THE NATURAL HISTORY OF DOLLIVER MEMORIAL STATE PARK, WEBSTER COUNTY, IOWA

edited by
Raymond R. Anderson and Chad L. Fields

Geological Society of Iowa

September 29, 2007 *Guidebook 81*

Cover Photograph

Iowa Geological Survey geologist Brian Witzke examines Pennsylvanian Cherokee Group sandstones and conglomerates at the Copperas Beds along Prairie Creek in Dolliver Memorial State Park.

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INTRODUCTION TO THE NATURAL HISTORY OF DOLLIVER MEMORIAL STATE PARK

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Figure 1. The structure at the northern entrance to Dolliver Memorial State Park, constructed by the C.C.C. in 1934 is listed in the National Register of Historic Places.

Dolliver Memorial State Park was dedicated in 1925 to become Iowa's third State Park, following Backbone State Park (1920) and Ledges State Park (1924). The 457-acre park is located on the banks of the Des Moines River in southeast Webster County, and features scenic sandstone bluffs in a hardwood forest. The park boasts two lodges (Fig. 2) that may be rented by the public, two family cabins with sinks and refrigerators, a group camp area with a dining hall, modern rest rooms and showers, 10 separate sleeping cabins (Fig. 3), and a 33-site campground

Figure 2. The two lodges in Dolliver Memorial State Park were constructed by the C.C.C. in 1934 Photos **a.** and **b**. are two views of the Center Lodge, **c.** is the South Lodge.

Figure 3. One of 10 cabins constructed by the CCC at the group camp area.

with electrical hookups, modern restroom and showers and a trailer dump station. The park has hiking trails that provide access to the park's forested hillsides, natural sandstone cliffs, and Indian mounds. Additionally, the park has picnic areas that include shelters, a modern boat ramp, and a popular canoe "take-out."

Participants on this field trip will have an opportunity to view many of the scenic wonders that compelled local citizens to donate a major portion of funds required to purchase this land and have it preserved as a memorial to their famous adopted son, Jonathan P. Dolliver. The modern Des Moines River (Fig. 4) has carved a canyon through the sandstones deposited by another river, 300 million years before, in Pennsylvanian time. In the geological eras between the two rivers, seas had advanced and retreated over the region many times, thousands of feet of rock was deposited and eroded, and numerous sheets of glacial ice, thousands of feet thick slid over the area then melted away leaving tell-tail glacial erratics.

The area of Dolliver Memorial State Park was heavily forested when modern settlers moved into the region. Although much of the area's timber was cut, numerous trees of 200 to 300 years of age or older have been identified in the park, which is now dominated by a mature oak-dominated forest. The abundance of deer, turkey, and other animals in this forest sustained many early settlers, and even today the park has a diverse abundance of birds, mammals, amphibians, reptiles, fish, mussels, butterflies and many other animals.

Figure 4. View down the Des Moines River at Dolliver Memorial State Park

The history of Dolliver Park is as colorful as the beautiful landscape. Native Americans visited and utilized the area, leaving behind graphic evidence of their presence as art and bone piles. Early settlers farmed, hunted, and fished in the region. Early geologists exploring the land discovered unusual copperas beds. When Iowa initiated a State Park system, the citizens of Webster County were quick to endorse the region to be Iowa's third State Park. During the depression, the Federal government sent CCC workers to Dolliver and other areas to help in the development and expansion of the Iowa State Park system. Improvements have continued, and today Dolliver Memorial State Park is one of the shining jewels in our impressive park system. The guidebook authors and trip leaders hope that we can help you learn more about the natural and cultural history of the area. We also hope that you will enjoy your visit to Dolliver Memorial State Park.

BRIEF QUATERNARY HISTORY OF FORT DODGE AREA

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INTRODUCTION

The oldest Quaternary deposits in the area are Pre-Illinoian tills and related deposits. There are no exposures in the park, but thin exposures have been studied at nearby gypsum pits. Their distribution and properties are poorly understood due to their lack of exposure. In the vicinity of the park, these deposits rest on Pennsylvanian-age shales and sandstones, separated by an unconformity representing approximately 300 million years. The Pre-Illinoian deposits are overlain by Sheldon Creek Formation glacial till which in the area dates to between about 26,600 and 41,800 radiocarbon years before present (RCYBP) (Bettis et al., 1996). The Sheldon Creek (Tazewell till) represents at least two mid-Wisconsin glacial advances and has properties very similar to the Des Moines Lobe (DML) Dows Formation glacial till. No loess is present in this area as it was occupied by glacial ice during the period of loess deposition in Iowa (30,000 to 12,500 years ago). At the base of the younger DML deposits (Dows Fm.) are organic-rich pond sediments that appear to represent an open, treeless landscape dotted with shallow pools and meltwater-fed streams. Schwert and Torpen, in Bettis et .al (1996), identified associated insect assemblages of "non-glacial" affinities at the nearby National Gypsum Quarry site (Figure 1). Plant macrofossils from these deposits produced a date of 15,310 RCYBP which is in agreement with a 15,140 RCYBP date from G.R. Hallberg (Bettis et al., 1996). These dates appear to signal a period of transition in the midcontinent from "full glacial" artic conditions which prevailed from 22,000 to 16,500 years ago to a climatic warming that occurred as the DML advanced into central Iowa.

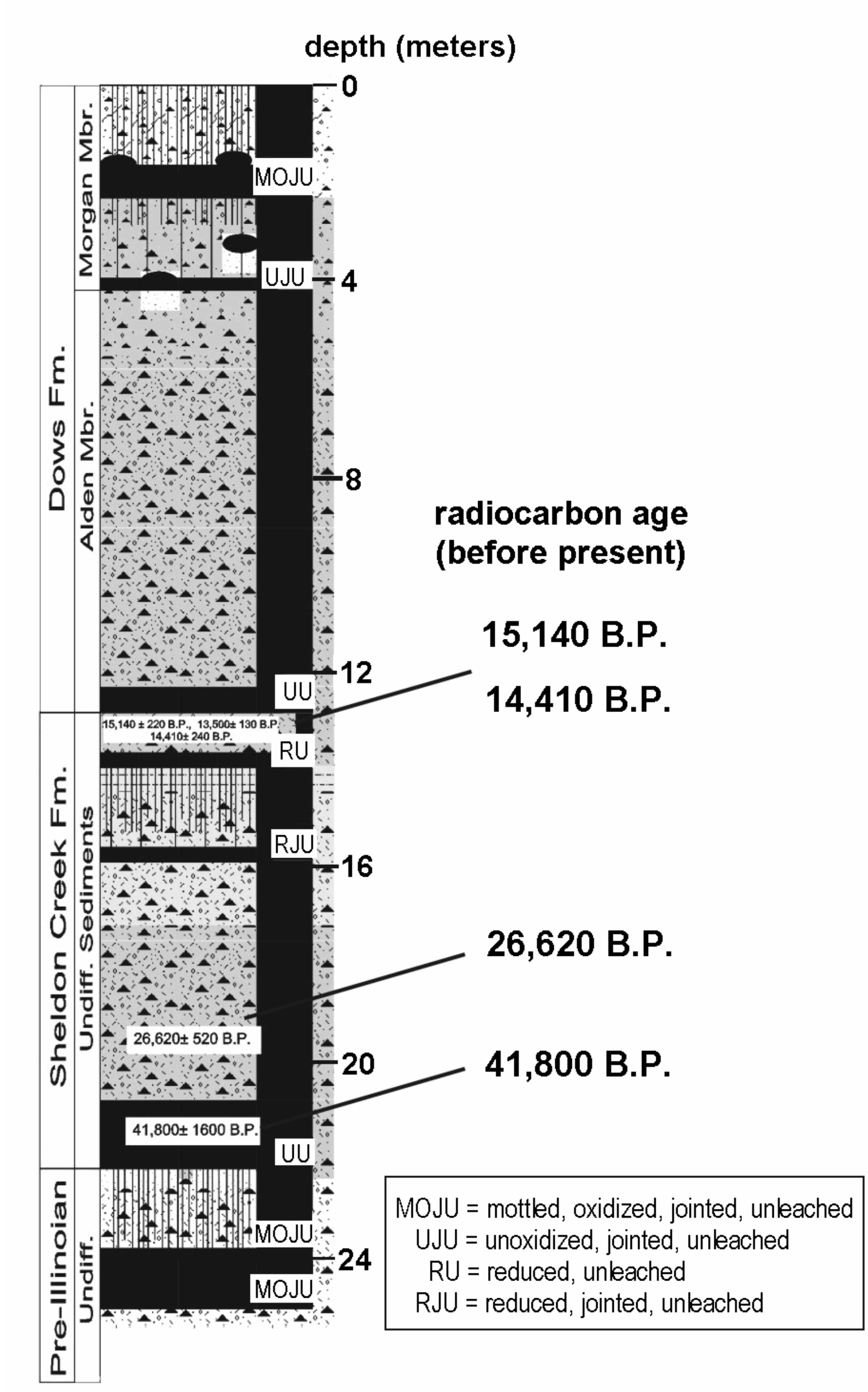

Figure 1. Graphic log of an exposed sequence from the National Gypsum Quarry, Fort Dodge, Iowa. Modified from Bettis, et al, (1996).

INTRODUCTION TO THE DES MOINES LOBE LANDFORM REGION

The distinctive landform region called the Des Moines Lobe (DML) formed from a lobate extension of the last great continental glacier. During the Wisconsin Episode, the southern margin of the Laurentide Ice Sheet split into several lobes that each flowed down regional topographic lows. The DML extended from central Canada through the Dakotas and Minnesota into Iowa, terminating at what is now the City of Des Moines (Fig. 2).

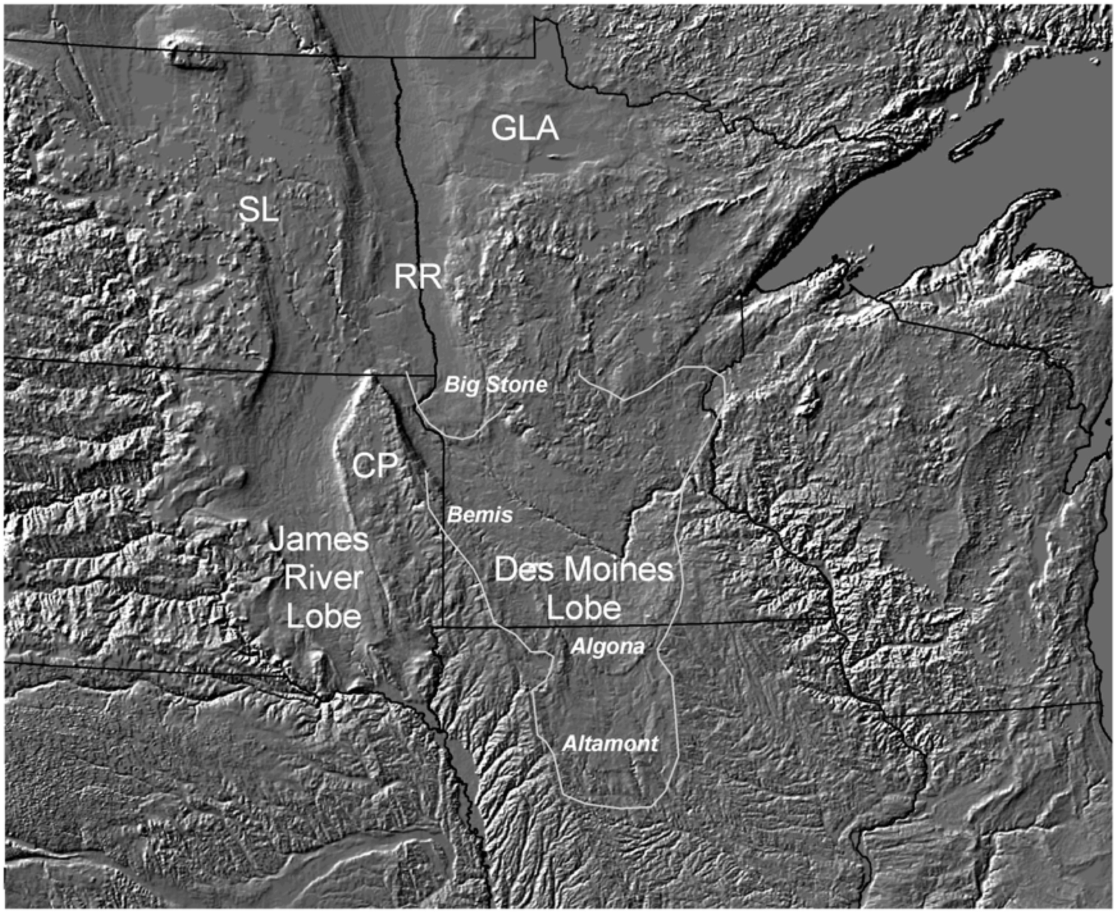

Figure 2. Location of the Des Moines Lobe in the Upper Midwest and the Coteau des Prairies (CP), Glacial Lake Souris (SL), Red River Valley (RR) and Glacial Lake Agassiz (GL).some of the northern features are not described in the text.

The DML entered Iowa shortly before 15,000 RCYBP and reached the terminal position at Des Moines about 13,800 RCYBP. The glacier stagnated after reaching its terminus. The lobe readvanced to the position of the Altamont ice margin just north of Ames and Boone about 13,500 years ago before stagnating again. Between 13,500 and 12,600 RCYBP, there were three minor readvances marked by the Clare, Renwick, and West Bend moraines. The morainic topography associated with these advances is discontinuous, and only the terminal margins are recognized. The final advance into Iowa, the Algona ice margin, occurred about 12,300 RCYBP (Fig. 3). This advance also was followed by stagnation and wastage of the glacier. It was during the Algona advance that the upper Des Moines River originated as the major axial drainage of the DML (Bettis and Hoyer, 1986).

The DML was active in Iowa between about 15,000 and 12,000 RCYBP, about 5,000 to 8,000 years later than glacial lobes to the east made their southernmost maximum advance (Johnson, 1986; Fullerton, 1986). The Lobe advance occurred well into a period of regional warming and was climatically out of equilibrium (Kemmis et al., 1994). Ice thickness reconstructions indicate that the lobe was probably thin and gently sloping (Mathews, 1974; Clark, 1992; Brevik, 2000; Hooyer and Iverson, 2002). Clark (1992) reconstructed the Lobe's thickness near Ames, Iowa, at ~80 m. More recently, ice reconstructions by Hooyer and Iverson (2000) were based on a model assuming the Bemis Moraine was ice-cored, which yielded ice thickness estimates of ~250 m. Despite these variations, all agree that the DML ice sheet was extremely thin and gently sloping. This ice advance was rapid and episodic, and was most likely fueled by basal lubrication; in other words, a warm-based, non-deforming bed glacier. These assumptions are backed up by evidence of numerous plants (Baker et al., 1986) and trees (Bettis et al., 1996) found at the contact of the DML with underlying units. Furthermore, the complex landform sediment assemblages found on the DML in Iowa seem more indicative of regional stagnation of a surging glacier, not rapid recession.

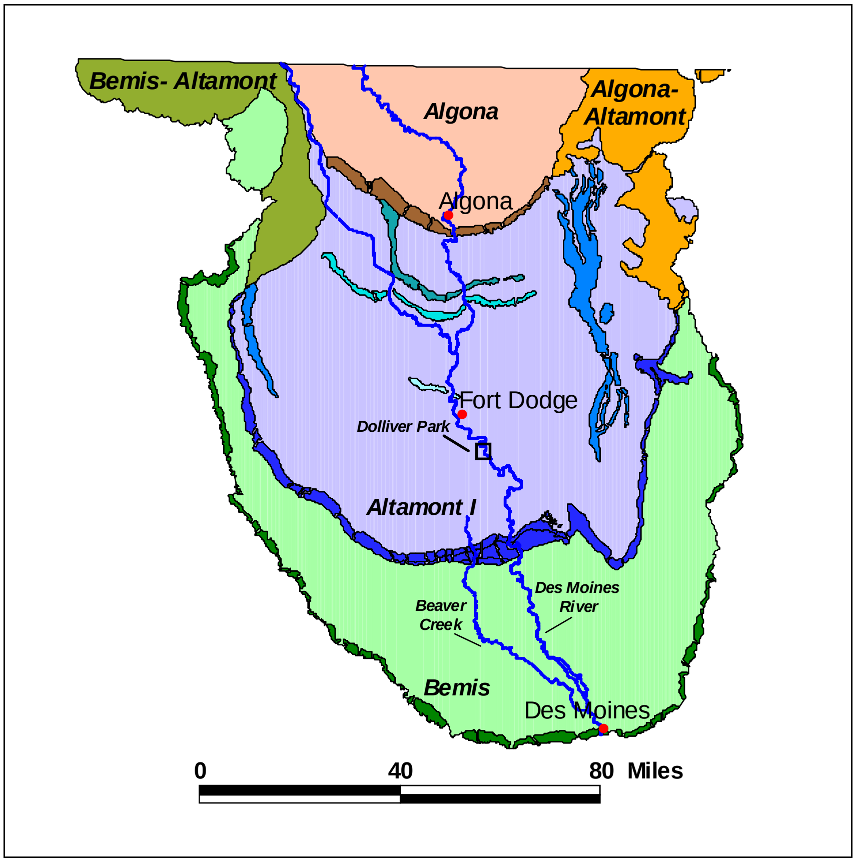

Figure 3. Extent of Des Moines Lobe in Iowa with end moraines. Note Des Moines River Valley, Beaver Creek Valley and Dolliver Park locations.

LATE WISCONSIN HISTORY OF THE UPPER DES MOINES RIVER VALLEY

One of the main attractions of Dolliver State Park is the entrenched picturesque Des Moines River Valley and its surrounding sandstone walls that can be viewed within the park. The park owes its beauty to the youthful geologic history of the Des Moines River. Its headwaters, the

East and West Fork originated in the lakes and prairies of southwestern Minnesota and are related to the drainage of the last advance of the Des Moines Lobe. The Des Moines River flows roughly north-south down the axis of the Des Moines Lobe (Fig. 3).

A century ago there was some dispute among geologists H.F. Bain and James H. Lees as to the age of the valley. Bain maintained that the valley above Beaver Creek (near Saylorville Dam in Polk County) was late Wisconsin in age and related to the DML. While Lees (1916) concluded at a later date that the valley above Des Moines, Iowa was pre-Wisconsin and probably “Kansan” in age. Earlier, Bain (1896) had concluded that Beaver Creek, which headed on an earlier advance of DML, had reoccupied an older Pre-Wisconsin valley in the Des Moines area. More recent studies (Bettis and Hoyer, 1986) agreed with Bain that the valley above Beaver Creek is very young and related to the drainage of the DML.

Initial valley formation was related to downcutting by meltwaters issuing from the DML when the ice margin sat at the position of the Algona Moraine, the youngest advance of the DML in Iowa. Sequences of discontinuous, unpaired late Wisconsin terraces were formed between 12,600 to perhaps 11,000 radiocarbon years before present (RCYBP). In their investigations of the Des Moines Valley (DMV), Kemmis et al., 1988, noted that entrenchment in the Boone area had resulted in 220 ft of valley deepening over a relatively short period of time. Near Lehigh, in the park vicinity, the valley deepening approaches 190 ft. These terraces associated with the DMV are “benched”; therefore the outwash does not extend to the present floodplain (as seen here at the terrace level near the entrance to the park). The late Wisconsin (LW) terraces are multi-leveled and indicate that there were multiple periods of incision and aggradation, with successive terraces benched progressively lower into glacial deposits or bedrock. The more extensive LW terrace deposits tend to occur high on the landscape and at the inside of valley meanders. These are the oldest LW terraces and may have been formed as meanders were cutoff by episodic flood events. The youngest LW terraces at lower elevations tend to have a narrower, longitudinal geometry. All of these terraces are capped with a sequence of coarse sand and gravel that represents greatly increased meltwater and sediment supply that are most likely related to subglacial lake outbursts (jökullups). On the DML, these gravel deposits are highly valued since they can be readily mined and in many places are able to be extracted without encountering the water table.

In fact, shortly before you enter the park’s north entrance you will drop onto a high Late Wisconsin (LW) terrace level of the Des Moines Valley. The soils map for the area indicates that the terrace is mapped as the Wadena soil series, characterized as 20 to 40 inches of loamy material over coarse sand and gravel (Fig. 4). It appears that there has been sand and gravel extraction occurring at this site for some time. Nearly twenty years ago the authors visited this pit and recollect seeing a sand and gravel deposit less than 10-15 feet thick with a boulder lag that may overlie glacial till or possibly may directly overlie the Pennsylvanian Cherokee Group bedrock exposed along the valley walls in the park. Tributary valleys also underwent rapid evolution during the late Wisconsin in response to downcutting of the (DMV). Most of the larger tributaries in the area, such as Prairie Creek and nearby Brushy Creek, probably originated as subglacial or englacial channels related to the DMV. As the DMV cut down episodically between 12,300 and 11,000 RCYB, the major tributaries incised and eroded headward.

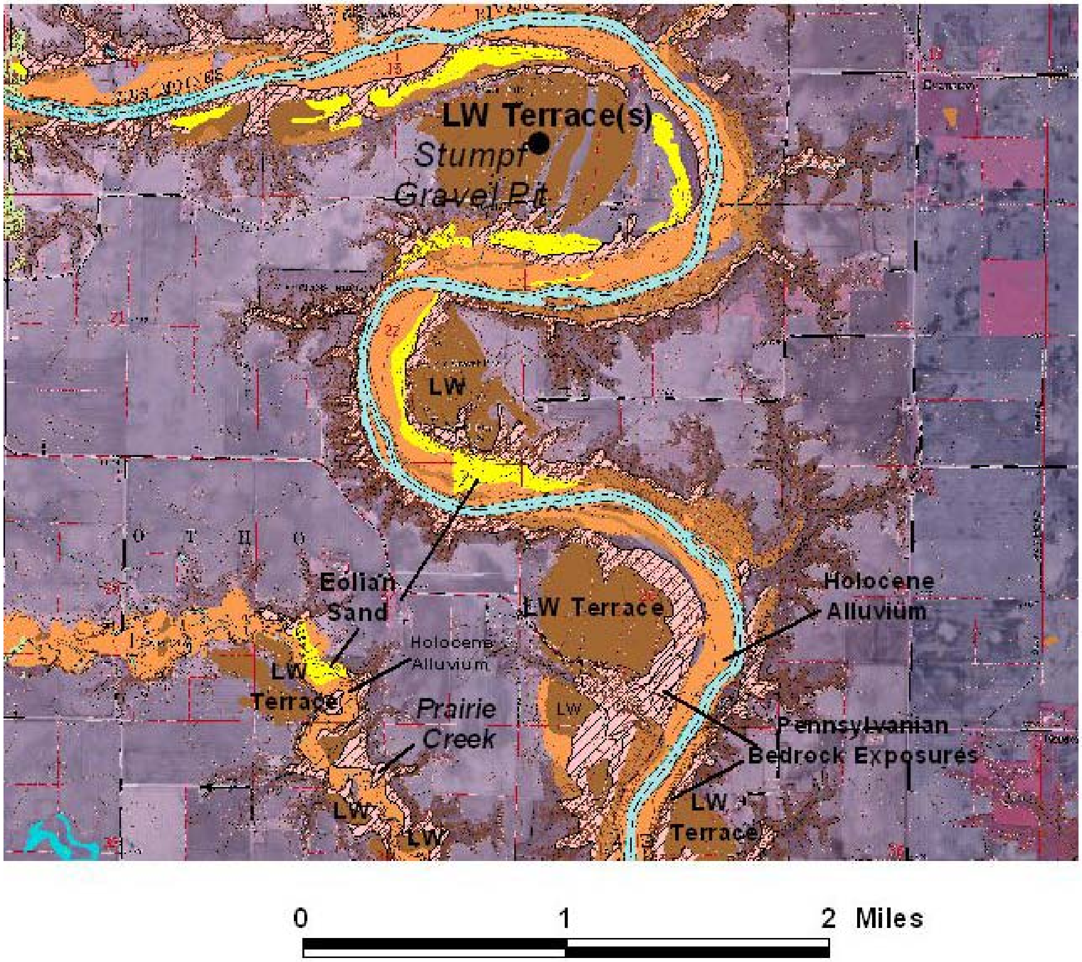

Figure 4. Des Moines River and Prairie Creek Valleys in the vicinity of Dolliver State Park and related late Wisconsin and Holocene age alluvial deposits. Pennsylvanian bedrock exposures are noted with a hatched pattern.

