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## A Multidisciplinary Approach for Determining the Extents of the Beds of Complex Natural Lakes in Louisiana

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A Multidisciplinary Approach  
for  
Determining the Extents of the Beds of Complex Natural Lakes in Louisiana

A Dissertation

Submitted to the Graduate Faculty of the  
University of New Orleans  
in partial fulfillment of the  
requirements for the degree of

Doctor of Philosophy  
in  
Engineering and Applied Science

by  
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## ABSTRACT

In Louisiana, the beds of natural lakes are owned by the state. The locations of property boundary lines separating state property from private lands have usually been set by determining the levels of natural monuments known as *ordinary high water* marks. The term is confusing and subjective, leading to controversy in reference to its determination. Catahoula Lake in central Louisiana was chosen as a study site because of its large size, its 20-foot variation in water levels, and its low-relief perimeter. Geology, geomorphology, hydrology, archaeology, vegetation, dendrochronology and dendrohydrology of the ancient cypress fringe, nineteenth century land survey records, historical records, and time-series statistics were applied to determine the elevation range of ordinary high water. Research suggests that the level of the ordinary high water natural monument used universally in Louisiana to define lake boundaries is not the correct natural monument. This research suggests that, for example, the natural monument that defines the Catahoula Lake boundary is not a vertical monument, but rather an areal monument that was originally recognized by nineteenth century U.S. government surveyors and embedded in the evidence extracted from their original field notes. The solution coincides with the boundaries of regional land patents and offers a consistent solution to determining the boundaries of thousands of acres of disputed lands. The procedure is applicable to other lake and swamp boundaries in Louisiana and other states.

Key Words: Lake, lake boundary, lake shore, bed, shore, bank, survey, river, stream, geomorphology, geology, tree rings, cross dating, dendrohydrology, dendrochronology, dendrosedimentology, pollenology, baldcypress, ordinary high water, ordinary high water mark, Swamplands Act, areal, cypress fringe, alluvial ridge, natural monuments, cypress knee, Great Red River Raft, Atchafalaya River raft, US General Land Office, land survey, patent, oil and gas litigation.

## CHAPTER 1

### INTRODUCTION

Lake-front properties and their boundaries are becoming increasingly important as a result of mineral discoveries and the growth of outdoor recreation. The Louisiana Revised Statute 41:1701 states that "The beds and bottoms of all navigable waters and the banks or shores of bays, arms of the sea, the Gulf of Mexico, and navigable lakes belong to the state of Louisiana." Incredibly, the exact definition of the limits of the beds of navigable lakes has never been determined in Louisiana. As a result of that, boundary disputes have repeatedly arisen. The goal of this paper is to develop a procedure that may be useful in determining boundaries of complex natural lakes.

The problem lies in the definition of what constitutes the bed of a lake. The term *ordinary high water* (OHW) originated as an imprecise, non-scientific term used by our ancestors in Europe, and now the term is being applied to precise scientific determinations of boundaries (Flushman, 2002). The Louisiana Civil Code uses the term OHW to define the upper limits of navigable stream servitudes. Courts have applied the OHW to the boundaries of lakes, although the Louisiana Civil Code does not apply the term to lakes. The U.S. Government Accountability Office (GAO, 2004) reported that OHW determinations by the U.S. Army Corps of Engineers (USACE) were inconsistent, and they concluded that "It is possible that well trained and competent staff might interpret the term [OHW] differently." The problem may be further complicated if the OHW is ambulatory. Original lake boundaries are defined by where they existed in 1812, when Louisiana was admitted as a state. If a lakebed expands due to natural causes, the boundary expands, and the state acquires the additional land. However, if the

lake bed recedes, the state boundary does not recede, and the riparian owner is not entitled to dereliction. The state ownership boundary may, therefore, be defined as the largest natural expanse of the bed since sovereignty in 1812 (Louisiana Civil Code, Article 500).

Catahoula Lake (Figures 1 and 2) was chosen as a study area because it is a large natural lake with a disputed boundary, has a complex geologic and hydrologic history, and its water level fluctuates at least 20 feet annually (USACE, 2009). Catahoula Lake is located in central Louisiana. It has a 2,400-square-mile watershed which covers approximately 30,000 acres (Louisiana Department of Natural Resources, 2009). Oil and gas resources are located beneath it (Louisiana Department of Natural Resources, 2009). In addition, it is one of the largest recreational areas in Louisiana. Previous attempts to determine the lake boundary have resulted in disagreement. In some parts of the lake, a one-foot vertical discrepancy of the OHW can shift the lake boundary by as much as a mile. At the time of this writing, the lake boundary was still in dispute.

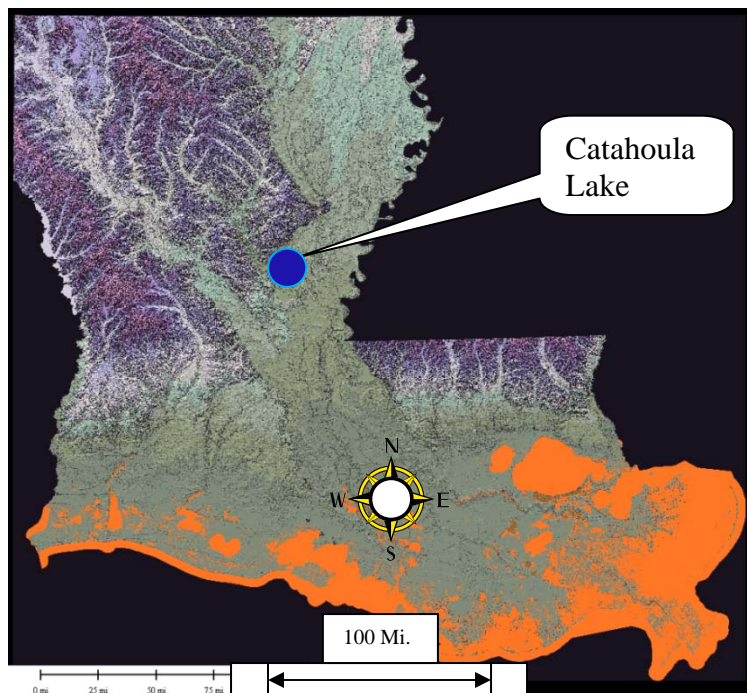


Figure 1 Vicinity map (NASA, 2007).



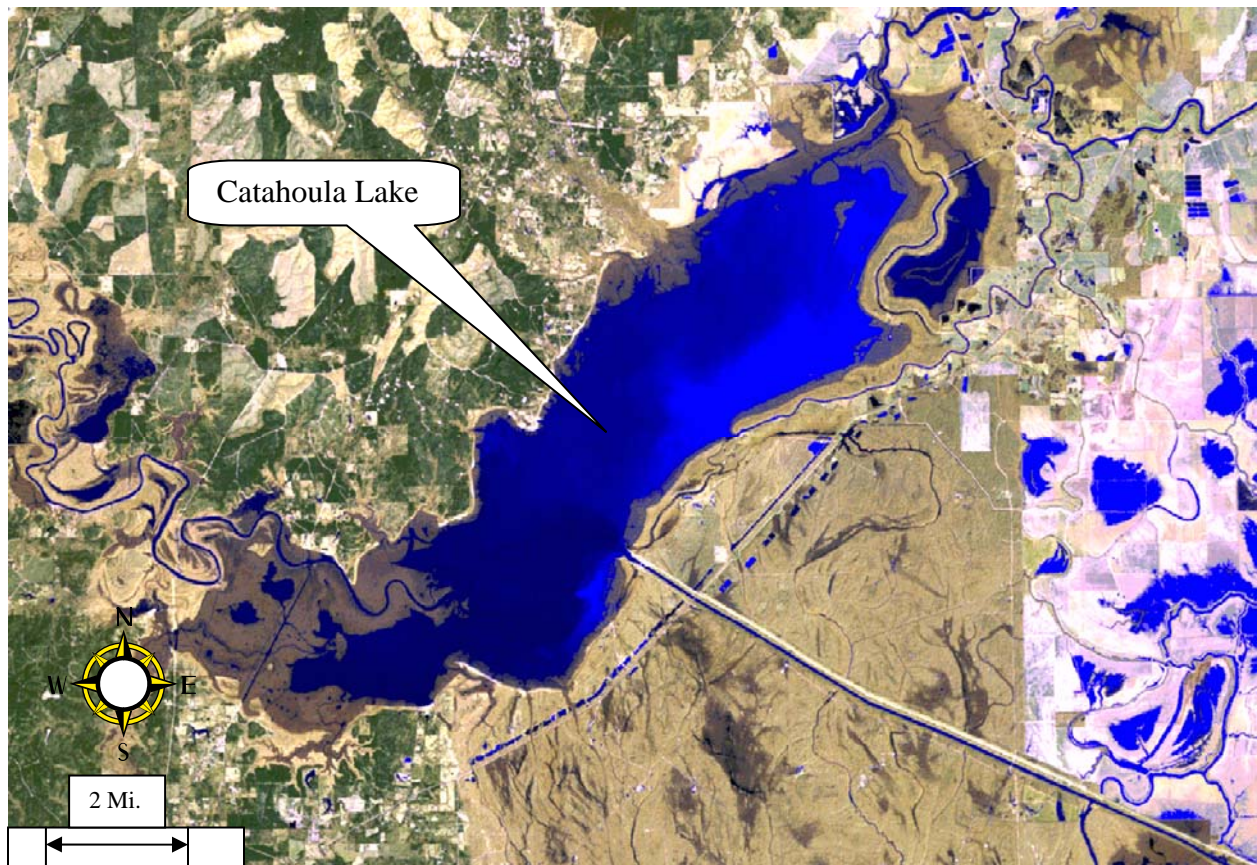


Figure 2. Catahoula Lake (NASA Landsat TM Image, 2009).

Between 1809 and 1853, the U.S. General Land Office (GLO) surveyed the boundary of Catahoula Lake and the land surrounding it (Figure 3). To the layman, it might seem that the GLO survey should have resolved the boundary issue. However, courts have consistently held that GLO boundary surveys of the perimeters of lakes (meander lines) do not constitute lake boundaries. *Railroad Co. v. Schurmeier* (74 U.S. 272, 1868) states:

Meander lines are run in surveying fractional portions of the public lands... not as boundaries... but to define the sinuosities of the banks . . . ascertaining the quantity of land... The plat shows to a demonstration that the watercourse, and not the meander line... is the boundary.



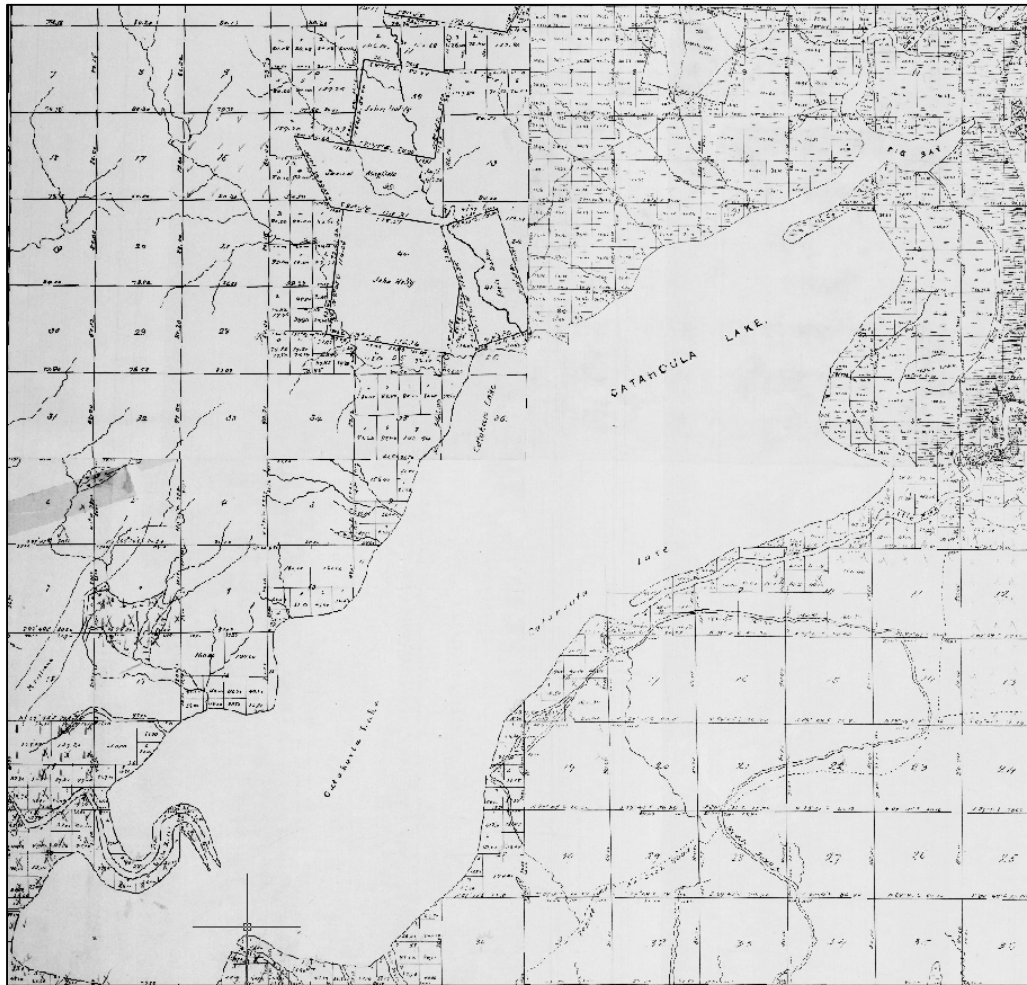


Figure 3. Mosaic of GLO surveys 1809-1853 (Source: Louisiana State Land Office).

The 1973 *Manual of Instructions for the Survey of the Public Lands of the United States* (*Manual of Instructions*), (United States Department of the Interior, 1973) provides a definition of the OHW: "The line which the water impresses upon the soil by covering it for sufficient periods to deprive it of vegetation." Interpreted literally, the *Manual of Instructions* states that trees and other vegetation will not survive below the ordinary high water level of Catahoula Lake. The numerous baldcypress and other water-tolerant woody species found in most natural

lakes in Louisiana are evidence that this *Manual of Instructions* definition of OHW may not be universally acceptable.

The *Manual of Instructions* refers to escarpments formed by the water:

Mean (ordinary) high water elevation is found at the margin of the area occupied by the water for the greater portion of each average year. At this level a definite escarpment in the soil is generally traceable, at the top of which is the true position for the meander line. A pronounced escarpment, the result of the action of storm and flood waters, is often found above the principal water level, and separated from the latter by the storm or flood beach. Another, less evident, escarpment is found at the average low level, especially of lakes, the lower escarpment being separated from the principal escarpment by the normal beach or shore.

This word [ordinary high water]...does not mean the abnormally low level of a lake during one of a series of excessively dry years, or the abnormally high level of a lake during an exceptional wet year or a series of wet years, but the average or mean level obtained under fairly normal or average weather conditions, allowing the proper range between high and low water mark in average years.

This vague description perpetuates the problem by continuing to use an ancient, non-scientific definition of OHW and attempting to describe it with non-specific modifiers.

The limit of the bed of Catahoula Lake is complicated to determine for the following reasons:

1. The definition of OHW is derived from a non-scientific term used by our European ancestors when precise water boundary delineation was not practiced.
2. Catahoula Lake has experienced significant hydrologic changes since 1812. Louisiana does not allow for private acquisition of dereliction on lakes, and the highest natural OHW between 1812 and the present is more difficult to determine than the present-day OHW.
3. The water level at Catahoula Lake fluctuates by at least 20 feet annually and does not reach a consistent ordinary high water level which makes an indisputable high water mark upon the ground.
4. Catahoula Lake is more than 12 miles long, and the shorelines are subject to varying wave action, producing escarpments at varying levels.
5. Vegetation breaks the waves in some parts of the lake, causing variations in the elevations of escarpments. Wave action in the open water can easily exceed one foot, causing higher run-up and erosion where the shore is directly exposed to waves with substantial fetch.
6. Sedimentation has occurred in the areas where tributaries have produced natural levees and deltas. Some of the alluvial deposits since 1812 have been substantial.

7. Soils vary around the perimeter of the lake. Some of the soils are more erodible, therefore, facilitating escarpments at higher levels than soils that are more resistant to erosion.
8. The nineteenth century surveys of the edge of the lake by GLO were often not accurate, and some were fraudulent. Jurisprudence shows that meander line surveys of lake shores by the GLO are not considered lake boundaries.
9. In some parts of Catahoula Lake, a one-foot differential in the determination of the elevation of the OHW can shift the lake boundary by as much as one mile.
10. It is difficult to determine whether OHW changes are due to natural causes or man-made activities.
11. A determination has not been made to establish how long an OHW must exist at a certain level before it defines the limits of a lakebed.
12. The boundary location affects substantial financial interests related to oil and recreation. Various experts have participated in litigation representing both sides, and the findings of these experts may be biased.
13. The lake has experienced geologic changes, and some of the remnant structures are confusing.

14. Some of the indicators of OHW may have formed due to conditions that ceased to exist before 1812, and therefore may be false indicators.

The English system is the current system of units in use for civil engineering and land surveying in Louisiana. The units and vertical datums used over the recorded history of the lake vary. This writing uses the English unit system and the North American Vertical Datum of 1988 (NAVD88). Vertical datum discrepancies were found in the older survey data, including Cairo Datum, and were adjusted in accordance with the best available information obtained from the Mississippi River Commission benchmark files. The variation between the National Geodetic Vertical Datum of 1929 (NGVD 29), Mean Gulf Level (MGL), and NAVD88 were found to vary less than 0.1 foot between datums (National Geodetic Survey, 2009), which is within the significance of precision expected in the hydraulic analysis of the Catahoula Lake regime and is probably more precise than the accuracy of the regional land surveying. All elevations in this study will be referred to in relation to MSL.

## CHAPTER 2

### PREVIOUS STUDIES

#### *Richard Russell*

At the request of Carter Oil Company in 1941, Richard Russell, Professor of Physical Geography at LSU, prepared a study entitled "The Elevation of the Shore Line of Catahoula Lake, La Salle Parish, Louisiana."

Russell identified eight indicators of the shoreline (Russell, 1942).

1. Strand line upon which debris has collected. Russell found strand lines between 38 feet and 50 feet Mean Gulf Level (50 feet MSL). He concluded that the strand lines at Catahoula Lake were so variable and temporary that they were not good indicators of the legal boundary between land and water.
2. Beach deposits of sand, gravel, and other sedimentary materials. Russell reported that various sandy beaches surround Catahoula Lake up to an elevation of about 50 feet. The most conspicuous beach occurred at an elevation of about 36 to 38 feet MGL (50 feet MSL).
3. Notches cut by wave action. Russell observed notching at an elevation of 54 and at an elevation 36 feet MGL (36 feet MSL).
4. Distribution of vegetation. Russell provided a sketch showing vegetation zones (Figure 4). His sketch identified the notch at 36 feet and showed the lakeward movement of eroded sand from the 1812 position. Russell described a continuous zone of cypress trees at a "remarkably consistent elevation" of approximately 36 feet. Regarding the baldcypress, he wrote, "They thrive best where there is flooding at some season of the year, and hence characterize the shores of many streams and lakes

in Louisiana." He also noted water marks 10 feet above the bases of the trees, and attributed them to water levels of higher floods. Russell identified the water elm-swamp-privet zone below the cypress zone. The area above the cypress zone was identified as the sandy beach zone, with its sparse vegetation due to the presence of sandy soil that dries out rapidly, preventing germination.

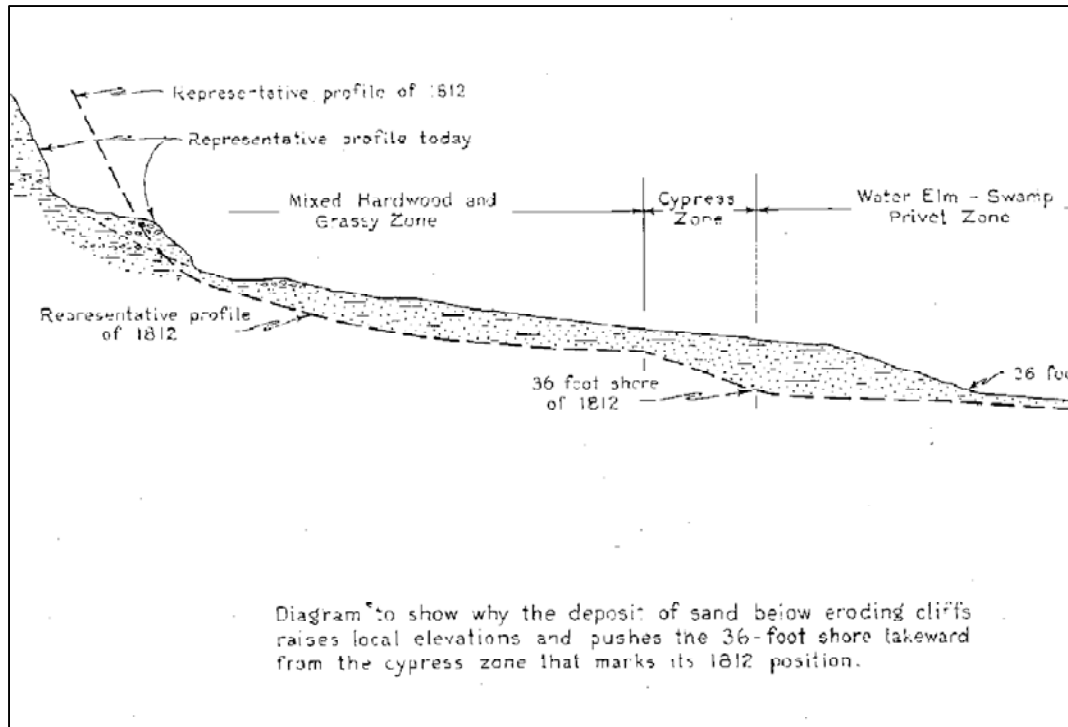


Figure 4. Russell's diagram of the shore of Catahoula Lake (Russell, 1942).

5. The elevations of deltas of inflowing streams. Russell identified Little River at its entry to the lake on the western side. An excerpt from the War Department quadrangle used by Russell is shown in Figure 5. Russell wrote that the ridge of the natural levee was approximately 40 feet on the right descending bank, and "The level of the lake thus indicated by the delta of Little River is somewhat below 40 feet. The

upper four feet or so represents the amount that alluviation during floods has built the levees above the lake level."

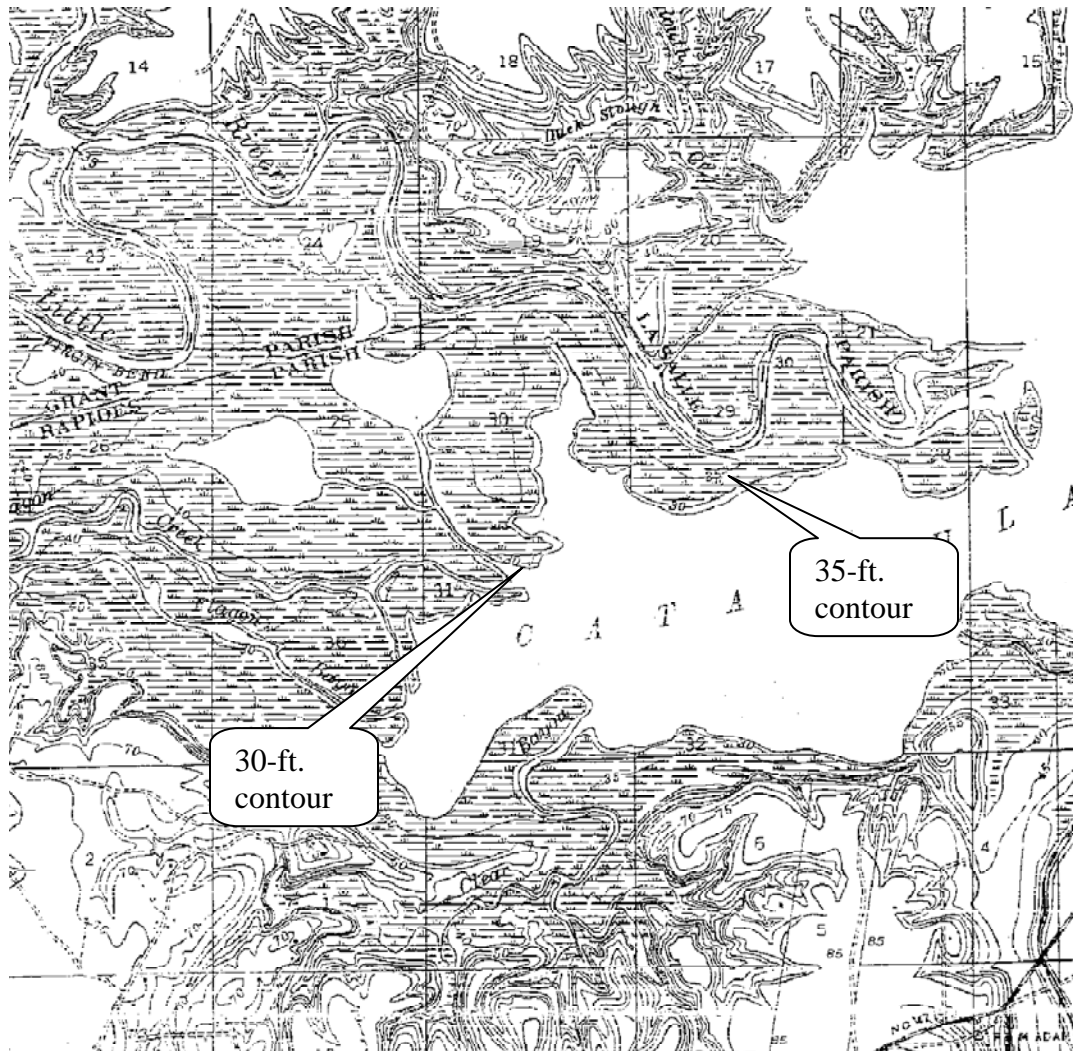


Figure 5. An excerpt from the 1935 War Department Corps of Engineers, Buckeye, Louisiana quadrangle. This is the latest quadrangle that would have been available at the time of Russell's writing. Russell reported that the ridges of the natural levee were about 40 feet MSL (U.S. War Department, 1935).

6. The water marks on the trees and the elevations of the cypress knees. Russell described the swollen butts of the large baldcypress extending upwards of 10 to 20 feet. Russell wrote, "The trees are bottle-shaped. This is to be taken that the trees



have developed an abnormality caused by frequent high floods of long continued stand."

Regarding cypress knees, he wrote:

They ordinarily rise just slightly above flood levels. Where few floods occur the cypress may be kneeless. Along streams that differ in stage considerably the knees are rather reliable indicators of normal high water levels...The tops of the low knees are remarkably uniform in elevation, their upper surfaces forming almost a plane at about 36 to 38 feet. This elevation is a far better guide to the elevation of the lake than are the more conspicuous swelled butts or the water marks above.

7. Logs of driftwood stranded at levels other than along shores. Russell described logs embedded in highway excavations at approximately the 50-foot level.
8. The distribution of Indian villages Russell described the large Indian mounds around the lake.

It is apparent that flooding was limited to levels considerably lower than those to which waters reach today. The elevation of regular floods in the pre-historic times appears to have been about 40 feet, a stage above which Indian settlements are numerous and below which they did not exist...

The large Indian mound on Muddy Bayou, some seven miles southeast of Catahoula Lake, was built on a surface over 45 feet in elevation. This agrees with the great group of settlements, burials, and mounds on the levee of Larto Lake, still farther to the southeast. The notable mounds a

short distance from French Fork of Little River, are at an elevation in excess of 50 feet. The Indian settlements on the upper part of the delta of Little River are at elevations of slightly more than 40 feet. It is also noted that the higher floods of recent years are the direct result of higher and more perfect artificial levees along the Mississippi and Red Rivers. As these levees attained some real degree of perfection only since about the year 1882, it is reasonable to believe that the higher floods in the lake started at about that time... The lake was probably subject to floods up to the level of about 40 feet at such regular intervals that the Indians found it impracticable to live at a lower elevation than that...It is reasonable to suppose that between the time the Indians built their villages around the lake and the time of an effective artificial levee system, the lake was subject to small stage variations as compared to those experienced at present. The levels indicated by the more conservative criteria are undoubtedly those in effect in the year 1812 and consistently maintained until some such date as the year 1882, when the more radical regimen of later years was initiated...

Russell concluded that the elevation of the shore line of Catahoula Lake in 1812 was 36 feet MSL. He opined that the higher shore line above 36 feet was mainly of recent origin, dating back to about 1882, when the artificial levee system became effective and was, therefore, artificially induced.

*Clair A. Brown*

Clair A. Brown, a professor of botany at LSU, assisted Russell on the Catahoula Lake shoreline determination, and shortly afterwards wrote "Vegetation and Lake Level Correlations at Catahoula Lake, Louisiana," (Brown, Vegetation and Lake Level Correlations at Catahoula Lake, Louisiana, 1943). Brown's generalized profile of the lake (Figure 6) provides a depiction of the vegetative banding as it relates to the various water levels at Catahoula Lake. See Figures 7-12.

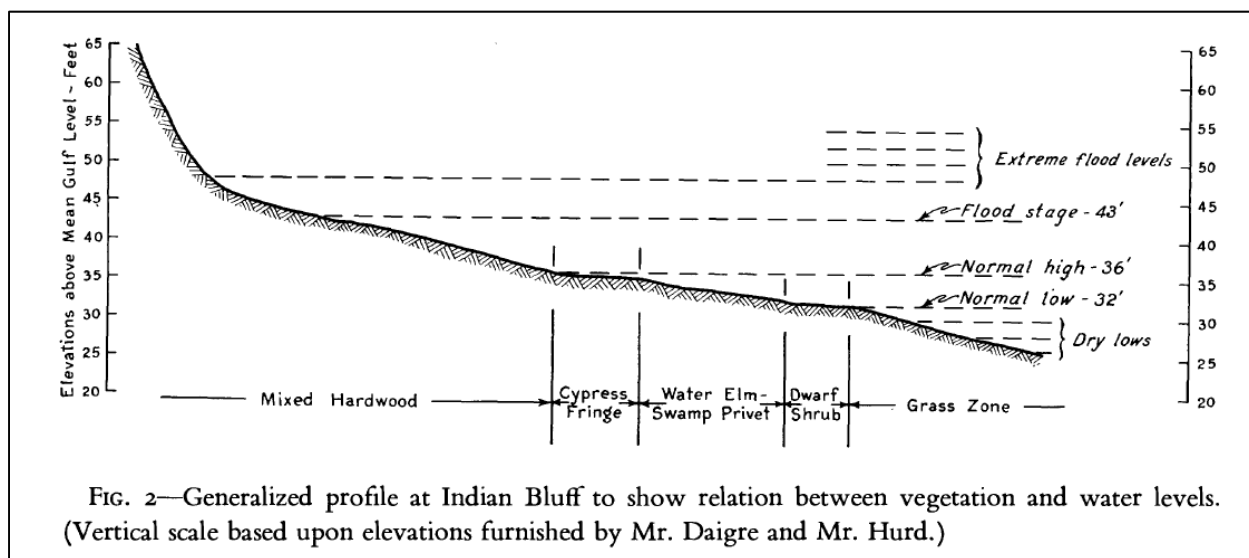


Figure 6. Brown's profile of vegetative banding and correlation to lake water levels (Brown, 1943).



Figure 7. Brown (1943): "Typical bottle-shaped buttress on an old cypress in the water elm-swamp privet zone. The conspicuous water mark is between eight and nine feet above the ground and indicates flood stage (43 feet); the total height of the bottle is about 15 feet and indicates extreme flood stage (46-48 feet)."



Figure 8. Brown (1943): "A typical cypress of the cypress zone. Note the low knees and swollen base. This tree is at the 36 foot elevation. The trees and shrubs in the background belong to the water elm-swamp privet zone..."



Figure 9. Brown (1943): "Weird root formation of cypress along French Fork of Little River. About four feet of soil has been washed away from these roots."



Figure 10. Brown (1943): "A clump of cypress near the mouth of French Fork of Little River. About six feet of soil has been washed away from the roots."





Figure 11. Brown (1943): "The exposed root system of cypress along the French Fork of Little River. These trees are above the 36 foot and below the 38-foot level. Wave and stream erosion during some flood probably washed away the soil from these roots."



Figure 12. Brown (1943): "Note the relatively small knees on the exposed roots of a cypress at the 36 foot level at French Fork of Little River."

Brown described the baldcypress:

Irrespective of their actual function, most observers agree with Matton that the height of the knees corresponds rather closely to the average high-water level for the locality...It must be emphasized here that the cypresses show the following peculiar morphological features: (1) the low knees are sharply confined to the narrow cypress zone; (2) the maximum development of the bottle-shaped buttress base occurs on the trees at low elevations; (3) in shape and size the buttress grades into lower and small forms at higher elevations.

Brown concluded:

Normal high water is at 36 feet. Flood stage is probably close to 43 feet, and extreme flood stage is ordinarily between 46 and 48 feet, though in recent years records indicate levels close to 57 feet.

The 36 foot elevation established as the limits of the bed of the lake by Russell and Brown was used by Carter Oil Company and the by the State of Louisiana for the lake boundary, although others did not accept it.

#### *Comments Regarding Russell's Work*

Although Russell's determination of the extent of the bed of Catahoula Lake has been reviewed and accepted by the State of Louisiana Office of State Lands and Carter Oil Company, the writer questions four of Russell's findings:

1. Russell described the baldcypress fringe at a "remarkably consistent elevation of approximately 36 feet." Russell's acceptance of the 36 foot cypress fringe as the boundary is valid only if it exists as a result of hydrologic or other physical events that



active inscribed the natural lake boundary in 1812. Russell's work did not verify that the cypress fringe functioned or developed because of conditions that existed in 1812, and, therefore, its relevance to the 1812 shoreline may be questionable.

2. The writer's field survey of the natural levees that extend along Little River into Catahoula Lake reveals that the 1935 War Department quadrangle map (Figure 5) used by Russell to determine the 40-foot elevation of the ridge along the right descending bank of Little River is incorrect. At no point today does the ridge of the natural levee on either side of Little River in Catahoula Lake exceed 36 feet. This was further confirmed by my field inspection when Catahoula Lake was precisely at the 36 foot stage. The current USGS quadrangle map also confirms this discrepancy (Figure 13). The reason for the contour discrepancy is simply the limited accuracy of high-altitude photogrammetric contouring used to prepare 1936 quadrangle map. None of the baldcypress root systems (ages 50 to 200 years) is exposed, thus indicating that this area has not eroded.

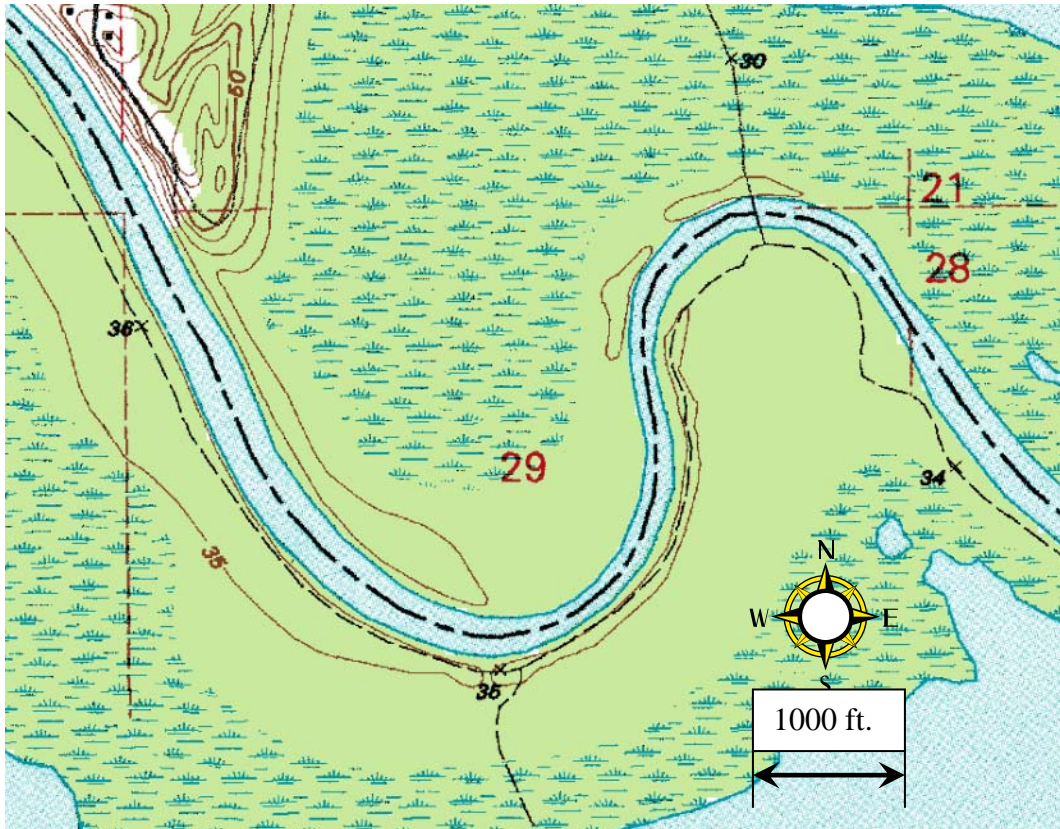


Figure 13. 1994 USGS Holloway Quadrangle Map showing area where Little River extends into Catahoula Lake and natural levee elevations (U.S. Geological Survey, 1994).

3. The writer has reservations about Russell's opinion that Indian mounds do not exist below the 40-foot elevation and that the water levels higher than 40 feet were induced by perfected man-made levees after 1882. Hydrologic evidence and vegetative banding as recorded by GLO surveyors between 1809 and 1852 refute Russell's statement.
4. Russell described the tops of cypress knees approximating the shore elevation of 36 feet. He did not report that cypress knees exist at Catahoula Lake throughout the continuous range of 29 feet to 44 feet. In addition, he did not age the knees to determine whether they existed or were relevant to 1812 conditions.

### *Comments Regarding Brown's Work*

Figures 4 and 6 reveal an inconsistency between Russell and Brown regarding the position of the cypress fringe. Brown places the cypress fringe at 36 feet and below, while Russell places the cypress fringe at 36 feet and above. Brown photographed the cypress fringe at various points around Catahoula Lake, as shown in Figures 7 through 12. The writer found one of the same trees Brown photographed at French Fork (Figure 9). The root crown of the tree is at elevation 41, instead of elevation 36, as Brown indicated for the cypress fringe. A photograph of Brown standing on a ladder against the tree (Brown, 1943) shown below in Figure 14. Figure 15 shows the same tree photographed by the writer in 2009 when the lake was at elevation 34.85, according to the USACE Vicksburg District gage (US Army Corps of Engineers, 2009). Clearly, this tree root crown is well above the 36 foot cypress fringe reported by Brown. Figure 16 is another picture of baldcypress at French Fork, taken when the lake was at 35.8 feet. No root crown was found below 36 feet. Instead, the root crowns ranged from approximately 36 feet up to 42 feet.



Figure 2.3. Exposed horizontal and descending roots on a cypress tree near Catahoula Lake.

Figure 14. Baldcypress at French Fork (Brown 1943).



Figure 15. The same baldcypress as Figure 14 in 2009. The root crown of this tree is at elevation 41.



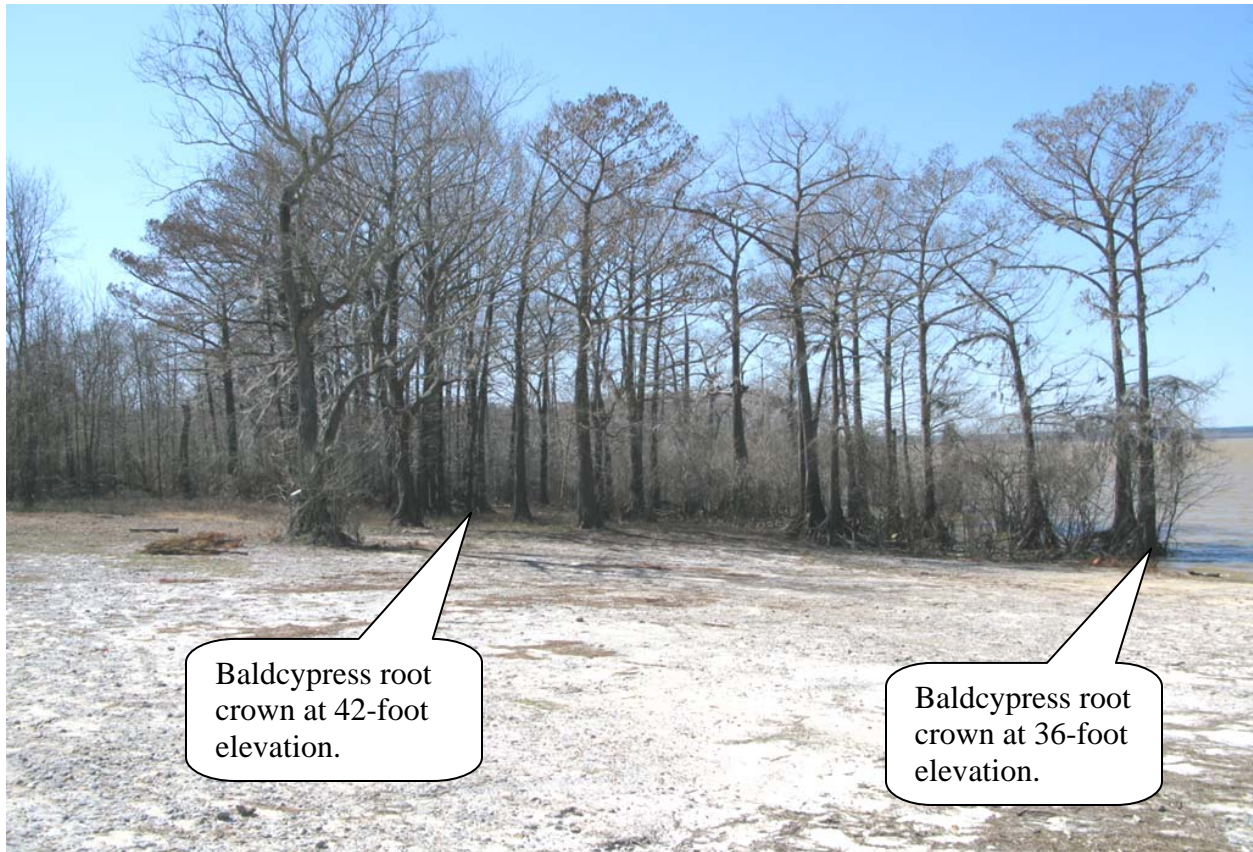


Figure 16. This photograph taken at French Fork in 2009 when the lake stage is at 35.8 feet shows that the cypress fringe lies above 36 feet in this location. This contradicts Brown's report of this same area at the mouth of Little River at French Fork, which stated that the root crowns followed the approximate 36 foot contour. The baldcypress with the mangled tops are more than 200 years old, and the younger trees are at least 90 years old, based on recent corings, which will be addressed later. The root crown elevations range from 36 feet to 42 feet. The cypress fringe in this area clearly lies between 36 and 42 feet, which contradicts Brown's report and profile sketch (Figure 6).

## CHAPTER 3

### HYPOTHESIS

The Russell and Brown studies (1942 and 1943) concluded that the shoreline of Catahoula Lake as it existed in 1812 lies at the present day 36 foot contour. The State of Louisiana adopted the 36 foot contour as the official boundary of Catahoula Lake after the Russell and Brown studies were completed (St. Romain, 2007). Recent litigation, *Sanders v. State of Louisiana* (La.App. 3 Cir., Jan. 30, 2008) has resulted in affirmation, at the appellate court level, of the 36 foot contour as the boundary. The ruling was limited to Sanders' tract only. During the course of that litigation and previous work by the writer on the boundary dispute between Rapides and Grant Parishes, (La. App. 3 Cir. 02/22/06), the writer reviewed the work of Russell (1942) and Brown (1943) and identified all physical features and conditions described in their work, including but not limited to, the ancient cypress fringe that follows the 36 foot contour with "remarkable precision" (Figures 17-19) and the escarpment that follows the 36 foot contour. Like Russell (1942), the writer can determine in the field the location of the 36 foot contour simply by observing the vegetation and terrain without the benefit of a surveyor's level. The cypress fringe identified by Russell and Brown contains the identical magnificent baldcypress that were standing at the edge of Catahoula Lake long before Columbus discovered America. Although the physiography described by Russell and Brown is impressive, and their work has been accepted by others as authoritative, the writer offers the following hypothesis:

*The previous determination of the extent of the bed of Catahoula Lake at the 36 foot contour is based upon scientific principles that cannot withstand a challenge from a*

*multidisciplinary engineering and scientific approach. A more viable solution exists and may be applicable not only to Catahoula Lake, but also to other complex natural lakes.*

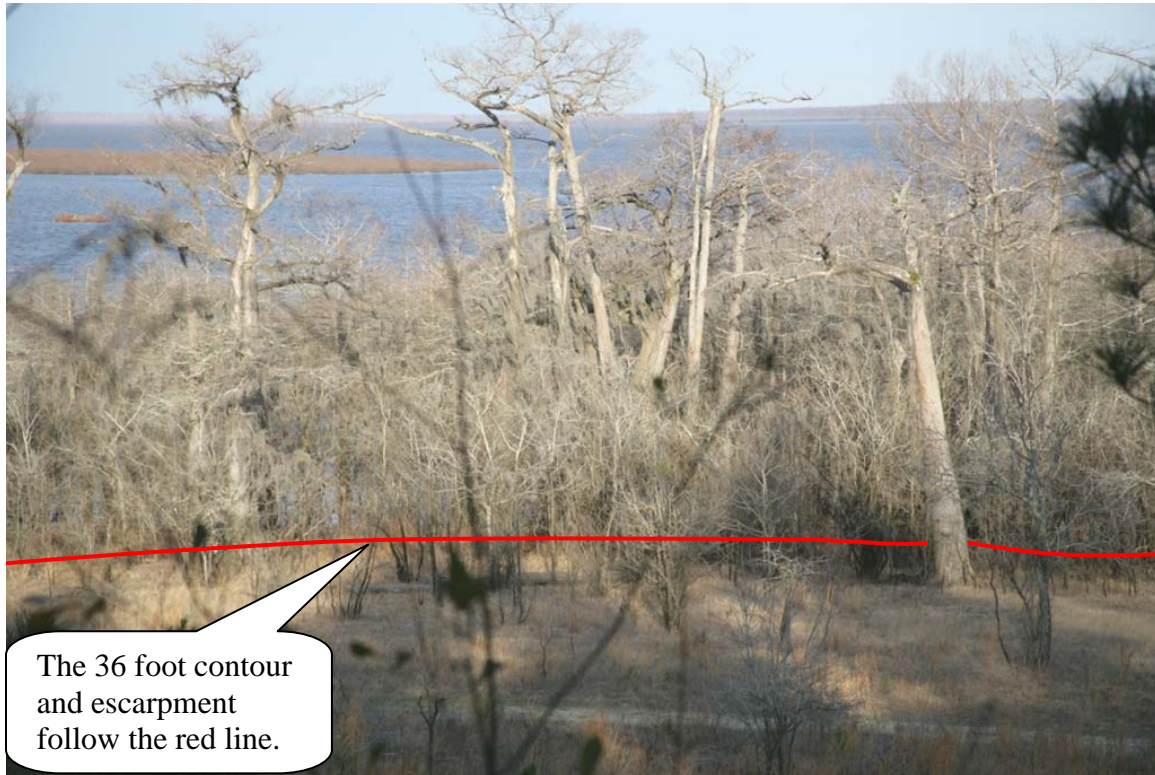


Figure 17. The ancient cypress fringe as viewed from the western edge of Catahoula Lake.



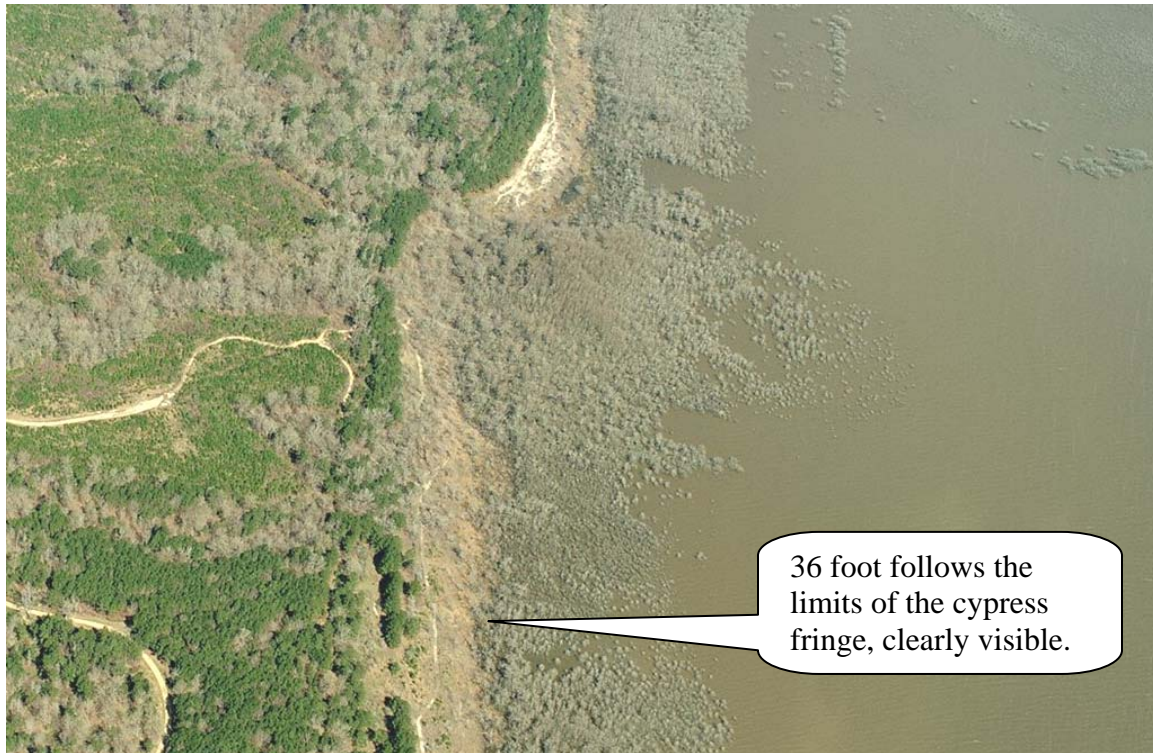


Figure 18. An oblique view of the cypress fringe on the western boundary of Catahoula Lake (Microsoft, 2009).





