBRIDE NATURE RECREATION AREA

Brian J. Witzke
Iowa Geological Survey
Iowa City, IA 52242

## INTRODUCTION

Extensive bedrock exposures of Devonian limestone are accessible along the shores of Coralville Lake in and around Lake Macbride State Park (LMSP) and Macbride Nature and Recreation Area (MNRA) (Fig. 1). These limestone strata belong to the Wapsipinicon and Cedar Valley Groups of Middle Devonian age (Witzke et al., 1988). In the Lake Macbride area, the Wapsipinicon Group is represented by exposures of the Davenport Member, and the Cedar Valley Group includes strata of the Little Cedar Formation (Solon and Rapid members). These geologic units are recognized across a broad area of the Midwest. The Wapsipinicon Group is known from both surface exposures and well penetrations over the region that covers eastern and central Iowa, western Illinois, northeastern Missouri, and southern Minnesota. The Cedar Valley Group (also known as the Cedar Valley Limestone) is even more widespread, covering the same region and extending farther into central Missouri and the subsurface of western Iowa, eastern Nebraska and eastern Kansas. Numerous exposures of Cedar Valley limestone strata are seen in quarries, roadcuts, and natural outcrops across a broad region of eastern and north-central Iowa, but the exposures seen along the shores of Coralville Lake, including the Lake Macbride area, are probably the best and most instructive available anywhere (Plocher, 1989; Witzke and Bunker, 1994).

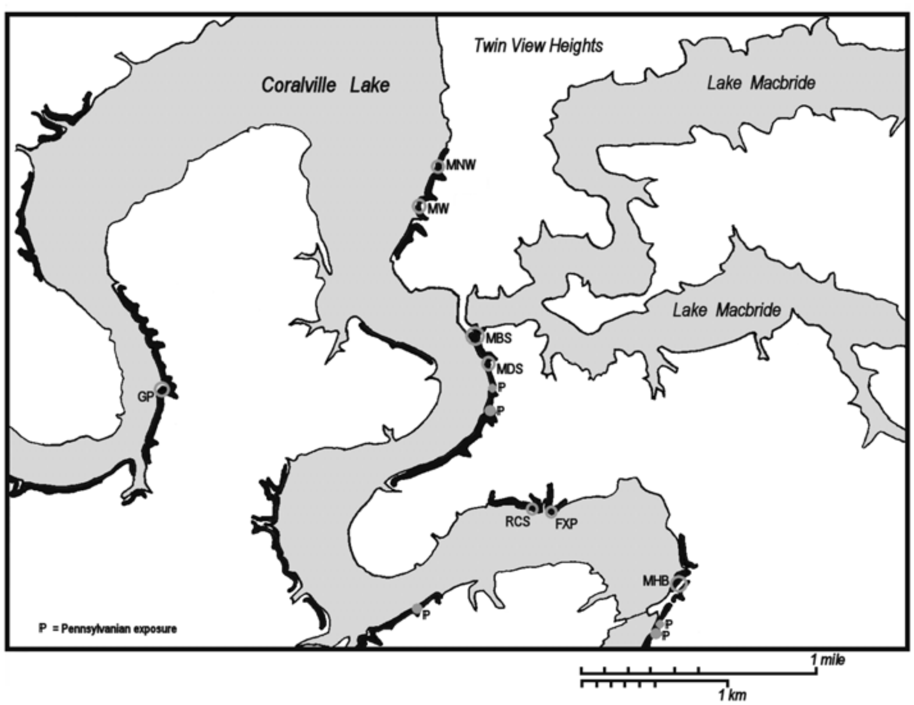


**Figure 1**. Map showing the distribution of bedrock exposures in the Lake Macbride area (adapted from Bettis, 1989). Bedrock exposure shown in black (mostly Devonian limestones). The location of measured sections discussed in the text and shown on Figures 2 and 4 are labeled (2- or 3-letter designations). Exposures of Pennsylvanian bedrock are also noted.

These strata were originally deposited as lime sediments in a shallow tropical sea that flooded much of the interior of North America during the Middle Devonian about 375 million years ago. The region that would one day be known as Iowa occupied an area south of the equator in the southern tropics at that time (the North American continent progressively drifted northward since the Devonian to reach its present position in mid northern latitudes). Seaways expanded and contracted across the interior of the continent numerous times during the Devonian, deepening and shallowing in response to global changes in sea level. One of the most pronounced deepening episodes of the Devonian (known as the Taghanic Onlap) is recorded by limestone strata of the Little Cedar Formation of Iowa, strata that are wonderfully displayed in the Lake Macbride area. These strata contain a wealth of fossils that provide evidence of the abundance and diversity of animals that inhabited the shallow Devonian seas of eastern Iowa (see Witzke and Bunker, 1994, for a summary of fossils that can be seen in the Coralville Lake area).

## DAVENPORT MEMBER

The Davenport Member is the uppermost unit of the Pinicon Ridge Formation of the Wapsipinicon Group, and interesting exposures of the upper part of the member are accessible along the shores of Coralville Lake in the northwestern part of Lake Macbride State Park. These exposures represent the oldest Devonian strata seen along the entire extent of Coralville Lake. The reason that the Davenport Member is seen in this area is due to the gentle upwarping of strata along the axis of the Twin View Heights Anticline, a broad northeast-trending geologic structure centered near Twin View Heights immediately north of Lake Macbride State Park (Plocher and Bunker, 1989). The unfossiliferous Davenport Member is overlain unconformably by fossiliferous limestone strata of the Solon Member (Fig. 2).

Exposures of the upper Davenport Member at LMSP are dominated by unfossiliferous limestone breccias. The breccias are characterized by broken angular pieces of dense limestone clasts typically varying in size from a few millimeters to 20 cm, but large blocks up to a meter or more in diameter are also entrained within the breccias. The angular clasts are enclosed and cemented within a matrix of dense limestone, in part argillaceous (i.e., contains clay) to sandy. The breccia clasts are dominated by dense "sublithographic" limestone, laminated in part. Some of the laminations represent sediment accumulations facilitated by blue-green algal (cyanobacterial) mats known as stromatolites. The term "sublithographic" refers to the resemblance of these lime mudstones to dense limestones once used in the preparation of lithographic plates. The breccias are replaced laterally over short distances by dense unbrecciated beds of sublithographic limestone. Some limestone beds seen at LMSP are highly fractured and display incipient brecciation but lack well-defined angular clasts cemented in a limestone matrix; these are informally known as "crackle breccias." Occasional clasts of fossiliferous Solon limestone are found within the upper Davenport breccias.

Depending on lake levels, up to 3 m (10 ft) of Davenport strata can be seen at LMSP. The upper surface of Davenport Member, beneath the Solon Member, is highly irregular, locally displaying up to 3 m (10 ft) of relief with complex brecciation of both Davenport and lower Solon strata. This highly irregular surface is dramatically displayed where elongate ridges of Davenport breccias (resembling dikes) are buried by the Solon limestones. In places, sandy and silty limestones fill fractures and pods within the upper Davenport beds, probably infillings of basal Solon sandy sediments.

Limestone breccias of the Davenport Member are widely seen across eastern Iowa, and their formation is interpreted to result from the dissolution of evaporites caused fracturing and collapse of interbedded limestone beds (a process known as evaporite-solution collapse). Interbedded limestone and evaporite (gypsum and anhydrite) units are still preserved in the subsurface of southeastern Iowa, where the Davenport Member is not brecciated. As the soluble evaporite

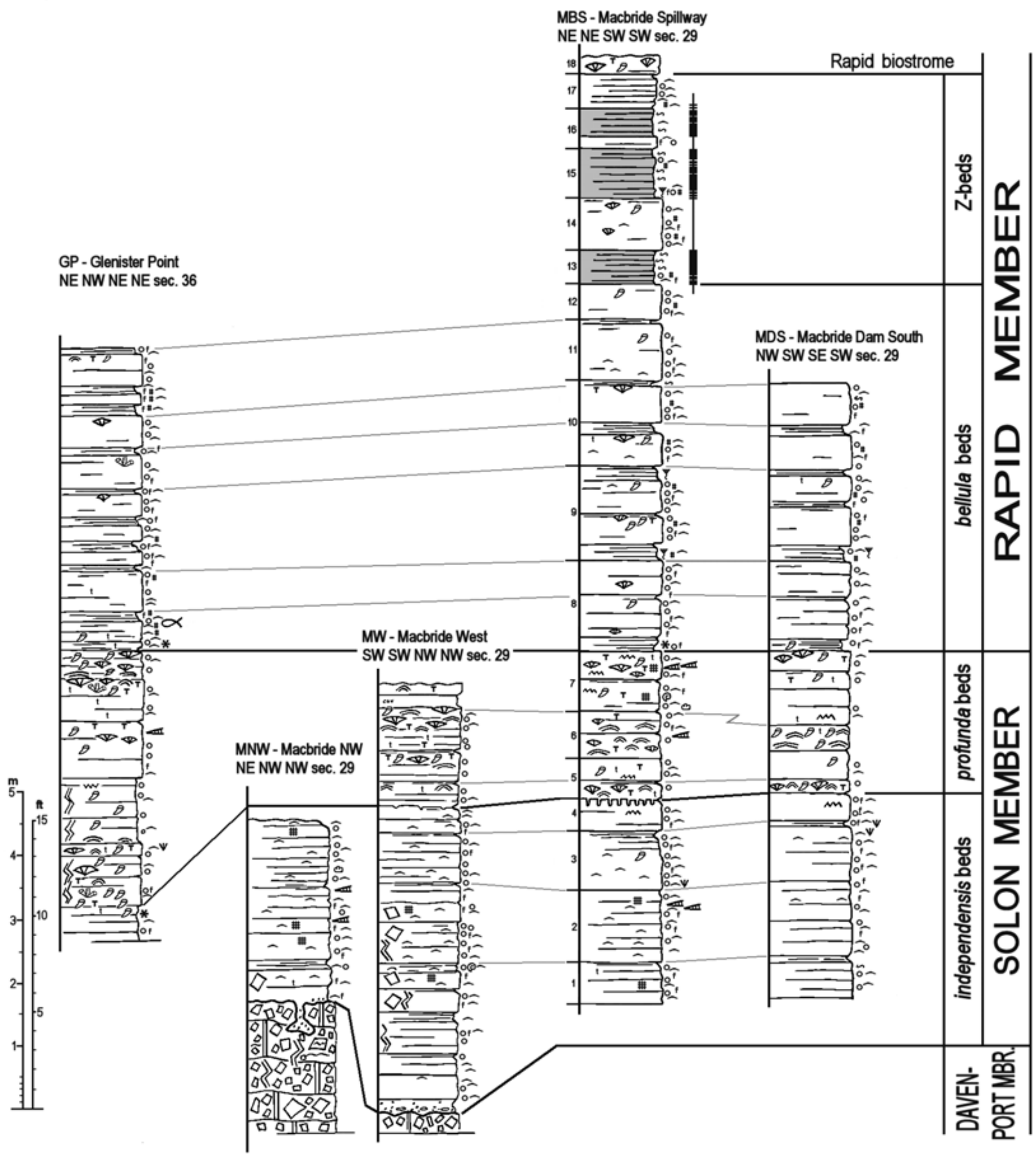


**Figure 2**. Graphic stratigraphic sections of Devonian bedrock exposures (Davenport, Solon, Rapid members) in the Lake Macbride area. Symbols as in Figure 4. All sections are in T81N, R6W, except Locality GP (T81N, R7W). See Figure 1 for locations.

beds were dissolved, the volume of rock was reduced, and the intervening limestone beds became broken and jumbled as the interval internally collapsed. The absence of shelly fossils and the presence of evaporites within the Davenport Member indicate a generally inhospitable and highly restricted hypersaline shallow sea in the region (Witzke and Bunker, 2006a). Normal seawater entered the shallow and restricted Wapsipinicon sea from the east, but circulatory barriers and excessive evaporation led to increasing salinities within the shallow waters of this sea and its marginal mudflats. Dissolution of Wapsipinicon evaporites resulted from the incursion of fresh-waters following the withdrawal of the shallow sea, as well as during the subsequent flooding of normal-marine seawater (which could also dissolve the evaporites) that initiated Solon deposition.

## LITTLE CEDAR FORMATION

The Little Cedar Formation is the basal formation of the Cedar Valley Group, and it includes the Solon and Rapid members in southeastern Iowa (Witzke et al., 1988; Witzke and Bunker, 2006b). These fossiliferous limestone strata are particularly well exposed in Johnson County, including a number of quarries (especially the Conklin and Klein quarries in Coralville) as well as outcrops in the Coralville Lake area (Fig. 3), including the Devonian Fossil Gorge section below the emergency spillway of the Coralville dam (Witzke and Bunker, 1994; Witzke et al., 1999). Individual beds within the formation can be traced across the county (Fig. 3) and much of southeastern Iowa (Witzke and Bunker, 2006b). The general succession of strata within the Little Cedar Formation of the Lake Macbride area is summarized below.

### Solon Member

Instructive exposures of the Solon Member are well displayed along the shores of Coralville Lake in the northwestern part of Lake Macbride State Park as well as at the spillway of the Lake Macbride dam and extending southward into the Macbride Nature and Recreation area. (Fig. 2). Additional exposures of the Solon Member are seen west of the park along the shores of Coralville Lake (e.g. Locality GP, Fig. 1). The Solon Member derives its name from nearby exposures at Solon, but the exposures in the Lake Macbride area are much more complete and readily accessible, and the Lake Macbride area is here designated the primary reference area for the member. The Solon Member is subdivided into two general units (see Witzke and Bunker, 1994): 1) the lower "independensis beds", and 2) the upper "profunda beds." The lower interval locally shows varying degrees of brecciation, fracturing, and complex internal block displacements in the Lake Macbride area and elsewhere in eastern Iowa. These features indicate that evaporite-solution collapse processes were still operating during deposition of the Solon Member. The degree of brecciation decreases upsection, probably marking the end of evaporite-solution collapse of underlying Wapsipinicon beds sometime during upper Solon or lower Rapid deposition.

#### *Lower Solon "independensis beds"*

The lower Solon "independensis beds" overlie an irregular surface at the top of the Davenport Member. The interval averages about 4 m (13 ft) thick in the Lake Macbride area, but it is locally thicker where it overlies depressions along the underlying surface. The interval derives its name from the characteristic and common atrypids brachiopod fossil *Independatrypa independensis*. The interval is dominated by fossiliferous limestone beds, slightly argillaceous, and with scattered thin argillaceous to shaley partings. The beds are relatively thin and irregularly bedded. The limestones are very fossiliferous and characterized by an abundance of calcitic skeletal grains, especially brachiopod shells and crinoid debris. The limestones are classified as skeletal wackestones and packstones, indicating the abundance of fossil grains.

A rich fossil fauna is recognized in the "independensis beds" of the Lake Macbride area, and some of the major fossils that have been observed are listed here. The commonest brachiopods include the atrypids *Independatrypa independensis* and *Spinatrypa mascula* and the orthid *Schizophoria meeki*. Preservation commonly is superb, and some articulated shells of Independatrypa preserve delicate internal spiral structures (spiralia). Many additional brachiopods have also been identified including species of *Pseudoatrypa*, *Athyris*, *Orthospirifer*, *Tylothyris*, *Cyrtina*, *Strophodonta*, *Productella*, and *Cranaena* (a full faunal list of Solon brachiopods is given by Day, 1992). Dense accumulations of large terebratulids (shells to 2.5 cm) observed at Locality MNW (Fig. 1) may belong to either *Cranaena* or *Rensselandia*. Crinoid debris, primarily disarticulated stem columnals, is quite common in the interval, and although their taxonomic identity remains unknown, their presence indicates that this group of stalked echinoderms was an abundant part of the lower Solon benthic fauna.

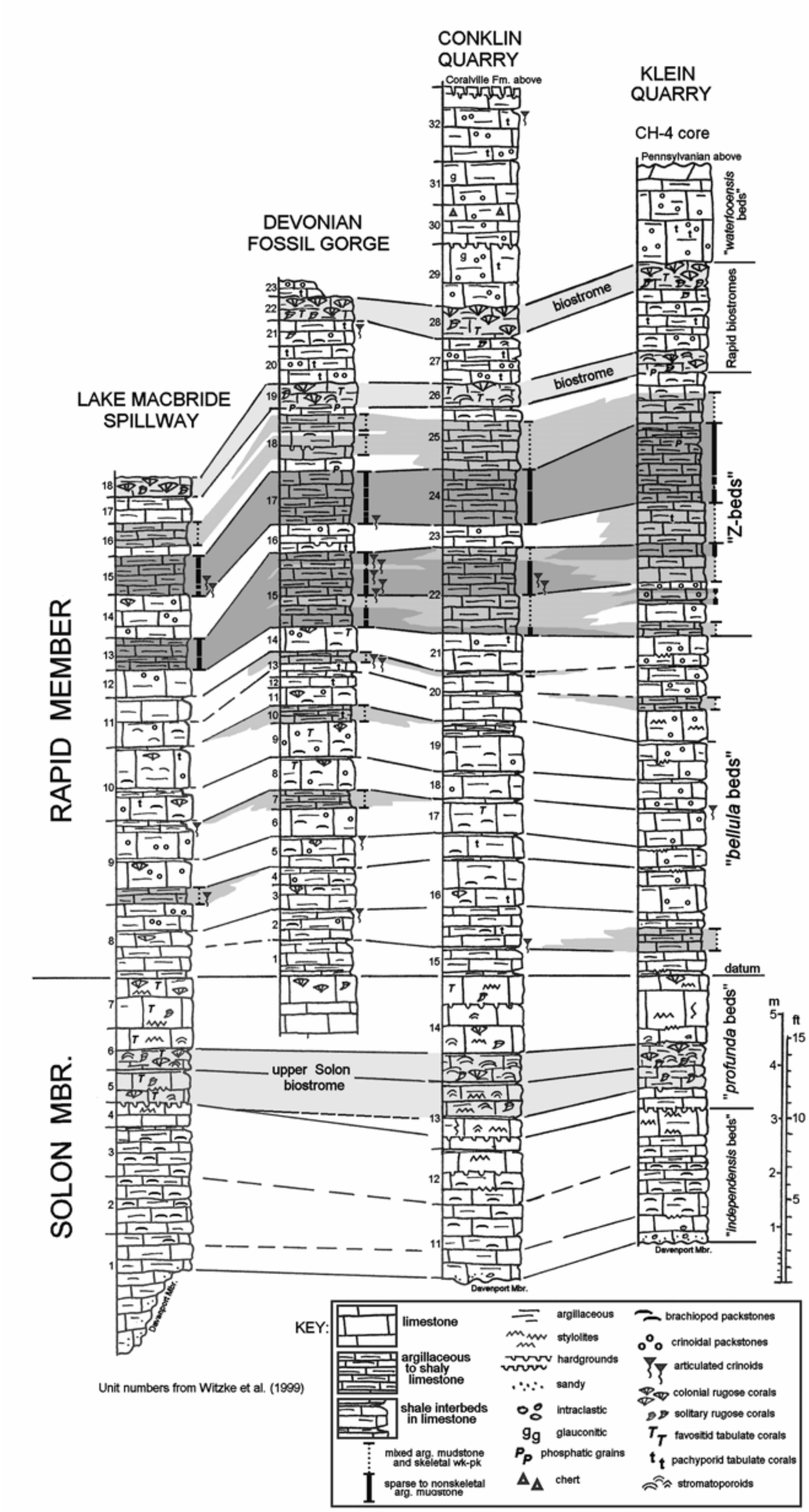


**Figure 3**. Representative graphic stratigraphic sections of the Little Cedar Formation in Johnson Co., Iowa. See Witzke and Bunker (1994) for discussion of the Devonian Fossil Gorge section located below the emergency spillway of the Coralville Dam. The Conklin and Klein quarries are located within the City of Coralville (see Witzke et al., 1999; Witzke and Bunker, 2006b).

Bryozoan fossils are a less conspicuous part of the fauna, but microscopic and macroscopic examination of the limestones indicates that these small colonial organisms were a significant part of the lower Solon fauna. Most identified bryozoans are lacey fenestellids, but trepostome bryozoans are also present in some beds. Trilobites are occasionally seen, and *Phacops iowensis* and *Crassiproetus* have been recognized at LMSP (see Hickerson, 1992, for a full listing of Solon trilobites). Corals are not common in the "independensis beds," although scattered solitary rugose corals (cup corals) and small auloporid tabulate corals have been recognized. Cup-shaped sponges bearing hexagonal calcareous spicules (*Astraeospongia*) are rare. Mollusk fossils are rare, but molds of nautiloid shells (ancient relatives of the modern chambered nautilus) are locally noteworthy. Vertebrate fossils include scattered fish teeth/bones (ptyctodont placoderms) and conodonts (an extinct group characterized by tooth-like microfossils). Mitchell (1977) also noted styliolines (an enigmatic fossil group with elongate shells) at the Lake Macbride spillway.

The lower Solon was deposited in a seaway that flooded a vast area of the North American continental interior, and the fauna migrated into eastern Iowa from distant regions of western Canada, New York, and elsewhere. The "independensis beds" were deposited in the deepest water environments of the Solon Member succession, and the fossil fauna indicates stable normal marine salinities within the seaway. The fauna and lithologies (rock types) closely resemble those seen in the portions of the stratigraphically higher Rapid Member (especially the bellula beds), and deposition was probably similar. Accumulations of brachiopods in lenses probably resulted from bottom currents generated by episodic tropical storms. The abundance of mud and the preservation of delicate fossil structures indicate that bottom current were generally incapable of winnowing mud and abrading shells. This indicates deposition below the depth of normal wave current activity. A prominent hardground surface (an irregular submarine surface marked by irregular sculpting) at the top of the lower Solon marks a period of nondeposition in the Solon succession.

### *Upper Solon "profunda beds"*

The upper Solon "profunda beds" contain remarkable accumulations of fossil corals and stromatoporoids in the Lake Macbride area, where it averages about 2.5 m (8 ft) thick; it is locally thicker in the area (up to 4 m thick at Loc. GP, Fig. 2). The name derives from the common colonial coral *Hexagonaria profunda*. The "profunda beds" are generally characterized by thicker and more massive beds of less argillaceous limestone than the underlying "independensis beds." The limestones are dominated by fine skeletal packstones in part with broken and abraded skeletal debris. Dense accumulations of corals and stromatoporoids (extinct sponges) characterize parts of the interval, especially the lower beds, and these accumulations are termed biostromes. Unlike true organic reefs which form topographic buildups on the seafloor, biostromes are horizontally bedded tabular beds, commonly with widespread geographic extent. However, variations in thickness within the "profunda beds" likely result from the development of locally thicker accumulations of corals and stromatoporoids, which are termed bioherms (reef-like buildups). Mitchell (1977) identified a stromatoporoid-rich bioherm at the Macbride spillway. It is true that dense accumulations of stromatoporoids are particularly well developed at that locality, but the dipping beds within the upper Solon which he interpreted as a bioherm buildup is more likely related to complex faulting and folding seen within the Little Cedar Formation at the spillway (see discussion by Anderson, this guidebook). While all limestone beds within the "profunda beds" are known to contain corals or stromatoporoids, those beds with only scattered or sparsely distributed coralline fossils are not considered to be biostromes.

A variety of fossils are identified in the "profunda beds" in the Lake Macbride area. Corals are particularly conspicuous and well preserved. Rugose and tabulate corals, both long extinct groups of corals unknown in the modern world, are present. Large colonial rugose corals, generally ranging in size between about 10 and 40 cm in diameter, are among the most attractive fossils seen, and these include the name bearer *Hexagonaria profunda* as well as *Asterobillingsia* (a form similar to *Hexagonaria* but with significantly larger individual corallites); the latter coral is restricted to the upper Solon interval in Johnson County. Fasciculate rugose corals (a loosely connected mass of cylindrical corallites) are rare, and these forms remain unstudied. Solitary rugose corals, also known as cup corals and horn corals because of their conical forms, are common in the interval, ranging in size from about 2 to 10 cm. Tabulate corals are colonial corals with relatively small individual corallites, and these are represented in the interval by a number of forms. The largest tabulates are massive, hemispherical or cylindrical forms (2 to 20 cm diameter) generally assigned to the genus *Favosites*. *Favosites* is commonly known as "honeycomb coral" because the hexagonal corallites resemble honeycomb. Additional tabulate corals include relatively common sheet-like alveolitids as well as rarer auloporids and small branching pachyporids (these forms remain unstudied and generically indeterminate, presently assigned to family only).

Stromatoporoids are an extinct group of sponges that possessed a dense calcite skeleton that displays a laminated structure with pillars and pores. Most stromatoporoids in the "profunda beds" are lamellar pancake-like forms, commonly 5 to 40 cm in diameter (locally larger). Additional stromatoporoids include massive to hemispherical forms, some displaying a lumpy exterior. Shapo (2003) identified several different genera of stromatoporoids from the Solon biostromes in the Coralville Lake area, including *Petridiostroma*, *Schistodictyon*, *Stictostroma*, and *Coenostroma*.

Brachiopods are relatively common in the "profunda beds," but they are proportionately less common than in the lower Solon. Identified forms in the Lake Macbride area include *Independatrypa*, *Spinatrypa*, *Orthospirifer*, *Athyris*, *Strophodonta*, leptostrophiids, *Cranaena*, and *Pentamerella*. Unidentified crinoid debris is common but taxonomically indeterminate. Bryozoans include fenestellids and massive trepostomes). Proetid trilobites are noted but rare. Mollusks are relatively more common than in the lower Solon, and bivalves (clams), gastropods (snails), nautiloids, and rostroconchs (an extinct clam-like group) have been recognized. Nautiloid molds are moderately common in a zone near the top of the Solon Member in the Macbride spillway area, where both straight-shelled forms ("Orthoceras") and curved-shelled forms ("Gomphoceras") are locally concentrated (the chambered shell molds vary between 10 and 25 cm long). A few additional fossils have been noted in the upper Solon beds, including spirorbid worm tubes, possible calcareous algae (Mitchell, 1977), fish teeth/bones, and microfossils (foraminifera, ostracodes, conodonts).

Compared to the lower Solon, the upper Solon interval is interpreted to have been deposited in shallower subtidal marine environments. The fine skeletal packstone lithologies that contain broken to abraded shelly grains indicate deposition in more agitated bottom environments that were likely subjected to frequent storm currents or normal wave current activity. The marked increase in corals and stromatoporoids within the upper Solon is also interpreted to reflect shallowing depositional conditions, perhaps analogous with modern coral-rich bottom communities. The upper Solon shows evidence regionally of shallowing upward deposition, culminating in subaerially exposed mudflats in northeastern Missouri (Witzke and Bunker, 2006b). The shallowing trend interpreted for the upper Solon beds was reversed as the seaway began to deepen once again with the onset of Rapid Member deposition.

## Rapid Member

The Rapid Member conformably overlies the Solon Member in southeastern Iowa, and the member is well exposed at many localities in the Coralville Lake and Lake Macbride area as well as in numerous quarries (e.g., Fig. 3). Rapid Member strata are well exposed at the Lake Macbride spillway, and exposures continuing southward along the Coralville Lake shore in the

Macbride Nature Recreation area as well as the Mehaffey Bridge area (and elsewhere, including the excellent exposure at the Devonian Fossil Gorge). The name derives from Rapid Creek north of Iowa City and south of the Coralville dam in Johnson County, and the main reference section is found in the nearby Conklin Quarry (Fig. 3). The Rapid Member is characterized by gray argillaceous limestone beds, and it is recognized across southeastern Iowa and adjoining parts of Illinois (Witzke and Bunker, 2006b). The Rapid Member in Johnson County and the Coralville Lake area has been subdivided into four units, each discussed in ascending order below.

***Lower Rapid "bellula beds"***

Fossiliferous limestone ledges mark the lower 6 m (20 ft) or so of the Rapid Member, an interval known as the "bellula beds," named after the characteristic brachiopod *Spinatrypa bellula* (see Witzke and Bunker, 1994, for historical references). The "bellula beds" are marked by eight or nine repetitive couplets, each characterized by a thick (25-90 cm) resistant ledge of argillaceous fossiliferous limestone and a thin (2-15 cm) non-resistant thin-bedded argillaceous to shaley limestone interval. These couplets are broadly correlatable across Johnson County (Figs. 2, 4). The ledges contain an abundance of calcitic fossil grains (wackestones to packstones), especially brachiopod shells, crinoid debris, and bryozoans. The ledges are not uniform in thickness, but display minor variations on outcrop. The thin shaley intervals are less fossiliferous (generally wackestones, some mudstones) and form recesses on weathered exposures between the more resistant limestone ledges (Fig. 4).

The "bellula beds" are richly fossiliferous and contain a fauna grossly similar to that seen in the "independensis beds." Brachiopods are especially noteworthy, sometimes seen as brachiopod-rich stringers within the limestone beds. In addition to the name-bearer, *Spinatrypa bellula* (a spiny atrypid), other common brachiopods include *Pseudoatrypa*, *Orthospirifer*, *Tylothyris*, *Strophodonta*, and *Schizophoria*. Additional brachiopods recognized in the Lake Macbride area include *Eosyringothyris*, *Seratrypa*, *Independatrypa*, *Cyrtina*, *Athyris*, *Dichacaenia*, *Schuchertella*, *Striatochonetes*, and *Cranaena* (see Day, 1992, for a complete listing of lower Rapid brachiopods). Bryozoans are a prominent part of the fauna, dominantly well-preserved lacey fronds of fenestellids and small flat branches of cystodictyonid bryozoans. Trepostome bryozoans are noted but are generally sparse compared to the abundant fenestellids.

Disarticulated crinoid grains are prominent through most of the "bellula beds," indicating the importance of these stalked echinoderms in the bottom-dwelling communities. Occasional specimens of articulated crinoid stems and calyxes (heads) are found in the ledges (including large *Megistocrinus*). The thin shaley units commonly contain partially articulated crinoid fossils, primarily stem segments but also including delicate pinnulated arms and calyces. Trilobites are not common, but several different trilobites have been recognized in the Lake Macbride area including *Phacops*, *Greenops*, *Crassiproetus*, and *Dechenella* (see Hickerson, 1992, for a listing of Rapid trilobites). Corals are noteworthy but generally not common in the "bellula beds." Small solitary rugose corals (horn and cup corals) are seen in some beds, and larger colonial coral masses (5-25 cm diameter) are locally seen in the upper parts of some ledges (Fig. 4). The colonial forms are dominated by *Hexagonaria* and *Favosites* (massive to cylindrical). Other corals, including alveolitids, branching pachyporids, and fasciculate rugosans, have been noted but are rare. A single stromatoporoid was noted in the middle "bellula beds" in the MNRA (Loc. RCS, Fig. 4). Cup-shaped spiculate sponges (*Astraeospongium*) are locally noted near the base of the interval. Additional fossil include tentaculites (enigmatic conical shells), fish teeth (especially *Ptyctodus*), nautiloids, and various microfossils (conodonts, ostracodes, chitinozoans). A large head plate of an arthrodire (placoderm) was identified in the basal beds at Locality GP (Fig. 2).

The "bellula beds" contain an abundance of carbonate mud and clay indicating that bottom currents were insufficient to winnow these fine sediments. However, lensoidal packstone string-

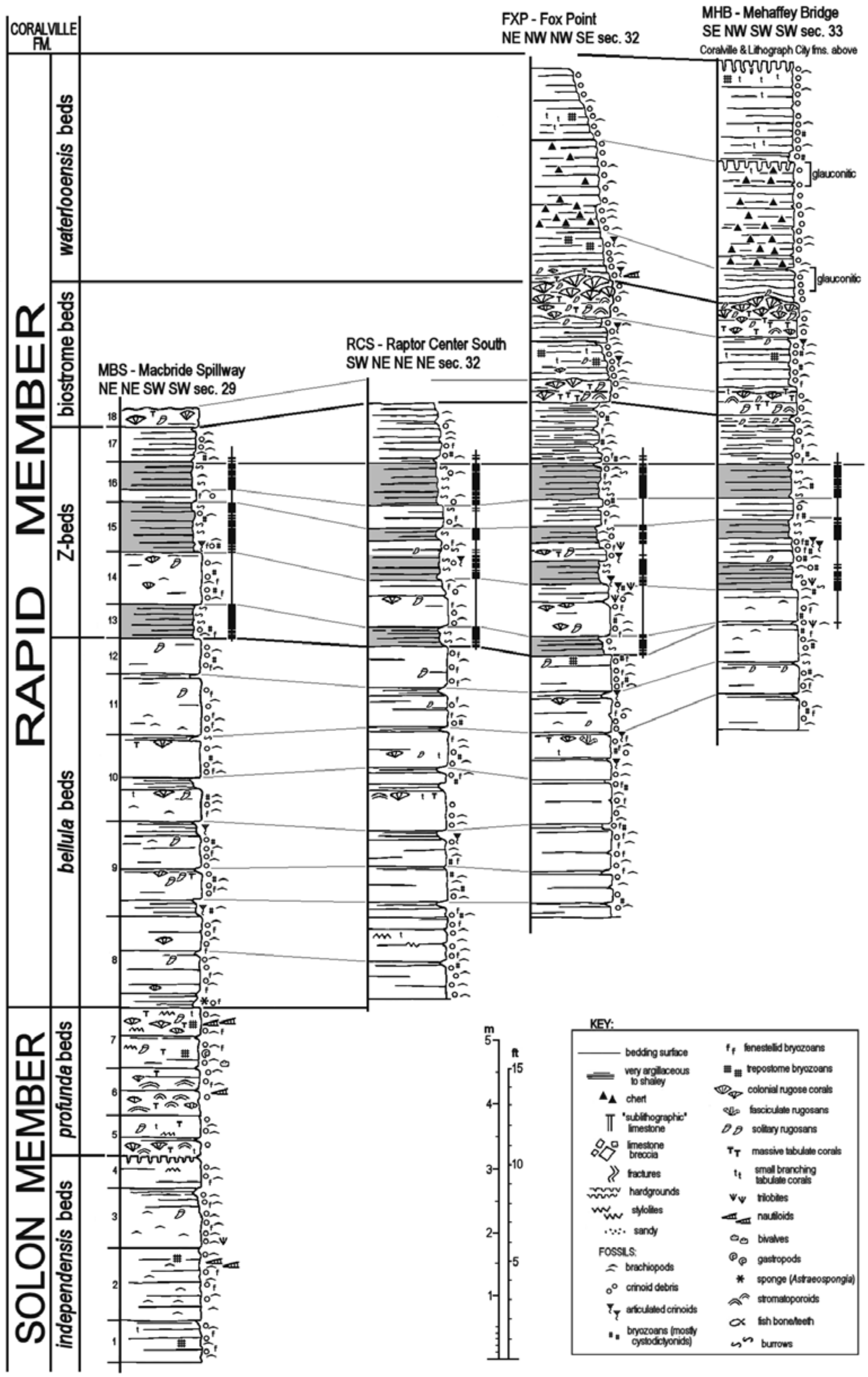


**Figure 4**. Graphic stratigraphic sections of the Little Cedar Formation in the Lake Macbride area. Mehaffey Bridge section adapted form Plocher (1989). Intervals of unfossiliferous to sparsely fossiliferous lime mudstones (Z-beds) are shaded and makred by vertical black bars. All sections are in T81N, R6W. See Figure 1 for locations.

ers indicate that episodic strong currents disrupted the bottom environments, probably tropical storm currents. The abundance of marine fossils in the interval indicates stable salinity and an abundant supply of nutrients (for the filter-feeding organisms) within the seaway. The "bellula beds" were deposited during a general deepening of the seaway which culminated in even deeper-water environments interpreted for subsequent Z-bed deposition.

### *Middle Rapid Z-beds*

A very argillaceous to shaley limestone interval between the "bellula beds" and the Rapid biostromes is known as the "Z-beds" (see summary of nomenclature for this interval given by Witzke and Bunker, 1994). This interval is about 3.5-4 m (11-13 ft) thick in the Lake Macbride area (Fig. 4). Two general limestone lithologies are seen within the Z-beds: 1) unfossiliferous to sparsely fossiliferous argillaceous lime mudstones, commonly with horizontal burrow traces; and 2) fossiliferous limestone ledges and argillaceous to shaley limestone beds that resemble those seen in the "bellula beds." The top unit of the Z-beds is a distinctive argillaceous to shaley fossiliferous mudstone to wackestone with a relatively diverse brachiopod fauna.

The unfossiliferous to sparsely fossiliferous lime mudstones are unique to this interval. Skeletal fossils are very rare, but occasional crinoid grains, fenestellid bryozoans, and chonetid brachiopods (*Striatochonetes*) are noted. Scattered burrows are primarily thin elongate horizontal traces (probably formed by marine worms), but a few additional burrow forms have also been noted (*Chondrites*, *Zoophycus*). Thin stringers of fossiliferous material occur within the mudstone beds, and these contain a relatively rich assemblage of fossils similar to that noted in the "bellula beds." Articulated crinoid material is not uncommon in these thin stringers (including *Megistocrinus*, melocrinitids).

Interbeds of fossiliferous limestone within the Z-beds interval contain a variety of fossils in the Lake Macbride area, most generally indistinguishable from fossils seen in the "bellula beds." Brachiopods are common (especially *Pseudoatrypa*, *Spinatrypa*, *Orthospirifer*, *Schizophoria*). A few brachiopods become more common within the interval, especially *Pentamerella* and *Schuchertella*. The upper interval of the Z-beds includes additional brachiopods, especially chonetids. Bryozoans are common (fenestellids, cystodictyonids), and large sheet-like fronds (to 20 cm) are seen in some beds. As seen in ledges of the "bellula beds," solitary and colonial corals are identified in a few beds, but these occurrences are localized. Trilobites are recognized in the Lake Macbride area including *Greenops* (articulated specimen noted) and proetids.

The unfossiliferous lime mudstones of the Z-beds are interpreted to have deposited in the deepest-water environments recognized for the duration of the Cedar Valley Group deposition. Deposition has been interpreted to have occurred at depths at or below the limits of storm current activity in a stratified seaway (Witzke and Bunker, 1994, 2006b). Distal storm current activity occasionally smothered articulated crinoids and other fossils, but otherwise the mud-rich sediments were not subjected to current winnowing. The absence of shelly faunas from the lime mudstones is surprising considering the abundance of fossils in other limestone beds of the Rapid Member. The general absence of shelly fauna suggests that some sort of environmental stress was acting on the sea bottom that excluded most organisms. This stress has been interpreted to result from the presence of oxygen-deficient bottom waters within a stratified seaway. The oxycline, a zone of downward-decreasing oxygenation, is interpreted to have impinged on the bottom during much of Rapid mudstone deposition. Fluctuations in the position of the oxycline (due to changes in water depth, storm mixing events, or other factors) may be responsible for episodic development of oxygenated bottom conditions and the interfingering of fossiliferous limestones and unfossiliferous lime mudstones within the Z-beds succession. Bottom conditions underwent a significant change at the base of the overlying Rapid biostromes.

***Rapid biostrome interval***

A relatively thin interval (2 m) above the Z-beds contains two units with remarkably dense accumulations of fossil coral (Fig. 4). These beds comprise the lower and upper coral biostromes, which along with the intervening argillaceous crinoidal wackestone and packstone beds, are known as the Rapid biostrome interval. This thin coral-rich interval is widely recognized across most of eastern Iowa. The lower biostrome contains masses of colonial corals (*Hexagonaria*, *Favosites, Alveolites*), solitary corals, and massive to lumpy stromatoporoids in a matrix of skeletal packstone. The upper part of the upper biostrome is a nearly solid mass of colonial rugose corals (*Hexagonaria*) with minor *Favosites*, horn corals, and stromatoporoids. *Hexagonaria* masses vary between about 10 and 50 cm in diameter; many are in life position, but some are overturned. The lower part of the upper biostrome is less coralline, but still contains abundant corals and scattered stromatoporoids. Although corals are the most conspicuous fossils within the Rapid biostromes, crinoid debris and brachiopods are recognized within the matrix between the coral heads (brachiopods include *Devonatrypa*, *Orthospirifer*). Shapo (2003) identified several stromatoporoid genera within the Rapid biostromes of the Coralville Lake area (*Petridiostroma*, *Stictostroma*, *Coenostroma*).

The intervening beds between the biostromes are in part very crinoidal, and some beds contain long articulated crinoid stems. Brachiopods are scattered to common (*Orthospirifer*, *Devonatrypa*, *Schizophoria*, *Eosyringothyris*). Bryozoans are scattered, locally including large masses of trepostome bryozoans (to 10 cm diameter). Some surfaces within this interval contain scattered to common thin branches of pachyporid tabulate corals. Horn corals are common immediately below the upper biostrome.

Deposition of the Rapid biostromes marked a dramatic change in bottom environments, apparently resulting from changes in water circulation that eliminated bottom oxygen stresses and enabled abundant corals and other organisms to flourish in the fully oxygenated waters. This change may have resulted from a general shallowing of the seaway. Subsequent deepening is interpreted for the overlying “waterlooensis beds.”

