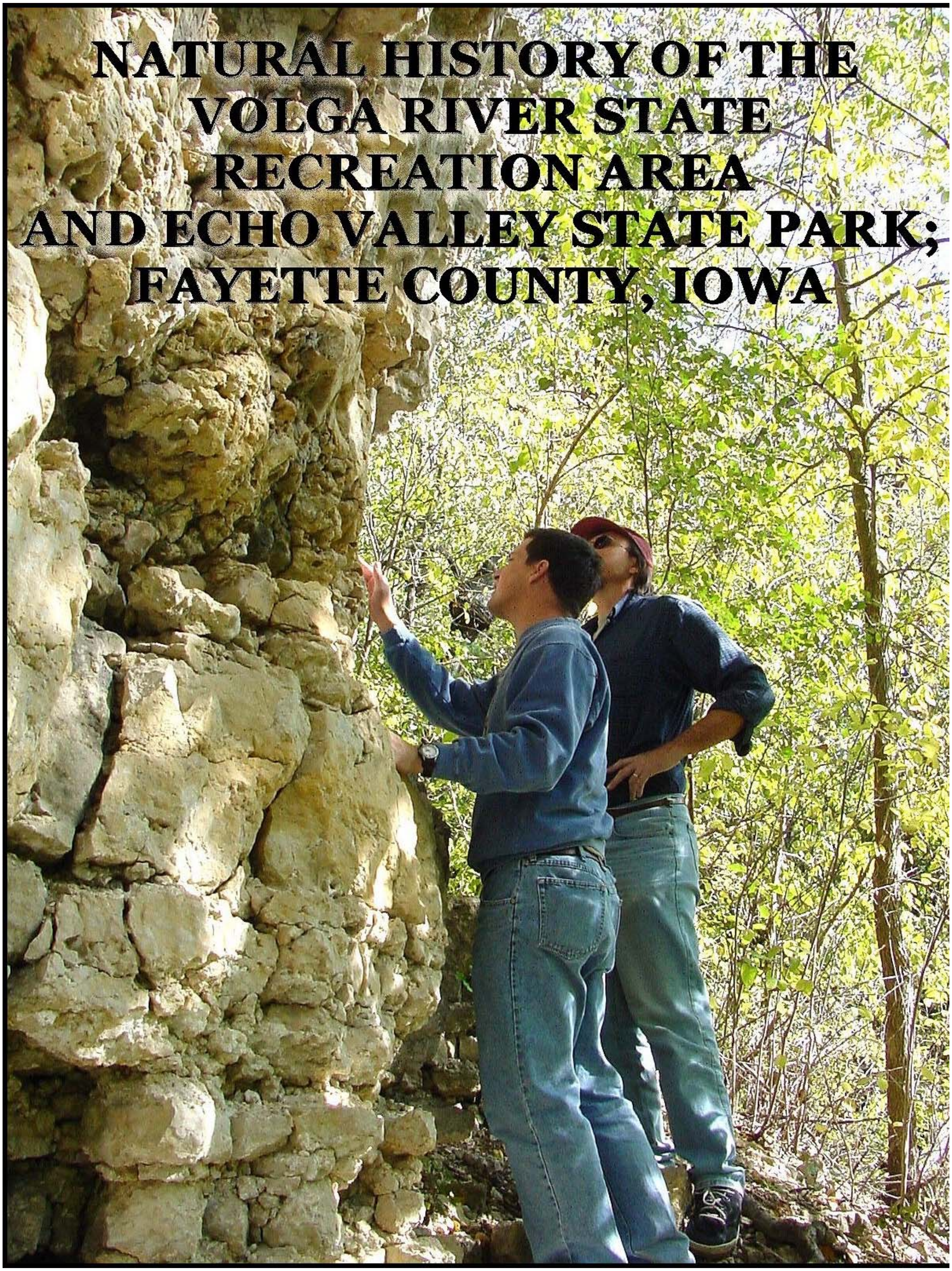
NATURAL HISTORY OF THE VOLGA RIVER STATE RECREATION AREA AND ECHO VALLEY STATE PARK; FAYETTE COUNTY, IOWA



Geological Society of Iowa

November 8, 2003 Guidebook 74

Cover photograph : Iowa Geological Survey geologists Rick Langel and Brian Witzke examine the Silurian limestones of the Waucoma Formation at the Glover Creek Backbone at Echo Valley State Park, Fayette County, Iowa.

THE NATURAL HISTORY OF VOLGA RIVER STATE RECREATION AREA AND ECHO VALLEY STATE PARK, FAYETTE COUNTY, IOWA

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INTRODUCTION TO THE NATURAL HISTORY OF VOLGA RIVER STATE RECREACTION AREA AND ECHO VALLEY STATE PARK, FAYETTE COUNTY, IOWA

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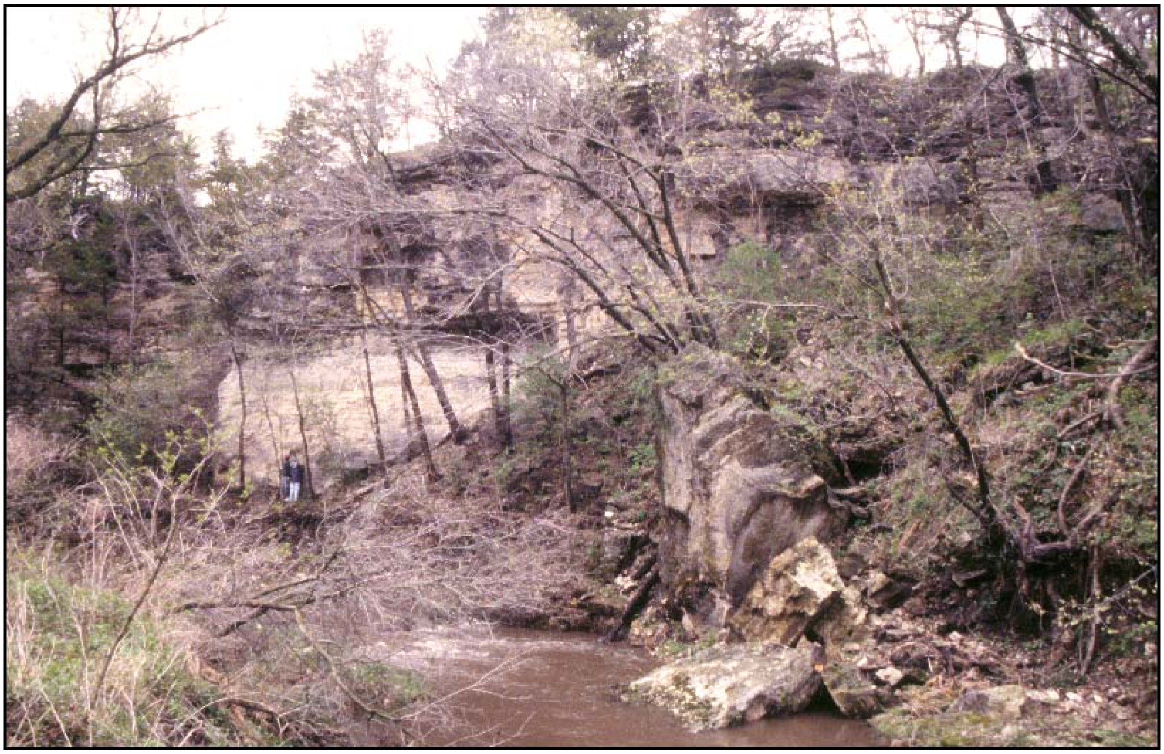
Today's field trip will visit two of Iowa's beautiful northeast Iowa parklands, the Volga River State Recreation Area and Echo Valley State Park, both located in central Fayette County. Both areas lie near the eastern limit of the Paleozoic Plateau, the landscape region that is dominated by deeply-eroded Paleozoic sedimentary rocks covered with a thin mantle of loess and only scattered patches of glacial till. Land that became the Volga River State Recreation Area, just northeast of Fayette, was originally acquired for the construction of a large recreational lake on the Volga River, but the fractured and porous nature of the Silurian bedrock made such a lake impractical and led to the creation of the much smaller Frog Hollow Lake. The rugged topography and the varied geology of the Recreation Area creates diverse habitats for plants and provides interesting places to view vegetation in a large, semi-natural setting. The area also hosts spectacular cliff exposures of the Silurian Hopkinton dolomite, as well as one of Iowa's best exposures of the underlying Ordovician Brainard Shale. Several historic areas are also found in and around the area including the Albany Bridge and the town of Lima and its cemetery.


Silurian limestone and dolomite exposed along Otter Creek at Echo Valley State Park.

Echo Valley State Park has been in the Iowa Parks System since 1936. Located just southeast of West Union, the park features several spectacular natural exposures of the Silurian Waucoma Limestone, including exposures on the Glover Backbone, a natural ridge between Otter and Glover creeks that is very reminiscent of the Devil's Backbone at Backbone State Park. Echo Valley Park also hosts numerous historical features including a well-preserved lime kiln, stone piers for two railroad bridges constructed in the late 1800s, and a number of Civilian Conservation Corps projects, including a now dismantled dam. Both Otter Creek and Glover Creek are coldwater streams and are stocked with trout annually by the Iowa Department of Natural Resources, making them popular with area anglers. Echo Valley State Park is now being managed by the Fayette County Conservation Board.

The field trip leaders welcome you to these beautiful Iowa parklands. For your safety and the best enjoyment of this field trip, I encourage you to follow the instructions of the trip leaders.



Otter Creek (foreground) flows past the south face of Glover Backbone, exposing a sheer face of Silurian limestone and dolomite strata.

A BRIEF HISTORY OF FAYETTE COUNTY, IOWA

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The following text was modified from
Removal of the Winnebagoes, http://www.rootsweb.com/~iafayett/removal.htm, 27 Sept. 2003
The 1878 History of Fayette County, http://www.rootsweb.com/~iafayett/fayhist.htm, 27 Sept. 2003
The 1910 History of Fayette County, http://www.uiowa.edu/~osa/regions/neast /fayette.htm, 9 Oct. 2003
History of County Governments in Iowa, 1992, Iowa State Association of Counties, Des Moines, Iowa

The word "Iowa" comes from the American Indian tribe of the same name. Iowa was part of the Louisiana Purchase, a deal arranged between President Thomas Jefferson and Napoleon Bonaparte of France that brought a vast tract of the continent under the control of the United States. The area was closed to white settlement until the early 1830s. Fayette County, as it was originally conceived, was one of the largest counties ever organized. It had an area of about 140,000 square miles and included all of the present state of Minnesota west of the Mississippi. The county was named in honor of Marquis de Lafayette, a Frenchman who helped the American Colonies in the Revolutionary War.

REMOVAL OF THE INDIANS FROM FAYETTE COUNTY

As the Euro-American settlement of the Louisiana Purchase lands advanced westward, numerous conflicts broke out with the native Americans who lived there. Treaties with the Sac and Fox tribes negotiated under dubious conditions in 1804 and 1816 called for the tribes to move west into Iowa from their western Illinois homelands. A brief attempt by Chief Black Howk to move his village back to their ancestral homeland in the Rock Island area led to a military conflict with U.S. Army forces in 1832. The short-lived conflict, known as the Black Hawk War, ended with the Sauk and Fox being forced to make additional land cessions, their first-such cessions west of the Mississippi. Histories relate that the United States received six million acres of Sac and Fox land. The acquisition was later called the Black Hawk Purchase, and the land itself was called the Iowa District. This district included 4 townships in southeast Fayette County. In return, the tribes were paid twenty thousand dollars per year for thirty years. Their debts were paid off, and the new Sac settlements were promised a blacksmith and a gunsmith. Additionally, the United States reportedly gave the Sauk and Fox 40 barrels of salt and 40 barrels of tobacco. The tribes were ordered out of the area a year later.

The first white settlers apparently moved in this southeast Fayette County area in 1840. The only-know Euro-Americans in the area prior to this time were two men named Edson and Grant who attempted to build a mill on Otter Creek, and it is also probable that trappers and Indian traders may have built temporary cabins in this region prior to that time. At about the same time, in 1840, the Government established a military post north of Fayette County, in Winnesheik, called Fort Atkinson, and three or four miles south established a mission school for the Winnebagoes.

Within 10 years, pressure from Euro-American settlers to expand into Sac and Fox lands west of the Black Hawk Treaty boundary led to the negotiation of a new treaty with the tribe. The Treaty of October 13, 1846 forced the Winnebago Nation of Indians to renounce their title to these “Reserve” lands, including the northern portions of Fayette County. In June, 1848 the Winnebago tribes were forced off these lands by order of the Government Agent, in charge, J. E. Fletcher, and were conducted to their new reservation in Minnesota. Although the Indians had agreed to cede their Iowa Reserve to the U.S. in 1846, when the time arrived for their removal there was great reluctance to leave the land that had been their home since the Black Hawk War. Some were disposed to rebel; but, after a few days' deliberation in council, the tribe of about two thousand nine hundred Winnebagoes packed up for the journey. Their march to their new Long Prairie Minnesota reservation took nearly two months.

The southwest corner of present Fayette County, including all of Oran and Fremont, and a portion of Jefferson Township, remained in possession of the Sac and Fox Indians until they ceded it to the United States under provisions of a treaty ratified on the 21st of October, 1837. The tribe was then were moved to the Osage River Reservation in Kansas.

THE ORGANIZATION AND OCCUPATION OF FAYETTE COUNTY

Fayette County had a nominal organization in December of 1837 when the lands of the Black Hawk Purchase were subdivided into political districts. At that time Fayette County bounded an area of about one hundred and forty thousand square miles, including all of the present state of Minnesota west of the Mississippi River, except a small tract in the southeast corner. Nearly all the current counties in northeastern Iowa were formed, in whole or in part, from territory of this original Fayette County. This original Fayette County was a county on paper only, having no county officers. With the addition of the Winnnebago Reserve lands of northern Fayette County in 1846 and the ceding of the Sac and Fox lands of southwest part of the county a year later, the current boundaries of Fayette County were established in 1847. At that time there were only four fully surveyed townships in the county, Putnam, Fairfield, Smithfield and Scott. But with the cession of these new territories, irregular boundaries were straightened, and the outlines of today's Fayette County were established and it was reduced to its present boundaries in 1847, and formally organized in 1850. An election was ordered on the 7th of April, 1851, for the purpose of locating the county seat. The contestants were Centerville, Lightville (afterwards Lima), at Light's Mill on the Volga River, West Union, Auburn, and Claremont, now Clermont, and once called "Norway." West Union won, although over the following years, three distinct uproars occurred over the location of the county seat (for additional information on Fayette County's courthouses see inset on this page).

Fayette County Courthouses

In 1850 William Wells, Jacob Lybrand, and J.W. Rogers donated a 400-square-foot plot of ground to Fayette County for public buildings in the town of Knob Prairie. To further the chances of the town being named the county seat, the name of the town was changed to West Union. In 1851 a Fayette County Representative drafted a bill at the Third General Assembly that called for an election to choose the site for the county seat. They proposed six Fayette County towns as potential seats: West Union, Lightville (later renamed Lima), Light's Mill, Douglas (later renamed Auburn), Centerville, and Clermont. The two towns that received the most legislative votes were then voted on by the residents of Fayette County in a May election. The voters chose West Union over Lightville, but before a courthouse could be built a vote was taken in August 1853 to remove the county seat. West Union again won the right to house the county seat.

A Fayette County courthouse was designed and proposed in 1853, but it was not built until three years later. Prior to its construction, business of the county was conducted in the Methodist Church. Finally, in 1856 the first Fayette County Courthouse was completed, at a cost $7,820. The two-story brick and stone building was situated on the town square donated by Wells. This building burned to the ground after J.C. Thompson started a fire in his jail cell, which was in the basement of the courthouse. He escaped and was later captured in Calmar.

A second County court house was built in West Union after two years of debating its location. Originally planned to cost $6,750, the second Fayette County Courthouse suffered cost over-runs and was finally constructed at a cost of about $10,000. An 1891 proposal to fund the fireproofing of the building failed, but the second courthouse was gradual improvement, with fire-safe vaults, a larger heating plant, a tower, a clock, and more office space added over a period of 15 years. Unfortunately, these improvements were not sufficient to protect the building, which was also destroyed by a fire, on February 5, 1922. Only $24,000 of the estimated $40,000 value of the second Fayette County Courthouse was covered by insurance. However, most of the county records were saved.

The second court house fire re-opened the battle for the county seat, with Fayette and Oelwein attempting to wrest the county seat away from West Union. However, once again West Union prevailed and the third, and current, Fayette County Courthouse was built.

The citizens of West Union and surrounding areas donated $100,000 toward the new structure. The cornerstone was laid on June 21, 1923, and the formal dedication was held on October 8, 1924. Designed by J. G. Ralston and constructed of the majestic gray Bedford stone, the building construction cost was $298,690. In 1981 the Fayette County Courthouse was added to the National Register of Historic Places (Building #81000236) as a significant example of Beaux Arts architecture.

The trail along which the first white settlements made their way into Fayette County entered the county near the northeast corner of Putnam Township, following a northwesterly course until it crossed the Volga River about four miles north of Fayette. From there, the trail trended north through Center, Windsor and Auburn townships, crossing Little Turkey river in section 29, of Auburn township, continuing north to the Fort.Atkinson This trial constituted the main thoroughfare then open to early Fayette County pioneers, who considered a visit to the fort an outing to their local market.

EARLY FAYETTE LANDSCAPE

More than one-fourth the area of Fayette County was originally covered with timber, much of which was of excellent quality. The most common varieties were various species of oak, maple, elm, hickory, walnut, cherry, basswood or linden, cottonwood, iron wood, some scraggy pine and cedar, willow, etc.

About the southwest half of Fayette County was originally prairie land, which hosted little natural timber. This area was more level, though well watered with small streams. The heaviest belts of natural timber, the most rugged bluffs, and the most rough and hilly land to be found in Fayette County lie along the Turkey River in the northeast area of the county. This region also, were hosted some of the most valuable farms in the county, and some of the most picturesque valleys to be found anywhere.

Numerous streams flow into the Turkey, the most important of which are the Little Turkey, Crane Creek, and Otter Creek, in the northern part, each of which drains a large area of country. The Volga River and its numerous tributaries drain the southcentral portion of the county from northwest to southeast

The Little Wapsipinnicon traverses the southwestern portion of the county, flowing southeasterly. Numerous creeks, all flowing south, are tributaries to the Little Wapsipinnicon, including Buffalo Creek, Pine Creek, and Otter Creeks. Other larger streams in the county inclued the Maquoketa River, Brush Creek, Bell Creek, and Prairie Creek. The county was also blessed with many fine springs of pure water.

The pioneers, in seeking sites for their cabin homes, sought a location near some good spring if possible, regardless of prospective roads or farm boundaries; and in later years it often became necessary to relocate the homesite in order to be established on some highway.

VOLGA LAKE: A HISTORY OF POLITICS AND SCIENCE

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The history of the Volga Lake project began as the vision of two Fayette residents, Dr. Gene Garbee, former president of Upper Iowa University, and banker Gene Harvey. They promoted a huge park and lake along the Volga River northeast of Fayette (Fig. 1) initially with presentations to various civic and service groups. Momentum for the park and lake began to build, with the early support of a former Iowa Conservation Commission member, and plans soon evolved for an 80- to 100-foot high dam across the Volga River at the village of Lima (Fig. 2) near the mouth of Grannis Creek. The planned lake would have covered about 1,680 acres of the Volga River and Frog Hollow creek basin.

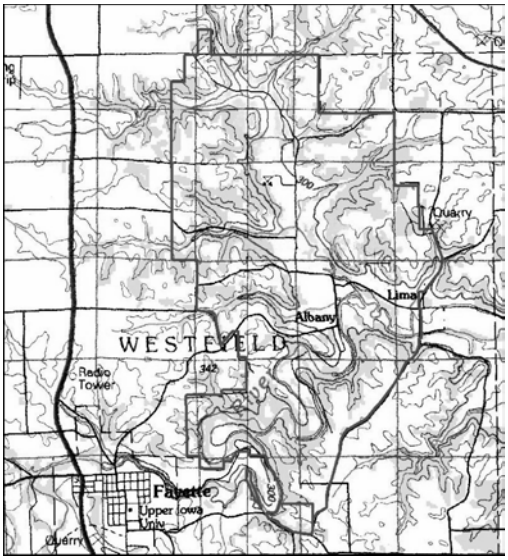


Figure 1. Area of Volga Lake project along the Volga River north of Fayette.

In 1965, the project came to the attention of the Iowa Geological Survey, which expressed concern for the ability of the fractured and karstified Silurian dolomite bedrock exposed in the region to hold lake water. By 1966, the plans for the lake had been scaled down, with the planned dam moved upstream a half-mile north of Albany. In the revised plan, the lake covered only 1,140 acres of the river valley (Fig. 3). When the revised plan did not win the immediate favor of the Iowa Conservation Commission, area residents began to complain that the Commission was giving priority to projects in western and central Iowa.

Figure 2. Original plans for Volga Lake would have covered 1,680 acres.

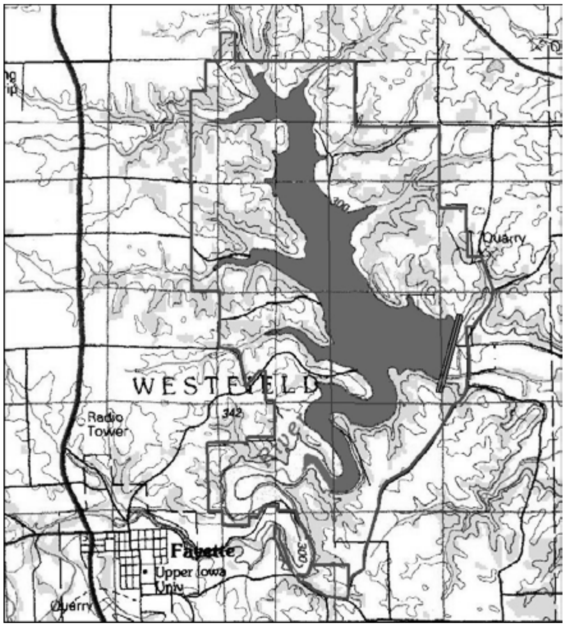
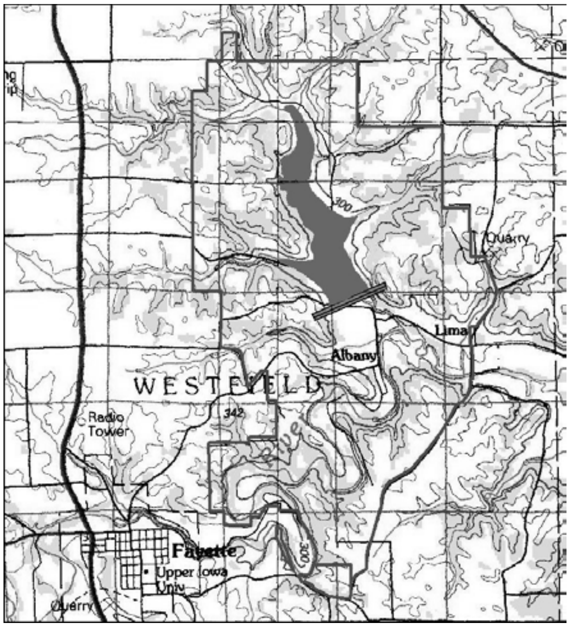


Figure 3. The 1966 plan for a scaled down Volga Lake covering 1,140 acres.



The following year, the Iowa Legislature appropriated $1 million for the purchase of land for the proposed park. Soon afterwards, state officials proposed yet another new dam site. The newly proposed site (Fig. 4) was not on the Volga River, but on Frog Hollow Creek, a tributary stream that entered the Volga north of Albany. The Frog Hollow Dam was to impound between 550 and 777 acres of water, the smallest of the Volga Lake proposal to that date.