Figure 19. An ancient baldcypress in the cypress fringe. The tops of the cypress knees above the water line are at an approximate elevation of 36.1 feet. This tree is on the ridge of the right descending bank of Little River in Catahoula Lake, which is the same area that Russell reported to be at elevation 40. On the date of this photograph the lake was at 34.8 feet.

## CHAPTER 4

### PHYSICAL SETTING AND GEOLOGICAL DEVELOPMENT

#### *Physical Setting*

Russell (1942) described Catahoula Lake as a rim-swamp lake located on the western boundary of the Mississippi River alluvial plain and part of the complex hydrologic regime of the Mississippi River (Figure 20). Little River, the main tributary of Catahoula Lake, enters the basin in the southwest quadrant, exits Catahoula Lake at French Fork on the east side of the lake, and flows 24 miles to Black River. Black River flows 41 miles south to Red River. Red River empties into Old River, which was the former channel of the Mississippi River prior to the excavation of the Mississippi River cutoff at Turnbull Island in 1838 (Reuss, 2002). Dry River exits the north end of the lake and connects with Little River. Saline Bayou connects Catahoula Lake to Red River during periods of high water. The low gradient along the rivers allows correlation between the water level in Catahoula Lake and its distributaries as far downstream as the mouth of Red River. Prior to the construction of the Old River Control Structure, Red River water levels were influenced by the Mississippi River water levels. Low topographic relief causes the water level in Catahoula Lake to be affected by the downstream rivers. During late summer, when the rivers are low, the lake surface shrinks from 30,000 acres to approximately 5,000 acres of permanent water having a depth of only one to 12 inches (Wills, 1965). Russell (1942) and Brown (1943) determined that the extent of the shoreline of Catahoula Lake extended to the 36 foot stage. The lake hydrograph does not indicate hydrologic stability at the 36 foot stage; instead, the hydrograph shows that the lake levels are changing near their maximum rate



of change when passing through the 36 foot stage (Figure 21). Figures 22 and 23 show Catahoula Lake during low and high stages.

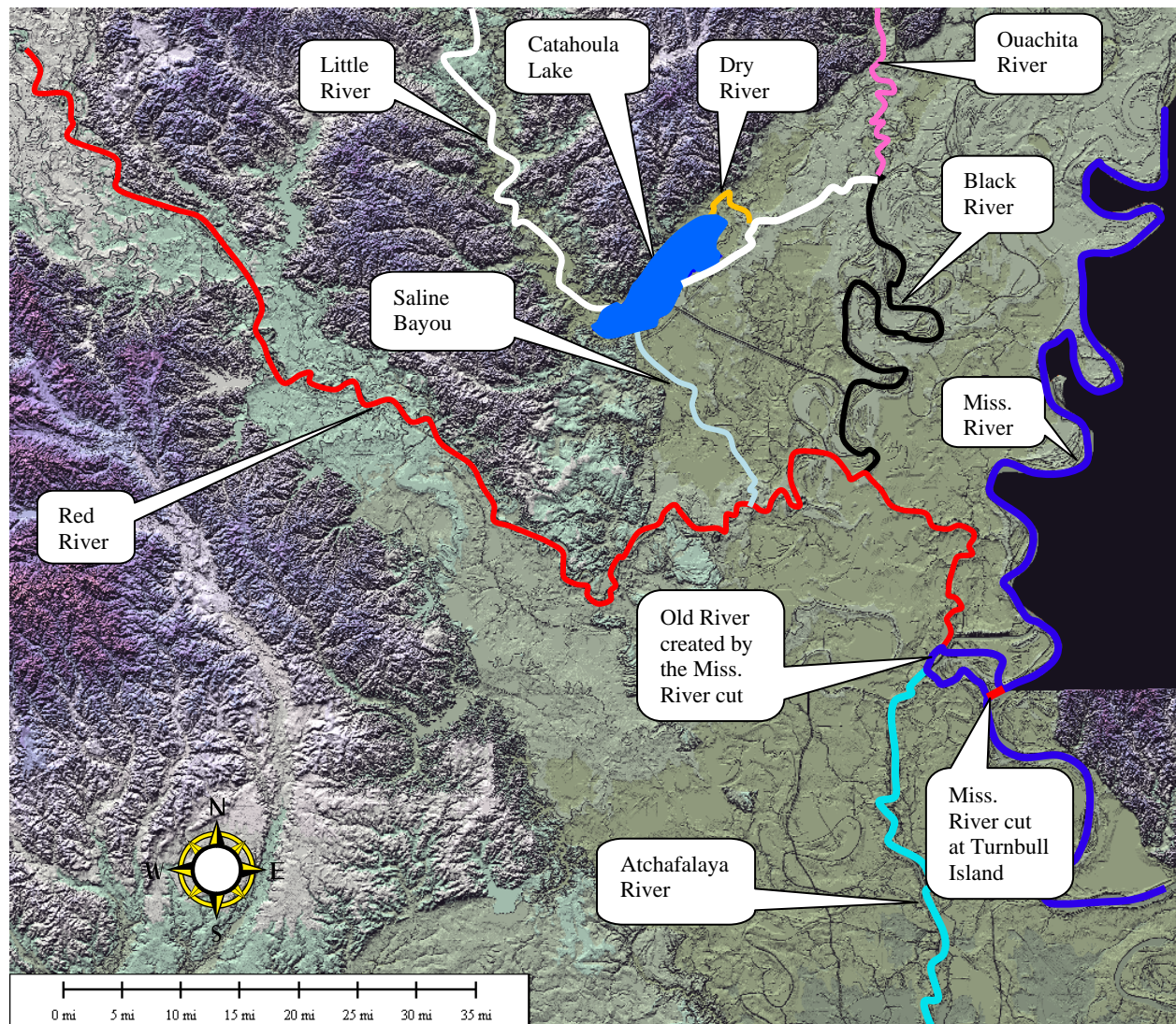


Figure 20. Catahoula Lake and the major streams prior to alteration of the hydrologic regime by man (NASA Landsat TM Image, 2007). Little River enters Catahoula Lake on the west side and exits the lake on the east side.

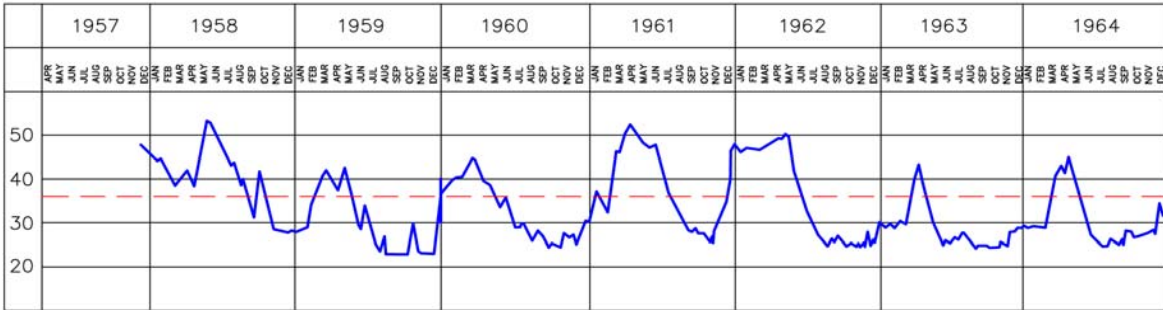


Figure 21. Hydrograph of Catahoula Lake based upon monthly readings, 1958-1964. The hydrograph resembles a river hydrograph because the lake levels are controlled by the stages of its distributaries (USACE, 1957-1964).



Figure 22. A view of Catahoula Lake at the approximate 36 foot stage.





Figure 23. During the late summer, the lake turns into a huge pasture, with only about 5,000 acres of permanent water at a depth of 1 to 12 inches (Wills, 1965).

Russell provides a description of the geologic development of Catahoula Lake in his study “The Elevation of the Shore Line of Catahoula Lake” (1942):

Catahoula Lake occupies a position at the extreme western side of the alluvial valley of the Mississippi River. The floor of the alluvial valley is the product of deposition on the part of the Mississippi and other rivers during the “Recent” epoch of geological time...

The filling of the glacial stage, low-level pre-“Recent” valley of the Mississippi River has accompanied the universal rise in sea levels. In the earlier stages the filling was fairly rapid. Vigorous tributary streams carried large amounts of sand and gravel... ... as time went on the filling took place more slowly. Tributary

streams were less able to carry coarse materials, so that silt, clay, and fine materials in general constitute the upper part of the “Recent” alluvium...

...In numerous published reports the writer has shown that the Mississippi River itself has had a complex history involving many successive channels during the latest and part of “Recent” times. The existing course below Lake Providence is comparatively recent, having been established on the order of two thousand years ago. An older course followed the existing Tensas, Black and numerous bayous into Bayou Teche of southern Louisiana.

...Its history as the main channel of the Mississippi River was terminated when a crevasse near Lake Providence offered such hydrologic advantages that the Tensas-Black-Teche channel was abandoned in favor of a more recent direct course to the Gulf leading down the eastern margin of the alluvial valley.

...Heavy alluviation along the Tensas-Black-Teche Mississippi channel built high natural levees and generated backswamps on either side...

...To the west of the Tensas-Black-Teche natural levees lies the low basin in which Catahoula is located. The Catahoula Lake basin is a low area lying west of the Tensas-Black-Teche Mississippi alluvial ridge, or natural levee, and east of a hilly belt in LaSalle Parish... It owes its presence chiefly to Tertiary rocks, particularly those of Miocene age. To the south side of this valley-side basin are natural levees of Red River. These form a barrier that has been rather ineffectively breached by overflow waters impounded within Catahoula Lake.

...Catahoula Lake is not as simple as if it were a triangle whose sides are (1) Tensas-Black natural levees, (2) Red River natural levees, and (3) Miocene Hills, though these are the essential parts of its delimiting margins. There have been many crevasses of local consequences, each with more or less alluvial deposition along its channels, that tend to increase the complexities of basin outlines and obscure some of their essential features. Every irregularity can be explained... In general, it can be said that the Catahoula Lake basin has witnessed numerous channel changes, of several different streams, at several different times. Each channel of any consequence has tended to build natural levees and these are the upland parts of the basin. They are irregular in plan and elevation, so that the floor of the basin is by no means simple as we see today.

The specific outlines of the elongated southeastern shore of Catahoula Lake are determined chiefly by the natural levee of an old channel that discharged from the Mississippi River channel now called Black River at Jonesville and flowed westward toward the head of the lake, then southwestward and into the channel now called Big Saline Bayou. There are complications in the channel west of Archie caused by a still older and abandoned course of the Ouachita in that vicinity. The channel has in part been removed by wave erosion along the southeastern corner of Catahoula Lake and is therefore no longer continuous. The direction of flow has been reversed in the upper part of the channel, the French Fork of Little River using it as one of the outlets for Catahoula Lake overflow. The specific reason that Catahoula Lake stops southward where it does instead of extending to the immediate natural levees of Red River is the presence of natural

levees of the old channel leading westward from Jonesville and southward at Saline Bayou. The channel of this old stream encountered bluffs south of the westernmost part of southern Catahoula Lake, where it was forced to turn southward. The natural levees of this channel and the bluffs form the southern barrier that outlines the southward extent of the lake today.

Figure 24 shows a LiDAR digital section across the alluvial ridge.

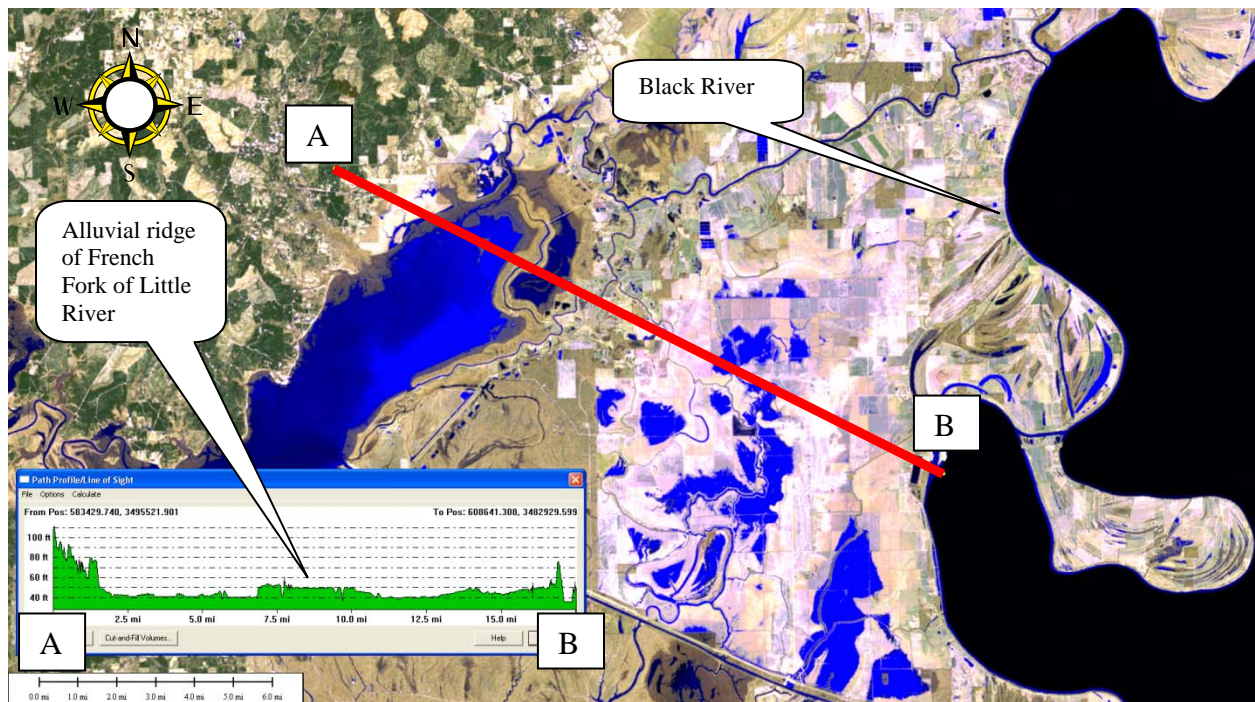


Figure 24. Cross section from west side of alluvial plain to Black River. From left to right, western edge of the alluvial plain, ridges formed by Cowpen Bayou, Little River, and Cocodrie Bayou and Black River are visible (Base map, NASA Landsat Image, 2006).

Figure 25 is an excerpt from the Louisiana Topographic Relief Map (NASA Landsat Imagery, 2007), which shows scarring in the alluvial plain.



The major stream departing French Fork and flowing southerly is a branch of Indian Bayou which is no longer as active as it was in the past (Figure 26).

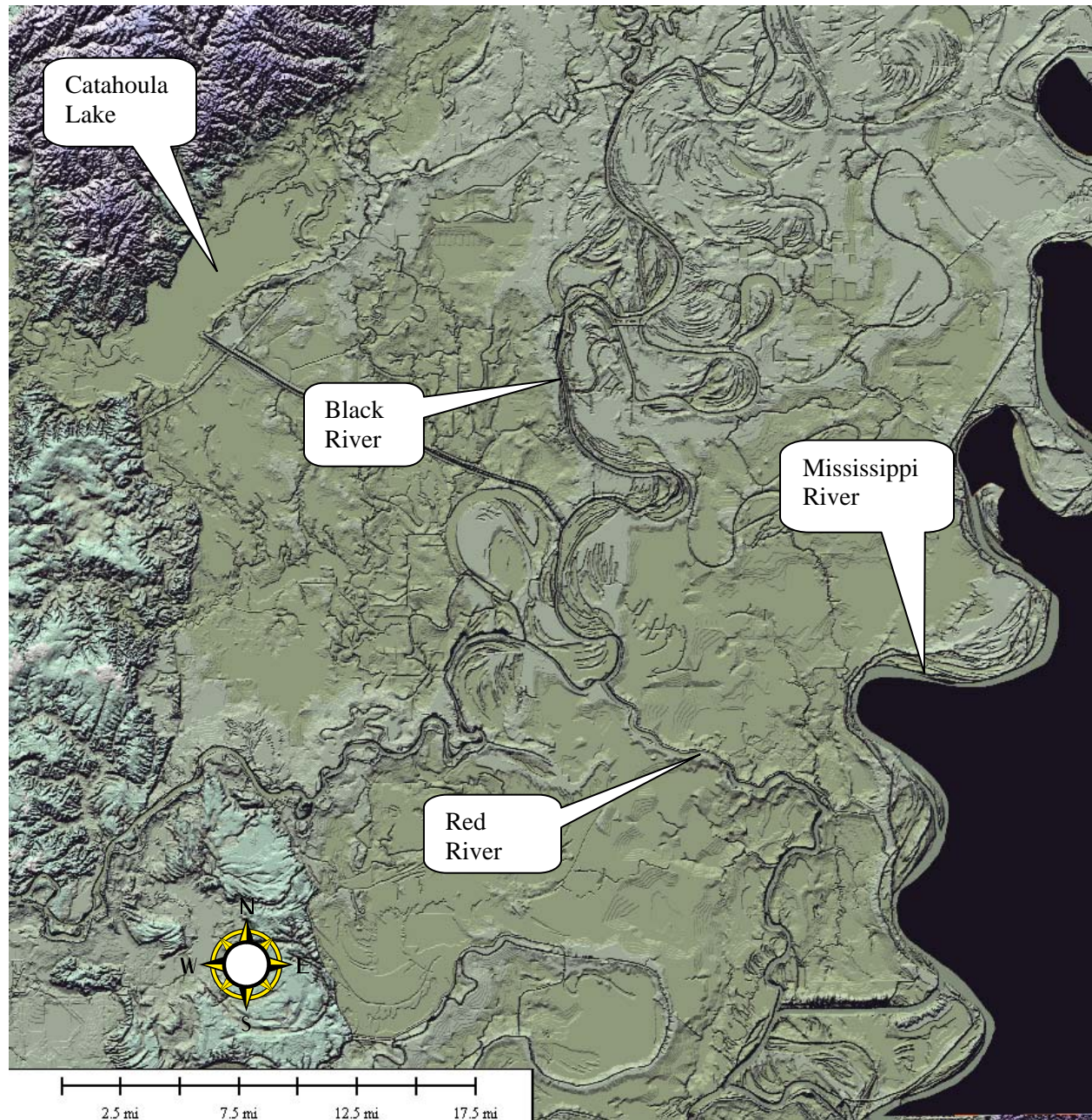


Figure 25. Scarring and remnants of old channels are visible between the Mississippi River and the western confines of the basin (Base map, NASA Landsat Image, 2007).

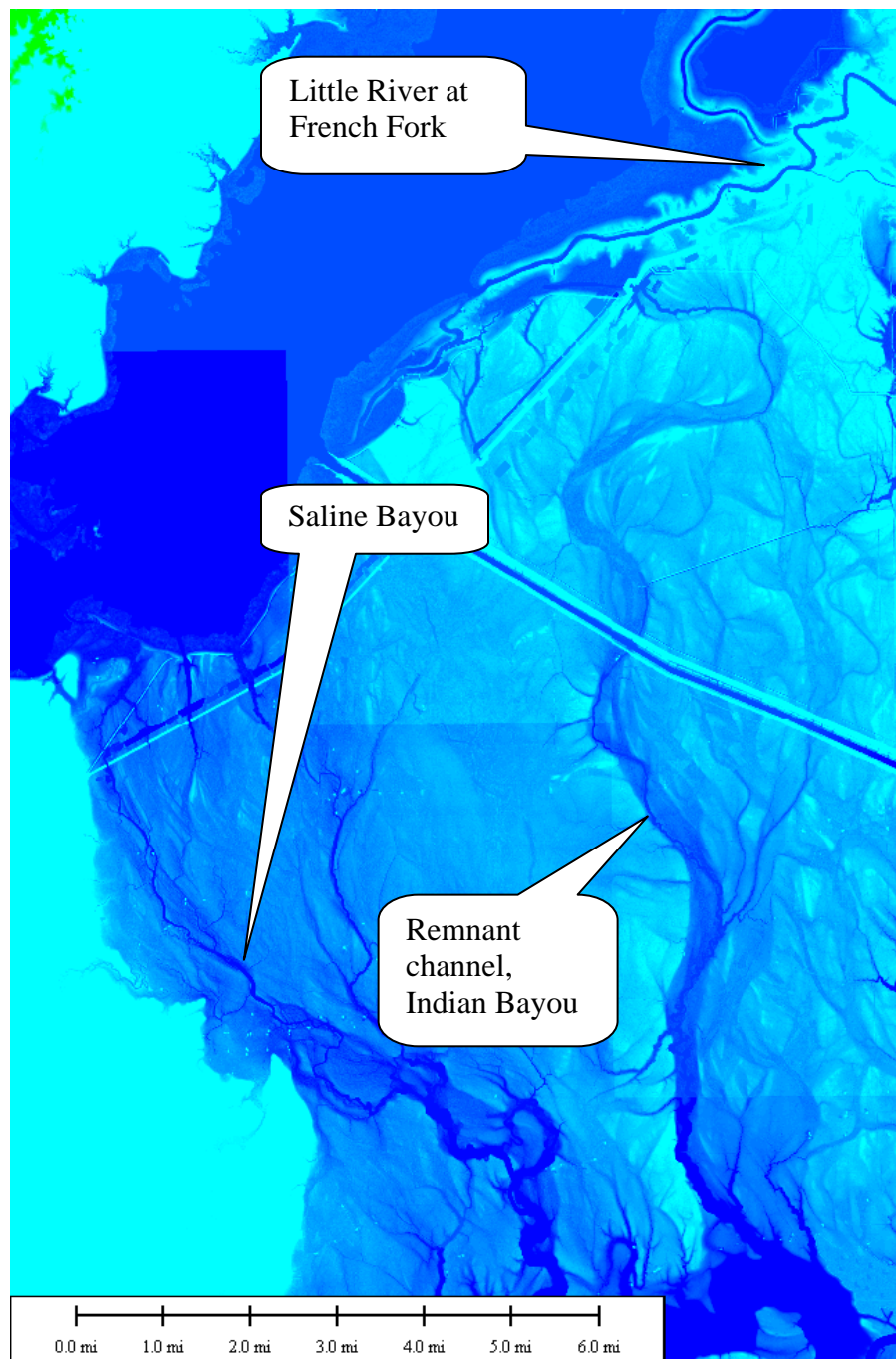


Figure 26. Remnant channel visible on contrast-adjusted LiDAR lattice (Base map, Louisiana State University, 2009).

The natural levees of Little River on the west side of Catahoula Lake are about 10 feet lower than the natural levees of Cowpen Bayou, French Fork, Saline Point, and Indian Bayou on the east side (Figure 27). This was explained by Fisk (1938):

Within the recent delta of Little River may be found a few scattered remnants of older natural levees formed at the time the Ouachita was occupying French Fork's course. It appears certain that Little River [from the west] must have joined the Ouachita near the southwest corner of Catahoula Lake, and the height of these ancient levees must have been governed by the Ouachita. If this assumption is correct, the older drainage system had a base level 5 to 10 feet lower than the present one.



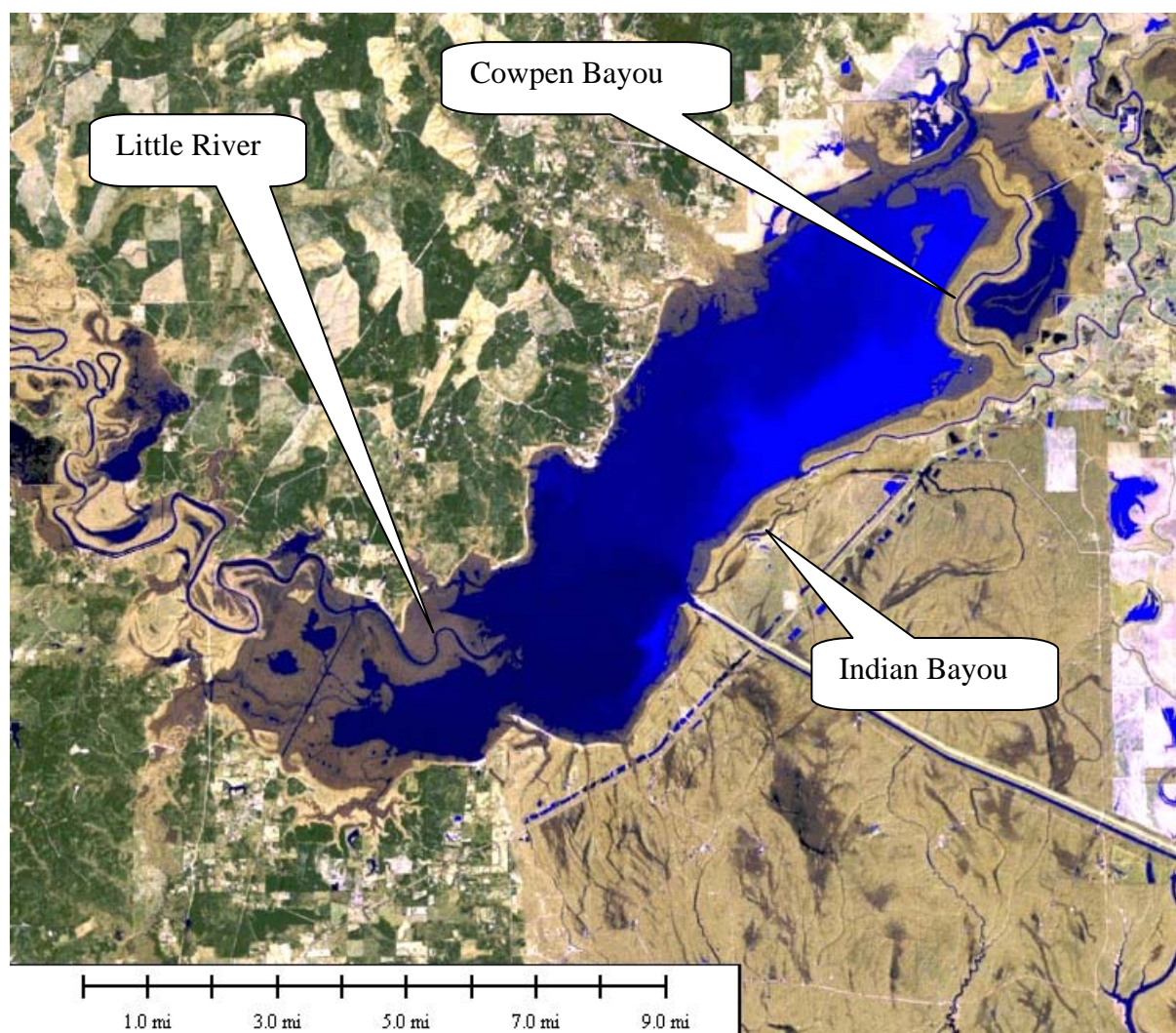


Figure 27. The ridge of the natural levee of Little River is about 10 feet lower than the other natural levees in the lake basin (Base map, NASA Landsat Imagery, 2009).

The natural levee of Little River at Russell's landing may not be due to the Ouachita influence described by Fisk. Little River's natural levees slope longitudinally with the route of Little River as they approach Catahoula Lake. Little River's natural levee begins at the bottom of the lake and extends upstream alongside the river up the alluvial valley of Little River and reaches a level of 45 feet about 10 miles upstream from Russell's Landing (USGS quadrangle, 1994). The lower elevations of the ridges of the Little River natural levees as the river

approaches the lake may be explained by the fact that the river encountered the same hydrologic regime associated with Cowpen Bayou (at the 45-foot elevation) upstream of Russell's Landing. Most of the more valuable natural-levee farmland in the Red River and Mississippi River alluvial flood plains is on natural levees. Those natural levees are not considered to define lake elevations; similarly, the lower portion of the longitudinally-sloped natural levee of Little River should not be used to indicate lake boundary. The lower elevation of the natural levees of Little River in the lake does not necessarily indicate a former lower channel or lower lake level or a recent hydrologic regime change.

Baldcypress, aged approximately 2,000 years according to corings collected and analyzed by the writer, lie along a former channel, now silted in completely (Figure 28). The root crowns of these trees lie approximately 15 feet below the natural levees of Cowpen Bayou, French Fork, and Big Saline Bayou, and are about 6 to 8 feet below the cypress belt surrounding the lake. These trees might be part of the lower regime described by Fisk. Several of the ancient baldcypress were cored, and that is addressed later in this dissertation.



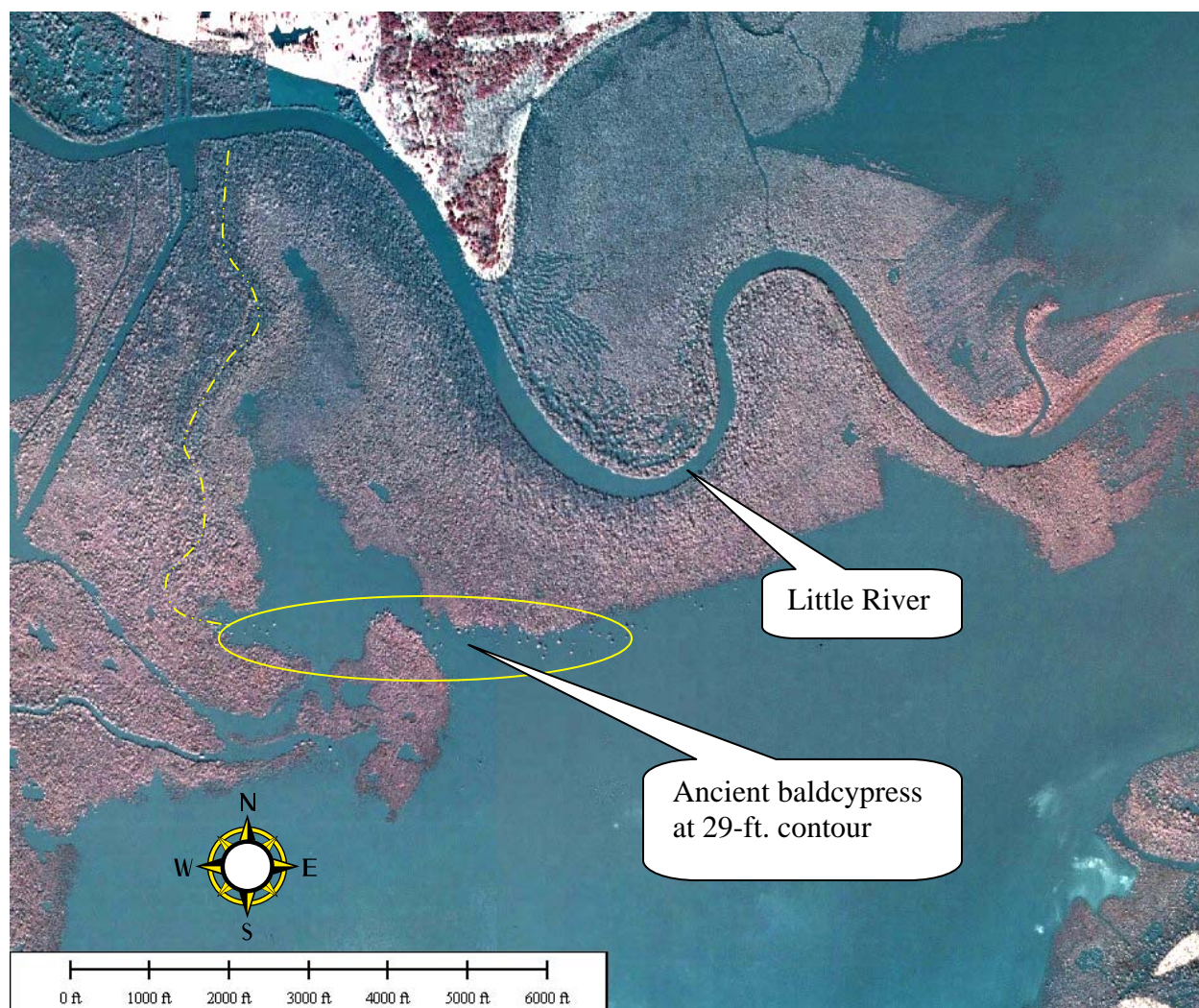


Figure 28. Region of very old baldcypress at the approximate 29-ft. contour and a former remnant channel of Little River. Tree corings collected and analyzed by the writer indicate that these trees may be at least 2,000 years old (Base map, USGS, 2004).

Figure 29 shows several of the ancient baldcypress which lie at about the 29-foot contour encircled in the ellipse in Figure 28. On the date of this photograph, the water is at a seasonal high (period of annual inundation as described by Darby, 1817). The water level is 16 feet above the bases of these trees. The diameters of these large trees are approximately 8 feet at a point 20 feet above their bases. Note the swollen butts, which top out at about 6 feet above the level of the water at approximate elevation 51. According to Brown (1943), the tops of swollen

buttresses indicate levels of extended high water. These trees have experienced extended high water at the 51-foot elevation for durations sufficient to cause buttress swelling.



Figure 29. Ancient baldcypress that lie along the route of a former stream, now buried. Two additional ancient baldcypress are visible in the background. These trees are hollow, and their ages can only be estimated. Tree corings curve indicate that these trees may be 2,000 years old.

According to Russell (1942), Catahoula Lake has not experienced significant change over the last several centuries:

No great change in outlines has happened during the last several centuries, but minor changes have occurred, chiefly at the mouths of inflowing streams where deltas have encroached various distances into the waters of the lake.



Figure 30 is an overlay of a mosaic of the 1809-1842 GLO township maps over a Landsat TM image (Louisiana State University, 2009), which supports Russell's statement (1942).

Several instances of GLO gross error and fraud will be examined later.

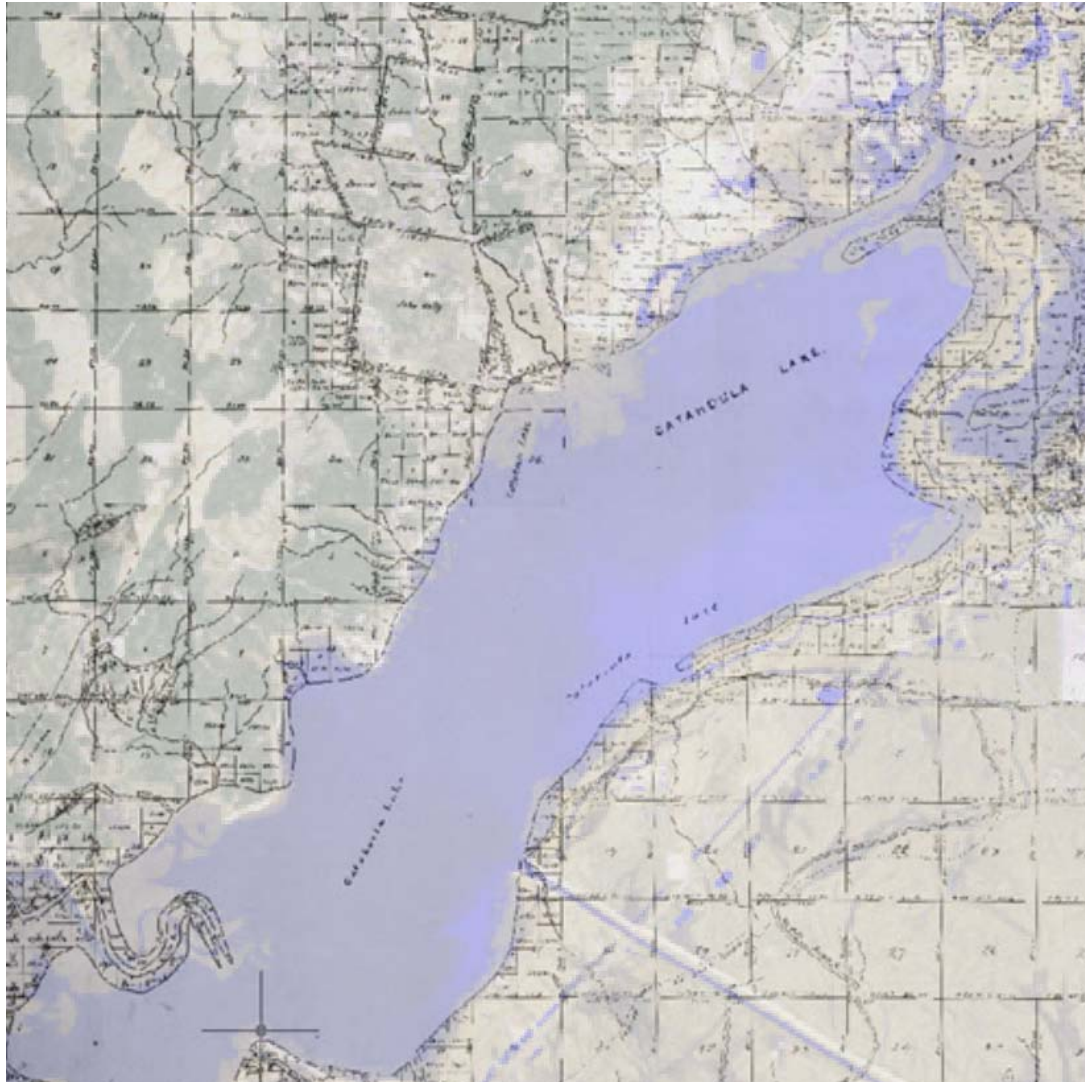


Figure 30. An overlay of the 1809-1842 GLO township plats over the Landsat TM 2004 image



## CHAPTER 5

### HISTORICAL ACCOUNTS OF CATAHOULA LAKE AND THE REGION

Catahoula Lake and its distributaries were explored in 1804-1805 by William Dunbar and George Hunter (American Philosophical Society, 1963) and by William Darby during his Louisiana exploration between 1808 and 1816 (Darby, 1817). Their diaries describe the region and are useful in evaluating the physical setting near the time of statehood.

#### *William Dunbar and George Hunter (1804-1805)*

Dunbar and Hunter were commissioned by President Thomas Jefferson in 1804 to explore the Ouachita and Black Rivers (American Philosophical Society, 1963). Dunbar described Catahoula Lake:

...The latter is a creek twelve leagues long, which is the issue of a lake of the same name eight leagues in length and about two leagues in breadth. It lies west of the mouth of the Ocatahoula, and communicates with the Red River during the great annual inundation. At the west or northwest angle of the lake, a creek called Little River enters, which preserves a channel of running water at all seasons, meandering along the bed of the lake; but in all other parts, it superficies, during the dry season from July to November, and often later, is completely drained, and becomes covered with the most luxuriant herbage; the bed of the lake then becomes the residence of immense herds of deer, or turkies [sic] geese, crane, etc., which feed on the grass and grain.

Dunbar's reference to the communication of Catahoula with Red River during the "annual inundation" indicates that the large flat region in the Saline area complex was inundated annually. According to 2009 LiDAR digital terrain models, the majority of that region is very flat and averages approximately 45 feet in elevation (American Philosophical Society, 1963).

Cades Hebrard, a fascinating Canadian settler, resided at the mouth of Little River at Black River, and lived on "a most unusual site" on top of a huge Indian mound. According to Hunter (1804), Hebrard operated a ferry, owned a 200-acre farm protected by a dike, and claimed to have "no bad neighbors." According to Hunter's diary, their party arrived at the mouth of Little River on October 23, 1804. An excerpt from Hunter's journal reveals an anachronism (American Philosophical Society, 1963):

We landed at Monsr. Cades here, where he keeps a ferry boat to carry over  
travellers [sic] to and from Natchez to Fort Miro. Here we staid [sic] till evening  
to get the necessary information to enable us to pursue our rout [sic], which we  
took down in writing as follows...

According to Hunter, the party set out at daylight the next day continuing up the Ouachita River. The question obviously arises as to how the explorers could have travelled a round trip of 24 leagues (24 hours of walking) from Hebrard's farm to Catahoula Lake and back. Dunbar's sketch of the route and the lake (Figure 31) shows the river connecting with the lake on the end instead of on the side (American Philosophical Society, 1963). This evidence indicates that Dunbar's description of Catahoula Lake might have been obtained from Cades Hebrard and that his party did not visit Catahoula Lake.

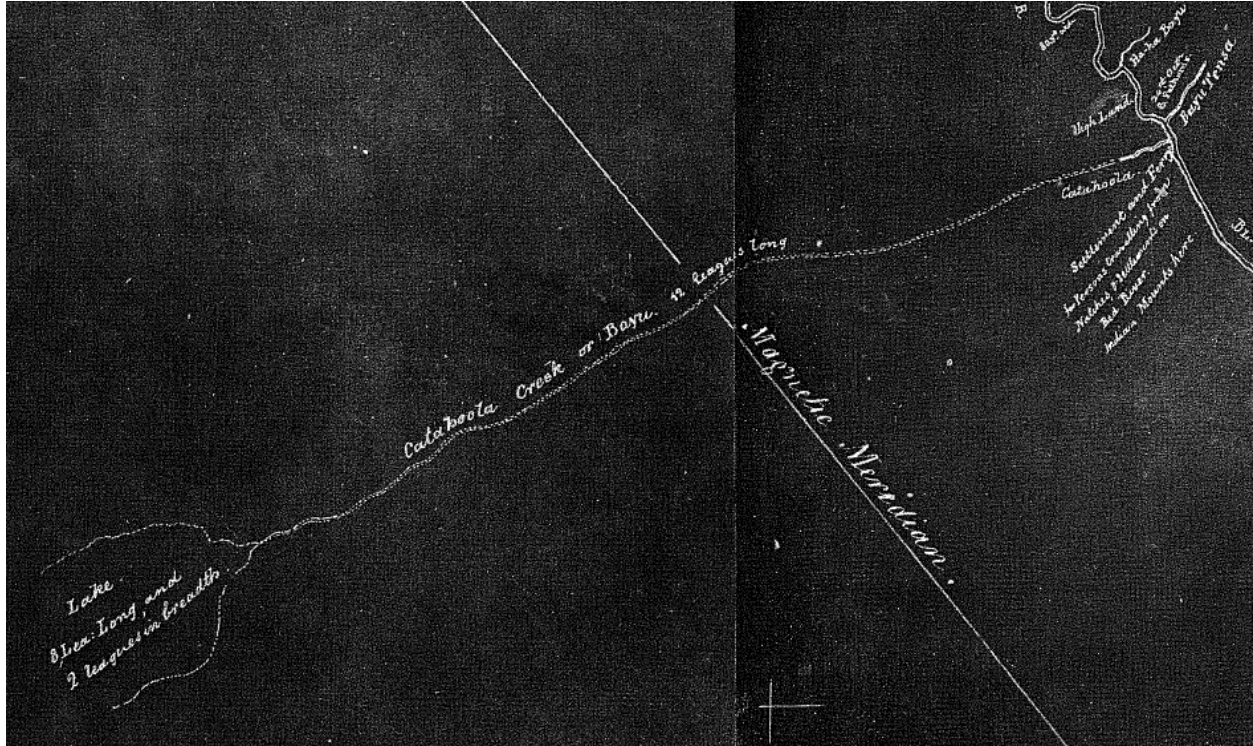


Figure 31. Dunbar's sketch (1804) of Catahoula Lake and Catahoula Creek (Little River). The 12-league distance along Catahoula Creek is shown (American Philosophical Society, 1963).

Dunbar and Hunter recorded the river depth at the mouth of the Ouachita as ranging between 5 and 6 fathoms (30 to 36 feet) in the area upstream and downstream of the mouth of Little River.

In 1806, Dunbar described the Mississippi and upper end of the Atchafalaya (Figures 32 and 33). His letter to President Jefferson (1806) describes the water levels and the upper end of the Atchafalaya. He describes the Atchafalaya as "*a small outlet.*" His description of the Atchafalaya as being "open" related to the large open space that provided necessary aerial spatial clearance to perform astronomic observations, and was not related to river water obstructions.

C1806, May 6

Washer 6<sup>th</sup> May 1806

Dear Sir

I have had the honor of receiving your letter of the 28<sup>th</sup> March accompanied by the printed account of discoveries on the Missouri & which I have read with particular satisfaction.

M<sup>r</sup> Freeman with his party left this place the 28<sup>th</sup> April for the Red River, very commodiously fitted out with Lieut<sup>t</sup> Humphrey as geographical assistant, he is a young officer of considerable talents: Lieut<sup>t</sup> Gaines having at last declined going, it was fortunate that we met with M<sup>r</sup> Humphrey who bears an excellent character in every respect; M<sup>r</sup> Freeman and he seem already particularly attached. we are in hopes that both he & M<sup>r</sup> Custis will be able to take celestial altitudes so as to form a complete set of observers with M<sup>r</sup> Freeman.

In consequence of the permission given by your orders & instructions to the Conductor of the Party, I have taken the liberty of adding a few hints derived from my own experience, which may be useful to the Gentlemen.

M<sup>r</sup> Briggs' measurement across between the Mississippi and Washita makes a very material change in the relative position of the two rivers, this appears to be 50 miles. His observations for the Longitude [he informs me] will remove M<sup>r</sup> Elliotts Mississippi farther East, but he has not completed his Calculations.

27786

Figure 32. Dunbar's Letter to President Thomas Jefferson, Page 1 of 2 (American Philosophical Society, 1963).

Dunbar W<sup>m</sup> Natchez May 6. 06. rec June 10

The Mississippi is so remarkably low this season as not to flow into the bayous or outlets which are generally brim-full at this time, the Michoudoula which is always open is probably the only small outlet which carries any water from the Mississippi; altho this is not unfavorable for operations by Chain & Compass except it does not admit of that facility of transport favorable to my views in ascertaining the position of points of the alluvial Country by astronomical observation; I cannot therefore take advantage of your indulgence for this season; next year may prove more favorable & may not probably be too late.

M<sup>r</sup>. Briggs is much gratified by the communication which I made him.

I have the honor to be with perfect respect and attachment

Your most Obedient Servant

William Dunbar

Figure 33. Dunbar's letter to President Thomas Jefferson, Page 2 (American Philosophical Society, 1963).

*William Darby (1808-1816)*

William Darby's *A Geographic Description of the State of Louisiana and the Southern Part of the State of Mississippi and Territory of Alabama* (Darby, 1817) provides a description of the geography of the region. Darby traveled approximately 20,000 miles, "mostly on foot" throughout the State of Louisiana. An excerpt from Darby's Map showing the Catahoula area is shown in Figure 34. Darby described Catahoula Lake and compared it to lakes along Red River (Figure 35):

Fourteen miles below the Boeuf, the Ouachitta loses its name by its union with the rivers Tensaw and Ocatahoola (Catahoula). This singular small river, Ocatahoola, is a very striking example to show how near the surface of Louisiana approaches that of the superficies of a real sphere. The map will exhibit the places where this river has its source, but no delineation upon a plane can convey correct ideas of the peculiar traits of its geography. The lake through which this river flows, is alternately a wide expanse of water ten or fifteen feet deep, and extensive grassy plain, the river winding through its center, and receiving several fine creeks from the north, which in the season of inundation empty themselves into the mass of water at the margin of the woods (p.188).

The nature of those lakes (Red River lakes) is singular; from their appellation we would be led to believe them the constant repository of water, though in reality they are merely reservoirs emptied and filled annually by the hand of nature. In the autumnal months, after the waters have been drained by the depression of the river, the beds of most of the lakes become dry, and exhibit a meadow of succulent herbage with channels for the waters that continue meandering through

them. In most of these channels, there is a flux and reflux, according as the water in the river and lake preponderates in height. The Spanish Lake and the Natchitoches lakes are examples of this. When the Red River commences its annual rise, the waters run with a strong current into the lake, which gradually filling, returns the water into the river with equal velocity when the depression of the river by summer heats, begins to take place. This flux and reflux is continual; the channels that form the communication between the lakes and river are never dry (p. 195)....The Ocatahoula, Saline, and Black River lakes, partake of the nature of those along Red River, and the region between Black River and the pine forests, is similar to that between the Ouachitta and the Mississippi (p. 250).



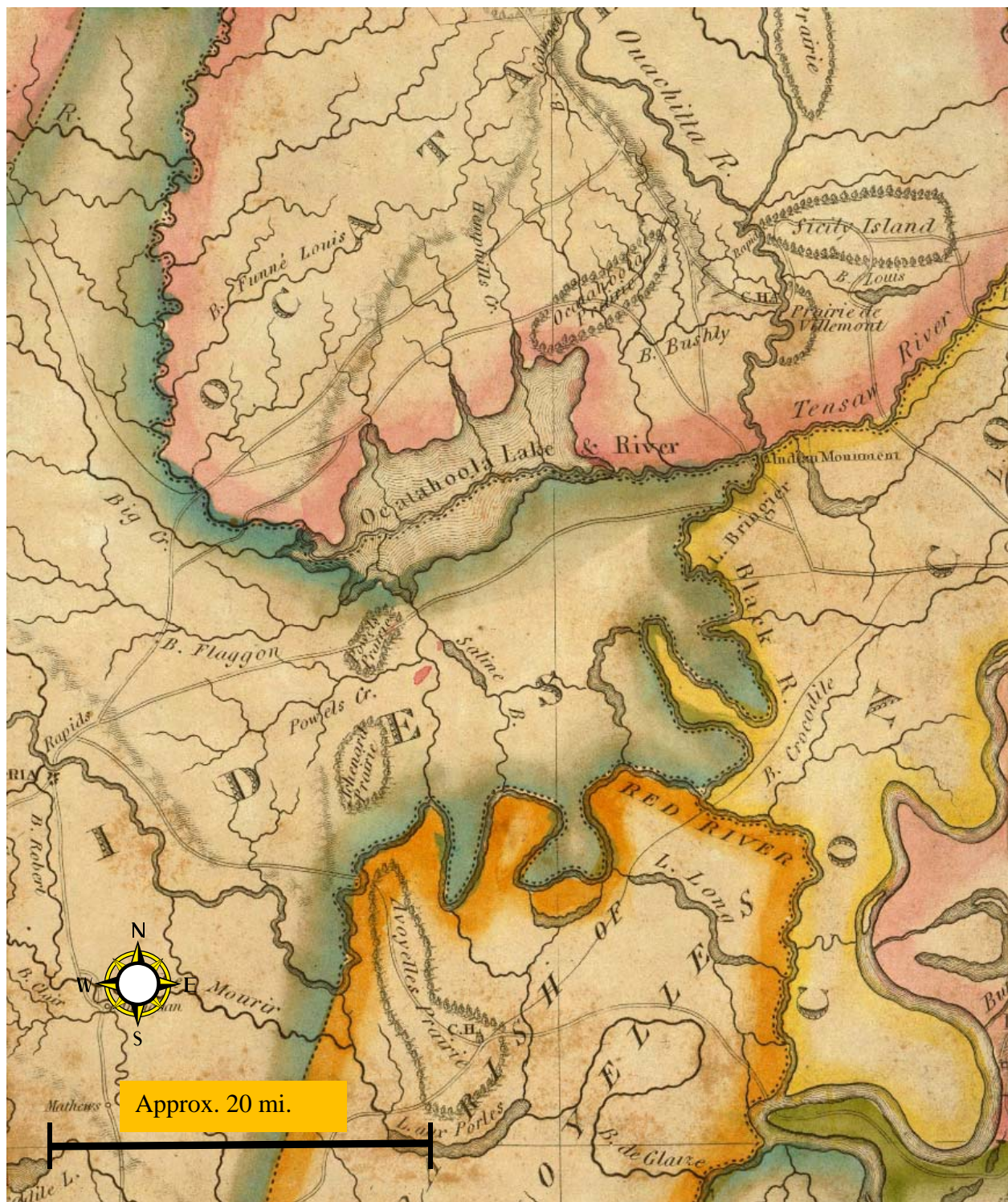


Figure 34. Darby's Map (Darby, 1817) of the region from Catahoula Lake to the Mississippi River. The scale is approximate.





