

AD-A111 414

KENWILL INC JACKSBORO TN

F/8 6/3

DETERMINATION OF PRESENCE AND HABITAT SUITABILITY FOR THE INDIA--ETC(U)

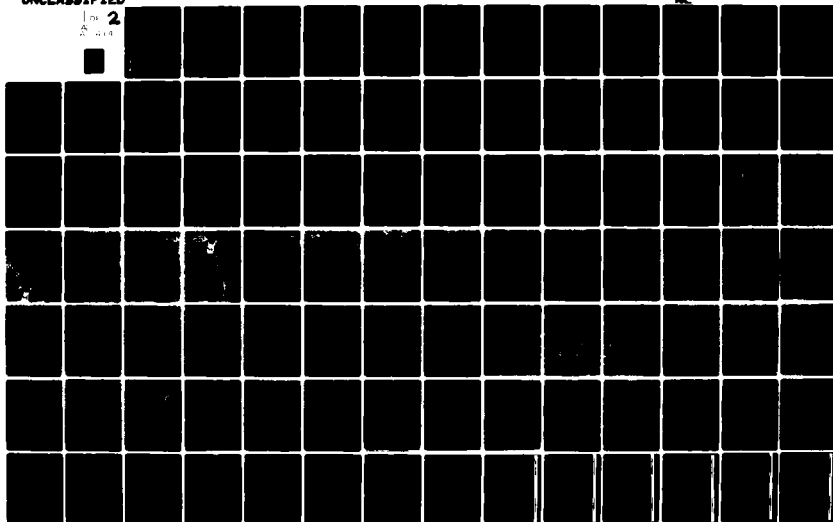
JAN 82 A R RABINOWITZ

DACW93-81-C-0103

UNCLASSIFIED

2

ML



UNC



ADA111414

1

72

0

DETERMINATION OF PRESENCE AND HABITAT
SUITABILITY FOR THE INDIANA BAT
(MYOTIS SODALIS) AND GRAY BAT
(MYOTIS GRISESCENS) FOR THE PINE FORD
STUDY AREA, JEFFERSON, WASHINGTON,
ST. LOUIS AND FRANKLIN COUNTIES, MISSOURI

SUBMITTED TO THE

ST. LOUIS DISTRICT, U.S. ARMY CORPS OF ENGINEERS
PROJ. DACW43-81-C-0103

PREPARED BY

KENWILL, INCORPORATED
P.O. BOX 450
JACKSBORO, TENNESSEE 37757

PROJECT LEADER: ALAN R. RABINOWITZ, Ph.D.

This document has been approved
for public release and sale; its
distribution is unlimited.

82 02 26 095

11

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A111414	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Determination of Presence and Habitat Suitability for the Indiana Bat (<u>Myotis sodalis</u>) & Gray Bat (<u>Myotis grisescens</u>) for Pine Ford Study Area, Jefferson, Washington, St. Louis, Franklin Counties, Missouri		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) Alan R. Rabinowitz, Ph.D		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Kenwill, Inc. P.O. Box 450 Jacksboro, TN 37757		8. CONTRACT OR GRANT NUMBER(s) DACW43-81-C-0103
11. CONTROLLING OFFICE NAME AND ADDRESS St. Louis District, US Army Corps of Engineers, 210 Tucker Blvd. North, St. Louis, MO 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE January 1982
		13. NUMBER OF PAGES 46
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Bats, Indiana Bat, Gray Bat		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) From 29 June 1981, through 14 August 1981, fifty five trap nights and four monitor nights on the Big River and its tributaries within the Pine Ford Study Area resulted in the capture of 393 bats of ten species. High mist nets that spanned the river from bank to bank and extended from water level to a height of 7.5 meters were used. Ultrasonic monitors were used to document bat activity levels at net sites and to assess the presence of myotine bats in areas that		

DTIC
SELECTED
FEB 26 1982

A

DD FORM 1473

EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Block 20: Abstract.

could not be netted. Activity patterns and capture times of different species appeared to be related to the presence of mayfly hatches. The red bat (Lasiurus borealis), was the most common bat captured, comprising fifty-four percent of the total sample. Two federally endangered species, the Indiana bat, (Myotis sodalis) and the gray bat, (Myotis grisescens), also were captured, comprising 2.3 percent and 1.5 percent of the total sample, respectively. Of the nine M. sodalis captured, all were adult males except for two adult females. One lactating female M. sodalis was captured on 1 July and a post-lactating female M. sodalis was captured on 22 July. Of six M. grisescens captured, all were adult males except for one juvenile female captured on 12 August. Subsequent retrapping of areas, in which females of endangered species were captured, indicated no signs of maternity colonies. Overall, the portion of the Big River within the study area produced an average capture of 7.0 bats per net night and a Shannon-Wiener diversity index value of 1.97, indicating a relatively dense and diverse bat fauna.

On 14 August, one trap night and two monitor nights were located on a portion of the Meramec River approximately 5.6 kilometers from its junction with the Mississippi River. These investigations resulted in the capture of one L. borealis and very low activity patterns. The lack of extensive riparian habitat in this area, as well as the poor capture data, indicated a probable lack of an extensive bat fauna in this area.

ACKNOWLEDGEMENTS

This project could not have been carried out without the assistance of many different individuals. Foremost on the list are the project personnel, John Eiler, Eric Bryant and Scott Mabury, whose long hours and tireless efforts allowed the project to be completed despite many setbacks. In addition, there were several individuals whose cooperation saved us much time and helped us greatly. These included:

John Brady, Biologist, U.S. Army Corps of Engineers,
St. Louis District.

Gene Gardner, Biologist, Missouri Dept. of Conservation.

Rick Clawson, Biologist, Missouri Dept. of Conservation.

James Cope, Biologist, Earlham College, Richmond,
Indiana.

Bill Mayberry, Naturalist, Washington St. Park,
DeSoto, Mo.

Finally, there were all those good people in and around DeSoto, Missouri and the Pine Ford Study Area whose hospitality and cooperation made a difficult project much easier.

TABLE OF CONTENTS

	PAGE
ABSTRACT.....	1
INTRODUCTION.....	3
MATERIALS AND METHODS.....	8
Description of Study Area.....	8
Trapping of Bats.....	10
Trap Sites.....	12
RESULTS AND DISCUSSION.....	15
Bat Trapping.....	15
Stream Characterization.....	21
Insect Trapping.....	25
Discussion.....	26
CONCLUSIONS.....	30
LITERATURE CITED.....	35
APPENDIX.....	38



Accession For	DTIC
NTIS GRA&I	
DTIC TAB	
Unannounced	
Justification	
File	
Date	
Area	
by	A

LIST OF TABLES

TABLE	PAGE
1. Status of Bat Species Known to Occur in Missouri.....	4
2. Bat Species Captured Over the Big River and Its Tributaries in the Pine Ford Study Area, 29 June - 14 August, 1981.....	17
3. Comparison of Bat Captures Over the Main Channel of the Big River With Those Over Its Tributaries Within the Pine Ford Study Area.....	18
4. Location and Dates of Capture of the Endangered Indiana Bat, <u>Myotis sodalis</u> and the Endangered Gray Bat, <u>Myotis grisescens</u> , Over the Big River And Its Tributaries.....	19
5. Mean Capture Times for Bat Species Captured Over the Big River and Its Tributaries in the Pine Ford Study Area, 29 June - 14 August, 1981.....	22
6. Stream Characteristics Around Trap Sites for the Big River and Its Tributaries Within the Pine Ford Study Area.....	23

LIST OF FIGURES

FIGURE	PAGE
1. Trap Sites Located Within the Northern Portion of the Pine Ford Study Area. (Cedar Hill, Mo. Quadrangle).....	31
2. Trap Sites Located Within the Central Portion of the Pine Ford Study Area. (Fletcher, Mo. Quadrangle).....	32
3. Trap Sites Located Within the Southern Portion of the Pine Ford Study Area. (Tiff, Mo. Quadrangle).....	33
4. Trap Sites Located on the Meramec River. (Oakvill, Mo. - Ill. Quadrangle).....	34