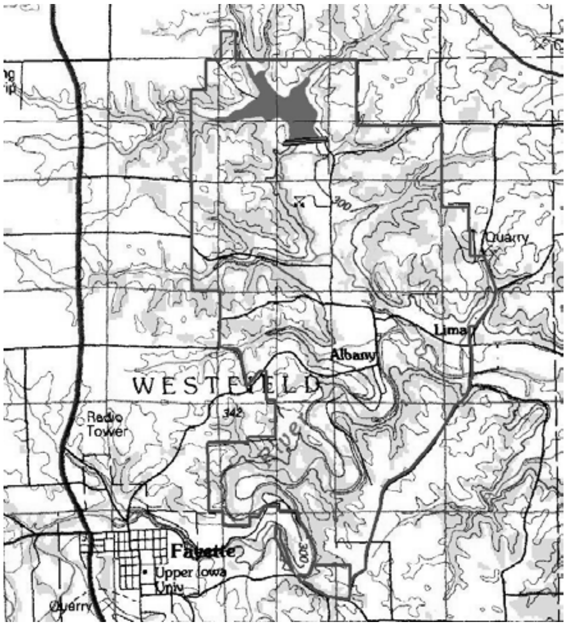


Figure 4. The 1970 proposal for Volga Lake on Frog Hollow Creek.

In 1970, the Iowa Conservation Commission made the official decision to move the dam to the Frog Hollow site and to ask the legisature for an additional $50,000 to investigate the competancy of the rocks in the area of the lake to hold water. This proposal launched barage of criticism from legislators representing other areas of the state, with acusations of "*pork barrel politics*" directed towards key northeast Iowa politicians, who responded with complaints that "*northeast Iowa has been overlooked, underfunded, and ignored by the Iowa Highway Commission and we feel we should at least have some good parks and lakes*" (Barbour, 1977).

Sen. Hilarius Heying

When his 1974 legislative program was introduced early that year, Iowa Governor Robert Ray was challanged by northeast Iowa legislators Senator Hilarius (H.L.) Heying (a Democrat from West Union) and Representative Don Avenson (a Democrat from Oelwein) for slighting the Volga Park and Lake. They expressed "*frustration*" and a feeling of being "*cheated*" by the governor, who recommended funding for two new projects while cutting Volga funding. Late in 1975, Governor Ray met with the Iowa Conservation Commission to discuss the merits of proceeding with construction of a lake in the Volga River project area. He later indicated that although he originally favored the project, "*the lake's soil conditions which would require grouting in the sub-structure of the dam*" (Babour, 1977) would require a restudy. The results of this study, by Waterloo engineering firm Brice, Petrides and Associates, was announced in 1976. The firm indicated that two feet of clay or bentonite would be needed to seal the bottom of the lake from leakage. Later that year, Senator Heying nearly succeeded in getting Senate committee approval for a $750,000 appropriation for the lake project. During the discussion, Sioux City Republican senator Kevin Kelly apparently said that "*it would be a cold day in hell when I move for approval of a measure which promotes a pork-barrel, log-rolling process for a leaky-bottomed lake*."

Rep. Don Avenson

Meanwhile, in the Iowa House of Representatives, Don Avenson continued to promote the original large lake plan for the Volga project, but saw it defeated by a 74-18 vote. Not to be deterred, Representative Avenson quickly drafted

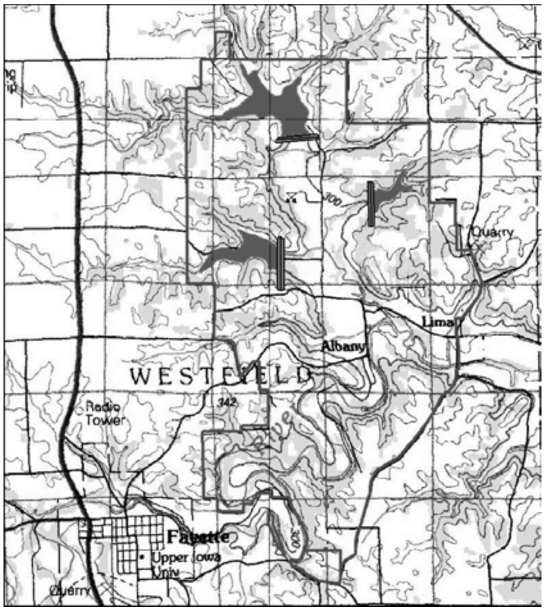


Figure 5. The 1977 plan for 3 lakes along the Volga River first proposed by Don Avenson.

a new plan to replace the single large lake with up to five small "*leakless*" lakes, and the appropriations bill was sent to Governor Ray in May. However, now both Senator Heying and Elkader Republican Senator Dale Tieden objected because the bill failed to consider the construction of a larger lake, with Heying saying that the bill "*calls for construction of lakes that have been neither designed or engineered without alternative options*." (Babour, 1977). But, Governor Ray did approve the bill, mandating that the Conservation Commission construct three lakes with a combined size of 245 acres, the largest about 145 acres (Fig. 5). A disgusted Heying responded by filing a bill requiring that the Conservation Commission sell the 5,200 acres of land already acquired for the Volga Lake project by the State. This bill was never acted on by the Iowa Senate. Subsequent engineering studies of the multi-lake plan showed that these lakes would also have serious leakage problems, each also requiring clay liners. They estimated that the total cost of sealing all three lakes with clay would probably cost $5.6 million for the project, about $36,000 per surface acre. When the Conservation Commision compared this cost to the estimates of $3,000 to $4,000 per acre to construct Brushy Creek in Webster County, they voted to direct Commission Director Fred Priewert to inform the 1977 Iowa Legislature that any further lake work would be a waste of money. Representative Avenson branded the Commission vote as an act "*of arrogant regionalism*" by a "*group of people who don't represent anybody*." Avenson stated that the expected $5½ million cost of the three lake project was much less than the $15 million estimate for the large lake. Following the Conservation Commision vote, the Iowa Senate pased a bill to release the Iowa Conservation Commission from the previous legislative mandate to build three lakes at the Volga State Recreation Area. Instead they directed the Commission to go ahead with the single lake on Frog Hollow Creek using the $1.5 million previously allocated for the project.

Just when all seemed clear for the the construction of Volga Lake at Frog Hollow a new snag appeared that threatened the beleagered project. Lyle Johnson, the Fayette County District Conservationist, announced that 6,000 to 7,000 acres of the Frog Creek watershed was not adequately protected to prevent erosion and siltation. State law required that at least 75% of the land in the watershed of a proposed dam must have protection against excessive erosion; the federal standard was an average soil los between three and five tons per year. Johnson estimated that only about 60% of the watershed was currently within the standard. Using Johnson's numbers, a reporter for the *Cedar Rapids Gazette* estimatied that it would require about $350,000 to complete the required terrace construction and other conservation activities. Apparently Johnson's warning was not headed, because in April 1977, the Legislature authorized funding to match a federal grant of $2.7 million for the project. In a 1984 editorial titled *Frog Hollow Pig Wollow*, the *Des Moines Register* (1984) charged that "the Iowa Legislature simply ignored the law." They went on to describe the heavy siltation that was already beginning to fill the lake, and went on to address the possibility of constructing siltation dams to intercept the sediment. Of the 21 logical sites that the *Register* identified for such dams, only one could be constructed on State land. They predicted that the construction of the siltation dam would produce a 20 acre triangular mudflat of "*near-sterile silt to enhance the beauty of a recreation area*." They concluded the discussion by proposing the name Frog Hollow Hog Wollow for the area, should the dam be built.

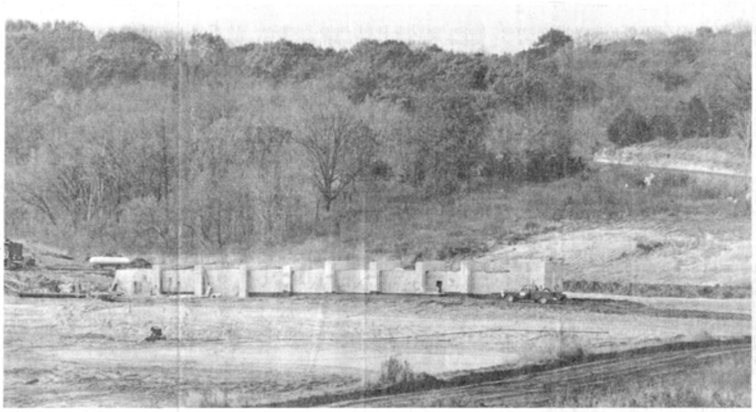


Figure 6. Newspaper photo of the spillway for Volga Lake nearing completion in November, 1978 (Hough, 1978).

Figure 7. Volga Lake on Frog Hollow Creek.

Construction of Volga Lake finally began in May, 1978, with the low construction bid of about $1.8 million, fully 25% lower than the Commission engineer's estimate. About ⅓ of the construction costs were allocated to the placement of the 2 to 4 feet of clay needed to seal the lakebed to prevent leakage. The clay (presumably glacial till) was stripped from a hill west of the lake. The dam, constructed of a clay core with a stone rip-rapped suface, is 35 feet high and 1,600 feet long. Construction of the dam and the clay liner necessitated the movement of an estimated 1.2 million cubic yards of clay. The dam is protected by a concrete spillway and impounds water that covers a 135-acre area (Fig. 7) to a maximum depth of 25 feet, averaging 10 to 15 feet in depth over most of its area.

In 1980, the Iowa Conservation Commission released a Master Development Plan for the Volga River State Recreation Area. Much of the Plan (see page 60) has already been adopted, including development of campgrounds, hiking trails, and horesback and snowmobile trails. Future projects include the construction of a beach on the lake, a series of cabins, and tabogan runs, as well as many more trails, camping areas, and other day use activity areas.

What began as an ambitious develoment project envisioned by local business leaders and championed by local politicians fell victum to science and the porous and permeable nature of fracured Silurian dolomite at the lake site. After several reincarnations, all trumped or seriously impacted by the inability of the local bedrock to contain the lake water, a plan emerged to create one lake by sealing the porous bedrock with a thick layer of clay at Frog Hollow at the north end of the Recreation Area. The project proved to be a compromise for everyone. The northeast Iowa politicians gained a recreational lake, but opposing political factions managed to get the project scaled down to a fraction of its original planned size.

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A BRIEF DEVELOPMENTAL HISTORY OF ECHO VALLEY STATE PARK

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In the early 1930's, Fayette County resident H.A. Schaeffer and a supervisor from the fish hatchery at Spirit Lake, IA were standing between Skunk Creek (later to be renamed Glover's Creek) and Otter Creek when they observed that the area would make a wonderful place for a park. Mr. Schaefer organized a committee of interested citizens who met for the first time on Dec. 30, 1933 and later began soliciting donations and arranging state sponsorship for the project. One committee member, Mrs. T. A. King, was a commissioner for the State Conservation Commission and arranged for the park to be owned by the state.

A total of $3,056.49 was raised in amounts ranging from four cents donated by a child in school to $100 given by a couple of organizations. Proceeds from a dance given by the American Legion amounting to $30.00 were donated to the fund. Two alumni teams challenged the first and second high school basketball teams to a doubleheader game with proceeds going to the park.

By January 5, 1934, the Fayette County Union reported that $1,903.00 had been pledged. According to the Union, by Feb 22, 1934, "An amount necessary to purchase the backbone region east of West Union had been subscribed and collected, all but $95.00, and that is practically in sight." The newspaper went on to note that, "It is quite remarkable that in these days of adversity, an amount could be realized in six weeks time." Everyone knew that they were in the midst of the Great Depression and they were proud of their accomplishment.

From then on, the state took control of the project. They had the county engineers make the necessary survey for the state park. The state then obtained the options on the land for a total of 100.9 acres owned by Louis Light, George B. Woodard, Henry Wilbur, Andrew Murk, Fred Williams, Frances Byers, R. N. Darnel, and Warren Robbie. The Chicago-Rock Island & Pacific Railroad continued to own and operate its rail line through the park (Fig. 1).

Figure 1. Old railroad bridge pier along Otter Creek west of the picnic area.

A county crew, under the supervision of A. S. Finch, built a road through the park and fenced the newly acquired property. The property included a piece that had a gristmill constructed on it at one time and that had burned to the ground in 1883. The gristmill of S.G. Gurdy, the only one on the Otter, burned after what was believed to be a fire in the attic area caused by friction from the hot moving mill parts after the mill had been run hard all day.

The state had the plans for the dam and the lake drawn up. Fayette county employees, along with a group of Works Progress Administration (WPA) men, began work.

The area where the limestone shelter house and pit toilets are presently located was excavated several feet and the fill was used in the dam. The Civilian Conservation Corps (CCC) built the shelter house and the pit toilets after the area was lowered and leveled. A well was drilled near the shelter house and the WPA and county employees planted pine trees that remain in the park today.

Prior to the land becoming a park, a lime kiln (Fig. 2) had been constructed on land near the railroad grade and near the site of where the Gurdy gristmill once stood. Limestone headed to the kiln was brought in by rail, where it was fired and then used in the construction of masonry houses in West Union and for mortar for the CCC crew when they built the park's buildings.

Figure 2. The lime kiln at Echo Valley State Park was constructed prior to acquisition of the park property.

Members of the CCC were brought in daily from Decorah and Manchester. According to Mr. Finch, they didn't put in much actual work time because of the time needed for transportation in model "A" trucks on roads that were not paved. Actual construction of the dam was financed by the state. There were 412 men in the WPA in the county under different projects and Mr. Finch recalled that there were approximately 30 involved with the park project.

In 1935, the Iowa Conservation Commission asked for input from the public for a name for the new park. Of the many names submitted by residents of the community, Echo, in various combinations and forms, was most frequently suggested and was descriptive of park visitors getting three repeats when a message was shouted in the deepest part of the valley. The Fayette County Union wrote, "It seems proper to select as part of the name, the feature which makes the area distinctive for this park or preserve." The article noted "the Commission, in selecting a descriptive name like Echo Valley, was following a recommendation of the Iowa Conservation Plan and National Park Service in choosing a physiographic name."

Unfortunately the sixteen-acre lake, which was the central figure of the finished park in the 1930's, was short lived. Silt, eroding from fields into the area tributary to Otter creek, soon began to fill the lake.

Maintenance was sketchy during the war years when manpower was short. By the end of the war the dam had deteriorated, the lake filled with silt, and Otter Creek took a course along the base of the divide. According to Ernest R. Ballard, the park's first custodian, the dam was completed by 1936 when the lake saw its first and only drowning. The water was some forty feet deep immediately in front of the dam but by 1947 the lake was drained by game warden Tom Berkley after it had silted in so badly that maximum water depth was only eight to ten feet.

In later years, the county wanted to have complete ownership of the park, which was owned by the state and maintained by the county. The state refused. Paradoxically, in 1960, the state asked the county to take the park, but the county refused because it had begun a series of county parks of its own. Echo Valley is still owned by the state. Since 1986, it has been under a long-term management agreement with the Fayette County Conservation Board.

In 1960, the state allocated $10,000 to build a road to the shelter and for construction of picnic facilities and latrines near the ford. An access road was also built along the west edge of the park to reach Glover's Creek on the backside of the divide.

The rail line that had been built in 1903 was abandoned by the middle of the century and its bridges were removed during the 1960's. The rail grade exists today in its original state but was never acquired by the state. In 2001, a private individual purchased the railroad grade and improved the corridor as a trail for public use (Fig. 3).

Figure 3. A foot bridge constructed across Otter Creek rests on the piers of the old Chicago-Rock Island and Pacific railroad right-of-way. The right-of-way has been developed into the Pearson trail.

TROUT FISHING IN ECHO VALLEY STATE PARK

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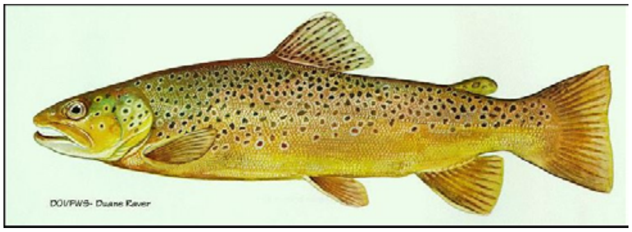
There are two coldwater trout streams in Echo Valley State Park, Glovers Creek and Otter Creek. Glovers is a tributary to Otter. Both are coldwater throughout the entire year and both are stocked from April through October.



Brown Trout

Existing stocking records only go back to 1943. In that year, Glovers was stocked with 2,500 trout, and may have been stocked for many years before that. Most commonly, Glovers received a combination of rainbow and brown trout, but some years it was also stocked with brook trout. The numbers of fish stocked in Glovers ranged from a low of 400 in 1961 to the current high of 8,090. Currently Glovers is stocked with 7,600 rainbow and 490 brook trout that are catchable size (~1/2 pound).

Otter Creek was first stocked in 1945 according to current records. In that year it received 1,800 trout, and may also have been stocked in years prior to 1943 but no records exist to substantiate this. Otter Creek has also received a combination of rainbow and brown, with brook trout also stocked in some years. It now annually receives 5,320 rainbow, 1,180 brown and 420 brook trout that are also catchable size. Not all the trout stocked in Otter Creek go into the Echo Valley stream section as some are stocked on private properties further downstream on Otter Creek.

Brook Trout

The most recent trout angler telephone survey indicated that Glovers Creek received about 1,165 angler trips and Otter Creek 4,893 angler trips during calendar year 2001. Previous angler surveys have estimated much larger numbers of estimated angler trips on Glovers Creek than the 2001 survey.

Rainbow Trout

The DNR recently completed the acquisition of the 187 acre Vickie and Conley Meyer tract which lies adjacent to the north boundary of Echo Valley State Park. This property contains approximately 3,200 feet of Glovers Creek. It was purchased with Sport Fish Restoration monies received by the Fisheries Bureau. Future management of this property is currently being worked out. This excellent acquisition will give added protection to the coldwater streams in Echo Valley State Park.

Fish illustrations from U.S. Fish and Wildlife Service

VEGETATION OF THE VOLGA RIVER STATE RECREATION AREA

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With the Silurian Escarpment running along its western edge, the Volga River Recreation Area (VRRA) is contained within the Paleozoic Plateau just east of its boundary with the Iowan Surface. Its rugged topography and varied geology create diverse habitats for plants and provide interesting places to view vegetation in a large, semi-natural setting. The canyon formed by entrenchment of the Volga River through Silurian bedrock, deep sand deposits along Frog Hollow Creek, and steep wooded slopes contain the most significant concentrations of natural vegetation and native species.

The first public land holding in VRRA dates to 1959, when the Iowa Conservation Commission (now the Department of Natural Resources [IDNR]) established the 195-acre Big Rock Wildlife Area along the Volga River in what is now the far southwestern corner of VRRA. Land acquisition between 1960 and 1980 (with smaller additions in the 1990s) expanded VRRA to its present 5575 acres, making it one of the largest tracts of public land in Iowa. Compared to other DNR parks established in the 1920s and 1930s, VRRA is thus a relatively young park with most of its land released from farming activities only within the last 20-40 years. Topography, soils, and past land use play major roles in understanding the pattern and species composition of the current vegetation.

HISTORIC VEGETATION

To gain perspective on the current vegetation, it is useful to examine historic records provided by the township plat maps drawn by the General Land Office (GLO) surveyors that traversed Fayette County between 1837 and 1849. Westfield Township (T93N R8W), containing what is now VRRA, was mapped in 1848. Anderson (1996) compiled these township plats into county-wide maps of historic vegetation (Figure 1). At a broad scale, note that the Silurian Escarpment separates land mapped predominantly as "prairie" from land mapped predominantly as "timber"; the dissected terrain of the Paleozoic Plateau evidently favored the development of forest while the smooth, rolling aspect of the Iowa Surface favored grassland (Figure 1).

Tree species populating timber areas depicted on historic maps for Fayette County were analyzed by Miller (1995), who found that white oak (*Quercus alba*) was the species most frequently recorded by GLO surveyors as witness trees along the wooded segments of section lines, comprising 29% of all tree observations in "timber." Bur oak (*Quercus macrocarpa*) and black oak (*Quercus velutina*) were next in importance, representing 22% and 16%, respectively. Together, these three oak species comprised 67% of all witness trees in timbered areas. For prairie, Miller (1995) found that witness trees were predominantly (47%) bur oak. Miller (1995) also examined density and size of trees recorded in the GLO record, finding that the mean distance from the section line to a witness tree was 13 meters (40 feet) in timber and 24 meters (74 feet), indicating (as expected) more widely scattered trees in prairie. However, little difference in the mean diameter of witness trees was evident: 33 cm (13 inches) in timber and 29 cm (12 inches) in prairie.

Within the VRRA, the GLO records indicates that approximately 95% of the area was "timber" in 1848 and that a large (approximately 250 acres) oval area of "prairie" existed along its east-central border (north of the Volga River near the present-day east entrance). Caution is needed when interpreting the GLO plats at this scale because small inclusions within large map units were generally not differentiated or labeled. Nonetheless, it is interesting to compare the admittedly sketchy descriptions of the location, size, and species composition of these two general, historic vegetation types with present-day conditions, as will be done after describing the modern vegetation.

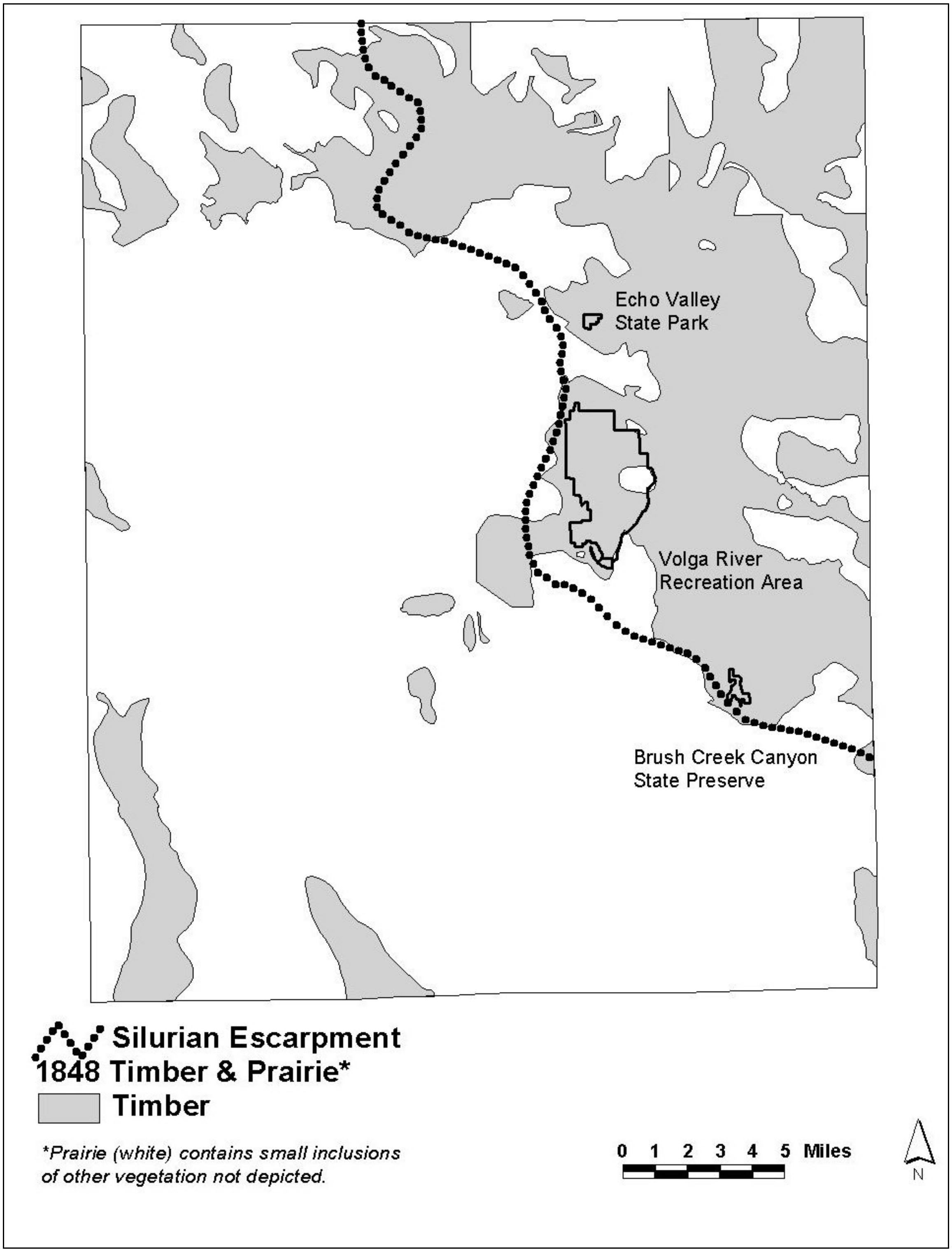

Figure 1. Historic vegetation of Fayette County, 1837-1849.