***Upper Rapid “waterlooensis beds”***

The highest limestone beds of the Rapid Member, which reach thicknesses to about 4 m (13 ft) in the Lake Macbride area (Fig. 4), are termed the “waterlooensis beds” after the common brachiopod *Devonatrypa waterlooensis* (see Witzke and Bunker, 1994, for further discussion). These strata are characterized by crinoidal wackestones and packstones with scattered brachiopods, bryozoans, and other fossils. These are the only beds within the Rapid Member of Johnson County that contain chert, and chert nodules are scattered to common within the lower to middle part of the interval in the Lake Macbride area. The limestone beds are slightly argillaceous and slightly dolomitic, and some of the fossil grains are partially silicified; some beds are glauconitic (sand-sized green pellets of glaucony). A prominent hardground surface occurs near the middle of the interval, and the top of the Rapid Member is marked by a hardground discontinuity surface (as seen at the nearby Mehaffey Bridge roadcut section; Fig. 4).

The “waterlooensis beds” in the Lake Macbride area are fossiliferous, dominated by an abundance of disarticulated crinoid debris. The basal strata contain abundant articulated crinoid stem segments (including *Megistocrinus*), and occasional crinoid calyxes are noted (*Melocrinites*). Although crinoid debris is the dominant fossil of the interval, brachiopods are scattered throughout, especially the large atrypid brachiopod *Devonatrypa waterlooensis* and the spiriferid *Orthospirifer iowensis*. Additional brachiopod taxa are recognized in some beds (e.g., *Tylothyris*, *Schizophoria*, *Athyris*, *Strophodonta*, *Cranaena*; see Day, 1992, for a complete listing). Solitary and colonial corals (*Hexagonaria*, *Favosites*) are locally recognized near the base. Thin branches of pachyporid tabulate corals and small auloporid corals are scattered in some of the higher beds. Bryozoans occur within the "waterlooensis beds,"although they are not as common as in lower Rapid strata; cystodictyonids and large trepostomes (to 5 cm) are present.

A short distance to the northwest of Lake Macbride in the upper reaches of Coralville Lake, the top of the Rapid Member is characterized by cross-bedded crinoidal grainstones that record the final shallowing phases of Rapid deposition in the area. In the Lake Macbride area and southeastward across most of southeastern Iowa, the top of the Rapid Member is marked by a discontinuity surface which represents a submarine hiatus in deposition. Overall, the "waterlooensis beds" are interpreted to record a general deepening of the seaway, but the seas shallowed at the end of Little Cedar deposition. Although the Lake Macbride area remained underwater at that time, the seaway entirely withdrew from northern and central Iowa at the close of Little Cedar deposition (with subaerially exposed mudflats recognized as close as Benton County; Witzke and Bunker, 2006b).

## CORALVILLE AND LITHOGRAPHIC CITY FORMATIONS

Higher strata of the Cedar Valley Group are not well exposed in the Lake Macbride area, but these strata are well represented a short distance away along Coralville Lake near the Mehaffey Bridge and in the Old State Quarry area (see Witzke and Bunker, 1994; Plocher, 1989). The Coralville and Lithographic City formations are recognized above the Rapid Member in that area and in other areas of Johnson County. In the Coralville Lake area, the Coralville Formation is characterized by a lower interval rich in corals and stromatoporoids (Cou Falls Member) and an upper interval of peritidal lime mudstones (Iowa City Member). The Lithograph City Formation includes fossiliferous limestones of the State Quarry Member and upper dolomite beds of the Andalusia Member in the Coralville Lake area. The State Quarry Member infills deep erosional channels that are locally incised into the Coralville Formation and Rapid Member. Plocher and Bunker (1989) identified minor ledges of Coralville and State Quarry strata in the highest bedrock exposures within the Macbride Nature Recreation Area.

## PENNSYLVANIAN BEDROCK

A prolonged period of erosion during the Late Mississippian and Early Pennsylvanian resulted in the incision of river channels that eroded downward into strata of the Cedar Valley Group in the Coralville Lake area and elsewhere in eastern Iowa. These erosional channels were subsequently filled with fluvial (river) and estuarine deposits during the Early and Middle Pennsylvanian, and remnants of these channel-filling deposits can be seen in places along the shores of Coralville Lake, including the Macbride Nature Recreation Area (Fig. 1). These are the youngest bedrock strata in the Lake Macbride area. Several types of rocks are recognized, including fine- to medium-grained sandstone, conglomeratic sandstone, siltstone, mudstone, and shale, in part cemented by iron oxides. Fossil plants that are preserved as impressions or carbonized remains are occasionally seen, mostly indeterminate woody fragments but also including identifiable plant stems and branches (*Calamites*, *Lepidodendron*).

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# GEOLOGIC STRUCTURES AT THE LAKE MACBRIDE SPILLWAY AND IN THE AREA OF LAKE MACBRIDE STATE PARK, IOWA

Raymond R. Anderson
Iowa Geological Survey
Iowa City, IA 52242-1319

## INTRODUCTION

Numerous geologic structures of many scales can be observed in the Middle Devonian rocks in the area of Lake Macbride State Park. These structures include an anticline over 11 km (7 mi) along strike, thrust faults some with displacement over 18 m (50 ft ), normal and reversed near vertical faulting, zones of brecciation, and “breccia dikes”. While these structures have been investigated in senior theses by University of Iowa geoscience students (Czeck, 1996; Schwartz, 1996), reported at Geological Society of America meetings (Czeck and Faulds, 1996; and Schwartz and Faulds, 1996), and visited by many geological field trips (e.g., Gilotti and Wood, 1999, and Plocher, and others, 1989) there has been no comprehensive examination, description, and explanation for these features. A review of these studies suggest that well documented dissolution of Davenport Mbr evaporites explains some of these smaller-scale features, the larger structures are clearly the product of regional tectonic activity.

## EVAPORITE DISSOLUTION

### Breccia

The brecciated nature of the Davenport Mbr of the Pinicon Ridge Fm (Middle Devonian Wapsipinicon Group) has been described in theses and manuscripts by workers studying the Devonian of eastern Iowa and adjacent areas of Minnesota and Illinois (Witzke and Bunker, 2006). They described distinctive strata characterized by prominently brecciated limestone. The limestone breccia contains abundant angular broken clasts of limestone, laminated in part, in a matrix of dense unfossiliferous limestone. These clasts vary in size from commonly 1 – 10 cm (0.3 – 4 in) to up to 1 m (3 ft) or more. These clasts are typically well cemented within a limestone matrix cement, but some pods may contain sandy or silty limestone sometimes including fossils and clasts of the overlying Solon Mbr (Little Cedar Fm – Middle Devonian Cedar Valley Gp). The abrupt contact of the Davenport Mbr with the overlying Solon Mbr displays up to 3 m (10 feet) of relief. (Witzke and Bunker, 1994). This brecciation is observed in exposure and drill core in a wide area of eastern Iowa, from the Quad Cities area to the Minnesota border. Davenport Mbr strata located south and west of this area are unbrecciated. The evaporites are not observed in the area of Davenport brecciation, leading to the conclusion that the brecciation was the product of dissolution of the evaporites and the collapse of the interbedded Davenport strata.

That the brecciation was diachronous is demonstrated by the presence of unbrecciated Solon Mbr rocks resting directly on brecciated Davenport in some areas, the inclusion of whole-shell Solon fossils between clasts of brecciated Davenport at their contact in other areas, and the inclusion of lithified Solon clasts within the Davenport breccia and/or the brecciation of Solon strata near its contact with brecciated Davenport Mbr limestones. This indicates that in some areas the episode of evaporite dissolution and collapse was completed before Solon deposition, was contemporaneous with Solon deposition in other areas, and even active after lithification of lower Solon strata in others.

## Small-Scale High Angle Faults

The evaporite dissolution collapse of Davenport Mbr limestones probably created most of the small-scale structures observed in the area of Lake Macbride State Park. These would include the small-scale, high-angle normal and reverse faults. Czeck (1996) and Schwartz (1996) noted that these minor faults are fairly common around the Coralville Reservoir. The normal and reverse faults are thought to be coeval because consistent cross-cutting relationships could not be established. The faults are also thought to die out above the Little Cedar Fm. (Czeck and Faulds, 1996; Schwartz and Faulds, 1996), a finding that is consistent with the stratigraphic and brecciation relationships described above. Several of these faults that can be observed at the Lake Macbride spillway (Stop 5 on this field trip). An annotated photograph of the north wall of the spillway, Figure 11 on page 117 of this guidebook, identifies this as structure 5.

**Figure 1.** Brian's hand is resting on a tipped block of Solon Mbr limestome, juxtaposed against Davenport breccia (foreground) at Stop 3 along Coralville Lake.

## "Breccia Dikes"

The "breccia dikes" in the Lake Macbride area do not owe their origins to the same processes as traditional breccia dikes, but have the same general appearance. These "breccia dikes (Fig. 1) are masses of Davenport breccia juxtaposed against Solon strata in an area of Solon bedrock. Evaporites interbedded with Davenport limestones were dissolved by groundwater before, during and shortly after Solon deposition, causing blocks of Solon and upper Davenport strata to subside. The "breccia dikes" are interpreted as local areas where the evaporite beds initially were not completely dissolved. The slow collapse of large blocks of lithified Solon strata in areas of maximum dissolution would have juxtaposed these rocks with underlying Davenport strata where some evaporite remains (Fig. 2). The effect would be similar to collapse of a shallow mine around its pillars. So, unlike true breccia dike, which are formed when brecciated rock is intruded into country rock, these "breccia dikes" are produced by the country rock moving down around the breccia.

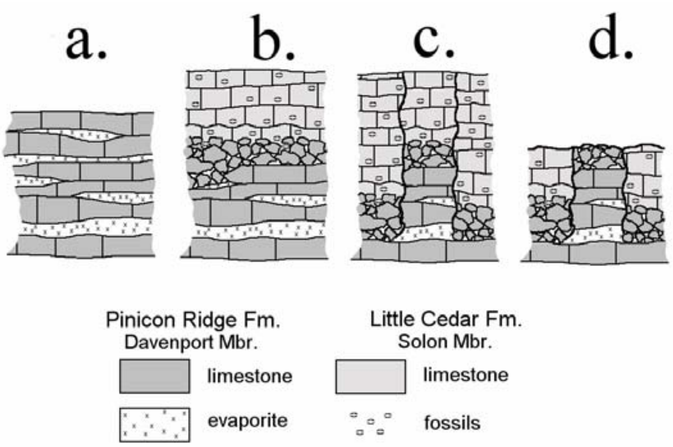


**Figure 2.** Graphic presentation of the evaporite dissolution collapse that created the "breccia dikes" observed at Stop 4. **a.** evaporites are interbedded with Davenport Mbr limestones **b.** dissolution of some of these evaporites cause collapse and brecciation of overlying Davenport limestone prior to and during deposition of overlying Solon limestones; Solon fossils are observed to have fallen between Davenport clasts. **c.** remaining evaporites dissolve in most areas and overlying strata subside, juxtaposing Solon strata with Davenport limestones in undissolved areas. **d.** finally regional erosion exposes these juxtaposed units.

# REGIONAL TECTONIC ACTIVITY

## Large-Scale Synforms

While evaporite dissolution collapse explains some of the small-scale structures in the Lake Macbride area, others and the larger-scale features require regional tectonic activity. The largest of these features is the Twin View Heights Anticline, reported by Plocher and Bunker (1994). They mapped the north-east-trending axis of this prominent structure just north of Lake Macbride State Park (Fig. 2). It was identified by mapping exposures of Wapsipinicon Gp strata along Coralville Lake below the Twin View Heights addition. The map of the elevation of the top of the Wapsipinicon Gp (Fig 2) shows the surface rising up to 100 feet (30 m) over a distance of about 3 miles (5 km) moving towards the crest. The map also identifies a small parallel syncline just south of Lake Macbride State Park. The Wapsipinicon Gp surface dips almost 100 ft (30 m) into this structure, which structurally preserves "North Liberty Group" beds of the Upper Devonian Lime Creek Fm (Plocher and Bunker, 1994).

## Low Angle Reverse Faults

Another series of structures probably related to regional tectonic activity include most of the faults displaying reverse displacements. These include the well-displayed thrust faults exposed in the north wall of the Lake Macbride spillway (Fig. 3). Gilloti and Wood (1999) mapped and described the most prominent of these structures (see T-T' on Fig. 11b, p. 117 of this guidebook) as a thrust fault displaying classic stair-step geometry where the thrust cuts steeply through the massive limestones defining a footwall ramp then gliding parallel to the bedding to define a footwall flat near the top of the spillway exposure. The hanging-wall is gently folded to form a classic hanging wall ramp anticline. Although bedding in the core of the anticline is disturbed by brecciation (b. in Fig 11b), it is well-defined on the main east-dipping limb and also visible in the tan, shaly, west-dipping beds. The discordance in bedding between the tan, shaly beds and the underlying, subhorizontal gray limestone defines the flat footwall. Grooved slickensides exposed on the thrust surface are approximately down-dip. A displacement of a few meters is best described by the offset of the conspicuous, meter-thick, massive, gray limestone bed (highlighted by white screen in Fig 11b, p. 117). In addition, a set of moderately west-dipping, smaller faults and fractures occurs in the hanging-wall of the thrust, just above the footwall ramp (∗ on Fig. 11b). Offsets are both normal and reverse. Pockets of breccia are common, and shaly interbeds can be seen to have thickened and thinned in the core of the fold. These features are brittle accommodation structures formed in response to the hanging-wall moving over the ramp (e.g. Wojtal, 1986). Two high-angle faults with normal offsets, labeled 1, 2 (Fig. 11b), were identified by Gilloti and Wood (1999) on the west end of the north spillway wall. They concluded that these faults must have formed after the thrust fault because fractures 3 and 4 cut cleanly through the thrust. The steep fault zones vary in character along their length from single fractures, to fracture sets, to anastomozing fracture networks, to pockets of breccia. Some of them also change orientation and curve upwards. The final major feature documented by Gilloti and Wood (1999) on the north wall of the spillway is a particularly complex fracture identified as 5 on Fig. 11a (p. 117). They noted that this fracture accounted for the flexure in bedding just above the spillway apron.

Gilloti and Wood (1999) restated ideas from previous workers (Czeck and Faulds, 1996; Schwartz and Faulds, 1996) that since many of the faults in the area of Lake Macbride are thought to die out above the Little Cedar Fm. they must be Middle Devonian in age . These authors attribute the faulting to tectonism resulting from the Appalachian Acadian Orogeny, but note that some of the faulting may also be due to evaporite collapse in the underlying Wapsipinicon Group. While a Middle Devonian age for the faulting is coeval with the Acadian Orogeny

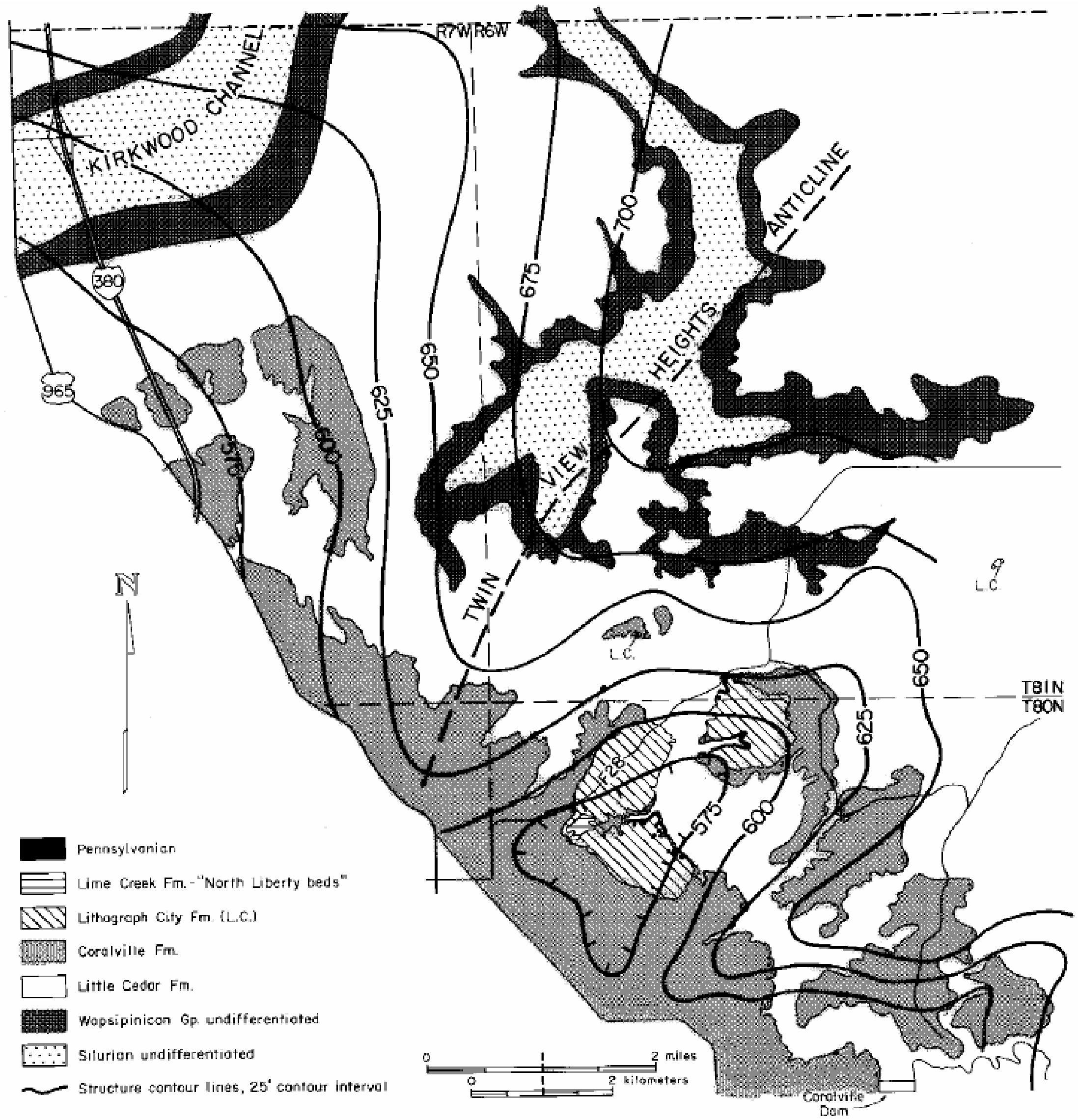


**Figure 3.** Geologic structure contour map of the Coralville Lake Area displaying the elevation of the top of the Wapsipinicon Gp (from Plocher and Bunker, 1989). Map displays the Twin View Heights Anticline and associated syncline to the south.

(about 400 million years ago), this tectonic activity was concentrated about 800 miles from the Lake Macbride area (Fig. 4), a long distance to transfer these deformational energies. A much closer period of mountain building was the Ouachita Orogeny (about 300 million years ago), which affected and area as close as central Arkansas (about 450 miles from the Lake Macbride area). It is possible that some of these larger thrust fault and other larger features were the product of this tectonic activity. Some of the major faults in and near Iowa (Thurman –Redfield in southwest Iowa and the Humboltd Fault in nearby Nebraska and Kansas), show large-scale movements contemporaneous with Ouachita Orogenic activity.


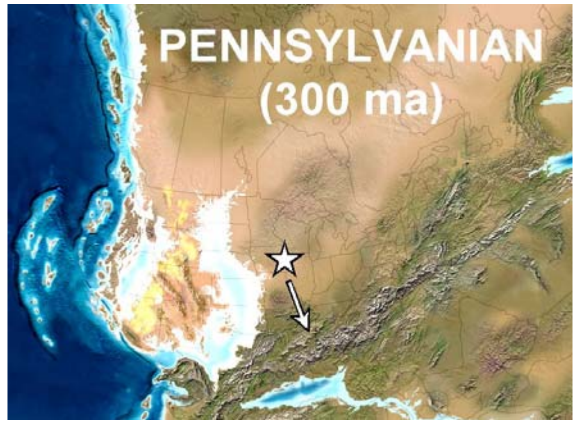


**Figure 4.** Location of Iowa and the Devonian Acadian Orogeny (left) and the Pennsylvanian Ouachta Orogeny (right). White star identifies location of eastern Iowa, the white arrow shows distance and direction to area of orogenic activity. Paleogeographic maps courtesy of Dr. Ron Blakey, Northern Arizona University.

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# THE ARCHAEOLOGY OF THE LAKE MACBRIDE AREA

Joe Alan Artz[a], Lynn Alex[a], Jonathan Sellars[b], Leslie Ambrosino[b], and Mark L. Anderson[a]
[b]University of Iowa Office of the State Archaeologist
[b]Consulting Archaeological Services, Creston, Iowa.

This section integrates previously published work by Lynn Alex (2000, 2005) and Jon Sellars and Leslie Ambrosino (2000). These works were funded by the U.S. Army Corps of Engineers and the Iowa Department of Natural Resources. Artz edited the longer works into the condensed version presented here. Anderson and Artz contributed the section on chert sources.

## OVERVIEW

There are over 1,200 archaeological sites recorded in Johnson County, about one twentieth of all known in the state. Over 300 sites have been found in the immediate vicinity of Coralville Reservoir and Lake Macbride. Discoveries range from spear points lost 12,000 years ago by Ice-Age hunters to the foundations of structures built by the Civilian Conservation Corps (CCC) in the 1930s. The Iowa River was an important waterway for both prehistoric peoples and later pioneers. The river setting was a source of water and shelter for both humans and the game they sought, offered materials for stone tools, provided timber and edible plants, and served as a transportation route. Archaeological campsites, habitations, burial mounds, and resource procurement sites are found along the river and its tributaries in a variety of settings including uplands, high terraces, and alluvial bottoms.

Many of these sites consist of artifacts and other material remains exposed at the land surface. Many, however, are deeply buried beneath flood and hillslope deposits. Others have been and continue to be eroded away, or destroyed by development.

## HISTORY OF ARCHEOLOGICAL RESEARCH

People have been interested in the archaeology of the Lake Macbride area for over a century. During the 1800s private citizens opened many earthen burial mounds along the Iowa River. In 1888, notice of over 100 mounds in Johnson County appeared in the annual report of the Smithsonian Institution. Five of 18 mounds were partially excavated at the Aicher Mound group (13JH1). After the turn of the century, a survey on horseback of the Iowa River north of Iowa City by an Iowa City minister resulted in a more systematic account of archaeological sites, although mounds remained a focus. Charles R. Keyes, at Cornell College in Mt. Vernon, Iowa, reported mounds as well as habitation sites in Johnson County as part of the first State Archaeological Survey which he initiated in 1922.

The creation and management of the Coralville Dam and Reservoir, part of the U.S. government's decision to control flooding along major river systems, initiated more careful identification and study of archaeological sites. Over 32,700 acres of land were acquired along the Iowa River for the reservoir, including 1,820 acres for the conservation pool and an additional 24,800 acres for the flood pool. The construction was authorized in 1938 under the supervision of the U.S. Army Corps of Engineers, Rock Island District, and was completed in 1958.

Reservoir construction and subsequent flooding of the Iowa valley threatened to destroy archaeological sites and the Corps designed a comprehensive plan to recover information before sites were lost. Archaeological research began in 1949 and continued in 1956 under the auspices of the Smithsonian Institution's River Basin Surveys. Only 19 new sites were recorded by these.

**Figure 1.** Excavations in progress in 1968 at the Woodland-period Walters site, on the Coralville Lake shoreline near the north boundary of Lake Macbride State Park.

Reservoir construction and subsequent flooding of the Iowa valley threatened to destroy archaeological sites and the Corps designed a comprehensive plan to recover information before sites were lost. Archaeological research began in 1949 and continued in 1956 under the auspices of the Smithsonian Institution's River Basin Surveys. Only 19 new sites were recorded by these projects and several were excavated (Figure 1), including mounds and habitation sites. Since the 1960s, the Corps and other government agencies have continued to foster archaeological studies on the lands it owns or manages by identifying and, if possible, preserving or excavating sites threatened by shoreline erosion, periodic high water levels, and construction of roads and recreation facilities. These studies have documented hundreds of additional sites and a more comprehensive story of Iowa River prehistory. Many sites previously recorded have already been deeply impacted by erosion, agricultural activities, collectors, and earlier excavations. More deeply buried sites await discovery when suitable techniques may be applied.

Lake Macbride State Park has not been the subject of intensive archaeological survey. Prior to 2000, only 10 sites were recorded within the park's boundaries. Seven of these were reported in the early 1980s by Duane Miller, an active avocational archaeologist from Iowa City. Professional archaeological surveys within the park have been undertaken for specific impacts such as surveys for trails and recreational facilities. These surveys identified three more archaeological sites, all dating from the historic period.

In 1989, structures constructed by CCC workers were evaluate by architectural historians (Mishler and Eckels 1989). Seven of the Park's CCC structures are included in a National Register of Historic Places listing of CCC properties in Iowa state parks (McKay 1989).

In 2000, the waters of Lake Macbride were lowered 17 feet in order to allow the Iowa Department of Natural Resources to remove sediments and stabilize the shoreline. This project exposed land (Figure 1) that had been underwater for fifty years when the lake level was raised.

Consulting Archaeological Services, a southwest Iowa firm contracted to find and investigate cultural properties, discovered 37 archaeological sites and one limestone footbridge, all previously inundated by the lake. Twenty-five sites represent the encampments, habitations, and resource procurement sites of prehistoric Native Americans. Although erosion had severely damaged most of these sites, artifacts and features such as hearths, roasting pits, and storage pits were still found intact.

The other twelve sites represented the structural remains from more recent times, including the foundation of a bathhouse constructed by the CCC in the 1930s.

## PREHISTORY AT LAKE MACBRIDE

Prehistoric sites identified during the Lake Macbride study range in age from Early Archaic, perhaps 9000 years old, to those of the Late Woodland (AD 650-1200) and Late Prehistoric periods (AD 1200-1700). Resource procurement sites like 13JH1066, the earliest found at Lake Macbride, are common. They represent scatters of chipped stone refuse and debris where stone tools were made and resharpened prior to their use for hunting and gathering. Angular and reddened, fire-cracked rocks are the remnants of rock-lined hearths or cooking pits left by the prehistoric inhabitants who briefly stopped at these locations. The Early Archaic spear point found at 13JH1066 was made of Burlington chert, a type of material from southeast Iowa. It suggests that nine millennia ago, inhabitants in Johnson County were traveling or trading to acquire good quality stone for tools.

13JH1078 is typical of a small campsite of the Late Archaic period (3000-800 BC). Here two types of spear points, stone knives, flakes, and fire-cracked rock were found amongst several hearths or roasting pits.

Other sites such as 13JH663, 13JH1061, 13JH1079, 13JH1089, and 13JH1091 are likely multicomponent camps or habitations, locations to which people returned for hundreds of years. At these spots, tools related to the procurement and processing of food predominate. They include chipped stone points, drills, knives and scrapers which were made and resharpened on site, hand-held grinding stones or manos used to grind grain and plants, and small amounts of pottery.

Sites of the Woodland period (800 B.C.-A.D. 1200) are well represented in Johnson County and several were found in the Lake Macbride survey. A good example was 13JH438, a habitation site dating to the Late Woodland period, AD 650-800. Over 1000 artifacts, including pottery and stone tools, and seven features were uncovered. The features included hearths, roasting pits, and possible dumps or storage areas. When the location of these features were mapped they showed clustering in three distinct areas possibly representing activity locations at a large camp or repeated encampments at a favorite spot over time.

Pottery found at 13JH438 is a type archaeologists call Madison cord or fabric impressed. It dates to the Late Woodland time period (AD 650-800) and was being made by communities who also built the Effigy Mounds in northeast Iowa. The decoration on this kind of pottery was made by impressing an intricately woven cloth or collar onto the surface of a vessel before it was fired. One of the hearths at the site may actually have been a pit used to fire the pottery.

The chipped stone projectile points found at 13JH438 include a Middle Woodland Pelican Lake type, and Reed, Des Moines, and Fresno styles. The Pelican Lake point represents a dart or spear point normally found at much older sites in Iowa and probably used with the spear thrower. The other points are arrowheads and time-wise, fit in well with the type of pottery found at the site. Perhaps the older spear point had been collected by one of the site's inhabitants and kept as a curio.

Other stone artifacts found at the site (cores, various types of flakes, and debris) show that it was a spot where tools were actually being made, and later resharpened and repaired. Hand-held grinding stones called manos, indicate grinding tools used on seeds or other plants. Unfortunately, bone tools, animal bone, and plant remains were not preserved under the Lake Macbride sediments. Other traces of prehistoric life, including evidence of houses, were likely eroded away.

Evidence of a Late Woodland-period house was found at the Walters site, 13JH42. This site was located on the Coralville Reservoir shoreline not far north of the Lake Macbride dam. Excavations were conducted by the University of Iowa after the site was exposed by wave action. Evidence for the house (Figure 2) consisted of a dark-colored, ovoid soil feature, 4.9 m wide that contained most of the artifacts found at the site as well as large quantities of daub. Daub is fired

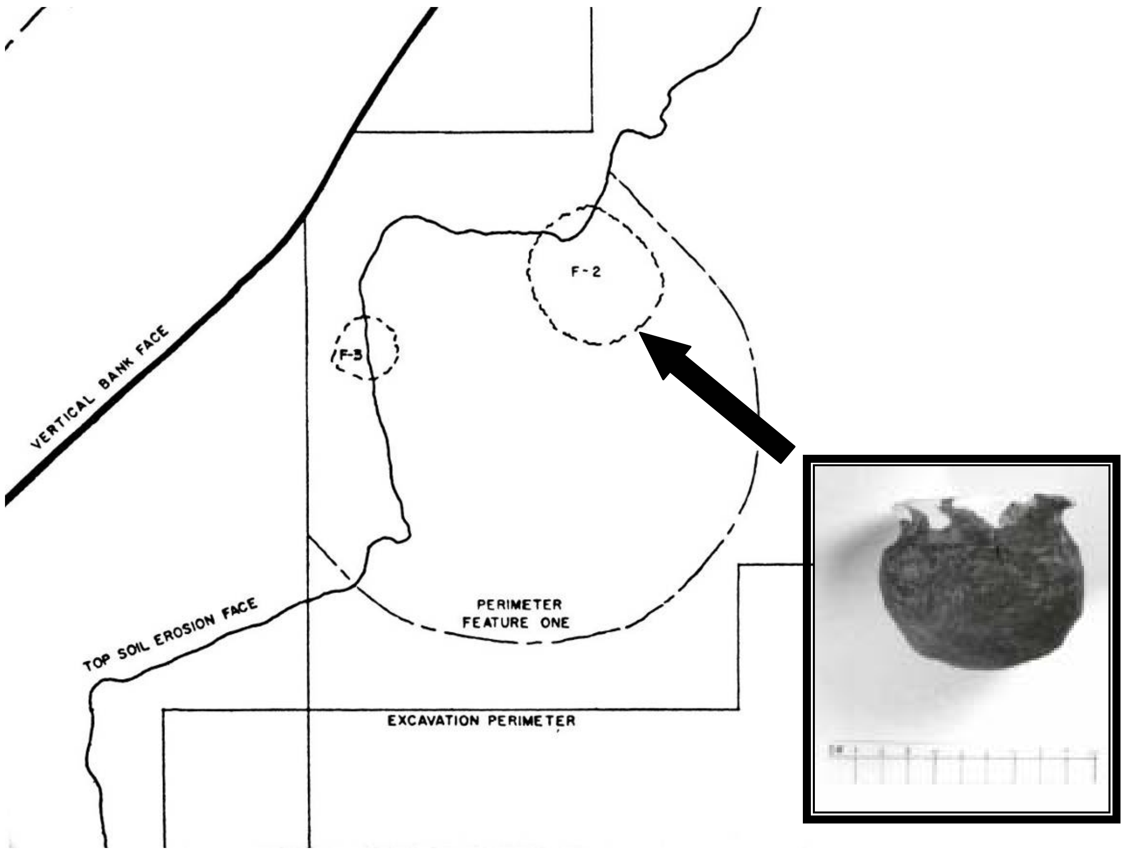


**Figure 2**. Plan of Late Woodland house excavated in 1968 at the Walters site. Inset: miniature pottery vessel found in storage pit in house. Both figures from Anderson (1971).

clay with grass and stick impressions indicating its use as wall plaster. Two shallow, basin-shaped pits, one containing a complete miniature pot (Figure 2, inset), occurred inside the suspected house area. Small, triangular Late Woodland projectile points and pottery including Madison, Minott's, Weaver, and Canton wares, as well as stone scrapers, choppers and manos, made up the numerous artifacts discovered (Anderson 1971).

## THE GEOARCHEOLOGY OF LAKE IMPOUNDMENTS

The word "archaeological artifact" brings to mind small, portable objects such as arrowheads and pottery sherds from prehistory, and glass bottles, stoneware crockery, and iron nails from history. But as the British geoarchaeologist A. G. Brown (1997) observed, mankind's intensive use and modification of the Earth's surface has created a situation in which the landscape itself has become an artifact of human culture. Lake Macbride is an excellent example.

Construction of the original CCC dam in the 1930s swiftly transformed the valleys of the lower reaches of Jordan and Mill creeks from an open, fluvial system, into a semi-closed, lacustrine system. The floodplain and stream terraces became a lake bed on which deposits of fine-grained sediment began to accumulate. These sediments were delivered to the lake by the streams of the Jordan-Mill Creek drainage basin and from the slopes bordering the lake. Shoreline erosion also contributed sediment.

Studies by the U.S. Army Engineer Waterways Experiment Station (Ebert et al. 1989; Ware 1989) identify three major impact zones within artificial lakes (Figure 3). The "conservation pool" includes the deepest portions of the lake which are insulated from wave action and where sediment is stored. The "fluctuation or drawdown zone" includes the "zone exposed to periodic, usually annual, shoreline fluctuation. This zone includes the flood pool, which represents the highest level to which the lake can rise in times of high water. It is the zone across which the shoreline advances and retreats as pool levels fluctuation. The "backshore zone" includes all the lake's watershed that is above flood pool, "extending upstream and upslope from the flood pool. This zone supplies water and sediment to the lake, but is not itself impacted by lake processes, unless pool levels raise (Ware 1989:20-29).

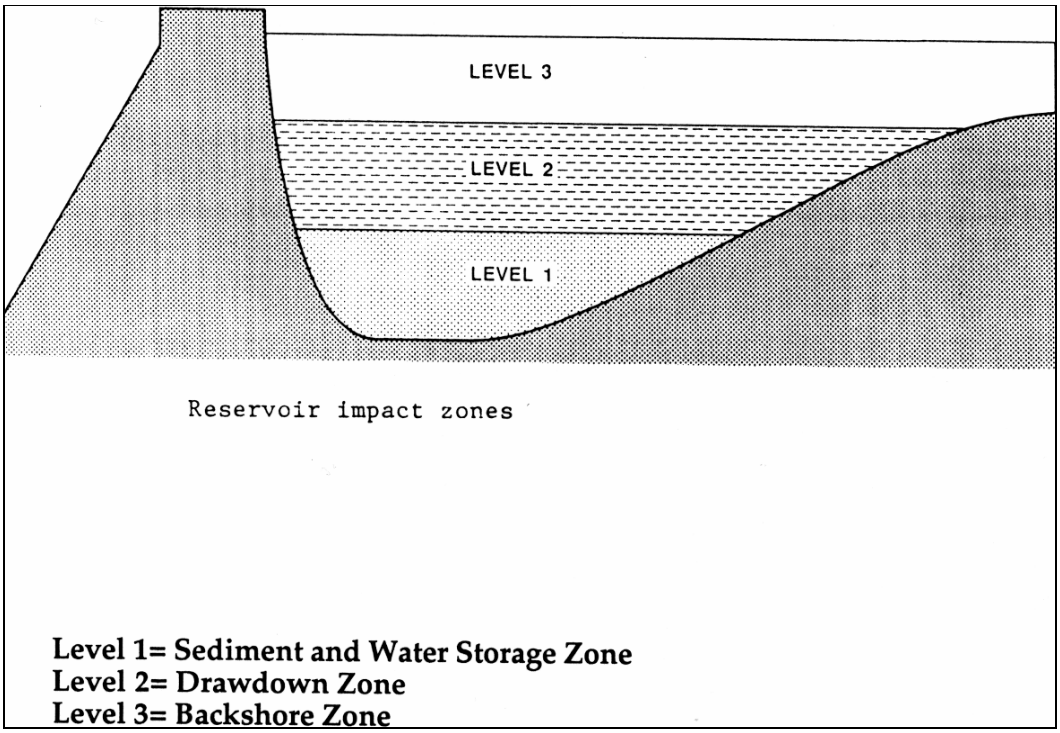


**Figure 3.** Schematic of geomorphic zones in a schematized artificial lake (from Ware 1989).

The development of these three zones was undoubtedly initiated with the closing of the CCC dam. The system would have been rejuvenated in 1957-58, when the pool was raised 28 ft (8.5 m) to accommodate construction of Coralville Dam. This pool raise would have increased the surface area of the conservation pool zone, and expanded the wave-cut drawdown zone to a higher elevation. The system was subsequently affected by an 8 ft (2.4 m) drawdown in 1967, and the 17 ft (5.2 m) drawdown of 2000.

Ware (1989) and Ebert et al. (1989) studied the effects of inundation on prehistoric archaeological sites. They found that, regardless of lake size, regional geology, and intensity of use (e.g., boating traffic), archaeological sites in the draw-down zone were subject to the most severe impacts from wave erosion and other high-energy hydrological processes. In the conservation pool zone, sites are not eroded but become deeply buried by lake sediments.

The vast majority of the Consulting Archaeological Services survey area was located in Lake Macbride's draw-down zone (Figure 4). Within this zone, the surveyors recognized three major geomorphological zones: eroded, hard-packed surfaces (drawdown zone), low-lying areas of recent silt deposition (conservation pool zone), and steeply sloping bedrock exposures.

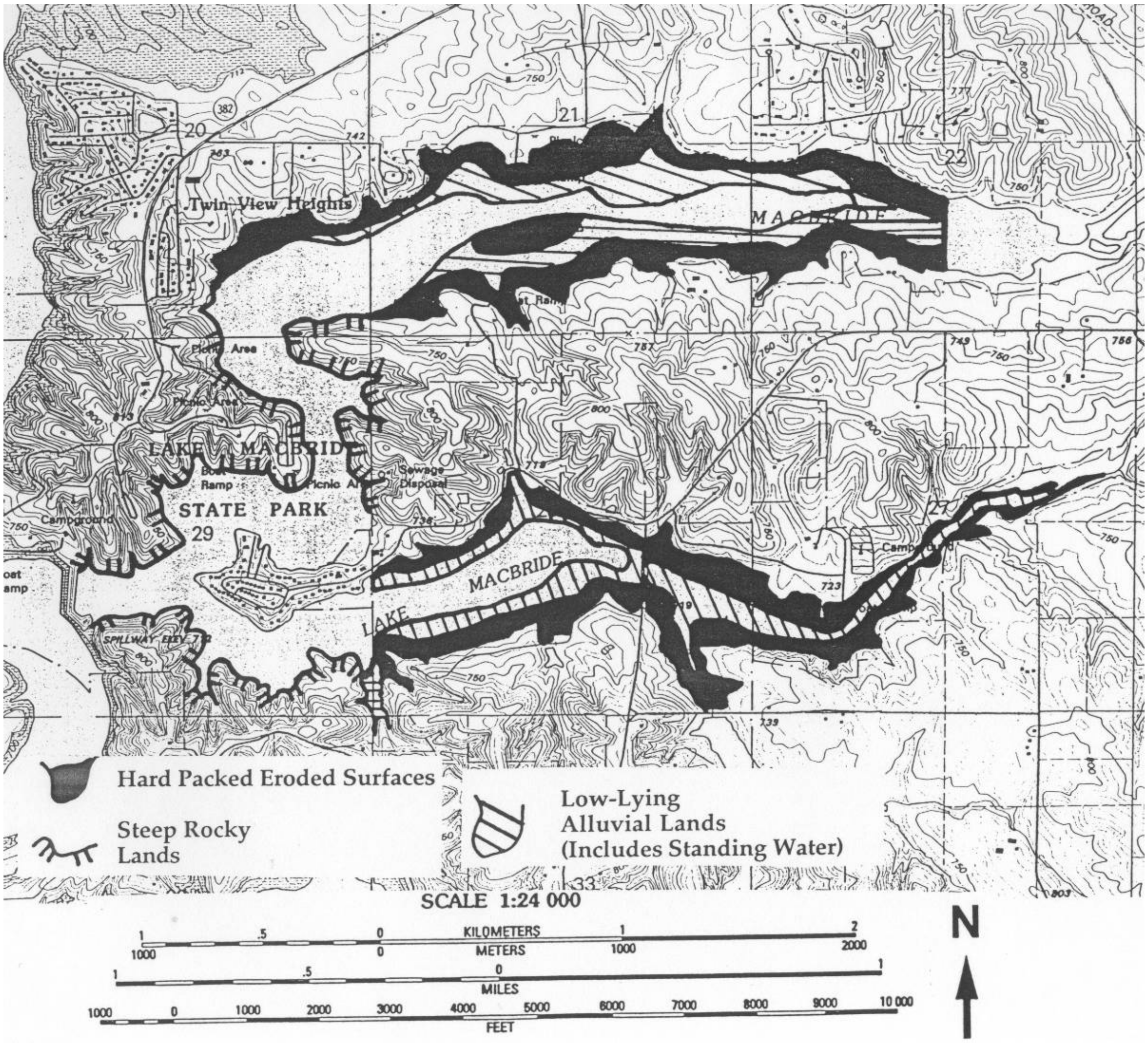


**Figure 4.** Geomorphic zones at Lake Macbride as mapped by CAS survey (after Sellars and Ambrosino 2000). Hard Packed Eroded Surfaces and Low-Lying Alluvial Lands correspond to the Draw Down and Conservation Pool zones of Ware (1989).

