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Wetlands Research Program Technical Report WRP-SM-14

Characterization of Changes to Bottomland Hardwood Forests and Forested Wetlands in the Cache River, Arkansas, Watershed

by Mark R. Graves, M. Rose Kress, Scott Bourne



October 1995 – Final Report
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	Task		Task
CP	Critical Processes	RE	Restoration & Establishment
DE	Delineation & Evaluation	SM	Stewardship & Management

Wetlands Research Program

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Characterization of Changes to Bottomland Hardwood Forests and Forested Wetlands in the Cache River, Arkansas, Watershed

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Final report

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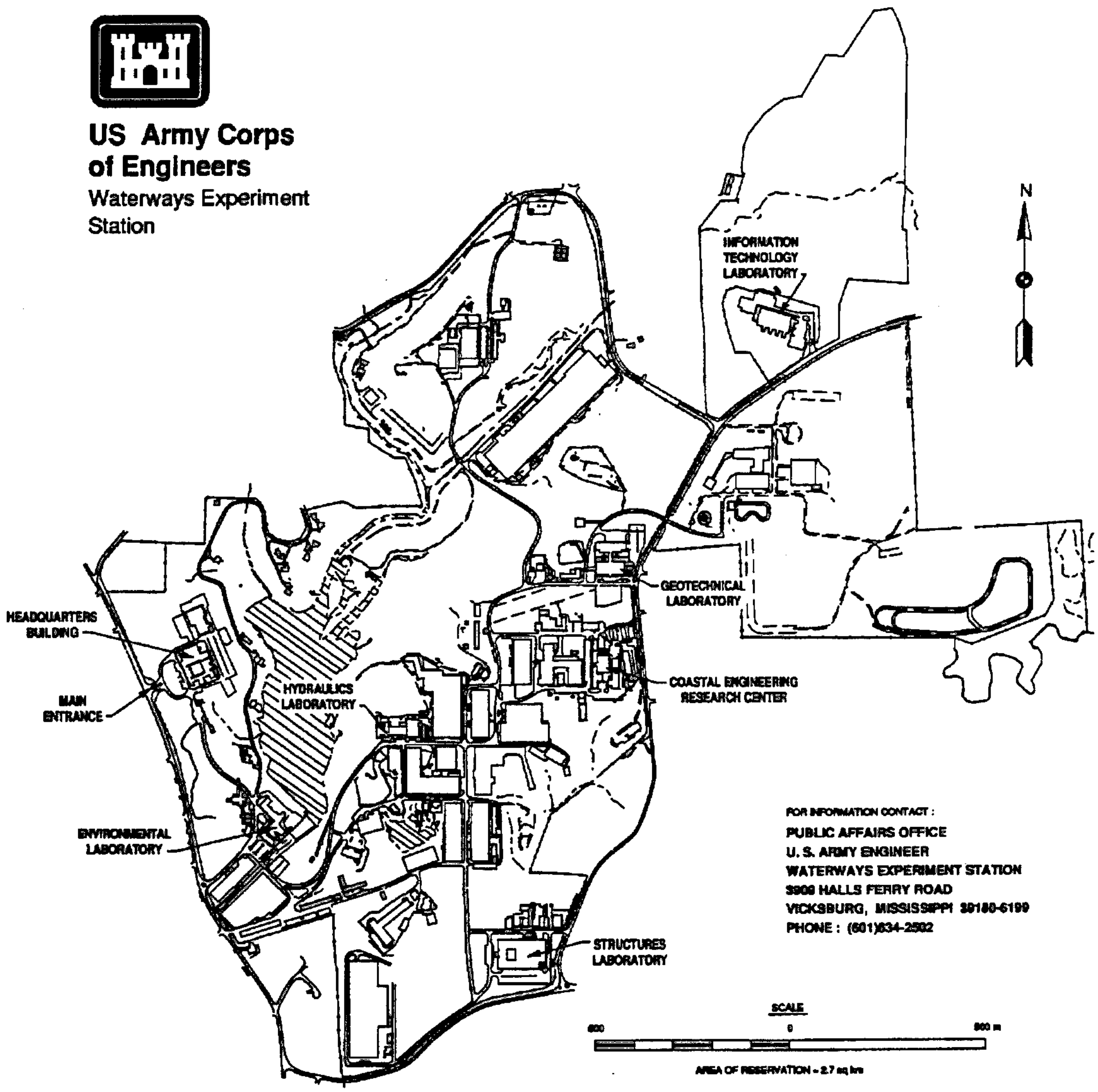

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Change Assessment

Characterization of Changes to Bottomland Hardwood Forests and Forested Wetlands in the Cache River, Arkansas, Watershed (TR WRP-SM-14)

ISSUE:

This study was designed to quantify changes in forest cover in the Cache River, Arkansas, watershed since the 1930s. Digital spatial analysis and image-processing techniques were demonstrated as time and cost-effective techniques for determining basinwide changes to wetland systems related to the removal of forest cover.

RESEARCH:

Digital spatial data analysis and image-processing techniques were used to document changes to forest cover and forested wetlands in the Cache River, Arkansas, watershed. Historical and recent topographic maps and digital satellite imagery were used to determine the amount of forest cover removal. Changes in forest fragmentation were quantified based on the distribution and geometry of forest stands.

SUMMARY:

Between 1935 and 1975, approximately 100,000 ha of forest cover was removed in the Cache River watershed. Little change in forest cover was noted in satellite imagery acquired after this period. Comparisons of forest cover with hydric soils data for the watershed indicate that, in the lower portions of the watershed, up to 80 percent of the forest cover removed represented forested wetlands. The remaining forest stands are much more fragmented in nature.

AVAILABILITY OF REPORT:

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About the Authors:

Mark R. Graves and M. Rose Kress are physical scientists at the U.S. Army Engineer Waterways Experiment Station (WES) Environmental Laboratory. Scott G. Bourne is a GIS analyst employed by Computer Sciences Corporation. Point of contact at WES is Mr. Graves at (601) 634-2557.

Contents

Preface

The work described in this report was authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Stewardship and Management Task Area of the Wetlands Research Program (WRP). The work was performed under Work Unit 32762, "Techniques for Characterizing Changes to Wetland Systems," for which Mr. Mark R. Graves was Principal Investigator. Ms. Denise White (CECW-ON) was the WRP Technical Monitor.

Mr. Dave Mathis (CERD-C) was the WRP Coordinator at the Directorate of Research and Development, HQUSACE; Dr. William L. Klesch (CECW-PO) served as the WRP Technical Monitor's Representative; Dr. Russell F. Theriot, U.S. Army Engineer Waterways Experiment Station (WES), was the WRP Manager. Mr. Chester Martin (CEWES-EN-S) was the Stewardship and Management Task Area Manager.

This report was prepared by Mr. Mark Graves and Dr. Rose Kress, Environmental Characterization Branch (ECB), Natural Resources Division (NRD), Environmental Laboratory (EL), WES, and Mr. Scott Bourne, a GIS analyst at Computer Sciences Corporation, Vicksburg, MS. Mr. Jerrell R. Ballard, Jr., Ms. May Causey, Ms. Jackie Hutto, and Mr. Clarence Currie of ECB assisted in database design and development.

The work was conducted under the direct supervision of Mr. Harold W. West, Chief, ECB, and the general supervision of Dr. Robert M. Engler, Chief, NRD. Dr. John W. Keeley was Director, EL.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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1 Introduction

Wetland Systems

Wetlands are complex systems which have unique hydrophytic vegetation, hydric soils, and hydrologic conditions. These three components are interdependent, and the wetland as a whole is affected by changes in the upland areas in the surrounding watershed. Hydrology is perhaps the wetland component most immediately influenced by changes in the watershed. Deforestation, urbanization, agricultural activities, and flood control measures all influence the natural cycles of surface and groundwater movement within a watershed. Changes in the amount, frequency, duration, and seasonality of flooding have a direct impact on the functioning of wetland systems.

Vegetation cover is an important factor affecting the hydrologic characteristics of a watershed. For example, clearing of natural vegetation (especially forest cover) can introduce drastic changes in the surface runoff pattern of a watershed. Changes in vegetation cover, even far outside the boundary of a wetland, can influence changes in runoff, erosion, sedimentation, and water quality that may strongly affect the characteristics of wetlands in the watershed. The ability to understand the functioning of wetland systems as part of a larger landscape requires the monitoring and quantification of conditions in the entire watershed.

Purpose

This study was designed to quantify changes in forest cover in the Cache River, Arkansas, watershed since the 1930s. The purpose was to demonstrate methods for determining changes to wetland systems related to the removal of forest cover in the surrounding watershed. The scope of this study was limited to the compilation, processing, and analysis of existing map and satellite data.

2 Importance of Bottomland Hardwood Forests

Wetlands are an ecologically important transitional environment between aquatic and terrestrial ecosystems. Bottomland hardwood (BLH) forested wetlands are regarded as especially important, supporting an abundance of aquatic and terrestrial organisms. Found within the broad floodplains of rivers and streams in the southcentral and southeastern United States, BLH forests also play an important part in nutrient cycling, sediment trapping, and flood reduction (Conner and Day 1982). They are characterized by rich soils and historically have been cleared and converted to agriculture at high rates. It is estimated that approximately 60 percent of the BLH forests in the Mississippi River valley had been cleared by the late 1970s.

Effects of Forest Removal and Channelization on Hydrology

Removal of forest cover in a watershed reduces rainfall interception, transpiration, and infiltration and increases surface runoff (Burt and Swank 1992; Anderson et al. 1993; Gustard and Wesselink 1993; Calder 1993). Infiltration is one of the most important components of the hydrologic system. The removal of forest cover decreases infiltration, increases surface runoff, and reduces lag time (the time it takes the rainfall to make its way through the watershed).