MODERN VEGETATION

Approximately 52% of VRRA is presently forested (Figure 2), with the balance being open grassy areas (primarily introduced bromegrass [*Bromus inermis*], 31%), cropfields designed as wildlife food plots (12%), prairie grass plantings (2%), and the 130-acre impoundment of Frog Hollow Lake (2%). As part of the development of a master plan for VRRA in the early 1980s, studies of the vegetation were completed: *Assessment of Terrestrial Vegetation* by Knutson (1979) and *Timber Management Recommendations* by Beyer (1983). These studies, as updated with observations by this author, provide much of the information used to characterize the current vegetation in more detail. They showed that, except for three very small (approximately 1 acre each) remnants of native grasslands, the natural vegetation of VRRA consists primarily of forest communities. Integrating all of these studies and observations, the Ecosystem Management Plan for VRRA (IDNR 1998) identified six forest types based on dominant tree species:

- **Northern mixed hardwoods** (795 acres)- Forests dominated by a mixture of sugar maple (*Acer saccharum*), basswood (*Tilia americana*), red oak (*Quercus borealis*), white ash (*Fraxinus americana*), and elm (*Ulmus spp.*) located primarily on steep, often rocky, north- and northeast-facing slopes. This roughly corresponds to the "mesic forest" community-type recognized by Curtis (1959) for southern Wisconsin. This type is scattered throughout VRRA, but forms semi-contiguous stands along the Volga River.
- **White Oak-Red Oak** (220 acres)- Forests dominated by white oak (*Quercus alba*) and red oak (*Q. borealis*), often accompanied by elm (*Ulmus spp.*), walnut (*Juglans nigra*), white ash (*Fraxinus americana*), and sugar maple (*Acer saccharum*), located primarily on broad, loess capped ridges and gentle slopes. This roughly corresponds to a blending of the "dry forest" and "dry-mesic forest" community-types of Curtis (1959) for southern Wisconsin. At VRRA, this type is also scattered throughout the area.
- **Black Oak-Bur Oak-Hickory** (308 acres)- Forests dominated by black oak (*Quercus velutina*), northern pin oak (*Q. ellipsoidalis*), bur oak (*Q. macrocarpa*), and shagbark hickory (*Carya ovata*), often accompanied by elm (*Ulmus spp.*) and bitternut hickory (*C. cordiformis*), located on sandy, droughty soils. These stands may represent highly altered examples of the "oak opening" community-type described for southern Wisconsin by Curtis (1959). This type is scattered throughout VRRA, but the largest stands occur on the upland north of the east entrance where the GLO surveyors mapped the "prairie" area in 1848.
- **Red Cedar-Bur Oak** (252 acres)- Forests dominated by eastern red cedar (*Juniperus virginiana*) and bur oak (*Quercus macrocarpa*), often accompanied by black oak (*Q. velutina*) and shagbark hickory (*Carya ovata*), located on steep, rocky, south- and southwest-facing slopes. This community-type is roughly equivalent to the "cedar glade" type described by Curtis (1959) for southern Wisconsin, but with very dense tree and shrub layers and a sparse herbaceous layer generally lacking in characteristic prairie plants. This type is scattered throughout VRRA, but many of the stands occur on bluffs above the Volga River.
- **Bottomland hardwoods** (205 acres)- Forest variously dominated by cottonwood (*Populus deltoides*), willows (*Salix spp.*), elm (*Ulmus spp.*), green ash (*Fraxinus pennsylvanicus*), walnut (*Juglans nigra*), and boxelder (*Acer negundo*), located along in long, narrow strips along streams. It represents a blending of the "wet forest" and "wet-mesic forest" community-types described by Curtis (1959) for southern Wisconsin. Along Frog Hollow Creek, stands of this type are very narrow, highly fragmented, and bordered by agricultural fields; along the Volga River, the stands are larger and bordered by other forests.
- **Other** (158 acres)- Stands of trees, usually on uplands, that do not fit neatly into any of the above types, variously populated with bitternut hickory (*Carya cordiformis*), ironwood (*Ostrya virginiana*), aspen (including *Populus tremuloides* [quaking aspen] and *P. grandidentata* [bigtooth aspen]), elm (*Ulmus spp.*), and boxelder (*Acer negundo*), often located along the

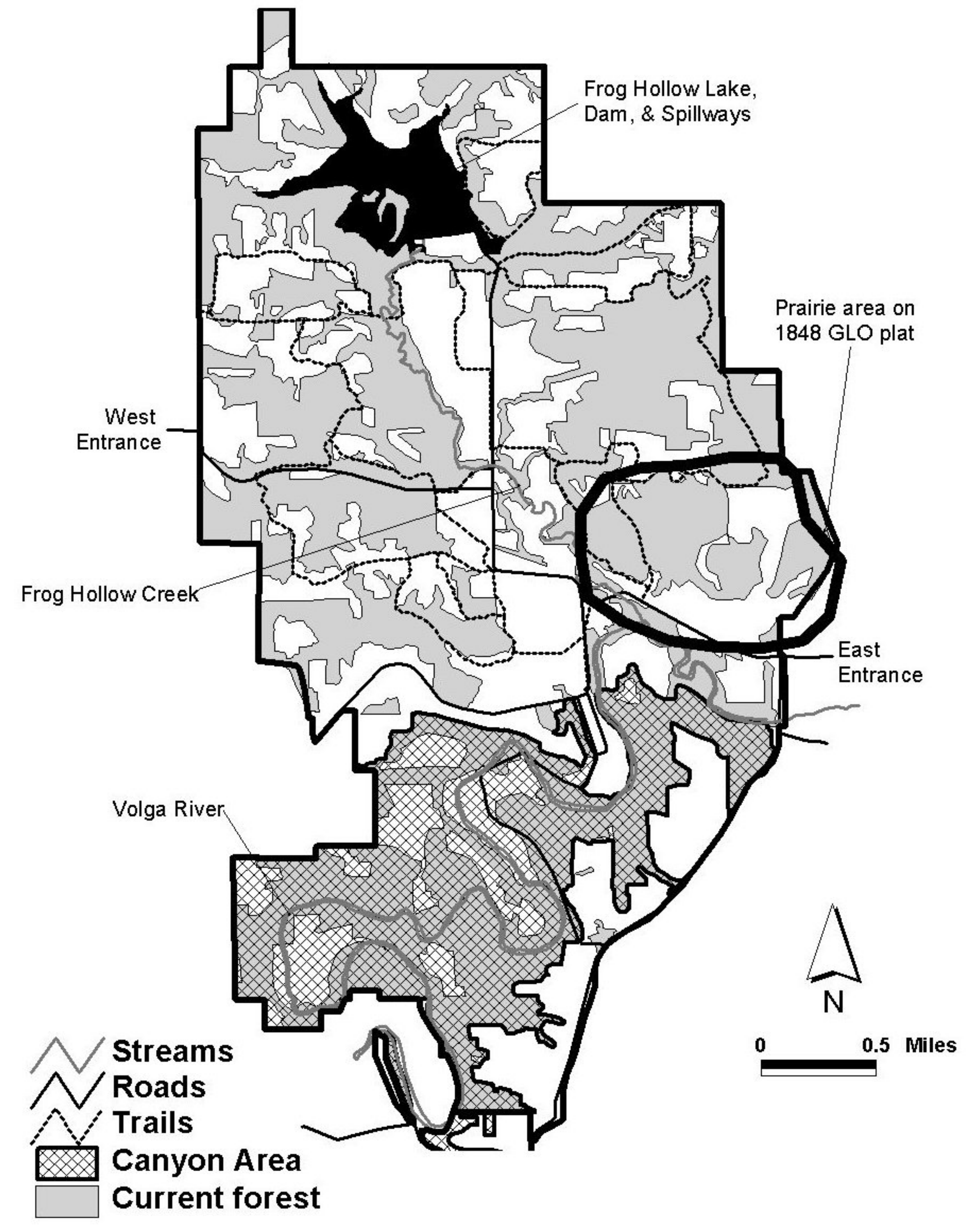

Figure 2. Current forest cover and original prairie area in Volga River Recreation Area.

forested edges of abandoned agricultural fields. Scattered throughout the VRRA, these stands likely represent trees pioneering into formerly open areas or highly altered examples of one or more of the above community-types.

COMPARISON OF HISTORIC AND CURRENT VEGETATION

Former prairie area

Detailed interpretation of change in vegetation between 1848 and the present based on comparison of historic and modern maps is problematic because of differences in definitions of vegetation types and in mapping conventions, but general comparisons at a coarse scale are valid. The general contrast between historic and current conditions in the 250-acre prairie area depicted on the 1848 GLO plat map (on a flat upland and associated south-facing slope located north of the present east entrance to VRRA) indicates several striking changes (Figure 3):

- Forest now covers over 80% of the former prairie area.
- Non-forested areas almost entirely consist of former cropfields that are now 1) open areas of non-native grasses, 2) plantations of native grasses, or 3) small cropfields maintained as wildlife food plots.
- Native prairie vegetation today is confined to two small areas: a long, narrow "hill prairie" on a dry slope and a lowland "wet meadow" on saturated soil.

Of the present forested acreage in this former prairie area, the single largest proportion (40%) is occupied by the Black Oak-Bur Oak-Hickory community and a stand of the closely related Red Cedar-Bur Oak community (Figure 3). Conversely, nearly 75% of the entire Black Oak-Bur Oak-Hickory acreage in VRRA is within or immediately contiguous with the former prairie area (which represents about 5% of the geographic area of VRRA). This modern forest type thus appears to be a prominent feature of and concentrated within the former prairie area. (Note: if the location of the polygon representing the former prairie area is shifted slightly northward to more closely correspond with the topography of the upland in this vicinity [and possibly its intended location on the original GLO plat], an even better fit with the current distribution of the Black Oak-Bur Oak-Hickory community is obtained.)

The importance of bur oak and black oak in this area suggests that this former prairie area may have been an "oak opening". (Although the term "prairie" implies treelessness, Miller (1995) found in the GLO record for Fayette County that scattered trees- primarily bur oaks- were found [and used as witness trees] in prairie areas.) According to Curtis (1959), oak openings were originally open savannas characterized by scattered bur oak trees mixed with prairie vegetation, but which have become encroached with young, dense oak forests due to fire suppression in the post-settlement era. He further comments (pp. 335-336):

> *"One of the most significant features of this closing of the oak openings was the seemingly spontaneous generation of black oaks in the new growth. Frequently a pure stand of black oaks would spring up among the widely spaced bur oak veterans although there might not be any mature black oaks for miles around…the black oaks were there all the time, but were growing as oak brush or grubs among the prairie grasses…When the fires stopped, the oak brush developed into mature trees that characteristically had two or three trunks per tree."*

The hill prairie in the southwest part of the original prairie area appears to be a small remnant of a much larger prairie area, or at least a prairie opening within a former savanna. Attention was first drawn to the biological significance of this remnant by Knutson (1979). This long, narrow prairie (less than 50 feet wide and about 1000 feet long) occurs on thin, dry soil at the crest of a steep hillside where farming was impossible and where tree growth has been slower than in the surrounding forest. Big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium*)

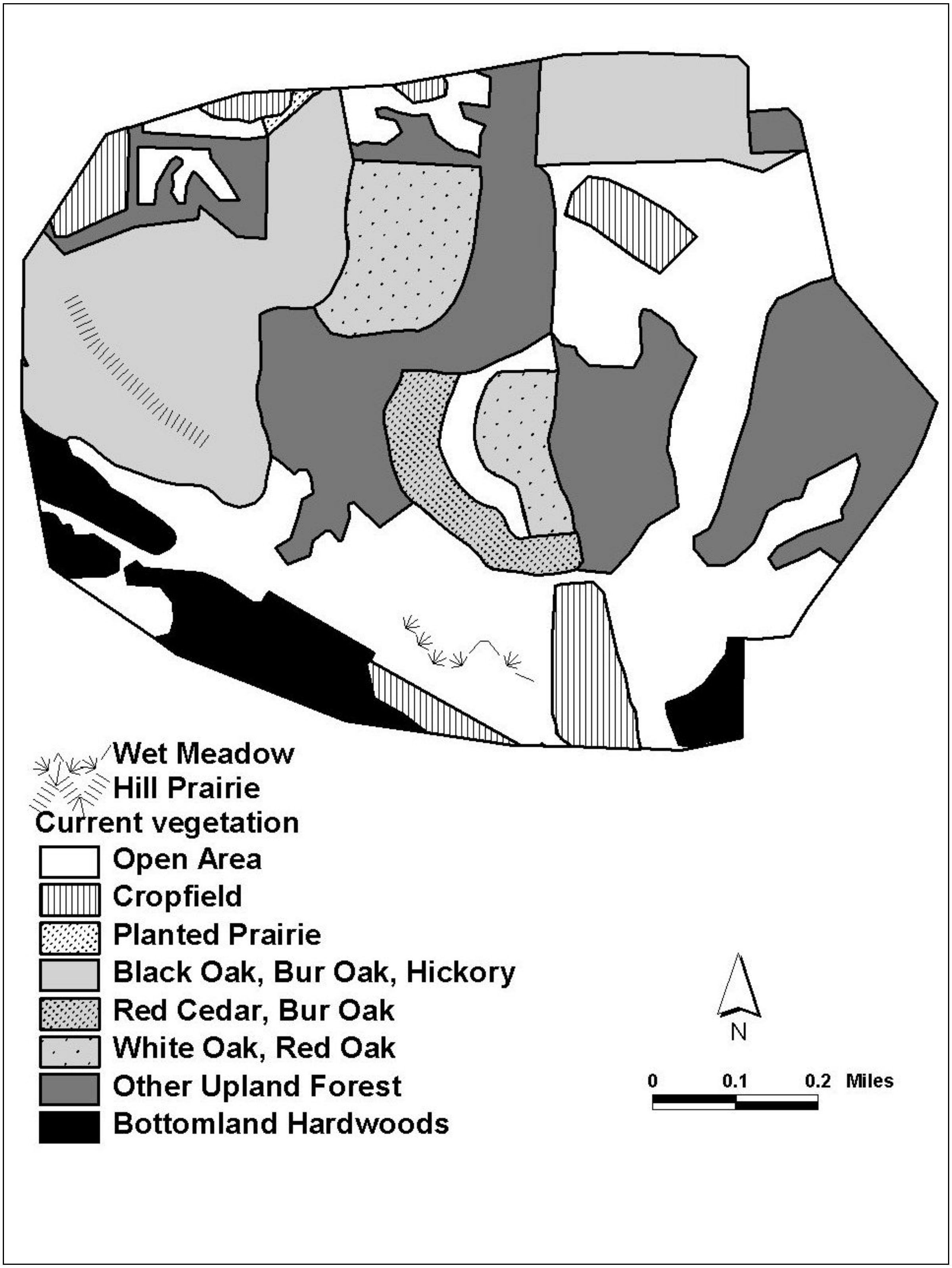

Figure 3. Current vegetation of former prairie area.

are the dominant grasses associated with typical "prairie" plants such as pasqueflower (*Pulsatilla patens*), leadplant (*Amorpha canescens*), rough blazingstar (*Liatris aspera*), stiff goldenrod (*Solidago rigida*), and purple prairie-clover (*Dalea purpurea*) also present. The prairie is surrounded today by a dense stand of black oak, northern pin oak, bur oak, and other tree species. Encroachment of woody vegetation into the prairie remnant is a severe problem despite prescribed burning and manual clearing of brush in recent years. The Ecosystem Management Plan (IDNR 1998) calls for restoration of this prairie and the former savanna areas surrounding it.

Former forest area

Approximately 95% of VRRA was mapped as "timber" on the 1948 GLO plat. Today, about 52% is mapped as forest, indicating a substantial decrease in forest cover over the past 150 years. Problems with a literal interpretation of this apparent change include:

- GLO surveyors may have mapped a single type ("timber") where several types, including non-forested ones, may have existed. It is important to recall that the primary charge of the GLO surveyors was to demarcate boundaries for land so that it could be sold to settlers. Although they recorded observations about vegetation, such observations were typically general in nature, lacking botanical details beyond the extent of major types, identity of witness trees at quarter points (½ mile apart), and listings of other common plants seen while walking along section lines (1 mile apart). Small occurrences of non-forested land within large areas of forested land were often included with a general label of "timber" without comment. If applicable to VRRA, this would tend to lower the 1848 estimate of forest cover to something less than 95%.
- The terms "timber" as used by GLO surveyors and "timberland" as used by modern foresters [or "forest" used by ecologists] may have different meanings. The modern definition of "timberland" is forest land capable of producing at least 20 cubic feet per acre of annual growth (Leatherberry et al. 1992), which may retrospectively exclude significant areas of GLO "timber." In a study of GLO records in Fayette County, Miller (1995) found that the average distance from a quarter point location to a witness tree in 1848 was 40 feet. In a modern forest, trees are commonly more numerous and densely packed, to the extent that distances from any given point to a tree suitable for use as a witness are often less than an average of 40 feet. "Timber" on the GLO record may thus have included open, low-density wooded areas that would not qualify as "timberland" or "forest" by today's standard. Accordingly, a map of "timberland" on the 1848 landscape according to modern standards may have shown less than 95% coverage in VRRA, lessening the apparent contrast between the two dates.
- Pairwise comparison of forested area in 1848 and current conditions masks intervening trends. Examination of aerial photographs from the late 1930s in Iowa generally reveals that forest cover was lower then than today, especially in protected areas (for example, see Maquoketa Caves State Park in Jackson County (Pearson 2001)). Today's forest cover of 52% at VRRA may include increases in area since the late 1930s. This would also make the forest decline evident after 1848 more dramatic than suggested by a comparison with modern, partially recovered conditions.

Nonetheless, the large difference between historic and modern maps of forest cover in VRRA indicates that there has been significant conversion of land from wooded to open conditions. Forest cover today is largely restricted to steep slopes not suited to cultivation. Much of the forest making up the 95% cover on the GLO maps likely occurred on broad uplands between ravines, sites that were cleared of trees and farmed for many years prior to state ownership. Although cultivation has been greatly reduced under state ownership (with areas maintained as smaller food plots, planted to grass, or allowed to undergo natural succession), most of the former cropfields have remained unforested; however, the Ecosystem Management Plan (IDNR 1998) calls for reforestation of many open areas.

Of the six forest types described earlier (see **Modern Vegetation**), the two that are the most representative of natural upland forest in VRRA are the "northern mixed hardwoods" and "white oak-red oak" types. These communities are found within areas mapped as "timber" on the GLO plat maps, occur on loamy soil, and have not been cleared for use as cropfields in the past. White oak, red oak, sugar maple, and basswood are typically the dominant tree species. They were termed "Primary Upland Forests" by Knutson (1979), denoting forest areas in VRRA that were relatively undisturbed and where "the wildflowers and ferns associated with typical deciduous forest in the Midwest" could be found. Characteristic species include:

- Ferns: maidenhair-fern (*Adiantum pedatum*), walking fern (*Asplenium rhizophyllum*), lady-fern (*Athyrium filix-femina*), rattlesnake-fern (*Botrychium virginianum*), creeping fragile fern (*Cystopteris protrusa*), and interrupted fern (*Osmunda claytoniana*)
- Spring ephemerals: wild leek (*Allium triococcum*), spring beauty (*Claytonia virginica*), toothwort (*Dentaria laciniata*), hepatica (*Hepatica acutiloba*), false rue anemone (*Isopyrum biternatum*), woodland phlox (*Phlox divaricata*), and bloodroot (*Sanguinaria canadensis*)
- Shade-tolerant forbs: white baneberry (*Actea pachypoda*), wild ginger (*Asarum canadense*), blue cohosh (*Caulophyllum thalictroides*), mitre-wort (*Mitella diphylla*), ginseng (*Panax quinquefolia*), and Jacob's-ladder (*Polemonium reptans*)
- Orchids: putty-root orchid (*Aplectrum hyemale*), autumn coral-root (*Corallorhiza odontorhiza*), yellow lady's-slipper (*Cypripedium calceolus*), showy orchis (*Galearis spectabilis*), rattlesnake plantain (*Goodyera pubescens*), and nodding pogonia (*Triphora trianthophora*)

Although stands of these types occur in many places, the largest, most continuous occurrences of these types are associated with blufflands along the Volga River (the "Canyon Area"), a rugged, heavily wooded landscape in the southern part of VRRA (Figure 2). The canyon area is also a relatively wild, roadless, and undeveloped part of the park conducive to primitive outdoor activities like hiking and canoeing on the Volga River. For the "Canyon Landscape Zone", the Ecosystem Management Plan (IDNR 1998) calls for promoting mature, contiguous forest through preservation of old stands with non-intensive management, using long rotations for actively managed stands, and reforesting former clearings.

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ARCHAEOLOGY AND GEOARCHAEOLOGY OF THE VOLGA RIVER STATE RECREATION AREA

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The Volga River State Recreation Area (VRSRA) was the subject of a brief, but intensive burst of archaeological fieldwork between 1975 and 1978. Field crews surveyed nearly 2.5 square miles of land in Frog Hollow and the adjacent uplands, recording 57 archaeological sites. Thousands of artifacts were recovered from the surface of the sites and the small-scale excavations that were conducted at a half dozen sites. Nearly 25 years later, this work remains among the more extensive archaeological studies carried out in northeastern Iowa, and the largest such study ever conducted in Fayette County. The VRSRA archaeological projects account for one third the total area surveyed for archaeological sites in the county (622 of 1857 ha), and for nearly half (57 of 138) the recorded sites.

THE STUDIES

The 1975-1978 investigations were funded by the Iowa State Conservation Commission to determine the impact of reservoir construction on cultural resources (i.e., archaeological sites). In 1975, as government agencies and public citizens debated how best to use these recently acquired public lands, Dean Thompson, from the State Historic Preservation Office (at the time based in Iowa City), conducted an initial survey that recorded 10 prehistoric archaeological sites (Thompson 1975). The following year, Clark Mallam of the Department of Anthropology at Luther College, Decorah, Iowa, added an additional 37 sites to the roster (Mallam and Housker 1976). Mallam recommended additional study, which was undertaken in 1978 under the direction of David Benn, also from Luther College. Benn continued work at known sites and discovered, recorded, and excavated an additional 16 sites (Benn and Bettis, 1979). Benn's investigations coincided with the beginning of construction at Frog Hollow Lake.

At the time they undertook the VRSRA studies, Mallam and Benn were deeply involved in developing models for prehistoric settlement and land use in northeastern Iowa, work that culminated in seminal publications by both (Benn 1980; Mallam 1976). Their models posited that major villages and associated mortuary complexes (i.e., mound sites) in northeast Iowa were concentrated along the major rivers, with families and task groups moving "inland" on a seasonal basis to hunt and gather in the uplands. The VRSRA was well located to test the implications of these models for settings removed from the region's larger rivers.