According to Bettis and Hoyer (1986) by 11,000 years ago the DMV had cut to its present level and was no longer carrying outwash. The valley walls were steep and gradients high on tributaries allowing for storage of large amounts of sediment in the valleys. About 4,000 years ago the DMV downcut again and began constructing a new floodplain. In the park, this youngest alluvium is contained within the active channel belt and is subject to flooding periodically.

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PENNSYLVANIAN CHEROKEE GROUP STRATA IN THE AREA OF DOLLIVER MEMORIAL STATE PARK

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INTRODUCTION

During Pennsylvanian time North America and Europe (Euramerica) were joined to the rest of Earth's continents (Gondwana) to the south by the Appalachian-Hercynian Orogenic Belt. The Caledonian-Appalachian Mountains stretched from the northern Appalachians through the present day United Kingdom, Greenland, and Norway. Euramerica and Gondwana were drawing together, soon to form the supercontinent of Pangea (Witzke, 2002). Gondwana was restricted to the southern hemisphere, straddling the South Pole, but Euramerica straddled the equator, with the Midcontinent and Iowa lying within a few degrees of the equator throughout the Pennsylvanian (Heckel, 1999). During the Middle Pennsylvanian, Iowa occupied a position in the humid equatorial rainbelt.

A relatively shallow epeiric sea covered much of the Midcontinent in an area called the Midwest or Western Interior Basin during the middle and upper Pennsylvanian. In Iowa, the major area of deposition and present exposure of Pennsylvanian sediments is the Forest City Basin. Pennsylvanian strata were deposited on a deeply eroded Mississippian surface. Deposition of Pennsylvanian strata in the Western Interior Basin is characterized by the cyclic nature of its lithologic packages. Called cyclothems, these cyclic packages were controlled by major fluctuations in sea level, the product of the waxing and waning of large-scale continental glaciers in Gondwana.

Pennsylvanian strata in the Western Interior Basin is subdivided into a series of stages, in ascending order, the Morrowan (lower Pennsylvanian), Atokan, Desmoinesian (middle Pennsylvanian), Missourian, and Virgilian (upper Pennsylvanian). In most regions of Iowa where Pennsylvanian rocks are preserved, including Webster County and Dolliver State Park, the basal unit is the lower Desmoinesian Cherokee Group.

PENNSYLVANIAN GEOLOGY OF IOWA

Howes (1988a) noted that historically, Cherokee Group stratigraphy in Iowa was informal and limited to designations of an "upper" and "lower" Cherokee. The earliest work to subdivide these large and complex stratigraphic sequences began in the 1930s with unpublished work by L.M. Cline and an unpublished dissertation by Stookey (1935), who divided the group into two formations, naming a lower Wapello Formation with eight members and an upper Lucas Formation with eight members, including the basal Whitebreast Coal. In the 1940s Cline and Stookey expanded their work to the entire Des Moines Supergroup, proposing formation and member names based on field studies in Iowa; however, their sub-divisions were never published nor formally adopted.

The most recent and comprehensive investigation of the Pennsylvanian in Iowa, especially the Cherokee Group, occurred from 1974 - 1979 when the Iowa Geological Survey conducted its Coal Resources Project. The goal of this project was to unravel the stratigraphy and deposition environments of the Cherokee Group. The project drilled Pennsylvanian cores at 85 locations in southeast and south-central Iowa (cores which are reposited and available for future research at the Iowa Geological Survey's Oakdale Rock Library). Coal project geologists conducted extensive lithologic and biostratigraphic studies of the cores, developing biostratigraphic tools (conodonts for marine horizons, Swade, 1982; and palynomorphs for terrestrial horizons, Ravn, 1979) to accurately correlate stratigraphic units among cores. Ravn (1986) established a palynostratigraphic zonation for the Cherokee Group that can be used to correlate between coal beds in Iowa, and the currently accepted formal subdivision of the Cherokee Group in Iowa relies heavily on his zonation (see Howes, 1988b).

The complexity of the Cherokee Group in Iowa results from the similarities of the repetitive cyclic depositional packages, known as cyclothems. These cycles were orchestrated by a large mass of continental glacial ice around the Pennsylvanian South Pole on the southern continent of Gondwana (Fig. 1). As these glaciers grew in size they drew water from the oceans, producing a lowering of sea level elevation of about 100 meters. As the Pennsylvanian sea rose with the glacial melting, its waters traveled hundreds of miles into the central part of Pangea (now North America), advancing into Iowa from the southwest via the Forest City Basin and into southeastern-most Iowa through the Illinois Basin. Understanding cyclothems is critical in understanding the complex aspects of Cherokee Group deposition.

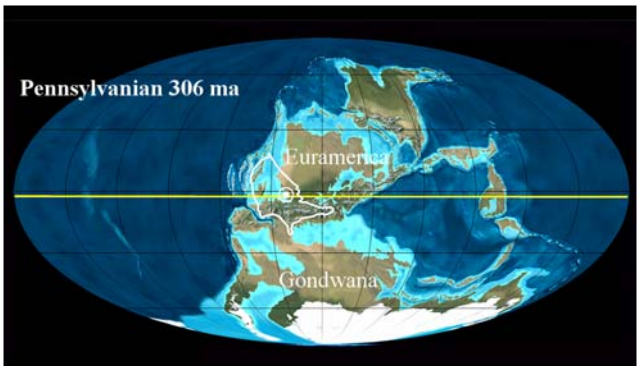

Figure 1. Pennsylvanian (306 ma) paleogeography showing outline of U.S. and the Iowa area circled. Modified from Blakey, 2007.

Pennsylvanian Cyclothems

Pennsylvanian rocks in Webster County, and most of Iowa, are the product of repetitive, sequential deposition of sediments called cyclothems (Wanless and Weller, 1932), dominated by shales but also including sandstones, siltstones, limestones, and coals. Some cyclothem sequences are continuous over considerable areas, but others are much more areally restricted or may exhibit local variations. Heckel (1984, 1999), described an idealized Kansas type cyclothem (Fig. 2) as displaying a distinctive vertical sequence of lithologic members. Each member represents a particular phase of deposition during a single cycle of relative sea-level change called "transgression-regression". The Kansas cyclothem model begins with a basal sandstone of beach or channel origin, grading upward into a gray, sandy shale, then a lighter gray mudstone or underclay (fireclay) which acted as a substrate for coal-forming vegetation. Rising sea levels drowned the coal forest depositing first shallow marine shales, then as the water deepened calcareous muds that form limestone

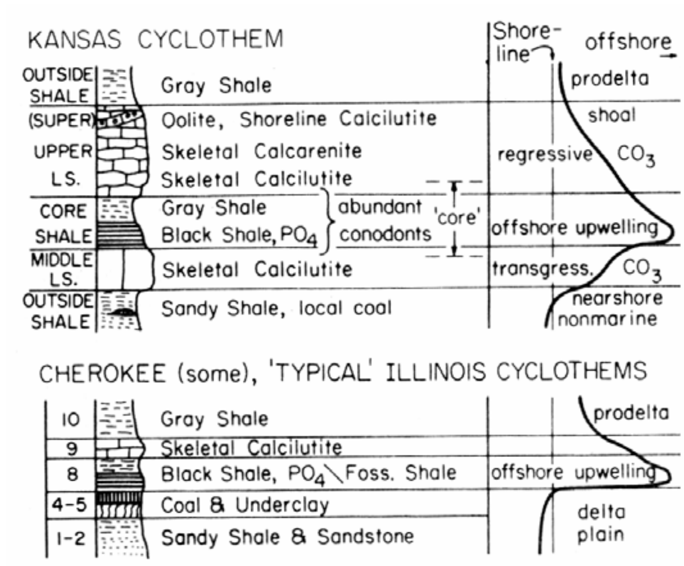

Figure 2. Idealized Kansas Cyclothem compared with a Cherokee Cyclothem (left) with relative depths of marine deposition (right). Modified from Heckel (1984).

beds. Finally, in the deepest anoxic water, phosphatic black shales were deposited as the sea reached its greatest advance onto the continent, the maximum transgression. As the sea receded, shallowed, and become oxygenated, the deposition of a gray marine shale began, then shallower still until the sea floor passed into the photic zone where the sunlight permited the production of calcium carbonate and the deposition of shaly limestone with a restricted fossil assemblage. The sea continued to shallow, oxygenation and the penetration of sunlight increase, produced a more normal marine environment with a diverse fauna which increased the production of limestone. When the sea become very shallow, water circulation was reduced producing a hypersaline environment inhabited by algae and other carbonate mud producing organisms, followed by an even shallower water shale environment where few organisms could survive. These limestones graded upward into terrestrial shales, similar to those that started the cycle, and it began again.

Cherokee cyclothems (Fig. 3), also known as Illinois cyclothems (Heckel, 1984), differ from the typical Kansas cyclothems in that the deep water black phosphate shale frequently rests directly on the coal. The carbonate-producing algae rarely grew on a subsiding peat swamp, so the transgressive limestone seen in the Kansas cyclothem did not develop (Heckel, 1984). Another factor affecting Cherokee deposition was the depth of the transgressing sea. The magnitude of sea level depth change during a Cherokee cyclothem could be measured in the tens of meters, while deposition of a typical Kansas cyclothem involved sea level depth changes of about 100 meters. Additionally, the Cherokee seas were advancing onto the high relief pre-Pennsylvanian or eroding Pennsylvanian surface, whereas the typical Kansas cyclothems were advancing onto low-relief platform. The Marmaton Group and other Pennsylvanian units younger than the Cherokee Group in Iowa display typical Kansas cyclothem deposition.

All or portions of as many as 100 cyclothems are present in the Pennsylvanian rocks of Iowa. This repetitive rising and falling of sea level is the product of the repeated growth and melting of the continental glacial ice that formed on the ancient continent of Gondwana, which lay at the South Pole at the time. The extent of the Pennsylvanian glaciation was comparable to the maximum extent of the Pleistocene glacial growth. As the Pennsylvanian ice expanded and melted, sea level sometimes rose and fell as much as 100 meters. Each transgressive-regressive cycle lasted from about 20,000 to 400,000 years. The sea level rise advanced hundreds of miles on to the low-lying interior of North America.

Pennsylvanian Cherokee Group in Iowa

The Cherokee Group was named for exposures in Cherokee County, Kansas (Haworth and Kirk, 1894). Strata assigned to the Cherokee Group occur either in exposures or in the subsurface across all of the Western Interior Basin of Iowa, Missouri, Nebraska, Kansas, and Oklahoma (Ravn and others, 1984). The Cherokee Group is the basal Pennsylvanian unit over most of Iowa. It lies with a major disconformable contact above various Mississippian formations in Webster County, Iowa. The strata of the Cherokee Group are characterized by extremely complex lateral and vertical facies relationships, which have always presented serious correlation and nomenclature problems. A detailed discussion of the stratigraphy of the Cherokee Group can be viewed in Ravn and others (1984). The depositional history of the Cherokee Group in Iowa records numerous episodes of sedimentation, shale-dominated, coal-bearing cyclothems with locally thick sandstones. A few contain thin limestones associated with minor and intermediate scale cyclothems, with only one major cyclothem (Verdigris-Ardmore) being traceable from Oklahoma to Indiana and to the Appalachian Basin (in Iowa it is prominently displayed in the Saylorville spillway). The minor cyclothems are less traceable because they are developed only in nearshore to shoreline facies like many cyclothems in the Appalachian Basin. In the most extreme case, there may be no marine facies in a cyclothem and a coal represents the maximum transgressive highstand facies (Heckel, 1995).

The Cherokee Group is best known in Iowa for its coal resources, a major past (and perhaps future) Iowa energy resource. The major units, from the base up, include the Kilbourn, Kalo, Floris, and Swede Hollow formations (Fig. 3). Two additional units, the Caseyville and Spoon formations, are present only in eastern-most Iowa. Each of these formations display the influence of fluctuating or cyclic depositional environments (Fig. 4), but this influence was often masked or subdued by the dominance of less regular, nonmarine deltaic, and fluvial sedimentary regimes. Ravn and others (1984) described the uncertainty in identifying specific Cherokee units. They mentioned the great uncertainty that remains concerning the actual number of major cyclic depositional events in the lower Cherokee and the false impression of lateral traceability of individual lithologic units that would be implied by assigning each to formational status. Instead they presented a classification designed to provide a system reflecting more accurately the broader depositional setting and history of the Cherokee Group. The Cherokee Group ranges up to 750 feet thick in the state (generally less in central Iowa), about 1/3 of the total thickness of Iowa Pennsylvanian strata. The maximum known thickness of the Cherokee Group in Webster County is 232 feet at the town of Dayton.

Cherokee Group of Iowa

Swede Hollow Formation
Bevier Coal
Wheeler Coal
Ardmore Limestone
Oakley Shale
Whitebreast Coal

Floris Formation
Carruthers Coal
Laddsdale Coal

Kalo Formation
Cliffland Coal
Blackoak Coal

Kilbourn Formation

Figure 3. Cherokee Stratigraphy in north-central Iowa (from Iowa Geological Survey).

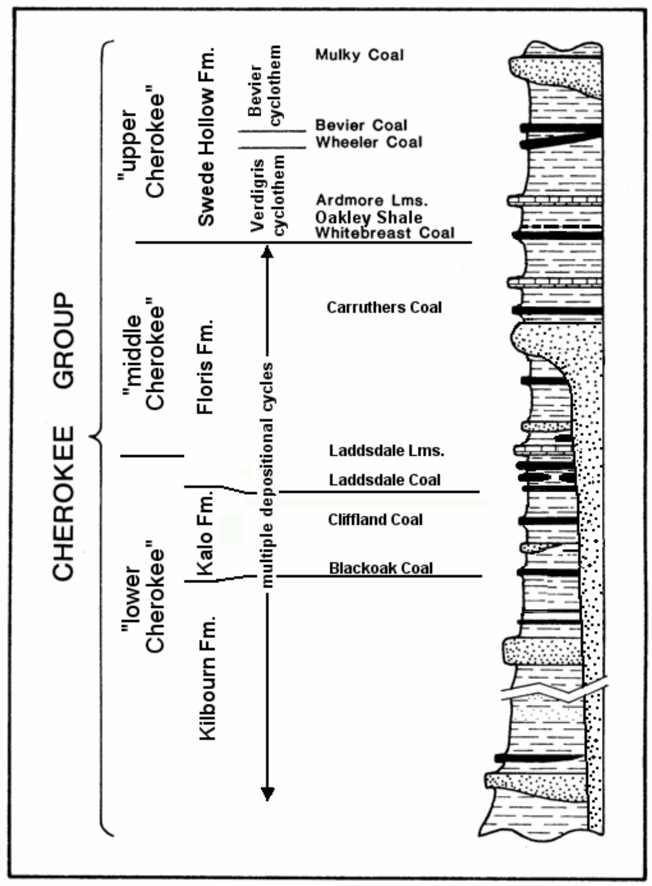

Figure 4. Graphic section of Cherokee Stratigraphy in Iowa (modified from Burggraf, 1981, with information from Phil Heckel, personal communication 2007).

The Cherokee contains most of the coal resources in Iowa as well as the rest of the midcontinent area. In the past, various informal divisions have been used to separate the upper and lower Cherokee, primarily distinguishing the somewhat more regular and persistent strata of the upper Cherokee (subsequently divided into the upper and middle) and its dominantly marine lithologies from the irregular, discontinuous strata of the lower Cherokee and its dominantly fluviodeltaic lithologies (Ravn and others, 1984). The lack of laterally continuous beds in the lower Cherokee has resulted in a proliferation of informal names applied to coals and other distinctive lithologies. Coal bed names in Iowa were traditionally either derived locally, usually from the mining operations; or extended from the nomenclature of strata in neighboring states. Unfortunately, most of the past names assigned to coals had only local significance. Other names have been proposed in many unpublished theses; but certain coal names have been used extensively in the literature discussing Cherokee Group Coals. Certain names applied to mined beds however, are not necessarily consistent with stratigraphic interpretations. Some coal seams may not have been named, while others may have more than one name. Conversely, a single name may apply to different seams. Palynologic studies by the Iowa Geological Survey Coal Division in the late 1970s and early 1980s led to the formalization of the coal stratigraphy and nomenclature for Iowa (Ravn, 1979, 1986; and Ravn and others, 1984).

Kilbourn Formation

The Kilbourn Formation represents initial Pennsylvanian deposition on the land surface that was being developed on argillaceous (clayey or shaly) and arenaceous (sandy) Mississippian carbonates, where stream incision on these carbonates had produced a surface of considerable relief and irregularity (Fig. 5) (Ravn and others, 1984). Kilbourn deposition was the result of subsidence in the Forest City Basin, in combination with several marine transgressions and regressions. The deposition predominately took place in the incised paleo-valleys during the relative rises in sea level, while pedogenesis (soil formation) and erosion continued on the interfluves (area between adjacent streams) (Fig. 6). Several depositional cycles are encountered in the subsurface of south-central Iowa, dominated by non-marine sandstones, shales, siltstones, mudstones, and coals. Thin marine limestones and shales (including phosphatic black shales) were deposited in the distal (landward) ends of estuaries during maximum transgression. Calcareous shales commonly display beds of cone-in-cone structure. Most of the sediments are thin and discontinuous, but they eventually filled the paleo-valleys and nearly leveled topographic relief. The prominent coals were correlated to the Tarter, Manley, and Reynoldsburg coals of the Illinois Basin on the basis of palynology (study of pollen) by Ravn and others (1984), but they have not been named in Iowa.

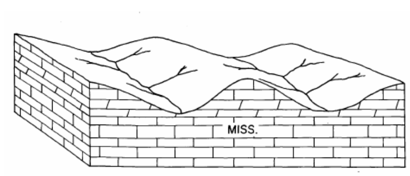

Figure 5. Block model of the pre-Pennsylvanian landscape (Ravn and others, 1984).

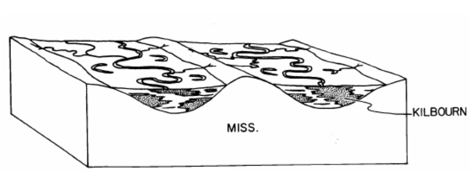

Figure 6. Block model of Kilbourn Fm. deposition (Ravn and others, 1984).

Kalo Formation

The Kalo formation was named for the town of Kalo, located just a few miles north of Dolliver Memorial State Park by Ravn and others (1984). The formation includes strata from the base of the Blackoak Coal to the base of the Laddsdale coal in the overlying Floris Formation. Two major coals, the lower Blackoak and the upper Cliffland, are the only two named members of the Kalo Formation in Iowa. The leveling of the Mississippian erosional surface by Kilbourn deposition allowed the first widespread episodes of coal deposition occurred in Iowa (Fig. 7). The

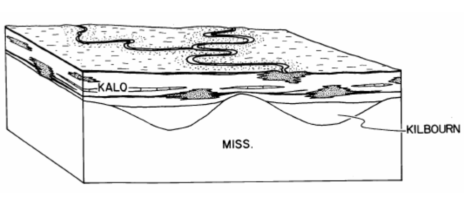

Figure 7. Block model of Kalo Fm. deposition (Ravn and others, 1984).

Atokan-Desmoinesian boundary is placed between the lower Blackoak and upper Cliffland coals. Ravn and others (1981) recognized the top of the Atokan by the final regular appearance of the palynomorph *Dictyotriletes bireticulatus*, which occurs in the Blackoak Coal, but not in the Cliffland Coal in Iowa. This is in agreement with the boundary placement suggested in Illinois. Further support for this boundary is suggested by the fact that the conodont genera *Idiognathoides* and *Declinognathodus* (both considered restricted to the Atokan of the midcontinent) do not range above the Blackoak Coal. Based on palynology, the Blackoak Coal correlates to the Pope Creek Coal of Illinois, and the Cliffland Coal correlates to the Rock Island (No. 1) Coal of Illinois.

Floris Formation

The Floris Formation includes strata from the base of the lower Laddsdale Coal to the base of the Whitebreast Coal at the top of the formation. Ravn and others (1984) noted that the Laddsdale Coal Member characterized the lower part of the Floris. Coals that were recently mined in Iowa are typically in the Laddsdale Member. They described the Laddsdale as part of an extremely complex sedimentary unit (see Fig. 8) consisting of up to five or six coal beds of varying thickness and separated by unnamed shale and marine sediments. The type section appears to represent the most complex development of the Laddsdale Member. It consists of five coal seams from one inch to 34 inches thick over a total thickness of 30 feet. The individual coal beds in the Laddsdale are lensoidal and generally cannot be traced with reliability, except in areas of closely spaced exposures or by drill holes. Although these coals may sometimes achieve thicknesses of 72 inches or more in a few localities, their discontinuous nature demands careful exploration work. The Laddsdale has been surface mined in Marion and Lucas counties. The associated strata are predominantly non-marine shales and siltstones, which may coarsen upward into sandstone. In some instances a fossiliferous marine shale or limestone may occur. Thus, these coals may represent from one to six depositional cycles over a period of time in which there was little change tin the flora. As with the Blackoak and Cliffland Coals, they are palynologically distinct from other Cherokee coals, but individual coals cannot be distinguished from each other. Above the Laddsdale are one or more palynologically distinct unnamed coals. Lenticular marine limestones are often associated with these coals. At this point the relationship of the coals and the marine unit to each other in this interval is poorly understood. Higher up is another palynologically distinct coal, the Carruthers. In contrast to the lower Floris coals, it is relatively persistent over a wide area. A fossiliferous marine shale and/or limestone usually directly overlie the coal, and a thin, persistent, phosphatic black shale with a distinct conodont fauna lies two to ten feet above it. The Carruthers correlates with the Greenbush and De Koven Coals of Illinois. A persistent coal smut and lenticular marine sequence that lies several feet above the Carruthers Coal near the top of the Floris Formation, is thought to correlate with the Abingdon Coal of Illinois. In general, the Floris represents a transition from non-marine fluvial and deltaic processes to more marine processes. Major incised valleys and their associated thick sandstone fills, probably occurred before deposition of the Carruthers Coal. These early Floris sequences of sandstone, 140 or more feet thick, cut downward into the underlying Kalo and Kilbourn Formations, and occasionally into the Misissippian. One exception to this is the 50 foot thick informally named "Hanging Rock Sandstone" in southwestern Dallas County that occurs just below the paleosol (underclay) below the overlying Whitebreast Coal.