Nestler and Long (1994) conducted an evaluation of the hydrologic indices of the Cache River, AR, watershed. Based on long-term U.S. Geological Survey (USGS) records, they found hydrologic changes consistent with those described above. They concluded that changes in timing and duration of discharge had changed significantly since the 1950s and may be due to the loss of interception and storage by forested land.

Hydrologic changes in the Cache River watershed were compounded by extensive improvements (e.g., channelization and levee construction) during the last 70 years, especially during the 1920s and 1930s (Nestler and Long 1994). Channelization replaced the natural meandering channel with straight, well-defined segments. The channelized segments are shorter, have a steeper gradient, provide less resistance to flow, and result in increased flow velocities.

Many levees have been constructed along the Cache River to protect cropland from flooding. Forest removal, channelization, and levee construction all tend to decrease the natural water storage capacity of a watershed.

The net effect of these developments in the watershed is a drastic change in the unit hydrograph. Water cycles through the watershed in a shorter period of time. These changes affect the flood magnitude, flood duration, and flood frequency in wetland areas. Over time these changes can affect the wetland vegetation. Nestler and Long (1994) concluded that the Cache River system is increasingly dominated by hydrologic processes of short duration rather than long-term processes such as recharge from groundwater. They also concluded that changes in wetland vegetation in response to these hydrologic changes may be slow and thus difficult to quantify.

Effects of Forest Removal on Erosion and Sediment Transport

The hydrologic changes described above, including increased surface runoff and flow velocities, act to increase soil erosion. Tilling of agricultural fields also contributes to increased erosion. Eroded soil becomes sediment, some of which is eventually deposited in the low energy areas of the watershed including wetlands. Kleiss (1994), in a detailed analysis of sedimentation rates in the BLH forested wetlands of the Cache River, reported sedimentation rates have increased markedly during the last 50 to 60 years. These changes were most pronounced during the 1920s and 1930s when intense conversion of forest to agriculture was occurring. The increased accumulation of sediment can have a detrimental effect on BLH wetlands.

Each of the studies mentioned above suggests that removal of forest cover may be an important factor in observed changes to the functioning of BLH forested wetlands.

3 Materials and Methods

The basic methodology used in this study was a time series analysis of available data related to the forest cover, wetlands, and soils in the Cache River watershed. These analyses were conducted using a combination of Geographic Information System (GIS) and remote sensing techniques. The use of these techniques allowed large volumes of spatial data to be compiled, displayed, and analyzed. Changes to forests between 1935 and 1975 were determined for the entire watershed using data from topographic maps produced by the U.S. Army Corps of Engineers (USACE) and USGS. Additional analysis of forest cover and forested wetlands was conducted in the lower watershed (Figure 1). This lower watershed area is approximately 125,000 ha.

A search for existing data resulted in the selection of four primary sources of spatial data for use in this study. These four sources were topographic maps, U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps, U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS), county soil surveys, and digital satellite imagery.

Relevant data from each of these sources were converted to digital format, co-registered, and compiled into a comprehensive digital spatial database for analysis. Data capture and processing procedures were tailored to the source and are discussed below.

The final digital database consisted of seven different representations of forest cover in the Cache River watershed spanning the years 1935 to 1987. Two forms of ancillary data, wetland type and soil type, were also included in the database. These wetland and soil data provide important supporting information for the time series analyses.

Study Site

The Cache River watershed in northeastern Arkansas (Figure 1) is a long (229 km), narrow drainage basin. The river flows in a south-southwest direction from extreme southern Missouri to its confluence with the White River in northeastern Arkansas. The watershed ranges from 7.5 to 24 km wide, covers approximately 288,000 ha, and exhibits little relief. Elevation ranges from

46 m mean sea level (msl) to 161 m msl. Mean annual rainfall is 120 cm. The greatest precipitation occurs during winter and spring. Much of the upper and middle portions of the watershed were channelized during the 1920s and again in the 1960s. The lower watershed underwent partial channelization during the 1970s (Mauney and Harp 1979).

The wetlands in the Cache River watershed are primarily southern BLHs. Some relatively large stands of native vegetation remain in the lowermost portions of the watershed. Tupelo gum (*Nyssa aquatica*) and bald cypress (*Taxodium distichium*) are the dominant tree species in these areas.

The Cache River watershed has been affected by timbering, ditching, road construction, and, most notably, conversion of forested areas to agricultural use. Almost completely forested in its natural state, only 20 percent of the watershed remains forested today. The dominant land use is agriculture. Rice, cotton, and soybeans are the major crops. These changes have altered the water flow and quality and the natural wetland conditions in the watershed.

Topographic Maps

Two sets of topographic maps were obtained for the study area. One set consists of 17 map sheets dated 1935 to 1940 at a scale of 1:62,500. These maps were prepared under the direction of the Mississippi River Commission and published by the War Department, Corps of Engineers. They conform to USGS boundary and naming conventions for the current 1:62,500-scale topographic map series. Forested areas are depicted as green-tinted areas on these maps. The forest cover information on the maps was developed by interpreting aerial photography. No date or scale for the photographs used to develop these older maps was stated on the maps. Figure 2 shows the location, name, and publication date of the maps. The 1935 forest cover data were developed from this set of maps.

The second set of topographic maps used in this study was the most recent edition of the USGS 1:24,000-scale maps of the study area. Portions of 41 maps were needed to cover the Cache River watershed (Table 1 and Figure 3). Publication dates for these maps are 1964 to 1984, and they are based on aerial photography dated 1963 to 1980. Forested areas, as interpreted from the photographs, are depicted as green-tinted areas on the maps. Although the photographs for this series of maps span a 17-year period, the forest cover data derived from them were combined into a single file for use in data analysis. The percentage of the watershed represented by each date of photography in this set of maps is given in Table 2. The 1975 forest cover data were developed from this set of maps.

All forested areas (green tint) within the Cache River watershed were manually digitized from these two sets of maps. The 1935 and 1975 forest cover data are shown in Figures 4 and 5, respectively. The channelized nature of the Cache River is clearly seen in the large-scale insets in these figures.

The 1935 and 1975 forest cover data discussed above were processed for the entire Cache River watershed. Additional data were processed for the lower watershed shown in Figure 1. These additional data include USFWS NWI maps, USDA/SCS soil survey reports, and five dates of Landsat satellite imagery.

NWI Maps

NWI maps were acquired from the USFWS in the form of 1:24,000-scale maps on mylar media. The 1:24,000-scale NWI data were not available for three quad sheets on the northern edge of the southern watershed—the Cash, Podo Creek, and Risher map sheets. Thus, the boundary of the available NWI data does not match exactly that of the southern watershed shown in Figure 1.

The wetland areas and linear wetland features depicted on the available NWI maps were manually digitized. The complete NWI classification (U.S. Department of Interior 1979) for each wetland feature was included in the database. The publication date for most of the NWI maps was 1990. However, the wetland interpretations were based on color infrared aerial photographs dated 1984 to 1986. The dates of aerial photographs used (by USFWS) to prepare the NWI maps are given in Table 3. NWI classification of forested wetlands is shown in Figure 6 for the portion of the lower watershed for which NWI data are available. Figure 6 is based on the distribution of Palustrine forest categories in the NWI data.

USDA County Soil Surveys

Data describing surface soils in the Cache River watershed were obtained from SCS soil survey reports for five counties: Woodruff (USDA 1968), Jackson (USDA 1974), Craighead (USDA 1979), Poinsett (USDA 1977), and Lawrence (USDA 1978). The mapping units used in these soil survey reports represent the soil classification system adopted by the National Cooperative Soil Survey (USDA 1960). Each soil survey report contains a set of uncontrolled, black and white photomosaics (approximate scale 1:20,000) upon which the soil units are delineated and labeled. Soil unit boundaries were manually digitized from these photomosaics and co-registered with other spatial data.

Soils in the Cache River watershed were designated as either hydric or nonhydric as determined by the National Technical Committee on Hydric Soils (USDA 1991). The distribution of hydric and nonhydric soils in the lower watershed is shown in Figure 7. Approximately 71 percent of the soils exhibit hydric characteristics.

Digital Satellite Imagery

Remotely sensed data are useful for characterization and monitoring of changes to wetlands. Digital satellite imagery, commercially available since 1972, has been used extensively for mapping of various wetland types (Lampman 1993).

For the lower watershed, five sets of digital satellite imagery were acquired for mapping of forest cover. Table 4 lists the types and dates of satellite imagery used. Two adjacent satellite images were required to cover the lower watershed.

Forest and nonforest areas were identified using standard unsupervised classification methods (ERDAS 1994). Figures 8 to 12 show forested areas within the lower watershed for each set of satellite imagery.

4 Analysis and Discussion

Forest Cover and Forested Wetlands Assessments

The 1935 forest cover (as determined from the 1:62,500-scale set of maps) is shown in Figure 4. The large-scale inset in Figure 4 illustrates the level of detail available from the 1:62,500-scale topographic maps. The total 1935 forested area was 169,000 ha or 59 percent of the watershed. Nonforested area was 119,000 ha or 41 percent of the watershed.

The 1975 forest cover (as determined from the 1:24,000-scale set of maps) is shown in Figure 5. The enlarged area in Figure 5 shows some significant changes in forest cover from the 1935 data presented in Figure 4. The total 1975 forested area was 60,000 ha or only 21 percent of the Cache River watershed. Nonforested area was 228,000 ha or 79 percent of the watershed.