...we would be led to conclude the land upon which the cane is found, subject to continual or partial submersion. Repeated observation has, however, proved that the cane is never the product of land subject to repeated inundation from the Mississippi floods. The margin of cane marks, with unerring precision, the line that separates the overflowed lands from those that have by repeated efforts of nature wrested from the partial dominion of water (p. 129).

...South of Red River, and east of the hills to the Atchafalaya River, the low grounds present an intermixture of bayous and lakes, whose banks are covered with cane and palmetto brakes, and their surface is above the annual overflow (p. 252).

Darby described the regional hydrology and general physiography:

Great damage has been done to this range by the floods of 1811, 1812, and 1813, particularly by the latter. How far extensive embankments would protect the plantations from the water, remains yet undetermined; but more difficulty will ever exist here than below Atchafalaya, in guarding against water, on the account of the proximity of the great receptacle of outlet, which, when surcharged, decreases the inclination of the plane from the Mississippi, and has a tendency to produce reflow towards that river. This reflux is more dangerous, and infinitely more difficult to prevent, than the inundation from the river itself. The Red River, when high, which generally happens at the same time with the Mississippi, checks the discharge from Black River and contributes in no small degree to throw back the mingling of waters of Ouachitta and Tensaw, upon Concordia. In all floods

since 1800, this part of Louisiana has been more injured than any other near the banks of the Mississippi (pp. 189-190).

The banks of the Black River are very fertile; but the arable margins narrow, and subject to occasional submersion. This river is about 200 yards wide, the current gentle, and with sufficient depth of water throughout the year for large boats.

Thirty miles below the mouth of Black River, the Red River joints the Mississippi (p. 190).

Darby described the Atchafalaya River and the raft that blocked it at its upper end:

From an attentive observation of the Atchafalaya during the autumn of 1808, 1809 and 1810, I am much inclined to give credence to the general supposition, that at some past time the waters of the Red River and Mississippi did not intermingle. The appearance of the banks of each river, the colour of the strata and their position, scarce leave a doubt that the Atchafalaya was at some remote period the continuation of the Red River.

The point of confluence of these two mighty streams is one of these singular geographical positions that cannot be viewed without astonishment. To behold the alluvial banks, and the willow and cotton tree forests so familiar on the Mississippi, nothing peculiar would strike the eye on a cursory survey of this spot....

...the peninsula formed by the Mississippi (Turnbull Island) opposite the entrance of Red River, is generally above overflow, but a small comparative quantity of water, even at the highest freshes crosses this point.

The Atchafalaya, from its efflux, has some land along its left bank, above overflow, which reaches about eight miles, where the bank becomes subject to partial inundation. The right bank, from a very short distance below the efflux to the mouth of the Bayou de Glaize, is liable to annual and deep submersion...

A general error has prevailed that the raft or body of timber that chokes this river (Atchafalaya), impedes the issue of water from the Mississippi. A moment's examination of the map will serve to remove this impression. The distance from the Mississippi to the head of the raft is twenty-seven miles, and the current of the Atchafalaya extremely rapid. By the inclination of the plane along which the Atchafalaya runs, and the irresistible impetus given to the stream by the peculiar assemblage of waters at its efflux, the river suffers no diminution by the raft; but the bank for some distance above, and contiguous to this enormous mass of timber, is rendered much more liable to inundation...

...It is now about thirty-nine years since the raft first stopped in the river, and has been increasing ever since. The author of this sketch, who measured the banks of the river along the whole length of the raft, and some distance above and below, and had the opportunity of examining its contents three successive years, can vouch for the following facts...

...The distance between the extremities of the raft is upwards of twenty miles, but the whole extent not being filled up by timber, the aggregate of ten miles was assumed as near the truth. The width of the river varies, but the medium breadth is about 220 yards (pp. 126-134).

Darby's findings will be used later in reference to the development of the boundary of the lake.

## CHAPTER 6

### HYDROLOGY

#### *Historical Changes*

The regional hydrology has been extensively altered by man. Darby's Map (1817) provides a remarkably accurate representation of the geography prior to disturbance by man (Figure 36). The man-made hydrological changes are inscribed upon Darby's Map (Darby, 1817) and are discussed below. The composite quantitative effects on Catahoula Lake are developed in a subsequent section.

#### *Mississippi River cutoff*

In 1831, Captain Shreve excavated a small channel which cut off approximately 15 miles of the Mississippi River (Figure 37). The channel quickly became the main channel of the Mississippi (James, 1873). The shorter course lowered the hydraulic gradient of the Mississippi River and had the effect of lowering the water surface profile to Catahoula Lake. Assuming a linear gradient and an approximate OHW stage of 36 feet, the shortening of the approximate 360-mile course to the Gulf of Mexico yields a gradient of 0.1 feet per mile. Since Red River intersected the old 15 mile-long Mississippi channel about midway, it is reasonable to estimate that Shreve's cut lowered the gradient at the mouth of the Red by about 0.075 feet, which, in turn, translated the hydraulic grade lines of Red River, Black River, Little River, and Catahoula Lake downward. Gage data circa 1831 is not adequate to determine the net effect upon Catahoula Lake.



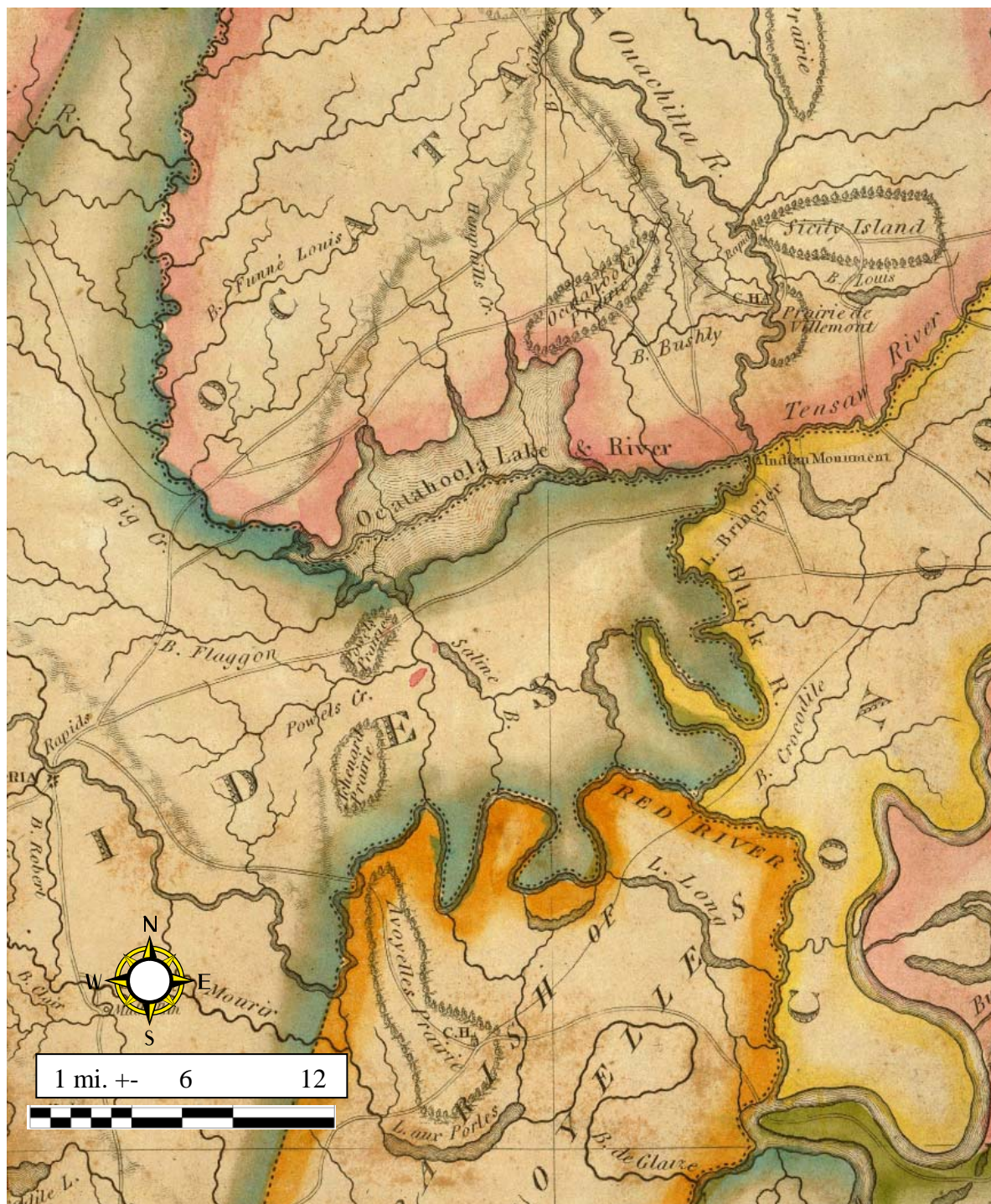


Figure 36. Darby's Map (Darby, 1817) of the region from Catahoula Lake to the Mississippi River. The scale is approximate.



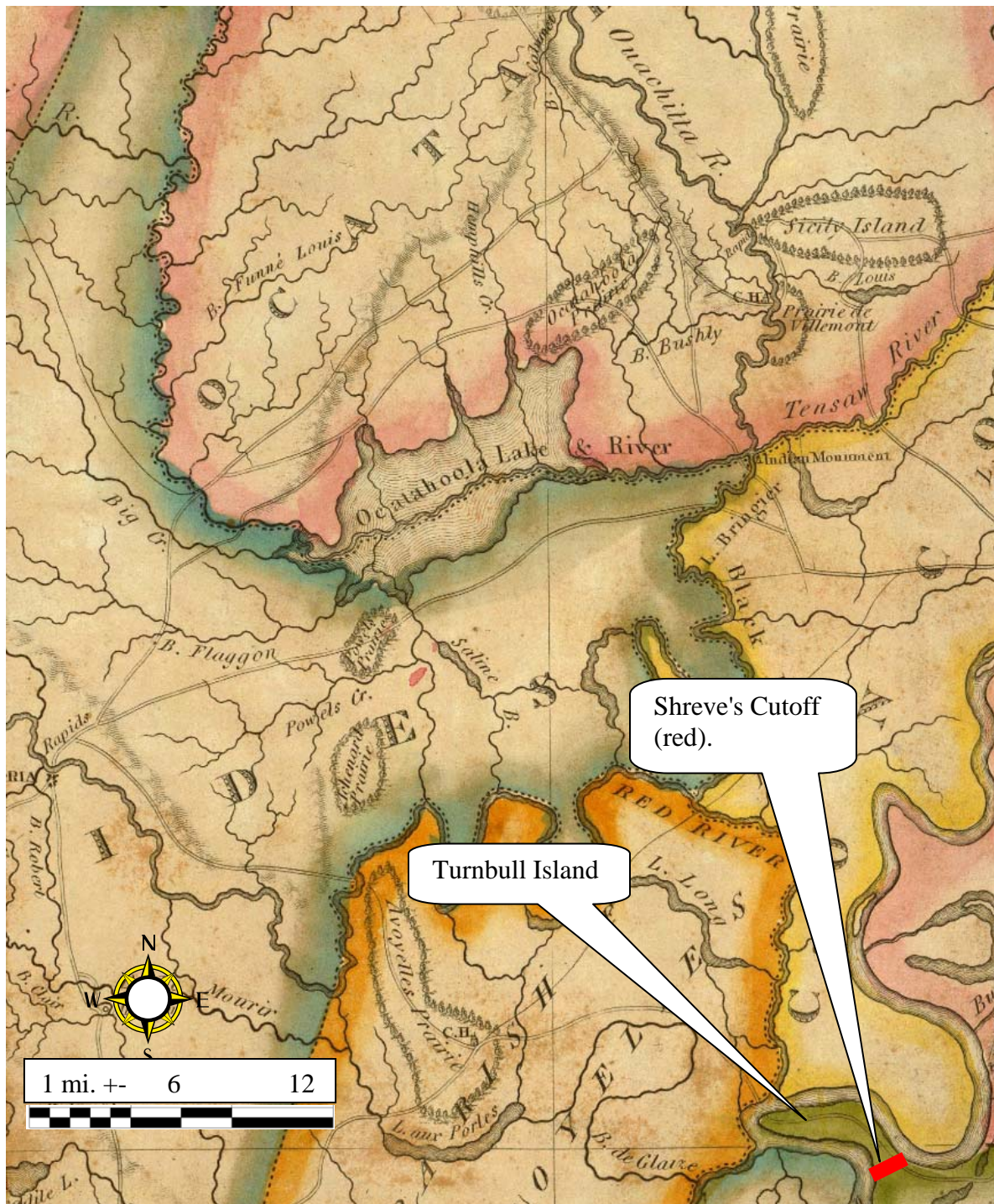


Figure 37. Shreve's Cutoff shortened the Mississippi River by approximately 15 miles, formed Turnbull Island, and lowered the hydraulic gradient (Darby, 1817).

### *Atchafalaya River raft and the old river structure*

At the turn of the nineteenth century, the Atchafalaya was blocked by a raft having a length of approximately 20 miles (Darby, 1817). Nineteenth century observers noted severe accumulations of the raft starting in about 1775 (Reuss, 2004). Gauld's hydrographic survey in the spring of 1774 (Figure 38) shows that the depth of the Atchafalaya at its upper end at the Mississippi River was only 2 fathoms (12 feet) deep. Darby (1817) reported that the raft was approximately 675 feet wide. A two-year federal project to remove the raft began in 1858 (Reuss, 2004). Before the raft was completely cleared, the Atchafalaya had established itself as the major distributary of the Mississippi River (Reuss, 2004). After the raft was removed, flooding increased downstream because of the increased flow (Reuss, 2004). Today, the width has more than doubled to about 1,500 feet (DOQQ, 2004) and the depth as measured on January 11, 2009 has increased from its 12-foot depth in 1774 to a depth of approximately 100 feet at a location 400 feet downstream from the north end. The Atchafalaya River course to the Gulf of Mexico is approximately 140 miles, and the course of the Mississippi River to the gulf is approximately 360 miles (LSU GIS, 2009). The removal of the log jam obstruction allowed the steeper gradient of the Atchafalaya to produce a higher velocity and resulted in increased capacity for sediment transport and incision.

The Atchafalaya began to capture more Mississippi River water soon after the raft was cleared. In 1880, the Atchafalaya assimilated approximately 3% of the latitudinal flows of the Mississippi (Mississippi River Commission, 1951). Two sill dams were constructed near Simmesport in 1884 to reduce the velocity of the Atchafalaya, but they were unsuccessful, and washed out in 1920 (Reuss, 2004). The Mississippi River Commission (1951) estimated that approximately 24% of the latitudinal flows were captured by the Atchafalaya in 1950-51 (Figure 39). The report predicted that, by 1970, 40% of the latitudinal flows would be captured by the



Atchafalaya. The Old River Structure was constructed in 1963 to control the capture of the Mississippi by the Atchafalaya (Figures 40-42).

Since 1950, the Atchafalaya has incised approximately 10 feet (USACE, 2000), further reducing the regional hydraulic grade line, including that of Catahoula Lake (Figure 43).

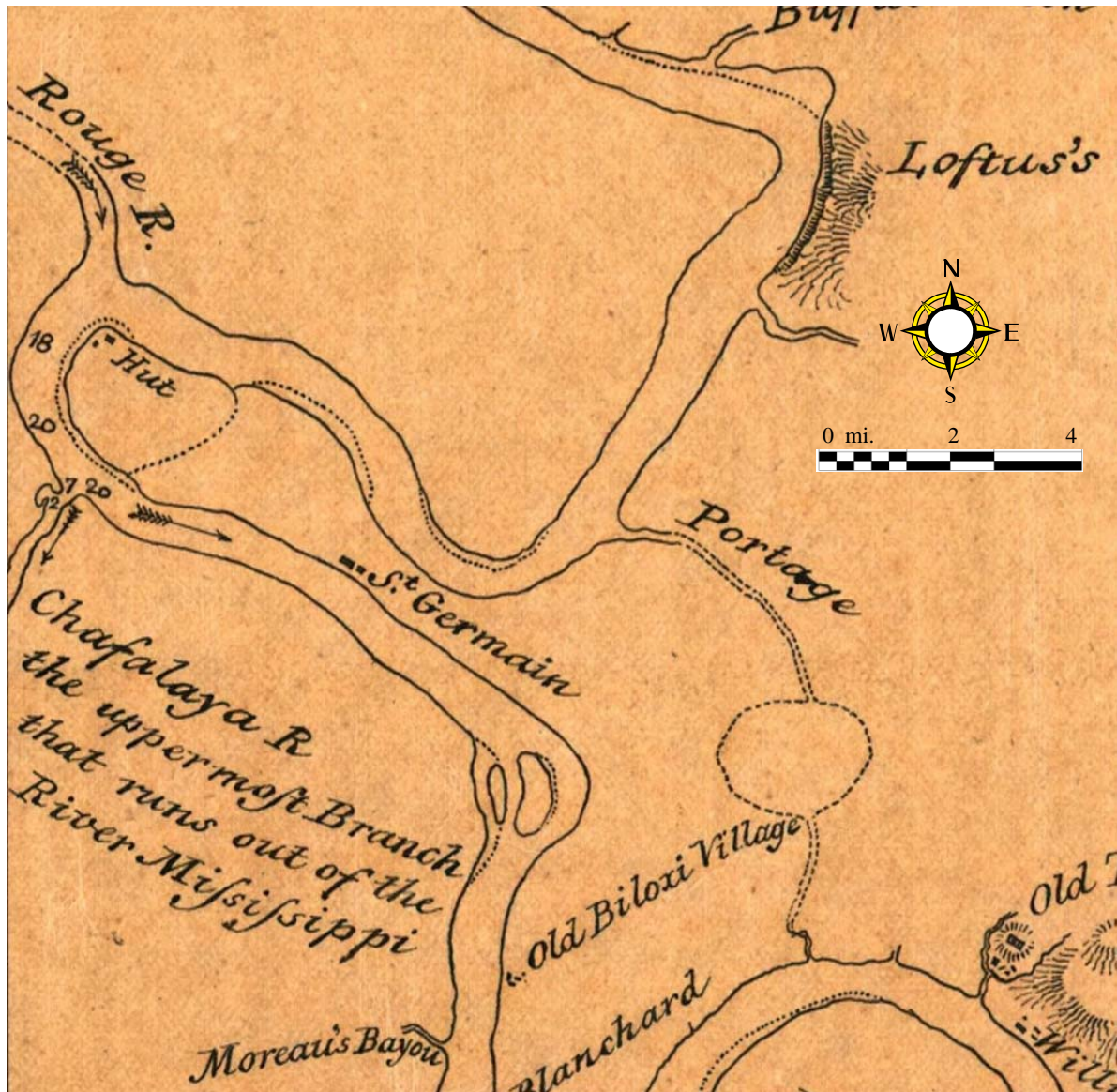


Figure 38. George Gauld's Map of 1778 (Gauld, 1778). Depths are in fathoms (1 fathom = 6 feet). The "peninsula" at the location of St. Germain and the hut are known today as Turnbull Island. Rouge River is Red River, and Chafalaya River is Atchafalaya River. Note the portage, which removed approximately 40 miles of travel on the Mississippi and would have been more useful for north-bound river traffic.

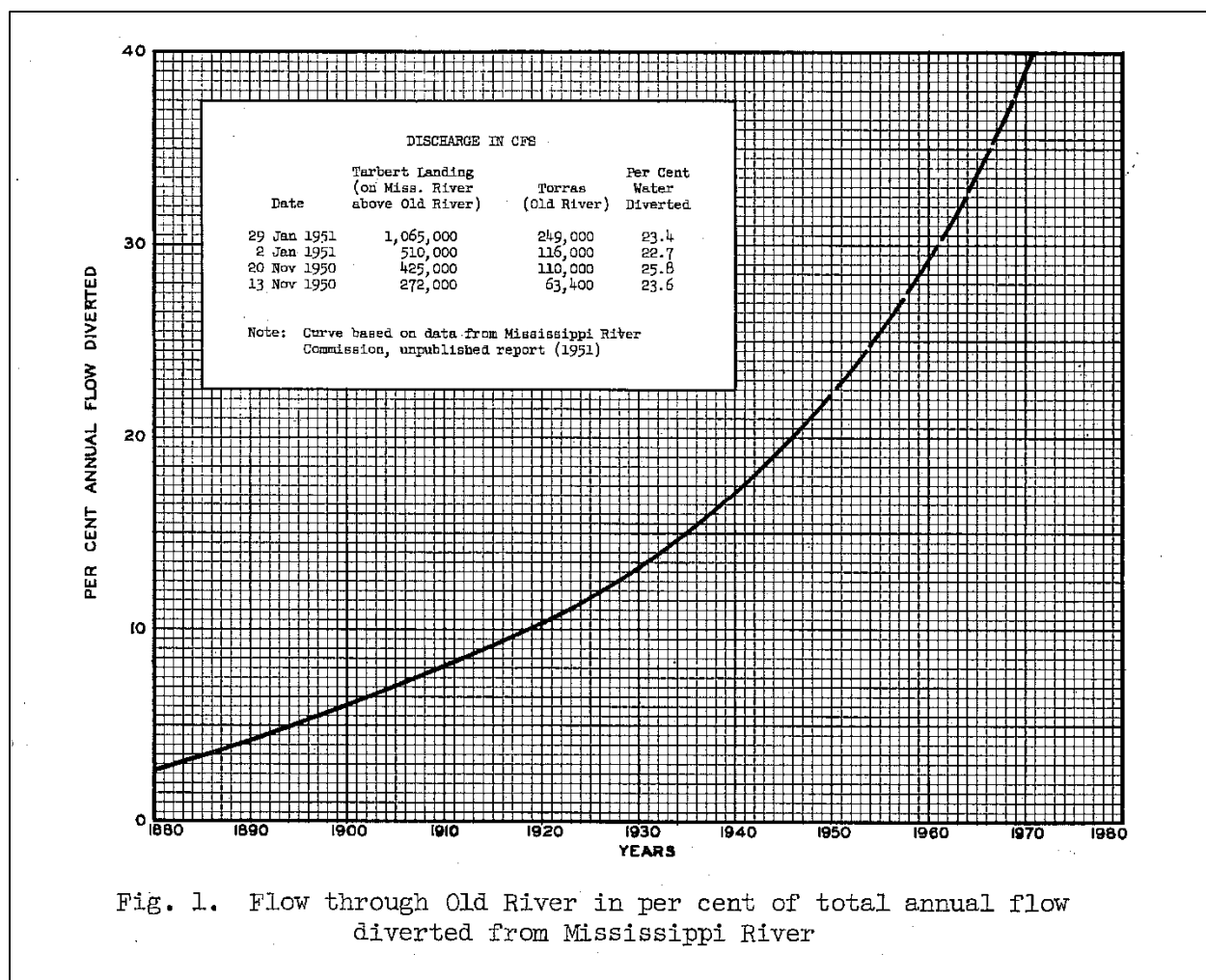


Figure 39. Percentage Annual Flow capture by Atchafalaya River (Mississippi River Commission, 1951).







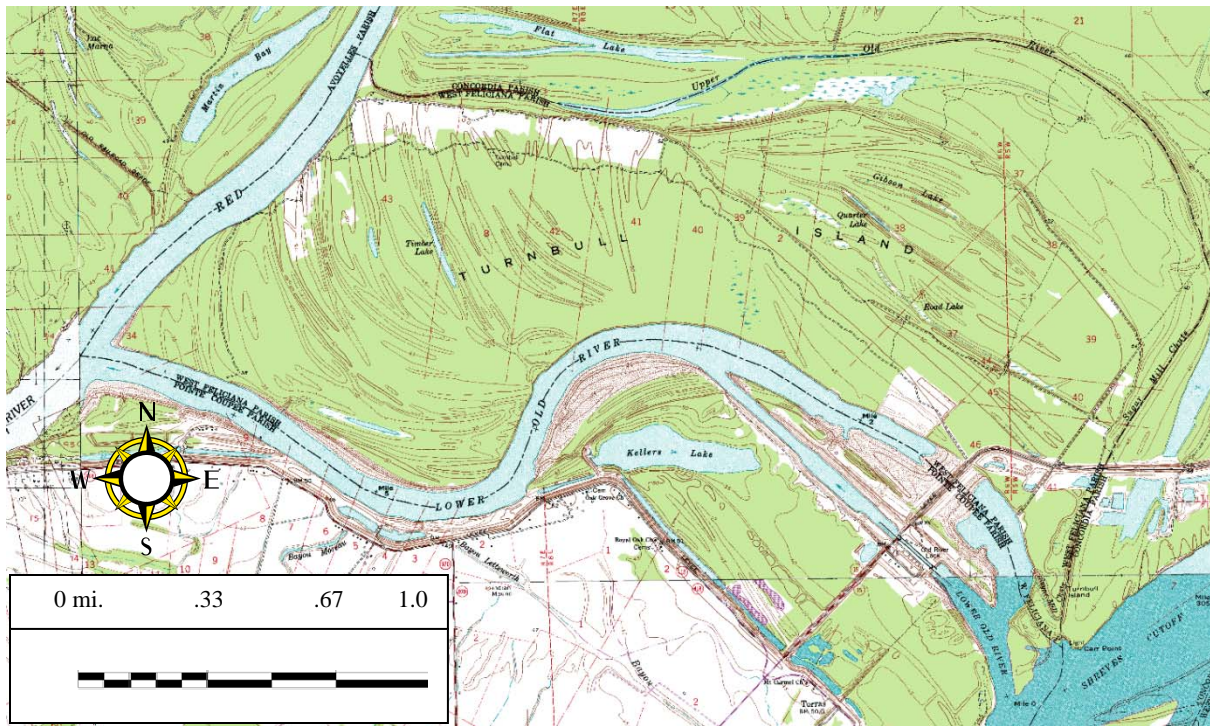


Figure 41. Original Old River Structure (USGS, 1984) (US Geological Survey, 1984).

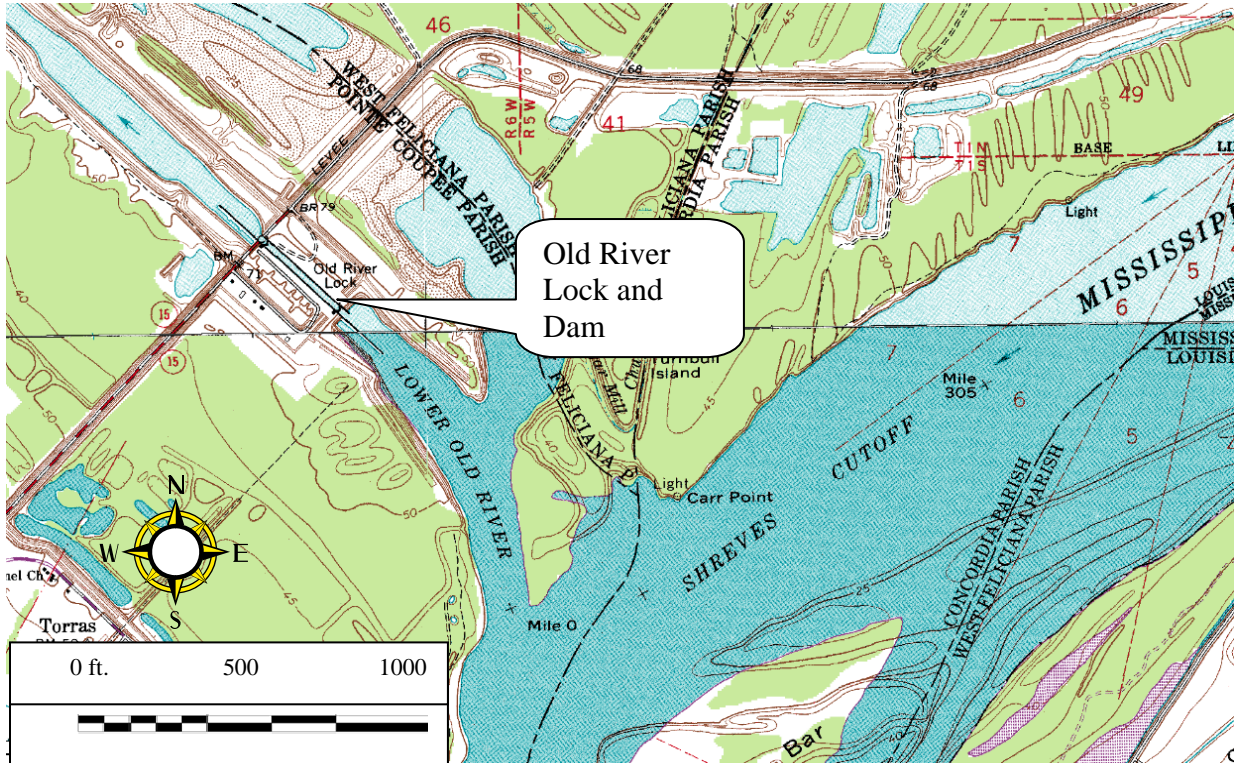


Figure 42. Enlargement of Old River Lock area (US Geological Survey, 1984).

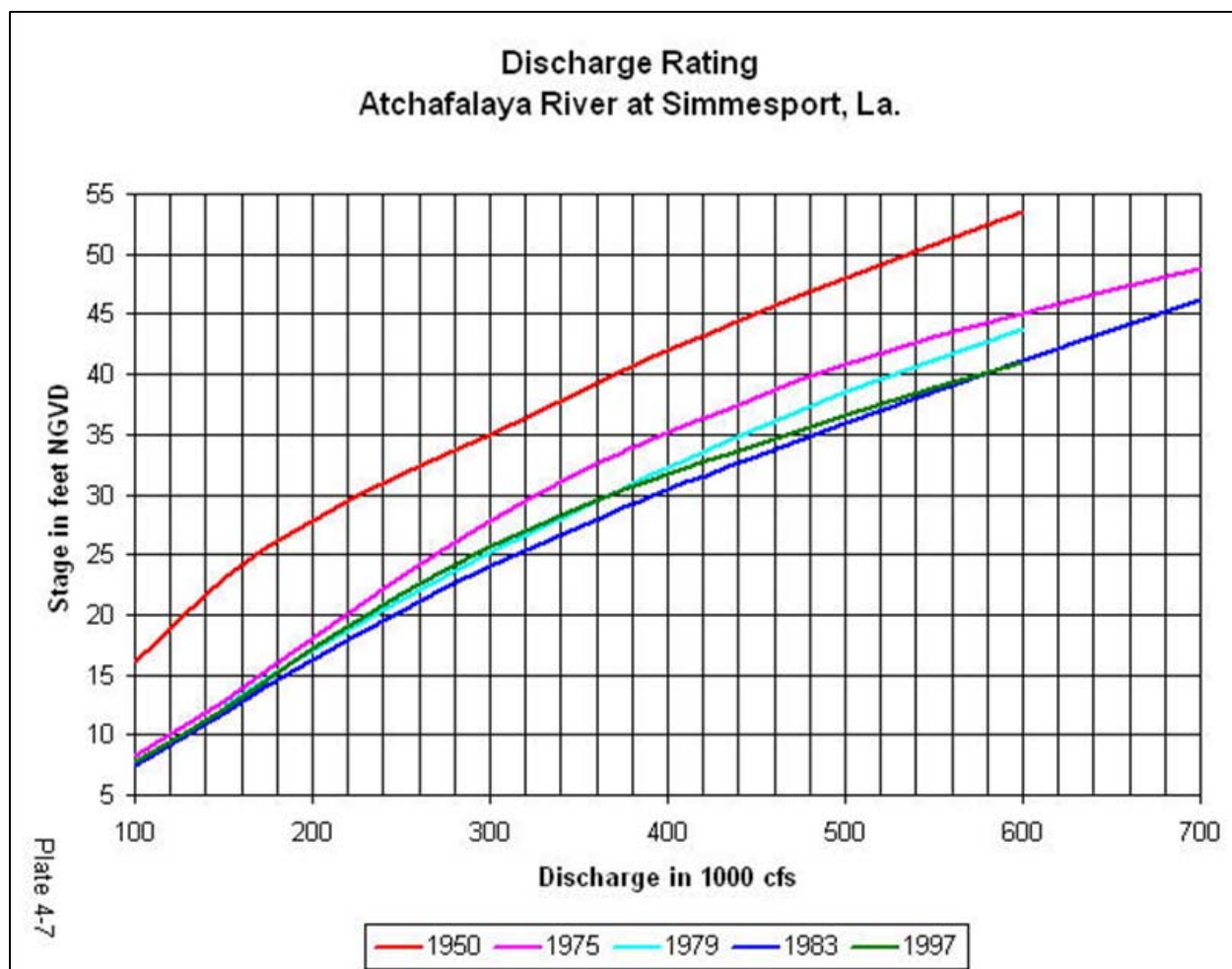


Figure 43. Discharge Rating Curves for Atchafalaya River at Simmesport, (US Army Corps of Engineers, 2000).

The original Old River Structure was completed in 1963. The structure consists of a lock and dam system that prevents the Mississippi from capturing the Atchafalaya. The restriction of flow into the Old River system results in Old River/Atchafalaya stages being lower than Mississippi River stages. The gage data between March 24, 1987 and November 24, 2007 (Figure 44) demonstrates the typical differential. Figure 45 is a plot of exceedance curves for the same time period. If the Mississippi River Commission 1951 report (Figure 39) correctly represents the Atchafalaya assimilating only 3% of the latitudinal flows in 1880, it is reasonable to conclude that Mississippi River water levels (now Old River) at the mouth of the Red would



have been an average of approximately 13 feet higher had the Atchafalaya raft not been removed and had the Old River Structure not been constructed (Figure 46). Assuming no significant aggradation or incision of the Mississippi between 1812 and present, the water levels at the mouth of the Red River would have averaged approximately 13 feet higher in 1812 and would have had the effect of increasing the exceedance curves for Catahoula Lake.

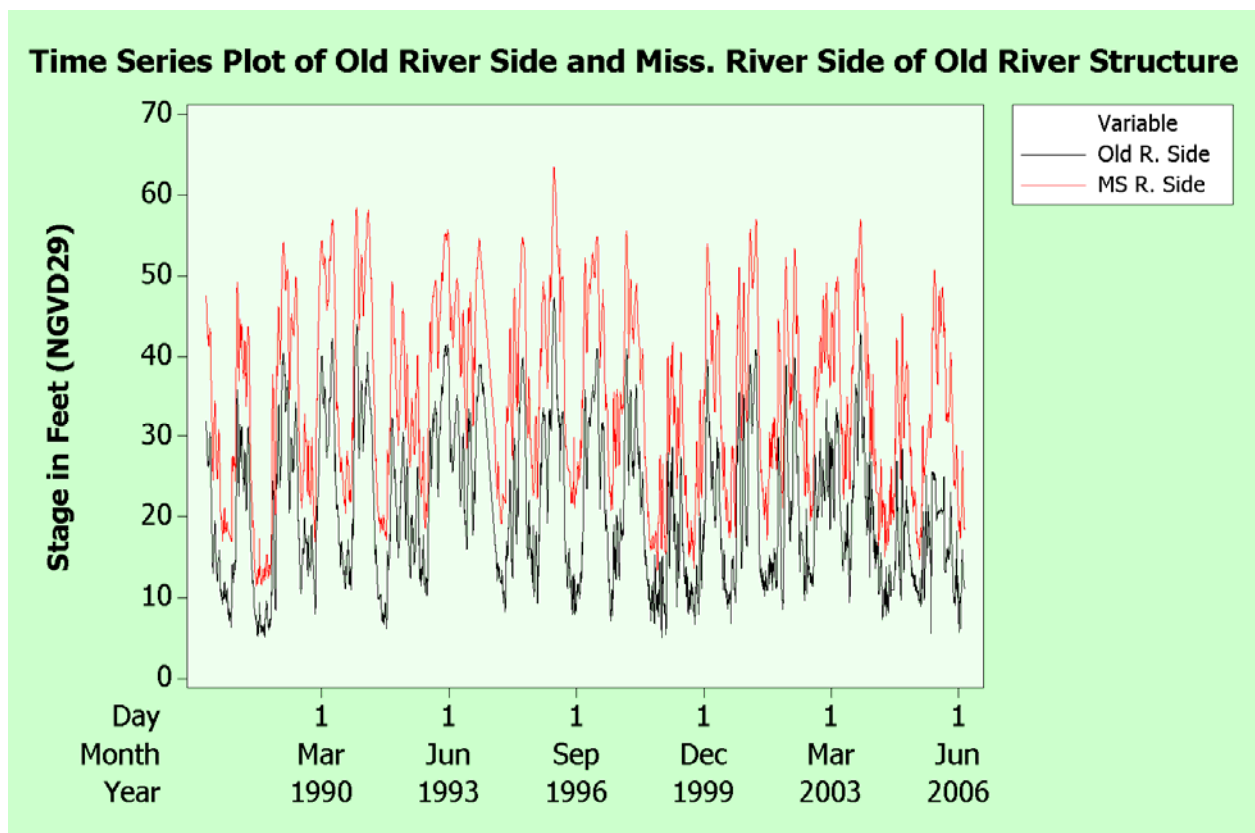


Figure 44. Comparison of Mississippi River water levels on the Mississippi River side of the Old River Structure with Old River water levels for the same time period from March 1987 through November 2007. All readings were taken at noon (US Army Corps of Engineers, 2009).

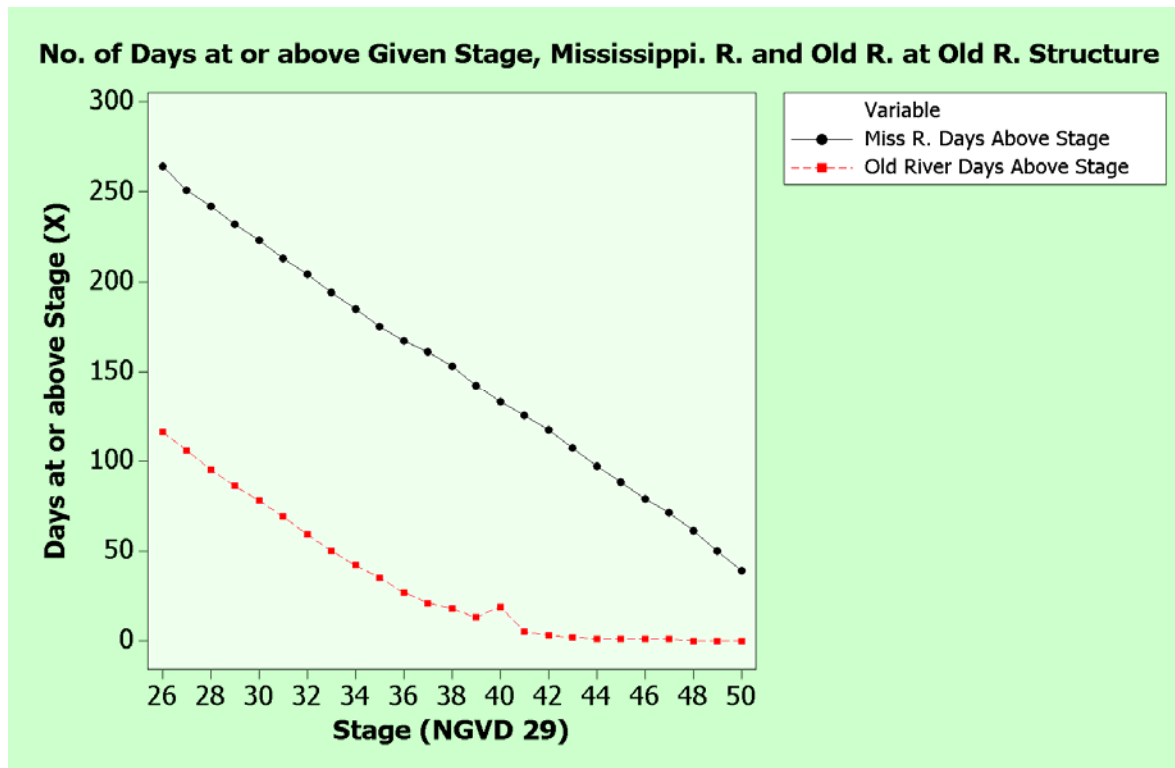


Figure 45. Number of days the Mississippi River and Old River met or exceeded various stages in 2007. The Old River Structure, as intended, has clearly reduced the Old River exceedances of levels (US Army Corps of Engineers, 2009)

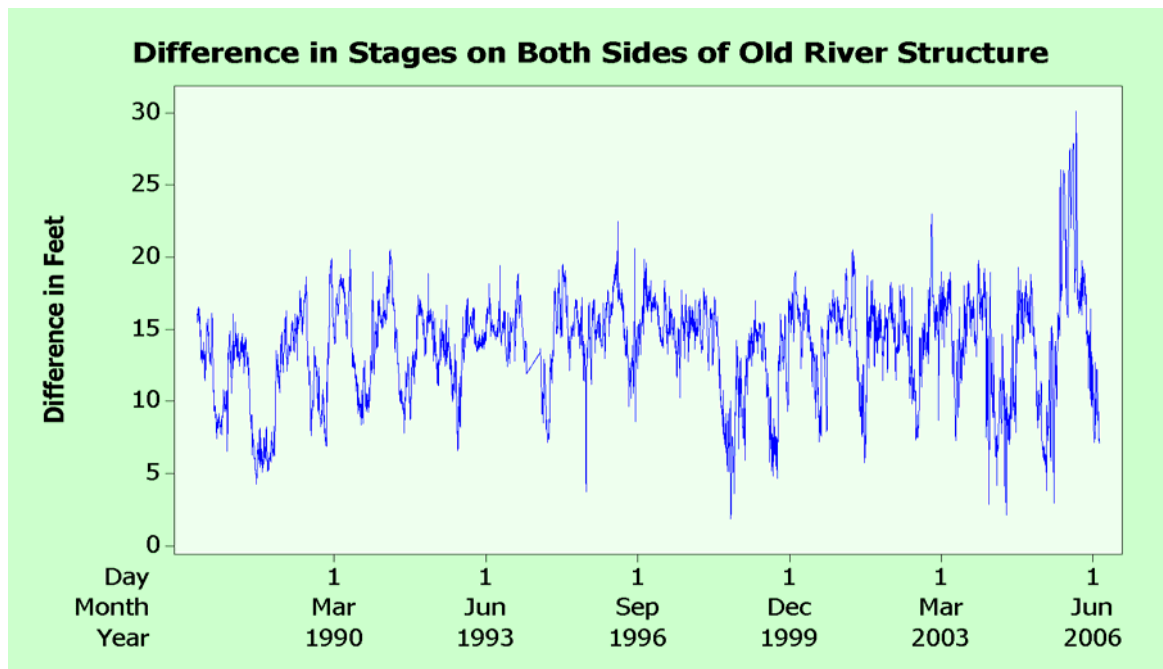


Figure 46. A plot of the differences in gages between the Mississippi River and Old River at the Old River Structure showing that the Old River side of the structure is lower than the Mississippi River side of the structure. The mean of the differences is 13.74 feet with a standard deviation of 3.52 (US Army Corps of Engineers, 2009).

## *Ouachita-Black River navigation project*

Starting in 1926, the USACE constructed six locks and dams on the upper Ouachita River. The Jonesville lock (Figure 47) was placed in operation first (USACE, 2006).

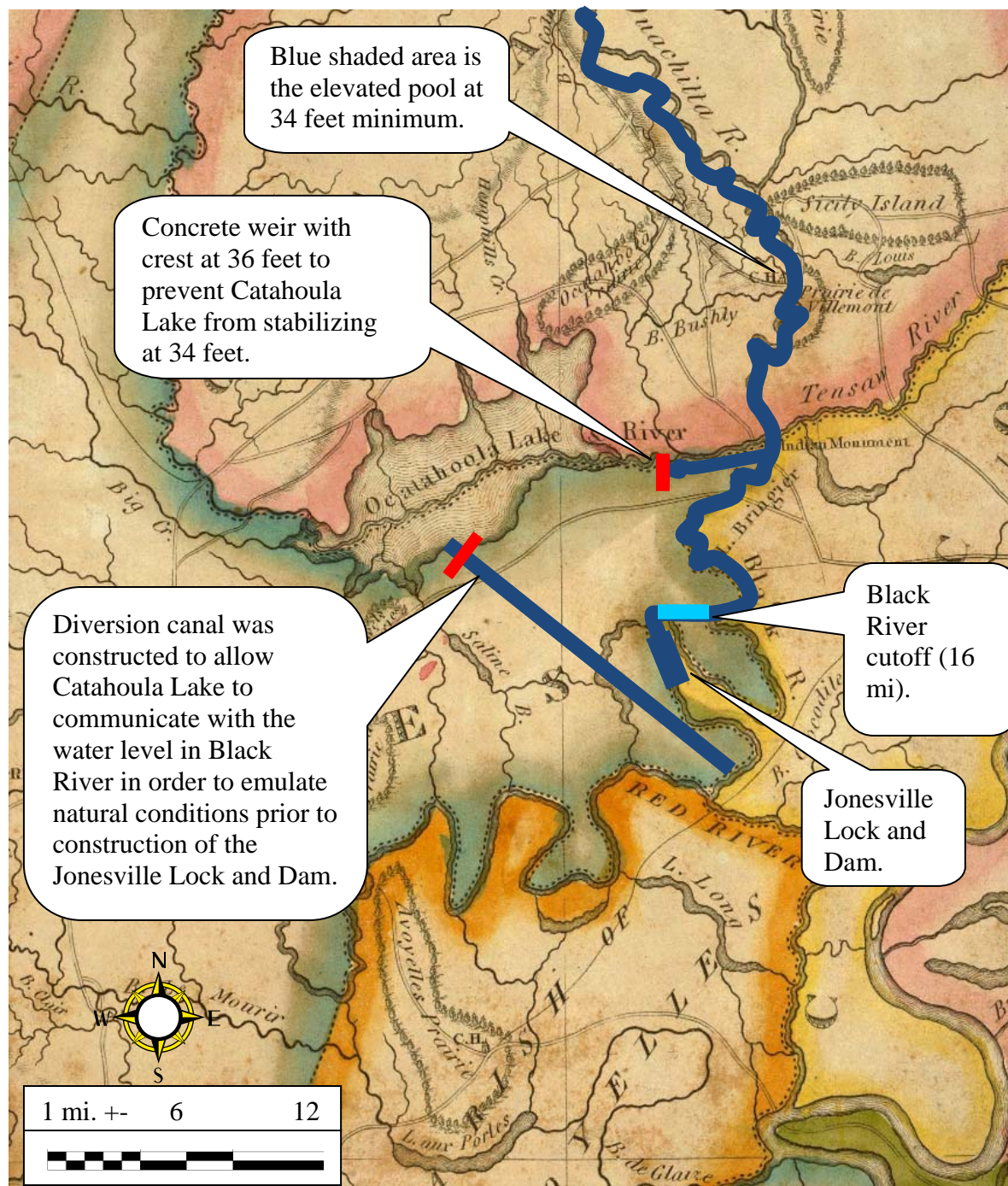


Figure 47. Effect of the Black River Navigation Project (Base map, Darby, 1817).



The Jonesville lock lies below the mouth of Little River. The lock system shaved peak flows from the Black River. To prevent the higher water levels in Catahoula Lake from rising and stabilizing at the new 34-foot pool stage of Black River above the lock, a diversion canal and flow control structure were constructed below the lock between Catahoula Lake and Black River. A weir with a crown at 36 feet was installed on Little River at Archie to prevent the Black above the lock from flowing into Catahoula Lake via Little River when the pool stage of the Black above the lock was at the 34-foot pool stage. When Black River exceeds 34 feet on the upstream side of the Jonesville Lock, the Jonesville Lock gates are opened as verified by the gages on both sides of the lock (Figures 48 and 49).

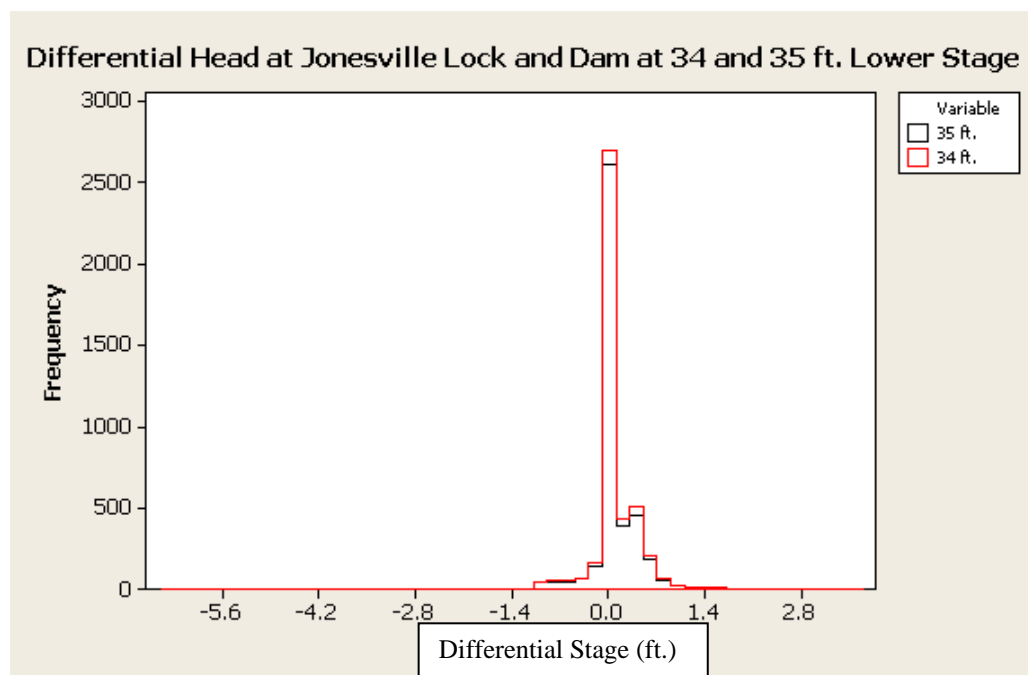


Figure 48. Differential stage across Jonesville Lock and Dam at 34 and 35 feet NGVD Stages from January 1, 1973 through March 9, 2009, (US Army Corps of Engineers, 2009).