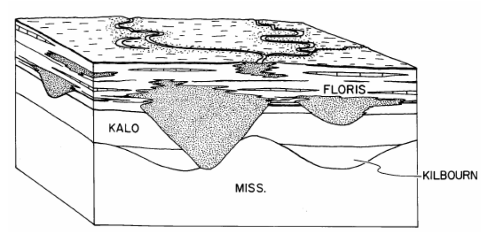

Figure 8. Block model of Floris Fm. deposition (Ravn and others, 1984).

Swede Hollow Formation

The Swede Hollow Formation is the uppermost formation with the Cherokee Group and includes strata from the base of the Whitebreast Coal Member to the top of the Mulky Coal Member. The lower Members of the Swede Hollow Formation are part of the first major marine cycle in the midcontinent Pennsylvanian (Ravn and others, 1984) (Fig. 9). This cycle spans the interval from the top of the paleosol below the Whitebreast Coal, including the Oakley Shale, and Ardmore Limestone, to the top of the paleosol below the Wheeler Coal in Iowa. The Verdigris Limestone is a lithostratigraphic unit comprising the Oakley Shale overlain by the Ardmore Limestone. The Verdigris extends across the entire midcontinent and can easily be recognized on geophysical logs, in cores, outcrops and well cuttings. Therefore, it is an important unit for mapping purposes. The Wheeler Coal represents a minor cycle in south-central Iowa. The Bevier Coal marks another marine cycle, the Bevier cyclothem, and extends upward to the top of the paleosol below the Mulky Coal. A lenticular limestone or dark fossiliferous shale with an abundant conodont fauna may occur above the Mulky Coal, and in southwestern Dallas County, an unnamed, thick sandstone occurs in the upper Swede Hollow Formation. In places it cuts out the entire Verdigris cycle, but its exact relationship to the Wheeler and Bevier coals is unknown.

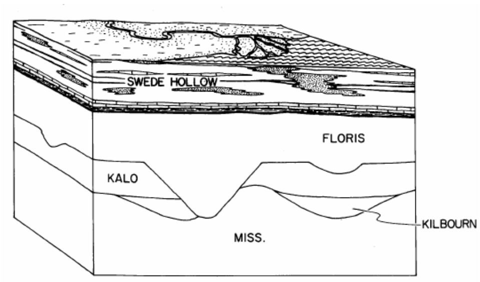

Figure 9. Block model of Swede Hollow Fm. deposition (Ravn and others, 1984).

PENNSYLVANIAN CHEROKEE GROUP IN WEBSTER COUNTY

Pennsylvanian rocks are only sparsely exposed in north-central Iowa, with outcroppings restricted to major river valleys and their tributaries where erosional down-cutting has exposed the bedrock. There are numerous Pennsylvanian exposures along the Des Moines River in Webster County, primarily south of Fort Dodge, including the Kalo bluffs, Woodman's Hollow, and Dolliver Memorial State Park. Pennsylvanian strata exposed include sandstone, mudrock, carbonaceous shale, coals, and limestone facies of the Lower Cherokee Group.

Early investigations of the Dolliver area

The earliest discussion of the rocks in the area of Dolliver Memorial State Park and southern Webster County was by Dale David Owen who with his Geologic Corps explored over 200,000 square miles of the upper mid-continent (Wisconsin, Iowa, Minnesota, and portions of Nebraska and South Dakota) in 1848 and 1849. His report to the U.S. Treasury Department (Owen, 1852) included a description of the rocks he observed during passage up the Des Moines River. He noted (Owen, 1852, p. 125);

> *"Ten miles above the Boone Fork of the Des Moines, solid ledges of sandstone, containing vegetable impressions, and embracing some thin, interpolated layers of conglomerate, presenting themselves to view. These sandstones gradually increase in thickness on approaching the great easterly bend of the 'Burnt Woods District,' where the current of the Des Moines strikes mural escarpments of thirty to fifty feet on alternating sides, as it is deflected from one high point of land to another. Twenty to twenty-five miles above the Boone Fork, they even attain the height of one hundred and ten feet."*

> *"Near the termination of these bluffs, just below our encampment of the 5th September* (inside the large bend in the river about 1 mile northeast of Woodmans Hollow)*, in sight of the Burnt Woods, there is a good deal of hydrated oxide of iron, but rather too much*

impregnated with sandy particles to be of practical value" (this is the Copperas Beds at Dolliver Park).

They also noted a stretch of the Des Moines River, where the river trends nearly east-west just below the confluence of Holliday Creek, that they called Lott's Rapids as nearly impassible due to an abundance of large glacial erratics.

> *"The sandstones, with some shaly intermixtures, continues within sight of Lott's Rapids, about five miles below the point where the north and south line, between Ranges 28 and 29, crosses the Des Moines. . Here, limestones can be seen at a low stage of water, covered with a multitude of boulders, which fill the channel; and there so obstruct the navigation, that it was with difficulty we succeeded in floating the bark canoe containing our provisions and camp equipage, over the shoals. It seems as if an accumulation of drift had taken place, from some local cause, such, perhaps, as the stranding of an iceberg loaded with erratics; since above and below the rapids, boulders are much less abundant than they are immediately on them."*

The strata in the Dolliver area were also discussed by Charles White (1870) in the Iowa Geological Survey's first report on the geology of the entire State of Iowa. In his Chapter IV, Geology of the Coal Counties, he included a brief description of Pennsylvanian rocks in Webster County. White included the first stratigraphic section for Webster County in his report (Fig. 10). He described the general geologic setting of the area, with emphasis on the coal resources (White, 1870, p. 254).

> *"The usual deep deposit of drift covers the surface of Webster county, hiding from view the underlying strata except in the valleys. Although the strata are thus hidden from view elsewhere, it is believed that about four-fifths of the area of the county are occupied by the Lower coal measures, the strata of which, including valuable beds of coal, are well developed. These strata are more fully developed, and their coal-beds thicker and better than might be expected in view of the fact that the northern border of the Iowa coal-field is understood to pass through the northern part of this county."*

> *"Thus far, at least three distinct beds of coal have been identified within the limits of Webster county, the upper one of which seems to be the thickest, purest, and consequently the most valuable. It is only along the valley-sides of the Des Moines and its tributary creeks that these beds are at present accessible, but there can be no doubt that they may be reached by shafts from the prairie surfaces, over a large part of the county." White concluded that "···there is no reason at present to assume, this thickest bed alone will furnish immense quantities of coal for both local use and for shipment, for there are good reasons for believing that the same bed may be as successfully mined in various other parts of the county."*

A more detailed description of the rocks of Webster County was provided by Frank Wilder in his report published in Iowa Geological Survey Annual Report Volume XIII (Wilder, 1902). On pages 85-88 he noted;

> *"The Coal Measure sandstones are striking stratigraphic features in the southern part of the county where a maximum thickness of sixty feet is exposed. Most of the layers are ferruginous, but near Lehigh the upper courses at certain points are cemented with carbonate of lime. The bond between the grains is slight when iron is the cementing substance. The layers containing carbonate of lime, however, are firm and suitable for building. Typical exposures of these sandstones may be seen on Prairie creek in Otho township, section 35, the so-called copperas beds, and at Wild Cat cave in Pleasant Valley township, section 11, SW ¼."*

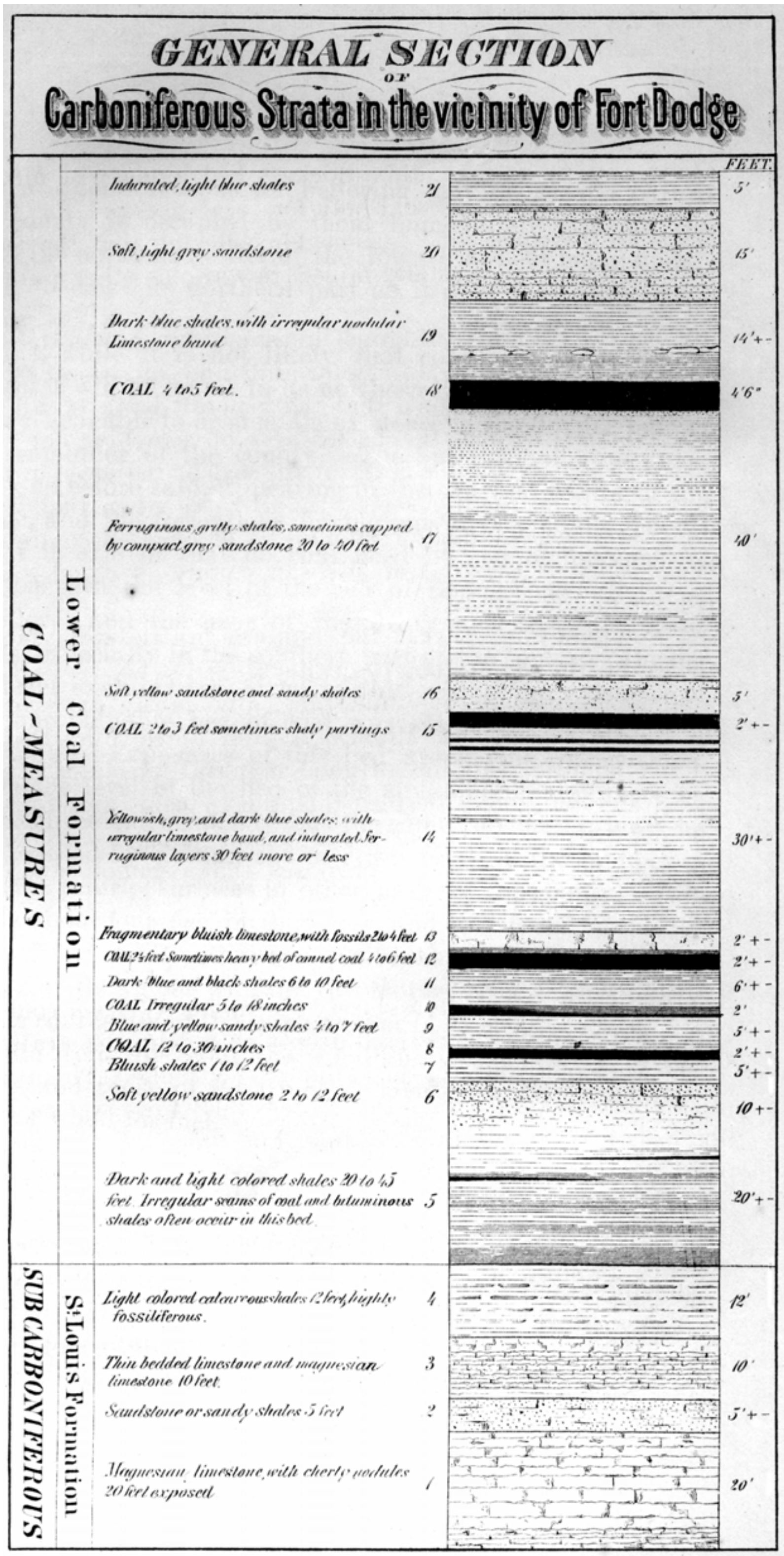

Figure 10. The first stratigraphic section of Carboniferous strata in Webster County (White, 1870, p. 257)

Figure 11. Concretions in the sandstones near Prairie Creek. Photo by Samuel Calvin from University of Iowa Calvin Image Database.

"The concretions in the sandstones are very abundant and of all sizes from a foot to a fraction of an inch (see Fig. 11). Many of the smaller ones are hollow. Cross-bedding is everywhere conspicuous. At times the laminae are curiously contorted, not merely slanting, as is common in cross-bedding, but bent over so that the arch like a bow. Such structure is difficult to explain. Lateral or vertical pressures on plastic, cross-bedded and may account for it. Very common in the Coal Measures sandstones are small shining particles of selenite."

"The iron conglomerate, containing iron and northern pebbles, was found only near the mouth of Prairie creek and in a ravine a mile farther south. Perhaps one-half of the rock consists of small pebbles and the rest of the cementing iron. The rock so formed is very hard and seems to weather very little. Where it has been long exposed to the air the pebbles have fallen out and the rock has a vesicular appearance, in color and structure resembling lava."

RECENT GEOLOGIC STUDIES IN DOLLIVER PARK

More recent work in the Dolliver Memorial State Park area by faculty and students at Iowa State University Department of Earth Science was published in a guidebook for the 1981 North-Central Section of the Geological Society of America (Lemish and others, 1981). Their work provided much of the information for the preparation of this portion of the guidebook.

Lemish and others (1981a), revisited by Vondra (2005), examined the Cherokee Group rocks in the Webster County area. They noted that the encroachment of the Middle Pennsylvanian sea onto the Mississippian erosion surface led to the deposition of the clastics- and coal-dominated sediments of Cherokee Group.

In their studies of exposures of the Cherokee Group in Webster County, Burggraf and others (1981a) identified six lithofacies, occurring as complexly interfingering rock bodies. These facies, grouped within the larger sand facies or mudrock facies, are listed in Figure 12.

Sandstone Facies

Sandstones of the Cherokee Group in Webster County (Fig. 5) were described by Burggraf and others (1981a) as including a lenticuar fine- to medium grained, cross-stratified sandstone facies and a fine-grained, parallel-laminated to ripple-bedded sandstone facies.

CHEROKEE GROUP FACIES

Sandstone Facies

1. Lenticular fine- to medium-grained cross-stratified sandstone
2. Fine-grained parallel-laminated to ripple-bedded sandstone

Mudstone Facies

3. Laminated fine sandy siltstone, gray claystone, and coal
4. Interbedded laminated very fine sandstone, siltstone, and claystone
5. Laminated siltstone and gray claystone
6. Carbonaceous shale and limestone

Figure 12. Cherokee Group facies in southern Webster County (Burggraf and others (1981a)

***Lenticular fine- to medium-grained cross-stratified sandstone facie*s** The lenticular fine- to medium-grained cross-stratified sandstone facies (lenticular facies) consists of resistant lenticular sandstones observed in nearly vertical cliffs along the Des Moines River and its immediate tributaries. Burggraf and others (1981a) described these sandstones as very pale orange to moderate yellowish brown with variable amounts of iron oxide cement ranging in color from dark yellowish orange to moderate brown. The facies is composed of bundles of stacked sets of large-scale planar cross-stratified fine- to medium-grained sandstones, commonly displaying set thicknesses of 1 to 2 feet. The lowermost set in each bundle are thickest, with subsequent sets progressively decreasing in thickness. Most sets display prominent foresets which dip to the southwest about 25º, and planar cross-stratified sets occur much more common than large-scale trough cross-stratifications. Truncation of underlying sets, internal scour features, and reactivation surfaces are common in this facies, and successive sets are usually separated either by an erosional surface or by a thin set (less than 5 inches) of low-angle, parallel-laminated sand or a thin set of ripple-laminated fine sand. Although planar cross-stratified sets dominate the lenticular facies large-scale trough cross-stratification also occurs in these strata.

The lenticular facies is marked by a sharp erosional contact with underlying units, frequently incorporating well rounded rip-up clasts of argillaceous siltstone or claystone marked by dark reddish brown to moderate brown oxidation rims.

The sandstone matrix of this basal rip-up clast-rich unit is dominated by subrounded to subangular quartz. feldspar, and mica and may reach up to several feet in thickness. The facies is commonly exposed in thickness of at least 30 feet, and reaches a maximum thickness en excess of 60 feet (Burggraf and others, 1981a) at Wildcat Den (see Figure 13).

An unusual phenomenon that is frequently observed in the large-scale planar cross-stratified sandstone of this facies is the overturning of the upper portion of the foresets. This phenomenon as described by Burggraf and others (1981) and called "intraformational recumbent folding" by Reineck and Singh (1975) is confined to a single set among a thick coset of tabular cross-strata and may be associated with other contorted and/or convolute bedding. This phenomenon was attributed to a variety of processes ranging from simple gravitational slumping to liquefaction (Potter and Glass, 1958; Ore, 1963; Stewart, 1964; and Rust, 1968), but Allen and Banks (1972) modeled the deformation as a function of earthquake-triggered liquefaction.

Fine-grained parallel-laminated to ripple-bedded sandstone facies The fine-grained, parallel-laminated to ripple-bedded sandstone facies (parallel-laminated facies) consists of tabular, planer to undulating bodies of fine-grained sandstones (Burggraf and others, 1981a). Although this facies may be locally extensive, perhaps extending of several hundred feet (Burggraf and others,

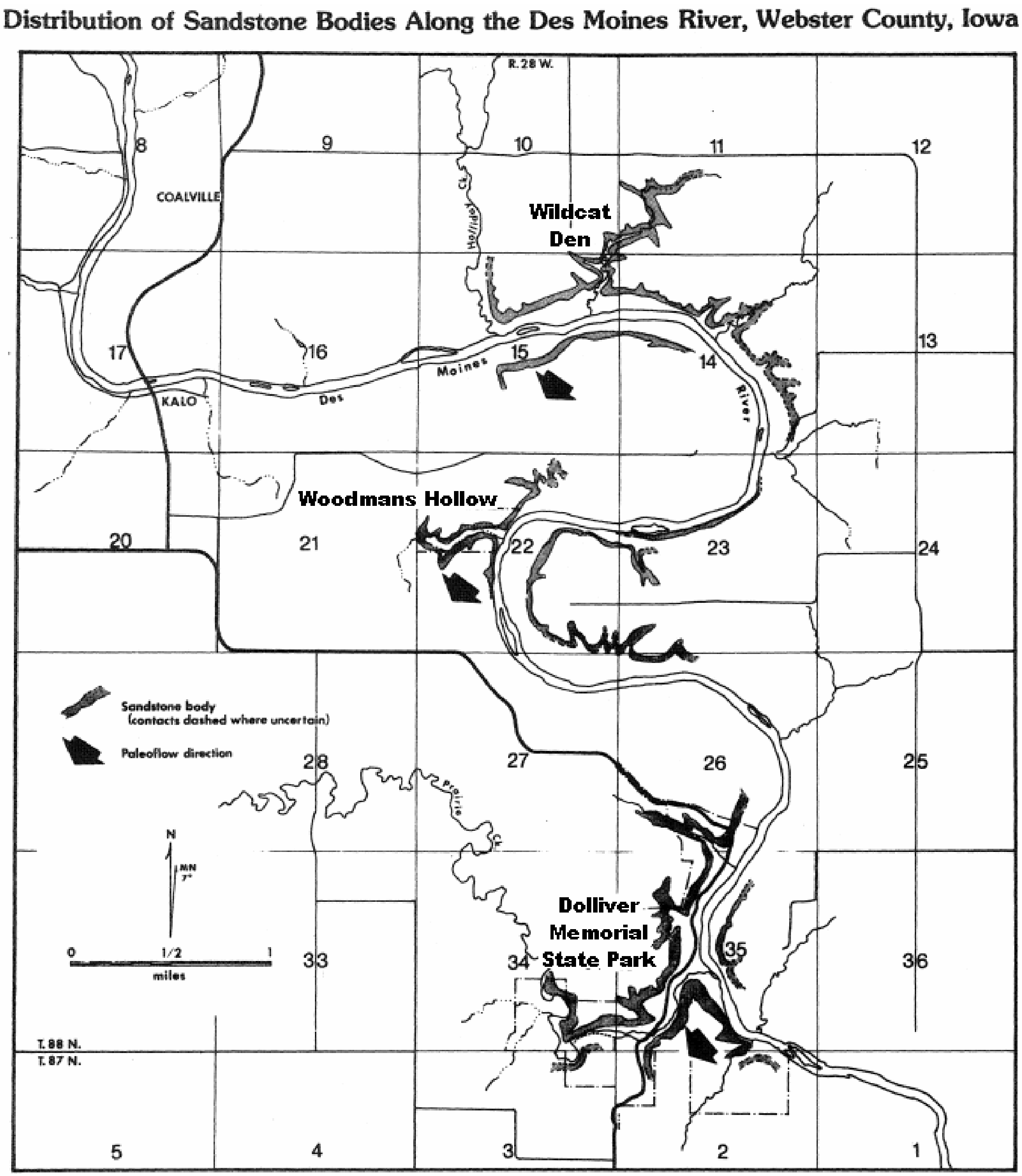

Figure 13. Pennsylvanian Cherokee Group sandstones along the Des Moines River in east-central Webster County, Iowa (from Burggraf, 1981a).

1981a) it is not well exposed, precluding accurate descriptions of lateral extent and other features. The basal contacts of the fine-grained facies are sharp and, while displaying local areas of minor basal scouring, are generally conformable. The sands of this facies are moderate yellowish brown to moderate brown parallel-laminated to indistinctly ripple-bedded fine- to very fine-grained sand, commonly with a ripple-bedded fine sandy siltstone cap.

Elongate sand lentils, up to 6 feet in thickness and 15-20 feet wide are found closely associated with the fine-grained facies. They consist of parallel-laminated to large-scale trough cross-stratified fine- to very fine-grained sandstone, often displaying an upper zone of ripple-bedded moderate yellowish brown to grayish orange fine sandy siltstone that may be several inches thick. Both of these types of sand bodies are enclosed by deposits of laminated fine sandy siltstone, claystone, coal, or siltstone facies.

Mudrock facies

Rocks representing the mudrock facies of Burggraf and others (1981a) are not well exposed in Webster County. Exposures are almost always overlain (protected) by sand facies rocks. They were, however, able to distinguish four subfacies.

Laminated fine sandy siltstone, gray claystone, and coal facies The laminated fine sandy siltstone, gray claystone, and coal facies consists of parallel-laminated to thinly bedded, moderate yellowish brown to grayish orange, fine sandy siltstone, light olive gray laminated argillaceous siltstone, medium gray to dark gray claystone, and brownish black gray black, and black coal and argillaceous coal. Basal contacts are gradational, frequently fining upward from arenaceous siltstone to gray claystone and coal. Plant remains as branches and leaves are abundant in dark laminated bedding planes. Coal and carbonaceous shale occur in beds up to three feet thick in bluffs near Kalo and are commonly underlain by massive to laminated gray claystones.

Interbedded laminated very fine-grained sandstone, siltstone, and claystone facies Deposits of the interbedded laminated very fine-grained sandstone, siltstone, and claystone facies of Burggraf and others (1981a) consist of thin beds of light yellowish gray and yellow gray to grayish orange) very find-grained sandstone with mottled areas of dark yellowish orange. The sands were observed to be tabular to slightly lenticular bodies, usually less than 4 inches thick, frequently displaying sharp erosional bases, are rich in carbonaceous materials, and fine upward into parallel and wavy-laminated silty fine sandstone and siltstone. The sandy intervals include alternating lamina of light gray very fine-grained sand and yellow gray to medium gray silty sand, separated by laminations of olive gray silty claystone. The sandstones in this unit are also rich in carbonadeous materials and often display a contorted structure that includes irregularly shaped bodies of light colored sandstone enclosed by darker, finer-grained materials.

Burggraf and others (1981a) identified large-scale truncation (Scour and fill?) features within this facies, displaying magnitudes from a few inches to greater than 15 feet. Strata at the base of the fill cycle in these structures may dip as much as 20˚, progressively decreasing upward. This facies reaches a maximum thickness of about 35 feet near Kalo and grades into deposits of the laminated siltstone and gray claystone facies.

Laminated siltstone and gray claystone facies Rocks of the laminated siltstone and gray claystone facies, as described by Burggraf and others (1981a) were deposited directly on underlying marine carbonates of the Mississippian System. The facies includes olive gray and light yellowish gray to light gray laminated siltstones and silty claystones, often including abundant fragmented carbonaceous debris and carbonate concretions of variable size. This facies is disconformably overlain by rocks of the lenticular fine-to medium-grained cross-stratified sandstone facies and interfingers with, or is disconformably overlain by, the interbedded laminated very fine-grained sandstone, and claystone facies. It is conformably overlain and interfingers with rocks of the carbonaceous shale and limestone facies.