ARCHAEOLOGICAL RESULTS

VRSRA surveys confirmed the models' predictions in that none of the surveys discovered large villages and base camps occupied on a year-round basis, and no burial mounds were found. Other conclusions are summarized as follows (Benn and Bettis 1979:93-94):

- "Frog Hollow was the scene of numerous, brief procurement expeditions by small bands primarily procuring deer." Deer procurement was inferred from a preponderance of stone tools associated with hunting (projectile points), butchering (knives) and hide working (scrapers).
- "Procurement bands entered the Frog Hollow area with prepared cherts [i.e., nearly finished tool preforms] for tool making….but also made extensive use of locally available cherts for expedient tools."

- "Annually consistent but intermittent exploitation of Frog Hollow persisted from the Late Archaic to the Late Woodland period" with a few occupations documented from the Early Archaic and Paleoindian periods.

Artifacts recovered from the 1975 to 1979 work were primarily chipped stone tools, flaking debris from the manufacture or maintenance of stone tools, and fire-cracked rock from cooking activities. Only five bone fragments and five small potsherds were recovered from the sites. The sparse occurrence of bone was attributed to chemical and mineral weathering of these (and probably other) organic materials. Highly mobile hunter-gatherers might have preferred less breakable containers to ceramic vessels.

The typical prehistoric site within the VRSRA is a complex of artifact scatters. Individual scatters, typically 20-50 m in diameter, were assigned to functional types based on the kinds and quantities of artifacts recovered. Sites with high artifact density and a wide range of tool types were interpreted as seasonal camps, where groups lived during their hunting/gathering forays into the area. These sites tended to yield stone tools made from nonlocal cherts, transported into the area in finished or near-finished form, as well as evidence for the on-site manufacture of tools from the local Silurian cherts. Other sites, yielding fewer artifacts and only one or two tool types, were interpreted as "procurement sites" where activities focused on the procurement or processing of a resource that was then transported back to the camps for consumption. Many procurement sites yielded evidence for the on-site manufacture of expedient tools from local cherts. Occasional discards of broken and exhausted tools of nonlocal chert were evident on some procurement sites (Benn and Bettis 1979).

If present-day archaeologists were to reanalyze artifacts from the VRSRA projects, their conclusions would probably not differ substantially from those reached in 1975-1978. We still use the same basic lines of evidence – site size; kinds and relative quantities of artifacts; proportions of local and nonlocal lithics – to infer the role sites played in prehistoric land use systems. This approach to archaeological interpretation, widely adopted throughout North American archaeology in the 1970s, emphasized artifact- and landscape-based approaches to reconstructing past human lifeways. Mallam and Benn were among the strongest proponents of these new methods in Iowa archaeology. If not "standard setters," they were most certainly the "standard bearers" of the new approaches.

A significant aspect of the 1975-1979 studies was the continuity of the research. Thompson made the artifacts he recovered in 1975 available to Mallam for analysis. Benn and Bettis (1979) took Mallam's earlier work as a point of departure, refining, revising, and elaborating his initial hypotheses in the light of new data. Since the 1970s, only two additional surveys have been conducted in portions in the VRSRA. Both were relatively small-scale, rapidly-completed endeavors (Fishel 1997; Roberts 1992). Although six newly-discovered sites were recorded by these surveys, neither attempted to integrate their results with those of the earlier work. In this, they stand in contrast to the cumulative, collaborative spirit of the initial studies from the 1970s.

GEOARCHAEOLOGICAL RESULTS

The 1978 investigation at VRSRA included one of the earlier examples of geoarchaeological study undertaken in Iowa. E. Arthur Bettis, then a graduate student at Iowa State University, identified the area's major geomorphic surfaces. Conclusions and interpretations from local geology were used to develop implications for the archaeological record (Benn and Bettis 1979:41-44). For example, evidence for extensive valley downcutting prior to the late Holocene meant a likely absence of archaeological sites from the early and middle Holocene in the valley, although such deposits might be present on uplands. Bettis also described the geology and pedology of individual archaeological sites, calling archaeologists' attention to geological phenomenon such as stone lines that provided evidence of past erosion. Benn and Bettis (1979) were among the first in Iowa to discuss the implications of bioturbation (soil churning by burrowing fauna, tree throw, etc.) for the burial of artifacts in upland soils.

Bettis' geomorphic map of a portion of the project area, reproduced here (Figure 2), shows a typical Iowan Erosion Surface landscape of eroded, loess-mantled uplands flanking a deeply incised valley with inset Late Wisconsinan and Holocene valley fills. A valley cross section along the axis of the Frog Hollow Lake dam (Figure 3) revealed upwards of 12 m of Pleistocene sand and gravel overlain by a thin veneer of Holocene alluvium and, at the valley margins, Wisconsinan through Holocene colluvium.

Bettis stated:

> Late Wisconsin loess or sands…mantle most of the upland surfaces in the area. A few patches of eroded till (pre-Illinoian) are present at the surface…and predominate on the landscape a few kilometers to the west…. As a result of erosion of the uplands during development of the Iowan Erosion Surface (IES), thick, coarse alluvial fills accumulated in small valleys such as Frog Hollow and were covered by eolian materials, primarily sand, following deposition….Debris washed from the uplands was carried down tributary valleys and debouched into Frog Hollow, choking the valley…. [T]he valley floor [during the development of the IES] was essentially a series of coalescing alluvial fans….” (Benn and Bettis 1979:16-19).

Major downcutting occurred in Frog Hollow during the Holocene. The sandy Pleistocene valley floor was left standing as a terrace ca. 4 m above the present-day floodplain (Figure 4). Bettis referred to this Late Wisconsinan surface as a “pediment terrace” to emphasize its genetic relationship to the IES uplands. Alluvium underlying the inset Holocene-surfaces is much siltier that that deposited during the Late Wisconsinan (Benn and Bettis 1979:20). This reflects a major shift from a high-energy Late Wisconsinan regime of upland-dominated mass-wasting and eolian sedimentation, to a lower-energy Holocene regime, driven primarily by streamflow responding to groundwater discharge and precipitation runoff. Intervening between these two regimes was a third, probably occurring during the early and middle Holocene, during which much Late Wisconsinan sediment was flushed from the valley. Because this interval was largely erosional, it left little sedimentological record in Frog Hollow, but instead is manifested geomorphologically by former Late Wisconsinan floodplains standing 4 m above the inset Holocene valley fills.

Interestingly, the down-valley gradient on the Late Wisconsinan terraces is only half that of the present day floodplain: 7.4 ft/mi versus 15 ft/mi (Benn and Bettis 1979:20). The lower gradient suggests that Frog Hollow was choking on sediment washing off the IES uplands. Bettis identified no Holocene alluvium of early or middle Holocene age in Frog Hollow. It is likely that during this period the valley essentially served as a conveyor belt to carry surplus sediment downstream to the Volga. It’s unfortunate that Bettis’ study area, limited as it was to areas impacted by Frog Hollow Lake construction, did not extend to the Volga River. The relationship between deposits and surfaces on the Volga and deposits and surfaces of similar age on its tributary, Frog Hollow, would be a very interesting topic for study.

A geoarchaeological study of Frog Hollow, if undertaken today, would involve a great deal more subsurface investigation than any of the 1970s projects attempted. As shown in Figure 2, most of the area surveyed for sites in the VRSRA is located on the valley bottoms of Frog Hollow and the Volga River, but with the exception of the area enclosed by the limits of Bettis’ geomorphic map (Figure 2, and dashed line on Figure 1), archaeologists only walked over the surface of these floodplains and terraces. There was no intensive search for buried archaeological sites, and neither was there extensive geological coring to identify and map Holocene alluvium where buried sites were likely to be found.

That was all about to change. From Frog Hollow, Benn recalls, he and Bettis went directly to the Rainbow site in the Loess Hills of western Iowa (personal communication 2003). There, they found extremely deeply buried cultural deposits from the Late Archaic and Woodland periods (Benn 1990), while a short distance away, at Cherokee, archaeologists were encountering deeply buried Paleoindian through Early Archaic cultural deposits (Anderson and Semken 1980). To many archaeologists in the Midwest, Rainbow and Cherokee were a wake-up call that Iowa archaeology was more than just a near-surface phenomenon, and the geologists and soil scientists would have a significant role to play in future archaeological endeavors in the state (Thompson and Bettis 1980).

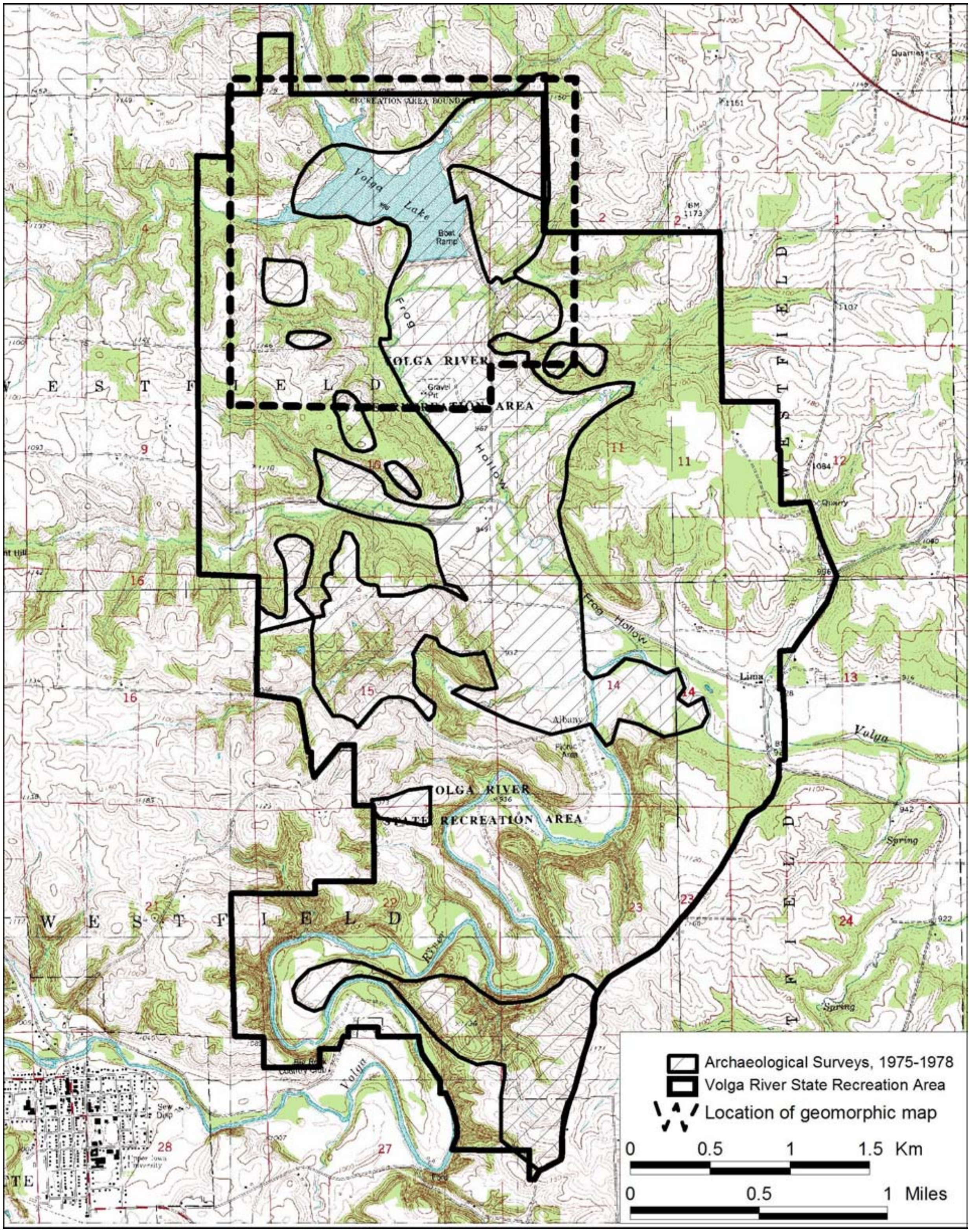


Figure 1. Map of the Volga River State Recreation Area, showing areas surveyed for archaeological sites in 1975-1979. Base map: West Union, Elgin, Wadena, and Fayette USGS 7.5 min quadrangles. Dashed line is location of geomorphic map reproduced as Figure 2.

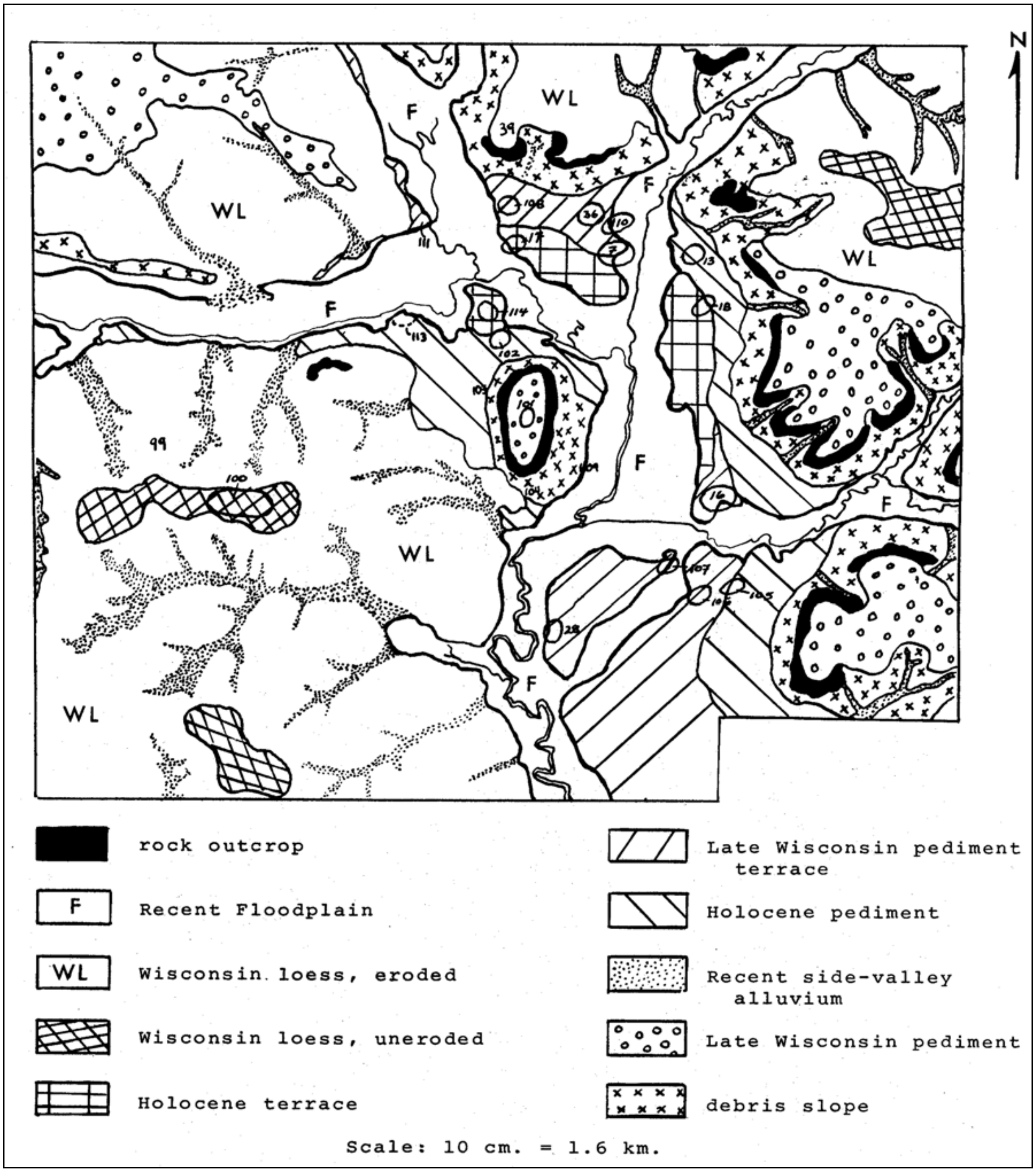
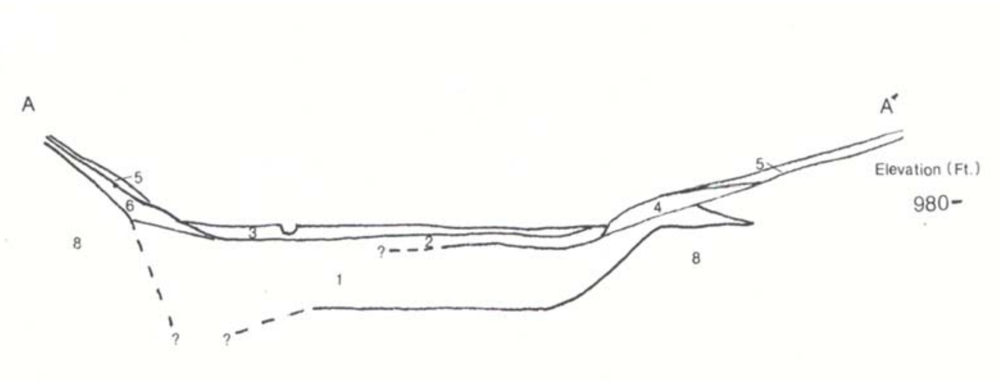


Figure 2. Geomorphic map of a portion of the VRSRA (from Benn and Bettis 1979). Numbered ellipses represent archaeological sites.. Location of the mapped area is shown in Figure 1.



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Distance from A-A' is about 625 m
     vertical exaggeration 4x
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Key
1. Early-Late Pleistocene sand and gravel
2. Early-Late Pleistocene sand with gravel lenses
3. Holocene alluvium; usually loamy or claey, local sandy area
4. Late Wisconsin pediment terraces; upper part wind-reworked
5. Holocene sideslope deposits; primarily reworked aeolian sand
6. residuumand pre-aeolian sand colluvium
7. Late Wisconsin-early Holocene aeolian material; mostly sand in valley, loess in upland
8. Paleozoic bedrock

Figure 3. Cross section of Frog Hollow along the axis of the dam for Frog Hollow Lake, prepared from engineering bore logs (after Benn and Bettis 1979).

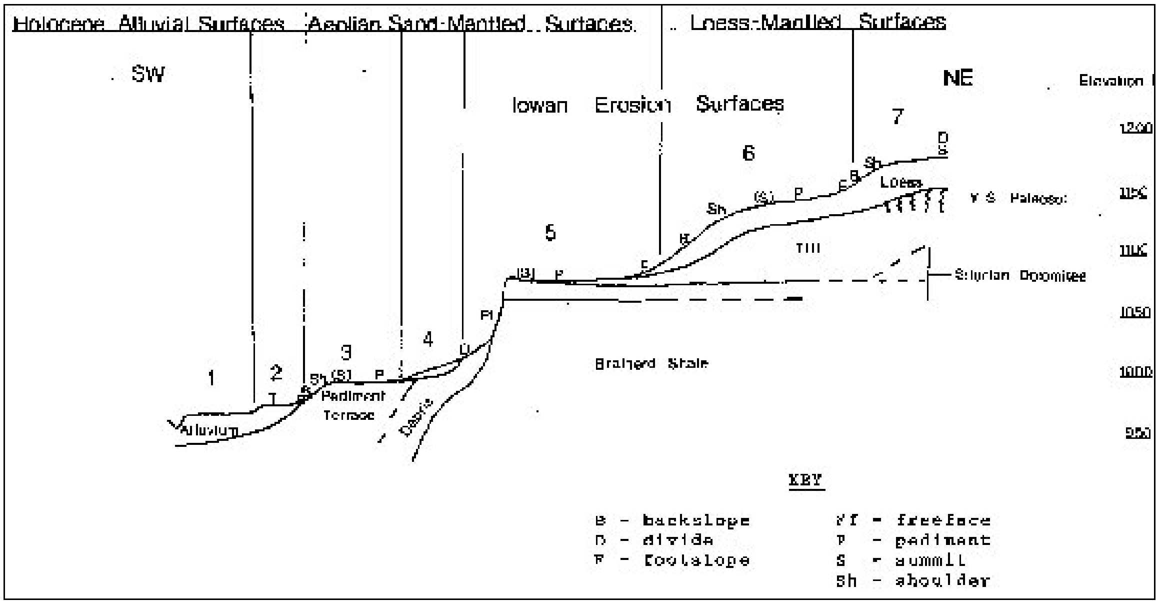

Figure 4. Schematic cross section of Frog Hollow, showing the major geomorphic surfaces, numbered 1-7 in ascending order in the landscape, and the underlying geological deposits (from Benn and Bettis 1979). In addition to showing the relationship of Late Quaternary sediments in the project area, this diagram integrates concepts of Ruhe (1969) and others regarding hillslope nomenclature and stepped erosion surfaces with models of IES landscape evolution by Hallberg and others (e.g., Hallberg et al. 1978).

SUMMARY AND CONCLUSIONS

Frog Hollow was utilized, probably on a seasonal basis, by small groups of Native Americans who came to the locality to hunt and gather local resources. Many of these groups probably "tooled up" elsewhere before arriving, since broken and worn out tools of nonlocal cherts are a relatively common occurrence on sites of the VRSRA. They took advantage of local Silurian cherts to "retool" (i.e., refurbish their toolkits) and also as a source for expedient tools: for example, a naturally sharp chert flake, collected and used, with minimal modification, for a single use and then discarded – the hunter-gatherer equivalent of "disposable." Over the millennia, they repeatedly returned to certain, preferred locations, primarily higher, better drained terraces and upland ridgetops.

They lived in a landscape that was emerging from a period of dynamic change, during which the region's geomorphology was dramatically transformed. Early in mankind's tenure in North America, the Frog Hollow locality would probably have been a relatively inhospitable place of eroded slopes, cold winds, frozen ground, and debris-choked valleys. With the end of the Ice Age, this changed. Fluvial processes, driven by runoff from rain and snow melt, gradually removed much of the over-thickened Late Wisconsinan valley fills, allowing forests and prairies to become established in the valley bottoms. The evolution of the Holocene valley networks was the final major geological event in creating the rich and variable landscape we see before us today.

Archaeological studies at VRSRA are an excellent example of how "environmental impact" studies, undertaken to meet the demands of federal and state regulation, can result in good science that stands the test of time. When good policy leads to good science, the public, which funds the endeavor, is doubly served to the benefit of not only themselves but of generations to come.

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QUATERNARY MATERIALS OF VOLGA RIVER STATE RECREATION AREA

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The Volga River State Recreation Area is part of the Paleozoic Plateau landform region (Prior, 1991), although the Iowan Surface boundary lies nearby (Figure 1). In general, the area shows the characteristic deep valleys, bedrock exposures, and limited glacial deposits of the Paleozoic Plateau. On Stop 1 we will walk a portion of the Lima Trail near Frog Hollow Lake and discuss the Quaternary deposits. We will see a range of materials including bedrock outcrop, soil formed in colluvium over shallow bedrock, scattered glacial erratics, and eolian silt and sand. Participants will have the opportunity to discuss whether or not these deposits are "in-place" as well as offer suggestions on the origin and nature of these features.