**Descriptive Statistics: 34 ft., 35 ft.**

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
34 ft.	4370	8765	0.05927	0.00578	0.38206	-6.50000	0.000000000
35 ft.	4094	9040	0.05269	0.00589	0.37683	-6.50000	0.000000000

Variable	Median	Q3	Maximum
34 ft.	0.000000000	0.10000	3.67000
35 ft.	0.000000000	0.10000	3.67000

Figure 49. Descriptive Statistics of the Differential Head across the Jonesville Lock and Dam for 34 and 35 feet NGVD Stages (US Army Corps of Engineers, 2009).

The mean of the differential head (upper versus lower) at the lock at 34 feet is only 0.06 feet, with a standard deviation of only 0.38 feet. In terms of Catahoula Lake hydrology, the lake is insignificantly affected by the lock when the stages exceed 34 feet. Stage data demonstrates that, as the water levels get higher, the differential head diminishes (USACE, [www.rivergages.com](http://www.rivergages.com)). The minimal head loss may be relevant if the OHW of Catahoula Lake proves to be at or above the 34-foot stage and leads to the conclusion that the OHW is not significantly affected by the Jonesville Lock and Dam.

#### *Artificial levee system*

The construction of artificial levees along the rivers began with French patents in the eighteenth century. French patents required that each patentee construct a levee to protect his lands (Reuss, 2004). It was not until 1882 that the levee system had a substantial effect on regional drainage (Russell, 1942). The levees confined water and required outlets to prevent floods of downstream areas of the Atchafalaya. LiDAR elevation data (LSU, 2009) overlaid on DOQQ images (USGS, 2004) reveals that the levees lie generally above the 45-foot contour along the Black, Red, Atchafalaya, and the Mississippi River in the study region. This level is above the OHW of Catahoula Lake. The confining of the river waters above 45 feet increases water levels in the river when the water exceeds 45 feet. However, the levee system also blocks

tributary bayous and prevents their flow into the rivers, thereby functioning to lower the stages in area rivers. The net effect of the levee system on the OHW of Catahoula Lake will be addressed as part of the composite quantitative hydrology since the river stages represent conditions with the levees in place.

*Estimates of the Quantitative Effect on Catahoula Lake Stages Caused by the Old River Structure and the Incising of the Atchafalaya River*

The most significant hydrologic changes in the regime are the Old River Structure and the incising of the Atchafalaya River (Figures 42-49). Since these changes are relatively recent and since gage data on the Black River at Jonesville, at Old River Structure, and the Atchafalaya are available, an estimate of the effect on the Catahoula Lake hydrograph can be made. Since the differential heads at stages above 34 feet on Black River at the locks are relatively small (Figures 48 and 49), the data at stages higher than 34 feet produces realistic correlations between the Black River gage at Jonesville and the discharge rating curve in the Atchafalaya at Simmesport and the hydrograph at the Old River Structure (the point where Red River once emptied into the Mississippi River). The most direct method for determining the effect of these changes is simply to evaluate the exceedance curves and hydrograph for Black River at Jonesville between 1928 and present. Figure 50 shows the trend in stages above 34 feet between January 1, 1929 and January 1, 1996. Figure 51 presents exceedance curves for Black River at Jonesville stages from 1929 through 1995 for 35 to 50 feet.

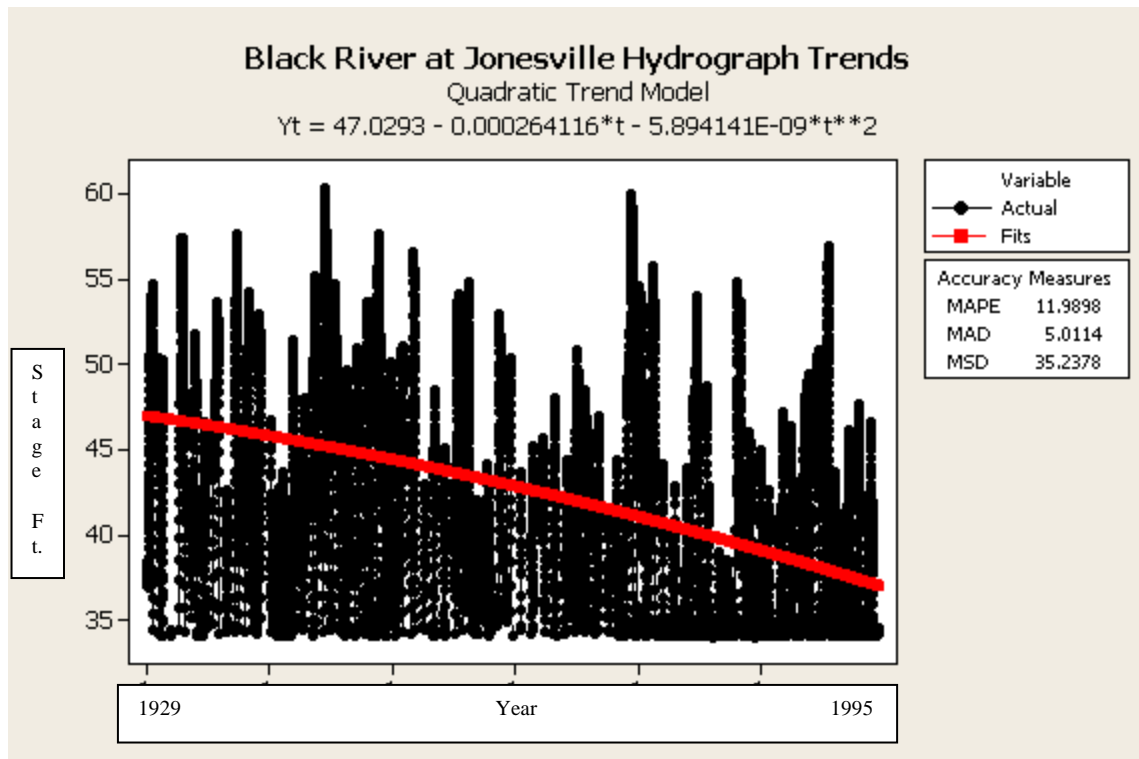


Figure 50. Stages above elevation 34 for Black River at Jonesville between January 1, 1928 and January 1, 1996. The red trend line is the trend of the mean (US Army Corps of Engineers, 2009).

The definition of OHW promoted by the *Manual of Instructions for the Survey of the Public Lands of the United States* (BLM, 1973) indicates that the duration of the water at a given stage is important. For example, an annual high water at a certain stage for only one day per year would not kill most trees and would not be sufficient to be classified as OHW. An evaluation of the exceedance curve (Figure 51) from the standpoint of comparative exceedances provides a comparison with the intent of the *Manual of Instructions*. As an example, in 1995, Black River exceeded the 40-foot elevation stage on 89 days (Table 1). This would have allowed the lake to inundate (and make its hydraulic imprint upon nature) for 89 days for all land below the 40-foot contour. However, in 1929, the lake would have inundated (and made its imprint upon nature) for 89 days all land below the 46 foot contour, which

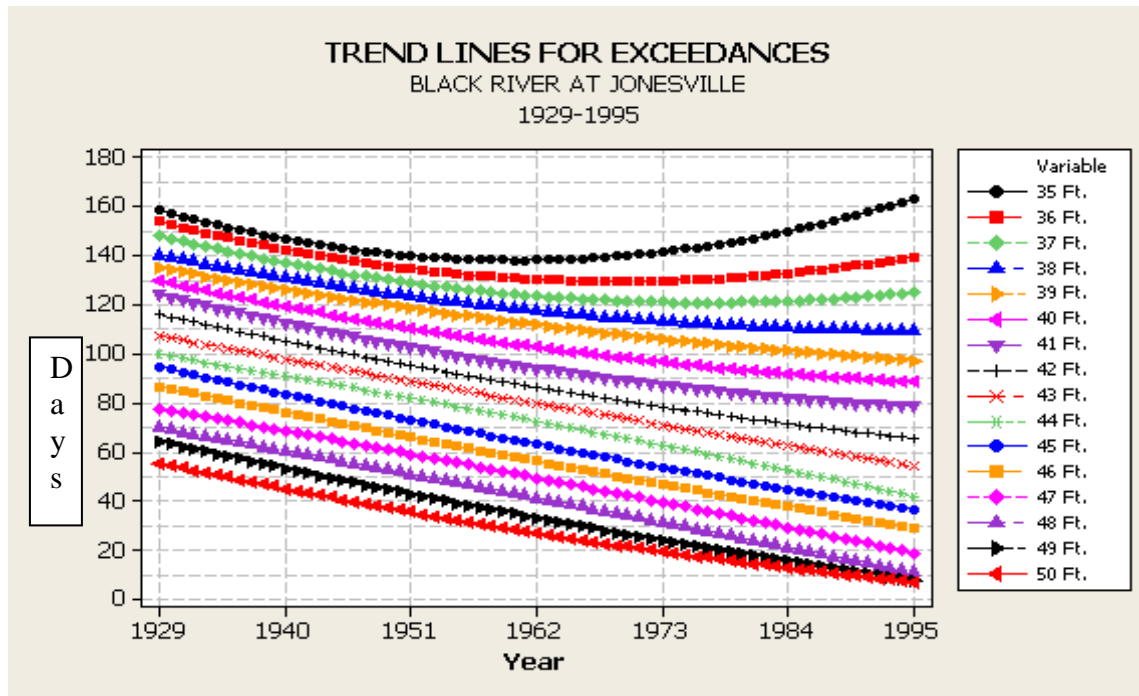


Figure 51. Trend lines for exceedances show a drop in exceedance rates between 1929 and 1996 (Gage Data, US Army Corps of Engineers, 2009).

is 6 feet higher. Both stage and duration are important in determining the level of OHW. The comparison of exceedances demonstrates that the Black River at Jonesville is making an imprint upon nature at an elevation lower than it was in 1929 and that recession has been continuous for all stages above 38 feet. A discontinuity with lower levels that would be expected by the Old River Structure is not visible in the data; in fact, the stages at lower levels show a reversed, upward stage trend. It is reasonable to conclude that the incising of the Atchafalaya River stages which began after the Atchafalaya River Raft was cleared (Reuss, 2004) and which continued through 1980 (Figure 43) has effectively translated downward the hydrologic regime of the Black River at Jonesville. It is noteworthy that the apparent absence of an effect by the Old River Structure supports Fisk (1938) and others, who warned that the Old River Structure was needed to prevent the Atchafalaya from capturing the Mississippi.



**Table 1. Equivalent Exceedances for Black River Stages, 1929-1995 (USACE, 1929-1995).**

Stage Elevation (NAVD 88)	Exceedance in 1995	Elevation of Equivalent in 1929	Differential Elevation (Drop in exceedance between 1929 and 1995)
37 ft.	125 days	41ft.	4 ft. lower
40 ft.	89 days	46 ft.	6 ft. lower
43 ft.	55 days	50 ft.	7 ft. lower

Exceedance values for Catahoula Lake, 1961-2008 are plotted in Figure 52. Exceedance values have dropped since 1961. Earlier gage data at Catahoula Lake are not available. The rise in exceedances between 1961 and 1977 may be explained by operational procedures for stages below 39 feet, but are beyond the scope of this research. Table 2 presents equivalent exceedances for Catahoula Lake between 1961 and 2008.

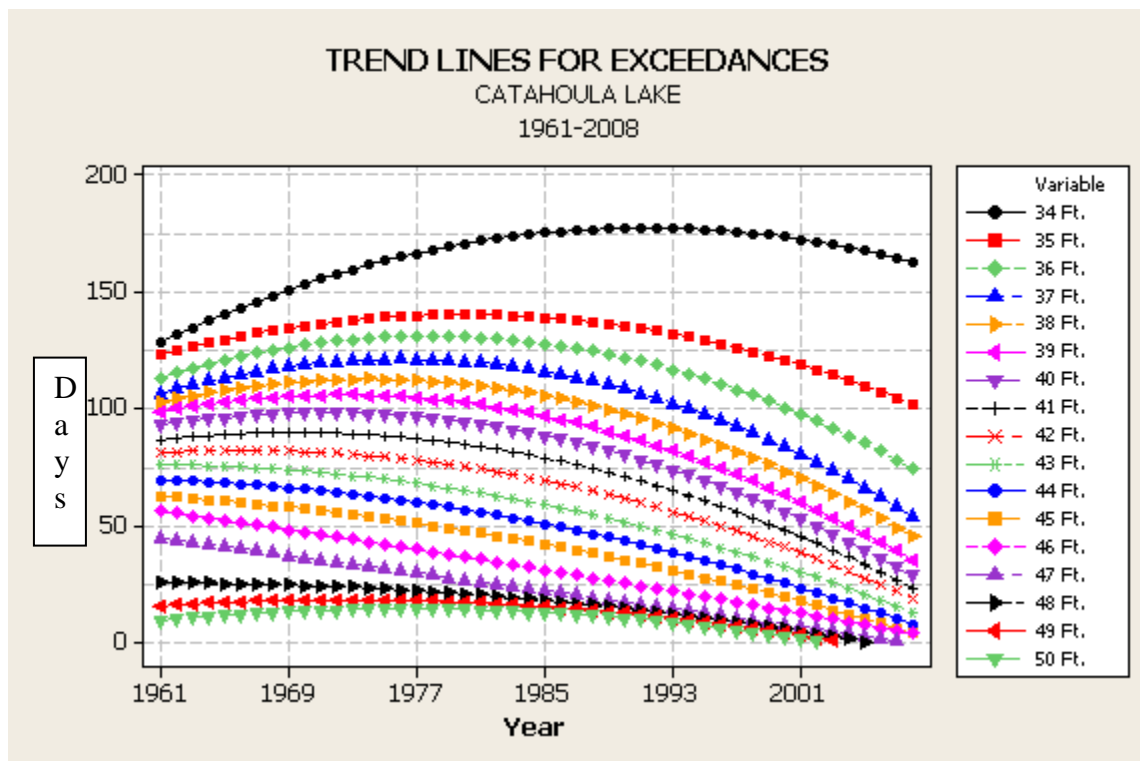


Figure 52. Trend lines for exceedances show a drop in exceedance rates between 1929 and 1996, MSL (Gage Data, US Army Corps of Engineers, 2009).

**Table 2. Equivalent Exceedances for Catahoula Lake Stages, 1961-2008 (USACE, 1961-2008).**

Stage Elevation (NAVD 88)	Exceedance in 2008	Elevation of Equivalent in 1961	Differential Elevation (Drop in exceedance between 1961 and 2009)
37 ft.	53 days	46ft.	9 ft. lower
40 ft.	27 days	48 ft.	8 ft. lower
43 ft.	18 days	50 ft.	7 ft. lower

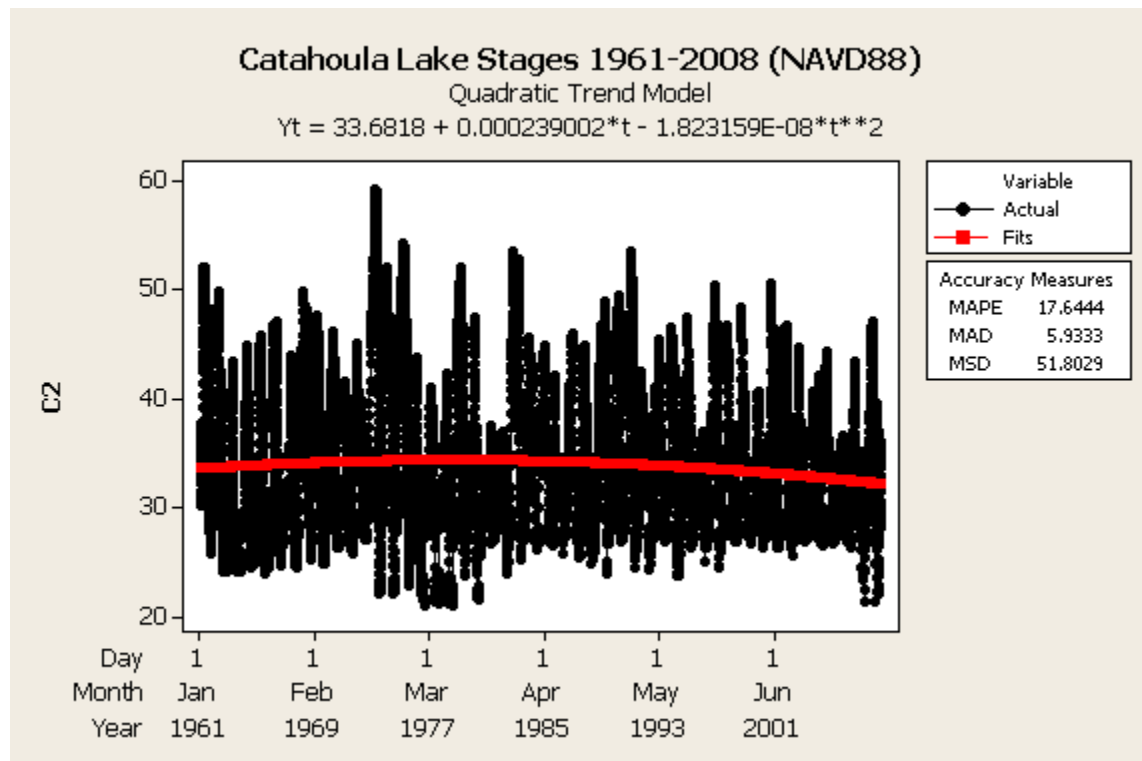


Figure 53. Catahoula Lake stages, 1961-2008 (Placid Oil Company and US Army Corps of Engineers, 2009).

Figure 54 demonstrates the correlation between Black River stages and Catahoula Lake stages between 1961 and 2008.

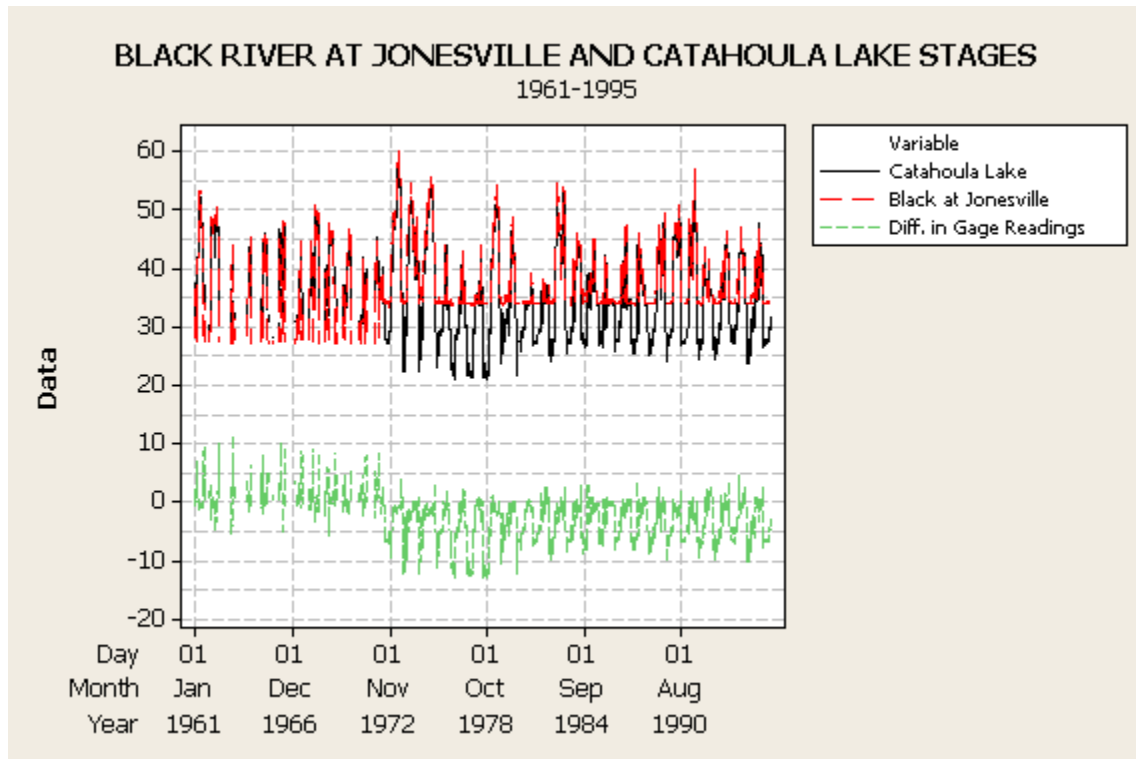


Figure 54. Black River and Catahoula Lake stages (MSL) .

A comparison with Figure 50 clearly reveals that Catahoula Lake has not been affected as much as Black River by the regional hydrologic regime change between 1961 and the present.

Peak annual stages in the Jonesville area and for Harrisonburg between 1828 and 1900 are presented in tabular form in Figure 55. The trend of the peaks is shown in Figure 56. Peak stage data between 1828 and 1995 for the Black River at Jonesville (Secretary of War, 1902; Placid, 1961-1973; USACE, 1995) reveal a downward trend in the peak stages of Black River. It is noteworthy that the data between 1828 and 1900 is not continuous and might be subject to bias by measurement only of extreme events. The purpose of the data is to demonstrate support

Peak Annual Stages of Black River from 1828-1900 in Jonesville Area									
	Black R. Station*	Jonesville*	Trinity*	Gillespie Place*	Avg.	Adjusted Avg. Harrisonburg	Harrisonburg*	Diff Meters	Overall Adusted for HGL slope
Km from Mouth	91	91.1	91.5	93.9			117.2		Average for
Miles from Mouth	56.6	56.7	56.9	58.4			72.9		Jonesville (NAVD 88)
Year									Cairo Datum (m) Ft.
1828						25.02	25.73		25.02 61.8
1850						24.05	24.76		24.05 58.6
1858						22.82	23.53		22.82 54.6
1865				24.67	24.67		25.26	0.59	24.67 60.7
1867			24.38	24.68	24.53		25.11	0.58	24.53 60.2
1871			23.53		23.53				23.53 56.9
1874			24.36		24.36				24.36 59.6
1882		25.3	25.34		25.32		26.2	0.88	25.32 62.8
1890	24.34	24.35			24.35		25.08	0.73	24.35 59.6
1892		24.11			24.11		24.83	0.72	24.11 58.8
1893	24.25	24.23	24.25		24.24		25.01	0.77	24.24 59.3
1894	21.63				21.63				21.63 50.7
1895	17.91				17.91				17.91 38.5
1896	19.86				19.86				19.86 44.9
1897	23.91				23.91				23.91 58.2
1898	20.53				20.53				20.53 47.1
1899	20.16				20.16				20.16 45.9
1900	20.41				20.41			0.71	20.41 46.7
* Cairo Datum in meters									

Figure 55. Peak annual stages of Black River from 1828-1900 in the Jonesville Area (The Secretary of War, 1902).

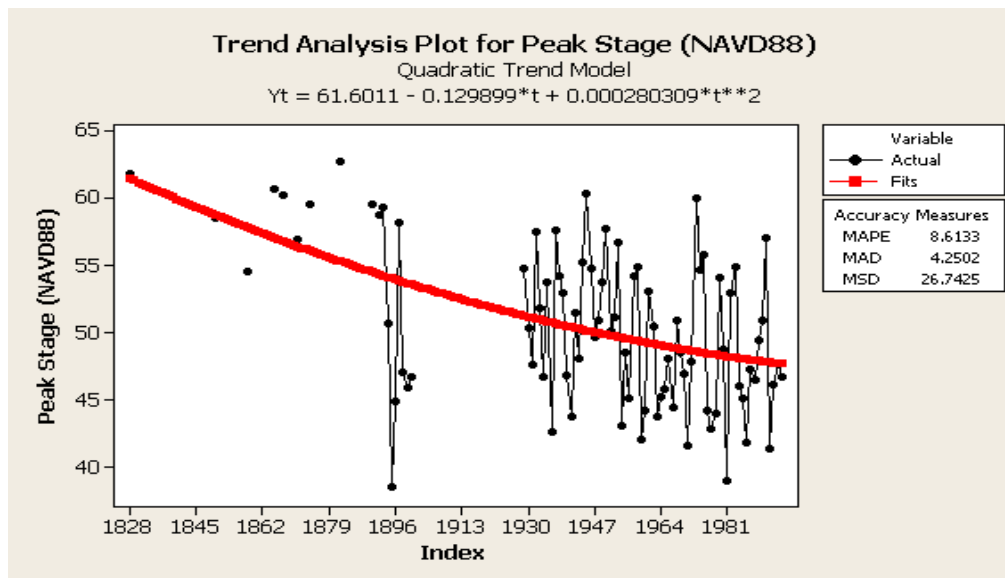


Figure 56. Trend of peak stages in Black River at Jonesville, 1828-1995.

Low Water Marks of Black River from 1873-1900 at Jonesville						
Date	Elevation*		Elevation			
			NAVD 88			
1873	8.7		8.3			
1895	8.22		6.7			
1896	8.03		6.1			
1897	7.76		5.2			
1898	10.32		13.6			
1899	8.06		6.2			
1900	9.34		10.4			
* Meters above Cairo Datum						

Figure 57. Low water marks on the Black River at Jonesville, 1873-1900. Conversions are not linear due to changes in Cairo Datum during the period from 1873-1900. The datum discrepancies are not significant enough to affect the conclusion that the river subsided to annual lows below the bottom of Catahoula Lake. (Secretary of War, 1902).



for the downward trend in hydrology since 1812. The data further supports the theory that dereliction has not occurred on Catahoula Lake.

The bottom of Catahoula Lake is more than 15 feet above the low-water river stages shown in Figure 57 (Wills, 1965 and field measurements by the writer).

### *Discussion*

The hydrologic evidence that Catahoula Lake was cyclic in 1812 is supported by the historical data recorded by Dunbar and Hunter (1804) and Darby (1817).

Dunbar (1804) described the hydrology as follows:

...The latter is a creek twelve leagues long, which is the issue of a lake of the same name eight leagues in length and about two leagues in breadth. It lies west of the mouth of the Ocatahoula, and communicates with the Red River during the great annual inundation. At the west or northwest angle of the lake, a creek called Little River enters, which preserves a channel of running water at all seasons, meandering along the bed of the lake; but in all other parts, it superficies, during the dry season from July to November, and often later, is completely drained, and becomes covered with the most luxuriant herbage; the bed of the lake then becomes the residence of immense herds of deer, or turkies [sic] geese, crane, etc., which feed on the grass and grain.

Darby (1817) provided a similar independent assessment of the hydrology:

The lake through which this river flows is alternately a wide expanse of water ten or fifteen feet deep and extensive grassy plain, the river winding through its center...

The following conclusions can be made regarding data presented hereinabove:

1. Catahoula Lake levels are related to water levels in Black River at Jonesville.
2. Catahoula Lake levels are annually cyclic and have been since 1812.
3. Exceedance curves at Catahoula Lake and Black River in Jonesville are receding, but are not congruent. No evidence exists that the hydrologic regime was higher between 1929 and present, thus the state has not acquired land by dereliction since 1929 (Louisiana Civil Code, Article 500).
4. The Catahoula Lake hydrograph does not stabilize at any specific elevation, thus confusing the hydrographic determination of OHW. It will be demonstrated in a later chapter that the determination of the OHW of Catahoula Lake today is subjective and subject to controversy. This corresponds to GAO's reporting (GAO, 2004) regarding inconsistencies in nationwide OHW determinations: "It is possible that well trained and competent staff might interpret the term [OHW] differently."
5. Given the fact that the OHW cannot be determined from hydrographic data today, it is reasonable to conclude that ancient hydrographic data cannot be used to determine the OHW of 1812 unless Catahoula Lake was stable at some period after 1812.
6. The value of hydrologic data and other hydrologic evidence contained herein are relevant for verification of the cyclic nature of the Catahoula Lake hydrograph between 1812 and present, and the final OHW determination must be developed from methods other than from water levels.

## CHAPTER 7

### DENDROLOGY

#### *Dendrohydrology*

Baldcypress exhibit extreme sensitivity to moisture during the growing season from January to June (Stahle & Cleaveland, 1987). As previously demonstrated, the OHW of Catahoula Lake today cannot be determined from the hydrograph because of the extreme variance in water levels and annual peaks. Therefore, dendrohydrological predictions of the water levels in 1812 were not possible.

Healthy baldcypress of more than 200 years are uncommon on Catahoula Lake, apparently as a result of extensive logging in the nineteenth century (Mancil, 1972). Twenty healthy baldcypress aged approximately 100 years were sampled at Bacon Run in the cypress fringe on the west side of the lake (Figure 58). Using cross dating, a chronology was developed. The time series was detrended to account for the age-growth curve. Autocorrelation of each series was found to be negligible (Figures 59-62).

The tree ring indices were correlated with the growing season (January 1 through June 30) water levels in Catahoula Lake between 1961 and 2008. Lags from zero to four were analyzed. The baldcypress were found not to have a strong correlation with the growing season lake levels and exceedances of any stage (Figures 63 and 64 and Table 3).



Figure 58. Location of sample of 20 baldcypress at Bacon Run (Base map, US Geological Survey, 1985).

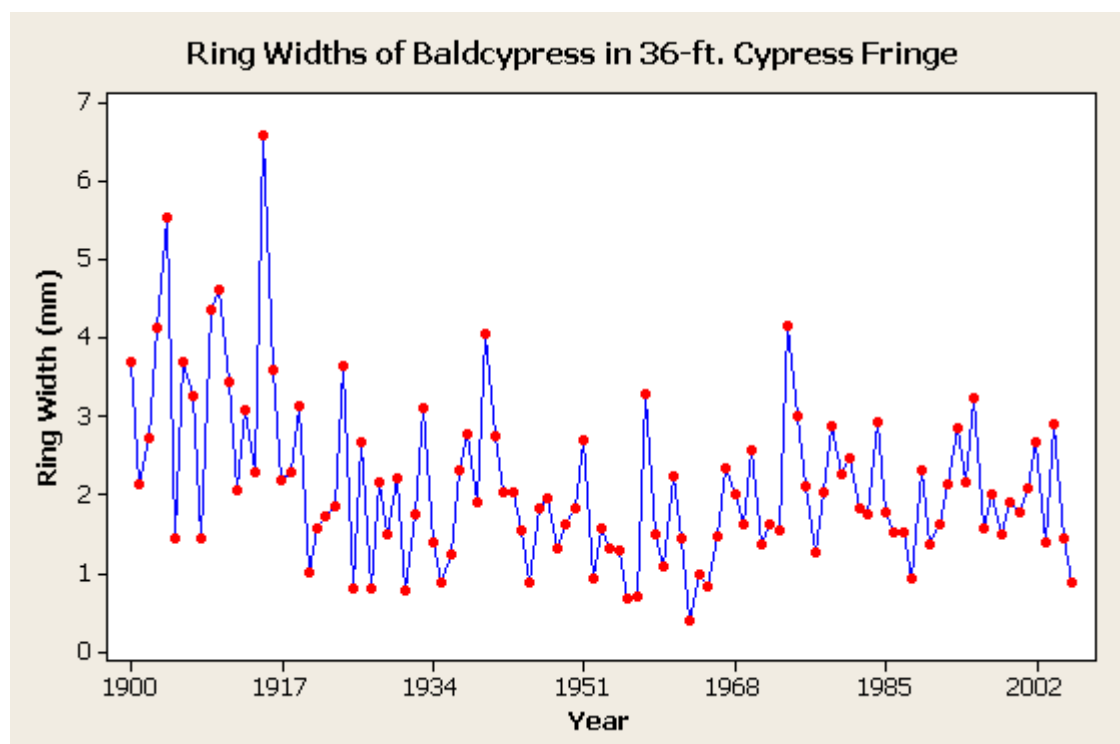


Figure 59. Mean Ring widths from 20 cores in the western cypress fringe.

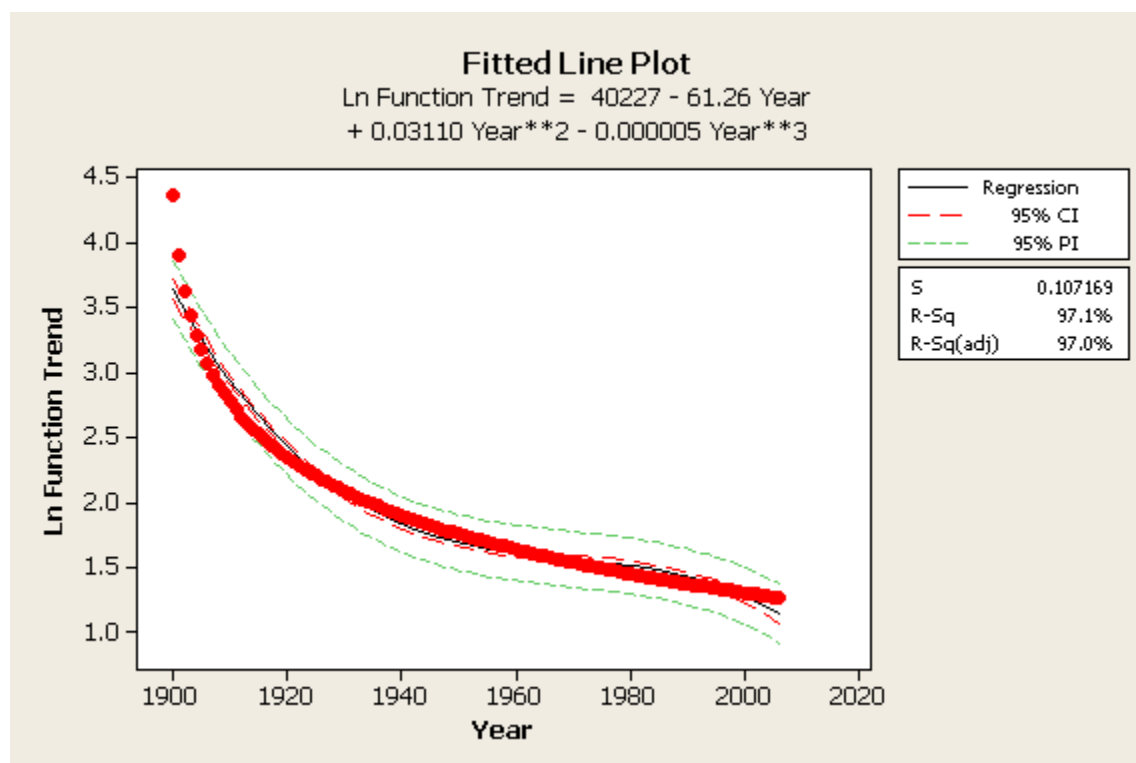


Figure 60. The age-growth trend line of the mean ring widths is shown in red.



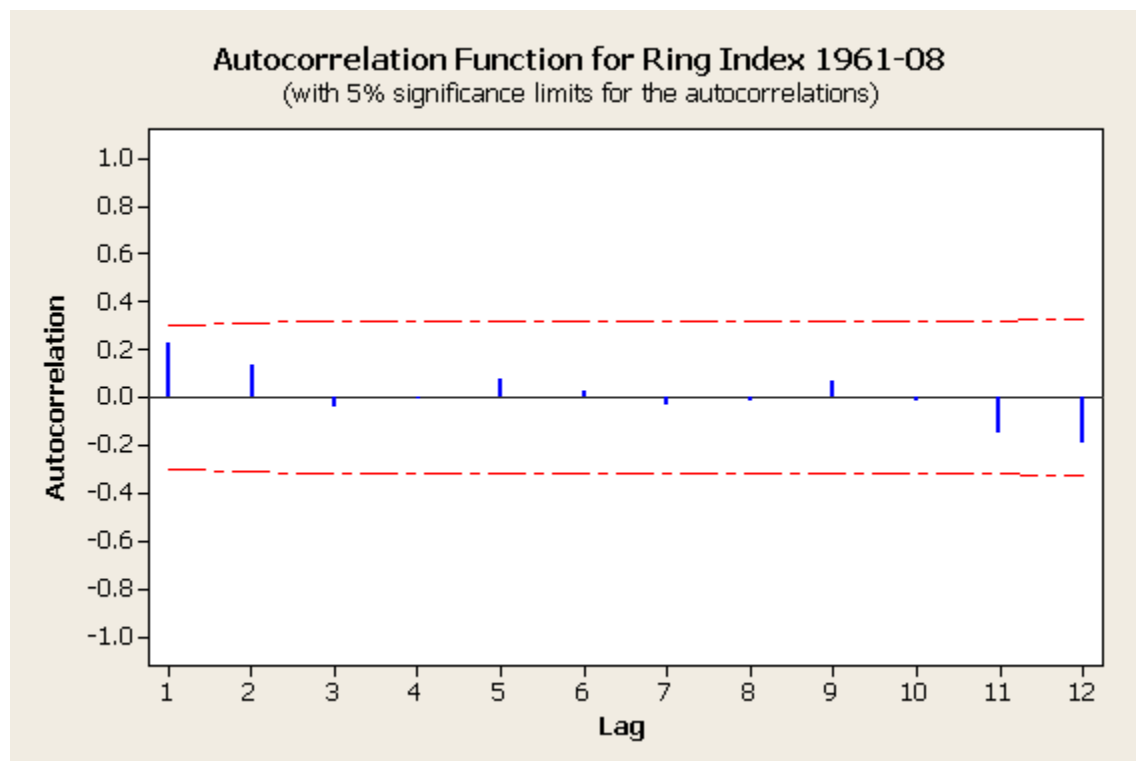


Figure 61. Ring Index autocorrelation function.

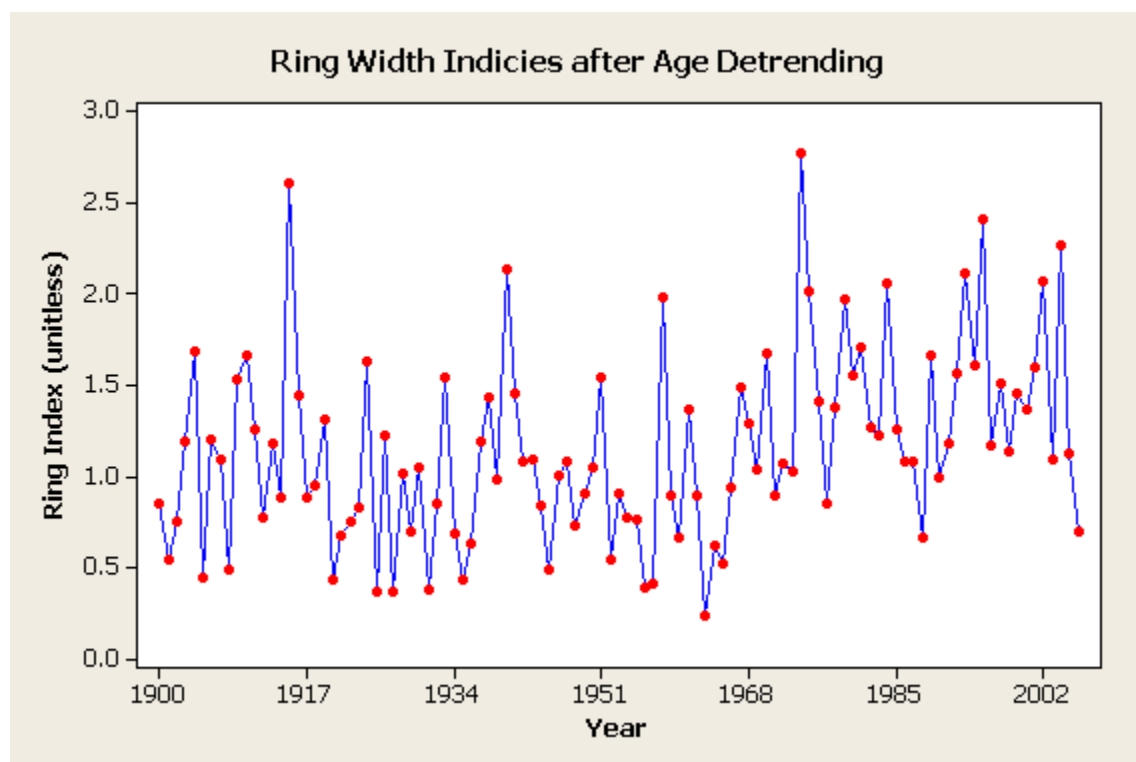


Figure 62. Ring Indices 1900-2006 after detrending for age-growth rate.

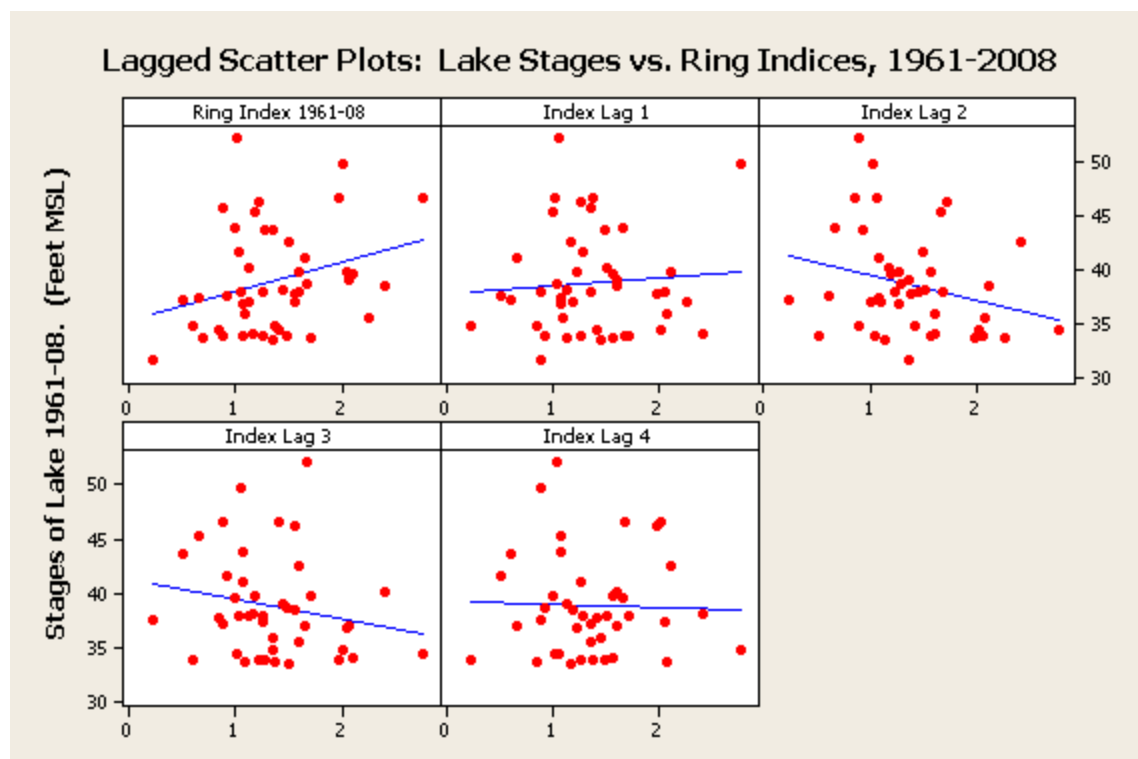


Figure 63. Lagged scatter plots for lags of 0 to 4. No correlation is apparent.

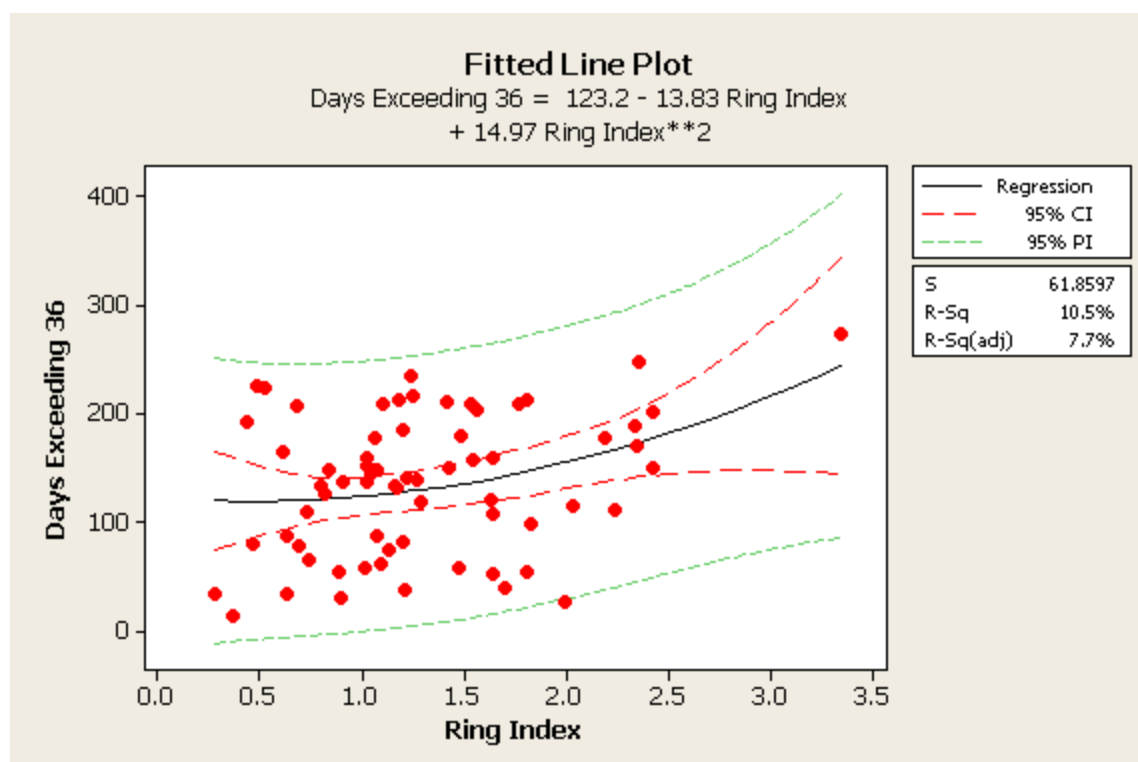


Figure 64. A fitted line plot reveals that the stage exceedances in the 36 foot range have a weak relationship not adequate for exceedance prediction.

Table 3. Pearson's Correlation Coefficients for Lake Stages versus Ring Indices.

Lags	Pearson's Correlation Coefficients
0	0.292
1	0.071
2	0.255
3	-0.200
4	-0.029

It is clear from the above data that the tree ring indices are not well correlated with the lake levels and exceedances, and it would be impractical to use this stand of baldcypress to predict water levels based upon tree ring indices. Michot (2003) reported an inverse trend in terms of the correlation of ring indices and lake stages between 1961 and 2003 for lake levels between January and June.

The baldcypress in the area of the study lie on top of the sandy outwash from the western hills. During the three years that the writer has studied this area, the sandy soil along the western fringe of the lake was always found to be moist, even during the driest parts of the summer. Piezometers were not installed, but groundwater was usually encountered within two feet of the surface. Figure 63 shows baldcypress in the moist sand in the fringe at about 36 feet. Farther out in the lake, at approximately the 34.5-ft. contour, approximately one foot of silty clay topsoil overlays the sand. The trees of the cypress fringe follow the basins of the tributaries of the lake up to higher elevations (Figure 65). Approximately twenty-five hand-probe cores were taken in various locations in the western cypress fringe. In all areas in the 36 foot range on the western fringe, white sand was found at the surface or immediately below the topsoil. In some areas of

the fringe, near tributary entrances, the net resultant flow of ground water has a vertical component, causing quicksand that will not support the weight of a person. The quicksand is void of trees. Since these trees do not correlate with lake levels, they may be living in the fringe simply as a result of high moisture levels in the soil. The sandy material around in the littoral zone in the root systems at the 36 foot contour may explain the escarpment in the fringe since no evidence indicates that the lake was ever stable at or near 36 feet between 1812 and the present.

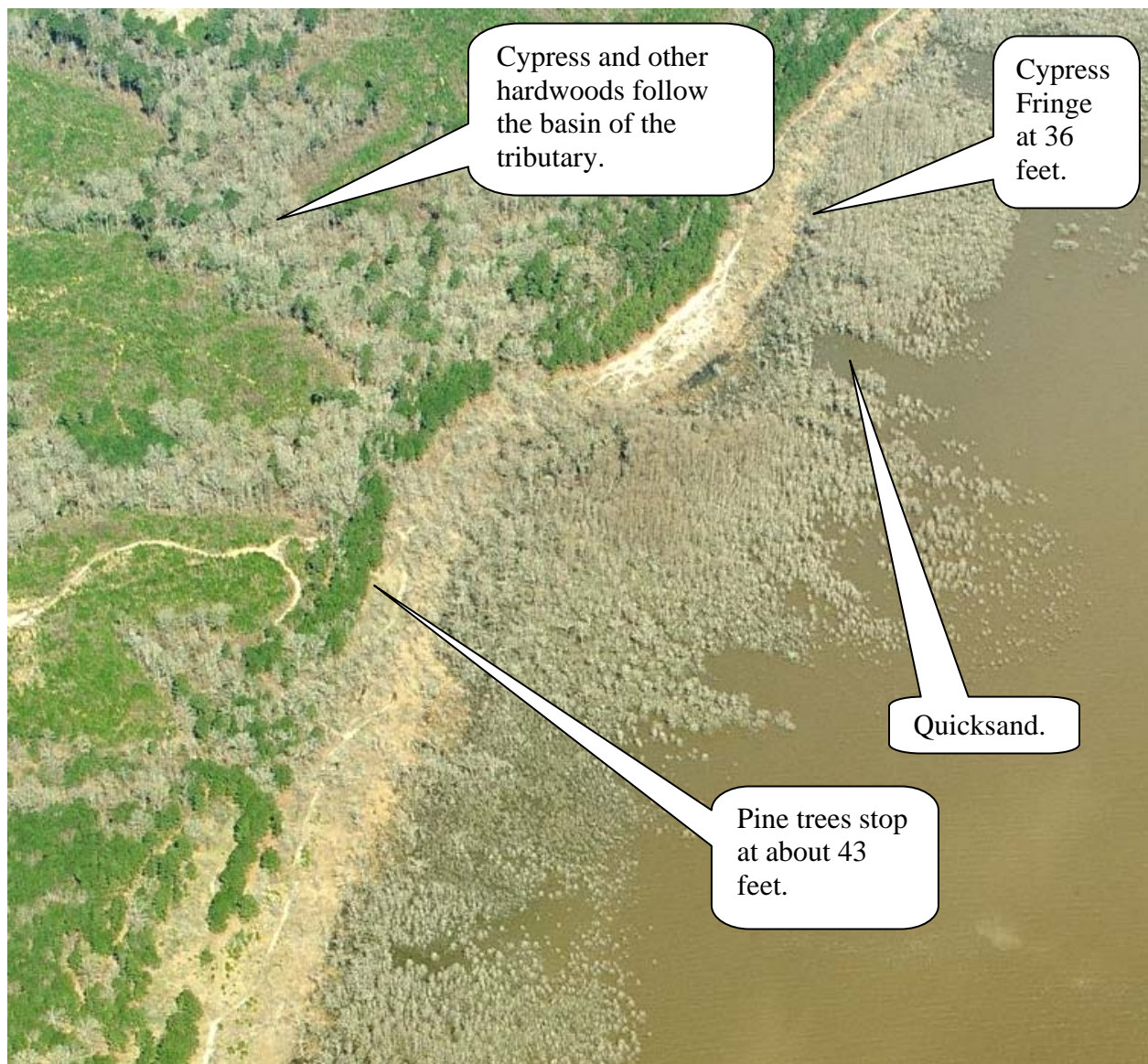


Figure 65. Cypress fringe where a tributary enters the lake (Microsoft, 2009).