## Draw Down Zone

Eroded hard-packed surfaces, the most areally extensive, were usually inset a meter or more below the adjacent, never-inundated upland slopes (backshore zone). Stumps and roots of drowned trees were elevated above the eroded surfaces (Figures 5A, B). The wave-cut surfaces exposed either exhumed, pre-Wisconsinan paleosols, or the clay-rich subsoils (Bt and C horizons) of loess-derived soils.

Most of the prehistoric sites recorded by the CAS survey were found on the eroded surfaces of the draw-down zone. Prehistoric artifacts and features were collapsed onto these wave-cut surfaces. At several sites, however, intact remnants of hearths and roasting pits (Figure 5C, D) were found. Only the bottom part of these pit features, originally excavated into the soil, had escaped erosion. The remains of four late 19th and early 20th century farmsteads, abandoned prior to impoundment, were also found in the draw done zone.

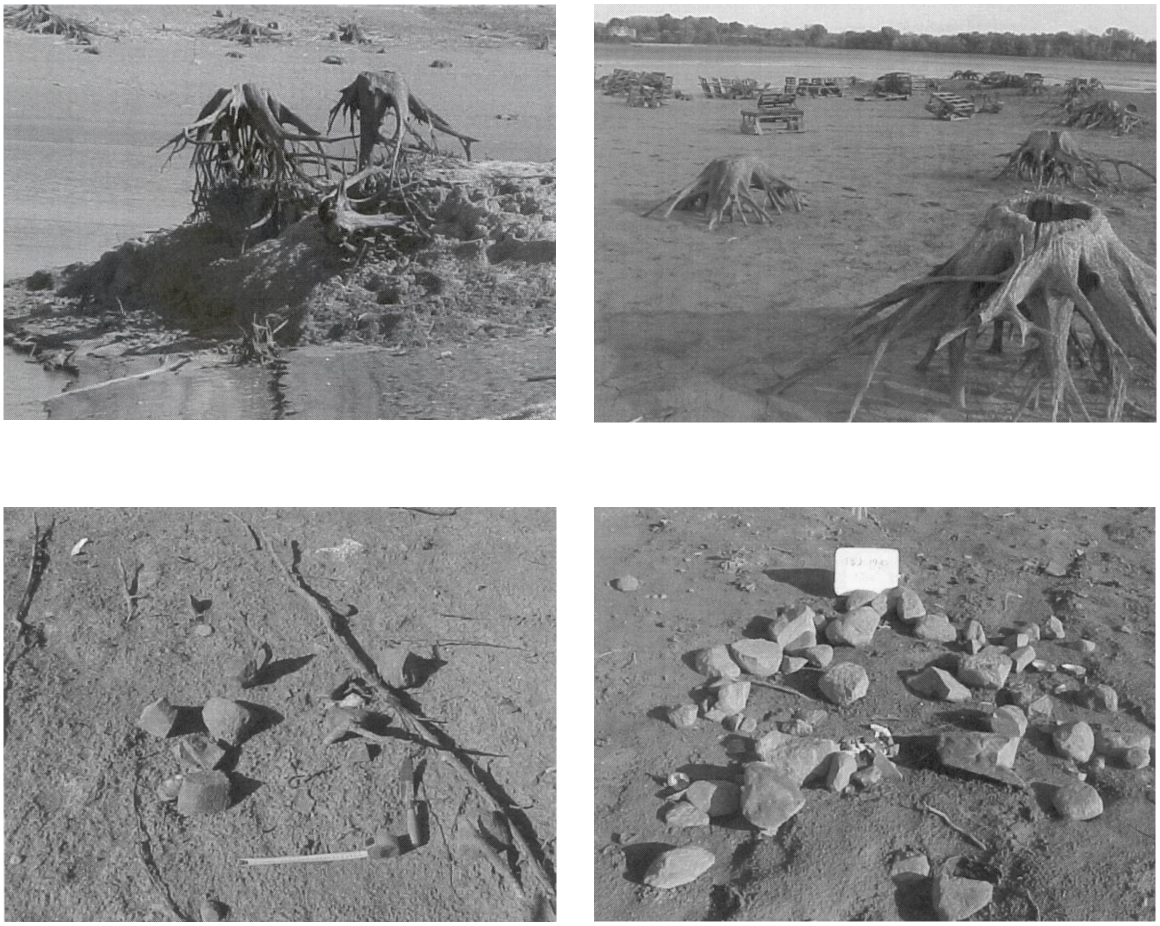

**Figure 5.** Geoarchaeology of the draw down zone, Lake Macbride. Top row: tree stumps provide evidence for extent of wave erosion. Bottom row: prehistoric rock features were collapsed onto or exposed on the wave-cut erosion surfaces.

## Conservation Pool Zone

The survey area also included areas of recent silt deposition in the conservation pool zone, in the deeper portions of the lake bed, and in inlets along the lake shore. The sediments were usually water saturated, which made subsurface testing for buried archaeological sites difficult. Many of the auger, shovel, and hand probe tests filled with water before the recent silty alluvium was penetrated. In higher, drier locations of the conservation pool zone, the post-inundation silts were found to overlie eroded surfaces at depths of 60-280 cm below surface.

Two CCC-era structures were exposed by the drawdown: a bath house foundation and a limestone footbridge. The bridge originally spanned a small tributary stream. The downstream end of the bridge was partially exposed (Figure 6), but the upstream side was completely covered by historic silts.

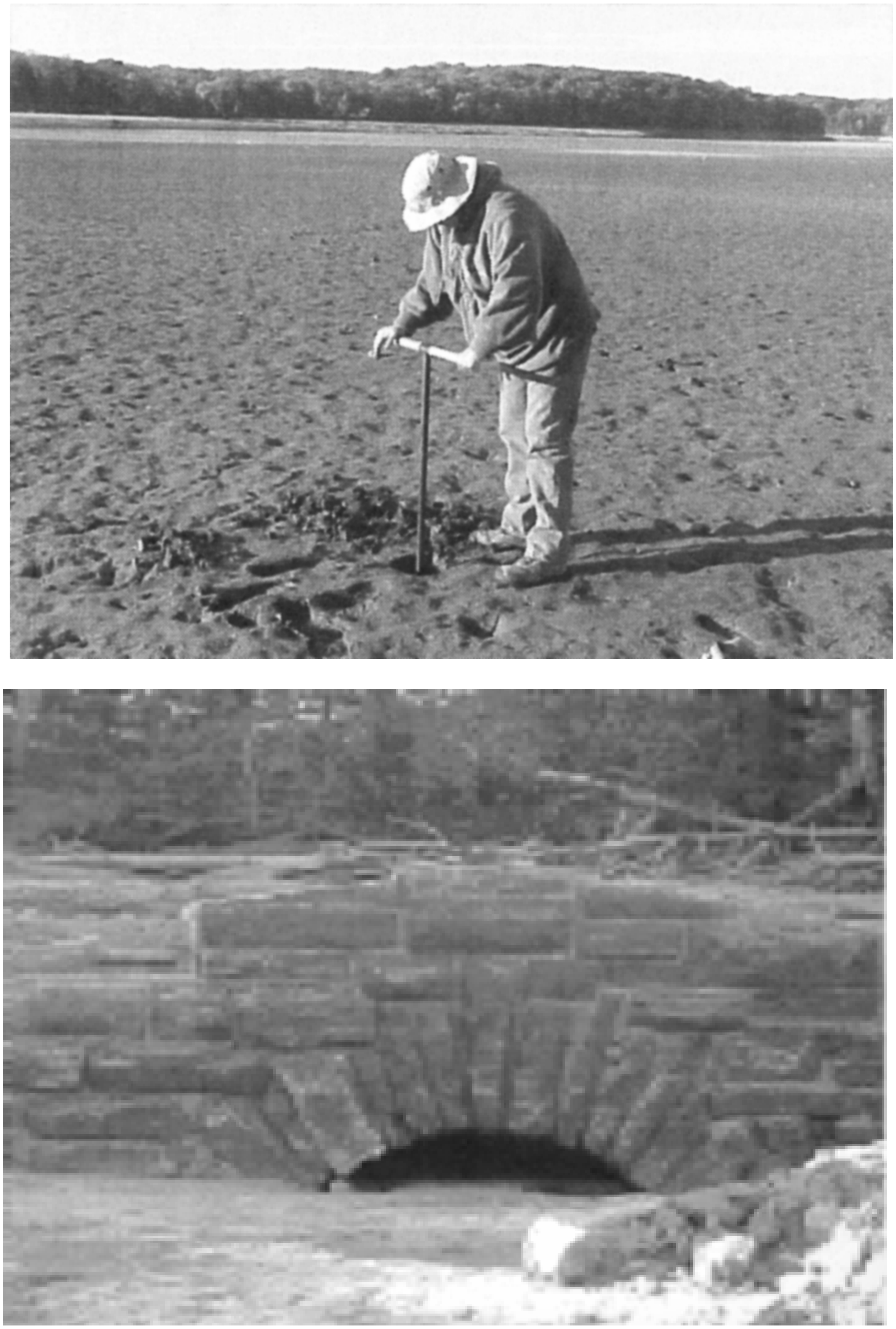

**Figure 6.** Geoarchaeology of the conservation pool zone, Lake Macbride. Top. CAS archaeologist determines thickness of lake sediment. Bottom: Partially-silted CCC footbridge exposed by Lake Macbride draw down.

The footbridge and its adjacent stone steps were part of a foot trail system, completed in 1935, that linked public use areas, with a lodge, shelters, and picnic areas, with undeveloped wooded and wetland tracts (NPS 1935; Anonymous 1935). The trail system remained in active, public use until submerged by the raising of the lake pool in 1957-58.

The bridge, steps, and foot trails were constructed by workers from CCC Company 782 from camp PE60 (Mishler and Eckels 1989; Alleger and Alleger 1936). Camp PE60 was located in Solon, with a strength that varied considerably, from 38 - 226 men; the camp was reportedly popular because of its comfortable, heated barracks (Alleger and Alleger 1936:98). Most of the personnel in CCC Company 782 came from the Iowa City, Solon, and Cedar Rapids region, although the company also included men from further afield, including Illinois and Kansas (Alleger and Alleger 1936:99-100).

A December, 1935, CCC supervisor's field report states that all the stone used in structures in Macbride Park were hauled from Palisades State Park and Mt. Vernon. A contemporary CCC District History notes that a quarry at a natural rock outcrop near the dam axis was utilized as a source of rip-rap for the slopes of the dam and for other park uses (Alleger and Alleger 1936:99).

In addition to the historic archaeological sites noted above, tremendous quantities of refuse and debris of relatively modern origin was observed throughout the survey area, ranging aluminum beverage cans (by far the most commonly observed items) to automobile tires, boat anchors, outboard engines, lawn furniture, fishing tackle, barbecue grills, and --in one case-- an aluminum kitchen sink assembly. A clean up effort, undertaken after the CAS field investigations, recovered several tons of trash and debris from the exposed lake bed. None of the refuse noted above was recorded as an archaeological site, unless the discarded material was recovered in association with one of the properties detailed in this report.

The majority of the historic debris observed by the archaeological surveyors appeared to be of 1970s, 80s, and 90s origins. The absence of 1950s- to 60s-era materials may be attributed to an earlier clean-up of the lake bed that, according to long time DNR employees, was undertaken at the time of the 1967 draw down. Items discarded into the lake prior to the 1950s are undoubtedly buried within sediments in the deepest parts of the lake bed.

## CHERT SOURCES: EVIDENCE FOR REGIONAL TRADE AND TRAVEL

The 26 prehistoric sites yielded nearly one thousand chipped stone artifacts, including stone tools and debris from tool manufacture and maintenance. Most of these items are of chert, and represent the prehistoric exploitation of stone from eight different southeastern Iowa bedrock strata (Figures 7-8).

Many cherts can be identified to source from the macroscopic observation of hand specimens, using Morrow's (1994) key to chert types or comparative collections like the one maintained at OSA (Anderson and Horgan 2006). The relative proportion of chert types at a site, or in an assemblage of sites (Figure 7), provides insight into prehistoric trade and travel. Most often, the more distant the source, the fewer items of that material are represented in sites. This rule seems to hold for the cherts from Lake Macbride (Figure 8). `

In archaeological sites, local cherts are represented by all stages of lithic reduction, from the initial knapping of fresh cobbles through tool finishing. Nonlocal cherts are often represented as either finished (often broken) tools or as waste flakes derived from sharpening and reworking such tools. In other words, the nonlocal cherts were brought into the locality in "ready-to-use" form. Morrow (1996) identified a distance-from-source of 40 km beyond which cherts will occur primarily as finished tools or maintenance-related flaking debris. This distance factor is perhaps reflected at in the Lake Macbride assemblage, where the two and perhaps three most common cherts crop out within 50 km of the study area (Figure 8).

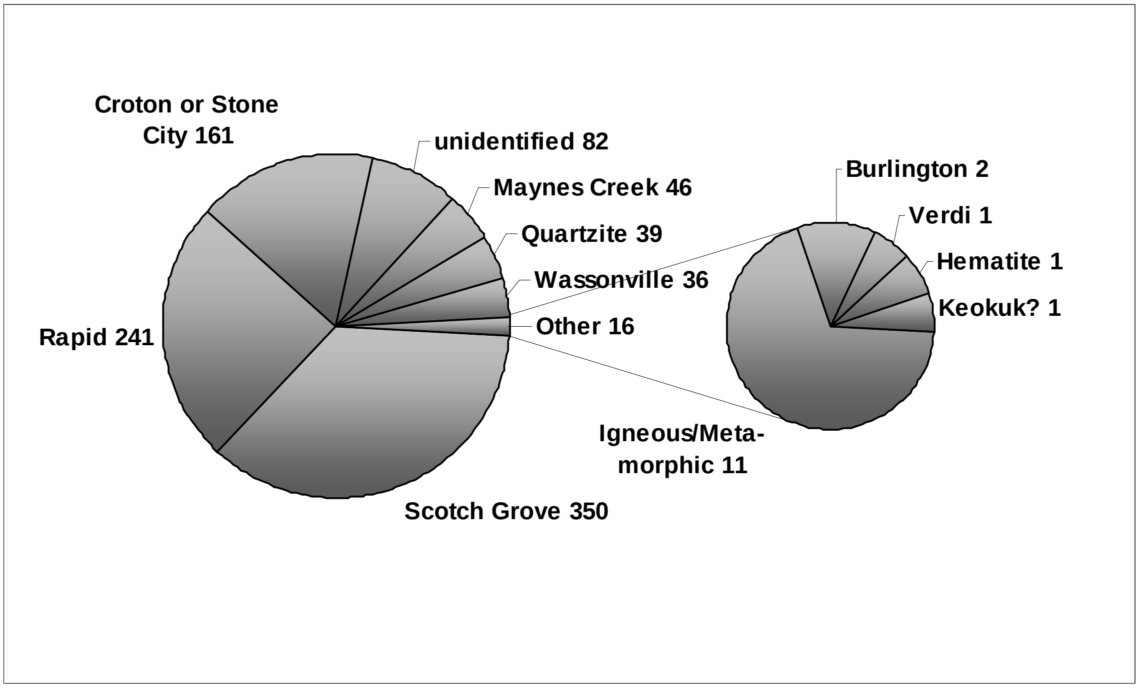


**Figure 7.** Pie charts showing distribution of stone tool and flaking debris raw materials from Lake Macbride archaeological sites. Most artifacts are from chert-bearing bedrock units found predominantly in southeast Iowa. Quartzite and igneous/metamorphic lithologies are probably derived from local till-deposits. Data compiled from Sellars and Ambrosino (2000)

The distance-to-source influences are evident for Burlington chert. The Burlington chert outcrop zone extends from southeast Iowa to east central Missouri, and was one of the highest quality, most intensively used chert resources in the Midwest during prehistory. At Lake Macbride, only two specimens of the chert were found: an Early Archaic Hardin point and a small flake, both recovered from the same site (Sellars and Ambrosino 2000). Similarly, at the Late Archaic Edgewater Park site in Coralville (Whittaker et al. 2006), Burlington chert was represented by only a few flakes derived from late-stage bifacial tool manufacture.

The following paragraphs summarize the bedrock chert sources represented at Lake Macbride. The discussion highlights two points. One is that archaeological terminology for chert types is tied to the geological stratigraphic framework, with revisions to the latter prompting revisions in the former. The second point is that geological and archaeological studies, together, bring to previously unknown or understudied chert sources that clarify our understanding of prehistoric trade, travel, and technological logistics.

All stratigraphic units discussed below incorporate current revisions to bedrock lithostratigraphy by the Iowa Geological Survey (e.g., Witzke et al. 1998, 2003, 2004).

***Rapid Chert*** is a lower Devonian chert from the Rapid Member of the Little Cedar Formation of the Lower Cedar Valley Group. It is the most readily available lithic resource in the immediate vicinity of Lake Macbride. Outcrops occur in multiple areas within the Coralville reservoir basin, extending west into Iowa County and north into Buchanan and Howard counties.

***Scotch Grove Chert*** was formerly called Wapsipinicon Chert, with its source in the Middle Devonian, Wapsipinicon Formation (Morrow 1994). This formation, as revised, is not cherty. Morrow's Waspinicon chert is, however, similar to cherts from the upper Silurian Scotch Grove

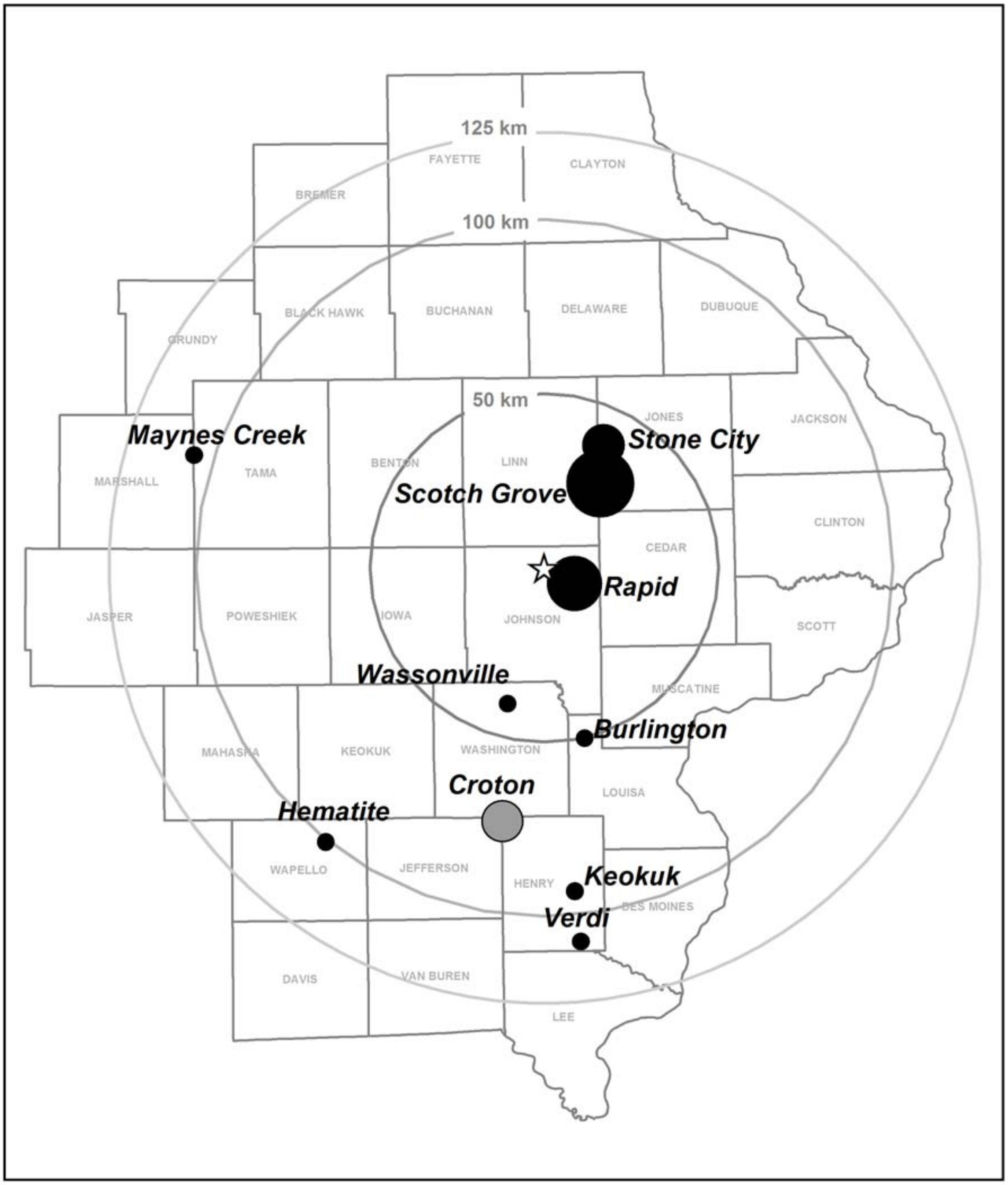


**Figure 8**. Map of chert sources represented in stone tools and flaking debris from Lake Macbride archaeological sites. Size of circle is proportional to its representation in Figure 7. Circles are centered on the closest known outcrops to Lake Macbride. Material called Scotch Grove was formerly called Waspinicon Chert by archaeologists. Material from Lake Macbride identified as Croton is also similar to chert from a quarry near Stone City.

and La Porte City Formations. The Martin-Marietta quarry on the Cedar River in southeast Linn County, visited by the 2005 Geological Society of Iowa field trip (Anderson and Langel 2005),exposes a Scotch Grove chert that crops out in Linn and Jones counties. This chert is perhaps the best candidate for the most abundant type represented in the Lake Macbride archaeological assemblage.

***Maynes Creek Chert*** was widely sought after by prehistoric peoples for its high quality and diversity. It is easily accessible in Mississippian outcrops of the Maynes Creek Formation in north central Iowa along the Iowa River and its tributaries. These outcrops occur well to the west of the Lake MacBride area primarily in Tama, Marshall, Grundy, and Hardin Counties. Maynes Creek is a relatively minor component of the Lake Macbride assemblages, but by contrast, comprised 95 percent of the lithic assemblage from the Edgewater Park site (13JH1132) on the Iowa River in Coralville (Whittaker et al. 2006).

***Wassonville Chert***, found throughout much of Washington County, is Mississippian aged from the Wassonville Formation. The formation is probably laterally equivalent to much of the Maynes Creek Formation with both being primarily cherty dolomites and very similar in appearance and composition.

***Burlington, Verdi, and Keokuk Chert*** all originate from Mississippian aged bedrock located in southeastern Iowa. Closest to Lake Macbride are the Burlington chert outcrops of northern Louisa County. In the Lake MacBride assemblages, these cherts are represented by only 1-2 specimens each.

***Croton Chert*** was known to archaeologists as Warsaw Chert prior to geologic revisions. Croton is Mississippian aged, derived from the St Louis Formation. At Lake Macbride, cherts similar to Croton are the third most frequent chert type, even though the nearest Croton outcrops are further away than the higher quality, better accessible Wassonville or Burlington chert outcrops (Figure 8). An alternative candidate may be a similar chert from Middle Devonian strata in quarries near Stone City in Jones County. Pending further research, this chert is referred to as "Stone City Quarry Chert**.**"

***Hematite*** is an iron ore that occurs in sedimentary beds in Missouri and southern Iowa, and in veins within igneous rocks in northern Minnesota. It was used by prehistoric people as a raw material for pigment, axes, adzes and other wood working implements. ematite can be found in glacial till deposits and stream gravels across the state, which may well be the source of the hematite flake found at Lake Macbride. However, a good quality source of the material has recently been identified in Wapello County, where a number of ground over flaked tools occur in avocational and professional collections. This material is a new addition to the OSA lithic raw material type collection. It will be interesting to see which archaeologically recovered hematite tools can be identified to the newly found source location.

## SITE DENSITY

The CAS survey encountered a site density of 1 site per 18 acres. This site density is higher than that usually encountered in valleys of a similar size to Jordan and Mill Creeks (Benn 1987; Ray and Benn 1988; Sellars and Stanley 1987; Sellars et al. 1998). This high density is almost certainly a result of survey conditions. The exposed and eroded land surfaces provided excellent surface visibility, greatly facilitating site identification. Shoreline erosion has resulted in the removal of surface vegetation and overlying sediments that often obscure site discovery. So, despite the fact that the sites encountered were highly eroded, the survey nonetheless provides an estimate of actual site density, unimpaired by factors such as vegetation cover and burial that often reduce the chances of sites, if present, being found. We should perhaps view the results of fortuitous projects such as the Lake Macbride investigations as a reminder that it is important to constantly strive for more refined and productive archaeological survey techniques.

## PRESERVATION, CONSERVATION, INTERPRETATION

Recorded archaeological sites are a reflection not only of where people lived in the past but also where people have looked for sites. Federal law requires agencies such as the Corps of Engineers and the Department of Transportation to determine if significant archaeological sites are present on lands being developed or impacted. Before the Coralville dam was built, archaeological survey discovered dozens of new sites in the Iowa valley. Subsequent research, like the extensive studies done along Highway 1 near Solon east of Lake Macbride, brought additional sites to light.

What we know about the Iowa's prehistory has increased steadily as a result of many individual projects like the CAS survey at Lake MacBride. The results of each project provides information to assist archaeologists in understanding the sequence of prehistoric and historic cultures that occupied the region, how they adjusted to environmental changes and in what ways they successfully utilized local resources. Collections from the sites are carefully curated at a number of institutions including the Smithsonian Institution and the Office of the State Archaeologist at the University of Iowa. They remain a resource for further study, interpretation, and exhibit.

After the CAS archaeological study was concluded the lake levels were slowly raised. While many of the discovered sites are once again beneath water, this project has added a missing piece to our understanding of the past.

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# THE VEGETATION OF LAKE MACBRIDE STATE PARK

John Pearson
Conservation & Recreation Division
Iowa Department of Natural Resources
Des Moines, IA 50319-0034

## INTRODUCTION

Located along the border of the Southern Iowa Drift Plain and the Iowan Surface in Johnson County, Lake Macbride State Park comprises nearly 2200 acres of land and water along Mill Creek and Jordan Creek immediately above their confluence with the Iowa River. The first tracts of public land were acquired by the Iowa Conservation Commission (ICC, now the Department of Natural Resources [DNR]) in the 1930s, centered on the confluence of the two creeks whose impoundment in 1936 created Lake Macbride. This forked impoundment was enlarged in 1955, extending it farther up the creek valleys onto land acquired for that purpose by the Army Corps of Engineers (ACE). In concert with ACE acquisition of the creek bottomlands, the peninsula between the two valleys was acquired by ICC and added to the original state park; the combined acreage of all ICC and ACE tracts is now managed by the DNR as Lake Macbride State Park.

When mapped by surveyors from the General Land Office (GLO) between 1837 and 1842, the vegetation of Johnson County was generally depicted as dominated by "prairie" on broad, rolling uplands and occupied by "timber" and "groves" in valleys, a pattern typical of most of Iowa (Anderson, 1996). In the north-central part of the county, a broad band of "oak barrens" was mapped as flanking the Iowa River, especially on its east side (Fig. 1). No explicit description of "oak barrens" was provided by GLO surveyors, but it seems to have been open forest consisting of a mixture of trees and grasses, perhaps resembling what modern ecologists term "savanna" or "woodland" (Miller, 1995). Most of Lake Macbride State Park is contained within the area formerly mapped as oak barrens, but a small area in the extreme northeast corner of the park extends into the area formerly mapped as prairie (Fig. 2).

Today, nearly half of the park is comprised of the impounded water of Lake Macbride and associated marshy deltas. Of approximately 1200 acres of upland, about 70% is forest (of various types), 15% is thicket (brushy areas of shrubs and small trees in various stages of succession to forest), 10% is devoted to man-made facilities (picnic areas, campground, buildings, trails, lawns, etc.), and 5% is open grassland (old fields and prairie plantings) (Fig. 3). Patches of vegetation form a diverse mosaic, reflecting contrasts in past land use that will be explored in this paper.

## VEGETATION DYNAMICS

### Comparison of 1938 and 2004 Conditions

Combined with field visits to record the composition of park vegetation in 2004 (primarily by John Pearson, DNR plant ecologist and Mark Vitosh, DNR district forester with data digitized by staff of the Johnson County Soil and Water Conservation District), comparison of digital aerial photographs of land cover in 1938 and 2004 for Johnson County in the NRGIS Library (http://www.igsb.uiowa.edu/nrgislibx/ ) enabled a study of vegetation change over a 66-year period, spanning nearly the entire history of Lake Macbride State Park. Taken only five years after the first acquisition of land and only one year after the official opening of the park, the 1938 photograph captures the initial condition of land in the original park area as it changed from private to public stewardship and as cultivation, grazing, and woodcutting were discontinued. The vegetation began to change in the original park area in the 1930s, but change in the later

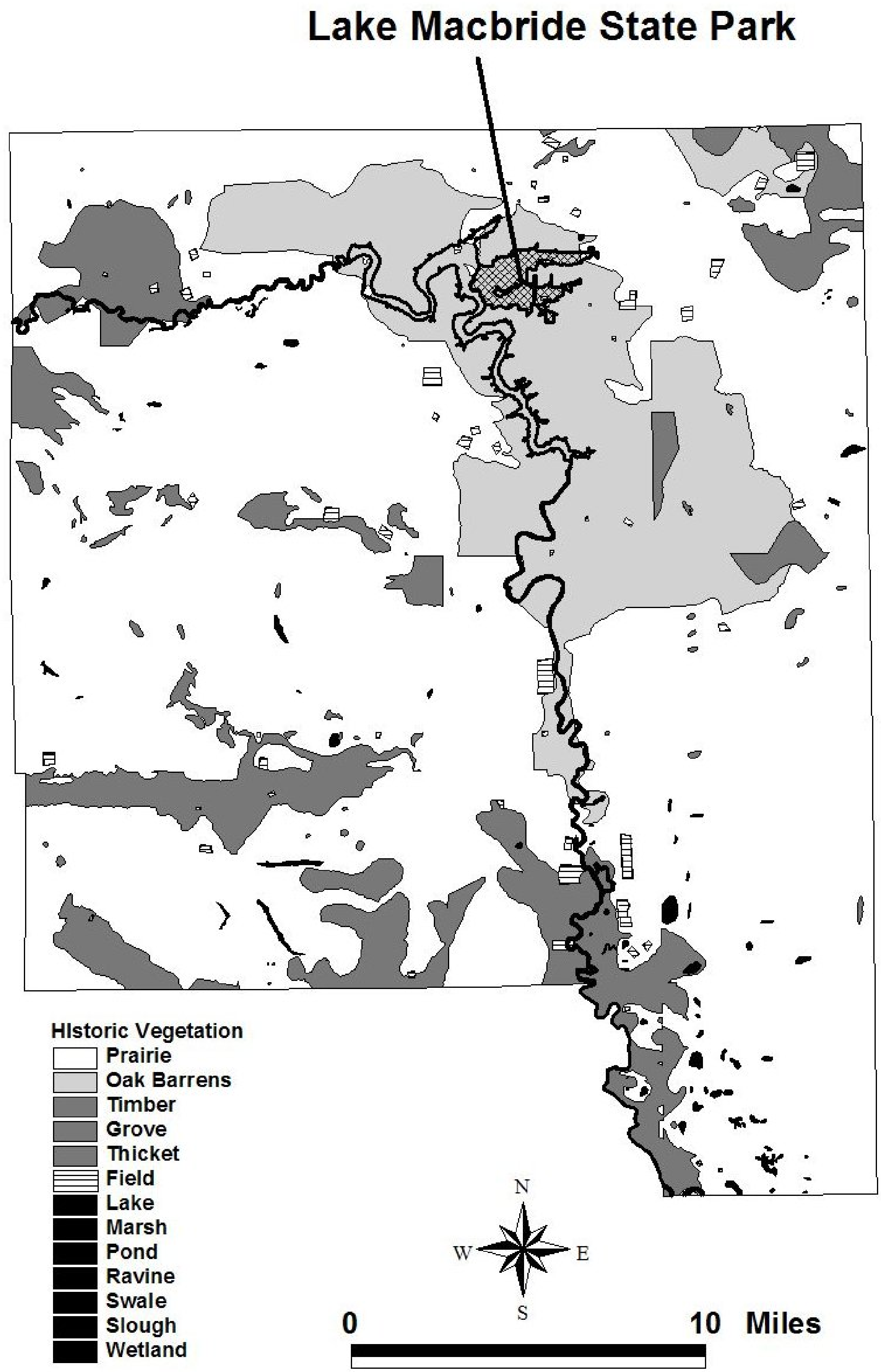


**Figure 1.** Historic vegetation of Johnson County from compilation of township plat maps by General Land Office (GLO) surveyors in 1837-1842 (adapted from Anderson, 1996). Note location of Lake Macbride State Park in "oak barrens" area.

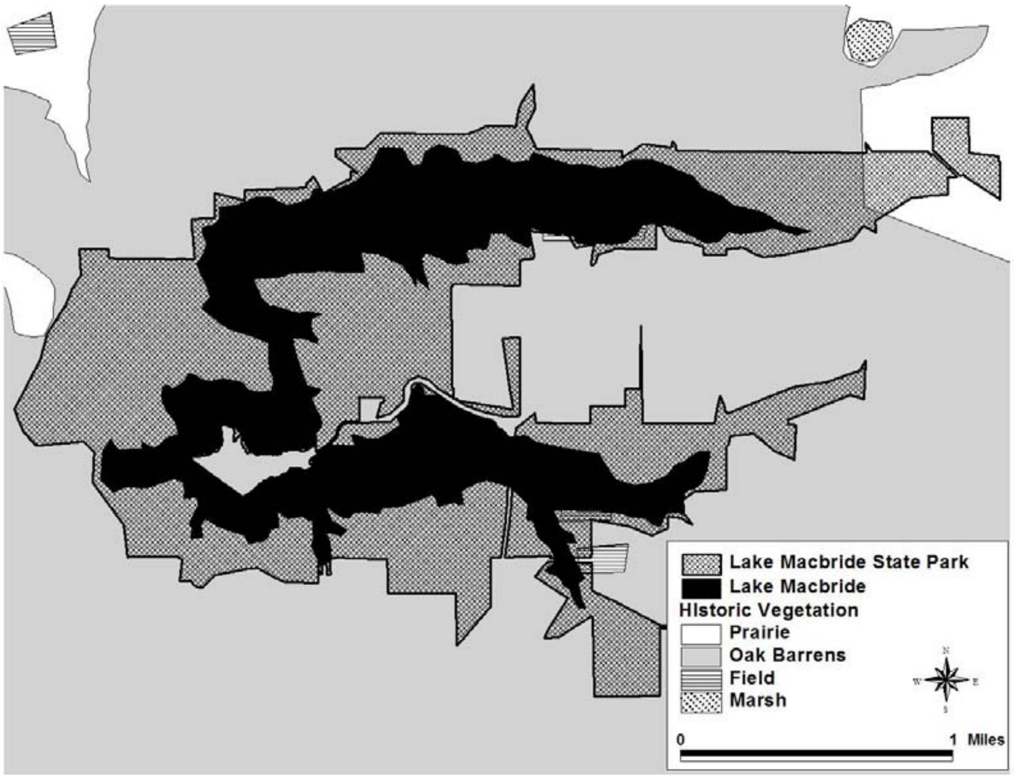


**Figure 2.** Historic vegetation (1837-1842 GLO survey) in vicinity of Lake Macbride State Park (adapted from Anderson, 1996).

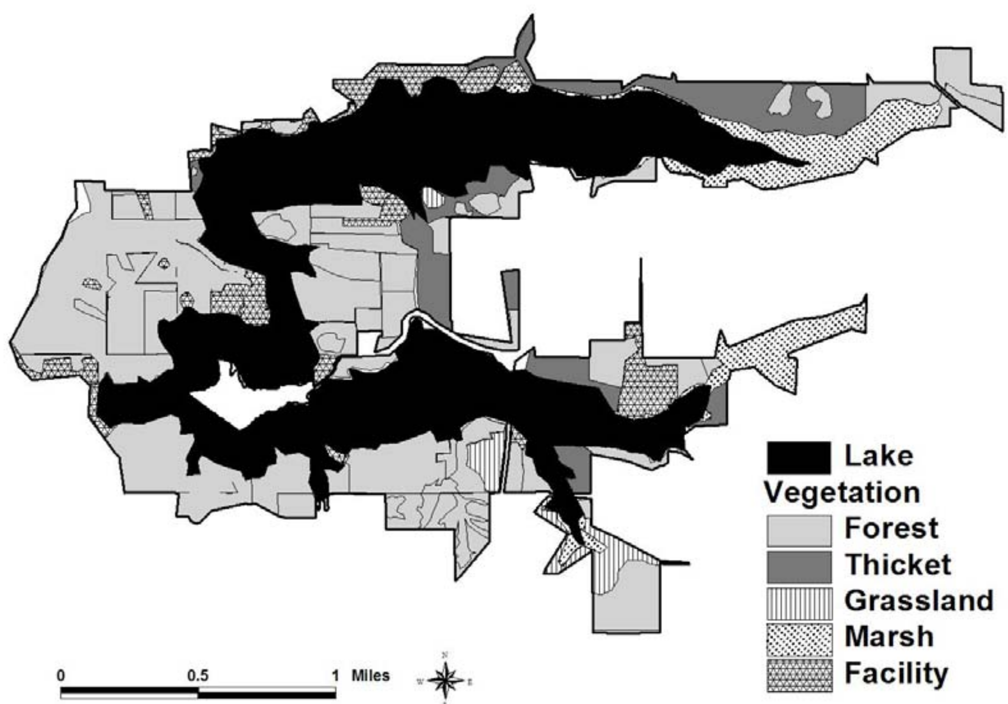


**Figure 3**. Current vegetation of Lake Macbride State Park.

additions to the park did not begin until those lands were retired in the 1950s, 1960s, and 1970s. By 2004, vegetation change in the original park area had been progressing for approximately 70 years while change in the newer additions had been underway for approximately 30-50 years.

Two areas within the park were selected for detailed comparison of their past and present vegetation: the "old park area" and the "sailboat area" (Fig. 4). Although located only a short distance from each other (across the Mill Creek arm of Lake Macbride) and sharing a common soil series (Fayette silt loam [Typic Hapludalf], considered a "forest" soil), these two areas represent a spectrum of topography and past land use. The "old park" area is a peninsula between the Iowa River (now Coralville Lake) and Mill Creek (now the north arm of Lake Macbride) that is partly comprised of land acquired and developed as the original state park in the 1930s; more importantly, a large proportion of this peninsula is comprised of steep slopes whose forest cover was never cleared for cropland (Fig. 4). In contrast, the "sailboat area" (named for the presence of a sailboat storage yard) is a peninsula between Mill Creek and Jordan Creek (now the north and south arms of Lake Macbride) that is largely comprised of land acquired in the 1950s and 1960s and developed as an expansion of the park; the absence of steep slopes on this peninsula allowed extensive pre-park conversion of forest to cropland (and subsequent reversion to forest following acquisition by the park). In the following section, differences between the 1938 and 2004 aerial photographs are identified and the current species composition of the vegetation in both areas is described.

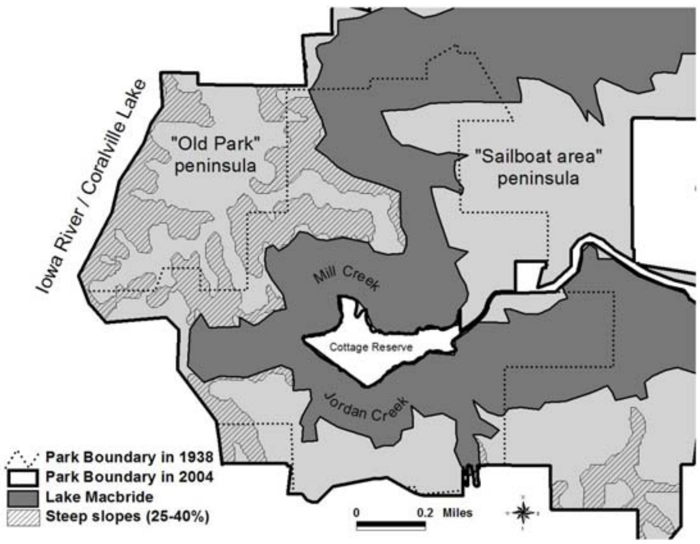


**Figure 4.** Location of "old park" and "sailboat area" peninsulas in western part of park. Note absence of steep slopes on the sailboat area peninsula.