APPENDIX

	PAGE
Field Data.....	38

ABSTRACT

From 29 June 1981, through 14 August 1981, fifty five trap nights and four monitor nights on the Big River and its tributaries within the Pine Ford Study Area resulted in the capture of 393 bats of ten species. High mist nets that spanned the river from bank to bank and extended from water level to a height of 7.5 meters were used. Ultra-sonic monitors were used to document bat activity levels at net sites and to assess the presence of myotine bats in areas that could not be netted. Activity patterns and capture times of different species appeared to be related to the presence of mayfly hatches. The red bat, (Lasiurus borealis), was the most common bat captured, comprising fifty-four percent of the total sample. Two federally endangered species, the Indiana bat, (Myotis sodalis) and the gray bat, (Myotis grisescens), also were captured, comprising 2.3 percent and 1.5 percent of the total sample, respectively. Of the nine M. sodalis captured, all were adult males except for two adult females. One lactating female M. sodalis was captured on 1 July and a post-lactating female M. sodalis was captured on 22 July. Of six M. grisescens captured, all were adult males except for one juvenile female captured on 12 August. Subsequent retrapping of areas, in

which females of endangered species were captured, indicated no signs of maternity colonies. Overall, the portion of the Big River within the study area produced an average capture of 7.0 bats per net night and a Shannon-Wiener diversity index value of 1.97, indicating a relatively dense and diverse bat fauna.

On 14 August, one trap night and two monitor nights were located on a portion of the Meramec River approximately 5.6 kilometers from its junction with the Mississippi River. These investigations resulted in the capture of one L. borealis and very low activity patterns. The lack of extensive riparian habitat in this area, as well as the poor capture data, indicated a probable lack of an extensive bat fauna in this area.

INTRODUCTION

The purpose of this study was to determine the summer habitat suitability and presence of the Indiana bat (Myotis sodalis) and gray bat (Myotis grisescens) on portions of the Big River and its permanently flowing tributaries within the Pine Ford Study Area. The study area was selected on the basis of the potential loss of forest and riparian habitat to the proposed Pine Ford Lake Project authorized by Section 203, Public Law 89-789 (Flood Control Act of 1966). In addition, several sites along the Meramec River were to be trapped and/or monitored for the presence of different bat species. This study was funded by the St. Louis U.S. Army Engineer District under contract number DACW43-81-C-0130. The work was conducted under a U.S. Fish and Wildlife endangered species permit No. PRT 2-4857 and a scientific collecting permit from the Missouri Department of Conservation.

Thirteen species of bats are known to occur within the state of Missouri (Hall and Kelson, 1959, Barbour and Davis, 1969) (Table 1). Three of these species, M. sodalis, M. grisescens and the Ozark big eared bat, (Plecotus townsendii ingens) currently are listed on the federal endangered species list and one species, the Keens bat (Myotis keeni)

TABLE 1. Status of Bat Species Known to Occur in Missouri

SPECIES	STATUS
<u>Myotis lucifugus</u> (small brown bat)	Common
<u>M. grisescens</u> (gray bat)	Endangered
<u>M. sodalis</u> (Indiana bat)	Endangered
<u>M. leibii</u> (least bat)	Status undetermined
<u>M. keenii</u> (Keens bat)	Rare
<u>Pipistrellus subflavus</u> (eastern pipistrelle)	Common
<u>Nycticeus humeralis</u> (evening bat)	Common
<u>Lasiurus borealis</u> (red bat)	Common
<u>L. cinereus</u> (hoary bat)	Common
<u>Lasionycterus noctivagans</u> (silver haired bat)	Common
<u>Eptesicus fuscus</u> (big brown bat)	Common
<u>Plecotus townsendii ingens</u> (Ozark big-eared bat)*	Endangered
<u>P. rafinesquii</u> (eastern big-eared bat)*	Rare

* Did not occur with the project study area.

is considered rare within the state. Only two of the thirteen species, the Ozark big eared bat (Plecotus townsendii ingens) and the eastern big eared bat (Plecotus rafinesquii), were not known to occur within the study area. A third species, the silver-haired bat (Lasionycteris noctivagans), usually is not found in Missouri during the summer months (LaVal and LaVal, 1980).

With the addition of M. sodalis to the federal endangered species list in 1967 and M. grisescens in 1976, the need for managing the habitat of these two species became an important legal as well as scientific consideration. Although there have been several key studies concerning the status and management of M. sodalis and M. grisescens (Humphrey, 1978; Tuttle, 1980; LaVal and LaVal, 1980; Rabinowitz and Tuttle, 1980), very little has been done concerning their land use associations and presence along potential foraging areas due to the difficulty in obtaining such data.

Both sexes of M. sodalis winter in caves. However, during the summer months, nursery colonies have been found beneath the bark of dead trees in wooded riparian habitat (Cope and Humphrey, 1977; Humphrey et al., 1977; Cope et al., 1978). Foraging habitat during this period includes the foliage of riparian and floodplain trees relatively close to the summer roost (Humphrey et al., 1977). Urbanization and deforestation

have long been considered a factor contributing to the decline of this species (Mohr, 1972).

Humphrey (1978) has speculated that loss of suitable habitat has caused a 50 percent decline of M. sodalis in recent years.

M. grisescens spends both the winter and summer in caves. Summer caves, especially those used by maternity colonies, are located primarily within one kilometer of rivers or reservoirs over which the bats feed (Tuttle, 1976). Except for periods of inclement weather in early spring and late fall, M. grisescens adults feed almost exclusively over water along river or reservoir edges (LaVal et al., 1977) where they have been shown to feed heavily on mayfly populations (Rabinowitz, 1978). In Missouri, M. grisescens were observed to forage mostly over streams with well developed riparian vegetation, flying as much as 17 kilometers upstream and downstream from the roost cave (LaVal et al., 1977). Environmental disturbance, such as deforestation, is considered a serious threat to the future status of this species (Tuttle, 1979).

Only recently have large, high mist net systems been developed sufficiently to sample bats accurately as they fly and forage along waterways (Cope et al., 1978; Gardner and Gardner, 1980; LaVal and LaVal, 1980). This technique allows

for an in-depth assessment of riparian areas as potential nursery and/or foraging areas for different bat species. Utilizing this technique, we were able to determine the summer habitat suitability and presence of M. sodalis and M. grisescens on portions of the Big River and its permanently flowing tributaries within the Pine Ford Study Area.

MATERIALS AND METHODS

Description of Study Area

The Big River is one of seven major free-flowing rivers remaining in Missouri. It lies within the Big River Basin located in east central Missouri and is a portion of the Meramec River Basin. The Big River originates in the St. Francis Mountain region, an area composed of igneous rocks of Cambrian and pre-Cambrian origin. The majority of its watershed lies within the Salem Plateau province composed of sedimentary limestones and dolomites of Ordovician origin and younger predominate (Mills, Hocutt, and Stauffer, 1978).

The Big River Study Area was selected on the basis of the location of the proposed Pine Ford Lake Project. The Pine Ford Study Area was established between river kilometer 50 at Morse Mills and river kilometer 106 at Washington State Park (Fig. 1 thru 3). This area includes portions of Jefferson, Washington, St. Louis and Franklin Counties, Missouri. Over the 56 kilometer length of the river in the project area, the main channel varied from approximately 30 to 70 meters in width with frequent pools and riffles. The riparian forest strips along the

main channel were dominated by an overstory of sycamore (Platanus occidentalis), maple (Acer spp.) and box elder (Acer negundo) and an understory of poison ivy (Rhus radicans) and stinging nettle (Urtica dioica). All permanently flowing tributaries within the study area, as well as several intermittent streams, also were netted for bats. These areas had the same basic riparian and substrate characteristics but were considerably shallower and varied in width from two to three meters. The bottom substrate of both the main channel and the tributaries varied from rocky to mud bottoms with most areas consisting of some combination of rock, gravel, mud and sand.