Forest cover in the Cache River watershed decreased by nearly 110,000 ha between 1935 and 1975. Forest removal was widespread throughout the watershed (Figure 8) and has resulted in a fragmented forest. The largest forested area remaining in 1975 was located in the southern watershed.

The number and size of forested areas are important characteristics. Four measures of fragmentation were computed for the Cache River watershed. These are:

a. *Frequency*. The number of stands.

b. *Size*. Maximum and minimum stand size (ha).

c. *Forest edge* (*stand perimeter*). Total length of the forest/nonforest interface (km).

d. *Core area*. Total area of forest greater than 100 m from a forest edge (ha).

A summary of these calculated measures is presented in Table 5. Total forested area, maximum stand size, and core area have declined markedly.

The number of forested areas has increased. This type information is useful in determining changes in habitat quality for certain key indicator species.

Not all of the forested areas depicted on the two sets of topographic maps or mapped from the satellite data can be considered forested wetlands. Indirect evidence concerning the extent of forested wetlands in the lower watershed was developed by comparing the distribution of hydric soils (Figure 7) to each map of forest cover. Forested areas with hydric soils in the Cache River watershed have a high probability of being forested wetlands. Table 6 shows the forested wetland data for the lower watershed. Based on this analysis, approximately 39,000 ha of forested wetlands were cleared between 1935 and 1972.

In a separate analysis, the NWI data were compared with the hydric soil data. NWI identifies forested wetlands in the Cache River watershed as various Palustrine forested categories (PFO). The spatial correspondence between the NWI PFO areas and the hydric soil areas was determined. Of the 15,432 ha of PFO, 14,382 ha (or 93 percent) had hydric soil.

Transect Data for 1935 and 1975

Another technique was used to characterize differences in forest cover between the two dates. Transects were analyzed to provide information about spatial and temporal trends. For each transect selected, two quantitative measures were calculated. These measures are the number of forest/nonforest interfaces (transitions from forest to nonforest along a transect), and the percentage of the transect length that is forested and nonforested.

Six transects were selected for this analysis (Figure 9). Two of these transects (12 and 10) coincide with shorter transects used by other researchers for field investigations. The other four transects (2,3,5,6) were selected arbitrarily, two in the upper watershed and two in the lower watershed. Each transect was oriented perpendicular to the stream channel and started and stopped at the watershed boundary. Table 7 lists the calculated values for the transects based on the 1935 and 1975 forest cover data.

The 1935 transect data are fairly uniform despite the variation in length of the transects. Each transect encountered approximately 30 transitions between forest and nonforest (range 25 to 34), and approximately 50 percent of each transect was forested (range 49 to 62 percent). Data for the 1975 forest cover along the same transects are more variable. There is a wide range in the number of forest/nonforest transitions (15 to 61) and percentage of forested length ranges from 3 to 53 percent.

Transects 10 and 12 in the lower watershed were essentially unchanged between 1935 and 1975. Calculations for the other four transects were used to compare conditions in the upper and lower watershed. Approximately 20 percent of the length of transects 2,3,5, and 6 was forested in 1975. However, these four transects differ markedly in the number of forest/nonforest transitions. The number of transitions was nearly three times higher for the transects in the upper watershed (transects 5 and 6), indicating greater forest stand fragmentation than in the lower watershed.

Forest Cover from Satellite Images

Satellite data covering the lower watershed were analyzed to determine forest cover as discussed in Chapter 3. Figures 10-14 illustrate the forest cover determined from each of the five sets of satellite data. Table 6 is a summary of the forest cover as determined from the various source materials used in this study for the lower watershed.

In the lower watershed, approximately 48,000 ha of forest were removed between 1935 and 1972. Little change in forest cover occurred in the lower watershed after 1972. There was a less than 10-percent variation in total forested area as determined from the six different data sources between 1972 and 1987. These differences can be attributed to differences in the quality and level of detail of the source materials.

5 Summary

Spatial data analysis and image processing techniques were used to document changes to forest cover and forested wetlands in the Cache River, AR, watershed. Historical topographic maps, recent topographic maps, and digital satellite imagery were used to determine the magnitude of forest removal. Changes in forest fragmentation were quantified based on the distribution and geometry of forest stands.

Between 1935 and 1972, approximately 100,000 ha of forest cover (30 percent of the watershed area) were removed. Little change in forest cover occurred after 1975. Comparisons of forest cover with hydric soils data indicate that, in the lower watershed area, up to 80 percent of the forest removed may have been forested wetlands.

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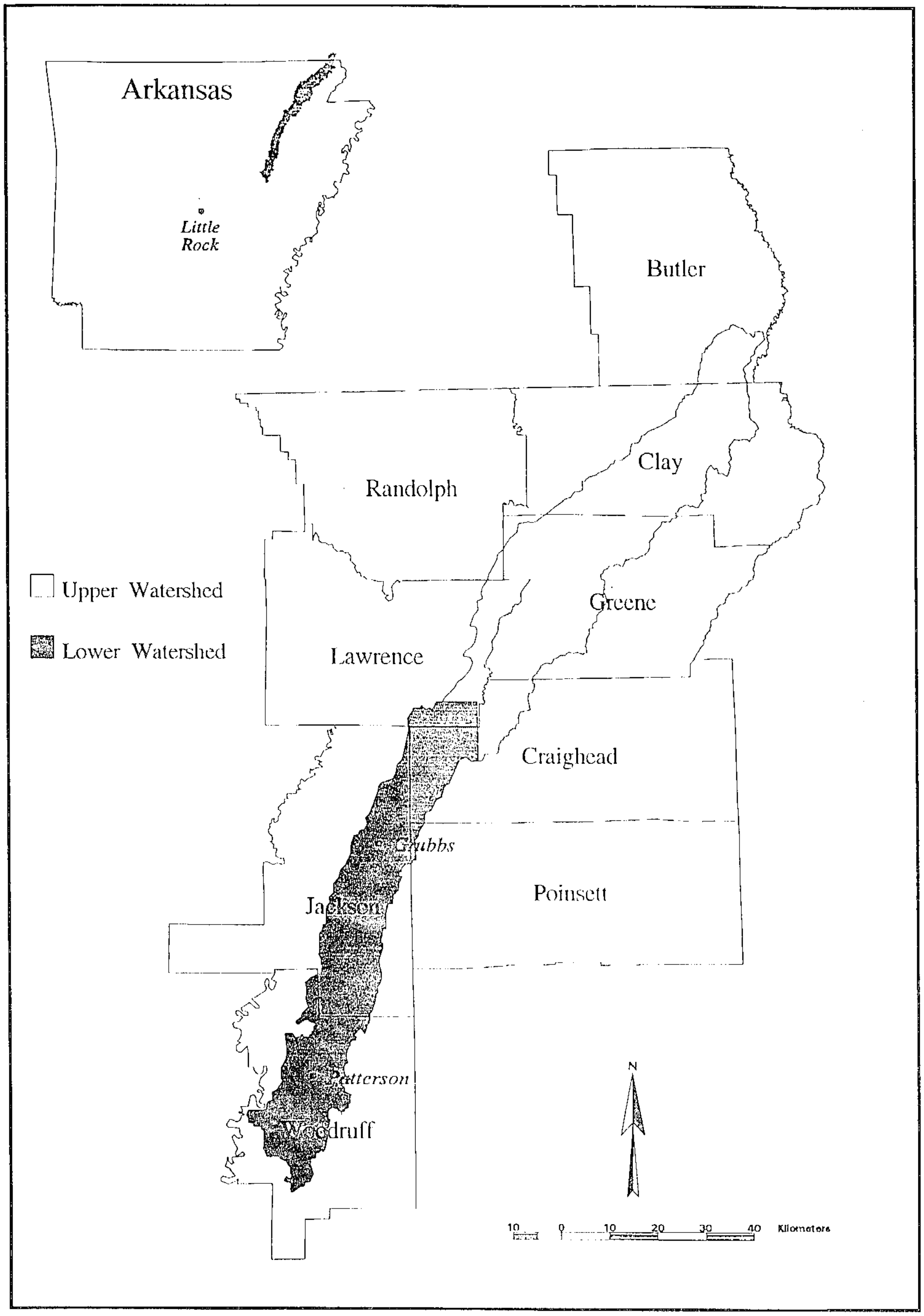

Figure 1. Location of Cache River, AR, watershed and limits of upper and lower watersheds