### *Dendrosedimentology*

Baldcypress can form adventitious roots if they are inundated for extended periods of time. A high, stable level of water can affect the level of the OHW. Adventitious roots emerge at the approximate level of the high water and are indicators of extended periods of high water (Brown & Montz, Baldcypress, the Tree Unique, The Wood Eternal, 1986). The baldcypress at French Fork have exposed roots similar to adventitious roots (Figure 14). Smaller hardwood trees with at least 18 inches of exposed roots were found in this region. The trees were aged less than 60 years and were found at French Fork (Figure 66). This documents the fact that the roots of the trees in the area are exposed due to erosion, and not because of higher stable lake levels that caused formation of adventitious roots. The wind fetch distance allows strong northwesterly and southwesterly winds associated with cold fronts to build substantial waves which have eroded the soil from around the trees at French Fork and at Saline Point (Figure 67). Evidence of erosion on the backslope of the natural levee of Cowpen is shown in Figure 68.

Russell (1942) reported that very little sedimentation has occurred in Catahoula Lake, except where the creeks enter the basin. Root crowns of tree deltas were found covered with sediment, but, in other areas, baldcypress of ages up to at least 200 years have exposed root crowns. Sedimentation and erosion are relevant to the lake boundary because the state acquires the expanded boundary of the lake bed when the bordering upland is eroded and becomes lake bed (Louisiana Civil Code, Article 500).





Figure 66. Exposed baldcypress roots at French Fork. These roots are exposed due to erosion, and are not adventitious roots caused by high, stable water levels.



Figure 67. Cypress knees and exposed roots of baldcypress on the west side of Saline Bayou at Saline Point indicate approximately 0.5 feet of erosion since the birth of the baldcypress in the background (estimated at 120 years).





Figure 68. Exposed baldcypress roots and knees on the east side of the lake on the natural levee of Cowpen Bayou. Approximately two feet of erosion has taken place since these roots formed.

### *Forest Banding*

Forest banding is a natural marker that is frequently used to determine the OHW of natural lakes. Catahoula Lake water levels affect the distribution of trees and cause the formation of bands of species relevant to their water tolerance (Russell, 1942, Brown, 1943) Figure 65 shows the upper limits of the 36 foot baldcypress fringe and the lower limits of pine trees. Overcup oak, not identifiable in the photograph, are more water tolerant than the pines and extend down to an elevation of approximately 40 feet in this region of the lake. A photograph taken on the east side of the lake between Saline Point and French Fork shows the forest banding as viewed from the lake (Figure 69). The baldcypress zone around the lake was a significant

factor in the determination of the shoreline of the lake. However, the profiles of forest banding by Russell (1942) and Brown (1943) in Figure 70 reveal a discrepancy. Russell places the cypress zone at an elevation well above 36 feet, and Brown places its upper limit at 36 feet. This disparity (combined with Brown's erroneous elevations at French Fork) is due to variation in the location of the cypress fringe in various parts of the lake.

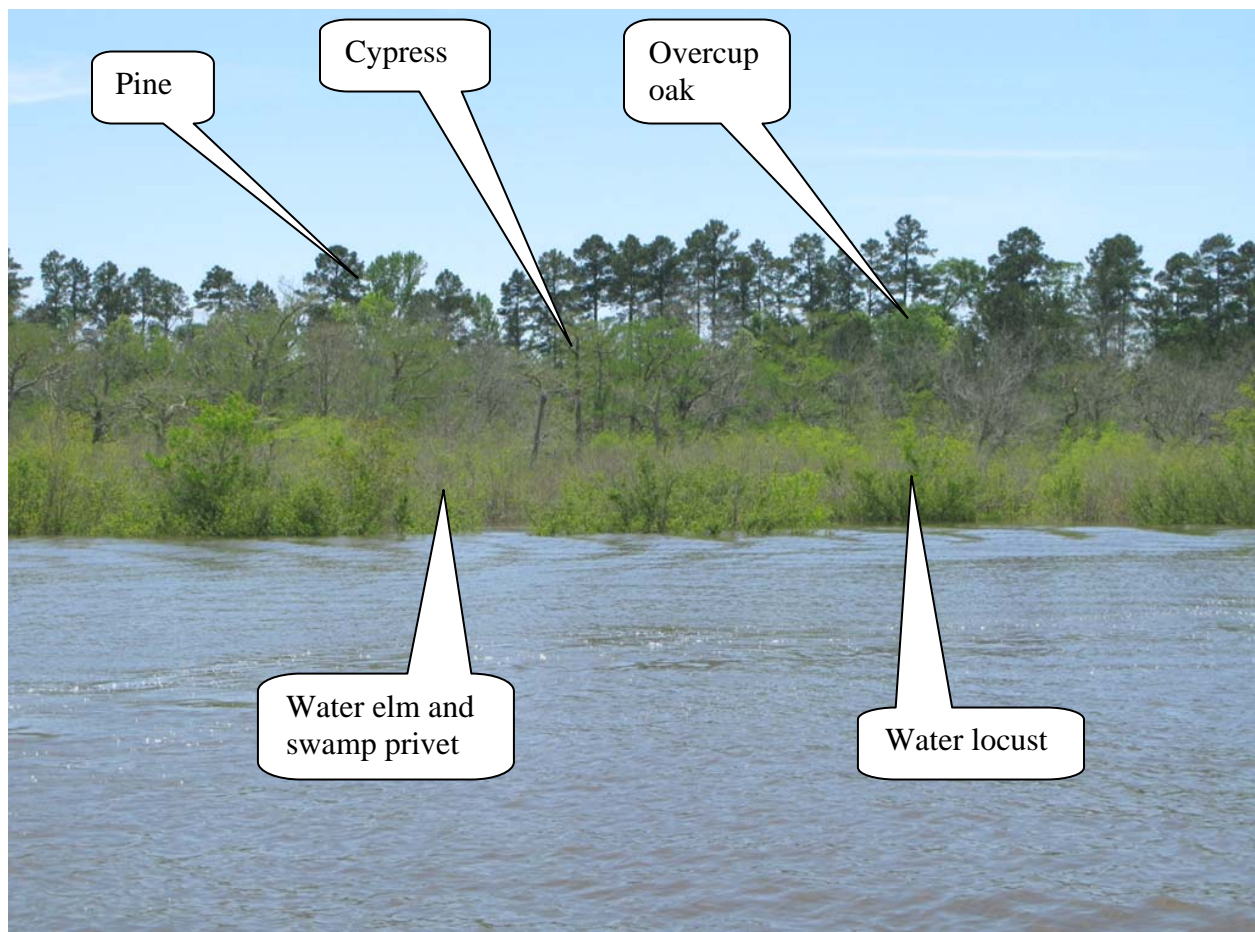


Figure 69. Typical forest banding as viewed from the lake when the stage is approximately 43 feet.



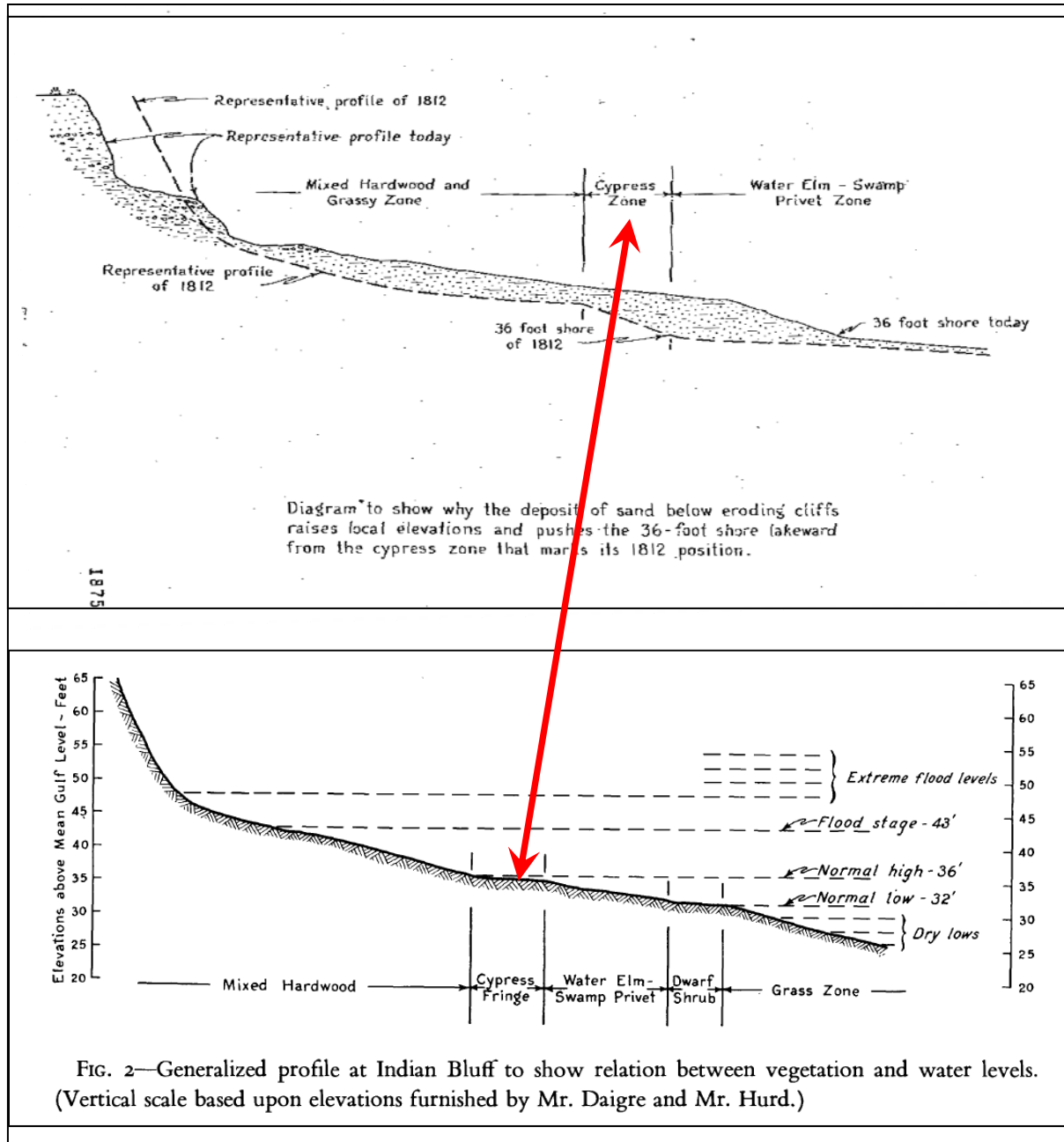


Figure 70. Lake profiles by Russell (1942) (top) and Brown (1943) (bottom) and their discrepancy in placement of the cypress fringe.

In lieu of transects, the writer field inspected the lake at every one-foot stage variation between 30 and 45 feet to more precisely identify the elevations of the forest banding. Three primary forest banding conditions were identified (Figure 71):



- Condition 1: A well-defined line of old baldcypress occupy the edge of the lake at the 34 to 36 foot elevation (Figure 71). A sandy zone largely devoid of trees lies between the 36 and 38 foot contours. Overcup and willow oak begin to appear at the approximate 38 foot contour and become well established at the 40 foot contour. Pine appear with a lower sharp boundary at the 43 foot contour. Swamp privet, water elm, and water locust extend down to elevation 30. Bitter pecan appears at about elevation 38 and extends down to the approximate 32 foot elevation.
- Condition 2: The cypress fringe begins at the approximate 34 foot contour and extends up to the 42 foot level (Figure 71). A sandy zone largely devoid of trees lies between the 36 and 38 foot contour on the west side of the lake along the bluffs and at Saline Point, but it does not exist on the other parts of the lake. Overcup and willow oak begin to appear at the approximate 38 foot contour and become well established at the 40 foot contour. Pine appear with a lower sharp boundary at the 43 foot contour on the western side of the lake in the hills, but they yield to overcup, willow oak, and bitter pecan above 40 feet in the basin.
- Condition 3: The cypress fringe begins at the approximate 35 foot contour and extends up to the 42 foot level (Figure 71). Woody vegetation does not exist below the 35-foot contour. This condition exists on the right descending bank of French Fork of Little River, an area examined by Brown (1943). Overcup and willow oak begin at the approximate 38-foot contour and become the predominant species at about the 42 foot contour and above. Pine trees occupy all upland hilly land.

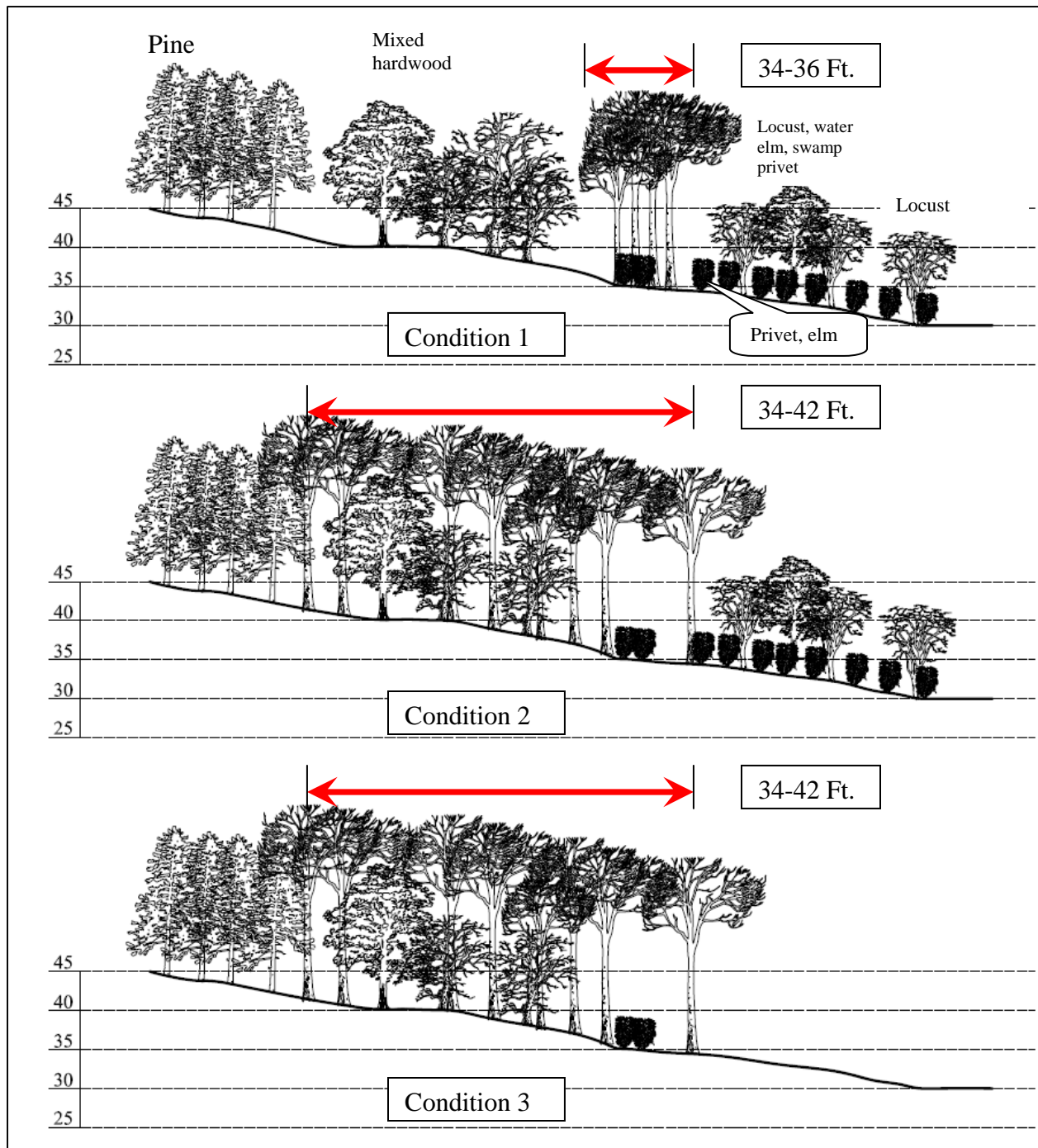


Figure 71. Cypress zone and forest banding profile for three conditions at Catahoula Lake. The cypress zone extends to the limits marked by the red arrows.

### *Cypress Knees*

Cypress knees are sometimes used to approximate the ordinary high water levels (Brown and Montz, 1986). Field inspections when the lake level was low reveal that the tops of the cypress knees exist in a range of 32 to 43 feet. Kernell and Levy (Kernell & Levy, 1990) reported a strong correlation between greatest water depth and highest cypress knees, suggesting growth hormones are stimulated when the knee is inundated.

During the course of this work, the writer monitored the growth of cypress knees in his front yard in Alexandria, Louisiana, where three baldcypress exist. One tree was irrigated continuously at a low rate sufficiently adequate to keep the soil moist continuously for one year. The cypress knees of the watered tree grew over 4 inches; the knees on the other two trees experienced no visible growth. While the test was not designed using precise scientific control, the rapid growth at the irrigated knees was clearly faster than for the other trees. That limited experiment demonstrates the potential growth rate of cypress knees. It reveals that, if temporary Catahoula Lake conditions promote higher cypress knee growth, cypress knees could grow to a higher level than normal; after the conditions subsided, the knee height would remain higher than would normally be indicated by new conditions. In the experience of the writer, it is clear that the excessive folding of the rings in cypress knees prevents them from being dated by ring counting.

### *Discussion*

The following conclusions can be made regarding data presented hereinabove:

1. The highly variable water levels, groundwater, and extensive logging of older trees in the nineteenth century render the correlation of tree ring indices and water levels inadequate for the determination of the OHW of Catahoula Lake in 1812.

2. Dendrological evidence demonstrates that erosion has expanded the lake bed since 1812 and has further confused its extent.
3. Forest banding at Catahoula Lake provides 6 possible levels for the OHW: 1) 43 feet, at the location of the lower limits of the pine, 2) 42 feet, at the upper limits of the cypress fringe, 3) 38 feet, at the lower level of the overcup oak and willow oak, 4) 36 feet, at the upper edge of the thin cypress belt at the 36 foot contour, 5) 34 feet, at the lower edge of the cypress belt, and 6) 30 feet, at the lower limits of the woody fringe consisting of water locust, swamp privet and water elm. The highly variable Catahoula hydrograph, along with wave action and soil type variation have produced variance in the forest banding, which, in turn, prevents its use as the OHW marker. The lake boundary cannot be conclusively determined from forest banding because of hydrographic variance that has existed since at least 1812.
4. The OHW of the lake cannot be determined from cypress knees because of the wide range of the elevations of their tops and the inability to date the knees. Although cypress knees are one of the several natural markers of high water, they can provide misleading evidence. Knees at the 36-foot level were misinterpreted by Russell (1942) and Brown (1943). The tallest cypress knees at 43 feet MSL approximate a high water level, but they are not indicative of the extents of the boundary of Catahoula Lake. Cypress knees may be better indicators in a more stable hydrologic regime.

## CHAPTER 8

### SURVEYORS' EVIDENCE, 1809-1942

#### *GLO Surveys*

In 1785, the United States created the Public Land Survey to examine the lands of the United States and divide it into parcels for sale or grant (Cazier, 1975). The U.S. General Land Office (GLO) was authorized to administer the surveying in Louisiana. GLO surveys in the Catahoula Lake region began in 1809, and were completed by 1885 (State Land Office township plats, 1809-1885).

The territory was divided into townships 6 miles square. The navigable lakes, streams, and pre-sovereign claims were surveyed, and the remaining land in each township was divided into sections each being approximately one mile square except where they abutted water bodies or previous claim boundaries. The GLO surveyors decided in the field whether they believed water bodies to be navigable; if they believed them navigable, they surveyed *the margins of the watercourses*. The survey lines along the margins of watercourses are called meander lines. The GLO instructions did not contain the term *ordinary high water* (United States Surveyor General, 1815 and 1831). Although it would seem that the GLO meander line traverses of a lake would define the ownership boundary around the lake, courts have consistently held that meander lines are not the property boundaries of lakes; meander lines are to be used to plot the general sinuosities of shorelines, and that lake boundaries are the actual natural edges of lakes (United States Department of the Interior, 1973 and Simpson, 1994).

GLO surveyors were initially awarded contracts to survey the exteriors of townships. Later contracts were awarded to survey the interior sections in the townships. Section lines and township lines were paid for at higher rates than meander lines (Cazier, 1975). Meander lines



have been documented by the writer and other surveyors to deviate from the beds of lakes by hundreds of feet or more. Simpson (1994) described the quality of GLO meander lines:

I have examined survey work done in the 1800's where the courses of the meanders were only one to three chains in length and followed the banks very closely, even through what must have been very thick brush. I have also tried to retrace meander lines where one or more courses, which were run at about the same period, where the meanders were one-half mile in length and did not seem to fit anything imaginable on the ground. No doubt, everything in between is possible.

During his 32 years as a civil engineer and land surveyor, the writer has documented meander lines to be erroneous by more than 1000 feet in some instances.

Although the positional accuracy of meander lines is highly variable, they can be divided into two categories, fraudulent and non-fraudulent. Courts have generally not accepted meander lines as boundaries except in cases of extreme fraud where the surveyor meandered a water body that did not exist (United States Department of the Interior, 1973). Catahoula Lake contains both fraudulent and non-fraudulent meander lines.

A precise plotting of the nineteenth century GLO meander lines surrounding Catahoula Lake (Figure 72) might indicate to the reader that they match the lake very well and that there should be no cause for boundary ambiguity. However, a close examination reveals problems. Figure 73 is an excerpt from the 1842 GLO plat, and the field notes for the meander line traverse is shown in Figure 74. A precise plotting of the field notes (Figure 75) demonstrates that, although the meander line represents the general sinuosities of the shoreline, it does not follow a consistent contour. This meander line is typical of a non-fraudulent meander.

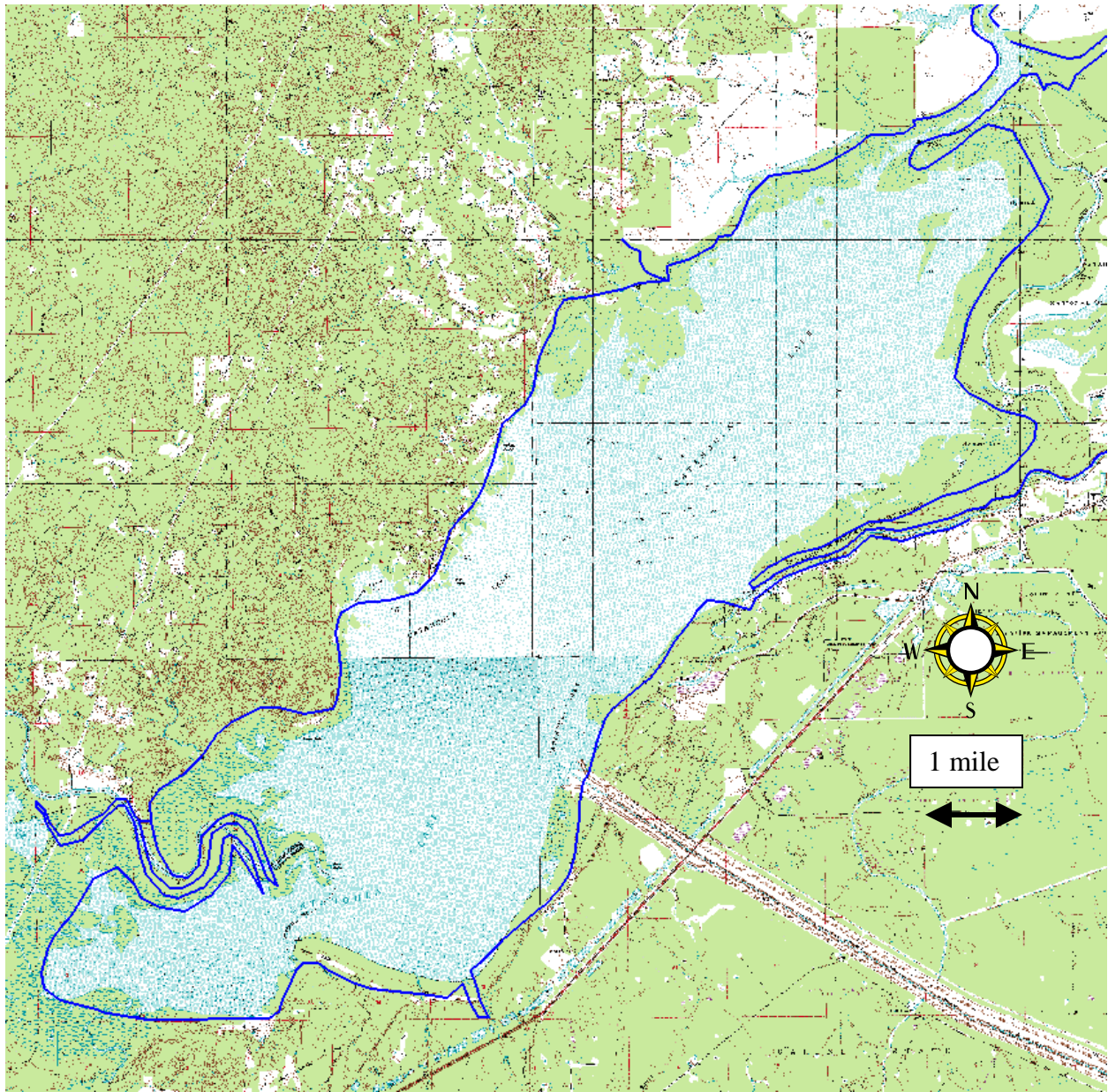


Figure 72. A precise plotting of the 19th century GLO meander lines around Catahoula Lake (Base map, USGS, 1985-1998).

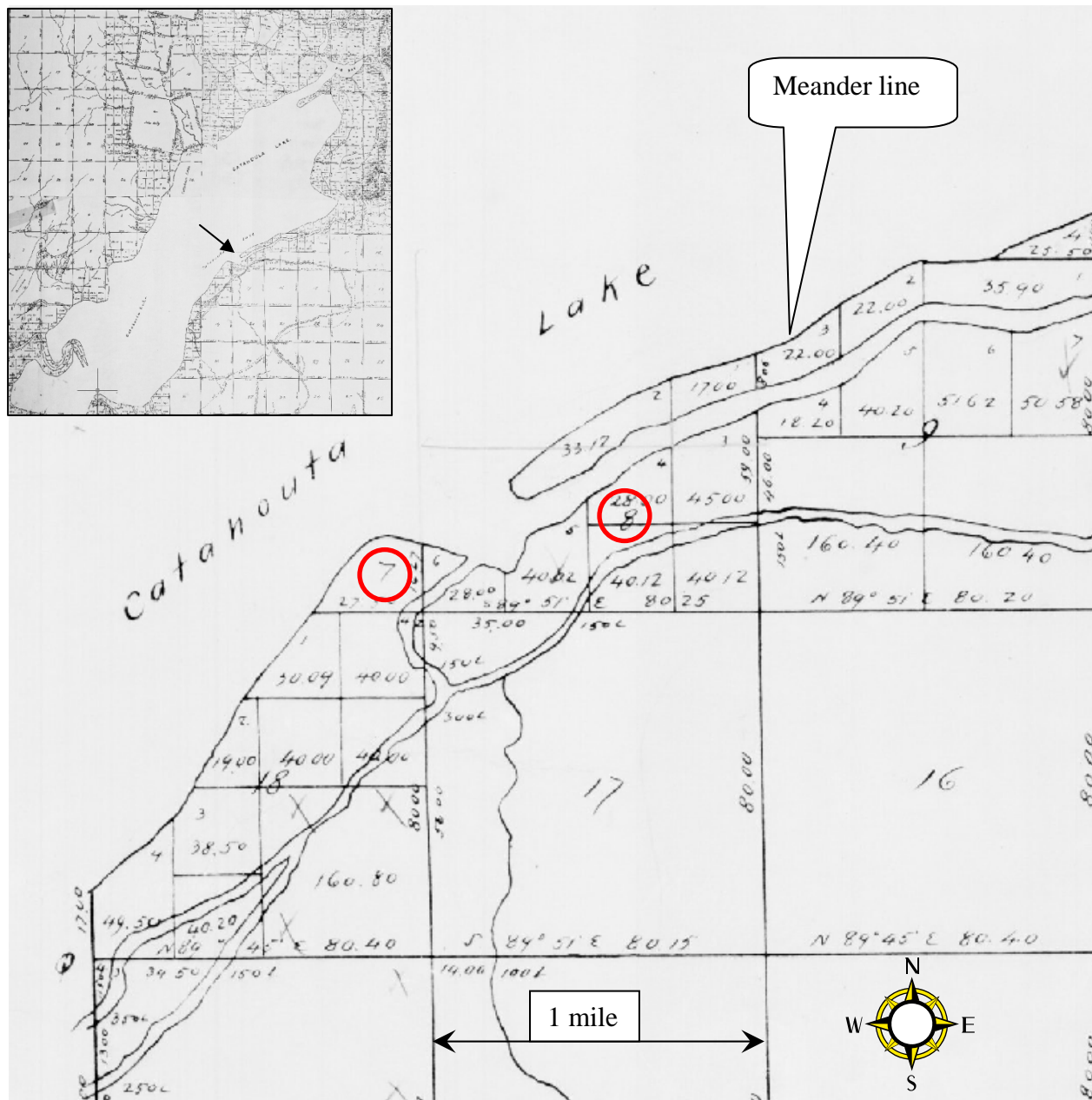


Figure 73. An excerpt from the 1842 Township Plat of Township 6 North, Range 4 East on the southeastern shore of Catahoula Lake. Section numbers are encircled in red (Louisiana State Land Office, 1809-1884).

Thence in front of section 9  
 S 73 N 15.00  
 N 82 N 27.00  
 S 50 N 23.60  
 S 73 N 22.60 to the Post between  
 Sections 8 & 9  


---

 Thence in front of section 8  
 S 70 N 33.00  
 S 50 N 17.00  
 S 60 N 13.00 to the Junction

of Little River with the  
 Catahoula Lake Thence down the Lake  
 S 22 N 9.50  
 N 80 N 8.30 Cross the mouth of  
 a Bayou 4.00 lks wide  
 N 69 N 14.00 to the Post  
 between Sections 7 & 8  


---

 Thence in front of section 7  
 N 85 N 13.00  
 S 45 N 12.00  
 S 33 N 10.50 lks to the post  
 between Sections 7 & 18

Figure 74. An excerpt from GLO survey field notes of Catahoula Lake meander lines in front of Sections 7 and 8 by J.N. Walker, December 1837 (United States General Land Office, 1808-1884). The distance measurements are in chains (66 feet).



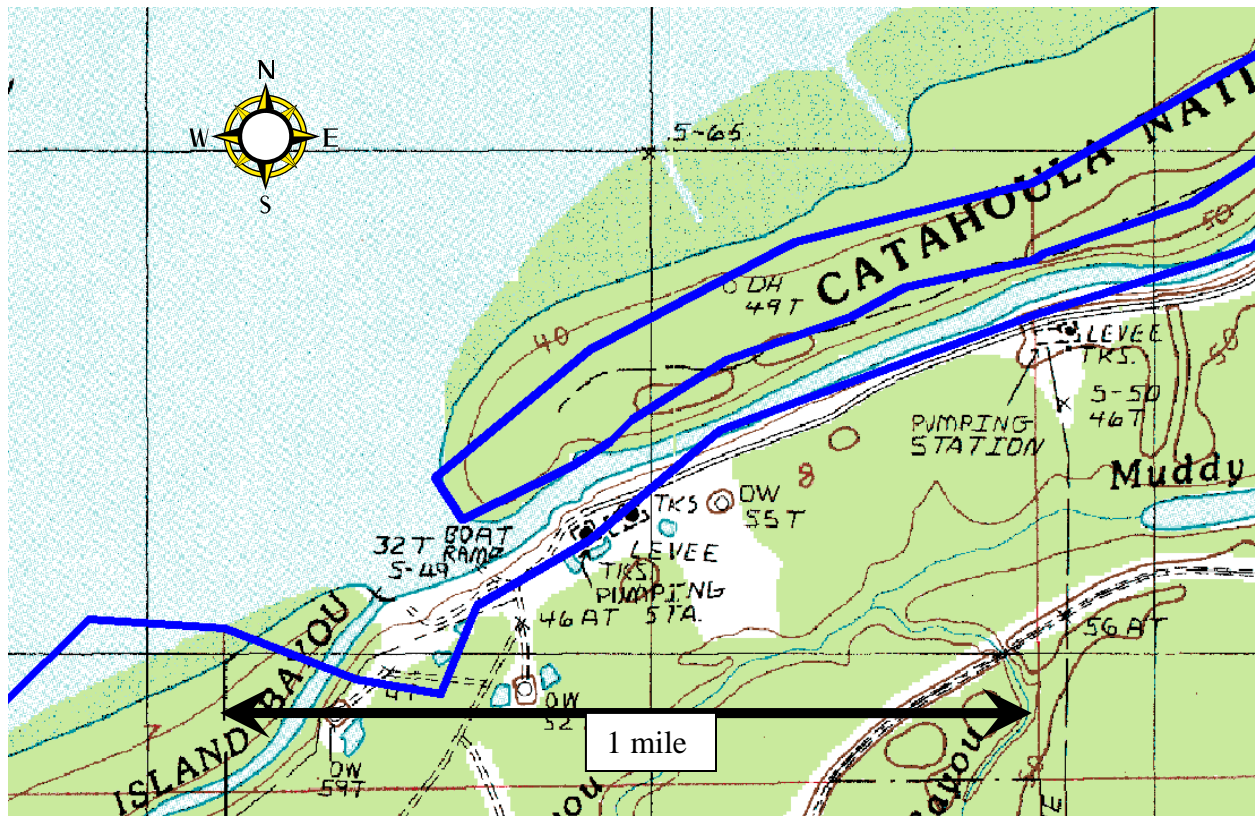


Figure 75. A precise plotting of the 1838 meander lines in front of Section 8 on the Buckeye NE Quadrangle Map (USGS, 1998). This plotting demonstrates that even non-fraudulent meander lines do nothing more than plot the general sinuosities of the shoreline. The natural monument, the lake itself, is the boundary.

### *Gross Error, Fraud and Variability in the GLO Traverses of Meander Lines*

Close examination of the GLO field data reveals gross error, fraud, and variability between different GLO surveyors who surveyed the same lines at Catahoula Lake. Five significant cases were discovered and are discussed below.

*Southwest quadrant of the lake where Little River empties into Catahoula Lake in Township 6 North, Range 3 East*

Figure 76 is an excerpt from the 1842 GLO township plat. The prominent S-curve of Little River was meandered by (United States General Land Office, 1808-1884). The feature is approximately two and a half miles long. The S-curve apparently conforms to the S-curve



visible on the 2004 DOQQ. However, a precise plotting of the field survey notes reveals that the GLO survey deviates by as much as 1,000 feet from the location of Little River today. The movement of the river from Walker's position to the present-day position is opposite the expected movement of the river toward its cut banks. Walker reportedly surveyed each natural levee independently and produced independent meander vector traverses of each levee. The traverses mathematically closed within contract standards of 75 feet, indicating that his field survey was sufficiently accurate. The independent polygons of each side of the river are parallel and their shapes match. To determine whether Little River had moved in an unexpected direction, baldcypress on each meandered natural levee were dated. Ancient baldcypress predating the Walker survey were found on both natural levees. Figure 77 is an example of an ancient baldcypress that proves Little River did not move from the location that the GLO showed it to its present position. Little River did not occupy the position shown by the GLO, and Walker's survey was inaccurate by a distance of up to about 1,100 feet. Many of the traverse angle points on Walker's meander of Little River appear directly opposite each other on both sides of the river (Figure 77). The writer spent two days on this 2.5-mile stretch of Little River attempting to emulate Walker's traverse points using a compass and chain, and concluded that it is highly unlikely that Walker would have actually set the traverse angle points across the river from each other.

Further examination revealed that by scaling Walker's traverse by down to 73% of full scale and rotating it clockwise 14.2 degrees, Walker's traverse matched the river (Figure 79). Interestingly, field investigation reveals that the tip of the scaled and rotated traverses terminates at the lower edge of the ancient baldcypress.

The writer has concluded that Walker's survey of the boundary of Little River and Catahoula Lake in this region was prepared by pacing the left descending bank and estimating the river courses. The right descending bank was simply protracted on paper to correspond with the left descending bank. This is a clear case of a U.S. GLO surveyor's erroneous and fraudulent misrepresentation of the survey of Little River and Catahoula Lake, and it demonstrates one reason that meander lines should not normally constitute the boundary of a lake.

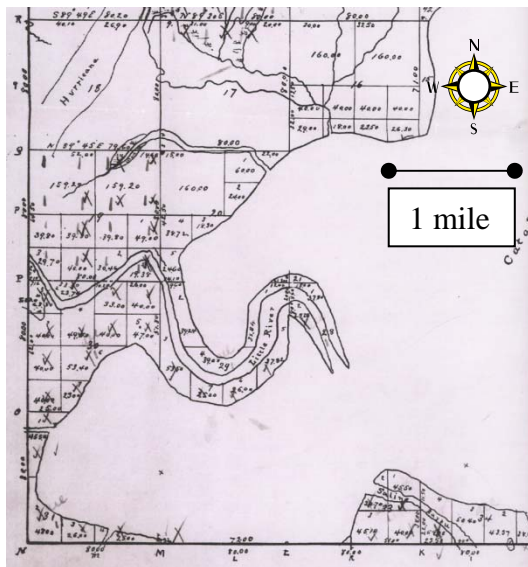


Figure 76. An excerpt from the 1842 township plat for Township 6 North, Range 3 East. The X marks with the check on one of the legs indicates that the land was patented as swampland (United States General Land Office, 1808-1884).

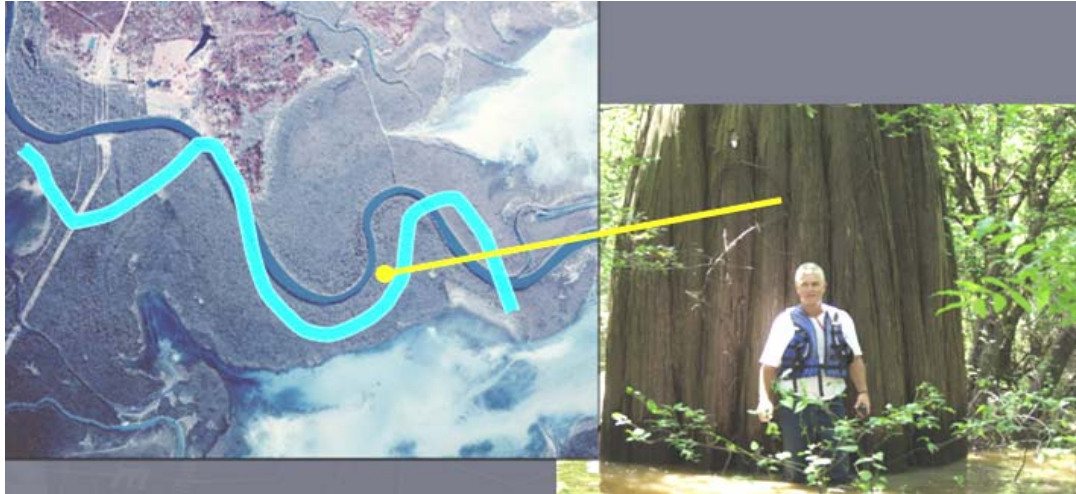


Figure 77. An ancient baldcypress between the traverse recorded by the GLO in 1838 (cyan) and the true location of Little River.

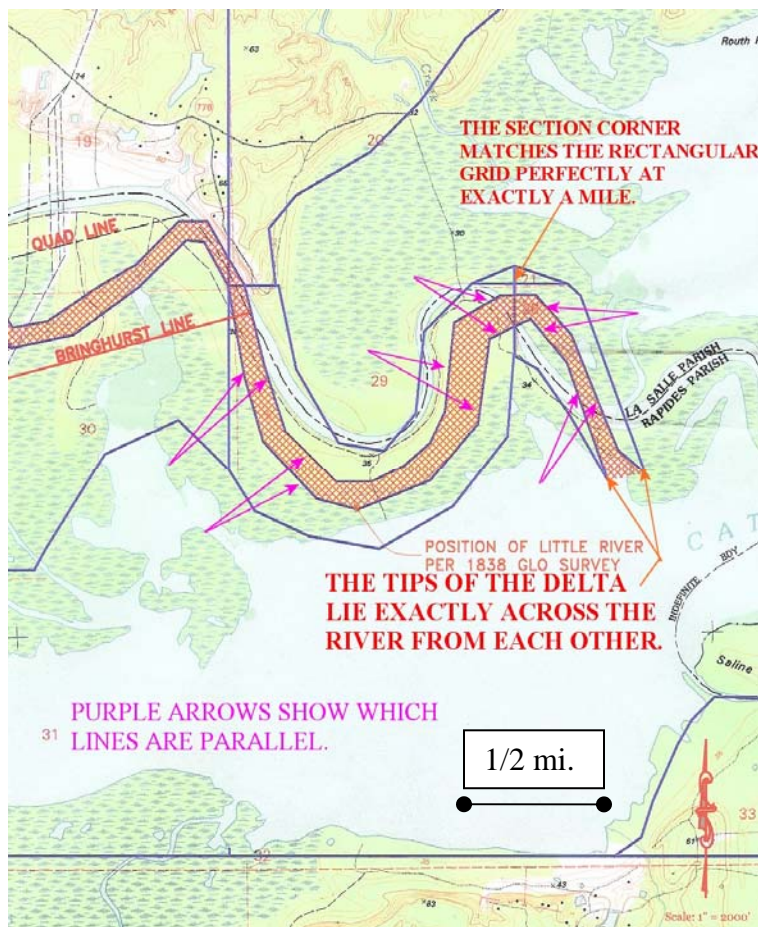


Figure 78. The 1838 GLO survey meander lines are shown on each side of the natural levees of Little River extending into the lake (Base map, USGS, 1998).



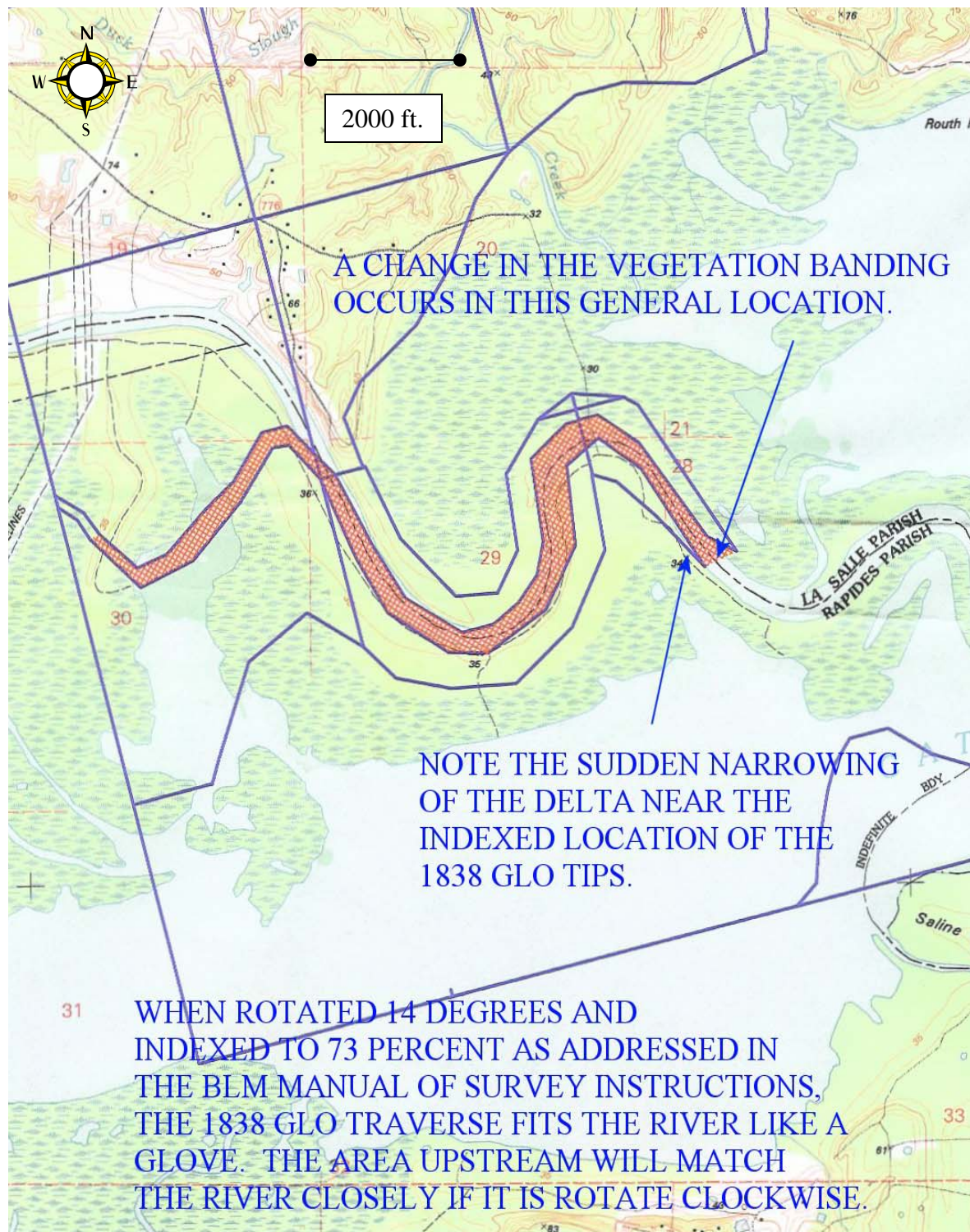
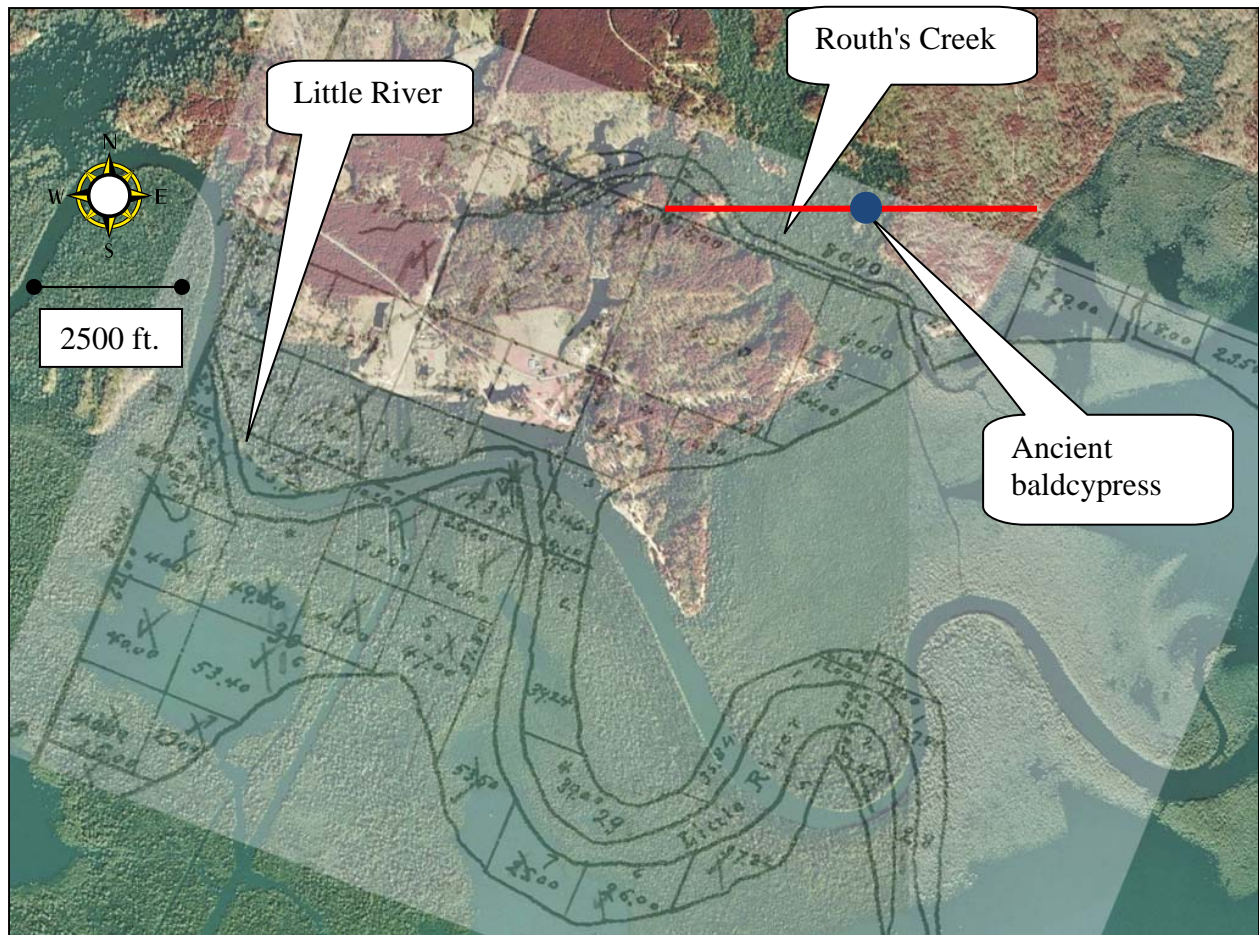


Figure 79. The GLO survey data rotated and scaled into position. The adjusted traverse ends at the 34-foot elevation and is the location where the old-growth baldcypress stop today (Base map, USGS, 1998).