One trap night and two monitor nights also were carried out on a portion of the Meramec River. The section of the river studied was approximately 5.6 km from the junction of the Meramec River with the Mississippi River, within the Oakville Quadrangle (Fig. 4). This area was dominated by maples with a mixed understory. The canopy was approximately 21 meters high with virtually no canopy cover over the river. The river was approximately 75 meters wide and over 1.8 meters deep with a substrate consisting primarily of mud.

Trapping of Bats

Live capture of bats flying over the waterway was accomplished with large mist nets (Bleitz Wildlife Foundation, Hollywood, CA.) placed over the river perpendicular to the banks. All mist nets were 38 mm mesh but of variable lengths and heights. On the main channel of the river, mist nets 18 meters long and three meters high, were used almost exclusively. Over tributaries, nets varied from 5.4 meters to 18 meters in length and from 2.1 to three meters in height. Nets were erected over the river by using three interconnecting galvanized steel television antennae poles that reached a height of 7.5 meters. Once the poles were connected, a rope and pulley system was attached, and the were erected on both sides of the river using guy lines. Mist nets then were attached to the pulley system and stacked on top of one another. The nets could then be raised such that all the area between the poles from just above water level to a height of 7.5 meters was covered. In addition, the pulley system allowed for easy and efficient access to captured bats.

Due to the necessity of placing the mist net poles on the banks or in relatively shallow water, sites had to be located that were narrow in width and shallow in depth.

When possible, areas of the stream were also chosen where trees created a tunnel-like effect so that bats would be funnelled into the net. Nets were raised at sundown and checked at intervals of fifteen minutes until midnight. During this time, ultrasonic bat monitors (Westec Services, Inc., San Diego, CA.) were used continually to monitor activity at the trap site. The monitors also could be utilized to indicate when a bat was captured in the net and sometimes the genus of the captured bat. In addition, levels of activity could be compared with trap success to indicate if bats were successful in detecting and avoiding the nets.

Upon capture, bats were removed from the nets as quickly as possible. Medicinal ether was used to anesthetize bats that were tangled severely in the net or when they were to be held for further examination. Data recorded for each bat included species, sex, age, reproductive condition, time of capture and location of capture. Female bats were diagnosed as lactating or post-lactating on the basis of teat examination. The assignment of bats into either an adult or juvenile category was determined by closure of the phalangeal epiphyses. Bats were designated as juveniles by their small overall size and incomplete ossification

of the epiphysis. All bats captured and examined were released immediately unharmed at the site of capture that same night.

Trapping on the Meramec River had to be carried out somewhat differently due to the width and depth of the river. The mist net was placed only on one bank running out over the shoreline perpendicular to the river. This allowed for the capture of bats foraging or flying along the shoreline.

Trap Sites

The study area was broken into three sections: lower, middle and upper river kilometers. This division was necessary due to the short field time allotted for the program and the requirement that the entire study area would be sampled. These three sections were sampled continuously through the sampling period in order that a change in bat utilization could be detected.

Based upon M. sodalis optimal riparian habitat, the entire study area was classified into four categories.

These categories were:

- I. No trees on either bank
- II. Scattered small trees (less than 16" dbh)
- III. Mature trees on both banks (Greater than 16"

dbh) with less than three meters overhanging branches

- IV. Mature trees on both banks (greater than 16" dbh) with greater than three meters overhanging branches.

Trap sites were selected based upon four criteria. These criteria are listed below in order of their importance:

1. Trap sites should be approximately one kilometer apart.
2. Trap sites had to be in M. sodalis riparian habitat categories III or IV.
3. Trap sites had to be relatively narrow and shallow in order that a 18 meter long net could cover the flyway sufficiently and allow for adequate bat removal upon capture.
4. Trap sites had to approximate 100 percent cover between riparian canopies in order to create a tunnel-like effect so that virtually all bats passing through the flyway could be captured.

The trap site spacing was given number one priority based upon previous studies of M. sodalis. The foraging range of observed female M. sodalis and their young around

maternity colonies has been reported to be 0.8 km (Humphrey et al., 1977) and 1.2 km (Cope et al., 1978). Nets placed approximately 1 km apart along the entire project area should have guaranteed the capture of M. sodalis and their young if any maternity colony was in the area.

In areas which could not be trapped due to the width and/or depth of the river, bat monitors were utilized to document activity patterns and to assess the presence of myotine bats. Early in the evening, observed bats could be identified based upon their size and flight activity patterns (Gardner, 1978).

RESULTS AND DISCUSSION

Bat Trapping

From 29 June through 14 August, bats were trapped on the Big River and its tributaries between river kilometer 50 at Morse Mills and river kilometer 106 at Washington State Park. It was rare to find locations that met all four priorities of a good trap site. Thus, bats often were able to get around or over the mist nets once the net was detected. Comparisons of relative activity at a site, based on the ultrasonic monitors and capture data, indicated that bats usually were captured initially but would avoid the nets after release. Activity at the nets by the researchers also served to alarm bats in the area and probably contributed to bats becoming more aware of and avoiding the nets. However, there was no reason to believe that bats were not being captured in the relative proportions that they were occurring over the water. A total of fifty-five trap nights and four monitor nights on the Big River resulted in the capture of 393 bats of ten species (Table 2). The red bat (Lasiurus borealis) was the most common bat captured, comprising 55 percent of the total sample. This was followed by the eastern pipistrelle

bat (Pipistrellus subflavus) (17%) and the evening bat (Nycticeius humeralis) (15%). These three species together comprised 87% of the total sample. Comparison of captures over the main channel with those over tributaries (Table 3) indicated a much greater percentage of myotine bats and N. humeralis captured on tributaries relative to the other bats.

Of the myotine bats captured, there were two federal endangered species, M. sodalis and M. grisescens. They comprised 2.3% and 1.5% of the total sample respectively. The locations of their capture are listed in Table 4. Of the nine M. sodalis captured, only two were females. One female, captured on 1 July, was lactating, while the second female, captured on 22 July, was post-lactating. Of the six M. grisescens captured, only one was a female juvenile, captured on 12 August. From 29 June through 15 July, adult females of all species that were examined (N=12) had swollen teats and were lactating. On 7 July, a female P. subflavus was captured on the Mineral Fork tributary (Site #51) with a single young attached to its nipple. From 16 July through 30 July, six of the eight females that were examined were lactating while the remaining two were post-lactating. After 30 July, all adult females examined (N=16) were post lactating.

Table 2. Bat Species Captured Over the Big River and Its Tributaries in the Pine Ford Study Area, 29 June - 14 August, 1981.

SPECIES	NO. OF MALES		NO. OF FEMALES		NO. UNKNOWN	TOTAL	PERCENT OF ALL	
	CAPTURED		CAPTURED				BATS CAPTURED	
<u>Myotis grisescens</u>	5		1		0	6	1.5	
<u>M. sodalis</u>	7		2		0	9	2.3	
<u>M. keenii</u>	3		2		0	5	1.3	
<u>M. lucifugus</u>	8		2		0	10	2.5	
<u>M. leibii</u>	0		1		0	1	0.3	
<u>Lasiurus cinereus</u>	2		2		0	4	1.0	
<u>L. borealis</u>	85		89		42	216	55.0	
<u>Pipistrellus subflavus</u>	25		33		9	67	17.0	
<u>Nycticeius humeralis</u>	9		46		3	58	14.8	
<u>Eptesicus fuscus</u>	13		2		2	17	4.3	

Table 3. Comparison of Bat Captures Over the Main Channel of the Big River With Those Over Its Tributaries
Within the Pine Ford Study Area.