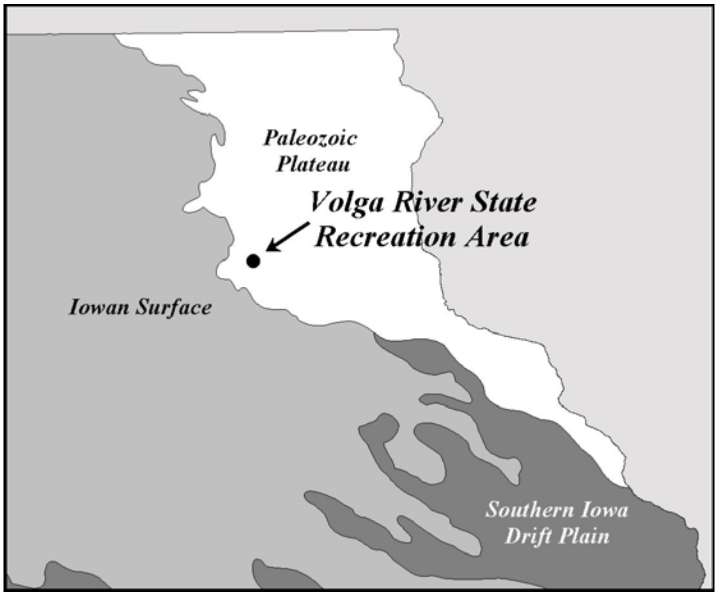

Figure 1. Location of the Volga River State Recreation Area on the Landforms of Iowa map.

LANDFORM REGION

The Volga River State Recreation Area exhibits the characteristic features of the Paleozoic Plateau, distinguishing it from the Iowan Surface to the west and the Southern Iowa Drift Plain to the southeast. The boundaries of this landform region are defined along the southern and western margins with the change from a low relief, gently rolling landscape to a rugged, dissected, rock-controlled landscape. Early studies identified the landscape region of northeast Iowa as the "Driftless Area" due to the belief that this area had never been glaciated. Later studies indicated this was not the case, and it was termed the Paleozoic Plateau (Prior, 1976).

"Driftless Area"

The first geological investigations of the area were completed during the 1840's under the direction of David Dale Owen (in Calvin, 1894), and numerous studies and maps were published for this region by the Iowa Geological Survey in the late 1800's. Whitney (1862) produced the first map depicting this area. Later researchers (Chamberlain, 1883; Chamberlain and Salisbury, 1886) identified a "pebbly border of earlier drift" throughout the region and recognized it as foreign material. They did not believe these materials had been deposited directly by the ice, and thought they were possibly ice-rafted debris or the result of floodwaters. McGee (1891) and Calvin (1894, 1906) recognized upland glacial materials and granite boulders, but did not consider them "proper" drift. Other studies described glacial outwash materials and boulders of non-native origin, but they were not determined to be directly deposited by glaciers. Due to the lack of glacially deposited materials, the high relief, and the extensive bedrock exposures, all these investigations led to the same conclusion- that the northeastern region of Iowa had not been glaciated.

Later studies by Williams (1914, 1923) documented 80 patches of glacial drift in what had previously been called the "Driftless Area." Due to the upland position of the drift and the differences between these materials and the Kansan drift to the west, researchers at an informal field conference in 1915 (Trowbridge, 1966) generally agreed that the drift east of the Kansan border was in fact deposited by a glacier and that the Kansan occurs both in the valleys and on the uplands. Kay and Apfel (1928) later published Williams' map showing the locations of upland drift in northeastern Iowa. From then on, the area was mapped as Nebraskan and no truly driftless area was recognized in Iowa.

In 1966, Trowbridge published a summary of previous works and included additional data from his studies of the region. Trowbridge documented more than 100 occurrences of glacial drift and determined that these materials are till and not outwash. Trowbridge's research further supported the idea that areas in northeast Iowa previously considered "driftless" by researchers had been glaciated. The original area designated as the "Driftless Area" was much smaller than the region of rugged topography and associated flora and fauna commonly referred to by natural scientists. The term Paleozoic Plateau (Prior, 1976) is a better description for this physiographic region and incorporates the much larger topographically and ecologically similar area referred to by natural scientists and biologists.

Paleozoic Plateau

The Paleozoic Plateau is a bedrock-controlled terrain with deeply entrenched valleys, karst topography, and an integrated drainage network. The Paleozoic Plateau is unique as the only region of Iowa where bedrock dominates the landscape. Unconsolidated materials and associated landforms (or dissections of them) including glacial materials, loess, and alluvium dominate the landscape in all other regions of Iowa.

The Paleozoic Plateau region is characterized by an abundance of bedrock exposures, deep and narrow valleys, and limited glacial deposits. The Quaternary deposits of the Paleozoic Plateau are limited to alluvial materials and loess covered patches of isolated glacial till. The steep slopes, bluffs, abundant rock outcrops, waterfalls and rapids, sinkholes, springs, and entrenched stream valleys create a view not present elsewhere in the state.

The characteristic features of the Paleozoic Plateau are representative of deep dissection by streams through gently inclined Paleozoic rock units with varying resistance to erosion. The rocks dip gently to the southwest, exposing progressively older Paleozoic rock units in the northeast corner of the state. The more resistant rock types (sandstones and carbonates) form cliffs and escarpments high on the landscape whereas the more easily weatherable shales have gentler slopes. This differential weathering creates a landscape reflecting the local bedrock. Topography is also controlled by extensive karst development in this area forming caves, sinkholes, springs, and subsurface caverns. In addition to the karst and other erosional features, the regional landform characteristics have been controlled by river development. The Mississippi River and its tributary valleys contain well preserved terraces, older floodplain deposit remnants, and entrenched and hanging meanders. All of these features indicate the complexity of the alluvial history and river development associated with glacial melting and drainage diversions.

Iowan Surface

In contrast with the Paleozoic Plateau landform region, the Iowan Surface has a very different physiography due to extensive erosion during past glacial episodes. Glaciers last passed over this area during Pre-Illinoian time; prior to the Wisconsinan glacial events the area was part of the

Southern Iowa Drift Plain. During the Wisconsinan, a severe cold-climate weathering period (21,000 to 16,500 years b.p.) erased all but a few remnants of the earlier landscape leaving behind the characteristic low relief, gently rolling topography of the Iowan Surface. During this time of intense weathering, erosion, and periglacial processes, such as strong winds, solifluction and freeze-thaw activity, were active and aided in the development of an erosional surface on top of the Pre-Illinoian deposits. Later episodes of soil development and the deposition of wind-derived sediment created the landscape we see today.

The Iowan Surface is underlain by the same material as the Southern Iowa Drift Plain; however, it is more deeply eroded and has poorly defined drainage divides. Downcutting processes by rivers and streams have also been less severe than those on the Southern Iowa Drift Plain. The Iowan Surface is characterized by low relief, slightly inclined topography, and gently rolling slopes.

Four features are typically considered characteristic of the Iowan Surface: paha, stone lines, erratics, and ice wedge casts. Paha, the Dakota Sioux word for hill or ridge, are found predominantly in the southern portion of the Iowan Surface. Paha are isolated, elongate hills of loess and eolian sand deposited on the land surface as the surrounding landscape was being eroded and lowered. These hills are aligned with a northwest to southeast orientation parallel to and in close proximity to river valleys, suggesting that paha may be dunelike features associated with strong northwest winds. Stone lines are lag deposits developed during times of erosion when finer particles were removed by wind and water. Stone lines are often covered by a thin layer of loess and are frequently observed in cross-sectional views. Glacial erratics (boulders transported by glacial advances) are also found scattered across the landscape of the Iowan Surface. Most of these erratics are igneous or metamorphic rocks originating from the north, likely Minnesota and Canada. Subsequent erosional events removed the finer-grained deposits surrounding the erratics, leaving them exposed at the surface. Also noted throughout the landscape are ice-wedge casts or polygons. Ice-wedge casts form as frozen ground cracks and fills with material through time. These features are commonly connected in a polygonal pattern, similar to the more familiar mud cracks, creating an integrated drainage network. Many of these features are not identified within the Volga State Recreation Area, but the close proximity of the Iowan Surface to the west indicates they may be present nearby.

QUATERNARY DEPOSITS

Quaternary glacial deposits in the Volga River State Recreation Area are not extensive. Colluvium and alluvial materials, located in river valleys and tributary channels, are the most prominent. Other deposits are mostly limited to upland eolian sand and silt (loess), but may also include isolated areas of glacial till or boulder lags.

Description of Materials along the Lima Trail

Within a short walk up the Lima Trail (Stop 1), most of the characteristic Quaternary deposits of the Paleozoic Plateau can be observed. At lower elevations near the trail head, the surficial materials consist of soils formed in colluvium and bedrock blocks. No glacial or eolian deposits are evident. As the trail continues to the east, the presence of glacial erratics near the trail may be noted. These boulders may be the result of human activity and clearing during trail building. However, a reconnaissance of the farm fields adjacent to the trail reveals the presence of common boulders. Therefore, it is believed that the presence of these boulders represents a boulder lag associated with the erosion of glacial deposits.

The most prominent Quaternary deposits along the trail are windblown materials, both sand and silt, which can be observed on the eastern end of the trail. These silt and sand deposits are characteristic of eolian materials and are described as light brown, well-sorted and well-rounded. The first upland area is composed predominantly of silt-size particles (loess). Farther up the trail, the material becomes sand dominated. Drilling information in the area is limited, making the thickness of eolian deposits difficult to determine. Due to the nature of the deposits, the transport mode was most certainly by wind, but the source is somewhat problematic. The thickest loess deposits in Iowa are commonly associated with glacial outwash channels. Other eolian deposits (especially in east-central Iowa) are associated with the edge of the Iowan Surface. However, these materials are not laterally continuous and were likely partially eroded through time, so their origin and distribution is not completely understood.

One of the more curious features along the trail is the presence of chert within the eolian sand. The chert is angular, poorly sorted, and is the dominant mineralogy outside of the quartz sand. Chert is present locally in the bedrock, so it may be a residuum deposit. However, the question would still remain as to how it was evenly mixed with the eolian sand and not present in the eolian silt. The chert fragments are too large to have been transported with the sand, and their presence on the uplands also limits the possibility of it being a colluvial deposit. Human influence is always a possibility, but looking at the individual chert pieces did not indicate that any of it had been worked. Further investigation may suggest otherwise. The group will have a chance to examine these materials and discussion will be encouraged.

Soil Map Comparison

A comparison with the Fayette County soil map (Kuehl and Highland, 1978) indicates that the trail area is part of the Fayette-Nordness-Rock outcrop association. The Fayette and Nordness soil series consist of loess over bedrock on uplands. Nordness soils encounter bedrock within 40 inches of the surface, whereas the loess thickness of Fayette soils can be much deeper. Limestone outcrops on side slopes in this association.

Soil units mapped along the Lima Trail include the Fayette, Nordness, Backbone, Coggon, and Donnan series soils. Backbone soils consist of coarse eolian materials shallow to bedrock (20-40 inches). Donnan and Coggon soils form on uplands in clayey paleosol and glacial till, respectively. Near the beginning of the trail head, the surficial materials consist of bedrock outcrop with a colluvial cover. As the trail increases in elevation, a change is noted to include the presence of residual glacial boulders and a mantle of eolian materials on the uplands. Cornfields near the trail have common glacial erratics present at the surface. The presence of boulders in the fields reduces the possibility that the boulders were moved in from a different location. The close relationship between the soil survey for the area and the observed quaternary deposits further indicates that these materials are in-place.

DISCUSSION

Quaternary deposits in the Volga State Recreation Area are limited, but the Lima Trail gives an opportunity to view most of the common types associated with the Paleozoic Plateau (aside from the alluvial deposits). These deposits are characteristic of what would be expected in the Paleozoic Plateau region, although some of the specific features pose interesting questions. The presence of boulders along the trail without the presence of glacial till suggests that they are a lag deposit associated with the formation of the Iowan Surface. The presence of glacial erratics throughout the cornfield reduces the possibility that these boulders have been transported by humans and that they are probably in-place. The distribution of the eolian sand and silt also appears to be in place based on both visual evidence and the correlation with the soils maps for the area. The abundance of chert fragments in the eolian sand does not have a clear explanation, and the question of source area also remains. This area presents some curious Quaternary features, and discussion is welcomed.

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BEDROCK GEOLOGY AT ECHO VALLEY PARK AND VOLGA RIVER STATE RECREATION AREA, FAYETTE COUNTY, IOWA

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INTRODUCTION

The picturesque "Paleozoic Pleateau" landform region (Prior, 1991) of northeast Iowa displays a rugged topography that is incised into the shallow Paleozoic bedrock. For the most part, this region lacks glacial deposits, but loess blankets much of the upland surface. The eastern and northern parts of Fayette County belong to this landform region, where Ordovician, Silurian, and Devonian bedrock is commonly displayed in the valleys and bluffs. The bedrock-controlled topography of the Paleozoic Plateau is replaced westward and southward across Fayette County by a different landform region, the "Iowan Surface," which was created by the erosion and modification of underlying glacial deposits, and the bedrock is buried by Pleistocene glacial deposits across most of this area. Echo Valley Park and Volga River State Recreation Area in Fayette County display a bedrock-influenced landscape characteristic of the Paleozoic Plateau landform region, with steep valleys, impressive topographic relief, and common bedrock exposure. However, these parks occupy areas close to the margin of the Iowan Surface.

Exposures of Middle Devonian, Lower Silurian, and Upper Ordovician bedrock are seen in Fayette County (Witzke et al., 1998). We will not be visiting any Devonian exposures as part of this field trip, but Devonian strata are exposed very close to Echo Valley State park (in the West Union area) and Volga River State Recreation Area (along Hwy 150 to the west, and in the area in and around Fayette; see especially Bunker et al., 1983). Devonian rocks and fossils have been identified within the southern part of the Volga Rec. Area, where Devonian rocks are locally seen to cap the bluffs in the Big Rock area and the bluffs and valleys within section 23 (Kellogg and Young, 1979). Middle Devonian strata of the Wapsipinicon Group unconformably overlie Silurian rocks in Fayette County, and Wapsipinicon units show stratal onlap across a paleo-escarpment (an ancient erosional upland) of Silurian rocks in the county (ibid.). Fossiliferous strata of the lower Cedar Valley Group (Middle Devonian) overlie the Wapsipinicon Group, and these limestone and dolomite beds are well displayed in quarries and roadcuts in the area around Fayette.

LOWER SILURIAN STRATA (LEDGES AND CLIFFS OF DOLOMITE AND LIMESTONE)

Silurian strata in Fayette County are unique in the eastern Iowa Silurian outcrop belt in several ways. Unlike the Silurian strata across most of eastern Iowa (and the central United States as well) which are composed almost exclusively of dolomite (a rock also known as dolostone), the Silurian carbonate rocks of Fayette County include both dolomite (calcium-magnesium carbonate) and limestone (calcium carbonate). All of these strata were originally deposited as lime sediments on an ancient seafloor, but across most of the central United States these sediments were chemically altered to dolomite, probably within mixed saline to freshwater groundwater systems (Witzke, 1981; Ludvigson et al., 1992). In fact, this process of dolomitization was so pervasive, that 100% of the original lime sediment was converted to dolomite across a vast area of the continental interior, including most of eastern Iowa. At most places in eastern Iowa, Silurian rocks are completely dolomitized, with no trace of original limestone remaining (as seen in some of Iowa's most picturesque state parks such as Palisades-Kepler, Backbone, and Maquoketa Caves; Witzke, 1992). However, in areas of Fayette County, true Silurian limestones are found, undolomitized strata that somehow escaped the regional effects of pervasive dolomitization. Our field trip stops show intervals of limestone sandwiched between layers of dolomite. How can we explain these beds of limestone in Fayette County in an otherwise dolomitized region of Silurian rocks?

The Silurian section of Fayette County is also unique within the outcrop belt in displaying a general northward truncation Silurian rocks beneath the sub-Middle Devonian erosional surface. In fact, the sub-Devonian edge of Silurian rocks occurs near the Fayette-Winneshiek county line; to the north, Devonian rocks rest directly on Ordovician strata. The edge of Silurian rocks is not a depositional edge, and there is no evidence of ancient shoreline deposits at this edge. Instead, the edge is strictly an erosional margin, marking the extent of erosional removal of Silurian rocks prior to the resumption of deposition in the Middle Devonian. Middle Devonian rocks buried this erosional escarpment, and the progressive onlap of these Devonian strata onto the feature underscores the development of a paleotopographic high associated with this erosional edge (Bunker et al., 1983). Silurian strata at Echo Valley State Park (Fig. 1) and the Volga River State Recreation Area (Fig. 3) are relatively thin compared to the much thicker sections of Silurian rocks seen southward in eastern Iowa, and only the oldest Silurian rocks are still preserved in the county.

Quaternary erosion has formed a prominent escarpment of relatively resistant Silurian strata above less resistant Ordovician shales below. This escarpment marks a prominent landform across parts of Fayette County and other places in northeast Iowa. The relatively steep escarpment of Silurian strata is cut by stream and river drainages forming prominent cliffs and picturesque rock-walled valleys in a number of places in Fayette County.

The Silurian rocks seen on this field trip include dolomite, limestone, and chert. These Silurian strata belong to several stratigraphic units including the Tete des Morts Formation, an undifferentiated Blanding-lower Hopkinton dolomite interval, and the Waucoma Limestone.

Tete des Morts Formation

The Tete des Morts Formation comprises the basal 10 to 20 feet (3-6 m) or so of Silurian dolomite in Fayette County, immediately above the Ordovician-Silurian unconformity. It is generally distinguishable not only by its basal stratigraphic position, but by its usually thick-bedded character. Large dolomite blocks, many greater than 5 feet (1.5 m) thick, are commonly transported down colluviated shale slopes below the Silurian escarpment in the area.

The Tete des Morts Formation was named for these thick-bedded dolomite strata along Tete des Morts Creek in Dubuque County (Brown and Whitlow, 1960; Willman, 1973), and the formation is recognized across much of eastern Iowa. Northward in Fayette County, these strata are replaced by basal Silurian limestone strata assigned to the Waucoma Formation (Bowman, 1985). It is likely that the Tete des Morts Formation and its stratigraphic equivalents in the Waucoma Limestone thin northward to a depositional margin near the northern boundary of Fayette County. The base of the Silurian section immediately north of the county line apparently correlates with the Blanding Formation (not the Tete des Morts) (see Witzke and Johnson, 1999).

Tete des Morts dolomite strata were deposited as the shallow Silurian sea spread northward and westward across eastern Iowa (Witzke, 1992). The formation is dominated by relatively pure carbonate strata, mostly dolomite but including dolomitic limestone near its diagenetic facies transition into the basal Waucoma Limestone northward in Fayette County. Unlike overlying Silurian strata, the Tete des Morts is relatively free of chert, although a few chert nodules may occur in the upper part of the formation. Visible fossils primarily include molds of crinoid debris, and molds and silicified fossils of laminar stromatoporoids and tabulate corals are also noted.

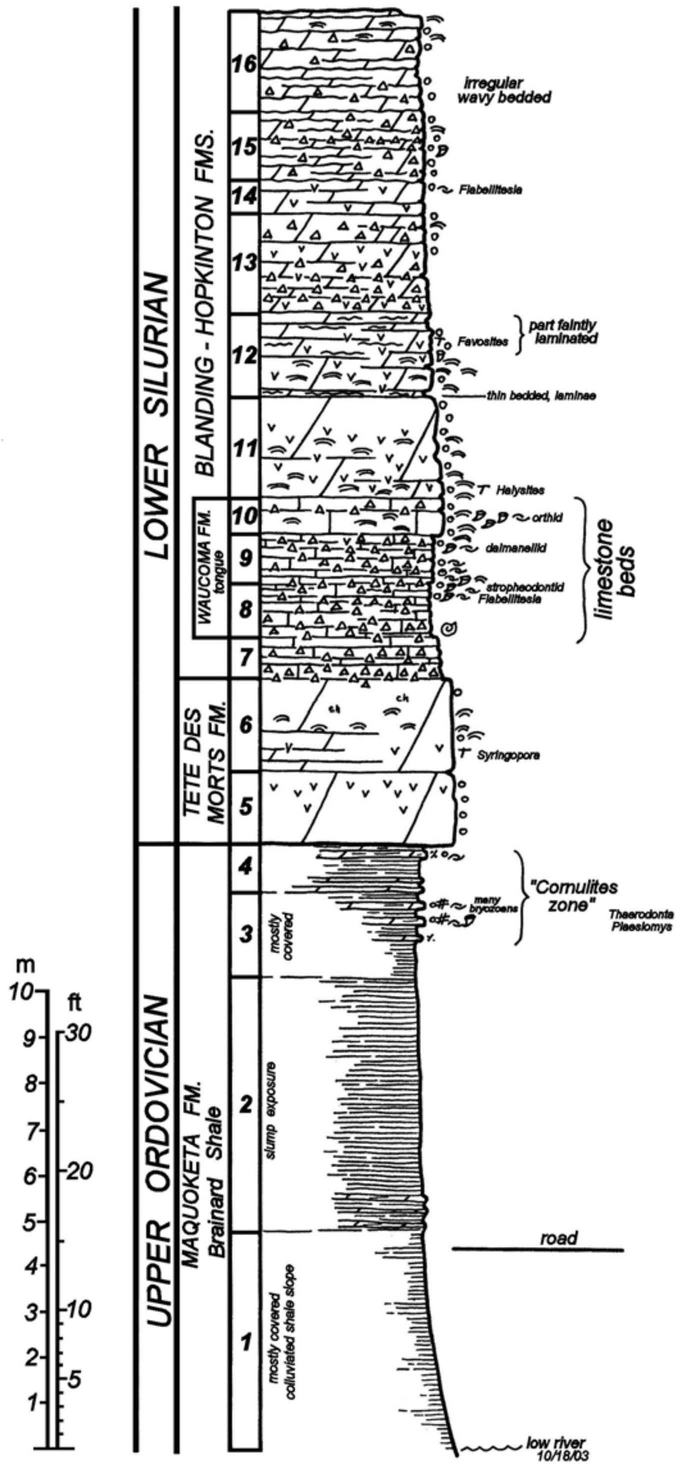

Figure 1. Graphic stratigraphic section of Ordovician and Silurian rocks displayed in the valley of the Volga River near the old Albany Bridge (NE SW SW SW sec. 14, T93N, R8W). Section measured by Brian Witzke and Stephanie Tassier-Surine. Symbols explained in Figure 2.

Waucoma Limestone

Introduction

Above the dolomite beds of the Tete des Morts Formation at Echo Valley and Volga River State Recreation Area, an interval of limestone and dolomitic limestone is identified. These strata provide a strong lithologic contrast with the Silurian dolomite beds above and below. For those unfamiliar with the Silurian carbonate rocks of eastern Iowa, a simple acid test (10% HCl) is a helpful way to distinguish limestone (strong fizz) from dolomite (weak fizz). Because of the lithologic distinctiveness and mapability of these limestone strata, the Silurian limestones of Fayette County have been differentiated as a separate Silurian formation, originally named the "Waucoma limestone" by Savage (1914). The Waucoma limestone beds are replaced southward in Fayette County by pervasively dolomitized strata of the Tete des Morts, Blanding, and lower Hopkinton formations (Bowman, 1985). At the field trip stops today, the Waucoma limestone is evident as a southward-extending limestone tongue within a the dolomite-dominated Lower Silurian succession. The limestone beds at Volga Rec Area are the southernmost exposures of the Waucoma limestone in the region. Farther south, all Silurian strata are pervasively dolomitized.