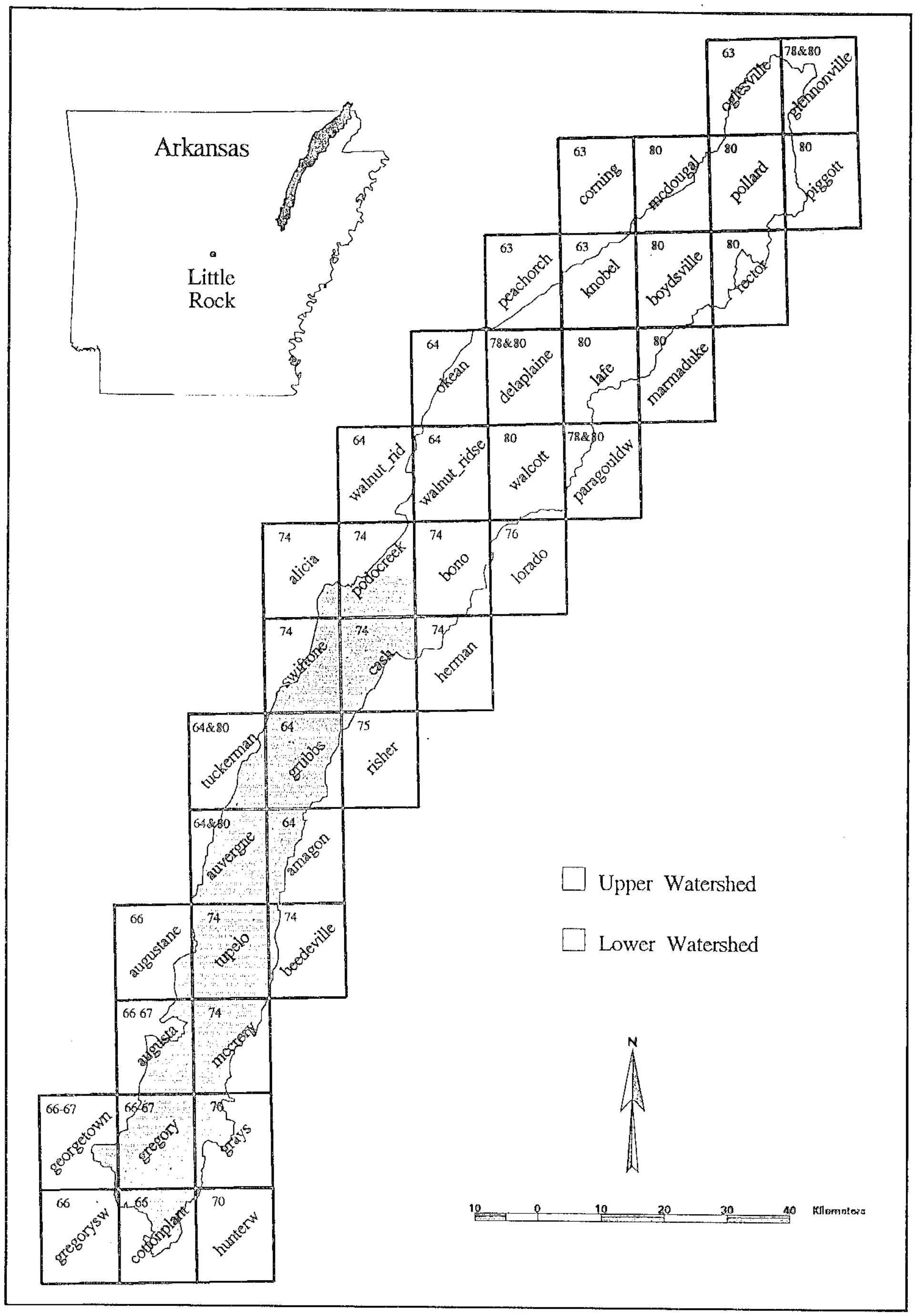

Figure 2. Name, location, and publication date of the 1:62,000-scale map set used to develop the 1935 forest cover data

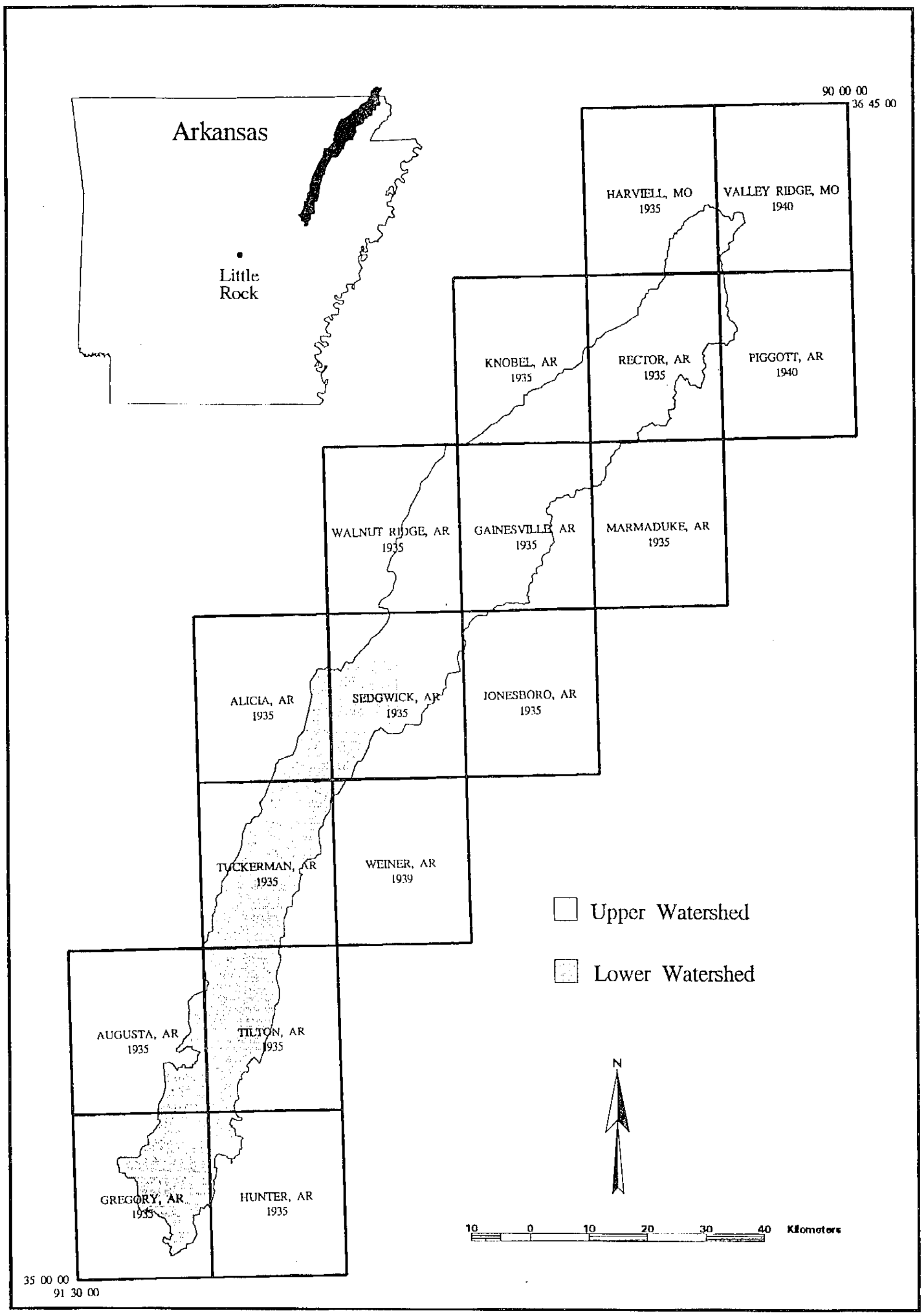

Figure 3. Name and location of the 1:24,000-scale map set used to develop the 1975 forest cover data. (Small numbers within each map boundary are the last two digits of the date of aerial photographs upon which the maps were based)