Carbonaceous shale and limestone facies The carbonaceous shale and limestone facies identified by Burggraf and others (1981a) occurs as a northwestwardly-thickening wedge of medium gray to gray black fissile carbonaceous shale with occasional thin lenses of medium gray argillaceous siltstone to 1 inch thick, and gray to dark bluish gray pyritiferous, fossiliferous limestone. Its basal contact is gradational.

The limestone observed in this facies occurs as a 14-inch thick arenaceous to argillaceous biomicrite and may locally include cone-in-cone structures. The limestone includes abundant pyritized brachiopods, complete and fragmentary.

The facies thickens in Webster County from less than 4 feet to about 15 feet in a northwesterly direction over about 1 mile in the Kalo area.

CHEROKEE GROUP EXPOSURES IN DOLLIVER MEMORIAL STATE PARK

Cherokee Group sandstones are extensively exposed along the Des Moines River and its tributaries in Dolliver Memorial State Park. As a part of this field trip, we will examine three of these exposures, at Boneyard Hollow (a canyon drained by an unnamed tributary stream at the north end of the park), the Copperas Beds (and exposure of conglomeratic sandstone along Prairie Creek near the south end of the park), and the area of a recent sandstone cliff failure along Prairie Creek near the south end of the park.

Boneyard Hollow, Dolliver Memorial State Park

The area of Dolliver Memorial State Park known as Boneyard Hollow (Figs. 14 & 15) is a northwest-trending canyon just south of the North Shelter near the north park entrance. The area was named by early pioneers for the numerous bison, elk, and deer bones they found in the canyon from animals apparently driven over the cliffs and into the canyon by Indians The Hollow was described in a field trip guidebook by Burggraf and others (1981b). They described the canyon as dominated by a thick sequence of sandstone overlying a poorly exposed light gray mudstone. The sandstone contains abundant, well displayed cross-bedding highlighted by iron oxide stained forset laminae (Fig. 14B). The contact between the sandstone and the mudstone is poorly exposed (Fig. 14A), but frequently hosts springs. Continuing northwestward up the drainage the south-facing cliff face exposes a zone about 15 feet above creek level that displays deformed cross-strata (Figs. 14C & 16). These deformations, discussed earlier in the text (see p. 21), have been identified as intraformational recumbent folding (Reineck and Singh, 1975) or recumbent-folded deformed crossbedding (Allen and Banks, 1972). The over-turning of the foreset laminae and other soft sediment deformation features suggested to Burggraf and others (1981b) a saturated condition for the sand beds shortly after deposition possibly deformed by seismic activity. These deformed beds continue for most of the length of the canyon.

Copperas Beds, Dolliver Memorial State Park

The Copperas Beds (Figs. 17 & 18) at Dolliver Memorial State Park lie a short distance from a parking lot near the picnic are, group camp, and South Lodge near the southern park entrance. The beds are accessed by a short walk to the west down a trail that parallels Prairie Creek. Where the trail reaches a wooden bridge that crosses the creek the Copperas Beds are exposed along a cutbank (Fig. 17C) just upstream from the bridge.

The Copperas Beds are composed of a series of thin to very thick beds of very fine to conglomeratic sandstone displaying abundant carbonized plant material (Fig. 19 c) and some permineralized branches and leaves (Burggraf and others, 1981b). Coarse clasts are dominated by mud rip-up clasts commonly incased by iron oxide. The beds get their name from the occurrence of sulfate efflorescences along the outcrop face (Figs. 17A & 19 a, b). This mineralization was described by White (1870), Keyes (1893) and Wilder (1902) and was identified by early geologist as ferrous sulfate, or copperas. In the late 1800's chemical analysis of the minerals by the Iowa Geological Survey identified the minerals as melanterite

Unit	Description
B.	Sandstone; pale yellowish orange (10YR8/6) to pale brown (5YR5/2); fine- to medium-grained; abundant large-scale planar cross-strata; strongly iron-stained in basal portion; upper contact covered; basal contact sharp, erosional; greater than 35 feet.
A.	Sandy mudstone to claystone; medium gray (N5) to dark yellowish orange (10YR6/6); lower contact covered; basal 4 feet is laminated claystone; gradational upward to sandy mudstone 7 feet thick; highly iron-stained; 11 feet exposed.

BONEYARD HOLLOW

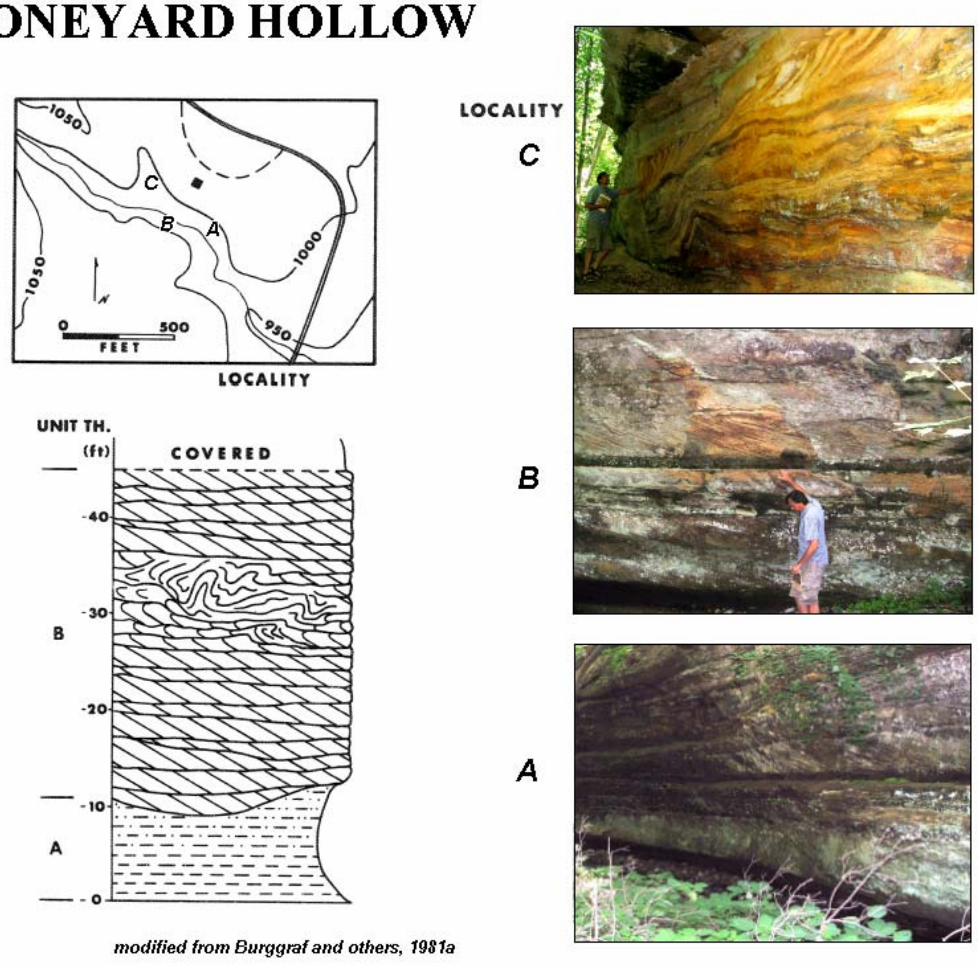

Figure 14. Graphic section and descriptions of Boneyard Hollow, Dolliver Memorial State Park. **A.** The sandy mudstone seen as a reentrant at the base of the section **; B**. prominent large-scale planar cross strata; **C.** deformed cross-strata. Modified from Burggraf and others, 1981a.

Figure 15. IGS geologist Brian Witzke examines Cherokee Group sandstone cliffs at Boneyard Hollow.

Figure 16. Deformed bedding and liesegang banding in Boneyard Hollow

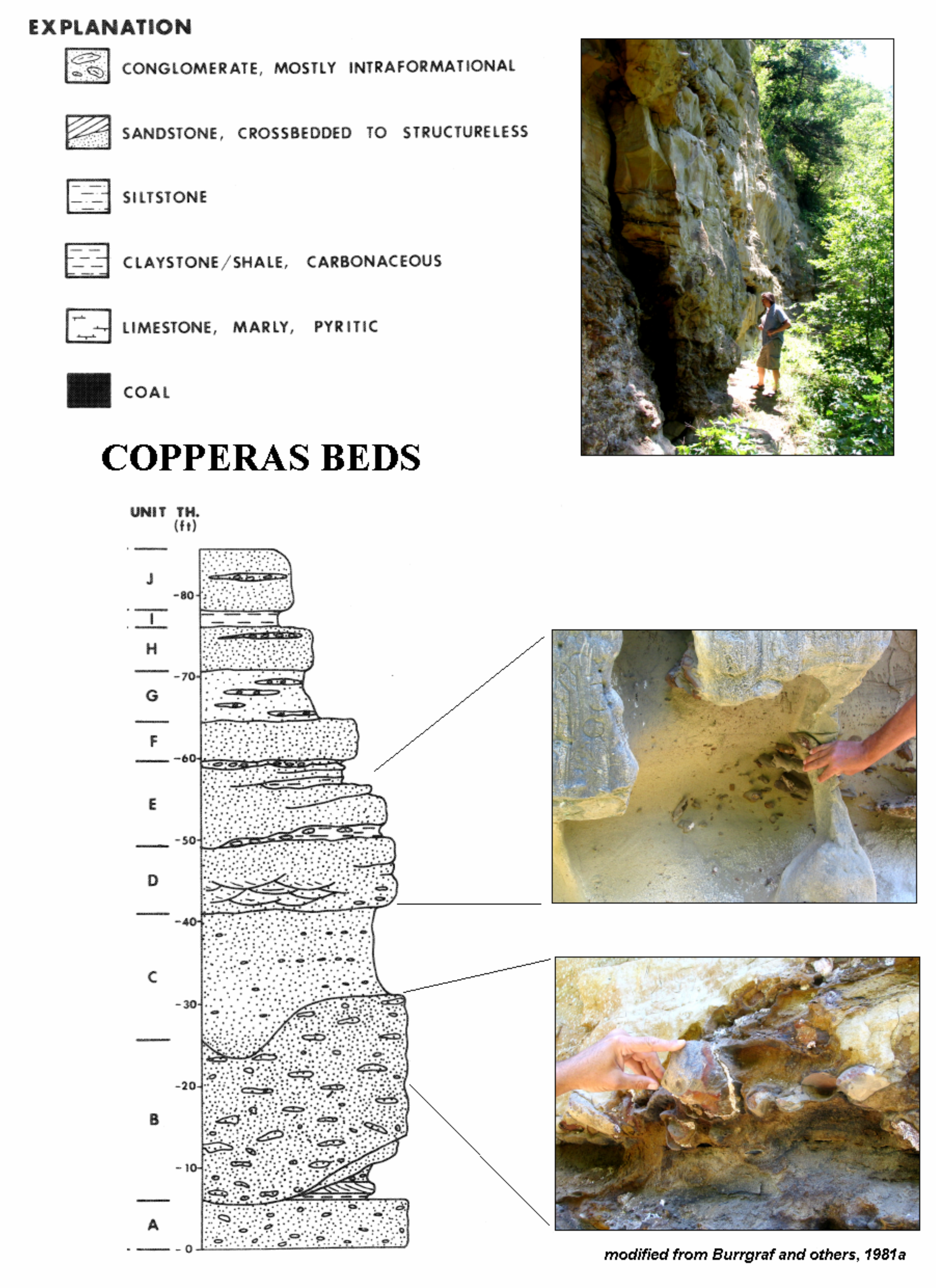

Figure 17. Graphic section of the Copperas Beds area, Dolliver Memorial State Park. See Figure 18 for written description of beds. **A.** basal conglomeratic unit with some clasts rimmed by sulfate efflorescences; **B.** sandstone-dominated interval with conglomeratic lenses; **C** view of the Copperas Bed rock face. Modified from Burggraf and others, 1981a.

Unit	Description
J.	Sandstone, silty; grayish orange (10YR7/4); very fine grained; indistinct bedding; very friable; 7 ft.
I.	Claystone, silty; light gray (N6); laminated; friable; 2 ft.
H.	Sandstone; similar to unit C; occasional claystone band; 5 ft.
G.	Alternating sandstone and claystone; similar to unit E; 6 ft.
F.	Sandstone; same as unit D; 5 ft.
E.	Sandstone - siltstone; sandstone; same as unit D; siltstone; argillaceous and carbonaceous with clay galls; friable; 8 ft.
D.	Sandstone, similar to unit C; some carbonaceous debris; horizontal laminations to trough crossbedding; lensatic, cobble-clast band at top; 10 ft.
C.	Sandstone, subarkose with thin claystone beds; dusky yellow (5Y6/4); fine-grained; quartz with silt galls, micaceous, clay mineral cement; basal contact sharp, scoured; moderately friable; up to 18 ft.
B.	Conglomerate, intraformational; dark reddish brown (10R3/4) to light brown (5YR5/6); very poorly sorted, pebble to boulder size, moderate sphericity and roundness, quartz and siltstone clasts cemented by ferroan dolomite; basal contact sharp and erosional; thin-bedded with slight imbrication; very well indurated, cliff former; up to 20 ft.
A.	Conglomerate - sandstone: cgl; quartz pebble and sandstone clasts; very dusky red (10R2/2) to moderate reddish brown (10R4/6); pebbles well rounded, poorly sorted; basal contact not exposed; thin bedded; very well indurated with dolomitic cement; sandstone; light brown (5YR5/6); quartzose; fine grained; small scale crossbedding; friable to moderately indurated; unit up to 10 ft.

from Burrgraf and others, 1981a

Figure 18. Descriptions of the graphic section of the Copperas Beds area, Dolliver Memorial State Park. See Figure 17 for graphic section. Modified from Burggraf and others, 1981a.

($Fe_2SO_4.7H_2O$). In more recent work by Cody and Biggs (1973) called the melanterite identification into question, noting that meanterite rapidly dehydrated into rozenite ($FeSO_4.4H_2O$) under conditions of low to moderate humidity. They reanalyzed the mineralization at Dolliver Park and identified rozenite as well as two less common minerals, halotrichite - $FeAl_2(SO_4)_4.22H_20$ and szomolnokite - $FeSO_4.H_2O$. This was the first reported occurrence of any of these minerals in Iowa, and perhaps the first report of szomolnokite in the midcontinental United States (Cody and Biggs, 1973). These minerals occur as fibrous white layers of elongate crystals intermixed with a mass of very fine-grained crystals. All of these minerals are readily soluble in water and may be completely washed off the outcrop face by heavy rainfall. The minerals are subsequently reprecipitated during periods of low to moderate humidity.

The "copperas" mineralization results from the abundance of pyritic coals and black shales within a short lateral distance. Iron, sulfur, and aluminum minerals are dissolved and transported through the porous and permeable Cherokee Group sandstones by groundwater. As the groundwater reaches the cliff face, the minerals are concentrated by surface evaporation, eventually precipitating and crystallizing.

Figure 19. Features of the Copparas Beds. **a.** iron sulfate efflorescences on the cliff face, **b.** iron sulfate efflorescences on a clast in an iron oxice matrix, **c.** carbonized plant material in conglomerate, d. carbonate concretion in Cherokee Group conglomerate.

2007 Cliff Face Failure along Prairie Creek

This stop is located on the east bank of Prairie Creek where the old park road fords the creek. In April of 2007, a large face of sandstone collapsed off the cliff face, temporarily damming the creek (Figs. 20, 21, 22). The collapse occurred because of the undercutting of the soft mudstone unit at the base of the cliff face by the flooding waters of Prairie Creek. The cliff was described by Burggraf and others (1981b) who noted that at the section base, usually visible just above the water level, arenaceous siltstone and laminated silty claystones with small lentels of very fine-grained sandstone are exposed. The overlying sandstone constitutes a thick sand sequence separated from the finer-grained deposits by a sharp erosional contact. The base of the sandstone displays abundant rip-up clasts and carbonaceous debris. The sandstones display abundant large-scale planar cross-bed sets, some of which are greater than 2 feet in thickness, and increase in thickness in a downstream direction. Each set displays an erosional base and is overlain by either shallowly dipping stoss-side cross-strata, most directed to the southwest. Individual beds

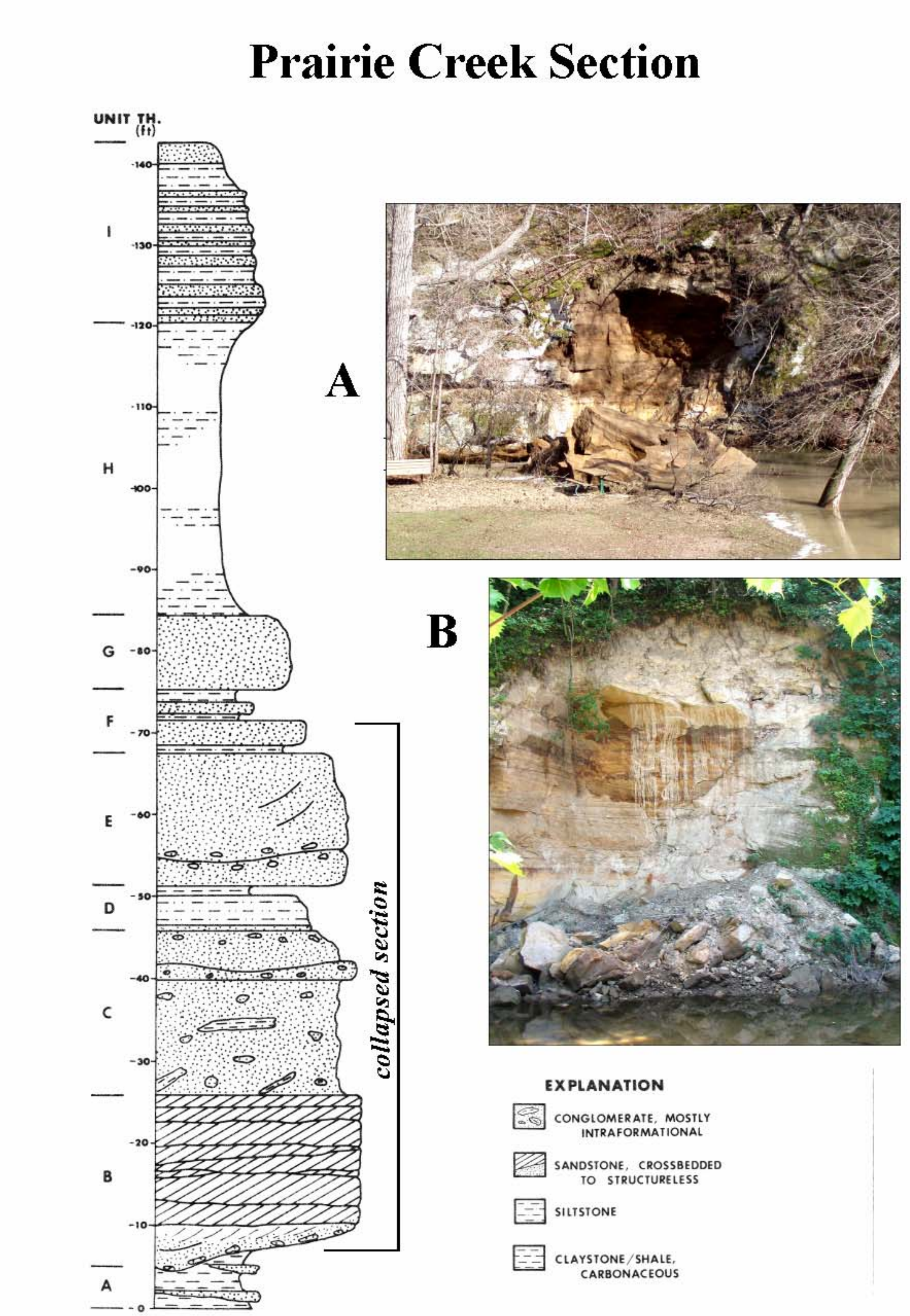

Figure 20. Graphic section of Cherokee Group strata along Prairie Creek that collapsed in 2007. **A.** shortly after rock collapse debris blocked creek**; B**. view of collapsed section after debris cleared from creek. Modified from Burggraf and others, 1981a**.**

Unit	Description
I.	Sandstone-siltstone repetitions; sandstones, calcareously cemented; similar to unit D below; 23 ft.
H.	Siltstone; sandy at base but very poorly exposed; covered slope; 36 ft.
G.	Sandstone, subarkose, similar to unit E; 9 ft.
F.	Alternating layers of sandstone and siltstone-claystone; as in unit D; 8 ft.
E.	Sandstone; same colors as unit B; fine-grained; indistinct bedding with scour surface and clay galls in lower portion; basal contact sharp; friable; 16 ft.
D.	Sandstone-siltstone; sandstone, carbonaceous with wood fragments; yellowish gray (5Y7/2), fine-grained, horizontal lamination; friable; 4 ft. thick; siltstone, argillaceous to arenaceous and carbonaceous; grayish orange (10YR7/4), to light gray (N7); laminated; friable; 1.5 ft. thick; total thickness 5.5 ft.
C.	Sandstone, abundant claystone bands and rip-up clasts of silt and sand; same colors as unit B; carbonaceous and micaceous; clasts up to 6 in. dia.; sandstone clast conglomerate in upper portion; indistinct bedding; moderately friable; 20 ft.
B.	Sandstone; subarkose; dark yellowish orange (10YR6/6), weathers moderate brown (5YR4/4); fine-grained, moderate sphericity and roundness, well sorted; quartzose with minor feldspar, siltstone rip-up clasts at base; basal contact sharp, irregular with isolated coaly pods; small to large scale trough and planar crossbedding in sets to 2.5 ft. thick; well indurated, cliff former; thins laterally; 22 ft.
A.	Siltstone-sandstone; stilstone, argillaceous and carbonaceous; medium dark gray (N4) to grayish orange (10YR7/4) at the top; thinly laminated to laminated; friable; sandstone; moderate yellowish brown (10YR5/4) to moderate brown (5YR5/5); very fine-grained, well sorted; basal contacts sharp; lenticular; faint cross-bedding, ripple marks on upper surfaces; moderate to well indurated; lenses to 3 ft. thick; basal contact of unit A not exposed; up to 12 ft.

Figure 21. Description of Cherokee Group strata at the Prairie Creek section shown in Figure 20. From Burggraf and others, 1981a.