*Meanders of the lakefront along the east boundary of Section 20, Township 6 North, Range 3 East and Routh's Creek*

This region was also surveyed by Walker in 1838 and is on the west bank of Catahoula Lake adjacent to and north of Little River (United States General Land Office, 1808-1884). An overlay of the Walker survey on the 2004 DOQQ indicates a problem with the location of Routh's Creek and possibly the meander lines along the lake in Section 20 (Figure 80). Walker's traverse of the north line of Section 20 (shown in red on Figure 80) reached the north quarter corner (midpoint of the section line). His field notes state that he set the point and noted that the only reference witness tree convenient for marking was a 6-inch elm. The writer retraced Walker's original survey in the field and found a long-accepted quarter corner on the north line of Section 20. The point fell 14 feet southeast of a 12-foot-diameter baldcypress estimated to be at least 300 years old (Figure 81). Obviously a retracement surveyor would ask how the GLO surveyor could have missed huge baldcypress 14 feet away. Closer analysis reveals that when Walker's survey is rotated clockwise, it matches the route of Routh's Creek, and that Walker's survey did not show the lake meanders in the correct position (Figure 80). The writer also attempted to retrace Walker's meanders of the lakefront in Section 20, and found that the meanders did not match his calls for a small drain entering the lake. While this portion of Walker's survey may not be fraudulent, it is a case of gross error.





Set  $\frac{1}{4}$  section Post on the Edge of the Creek  
 Elm 6 inch dia. S 20 N 1.18 lks no other  
 Tree of Reference +

Figure 80. If Walker's survey traverse of the north line of Section 20 (plotted in red as recorded in Walker's field notes) had been correct, Walker would have found himself setting his half mile post adjacent to the ancient baldcypress shown in Figure 80, and would not have made the note that he had only a 6 inch elm available to mark as a bearing tree. In addition, the rotation of the plat also solves an error associated with Little River. The handwritten manuscript is an excerpt from Walker's 1838 field notes, (United States General Land Office, 1808-1884).





Figure 81. An ancient baldcypress located on the quarter corner in the location where Walker stated he had no bearing trees to reference other than a 6 inch elm. Although Walker reported the half mile post to be on the edge of a creek, a creek does not lie within 300 feet of this tree. This indicates that Walker was not in this location when he marked his bearing tree, and it supports the conclusion of gross error on the part of Walker.

*Boggy Bend in Section 10, Township 6 North ,Range 3 East*

Walker surveyed this area in 1838 (Figure 82). He shows a long meander line that cuts across the lake. The writer retraced Walker's survey in the field and reconstructed the approximate position of the meander line. The ends of the section lines fall at the approximate 40-foot elevation, and Walker's meander lines clearly traverse across the lake bottom at elevation 30 feet today. The lake was obviously at a low stage during that time and probably facilitated rapid surveying of the meanders of the section. This portion of Walker's survey is another case of fraud. The meander line also demonstrates the cyclic nature of the lake in 1838 because Walker was able to traverse when the lake stage was at or below 30 feet.

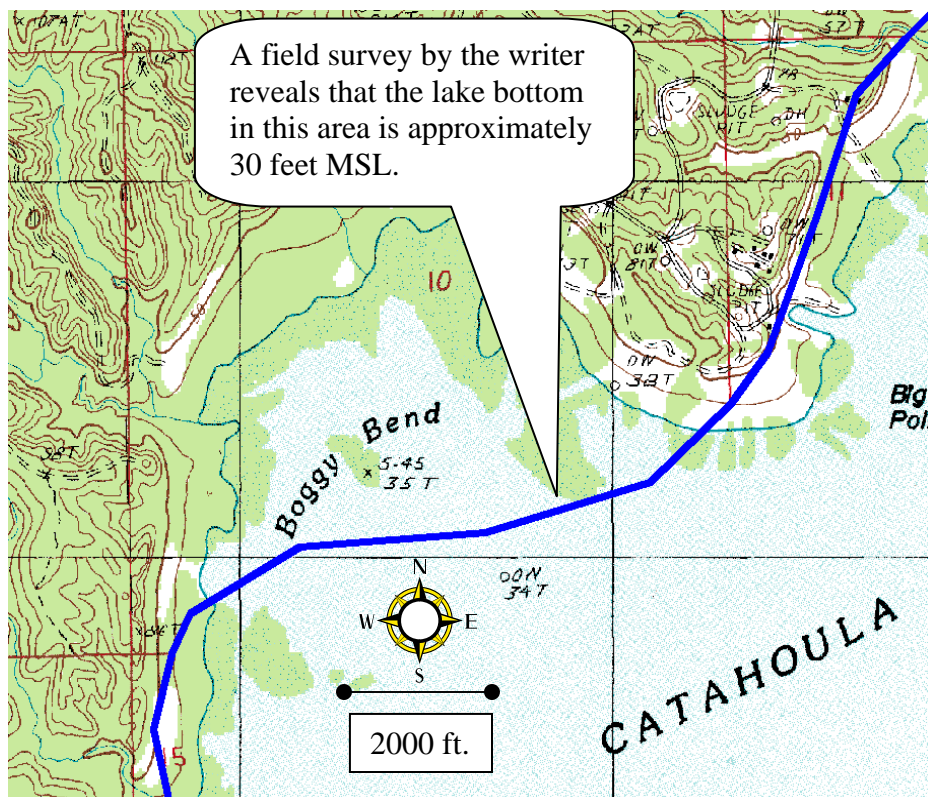


Figure 82. Walker's meander line traverse shortcut across Catahoula Lake (Base map, USGS, 1985).



*Saline Point in Township 6 North, Range 3 East*

A retracement of Walker's 1838 survey along the southern boundary of the lake reveals more meander line inaccuracies (Figure 83). The meander line does not match the documented true position of the location of Saline Bayou, as can be concluded by the ancient trees on both sides of the bayou and by the geomorphology. Close examination reveals that, once again, Walker appears to have meandered only one side of the stream and simply protracted the other side. In this case, he apparently confused which side he had meandered. When the meander of the lake is translated to the east side of Sandy Bayou, the meander line matches the lake.

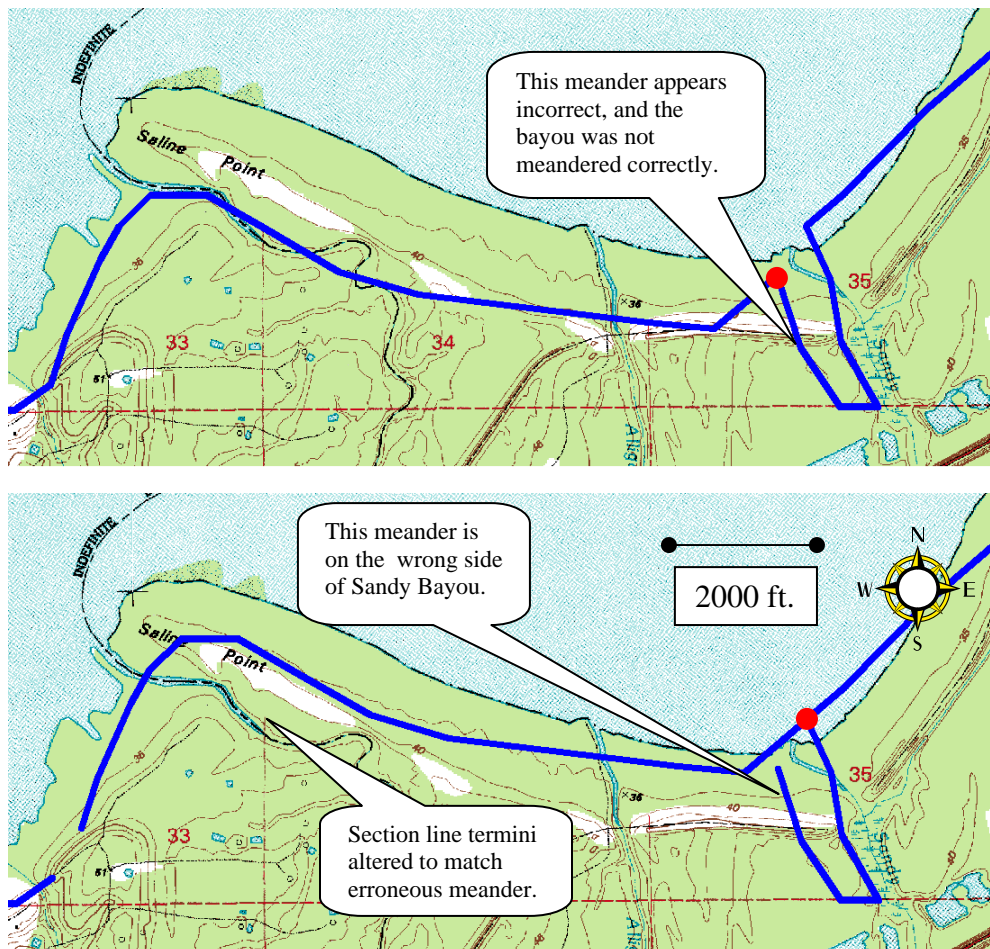


Figure 83. Translation of the lake meander line to originate on east side of Sandy Bayou results in a good match of the meander line to reality. Walker fraudulently shortened the section lines to match his erroneously translated meander traverse of the lake. Walker was traversing from east to west (Base map, USGS, 1998).

An examination of the two section lines running north to the lake confirms Walker's fraud. The field notes state that, as he was running north between Sections 33 and 34, he encountered Saline Bayou at 22.00 chains (1,452 feet). After crossing Saline Bayou Walker, he intercepted the edge of Catahoula Lake at a total station distance of 38.00 chains. The north end of the section line plotted by USGS shows the point precisely in the right place. But Walker's meander corner lies on the bank of Saline Bayou, instead of Catahoula Lake, which is on the north side of the ridge that occupies the area between Saline Bayou and the lake. Walker's notes indicate by subtraction (38.00-22.00) that the distance from Saline Bayou to the lake is 16 chains (1,056 feet), which is precisely at the meander line (Point A in Figure 84). Walker recorded a distance of 18 chains on the east side of Section 34, and USGS again plotted his recorded measurement precisely. The writer visited this point, and found that a meander corner set at 18 chains would be on the crown of a sandy ridge. It is possible that Walker fraudulently changed the line distance to match his erroneous meander (Point B), just as he did on the previous section line. Figure 85 is an excerpt from Walker's notes for this area.

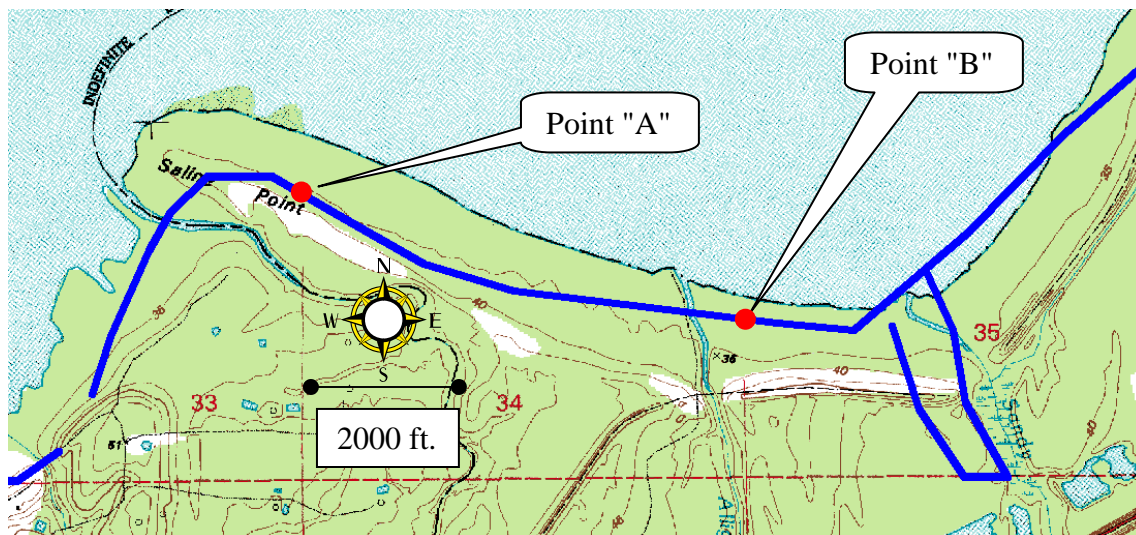


Figure 84. Walker's falsely adjusted section lines to match an erroneously plotted meander line (Base map, USGS, 1998).



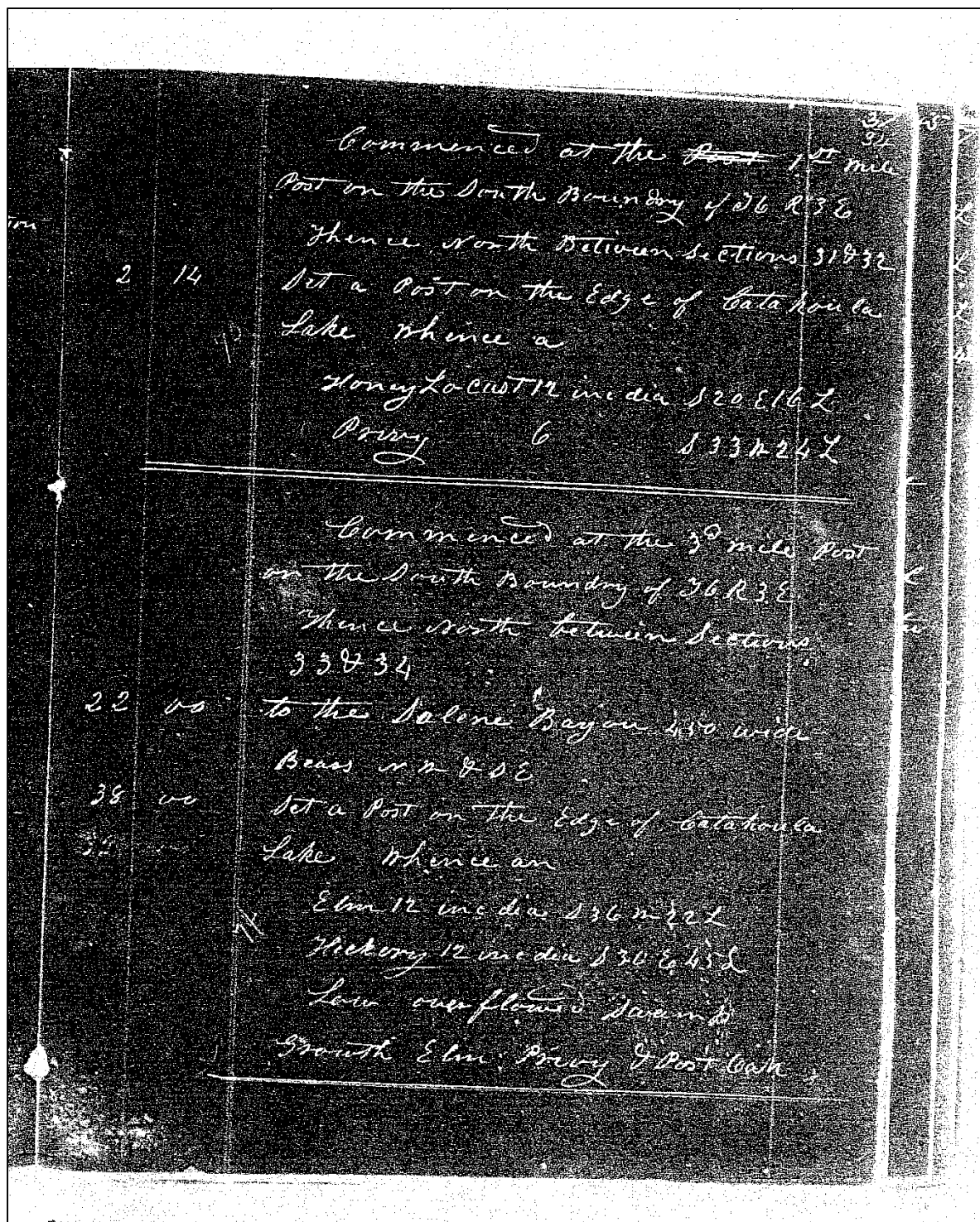


Figure 85. Walker's traverse notes on the section line common to Sections 33 and 34 shows a 16-chain (1,056-ft.) distance from Saline Bayou to the lake (United States General Land Office, 1808-1884).

### *Variability in the Water Boundary Surveys of GLO Surveyors*

The interpretation of the lake boundaries between GLO surveyors further complicates the lake boundary problem. Figure 85 is a mosaic of portions of the GLO township plats of Township 6 North, Range 3 East and Township 6 North, Range 2 East plats, dated 1842 and 1885 respectively. Note that the boundary of the lake as surveyed by the two GLO surveyors varies by approximately 1500 feet.

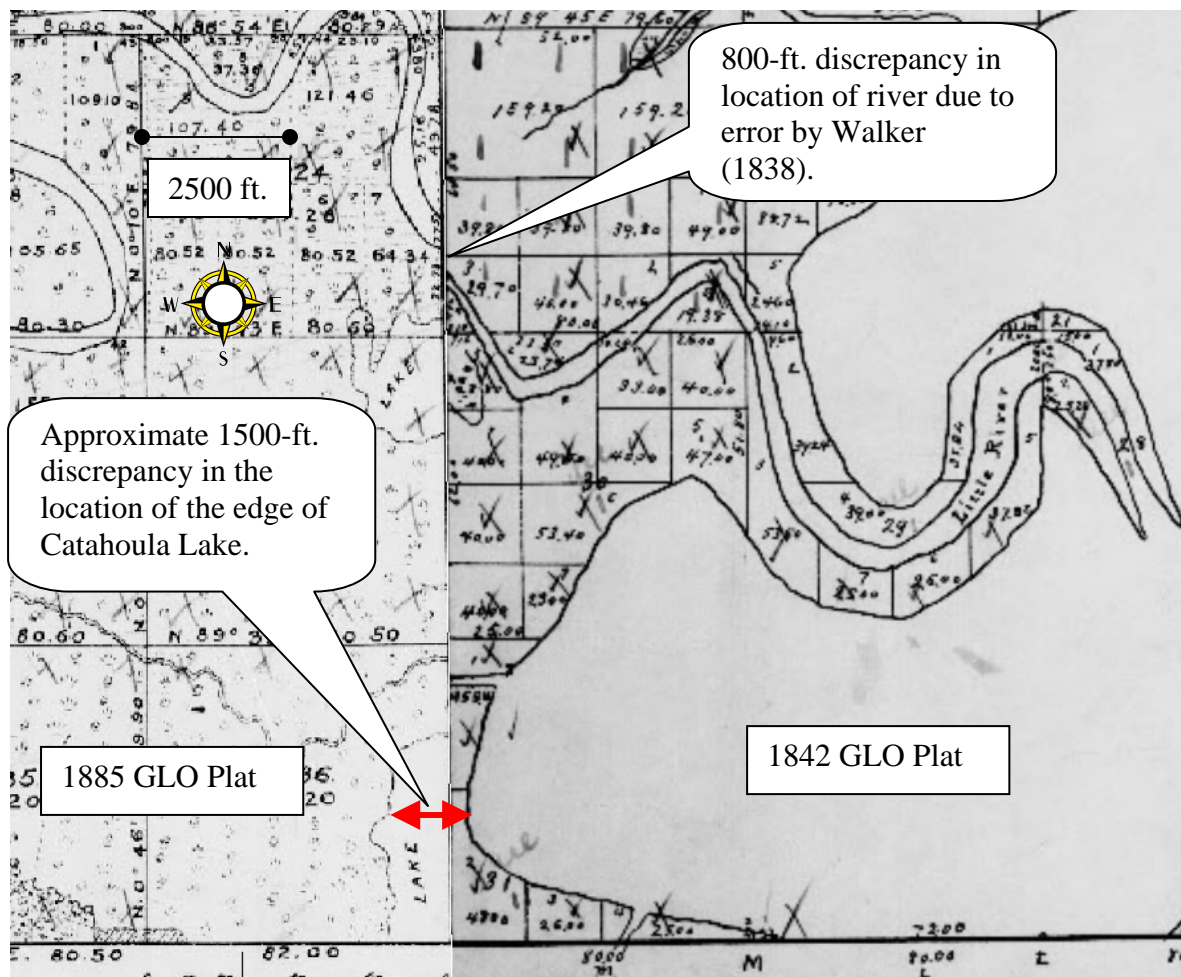


Figure 86. Discrepancy in lake boundary between the 1885 GLO township plat and the 1842 township plat (United States General Land Office, 1808-1884).

## *Physical Evidence Provided in GLO Surveys and other Surveys*

### *Section line bearing trees*

In addition to bearings and distance of section and meander line traverses, GLO surveyors recorded information about vegetation, drainage, water marks, stream widths, and soil types. This information is helpful in attempting to determine the boundary of the lake.

Ferry Lake (now Caddo Lake), a former raft lake in northwest Louisiana, was subject to extensive boundary litigation as a result of varying water levels caused by the Great Red River Raft. The raft was removed in 1873 and caused lake levels to drop (United States Department of the Interior, 1973). The meander lines were found to be erroneous and not representative of the lake boundary. A belt of overcup oak was found immediately above a belt covered predominantly by baldcypress which occupied the terraces below an easily traceable escarpment. The litigation was resolved by the determination of the lowest level of overcup oak trees (Manual of Instructions, 1973). Catahoula Lake has a similar belt of baldcypress and overcup oak surrounding its perimeter. However, in 1812, Catahoula Lake had not been stabilized by the Red River Raft, as Ferry Lake had been (United States Department of the Interior, 1973).

GLO survey field notes of 300,000 acres in the Black River and Catahoula Lake basins were examined to determine the lowest level of oak trees that existed at the time of the surveys (1809-1884). The region ranges in elevation from 27 feet and 50 feet, and the root crowns of baldcypress aging more than 200 years in the region are generally even with the ground except in areas where lakeshore erosion has taken place, as documented above. At each section corner and at every quarter corner (half-mile post), the GLO surveyors referenced 4 trees as a matter of providing restoration of any section corner that might be destroyed. The surveyors named the species of the tree, diameter, and relative position to the section corner. A review of hundreds of section line traverses revealed that some bearing trees were oaks. Applying the reasoning used

in the Ferry Lake case, the locations of all oak witness trees were plotted on a geo-referenced assembly of USGS Quadrangle Maps, LiDAR, USGS Digital Elevation Models, and DOQQ maps. The ground elevations were obtained from the LiDAR and USGS DEMs. GLO bearing tree data reveals that the lowest oak trees lie at the approximate 38 foot contour north of the lake in Township 7 North, Range 4 East. In 1854 Phelps recorded three overcup oaks at the southeast corner of Section 16, Township 7 North, Range 4 East (Figure 87), (United States General Land Office, 1808-1884). A sample of 6 overcup oaks in the Catahoula Basin reveals an average ring spacing of 0.125 inches. By applying that growth rate to the trees, the ages were estimated to be 120 years, 96 years, and 70 years. Therefore, conditions were suitable for overcup oak survival at the 38-foot contour from the middle to latter part of the eighteenth century. The USGS spot elevation of that point is 38 feet. The trees were 30, 24, and 20 inches in diameter. Paine (1884) recorded overcup down to the approximate 38-foot contour in three locations in Township 6 North, Range 2 East (Figure 88). Estimated germination dates of the overcups range from 1764 to 1812. Although these are the lowest elevations of recorded instances of oaks near 1812, this does not prove that oaks did not exist at lower elevations.



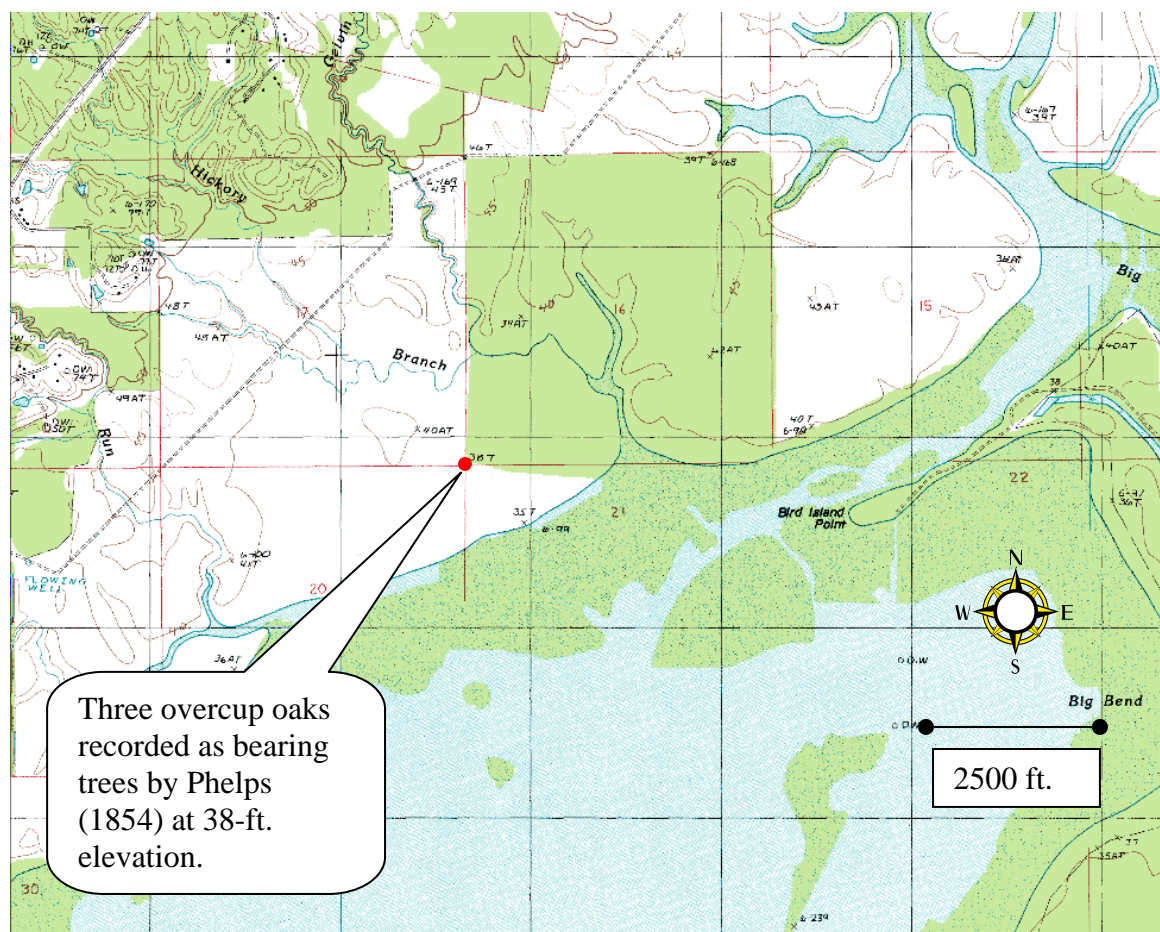


Figure 87. Three overcup oak bearing trees at 38 ft. recorded by Phelps (1854). The germination dates are estimated at 1734, 1758, and 1784 based on present-day growth of other regional overcups (Base map, USGS, 1985).

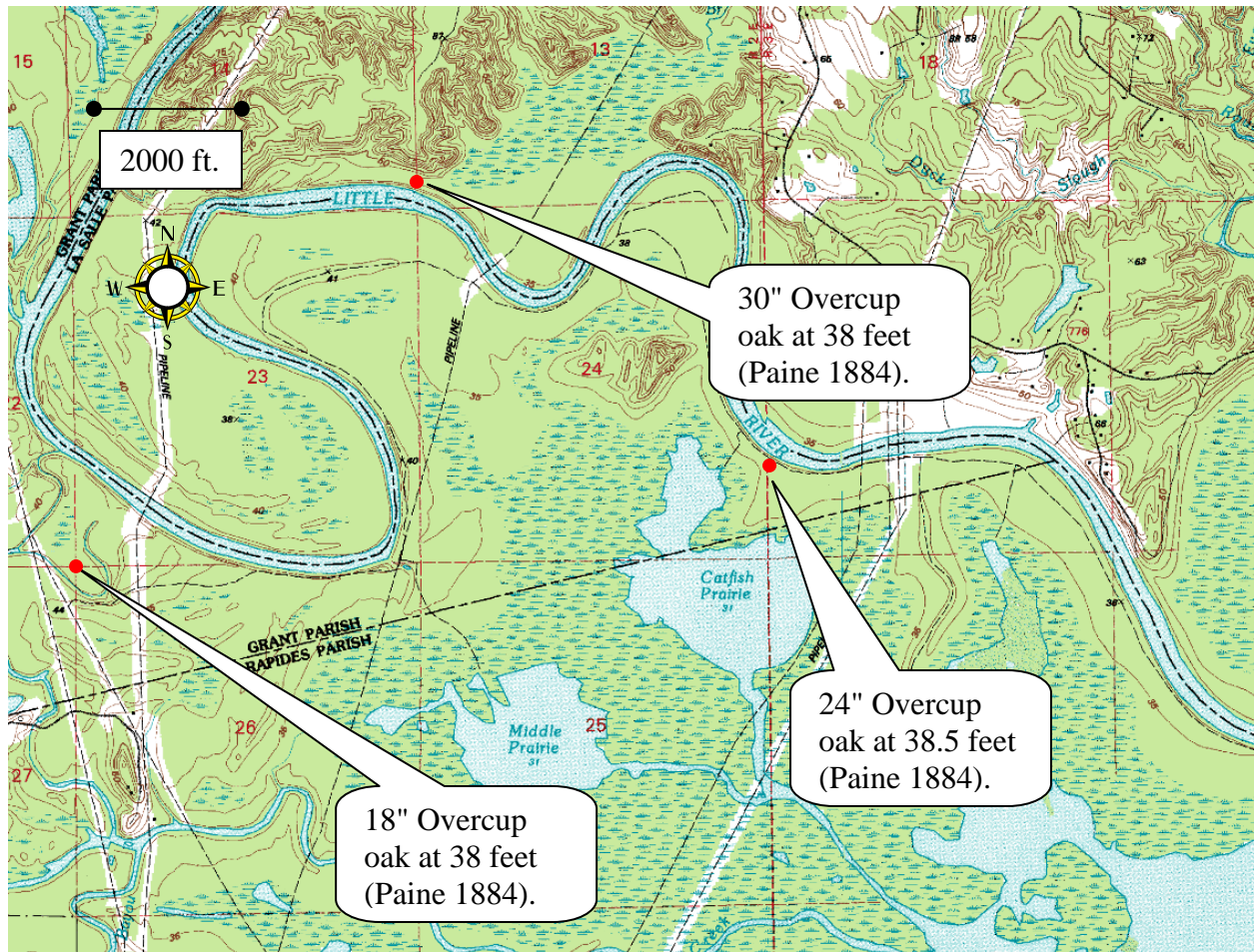


Figure 88. Overcup at elevation 38 on right descending bank of the natural levee of Little River, recorded by Paine (1884). Tree germination dates are estimated at 1764, 1788 and 1812 (Base map, USGS, 1998).

### *Terminating section lines and meander corners*

It has been demonstrated that meander lines do not adequately define the boundary of Catahoula Lake, and that meander lines were surveyed to plot the general sinuosities of the shoreline (Manual of Instructions, 1973). However, the regular section lines that terminate when the GLO surveyors encountered a lake may have more merit. When surveying a section line toward a lake, he was required to stop the section line traverse at the lake and set a point known as a meander corner.

The logic associated with the setting of a meander corner reveals an important decision-making scenario on the part of the GLO surveyor when he encountered a lake. Visualize a GLO

surveyor surveying through remote woodland or swamp and then encountering a lake. Some natural field condition caused the GLO to determine that he had arrived at a lake. His decision did not contain the bias associated with meandering the general sinuosities of a lake shore, where he would often deviate for convenience to avoid heavy brush or other conditions that would thwart his progress and reduce his profit. Therefore, meander corners may more accurately describe the boundary of the lake than meander lines.

GLO field notes for all section lines that terminate at Catahoula Lake were examined to extract any evidence that might indicate exactly what the GLO was surveying and marking as the lake boundary at each meander corner. All field notes at Catahoula Lake from 1809-1884 indicate that the survey work was done in November through January, a time during which the lake is normally low (Figure 21). Of the six GLO surveyors who surveyed the perimeter of the lake, only Walker referred to the meander corner position as being set on the water's edge (Walker, 1838). All other GLO surveyors simply stated that they set the meander corners on the edge of the lake (GLO notes, 1809-1884).

I first examined each meander corner for reliability. The field notes of each section line were examined and retraced on LiDAR overlaid on USGS Quadrangle Maps to determine their proper positions. The USGS Quadrangle Maps were found to have positioned the GLO section lines with an accuracy of better than 50 feet in every case with the exception of Walker's lines on the south end of the lake at Saline Point and on the natural levees of Little River, as demonstrated earlier. The meander corners on the natural levees of Little River were rejected from the analysis because of Walker's fraud. The fraudulent meander line shortcut taken by Walker across Boggy Bend had no apparent effect on the meander corners in that area.

Discarding the outlier elevations of above 50 feet in Sections 16 and 20, Township 6 North, Range 3 East, Walker's fraudulent survey work on the Little River, and correcting the gross error by Walker at Saline Bayou, the mean of the approximate elevations of the meander corners is 36.6 feet and the standard deviation is 3.6 feet (Figure 89). All meander corners were plotted and overlaid on current USGS quadrangle maps. The variance is too great to allow computation of a precise elevation for the boundary of the lake based upon meander corner elevations, and the plotting error and the contour data are not accurate enough to determine the elevation precisely in areas with little topographic relief. However, the data are useful to show a general range in terms of where the GLO set meander corners. Precise elevations can be determined by retracing the GLO surveys in the field and correcting for any sedimentation or erosion using the positions of the root crowns of nearby baldcypress. However, that work could require one year of land survey crew fieldwork and was excluded from this dissertation as a matter of practicality.



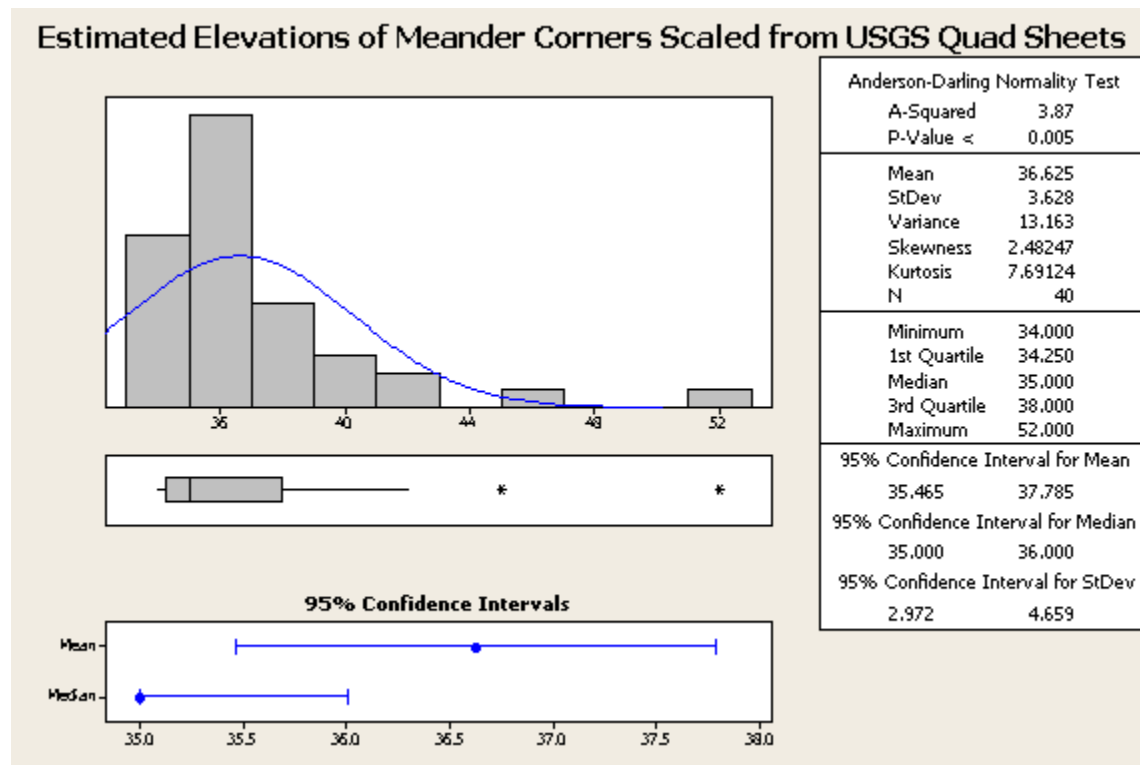


Figure 89. Estimated elevations of meander corners as scaled from USGS quadrangle maps (USGS, 1985, 1994, 1998).

### *Meander corner bearing trees*

The bearing trees for each meander corner were plotted (Figures 90-96). The bearing trees reveal important field evidence. Note that 63 of the 66 meander corner bearing trees are positioned on the landward sides of the meander corners. This is evidence that the GLO surveyors were considering the edge of the lake the point where they entered the open expanse of the lake.

Five of the meander corner bearing trees were overcup oak, and one was a white oak. All of the meander corner oaks were 12 inches or smaller, and are apparently substantially younger than the much larger section-line bearing trees. The shore in the area of French Fork is subject to substantial wave erosion, as demonstrated in Figure 14, and the current elevation is not a reliable indicator of the ground level at the time of the GLO survey. Erosion in this area prevented the

writer from establishing a former ground elevation. The other lowest-level oak is in the Saline Point area, where Walker fraudulently adjusted the location of the meander corner. The oak bearing tree at this location may not be accurate. The oak referenced in Figure 95 appears to be well above elevation 40. None of the meander corner oak bearing trees are verifiably lower than 38 feet.

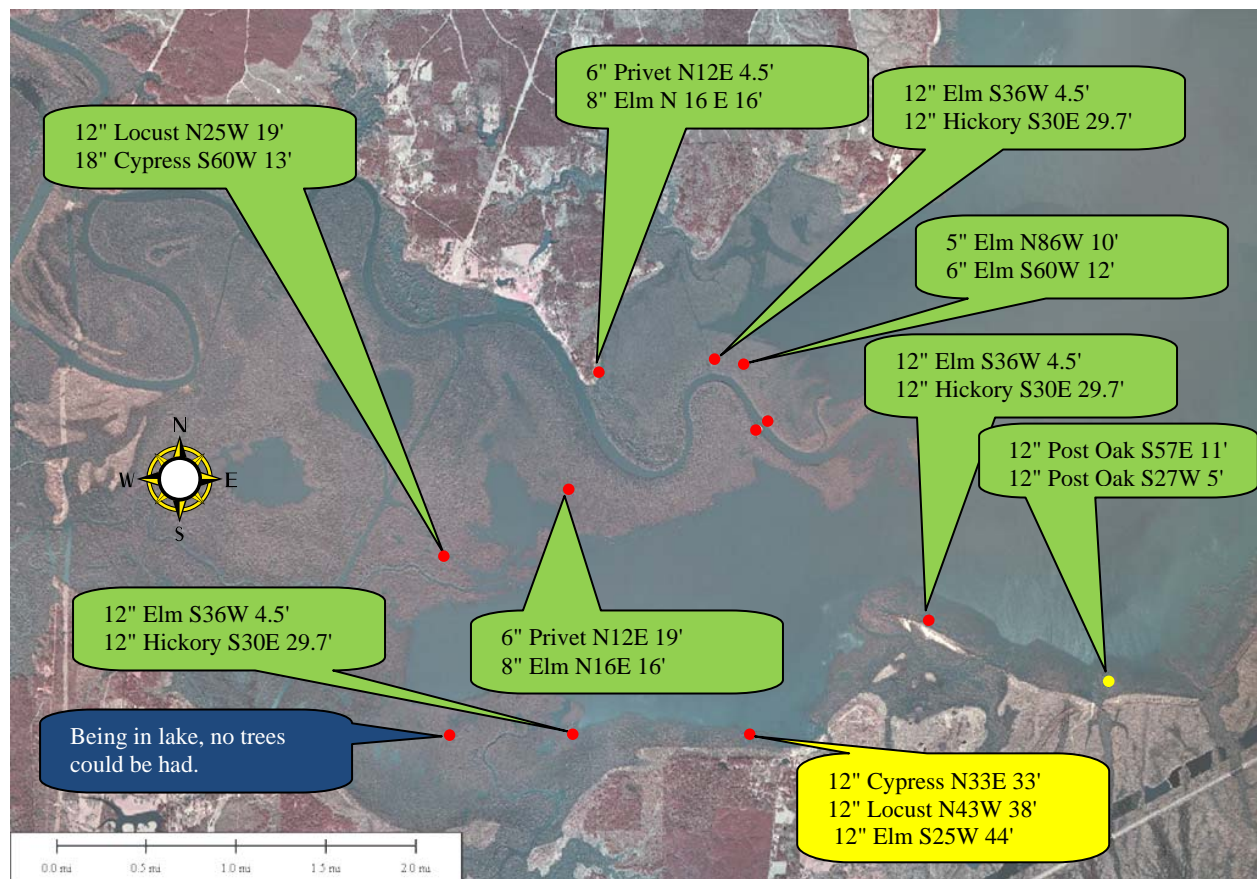


Figure 90. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner. A yellow callout box indicates that one or more trees are not landward of the meander corner. [Swamp] post oak is an alternate name for overcup oak (US Department of Agriculture, 2009), (Base aerial photo, USGS, 2004).

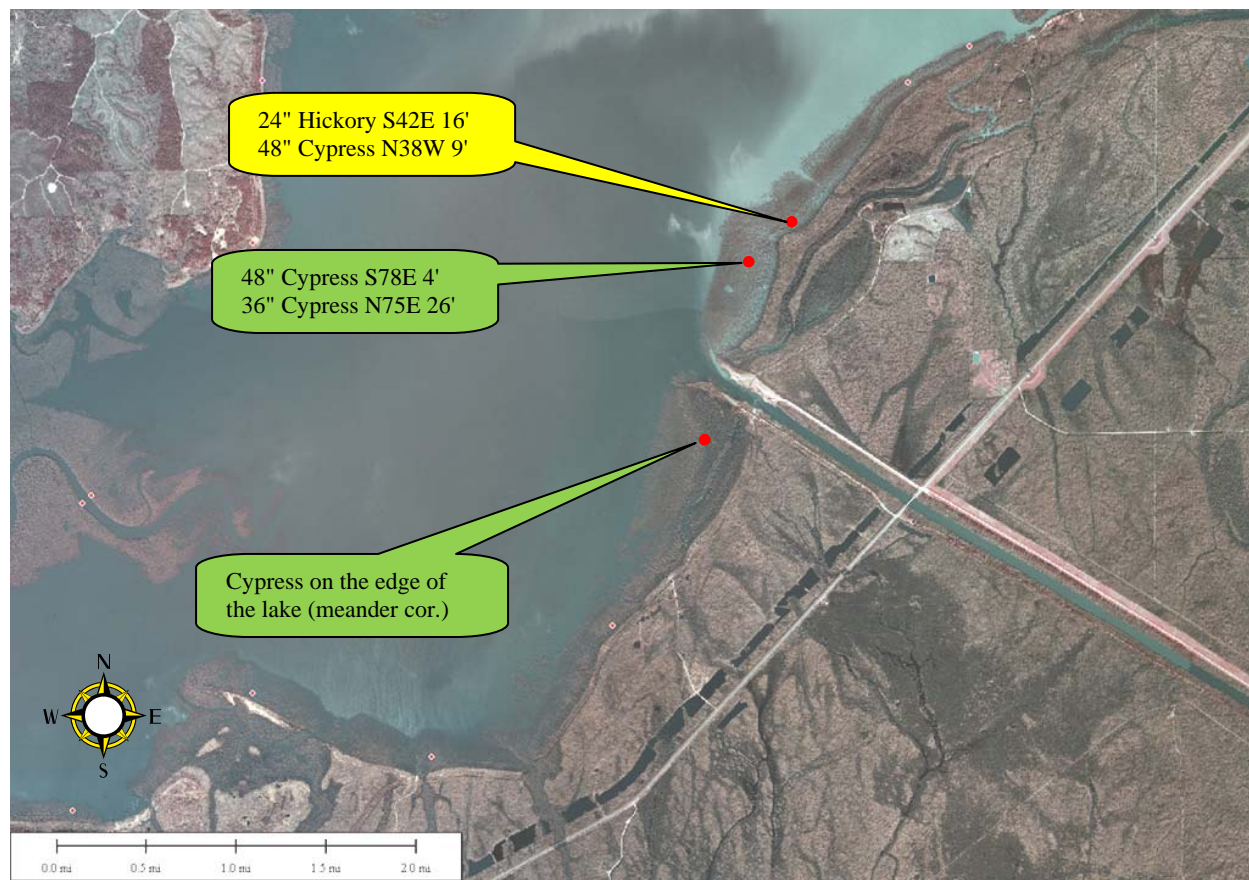


Figure 91. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner. A yellow callout box indicates that one or more trees are not landward of the meander corner (Base aerial photo, USGS, 2004).



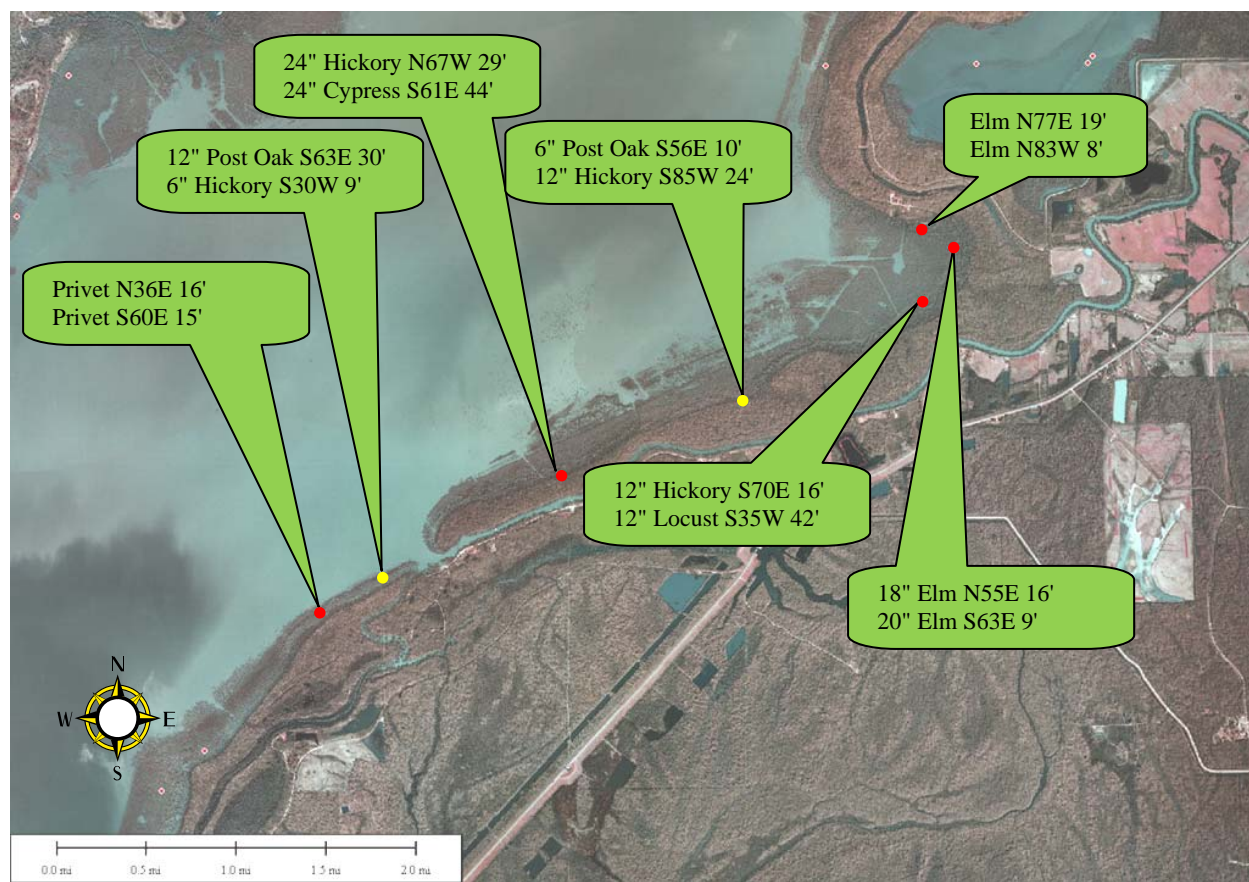


Figure 92. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner. [Swamp] post oak is an alternate name for overcup oak (Base aerial photo, USGS, 2004).