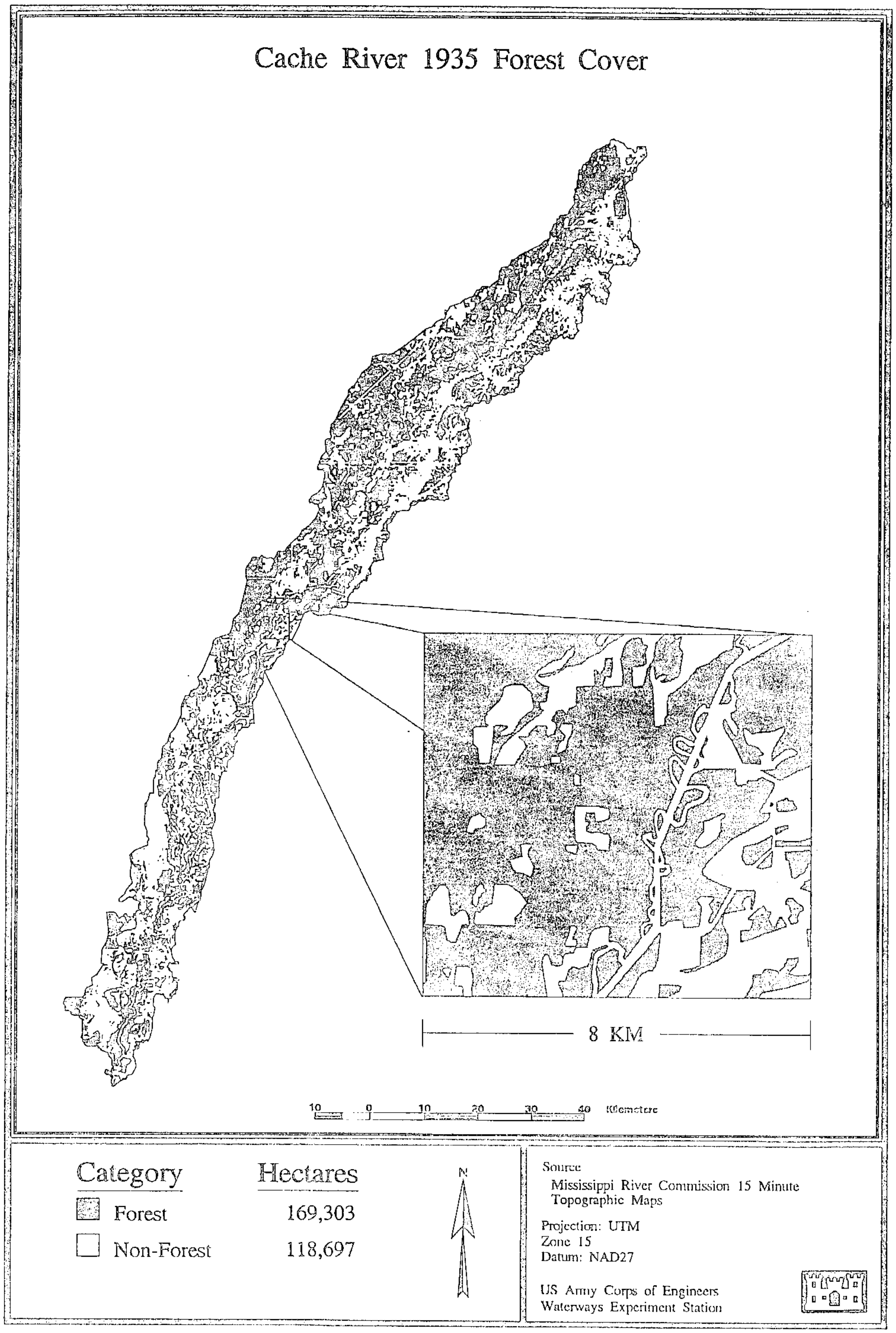

Figure 4. Forest cover in the Cache River watershed, 1935

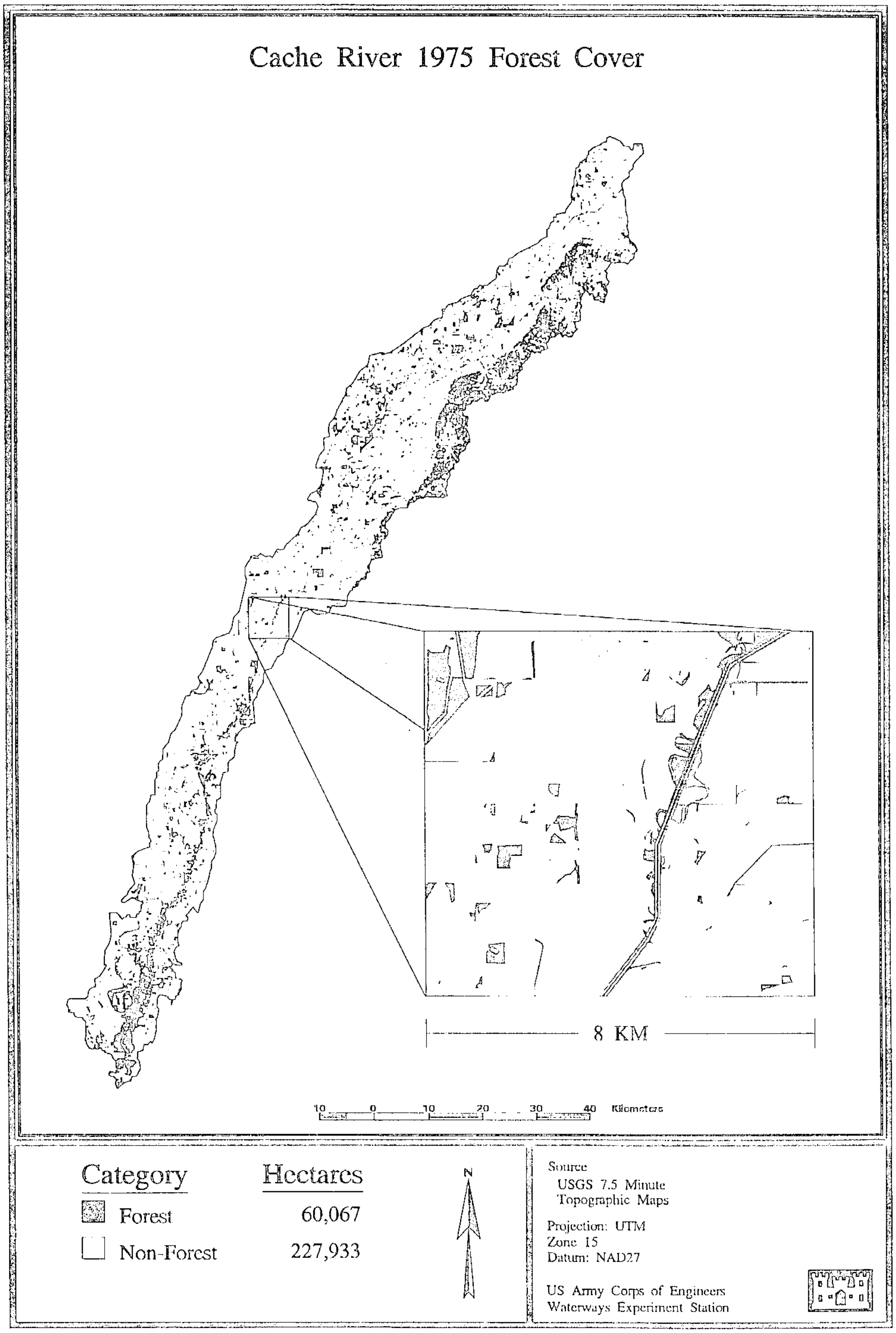

Figure 5. Forest cover in the Cache River watershed, 1975

Figure 6. Forested wetlands in the lower Cache River watershed as shown on USFWS NWI maps