### *Old Park Peninsula*

In 1938, most of this peninsula was forested, but clearings are evident in its center and along its north, east, and southwest edges (Fig. 5a). Two forest areas (in the east and south) have open canopies in which the dark crowns of large, widely spaced trees are distinct against a light background of open grassy groundcover: the southern patch was likely a recently retired wooded pasture while the eastern patch was likely a mowed picnic area (which continues to occupy this area today except for a portion between developed facilities released to forest regrowth). The large clearing in the center of the area and a smaller clearing along the north boundary reside on tracts that were not acquired by the park until after 1938, thus it is likely they were active cropfields or pastures at the time of this photograph. The clearing in the southwest corner contains the borrow pits used to construct the dam for Lake Macbride.

In 2004, the entire peninsula was densely forested except for narrow corridors along roads and small blocks containing parking lots or other man-made park facilities (Fig. 5b). The species composition of key areas is detailed below:

- Areas that were forested in 1938 and that remained forested to 2004 are now mature oak forest (Fig.5c) with an overstory dominated by large trees of white oak (*Quercus alba*) and red oak (*Q. borealis*), especially on rolling uplands and in shallow ravines. Sugar maple (*Acer saccharum*) and basswood (*Tilia americana*) join the oaks as co-dominant species on steep slopes and deep ravines overlooking Coralville Lake. Ironwood (*Ostrya virginiana*) is a common understory tree throughout. Having already consisted of mature trees in 1938, these stands are among the oldest in the park and express the species composition and dominance structure expected in a natural, undisturbed forest community.

- The former clearing in the center of the peninsula (treeless in 1938, but forested in 2004) is presently a stand of mature black locust (*Robinia pseudoacacia*) intermixed with lesser amounts of walnut (*Juglans nigra*), bigtooth aspen (*Populus grandidentata*), and cottonwood (*P. deltoides*) (Fig. 5 a-c). All of these species are pioneers of open, disturbed uplands. Black locust also occupies the former borrow pit area now located next to the boat ramp and fisheries station in the southwest corner of the peninsula. Black locust is native to the United States (specifically to the Appalachian and Ozark mountains (Fowells 1965)), but is introduced in Iowa (Eilers and Roosa 1994). It has been extensively planted outside of its natural range on old fields and strip mines as a “reclamation” species (Fowells 1965). Although historical records are lacking for Lake Macbride State Park, it is possible that black locust was planted on disturbed sites here as a soil conservation practice.
- A diverse mixture of young, pioneering tree species forming a dense, young forest (termed “successional woods” on Fig. 5c) now occupies old fields and open (likely pastured) woodlands that formerly occurred along the north park border adjacent to the entrance road in 1938. Some black locust presently occurs in these stands, but several other species are better represented, including walnut, elm (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica*), black cherry (*Prunus serotina*), honeylocust (*Gleditsia triacanthos*), and shagbark hickory (*Carya ovata*). Small amounts of young oak, particularly northern pin oak (*Quercus ellipsoidalis*) with some white oak (*Q. alba*), are also present. Reflecting the effects of past grazing, the woody understory is dominated by thorny shrubs, particularly gooseberry (*Ribes missouriense*) and greenbriar (*Smilax hispida*); additionally, an introduced shrub - Amur honeysuckle (*Lonicera maackii*) - is abundant, having spread from a nearby roadside planting.

***Sailboat Area Peninsula***

In 1938, most of this peninsula was outside of Lake Macbride State Park and was still being farmed. At that time, narrow strips of trees occurred in swales and along fence lines and two small blocks of forest existed in the southwest quadrant and near the northeast corner (Fig.6a). By 2004, forest and thicket covered the entire peninsula except for park facilities (roadway, boat ramp, parking lot, and sailboat storage yard) and a small patch of open grassland in the northeast corner (Fig. 6b). However, there is considerable variation among patches despite the visual similarity of their canopies as viewed on the 2004 aerial photograph:

- The two blocks of forest that were visible on the 1938 aerial photograph are today mature oak forests dominated by large trees of white oak and red oak (Fig. 6c).
- Three pine plantations are present in the northeast, northwest, and southwest corners of the peninsula (Fig. 6c). The northeast plantation is the youngest, having been established on an ACE tract acquired in the 1950s when Lake Macbride was extended up the valley of Mill Creek. The other two plantations are older, having been established on ICC tracts acquired in the 1930s. Today, the younger plantation is structurally simple with a dense canopy of mid-sized white pines (*Pinus strobus*), a sparse woody understory of scattered tree saplings and shrubs, and a forest floor densely covered with pine needles. The older plantations are structurally complex with a canopy of large pine trees

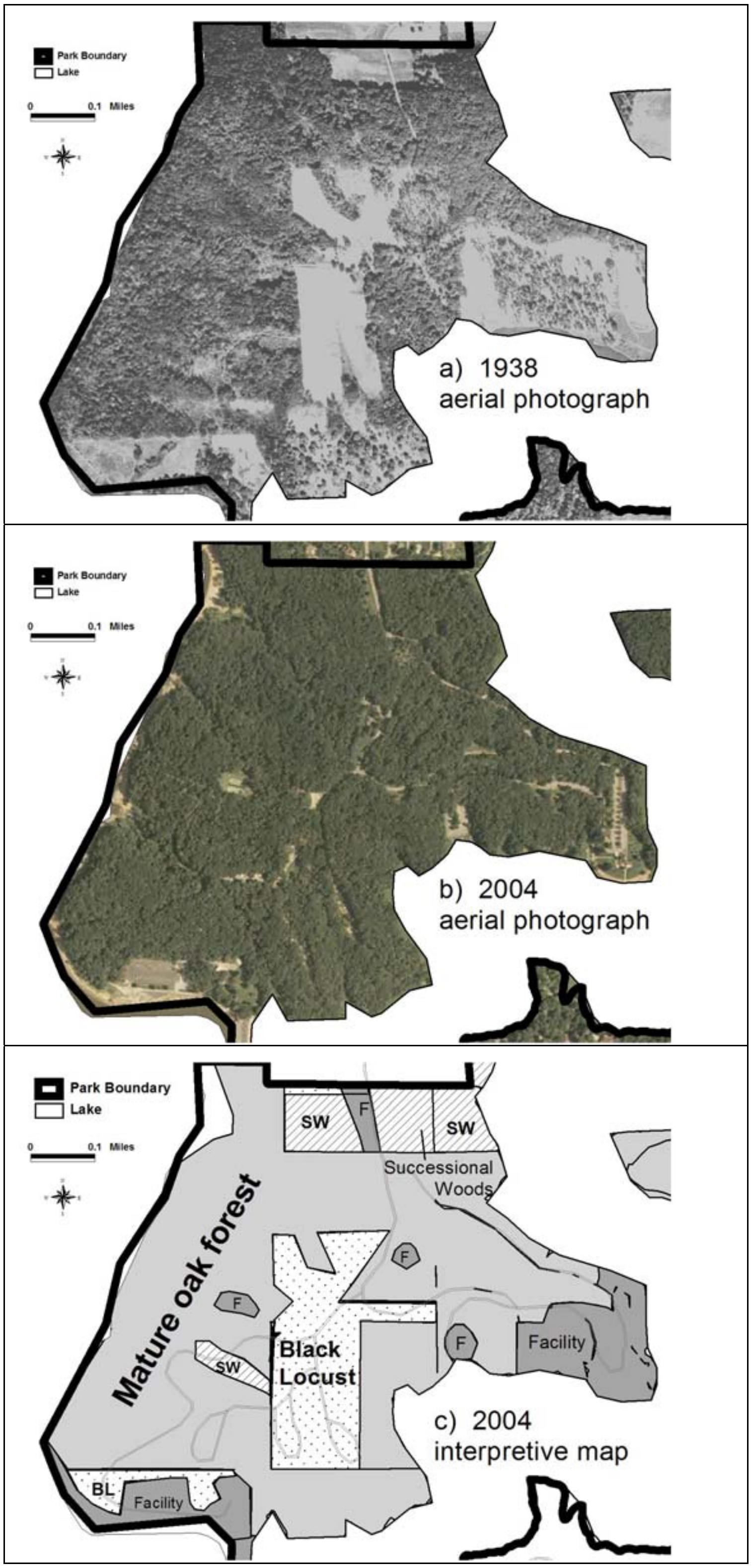


**Figure 5.** Vegetation of old park peninsula: a) 1938 aerial photograph, b) 2004 aerial photograph, c) 2004 interpretive map [symbols: BL (Black Locust), F (Facility), SW (Successional Woods)].

(primarily white pine) and large deciduous trees that have grown up between the pines (including walnut, elm, ash, and northern pin oak), a relatively dense woody understory, and a forest floor of mixed conifer and deciduous leaves. Interestingly, red oak has regenerated in these older plantations, with saplings evident in the northwestern stand and large trees present in the southwestern stand.

- The northwestern pine plantation consists of a central, pine-dominated stand (described above) surrounded by a deciduous forest community dominated by white oak, red oak, basswood, and sugar maple but also containing white pines planted in rows. The deciduous forest community appears to have developed in a portion of the pine plantation that was less densely stocked with planted pines; today its tree species composition and structure resemble a natural, undisturbed community except that large trees are lacking. The main pine stand and its flanking deciduous community occupy a site that was acquired by the park in 1934 and was still an open field in 1938 (Fig. 6a).
- A large area of successional woods surrounds the mature oak forest west of the road (Fig. 6c). These woods are comprised of a variety of former open fields whose conversion to forest began in different years, ranging from 1933 to 1967 (as they were acquired by the park). The youngest woods (primarily north of the mature oak forest) are dominated by small to mid-sized trees of elm, black locust, honeylocust, boxelder, and ash with a dense, shrubby understory of gray dogwood (*Cornus foemina*). Older woods (primarily south of the mature oak forest) are dominated by large trees of northern pin oak, ash, and black locust. The successional woods do not contain a significant amount of the tree species (white oak, red oak, basswood, sugar maple) that typically occur in mature, undisturbed, natural stands.
- A large, tall, dense thicket of autumn-olive (*Elaeagnus umbellata*) presently occupies the formerly open fields east of the road (acquired by the park in the late 1960s) (Fig. 6c). Widely planted in shelterbelts and wildlife habitat plantings, autumn-olive is an introduced species that has proven to be an aggressive invader of grasslands and other open habitats. It is likely that the autumn-olive thicket now established throughout the eastern part of the peninsula (and elsewhere in the park) spread from plantings installed after park establishment. A small grassy area (dominated by smooth brome [*Bromus inermis*], an introduced grass commonly planted in hayfields) in the north end of this thicket likely represents a residual patch of a former hayfield that has not yet been fully invaded by autumn-olive.
- Woods bordering the south side of the sailboat storage yard are strongly dominated by black locust; silver maple (*Acer saccharinum*) dominates the north side (Fig. 6c). Both were open fields in 1938 (Fig. 6a).

## Trends in Vegetation Change

### *Defragmentation*

Conversion of forest to cropland and pasture in the pre-park era fragmented the original forest into small, isolated remnants. This is exemplified in the extreme on the “sailboat area” peninsula where only two small blocks of forest remained in 1938 (Fig. 6a) after nearly 100 years of agricultural use following pioneer settlement (circa 1840). Less extremely, forest in the “old park” area had also been reduced in acreage, but still covered most of the peninsula in 1938 (Fig. 5a). Clearings within the forest, however, still represent “internal fragmentation” that interrupts the landscape and creates “edge effects” that are detrimental to bird species requiring large, unbroken forest.

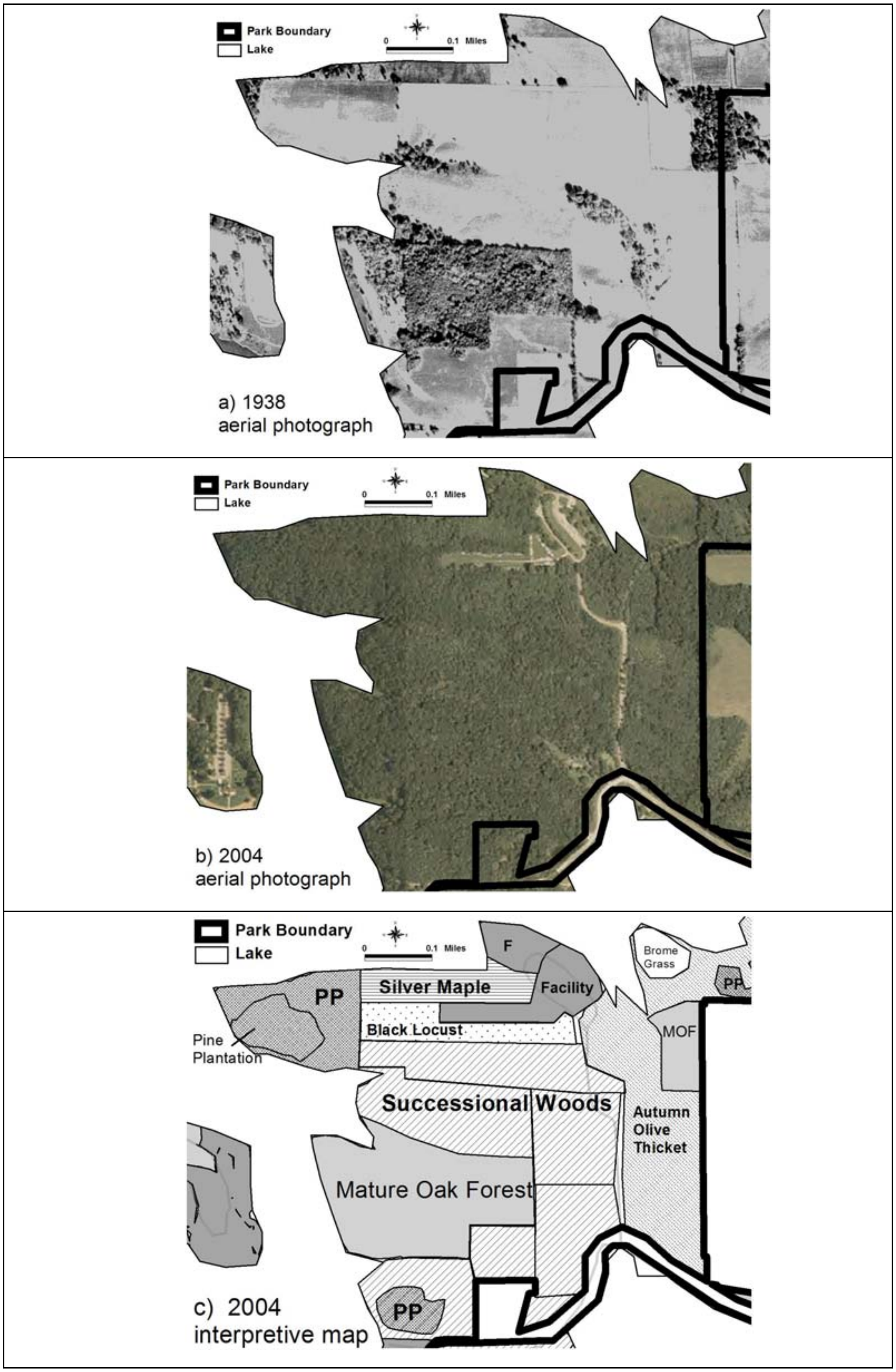


**Figure 6.** Vegetation of sailboat area peninsula: a) 1938 aerial photograph, b) 2004 aerial photograph, c) 2004 interpretive map [symbols: F (Facility), MOF (Mature Oak Forest), PP (Pine Plantation), SW (Successional Woods)].

Between 1938 and 2004, forest fragmentation in the park was reversed with reforestation of retired agricultural lands ("defragmentation"). Although the species composition of reestablished forest tracts differs from the original (see next section), forest of one kind or another now occupies 70% of the uplands surrounding the lake within the park (or 85% if thicket areas are included). The high amount of unbroken forest habitat in the park may help account for its attractiveness to many bird species.

### *Decline of White and Red Oak*

Although forest area has rebounded in the park, the species composition of the reestablished areas differs from that of the original forest community. The best examples of the original, "natural" forest in the park are the mature oak forests like the large tract on the "old park" peninsula (Fig. 5c) and the two small tracts in the "sailboat area" peninsula (Fig. 6c). The mature oak forests are dominated by white oak and red oak, the tree species most often recorded by GLO surveyors as they documented the forests that they encountered in Johnson County during 1837-1842. Although likely harvested for timber and grazed by livestock, these tracts were never cleared for cultivation, so retain much of their original character. Although oak forest (arguably in the form of open woodland, savanna, or "barrens") was likely the predominant vegetation of the park area in "pre-settlement" times (Fig. 2), only 25% of the upland vegetation in the park represents this community today. Although the mature oak forests are dominated by large trees of white and red oak, seedlings and saplings of these species are generally absent beneath the canopy, indicating (if current trends continue) that the community composition will change when the mature oaks eventually die and are replaced with other species (likely with shade-tolerant species such as sugar maple, basswood, and white ash).

Forest tracts that have regenerated on old fields since 1938 do not resemble the mature oak forests, even disregarding stand age and tree size. Tracts dominated by black locust do not contain significant numbers of white oak or red oak. The successional woods are populated with a wide variety of tree species, especially elm, ash, cherry, walnut, honeylocust, shagbark hickory, and northern pin oak, but generally contain little or no white or red oak (although a few stands of successional woods do contain scattered saplings of white oak). The autumn-olive thickets generally lack white and red oak as well. The only reforested tracts containing significant amounts of regenerating white oak or red oak (mixed with other species) are the older pine plantations, but these are small in size and few in number.

The general lack of significant regeneration of white oak and red oak in virtually all forests within the park reflects cumulative changes in their ecological environment that began with pioneer settlement in the 1840s. Periodic ground fires that swept through oak woodlands in "presettlement" times and maintained favorable conditions for oak regeneration were eliminated by forest fragmentation (preventing spread between patches), by livestock grazing of woodlots (reducing fuel loads, later followed by abandonment allowing colonization by fire-intolerant trees), and by cultural intolerance (fire suppression); collectively, these changes allowed open woodlands to develop closed canopies that prevented shade-intolerant oaks from regenerating in existing stands. Later, poor forestry practices such as high-grading (selective removal of high-value trees like oaks) and continuous grazing likely contributed to unfavorable conditions for oak regeneration and survival as well. After park establishment, white and red oaks failed to regenerate in mature oak stands due to deep shade and also failed to recolonize abandoned agricultural fields due to competition with pre-emptive trees and grasses; additionally, heavy browsing by deer may have negatively affected oak regeneration in both habitats.

### *Spread of Invasive Species*

Several non-native plant species form large stands in the park, including garlic mustard (*Alliaria petiolata*), autumn-olive, Amur honeysuckle, and black locust. These species differ in their origin, degree of spread, and problematic effects.

Garlic mustard is a shade-tolerant herb infesting forests throughout the Midwest and Iowa. It is found throughout Lake Macbride State Park ranging in local density from scattered plants to large patches. The shade tolerance of this species enables it to expand extensively into forests in the park, where it competes with native plants. The sheer abundance of this plant often discourages managers from attempting to control it, which may involve a variety of labor-intensive projects such as hand-pulling, weed-whipping, spot spraying of herbicides, prescribed burning of woodland areas, and selective torching of individual plants and patches with a hand-held torch (see brochure accompanying this guidebook).

Autumn-olive forms large stands in the eastern part of the sailboat area and on uplands flanking the upper end of the Jordan Creek arm of Lake Macbride, where it appears to have invaded former hayfields dominated by smooth brome (another non-native species), likely having spread from plantings established as wildlife habitat. It is also a component of successional woods and thickets on the north side of the Mill Creek arm of the lake and is presently encroaching into the few remaining (brome-dominated) grasslands left in the park. The density, height, and rapid growth of autumn-olive stands presently prevent the alternative use of infested areas for planting of preferred vegetation (such as prairie or native trees) and often blocks viewing of the lakeshore by park visitors. Park managers have recently begun to control infestations of autumn-olive with a small vehicle equipped with front-mounted steel blades that act as heavy-duty scissors (greatly accelerating the rate of treatment compared to use of chainsaws), supplemented with application of herbicide to cut stumps (to prevent resprouting); to date, this effort has been focused on the "Hillbilly Hill" area on the north side of the Jordan Creek arm of the lake.

Amur honeysuckle is commonly planted as an ornamental shrub in residential areas and public parks. Throughout the Midwest, it has spread to natural forest habitats, where it may form large, dense stands and compete with native plants. Many state parks in Iowa contain severe infestations of Amur honeysuckle that have likely spread from ornamental plantings in picnic areas and campgrounds. In Lake Macbride State Park, a notable stand of Amur honeysuckle occurs in successional woods along the entrance road to the old park area, where it appears to have spread from a roadside planting. Although it is not presently a severe problem, this shade-tolerant species has the potential to expand greatly into forests throughout the park. A recommended control is to cut the stems and treat the stumps with herbicide.

Black locust occurs in several places in the park. It is unknown if it was purposefully planted, but if so, the most likely locations are the old fields in the center of the old park peninsula and adjacent to the sailboat storage yard on the sailboat area peninsula. Both of these areas were open fields in 1938, so would have been candidates for planting of black locust as a reclamation species soon after establishment of the park. Its additional occurrences in successional woods and along edges of mature forests may represent its ability to spread as a volunteer colonizer of open sites. Although once planted for conservation purposes, black locust is now generally considered a nuisance because of its "weedy" growth habit (dense stands with numerous thorny branches and root-suckers), encroachment into open areas, competition with preferred species, and its non-native status (in Iowa). Control is difficult because of its vigorous resprouting ability. In the park, managers are wary of trying to remove the mature stand in the old park area by cutting out of concern for stimulating resprouting and are hopeful that this short-lived tree species (now approximately 70 years old in this location) will die out naturally without resprouting.

## Future Changes in Vegetation

Learning about past and present states of vegetation in the park raises questions of what its future state will be. If present trends continue, the mature oak forests will gradually change to another kind of forest community, one in which white and red oaks (in fact, any oak species) are absent or rare and in which sugar maple, basswood, and white ash may be the new dominant species. As they mature, the successional woods, black locust stands, and autumn-olive thickets likewise will contain little or no white and red oak, although northern pin oak may be significant component of the community along with elm, ash, walnut, and several other species. Lacking dominance by white and red oak, the new forests will not resemble present-day forests or presettlement forests. Because oaks produce acorns, the rarity of these species in the future will reduce the amount of mast presently available to acorn-consuming animals such as turkeys and squirrels. Invasion and expansion of shade-adapted, non-native plants threaten to diminish native plants adapted to open, oak-dominated woodland. The decline of oaks, deepening shade, and invasion of exotic species can thus be expected to affect both plant and animal composition of future forests.

Although oaks will decline if present trends continue, purposeful management by park managers could create an alternative future. Coupled with thinning of trees, prescribed burning in the mature oak forests could conceivably restore the woods to a semblance of their former "oak barrens" condition. Targeted release of scattered oak trees (by cutting of competing trees) within the successional woods could favor their growth and reproduction. Planting of oaks on recleared patches of successional woods and autumn-olive thickets could re-establish them in places where they are missing. With great effort, problematic invasive species like garlic mustard, Amur honeysuckle, and autumn-olive could be controlled to favor native plant species.

Aside from the challenging technical problems of restoring oak woodlands (including finding manpower for labor-intensive tasks and refining techniques for maximal positive effects and minimal negative effects), there is a philosophical tension between "preserving biodiversity" by manipulation of existing conditions and "preserving wildness" by letting nature take its course without human manipulation, however well-intentioned. Both perspectives are based on an appreciation for naturalness in parks and preserves, but differ in how it is defined. This issue was vigorously debated during a spontaneous email discussion about the fate of Browns Woods, a forest preserve in Des Moines with many similarities to the mature oak forests and successional woods of Lake Macbride State Park (Iowa Native Plants Listserv, April 25-26, 2001, "forests" thread). Two excerpts from that discussion representing the contrasting perspectives are quoted below (with minor editing for clarity).

### *The wildness perspective*

*I've been residing in Iowa for twenty five years now and am continually amazed as I witness how completely the Iowan seems to accept total control of the environment as the only sensible approach to nature. Both those who call themselves environmentalists and those whose eyes are on the profit line seem ready to reach for the newest, most deadly version of Round-up herbicide before they venture outside to develop or "restore" an area.*

*I am puzzled as people have repeatedly told me "we have gone too far to allow nature to run its course now" even in the face of evidence that allowing rivers, for example, to meander has great benefits. Is there a way to explain that nature can take care of a good many problems if we will just get out of the way and let her work? It doesn't seem so.*

*I'm at a loss as to how one could suggest that there is a really okay approach to nature other than the total control, we-must-manage-this-or-everything-will-be-out-of-sync attitude. I do wish from time to time that Iowans could recognize their supra-controlling attitude as a cultural phenomenon, and that the diversity that everyone also pays a lot of lip service to around here could include a recognition that there are other, equally valid ways of living with nature.*

*There was nothing wrong with Browns Woods as it was except that buckthorn which was not in Iowa in 1492 was growing there. Is it really so very important create and preserve areas that look just as they did in 1620 or 1850 or even 1906? I would rather not if it means introducing poisons into the environment.*

### *The biodiversity perspective*

*Browns Woods may have seemed fine to you, but did you consider asking the horse gentian, or purple milkweed, or dwarf larkspur? I think the decision to manage the preserve was done after careful thought about what should be done for the public that owns it. Conservation of biological diversity was high on the list.*

*The decision to make portions of the forest preserve more like savanna is an attempt to insure habitat for native savanna and woodland species (which by the way is extremely hard to find in Iowa, and relative to forests are much more endangered even though they were probably nearly as common as forests a 150 years ago). You surely can recognize the value in conserving habitats that provide homes for all our native species. I hope you understand that not all "wooded areas" are the same. There are many different types of natural "wooded communities" ranging from savanna (really more a type of prairie), to woodlands, to forests. They provide homes for different kinds of flora and fauna. One of the beauties of Iowa was that at the landscape scale, Iowa was a mixture of these communities -- which increased our native biodiversity.*

*I share your concerns about herbicide use, but to condemn managers for using herbicides to achieve restoration goals goes too far. We used technology to conquer and destroy most of Iowa's natural heritage; I think we need to be open to the judicial and careful use of bits of technology to restore our natural heritage and biodiversity.*

Routinely faced with formulating and executing a best course of action for the preservation of nature, natural area managers struggle to balance these perspectives. Recognizing value in a diversity of approaches, the ecological management plan for Lake Macbride State Park includes elements of both active and passive management.

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# FAUNA OF LAKE MACBRIDE STATE PARK

Daryl Howell, Zoologist
Conservation & Recreation Division, Iowa DNR
Des Moines, IA 50319

## Birds

Lake Macbride State Park provides excellent wildlife viewing opportunities for the public. The park has forest, shrub, and grassland terrestrial habitats in addition to a man-made 800-acre lake and a 200-acre wetland at the upper end of the lake. Coralville Lake borders Macbride on the west. The large amount of open water and wetlands of the reservoir and park provide excellent feeding and resting habitat for waterfowl and shorebirds during spring and fall migration. Common loons, American white pelicans, horned grebes, pied-billed grebes, and three species of mergansers are commonly seen during migration.

**Figure 1.** Great Blue Heron

The forest areas of the park are good places to look for migrating warblers and other passerines, as well as uncommon breeding species like the scarlet tanager and yellow-throated warbler. The amount of forest habitat in the park has actually been increasing during the last 70 years. Former farm fields are now successional forest, thus reducing habitat fragmentation of forest. During the Breeding Bird Atlas Project, 78 species were recorded for the park and adjacent area. Twenty species were confirmed as breeding and thirty-two as probable breeders. Chris Edwards, an avid birder and Iowa Ornithologist Union Member from North Liberty, has recorded 189 species encompassing all seasons since 1991 (Table 1).

**Table 1.** List of birds observed at Lake Macbride State Park by Chris Edwards, 1991-2006.

| | | |
|---|---|---|
| Greater White-fronted Goose | Common Goldeneye | Least Bittern |
| Snow Goose | Hooded Merganser | Great Blue Heron (Fig. 1) |
| Canada Goose | Common Merganser | Great Egret |
| Wood Duck | Red-breasted Merganser | Snowy Egret |
| Gadwall | Ruddy Duck | Green Heron |
| American Wigeon | Ring-necked Pheasant | Turkey Vulture |
| Mallard | Wild Turkey | Osprey |
| Blue-winged Teal | Northern Bobwhite | Bald Eagle |
| Northern Shoveler | Common Loon | Northern Harrier |
| Northern Pintail | Pied-billed Grebe | Sharp-shinned Hawk |
| Green-winged Teal | Horned Grebe | Cooper's Hawk |
| Canvasback | Red-necked Grebe | Red-shouldered Hawk |
| Redhead | Eared Grebe | Broad-winged Hawk |
| Ring-necked Duck | American White Pelican (Fig. 2) | Red-tailed Hawk |
| Lesser Scaup | Double-crested Cormorant | American Kestrel |

**Table 1.** (continued)

| | | |
|---|---|---|
| Sora | Red-eyed Vireo | Prairie Warbler |
| American Coot | Blue Jay | Palm Warbler |
| Killdeer | American Crow | Bay-breasted Warbler |
| Greater Yellowlegs | Horned Lark | Blackpoll Warbler |
| Lesser Yellowlegs | Purple Martin | Cerulean Warbler |
| Solitary Sandpiper | Tree Swallow | Black-and-white Warbler |
| Spotted Sandpiper | Northern Rough-winged Swallow | American Redstart |
| Least Sandpiper | Bank Swallow | Ovenbird |
| Pectoral Sandpiper | Cliff Swallow | Northern Waterthrush |
| Dunlin | Barn Swallow | Louisiana Waterthrush |
| Long-billed Dowitcher | Black-capped Chickadee | Connecticut Warbler |
| Wilson’s Snipe | Tufted Titmouse | Mourning Warbler |
| Bonaparte’s Gull | Red-breasted Nuthatch | Common Yellowthroat |
| Ring-billed Gull | White-breasted Nuthatch | Wilson’s Warbler |
| Herring Gull | Brown Creeper | Canada Warbler |
| Caspian Tern | Carolina Wren | Scarlet Tanager |
| Forster’s Tern | House Wren | Eastern Towhee |
| Mourning Dove | Winter Wren | American Tree Sparrow |
| Black-billed Cuckoo | Sedge Wren | Chipping Sparrow |
| Yellow-billed Cuckoo | Marsh Wren | Field Sparrow |
| Eastern Screech Owl | Golden-crowned Kinglet | Grasshopper Sparrow |
| Great Horned Owl | Ruby-crowned Kinglet | Fox Sparrow |
| Barred Owl | Blue-gray Gnatcatcher | Song Sparrow |
| Common Nighthawk | Eastern Bluebird | Lincoln’s Sparrow |
| Chimney Swift | Veery | Swamp Sparrow |
| Ruby-throated Hummingbird | Gray-cheeked Thrush | White-throated Sparrow |
| Belted Kingfisher | Swainson’s Thrush | Harris’ Sparrow |
| Red-headed Woodpecker | Hermit Thrush | White-crowned Sparrow |
| Red-bellied Woodpecker | Wood Thrush | Dark-eyed Junco |
| Yellow-bellied Sapsucker | American Robin | Northern Cardinal |
| Downy Woodpecker | Gray Catbird | Rose-breasted Grosbeak |
| Hairy Woodpecker | Brown Thrasher | Indigo Bunting |
| Northern Flicker | European Starling | Dickcissel |
| Pileated Woodpecker | Cedar Waxwing | Bobolink |
| Eastern Wood-Pewee | Blue-winged Warbler | Red-winged Blackbird |
| Alder Flycatcher | Golden-winged Warbler | Eastern Meadowlark |
| Least Flycatcher | Tennessee Warbler | Yellow-headed Blackbird |
| Willow Flycatcher | Orange-crowned Warbler | Rusty Blackbird |
| Eastern Phoebe | Nashville Warbler | Common Grackle |
| Great-crested Flycatcher | Northern Parula | Great-tailed Grackle |
| Eastern Kingbird | Yellow Warbler | Brown Headed Cowbird |
| White-eyed Vireo | Chestnut-sided Warbler | Orchard Oriole |
| Bell’s Vireo | Magnolia Warbler | Baltimore Oriole |
| Yellow-throated Vireo | Yellow-rumped Warbler | Purple Finch |
| Blue-headed Vireo | Black-throated Green Warbler | House Finch |
| Warbling Vireo | Blackburnian Warbler | American Goldfinch |
| Philadelphia Vireo | Yellow-throated Warbler | House Sparrow |

**Figure 2.** The American White Pelican

## Mammals

White-tailed deer (Fig. 3) are abundant in the park and the surrounding area. Other commonly observed mammals of the park include raccoons, fox squirrels, opossums and cottontail rabbits. Big and little brown bats, northern myotis, and red bats are all likely to occur in the park. The short-tailed shrew and white-footed mouse are two of Iowa's most common small mammals and both can be found at Lake Macbride State Park. The short-tailed shrew is about the size of a mouse, has a long pointed snout, tiny eyes, and is slate gray. It is the only poisonous mammal in North America. The poison is produced by one of the salivary glands and is both a neurotoxin and a hemotoxin. It is used to immobilize insects and other invertebrates for up to several days. This allows the shrew to have a source of fresh food for a few days.

**Figure 3.** White tailed deer doe.

## Amphibians and Reptiles

Although no comprehensive inventory of the amphibians and reptiles has been conducted at the park, Paul Sleeper, Iowa Department of Natural Resources Fisheries Biologist, has reported that he or other knowledgeable observers have seen seven species of snakes, five species of turtles, eight species of frogs and toads and the tiger salamander. Northern water, eastern garter, fox, and brown snakes are common in the park. As would be expected, painted and snapping turtles are the most commonly seen turtles. The state

**Figure 4**. Ornate box turtle.

threatened ornate box turtle (Fig. 4) has been seen in the park. Suitable grassland and prairie habitat for this species is limited in the park but is more available on areas outside the park.

## Fish

Lake Macbride is managed to provide sport fishing opportunities for the public. The lake is stocked annually with catfish and walleye and musky are stocked every two years. Twenty-three species of fish have been found in the lake by Paul Sleeper (Table 2). Many of the species listed in Table 2 were stocked. However a few, such as the common carp, may have been introduced when a minnow bucket was emptied into the lake at the end of a fishing trip.

**Table 2.** Fish species reported at Lake Macbride.

| Species considered as common | Species considered as occasional |
|---|---|
| Largemouth Bass | Red-eared Sunfish |
| Spotted Bass | Musky |
| Bluegill | Wiper (Hybrid Stripped Bass) |
| Green Sunfish | Northern Pike |
| Black Crappie | Black Bullhead |
| White Crappie | Spotfin Shiner |
| White Bass | Bluntnose Minnow |
| Walleye | White Sucker |
| Channel Catfish | Flathead Catfish |
| Common Carp | |
| Bigmouth Buffalo | |
| Smallmouth Buffalo | |
| Quillback Carpsucker | |
| Gizzard Shad | |

## Butterflies

Fifty-seven species of butterflies have been observed at Lake Macbride State Park by Chris Edwards during the last nine years (Table 3). About half of the species (28) are considered to be habitat generalists - species occurring in several habitats or along edges between habitats. The eastern tailed blue (the small blue butterflies often seen around mud puddles) and the eastern tiger swallowtail are familiar examples of these species.

The terrestrial habitat in the park is predominately forest and 21 of the 58 butterfly species are associated with forest habitats. The mourning cloak (Fig. 5) is usually the first butterfly to be seen in the spring. They can be found in forest and riparian areas from April until October. The mourning cloak is one of a few species that overwinter as adults.

**Figure 5**. Mourning Cloak.

Four species that use prairie habitats have been observed at the park. They include the byssus skipper, a state threatened species, and the regal fritillary, a state special concern species. Although there is very little habitat for these species in the park, they probably occur there because there are larger areas of prairie and restored prairie in the adjacent Macbride Recreation Area.

**Table 3.** List of butterflies observed at Lake Macbride State Park by Chris Edwards, 1998-2006.

| | | |
|---|---|---|
| Black Swallowtail | Meadow Fritillary | Silver-spotted Skipper |
| Giant Swallowtail | Pearl Crescent | Juvenal's Duskywing |
| Eastern Tiger Swallowtail | Question Mark | Horace's Duskywing |
| Checkered White | Eastern Comma | Wild Indigo Duskywing |
| Cabbage White | Gray Comma | Common Checkered-Skipper |
| Clouded Sulphur | Mourning Cloak | Common Sootywing |
| Orange Sulphur | Milbert's Tortoiseshell | Least Skipper |
| Cloudless Sulphur | American Lady | European Skipper |
| Little Yellow | Painted Lady | Fiery Skipper |
| Gray Copper | Red Admiral | Peck's Skipper |
| Bronze Copper | Common Buckeye | Tawny-edged Skipper |
| Coral Hairstreak | Red-spotted Purple | Little Glassywing |
| Banded Hairstreak | Viceroy | Sachem |
| Eastern Tailed-Blue | Hackberry Emperor | Delaware Skipper |
| Spring Azure | Tawny Emperor | Byssus Skipper |
| American Snout | Northern Pearly-eye | Hobomok Skipper |
| Variegated Fritillary | Little Wood-Satyr | Dion Skipper |
| Great Spangled Fritillary | Common Wood-Nymph | Black Dash |
| Regal Fritillary | Monarch | Dun Skipper |

## Wildlife Management

The major management issues concerning wildlife at the park concern high populations of white-tailed deer and Canada geese. Aerial surveys during winter in 2004 and 2005 estimated the population of white-tailed deer at 229 and 125 respectively for a 4.2 square mile count area that includes the park. Populations at these densities often affect plant communities and cause complaints from adjacent landowners. In 2005 a special bow hunt for antlerless deer was implemented to reduce deer numbers. Forty-nine deer were taken and the hunt was considered successful in reducing deer numbers to a more acceptable level. An archery-only hunt will again be held at the park from October 1, 2006 to January 21, 2007.

Canada geese have become re-established in Iowa as a breeding species. In fact, the population has grown to the point where there are too many geese in some parks and urban areas. The DNR has captured and moved juvenile Canada geese at Lake Macbride to reduce numbers and conflicts with park users in the beach area.

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# HISTORY OF LAKE MACBRIDE STATE PARK

compiled by Raymond R. Anderson
Iowa Geological Survey
Iowa City, Iowa 52242-1319

*modified from*

"***History of Lake Macbride State Park***"
by Gold Leighton Jenkinson, 1968
revised by Gwen Prentice, 2000
DNR
and ***"Early Twentieth Century Dream: Lake Macbride Reality to Present"***
by Robert Middendorf
DNR Fisheries Biologist

## INTRODUCTION

Macbride State Park and Lake is located in north-central Johnson County, in an area where the meandering Iowa River is incised tens of feet into Devonian-age limestone bedrock. This ancient river funneled torrid water from several melting glaciers through the area over the past 30 thousand years or more. These melt waters left behind rock dust, pulverized by the glaciers and blown out of the river valley by seasonal winds into the thick piles along the river valley. These thick loess deposits create steeply rolling hills we see at the park today. Two creeks flowed into the area from the east, Mill creek from the northeast and Jordan Creek from the southeast. These creeks flowed together only a few hundred yards from the Iowa River, then together squeezed through a fracture in the limestone created by an ancient fault and cascaded down into the Iowa River Valley.

The Lake Macbride State Park area was heavily forested when settled by Euro-Americans in the early 1800s. Although most of this land (Fig. 1) was cleared by settlers for farming and wood products, a great variety of second- and third-growth trees covered the area when it was recommended and quickly accepted as a part of Iowa's State Park System in 1933 when park construction began.

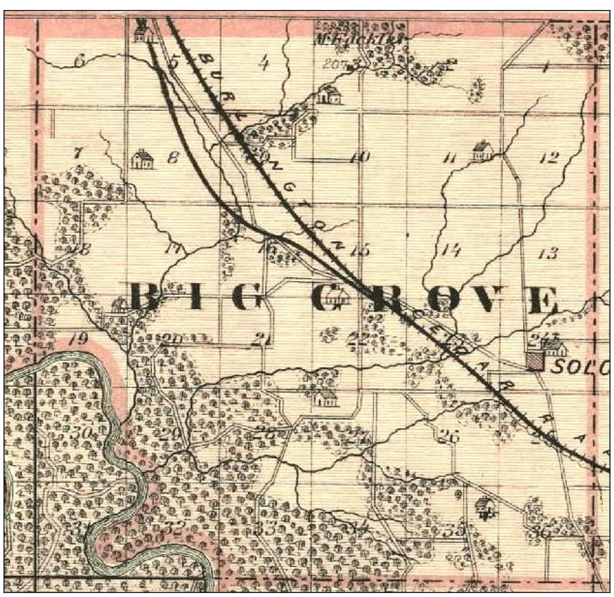
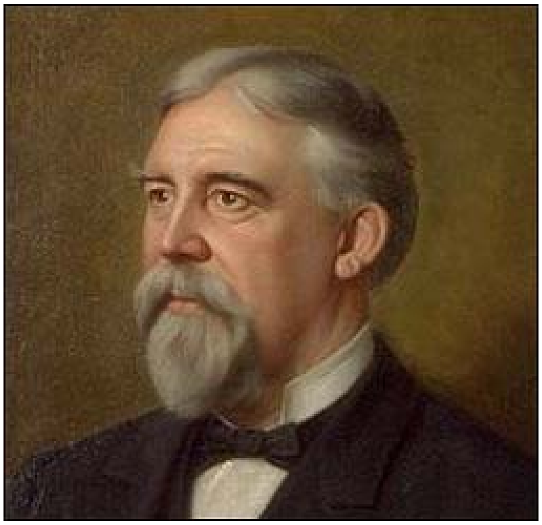



**Figure 1**. 1875 map of Big Grove Township. The two creeks that join in Macbride Park are visible in the southern half of the map, Mill Creek above and Jordan Creek below.