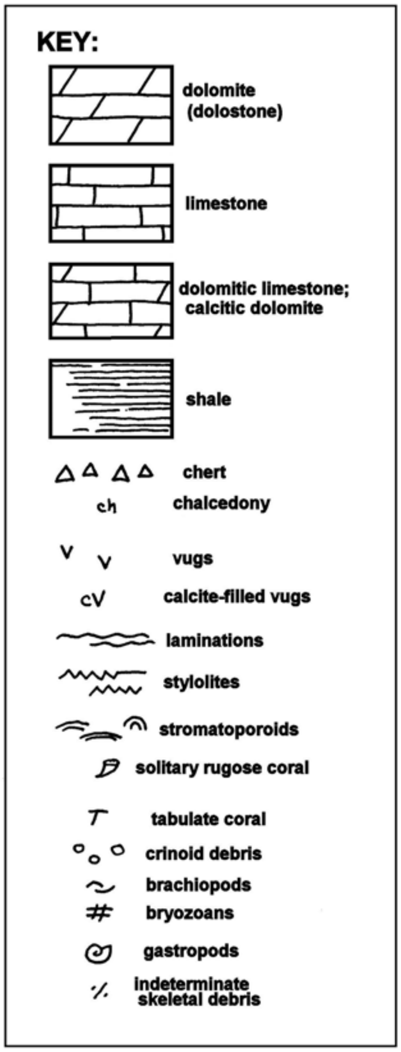

Figure 2. Key for symbols used on graphic bedrock sections (Figures 1 and 3).

Savage (1914) originally named a succession of Silurian limestone beds the "Waucoma limestone" after a series of 10 to 20 foot (3-6 m) thick exposures downstream from Waucoma along the Little Turkey River in northern Fayette County, Iowa. However, Savage (1926, p. 528-529) later dropped the term Waucoma and replaced it with the term "Kankakee limestone" (a name derived from northeast Illinois). Scoby (1935, p. 19) disagreed with Savage's correlation of these strata with the "Kankakee," and he re-assaigned these limestones to the "Edgewood" Formation (a stratigraphic unit first named in eastern Missouri). Witzke (1981, p. 177-178) concluded that the terms "Edgewood" and "Kankakee" were mistakenly correlated into the Iowa Silurian succession; as such, he resurrected the term Waucoma for the distinct limestone formation in northeast Iowa that encompasses Savage's (1914) original definition. Koch and Michael (1965, p. 10) stated that "the term 'Eldorado stone' has been popularly applied" to this limestone interval in northern Fayette County (named after quarries near Eldorado along the Turkey River drainage).

Three previous Geological Society of Iowa field trips have visited Waucoma Limestone strata in northern Fayette County, beginning with the trip of Koch and Michael (1965) who visited a Silurian limestone quarry near West Union. Bunker, Klapper, and Witzke (1983) discussed relationships between the Silurian limestone exposures along the Goeken Park/Eldorado road cut and the Silurian dolomite strata seen at the Fayette Quarry. Bounk (1983) discussed karstification of Waucoma Limestone strata, and his trip visited spectacular karstified exposures at Dutton's Cave Park, Wet Cave and Falling Spring, and Mittelstadt Cave, all in the West Union area.

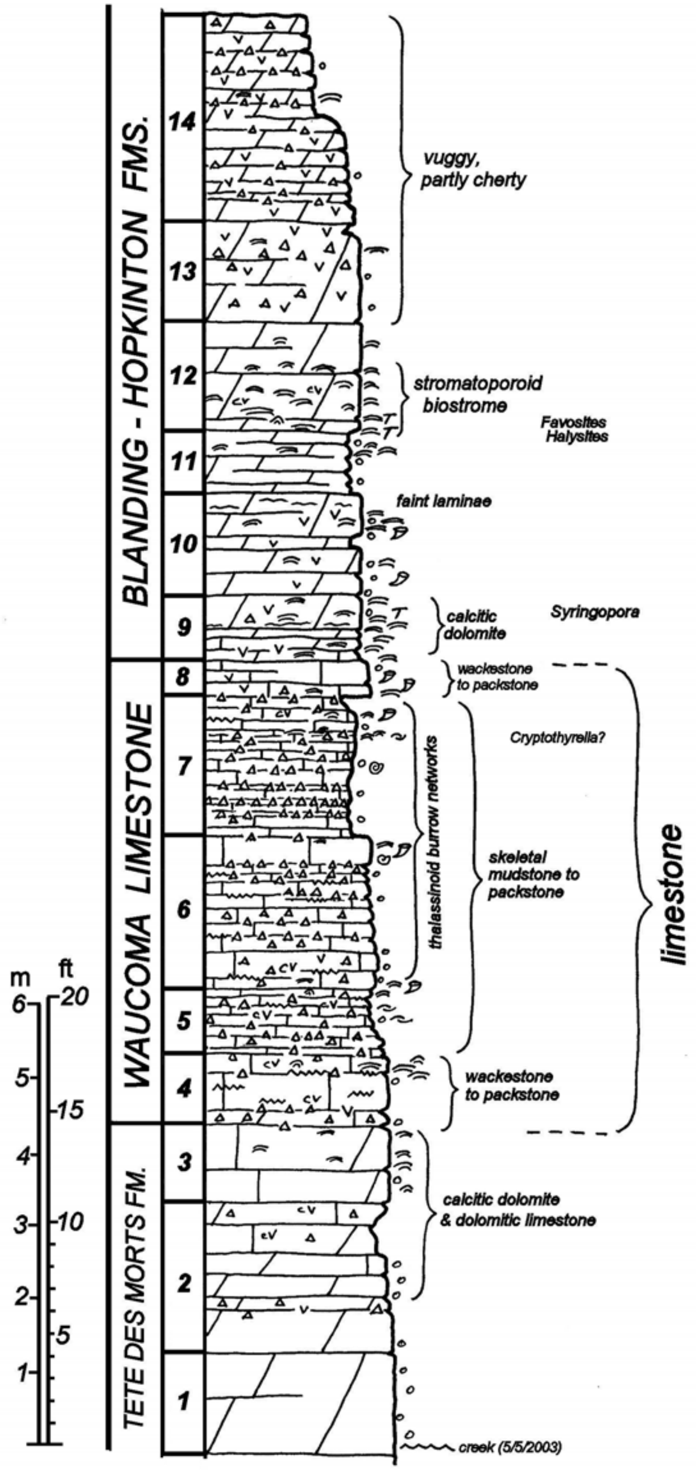

Figure 3. Graphic stratigraphic section of Silurian rocks exposed at the Backbone in Echo Valley Park (c E ½ NE NW sec. 22, T94N, R8W). Section measured by Brian Witzke and Bill Bunker. Symbols explained in Figure 2.

Following Witzke's (1981) preliminary work on the stratigraphy and deposition of the Waucoma Limestone as part of a regional stratigraphic synthesis, he returned to the Waucoma Limestone to characterize some of its gross lithologic characteristics (Witzke, 1983). Grid-counts at Goeken Park showed the Waucoma to contain a 1 to 2% volume of large fossils (macro-skeletal grains), dominantly lamellar (flat) stromatoporoids with scattered solitary corals, brachiopods, and nautiloids; the limestone matrix between these large grains was a fine- to medium-grained skeletal (especially crinoidal) wackestone to packstone. Bowman (1985) undertook a more comprehensive examination of the Waucoma Limestone, and his study remains the most comprehensive look at the Silurian limestones in Fayette County. Bowman (1985) examined many sections in Fayette County, including the Waucoma Limestone exposures at Echo Valley Park that will be visited as part of this field trip.

Distribution and Thickness

The Waucoma Formation is restricted to a relatively small region along the northeastern edge of the Silurian subcrop/outcrop belt in Iowa. It is best known from exposures in central to northwestern Fayette County, and outliers are also exposed in south-central Winneshiek County. Although not represented by surface exposures, the sub-Quaternary and sub-Devonian distribution of Waucoma limestone strata extends across west-central Fayette, southeast Chickasaw, and northeast Bremer counties (see mapped outcrop distribution by Witzke et al., 1998).

The Waucoma Formation reaches maximum thicknesses to 75 feet (23 m) in the subsurface of Fayette County, and the thickest known surface exposure at Dutton's Cave is 65 feet (20 m) thick (Bowman, 1985; Bounk, 1983). In areas where the Waucoma is overlain by Silurian dolomite strata, the formation varies from about 5 to 60 feet (1.5-18 m) in thickness. The Waucoma Formation is beveled northward beneath Middle Devonian strata, and near its northern limits in Winneshiek County the formation is a thin interval generally less than 10 feet (3 m) thick sandwiched between the Maquoketa and Pinicon Ridge formations.

Description

The Waucoma Formation is dominated by limestone, but dolomite and dolomitic limestone strata commonly occur in the lower part of the formation. The limestone strata variably are medium-bedded to massive, but irregularly-bedded and thin-bedded units also occur. Limestone lithologies are primarily skeletal wackestones and packstones, but skeletal mudstones and thin grainstones also are present (Bowman, 1985). The matrix typically is dominated by micrite with patches of microspar. Dolomite rhombs (calcitized in part) commonly are scattered within the micritic matrix, and some skeletal grains are partially dolomitized. Crinoid plates and ossicles comprise the dominant skeletal grains, but a variety of additional skeletal grain types also are present. Many limestone beds within the formation display lamellar to disc-shaped stromatoporoids and tabulate corals, but these generally comprise less than 2% of the total rock volume (Witzke, 1983). Most limestone strata display mottled and swirled textures indicative of extensive bioturbation, including so-called "thalassinoid" burrow networks. Pelleted fabrics are recognized in some beds, and small intraclasts are locally associated with thin grainstone units (Bowman, 1985). Spar-filled voids are locally common. Limestone strata are relatively free of argillaceous impurities, but scattered stylolites locally concentrate thin clay seams.

Some exposures of the Waucoma Formation are entirely free of chert, but nodular cherts are locally scattered to common in the middle to upper parts of the formation at many localities (such as those visited for this field trip). Nodular cherts are commonly "chalky" (dolomitic to calcitic), but many nodules are cored with "smooth" chert (pure microquartz). As seen on this field trip, chert nodules are commonly scattered in the limestone beds, but some strata show concentrations of chert nodules in thin bands; in a few examples, nodular bands locally coalesce into continuous thin beds of chert. Skeletal grain silicification and later-stage chalcedony and megquartz void fills also occur. The basal part of the formation is locally characterized by interbedded dolomite and dolomitic limestone strata, and dolomitic limestone interbeds are also seen in the upper part of the formation.

Fossils

Indeterminate crinoid debris dominates the fossil assemblages of the Waucoma Formation, but some identifiable echinodermal remains have been identified including crinoids (*Thalamocrinus*, *Cyathocrinites*), rhombiferans (*Brockocystis nodosaria*), and cyclocystoids (*Polytryphocycloides*, *Sievertsia*) (see Bowman, 1985). Corals and stromatoporoids are conspicuous in some beds. Lamellar disc-shaped stromatoporoids are locally common, most less than 8 inches (20 cm) in diameter (Tabulate Coral-Lamellar Stromatoporoid Community of Witzke and Johnson, 1999). Identifiable stromatoporoids include *Ecclimadictyon* and *Clathrodictyon* (see contribution by Carl Stock in this guidebook). Tabulate corals are less common, generally dominated by *Favosites* but locally including *Heliolites*, *Halysites*, and *Syringopora*. Solitary rugose corals and mollusks occur in some beds. Gastropods and straight-shelled nautiloids are locally common in some beds in the middle to upper parts of the formation. Occurrences of sponge spicules, bryozoans, ostracodes, and trilobites (*Stenopareia*) are recognized petrographically and on outcrop. Brachiopods are scattered as skeletal grains in the limestones, and the orthid *Flabellitesia* is the most characteristic form. Other brachiopods include *Cryptothyrella*?, *Dolerorthis*, dalmanellids, and stropheodontids. Brachiopod packstones are identified in the basal Waucoma in Winneshiek County that are characterized by dense accumulations of an indeterminate virgianid resembling *Platymerella* (Virgianid Community of Witzke and Johnson, 1999).

Stratigraphic Relations

The Waucoma Formation is a northern limestone facies that shares lateral stratigraphic relations with the dolomite succession to the south, but direct lithostratigraphic comparisons have proven difficult. The Waucoma unconformably overlies Ordovician shales of the Maquoketa Formation. The northward beveling of the Silurian succession beneath Middle Devonian strata provides some constraints on the upper limits of the Waucoma Formation. Devonian units directly overlie lower Hopkinton dolomite strata south of the Waucoma outcrop belt in Bremer and Fayette counties, and it is unlikely that higher Silurian units are present northward in Chickasaw and northern Fayette counties. As such, uppermost Waucoma strata would not likely correlate with any Silurian dolomite unit higher than the Sweeney Member of the Hopkinton Formation. The absence of *Pentamerus*-bearing intervals within the upper Waucoma further indicates that the Waucoma succession does not include any equivalents of the Marcus Member or higher strata within the Hopkinton Formation.

Lower Waucoma units do not resemble the argillaceous carbonates of the Mosalem Formation, the basal Silurian formation in parts of eastern Iowa, and correlation with any part of the Mosalem seems unlikely. However, the non-cherty dense carbonates of the lower Waucoma Formation are similar to the non-cherty thick-bedded carbonates of the Tete des Morts Formation, and correlation of these strata seems likely. In addition, the basal Silurian interval southward in Fayette County typically is assigned to the Tete des Morts Formation, underscoring probable correlation of basal units in both limestone and dolomite facies in adjoining parts of the county. However, the basal Waucoma beds near the northern limits of the formation contrast with those further south in containing pentamerid (virgianid) packstones. Elsewhere in the region, the lowest stratigraphic occurrences of pentamerids include *Stricklandia* in the basal Blanding Formation and *Platymerella* in the basal Sexton Creek Formation (eastern Missouri, western Illlinois) and Elwood Formation (northeast Illinois); these regional occurrences of stricklandiids and virgianids apparently correlate with the onset of early Aeronian transgression (Witzke and Johnson, 1999). If the basal Waucoma virgianid packstone unit of Winneshiek County also correlates with these regional pentamerid occurrences, a northward onlap of Waucoma strata is inferred. As noted, basal Waucoma strata in Fayette County most likely correlate with the Tete des Morts, but basal strata to the north in Winneshiek County probably correlate with the basal Blanding.

Much of the Waucoma Formation apparently correlates with the cherty Blanding Formation to the south, although the abundance of chert which characterizes the Blanding over most of its extent (Witzke, 1992) is not a general feature of the Waucoma. Nevertheless, cherty intervals are developed in the middle and upper Waucoma in the northern exposure, and the southward extending tongue of Waucoma strata (field trip stops) is also cherty. A northward decrease in chert content within the Blanding Formation is demonstrated across Fayette County, and the relative paucity of chert in correlative Waucoma strata of northern Fayette County is consistent with this trend of decreasing chert content. In places, the Waucoma limestone succession is conformably overlain by medium-grained non-cherty to cherty dolomite strata that resembles strata of the upper Blanding and lower Hopkinton formations to the south. This limestone-dolomite contact represents a diagenetic facies boundary, and it does not form a consistent stratigraphic datum.

Where not overlain by Silurian dolomite strata of the Blanding or lower Hopkinton formations, the Waucoma limestones are directly and unconformably overlain by Middle Devonian strata of the Pinicon Ridge Formation (Wapsipinicon Group). This contact is clearly exposed at several localities in northern Fayette County which show the Waucoma directly overlain by the Spring Grove Member. Likewise, all known well penetrations of the Waucoma-Wapsipinicon contact show the Spring Grove Member directly above the Waucoma. Farther to the south, however, Silurian dolomite strata are unconformably overlain by the Kenwood Member, the basal unit of the Pinicon Ridge Formation over most of eastern Iowa. The northward onlap of Silurian strata by units of the Pinicon Ridge Formation in Fayette County defines a sub-Middle Devonian paleotopographic high, the "Bremer High," and the Waucoma limestones are primarily restricted to the highest portions of this feature (Bunker et al., 1983).

Age

Probable stratigraphic equivalence of the Waucoma Formation with the Tete des Morts, Blanding, and lower Hopkinton formations to the south generally supports an Aeronian age (mid Llandoverian, Lower Silurian) for the Waucoma. The presence of the rhombiferan *Brockocystis nodosaria*, a taxon known from the Blanding Formation, further supports an Aeronian age. The presence of virgianids at the base of the formation indicates a Rhuddanian to lower Aeronian age (possibly correlative with *Platymerella*-bearing strata of the upper Elwood and basal Kankakee formations in northeast Illinois; Willman, 1973). Conodonts recovered from the Waucoma by Bowman (1985) were limited to *Panderodus* cf. *P. gracilis*, a long-ranging taxon. However, a number of well-preserved but reworked Silurian conodonts were recovered from basal Devonian strata in Winneshiek County immediately north of the sub-Devonian Waucoma edge (NE NE NE sec. 22, T96N, R9W); the stratigraphic and geographic position of this sample strongly suggests that the conodonts were reworked from adjacent beds of the lower Waucoma. Included are *Panderodus* cf. *P. gracilis*, *Walliserodus* cf. *W. curvatus*, *Pseudooneotus* cf. *P. beckmanni*, *Ozarkodina oldhamensis*, and *Ozarkodina hassi*. This conodont assemblage indicates a Rhuddanian and/or Aeronian age (Lower Silurian) for the source beds.

Deposition

Many shared similarities in carbonate fabrics and benthic faunas (lamellar stromatoporoids, crinoid debris) between laterally equivalent limestone and dolomite facies generally support similar depositional environments for the Waucoma Formation and the Tete des Morts-Blanding interval to the south. Subtidal carbonate shelf environments of normal-marine salinity are interpreted, and the abundance of carbonate mud indicates that the benthic environments were generally below normal wavebase and not subjected to continuous agitation. However, occurrences of packstone and grainstone lithologies, some displaying grading, intraclasts, and grain abrasion, indicates episodic bottom turbulence probably generated during storm events (Bowman, 1985). The presence of micrite envelopes around some skeletal grains supports a position within the photic zone. A northward onlap of the sub-Silurian unconformity surface is suggested during lower Waucoma deposition, with the basal strata (Tete des Morts equivalents) overstepped during the regional expansion of the Blanding seaway. This episode of seaway deepening at the field trip stops is marked by an interval of sparsely-fossiliferous mudstone-dominated limestone lithologies above the Tete des Morts Formation (units 7-9 at Albany Bridge; units 5-7 Echo Valley).

Why Limestone?

The entire Silurian succession is pervasively dolomitized at most localities in eastern Iowa, and the occurrence of non-dolomitized Silurian limestone strata in the Waucoma Formation of Fayette County seems regionally anomalous. The fortuitous preservation of the Waucoma Limestone enables geologists to directly compare these facies with laterally equivalent dolomite strata to the south. Dolomitization is a diagenetic process that commonly obscures or obliterates original depositional fabrics, especially at a microscopic scale (thin-section petrography). By contrast, the Waucoma Limestone beds provide clear evidence of the original textures and fabrics of the primary carbonate sediments (as aptly shown by Bowman, 1985). In essence, the Waucoma Limestone enables us to see what the sediments of the Tete des Morts and Blanding formations looked like before they were obscured and assaulted by dolomitization. The excellent preservation of stromatoporoids within the Waucoma Formation enables the fine skeletal structure to be seen, thereby allowing clear taxonomic identification of these fossils (see Stock, this guidebook). This is especially fortuitous, as dolomitization and silicification of these stromatoporoids elsewhere in the Lower Silurian precludes their identification.

But why are limestone strata preserved at all – why haven't these beds also been dolomitized? And what explains the southward intertonguing of Waucoma Limestone with the more widespread Silurian dolomites of eastern Iowa. The answers to these questions have proven difficult to come by, but further evaluation of the Waucoma will likely provide important insights into the process of regional dolomitization. Witzke (1981), Bowman (1985), and Ludvigson et al. (1992) all suggested that the Silurian carbonate sediments were diagenetically altered and regionally dolomitized during the progression of marine phreatic, mixing zone, and freshwater phreatic groundwater systems during the withdrawal of the interior seaway later in the Silurian. The process of dolomitization apparently requires long episodes of residence time within mixing-zone groundwater systems (Witzke, 1981). The relatively undolomitized character of the Waucoma Limestone suggests that these strata may have experienced limited residence time within the mixing-zone system, possibly due to comparatively rapid withdrawal of the seaway from more shoreward (and topographically higher) areas of northern Iowa (Witzke, 1981; Bowman, 1985).

Undifferentiated Blanding – Lower Hopkinton Strata

The highest part of the Silurian section exposed at Echo Valley and Volga River State Recreation Area, above the limestone beds of the Waucoma Formation, is characterized by a succession of dolomite and cherty dolomite strata. These dolomite beds are typically medium-crystalline saccharoidal (sugary-textured) dolomites with scattered to common vugs (vugs are open cavities that give the rock a Swiss-cheese-like appearance). Small molds of crinoid debris are commonly seen, and silicified masses of stromatoporoids and corals are locally prominent. In some beds, the corals and stromatoporoids are not silicified, but are preserved as molds within the dolomite strata. Scattered chert nodules and nodular chert bands occur within the succession, but not all beds are cherty, and chert content is variable both laterally and vertically in the section. This dolomite and cherty dolomite succession closely resembles strata of the upper Blanding and lower Hopkinton formations to the south.

The Blanding Formation, whose name derives from a town in northwest Illinois (Willman, 1973),is a widespread Silurian dolomite unit that ranges between about 35 and 65 feet (11-20 m) in thickness in the eastern Iowa outcrop. Across most of its extent in eastern Iowa it is distinguished by its very cherty character (Witzke, 1992), which contrasts with less cherty strata of the lower Hopkinton Formation above. However, northward across Fayette and Black Hawk counties, the Blanding loses its distinctive very cherty character, where it becomes largely indistinguishable from the partly cherty dolomites of the lower Hopkinton Formation. In these areas, the formations are not readily differentiatable, and the interval is best regarded as an undifferentiated Blanding-Hopkinton unit.

The Hopkinton Formation derives its name from exposures along the Maquoketa River near the town of Hopkinton in Delaware County. The Hopkinton Formation averages about 130 feet (40 m) thick in the eastern Iowa outcrop, where it is differentiated into four members (Witzke, 1992). Picturesque exposures of the Hopkinton Formation are displayed at many localities in eastern Iowa, including Backbone State

Park (Witzke, 1995). The highest Silurian dolomite strata at Echo Valley and Volga River State Recreation Area probably correlate with the basal part of the Hopkinton Formation, Sweeney Member. Higher Hopkinton strata, which contain prominent accumulations of *Pentamerus* or *Stricklandia* brachiopods, have not been recognized in central or northern Fayette County, indicating that the succession there ranges no higher than the lower Sweeney Member. Silurian dolomite strata of the Blanding-lower Hopkinton interval in Fayette County are unconformably overlain by Middle Devonian strata of the Pinicon Ridge Formation (Kenwood and Spring Grove embers).

UPPER ORDOVICIAN SHALE
(MOSTLY COVERED SLOPES)

Maquoketa Formation

The Maquoketa Formation (also termed the Maquoketa Shale in eastern Iowa) is a widespread Upper Ordovician rock unit that is recognized across much of the central United States. Its name derives from the Little Maquoketa River in Dubuque County, Iowa (see Witzke and Heathcote, 1997). The Maquoketa Formation in Fayette County ranges in thickness between about 260 and 290 feet (79-88 m), where the succession is subdivided into four members. Much of what is known about the Maquoketa Formation in Iowa derives from classic exposures in Fayette County, and, in fact, three of the four members derive their names from exposures in the county (Ladd, 1929). The Maquoketa succession is subdivided, in ascending order: Elgin Member (interbedded limestone and shale; basal phosphorite), Clermont Member (shale dominated), Fort Atkinson Member (limestone dominated; named after Fort Atkinson in Winneshiek County), and Brainard Member (shale dominated).