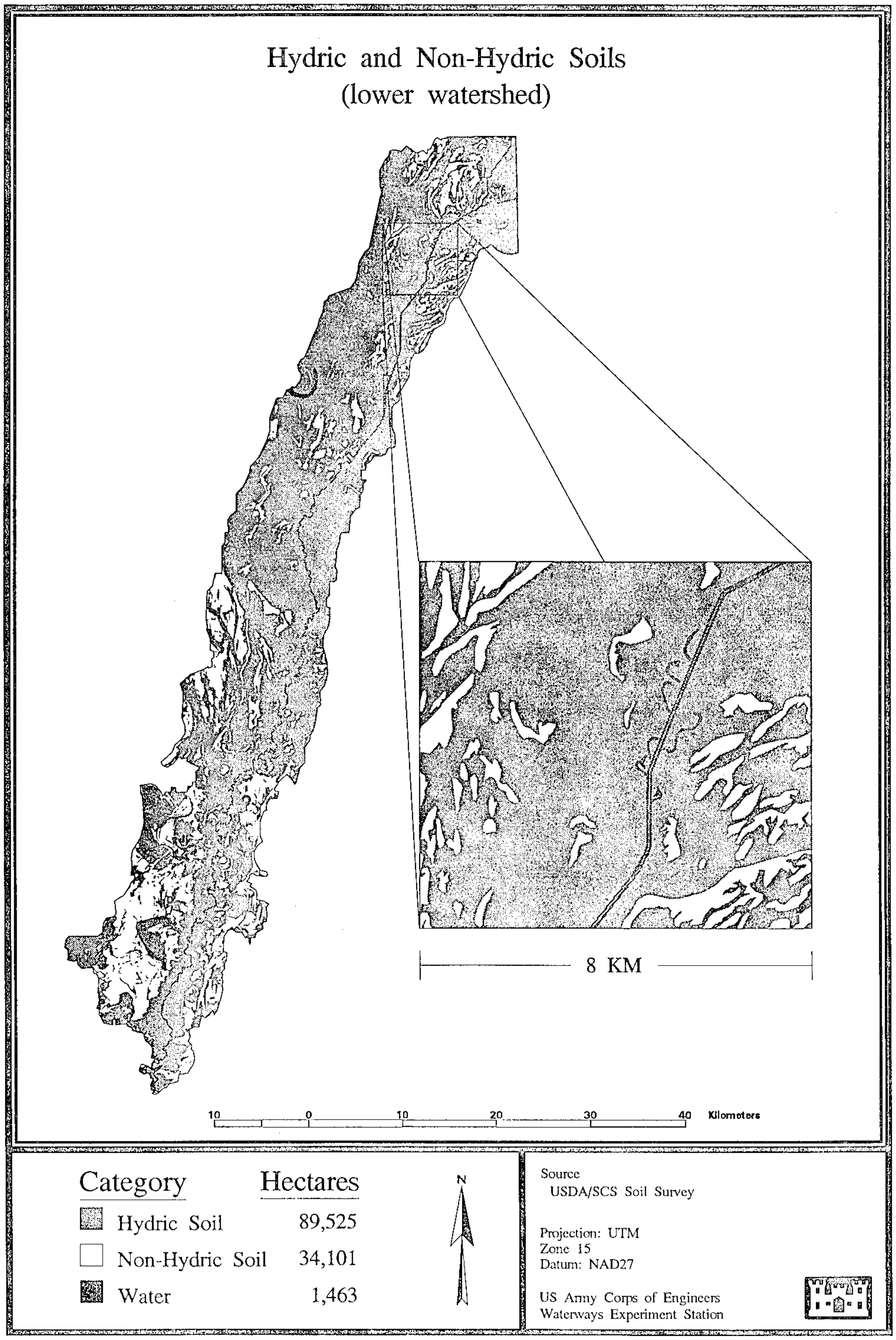

Figure 7. Hydric and nonhydric soils in the lower Cache River watershed

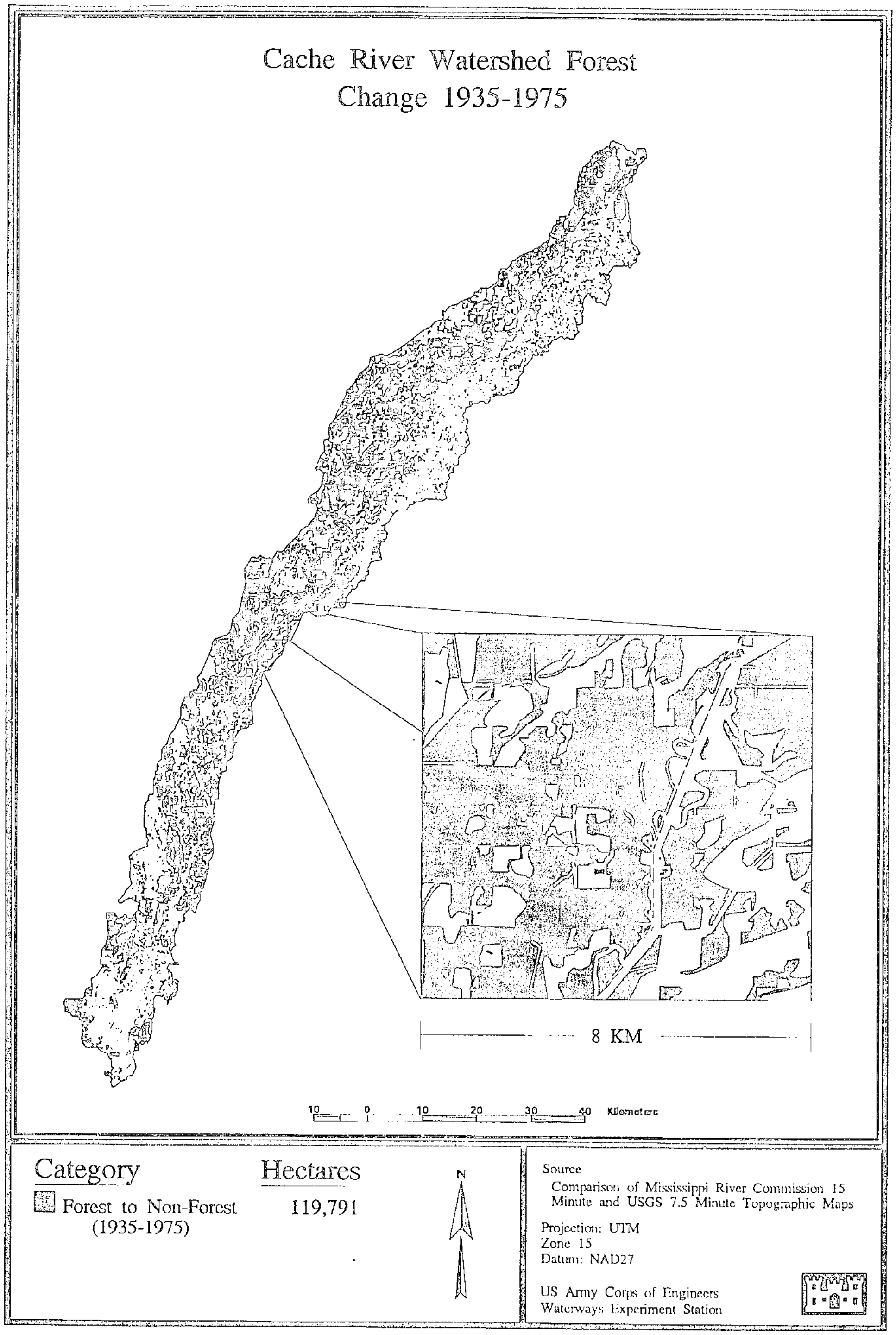

Figure 8. Forest cover change in the Cache River watershed between 1935 and 1975

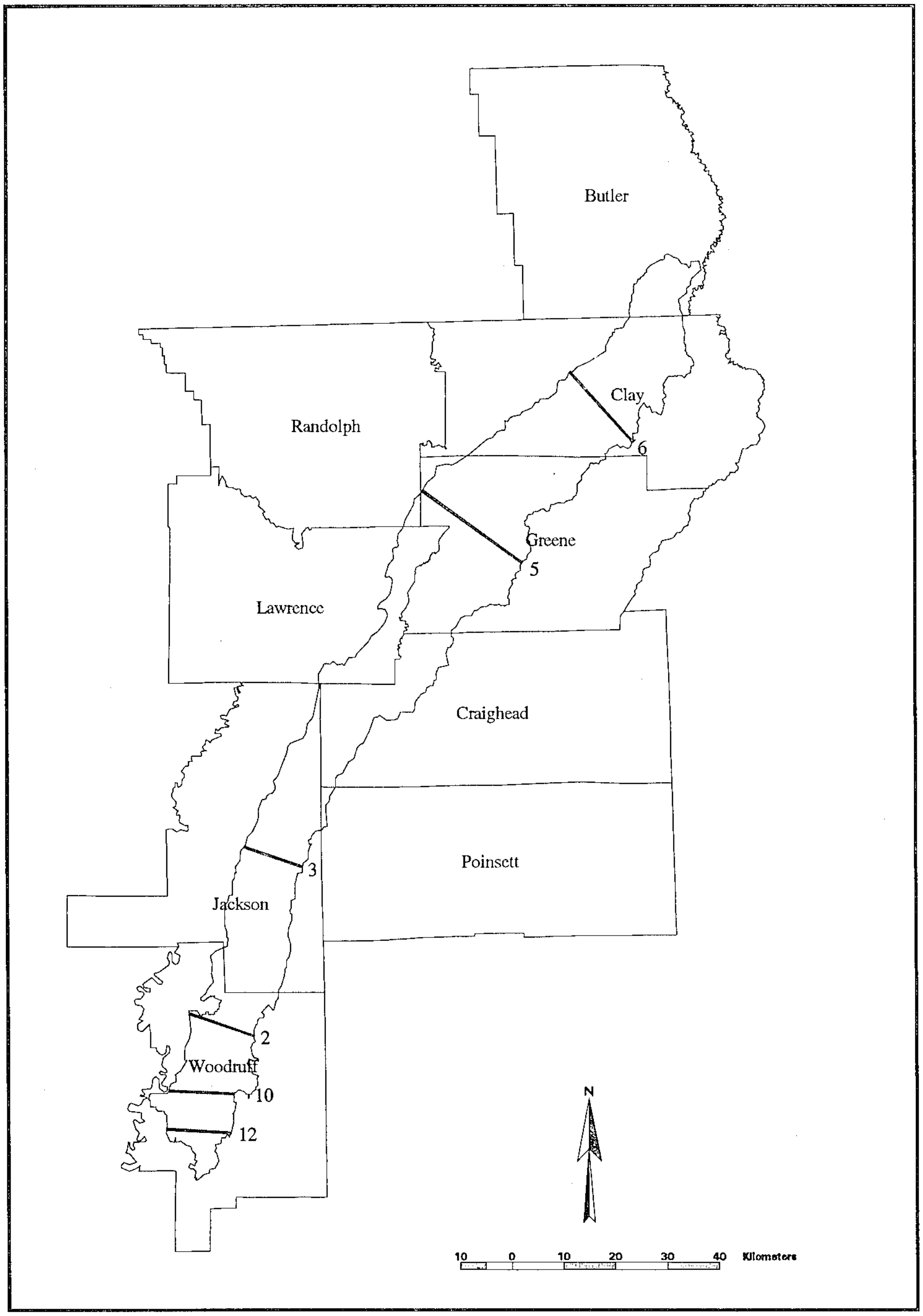

Figure 9. Location of transects selected for calculating measures of forest fragmentation

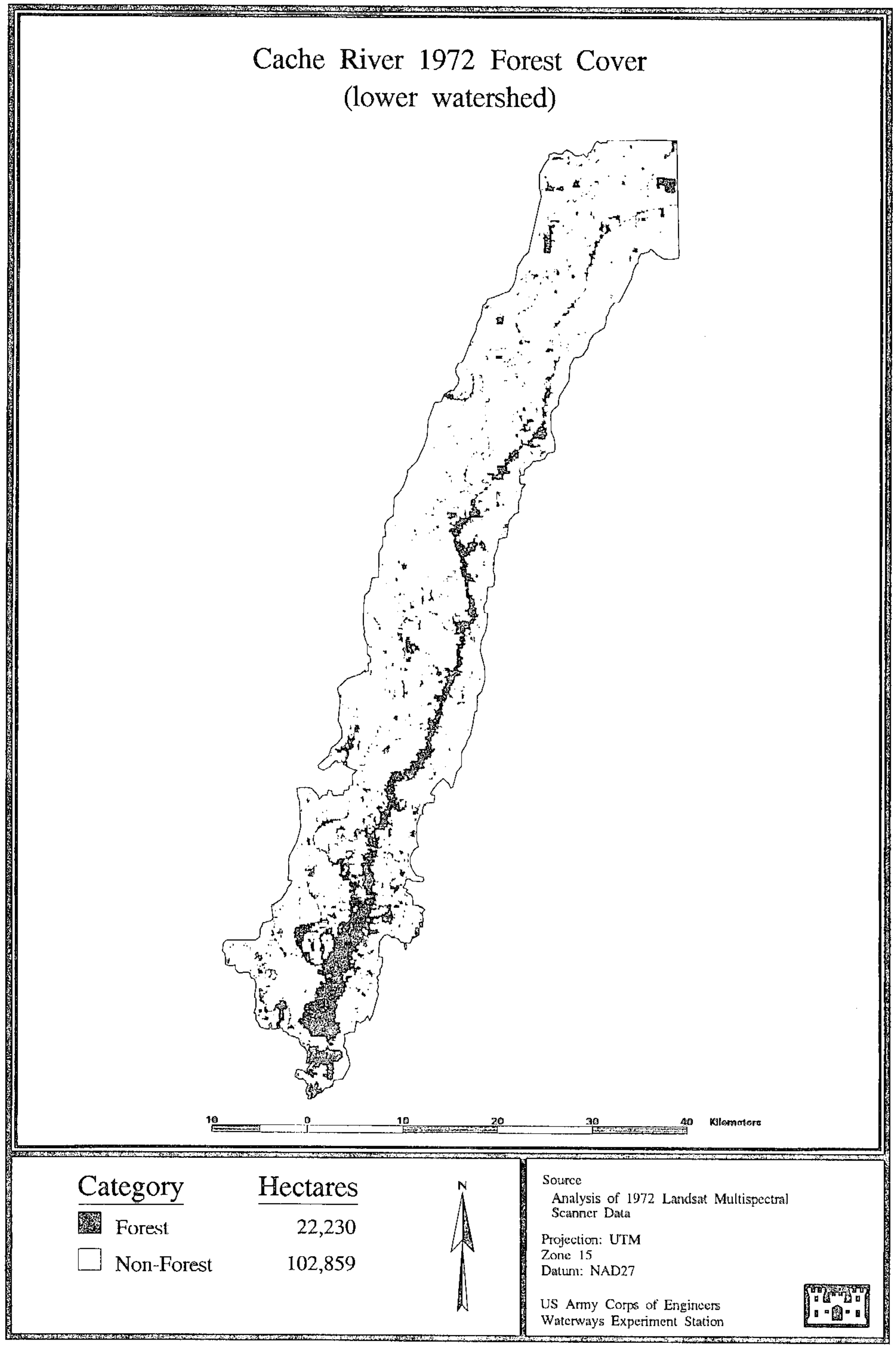

Figure 10. Forest cover in the lower Cache River watershed based on October 1972 Landsat multispectral scanner satellite data