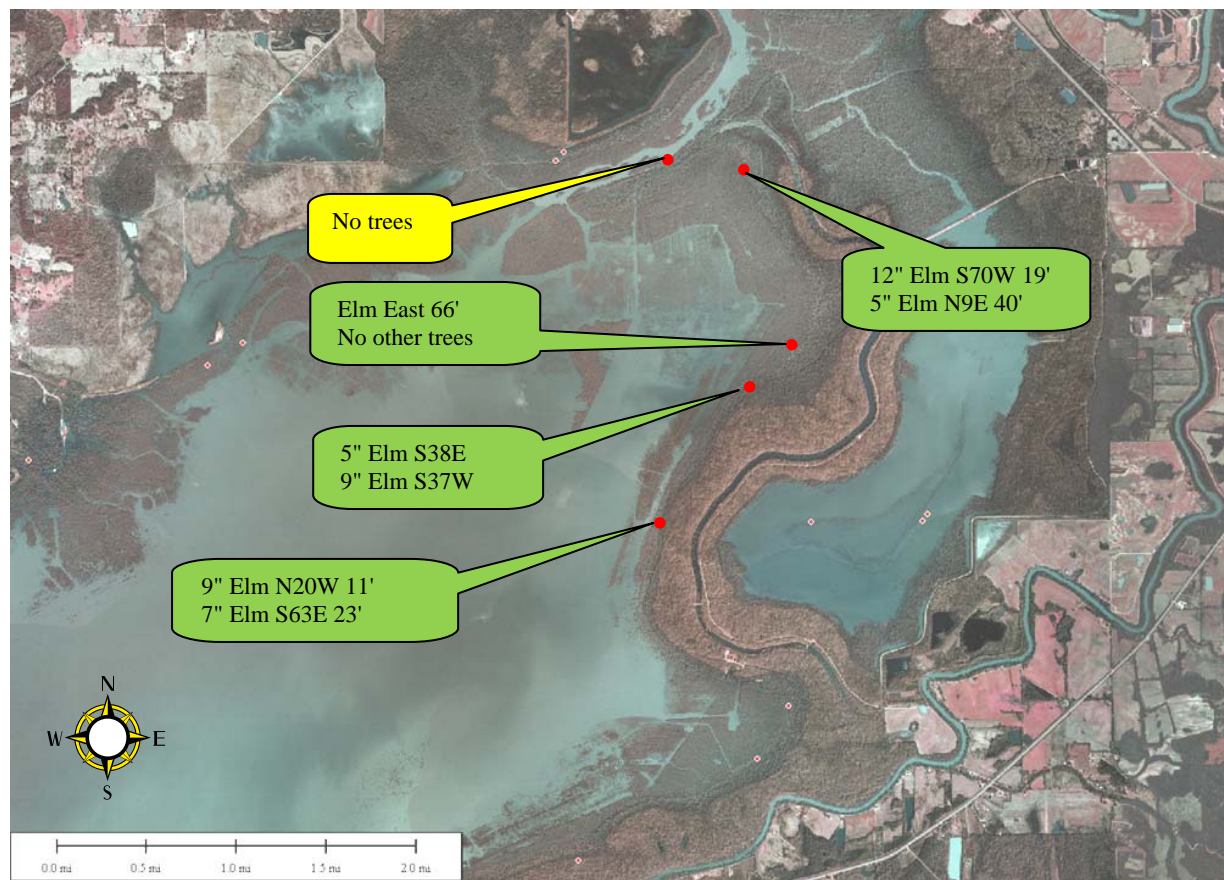


Figure 93. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner (Base aerial photo, USGS, 2004).



Figure 94. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner (Base aerial photo, USGS, 2004).

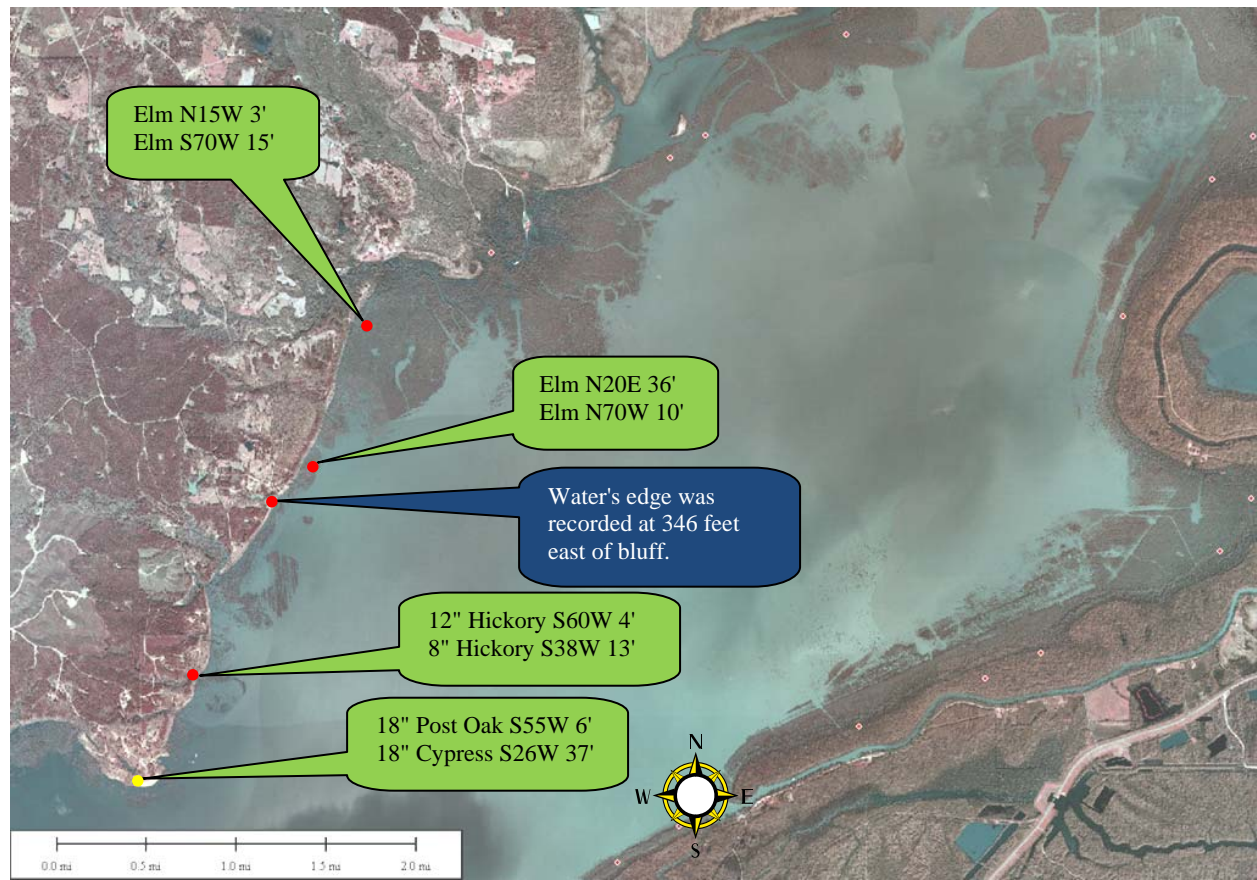


Figure 95. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner. [Swamp] post oak is an alternate name for overcup oak (US Department of Agriculture, 2009). (Base aerial photo, USGS, 2004).



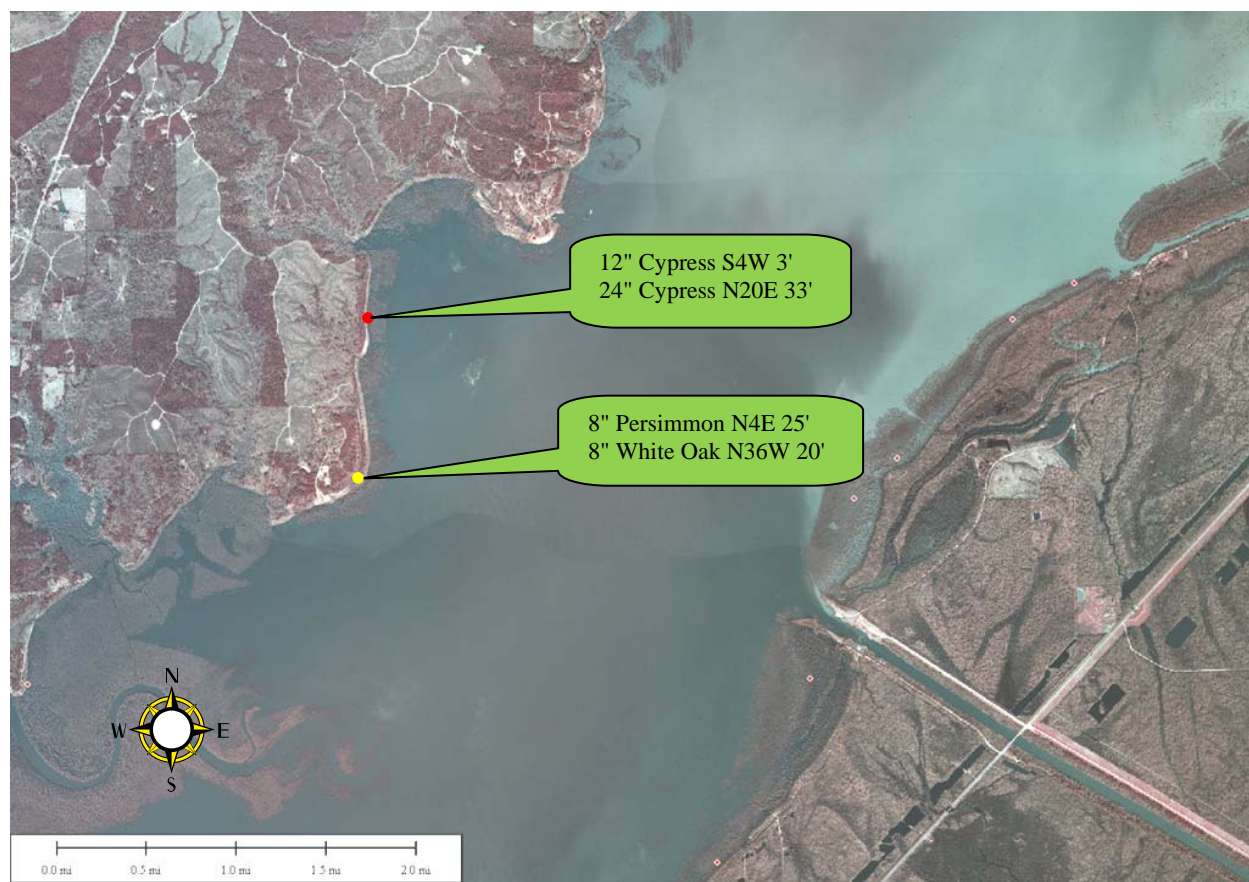


Figure 96. Meander corners and their bearing trees in the southwest part of the lake recorded by the GLO (1814-1852), (United States General Land Office, 1808-1884). Green callout boxes indicate that the bearing tree directions are in a landward direction from the meander corner (Base aerial photo, USGS, 2004).

*Bitter pecan, swamp privet, water elm, and water locust*

GLO surveyors referenced numerous water elm, swamp privet, and water locust trees as meander corner bearing trees. The writer's field survey reveals that all 4 species exist today in Catahoula Lake down to elevation 30, approximately 8 feet lower than the overcup oak. Although the Ferry Lake case referenced overcup as the determining species, an argument could be made that these 4 woody plants might also define the lower limit of the woody vegetation and, thus, the boundary of the lake.



### *Water marks*

GLO surveyors recorded water marks on trees, and reported the marks as height in feet above the ground. During the course of this dissertation, the writer observed and photographed many watermarks formed by the great annual inundation. The water marks were found to remain on the trees for at least two years, and, in some cases, longer. Therefore, the water marks recorded by the GLO in the nineteenth century do not necessarily indicate the high water mark for a given year. Approximately 350 water mark elevations were recorded by the GLO in the Catahoula Lake basin between 1809 and 1884. The water mark locations were plotted on USGS Quadrangle Maps, and the height was added to the ground elevation to arrive at an estimate of the elevations of the high water marks. The high water marks range from approximately 50 feet MSL up to approximately 60 feet MSL. The data are not consistent enough to determine an OHW. However, the data indicates the cyclic nature of the hydrology simply by virtue of the fact that the land was not flooded when surveyed by the GLO.

### *Palmetto and cane*

Darby (1817) noted during his exploration of Louisiana that palmetto and cane could not survive below the level of the great annual inundation:

The palmetto may be correctly considered the vegetable that marks the limit of the annual inundation. In all places where we have had good reason to consider the overflow annual, the palmetto ceased. Though able to resist partial and occasional immersion of its roots in water, we are led to believe this shrub would perish if the ground upon which it grew was subject to annual overflow (Darby, 1816, Chapter 3, pg. 82).

The cane decreases in size along the margin of the river, towards the inundated lands, and ceases near its verge, and is succeeded by the Fan Palmetto or *Latania*.

The *Latania* can only exist where the inundation leaves its branches out of the water; where the overflow exceeds the vegetable in height, it entirely ceases (Darby, 1817, Chapter 4, pg. 135).

South of Red River, east of the hills to the Atchafalaya River, the low grounds present an intermixture of bayous and lakes, whose banks are covered with cane and palmetto brakes, and their surface is above the annual overflow (Darby, 1817, Chapter 7, pg. 252).

GLO surveyors Terrell and Walker (1835) reported cane along the west and north lines of Section 14, Township 4 North, Range 4 East. According to LiDAR data, ground elevations range from 43 feet to approximately 47 feet. In 1814, DeFrance encountered a palmetto ridge on the east side of Township 6 North, Range 4 East in the second mile at 74 chains (3,907 feet). LiDAR indicates that the top of the ridge is at about 47 feet. Using Darby's description of the environment of palmetto, the great annual inundation probably did not exceed approximately 47 feet on a regular basis. The peak stage hydrograph of Catahoula Lake between 1961 and the present (Figure 97) indicates a mean peak of about 46.5 feet and a median of 46.28 feet. The 95% confidence interval for the mean is 45.2 feet to 47.9 feet. While this comparison is not conclusive, it indicates similarities in palmetto distribution and its relationship to the annual inundation between Darby's observations and those of the GLO in 1814 and 1835.

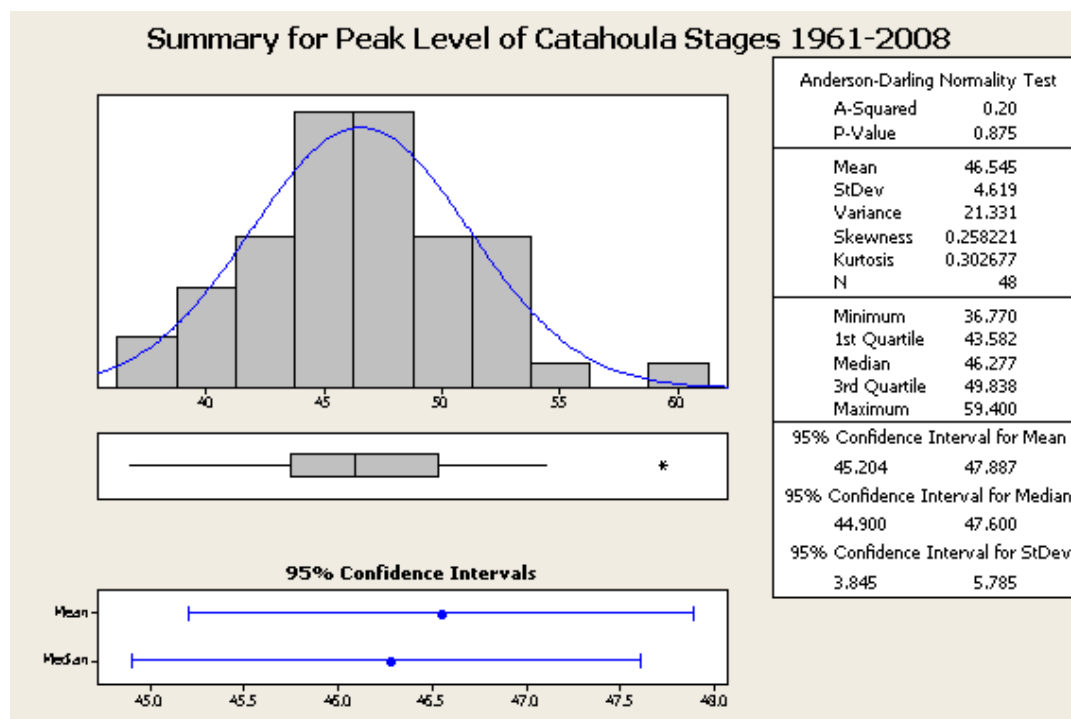


Figure 97. Summary statistics of peak levels of Catahoula Lake, 1961-2008 reasonably correspond with cane breaks and palmetto elevations recorded by the GLO in 1814 and 1835 (Placid Oil Co. gage and USACE Rivergages.com, 1961-2008).

### *General description of the terrain*

Fields and hummocks were noted in the GLO field notes when the land was not wooded. At the end of each mile, the GLO surveyor recorded the vegetation type and quality of the land. The area outside and adjacent to the Catahoula Lake meander lines was frequently referred to as low overflow swamp and was described as wooded (GLO, 1809-1884). Swampland was designated on the GLO township plats with a checkmark with a slash across it, as shown in Figure 98 (State Land Office, 2009).

### *Streams*

GLO surveyors recorded the stations that they crossed streams, and they meandered the courses of streams they believed navigable (United States General Land Office, 1808-1884).

This information is useful in GLO retracement surveying to verify locations that the original GLO surveyor surveyed.

### *Swampland*

DeFrance (1814), McCrummen (1824), Walker (1838), and Paine (1884) frequently stated that their traverses in low wooded areas were in swamps subject to overflow (United States General Land Office, 1808-1884). The areas in the southwest region of the lake where they reported swamps are shaded in translucent yellow in Figure 98.

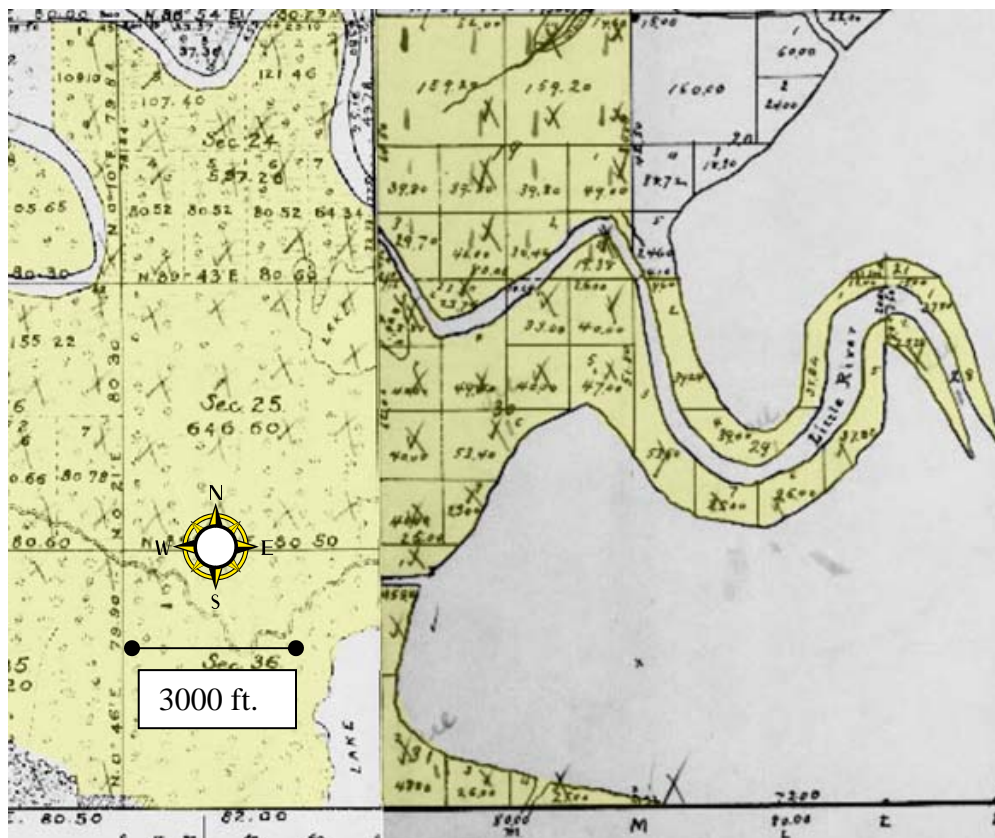


Figure 98. The land shown shaded in yellow was referred to by the GLO as swampland (DeFrance, 1814; McCrummen, 1824; Walker, 1838, and Paine, 1884 and State Land Office, 2009).

Figure 99 is an excerpt from DeFrance's notes (1814). DeFrance is describing the conditions along the east lines of Sections 36 and 25 in Figure 98 above. DeFrance states that he



is surveying along the edge of the lake and that his traverse line is in a swamp with a thick growth of privey [sic], swamp elm, and some cypress, and that the high water is about 15 feet above the surface (United States General Land Office, 1808-1884).

September 27. 1814 T 6 | T 6 22  
 Began at Post marked R 2 E | R 3 E  
 and Ran North - pass along the Edge of  
 Catahula lake T 5 | T 5  
 R 2 E | R 3 E

150 X the Flaken 3 1/2 chains wide R 2 Right, a  
 Swamp with a thick growth of Privey and  
 Swamp Elm & some Cypress high water above  
 15 feet above the surface

100 \$ 25 | \$ 30 \$ 25 a Cypress N 58 W 31 L.  
 \$ 36 | \$ 31 \$ 30 a honey Locust N 64 E 21 "  
 \$ 31 Swamp Elm \$ 64 E 32 "  
 \$ 36 Swamp Elm. \$ 70 W 5 "

2nd mile North  
 in Swamp, Timber Cypress Elm & Privey  
 enter a lake about half mile wide

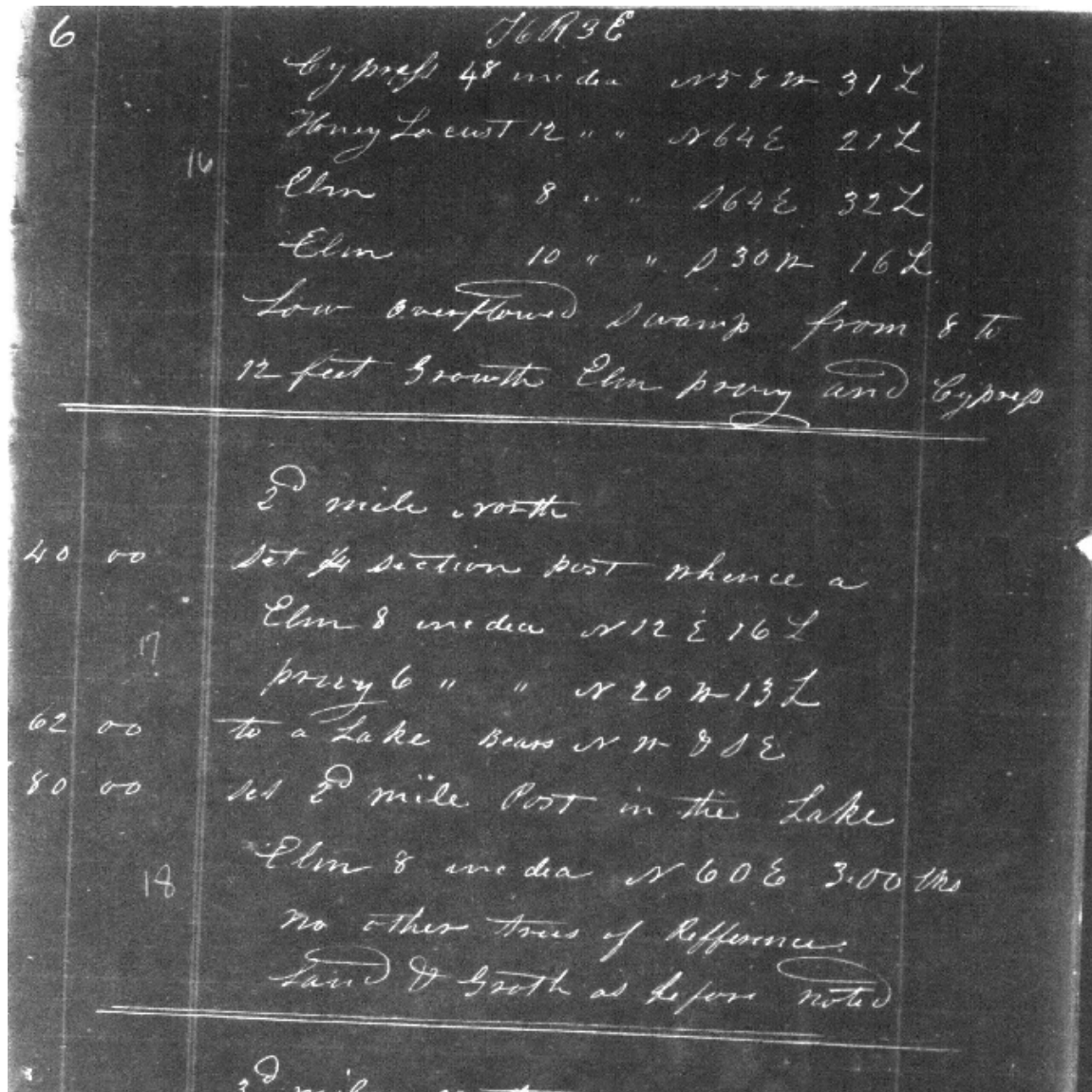
120 set up post \$ 25 | 19 } no bearing trees  
 100 25 | 30 }

3rd mile  
 to Little River -

23.50

Figure 99. An excerpt from DeFrance's notes (1814) along the west lines of Section 36 and 30 (State Land Office, 1814).

Walker (Figure 100) surveyed along the same line that DeFrance was surveying in 1814 (Figure 99). Walker classified the land as low overflow swamp with elm, privity [sic], and cypress (United States General Land Office, 1808-1884).



6  
 10  
 Cypress 48 in dia N 58 W 31 L  
 Honey Locust 12 " " N 64 E 21 L  
 Elm 8 " " S 64 E 32 L  
 Elm 10 " " S 30 W 16 L  
 Low overflowed Swamp from 8 to  
 12 feet Growth Elm privity and Cypress

---

2 mile north  
 40 00 Set 1/4 section post whence a  
 Elm 8 in dia N 12 E 16 L  
 privity 6 " " N 20 W 13 L  
 62 00 to a Lake bears N W & S E  
 80 00 set 1/2 mile post in the Lake  
 14  
 Elm 8 in dia N 60 E 3.00 lbs  
 no other trees of difference  
 Land & Growth as before noted

---

3 mile north

Figure 100. An excerpt from Walker's notes (1838) specifically describing overflow swamp on the west side of the lake along the west line of Section 30 (State Land Office, 1838).

Another representative sample of Walker's notes (1838) show that he was surveying west between Sections 13 and 24, and that he encountered the lake at 18.50 chains (1,221 feet). He

Map of Catagovia Lake showing Walker's traverse. The map includes a compass rose, a scale bar (2500 ft.), an inset map of the region, and a detailed view of the traverse line between Sections 13 and 24. The traverse is marked with points and distances, including a callout box stating: "Walker's traverse between Sections 13 and 24 to the lake."

Commenced at the 3<sup>d</sup> mile Post  
on the East boundary  
Thence west between sections 13 & 24  
Set a Post on the Edge of the Lake  
whence a by pass 48 inc. dia S 78 E 62  
do 36 inc. dia S 75 E 40 L  
Low overflowed Swamp Growth  
by pass 9 inc.

136



### Miscellaneous GLO evidence

Notes containing miscellaneous evidence in the southwest portion of the lake are shown in Figure 102. The callout boxes in the figure cite objects that each surveyor referenced.

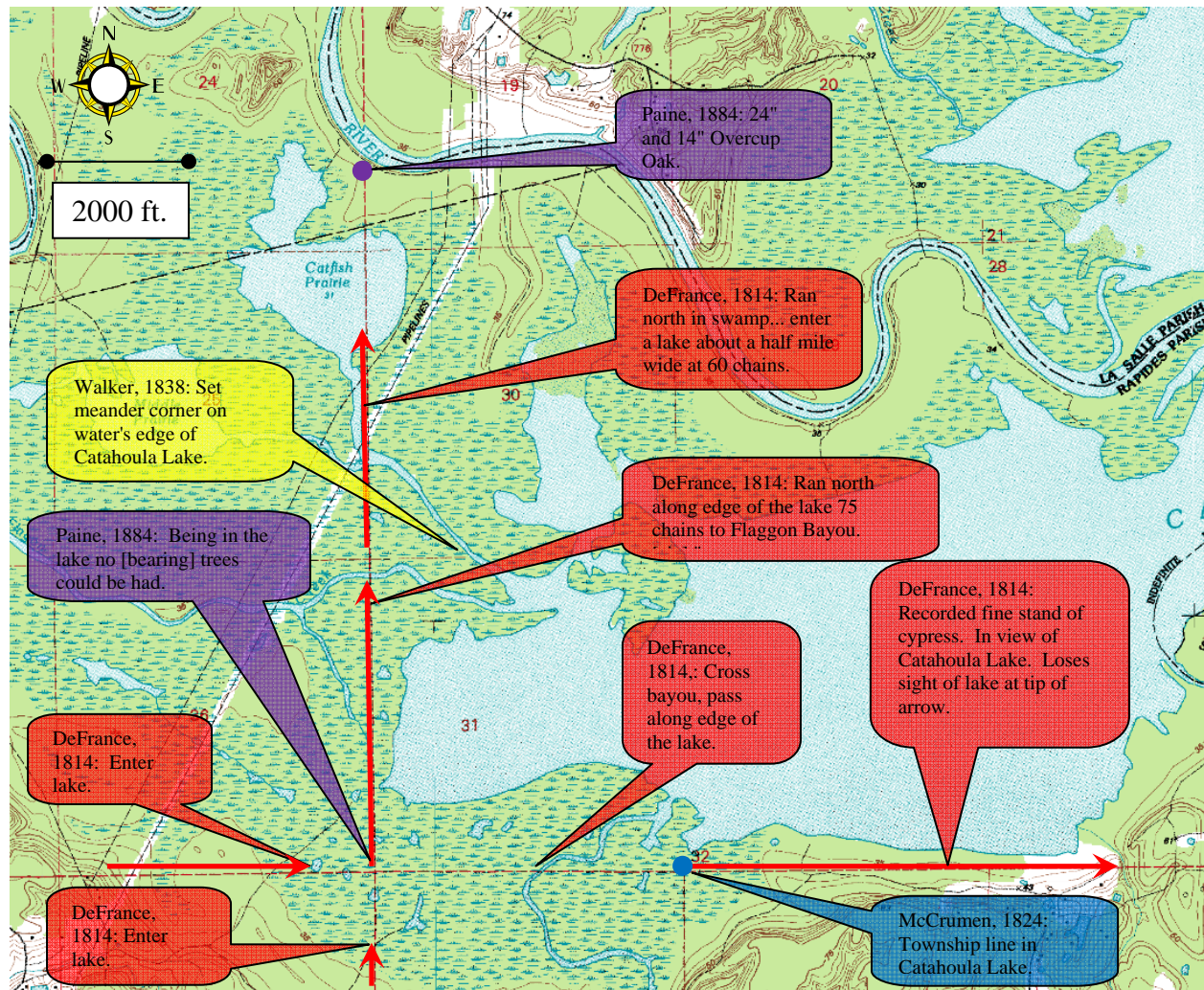


Figure 102. Miscellaneous evidence recorded by various GLO surveyors between 1814 and 1884.



### *The Heard and Daigre survey of 1942*

In 1942 Heard and Daigre surveyed the 36 foot contour of Catahoula Lake as part of Russell's determination of the shore line of Catahoula Lake (Heard and Daigre, 1942). Heard and Daigre placed two-inch iron pipes at many of the 36 foot contour meander traverse points. The writer retraced the survey by Heard and Daigre in 4 areas to determine the amount of reliction or accretion. The areas selected are listed below.

1. Hemphill Creek/Devil's Creek delta on the west side of the lake. Russell (1942) reported that substantial sedimentation occurred in the deltas of the creeks entering the west side of the lake. One of the original pipes was found in the delta at Point A (Figures 103-104). The natural ground above the top of the pipe was at elevation 39.1 feet, indicating that 3.1 feet of sediment had built up in this area since 1942.
2. A location approximately 3,000 feet northeast of the mouth of Hemphill Creek is an area where upland erosion would be expected to be minimal due to low relief (Figures 103-104). A two-inch pipe was recovered at Point B. The ground level was determined to be 36.1 feet, indicating only minimal sedimentation, possibly due to organic deposition.
3. A two-inch pipe on the south line of Section 25, Township 7 North, Range 3 East. The pipe was found at a location where the surface is at 36 feet, with an estimated tolerance of 0.5 feet. A level run was made from the water's surface approximately 1,400 feet southerly, and the water surface may have been variable during the day due

to strong winds. A precise elevation was not verified by closure to a stable lake surface or a verified benchmark.

4. Russell's Landing, where the left descending bank of Little River departs the hills, and the right descending bank is a natural levee. The meanders by Daigre and Heard are still very close to the same position they were in 1942, indicating no significant erosion or accretion.

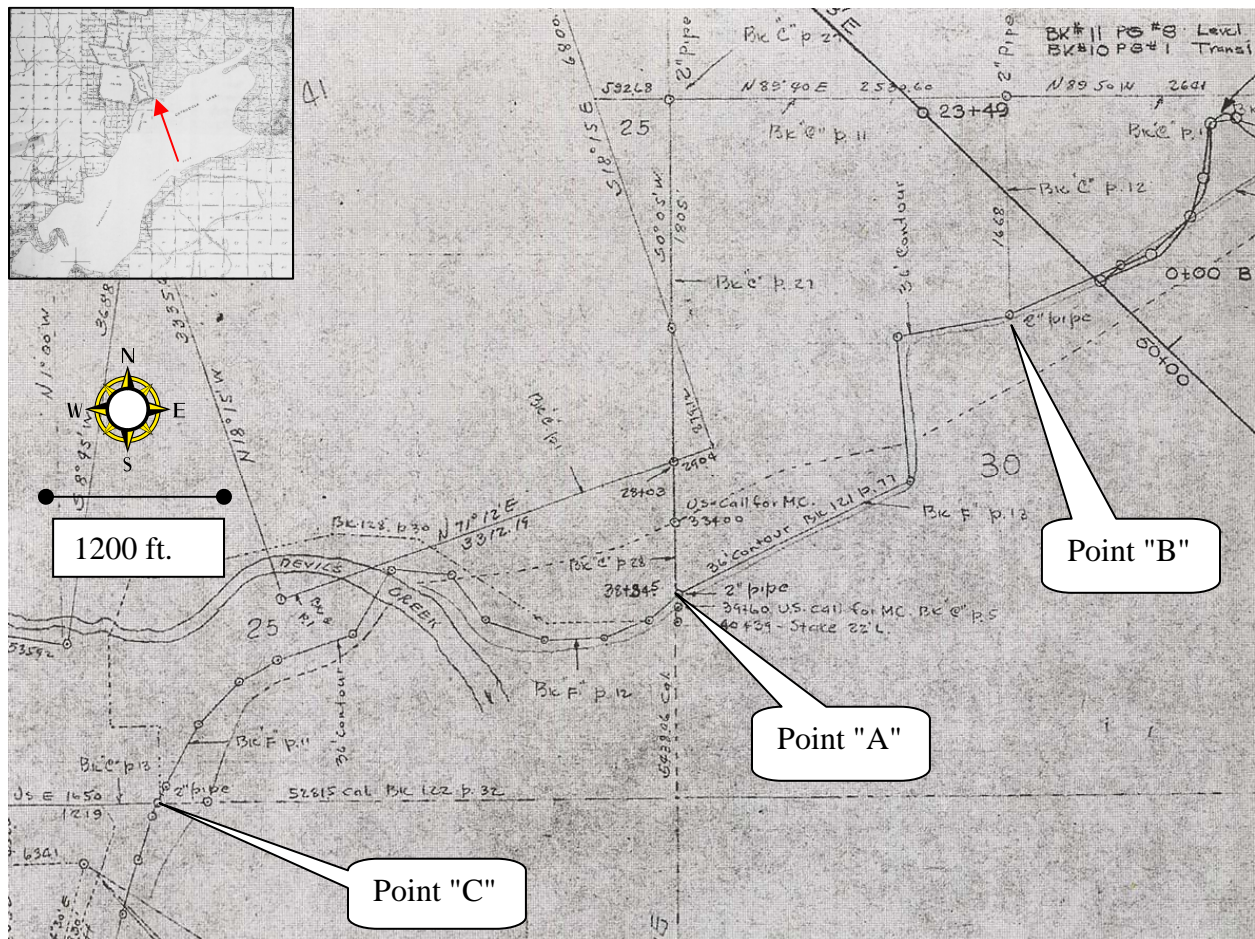


Figure 103. Sedimentation check points A, B, and C at the Devil's Creek-Hemphill Creek alluvial fan. Point A is in the sandy area subject to sedimentation, and Points B and C are outside the alluvial fan. Point A experienced 3.05 feet of sedimentation since 1942, and sedimentation since 1942 was negligible at Points B and C (Base map, Heard and Daigre, 1942).



Figure 104. The upper photo shows pipe at Point A. The lower photo is pipe at Point B.

### *Discussion*

The following items summarize the evidence discovered in the review of the nineteenth century GLO surveys and the Heard-Daigre Survey of Catahoula Lake.

1. The meander line surveys of the lake are used to plot the sinuosities of the shoreline and do not constitute the lake boundary.
2. The GLO surveyors committed gross errors and fraud in at least 5 instances on Catahoula Lake. GLO surveyors surveying the same lines at different times did not always record distances that were in agreement, and they did not always meander the same location of the lake boundary.
3. Bearing trees were surveyed by GLO and tied to known points such as section corners, quarter corners, and meander corners. Since the locations of the trees are known by virtue of the GLO survey, ground elevations can be applied in order to determine the approximate elevations of the bearing trees. In this case, overcup oak, a marker tree used in the Ferry Lake boundary dispute, was mapped and found to exist down to an approximate elevation of 38 feet MSL. Meander corners indicate possible lower (and smaller) oaks, but shoreline erosion and measurement errors prevent precise determination of the elevations of those oaks.
4. Water marks were recorded by all GLO surveyors, but they varied too much to be used to determine the OHW.



5. Palmetto was described by Darby (1817) as growing at levels higher than the great annual inundation. GLO field notes describe palmetto growing on ridges in areas where the terrain is at or above 45 feet MSL.
6. GLO surveyors referred to low, wooded areas around the lake as swamp, and the land was patented as swampland.
7. Water locust, swamp privet, water elm, and bitter pecan exist at elevations below the approximate 38 foot overcup belt limit. An argument can be made that these woody plants constitute the lake boundary.
8. A determination of the OHW of today could be controversial because of the cyclic nature of Catahoula Lake. The GLO surveyors were faced with the same problem. In addition, the GLO had no precise definition of exactly what constitutes the boundary of a lake. The problem is exacerbated by the flat terrain in the southern part of the lake.
9. Miscellaneous evidence recorded by the GLO may be used in conjunction with other evidence to render a possible solution to the lake boundary.

## CHAPTER 9

### THE COMPLEXITY OF THE PROBLEM

#### *Four Examples of the Problem*

The concepts of the complexities in determining OHW have been presented. Four examples of the problem are presented below. These are not the only problematic boundary areas on the lake.

#### *Southwest portion of the lake near Flaggon Bayou*

Figure 105 is an image provided by the State Land Office (1999). The overlays shows the meander lines by the GLO in white and the 36 foot contour as surveyed by Heard and Daigre in yellow. Approximately 3,300 acres lie between the meander lines and the 36 foot contour in this area (shaded in green). If the 36 foot contour line is determined to be the lake boundary, all of the privately owned land in this region could be claimed by the State of Louisiana.

Duck hunters in the southwest portion of the lake near Flaggon Bayou have cleared open areas in the woods to attract ducks (Figure 106). These lands were originally patented by the state and are now titled in the names of private owners (Louisiana State Land Office, 2009). The landowners obviously expect the water to inundate the cleared areas each duck season. One might conclude that, since the water levels inundate the cleared areas regularly each year, these areas are below the OHW and, thus, are owned by the state of Louisiana. The landowners have defended their property lines with posted signs and they pay property taxes on these lands (Rapides Parish Tax Records, 2009).

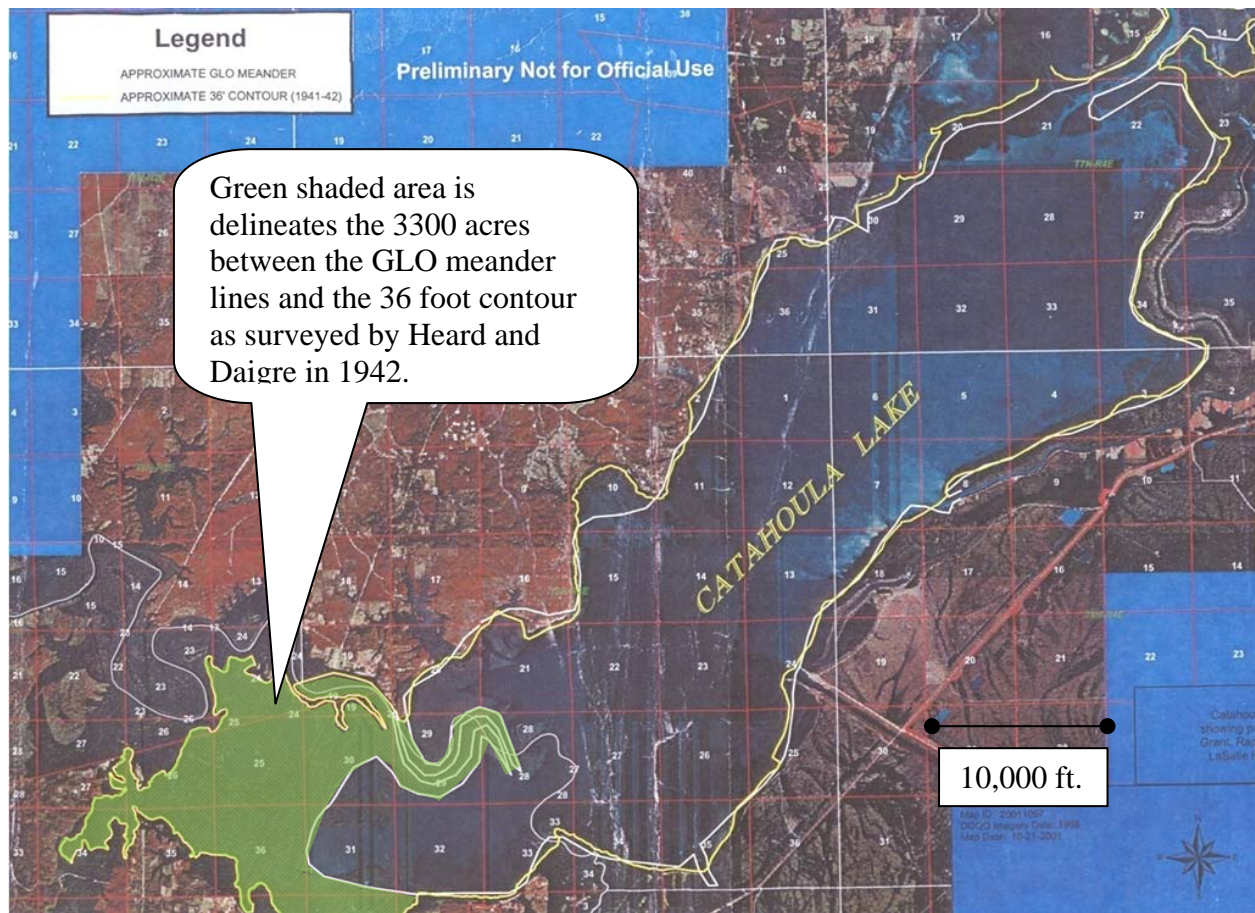


Figure 105. 3,300 acres of possibly disputed ownership in the southwest part of Catahoula Lake (Louisiana State Land Office, 2009). Green shading was added by the writer.



Figure 106. Duck hunting hole clearings in the region between the GLO meander line and the 36 foot contour as surveyed by Heard and Daigre in 1942 (Google Earth, Inc., 2009). This area is an enlargement of part of the area in Figure 105.



### *Boggy Bend*

The area shaded in green (Figure 107) shows a 225 acre difference between the Heard-Daigre 36 foot contour and the GLO meander line. The land in this area is claimed by a private landowner who has formed a class that has filed a class action lawsuit against the State of Louisiana to fix the boundary of the lake (Crooks et al v. State of Louisiana, 224262 9th JDC, Rapides Parish).

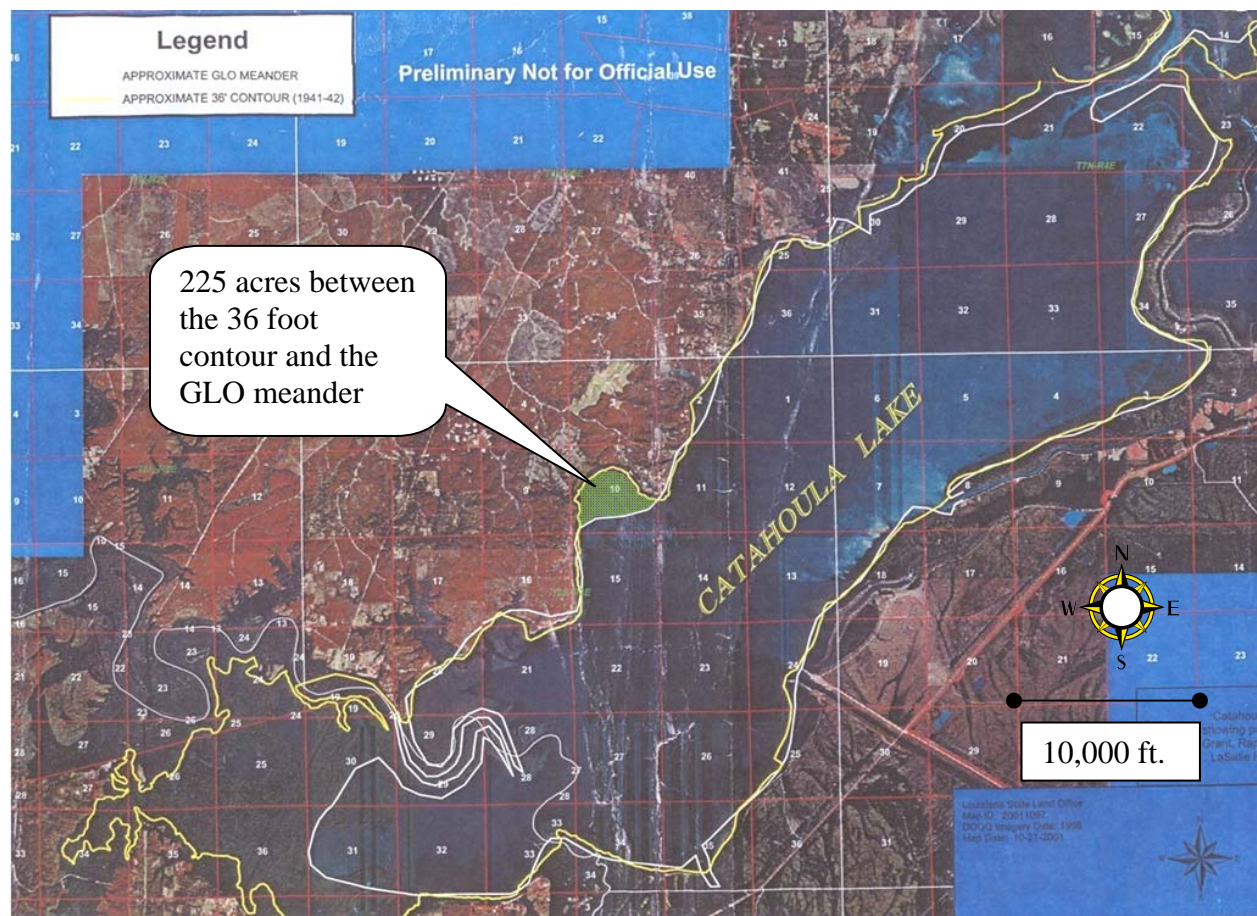


Figure 107. 225 acres between the GLO meanders and the 36 foot contour (Base map, State Land Office, 2008).

*Hemphill Creek-Devil's Creek area in Section 30 Township 7 North, Range 4 East*

In 2004, Henry Sanders sued the State of Louisiana (La.App. 3 Cir., Jan. 30, 2008) over the location of his riparian boundary (Figure 108).

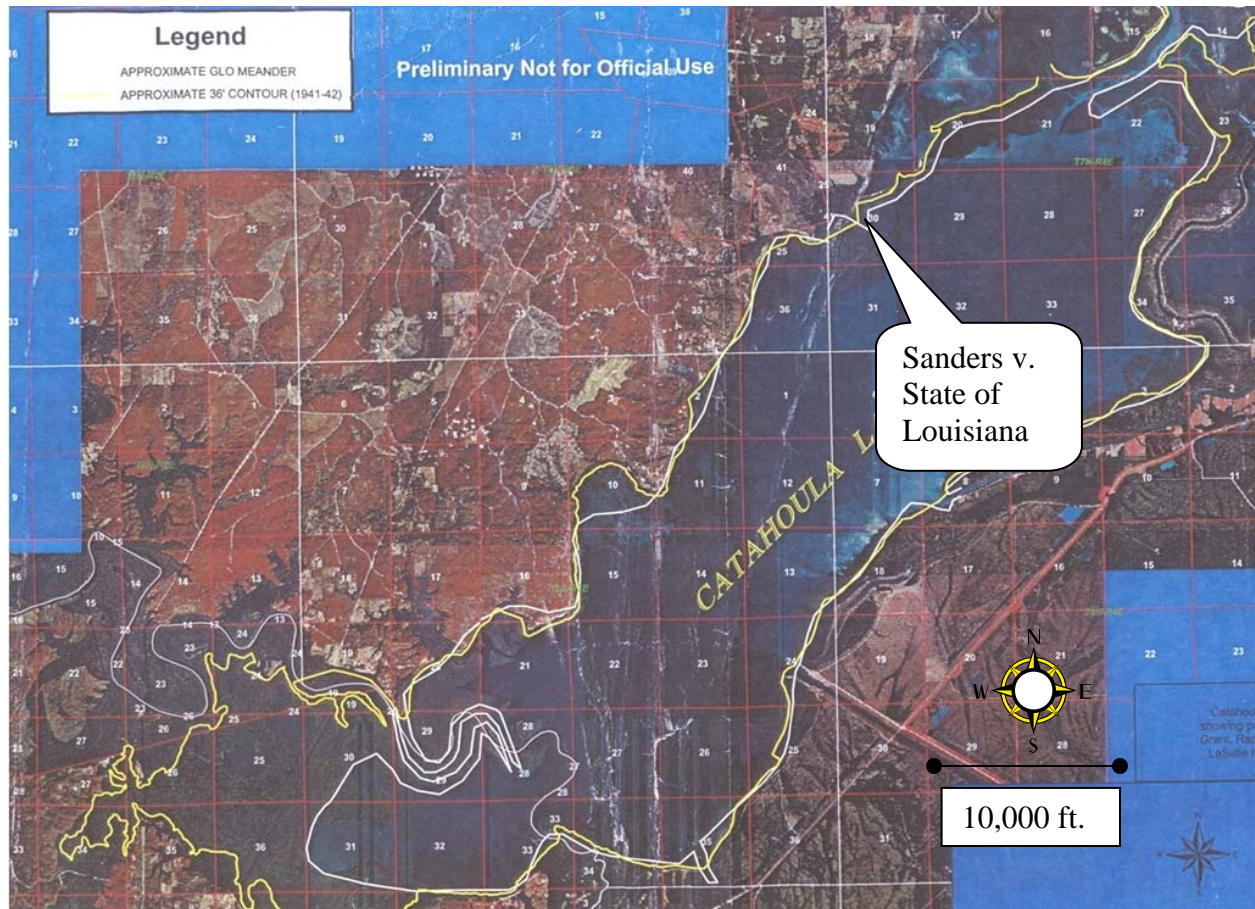


Figure 108. Henry Sanders v. State of Louisiana at Devil's Creek (Base map, State Land Office, 2008).