<u>GENUS</u>	<u>TOTAL NO. CAPTURED</u>	<u>PERCENT CAPTURED OVER MAIN CHANNEL</u>	<u>PERCENT CAPTURED OVER TRIBUTARIES</u>
<u>Myotis</u>	31	64.5	35.5
<u>Lasiurus</u>	220	83.0	17.0
<u>Pipistrellus</u>	67	88.0	12.0
<u>Nycticeius</u>	58	63.0	37.0
<u>Eptesicus</u>	17	94.0	6.0

Table 4. Location and Dates of Capture of the Endangered Indiana Bat, Myotis sodalis and the Endangered Gray Bat, Myotis grisescens Over the Big River and Its Tributaries.

<u>SPECIES</u>	<u>CAPTURE DATE</u>	<u>SEX^a</u>	<u>AGE^b</u>	<u>CAPTURE LOCATION^c</u>
<u>Myotis sodalis</u>	1 July 81	F ^d	A	Site 48R-Main channel-River kilometer 94
	1 July 81	M	A	Site 48R-Main channel-River kilometer 94
	1 July 81	M	A	Site 48R-Main channel-River kilometer 94
	10 July 81	M	A	Site 22R-Engel Ford Tributary-River kilometer 71
	22 July 81	F	A ^e	Site #7R-Bethlehem Creek-River kilometer 55
	30 July 81	M	A	Site #30-Grinnin Hollow Creek-River kilometer 79
	8 August 81	M	A	Site #31-Main channel-River kilometer 79
	9 August 81	M	A	Site #16-Main channel-River kilometer 65
	11 August 81	M	A	Site #20-Main channel-River kilometer 69
<u>Myotis grisescens</u>	29 June 81	M	A	Site #33-Main channel-River kilometer 81
	26 July 81	M	A	Site 35R-Calico Creek-River kilometer 82
	2 August 81	M	A	Site #34-Main channel-River kilometer 82
	12 August 81	M	A	Site 48R-Main channel-River kilometer 94
	12 August 81	M	A	Site 48R-Main channel-River kilometer 94
	12 August 81	F	J	Site 48R-Main channel-River kilometer 94

^aM = male, F = female

^bA = adult, J = juvenile

^cSite numbers correspond to Figures 1 - 3 site locations

^dFemale was lactating at time of capture

^eFemale was post-lactation at time of capture

Examination of the mean capture times of the various species (Table 5) indicated a possibility of temporal resource partitioning between some species. Kunz (1973) showed significantly different foraging patterns between L. borealis and the hoary bat (L. cinereus) with L. borealis being characterized by the earliest feeding period (one - two hours after sunset) and L. cinereus characterized by a later feeding period (four - five hours after sunset). This was substantiated in this study. Kunz (1973) also found no significant temporal foraging activity among the big brown bat (Eptesicus fuscus) the little brown bat (M. lucifugus) and L. borealis. This also was found to be true during this study. A possible means of alleviating overlap in temporal foraging may be by developing spatial strategies to reduce competition for resources (Kunz, 1973). However, there appeared to be no consistent patterns regarding the location where particular species were caught in the nets. Thus, there was no indication of spatial partitioning based upon capture data.

On 14 August, one trap set and two monitor sets were worked on the Meramec River. Only one bat, L. borealis, was captured in the mist net. The monitor stations recorded extremely low levels of bat activity at other sites in this area.

Stream Characterization

The characteristics of bat trap sites on both the main channel and the tributaries are reported in Table 6. Overall, the tributaries were narrower and shallower than the main channel sites, with a lower canopy and much greater canopy cover over the water. Substrate characteristics of both were similar (Table 6). The tributaries showed much greater tunnel-like effects over the nets and more potential roost trees were present.

Table 5. Mean Capture Times for Bat Species Captured Over the Big River and Its Tributaries in the Pine Ford Study Area 29 June - 14 August, 1981.

<u>SPECIES</u>	<u>SAMPLE SIZE</u> ¹	<u>MEAN CAPTURE TIME (CENTRAL DAYLIGHT TIME)</u>
<u>Myotis grisescens</u>	6	2155
<u>Pipistrellus subflavus</u>	67	2220
<u>Myotis sodalis</u>	9	2224
<u>Nycticeius humeralis</u>	58	2224
<u>Eptesicus fuscus</u>	17	2234
<u>Lasiurus borealis</u>	208	2237
<u>Myotis lucifugus</u>	10	2244
<u>Myotis keenii</u>	5	2304
<u>Lasiurus cinereus</u>	4	2335
<u>Myotis leibii</u> ²	1	----

¹ Sample sizes do not reflect total number of bats captured due to lack of data on escaped individuals.

² No mean capture time is recorded for Myotis leibii since only a single individual was captured.

Table 6. Stream Characteristics Around Bat Trap Sites for the Big River and Its Tributaries Within the Pine Ford Study Area.

	<u>MAIN CHANNEL</u>			<u>TRIBUTARIES</u>		
	<u>Mean</u>	<u>Sample Size</u>	<u>Range</u>	<u>Mean</u>	<u>Sample Size</u>	<u>Range</u>
Width (meters)	33.9	46	23.0- 55.0	11.8	8	6.10- 27.00
Depth (meters)	0.9	48	0.3- 3.0	0.3	8	0.87- 0.45
Percent canopy cover	33.0	44	0-100.0	89.0	8	40.00-100.00
Canopy height (meters)	21.2	40	15.0- 33.3	18.5	8	13.30- 31.70
Percent of times den trees present	6.5	46	-----	12.0	8	-----
Percent of times tunnel-like canopy cover over net	4.0 (total cover) 9.0 (partial cover)	46	-----	88.0 (total cover) 12.0 (partial cover)	8	-----
Percent of times for a particular substrate type	34.0 (gravel) 2.0 (sand) 64.0 (combination)	46	-----	50.0 (gravel) 50.0 (combination)	8	-----
Percent of times for a particular dominant tree size*	0.0 (Class 1) 2.2 (Class 2)	46	-----	0.0 (Class 1) 0.0 (Class 2)	8	-----

Table 6. Continued

	<u>MAIN CHANNEL</u>		<u>TRIBUTARIES</u>	
	<u>Mean</u>	<u>Sample Size</u>	<u>Mean</u>	<u>Sample Size</u>
Percent of times of a particular dominant tree size*	58.7		75.0	
	(Class 3)		(Class 3)	
	39.1		25.0	
	(Class 4)		(Class 4)	
				<u>Range</u>

* Class 1 = 0.0" to 4.9" dbh

Class 2 = 5.0" to 10.9" dbh

Class 3 = 11.0" to 15.9" dbh

Class 4 = 16.0" + dbh

Insect Trapping

As required by contract, two Johnson-Taylor suction traps were purchased for this study in order to determine temporal and spatial insect diversity and abundance at trap sites. However, due to their weight, size and fragile structure, they could not be transported on the river to the trap sites. Furthermore, the noise of the power generators needed to run the traps could affect the bats' behavior and thus trap success. Upon consultation with the project officer, this aspect of the study was not carried out. It was noted however, that high activity trap sites contained large number of mayflies. Furthermore, bat activity and capture times appeared to be correlated with the presence of mayfly hatches. This previously has been documented with the endangered M. grisescens in East Tennessee (Rabinowitz, 1979).

It is the suggestion of the author, as well as Dr. Merlin Tuttle (personal communication), that in the future, a study of this type should be carried out with sticky traps and/or blacklight traps. These traps are comparable in terms of insect trap success and can be correlated with bat activity (see Rabinowitz, 1979).

Discussion

The Big River and its tributaries within the Pine Ford Study Area have a rich and diverse bat fauna. All ten species that occur in the area during the summer months were captured. The overall bat capture rate, based upon numbers of bats captured per net night, was 7.0. This estimate is biased on the low side due to the difficulty of completely enclosing the river flyway with the mist nets on most occasions. This figure still is comparable to the 8.3 bats per net night reported by Cope et al. (1978) on the Big Blue River, which had the highest bat density of any river he had netted in Indiana. Calculation of species diversity using the Shannon-Wiener diversity index (Shannon and Wiener, 1963) gave a value of 1.97. Although the index value is influenced by sample size, it compares well with the figure of 1.62 obtained by Humphrey (1975) for Missouri. The fact that L. borealis was the most common species captured is in agreement with data obtained by LaVal and LaVal (1980) indicating that red bats are the most common species statewide. The large number of N. humeralis captured probably was related to the proximity of many trap sites to old farm buildings and barn structures. The large number of P. subflavus captured, probably was related to the abundance of rock cliff areas. However,

it must be considered that mist netting over streams yields a biased sample since those species that forage over streams more likely would be caught than those that just use streams as a flyway or only come to drink. Furthermore, species that are colonial may be absent in samples where nets are not erected in a colony's foraging area (LaVal and LaVal, 1980).