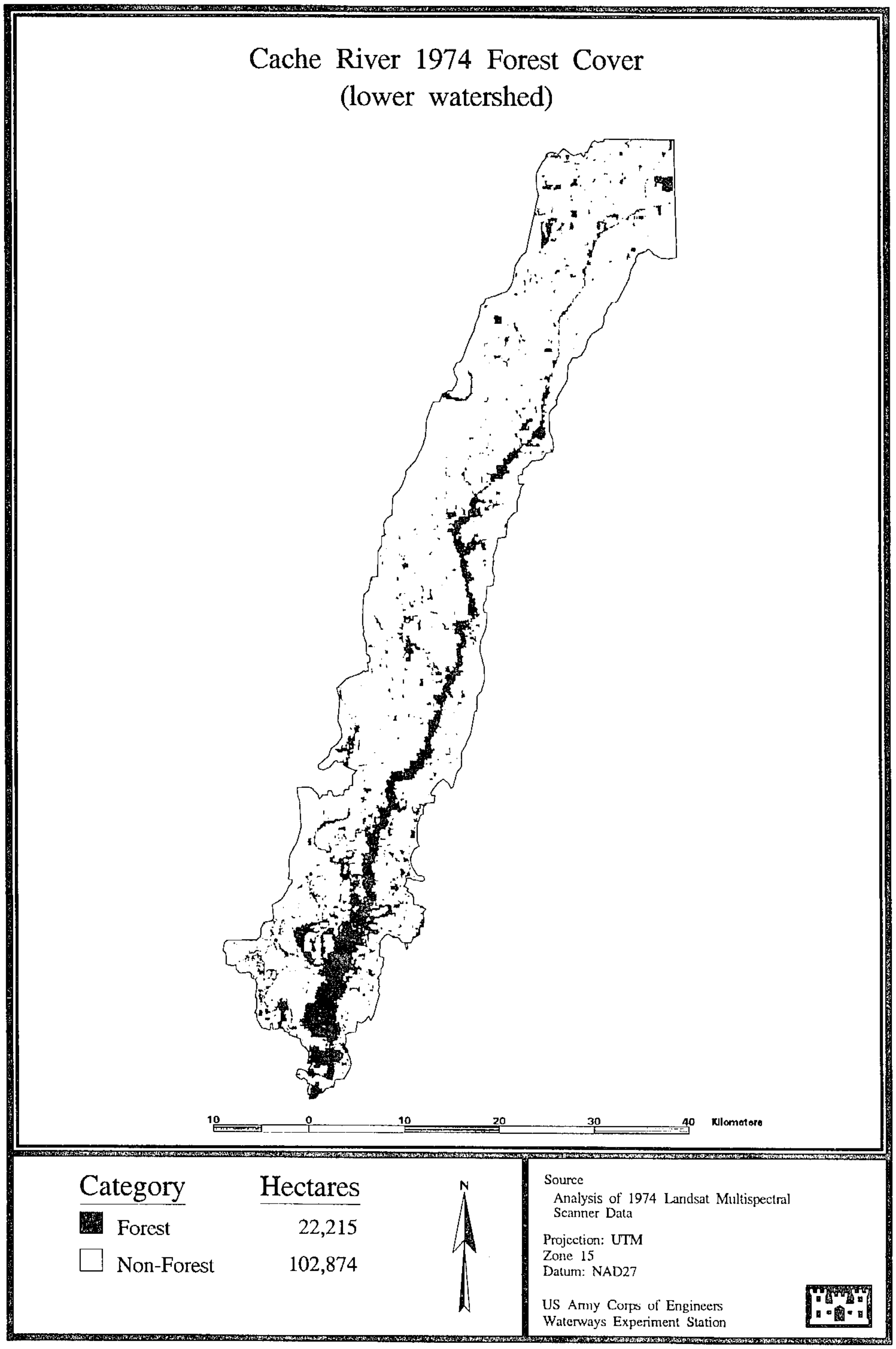

Figure 11. Forest cover in the lower Cache River watershed based on October 1974 Landsat multispectral scanner satellite data

Figure 12. Forest cover in the lower Cache River watershed based on April 1976 Landsat multispectral scanner satellite data

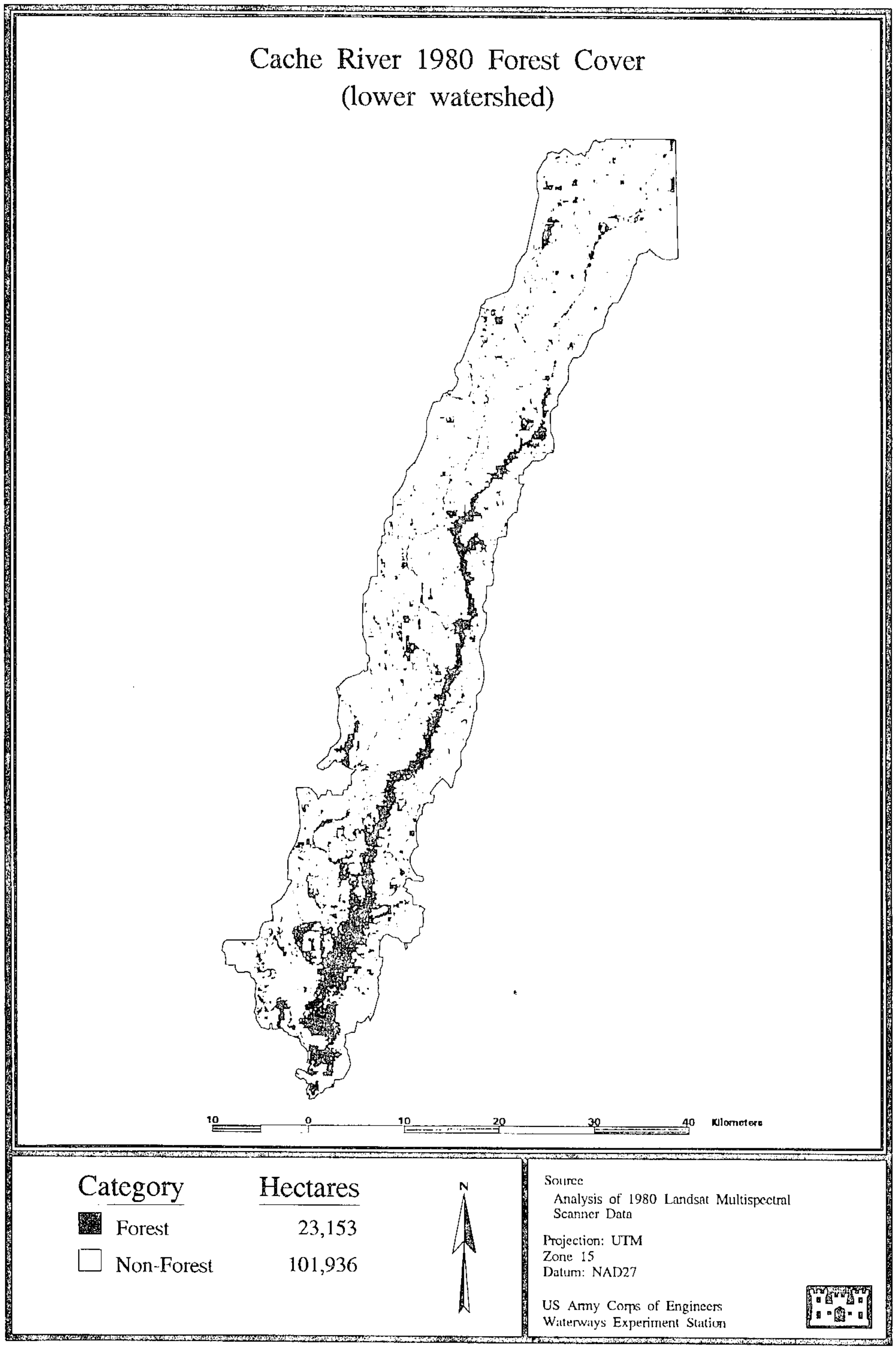

Figure 13. Forest cover in the lower Cache River watershed based on October 1980 Landsat multispectral scanner satellite data