The events are summarized below. See Figure 108.

1. Sanders claimed that the 36 foot contour of today is the boundary.
2. The State of Louisiana claimed the boundary at the 36 foot MSL line as surveyed by Heard and Daigre in 1942, using Russell's shoreline determination (1942) as its basis.

3. Sander's civil engineering expert reported that the OHW of Catahoula Lake was at 30.1 feet.
4. Sander's geologist expert claimed that the cypress fringe did not determine the lake boundary since it did not appear to be functional as a cypress fringe at statehood in 1812.
5. Based upon his interpretation of the botanical evidence, Sander's botanist agreed with Sander's geologist.
6. The state's geographical/geomorphology expert reported that the Russell (1942) study was correct, and proposed the Heard-Daigre 36 foot contour as the correct boundary.
7. The present-day 36 foot contour and the Heard-Daigre line were re-surveyed in the field and presented in court.
8. The district court ruled that the lake boundary was at 30.1 feet.
9. The case was appealed.
10. The appellate court accepted the study by Russell (1942) and ruled that the Heard-Daigre survey of the 36 foot contour (1942) is the boundary (La.App. 3 Cir., Jan. 30, 2008). The court did not take into consideration Russell's reporting that sedimentation had likely shifted the boundary into the lake since 1812. The state's

experts demonstrated that approximately 3 feet of silt had been deposit since 1942.

The appellate court ruling gave Sanders a substantial amount of reliction.

Importantly, the court restricted the ruling to Sander's property only.

A graphical representation of the problem is presented in Figure 109. The magenta lines are an overlay of the 1853 GLO township plat (1853). The green line is a digitally correct line based upon entry of the GLO traverse calls into a COGO program. The red line is the Heard-Daigre line (1942) that follows the 36 foot contour as retraced and re-established in the field on the ground by the writer. The yellow line is the present-day 36 foot contour as established on the ground by the writer along the boundary of the land in dispute shown by the cyan line. The blue line is the location of the lake boundary as proposed by Sanders' botanist and geologist. The chronology of the establishment of the lines clearly shows a progression of the Devil's Creek delta between 1853 (magenta) and the present-day 36 foot contour (yellow).



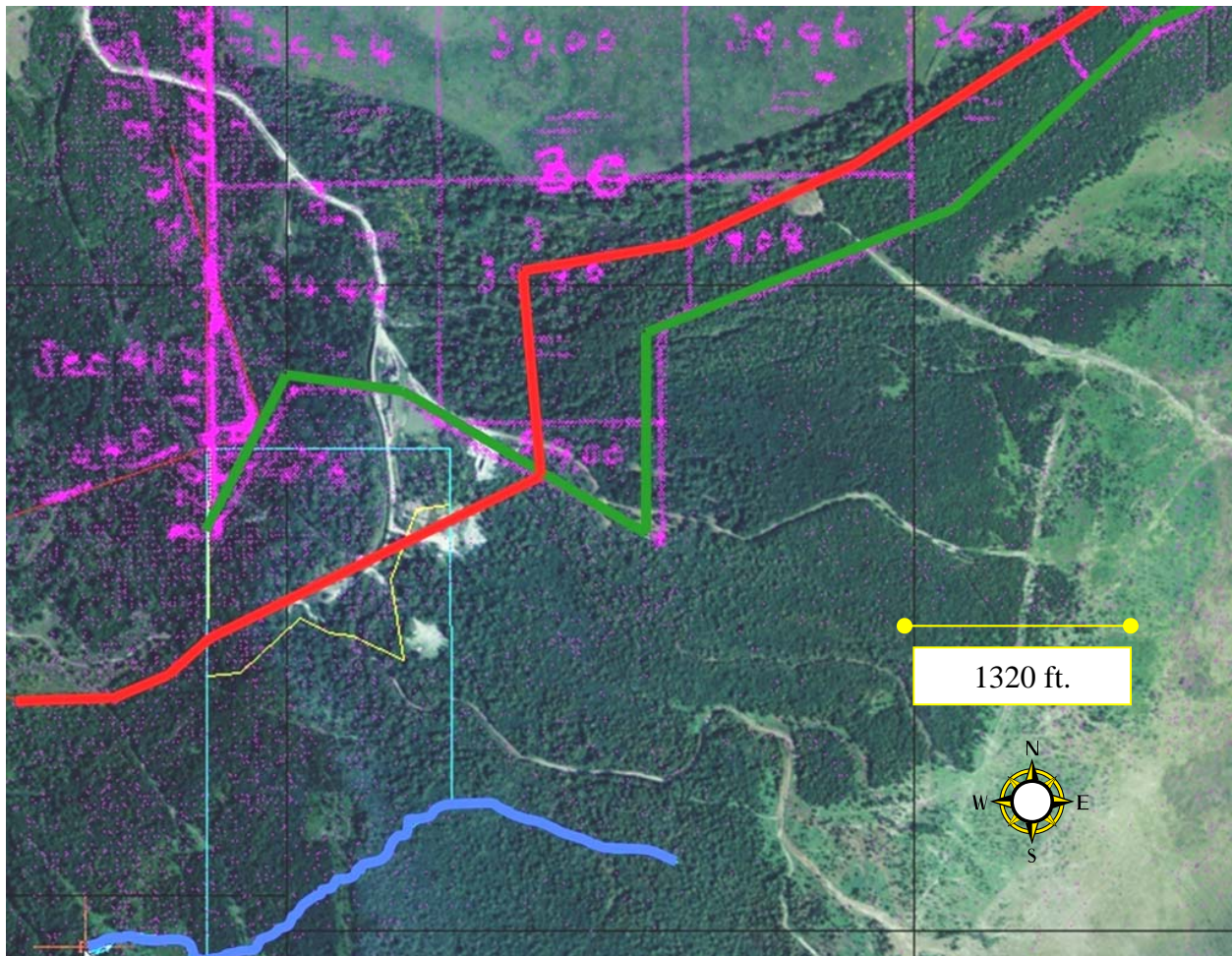


Figure 109. A map of the disputed lake boundary at Devil's Creek in Section 30, Township 7 North, Range 4 East (US General Land Office, 1808-1884).

*Rapides Parish boundary dispute*

The eastern end of the 27 mile-long boundary line common to Grant and Rapides Parishes terminates at a point defined as “the point where Little River empties into Catahoula Lake.” The lake boundary became the subject of extensive litigation between Rapides and Grant Parishes, (La. App. 3 Cir. 02/22/06). If the tip of the Little River delta were used as the lake boundary, the line would have shifted from its long-accepted location to a point about one mile south. Litigation lasted 6 years at a cost of approximately \$2,000,000 in legal and expert costs. The 36 foot contour proposed by Russell (1942) and Brown (1943) matched precisely with a

map prepared by the parish engineer (Figure 110), Confederate Captain R.W. Bringhurst, in 1871 (Bringhurst, 1871). Grant Parish proposed the tip of the S-curve 2.5 miles farther downstream (and latitudinally one mile south) based on the 1842 GLO township plat. Rapides proposed two boundary alternatives, the first of which was the 36 foot contour Russell (1942) and Brown, (1943), and the other was the parish line as positioned on the USGS quadrangle maps (USGS quadrangle maps, 1935-1998).

The USGS map was demonstrated to be based upon a USGS determination of the east end due apparently to errors in Walker's GLO survey (1838) of Little River as presented in Figure 110. The district and appellate courts ruled in favor of Rapides Parish and decided that the USGS quad sheet line was the parish boundary in accordance with the Common Error Doctrine (La. App. 3 Cir. 02/22/06). The parish line was, therefore, set, based upon acceptance of a boundary that had been established by areal means. This landmark ruling provides strong support for the application of areal methodology for setting of boundaries. This concept will be analyzed later in this study.

Had the Grant Parish experts detected and understood Walker's 1838 fraudulent survey, and had they applied proper land surveying retracement techniques, the parish line they proposed would have closely matched the position that the Rapides Parish surveyor had placed it in 1871. And the two industries' locations that incited the dispute would have remained in Rapides Parish even if the Grant Parish experts' strategy had been ruled correct.

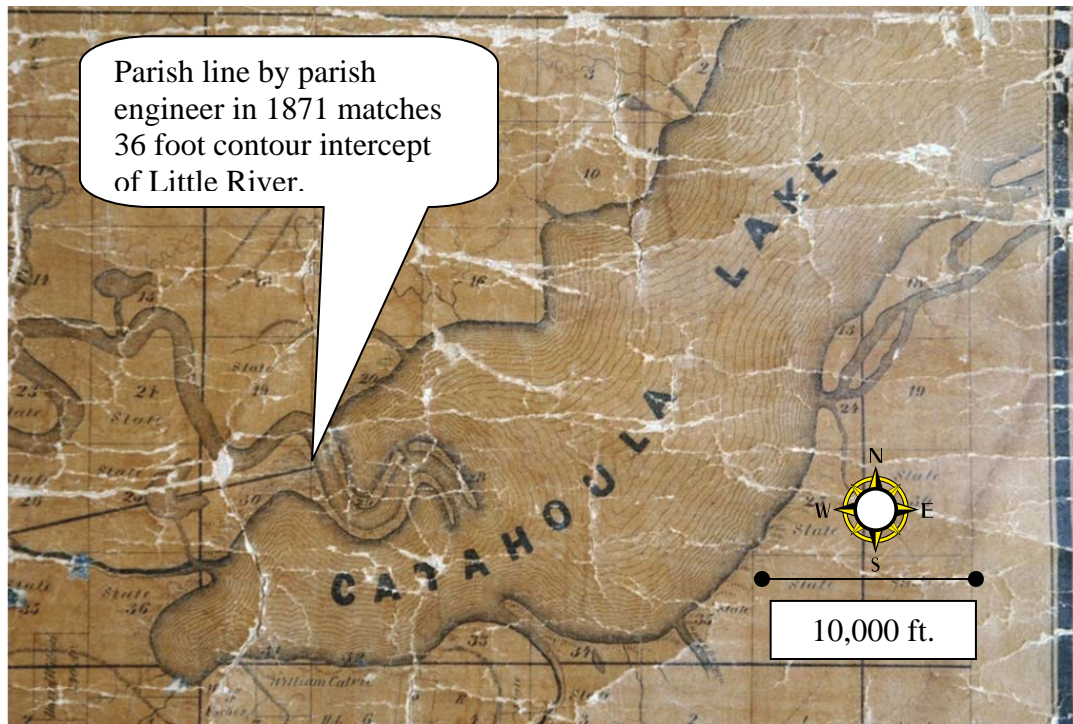


Figure 110. An excerpt from the Bringhurst Map of 1871 (Bringhurst, 1871).

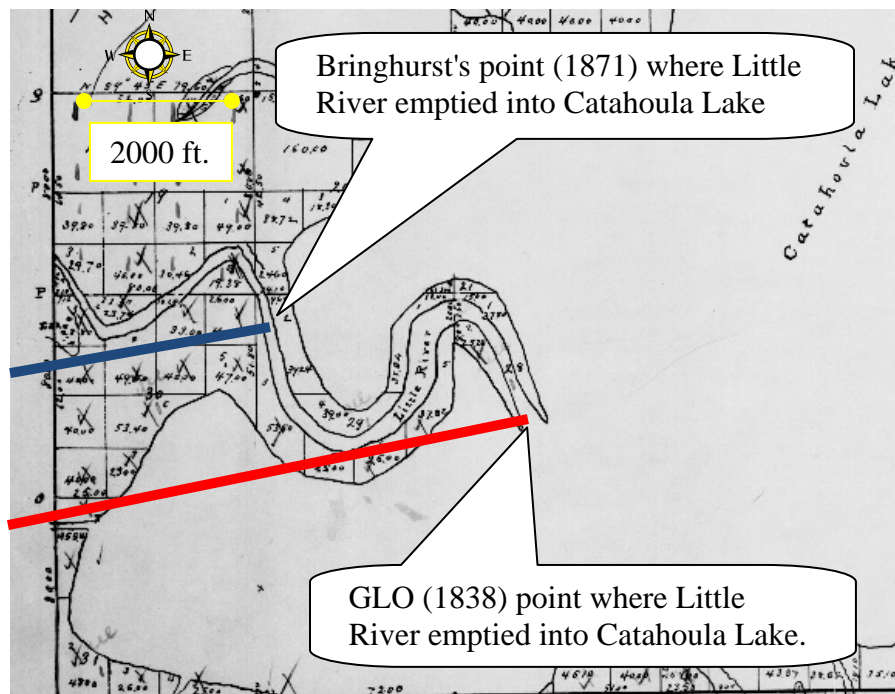


Figure 111. The eastern terminus of the boundary line common to Rapides and Grant Parishes, established 1869 depends on the location that Little River emptied into Catahoula Lake in 1869, when Grant Parish was created (Base map, State Land Office, 1842).



## CHAPTER 10

### TWO IMPORTANT GEOGRAPHIC LANDFORMS AND NATURAL MONUMENTS

#### *Is Catahoula Lake a Lake?*

Catahoula Lake has been a cyclic lake that is nearly dry during late summer and expands to its highest margin each spring. It has been documented that Catahoula Lake has been similarly cyclic at least back to state sovereignty in 1812. A landmark case, *State of Louisiana v. Placid Oil Company* (State v. Placid Oil Company, 300, So.2d 154, at 175) (1974) defined the multiple factor test for determination whether a water body is a lake or a stream. The multiple factor test was written as follows:

There is a multiple-factor test for classifying a water body as a lake or a stream. A judgment must be based upon a consideration of pertinent characteristics. Among these are the size, especially its width as compared to the streams that enter it; its depth; its banks; its channel; its current, especially as compared to that of streams that enter it; and its historical designation in official documents, especially on official maps.

In the opinion of the writer, Catahoula Lake meets the physical descriptions described in the multiple factor test, the most significant of which is the historical designation of official documents, especially on official maps. All maps examined by the writer during his 32-year engineering and land surveying career depict Catahoula Lake as a lake. Examples of the official designation of a lake are the following: Darby (1817), Dunbar (1804), the Louisiana State Land Office Township Plats (1809-1884), USGS Quadrangle Maps, (1950-1998), US War Department



Maps (1935), Locket, 1871, Bringham, 1871, the Official Map of the State of Louisiana (1870-present), and Heard and Daigre (1942).

Despite meeting the multiple factors rule set out in *State v. Placid*, plaintiffs in the current case of *Crooks et al v. State of Louisiana* (224262 9th JDC, Rapides Ph, LA) have asserted that Catahoula Lake is not a lake. Although this paper is not intended to be a legal document, it appears that the plaintiffs would not be entitled to the bed of Catahoula even it were proved not to be a lake. According to the *State Board of Commissioners et al. v. Capdeville et al.* (146 La. 94; 83 So. 421; 1919 La.), even if Catahoula Lake were not a lake and instead were overflow land, the title would have passed from the federal government to the State of Louisiana under the Swamp Lands Acts. This Louisiana Supreme Court ruling, as interpreted by Lexis Nexis (2009), states:

The board of commissioners argued that the state acquired the disputed land under the Swamp Land Acts, U.S. Comp. Stat. §§ 4958 - 4960 and that the state granted the land to the board under 1890 La. Acts 97, but that no deed had ever been executed by the state. The state argued that the disputed land were the beds of navigable streams and lakes that belonged to the state by virtue of its inherent sovereignty and could not be privately owned. The lower court found for the state officials, and the court affirmed. The court found that the beds of navigable streams and lakes never belonged to the United States but were the property of the states in virtue of their inherent sovereignty. The question of whether a stream or lake was navigable depended on the evidence in each case. The court found that the lands involved were all navigable. No property that was navigable fell under the Swamp Land Acts and could not have been included in lands granted to the

state by Congress. The disputed property therefore belonged to the state by virtue of its inherent sovereignty.

Numerous cases, including an 1895 case, *Horne v. Smith* (159 U.S. 40; 15 S. Ct. 988; 40 L. Ed. 68; 1895 U.S.), have held that U.S. government surveyors shall not be subject to collateral attack. The GLO surveyors (1809-1884) were the most contemporaneous professionals to visit the lake closest to the time of sovereignty. The writer makes the following conclusion about the status of Catahoula Lake:

1. Catahoula Lake passes the multiple factor test for definition of a lake as opposed to a stream in *State v. Placid Oil Company*.
2. If Catahoula Lake were determined by a court not to be a lake, the federal title would have passed to the State of Louisiana under the Swamp Lands Act of 1849; private landowners surrounding the tract would not be entitled to ownership of the basin.
3. This writing is not a legal document, and any professional opinion is subject to legal challenge.

*What is Swamp Land or Overflow Land?*

With the Act of March 2, 1849, the federal government conveyed swamp and overflow lands to the State of Louisiana. The Act as now contained in the United States Code defined the conveyed land as:

...The whole of the swamp and overflowed lands, made unfit for cultivation, and remaining unsold on or after the 28th day of September, 1850, are granted to the several States respectively, in which such lands are situated... (U.S.C. §982).

The definition of swamp and overflowed lands has been the subject of much litigation since the Act of March 2, 1849.

#### *Natural Monuments and the GLO Surveyors*

Title 46, Part LXI, Chapter 29, *Minimum Standards for Property Surveys*, Section 2905-D.4 addresses the requirements for researching and surveying property in Louisiana. D.4 states:

Special consideration shall be afforded by the rules of evidence and "hierarchy of calls" before any decision is made regarding property boundaries. "...The legal guides for determining a question of boundary or the location of a land line in their order of importance and value are: 1-natural monuments, 2-artificial monuments, 3-distances, 4-courses, 5-quantity. But the controlling consideration is the intention of the parties" [See citation *Myer vs. Comegys*, 147 La. 851, 86. So. 307, 309 (1920).]

Previous boundary litigation at Catahoula Lake has centered around the highest-order boundary determinant, natural monuments Russell and Brown (1942-43) determined what they believed to be the natural monument that defined the shoreline at 36 feet MSL based upon natural evidence. In *Sanders v. State of Louisiana* (La. App. 3 Cir. 02/22/06), Sanders' experts disagreed with the state's experts, and the case was decided by the appellate court's acceptance of the Russell and Brown determination of the shore line. However, no consideration was given to prohibition of dereliction in the State of Louisiana.

The confusion over the boundary remains because of the cyclic nature of the lake. Catahoula Lake has made imprints upon nature at various elevations. Experts seem to choose the marks which are most favorable to their side. The problem is exacerbated by the fact that the *Instructions to Surveyors* (US General Land Office, 1815-1831) did not specifically define what constituted the boundary of a lake. The term "ordinary high water" did not appear in the instructions. The attempt to locate a natural monument that was surveyed more than 100 years ago without the original surveyor having a clear definition of what the boundary of a lake should be, is (as demonstrated by litigation) a daunting task. Therefore, it is understandable that the courts have had difficulty in establishing the location of the boundary of Catahoula Lake.



## CHAPTER 11

### SUMMARY AND CONCLUSION

#### *General*

Despite efforts by scientists, engineers, surveyors and courts, the 14 conditions stated in Chapter One have prevented the successful determination of the boundary of Catahoula Lake. The lake is variable and has many confusing and false natural indicators. The writer has expended considerable effort attempting to apply hydrological and dendrohydrological approaches to determine the level of the OHW. But these sciences served only to bracket the OHW to a range of several feet; a one foot differential in the OHW can shift the boundary by more than a mile in some locations. More precision is required.

The GLO surveyors of the nineteenth century had no precise instructions to delineate lake boundaries, and the term OHW did not appear in their surveying instructions. The problem was exacerbated by gross error and fraud in some of their surveys. In addition, the courts have long held that the GLO meander lines do not represent lake boundaries anyway.

The lake has experienced hydrologic change since 1812. The Atchafalaya River Raft and the Old River Structure impacted the regional hydraulic grade lines. The Black River Navigation Project changed the levels in the distributary. The lake operators have tried to offset the changes by constructing a diversion canal and control structures. Sedimentation has occurred on Hemphill Creek and Devil's Creek. Extensive timber logging in the late nineteenth and early twentieth centuries has confused the evidence that would have been provided by forest banding. Cypress knee collectors and vendors have sawed off most of the tallest cypress knees. Illegal logging of baldcypress continues today.

The lake has many confusing geomorphologic features. The 10-foot differential in heights of the natural levees of Cowpen Bayou and the Little River are hard to explain without an understanding of the geological origin of the lake. The remarkably fine line of baldcypress on the western side of the lake along the 36 foot contour are unexplainable without application of principles of geology. The existence of the escarpment at 36 feet on the western side of the lake, despite the fact that the lake is never stable at 36 feet, is impossible to understand without an understanding of the principles of sediment transport.

Russell and Brown, lured by the magnificent baldcypress fringe and the escarpment in the fringe at 36 feet, chose 36 feet as the elevation of the shore line of the lake. But Brown misidentified elevations of the fringe; he reported the fringe to lie below the 36 foot contour, while Russell reported that it was above that contour. The State of Louisiana and many later experts relied on the reputations of Russell and Brown, and accepted their work, although neither Russell nor Brown demonstrated that the cypress fringe was functional in 1812 as a result of hydrologic conditions that existed in 1812. Litigants have retained experts who seem to have provided biased opinions of the level of the OHW depending on the interests of their clients. One scientist testified for the State of Louisiana that the OHW was at 36 feet, and, within a year, concluded for the same client that Larto Lake, which lies nearby and in the identical hydrologic regime, had an OHW of 43 feet.

After examining the large exposed roots of the baldcypress on the east side of the lake, state foresters have questioned whether the roots are adventitious roots that formed due to stable high water levels. Six feet of erosion did not seem possible.

After analyzing every natural feature and every available written account, the writer has demonstrated evidence to support the conclusions set out below.

### *The Hydrologic Regime and its Changes Since 1812*

Catahoula Lake levels are determined by discharge of water into its basin and by the levels of its distributaries. Prior to the construction of the Old River Structure in 1973, the Black River (thus Little River and Catahoula Lake) were affected by the high water levels during the annual inundation (Darby, 1817). Catahoula Lake level exceedances correlate with those of the Black River and Red River, but the data are not sufficient to predict the OHW of Catahoula Lake. Incising of the Atchafalaya and the Old River Structure have caused a reduction in the exceedances of the higher stages of the regional hydrologic regime, but the effect upon Catahoula Lake in the range of its OHW is too small to predict. Darby (1817) stated that Catahoula Lake annually reached depths of about 10 to 15 feet, which correlates to about 36 to 42 feet, assuming the depths were measured from the flat bottom of the lake, which averages about 26 feet today.

### *Catahoula Lake is Cyclic Today and has been Cyclic at Least Since 1812*

#### *Explorers' accounts*

William Dunbar and George Hunter (1804) explored the region and described the cyclic nature of Catahoula Lake. Their description, that the lake expanded in the spring and dried up in the summer, reasonably matches the conditions of today, although the duration of the high water cycles was not reported. William Darby's (1817) description of the cyclic nature of the lake was similar that of Dunbar and Hunter. All three explorers spoke of the annual inundation every spring.

### *GLO accounts of cyclic levels*

Walker's fraudulent shortcut across the bottom of the lake at Boggy Bend (Walker, 1838) reveals that the lake was cyclic in 1838. The writer's retracement of Walkers' traverse revealed that the ground along the lower part of his shortcut across the lake is at 30 feet MSL. Walker's fraudulent shortcut proves that the lake must have been below the 30 foot stage at the time of his 1838 traverse.

All surveyors in the region below the hill lands reported water marks at elevations between approximately 36 and 60 feet MSL. The lower range of the marks was limited by ground level.

### *Dendrology*

A precise dendrohydrological correlation of water levels to tree ring indices could not be constructed with an accuracy that would be considered useful, even for a 100 year old stand of healthy baldcypress in the fringe. The baldcypress on the west side of the lake were found to extend up to the 43-foot elevation.

Cypress knees are not reliable indicators of OHW at Catahoula Lake. They begin near the bottom of the lake and extend to approximately the 43-foot elevation.

### *Hydrology*

Hydrologic evidence dating as far back as 1828 indicates that the lake was cyclic. Low water marks recorded between 1873 and 1900 at Jonesville were all at least 15 feet lower than the bottom of Catahoula Lake. Data was insufficient to predict the OHW of the lake in 1812. Hydrologic data from 1828 to the present indicates the Catahoula Lake has continuously been cyclic and does not stabilize at 36 feet. The 36 foot shore line elevation proposed by Russell (1942) and Brown (1943) is not supported by hydrological evidence.



*The 36 foot Cypress Fringe and the Escarpment are not Indicators of the Ordinary High Water at 36 Feet as Reported by Russell and Brown*

The cypress fringe extends from about 34 feet up to about 42 feet. Russell reported the fringe above 36 feet. Brown reported it below 36 feet, although some of the same fringe trees he photographed were at as high as 41 feet.

The bluffs along the west side of the lake have eroded into the basin. The finer materials were carried off by the annual inundation, leaving a layer of coarse sand about 250 feet wide between the bluffs and the cypress fringe at 36 feet. The sandy region fringe is largely devoid of baldcypress and other trees because it desiccates to the extent that trees cannot germinate in it. Germination occurs only near the lower edge of the sandy outcrops, where the sand is moist. This condition exists along the bluff line on the western side of the lake and explains the remarkably precise cypress fringe that Russell and Brown described at 36 feet on the west side of the lake.

Where creeks and smaller drains enter the lake from the bluffs, the sand is moist and the cypress extend upstream to an elevation of about 43 feet.

In other parts of the west side of the lake, where the bluffs do not exist, the sandy beach has not formed. In these areas, the cypress fringe extends uniformly from its lower regions at about 34 feet up to about 42 feet and resembles the fringe on the rest of the lake (similar to the fringe at French Fork).

The escarpment at 36 feet described by Russell formed by the breaking of wind-induced waves when they intercepted the 36 foot cypress fringe and the coarse sand. Therefore, the escarpment does not indicate stable lake levels between 1812 and the present, and it does not support the Russell and Brown conclusion that the shore line of 1812 was at 36 feet.

Many of the baldcypress in the 36 foot fringe are more than 300 years old. No evidence was found that indicates that the baldcypress at 36 feet were in that position as a result of hydrologic conditions that have existed at Catahoula lake since 1812 other than the moist, sandy outcrop along the base of the western bluffs.

Ancient baldcypress predating 1000 A.D. were found as low as 30 feet, indicating that it is unlikely that the lake was stable at 36 feet for an extended period of time for the last 1,000 years.

#### *Establishment of the Approximate Elevation Range of the Ordinary High Water*

##### *GLO survey bearing trees*

GLO field notes from 1809 through 1884 referenced overcup oak bearing trees at many of their section corners and quarter corners (United States General Land Office, 1808-1884). Geo-referencing of their field notes upon LiDAR and USGS Quadrangle maps reveals that the lowest overcups were found uniformly at an elevation of about 38 feet. A few smaller overcups were noted by Walker (1838) down to about elevation 34 feet in his fraudulent survey of Little River in Catahoula Lake. The writer surveyed field elevations on Little River to verify the 34 foot elevations. Sedimentation on the natural levees of the Little River does not appear to be more than about one foot, based upon locations of the root crowns of the older baldcypress on the natural levees. Using the Ferry Lake case as a basis, the OHW would not be above 38 feet at Catahoula Lake. An argument could be made for a range of 34 to 38 feet as the OHW level based upon overcup. It is noteworthy that GLO evidence does not include all overcup trees in the region and, thus, the elevations provided herein are upper bracket levels only. A range of 4 feet is too large to precisely define the boundary of the lake.

The height that water reaches does not dictate forest banding. The duration of a given water level and the drying rate after the water recedes determine hydrologically-induced forest banding.

The writer inspected the lake as it passed through elevations 33 through 44 in order to map forest banding of overcup oak. This method included much larger and more representative sampling than transects. Large overcup were found to terminate at approximately the 38 foot contour. A few smaller overcup in the 8 inch diameter range were found at the 34 foot level in Little River between Catahoula Lake and Archie. The overcup banding is remarkably similar to the lower distribution of overcup reported by the GLO (1808-1884). This is the strongest evidence that the exceedances in the elevation range of 34 to 38 today may be similar to the exceedances in 1812.

#### *Stage exceedances*

River and lake stage exceedances reveal that, since 1929, the lake levels at elevations higher than 38 feet have continuously dropped, while exceedances at 36 and 35 feet were about the same in 1995 as they were in 1929. Hydrologic data are not sufficient to determine Catahoula Lake exceedances back to 1812. No evidence was found to indicate that the OHW increased after 1812 (which would have allowed permanent expansion of state ownership).

#### *OHW estimates based on overcup oak and stage exceedance data*

Bearing tree and exceedance data indicate that the OHW elevation in 1812 was somewhere between 34 and 38 feet, possibly lower. This range of elevations is not precise enough to determine the OHW of Catahoula Lake in 1812. Although it has not been scientifically proven that the stage exceedances were greater in 1812 than today, it is interesting to note that the open expanse of the lake is has reduced its level to approximately 30 feet at the

lower level of the swamp privet, water elm, and locust. Perhaps if these woody plants had existed at 30 feet circa 1812, the GLO would have defined the lake to be at approximately 30 feet. It is also interesting to note that the downward translation in the exceedances for the higher levels is approximately the same 6 foot differential between the GLO meander corners and the edge of woody vegetation today.

### *The Solution*

#### *The definition of the correct natural monument*

The State of Louisiana *Minimum Standards for Property Surveys* (Title 46, Part LXI, Chapter 29, *Minimum Standards for Property Survey* ) requires that the lake boundary surveyor establish the natural monument that defines the boundary (Louisiana Board of Registration for Professional Engineers and Land Surveyors, 1992). It has been demonstrated that scientific data and analysis prove only a range of elevations for the OHW at Catahoula Lake. The scientifically proven OHW elevation range is not precise enough to determine the lake boundary because of the low topographic relief around much of the lake and has caused the confusion that has existed since the day the precise boundary was questioned. It is the opinion of the writer that scientists, engineers, and surveyors have been searching for the wrong natural monument. The natural monument that should be searched for is not the vertical position of the OHW, but rather the areal boundary of the lake as surveyed by the GLO. It has been established that the GLO instructions did not contain the word OHW and that the origin of the term was subjective and imprecise. What precisely was the GLO surveying when they surveyed the lake boundary? Was it a natural monument? If it was a natural monument, would it suffice as the boundary? Evidence is summarized below.



*William Darby (1817)*

Darby (1817) described the boundary of the lake as follows:

Fourteen miles below the Boeuf, the Ouachitta loses its name by its union with the rivers Tensaw and Ocatahoola (Catahoula). This singular small river, Ocatahoola, is a very striking example to show how near the surface of Louisiana approaches that of the superficies of a real sphere. The map will exhibit the places where this river has its source, but no delineation upon a plane can convey correct ideas of the peculiar traits of its geography. The lake through which this river flows, is alternately a wide expanse of water ten or fifteen feet deep, and extensive grassy plain, the river winding through its center, and receiving several fine creeks from the north, which in the season of inundation empty themselves into the *mass of water at the margin of the woods*.

Darby (1817) considered the edge of the lake to be the margin of the woods.

*The GLO (1809-1888)*

The bearing trees referenced at the meander corners indicate that the GLO surveyors were terminating their meander corners where they reached the open lake. Of the 66 meander corner bearing trees recorded by the GLO, 63 were landward of the meander corners. In the non-hilly regions of the lake perimeter, particularly in the flat areas where the largest current boundary disputes exist, the GLO surveyors all described the terrain before reaching the open area of the lake as swamp and/or overflow land. Their description of the wooded areas being swamp and overflow land matches precisely the definition of swampland in the Swamp Land Act of 1849.

Part of a successful land survey retracement of the original GLO surveys requires the present-day retracing surveyor to attempt to observe the terrain as if he or she were the original surveyor. The GLO surveyors did not have quadrangle maps and aerial photos; they were simply surveying through woods and swamps until they reached the open expanse of the lake. Any present-day surveyor who puts him or herself in the footsteps of a nineteenth century GLO surveyor traversing the woods toward a lake similar to the photograph in Figure 112 can understand that the natural monument that the surveyor was calling before reaching the opening was swamp or overflow land. Swamp or overflow land are natural monuments, and they correspond to the last statement in the natural hierarchy of the *Minimum Standards for Property Surveys*, "... the controlling consideration is the intention of the parties" (Myer vs. Comegys, 147 La. 851, 86. So. 307, 309 1920).

Figure 102 contains an excerpt from the GLO that states that the surveyor lost sight of the lake. There is nothing he could lose sight of but the open expanse. Another excerpt in Figure 102 states that no bearing trees could be used because the surveyor was in the lake.

It is the opinion of the writer that the natural monuments that the GLO described around the confusing perimeter of the lake were swampland, overflow land, and lake. The natural monument defining the lake boundary was the location where the open lake met the swamp and overflow land at the margin of the woods.

Since this is an areal approach to the restoration of the natural monument and the intent of the United States in patenting the land, it is not surprising that the lines of possession along the southwest part of the lake match the GLO survey.

It is ironic that the cypress fringe used by Russell was the identical fringe used by the GLO as the lake boundary and that it was not formed as a result of conditions that existed in 1812 and had nothing to do with the 36-foot water level.

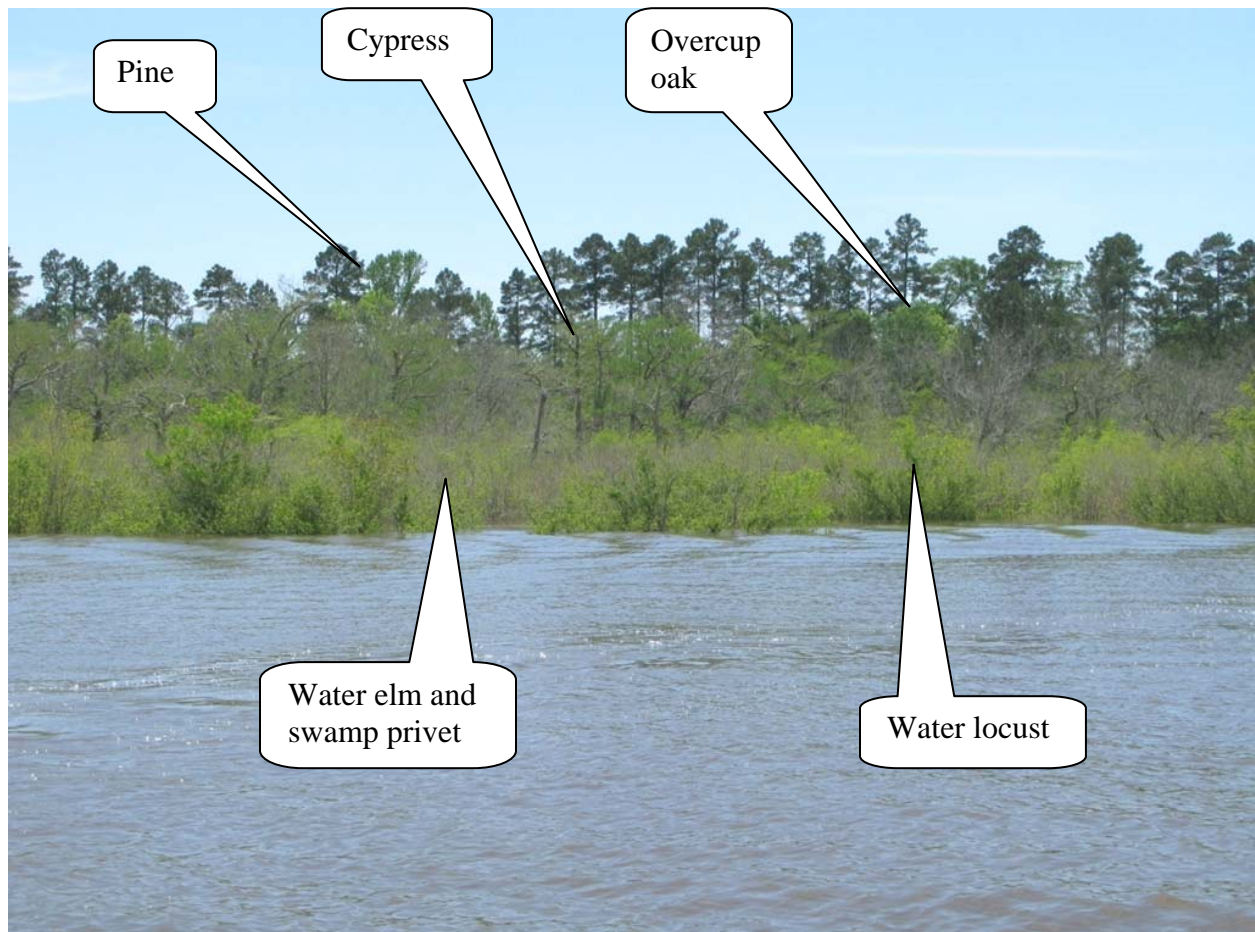


Figure 112. Typical forest banding as viewed from the lake when the stage is approximately 43 feet. Imagine you were a GLO surveyor surveying when the lake level was low, and you were in the swampy area of cypress, swamp privet, and water elm--and you recorded that you were in low overflow swamp. It is more likely than not that when you entered the huge, beautiful expanse of the lake bordering the margin of the woods that you would call that point the edge of the lake.

### *Implementation of the Solution*

The solution to the boundary should be implemented as follows:

1. A GLO retracement survey should be implemented for each section line approaching the lake and the original GLO meander corner positions should be restored (the old bearing trees are all likely missing as a result of logging). The physical environment and natural monuments of the opening should be re-established as closely as possible.
2. After the meander corners are set, new meander lines should be run through similar natural monument conditions as the meander corners. This solution will also be applicable to the gross error at Boggy Bend.
3. In areas where the natural monument conditions along the meander routes cannot be established, the meander lines recorded by the GLO shall be balanced and closed to the meanders to provide the best and most accurate estimate as to the location that the GLO surveyed.
4. The meander corners at Saline Point should be re-established using the section line calls crossing Saline Bayou, as prescribed earlier in this text.
5. The 2.5 mile long route of Little River in the southwest portion of the lake should be rotated and scaled to fit the geometry of the river, as prescribed earlier.

6. All meander corners and meander line traverse points should be tied to the Louisiana State Plane NAD83 coordinate system.
7. The discrepancy between GLO surveyors at the southwest corner of Township 6 North, Range 3 East and Township 6 North, Range 2 East should be resolved simply by the issued patent being the final determinant, which supports the Walker (1838) line.
8. The Sanders boundary line has been decided by the courts, and even though scientifically incorrect, cannot be changed. This ruling should not be used as a precedence for other rulings since the ruling is founded on incorrect scientific principles.

Based upon limited field surveying during the course of this study, it is anticipated that the meander corners will fall at approximately the 34 to 35-foot contour around most of the lake.

The benefit of this solution is that the vague scientific definition of OHW yields to the true intent of OHW as it was originally defined subjectively by our ancestors and implemented by the GLO.

Figure 113 is a preliminary map showing the anticipated general area of the final boundary line of the lake as intended by the GLO and the United States for patenting purposes. An approximation of the proposed extents of the lake is shaded in red in Figure 113. The largest variation from GLO meanders will be in the regions discussed above regarding GLO gross error and fraud. Lake bed limits on the Chicken Neck, Boggy Bend and the Flaggon Creek area in the



southwest portion of the lake will experience the most significant impact. The Chicken Neck area patents will be scaled to match the stream, with minor reduction in private claims. Boggy Bend private claims will be reduced. Saline Point will add more land to the original claims. The Flaggon Creek area will remain close to the meander line traverses in the region. Precise land surveying using the principles developed in this dissertation will result in an accurate determination of the proposed boundary for the entire lake.

### *Legal Issues*

This dissertation addresses an engineering and applied science solution to the problem. It is likely that litigation will continue and the battle between biased experts will resume. It is possible that the Common Error Doctrine might be applied as proposed by the courts. It is the opinion of the writer that the validation of the long-held patents and the GLO township maps used to write the patents in the 3,300 acre discrepancy in the southwest part of the lake would be a good example of the application of the Common Error Doctrine.

### *Acceptance of the Hypothesis*

The hypothesis stated in Chapter 3 is as follows:

*The previous determination of the extent of the bed of Catahoula Lake at the 36 foot contour is based upon scientific principles that cannot withstand a challenge from a multidisciplinary engineering and scientific approach. A more viable solution exists and may be applicable not only to Catahoula Lake, but also to other complex natural lakes.*

The conclusion of this study clearly supports the original hypothesis.

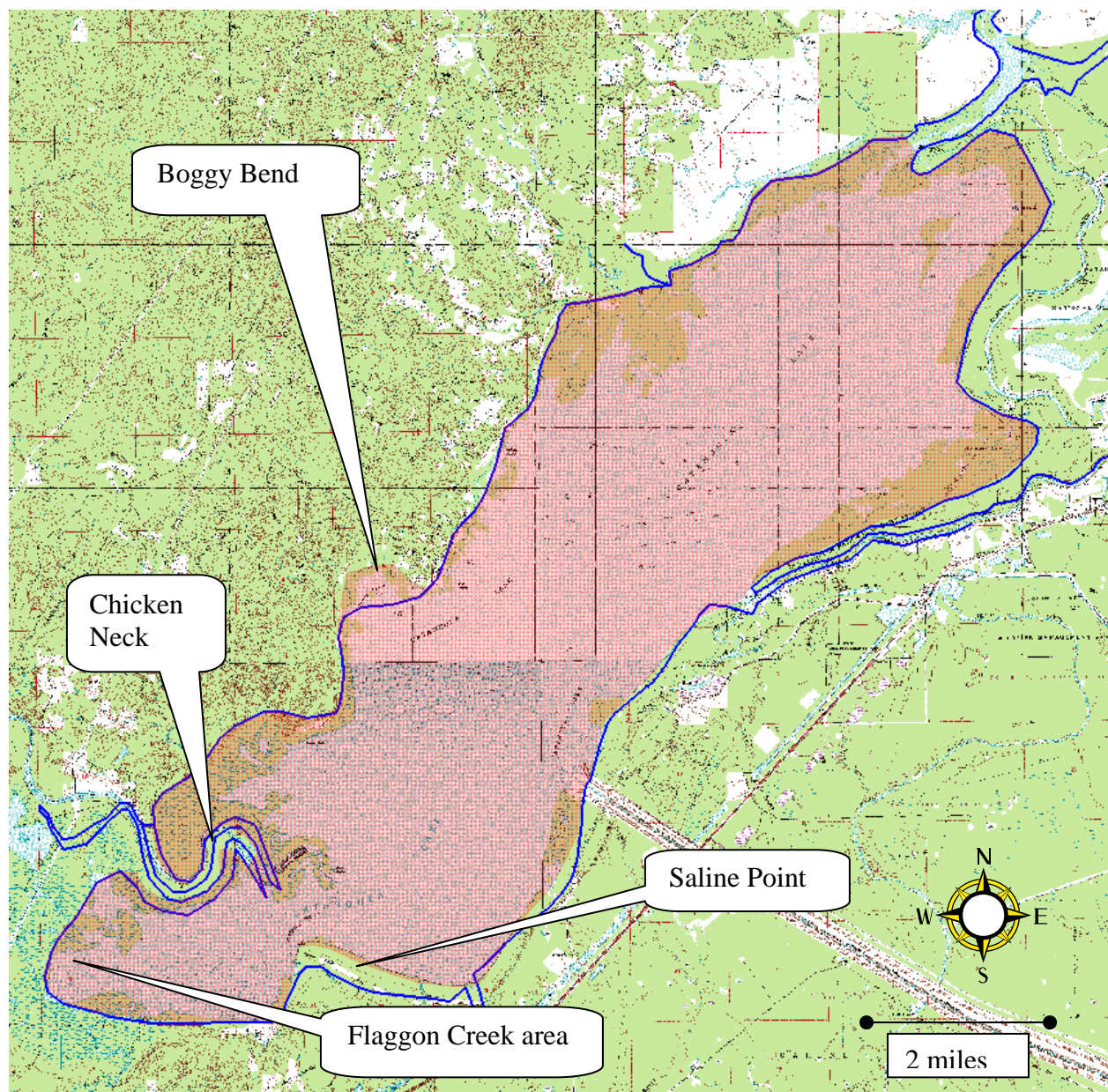


Figure 113. The area shaded in red approximates the proposed extents of the bed of Catahoula Lake. The largest areas impacted are at the chicken neck, Boggy Bend, Saline Point, and the southwest part of the lake at Flaggon Creek (Base map, USGS, 1985-1998). Importantly, the limits of the red shading are only a general graphic depiction of the approximate boundary. A field survey is required to properly establish the extents of the ownership of the bed of the lake.

## CHAPTER 12

### APPLICATIONS FOR OTHER LAKES AND FUTURE STUDIES

#### *Applications for Other Lakes*

This application may be applicable to other natural Louisiana lakes and lakes in other states where the civil code does not allow dereliction. The areal solution may not always be preferable over the vertical solution; all solutions should be developed only after complete scientific evaluation. The areal solution may reflect intent and therefore may be the solution that was intended when the lands surrounding lakes were patented. More emphasis should be given to the great value of information that can be derived from meander corners, and less emphasis should be given to the categorical denial of the use of GLO meander lines.

#### *Further Study*

Hopefully, the application of engineering and applied science to the establishment of lake boundaries will stimulate further study in the following areas:

1. Dendrological studies using ground-penetrating radar to recover tree stumps that will lead to more dendrological evidence of lake boundaries.
2. Improvements in development of dendrochronologies with the use of Monte Carlo simulation in cross-dating and more extensive use of statistical software. Weighted ring counts to reflect decisions made about when to reject tree rings as false may improve statistical correlation. Many statistical approaches assuming constants do not change in regression models. This is

an inherent weakness in most statistical approaches of time series. More powerful statistical software engines, such as AutoBox, address this problem and help to better evaluate time series data. There is much room for advancement in the field of dendrohydrology and dendrochronology.

3. GLO land survey information may be used to construct locations of historic forest banding. Statistical analyses may be useful in reference to applying the bearing tree information to develop probabilities about the reliability of predicted historic forest banding.
4. The study of movement of great river rafts in the region might reveal that the removal of the Atchafalaya River Raft had an impact on the commerce of Alexandria by essentially "pulling the plug" on Red River. The improved flow of the Atchafalaya River might have dropped the hydraulic grade line at Alexandria in the nineteenth century and reduced river transportation to Alexandria. Rapides Parish received its name because of the rapids in the Red River.
5. Pollenology may be used to detect conditions that existed in the lake bed at Catahoula Lake for the last 50,000 years. Preliminary discussions with Rebecca Tedford, a Ph.D. candidate at LSU, appear to reveal that sage grass pollen in the lake bed was low for several hundred years around 1500 AD. This might indicate that the lake was stable during that time, possibly because

the Great Red River Raft had not yet moved northerly past the mouth of the Black River.

6. Existing forest banding and daily gage data for the last 50 years at Catahoula Lake provide an excellent area of study to develop the relationship of water levels, exceedances, and soil types upon the survival of various species of trees. The exceedances have been reduced. A statistically valid increase in baldcypress at Bacon Run occurred at about the same time the Catahoula outfall structure was constructed. Were the water elm similarly stimulated? Research indicates that root and trunk inundation, duration of inundation, soil moisture, rate of drying may be important factors in forest banding. The writer suggests that inundation of the leaf systems of the water elm and swamp privet should be considered as they may relate to encroachment of the water elm. The durations of the higher water levels were demonstrated to be longer in the past than they are today. Perhaps the intrusion of these low-height trees is related to a reduction of higher level exceedances and the commensurate reduction in leaf system inundation of these two species.
7. Cocklebur is the predominant species in the lake bed during the summer. Cocklebur was not noted by earlier explorers. This broadleaf plant may be having a negative effect upon the other subdominant natural vegetation and the ecosystem. Analysis of the development and effect of cocklebur at Catahoula Lake may be a worthy study.



8. During the course of this dissertation, the writer has observed an incredibly rich wildlife habitat and many species of wildlife. One of the most unusual on the lake are the locust, which appear during cycles of at least several years, and gather in huge swarms. The noise these huge locust swarms make is astonishingly loud; the spooky sound and its movement around the lake makes one think of the arrival of a UFO. Catahoula may be a good study area for this locust.
9. It is the writer's impression that this beautiful natural lake has been pillaged by man for the last 200 years and that, today, is primarily a seasonal wildlife killing field. Except for lake managers and a few occasional bird watchers, it appears that virtually all other human visits are almost entirely for the purpose of killing animals, collecting Indian artifacts, cutting baldcypress and their knees, or producing oil. Lead shot accumulated on the bottom of the lake has poisoned countless thousands of waterfowl. One establishment selling cypress knees lies near the east side of the lake on Highway 28. During the writer's many field trips he noticed sawed-down baldcypress floating in areas along the western fringe of the lake. Enforcement to protect this beautiful state property should be increased. USACE activities have also damaged the lake. The USACE Old River Structure and the upper tributary navigation projects have lowered the stage exceedances and have shaved the peaks of the annual inundation. A study should be conducted to determine what protective

measures would be appropriate to preserve the unique and beautiful natural state of Catahoula Lake, and the protective measures should be implemented.

10. William Dunbar's 1804 close relationship with President Thomas Jefferson and the multitude of letters back and forth between Jefferson and Dunbar deserve further study. Although Dunbar frequently signed his letters to the president as "your most obedient servant," contradictions seem to exist (Figures 32 and 33). The anachronism in the Dunbar excursion, whereby only a one-night timeline between the party's arrival at Jonesville and its exploring of Catahoula Lake (12 hours away) indicates an inconsistency (See pages 38-39). A greater interest lies in a discovery made by the writer while trying to recover more detailed information from the Dunbar descendants in the Natchez, Mississippi region. During this effort, the two family descendants of Dunbar reported that he was discovered to have been a Tory, and that his family portrait had depicted him wearing a red Tory vest. The family members at some time in the unknown past altered his photograph by painting his vest black. According to the same two family members, the black paint is now flaking off, revealing part of the red Tory vest. *The Life, Letters, and Papers of William Dunbar* (Rowland, 1930) reveals that Thomas Jefferson did not trust George Hunter and was worried that he would return after the excursion to exploit minerals he had identified but had not revealed to the rest of the party. Was Hunter a thief? Was Dunbar a Tory or a convert? In-depth

research into the detailed history and activities of Dunbar, Hunter, and Jefferson may reveal interesting information and circumstances.

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## VITA

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