The Brainard Shale is exposed within the Volga River State Recreation area. Kellogg and Young (1979) were able to map the general distribution of this Ordovician unit at the base of the bluffs throughout much of the public area. The relatively impermeable nature of the Brainard Shale contrasts notably with the fractured and karstified Silurian carbonate rocks above. This contrast in permeability was of considerable importance for siting the reservoir within the recreation area, as the Silurian limestone and dolomite strata would have been unable to contain a deeper or bigger reservoir (as originally envisioned) without significant leaking. Water readily and rapidly moves through fractured and karstified Silurian rocks, but the Brainard Shale forms a barrier (aquitard) to further downward movement. As such, the Silurian-Ordovician contact at the top of the Brainard Shale forms a natural place for water discharge in springs and seeps, as seen at localities within the Volga River State Recreation Area. The relatively soft and easily erodable Brainard Shale does not hold up well on outcrop (unlike the resistant strata of the overlying Silurian beds), and the unit, even though widespread in the area, is generally poorly exposed and commonly overgrown with vegetation and covered with colluvium (blocks of Silurian rock moving downslope). Active slumping has locally exposed the Brainard Shale, as seen near the Albany Bridge.

The Brainard Shale derives its name from exposures north and east of the “small railway station” at the hamlet of Brainard (Calvin, 1906. p. 97), which lies in the Otter Creek Valley about 3.5 miles (5.5 km) northeast of the Volga River State Recreation Area. The Brainard Shale is dominated by green-gray to blue-gray dolomitic shale, averaging over 100 feet (30 m) thick in Fayette County. Most of the Brainard interval is dominated by a monotonous succession of unfossiliferous shale (the “barren lower portion” of Ladd, 1929). Thin argillaceous to shaly dolomite beds, generally unfossiliferous but locally burrowed, occur within the shale succession. The upper 5 to 20 feet (1.5-6 m) or so of the Brainard interval, by contrast, contains interbeds of fossiliferous dolomite. Although these strata are dolomitized, the fossil preservation is nearly perfect, and the beds closely resemble fossiliferous limestone. This interval has been termed the “*Cornulites* zone” by Ladd (1929), named after a distinctive ribbed worm-like tube that is scattered to common in these beds. A variety of fossils are known from these beds, especially bryozoans and brachiopods. The brachiopods *Thaerodonta*, *Plaesiomys*, *Lepidocyclus*, and *Hypsiptycha* are particularly common (Witzke et al., 1997). Crinoids, gastropods, trilobites, nautiloids, and solitary corals are also noted. These fossiliferous strata are noted in the upper Brainard interval near the Albany Bridge, primarily as float blocks. A well-known collecting locality for "*Cornulites* zone" slabs is in the valley of Patterson's spring near Brainard.

The Ordovician seas withdrew from eastern Iowa at the close of Maquoketa deposition, and a major erosional unconformity separates the Maquoketa shales from overlying Silurian carbonate strata. In places in eastern Iowa, significant erosionial relief was developed on the Maquoketa shales before the deposition of Silurian sediments.

THE FIELD TRIP

Our first examination of Paleozoic bedrock will be at Stops 2 and 3 at Volga River State Recreation Area. These stops show colluviated bedrock, which portrays the weathering and downslope breakdown of Silurian bedrock. Solutionally-pitted blocks, some very large, are scattered down the slopes, indicating downslope movement of the weathered and broken rock. The bedrock surface is a relatively diffuse contact, with broken and weathered blocks incorporated within loess and soil. These Silurian strata are primarily dolomite and cherty dolomite of the undifferentiated Blanding-lower Hopkinton interval.

A spectacular steep exposure along the valley walls of the Volga River will be visited near the Albany Bridge in the southern part of the recreation area (see Figure 3). This section is steep and potentially hazardous, and people uncomfortable on steep slopes are discouraged from accessing the section. Small exposures of the Brainard Shale are scattered in the lower parts of the valley walls, and a slump has exposed a fairly large shale section about 250 feet upstream from the bridge. The Ordovician-Silurian contact can be seen upslope from the road, near the bridge. The Silurian section at Albany Bridge is well displayed, and the entire section is accessible (but slopes and cliffs may be potentially hazardous). The thick-bedded dolomite strata of the Tete des Morts Formation is overlain by cherty recessive beds of the Blanding Formation. A tongue of cherty limestone, the Waucoma Limestone, occurs within this lower Blanding interval. Fossils are well preserved within the limestone beds, unlike the more poorly preserved molds and silicified fossils of the dolomite strata above and below. Above the limestone beds, the upper strata are included within an undifferentiated upper Blanding-lower Hopkinton formation. These beds are variably cherty, and silicified lamellar stromatoporoids are noteworthy in some beds. The section is capped by colluvium and loess at the top of the bluff.

The Silurian bedrock exposures at Echo Valley State Park form picturesque cliffs and ledges along Otter and Glover creeks. The most complete and most dramatic of these exposures is seen at the Glover Creek Backbone, a narrow ridge of Silurian rock between Glover and Otter Creeks flanked by cliffs and steep bedrock slopes (see Figure 1). About 65 feet (20 m) of Silurian strata are exposed there, and the section is accessible (please follow instructions of the trip leaders). Dolomitic strata of the Tete des Morts Formation begin at creek level, which are overlain by an instructive interval of cherty limestone belonging to the Waucoma Limestone. Skeletal material is concentrated within irregular burrow networks within the limestone. Much of the limestone interval is seen as a recessive cliff former, below the bold cliff face of the undifferentiated upper Blanding-lower Hopkinton interval. These upper strata are characterized by dolomite and cherty dolomite. Vugs and solutional openings become increasingly common upward in the interval. Stromatoporoids are scattered throughout, but are especially common within unit 12, where scattered tabulate corals are also seen. The Glover Creek Backbone at Echo Valley State Park is remarkably similar in appearance to the well-known feature at Backbone State Park in Delaware County, and both features are developed by the erosion of Silurian strata.

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STROMATOPOROIDS IN THE AERONIAN (LLANDOVERY, LOWER SILURIAN) OF THE US MID-CONTINENT

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It is a common belief that all limestones in the Silurian of the US Mid-Continent were dolomitized, and that all the stromatoporoids they contained were dolomitized or silicified, thus rendering them unidentifiable; however, there are some exceptions to the dolomitization. The authors of this paper began a collaboration to study the Llandovery-age (Early Silurian) stromatoporoids in the US, in order to describe their recovery following the latest Ordovician mass extinction. Our work has advanced to the stage where genera have been identified (Nestor & Stock, 2001), but species-level identifications are still in progress.

Most of the occurrences of unaltered Llandovery stromatoporoids are found in the Aeronian Stage, which is Middle Llandovery. We have collections of Aeronian stromatoporoids from six states in the US Mid-Continent that are described below. Collections of stromatoporoids from the Llandovery of New York, and Anticosti Island, Quebec are also in hand, but will not be discussed here. Nor will we discuss Upper Llandovery (Telychian) stromatoporoids from the LaPorte City Formation of Iowa and the Cordell Dolomite of Michigan.

STROMATOPOROID FAUNAS

Iowa.—The characteristics and extent of the Waucoma Formation are described elsewhere by Witzke (this guidebook). We have identified two genera of stromatoporoids from the Waucoma: *Clathrodictyon*, and *Ecclimadictyon*. In addition, we have questionably placed some specimens in *Stelodictyon*, a genus closely resembling *Clathrodictyon*. Our collections are from Echo Valley State Park and Goeken County Park, both in Fayette County.

Missouri.—This is the only state under consideration from which Aeronian stromatoporoids have been published in the past 90 years. Birkhead (1967) described three species of *Clathrodictyon* (now partly identified as *Ecclimadictyon*) from the Cyrene Member of the Edgewood Formation in northeastern Missouri. According to Thompson (1993), the Cyrene is now regarded as the Kissenger Limestone Member of the Bryant Knob Formation. A fourth species of *Clathrodictyon* came from the Sexton Creek Formation in the southeastern part of the state. The Bryant Knob and Sexton Creek are laterally equivalent. In 1998, we collected several more stromatoporoids from the Sexton Creek, but our collecting proved unsuccessful in the northeastern part of Missouri. It is our conclusion that both *Clathrodictyon* and *Ecclimadictyon* occur in the Aeronian of Missouri.

Oklahoma.—The Blackgum Formation is restricted to a small area of eastern Oklahoma (Amsden, 1980). Stromatoporoids were collected by Stock from the type locality on the eastern shore of Lake Tenkiller. Both *Clathrodictyon* and *Ecclimadictyon* are present in the Blackgum.

Alabama.—The Red Mountain Formation of Alabama includes all of the Llandovery, plus some lower Wenlock and upper Pridoli portions (Chowns, 1996). Stromatoporoids are a rare component of the mostly siliciclastic, geographically widespread Llandovery portion of the Red Mountain, but are more common in the geographically restricted Pridoli part (Stock, 1996). We have found *Ecclimadictyon* and *Forolinia* in the Aeronian portion of the Red Mountain.

Ohio.—The Brassfield Formation extends from northwestern Alabama through Tennessee and Kentucky into Ohio. We have found stromatoporoids in the Brassfield in southwestern Ohio. Stock's master's student, Deirdra Hahn, has studied the Brassfield stromatoporoids from West Milton, Ohio, northwest of Dayton, and we have studied those from northeast of Dayton, at Fairborn, Ohio. These collections yielded *Clathrodictyon*, *Ecclimadictyon*, *Intexodictyon*, and specimens questionably assigned to *Plexodictyon.* Bioherms in the Brassfield at Fairborn have been described by Schneider and Ausich (2002), and there are numerous small bioherms in the Brassfield at West Milton that were described briefly by Hahn (as Cantrell, 2000).

Michigan.—The Hendricks Formation of the Upper Peninsula of Michigan is a dolostone, within which occurs the Fiborn Limestone Member—the well preserved stromatoporoids are contained within this Member. The Silurian stratigraphy of the Upper Peninsula has been described in detail by Ehlers (1973). We found *Clathrodictyon*, *Ecclimadictyon*, *Intexodictyon, Petridiostroma, Syringostromella, Pachystroma, Lineastroma* and *Neobeatricea* in the Hendricks, as well as specimens questionably assigned to *Stelodictyon* and *Actinodictyon*. In addition to these, there is a new genus showing characteristics of both orders Labechiida and Actinostromatida—this is the most common genus collected. Our Michigan collections came from five localities in Mackinac County—there is a large bioherm present at the Inland Quarry site.

SUMMARY

The stromatoporoid fauna of the Waucoma Formation is typical for the Aeronian, in that it contains the ubiquitous *Clathrodictyon* and *Ecclimadictyon*. The low genus diversity of the Waucoma (three) is not unusual for Aeronian stromatoporoids. An epeiric sea inundated much of North America during the Aeronian, allowing the planktonic larvae of the stromatoporoids to drift among the various locales described in this paper.

The anomalously high genus diversity of the Hendricks Formation of northern Michigan stands out from the others. Why 11 genera instead of two-three, and why is the most common, new genus found only there? One can only assume that access to the Michigan Basin during the Aeronian was restricted, so that not all of its fauna could spread to other areas, or that there was a greater variety of depositional environments available relative to other mid-continent localities. Because five of the 11 genera present represent first occurrences in the geologic record, Stock and Nestor (2001) declared the Michigan Basin a center of originations for the Aeronian stromatoporoids.

The lone occurrence of *Forolinia* in Alabama is probably due to the locality being close to the then southern margin of the Laurentia plate, as the genus is also found in New York and on Anticosti Island, Quebec. *Forolinia* is also recorded from the Llandovery of Estonia.

ACKNOWLEDGMENTS

Acknowledgment is made to the Donors of the Petroleum Research Fund, administered by the American Chemical Society, for support of this research. In addition, the National Research Council Twinning program and the Estonian Science Foundation (grant No. 3749) partially supported the research. Stock was guided in the field by Brian Witzke in Iowa, and William Ausich and Roger Cuffey in Ohio. Thomas Thompson accompanied the authors in the field in southeastern Missouri. We express our thanks to Deirdra Hahn and John Griffin of the University of Alabama, who prepared many of the thin sections used in this research.

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FIELD TRIP STOPS AT THE VOLGA RIVER STATE RECREATION AREA

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INTRODUCTION

The Volga River State Recreation Area is one of Iowa's largest outdoor recreation areas with 5,492 acres of land. The land that constitutes the recreation area was aquired by the State of Iowa between 1968 and 1971 as a part of the Iowa Conservation Commission's "Large Lakes" program of the early 1960's. The original plan included the creation of a large artificial lake dedicated to water-oriented outdoor recreation in an area of the state that was deficient in such opportunities. The large lake could not be constructed because of potential high rates of water leakage through the fractured and permeable limestone and dolomite bedrock at the proposed lake site. Several alternative plans were also abandoned because of the bedrock (for more information see ***Volga Lake: A History of Politics and Science*** beginning on page 7 of this guidebook). Eventually, the 130-acre Frog Hollow Lake was completed in 1980. Potential seepage problems at this site were addressed by sealing the lake bottom with several feet of clay from a nearby hillside.

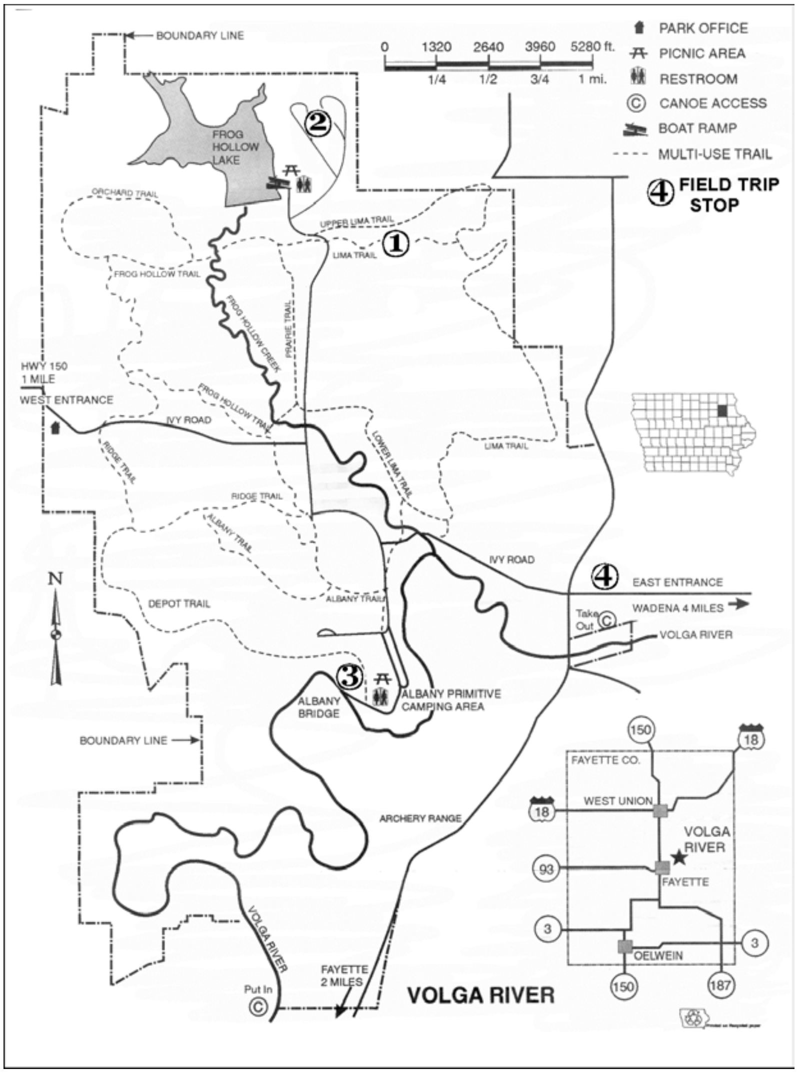

Figure 1. Map of the Volga River State Recreation Area.

Facilities at the recreation area are still being developed, but to date, completed facilities include the 130-acre lake with boat ramp; parking area and pit vault restroom; an accessible fishing pier; a non-modern campground for both equestrian and non-equestrian campers; multi-use trails; park office and maintenance area complex; and a comprehensive vegetation management program. The Volga River State Recreation Area is popular for small game, deer, and turkey hunting. Lake fishing has been reasonably good. Multi-use trail activities include hiking, horseback riding, snowmobiling, and mountain biking. Camping use is light to moderate with good numbers of equestrian campers. Drive through sightseeing is popular, but picnicking activity is very minimal at present due to the absence of formal picnic facilities.

FUTURE PLANS FOR THE VOLGA RIVER STATE RECREATION AREA

Development of the Volga River State Recreation Area is not yet completed. Based on the concept plan for the area, about two-thirds of the site was to be managed as a Natural Area- managed to maintain and enhance a highly diverse ecological mix of forest, savanna, grassland, marsh, pond, and other natural environments combined with selected agricultural uses for wildlife food plots and forage areas. Unique envirnomental features were to be protected and preserved.

Recreation development is planned to allow for a considerable activity range and visitation while placing an emphasis on the scenic and ecological qualities of the area. Proposed recreational facilities (Fig. 2) are to include picnic grounds with shelters and restrooms, a modern campground and primitive camping areas, a specialty group camp area, rental cabins, winter sports areas including ski, toboggan, and sled runs, cross country ski trails, trails for hiking, equestrian facilities and horse trails, snowmobile trails, a visitor interpretation center, a swimming beach, scenic overlooks, and fishing and hunting facilities. It was originally envisioned that these facilities would be completed by about 2000. DNR funding cuts have delayed completion of many of these projects, but officials are still confident of the ultimate completion of most.

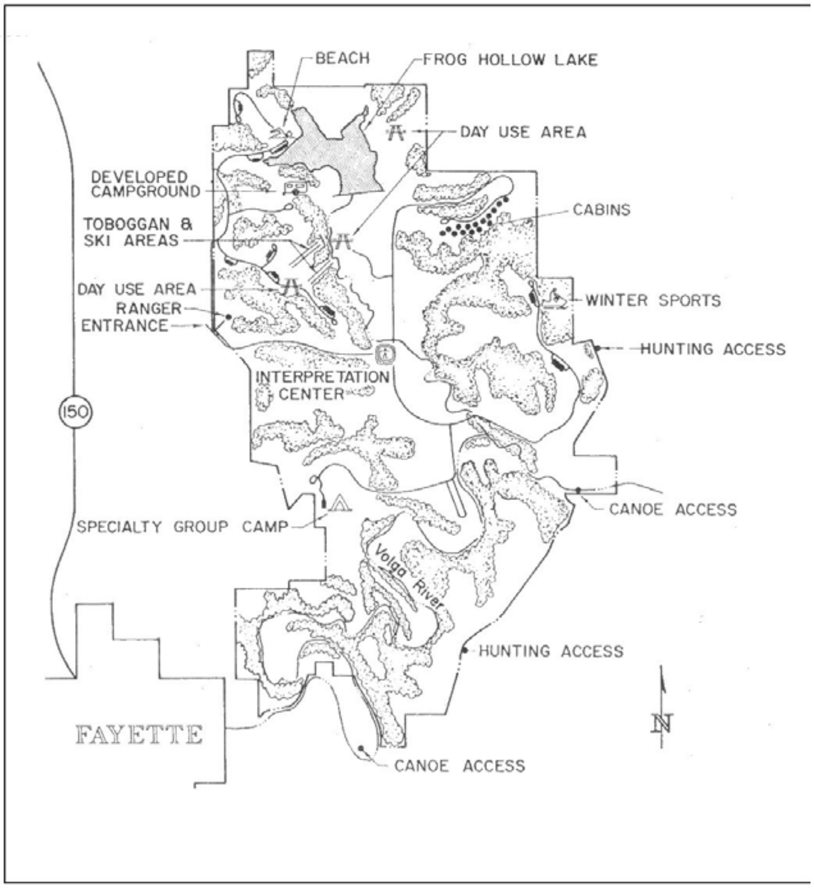

Figure 2. A 1979 uses and facilities plan for the Volga River State Recreation Areas.

FIELD TRIP STOPS AT VOLGA RIVER STATE RECREATION AREA

Field trip participants will gather at 9:00 am on November 8, 2003, at the parking area at the south end of Frog Hollow Lake at the north end of the State Recreation Area. The 130 acre Frog Hollow Lake, which was competed in 1980, represents the culmination of a sometimes bitter fight between local politicians who were pushing for a large water recreation facility for northeast Iowans and geoscientists and lake opponents who argued that the porous, fractured carbonate bedrock was too permeable to confine the lake (for a detailed discussion of the history of the lake see ***Volga Lake: A History of Politics and Science*** beginning on page 7 of this guidebook).

From the parking area we will hike about ½ mile to Field Trip **Stop 1.** Follow the trip leader south along I street to the Lima Trail (Fig. 3). The Lima Trail is named for the small village of Lima that once existed on the eastern end of the trail, just outside the limits of the Recreation Area. Procede along the Lima Trail for about ¼ mile.

Stop 1. Sand Prairie and Residuum Along the Lima Trail

by Stephanie Tassier-Surine
Iowa Geological Survey
and
John Pearson
Iowa DNR, Conservation & Recreation Division

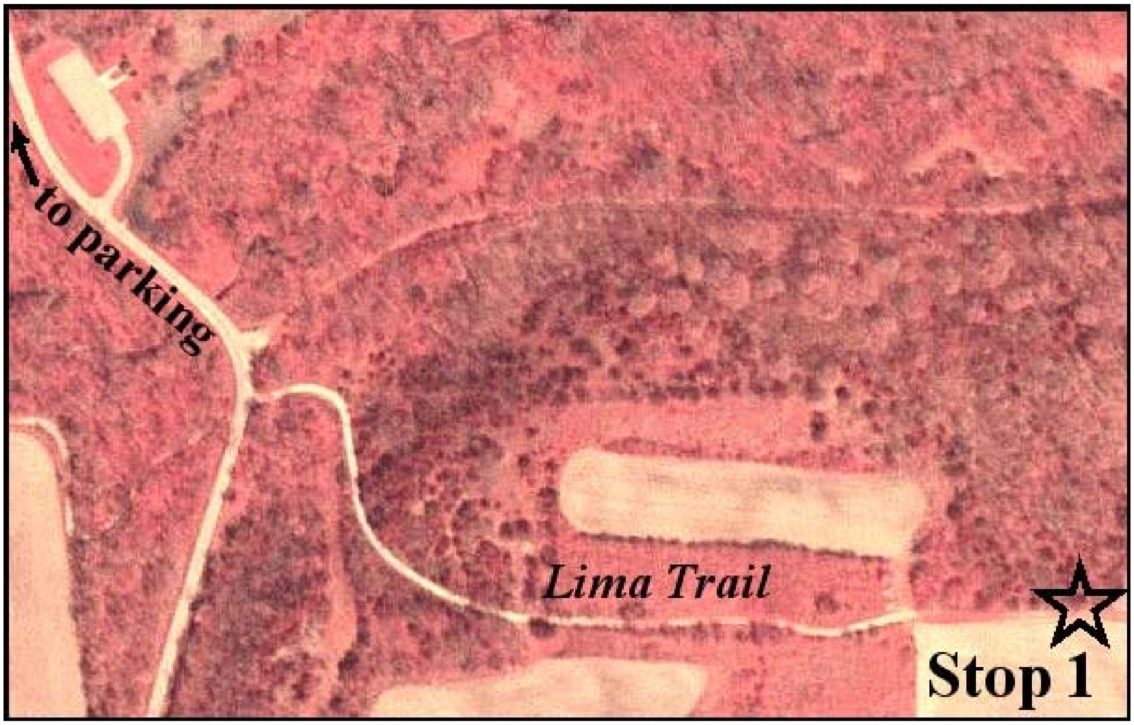

Figure 3. Aerial photograph showing route to Stop 1, Volga River State Recreation Area.

As you walk along the Lima Trail note that the trail passes into an area of fine-grained eolian sand. Continuing along the trail the sand becomes mixed with abundant, angular chert fragments. ***Why do you think that the chert is so abundant in this fine-grained sand?*** Moving further down the trail to **Stop 1,** the sand changes into a weathering residuum, a lag deposit from the weathering of glacial till and cherty Silurian dolomite bedrock. Note the variety of rock lithologies in this area.