### Events Leading to Development

In the earliest twentieth century, conservationists, sportsman, and citizens concerned about preserving natural areas in Iowa began advocating for the preparation of a comprehensive statewide conservation plan. In response, the 1931 Iowa General Assembly adopted a resolution that was approved by Governor Dan Turner instructing the State Board of Conservation and State Fish and Game Commission to collaborate on preparation of a twenty-five year conservation plan for development of parks and lakes in Iowa.



THOMAS HUSTON MACBRIDE (1848 – 1934)*

Thomas Huston Macbride was born July 31, 1848 in Rogersville, Tennessee to Reverend James Bovard Macbride and Sarah Huston Macbride. He attended Lenox College in Hopkinton, Iowa, and received his B.A. degree from Monmoth College, in Monmoth, Illinois, in 1869, and M.A. degree in 1873. His first teaching position was at Lenox College as a professor of languages and mathematics from 1870 to 1878.

On December 31, 1875, Macbride married one of his former students, Harriet Diffenderffer, and they raised two children. In 1878, he came to the University of Iowa as an assistant professor of modern sciences. He was named professor of botany in 1884, a position he held until he was named president of the university in 1914. He was succeeded in his presidency by Walter Jessup in 1916.

Macbride founded Iowa Lakeside Laboratory on West Okoboji Lake, which is utilized for summer botany studies. He is considered the father of conservation in Iowa, and Johnson County officials named a state park in his honor within months of his death on March 27, 1934.

*portrait by F. Schurig, 1907, ©University Relations, University of Iowa, compliments of University of Iowa Herbarium

*text from *http://www.lib.uiowa.edu/spec-coll/ Archives/ guides/ macbridethomas. htm#admin*

Johnson County civic groups, State University of Iowa personnel, and other individuals had long dreamed of having a lake in the county. Of particular interest was the beautiful rugged, heavily wooded valley of Mill and Jordan Creeks, west of Solon (Fig. 2). University of Iowa hydraulics Professor Floyd Nagler investigated much of the wooded Mill Creek area securing data on the feasibility of constructing an artificial lake. University of Iowa journalism Professor Fred Lazelle also made many nature-study trips through the Mill Creek area. He identified many native trees: red, white, and yellow burr oak; white and green ash; black cherry, shagbark hickory, bitternut hickory, hard and soft maples, hackberry, black walnut, willow, poplar, sycamore, hawthorne, linden, red birch, blue birch, quaking aspen, great-tooth poplar, cottonwood, red and white elm and crab apple. Wild flowers grew in abundance, and the woods and streams were inhabited by mink, muskrat, raccoon, red squirrel, chipmunk, rabbits, and beavers. Every bird known to Iowa inhabited the area during the different seasons of the year. This beautiful, wooded region was one of the first twelve areas to be recommended by the State Conservation Board for immediate conversion into a state park. It had scenic beauty, woods, water, and between five hundred and one thousand acres of land that could provide both land and water recreation. The main objective of such a park was to preserve the character of the site, protecting it against any type of damage, and making the tract available to the nature-loving citizens so they may see, study, and enjoy the out of doors.

The proposed wooded area was located in the Big Grove Township sections 28 and 29 (Fig. 2). It was fifteen miles from Iowa City and about the same distance from Cedar Rapids. It was fourteen miles from Mount Vernon, twenty-four miles from West Branch, five miles northeast from North Liberty, and four miles west from Solon. The name “Big Grove” is believed to refer to a large area of first growth timber covering fourteen square miles, between the Iowa and Cedar Rivers. In 1932 this area was recommended for inclusion in the state’s lake development plan, with construction of an artificial lake along Mill Creek recommended. Instrumental in securing this

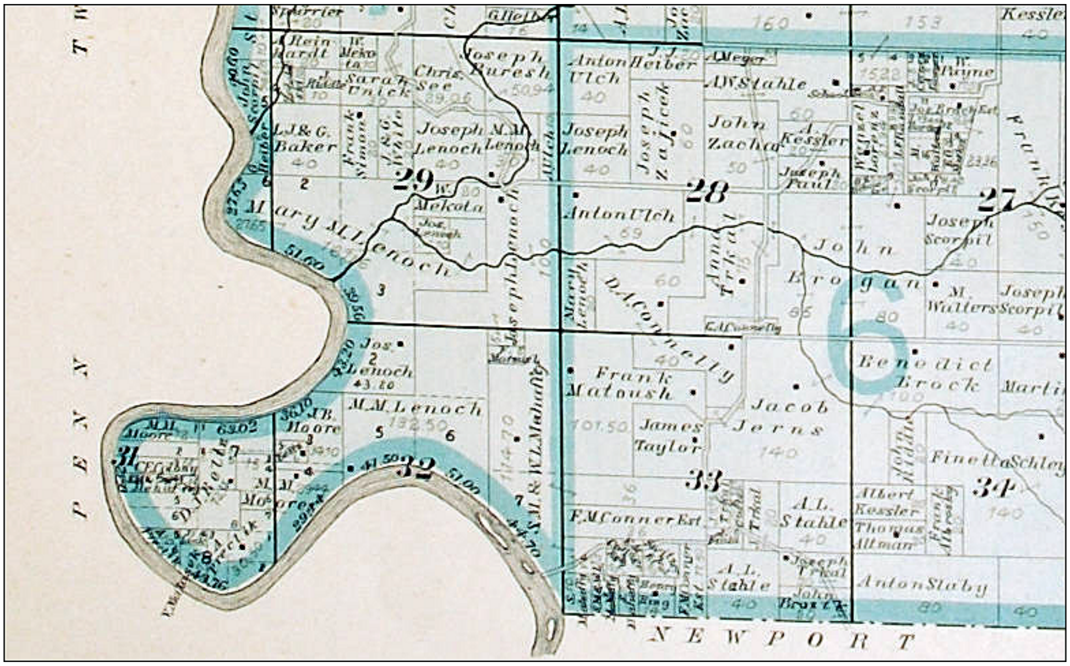



**Figure 2**. 1900 map of sections 28 and 29, Big Grove Township where Lake Macbride State Park was developed. Mill Creek, flowing from the northeast, and Jordan Creek flowing from the east, join and enter the Iowa River in the southwest of section 29.

action was Jay "Ding" Darling, Iowa's foremost conservationist and cartoonist. A plan of construction was then developed by the State Board of Conservation and consulting engineer, Jacob Crane. It was included in the State Conservation Board report at that time and was subsequently adopted.

In 1933, the Iowa City Chamber of Commerce empowered a committee, chaired by Iowa City Councilman Dr. E.J. Anthony, to ask the State to sponsor the plan for immediate conversion of the area into a state park and lake. Permission was given to proceed and a committee of members was appointed to take charge of the project. On August 29, 1933, a complete survey of the proposed park was made by the engineers of the State Conservation Board before attempting to secure options from the farmers who owned the land. A two hundred-acre lake was planned in an east to west direction, with the dam to be below the junction of Mill Creek and its tributary, Jordan Creek. The size of Mill Creek assured an ample flow of water, and it was thought the lake would average twenty feet depth. An eighty-acre peninsula projected into the center of the lakebed, and this was planned to be reserved for a cottage area overlooking the lake and bordered by the two creeks, forming a V. Engineers surveyed lines to determine the future level of the lake and about one hundred cottage sites were plotted on the high ridge.

Options were secured on 800 acres of land, at an average price of $45 per acre. The enormous footwork and travel necessary in obtaining the options was handled by Mr. A.A. Welt. Money for eventual payment was obtained through the sale of 132 lots for cottage sites, located on the 40-acre peninsula near the junction of Mill and Jordan Creeks. This was completed by September 20, 1933, the final day of the options. The money from the sale was used to pay for the entire park land, and numerous improvements. With fifty thousand dollars in federal emergency funds for the construction of the dam, the lake and park were completed and deeded to the State without any cost to the State of Iowa.

The park was dedicated in 1934, named for Doctor Thomas Huston Macbride, one of the pioneers of the conservation movement in Iowa. Macbride had dreamed of the development of

**Figure 3**. 1934 photo of the abandoned Sells Mill and charcoal kiln on Mill Creek. This area was submerged by Lake Macbride.

an artificial lake in Johnson County. Through a series of imaginative lectures during the early part of the twentieth century, he had promoted the lake and its value as a natural resource.

## LOCAL HISTORY TIDBITS

Mill Creek received its name from a water powered grist mill (Fig. 3) constructed by Anthony Sells in 1839. It is believed to have been the first inland mill in Iowa, and pioneers from miles around brought in their grain to be ground into flour and grist. Later known as "Hendricks Mill," it operated on the site until the close of the Civil War. Then a flood washed out the dam and damaged the mill. It was not rebuilt. A wooden structure was subsequently erected on the stone foundation and was used to store hay. The building was being used as a barn when the land was acquired for a park. Traces of the old mill dam and a nearby charcoal kiln were also visible in the area at the time of park land purchase.

The charcoal kiln (Fig. 3) was part of the early history of this area, which was known as "Sugar Bottom" for the large growth of native hard or sugar maples. In the mid 1800s, much of this maple was cut and burned to charcoal in the kiln. The charcoal was used by the Sinclair Company in Cedar Rapids, for processing their smoked meats.

Jordan Creek reportedly received its name when a Mr. Clarkson fell into an unnamed stream. He said laughingly that he had been "dipped in Jordan." The joke related so well to the local disputes about Biblical baptism that it was continually retold; and that unnamed stream has been called Jordan Creek ever since (JCSWCD, 2006).

Immigrants as early as 1839 followed the streams, rivers, and Indian paths and later, ox wagon tracks into the region. Johnson County lay at the convergence of four main roads leading to Dubuque, Burlington, Muscatine, and Mount Pleasant. Strangers crossing the prairie on the Iowa City-Dubuque route, however, found it extremely difficult to keep on the direct course, and often wandered far out of the way. This led the citizens of Iowa City to hire Lyman Dillon to plough a furrow from Dubuque to Iowa City in as direct a line as possible. This path, plowed by two men and five yoke of oxen and known as "Dillon's Furrow," guided travelers between the towns. It passed close to, if not directly through, the Mill Creek area. The furrow soon expanded into a roadway known as Prairie du Chien road, which ran for more than one hundred miles from Iowa City to Prairie du Chien, Wisconsin, much of its route following the path of "Dillon's Furrow." In this way, "Dillon's Furrow", which had begun as a plow furrow, became a road of primary importance.

On one of the lots in the cottage area a "sinkhole" was found, which many years earlier had been a cave. It was known as "Horse Thief Cave," and in pioneer days, horses stolen from surrounding areas were reportedly found in the cave by search parties.

## ORIGINAL CONSTRUCTION OF LAKE MACBRIDE STATE PARK

Construction of original lake and other facilities at Lake Macbride State Park began in November, 1933, and stretched into 1938. Much of the labor force was provided by federal programs to create jobs during the great depression.

### Construction of the First Lake Macbride Dam

The labor for constructing the Lake Macbride dam and other park facilities was furnished by the Civilian Conservation Corps, known as the CCC. It was organized to employ about one hundred young men from this area to work on conservation projects. Their base camp was in Solon, under the command of Lieutenant Walter Merriam of Iowa City. The construction work was directed by Superintendent F.S. Yetter from Anamosa.

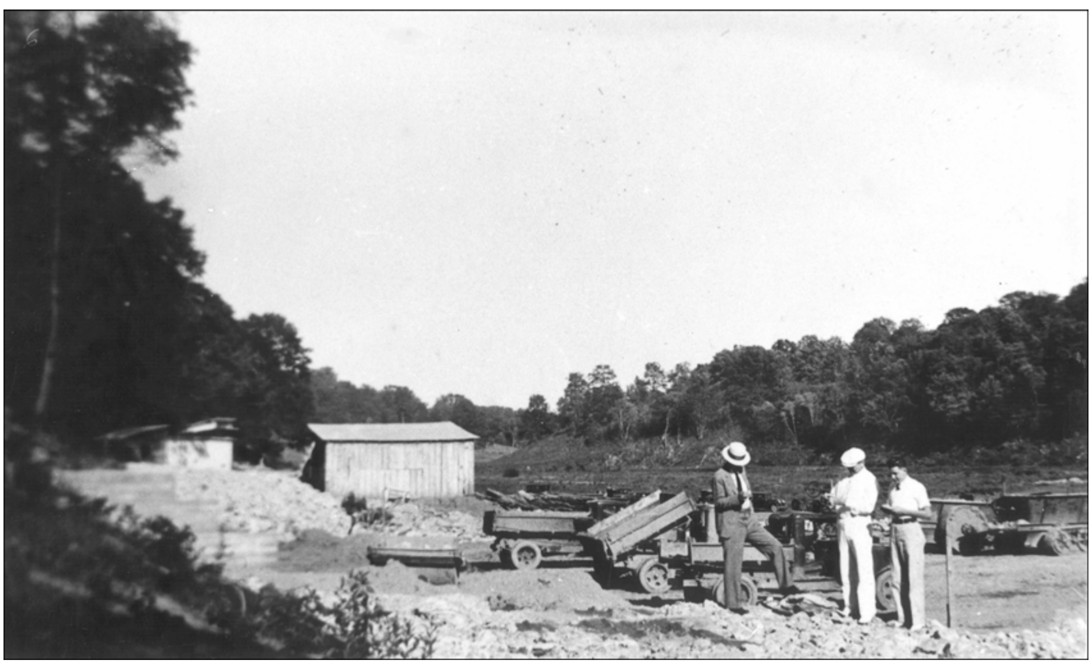


**Figure 4**. Equipment staged for construction of the original Lake Macbride Dam, 1934.

Engineers from the State Board of Conservation and Federal Emergency Conservation Commission staff made soundings in the valley for the base of the dam. The exact location was decided to be across a natural gorge between two high limestone bluffs, and below the junction of the Mill and Jordan Creeks. When the soundings were made, a bed of solid rock was struck at a depth of seventeen feet and four inches. Professor Floyd Nagler, from the University of Iowa College of Engineering, was a consultant on the design of this dam.

An enormous amount of hard work under adverse weather conditions had to be done before the actual work on the dam could begin. Ditches miles long had to be dug in the dusty valley for the large sewer pipes. Men also wove wire and timbers together to make tent-like structures on bone-dry land that would later become spawning grounds for thousands of fish.

The first project in the building of the dam was the construction of a concrete conduit three hundred feet long under the south end of the dam for the release of water while the construction was in progress. This structure was later to be used to drain the lake. Then a huge trench, fifty feet wide and approximately eight feet deep was dug across the valley under the site of the dam (Fig. 5). Sheets of piling three planks thick and fourteen feet long were spiked together and driven down against the solid rock. At each end of the dam, workmen cut into the solid rock and built concrete wing-walls, which extended from the rock cutouts into the ends of the dam. A car-

**Figure 5**. Construction of the first Lake Macbride dam in 1934. View looking north from rock knob south of original spillway.

load of reinforcing iron and more than two thousand sacks of cement were used in the construction of the wings and sluiceway. It took approximately six thousand additional sacks of cement and a proportionate amount of reinforcing iron to finish the spillway. Sand for all of the concrete work was hauled from the Palisades-Kepler State Park near Mount Vernon.

The huge trench across the valley was then filled with impervious clay, probably loess, from a nearby hill, so that it was up to the level of the valley floor. A load of the impervious clay from a high hill on the north side of the valley (now a picnic area) was hauled and dumped every minute. The thirty feet high dam was then constructed on this base. The clay was then spread by

**Figure 6**. Original Lake Macbride swimming beach prior to construction of bathhouse (ca. 1936). This area is now submerged below boat ramp west of current beach was submerged by Lake Macbride.

hand and rolled with a seven-ton roller that the CCC had constructed, drawn by a five-ton caterpillar tractor. Workers averaged about eight hundred yards of clay per working day, beginning April first. By May 21, 1934, the Lake Macbride dam had reached a height of twelve feet. Then limestone, quarried from the spillway on the south end of the dam, was hauled in and laid in place by hand on both sides of the dam's clay core. The stone was laid at a rate of about one hundred and seventy yards a day.

From initiation of work on November 1, 1933, the CCC put in a total of 16,407 man-work days, or 106,105 man-hours constructing the Lake Macbride dam and other facilities. The Civil Works Administration (CWA), a short-lived Federal works program to employ depression era workers over the winter, provided a small group that also worked many hours on the project. CWA employees spent 25,000 man-hours during the winters of 1933 and 1934 cutting trees and clearing brush from the lakebed and park area. In 1935 the CWA was incorporated into the new WPA (Works Progress Association).

To house the labor force, a CCC base camp for over 100 men was built in Solon, where they did their own camp housekeeping, cooking, and repair of equipment. Included in their park development work was dam and spillway construction, clearing and making miles of foot trails around the park, working on a beach (Fig. 6), and assembling several hundred rock and brush fish shelters (Fig. 7) in the lake bed. They also built a custodian's home, lodge, bathhouse, and a stone tiered bridge over Mill Creek (Fig. 8), all out of native blocks of limestone from Stone City. The CCC used sixteen thousand pounds of dynamite to quarry the rock at the spillway. A total of 114,368 miles were accumulated on the odometers of the trucks, and approximately 21,000 gallons of gasoline were used. The Federal Government placed an average value of three dollars per day on CCC labor. Using this as a base, the CCC group put in about fifty thousand dollars worth of work into the project. They also planted many thousands of trees and did erosion control on over twenty five hundred acres of land. This consisted of bank sloping, building earth and wire dams, and constructing fencing around planted and eroded areas.

**Figure 7**. CCC workers constructed fish habitat prior to filling Lake Macbride in 1934.

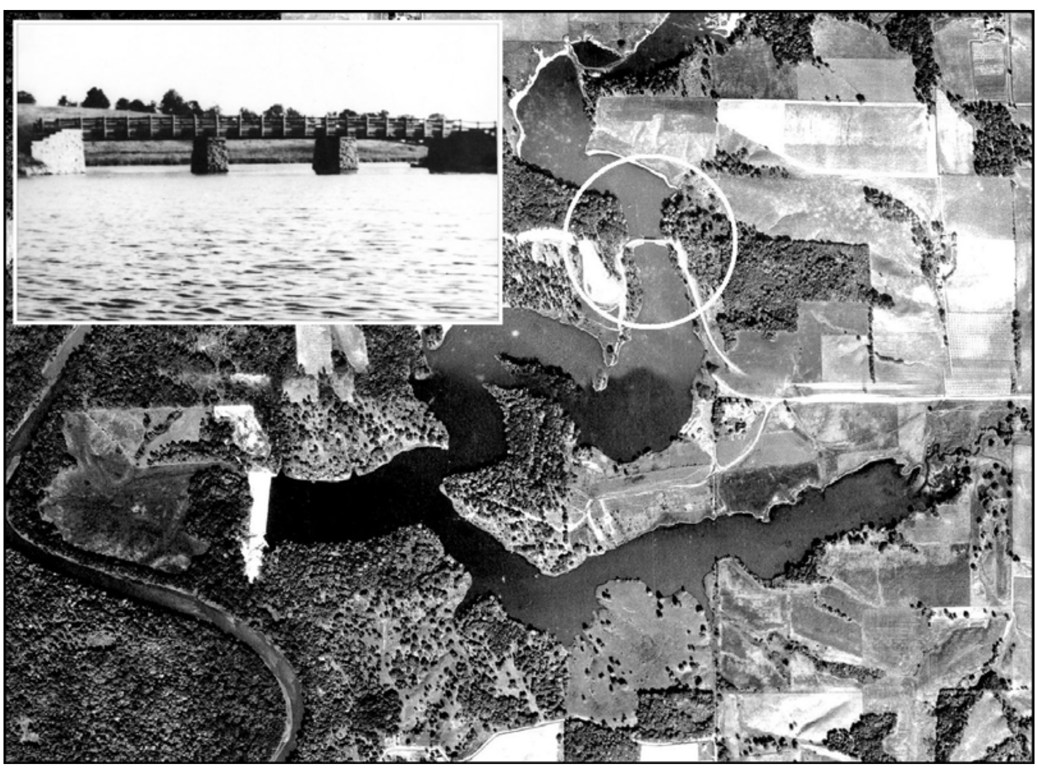


**Figure 8**. Bridge constructed by the CCC across Mill Creek provided access to Lake Macbride State Park from the east.

## Construction of Park Facilities

As the dam was being constructed, other park facilities were also being completed. One such project was a ninety-six foot bridge, spanning the north arm of the lake (see Artz, this guidebook, P. 37). It gave easy access to the public area, bathing and boating facilities, picnic areas, and shelters. Road construction, landscaping, planting, the construction of the custodian's residence, and of the service buildings for the maintenance of the area kept the workers busy during the summer of 1935.

## The Lake Macbride Beach

In anticipation of closing of the gates on the dam and the filling of the lake, grading began in the area chosen for the public bathing beach (Fig. 6). Under the direction of Supt. E.W. Olmstead, the CCC hauled in twelve hundred and fifty loads of sand from Palisades-Kepler State Park near Mt. Vernon, Iowa. This was spread over an area of more than three acres, creating a sand beach six hundred feet long and extending into the water one hundred and ten feet. A life line, five hundred and fifty feet long, marked the maximum depth of four and half feet. Beyond this, there was a gradual drop-off to a depth of eight to ten feet. A diving tower was provided and a life guard was on duty when the park was officially opened. The sand beach extended back fifty feet from the water's edge and above that was a sod-covered picnic area.

The bathhouse (Fig. 9) was built over a log frame and was constructed of native limestone from a quarry on the south end of what was to be Palisades-Kepler State Park west of Mount Vernon. A pumping system was installed to pump lake water to a five hundred gallon storage tank on the hill above the bathhouse. There, the water was warmed by the sun and purified, and it was then piped to the showers in the bathhouse.

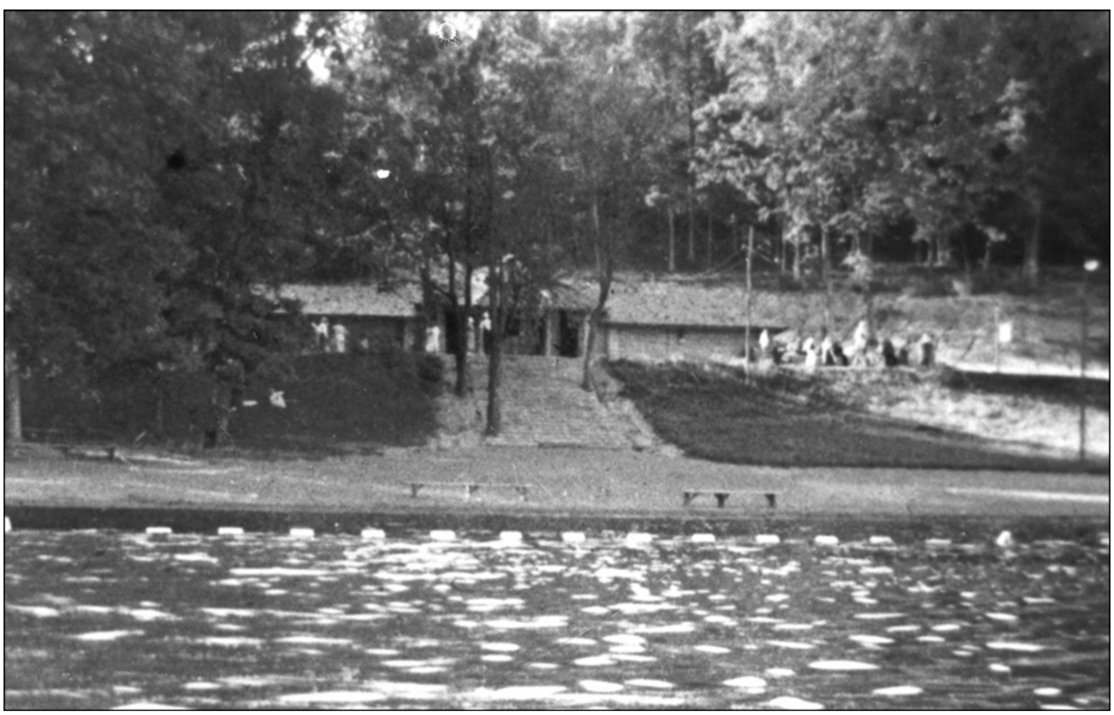


**Figure 9**. Original bathhouse and swimming beach, area now submerged below boat ramp west of current beach was submerged by Lake Macbride.

## Roads and Trails

While progress was being made in the development of Lake Macbride State Park, all roads in this vicinity leading to the future recreational center remained as they were in the horse and buggy era. During the dry season, they were extremely dusty; in wet weather, travel was almost impossible. The roads were narrow, twisting, and turning, making motoring a hazard, even when traveling at a very slow speed. The motorist was also in constant danger that the car might become mired in the mud. Motorists experienced the additional anxiety of meeting oncoming cars in a narrow place where passing would be difficult and dangerous.

The Iowa State Conservation Commission advised the abandonment of roads leading into the park on the northwest and on the south sides. Permanent impounding of the water had flooded the south road, and the northwest road had been entirely closed within the park area. A new road had been constructed to go along the public area of the park. The commission order followed National Park Service policies requiring only one entrance to the park, and limiting the mileage within the park for the sake of conservation principles and economy. This meant that the park could only be entered from the east via the Solon Road. Park visitors using the North Liberty road had to go east a short distance from the Mehaffey Bridge, then north, and then turn west to the main park entrance (see Fig. 10).

In April 1936, Conservation Commission engineers had been surveying a road from Solon west to the park. However, the Johnson County Board of Supervisors recommended that the five miles from North Liberty to the entrance of Lake Macbride be improved first. This road would provide access to the park at all times on an all weather highway. Twenty-eight thousand dollars was allocated for grading the road. As soon as the survey was made, the road was brought to grade, and the county then surfaced with gravel.

**Figure 10**. 1930s aerial photo mosaic of the area around Lake Macbride State Park (left-center of image). The access road from North Liberty enters from the lower left, crosses the Iowa River via the old Mehaffey bridge, and continues to the park. A direct access road from Solon (just off the upper right side of the photo) has not yet been constructed.

Within Lake Macbride State Park the CCC graveled all the park roads and constructed special parking areas that could accommodate five hundred cars. Twenty stone fireplaces were built in picnic areas.

The wildlife areas could only be reached by seven miles of graveled foot-trails. Trails along the shore from the bathhouse to the dam provided a beautiful walk among the trees. Rock steps and bridges across the ravines added to the beauty of the landscape. Dense woods, hills, the lake, and the trails added much variety and beauty to the scene. Even a beautiful waterfall was provided at the spillway as the water gushed over the frothy cascades to the Iowa River below.

As the park developed, more and more visitors were anxious to watch the changes that were taking place. Many were curious to see what magic was being accomplished in transforming the farm and pasture lands into a summer resort area. One Sunday in June, 1936, found a stream of visitors from all over Iowa. The men from the CCC counted two thousand cars, and the number of people in those cars reached five thousand. The parking area was several hundred feet wide and three blocks long.

While the park had not been officially opened, picnicking was permitted on the park grounds. Boating was popular and some visitors enjoyed swimming at their own risk, as they had been warned there was no supervision at that time.

All work in the park was completed during 1937. The lake filled to the twenty-eight foot level at the spillway, which formed an eight mile shoreline to the nearly two hundred acre lake. The new five mile stretch of road from North Liberty to the park was opened to traffic since the grading was finished and rock had been put on immediately.

## Dedication of the Park

Lake Macbride State Park, eastern Iowa's most beautiful park, was officially dedicated on May 30, 1934, 3 years before all construction projects were completed. As the day of the dedication drew near, the park committee urged visitors to come to the dedication early and view the dam, which was at that time of sufficient height to show its real magnitude. The park was accessed through North Liberty over the old Mehaffey bridge (Fig. 11) or less directly by way of Solon.

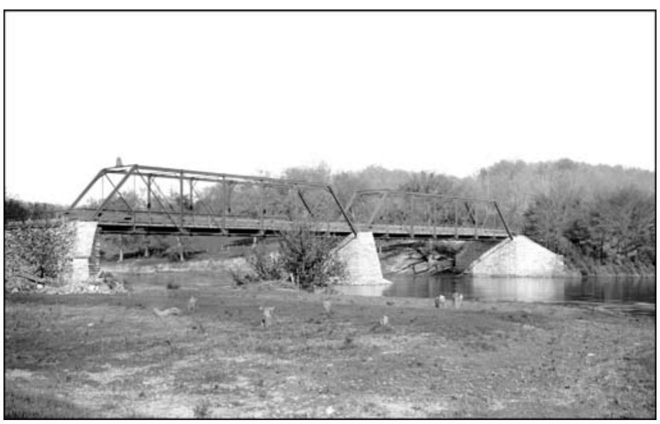


**Figure 11**. Old Mehaffey Bridge across the Iowa River. This bridge was just upstream of the current Mehaffey Bridge that crosses Coralville Lake.

The dedication program was held in the cottage reserve area on the peninsula between the two arms of the lake. Mr. Charles Maruth, assistant registrar at University of Iowa, served as Master of Ceremonies. Rousing applause from the two thousand spectators present greeted the announcement that the park would be named for University of Iowa President Emeritus, Thomas Huston Macbride, a prominent botanist and educational leader. The University of Iowa band directed by Dr. Orrie VanDoren opened the program, and a second band directed by Mr. Clifford Berkey played "The Star Spangled Banner."

Iowa Governor Clyde Herring was the first speaker. He said he wanted to add the endorsement of the State government to the project, which was made possible through the foresight of a few enthusiastic conservationists. He complimented the local committee, Dr. W.C. Boone, Chairman of the Fish and Game Commission, and J.N. "Ding" Darling for their work in the conservation of natural Iowa. He was followed to the podium by University of Iowa President-elect Eugene A. Gilmore, Coe College President Harry M. Gage, Iowa City Mayor Harry Breene, Cedar Rapids, Mayor Neal, Dr. W.C. Boone of Ottumwa, and finally Mr. Harry McGuire, Editor of "Outdoor Life" and the featured speaker for the afternoon. He warned of the danger of politicians gaining control of the fish and game departments in the states and pointed out that it would lead to the sacrifice of much of nature's beauty.

After the close of the program, many of the spectators lingered on, looking over the park. The dam, fourteen feet high at that time, drew many interested viewers.

## Completion of the Dam and Filling of Lake Macbride

When the Lake Macbride dam was completed in 1936 it was two hundred and twenty-eight feet wide at the bottom. It was five hundred and fifty feet in length with an additional one hundred and sixty-five feet for the spillway at the south side. The dam rose forty-two feet above the original stream level but the lake water level was maintained at an elevation of 584 feet above sea level, twenty-eight feet deep at the dam. In April of 1936 by Mr. C.H. Wilson, federal engineer in charge of coordinating all of the groups working in the state park (CCC, WPA, and National Park Service) conducted a final inspection visit to the park area. The gates on the new dam were then closed, blocking Mill and Jordan Creeks. Water was finally being permanently impounded in Lake Macbride, a goal that had been anticipated for nearly three years.

When Lake Macbride was given to the State, a provision was made that the State Commission could never sell or lease any portion of the park area, with the exception of the private cottage site, to any individuals for cottage sites. The commission's ruling against the sale of cabin sites in the public areas did allow that campgrounds were to be permitted. The camper had to provide his or her own tent or camping outfit. Camping was limited to areas that provided proper sanitation facilities. Camping longer than two weeks was not permitted. The attitude of the Iowa authorities was that state parks and lakes were the property of all of the people, and not for an exclusive few.

By developing Lake Macbride State Park in this naturally beautiful area of Big Grove Township the park was able to satisfy the needs of conservation and recreation in a very pleasant setting. The over five hundred thousand dollars and four years of time and energy expended produced one of the gems of the Iowa State Park System.

## The Cottage Reserve Area

The Cottage Reserve Corporation was formed and chartered for fifty years on July 11, 1934 when its Articles of Incorporation were filed with the Johnson County recorder. The new corporation would be in charge of the Lake Macbride Cottage Reserve Area (Fig. 12) after the Chamber of Commerce trustees completed their work.

The corporation, a non-profit organization, was organized for the purpose of supervising and managing the cottage area with

**Figure 12**. This aerial photo shows the Cottage Reserve area on the peninsula between the two arms of Lake Macbride as it appeared in the 1930s. It is an area of private lots, originally sold to provide funding to purchase park lands.

control over sewers, water, roads, and easements in the area. All lot owners became members by complying with the articles of membership and paying a membership fee. The corporation furnished police protection for the cottage area in cooperation with the park custodian, Roy Reed, who had been appointed by the Fish and Game Commission. The roads had been built in the cottage area, and at the highest point, a one hundred ninety-foot well had been drilled through one hundred and forty feet of rock. The pump and pressure tank had been installed and tested. Fresh, pure water was available to the newly built cottages.

One of the most prominent structures on the Cottage Reserve area was a beautiful Club House constructed by the Iowa City Lodge #1096 of the Loyal Order of Moose, built during the summer of 1935. The three-story building (Fig. 13) was erected on the east side of the lake. It was built on Lots 106, 107, and 108 in the cottage area, with a frontage of one hundred and eighty feet overlooking the lake. The architect for the building was J. Bradley Rust of Iowa City, Iowa. The building was a beautiful, substantial structure, finished in English style with a long, low roof. There were boat docks and a private beach for members.

**Figure 13**. Club house for the Iowa City Lodge #1096 of the Loyal Order of Moose, constructed in the cottage reserve area

The clubhouse was dedicated on Sunday afternoon, August 2, 1935, by Judge Willis Pierson, P.S.D., Regional Director for Illinois, Missouri, and Iowa. The program and dedicatory address were held in the large auditorium of the new clubhouse.

## Official Opening of Lake Macbride State Park

Lake Macbride was officially opened to the public on June 15, 1937. These visitors were greeted by an unusual lake project, which was a culmination of the efforts of many leading conservationists. According to an official count made by the CCC on opening day, more than three thousand persons visited Lake Macbride State Park. Cars loaded with picnickers and others in search of recreation roamed through the park throughout the day. Hundreds of others enjoyed the new sand beach for swimming, sunbathing, and games. Broad steps led from the beach up to the bathhouse (Figs. 6&9). At the bathhouse, dressing facilities were available and attendants not only provided baskets for checking clothing, but could provide rental bathing suits and towels. A lifeguard was provided at the beach during open hours to protect the swimmers.

## Opening of Lake Macbride for Fishing

Lake Macbride was not opened for fishing until at 5 o'clock in the morning on June 15, 1938 (Fig. 14), a year after the official park opening. It was an historic event that was best described by Bob Hogan, Sports Editor for the Iowa City Press Citizen. "*That four o'clock trek to Lake Macbride this morning, although not productive as far as fish were concerned, for us* (the Managing Editor and City Editor also) *at least—we didn't even take our poles—was one-never-to-be-forgotten. It was the first time we had ever seen a lake opened for the first time to fishing. It was the first time that we have seen fishermen, and women, in such groups that, in spots, it made angling almost impossible. There was many a time when anglers got their lines mixed up and crossed, but, it was all in good sport and there was not a sullen crack made. Probably if it had not been opening day with all the color, literally, of a circus then things might have been In the first two hours, an official check revealed that two hundred and ninety cars different. At five o'clock cars into the lake site were lined up for nearly a mile and a half, waiting the time when*

**Figure 14**. Fisherman waiting for the starting gun on the first day of open fishing at Lake Macbride on June 15, 1938.

*the conservation officers gave the signal to "go". In the first two hours, an official check revealed that two hundred and ninety cars had passed through the gates and each car averaged three occupants. The states of Nebraska, Wyoming, Illinois, Minnesota, in addition to Iowa, were represented. The all-night rain evidently had little effect on the fish in the lake for they were biting quite well".* This was not surprising, since the State Conservation Commission released information on the numbers and types of fish stocked in Lake Macbride. They included (in 1935) 3,867 large mouth bass and 9,385 black crappies, (in 1936) 16,000 large mouth bass, 250 yellow bullheads, 2,000 black bullheads, 4,675 black crappies, 4,700 white crappies, 4,400 bluegills, and 2,400 minnows and (in 1937) another large number of fish was added. Those included 22,700 large mouth bass, 11,800 black bullheads, 450 black crappies, and 6,350 bluegills.

Conservation officers from Johnson, Linn, and Cedar counties were on hand in all sections of the lake area. They were checking the catches and inspecting the bait. The purpose of checking the minnow bait was to make sure that no carp, quillback, and dogfish got into artificial lake waters. Four officials met the cars at the main gate, two of them checked the cars for occupants, county residence, and whether the occupants were adults or children.

The State Conservation Commission limited the catch for any one day to twelve fish in the aggregate, of which not more than five could be black bass, and not more than seven could be crappies. Another state law dealt with the use of minnows in artificial lakes. The law stated that it was unlawful for any person to use minnows or small fish as bait, in any state-owned artificial lake, which had not been inspected and approved by a representative of the commission. "The purpose of the law," declared Ed Sybil, State Conservation Officer for this territory, "is primarily to keep carp out of newly constructed lakes."

## 1950's Reconstruction and Expansion

In the late 1940s the U.S Army Corps of Engineers began planning the development of a flood control reservoir on the Iowa River above the Iowa City/Coralville metro area. As planned, the lake was to have a flood pool elevation of 612 feet above sea level, and would pool water in the area adjacent to the Lake Macbride dam. The 612-foot flood pool elevation was 28 feet higher than the elevation of the Lake Macbride spillway. Lake Macbride State Park officials realized that the lake level would have to be raised 28 feet to match the 612-foot flood pool elevation planned for the Coralville Reservoir. In order to prevent the flooding of Lake Macbride and park facilities at times of high water. A master plan to protect Lake Macbride was developed and approved by the Conservation Commission in 1947. In the 1950s, the Corps of Engineers purchased the additional lands necessary to implement plans to expand Lake Macbride. A first step in the Lake Macbride expansion work was to drain the existing lake, which began with the opening of the drain gates on October 17, 1956. The draining was completed within ten days, with fisheries personnel rescuing game fish to restock other lakes throughout Iowa.

Dam construction for a new and enlarged lake began almost immediately (Fig. 15) and was completed in November of 1957 (Fig. 16). A new spillway was blasted from a solid rock bluff south of the original spillway and the Macbride dam height was increased 28 feet by adding material to the top and sides of the old dam. Timber was cleared from land that would be inundated by the in-

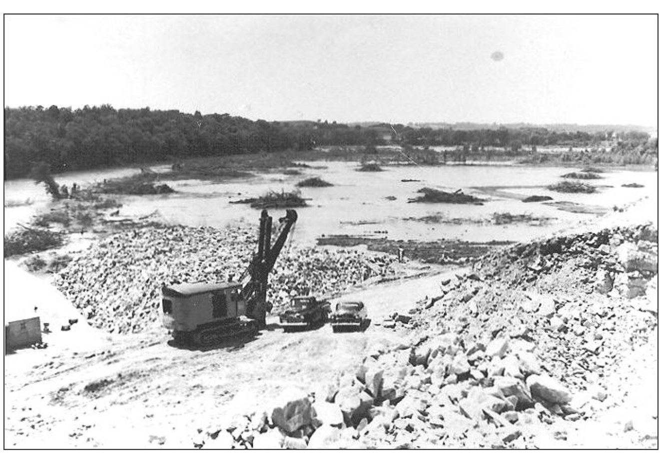


**Figure 15**. Construction work raising the level of the Lake Macbride dam in the mid- 1950s. Flooding of the new Coralville Reservoir had already begun and can be seen in the background.

**Figure 16**. A view of the newly expanded Lake Macbride dam, looking south towards the spillway (visible in the left background). When filled, the lake would reach the spillway elevation of 612 feet above seal level, making it 56 feet deep at the dam.

creased lake size. Then in December of 1957, the valve for impounding Lake Macbride water was closed. Water overflowed the spillway for the first time in January, 1960, thereby creating Iowa's largest state owned artificial lake at 950 acres.

Increasing the lake level 28 feet forced a major relocation program of nearly all facilities. Changes included relocating piece by piece (Fig. 17) the original bathhouse to a higher location 500 yards to the east where the new beach was set; a parking lot and boat ramp were constructed near the old beach location; a road was built to the new north park main entrance, and other roads changes as necessitated by the flooding of existing areas. Footpaths were rebuilt and relocated around the lake corresponding with the lake level. A park custodian's residence was built at the new main entrance area and the original one was maintained for the manager of the cabinet and sign shop.