A relatively small number of endangered M. sodalis and M. grisescens were captured in the study area. Of those captured, all but three were adult males. Thus, there appeared to be no strong indications of M. sodalis maternity roost trees or M. grisescens maternity caves within the study area, based upon capture data. Male M. sodalis may stay in caves, mines or under bridges during the summer months (Barbour and Davis, 1969) and usually do not occur within the foraging ranges of the females (Humphrey et al., 1977). The single lactating female captured on 1 July and the single post-lactating female captured on 22 July, raise the possibility of maternity roosts. However, both areas of capture, which were 15 km apart, were subsequently retrapped and no M. sodalis of either sex was captured in these areas again. Furthermore, no juvenile M. sodalis were captured at any time during the study. A possible bias in this study, however, was the time of the summer that it was conducted. The optimum trap time would have been during late May through early

June when females were pregnant and young are nonvolant. During this time, foraging is restricted to riparian habitat. Later in the summer, feeding is extended to other solitary trees and forest edge on the floodplain (Humphrey et al., 1977). The lack of any adult female M. grisescens in our capture sample was not surprising since females are restricted to very specialized maternity caves during the summer months (Tuttle, 1975). Although male adult M. grisescens also use caves during the summer, they have a much broader tolerance at this time for a wide range of thermal conditions and often stay in transient bachelor roosts. Thus, they may occupy any number of small caves which would not be suitable for females (Tuttle, 1976). Furthermore, M. grisescens have a much more extensive foraging range than M. sodalis while occupying summer roosts. They have been known to fly as much as 17 km from their roost cave (LaVal et al., 1977). The only female M. grisescens in the sample was a juvenile netted 12 August. It would be difficult to assess a place of origin for this bat considering that it was captured in late summer. During August, most bat species undergo swarming behavior (Mohr, 1976; Cope and Humphrey, 1977) flying long distances to investigate possible winter quarters. Some of these distances have been known to equal 800 km (Mohr, 1976).

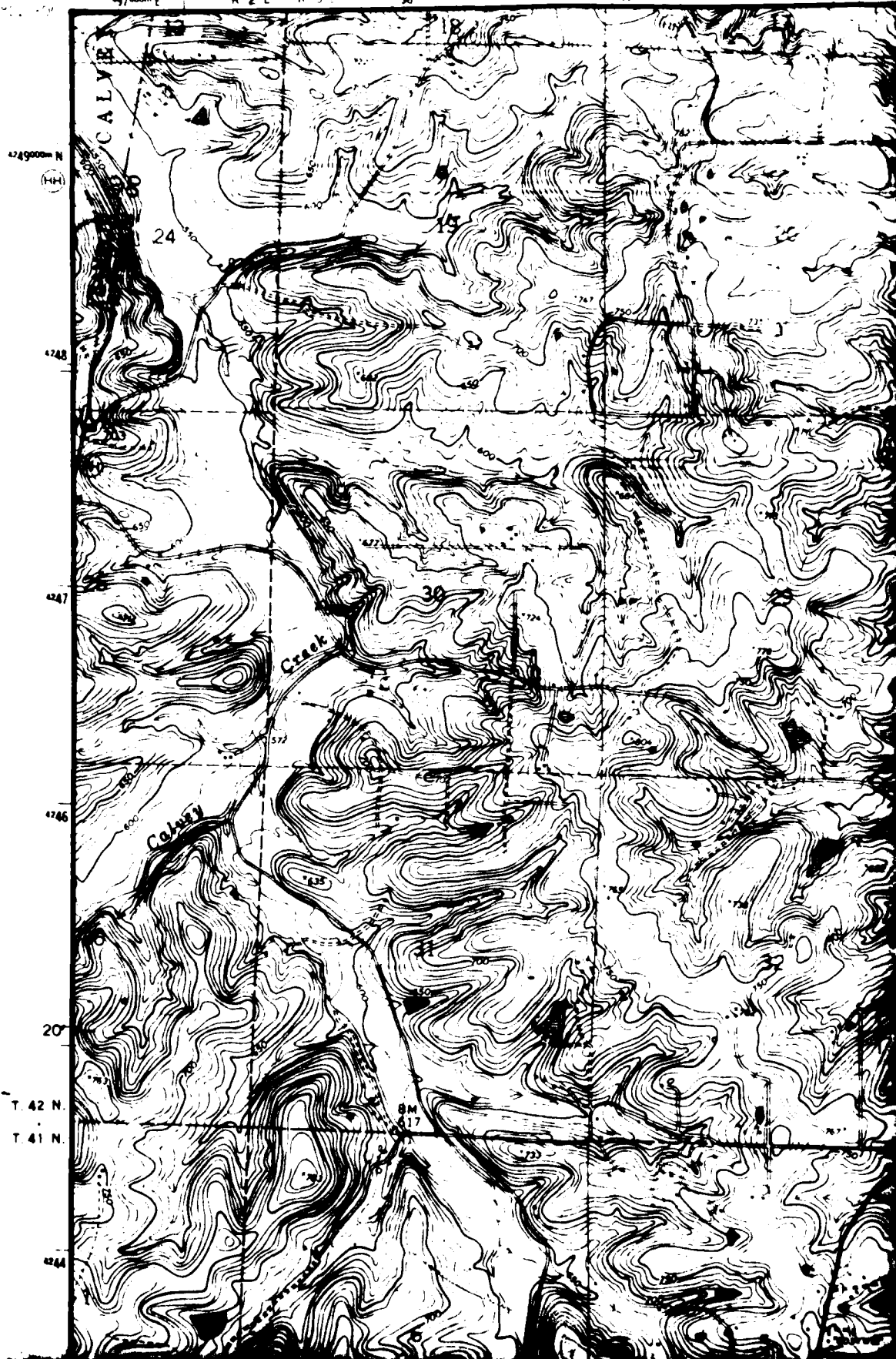
It also was important to compare the general riparian habitat characteristics on the Big River with those of other areas where M. sodalis maternity roosts have been located. Although this study area was similar in vegetation, canopy height and substrate characteristics to that found around the Knightstown, Indiana M. sodalis colony by Cope et al. (1978), it was not similar to the riparian habitat found around other colonies he located, nor was it very similar to that surveyed by Gardner and Gardner (1980). In addition, the main channel of the Big River was wider and deeper than that of any previous study where a colony had been located and there was a very low percentage of observed possible den trees.

The brief amount of time spent at the Meramec River sites allows no substantial conclusions to be drawn. However, the single trap night and two monitor nights indicated a poor habitat in terms of bat fauna. Activity levels and bat captures were extremely low and the substantial industrial and residential development in the area eliminates much of the possibility for good riparian habitat.

CONCLUSIONS

There appeared to be no M. sodalis or M. grisescens maternity colonies foraging or flying along the Big River or its tributaries within the defined boundries of the Pine Ford Study Area. However, the river within the study area is definitely used as a foraging site and flyway for males of both of these endangered species and possibly for occassional females from nearby colonies. Furthermore, the Big River has a relatively diverse and dense bat fauna and appears to be an important foraging area and/or flyway for adults and juveniles of many other bat species during the summer months.