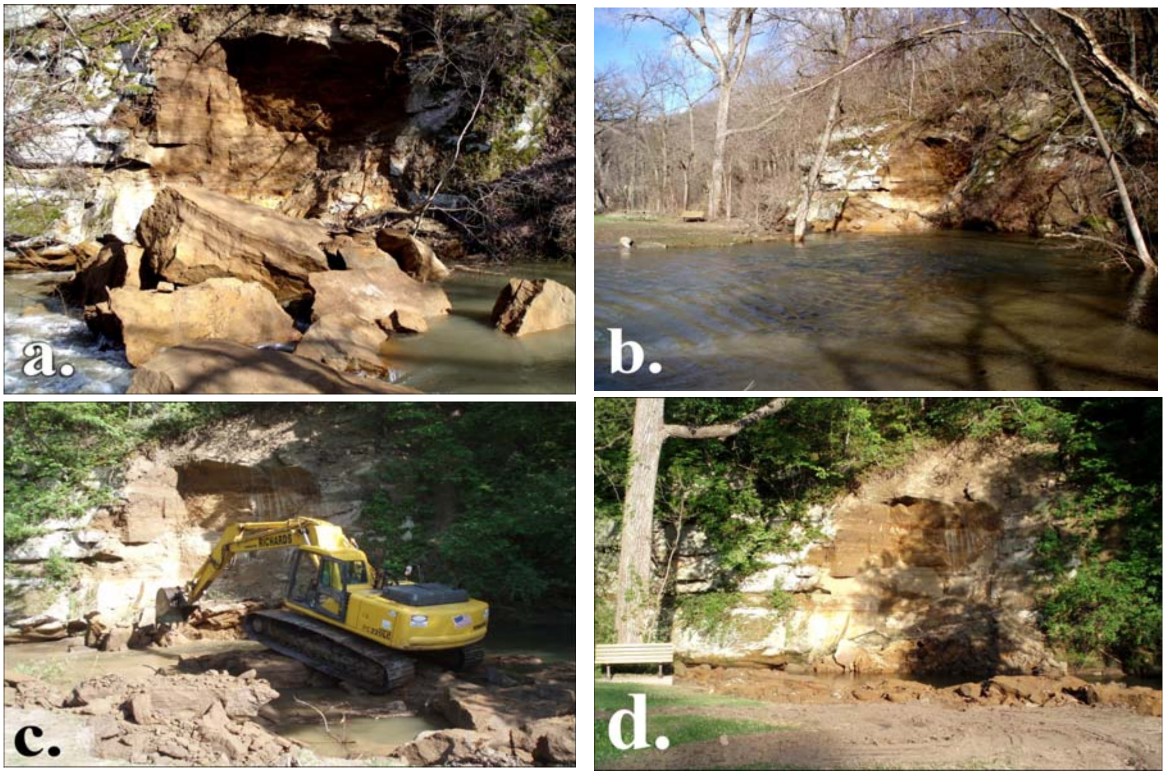

Figure 22. Photos of the cliff face collapse on Prairie Creek. **a.** large sandstone blocks fill creek, **b.** rock fall dammed Prairie Creek, **c.** large backhoe clearing rocks from creek, **d.** after creek cleared, rocks line both banks. Photos by Kevin Henning.

commonly exhibit normal grading and are strongly iron stained. The rock debris dammed the creek (Fig. 22a), raising water level several feet on the upstream side (Fig. 22b) before the water cut a new channel. A large backhoe was used to break up the larger blocks and clear the creek channel. We can now see the fallen blocks lining both banks of Prairie Creek at the rock fall site.

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ARCHAEOLOGY IN WEBSTER COUNTY AND DOLLIVER MEMORIAL STATE PARK

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ARCHAEOLOGY IN WEBSTER COUNTY

The Iowa Site File indicates that Webster County currently has approximately 500 recorded archaeological sites. They include the full range of possible culture periods from Paleo-Indian to Euro-American sites. Webster County has the largest number of recorded sites compared to its surrounding neighbor counties due to the large number of state and federally funded projects such as interstate road construction, reservoir construction, development of recreation areas and other projects that would mandate cultural resource management. Formal research, began in the 1920s by Charles R. Keyes, were mainly comprised of personal correspondence to Keyes with sites occasionally being recorded by field visits. Since work space and funds were non-existent, these early years saw little actual excavation with a few exceptions which did include volunteer projects in the Fort Dodge area (McKusick 1979:7). Work continued through the 1930s and 1940s by Keyes assistant, Ellison Orr, although it does not seem that any of Orr's work was conducted in Webster County. Sites continued to be recorded in Webster County throughout the 1950s and 1960s, largely by dedicated local amateurs. The recording of mounds and mound groups were frequently the focus of work during this period. The 1970s saw the beginnings of the current era of public archaeology where funding was available for the documentation of archaeological resources. The majority of these sites were located along the Des Moines River valley and its tributaries. Archaeological research in Webster County has continued to the current day under a variety of large and small scale projects including surveys for cell tower locations to the surveying of new alignment for the proposed U.S. 20 highway corridor. If the 500 Webster County sites, roughly 370 represent prehistoric occupations while 130 represent historic occupations.

Background

The prehistoric period in Iowa is separated from the historic period by the contact of Native Americans with Euro-Americans. This contact period is typically assigned to the late seventeenth and early eighteenth century for eastern Iowa however, it is not true for north-central or western Iowa. Although Euro-American contacts with Native Americans in Webster County may have begun in the eighteenth century there exists no documented evidence for that contact. Therefore, the prehistoric period for the areas represents human occupation prior to the early 1800s.

The prehistoric period is divided into the Pre-Clovis, Paleo-Indian, Archaic, Woodland, and Late Prehistoric periods. The Pre-Clovis period is not applicable to this study considering that this culture period predates 11,500 BP, a time when the Des Moines Lobe ice sheet covered the region, effectively making it uninhabitable. The other four culture periods are briefly described below based primarily on the work of Schermer et al. (1992), Perry (1996), J. Morrow (1996), T. Morrow (1996a, 1996b), Fishel (1996a, 1996b), and Anderson (1998).

Paleo-Indian

The Paleo-Indian period in Iowa dates between roughly 11,500–9,500 BP. The peoples occupying north-central Iowa during this period encountered a cooler and wetter climate and a recently deglaciated, coniferous forest covered landscape. These peoples were highly mobile hunters and gathers, living in small bands and focusing on a broad range of game including the large species, or mega fauna, which became extinct sometime within this period. Their tool assemblages included distinctive lanceolate point styles including Clovis, Folsom Gainey, Dalton and others, specialized butchering tools, the use of high-quality, often exotic raw materials, and unique manufacturing techniques specific to the Paleo-Indian period. Most sites of this period represent kill-butchering sites and little is know of other site types although they certainly exist. The probable low population density of Paleo-Indian groups indicates that sites dating from this period will be few and far between. Considering the lack of verified Paleo-Indian sites in the state, interpretations of settlement patterns, subsistence systems and other attributes currently rely on considerable speculation which will certainly be changed and modified once new data is added to the archaeological record.

Fluted points such as Clovis and Folsom have been recovered in 42 of the 99 Iowa counties (Morrow and Morrow 1994), while other Paleo-Indian lanceolate points have a wider distribution. The best documented Paleo-Indian site in Iowa is the Rummels-Maske site, Cedar County, which consists of a cache of Clovis points recovered from a plow-disturbed field. Three sites in Webster County have been identified as either having a Paleo-Indian component or association however, neither are close to Dolliver State Park. One of these sites represents a Clovis point find and is recorded by Morrow and Morrow (1994). By the end of the Paleo-Indian period environmental changes were occurring rapidly and are associated with the cultural changes identified with the Archaic period.

Archaic

The Archaic period in Iowa dates between roughly 9,500–2,500 BP and can be further divided into the Early Archaic period (9,500–7,500 BP), Middle Archaic period (7,500–4,500 BP) and the Late Archaic period (4,500–2,500 BP). Environmental change was occurring rapidly across Iowa and the Des Monies Lobe resulting in the expansion of deciduous forests mixed with areas of prairie in the western portions of the state. Coupled with this rapid change in flora was a relatively rapid change in fauna. The mega fauna of the Paleo-Indian period became extinct while the spruce-pine forests were quickly being replaced by deciduous forests mixed with scattered areas of prairie. These altering environmental changes were the apparent driving force in the change from Paleo-Indian to the Archaic.

The Early Archaic period is viewed in terms of a transition from an emphasis on big game hunting to a more integrated foraging adaptation. Peoples became focused on bison, deer, and elk along with smaller game animals and an increasing dependence on floral resources. Projectile points were no longer fluted although lanceolate styles continued to be used. Basal notching became characteristic of Early Archaic points indicating different hafting methods for different applications. Serrated and beveled edges are typical of many types of projectile points during this period. Ground stone tools, made by pecking and abrading igneous and metamorphic rock types, is added to the prehistoric tool kit during the Archaic. This class of tools were used in pounding, grinding, crushing and chopping activities likely focused on plant processing and greater wood use. Settlement sites include long and short term base camps as well as long and short term resource procurement camps. Population densities were still low but certainly greater than during the Paleo-Indian period. One excavated site, the Cherokee Sewer site located approximately 80 km (50 mi) northwest of Dolliver State Park, indicates that Early Archaic populations were still small and that they were tied to a seasonal round of resource exploitation.

The Middle Archaic is often combined with the Early because of a lack of data on this period. During this time environmental conditions were becoming increasingly arid creating the warmest period during the Holocene to date. This episode is known as the Hypsothermal, which saw great amounts of fine-grained sediments fill river valley and the creation of numerous alluvial fans throughout the drainage basins. Because human occupations focused more intensively along river valleys due to this drying period, many Middle Archaic sites are likely eroded away higher in the drainage basins and deeply buried in these alluvial fills lower in the basins. This is also the period when the prairie peninsula region spread across Iowa, including the Des Moines Lobe. Lithic assemblages are characterized by a wide range of medium sized, stemmed and notched point types with a notable decline in manufacturing quality. Pecked and ground stone tool frequency and variety expand during this period and include full and three-quarter grooved axes, banner stones, nutting stones and others. Specialized tool kits and an increased diversity of floral and faunal remains at these period sites found elsewhere indicate an increasing exploitation of the environment by the Middle Archaic peoples. Information on skeletal morphology and burial practices are known from the Middle Archaic partially due to preservation by burial in these alluvial sediments and is exemplified by the Turin site, Monona County. Four individuals were discovered at this site in a gravel operation and exhumed in the mid-1950s, dating to approximately 4,720 ± 250 RCYBP (Tiffany 1981).

The Late Archaic in Iowa is noted by an overall population increase and the exploitation of previously unoccupied areas, partially due to the end of the Hypsothermal and the return of moister conditions. There are clear indications of similar subsistence strategies over broad areas, local differentiation of artifact styles, developing intergroup trading networks and also increased territoriality. Projectile points are smaller and less well made with an increasing emphasis on expedient flake tools for the variety of procurement and processing tasks. Greater stability and diversity of environmental niches not only supported expanding populations and occupation types but also indicates an more sedentary way of life. Large, multiple-interment cemeteries are encountered in the archaeological record supporting the interpretation of greater population densities and sedentary life ways.

Eight sites are identified as Archaic in Webster County. Only one is associated with the Early Archaic while seven are associated with the Late Archaic based on diagnostic projectile points. No Middle Archaic sites have been identified to date.

Woodland

The Woodland period in Iowa dates between roughly 2,500–1,000 BP and can be further divided into the Early Woodland period (2,500–2,100 BP), Middle Woodland period (2,100–1,300 BP) and the Late Woodland period (1,300–1,000 BP). Early in this period the climatic conditions and landform development had stabilized to resemble those of today and vegetation patterns became much like the forest-prairie mix encountered by nineteenth century Euro-American settlers. With altering environmental conditions driving transition from the Paleo-Indian to Archaic period it can be said that cultural changes were driving transition from the Archaic to Woodland period. Characteristic of this transition are major technologic, economic, and social developments including the introduction of bow and arrow technology and pottery manufacture, plant domestication and cultivation, and burial mound construction. Although some of these adaptations began in the Archaic period it was not until the Woodland period that they are seen in the archaeological record as being accepted across a broad area.

The Early Woodland is not well documented in the Des Moines Lobe or across Iowa in general. Settlements appear as small, seasonally occupied while subsistence likely represents broad-based floral and faunal procurement. Projectile points were typically of the straight or contracting stem variety and the reliance on expedient flake tools continues. Lithic raw materials used in tool manufacture were often non-local, indicative of social interaction with other groups throughout the Midwest. The introduction of pottery manufacture began with the production of a thick walled, flat bottomed and thinner walled, bag-shaped vessels often decorated with incised lines in a variety of geometric designs about the neck and rims. Large burial mounds were created during the Early Woodland like those found throughout the Midwest, again testifying to the increasing social interaction not only over long distances but also within local groups considering the organization necessary for the construction of such monuments. Although Early Woodland sites are relatively common along the Mississippi trench they are not commonly recorded in the remainder of Iowa. This may be due to the concept of time transgression which means that the peoples of central and western Iowa maintained many of their Late Archaic lifeways longer than their eastern associates.

The Middle Woodland is noted for the elaboration of trade networks, artworks and complex mortuary practices. A cultural florescence known as the Hopewell developed in Ohio and Illinois and was connected to Iowa through what archaeologists refer to as the Hopewell Interaction Sphere. This sphere involved the dispersion of ideologies concerning technologic, economic, social and political organizations, attitudes and practices. Hopewell sites in eastern Iowa spread out from the Mississippi trench to establish settlements along the major rivers. Middle Woodland peoples in central Iowa retained a settlement system similar to the Archaic, which was comprised of small temporary sites near the shores of lakes and along streams where local faunal and floral resources could be easily exploited. At both locations Middle Woodland communities were actively involved in horticulture, farming crops which included goosefoot, marsh elder, squash and tobacco. Projectile point styles are dominated by well made, broad blade corner notched points and finely made, thin blades often made of exotic raw materials. A variety of other exotic raw materials besides lithic types used for point manufacture and include Gulf coast marine shell, Great Lakes copper, Appalachia mica, pipestone from southwestern Minnesota, and galena from northeast Iowa. Pottery types are more refined than during the previous period yet still have rather thick walls in a conoidal or bag-shaped form heavily decorated with combinations of incised lines, bosses, stamps and indentations typically in a zone about the neck and rim. The pottery in central and western Iowa were not as elaborate as those in the east but contain similar decorative motifs usually with heavy cord-roughened exterior surfaces. The burial complex is one of the most notable attributes of the Middle Woodland. Mounds were typically large, often containing multiple burials placed inside or outside log tombs. Sometimes individuals were buried with stone slabs covering the body and sometimes bodies were cremated prior to burial. It was typical to intern elaborate, high quality artifacts with individual burials clearly suggesting a special or higher status for those individuals. Taking all of these unique attributes together a picture of the Middle Woodland shows that the society was far reaching, political ties to disparate regions, relatively uniform manufacturing technologies and artifact assemblages, individual status differentiation and an ideological system that maintained social and religious class distinctions.

The Late Woodland is noted by ever increasing change and continued development of existing technologies and other social attitudes. Although the wide spread trade network dropped off, the interaction between groups continued. Populations grew rapidly and settlements spread across the landscape occupying most if not all of the available niches. It was during this period that the bow and arrow technology was introduced to the Midwest, most likely from groups to the north on the Canadian plains. The cultivation of crops continued and a diverse hunting and gathering subsistence system supported the growing population throughout the period. Corn was introduced near the end of the period yet didn’t really become a staple crop until the next period. Lithic technologies focused on the production of small points for arrows and expedient flake tools manufactured by a method referred to as nodule smashing where river cobbles provided the raw material. Mound construction, while not as elaborate as the previous period, was none the less important and is reflected in the existence of hundreds of mound groups across the state. One of these notable groups was the Effigy Mound Culture (1,350–1,000 BP) located in northeast Iowa. This culture constructed mounds not only in conical and linear forms but also in the form of animals including birds, bears, lizards, occasionally human and other forms. The populations which constructed these mounds lived in disperse locals exploiting their world in a seasonal pattern and possibly using the effigy mounds as indicators of territorial control by loosely related families which met seasonally and merged with other related family units into larger social groups.

A total of 62 sites are identified as Woodland in Webster County. None are associated with Early Woodland period, nine are associated with the Middle Woodland period, nine are associated with the Late Woodland period, and two are associated with both the Middle and Late Woodland periods.

Late Prehistoric

The Late Prehistoric period dates roughly between 1,000–350 BP and like the Archaic and Woodland periods can be further divided into several archaeologically distinct cultures including the Great Oasis, G Mill Creek, Glenwood and Oneota. The Plains Village pattern begins during this period marking a distinctive adaptation to the prairies of Iowa. Improved corn varieties, food surpluses, new storage methods, improved pottery technology, earthlodge houses and a greater complexity in social and political organization were common to these peoples. The exploitation of bison was becoming more important throughout this period with the animal supplying everything from meat to hides for clothing and dwelling covering to bones for tool manufacture.

The earliest of these groups was the Great Oasis people, whose sites are found across the northwest and north-central portions of Iowa. These people hunted and foraged in the previous pattern common to Late Woodland groups however, they also practiced intensive horticulture and appear to have had a more sedentary settlement system. Their villages are located on low terraces above the flood plains of rivers and streams and on lake shores. Their settlement system may represent larger villages occupied throughout the late fall, winter and early spring with smaller villages occupied during the summer for horticultural activities. If there were hunting sites within this system they are yet to be identified. Pottery was primarily of two types, high rim and wedge lip, and the decorative motifs were of carefully incised line of a variety of designs. Crops grown by the Great Oasis Variant peoples include corn, goosefoot, knotweed and maygrass as well as others. Although Great Oasis has been archaeological recognized for the past 50 years it has not been well defined except on a very local level.

The Mill Creek people occupy villages in northwest Iowa and are a part of what is known as the Initial Variant of the Middle Missouri Tradition. Their sites appear as deep midden deposits on terraces above the Big and Little Sioux Rivers and their tributaries. They were compact, well planned villages with fortification palisades and encircling ditches and contained multiple earthlodges with large internal storage pits. They practiced a mixed economy of hunting bison and other terrestrial and aquatic animals and intensive horticulture, growing large amounts of corn along with squash, goosefoot and marshelder. Mill Creek peoples had long distance trade connections with the prehistoric peoples of the Mississippi valley, including the large urban center at Cahokia in East St. Louis, and made hunting expeditions to the west for the procurement of bison as well as other trade goods such as chert for tool manufacture. Socio-religious systems are clearly indicated by the presence of Long-Nosed God masks found in many Mill Creek sites and shared with other archaeological manifestations throughout the eastern and southern United States. It has been speculated that the Mill Creek peoples moved up the Missouri trench and later may have been part of the root culture that became the Hidatsa and Mandan peoples.

The Glenwood people represent the expansion of the Central Plains Tradition Nebraska phase peoples into southwestern Iowa. Their sites appear as individual farmsteads of small clusters of earthlodges dispersed along ridge summits, and valley wall slopes along the Missouri and its tributaries. The Glenwood peoples were farmers, intensively growing corn, beans, squash, sunflowers and tobacco. Bison appears to be only a minor food source with deer and other terrestrial and aquatic animals making up the mainstay. The pottery is well made, globular forms with smoothed over cord marked bodies and decorative motifs about the rim or collar. Their pottery styles clearly associate Glenwood peoples with the Nebraska phase but later include forms, lacking collars, which is more characteristic of Mississippian groups. These peoples are understood to have been peaceful agriculturalists who may have eventually moved north and west, possibly combining with other groups to form the historically known Arikara and Pawnee peoples.

The Oneota people are noted as the last group of the Late Prehistoric period which dominated most of Iowa between roughly 900-300 BP. The Oneota can be identified throughout the Upper Midwest and into Canada with those groups within Iowa being divided into four regional phases, the Orr, Correctionville, Moingona and Burlington. Villages were large, both semipermanent and permanent, with houses varying from small, square to oval single family dwellings to large longhouses for many families. Pit features are common storage structures existing both internally and externally to their houses. Their economy was based on fishing, hunting, foraging and agriculture. Crops grown include corn squash, beans, goosefoot and pigweed. Bison and deer were mainstays of the diet with a variety of other animals, including dog, being consumed. Pottery differs from other Late Prehistoric peoples in that it was shell tempered which allowed the manufactures to create thinner, stronger walled vessels. Although the four regionally distinct phases appear to be autonomous there was in reality a great deal of socio-political interaction creating an overall cohesion among them. Archaeological evidence in Iowa strongly suggests that the Oneota continued into the Historic period and can be identified as ancestral to the Ioway, Oto, and Missouri peoples.

Nine sites have been identified as Late Prehistoric for Webster County. Five are identified as Late Prehistoric sites while four are recorded as Great Oasis sits of which two of these also have generalized Woodland components.

Historic Native Americans

There is no doubt that various Native American groups inhabited the territory that is presently referred to as Webster County. A thorough discussion in regard to this presence is hindered by the fact that there is a very obvious lack of written documentation of and about events involving Native Americans during the time of settlement. By the time Euro-Americans reached the Dolliver State Park area, most Native American groups had been removed from Iowa. This was a result of the operation of various treaties of cession executed between 1830 and 1851 (Conard and Rogers 1995:5). European settlements of Webster County began in 1846. Historians have often looked toward the military Fort Dodge for historical information in regard to military and settlement activities. Unfortunately, Fort Dodge stood for only three years as a fort, and most of the critical events involving Native Americans had occurred prior to its establishment as a military post (Conard and Rogers 1995:16). Furthermore, because Northwest Iowa did not have any similar military or trading posts in addition to Fort Dodge, the territory was practically terra incognita: Native American groups successfully slowed white encroachment for a surprising length of time. Thus, for the above reasons, historians have little to work with when trying to sketch out early contact events involving Native Americans

A total of 129 sites are identified as historic with the vast majority representing 19th through 20th century farmsteads. Three of these sites are affiliated with an early historic Native American presence

ARCHAEOLOGY IN DOLLIVER STATE PARK

Overview of archaeological sites in the park

There has been scarcely little archaeology conducted within Dolliver State Park. A total of seven archaeological sites are recorded within the park boundaries and another 38 within 1 km (1.6 miles). The vast majority of these 45 sites were identified by avocational archaeologists. The seven archaeological sites within the park include four occupation sites including 13WB42, 13WB124, 13WB432, and 13WB445, and three mound sites including 13WB46, 13WB101, and 13WB374.

All four prehistoric occupations are recorded as having no known cultural affiliation. Sites 13WB42, 432, and 445 represent lithic scatters, locations where the remains of tool manufacture and maintenance were recovered, along with fire cracked rock. This material indicates that fires were built at these sites suggesting that occupation covered at least a few days to maybe a week or so. Site 13WB124 is also noted as a prehistoric lithic scatter however, a unique descriptor exists in an early written history of the area (Pratt 1913). This brief account states that bones of deer, elk, and bison were eroding from the bank at a depth of roughly six feet. Apparently, flint, implements, projectile points, and possibly copper implements were also recovered from this location. The Iowa Site File for this site states that a geologists working the early 1900s records encountering bison bones about six feet under silt at this location. He theorized that the bones and artifacts likely slumped down from a higher level. When a private collector investigated the area in 1961, they note that the road construction had cut into the terrace edge and a large amount of soil had covered the face of the cut promoting tree growth. This made any inspection of the slump impossible however; one shard of woodland period pottery and one bison tooth was recovered from black-colored loam, which had eroded down the face of the cut. The possible presence of copper implements suggests that the site may date to the Late Archaic period. Copper was commonly used and traded by peoples of the Copper Culture, who occupied the lands surrounding the upper Great Lakes of Michigan, Huron, and Superior. Since archaeological confirmation of this site has not occurred, the site remains listed as a prehistoric occupation of unknown cultural affiliation.

Sites 13WB46 and 101 represent conical and linear mound locations while 13WB374 represents an isolated burial location. Site 13WB46 is recorded as a pair of mounds, one conical and one "snake-like" linear mound located on a high terrace of the Des Moines River. Site 13WB101 was originally recorded by Charles R. Keyes as being composed of three conical and three linear mounds on a high, broad, timbered ridge. A revisit of the site some 60 years after Keyes indicates that only three conical mounds could be confirmed. Both of these groups show signs of vandalism and pot hunting, a common and vexing modern impact to prehistoric mounds across the state. Site 13WB374 represents an isolated burial recovered from a gravel pit, which at the time of recording existed outside park boundaries. The area now resides within the park but evidence of the gravel pit has since been covered.