Homes in the private cottage area that would be below the lake

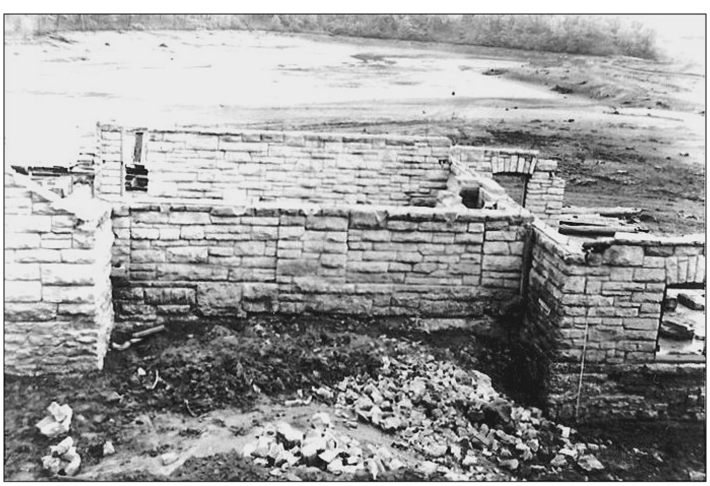


**Figure 17**. The partially dismantled old bathhouse. The structure was disassembled stone by stone and reconstructed above the new beach.

water level were purchased, and the owners were permitted to repurchase them for movement to higher locations. A waste water treatment plant was built, along with sewage lines, septic tanks, and filter beds.

On September 2, 1959 the Conservation Commission accepted from the Corps of Engineers, by license, 1118 acres of land purchased for park reconstruction. All remedial work for redevelopment, paid for by the Corps, was officially completed in January, 1960. The climax for a second Lake Macbride came in May, 1960 when fishing and the new beach (Fig. 18) were opened to the public for the first time.

**Figure 18**. The new Lake Macbride beach and bathhouse as viewed from the dam.

## RENOVATIONS, ADDITIONS, AND EVENTS IN THE LATE 1900's

In the years following its 1950s reconstruction, the popularity of Lake Macbride State Park for outdoor recreation has continued to expand. To meet the demands of this increased usage, new access roads, parking lots, picnic areas, shelters, and latrines have been built. Primitive and modern camping areas on the north and south park areas have been improved and expanded. A new boat storage and launching ramp for the ever-increasing sailboat enthusiasts was constructed. At various locations around the lake, earthen jetties were installed for fishermen use, and windbreak protection of shoreline and periodic placement of riprap for shoreline protection was been undertaken. For winter recreation snowmobile trails were

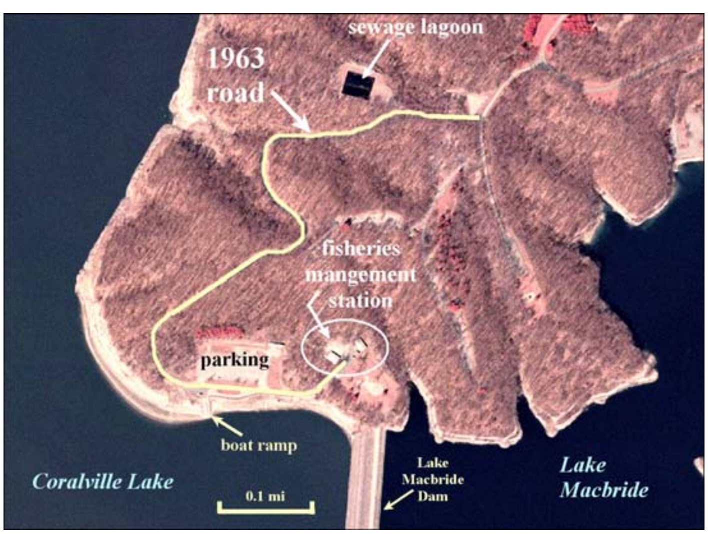



**Figure 19**. Location of some of the improvements and additions to Lake Macbride State park in the late 1900s, shown on color infrared aerial photography (ca. 2002).

laid out and marked throughout a vast portion of the park.

In 1963 a road was built to the north end of the dam (Fig 19). At a site overlooking the dam and Coralville Reservoir a fisheries management station was built and staffed to serve fishing waters in east central Iowa. Fishing is one of the major attractions of Lake Macbride, with over 60,000 angler day trips annually. Each year maintenance stockings of walleye and channel catfish are introduced to perpetuate population of these species. Other species available for catch are bluegill, largemouth bass, bullhead, and crappies, which are taken in large numbers.

## LAKE MACBRIDE AND THE FLOODS OF 1993

During June through August of 1993 more that 12 inches of rain fell in the northern Midwest, including Iowa. From April 1 through August 31 precipitation amounts approached 48 inches in eastern Iowa, easily surpassing the region's normal annual precipitation of 30-36 inches. Heavy snow melt in the spring of 1993 raised the level of the Coralville Reservoir to 700 feet (elevation above sea level) by March 5, not an unusual occurrence. However, the 12.3 inches of rain that fell in the Iowa River basin in June pushed the reservoir beyond its capacity. The lake level reached 711.4 feet on July 1, and even though the geometry of the reservoir was such that the 6" between 711.5 feet and the 712 foot elevation of the flood pool (and the elevation of the Coralville Dam spillway) constituted about 50% of the capacity of the Coralville Reservoir, the continued inflow of water pushed the reservoir beyond its capacity between July 5 and August 7, 1993. For 28 days water flowed over the Coralville Dam spillway, and for the first 12 of those days inflow into the reservoir averaged about 41,000 cfs, with total outflow (gates and spillway) only 25,300 cfs. The reservoir crested at 716.7 feet on July 24, 1993. With the Coralville Reservoir almost 5 feet higher than the Lake Macbride dam spillway, water backed up from the Coralville Reservoir into Lake Macbride flooding many park facilities (see Figure 20).

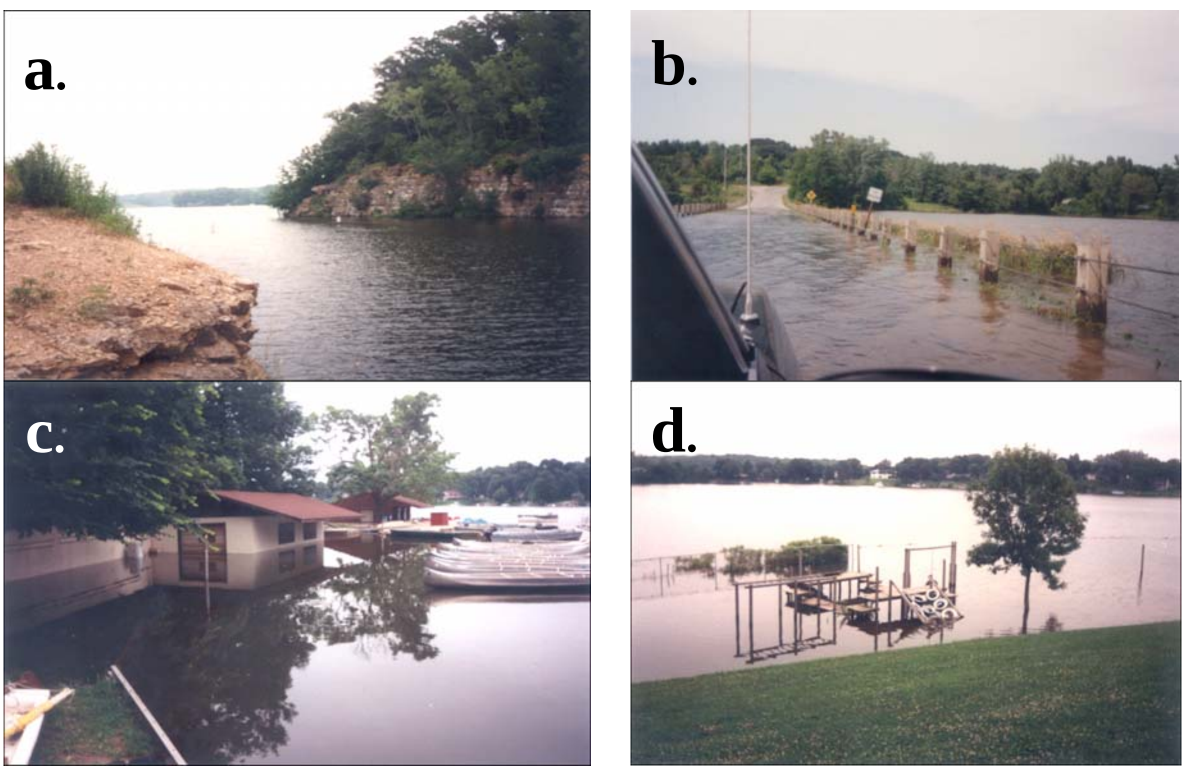



**Figure 20**. Photos of 1993 flooding at Lake Macbride from water flowing from the flooding Coralville Reservoir. Photo **a.** shows water flowing over the Macbride spillway, **b.** flooding of the causeway over the southern arm of the lake, **c.** flooding at the boat rental area, and **d.** flooding at the Macbride beach.

## RENOVATIONS IN THE 21$^{ST}$ CENTURY

With the arrival of the 21st century the problem of shoreline erosion around Lake Macbride had reached levels that required immediate attention. The decision was made to repair the lake's shoreline and provide protection by rip-rapping much of the shore with stone. On September 5, 2000, the gates of the Lake Macbride dam were opened and the draw-down of water in the lake began. The dropping of the water level was slow, totaling 16.5 feet over 31 days until October 5 (Fig. 21). Park officials were concerned about the functionality of the dam's gate system, since it had not been opened since the 1957 reconstruction. Of most concern was the possibility that the gate would not close properly, necessitating a complete draining to affect repairs. But all fears were unfounded since the gates performed properly.

With the water level lowered work began to repair and protect vulnerable shoreline areas. The initial activity was an examination of all exposed lake bed by the Office of the State Archaeologist to identify any valuable cultural artifacts or other features (See Artz, p. 37 of this guidebook). This work was completed and a report received by December 31, 2000. By February of 2001 the DNR had received approval to begin the project by the State Office of Historical Preservation and had received all permits required under EPA Clean Water Act Section 404, so construction began. After problems with the initial contractor, PCI (Peterson Contractors Incorporated) of Reinbeck was awarded the contract to construct temporary roads in the recently exposed lake bed then repair damaged shorelines and armor vulnerable areas with blocks of crushed stone from nearby quarries. Most of the stone was supplied by the River Products Company Conklin

**Figure 21**. Ultralight photo of the southern arm of Lake Macbride following lake drawdown for shoreline restoration in 2001. The causeway that carries county Road F-28 across the lake can be seen in background. Photo by Paul Sleeper, DNR Fisheries Biologist.

Quarry in Coralville. River products shipped rock from its Klein Quarry in Coralville (Devonian Cedar Valley Group limestone), with additional stone from the Wendling Quarries Incorporated Beverly Quarry in Cedar Rapids (Silurian Gower Formation dolomite). An average of 1.0 – 1.5 tons of rock was applied per foot of shoreline, applied in widths of 2 feet to 20 feet depending on the erosion threat, with about 10 miles of shoreline armored. A total of about 100,000 tons of stone was applied to the shoreline. The eroded shoreline was recontoured and covered with landscaping fabric to reduce erosion before the stone was applied. Along much of the shoreline side-dump semi-trailer trucks could drive directly to the work site to dump the rock which was placed on the fabric with end loaders (Fig 22). In other, less accessible areas the rock was loaded


**Figure 22**. Side-dump semi-trailer dumping armoring stone on landscaping fabric. The end loader behind the truck moved the rock into place. Photo by Paul Sleeper.

**Figure 23**. Smaller, tracked rear-dump trucks were employed to transport stone to less accessible areas of the Lake Macbride shoreline. Photos by Paul Sleeper.

into smaller, tracked rear-dump trucks for hauling to the work site (Fig. 23). While much of the shoreline work was completed in the winter when the exposed lake bottom was frozen, deep mud is some areas presented huge problems in times of thawing conditions. The tracked vehicles were necessary to haul the stone late in the winter when the surface of thefrozen ground began to thaw and become very slippery or very muddy. The shoreline renovation project was completed in 2002 at a total cost of $2.5 million.

In addition to shoreline renovation and protection, other repair and updating projects were accomplished. The pipe that carries treated waste water from the Cottage Reserve crosses the northern arm of Lake Macbride over an old road causeway and bridge that is normally submerged by the lake. This pipe was replaced and flanked large rocks to protect it along the causeway (Fig. 24). Also, numerous fish habitat structures were repaired or constructed while the water level was down.

**Figure 24**. Old and new pipeline carrying treated sewage from the Cottage Reserve area

## CONCLUSIONS

The first 60 years of Lake Macbride State Park history has been interesting and colorful. The park was originally promoted, funded, and named by the citizens of Johnson County and the surrounding area, and it continues to serve this population today as one of Iowa's most popular recreation areas. The park has continued to expand and evolve to meet the needs of these citizens and their changing life styles. Roads and trails were added to accommodate more automobiles, increase in bicycle traffic, and the expanded usage of snowmobiles. Camping facilities have expanded to serve modern campers as well as those who prefer primitive camping. Even a frisbee golf course was developed in response to the increase in the popularity of that sport. In the future the Iowa Department of Natural Resources and the hard-working men and women who oversee Lake Macbride State Park will continue to provide the best facilities possible to serve the citizens of eastern Iowa.

## ACKNOWLEDGEMENTS

Many people provided information for this review of the history of Lake Macbride State Park. The manuscript drew heavily from "***History of Lake Macbride State Park,***" originally written by by Gold Leighton Jenkinson in 1968, then revised by Park Ranger Gwen Prentice in 2000 and from "***Early Twentieth Century Dream: Lake Macbride Reality to Present***" written by Robert Middendorf, a DNR Fisheries Biologist. Important information and photographs were provided by Paul Sleeper, DNR Fisheries Biologist, and by Ron Puettmann, Lake Macbride Park Ranger. Mike Peterson of Peterson Contractors, Incorporated and Margaret Tuttle of River Products Company provided information on the 2001 shoreline renovation project. Information from these people was critical to the production of this history.

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# WATER QUALITY IN LAKE MACBRIDE

Chad Fields
Iowa Geological Survey
Iowa City, Iowa

## INTRODUCTION

Water quality is the measurement of impurities in a body of water (e.g. lakes, rivers, and oceans). These pollutants can be deposited directly in the water, but more often pollutants are deposited on the area of land contributing to a waterbody, called a watershed. Lake Macbride is located in the Iowa River watershed two miles west of Solon (Fig. 1). The lake is a manmade structure that first opened as a State Park in June of 1937. Lake Macbride State Park has many camping sites, a beach, a disc golf course, and approximately 15 miles of nature trails. Each year, the 2,180-acre state park has about 118,000 visitors. In 1955, following the construction of the Coralville Reservoir, Lake Macbride expanded to its present size (812 acres) by raising the water level 28 feet. The lake underwent improvements in September of 2000, including 12 miles of riprap, a 930-foot silt retention dam, and fish habitat structures.

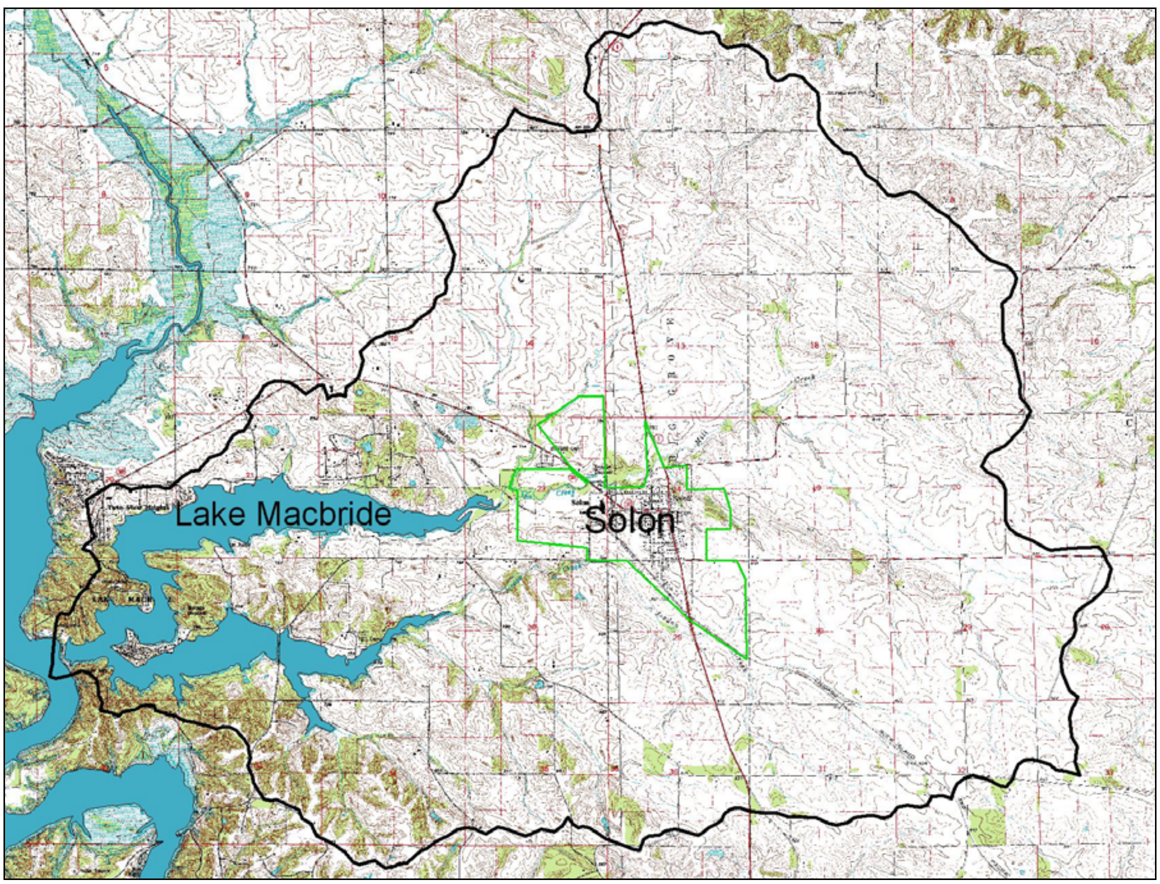


**Figure 1**. The Lake Macbride watershed.

Lake Macbride's deepest point is 47 feet and is located on the western edge of the lake. The average depth of the lake is 16.5 feet. The total volume of water in the lake is 16.6 million cubic meters. Two major streams enter the lake: Mill Creek feeds into the north arm, and Jordan Creek feeds into the southern arm (Fig. 1). The estimated water detention time in the Lake Macbride is calculated to be 0.8 years (IDNR, 2005). Water flows from Lake Macbride to the Iowa River Coralville Reservoir, eventually making its way to the Mississippi River and the Gulf of Mexico.

Lake Macbride's watershed is similar to a majority of Iowa lakes and rivers. The watershed is located in the Southern Iowan Drift Plain. At 16,220 acres, the watershed to lake ratio is a generous 20:1. A 2003 field-level land use assessment shows that the majority of land in the watershed is used for rowcrop agriculture (60%) followed by urban (9%), pasture (9%), timber (8%), park (8%), CRP (3%), and other (2%) (Fig. 2). The City of Solon is the only urban center in the watershed. The 2000 census lists the population of Solon at 1,177. In addition to the City, many low density unincorporated residences surround the north arm of the lake.

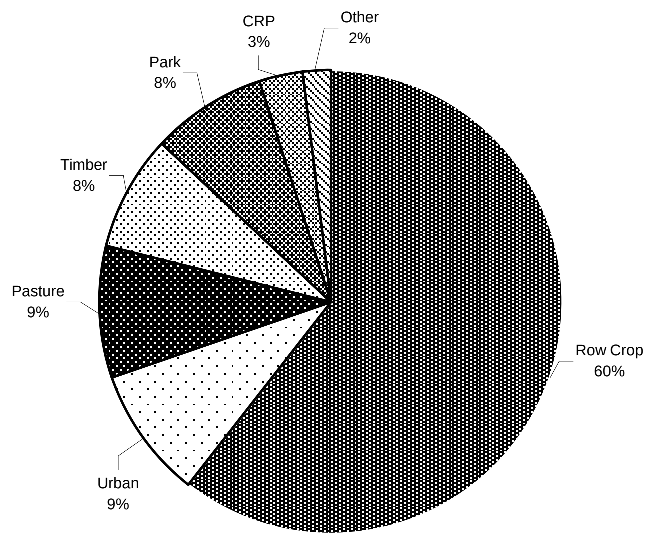


**Figure 2.** Land use in Lake Macbride watershed.

## WATERSHED IMPROVEMENT PROJECTS

Since land use in the Lake Macbride watershed is highly agricultural, conservation practices and watershed improvement strategies are important components of improving water quality in the lake. Since 1970, there has been recognition of a need for land development projects to improve the watershed and water quality. The most recent, the Lake Macbride Watershed Improvement Project, began in 2001 and lasted until 2005. An EPA Section 319 grant, the Watershed Protection Program Fund, and the Water Protection Fund financed the project. Lake Macbride Watershed Project goals included the installation of 20-acres of buffers, seven acres of grassed waterways, three sediment control basins, five acres of windbreaks, two acres of erosion control matting, 50 acres of pasture management, 667 feet of streambank stabilization 500 feet of terraces, and 20 acres of tree and shrub planting. Future projects hope to install wetlands and riparian buffers using cost share and other financial incentives for farmers and other landowners in the watershed.

## WATER QUALITY

Lake Macbride is listed in the impaired water bodies list as "fully supported/threatened" due to moderately high phosphorus concentrations, nutrient loading, lake siltation, and the presence of exotic species. The classification of fully supported/threatened occurs when pollution is enough to exceed the natural capacity of the lake. Over time, these pollutants could degrade water quality and make the lake no longer 'fully supported' as written in the Iowa Administrative Code.

Currently there are no DNR ambient monitoring stations in Lake Macbride. However, many separate water quality surveys have been done on the lake from 1979, 1986, 1990, and 2000-2003 (Bachmann et al., 1980; Kennedy and Miller, 1987; Bachmann et al., 1994; Downing and Ramstack, 2001; Downing and Ramstack, 2002; Downing et al., 2003; Downing and Antonio, 2004). Beach bacteria monitoring has been done weekly at Lake Macbride since the start of the Iowa Beach Monitoring project. Additionally, water monitoring data was collected for the Lake Macbride Total Maximum Daily Load (TMDL) report during the summer of 2003 by the Iowa Hygienic Laboratory (UHL). Bacteria information and TMDL monitoring data is available online at http//wqm.igsb.uiowa.edu/iastoret/.

### Secchi Depth, Phosphorus, and Chlorophyll-a

Iowa does not currently have numeric concentration criteria for nutrients. Instead, a narrative description states, "such waters shall be free from materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor, or other aesthetically objectionable conditions." In the case of the Lake Macbride TMDL, a Trophic State Index (TSI) was used to define and quantify the nutrient levels and objectives in Lake Macbride. Values for Lake Macbride were derived for Secchi depth (water clarity), phosphorus, and chlorophyll-a indicators (Table 1).

Secchi depth is a dimension of water clarity that is measured by a Secchi disk. A Secchi disk is a circular plate that is divided into black and white quarters. The disk is attached to a rope and lowered into the water until it is not visible any longer. Lower Secchi depth values are negatively correlated with higher algae, soil particles, or other suspended particles in the water column. Phosphorus is an important nutrient that feeds algae and microorganisms in a lake. However, lakes are particularly sensitive to being over enriched with phosphorus and can become 'eutrophic', meaning that algae and other plants dominate the lake. Unlike nitrate, which can be transported easily in the water, phosphorus tends to bind with and accumulate in lake bottom sediments. Over time, a previously phosphorus enriched lake can continue to recycle phosphorus from the sediments long after inputs of phosphorus decline. Chlorophyll-a is a photosynthetic pigment found in most plants, including algae. When algal blooms occur, chlorophyll-a levels will also be very high.

Mean values for Chlorophyll-a, Secchi depth, and total phosphorus were monitored during the 2000-2003 summer season (June though September) by the Iowa DNR and Iowa State University. Mean values from 2000-2003 are listed as:

- Chlorophyll-a: 17 μg/L
- Secchi depth: 1.5 m
- Total Phosphorus: 55 μg/L

Corresponding TSI values for Chlorophyll-a, Secchi depth, and Total Phosphorus are listed as 'relatively low', 'very good', and 'moderately high', respectively. This indicates that phosphorus is the leading pollutant in Lake Macbride.

**Table 1.** Corresponding TSI values for Secchi depth, phosphorus and chlorophyll-a levels for Iowa lakes (IDNR, 2005).

| TSI value | Secchi description | Secchi depth (m) | Phosphorus & Chlorophyll-a description | Phosphorus levels (ug/l) | Chlorophyll-a levels (ug/l) |
|---|---|---|---|---|---|
| > 75 | extremely poor | < 0.35 | extremely high | > 136 | > 92 |
| 70-75 | very poor | 0.5 – 0.35 | very high | 96 - 136 | 55 – 92 |
| 65-70 | poor | 0.71 – 0.5 | high | 68 – 96 | 33 – 55 |
| 60-65 | moderately poor | 1.0 – 0.71 | moderately high | 48 – 68 | 20 – 33 |
| 55-60 | relatively good | 1.41 – 1.0 | relatively low | 34 – 48 | 12 – 20 |
| 50-55 | very good | 2.0 – 1.41 | low | 24 – 34 | 7 – 12 |
| < 50 | exceptional | > 2.0 | extremely low | < 24 | < 7 |

## Sediment

Although sediment can be brought in by wind and precipitation, most sediment build up in Iowa lakes occurs due to water transport and erosion processes. Over time, sediment build-up can fill in a lake or a pond, especially if much of the watershed in row crop acres. Sediment also can carry adsorbed pollutants such as phosphorus and arsenic. These pollutants will stay in a lake as long as the sediment is on the bottom of the lake. Lake Macbride's watershed area was modeled using the Revised Soil Loss Equation (RUSLE). RUSLE is a soil loss equation designed to predict the longtime annual average soil loss carried by specific field slopes and specified cropping and management systems. Soil, land use, and other Geographic Information System (GIS) coverages were used as inputs into the RUSLE equation. Figure 3 lists the modeled inputs in tons/acre/year (t/a/y) in 30-meter cells in the Lake Macbride watershed.

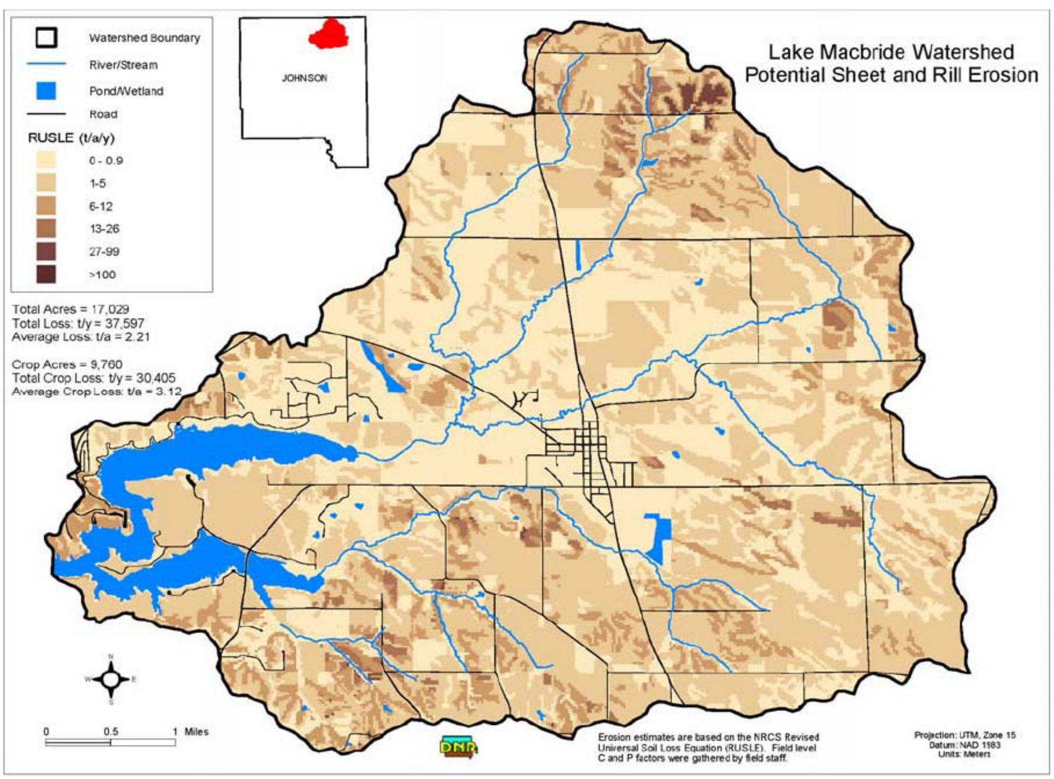


**Figure 3.** Lake Macbride watershed RUSLE modeling results of sediment erosion.

## Bacteria

The presence of *Escherichia coli* (*E. coli* – Fig 4) and other bacteria in our intestines are essential for us to remain healthy. There are billions upon billions of *E. coli* and other bacteria in each healthy human's intestinal tract. These bacteria live in your systems symbiotically, we provide them food and a healthy environment to grow and prosper, they in turn keep us healthy and fit. In fact, humans depend on *E. coli* in our intestines for a significant source of Vitamin K and B-complex vitamins.

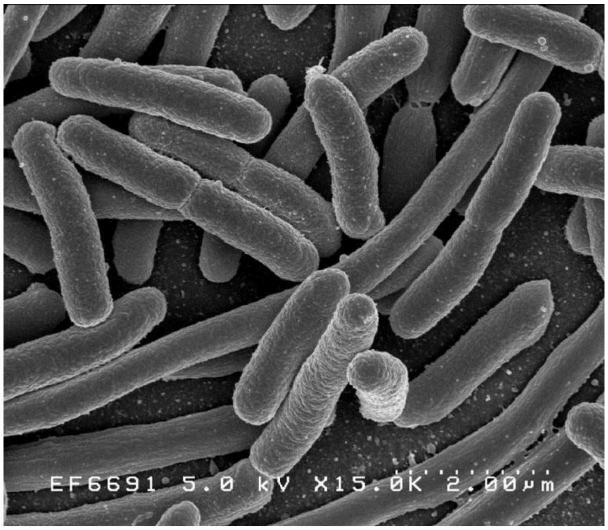


**Figure 4.** A scanning electron micrograph image of Escherichia

Despite the numerous 'good' strains of E. coli, there are certain strains that can cause sickness, infections, and GI tract irritation in humans. *E. coli* are also a useful tool in detecting pathogen levels in water, as they are both plentiful and relatively safe to handle. A pathogen is an infectious bilogical agent (bacteria, virus, and parasite) that causes disease or illness to its host. High *E. coli* levels do not necessarily mean that there is a high pathogen count, however, it does mean that there is a significant chance that there are a higher amount of pathogens. A recent study on beaches in Johnson County has detected a significant correlation between *E. coli* levels in beach water and GI tract irratation (O'Brien et al., in prep).

Since the summer of 2000, the Iowa DNR has sampled state-owned beaches such as Lake Macbride for *E. coli* levels in the water (Table 2). These samples have been taken weekly during the tourist season (May-October). There are two standards for *E. coli:* a one time level exceedance of 235 Colony Forming Units (CFU) /100 ml, and a geometric mean standard of 126 CFU/100 ml. The geometric mean is based on the five previous samples. These bacteria can be from many different sources, both human and animal (wild and domesticated). Since sampling began, Lake Macbride beach has been in the median of Iowa lakes for hits of E. coli. During the past seven years, high single sample results were noted three times in 2004, and 1 time each in 2005 and 2006. The geometric mean has had only six exceedances, all occurring in 2004.

Based on *E. coli*

| Beach | Number of weeks with one-time high* 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006*** | Total Last 5 | Total | Number of weeks with high geometric mean* 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006*** | Total Last 5 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| backbone ** | 8 | 6 | 8 | 7 | 14 | 9 | 5 | **43** | **57** | 7 | 3 | 5 | 6 | 19 | 11 | 6 | 47 | **57** |
| rock creek ** | 0 | 0 | 5 | 6 | 9 | 9 | 6 | **35** | **35** | 0 | 0 | 4 | 3 | 13 | 14 | 6 | 40 | **40** |
| clear lake ** | 0 | 2 | 6 | 2 | 10 | 11 | 3 | **32** | **34** | 0 | 0 | 1 | 0 | 12 | 13 | 0 | 26 | **26** |
| beeds lake ** | 3 | 3 | 2 | 3 | 6 | 6 | 3 | **20** | **26** | 2 | 0 | 4 | 3 | 6 | 9 | 0 | 22 | **24** |
| lake darling ** | 1 | 5 | 5 | 4 | 5 | 2 | 1 | **17** | **23** | 0 | 2 | 6 | 1 | 1 | 0 | 0 | 8 | **10** |
| union grove ** | 0 | 0 | 4 | 1 | 12 | 3 | 1 | **21** | **21** | 0 | 0 | 5 | 0 | 15 | 2 | 0 | 22 | **22** |
| george wyth ** | 1 | 2 | 5 | 1 | 2 | 9 | 0 | **17** | **20** | 0 | 1 | 7 | 4 | 1 | 9 | 0 | 21 | **22** |
| pine lake ** | 1 | 0 | 2 | 2 | 3 | 8 | 2 | **17** | **18** | 0 | 0 | 0 | 0 | 2 | 7 | 0 | 9 | **9** |
| geode | 2 | 1 | 3 | 9 | 2 | 0 | 0 | **14** | **17** | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | **5** |
| nine eagles ** | 0 | 2 | 2 | 3 | 3 | 3 | 3 | **14** | **16** | 0 | 0 | 0 | 0 | 3 | 4 | 2 | 9 | **9** |
| emerson ** |  | 0 | 3 | 1 | 4 | 3 | 2 | **13** | **13** |  | 0 | 0 | 0 | 2 | 4 | 3 | 9 | **9** |
| viking lake | 0 | 1 | 1 | 1 | 4 | 2 | 2 | **10** | **11** | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | **4** |
| lake of three fires | 0 | 0 | 3 | 1 | 4 | 2 | 0 | **10** | **10** | 0 | 0 | 0 | 1 | 8 | 0 | 0 | 9 | **9** |
| big creek | 1 | 0 | 0 | 1 | 5 | 0 | 1 | **7** | **8** | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | **6** |
| lake keomah | 1 | 0 | 0 | 0 | 2 | 2 | 3 | **7** | **8** | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | **2** |
| springbrook | 1 | 0 | 1 | 1 | 2 | 0 | 2 | **6** | **7** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | **1** |
| prairie rose | 0 | 0 | 4 | 0 | 1 | 0 | 1 | **6** | **6** | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | **5** |
| black hawk | 1 | 0 | 0 | 0 | 0 | 3 | 2 | **5** | **6** | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | **2** |
| crandall's |  | 0 | 2 | 1 | 1 | 1 | 1 | **6** | **6** |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| lake macbride | 0 | 0 | 0 | 0 | 3 | 1 | 1 | **5** | **5** | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | **6** |
| pleasant creek | 0 | 0 | 0 | 0 | 0 | 5 | 0 | **5** | **5** | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | **4** |
| green valley |  | 0 | 0 | 0 | 1 | 2 | 2 | **5** | **5** |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| brushy creek | 0 | 0 | 0 | 0 | 1 | 3 | 0 | **4** | **4** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| marble |  |  |  | 2 | 0 | 1 | 1 | **4** | **4** |  |  |  | 0 | 0 | 0 | 0 | 0 | **0** |
| north twin lake east |  |  |  | 2 | 0 | 2 | 0 | **4** | **4** |  |  |  | 0 | 0 | 0 | 0 | 0 | **0** |
| mcintosh woods * | 1 | 0 | 0 | 0 | 0 | 1 | 1 | **2** | **3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| blue lake | 0 |  | 0 | 0 | 2 | 1 | 0 | **3** | **3** | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| lacey-keosauqua | 0 | 0 |  | 1 | 0 | 0 | 2 | **3** | **3** | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | **0** |
| lake wapello | 0 | 0 | 0 | 2 | 1 | 0 | 0 | **3** | **3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| pikes point * | 1 | 0 | 1 | 0 | 0 | 0 | 0 | **1** | **2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| gull point * | 0 | 0 | 0 | 0 | 0 | 2 | 0 | **2** | **2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| lake anita * | 0 | 0 | 0 | 1 | 0 | 0 | 1 | **2** | **2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| lake manawa * | 0 | 0 | 0 | 1 | 1 | 0 | 0 | **2** | **2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| north twin lake west * |  |  |  | 0 | 0 | 2 | 0 | **2** | **2** |  |  |  | 0 | 0 | 0 | 0 | 0 | **0** |
| triboji * |  | 0 | 0 | 0 | 1 | 0 | 1 | **2** | **2** |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| red haw * | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **1** | **1** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | **1** |
| lake ahquabi * | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |

*Less frequently monitored (10 total)
**Vulnerable (10 total)
*** Data through 8/22/06

**Table 2**. E. Coli sampling results from 2000-2006 at state-owned beaches

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# FIELD TRIP STOPS

# Stop 1.

## INTRODUCTIONS

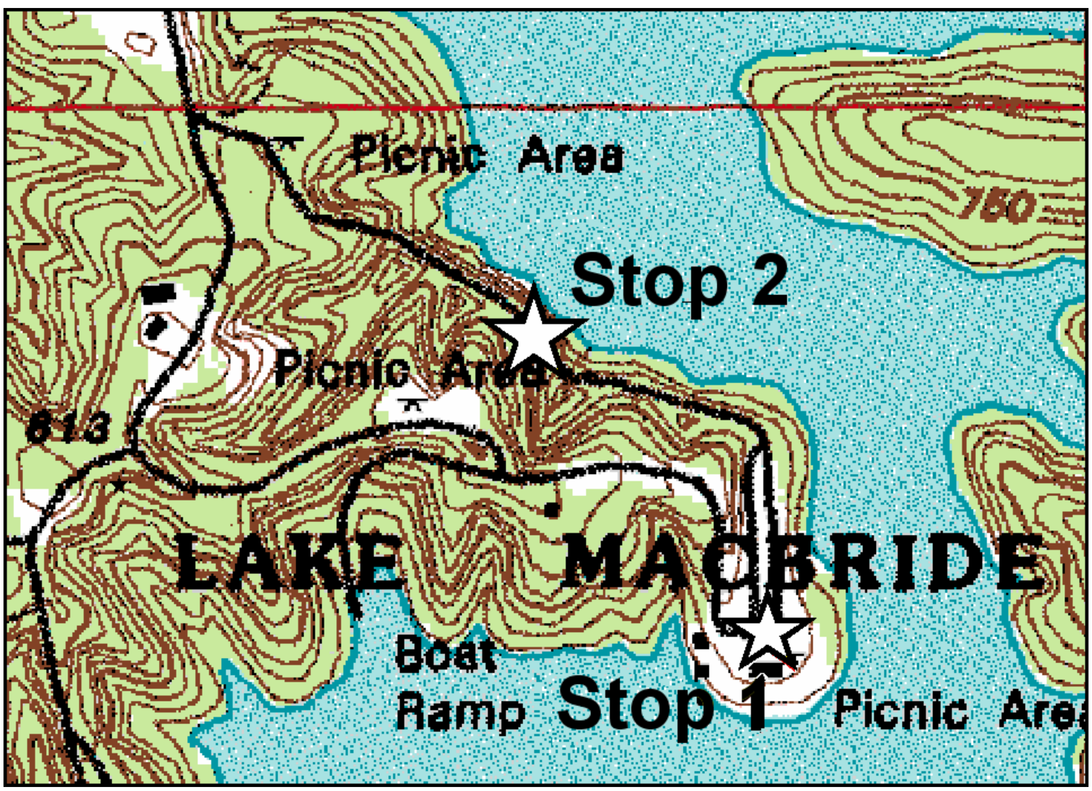
**Ray Anderson**
Senior Research Geologist, IDNR Iowa Geological Survey

## HISTORY OF LAKE MACBRIDE STATE PARK

**Ron Puettmann**
Lake Macbride Park Ranger, IDNR Conservation & Recreation Division

## WATER QUALITY IN LAKE MACBRIDE

**Chad Fields**
Geologist, IDNR Iowa Geological Survey



# HISTORY OF LAKE MACBRIDE STATE PARK

Ron Puettmann

Lake Macbride State Park is one of Iowa's oldest and most beautiful State Parks. The park has a rich and interesting history. Named after prominent botanist, educator, and former University of Iowa President Thomas H. Macbride, who had vigorously promoted a man-made lake in northern Johnson County, but unfortunately didn't live long enough to see his dream realized. With the help of many citizens of Iowa City and the surrounding area, land was acquired for the park, funding secured for construction of a dam, and work began in 1934. With the help of the CCC and other federal works projects the dam, buildings (Fig. 1), and infrastructure were completed. The park was officially dedicated on May 30, 1934, three years the dam was completed in the summer of 1936, the lake was filled, and Lake Macbride State Park officially opened on June 15, 1937. This bathhouse and the beach were moved in the 1950s when the lake level was raised (see figs. 3a & 3b). For additional information on the history of Lake Macbride State Park see the article by Anderson, p. 71 of this guidebook.