4-7 0970000 E H Z E R 3 E 48 49 1230



2

DEPARTMENT OF THE ARMY
OFFICE OF ENGINEERING



CEDAR HILL QUADRANGLE

MISSOURI

15 MINUTE SERIES TOPOGRAPHIC

Copy available to DTIC does not
permit fully legible reproduction



920 000
FEET

4748

4747

4746

4745

4744

4743

4742

4741

4740

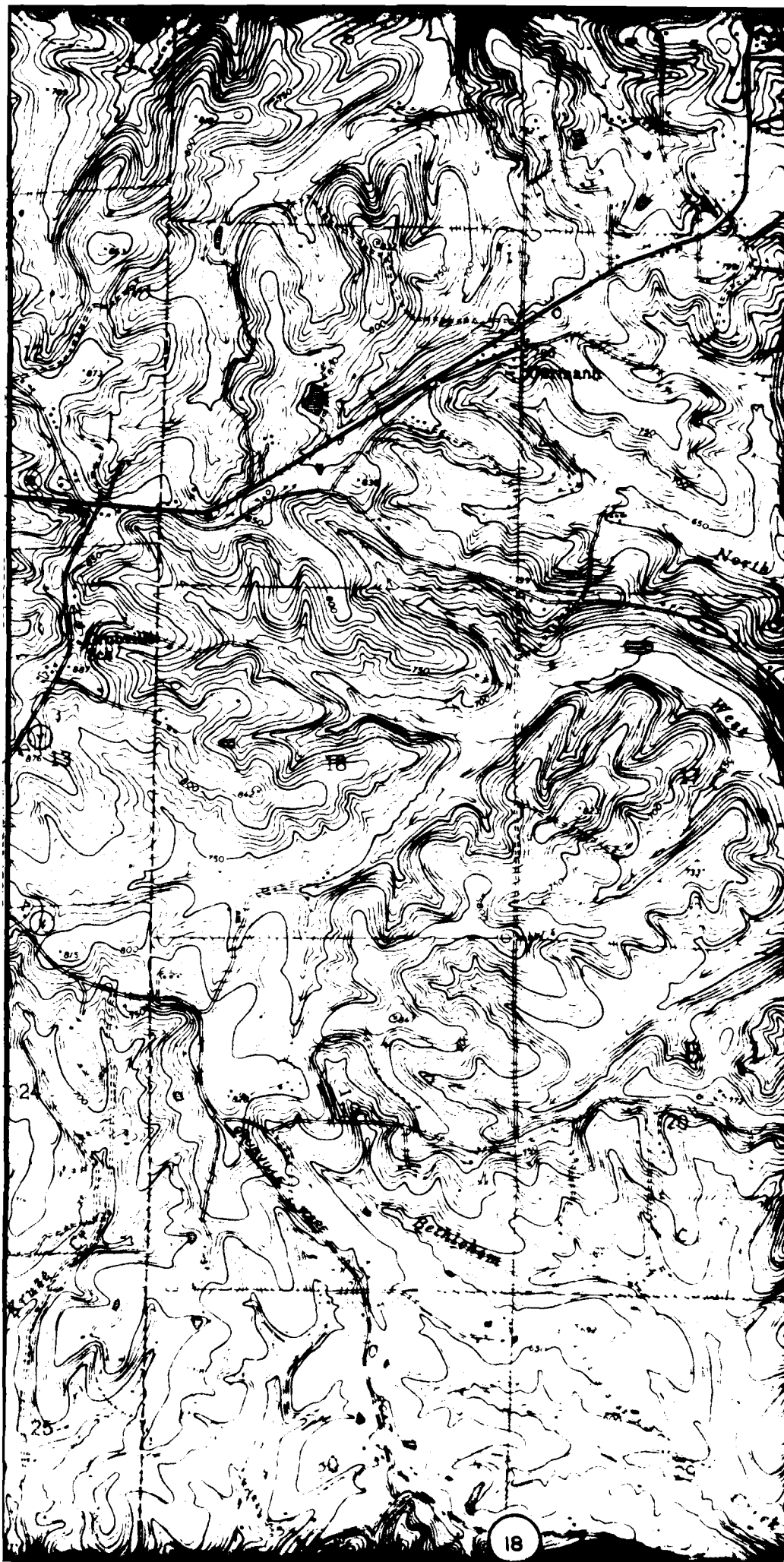
4739

4738

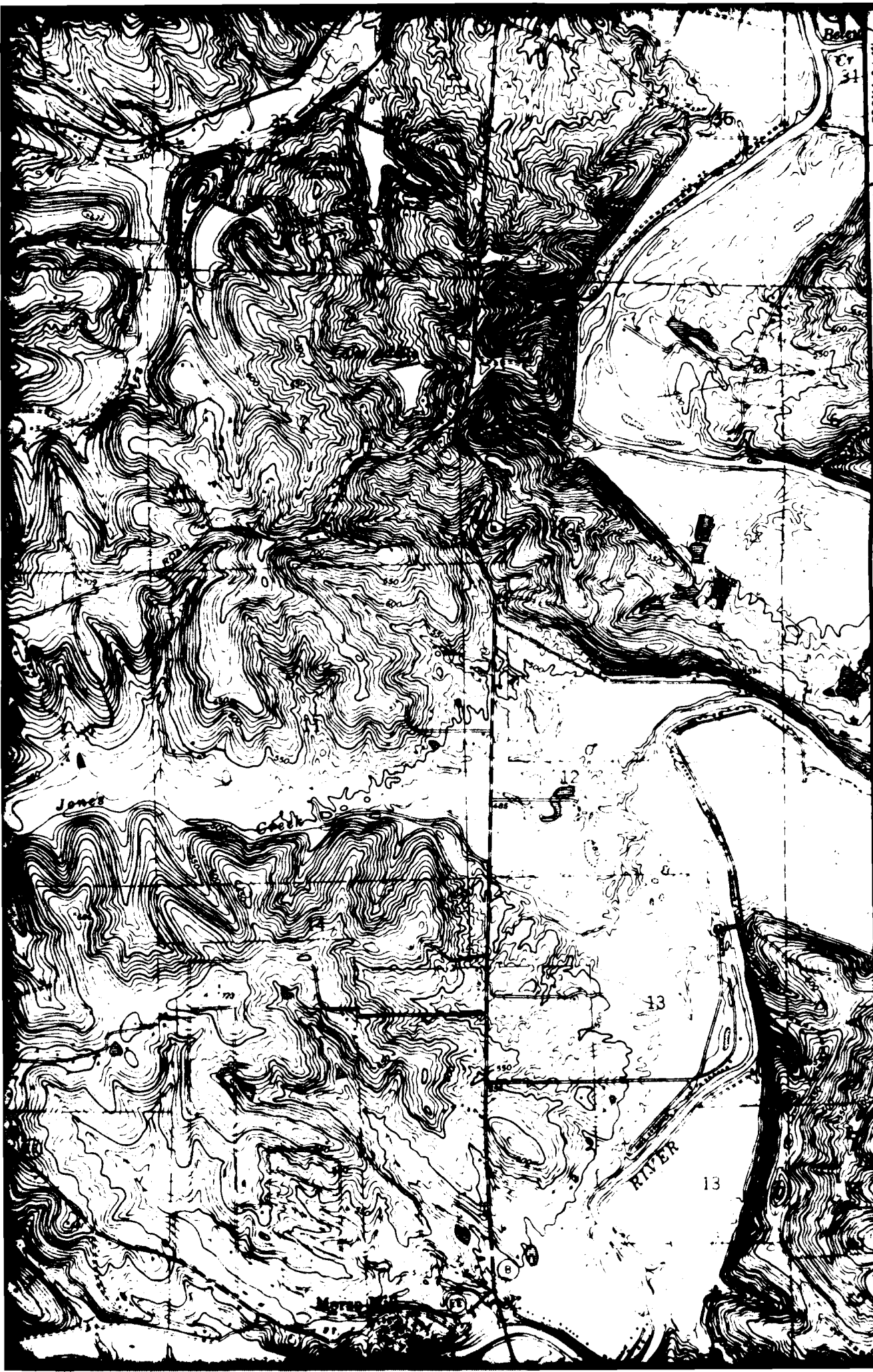
4737

4736

4735



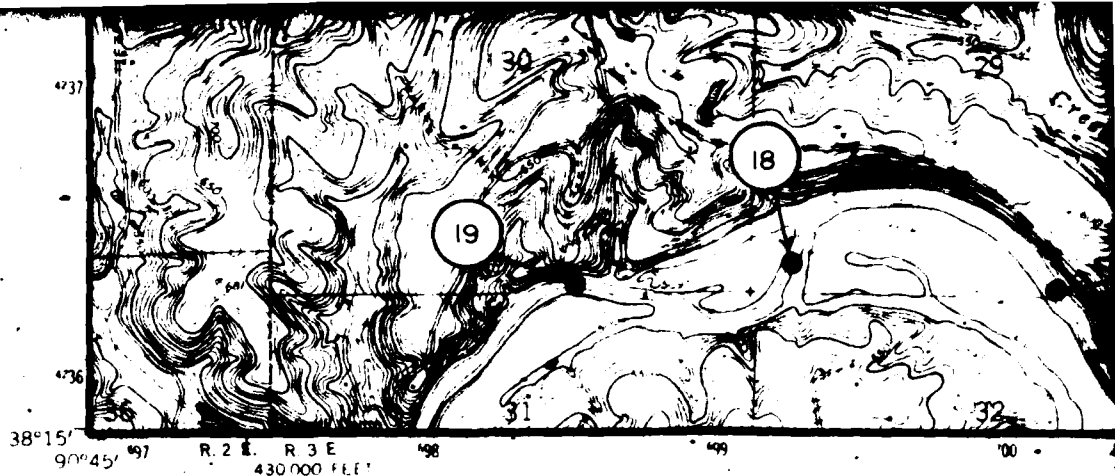




REGMA 2
4245
T 42 N.
T 41 N.
4244
(BE. F.W. CREEK)
4242
4241
17'30"
4240
4.39

6

7



IP CHWOODS 1:62,500
7860 III

Mapped by the Army Map Service
Published for civil use by the Geological Survey

Control by USGS, USC&GS, and USCE

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1952 Field check 1954

Polyconic projection 1927 North American datum
10,000 foot grid based on Missouri coordinate system, east zone
1000 meter Universal Transverse Mercator grid ticks, zone 16
shown in blue

Dashed land lines indicate approximate locations

Unchecked elevations are shown in brown

Revisions shown in purple compiled by the Geological Survey from
aerial photographs taken 1958 and 1974. This information
not field checked

UTM GRID AND MAGNETIC NORTH