The only recorded modern cultural resource surveys to take place within Dolliver State Park were conducted during the 1990s by the General Contracts Program at the Office of the State Archaeologist. The first survey, conducted in 1996, was for a proposed well drilling location resulting in the identification of 13WB445. The second survey, conducted in 1997, was for a proposed water system improvement but yielded no new archaeological sites.

Site 13WB484: a bison and Birdman petroglyph in the park

During fieldwork for the proposed U.S. 20 realignment corridor through Sac, Calhoun and Webster counties, I was contacted by David Bergmann, a postgraduate student at Iowa State University, regarding the presence of a bison petroglyph in Dolliver State Park. A petroglyph is an image placed on rock by actually pecking, carving, or otherwise inscribing the rock face leaving behind the intended image. After a few correspondences and the exchange of a couple of photographs and a map, I was able to visit the park and investigate the find.

Located a short distance up a small stream flowing through Boneyard Hollow is the outline of a bison inscribed on a sandstone wall above a small stream (Fig. 1). The image measures 75 x 30 cm, is roughly 2.6 m above the current ground surface, and is in very good condition. The incised lines forming the image are clear and appear to conform very well to those described as tool lines from other petroglyph sites in the state and upper Midwest. The image also has a partial cover of moss and lichen over the horns, shoulders, and back. There is considerable historic graffiti below, to the right, and above the bison image but fortunately, none over the bison itself. The absence of moss or lichen on these historic carvings strongly indicates that the bison is of greater age predating the historic period. The bison also appears to be more weather-worn than surrounding historic carvings supporting the prehistoric age assignment.

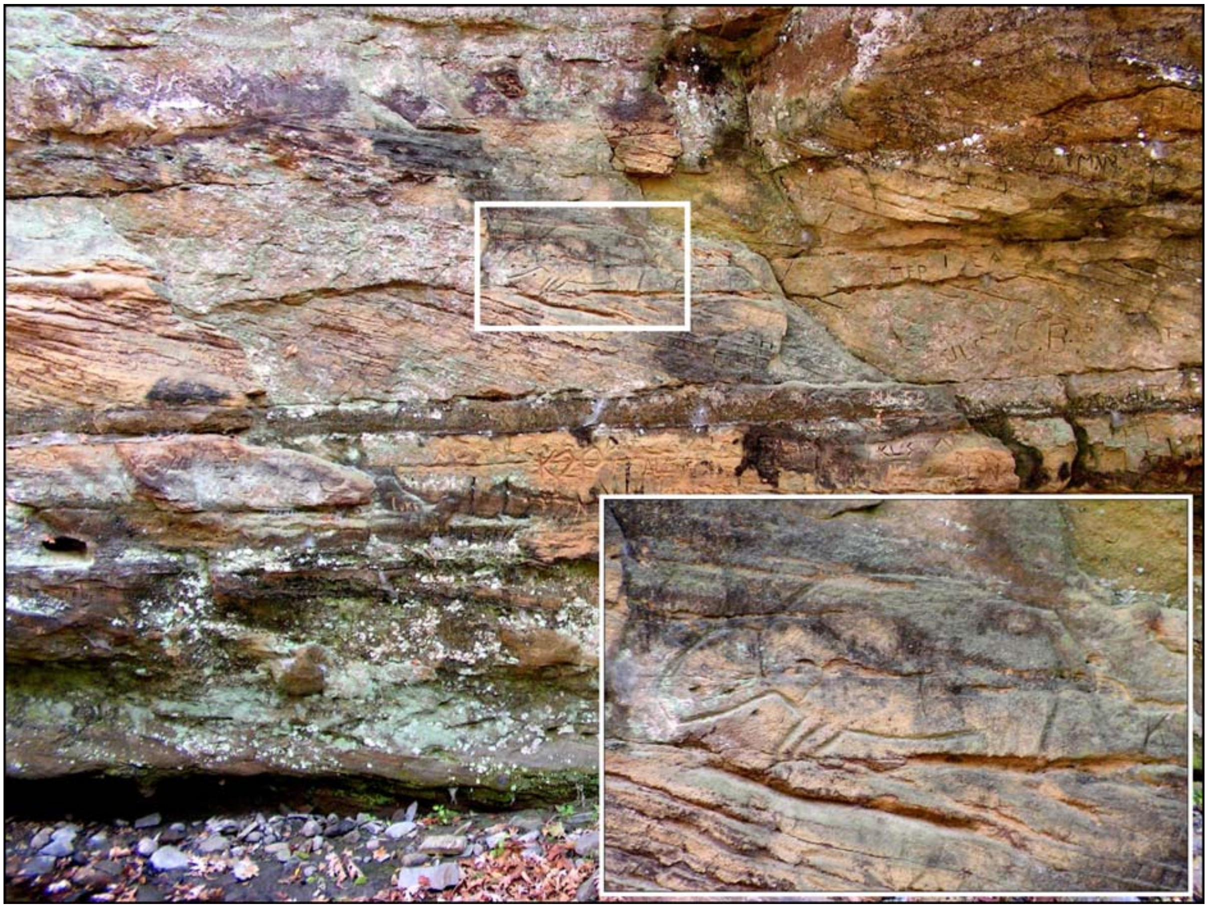

Figure 1. Inscribed bison image in sandstones of Boneyard Hollow, Dolliver State Park, and close-up of image (inset).

The bison image contains other elements that are consistent with prehistoric rock art. The rock face containing the petroglyph is composed of bedded sandstone belonging to the Cherokee Member and identified as Unit B of Boneyard Hollow (Lemish et. al. 1981). This rock face is relatively soft, attested to by the multitude of modern carvings found across the surface of this exposure. The lines forming the petroglyph have a "V" shaped profile suggesting that a tool such as a biface or other chipped stone implement was used in its creation. The image has several other significant attributes that may contribute to its meaning. There is a possible "heart line" running from the throat area to the heart, and on to the rear of the animal This may represent the "life force" of the animal and appears in other prehistoric rock art animal images. There is also a line that may possibly represent a dart or arrow pointing to the heart of the bison. These features often represent the hunters' power to kill, or the hopes of a successful hunt through the powers of sympathetic magic. Further analysis should answer these hypothesis and illuminate other elements of this image with greater clarity and understanding.

Figure 2. A birdman petroglyph partially covered by modern graffiti in Boneyard Hollow area of Dolliver State Park and birdman effigy on the seal of the Office of the State Archaeologist.

During photograph analysis in 2003, another image was noted on a different panel in the immediate vicinity. This image is located high above the current ground surface, as well as being surrounded by and potentially covered with historic graffiti. The image is the birdman effigy, similar to that found on the seal of the Office of the State Archaeologist (Fig. 2). The petroglyph is composed of the upper portion of the "birdman" and shows a elongated diamond-shaped body filled with a diamond cross-hatched pattern. The arms/wings are visible with what appear to be feathers but the head is not clear as the historic graffiti currently obstructs the image. Birdman imagery is associated with the Oneota peoples, Late Prehistoric occupants of the state of Iowa and the probable archaeological representation of the historic Ioway. Many archaeologists believe that the birdman iconography represents the symbolic authority of Oneota leaders, associating them with the powers attributed with raptors. The birdman motifs are prominent on ceramics, tablets, and rock art as well as later appearing in the mythology of Chiwere-Siouan and related peoples of the upper Midwest (Alex 2000). The presence of the birdman image places Oneota as the potential creators of the bison as well but further research will be needed to substantiate this hypothesis.

Basic photography has been applied and tracings have been made of the bison petroglyph with analysis continuing this winter. The birdman image has yet to be traced and its location may preclude such efforts. High resolution photographic imagery is planned for later this fall with the outcome being additional documentation and hopefully, additional information. Literature searches have yielded a considerable amount of information that needs to be processed as well.

Ultimately, the details of this research will be published in an archaeological journal. To date, this is the only known petroglyph site in central Iowa and represents a valuable cultural resource well worth careful preservation. Its location in a state park adds to the value of the park itself and may be of considerable assistance in its documentation and preservation.

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VEGETATION OF DOLLIVER STATE PARK

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Dolliver State Park is located along the deeply dissected confluence of Prairie Creek with the Des Moines River in Webster County, near the geographic center of the Des Moines Lobe landform region (Prior 2001). The park is heavily wooded, primarily with mature, upland, oak-dominated forest, but contains interesting xerophytic, mesophytic, and hydrophytic plant communities as well in the form of prairie openings, maple-basswood stands, and calcareous seeps. Numerous old trees (200-300 years in age) also add interest to the site. Over 400 vascular plant species and several interesting mosses and lichens have been observed in the park.

VEGETATION IN 1849-1854 ERA

Surveyors from the General Land Office (GLO) mapped the general distribution of major vegetation types in the townships of Webster County between 1849 and 1854; these township plats were later compiled into a county-wide map depicting the historic vegetation that existed prior to the advent of modern agriculture (Anderson 1996). Typical of most counties in Iowa, the predominant vegetation in Webster County was "prairie" on the broad uplands while the deep valley of the Des Moines River, which in turn was occupied by "timber" (Fig. 1). Numerous wetlands (including "lakes", "ponds", "sloughs", and "swamps") densely dotted the poorly drained prairie uplands; as mapped by GLO surveyors, the wetlands appear to be arranged in east-west and north-south lines (Fig. 1), but this is an artifact of a the gridwork of section lines walked by the surveyors, who mapped only wetlands directly encountered on their narrow, mile-apart transects; if extrapolated to fill the unmapped voids between section lines, the density of wetlands on the "pre-settlement" landscape must have been extremely high. Another special feature of interest on the county map is the long, narrow polygon of "windthrow" located in the timbered reach of the Des Moines River valley north of Dolliver State Park (Figure 1): this is likely the path of a southeast-trending tornado that knocked down a band of trees a short time prior to the arrival of the GLO surveyors.

Dolliver State Park lies almost entirely within a zone mapped as "timber" by the GLO surveyors in 1849-54; only a small fraction of the southwest edge of the park extended into "prairie" (Fig. 1).

VEGETATION IN 1938

As revealed by the first available aerial photograph (Fig. 2a), the park was also primarily forested in 1938 (thirteen years after dedication of the original park acreage), although a variety of openings were present. Most of the openings visible on the 1938 aerial photograph contain scattered trees with a grassy undergrowth, probably active or recently retired pastures. Others are associated with lawns and facilities along the park roads; a few, located around the park perimeter on flat uplands, are active or recently retired cropfields.

VEGETATION IN 2006

A 2006 aerial photograph of the park (Fig. 2b) shows that nearly all of the park is densely forested; other than lawns and facilities along the park roads, only a single large opening in the southwest corner of the park (a retired cropfield on a tract acquired in 1993) is evident.

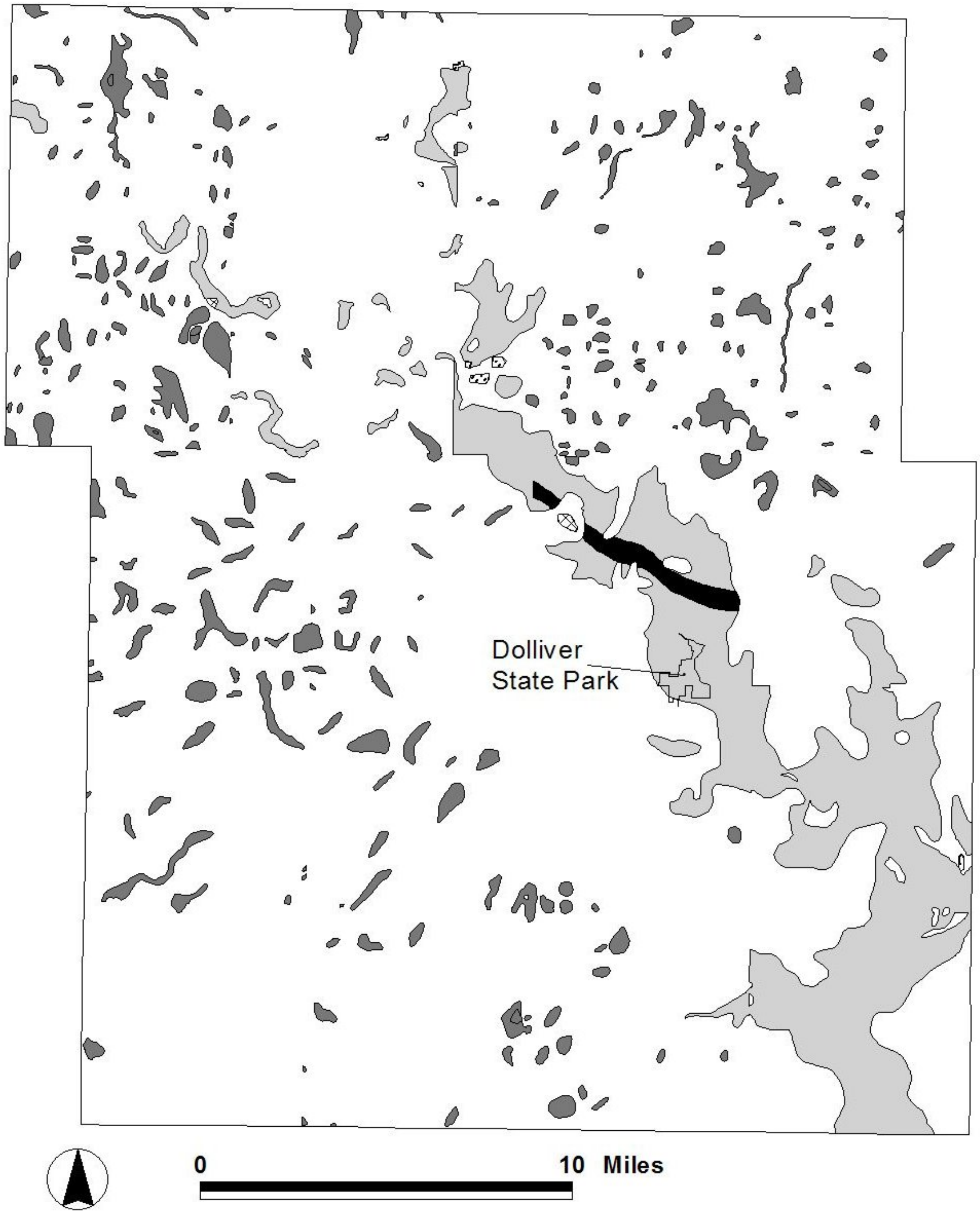

Figure 1. Historic vegetation map of Webster County based on compilations of General Land Office township survey plats for years 1849-54 (Anderson 1995). White matrix is "prairie"; light gray polygons are "timber" (also including "grove"); dark gray polygons represent various wetlands ("lake", "pond", "marsh", "slough", and "swamp"); black polygons represent "windthrow". Tiny polygons of "brush", "scattering trees", and "openings" are too small to depict at this county-wide scale

Upland forest Communities

The species composition and distribution of current plant communities in Dolliver State Park (Fig. 3) were studied in 1985 and 1986 by Johnson-Groh, Lewis, and Shearer (1987). They described six intergrading forest communities occupying relatively undisturbed upland slopes; named for their dominant canopy tree species and arranged in a series extending from dry to mesic (moist and shaded) upland habitats, they are:

- White oak (*Quercus alba*) forest on dry, flat uplands
- White oak-red oak (*Quercus alba-Quercus rubra*) forest on dry slopes of south and west aspects
- Red oak (*Quercus rubra*) forest on dry to mesic slopes of east, south, and west aspects
- Red oak-basswood (*Quercus rubra-Tilia americana*) forest on mesic slopes of east and north aspects
- Basswood (*Tilia americana*) forest on mesic slopes of north aspect
- Basswood-black maple (*Tilia americana-Acer nigrum*) forest on mesic slopes, mainly of east aspects.

Additionally, they described a "slump forest" on steep slopes of east, south, and west aspects on which soil has slumped to form a hummocky topography; the dominant species are white oak and red oak, but the community includes a variety of other species [such as chinquapin oak (*Quercus muhlenbergii*), shagbark hickory (*Carya ovata*), walnut (*Juglans nigra*), and black ash (*Fraxinus nigra*)] that are not abundant on more typical (unslumped) slopes. In all seven communities, ironwood (*Ostrya virginiana*) is the dominant tree in the understory. The most common plant species of the ground-flora of these communities are sedges (*Carex* spp.), Virginia creeper (*Parthenocissus quinquefolia*), hog peanut (*Amphicarpa bracteata*), goldenrods (*Solidago* spp.), pointed tick-trefoil (*Desmodium glutinosum*), early meadow-rue (*Thalictrum dioicum*), black snakeroot (*Sanicula* spp.), maidenhair fern (*Adiantum pedatum*), and Virginia waterleaf (*Hydrophyllum virginiana*).

These seven communities were also mapped in Ledges State Park by Johnson-Groh (1985). Dolliver State Park contains two additional upland communities that were not found in Ledges State Park:

Bur oak (*Quercus macrocarpa*) forest -- On some upland flats, particularly the large plateau in the west-central part of the park (Fig. 3), bur oak is strongly dominant. Johnson-Groh et al. (1987) noted that "these areas have a diverse mixture of tree species, including red oak [and white oak], bigtooth aspen, walnut, and basswood, and often show evidence of disturbance due to grazing." Consistent with their suspicion of past grazing, comparison of the distribution of the bur oak community in the park with the 1938 aerial photograph shows that it was located in a savanna-like vegetation that was likely a wooded pasture. Johnson-Groh et al. (1987) hypothesized that the abundance of bur oak in places may reflect a past history as bur oak savanna. Alternatively, bur oak communities occur on flat uplands that are elsewhere occupied by white oak forest communities and may represent a disturbed form of that community-type.

Bigtooth aspen (*Populus grandidentata*) groves – Found primarily on flat uplands mixed with white oak or bur oak communities, grazing may have allowed this species to establish large stands; wind-throw, Dutch elm disease, and oak wilt may also have created canopy openings which were later colonized by bigtooth aspen (Johnson-Groh et al. 1987).

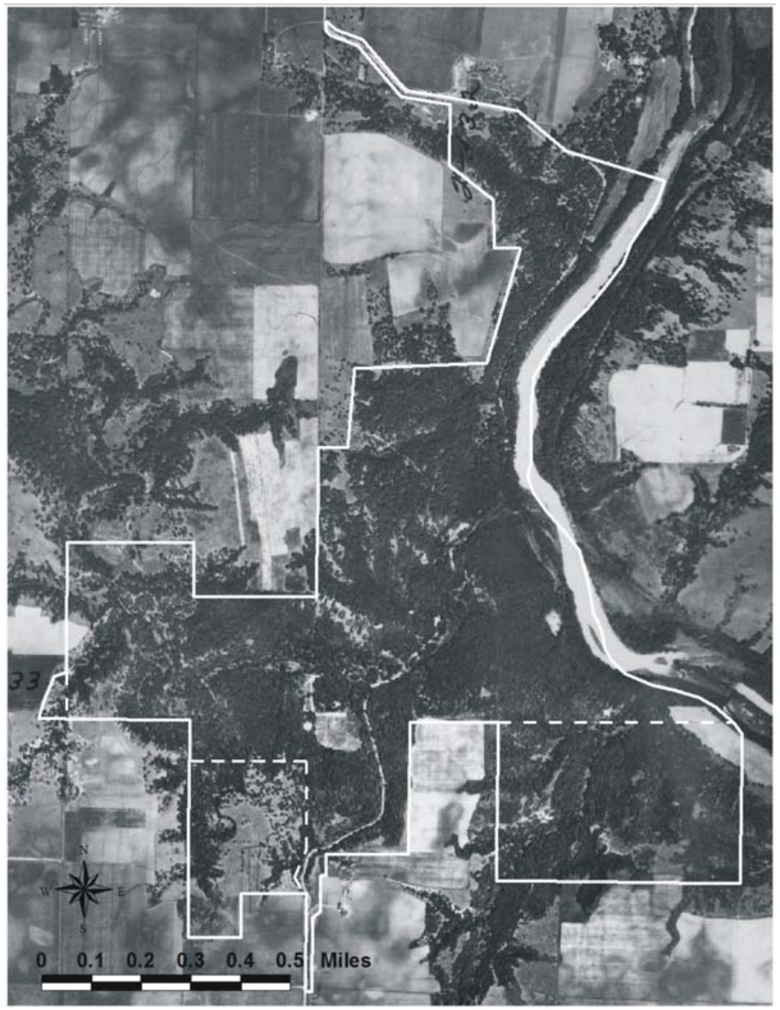

Figure 2a. Aerial photograph of Dolliver State Park circa 1938. Note: boundary of park in 1938 (dashed line) did not include the southeast and southwest corner of today's park.

Figure 2b. Aerial photograph of Dolliver State Park in 2006

Other upland communities

Two upland plant communities with only small, scattered patches in the park are:

Hill prairies – over 25 small patches of prairie vegetation were mapped by Johnson-Groh et al. (1987) in Dolliver State Park, mainly on south-facing and west-facing slopes (Figure 3). All were in varying degrees of encroachment by woody vegetation, but some still supported the major prairie grasses and forbs. When the distribution is overlaid on the 1938 aerial photograph (Figure 2a), it appears that the current prairies are small remnants on the steep edges of much larger openings that extended across savanna-like ridges and flat uplands.

Calcareous seep – A fairly large seepage area at the base of a steep slope just outside of the southwest edge of the park is the site of a hillside wetland that supports a large population of marsh marigold (*Caltha palustris*) as well as a moss (*Brachythecium rivulare*) and a liverwort (*Aneura pinguis*) often associated with calcareous fens. The seepage zone may have been created by groundwater emerging from shale bedrock buried by colluvium.

Bottomland communities

Three vegetation types were mapped in bottomlands along the Des Moines River and Prairie Creek by Johnson-Groh et al. (1987):

Undisturbed bottomland forest dominated by walnut (*Juglans nigra*), located along major drainageways and ravine bottoms (Fig. 3). Associated tree species include black ash, hackberry (*Celtis occidentalis*), and black maple. The most abundant herbaceous species are snakeroot (*Eupatorium* spp.) and Virginia waterleaf.

Disturbed bottomland forest, where cultivated lawns have replaced the understory and herbaceous undergrowth of undisturbed bottomland forests but left many large canopy trees in place. Honeylocust (*Gleditsia triacanthos*) and cottonwood (*Populus deltoides*) are major associated tree species while Kentucky bluegrass (*Poa pratensis*) is the dominant herbaceous species.

Floodplain areas along the Des Moines River are of an open, non-forested character due to frequent flooding; weedy herbaceous species predominate in this habitat.

Disturbed woods

Patches of this broadly inclusive vegetation type occurs throughout the park irrespective of slope or aspect and are primarily defined by a history of past heavy grazing (Johnson-Groh et al. 1987, Johnson-Groh 1985). Common trees species include honeylocust, ironwood, elm (*Ulmus* spp.), and eastern red cedar (*Juniperus virginiana*); common shrubs include multiflora rose (*Rosa multiflora*), blackberries (*Rubus* spp.), smooth sumac (*Rhus glabra*), prickly-ash (*Zanthoxylem americanum*), and hazelnut (*Corylus americana*). Poison ivy (*Toxicodendron radicans*) is also common in this community.