**Figure 1.** Shelter constructed of dolomite quarried at Palisades-Kepler State Park and constructed by the CCC in the 1930s.

# WATER QUALITY IN LAKE MACBRIDE

Chad Fields

Lake Macbride is fed by two major streams, Mill Creek which feeds into the north arm of the lake, and Jordan Creek feeds into the southern arm, creating Iowa's largest state owned artificial lake at 950 acres. The lake's deepest point is 47 feet and is located on the western edge of the lake. The average depth of the lake is 16.5 feet. The total volume of water in the lake is 16.6 million cubic meters. Like all surface waters in Iowa, Lake Macbride is threatened by many sources of contamination. The water quality has been monitored by several State agencies through the years, and in general, the lake has faired well, falling near the median of all Iowa lakes for *E. Coli*. For more information see the article by Fields, p. 93 of this guidebook.


**Figure 2.** Iowa DNR water quality notice at the Lake Macbride beach.

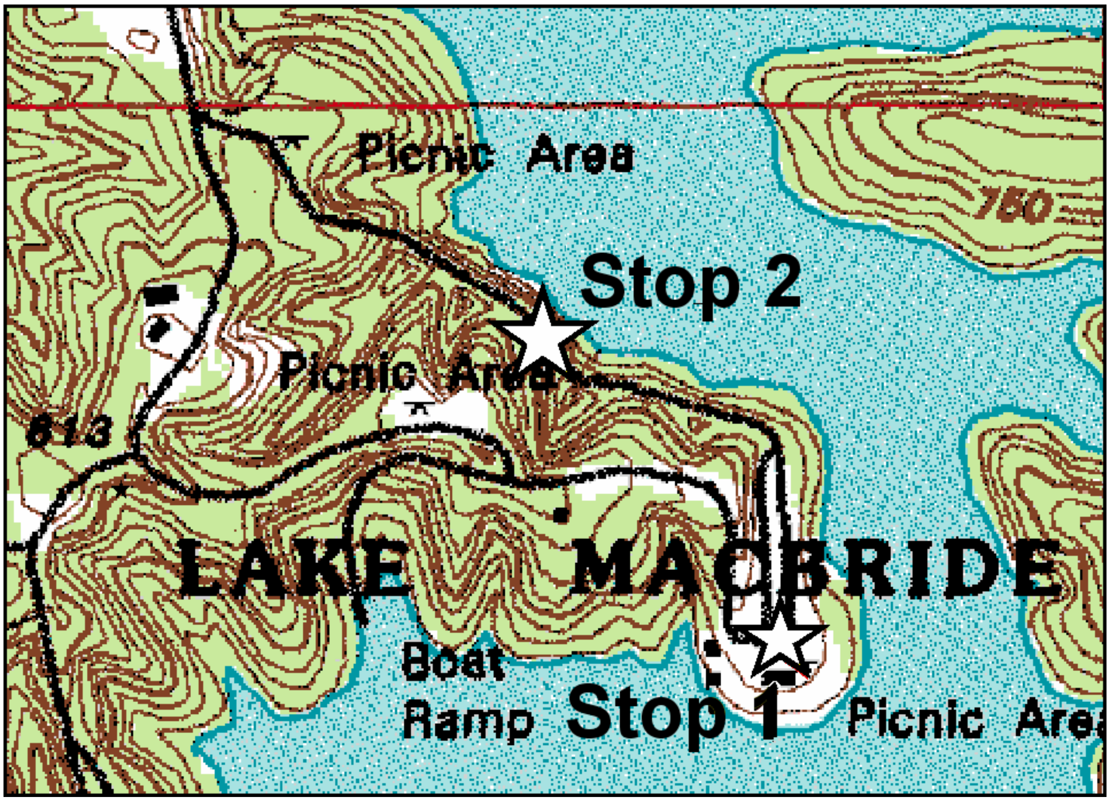
# Stop 2.

## VEGETATION OF MACBRIDE STATE PARK

***Mature Oak Forest***

**John Pearson**

Botanist/Plant Ecologist, IDNR Conservation & Recreation Division




Mature oak forest covers most of the "old park" peninsula, so this stop will be an opportunity to take a brief walk into a typical stand. Dominated by large trees of white oak and red oak, this forest community represents the least altered, most "natural" vegetation in the park.

While driving from this stop to the next, watch the roadside for flagging that marks the boundary between the mature oak forest and a black locust forest.

Figures 3a and 3b are aerial photos of this area of the Lake Macbride State Park. They show the forest cover in the 1930s (Fig. 3a) and in 2002 (Fig. 3b) and indicate that the forest remained virtually untouched in that period of time.

**Figure 3a.** 1930s aerial photo of Stops 1 & 2, including Lake Macbride and the old beach.

**Figure 3b.** 2002 color infrred aerial photo of Stops 1 & 2, including Lake Macbride and the new beach.

# Stop 3.

# VEGETATION OF MACBRIDE STATE PARK

***Black Locust Forest***

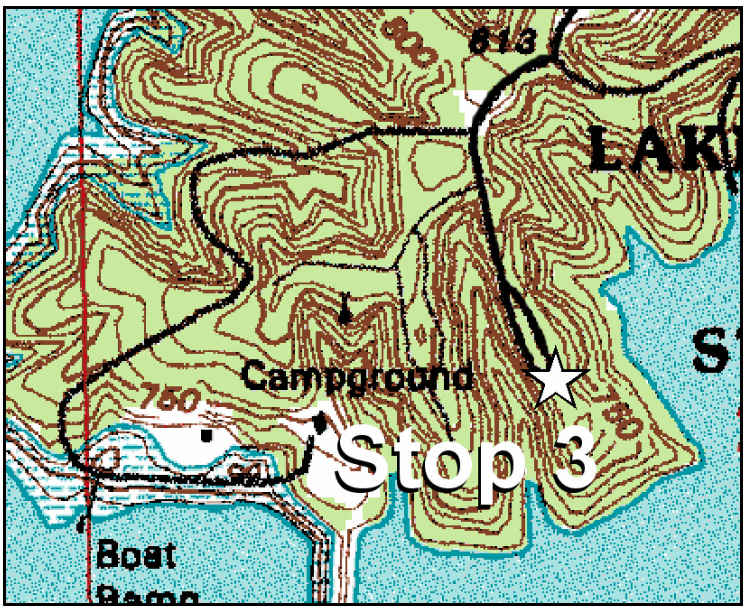
**John Pearson**

Botanist/Plant Ecologist, IDNR Conservation & Recreation Division

# FAUNA OF LAKE MACBRIDE STATE PARK

**Daryl Howell**

Zoologist, IDNR Conservation & Recreation Division




**John Pearson**

In 1938, this area was part of a large cropfield on a broad summit on the crest of the peninsula (Fig. 5a). Following acquisition of this tract in 1939, cultivation was discontinued and the old field was retired. Nearly 70 years later, a mature forest now occupies the former cropfield (see Figure 5 in the vegetation chapter of the guidebook, Pearson p. 59). Black locust (Fig. 4) now strongly dominates the forest community. It is unknown if the black locust trees were purposely planted as a soil conservation measure or whether they invaded the field as pioneering volunteers. White oak and red oak trees are not a significant part of the forest community in this stand.

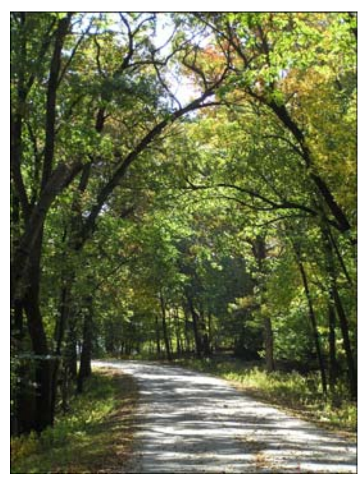


**Figure 4.** Black locust forest.

**Daryl Howell**

Lake Macbride State Park provides excellent wildlife viewing opportunities for the public. The large amount of open water and wetlands provide excellent habitat for waterfowl and shorebirds and many other species can be found in the park. For more information see Howell, p. 65 of this guidebook.

**Figure 5a.** 1930s aerial photograph of Stop 3 and the old beach.

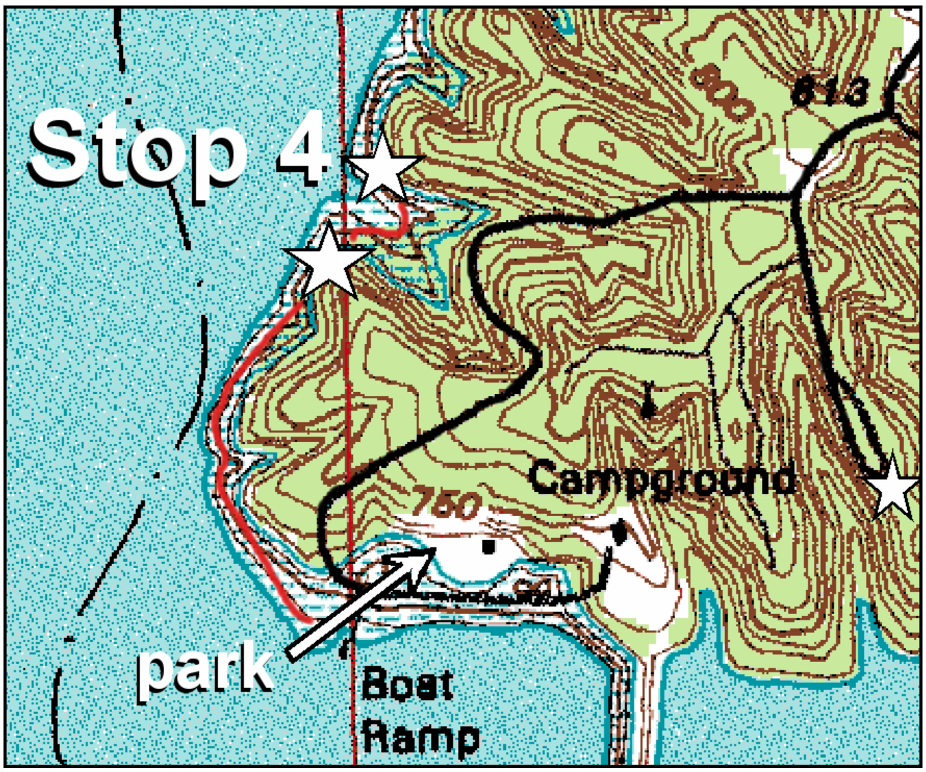
**Figure 5a.** 2002 color infrared aerial photograph of Stop 3 and the new boat ramp.

# Stop 4.
# QUATERNARY GEOLOGY OF LAKE MACBRIDE STATE PARK

**Stephanie Tassier-Surine**
Geologist, IDNR Iowa Geological Survey

# BEDROCK GEOLOGY OF LAKE MACBRIDE STATE PARK AREA

**Brian Witzke and Ray Anderson**
Senior Research Geologists, IDNR Iowa Geological Survey




## QUATERNARY GEOLOGY

**Stephanie Tassier-Surine**

To access Stop 4, we will walk down the Coralville Lake boat ramp and hike for about ¼ mile west then northeast along the shore. Along the way, we will see several Quaternary deposits. We will be walking on the first deposit that we will encounter. This is modern alluvium, sands, silts, and clays deposited by the waters on the Iowa River in Coralville Lake during higher water conditions. Older, Early-Phase High Terrace deposits are also present between the boat ramp and bedrock outcrops. But, the most prominent Quaternary unit that we will see is the Peoria Formation loess present at the top of the section along most of the path we will follow. Although only five to twenty feet is exposed along the path, the Peoria Formation silt may exceed 35 feet in thickness in the park and surrounding area. The thickest exposed sequence lies near the Fisheries Station, and interested trip participants will have an opportunity to see this section at our lunch stop.

Pre-Illinoian till is intermittently present along the path we will walk along the shore. In some areas the Sangamon Geosol formed in Pre-Illinoian till is visible as a reddish clay loam with pebbles (Fig. 6). Many of these pebbles and cobbles display glacial striae, scratches produced when the stone, frozen into the base of glacial ice, was scraped across the bedrock as the ice moved (see Fig. 4, Tassier Surine, p. 13) In other areas the only indication of the till is the presence of glacial erratics scattered on the bedrock surface. The contact of the glacial till with the overlying Peoria loess is buried in most places by colluvium, loess and other materials that have been moved down-slope by the efforts of wind, rain, and gravity. For additional information on the Quaternary geology of the area, see Tassier-Surine, p. 9 of this guidebook.

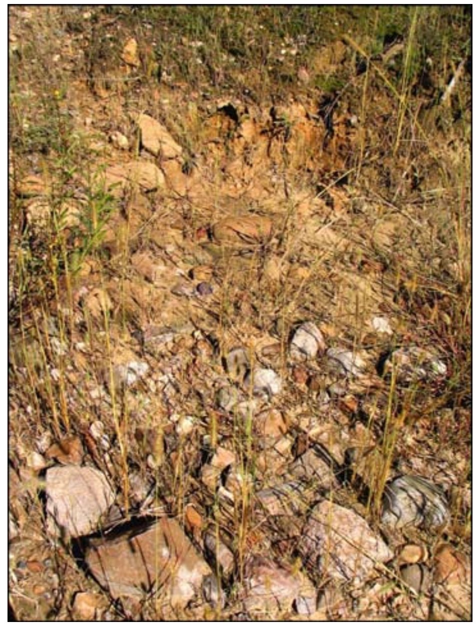


**Figure 6.** Erratics in glacial till seen at the far north end of Stop 4 along Coralville Lake.

## BEDROCK GEOLOGY OF THE LAKE MACBRIDE STATE PARK AREA

### Brian Witzke and Ray Anderson

**Figure 7.** Brecciated Davenport Mbr. (Wapsipinicon Fm) is exposed at Stop 4.

Walking northward from the boat launching ramp along the shoreline of Coralville lake we soon encounter exposures of Devonian bedrock. These are limestones of the Solon Mbr. of the Little Cedar Fm. (Cedar Valley Group), specifically (Fig. 8) lower Solon (“independensis beds”), characterized in this area by slightly argillaceous fossiliferous limestone (wackestone and packstone) with a diverse marine fauna (brachiopods, crinoid debris, bryozoans, etc.). A widespread submarine hardground surface occurs near the top of the lower Solon interval. The upper Solon (“profunda beds”) in Johnson County is dominated by fine skeletal packstone with accumulations of corals and stromatoporoids, in part forming widespread biostromes. Upper Solon strata were deposited in shallower environments than the lower Solon.

Continuing along the exposure numerous structures can be observed, including fractures, synforms, and faults. Another unusual structural feature is also present in this exposure, dike-like areas where brecciated limestones of the underlying Davenport Mbr. (Pinicon Ridge Fm. – Wapsipinicon Gp.) are juxtaposed against Solon strata. Blocks of Solon that abut these “breccia dikes” are frequently tilted or rotated. Here, across most of its extent, the Davenport Member (Fig 7) is dominated by limestone, primarily characterized by dense ‘sublithographic’ limestone, laminated to stromatolitic in part, and with common stylolites. The term ‘sublithographic’ refers to the resemblance to limestones used in lithographic

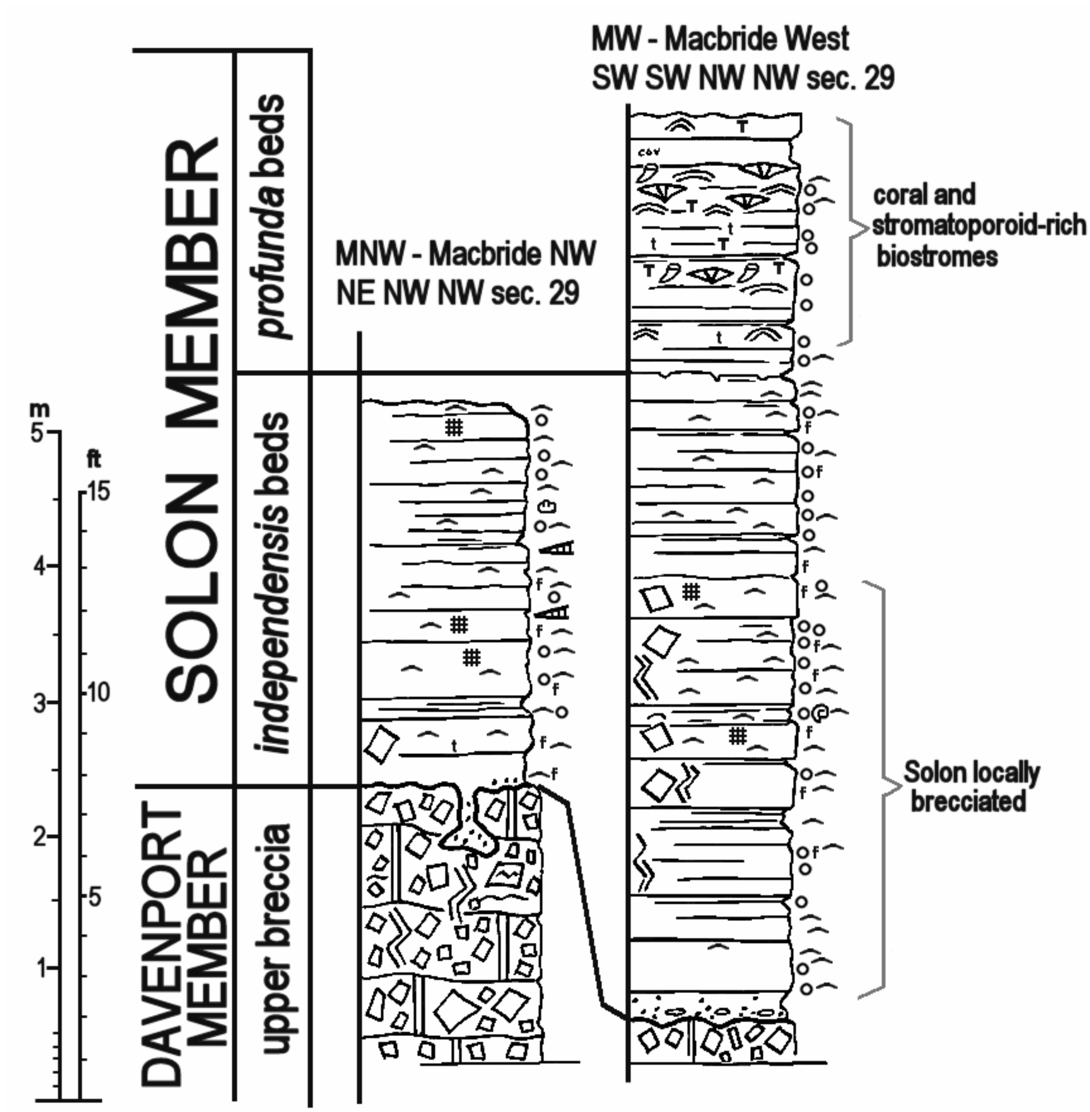



**Figure 8.** Graphic section of geologic units exposed at Stop 4.

engraving, and these dense lime mudstones often break with a conchoidal fracture. The Davenport limestones are dominantly mudstones, but pelletal and intraclastic units are also commonly present. A few limestone beds display calcite-filled fenestral and 'birdseye' fabrics and gypsum crystal molds. Scattered chalcedony concretions are recognized locally. The Davenport Member is best known for its well-developed limestone breccias, a characteristic feature in most sections across its geographic extent. These breccias consist of irregular unsorted angular clasts of limestone (varying in size from a few millimeters to large blocks in excess of 1 meter diameter) generally in a limestone to argillaceous limestone matrix. These breccia dikes are interpreted as the product of dissolution of evaporite beds within the upper Davenport, interpreted as having occurred before, during, and after Solon deposition. This dissolution produced subsidence of overlying Solon Mbr. limestones, juxtaposing them against Davenport strata in areas where evaporites were not completely dissolved.

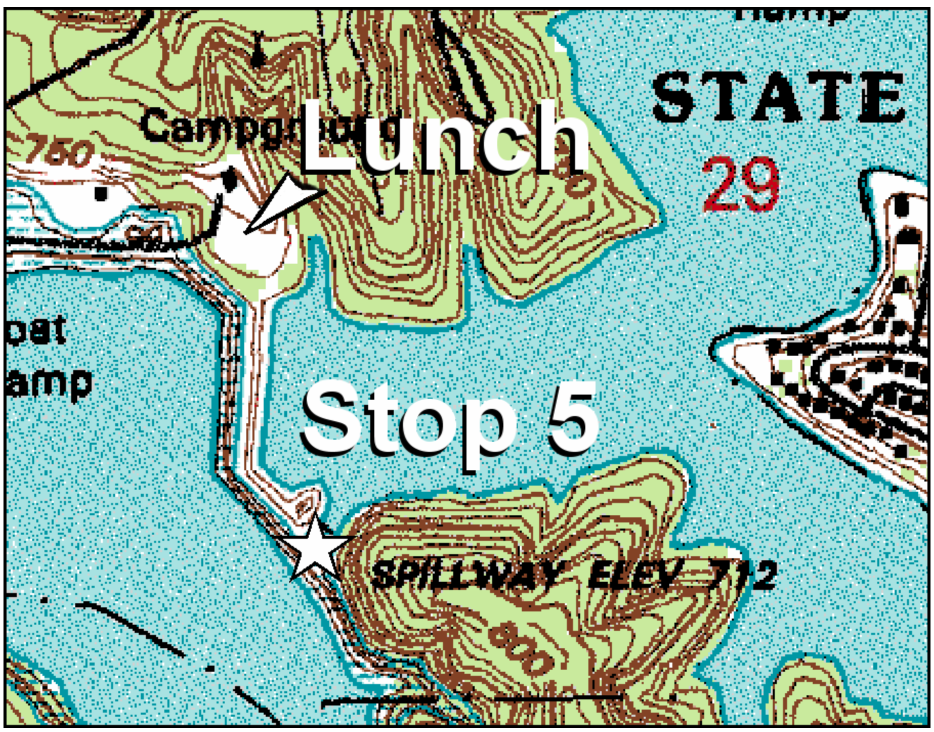
**Hike back to the cars and grab your lunch and drinks and hike up the road to the picnic area adjacent to the fisheries Station and parking area.**

# ***Lunch Break***

# *Stop 5.*

## GEOLOGIC STRUCTURAL FEATURES AT THE LAKE MACBRIDE SPILLWAY

**Ray Anderson and Brian Witzke**
Senior Research Geologists, IDNR Iowa Geological Survey




After the lunch break we will hike across the Lake Macbride dam to the spillway on its south end, Stop 5. This spillway was quarried from the rock bluff in the early 1950s (see Figs. 9a & 9b), when the elevation of the old dam was raised 28 feet to keep the waters of the Coralville Reservoir from flooding Lake Macbride. The spillway for the old dam was located just north of the rock knob on the north side of the current spillway. The rock that was removed during the quarrying of the spillway was used to armor the newly heightened dam. For more information on the early dam and the 1950s reconstruction, see Anderson, p. 1-8 of this guidebook).

## SPILLWAY STRATIGRAPHY

The rocks exposed at the Lake Macbride spillway are the Rapid and Solon members of the Little Cedar Fm (see Figs. 10 & 11). The contact between the Rapid and Solon (Fig. 10) lies just below the floor of the spillway, and it can be observed in exposures below the spillway. Its elevation was reported to be 711 feet by Plocher and others (1989), one foot below the top of the concrete apron on the east end of the spillway which lies at 712 feet.

**Figure 9a.** 1930s aerial photo of Lake Macbride, the dam, and the Iowa River.

**Figure 9b.** 2002 color infrared aerial photo of Lake Macbride, the dam, and the Iowa River.

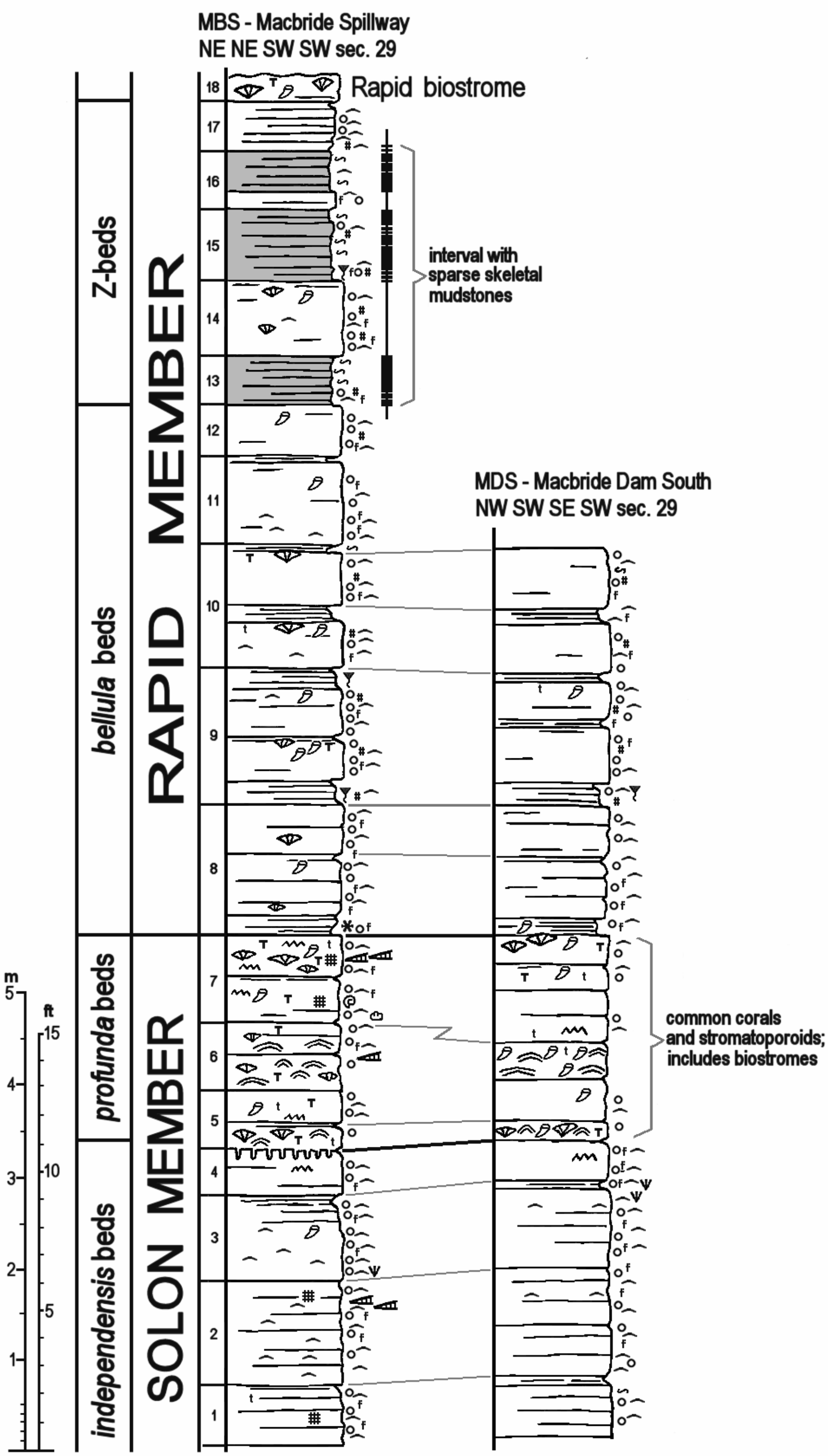



**Figure 10.** Graphic section of geologic units exposed at Stop 5, Lake Macbride spillway and detailed descriptive section on the following page.

*MBS-LAKE MACBRIDE STATE PARK SPILLWAY AREA*
***SPILLWAY SITE AND EXPOSURES DOWNSTREAM ALONG CORALVILLE LAKE***
c SW and SW SE SW sec. 29, T81N, R6W, Johnson Co., Iowa
unit descriptions by B.J. Witzke. B.J. Bunker, O.W. Plocher

## LITTLE CEDAR FORMATION
### RAPID MEMBER

### Biostrome beds

Unit 18. Lower biostrome. Limestone, coralline wackestone to packstone, argillaceous, biostromal with solitary and colonial rugosans (*Hexagonaria*); crinoid and brachiopod debris. Thickness 30 cm (1 ft).

**Z-beds**

Unit 17. Limestone, skeletal wackestone to mudstone, very argillaceous, crinoid debris, scattered bryozoans (cystodictyonids, fenestellids), brachiopods (*Pseudoatrypa*, *Tylothyris*, *Orthospirifer*, *Strophodonta*, *Schizophoria*, others). Thickness 50 cm (1.6 ft).

Unit 16. Limestone, sparse skeletal to nonskeletal mudstone, very argillaceous, scattered horizontal burrows, sparse skeletal material in stringers, scattered crinoid debris, brachiopods (including chonetids); basal 18 cm (0.6 ft) is argillaceous skeletal wackestone, crinoid debris, bryozoans (fenestellids), brachiopods (*Tylothyris*, *Strophodonta*, *Pentamerella*, others). Thickness 62 cm (2.0 ft).

Unit 15. Limestone, sparse skeletal mudstone, very argillaceous, scattered horizontal burrows, scattered skeletal material in thin stringers includes crinoid debris (and semi-articulated stems/arms/cups noted in lower part), bryozoans (fenestellid, cystodictyonids), brachiopods (*Orthospirifer*, *Tylothyris*, *Schizophoria*, *Strophodonta*). Thickness 75 cm (2.45 ft).

Unit 14. Limestone, skeletal wackestone topackstone, massive single bed, crinoid debris, bryozoans (fenestellids, cystodictyonids), brachiopods (*Orthospirifer*, *Pseudoatrypa*, *Spinatrypa*, *Schizophoria*), scattered corals (cup corals, *Hexagonaria*). Thickness 80 cm (2.6 ft).

Unit 13. Limestone, sparse skeletal mudstone, very argillaceous, scattered horizontal burrows, recessive, faintly laminated in part; rare crinoid and bryozoan debris, brachiopods (*Pseudoatrypa*, *Spinatrypa*, *Tylothyris*, *Schizophoria*). Thickness 58 cm (1.9 ft), thins laterally to 35 cm (1.15 ft) along lake.

**bellula beds**

Unit 12. Limestone, skeletal wackestone, argillaceous, single bed, local packstone in upper part; crinoid debris, bryozoans (cystodictyonids, fenestellids), brachiopods (*Orthospirifer*, *Spinatrypa*, *Schizophoria*, others), scattered horn coral. Thickness 56 cm (1.8 ft), thicker where unit 13 is thin.

Unit 11. Limestone, skeletal wackestone to packstone, argillaceous, recessive argillaceous to shaley parting at top; crioid debris, fenestellid bryozoans, scattered tentaculites, brachiopods common to abundant (especially lower part) (*Spinatrypa*, *Tylothyris*, *Strophodonta*, *Schizophoria*, others), scattered horn coral. Thickness 93 cm (3.05 ft).

Unit 10. Limestone, skeletal wackestone to packstone, argillaceous, wackestone in lower part, brachiopod-rich packstone stringers above; in two or more beds, very argillaceous to shaley bedding breaks 50-65 cm above base and at top of unit; burrows; crinoid debris, bryozoans (fenestellids, cystodictyonids), brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Tylothyris*, *Strophodonta*, *Schizophoria*); upper part of each bed locally with corals (*Hexagonaria*, horn coral, branching pachyporids, alveolitids). Thickness 1.35 m (4.4 ft).

Unit 9. Limestone, skeletal wackestone, wackestone-packstone lenses, argillaceous; basal 27 cm very argillaceous to shaley, skeletal mudstone-wackestone, recessive, semi-articulated crinoid material noted; middle interval with common coarse to very coarse crinoid debris, argillaceous bedding break 75 cm below top of unit; top 20 cm more argillaceous to shaley, local semi-articulated crinoid material, shaley bedding break at top; unit contains common crinoid debris, bryozoans (fenestellids, cystodictyonids), scattered tentaculites, scattered to common brachiopods (*Orthospirifer*, *Spinatrypa*, *Pseudoatrypa*, *Eosyringothyris*, *Strophodonta*, *Schizophoria*, *Schuchertella*); middle part of unit locally with corals (*Hexagonaria*, horn coral). Thickness 1.5 m (4.9 ft).

Unit 8. Limestone, skeletal wackestone-packstone, packstone lenses., argillaceous, medium to thick bedded; basal 20 cm thinner bedded, more argillaceous, prominent shaley parting at base; scattered crinoid debris, coarse crinoid columnals in upper part; scattered fenestellid bryozoans, scattered to common brachiopods (*Spinatrypa*, *Orthospirifer*, others); scattered sponges (*Astraeospongia*) in lower part, scattered corals (horn corals, *Hexagonaria*). Thickness 1.4 m (4.7 ft).

## SOLON MEMBER

**profunda beds**

Unit 7. Limestone, fine skeletal packstone, slightly argillaceous, common abraded skeletal debris, unit forms resistant ledge, massive to irregularly bedded, scattered stylolites, argillaceous partings at top and 45 cm below top; prominent burrowed surface at top; fine crinoid debris (scattered coarse), scattered brachiopods (*Independatrypa*, *Spinatrypa*, *Orthospirifer*, *Strophodonta*, *Schizophoria*, *Cranaena*, *Protoleptostrophia*), scattered bryozoans (fenestellids, trepostomes), upper half of unit with scattered to common corals, approaching biostrome in places (*Hexagonaria*, *Asterobillingsia*, horn corals, alveolitids, favositids, pachyporids), lower half with rare corals (horn corals, favositids); scattered to common nautiloids (straight-shelled "*Orthoceras*" and curve-shelled "*Gomphoceras*") especially 20-30 cm below top; bivalve mold noted near base. Thickness 90 cm (3.0 ft).

Unit 6. Limestone, fine skeletal packstone, part abraded grains, part slightly argillaceous, some argillaceous partings between irregular beds, scattered stylolites; lower 40 cm rich in corals and stromatoporoids (approaches biostrome), upper part less coralline; crinoid debris, scattered fenestellid bryozoans, scattered to locally common brachiopods (*Pentamerella*, *Cranaena*, *Independatrypa*, *Spinatrypa*, *Strophodonta*); common corals (*Hexagonaria*, *Asterobillingsia* [to 20 cm diameter], horn corals, cylindrical favositids, branching pachyporids), common stromatoporoids (mostly laminar forms [to 20 cm diameter], rare massive to hemispherical forms); rare nautiloid. Thickness 75 cm (2.5 ft).

Unit 5. Limestone, fine skeletal packstone, coarse skeletal stringers, part abraded grain, scattered stylolites, part slightly argillaceous, bedding break 23 cm above base, thin argillaceous zone top 4-7 cm; fine crinoid debris, scattered brachiopods (*Independatrypa*, *Pseudoatrypa*, *Athyris*, others), rare bryozoans (trepostomes), corals scattered to common (indeterminate fasciculate rugosans, small *Hexagonaria* [to 10 cm], cup corals, alveolitids, massive to encrusting favositids), scattered to common stromatoporoids (laminar and encrusting forms, rare hemispherical forms [to 10 cm]); coral/stromatoporoid-rich intervals are laterally discontinuous, most common in lower 20 cm; base marked by prominent hardground discontinuity surface, penetrates up to 11 cm into underlying unit. Thickness 60 cm (1.95 ft).

**independensis beds**

Unit 4. Limestone, skeletal wackestone, scattered stylolites, less skeletal in upper 25 cm; scattered crinoid debris and fenestellid bryozoans, scattered to common brachiopods in lower part (*Independatrypa*, *Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Tylothyris*, *Cyrtina*, *Strophodonta*, *Schizophoria*); hardground discontinuity surface at top, sculpted with up to 11 cm relief (infilled with unit 5 lithologies). Thickness 50 cm (1.6 ft).

Unit 3. Limestone, skeletal wackestone-packstone, slightly argillaceous, generally more argillaceous upwards, top 10 cm very argillaceous to shaley; scattered to abundant brachiopods, some whole-shell packstone stringers; scattered fine to coarse crinoid debris; scattered bryozoans (fenestellids, encrusting), rare cup corals; brachiopods (dominated by *Independatrypa*, *Strophodonta*; also *Spinatrypa*, *Pseudoatrypa*, *Tylothyris*, *Cyrtina*, *Orthospirifer*, *Athyris*, *Schizophoria*); rare trilobites (proetids, *Phacops*). Thickness 90-95 cm (3.0-3.2 ft).

Unit 2. Limestone, skeletal wackestone-packstone, slightly argillaceous, some argillaceous partings, irregularly bedded; scattered to abundant brachiopods, some whole-shell packstone stringers; scattered fine to coarse crinoid debris, rare bryozoans (fenestellids, trepostomes), brachiopods (dominated by *Independatrypa*, *Strophodonta*; also *Spinatrypa*, *Orthospirifer*, *Cyrtina*, *Schizophoria*, *Strophodonta*, *Cranaena*), rare nautiloids. Thickness 1.13 m (3.7 ft).

Unit 1. Limestone, skeletal wackestone-packstone, slight argillaceous, some argillaceous partings in upper part; scattered to abundant brachiopods, some whole-shell packstone stringers; scattered crinoid debris, scattered bryozoans (fenestellids, trepostomes), brachiopods (dominated by *Independatrypa*; also *Strophodonta*, *Spinatrypa*, *Orthospirifer*, *Schizophoria*, chonetid); rare auloporid coral. Thickness 65 cm (2.1 ft) exposed to low water level of Coralville Lake; unit in contact with underlying Davenport Member breccias in northern part of Lake MacBride State Park (along Coralville Lake), where it varies in thickness from 65 cm to 2.25 m (2.1-7.4 ft), locally sandy at base, above irregular Davenport surface.


**Figure 11.** Photographs of the north wall of the Lake Macbride spillway, a. as photographed, and b. annotated. Descriptions of annotations follow.

## SOME OBSERVATIONS OF STRUCTURES AT THE MACBRIDE SPILLWAY OUTCROP

reprinted from

Jane A Gilotti and Coulter Wood (1999)

The most prominent of the structures that are observed on the north wall of the Lake Macbride spillway is a thrust fault (designated as T –T' in Figure 1b). A classic stair-step geometry is developed where the thrust cuts steeply through the massive limestones to define a footwall ramp, and then glides parallel to the bedding to define a footwall flat near the top of the outcrop. The hanging-wall is gently folded to form a classic hanging-wall ramp anticline. Although bedding in the core of the anticline is disturbed by brecciation (b in Fig. 11b), it is well-defined on the main, east-dipping limb and also visible in the tan, shaly, west-dipping beds. The discordance in bedding between the tan, shaly beds and the underlying, subhorizontal gray limestone defines the footwall flat. Grooved slickenlines exposed on the thrust surface are approximately down-dip. A displacement of a few meters is best described by the offset of the conspicuous, meter-thick, massive, gray limestone bed (marked by thin white lines in Figure 11b). In addition, a set of moderately west-dipping, smaller faults and fractures occurs in the hanging-wall of the thrust, just above the footwall ramp (∗ on Fig. 11b). Offsets are both normal and reverse. Pockets of breccia are common, and shaly interbeds can be seen to have thickened and thinned in the core of the fold. These features are brittle accommodation structures formed in response to the hanging-wall moving over the ramp (e.g. Wojtal, 1986).

Five steep fracture zones cut clear through the outcrop. Many of the steep fractures are oblique to the outcrop face. Normal offset occurs on the fault zones labeled **1**, **2**, and **5** (Fig. 11b), while no offset is apparent on fracture zones **3** and **4** (Fig. 11b). These step fault zones must have formed after the thrust fault because fractures **3** and **4** cut cleanly through the thrust. The steep fault zones vary in character along their length from single fractures, to fracture sets, to anastomozing fracture networks, to pockets of breccia. Some of them also change orientation and curve upwards. Fracture zone **5** is particularly complex, but accounts for the flexure in bedding just above the spillway apron. Schwartz (1996) measured the faults at this outcrop and presented a stereonet. Further study of this outcrop is in progress (Coulter Wood, Senior Thesis).

Neither the thrust fault or the steep fracture zones are seen in the south wall of the spillway; however, similar minor faults are fairly common around the Coralville Reservoir (Czeck, 1996; Schwartz, 1996). The normal and reverse faults are thought to be coeval because consistent cross-cutting relationships could not be established. The faults are also thought to die out above the Cedar Rapids Member, and thus be Middle Devonian in age (Czeck and Faulds, 1996; Schwartz and Faulds, 1996). These authors attribute the faulting to tectonism resulting from the Appalachian Acadian Orogeny, but note that some of the faulting may also be due to evaporite collapse in the underlying Wapsipinicon Group. For more information on the structures in the Lake Macbride area and the references cited see Anderson, p. 1 of this guidebook.

## ROUTE TO STOP 6

Stop 6 is located in the Southern Unit of Lake Macbride State Park. To drive to this stop we must exit the northern unit of the park via County Road F-16 and continue to the junction of Iowa Highway 352 then southeast into Solon (Fig. 12). We want to leave Solon on County Road F28 on the west side of Solon. You can


**Figure 12.** Map of route from Stop 5 through Solon to Stops 6 – 8.


**Figure 8a**. Road map of Solon

continue on Hwy 352 to State Highway 1 (see Fig. 12a above), drive south on Hwy 1 to F28 (5$^{th}$ Street), then turn right (west) and continue out of Solon. A short cut is to turn right (south) on N. Chabal St (just past the school), turn right (west) on S. Sovers St. then left (south) on Racine Ave to F28. Turn right and drive west on F28, which becomes Mehaffey Bridge Road as it bend to the southwest. Turn right (west) on Cottage Reserve road just before the causeway over the south arm of Lake Macbride, drive about 0.5 miles the turn right (north) toward the Sailboat Area Shelter and proceed to Stop 6.