DEVIATION AT CENTER OF SHEET

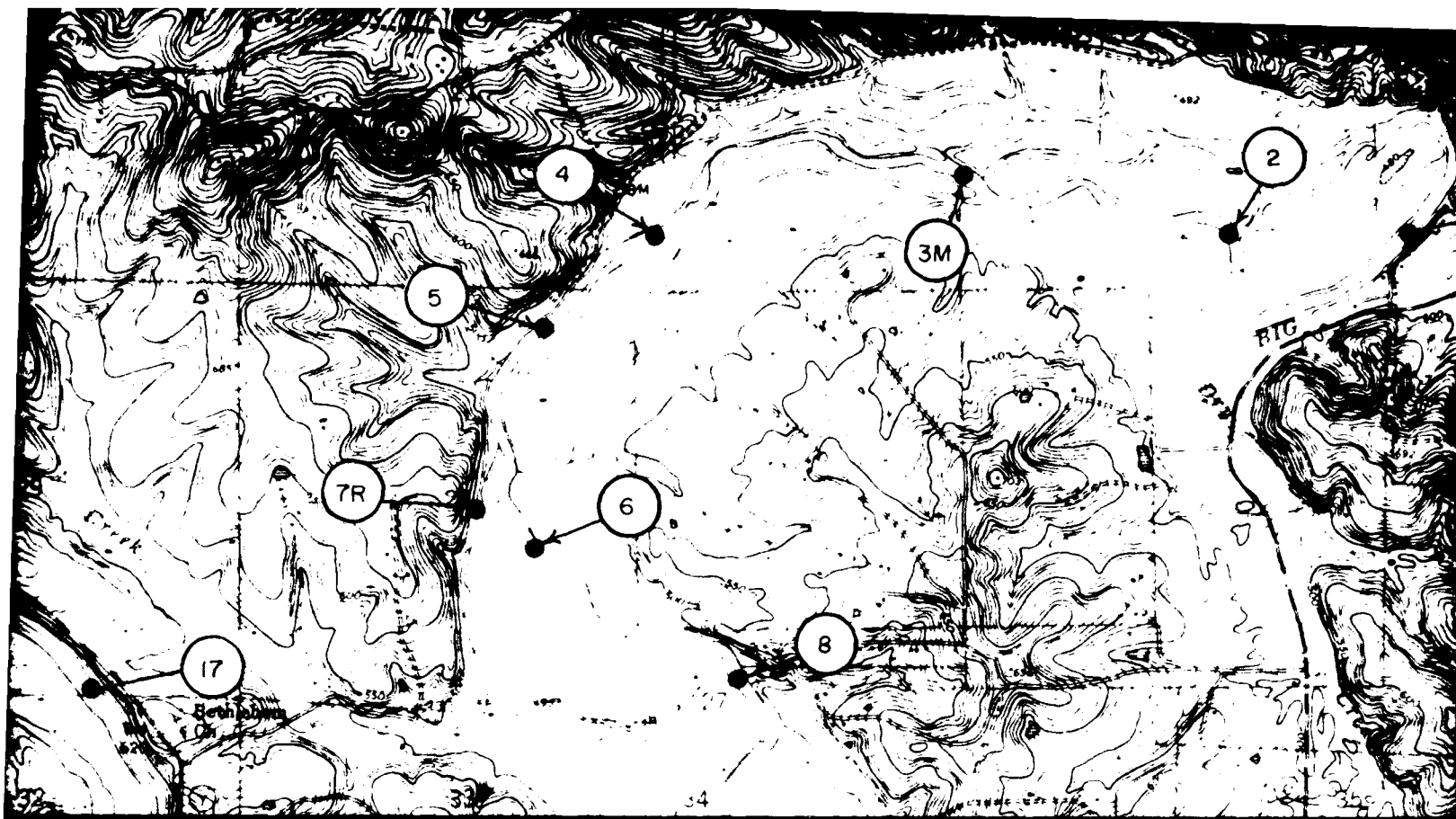
LEGEND



TRAP SITE NUMBER AND LOCATION

PREPARED BY:

KENWILL, INC.
P.O. BOX 450
JACKSBORO, TN. 37757



SCALE 1:24,000

CONTINUED INTERVAL IN FEET
NATIONAL GEODETIC VERTICAL DATUM 1929



THIS MAP WAS MADE BY THE NATIONAL MAPS AND AERIAL PHOTOGRAPHY
FOR SALE BY U.S. GEOLOGICAL SURVEY, CENVER, CUBA, 80224, OR RESTON, VIRGINIA 22092
AND BY THE DIVISION OF RESEARCH AND TECHNICAL INFORMATION
MISSOURI DEPARTMENT OF NATURAL RESOURCES, ROLLA, MISSOURI 65401
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

NOTES:

1. SITE NUMBERS DO NOT CORRESPOND TO THE ORDER IN WHICH SITES WERE NUMBERED CONSECUTIVELY FOR EASE OF REFERENCE WITHIN TEXT.
2. THE M NUMBERS REFER TO SITES THAT WERE ONLY MONITORED ONCE.
3. THE R NUMBERS REFER TO SITES THAT WERE TRAPPED TWICE DUE TO ENDANGERED SPECIES.



4239

4238000m N

5 M TO MISSOURI 21

38°15'

107000m E

1065000m E
1260000m E

ROAD CLASSIFICATION

Heavy duty

Light duty

Medium duty

Unimproved dirt

-State Route



QUADRANGLE LOCATION

CEDAR HILL, MO

N 3815 W 9037 5125

1954

PHOTO REVISED 1968 AND 1974

AMS 78601 SW SERIES V879

TO THE ORDER IN WHICH SITES WERE TRAPPED. THEY ARE
OF REFERENCE WITHIN TEXT.