OLD TREES

Several old white oak trees (over 200 years in age) are found in Dolliver State Park, mainly on the upper slopes of rugged wooded ravines. Duvick and Blasing (1983) identified these trees during a search for old trees suitable for use in a study tree rings to track climatic changes over recent centuries. White oaks were targeted because they are long-lived, widespread across eastern North America, and sensitive to drought. Of nearly 300 trees in Iowa that he identified, sixteen occur in Dolliver State Park. If these trees are still alive in 2007, ten are calculated to be between 200 and 300 years old while three are over 300 years old. The oldest individual (of the

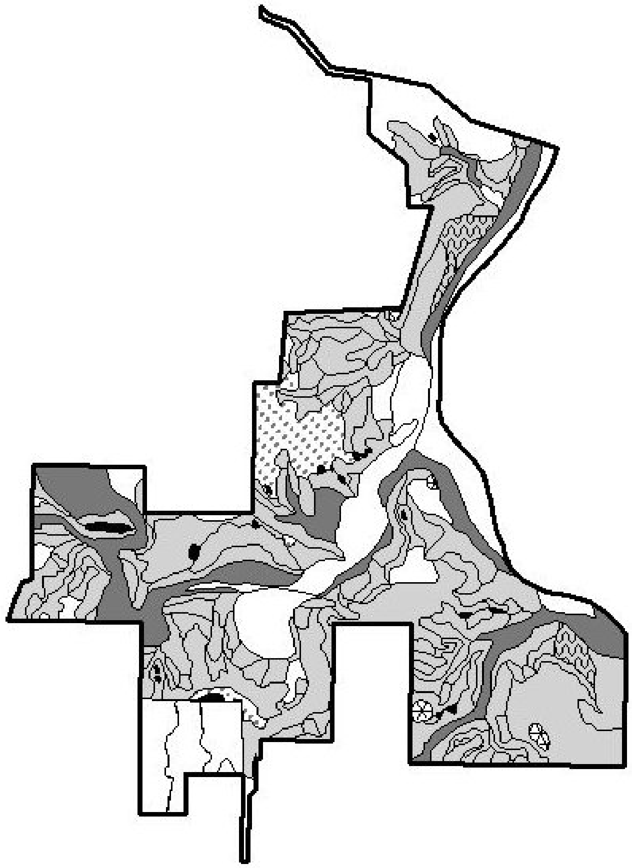

Figure 3. Current vegetation map of Dolliver State Park (adapted from Johnson-Groh et al. 1987). Light gray is combination all of undisturbed upland forest types (with "slump forest" subtype highlighted by wavy lines), white is combination of disturbed vegetation types, dark gray is bottomland forest; dotted polygons represent bur oak forest; small, scattered, black polygons are hill prairies

ones recorded by Duvick) should now be 337 years old. When last measured in 1987, these trees were between 16 and 40 inches in diameter; most were between 20 and 25 inches in diameter, appearing "moderately large" but not especially huge to most park visitors. Most of these trees have branches located less than ten feet above the ground (with some as low as four feet), suggesting that they developed open-grown crowns in an uncrowded, savanna-like environment.

FLORA

Over 400 vascular plant species were reported from Dolliver State Park by Johnson-Groh et al. (1987), including interesting northern species such as shining clubmoss (*Lycopodium lucidulum*) and wild lily-of-the-valley (*Maianthemum canadense*). They also mentioned the presence of a north-facing slope in the park with large, plush mats of *Pleurozium schreberi* (a moss) and *Cladonia* spp. ("reindeer moss", actually lichen), a community with affinities to forests found in northern Minnesota.

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FAUNA OF DOLLIVER MEMORIAL STATE PARK

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Dolliver Memorial State Park comprises 457 acres of steep wooded ravines, well drained ridge tops, and floodplain. The park is mostly forest with the exception of the campgrounds, picnic areas, and other developed areas and several small hill prairies on the ridge tops. Forest types include burr/white oak on the drier slopes and ridges, basswood/red oak on the more mesic slopes, and cottonwood/black walnut/basswood on the floodplain.

BIRDS

The diversity of forest types and the Des Moines River, which forms the eastern boundary of the park, make Dolliver an excellent area for viewing migrating warblers and other passerines in north central Iowa. Many species follow the Des Moines River because it provides one of the largest forested corridors in the central part of Iowa. The park also provides habitat for breeding forest species like the scarlet tanager (Fig. 1), oven bird, and the Louisiana waterthrush (Fig. 2). These species require larger blocks of forest for successful nesting. Webster County was the farthest northwest that the Louisiana waterthrush was found in Iowa during the breeding bird atlas survey (Jackson et al. 1996). This species is considered to be uncommon in Iowa because it is at the western edge of its range.

Figure 1. The scarlet tanager (photo by Jim Durbin).

Figure 2. The Louidiana waterthrush (photo by Jim Durbin).

Eighty-four species were observed in the nine section breeding bird atlas block that included the park. Twenty-four species were confirmed breeding and 44 were considered as probably breeding (Table 1). Because the atlas block included 5,760 acres, species like bobolink, vesper sparrow and grasshopper sparrow that use hayfields, grasslands or pastures for nesting, are included in the list even though they were found outside the park.

For the last 10 years, Christmas Bird Counts have recorded from 20 to more than 40 species for the Fort Dodge area, which includes Dolliver Memorial Park. Species that are often seen include: black-capped chickadee, red-bellied woodpecker, downy woodpecker, white-breasted nuthatch, dark-eyed junco, and northern cardinal. Looking back to counts from the early 1970's there are several species which were not reported at that time but are commonly observed now. Canada geese and trumpeter swans have both benefited from reintroduction efforts in Iowa and surrounding states. The house finch, an introduced species to the United States, was first observed in Iowa in 1982. It is now found in most towns and is expanding into the country and has been reported on several of the recent Christmas Bird Counts.

Table 1. List of confirmed and probable breeding birds for the Dolliver Park Atlas Block (Jackson et al. 1996).

Canada Goose	Wood Duck	Turkey Vulture
Red-tailed Hawk	Ring-necked Pheasant	Wild Turkey
Killdeer	Spotted Sandpiper	Rock Dove
Mourning Dove	Great Horned Owl	Barred Owl
Whip-poor-will	Chimney Swift	Ruby-throated Hummingbird
Belted Kingfisher	Red-headed Woodpecker	Red-bellied Woodpecker
Downy Woodpecker	Hairy Woodpecker	Northern Flicker
Eastern Wood-peewee	Eastern Phoebe	Great Crested Flycatcher
Eastern Kingbird	Purple Martin	Tree Swallow
N. Rough-winged Swallow	Bank Swallow	Cliff Swallow
Barn Swallow	Blue Jay	American Crow
Black-capped Chickadee	Tufted Titmouse	White-breasted Nuthatch
House Wren	Blue-gray Gnatcatcher	Eastern Bluebird
American Robin	Gray Catbird	Brown Thrasher
Cedar Waxwing	European Starling	Yellow-throated Vireo
Warbling Vireo	American Redstart	Ovenbird
Louisiana Waterthrush	Common Yellowthroat	Scarlet Tanager
Northern Cardinal	Rose-breasted Grosbeak	Indigo Bunting
Dickcissel	Eastern Towhee	Chipping Sparrow
Vesper Sparrow	Grasshopper Sparrow	Song Sparrow
Bobolink	Red-winged Blackbird	Western Meadowlark
Common Grackle	Brown-headed Cowbird	Baltimore Oriole
American Goldfinch	House Sparrow	

MAMMALS

Commonly seen mammals in the park are white-tailed deer, raccoon, opossum, fox squirrel, wood chuck, eastern chipmunk, and cottontail rabbit. The woodland vole (Fig. 3), meadow vole, white-footed mouse, short tailed shrew, and masked shrew are small mammals rarely seen but that can also be found in the park.

Figure 3. The woodland vole.

The woodland vole has soft, dense fur and a short tail. The fur on the back is dull reddish brown, sides are paler and the stomach is grayish buff. It is semifossorial, spending most of its time in burrows beneath leaf litter or among tree roots. The diet consists mostly of underground plant parts but nuts, seeds, and stems of various plants are also stored in underground chambers for use in winter. Average life expectancy is a few months, with only a few animals living for longer than a year. A female may have several litters during a lifetime. The gestation period is 24 days and litter size ranges from one to six with two being normal. Because the woodland vole spends most of its life in burrows, it is less subject to predation and this is probably why litter size is one half to one third that of the meadow vole.

River otter (Fig. 4) can be seen occasionally in the Des Moines River at Dolliver, while beaver and muskrat are commonly observed. The river otter population has increased steadily since reintroduction efforts were initiated by the DNR in the early 1980's. A limited trapping season was opened in 2006, when trappers were allowed to take 400 otters statewide.

Figure 4. The river otter.

Big brown and long-eared bats were captured in mist nets set over Prairie Creek in 2004 during Project A.W.A.R.E. Based on range information in Laubach et al. (2004), a comprehensive survey of the park would likely also find red, little brown, and possibly hoary, silver-haired and evening bats.

AMPHIBIANS AND REPTILES

No comprehensive survey of the park has been completed for amphibians and reptiles. Turtles expected to occur in the Des Moines River adjacent to the park are snapping, smooth softshell, and painted (Christiansen and Bailey, 1988. Based on range maps in Christiansen and Bailey (1990), Graham's crayfish, brown, eastern garter, redside garter, plains garter, milk, and fox snakes should occur in the park. The tiger salamander, northern leopard frog, gray tree frog, western chorus frog and American toad are amphibian species that are expected to occur in the park (Christiansen and Bailey, 1991.

FISH

The Des Moines River provides fishing opportunities for park visitors. Largemouth bass, channel catfish, crappie, bluegill, walleye are the primary game fish in this reach of the river. The estimated number of species in the river at the park is between 30 and 40.

FRESHWATER MUSSELS

Shell fragments from long-dead yellow sandshell mussels, a state endangered species, were found in this reach of the river in the early 1980's. A 1998 survey found black sandshell and white heelsplitter shells that were estimated to have died a few years prior to the survey (Arbuckle and Downing, 2000). No live mussels were found at the sample site adjacent to the park.

BUTTERFLIES

A review of butterfly records compiled by Schlicht et. al. (2007) indicates that about 30 species should be found in the park. The gray comma is the only species considered as rare or uncommon in Iowa. Species like the eastern tiger swallowtail, cabbage white, question mark, mourning cloak, and painted lady are very abundant and occur statewide.

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HISTORY OF SOUTHERN WEBSTER COUNTY AND DOLLIVER MEMORIAL STATE PARK

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INTRODUCTION

The area that is now Dolliver Memorial State Park has a rich and interesting history. The river bottoms in the area that is now the park was a favorite for early hunters who could find wild turkeys in large numbers. The surrounding uplands was heavily forested with walnut, maple and elm. According to C.N. Douglas (2005), Dolliver Park's custodian at the time of its dedication, (Douglas, n.d.) "*at one time the black walnut logs that had been cut for lumber were so thick that one could walk from the mouth of Pioneer Creek* (in the southern part of the Park) *to Lehigh, then Gyson's {?Tyson's} Mill, without getting off one of these logs.*" In the early spring sugar camps appeared to process sap from the many maple trees. Wild grapes, plums, gooseberries and other fruit were abundant in the area.

The first log cabin in Otho Township was built by Henry Lott in 1846 just north of the mouth of Boneyard Hollow near the north end of the park (Douglas, 2005). Mr. Lott did a little farming but spent most of his time hunting, trapping, and trading with Indians. He and his wife were still living in the cabin in 1849 when geologist David Dale Owen and his expedition to document the geology of Wisconsin, Iowa, and Minnesota (Owen, 1852) traveled up the Des Moines River past his land and camped about a half mile to the north.

Shortly thereafter a paddle wheel riverboat began operating in the Des Moines River in the area that is now Dolliver Memorial State Park. It was owned by Snell and Butterworth who operated a general store in Homer. Located in what is now western Hamilton County, Homer was the largest town in the area in the mid-1850s. The riverboat stopped at a landing constructed at Steamboat Rock, at what is now the north end of Dolliver Park, to chop and take on wood for fuel. Another Historic point in the area of Dolliver Memorial State Park is Todd's Island. It was named for Samuel Todd who operated a nearby saw mill about ¼ mile north of what is now Dolliver Park in the early 1860s (Douglas, 2005).

THE IOWA DRAGOONS

On your way to Dolliver Memorial Park you may have noticed signs marking the Dragoon Trail. The 200 mile trail (from Lake Red Rock to Fort Dodge) forms a "greenbelt" along the Des Moines, Boone and Raccoon rivers following the route blazed by a troop of lightly armed cavalry soldiers known as Dragoons. The Dragoons were among the first to scout Iowa after the Black Hawk Purchase of 1832 put the area under U.S. control. In the summer of 1835, the Dragoons blazed a trail along the Des Moines River and established outposts from present-day Des Moines to Fort Dodge.

The Fort Museum in Fort Dodge published an informative discussion of the Dragoons on their web site (Fort Museum, 2007) which provided much of the information for the following narrative. America's first mounted military units were called Dragoons, a term with its roots in European military history. European Dragoons were mounted infantry that rode by horseback to the site of battle and then dismounted to fight on foot. In the U.S. the Dragoons adopted traditional cavalry tactics and fought from horseback as well. The shock of a massed charge by sword-wielding horsemen had a powerful psychological effect on their enemies.

The Dragoon units fought valiantly in a least three major battles in the Revolutionary War, but in the following decades were alternately authorized and disbanded by Congress as the occasion dictated. By the 1833 the need for highly mobile troops to police the vast expanses the rapidly expanding frontier led Colonel Henry Dodge to establish the 1st United States Dragoons. The city of Fort Dodge was named for Dodge and his son Augustus Caesar Dodge. Some Dragoons were very flamboyant by any military standard, with long hair, colorful scarves, facial hair and even earrings frequently adorning these elite troops. Their swords were so tremendously long that they trailed on the ground behind. Most Dragoons however wore a more traditional uniform (Fig. 1).

Figure 1. Illustration of an Iowa Dragoon

In 1835 the Dragoons were ordered to conduct the first official exploration of the Des Moines River Valley. On June 7, 1835 three companies, under the command of Lt. Colonel Stephan Watts Kearney, left their post at Fort Des Moines No. 1, near present day Montrose, Iowa, on the Mississippi River and began the expedition. The troop consisted of one hundred-sixty Dragoons, five four-mule teams and wagons, tents, provisions, packhorses, and beef cattle, and included Captain Nathan Boone, son of old Daniel Boone and Lt. Albert Lea (Fig. 2), topographer for the expedition (Fort Museum, 2007).

The men moved northwesterly between the Des Moines and Skunk rivers to the mouth of the Boone River, north of present-day Stratford. Here they proceeded to the northeast into Minnesota Territory to Lake Pepin. From there they marched south to the area of Winona, Minnesota, where they rested for several weeks and procured fresh provisions.

On July 21, 1835, the Dragoons continued their explorations, moving in a generally westerly direction, and eventually reentering Iowa in what is now northwest Kossuth County. They reached the Des Moines River near present day Emmetsburg and continued down the river. On August 5 the Dragoons crossed the "Lizard River" (now called Lizard Creek at Fort Dodge) and named it for the numerous creatures, probably salamanders, seen scampering along it's banks. They continued their march to the southeast past the Dolliver Park area before reconnoitering the forks of the Des Moines and Raccoon Rivers (what is now Des Moines) and identifying the site as a good location for a future fort. They arrived back at Fort Des Moines No. 1 on August 19, 1835, their journey completed. Lt. Albert Lea's journal of the trek would be published in book form, *Notes on Wisconsin Territory, Particularly with Reference to the Iowa District, or Black Hawk Purchase,* giving the American public it's first detailed description of the land between the Mississippi and Missouri, America’s greatest rivers (Iowa History Project, 2007a). The publication was also the first to give widespread usage to the term "Iowa" and is generally credited with the naming of our state.

Figure 2. Lieutenant Albert Lea named Iowa.

In 1933, the State of Iowa opened the Dragoon Trail, a scenic drive along the Des Moines River that followed the path of the 1st United States Dragoons on their historic march. In 1935, to mark the 100th Anniversary of the Dragoon March, the Daughters of the American Revolution erected a series of bronze plaques at various locations along the old trail. One of these may be seen at a monument to the Dragoons at the Fort Museum in Fort Dodge, only a stone throw from where the Dragoons passed in 1835.

In 1850 Brevet Major Samuel Woods and the men of Company E of the Sixth United States Infantry arrived in southeast Iowa to assist with the removal of the Mesquakie tribe to reservation lands and then travel overland to the Des Moines River near what is now Fort Dodge and begin construction of a new military post (Iowa History Project, 2007b). Under the direction of Brevet Major Lewis A. Armistead civilian laborers were brought in to facilitate the construction of the new fort. By November 12 buildings had been completed and the troops were able to strike their tents and move inside for the winter. Originally christened Fort Clarke, 21 major buildings were completed the spring of 1851 when the name change to Fort Dodge, after Henry Dodge, U.S. senator from Wisconsin.

BONEYARD HOLLOW

A nearly box canyon in the sandstone at the northern end of Dolliver State Park has been called Boneyard Hollow (Fig. 3) for many years. Its name is said to derive from the huge quantity of bison, elk, and deer bones that were found in the canyon by early settlers. The bones were discovered buried by soil on both sides of the creek that ran through the canyon. They were reportedly very old, with mature trees growing on the deposit, and when excavated most of the bones immediately crumbled. Numerous arrow heads, flint and stone tools, and even copper tools were said to have been found when the deposit was excavated, leading to the speculation that the deposit represented "*kitchen refuse from a settlement of Mound Builders latter covered with silt from the Wisconsin drift*" (History of Webster Co, n.d.). Some time later Iowa Geology Professor Samuel Calvin supposedly visited the site. Although he did not offer an opinion as to the origin of the deposit, he stated that it was older than the historic period, but that it was highly improbable that the deposit was either pre-glacial or interglacial. Other theories proposed that the animals were driven over the cliffs bounding the canyon by Indians who then slaughtered them (e.g. Farnsworth, n.d., Messenger, 1901), or that the animals were driven into the box canyon, trapped, then slaughtered. Regardless of the origin of the bones, the name Boneyard Hollow has become attached to the canyon and it has become one of Dolliver Park's most popular. attractions. Boneyard Hollow will be one of the stops on this field trip.

Figure 3. Sandstone cliffs tower above Boneyard Hollow in the northern end of Dolliver Memorial State Park.

FATHER HENNEPIN'S TABLET

Figure 4. Albert Peterson and his family with their new E-M-P automobile.

In the early 1900s much of the land that is now Dolliver Park was owned by J.B. Black and was a favorite area for fishing and picnicking. Black's son, Irving, described an incident in 1912 (Black, n.d.) when Albert Peterson of Callender came to the area to buy a car, an Everitt 30 (aka E-M-F 30) from the Black and Kirkpatrik Company (Fig. 4). Afterwards, Peterson and his family visited the Black farm for picnicking and fishing near Boneyard Hollow when their daughter Ruth found a lead tablet inscribed in Latin. The tablet had a Fleur de Lis on one side and on the other the inscription "*ANNO DOMINO MDCCL LOUIS XV REX DUX Earquat et Pater Hennepin feris fugentes decederem fluminus – paseum muttum ad fluminis xxx eves ar in celatus hiemabamus adverta vernis terrarm occupatamus quae seccatur flumine nomine Louis XV.*" It was sent to Edgar Harlan, curator of the State Archives who passed it on to Archbishop Ireland in St. Paul, Minnesota, for translation. Loosely translated, the inscription read, *"In the year of our Lord, 1750, in the reign of King Louis XV, General Earquat and Father Hennepin fleeing from the wild beasts spent the winter concealed in a shelter and at the coming of spring took position in the name of King Louis XV of the land drained by this river."* However, Archbishop Ireland noted the extremely poor Latin grammar as evidence that the tablet was not authentic, for Father Hennepin was known to be an excellent Latin scholar. Additionally, Father Hennepin died in 1706 and historians have found no record of a General Earquat. The true story of the hoax tablet eventually came to light when two residents of Lehigh admitted that they had created and buried it in 1911 or 1912 near the mouth of Boneyard Hollow as a joke When if was not discovered they returned the following year and partially exposed it so that it could be more easily discovered. The hoax tablet did, however, encourage Edgar Harlan to visit the farm and the area that is now Dolliver Park, where he was so entranced by the beauty of the scenery that he contacted Dr. L.H. Pammel, head of the Botany Department at Iowa State College. Harlan and Pammel made several additional trips to the area that is now Dolliver Park. By drawing attention to the beauty and natural features of the area, the hoax tablet set in motion, events that led to the creation of a State Park.

Figure 5. Iron sulfates efflorescences on the cliff face at the Copperas Beds in Dolliver Memorial State Park

THE COPPERAS BEDS

One of the most interesting and unique areas of Dolliver Memorial State Park is the exposure known as the Copperas Beds. Copperas, or green vitriol, is a form of ferrous sulphate (Fig.5). Copperas was used extensively in the manufacture of iron pigments in a wide range of shades from yellow through red and brown to black for the textile industry and in the metallurgical industry where it was a key ingredient in the production of nitric acid and sulphuric acid. It was also used to produce printers' ink, as a tanning agent for leather and in the manufacture of gunpowder. Most commercial copperas was extracted from iron pyrite-rich nodules, however it forms naturally in the iron- and carbon-rich conglomeratic sandstones along Prairie Creek near the south end of the park. The copperas at Dolliver was first noted by Owen (1852) in his initial geologic survey of the Iowa Territory.

> *"Near the termination of these bluffs, just below our encampment of the 5th September, in sight of the Burnt Woods, there is a good deal of hydrated oxide of iron, but rather too much impregnated with sandy particles to be of practical value,"* Owen (1852, p125).

A number of minerals were discovered at the site, for many this is their only-known Iowa occurrence. The minerals and information on their discovery as well as additional photographs can be seen on page 18 of this guidebook. The Copperas Beds will be one stop on our field trip

JONATHAN PRENTIS DOLLIVER

Jonathan Prentis Dolliver (Fig. 6) was born near Kingwood, Preston County, Virginia, on February 6, 1858 (Pammel, 1925). He was the son of a Methodist minister, Rev. J. J. Dolliver, well known circuit riding evangelist for 50 years in western Virginia. His mother belonged to a prominent Virginia family, being a niece of the late William G. Brown, of Kingwood, West Virginia, and a sister of the Hon. John J. Brown, of Morgantown. One of five children (two brothers and two sisters), Jonathan was educated at the University of West Virginia, which he entered when he was only ten years of age. He graduated with high honors seven years later in 1875, the youngest member of his class and the youngest alumnus of the institution at that time. During the first three years of college he and an older brother walked daily from their home to their classes, a distance of four miles. After graduation, Jonathan spent two years were teaching and studying law in Morgantown, West Virginia. He was admitted to the bar in 1877 then moved to Fort Dodge, Iowa, with his brother to make their fortunes. They entered into the practice of law in 1878 in Fort Dodge. Early difficulties with the law business led his brother Robert to leave the firm and follow his father into the ministry. Although he lost his first court case, Jonathan Dolliver gained a great deal of attention for the eloquence of his address to the jury, and he soon began to receive invitations to speak at various political and patriotic gatherings. He so impressed Iowa Governor Carpenter and other prominent politicians that in 1883 he was asked to serve as the temporary chairman of the Republican State Convention where he delivered the keynote speech. In 1886 Dolliver was nominated for Congress, but was defeated. He was again nominated in 1888, and this time he won election. He served in congress, gaining such prominence that he was a candidate for the Presidency in 1900, but he chose to support the candidacy of Theodore Roosevelt and would not let his name be entered in nomination. One of Dolliver's last acts in the House of Representatives was the introduction of the first bill to protect antiquities on Federal lands.

Figure 6. Jonathan Prentis Dolliver, U.S. Congressman, Senator, and statesman. Photo from University of Iowa Libraries (2007).