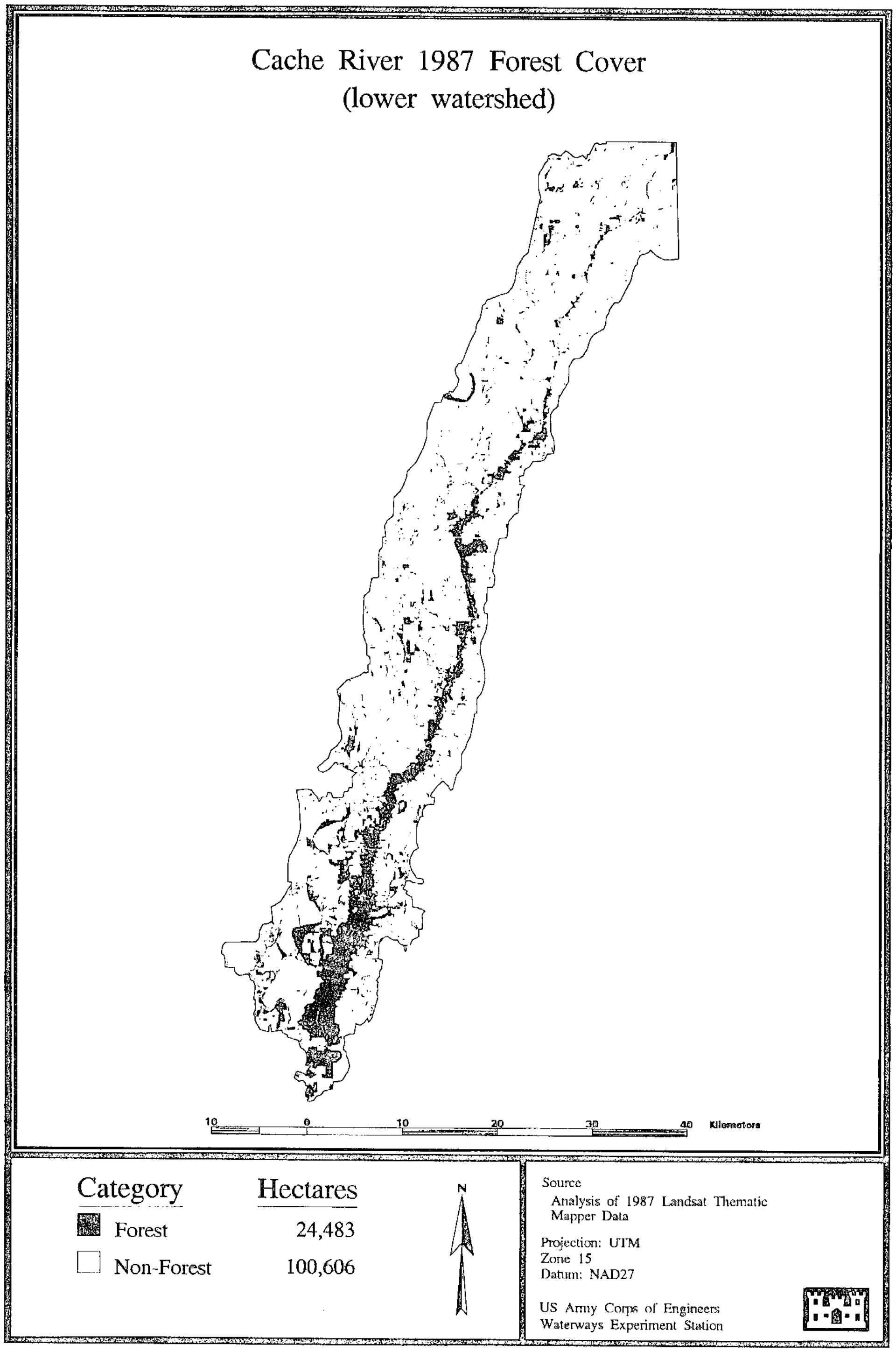

Figure 14. Forest cover in the lower Cache River watershed based on March 1987 Landsat thematic mapper satellite data

Table 1
USGS 1:24,000-Scale Topographic Maps Used to Develop the 1975 Forest Cover Data for the Cache River, AR, Watershed

Map Name	Publication Date	Photography Date for Forest Cover
Alicia, AR	1980	1974
Amagon, AR	1965	1964
Augusta, AR	1968	1966 and 1967
Augusta NE, AR	1967	1966
Auvergene, AR	1965	1964 and 1980
Beedeville, AR	1980	1974
Bono, AR	1980	1974
Boydsville, AR	1984	1980
Cash, AR	1980	1974
Corning, AR	1964	1963
Cotton Plant, AR	1968	1966
Delaphaine, AR	1984	1978 and 1980
Georgetown, AR	1968	1966 and 1967
Glennonville, MO	1983	1978 and 1980
Grays, AR	1971	1970
Gregory, AR	1968	1966 and 1967
Gregory SW, AR	1968	1966
Grubbs, AR	1965	1964
Herman, AR	1980	1974
Hunter West, AR	1971	1970
Knobel, AR	1964	1963
Lafe, AR	1984	1980
Lorado, AR	1983	1976
Marmaduke, AR	1984	1980
McCory, AR	1980	1974
McDougal, AR	1984	1980
Oglesville, MO	1964	1963
Okean, AR	1965	1964
Paragould West, AR	1984	1978 and 1980
Peach Orchard, AR	1964	1963

(Continued)

Table 1 (Concluded)

Map Name	Publication Date	Photography Date for Forest Cover
Piggott, AR-MO	1984	1980
Podo Creek, AR	1980	1974
Pollard, AR	1984	1980
Rector, AR	1984	1980
Risher, AR	1980	1975
Swifton East, AR	1980	1974
Tuckerman, AR	1965	1964 and 1980
Tupelo, AR	1980	1974
Walcott, AR	1983	1980
Walnut Ridge, AR	1965	1964
Walnut Ridge SE, AR	1965	1964

Table 2
Percentage of Cache River Watershed by Date of Photography on the USGS 1:24,000-Scale Map Set

Date of Photography	Percentage of Watershed
1963	8.2
1964	14.9
1966	2.6
1967	8.1
1970	1.6
1974	25.8
1975	0.1
1976	0.2
1980	32.7
1981	5.6

Table 3
Photography Used by USFWS for NWI Maps, Lower Cache River Watershed

Map Name	Date of Photography
Alicia, AR	Feb 1984
Amagon, AR	Feb 1984
Augusta, AR	Mar 1986
Augusta NE, AR	Mar 1986
Auvergene, AR	Mar 1985
Beedeville, AR	Feb 1984
Cotton Plant, AR	Mar 1986
Georgetown, AR	Feb 1984
Grays, AR	Mar 1985
Gregory, AR	Mar 1986
Gregory SW, AR	Feb 1984
Grubbs, AR	Feb 1984
McCrory, AR	Mar 1985
Swifton East, AR	Feb 1984
Tuckerman, AR	Mar 1985
Tupelo, AR	Mar 1985

Table 4
Landsat Satellite Imagery Analyzed

Sensor[1]	Date	Path, Row	Scene ID
MSS	Oct. 02, 1972	25, 35	8107116113500
MSS	Oct. 02, 1972	25, 36	8107116120500
MSS	Oct. 10, 1974	25, 35	8180916004500
MSS	Oct. 10, 1974	25, 36	8180916011500
MSS	Apr. 02, 1976	25, 35	8534915314500
MSS	Apr. 02, 1976	25, 36	8524915321500
MSS	Oct. 23, 1980	25, 35	82210115592X0
MSS	Oct. 23, 1980	25, 36	82210116001X0
TM	Mar. 28, 1987	24, 35	Y5112216051X0
TM	Mar. 28, 1987	24, 36	Y5112216053X0

[1] MSS = Multispectral scanner, 4 channels, 80-m resolution; TM = Thematic mapper, 7 channels, 30-m resolution.

Table 5
Measures of Forest Fragmentation in the Cache River Watershed Based on the 1935 and 1975 Forest Cover Data

Fragmentation Measure	1935	1975
Total forest area, ha	169,303	60,067
Number of stands	1,317	3,577
Maximum stand size, ha	42,842	6,120
Core area, ha	112,462	21,224
Wooded edge, km	6,503	7,396

Table 6
Summary of Forest and Forested Wetland for the Lower Cache River Watershed

Date	Forest, ha	Forested[1] Wetland, ha	Source
1935	70,439	58,982	1:62,000
1972	22,230	19,608	MSS
1974	22,215	19,524	MSS
1975	24,288	21,851	1:24,000
1976	23,858	20,746	MSS
1980	23,152	20,271	MSS
1987	24,482	21,569	TM

[1] Forested wetland determined as forest cover on hydric soil.

Table 7
Result of Transect Analysis for Six Transects Based on 1935 and 1975 Forest Cover Data

Transect Number	Transect Length, m	Number of Forest/ Non-Forest Transitions		Percent of Transect Length Forested	
		1935	1975	1935	1975
12	12,345	27	14	49	40
10	12,609	29	30	51	53
2	13,251	27	28	43	18
3	11,907	25	18	62	22
5	23,677	27	60	64	20
6	18,148	34	55	54	19

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13. ABSTRACT *(Maximum 200 words)*

Spatial data analysis and image processing techniques were used to document changes to forest cover and forested wetlands in the Cache River, AR, watershed. Historical topographic maps, recent topographic maps, and digital satellite imagery were used to determine the magnitude of forest removal. Changes in forest fragmentation were quantified based on the distribution and geometry of forest stands.

Between 1935 and 1972, approximately 100,000 ha of forest cover (30 percent of the watershed area) were removed. Little change in forest cover occurred after 1975. Comparisons of forest cover with hydric soils data indicate that, in the lower watershed area, up to 80 percent of the forest removed may have been forested wetlands.

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