# Stop 6.

## VEGETATION OF MACBRIDE STATE PARK

**Autumn-olive Thicket and Successional Woods**

**John A Pearson**

Botanist/Plant Ecologist, IDNR Conservation & Recreation Division


This area was farmed until 1967 (see Figs. 13a & 13b), possibly as a hayfield last planted to smooth brome grass. Today, it is a thicket of autumn-olive (see Figure 6 in the vegetation chapter of the guidebook, Pearson, p. 53), an introduced shrub often planted in shelterbelts as winter cover for wildlife. Commonly escaping from plantations, autumn-olive has proven to be an aggressive invader of grassland and other open areas throughout the Midwest. Park managers have begun to control this species by cutting it with a special vehicle equipped with steel blades acting as scissors.

Across the road from the autumn-olive thicket, a large area of "successional woods" (consisting of a wide variety of trees and shrubs, including elm, ash, black locust, honeylocust, boxelder, and gray dogwood) has developed on old fields abandoned in the 1950s. White oak and red oak are not a significant part of the community in either the successional woods or the autumn-olive thicket.

### ROUTE TO STOP 7

Continue driving north from Stop 7 and circle through parking area at sailboat launching dock and return to county road F28 (Mehaffey Bridge Road), turn right, cross the causeway over the south arm of Lake Macbride, and continue south for about 1.5 miles to the entrance of the University of Iowa Macbride Nature Recreation Area. Continue west for about 1.5 miles to main parking area. Park cars and with trip leader John Pearson hike back along road about ¼ mile to field trip Stop 7.

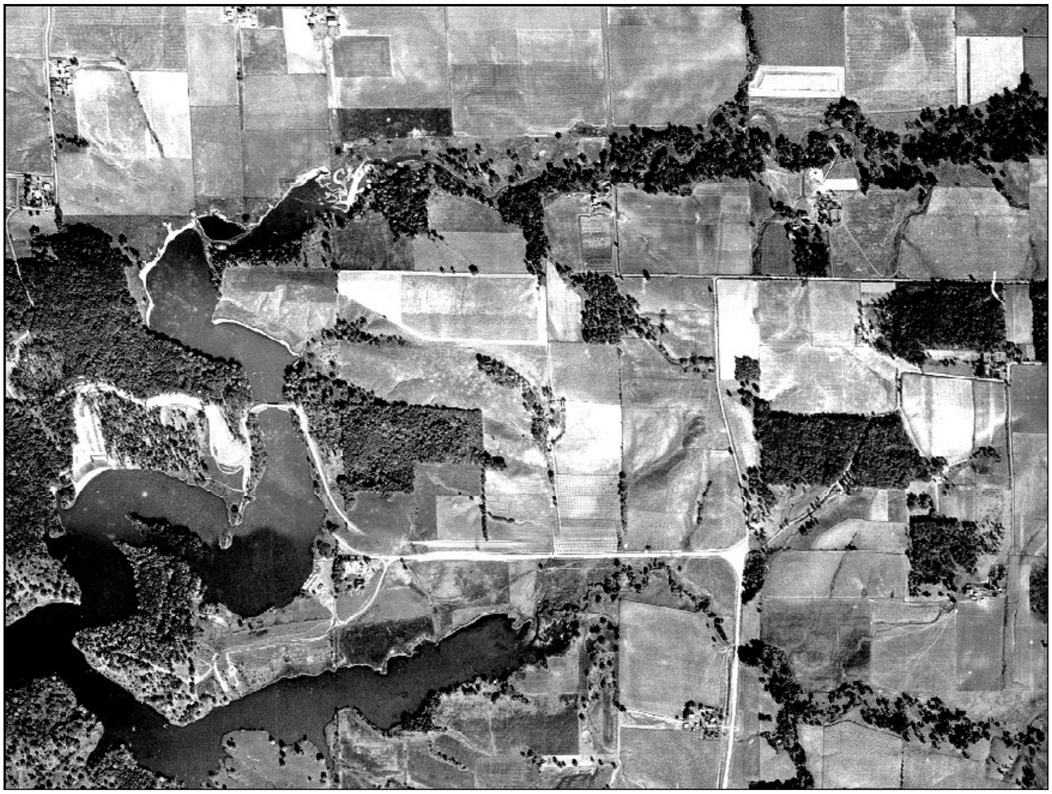


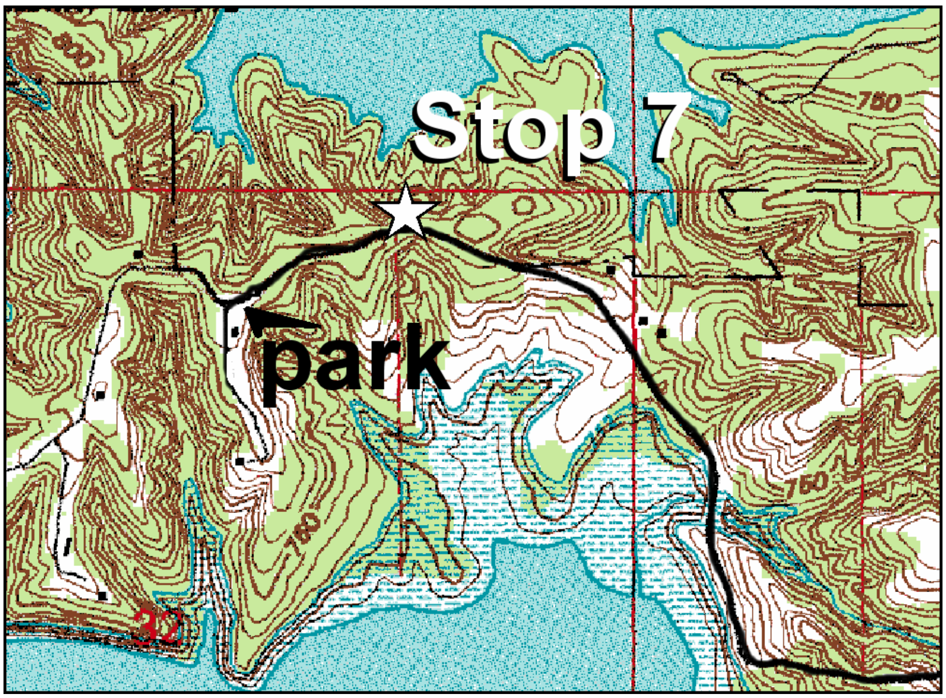
**Figure 13a.** 1930s aerial photo of Lake Macbride and the area of Stop 6.

**Figure 13b.** 2002 color infrared aerial photo of Lake Macbride and the area of Stop 6

# Stop 7.
# VEGETATION OF MACBRIDE STATE PARK
## Mature Oak Forest/Walnut Forest Contrast

**John A Pearson**

Botanist/Plant Ecologist, IDNR Conservation & Recreation Division




In 1938, the eastern part of this field trip site was an open pasture while the western part was a wooded pasture (see Fig. 14). Pasturing ceased in both areas in the mid-1930s when the tracts were acquired by the park. Today, both areas are forest, but the former open pasture is now occupied by mature walnut trees while the former wooded pasture is occupied by mature white oaks, sugar maples, and honeylocusts. The combination of full sun and heavy grazing evidently favored the germination and growth of walnuts in the open pasture. The wooded pasture is closer to the composition expected in a natural forest (white oak and maple) except for the importance of honeylocust (a common tree in pastures).

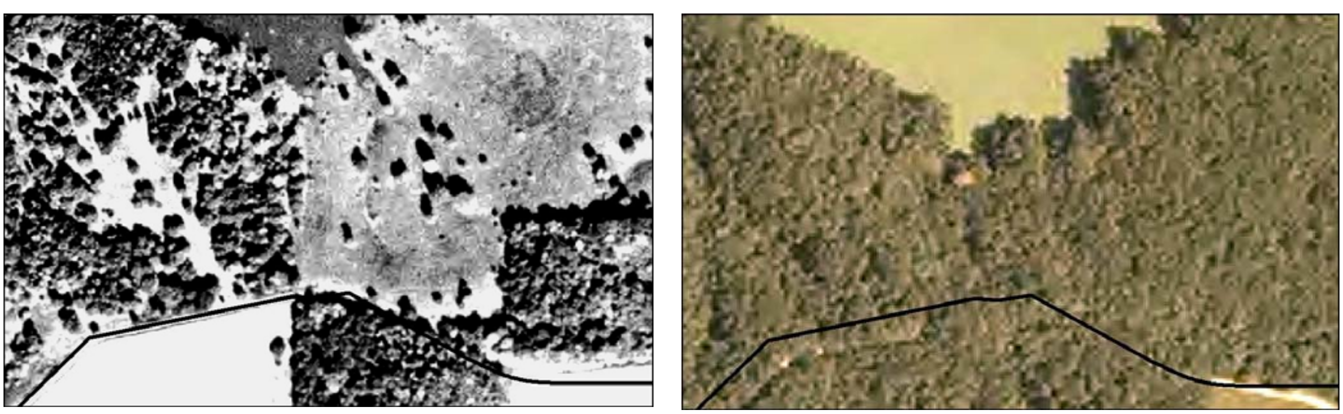


**Figure 9.** Aerial Photographs of the area of Stop 7 from 1938 (left) and 2004 right.

## ROUTE TO STOP 8

Depart Stop 7 with field trip leader Ray Anderson and walk back through parking area and down trial to exposures at Fox Point, about 1/3 mile.

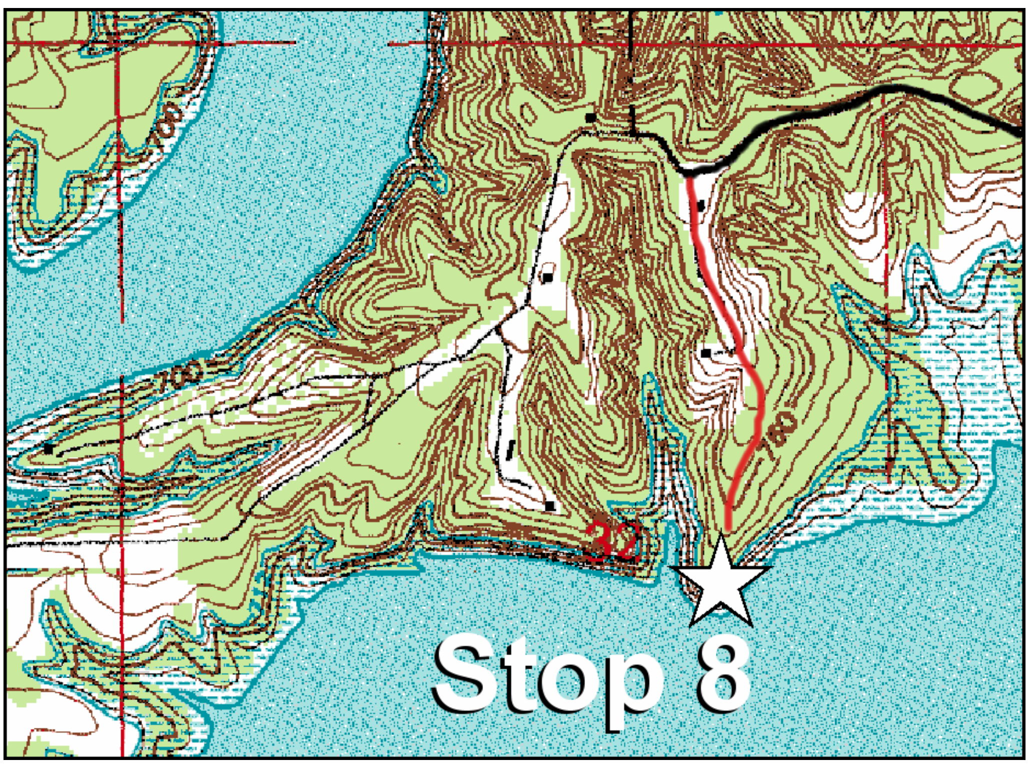
# Stop 8.

# THE ARCHAEOLOGY OF THE LAKE MACBRIDE AREA

**Joe Artz**
University of Iowa, Office of the State Archaeologist

# EXPOSURES OF RAPID MEMBER, LITTLE CEDAR FORMATION AT FOX POINT

**Brian Witzke**
Senior Research Geologist, IDNR Iowa Geological Survey




## THE ARCHAEOLOGY

Joe Artz

Over 300 sites have been found in the immediate vicinity of Coralville Reservoir and Lake Macbride. Discoveries range from spear points lost 12,000 years ago by Ice-Age hunters to the foundations of structures built by the Civilian Conservation Corps (CCC) in the 1930s. The Iowa River was an important waterway for both prehistoric peoples and later pioneers. The river setting was a source of water and shelter for both humans and the game they sought, offered materials for stone tools, provided timber and edible plants, and served as a transportation route. Archaeological campsites, habitations, burial mounds, and resource procurement sites are found along the river and its tributaries in a variety of settings including uplands, high terraces, and alluvial bottoms. There are over 1,200 archaeological sites recorded in Johnson County, about one twentieth of all known in the state.

The construction of the Coralville Dam and Reservoir by the U.S. Army Corps of Engineers led to the acquisition of 32,700 acres of land along the Iowa River for the reservoir, including 1,820 acres for the conservation pool and an additional 24,800 acres for the flood pool. The construction and subsequent flooding of the Iowa valley threatened to destroy archaeological sites, leading the Corps design a comprehensive plan to recover information before sites were lost. This archaeological research , which began in 1949 and continued in 1956 under the auspices of the Smithsonian Institution's River Basin Surveys, recorded only 19 new sites. Construction of the dam and reservoir was completed in 1958. Since the 1960s, the Corps and other government agencies have continued to foster archaeological studies on the lands it owns or manages by identifying and, if possible, preserving or excavating sites threatened by shoreline erosion or human activity. These studies have documented hundreds of additional sites and produced a more comprehensive story of Iowa River prehistory. . More deeply buried sites await discovery when suitable techniques may be applied.

Lake Macbride State Park has not been the subject of an intensive archaeological survey. Prior to 2000, only 10 sites were recorded within the park's boundaries. Seven of these were reported in the early1980s by Duane Miller, an active avocational archaeologist from Iowa City. Professional archaeological surveys within the park have been undertaken for specific impacts such as surveys for trails and recreational facilities. These surveys identified three more archaeological sites, all dating from the historic period.

In 2000, the waters of Lake Macbride were lowered 17 feet in order to allow the Iowa Department of Natural Resources to remove sediments and stabilize the shoreline. This project exposed land that had been underwater for fifty years when the lake level was raised. Consulting Archaeological Services, a southwest Iowa firm contracted to find and investigate cultural properties, discovered 37 archaeological sites and one limestone footbridge, all previously inundated by the lake. Twenty-five sites represent the encampments, habitations, and resource procurement sites of prehistoric Native Americans. Although erosion had severely damaged most of these sites, artifacts and features such as hearths, roasting pits, and storage pits were still found intact. The other twelve sites represented the structural remains from more recent times, including the foundation of a bathhouse constructed by the CCC in the 1930s (Fig. 15).

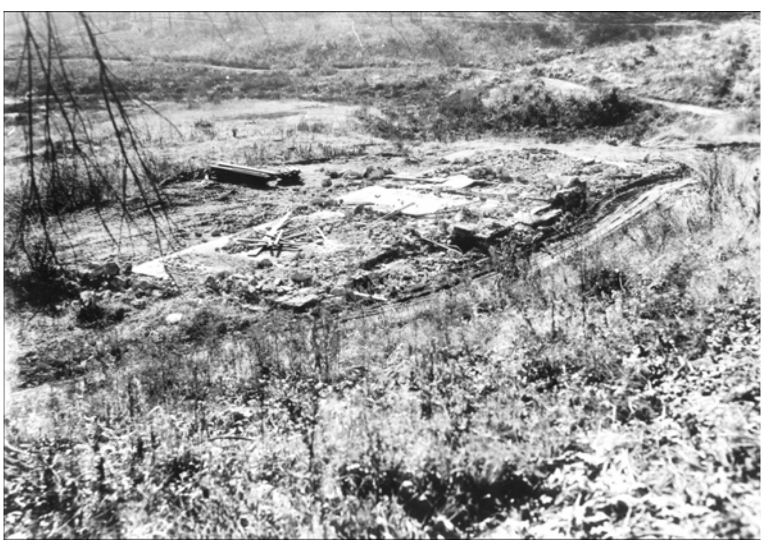


**Figure 15.** Foundation of the bathhouse, constructed by the CCC in the 1930s, as it appeared in the 1950s when the building was dismantled and moved to its current location.

Prehistoric sites identified during the Lake Macbride study range in age from Early Archaic, perhaps 9000 years old, to those of the Late Woodland (AD 650-1200) and Late Prehistoric periods (AD 1200-1700). Resource procurement sites like 13JH1066, the earliest found at Lake Macbride, are common. They represent scatters of chipped stone refuse and debris where stone tools were made and resharpened prior to their use for hunting and gathering. Angular and reddened, fire-cracked rocks are the remnants of rock-lined hearths or cooking pits left by the prehistoric inhabitants who briefly stopped at these locations. The Early Archaic spear point found at 13JH1066 was made of Burlington chert, a type of material from southeast Iowa. It suggests that nine millennia ago, inhabitants in Johnson County were traveling or trading to acquire good quality stone for tools.

For a more detailed discussion of the archaeology of the Lake Macbride area, see Artz, p. 37 of this guidebook.

## EXPOSURES OF THE RAPID MEMBER

Brian Witzke and Ray Anderson

The Rapid Member (Fig. 18) comprises upper unit of the Little Cedar Formation above the Solon Member, and it is interpreted to represent two T-R subcycles within the larger Little Cedar T-R sequence (Witzke and Bunker, 1994a). As for the Solon Member, the Rapid Member is also defined from localities in Johnson County, Iowa, where it averages about 16 m thick. The Rapid Member in this area forms a succession of distinctive subtidal carbonate lithofacies.(Witzke and Bunker, 1994a; Witzke et al., 1999):

1) The lower "bellula beds" (Fig. 18) are characterized by repetitive couplets of skeletal wackestone-packstone (commonly brachiopod-rich, especially the name-bearer *Spinatrypa bellula*) and thinner more argillaceous wackestones and mudstones. These couplets are correlatable across the county, and they possibly correspond to parasequence-scale units within the larger T-R sequence. The packstone units show local variations in thickness suggestive of large-scale current-generated low-angle bedforms, probably produced by episodic storm current activity. Scattered colonial corals occur in some beds, especially in the upper parts of individual beds.

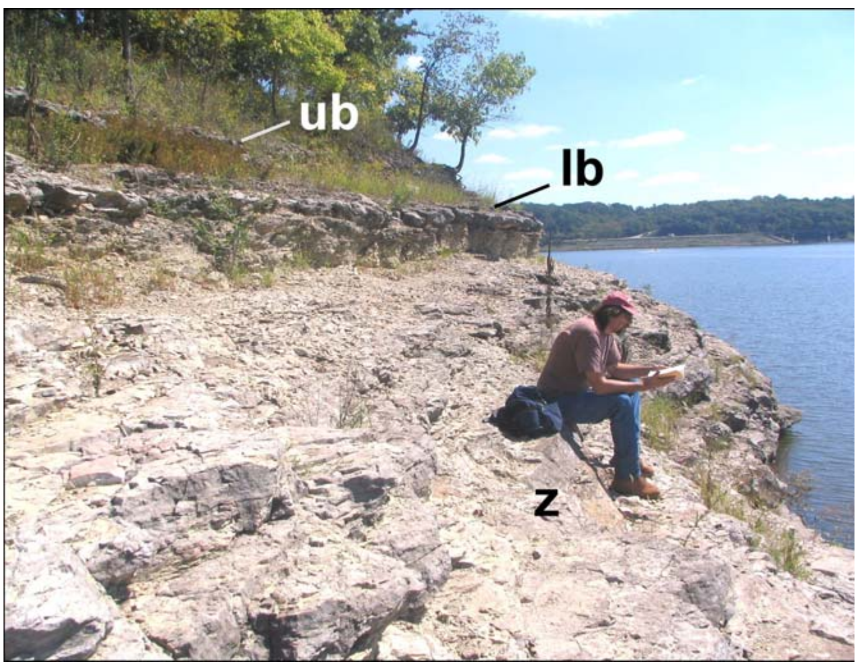



**Figure 16.** Author sits on the z-bed at Stop 6, the Fox Point exposure. The lower (lb) and upper (ub) Rapid biostroms can be seen as ledges above.

2) The overlying "Z-beds"(Fig. 16 & 18) (as defined by Witzke and Bunker, 1994a) are a lithologically distinctive facies dominated by unfossiliferous to sparsely fossiliferous burrowed argillaceous lime mudstones. Laterally discontinuous skeletal stringers and lenses of wackestone-packstone are interspersed within the mudstones, some displayed as starved megaripple bedforms, and some of these stringers contain associations of articulated and semi-articulated crinoids (especially *Megistocrinus* and melocrinitids; Witzke and Bunker, 1997b). The Z-beds also include thin intervals of skeletal wackestone and mixed wackestone-mudstone, with moderately diverse shelly faunas or low-diversity chonetid brachiopod faunas.

3) An interval containing coral-rich biostromes ("Rapid biostromes") occurs above the Z-beds (Fig. 17), characterized in Johnson County by lower and upper biostrome beds with intervening wackestone-packstone strata (in part very crinoidal, commonly with pachyporid corals or large trepostomes bryozoans). The lower biostrome bed commonly shows glauconitic to phosphatic enrichment (apatite grains) at its base.

4) The upper Rapid beds above the biostromes (termed the "waterlooensis beds") (Fig. 18) is characterized by argillaceous to dolomitic skeletal wackestones-packstones (especially crinoidal), cherty and glauconitic in

part. The top surface of the Rapid is marked by a burrowed discontinuity surface or sculpted hardground. However, northward in Johnson County, the highest part of the Rapid is marked by cross-bedded crinoidal packstones and grainstones recording the shallowest depositional facies of the Rapid Member in Johnson County (Witzke and Bunker, 1994a).

Rapid strata are replaced northwestward in Iowa by subtidal inner-shelf facies of the middle to upper Bassett Member, Eagle Center Member, and Chickasaw Shale, and the Little Cedar Formation is capped by peritidal facies of the Hinkle Member across the inner shelf. The Rapid biostrome beds of Johnson County are replaced northwestward by coral- and stromatoporoid-rich facies (locally biostromal) within the Bassett Member. Upper Rapid facies are replaced by similar cherty and glauconitic facies of the Eagle Center Member in the central to distal areas of the inner shelf, and by facies of the upper Bassett and Chickasaw Shale in more proximal areas of the inner shelf. The Hinkle Member marks the final regressive phase of shallowing sedimentation for the Little Cedar sequence, culminating in subaerial exposure (sub-Coralville erosional surface) as the seaway withdrew from the inner-shelf area.

**Figure 17.** Upper and Lower Rapid biostromes are prominent ledge-formers at Fox Point. These fossil packstone units can be traced from the Quad Cities area northwest beyond the Waterloo area.

Faulting is also prominent at the Fox Point exposure. Marker beds such as the upper and lower Rapid biostrome make it easy to observe these structures. High-angle faulting is seen along the west side of the exposure where total displacements of 4.5 m (15 ft) are observed between beds of the Upper Rapid biostrome. Upper Rapid strata ("waterlooensis beds") are preserved within the down-dropped blocks associated with this faulting. For more information on the Rapid Mbr. and references cited here, see Witzke, p. 17, this guidebook.

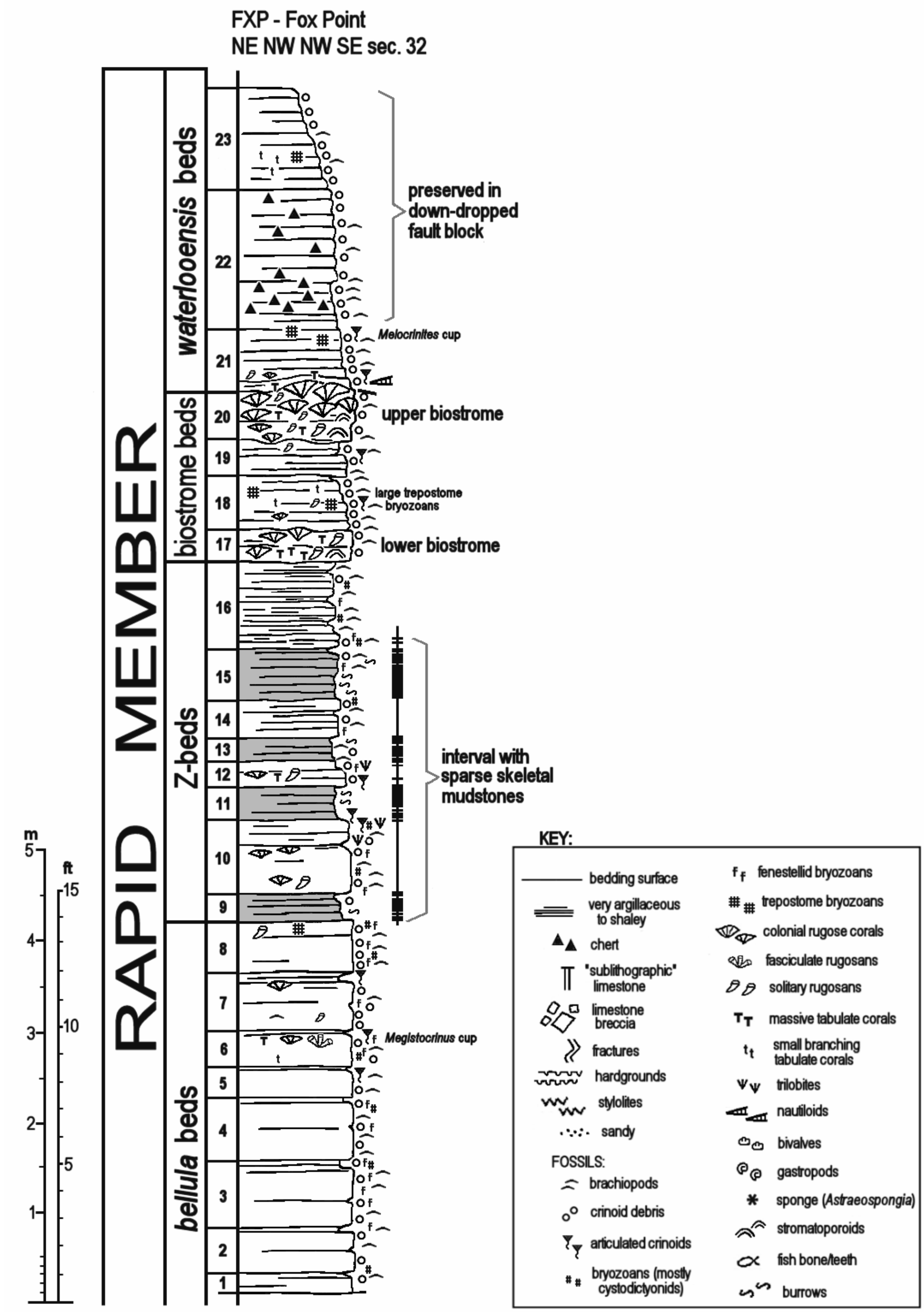



**Figure 18.** Graphic section of Rapid Mbr. Strata exposed at Fox Point on the University of Iowa Macbride Nature and Recreation Area.

**FXP-Fox Point section**
Macbride Nature Recreation Area
NE NW NW SE sec. 32, T81N, R6W, Johnson Co., Iowa
section measured Apr. 14, 2005, Sept. 19, 2006; Brian Witzke

**MIDDLE DEVONIAN**
**LITTLE CEDAR FORMATION**
**RAPID MEMBER**
**waterlooensis beds**

[note: units 22-23 are preserved in down-dropped blocks along the west side of the exposure; 4.5 m total offset measured from top of upper biostrome]

UNIT 23. Limestone, partly dolomitic, slightly argillaceous, fine to coarse crinoidal wackestone to packstone; scattered brachiopods (*Devonatrypa*); lower half with scattered small tabulate corals (branching pachyporids 2-9 cm, auloporid) and large trepostome bryozoans (to 4 cm). Poorly exposed along edge of wooded slope. Maximum thickness about 1.2 m.

UNIT 22. Limestone, partly dolomitic, slightly argillaceous, fine to coarse crinoidal wackestone to packstone, some fossils partly silicified, some beds slightly glauconitic; irregularly bedded 2-15 cm, slope-former with some ledges (especially upward); scattered chert nodules (especially in lower 50 cm); basal 10 cm more argillaceous and thinner bedded, recessive; coarse crinoidal debris (including *Megistocrinus*), scattered brachiopods (*Devonatrypa*, *Orthospirifer*), rare trepostome bryozoans. Thickness about 1.55 m.

UNIT 21. Limestone, partly dolomitic, slightly argillaceous, fine to coarse crinoidal wackestone to packstone, some fossils partly silicified, some beds are slightly glauconitic; ledge former with irregular thin beds (2-5 cm); basal 16 cm coarsely crinoidal, stems to 5 cm, scattered crinoid calyxes (*Melocrinites*), nautiloid at top ("*Gomphoceras*"), scattered to common brachiopods (*Devonatrypa*, *Orthospirifer*, *Tylothyris*, *Cupularostrum*), scattered large trepostome bryozoans (to 5 cm), rare corals (*Hexagonaria* to 9 cm); remainder of unit with scattered brachiopods (*Devonatrypa*, *Orthospirifer*), scattered massive to branching trepostome bryozoans (to 5 cm), rare crinoid cups (*Melocrinites*), corals locally in lower part (small *Hexagonaria* to 3 cm, *Favosites* 4-6 cm, solitary rugosans). Total thickness varies slightly, thinnest where unit 20 is thickest, maximum about 75 cm.

**biostrome beds**

UNIT 20. Upper biostrome. Limestone, coral-rich, matrix skeletal wackestone to packstone, fossils partly silicified, slightly argillaceous to argillaceous, crinoid debris, scattered brachiopods (*Orthospirifer*, *Devonatrypa*); lower 25 cm with scattered to common corals (*Favosites*, *Hexagonaria*, solitary rugosans) and massive to hemispherical stromatoporoids (5-20 cm diameter); remainder of unit marked by nearly solid masses of colonial rugose corals (*Hexagonaria* to 50 cm diameter), variably in life position or overturned, minor intervening argillaceous wackestone-packstone matrix, scattered solitary rugose corals (to 10 cm), rare *Favosites* and massive to encrusting stromatoporoids (to 8 cm). Slightly irregular basal surface; irregular upper surface conforms to coral heads, up to 20 cm local relief; thickness 50-70 cm.

UNIT 19. Limestone, argillaceous, skeletal wackestone, lower bed wackestone to packstone; crinoidal, brachiopods (*Orthospirifer*, *Schizophoria*); basal 22 cm forms ledge; upper 14-22 cm thin bedded and recessive, shaley in lower part, scattered to common solitary rugose corals (to 5 cm diameter), long articulated crinoid stems at base. Irregular upper surface complementary with overlying coral masses; thickness 36-44 cm.

UNIT 18. Limestone, slightly argillaceous to argillaceous, skeletal wackestone to packstone; irregularly bedded (3-10 cm), argillaceous mudstone to wackestone in top 10 cm, top 5 cm is shaley recessive; lower 35 cm very crinoidal packstone (common articulated crinoid stems), scattered to common brachiopods (*Orthospirifer*, *Schizophoria*, *Devonatrypa*, *Eosyringothyris*), scattered corals (*Hexagonaria* near base, upper part with solitary rugosans and small favositids [3-5 cm]), scattered large trepostome bryozoans (to 10 cm diameter) and thin branches of pachyporid corals along surfaces 30-35 cm above base; upper 21 cm dominated by argillaceous wackestone, interbedded packstone stringers in lower part, mudstone noted upward, crinoidal (including scattered stems), scattered brachiopods (*Pseudoatrypa*, *Schizophoria*, *Orthospirifer*, *Tylothyris*, *Seratrypa*), lower part with scattered branching pachyporid corals and trepostome bryozoans (to 6 cm diameter). Thickness 56 cm.

UNIT 17. Lower biostrome. Limestone, coral-rich, matrix of skeletal packstone, upward skeletal wackestone-packstone; lower 19-22 cm forms overhanging ledge, irregular upper surface (conforms to coral heads), crinoidal, scattered brachiopods, common corals include *Hexagonaria* (3-23 cm diameter, some in life position), massive *Favosites* (4-26 cm diameter), solitary rugosans, massive to lumpy stromatoporoids (5-15 cm); upper 20 cm thinner bedded upward, gradational at top, crinoidal, brachiopods, scattered to common colonial corals *Hexagonaria* (to 26 cm) and massive *Favosites* (15-30 cm). Thickness 38-42 cm.

**Z-beds**

UNIT 16. Limestone, argillaceous to very argillaceous, dominantly mixed skeletal mudstone to wackestone, minor packstone (at base, scattered stringers above); interval thin irregularly bedded, forms recessive vertical face below biostrome; recessive shaley intervals noted 11-16 cm and 24-29 cm above base and 5-11 cm and 33-48 cm below top; basal bed with scattered phosphatic grains (to 4 mm); brachiopods scattered to common, partly in stringers, (includes chonetids, *Pseudoatrypa*, *Seratrypa*, *Orthospirifer*, *Cyrtina*, *Eosyringothyris*, *Athyris*, *Strophodonta*, *Schizophoria*); scattered bryozoans (cystodictyonids, fenestellids, trepostomes), scattered crinoid debris. Irregular upper surface below coral heads in basal unit 17; thickness 91-98 cm.

UNIT 15. Limestone, argillaceous to very argillaceous, dominantly unfossiliferous nonskeletal mudstone, scattered horizontal burrows; thin bedded, recessive slope former, minor ledges; argillaceous to shaley recessive top 5 cm; skeletal debris (in lenses) noted near top and 20 cm below top, brachiopods (*Orthospirifer*), crinoid debris, fenestellid bryozoans. Thickness 64 cm.

UNIT 14. Limestone, argillaceous, skeletal mudstone to wackestone with wackestone-packstone skeletal stringers; thin bedded recessive slope former, minor ledges; lower 28 cm dominated by thin wackestone-packstone stringers and packstone-filled burrow mottles in mudstone-wackestone, thin argillaceous to shaley recessive at top; upper 21 cm dominated by mudstone-wackestone with scattered skeletal stringers, top 6 cm burrowed mudstone; common crinoid debris, bryozoans (fenestellids, cystodictyonids) brachiopods (*Orthospirifer*, *Schizophoria*, *Tylothyris*, *Eosyringothyris*, *Strophodonta*). Thickness 49 cm.

UNIT 13. Limestone, argillaceous to very argillaceous, unfossiliferous nonskeletal mudstone, scattered horizontal burrows; recessive; thin skeletal lenses noted 5 and 9 cm above base, scattered crinoid debris, brachiopods (chonetids, *Orthospirifer*). Thickness 24 cm.

UNIT 12. Limestone, argillaceous, mixed skeletal mudstone-wackestone; base minor ledge former, thinner bedded recessive above; basal ledge 14 cm, crinoidal wackestone, mudstone upper; upper 11 cm includes skeletal packstone lenses; long crinoid stems scattered on some bedding surfaces (includes *Megistocrinus*), scattered brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Schizophoria*, *Tylothyris*), localized masses of fenestellid bryozoans sheets (to 20 cm diameter), scattered cystodictyonid bryozoans; upper part of lower ledge includes localized corals (*Hexagonaria* to 18 cm, *Favosites* 4-7 cm, solitary rugosans to 8 cm), articulated trilobite noted (*Greenops* 4.2 cm). Thickness 25 cm.

UNIT 11. Limestone, argillaceous to very argillaceous, mostly unfossiliferous nonskeletal mudstone with scattered horizontal burrows; lower 10 cm with scattered crinoid debris and articulated stems; recessive. Thickness 42 cm.

UNIT 10. Limestone, argillaceous, lower massive skeletal packstone ledge (52 cm), irregularly bedded wackestone-packstone above, includes mudstone-wackestone upward; very argillaceous re-entrant 52-56 cm above base; crinoid debris (including *Megistocrinus*), bryozoans (fenestellids, cystodictyonids), common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Strophodonta*, *Schizophoria*, *Orthospirifer*, *Schuchertella*, *Cranaena*, *Elita*, *Tyolothyris*); scattered *Hexagonaria* corals noted 16 cm (35 cm diam), 41 cm (10 cm diam) and 46 cm (3 cm diam) above base, solitary rugose coral noted 14 cm above base; upper surface includes articulated crinoid stems and arms, trilobites (*Greenops*). Thickness 76 cm.

UNIT 9. Limestone, very argillaceous to shaley, dominantly unfossiliferous nonskeletal mudstone, scattered horizontal burrows, large *Zoophycus* burrows noted; recessive unit; 8 cm below top; includes skeletal wackestone-packstone stringer (2-4 cm thick) with crinoid debris, fenestellid bryozoans, brachiopods (atrypids), scattered phosphatic grains (1-2 mm). Thickness 30-32 cm.

**bellula beds**

UNIT 8. Limestone, slightly argillaceous, skeletal packstone and mixed wackestone-packstone; massive ledge former, thinner irregular beds top 20 cm (with lensoidal packstones), argillaceous recessive break at top; very crinoidal (including *Megistocrinus*), common bryozoans (fenestellids, cystodictyonids), scattered to common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Strophodonta*, *Orthospirifer*, *Tylothyris*, Schizophoria, chonetids); solitary rugose coral and trepostome bryozoan noted near top. Thickness 57-63 cm.

UNIT 7. Limestone, slightly argillaceous, skeletal packstone; massive ledge lower half, irregularly bedded upward, shaley re-entrant upper 10 cm; crinoidal (upper beds with articulated crinoid stems), common bryozoans (fenestellids, cystodictyonids), common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Tylothyris*, *Cyrtina*), rare tentaculites, scattered corals include solitary rugosan (lower part) and small fasciculate rugosan (3 cm diameter in upper part). Thickness 61-75 cm.

UNIT 6. Limestone, slightly argillaceous, skeletal packstone; ledge former, thin argillaceous streak at top; crinoidal debris, fenestellid bryozoans (sheets to 9 cm diameter), common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*); small branch of pachyporid coral noted 7 cm above base; top 15 cm with scattered corals including solitary rugosans, *Hexagonaria*, fasciculate rugosan, flat *Favosites* (8 cm diameter). Thickness 31-45 cm.

UNIT 5. Limestone, slightly argillaceous, skeletal packstone; ledge former, 2-5 cm shaley re-entrant at top; crinoidal, bryozoans (fenestellids, 2 cm trepostome near base), common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Tylothyris*). Thickness 22-34 cm.

UNIT 4. Limestone, slightly argillaceous, skeletal wackestone to packstone, packstone stringers; ledge former, minor shaley bedding break 25-30 cm below top, shaley parting at top; crinoidal (including *Megistocrinus*, crinoid stems at top), bryozoans (fenestellids, cystodictyonids), common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Strophodonta*). Thickness 70 cm.

UNIT 3. Limestone, argillaceous, skeletal wackestone to packstone, upward wackestone to mudstone; basal 17 cm ledge former, more argillaceous and thinner bedded above, thin skeletal stringers, becomes recessive upward, top 25 cm dominated by sparse skeletal mudstone; fine to coarse crinoid debris, bryozoans (fenestellids, cystodictyonids), scattered to common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Strophodonta*). Thickness 73 cm.

UNIT 2. Limestone, slightly argillaceous, skeletal wackestone to packstone, wackestone dominated upward; ledge former, minor bedding break 25 cm above base, top 4 cm argillaceous to shaley re-entrant at top; common crinoid debris, upper surface with large articulated stems (*Megistocrinus*) and cup plates, bryozoans (fenestellids, cystodictyonids) scattered to common brachiopods (*Spinatrypa*, *Pseudoatrypa*, *Orthospirifer*, *Tylothyris*, *Strophodonta*). Thickness 49 cm.

UNIT 1. Limestone, argillaceous, skeletal wackestone; argillaceous bedding break at top; crinoid debris, bryozoans, brachiopods (*Pseudoatrypa*, etc.). Partial ledge exposed to water level, thickness 20 cm.

**Geological Society of Iowa**
**109 Trowbridge Hall**
**Iowa City, Iowa 52242-1319**
http://www.igsb.uiowa.edu/gsi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Natural History of Lake Macbride State Park, Johnson County, Iowa
2. field trip Stop location and number
0 .25 mi.
to Solon
to Solon
to North Liberty
Twin View Heights
Coralville Lake
Coralville Lake
LAKE
LAKE MACBRIDE
LAKE MACBRIDE STATE PARK
Picnic Area
Boat Ramp
Campground
Sewage Disposal
Spillway
1.
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