Within a month after the 1900 Republican convention, Iowa Senator John H. Gear passed away, and Iowa Governor Leslie Shaw appointed Dolliver to fill the vacancy, joining influential Iowa Senator William Boyd Allison in Washington. Dolliver ran for a full term as Iowa Senator in 1902 and was elected, serving until his death. He was noted as a progressive politician. He was described as a "Republican of the school of Abraham Lincoln" who steadfastly strove to improve the conditions of plain people. He was most famous for many fights against proposed tariffs that he felt were intended to protect U.S. monopolistic industries.

Jonathan Dolliver died in Fort Dodge on October 15, 1910. Theodore Roosevelt noted that *"Not merely the state of Iowa, but all for the people of the United States have lost one of the ablest, most patriotic, public servants that we have ever seen in recent years in public life."* Pulitzer Prize winning historian Frank Luther Mott said in the *Palimpsest* that *"Dolliver was one of the few congressmen who would at times command absolute silence. His readiness of tongue, his strong diction, and his masterful presence were the instruments of the true orator."*

BLACK'S FARM BECOMES A STATE PARK

Early Iowa conservationists, sportsmen, and citizens concerned about preserving natural areas in Iowa had long advocated for the preparation of a comprehensive statewide conservation plan. The conservation movement in Iowa was begun in earnest by two botanists, Thomas McBride of the University of Iowa and Louis Pammel of Iowa State College. Their efforts resulted in the establishment of the Iowa State Board of Conservation in 1917 and three years later the dedication of Backbone, Iowa's first state park.

Figure 7. Former land owner J.B. Black was Dolliver Park's first custodian.

At about the same time a group of leading Webster County citizens including O.M. Olson and Rev. F.E. Drake presented a petition to create a State park in the around the junction of Prairie Creek and the Des Moines River (Pammel, 1925). The petition was supported by 1915 reports by Edgar Harlan and John Ford advocating the State's purchase and development of the area for recreational, historic, and scientific purposes. Efforts to create a State park in the area waned as the U.S. moved into World War I, but then in 1920 interest was revived when R.O. Green from the Fort Dodge Chamber of Commerce offered the Iowa State Board of Conservation $10,000 that had been raised for a memorial to Jonathan Dolliver, a recently deceased Fort Dodge resident and U.S. Senator (see biography of J.P. Dolliver above). The offer was contingent on the Board using the money to purchase the land for a State Park and name the park Dolliver Memorial Park. The Board quickly agreed to the offer and purchased a 457 acre plot of land along the Des Moines River for $38,500 and to place within the park a suitable memorial to honor Senator Dolliver. Two local land owners also agreed to donate a strip of land for construction of an access road. On December 3, 1920 the Conservation Board adopted a resolution asking the State Executive Council to immediately acquire Dolliver Memorial Park, and the final acquisition was completed on April 22, 1921. Funds were soon allocated for park maintenance ($300), to pay the salary of a park custodian ($400), and to construct roads and bridges ($600). The first park custodian J.B. Black (Fig. 7) had previously owned much of the park land. He was followed by C.N. Douglas who managed the park at its dedication in 1925.

Dolliver Park is Dedicated

Dolliver Memorial State Park was dedicated on Sunday June 28, 1925 (Fig. 8a), becoming Iowa's third State Park. The ceremonies were organized by Mrs. E.F. Armstrong and Mr. W.C. Merckens of Fort Dodge (Pammel, 1925), and the program included musical selections by the Dayton Band, the Call of the Trumpets, an invocation by Rev. J.J. Share, singing of "America" led by the Webster County Male Chorus, a review of the history of Dolliver Park by Mr. John Ford, Presentation of Dolliver Memorial Park by Dr. L.H. Pammel, the unveiling of the Dolliver Memorial Tablet by

Figure 8. Photographs of the dedication of Dolliver Memorial State Park. **a.** crowd gathered to hear the dedication of the park; **b**. Frances Dolliver unveiling the Memorial Tablet with Jonathan Dolliver Jr., O.M. Oleson, and J.B. Weaver to her left..

Frances Pearsons Dolliver (Fig 8b.), "Jonathan Prentiss Dolliver—A living Memory by Hon. J.B. Weaver, musical selections by the Webster County Male Chorus, acceptance and dedication of the park by Hon. J.C. McClune, benediction by Rev. W.H. Welch, and finally music by the Gowrie Orchestra. One of the highlights of the ceremony was the unveiling the Dolliver Memorial Tablet (see discussion of tablet below) designed by noted sculptor Lorado Taft. The ceremony was attended by an estimated 13,500 citizens.

Dolliver Memorial Plaque

The bronze plaque that memorialized Senator Jonathan P. Dolliver (Fig. 9) was designed by Lorado Taft. Lorado Zodoc Taft, well-known American Sculptor, writer, and educator, was born in Elmwood, Illinois, in 1860. After earning Bachelor's and Master's degrees from the University of Illinois he traveled to Paris where he studied sculpture at Ecole des Beaux-Arts for six years. On returning to the United States he accepted a teaching position at the Chicago Art Institute where he remained for 43 years. While there he supervised sculptors preparing adornments on buildings for the 1893 World Columbian Exposition. Because of a shortage of sculptors Taft asked if he could employ some of his female students as assistants (women as sculptors were not an accepted reality at that time) for the Horticultural Building. Head architect Daniel Burnham responded with the classic reply, 'Hire anyone, even white rabbits if they'll do the work." From that arose a group of talented women sculptors who were to retain the name, "the White Rabbits." These included Enid Yandell, Carol Brooks MacNeil, Bessie Potter Vonnoh, Janet Scudder, and Julia Bracken. History has given Taft credit for helping advancing the status of women as sculptors. Lorado Taft who died in 1936 was a member of the National Sculpture Society and today is best remembered for his sculptures and fountains, most in the Chicago area. The memorial plaque at Dolliver Memorial State Park is mounted on the sandstone bluff above a spring between the two park lodges. It includes a bust of Senator Dolliver in positive relief and a quotation from the Senator. The text on the plaque is reproduced below.

Figure 9. Bronze tablet memorializing Jonathan Dolliver. Text on tablet reproduced to the right.

Dolliver Memorial State Park
Dedicated June 28, 1925 to the memory of
Jonathan Prentiss Dolliver
1858 1910

Scholar—Orator—Statesman.
United states House of Representatives 1888-1900
United States Senate 1900-1910

"The miracle of homestead settlement brought to these prairies the best blood of the world's energies, an heroic generation that, with the rude sermons of poverty and labor, dedicated this ample territory. The men and devoted women who settle a country are the lasting and preferred creators of every succeeding generation. We will never be able to repay them. The frontier servitude of their experience is beyond the arithmetic of gratitude. May their lives be spared to witness, with their children, the full measure of political commercial and industrial prosperity to see the country in which their frontier fortunes have been cast filled with industrious, happy and high minded people."

"From a Fourth of July oration, 1880, at Jefferson, Iowa."

THE CCC IN DOLLIVER PARK

The Civilian Conservation Corps (CCC) was established on March 19, 1933, as part of President Franklin Roosevelt's New Deal legislation. Designed to combat poverty and unemployment caused by the Great Depression, it was a work relief program for young men from unemployed families (Conard, 1966). The CCC became very popular and operated in every U.S. state and several territories. The young men lived in camps of about 200 men each and worked for six month periods on outdoor construction projects. The Civilian Conservation Corps

Figure 10. The C.C.C. workers at Dolliver Memorial State Park lived in a series of wooden barracks at the present site of the park's group camp area. Upon completion of their work in the park, the men razed the barracks and used the wood to construct a series of cabins for park visitors.

built hundreds of structures within Iowa's state parks, ranging from big lodges like these to small benches and fountains. Most were constructed in a distinctive "natural" style, utilizing local stone and wood. The CCC program helped Iowa expand its park system—from 38 parks in the early 1930s to 87 state parks, preserves and related units by 1942.

Figure 11. The maintenance shop at Dolliver Memorial State Park as it appeared shortly after construction by the C.C.C. in 1934 and as it appears today. The shop was listed on the National Register of Historic Places (#90001684) in 1990.

C.C.C. Company 2725 established camp DSP-3 (now SP-6) in Dolliver Memorial State Park on August 7, 1934, and immediately set to work constructing a series of barracks (Fig,.10) and a shop (Fig. 11). Aerial photography of Webster County from 1939 by the A.A.A. (Agricultural Adjustment Agency – a New Deal program to pay farmers to reduce their crop production) captured the area of the C.C.C. camp at Dolliver shorly after the barracks were constructed (Fig 12a). It shows the losge, cabins, the mess hall, rest room facilities, shortly after they were constructed and the remains of a baseball diamond. It is interesting to compare that photograph with a color infrared aerial photograph of the same area today (Fig. 12b) showing most of the same features in the area around the group camp. As a part of their work at Dolliver Park, the C.C.C. constructed and improved roads, created hiking trails, and constructed a series of buildings and other structures in

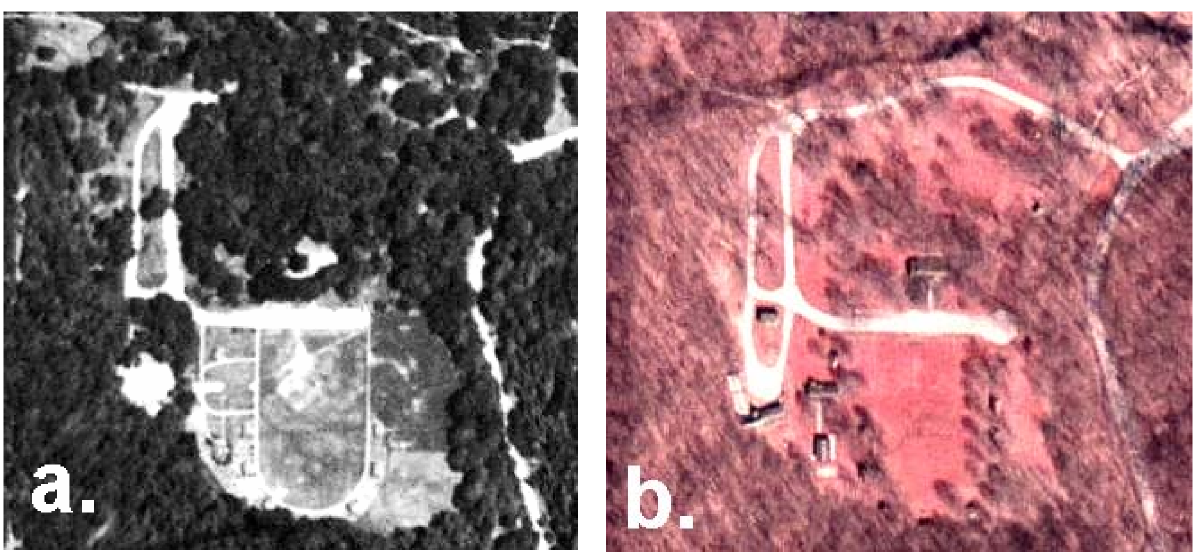
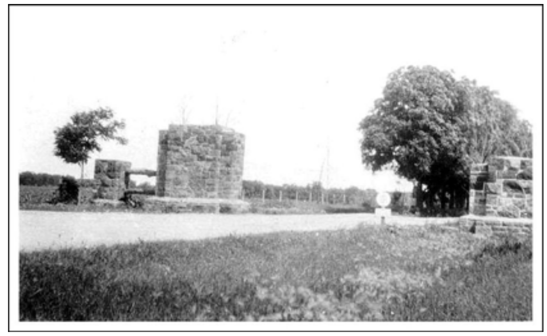


Figure 12. **a.** Arial photo of the C.C.C. camp at Dolliver Memorial State Park as it appeared in 1939 shortly after the C.C.C. crews departed and **b.** color infrared aerial photo of the area (now the group camp) as it appeared in 2002.

the park. These structures included northern (Fig 13a) and southern (Fig. 13b) park entrance features, the central (Fig 13c) and southern (Fig 13d). two stone cabins for park visitors, and several open shelters (Figs 13e & 13f. Unfortunately many of these structures deteriorated through the years and were dismantled. When their construction activities at Dolliver Park were completed, the C.C.C. dismantled the barracks buildings and used the wood to construct 10 cabins for use by group campers. The maintenance shop building (Fig. 11) was turned over to the State Park and is still in use today.

a. the north entrance to Dolliver Park



b. the south entrance to Dolliver Park

c. the Center Lodge at Dolliver Park

d. the Southern Lodge at Dolliver Park

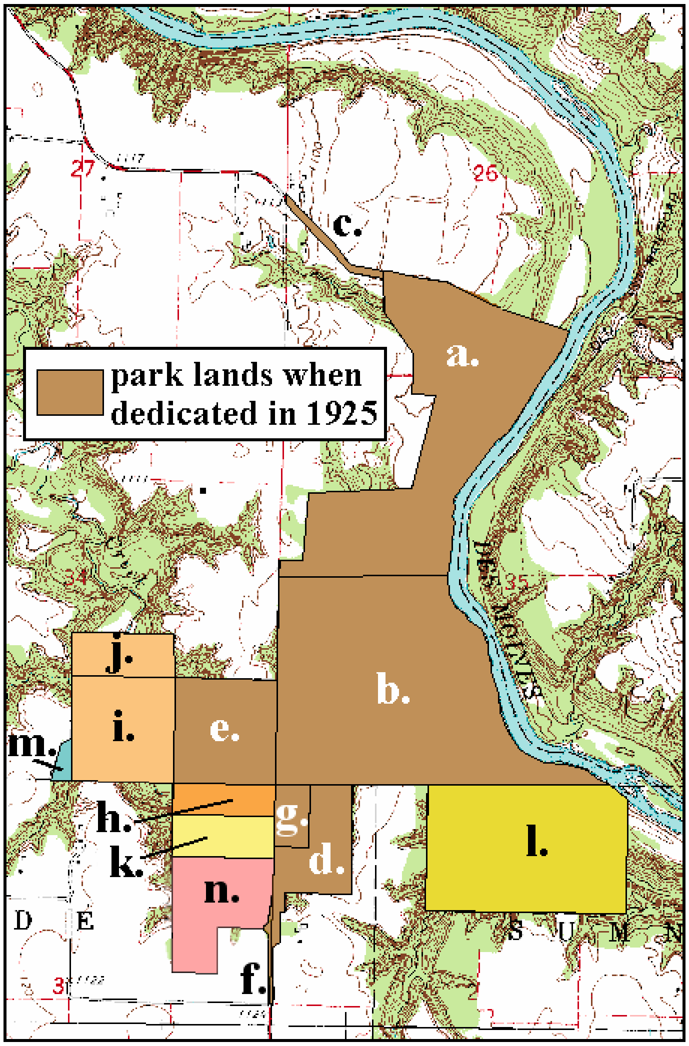
e. . an open shelter* at Dolliver Park

f. an open "umbrella" shelter* at Dolliver Park

Figure 13. Period photographs of various C.C.C. structures at Dolliver Memorial State Park.
* identifies structures that no longer exist.

MODERN CHANGES TO DOLLIVER PARK

When Dolliver Memorial State Park was dedicated in 1925 it included 393 acres of the Des Moines River Valley and nearby uplands (Fig. 14). Since then the park has continued to grow with the addition of many new parcels of land. The first addition was a 13 acre parcel (Fig. 14h) purchased from Litchfield Realty Company in 1930. Two parcels were added to the southwest area of the park in 1938, 41 acres purchased from Marie Schwerm (Fig. 14i) and 17 acres from Edward Gilchrist (Fig 14j). In 1940 the State obtained a tract of 16 acres (Fig. 14k) at the park's south end from Litchfield Reality, and in 1945 a large 97-acre parcel (Fig. 14l) from B.E. Stonebreaker in the southeast corner of the park. A 2-acre tract of land (Fig. 14m) was added to the southwest corner of Dolliver Park in 1951, purchased from F.A. and A.G. Barkley, and the most recent piece of the park came in 1993 with the purchase of 35 acres adjacent to the south entrance(Fig. 14n) from the Litchfield Realty Co. Dolliver Park now includes 614 acres.



Land Acquired for Dolliver Memorial State Park

	Date	Acres	previous owner
a.	1920	134	Black, J.B. & Carrie A.
b.	1920	178	Smeltzer, C.T.
c.	1922	4	Black, J.B. & Carrie A.
d.	1922	27	Johnson, Wesley & Anna P.
e.	1922	41	Johnson, Wesley & Anna P.
f.	1923	1	Litchfield Realty Co.
g.	1924	8	Johnson, Wesley and Anna P.
	1925		**Dolliver Park Dedicated**
h.	1930	13	Litchfield Realty Co.
i.	1938	41	Schwerm, Marie E.
.j.	1938	17	Gitchrist, Edward F & A.J.
k.	1940	16	Litchfield Realty Co.
l.	1945	97	Stonebreaker, B.E. & Mira M.
m.	1951	2	Barkley, F.A. & A.G.
n.	1993	35	Litchfield Realty Co.

Figure 14. Map of land parcels that were obtained by the State of Iowa to create Dolliver Memorial State Park, the date obtained, acreage and previous land owner.

The primary north-south road through Dolliver Park (county road D-33 or Dolliver Park Avenue) is a primary thoroughfare from Fort Dodge and Kalo to Lehigh. Until recently the crossing of Prairie Creek in the park was via a paved ford. The ford was frequently not passable due to flooding on the creek or the Des Moines River. In 1997 the DNR constructed a bridge (Fig. 15) across the creek to provide better accessibility. The use of native sandstone and wood on the guard rails of the bridge integrates it with other structures in the park. The new bridge insures a route of passage through the park most of the year. Minor episodes of flooding on Prairie Creek or the Des Moines River that made the ford impassible no longer block the road, however higher water flooding is still a problem in the park (see Fig, 16).

Figure 15. Bridge over Prairie Creek constructed in 1997

FLOODING IN DOLLIVER PARK

Flooding in the lowland areas of Dolliver Memorial State Park by the Des Moines River or Prairie Creek is a constant threat and a frequent problem. Both streams are tightly constrained by sandstone cliffs and have only narrow flood plains in the park, so high flow volumes causes them to rise rapidly, inundating the streams; floodplains. After all, "*that's why they call it a floodplain.*" Although the park is threatened by flooding every year, this year (2007) has proven to be more damaging than normal. This spring high water on the Des Moines River flooded low-lying areas of the park (see Figs. 16a and 16b) blocking the main park road for several days. An even more disastrous round of flooding culminated in August when already high waters were compounded with a local 5.5 inch rainfall that sent Prairie Creek out of its banks, washing out 3 foot bridges, destroying picnic tables and other park facilities, and depositing tons of sediment on park roads, trails, playgrounds, and parklands.

Figure 16a. Flooding of Prairie Creek at road ford in the Spring of 2007.

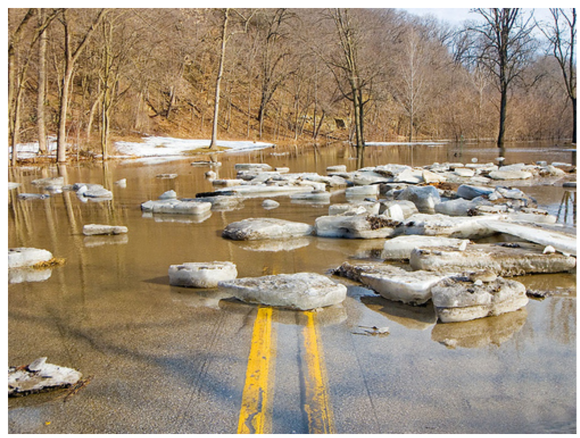


Figure 16b. Ice from the flooding Des Moines River on main park road, Spring of 2007.

Figure 16c. Des Moines River floods park road in August of 2007.

Figure 16d. Foot Bridge over Prairie Creek destroyed by flood, August of 1997.

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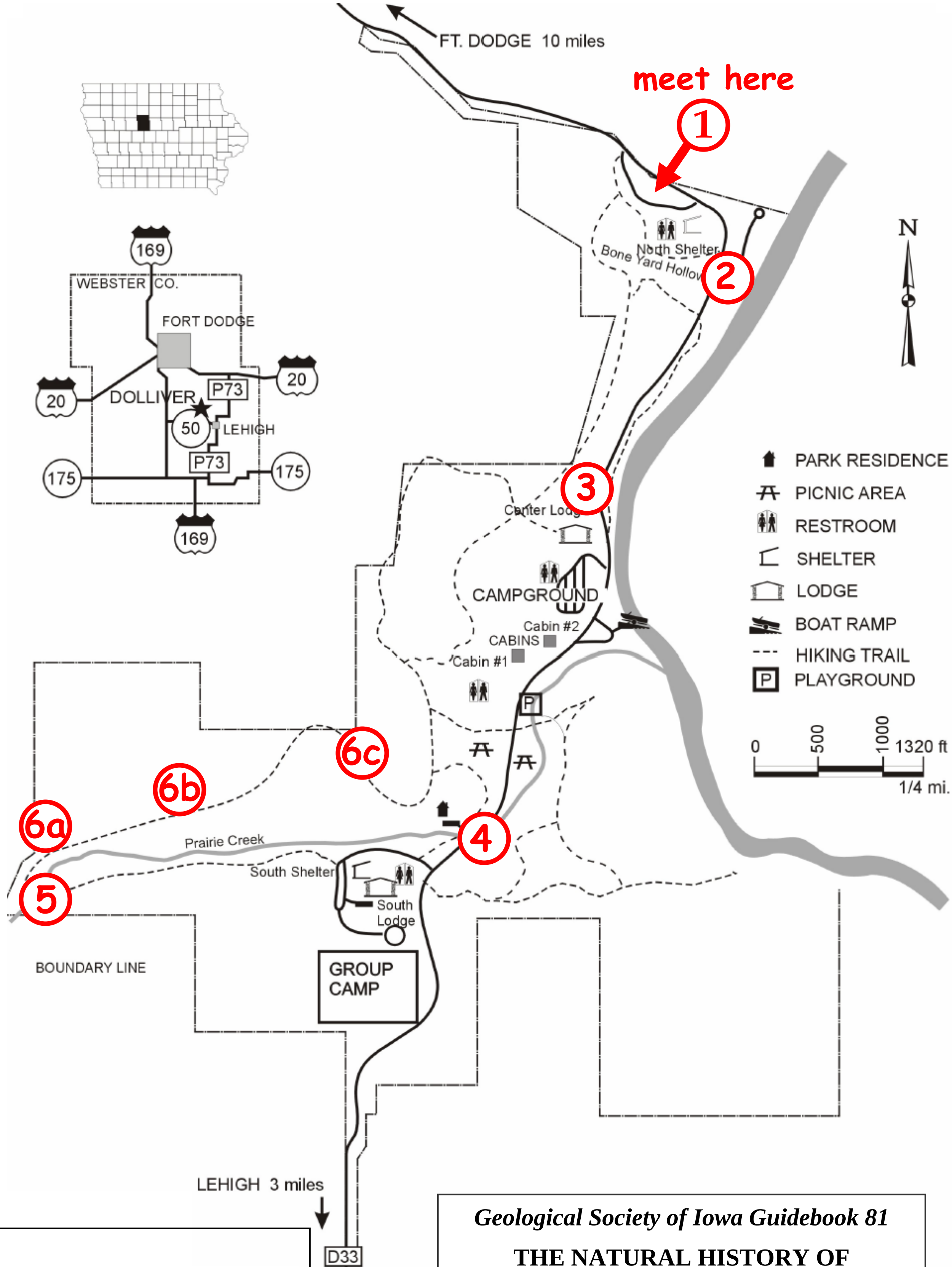

3 Field Trip Stop Location

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