Depart **Stop 1** and return back along the Lima Trail to the cars. Form a car caravan and follow the trip leaders to the first cul-de-sac road in the northeast corner of the Recreation Area (see map Fig. 1). Park cars as instructed by trip leaders. We will look at exposures of colluviated Silurian dolomite in the low bluff to the east of the parking area. (Fig. 4).

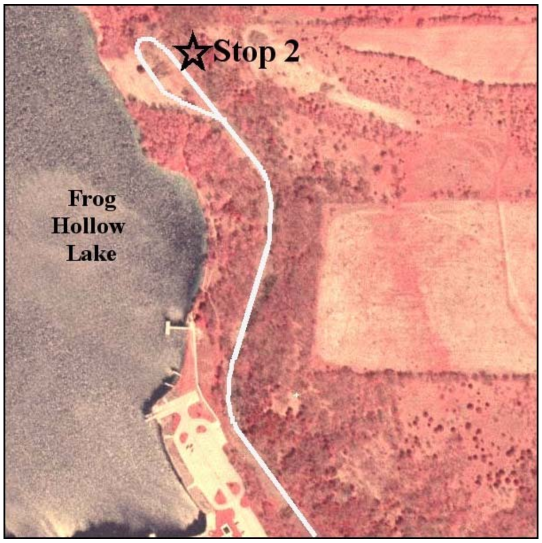

Figure 4. Aerial photograph showing Frog Hollow Lake and the road to Stop 2.

Stop 2. The Colluviated Bedrock Surface at Volga River State Recreation Area

by Brian Witzke
Iowa Geological Survey

Colluvium is defined by the American Geological Institute's ***Dictionary of Geological Term****s* as "*A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.*" Colluvium is a commonly observed material in high-relief regions, such as northeast Iowa. For geoscientists working in these areas, it is very important to be able to identify this material and to understand its significance and the information that it can convey. At this stop we will examine colluviated Silurian bedrock and see what information we can learn from such a deposit.

Depart parking area at **Stop 2** following field trip leaders, return to I Street, and head south. Pass junction with Ivy Road (road to park entrance) and continue south following Ivy road to stop sign. Turn left (east) with Ivy Road then take curve to the right (south)-Ivy Road continues east. Continue south past equestrian campground. ***Note: the roads in the equestrian campground were the streets in the town of Albany that was purchased and cleared by the State when planning a large lake for the area*** (for more information see ***Volga Lake: A History of Politics and Science*** beginning on page 7 of this guidebook). Follow the road south then west and park near the Albany Bridge as directed by field trip leaders.

Figure 6. Albany Bridge was left standing when the town of Albany was cleared for the construction of Volga Lake.

Stop 3. The Ordovician - Silurian Contact at the Albany Bridge Section

by Brian Witzke
Iowa Geological Survey

The trees that line the north side of the road hide precipitous cliffs of Silurian dolomite and limestone. At this location is an excellent exposure of the contact of the Silurian dolomites [see stratigraphic section, p. 43] with the underlying Ordovician Maquoketa Formation Brainard Shale (see Fig. 7). For more information on these rocks see discussion by Witzke, p. 41 of this guidebook. At this stop, Brian Witzke (Iowa Geological Survey) will discuss these units, and the nature of the incision of the Volga River into these rocks and the Silurian Escarpment. Some of you will be able to follow the trip leaders up the very steep trail near the Albany Bridge to the foot of the bluff to view the contact pictured in Figure 7. You will be have time to explore the rock exposures along the Volga River on your own, but **BE VERY CAREFUL. THE SLOPES ARE VERY STEEP AND UNSTABLE.**

Figure 7. Field trip leader Brian Witzke at Stop 3. Head of hammer marks the contact between the Silurian Tete des Morts Fm. dolomites and the underlying Ordovician Brainard Shale.

Depart **Stop 3** and return back north past the Equestrian campground to Ivy Road. **(**for Optional Stop 4 see below**)** Follow Ivy Road west and north to the entrance to Volga River State Recreation Area. Continue west to Highway 150, turn right (north) and continue to West Union. At the south edge of West Union turn right (east) on Highway 56 and continue for several blocks until road curves right (south). Turn north (left) on South Pine Street and continue north for several blocks to the intersection with Echo Valley Road. Turn right (east) on Echo Valley Road and follow it for about ¼ mile to the entrance of Echo Valley State Park.

Stop 4 (Optional). Lima Cemetary

by Raymond R. Anderson and Jerry Reisinger
Iowa Department of Natural Resources

The Town of Lima

The town of Lima was one of the first areas of Fayette County to be inhabited by Euro-Americans. Its first residents, Erastus (Eucharasitic) A. Light and Harvey Light, T.R. Talbott and Stephen Ludlow moved to what was to become Lima from Wisconsin in 1849. They named their new village Lightville. The Lights built a mill for sawing lumber and grinding corn on the Volga River in 1849-1850. In 1851, the town was platted and named Volga at that time. Later that year Volga barely lost a countywide election to West Union for the honor of being the County Seat. In 1853, a legislative act changed the name of the town to Lima, because the name Volga had already been taken by a Clayton County town. A general store was started in Lima very soon after it was founded. The Lima general store became an area institution. In the early 1870s, work began on railroads in the area, but because of a series of economic failures the track didn't make it to Lima until 1882 when the Chicago, Milwaukee & St. Paul reached the Lima on the way to West Union. The line, which came from the Mississippi River up the Turkey Valley then on to the Volga Valley, to Volga City, Wadena, Lima and finally West Union, would function until 1938, when the rails were torn out. In its heyday, Lima boasted a post office, lumberyard, and stockyards. A small railroad steam engine that worked the line from Wadena to Lima to West Union was affectionately known by locals as the "Dinky".

The Lima Cemetery

Much of the history of Lima is documented at the Lima Cemetery. Included in the reasonably rich on-line record of the town of Lima is a comprehensive list of burials at the cemetery. One of the most interesting is that of John Crawford. Crawford had worked faithfully on the area farm of Crit Harrison for 18 years. When he died of tuberculosis in 1905, his two sisters, who lived in Wadena, were determined that their brother should have a proper monument. With money the two sisters had saved, and additional funds from Harrison, Harrison's sister, Lib, set out with to find a suitable monument. She traveled to Barre, Vermont and contracted for a monument, but the sculptor ruined the granite block. So, the company sent to Italy for a sculptor who completed the monument and it was shipped by rail to Lima, and set in place with great difficulty, about two years after Crawford's death. The monument (Fig. 9) includes a life-size sculpture of Crawford with his gun and his dog, rendered from a photograph so accurately that acquaintances could reportedly recognize him, and a bronze bronze tablet with a quotation from a speech delivered before the United States Senate by former Missouri Senator George G. Vest. The inscription reads, ***The One Absolutely Unselfish Friend That Man Can Have In This Selfish World Is His Dog.***

Figure 8. Gate to the Lima Cemetery, off Ivy Road about 1/8 mile east of the Volga River State Recreation Area.

Figure 9. Monument to John H. Crawford, 1863 – 1905. The monument is a life-size rendering of John, his gun, and his dog.

FIELD TRIP STOPS AT ECHO VALLEY STATE PARK

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INTRODUCTION

Echo Valley State Park lies about 3 miles southeast of West Union (see Figure 1). The park includes a little over 100 acres of primarily forested land along Glover Creek and Otter Creek. Echo Valley State Park became an Iowa State Park in 1935. Since 1986, the park has been managed by the Fayette County Conservation Board. For additional details on the history of Echo Valley State Park see ***A Brief Developmental History of Echo Valley State Park*** beginning on page 11 of this guidebook. The park features precipitous bluffs of Silurian limestones and dolomites that are best viewed at the picnic area near the park entrance (Fig. 1) where Otter Creek abuts the cliffs and the Glover Creek Backbone, a narrow ridge bounded by cliffs cut by Otter Creek and Glover Creek (Fig. 2). We will hike up to the backbone and examine the Silurian strata exposed on the Otter Creek face of the bluff.

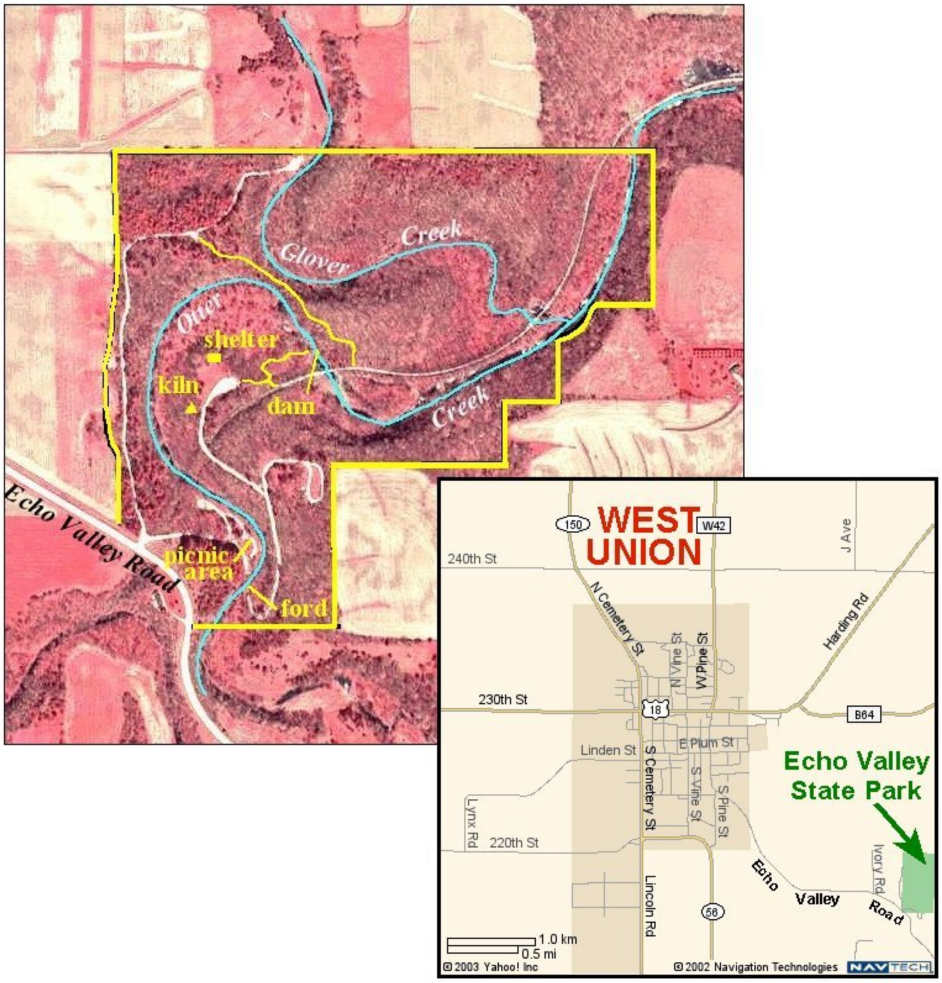

Figure 1. Aerial photograph of Echo Valley State Park with key features delineated,with inset map showing route from West Union to the park.

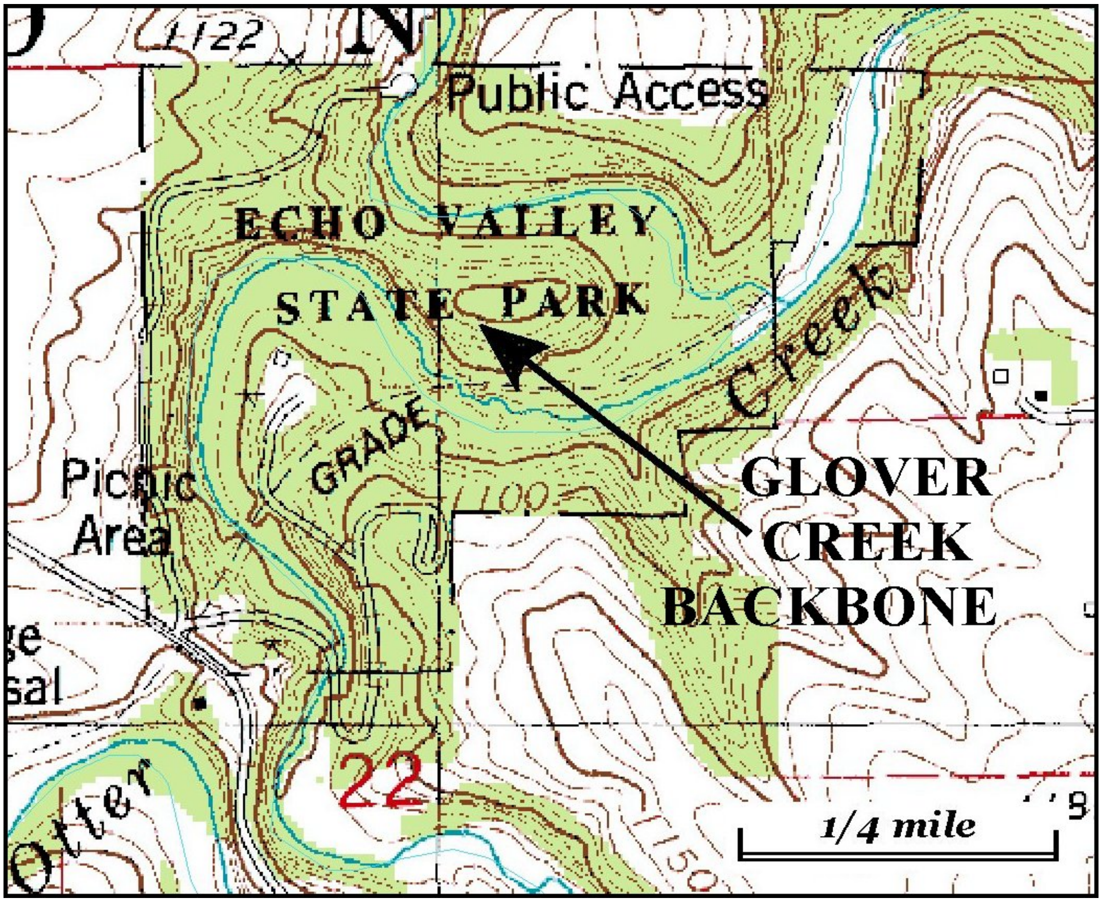

Figure 2. Topographic map of Echo Valley State Park.

Echo Valley State Park features a number of structures constructed by the Civilian Conservation Corps (CCC) in the 1930's. We will highlight many of these structures during our visit to the park, including the Lime Kiln, Park Shelter, Stone Stairway, and the Old Dam.

FIELD TRIP STOPS IN ECHO VALLEY STATE PARK

We will enter Echo Valley State Park from West Union via Echo Valley Road and procede to the Picnic Area (Fig. 1). The Picnic Area features a small shelter and a beautiful view of Silurian Waucoma Formation Limestones exposed in a cliff face across Otter Creek (Fig. 3). Otter Creek is stocked with trout by the Iowa DNR and is a favorite fishing location for many anglers.

Figure 3. Stop 1 in Echo Valley State Park is the picnic area just inside the park entrance.

Stop 1. Echo Valley Picnic Area

Our first stop at Echo Valley State Park will be the Picnic Area just inside the park entrance (Fig. 3). This will be a brief stop for a quick introduction to the park and a discussion of what we will be seeing and doing.

Depart the Picnic Area and cross Otter Creek at the ford. Follow the road around the curve and up the hill, bearing left when the road forks and procede to the parking area near the CCC Shelter (Fig. 4). Rest rooms are available at this area. We will leave our cars parked in the CCC Shelter parking area for the duration of our visit to Echo Valley State Park.

Figure 4. Parking area at CCC shelter, Echo Valley State Park.

Stop 2. Echo Valley Lime Kiln

From the parking area we will walk southwest across the grassy area to the trail at the edge of the woods. Following the trial a few hundred yards we will reach the lime kiln that is thought to have been constructed before the 1930s. The kiln used a wood fire to heat fragments of limestone to up to about 1000° C. This heating expels carbon dioxide and changes the limestone, calcium carbonate ($CaCO_3$), to calcium oxide (CaO). Burned lime was then slaked with water, which produced great heat and changed calcium oxide to calcium hydroxide ($Ca(OH)_2$). Slaking was mostly done in a wooden tub, and the slaked lime was then stored in a lime pit. The slaked lime was mixed with sand to produce mortar for cementing building stones or plastering walls. When the lime mortar dries in the air, the slaked lime is changed into hard lime. The sign in front of the kiln reads ***"The structures here date back to before the time of the CCC. The foundation in the front is from a grist mill that burnt to the ground in 1883. The structure in the back is a lime kiln. Morter made in this kiln was used to build houses in West Union and the CCC structures in this park."*** The limestone that was burned in the kiln was hauled to the kiln in railroad cars. In front of the kiln is the foundation of an earlier structure, the Gurdy grist mill that burned in 1883.

Figure 5. Photograph of the lime kiln at Echo Valley State Park.

From the lime kiln we will walk back across the grassy area past the CCC Shelter and head east down the trail toward Otter Creek. Take the north (left) fork in the trail and procede along the ridge to the head of the CCC Stone Stairway (Fig. 6). The Stone Stairs lead down to the south bank of Otter Creek at the site where a CCC dam once stood.

Figure 6. CCC Stone Stairway on the route to Stop 3, the old CCC dam.

Stop 3. Old CCC Dam Site

At this site, the CCC constructed a dam across Otter Creek in the 1930s. The dam impounded about 16 acres of water (see Reisinger, p 11 of the guidebook) and reached a maximum depth of 40 feet near the dam. The lake did not last long, however, experiencing serious siltation problems, and by 1947 the dam was dismantled and Otter Creek returned to its original bed. A portion of the dam structure on the north bank of Otter Creek remains and can be observed from the south bank (Fig. 7). Circular holes can be seen in this structure, mortar molds around the ends of logs that once spanned the creek and strengthened the earthen dam. The earth that was used to construct the dam was taken from the hill that is now the parking area by the CCC shelter. A control gate and spillway was constructed against the north wall of the canyon, and it can still be seen on the north side of the structure that is visible from the south bank.

Figure 7. Old CCC dam structure on north bank of Otter Creek.

The fourth stop of the Echo Valley part of the field trip will be on the Glover Creek Backbone north of Otter Creek. To get to **Stop 4**, return back up the CCC Stone Stairway and along the ridge, following the trail east to the graveled Jansen Trail. Head north (left) on the Jansen trail and cross the foot bridge over Otter Creek. Note that the foot bridge (see photograph on page 13 of this guidebook) rests on the piers of the old Chicago-Rock Island & Pacific railroad bridge. The original railroad bridge was dismantled and removed in the 1960s and was recently replaced by the footbridge. A few yards north of the bridge a trail bears west (left) off the Jansen Trail and heads up the hill. Follow this trail up the hill and along the ridge for about 100 yards to **Stop 4**.

Stop 4. Review of the Vegetation of Echo Valley State Park

by John Pearson

Iowa DNR

Depart **Stop 4** and continue west along the trail at the crest of the Glover Creek Backbone to **Stop 5,** a trail that leads down the face of Glover Creek Backbone above Otter Creek.

Stop 5. Silurian Waucoma Limestone at the Glover Creek Backbone, Echo Valley State Park

by Brian Witzke

Figure 8. Head of trail down the face of the bluff at Stop 5.

Figure 9. View of Waucoma Fm along trail down bluff at Stop 5.

Figure 10. View of cliff face to be examined at Stop 5.

WAIT AT THE HEAD OF THE TRAIL DOWN THE FACE OF THE GLOVER CREEK BACKBONE EXPOSURE FOR THE TRIP LEADERS. FOLLOW THEIR DIRECTIONS AND BE CAREFUL ON THE TRAIL; IT CAN BE SLIPPERY AND DANGEROUS.

Proceed carefully down the trail. For a discussion of the rocks exposed on the Glover Creek Backbone section see Witzke, p 41 of this guidebook.

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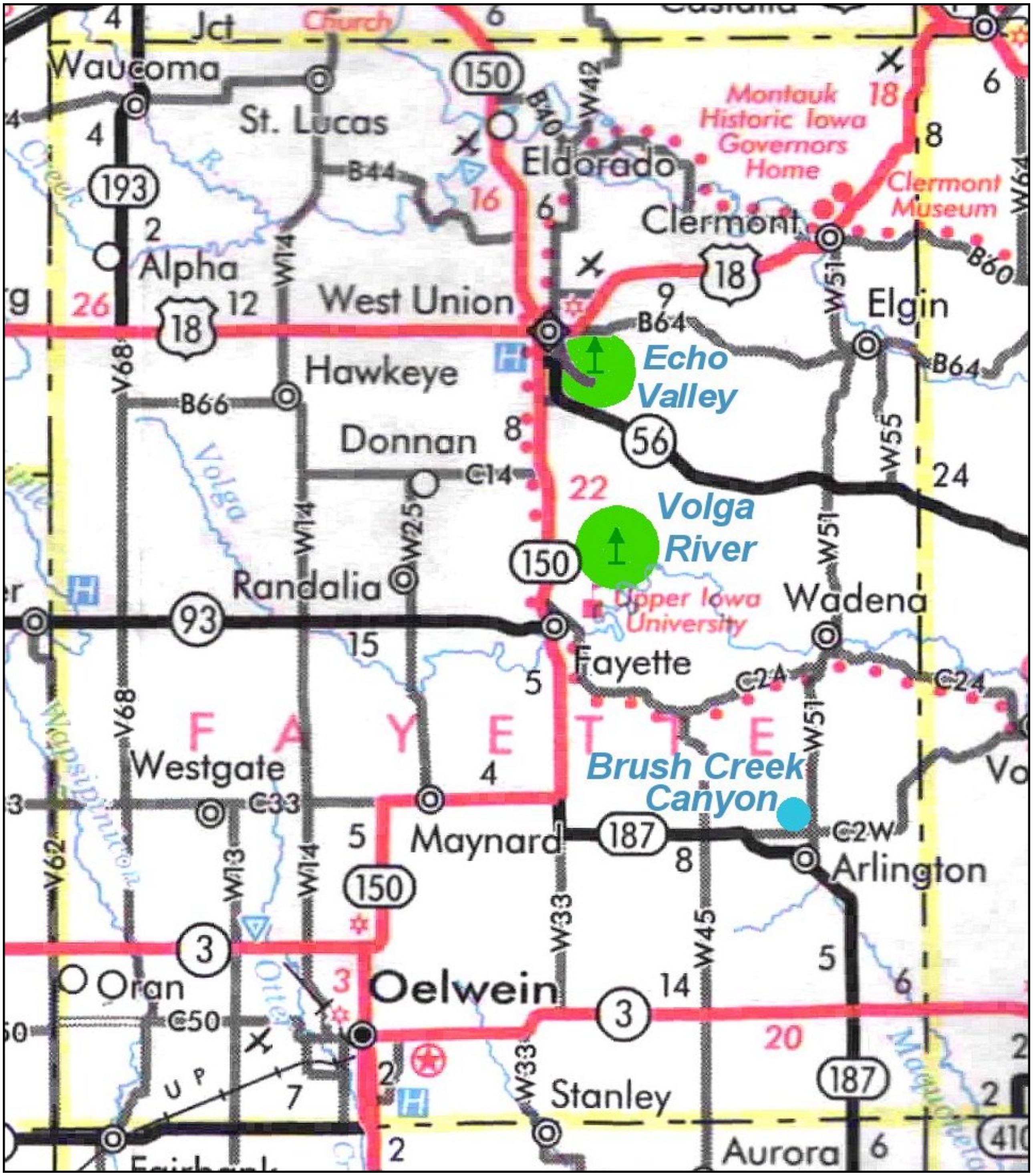
NATURAL HISTORY OF THE VOLGA RIVER STATE RECREATION AREA AND ECHO VALLEY STATE PARK FAYETTE COUNTY, IOWA



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November 8, 2003

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