THAT WERE ONLY MONITORED AND NOT TRAPPED.

THAT WERE TRAPPED TWICE DUE TO PREVIOUS CAPTURE OF

LEGEND



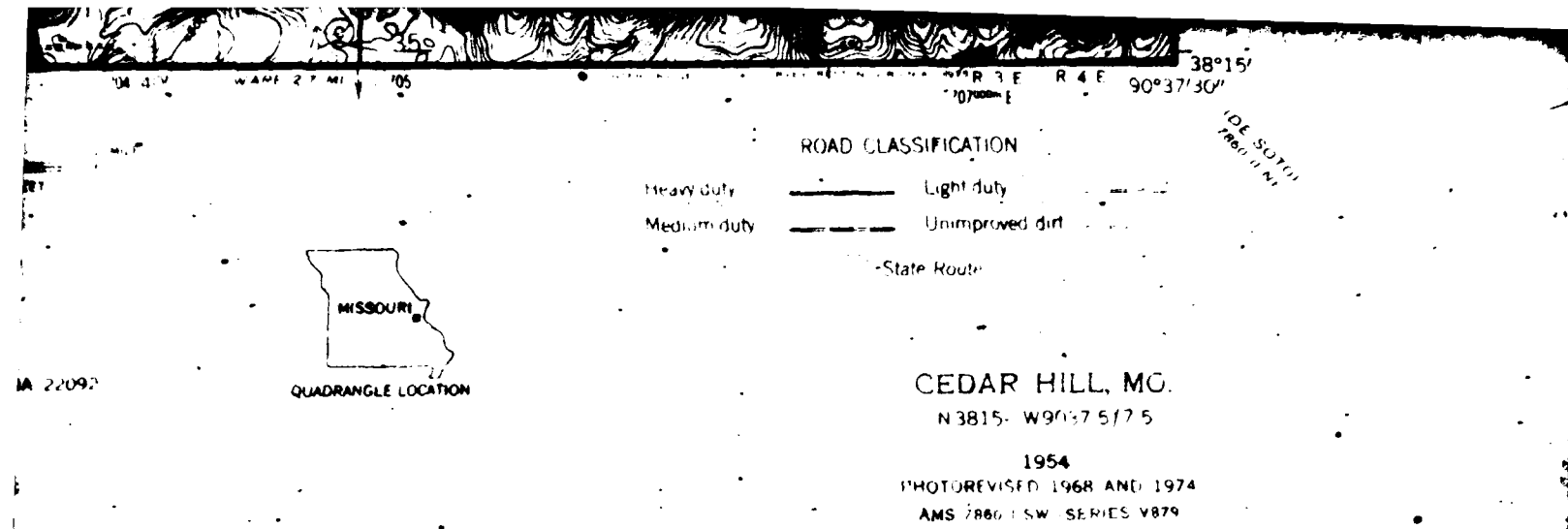
TRAP SITE NUMBER AND LOCATION

NO

SITE NUMBERS DO NOT CORRESPOND TO THE ORDER IN WHICH SITES WERE TRAPPED. THE
NUMBERED CONSECUTIVELY FOR EASE OF REFERENCE WITHIN TEXT.

THE M NUMBERS REFER TO SITES THAT WERE ONLY MONITORED AND NOT TRAPPED.

THE R NUMBERS REFER TO SITES THAT WERE TRAPPED TWICE DUE TO PREVIOUS CAPTURE
ENDANGERED SPECIES.



THE ORDER IN WHICH SITES WERE TRAPPED. THEY ARE
REFERENCE WITHIN TEXT.

WERE ONLY MONITORED AND NOT TRAPPED.

WERE TRAPPED TWICE DUE TO PREVIOUS CAPTURE OF

FIGURE:

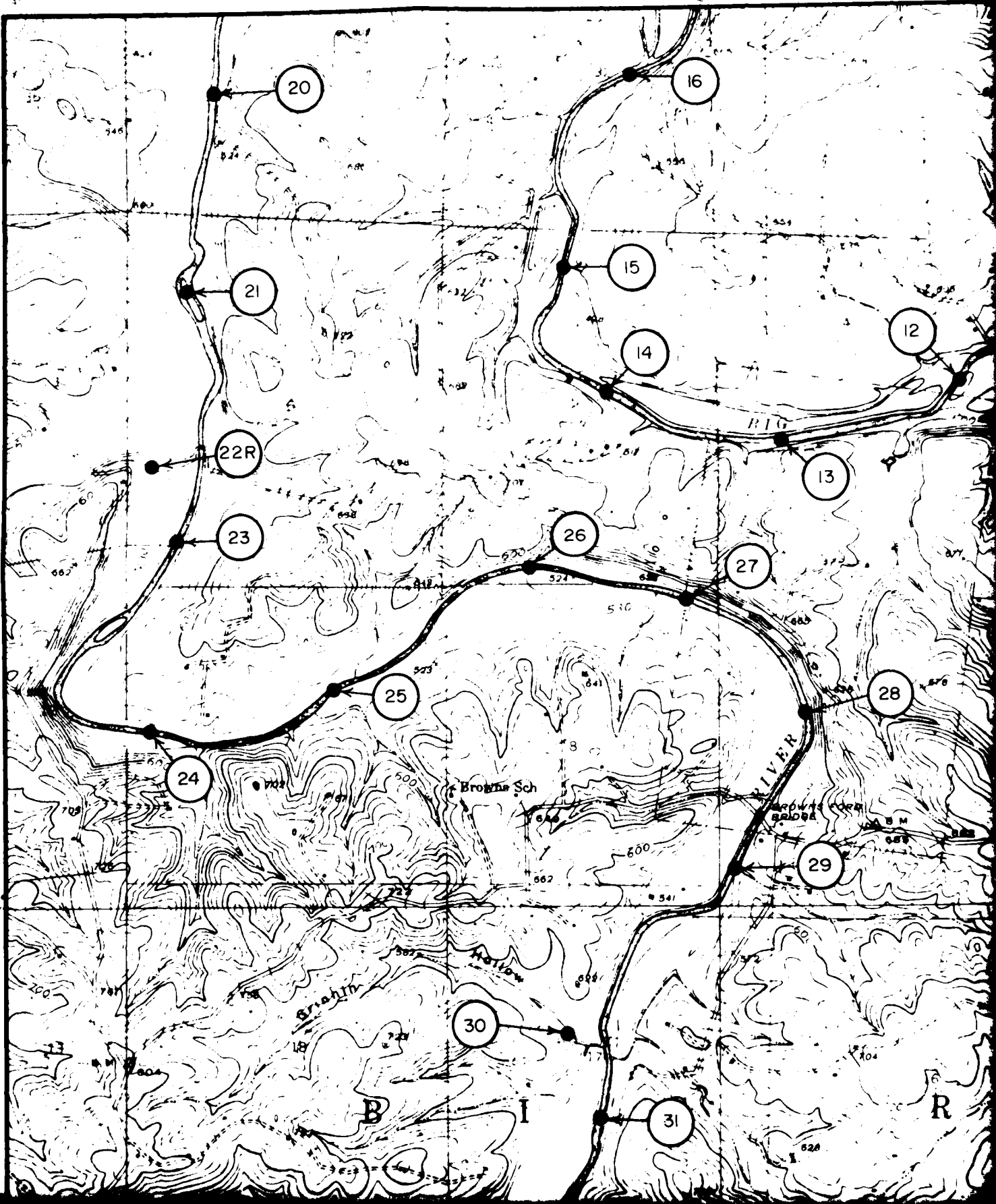
1. TRAP SITES LOCATED WITHIN THE NORTHERN
PORTION OF THE PINE FORD STUDY AREA.

142501

5

1 41 N
1 40 N

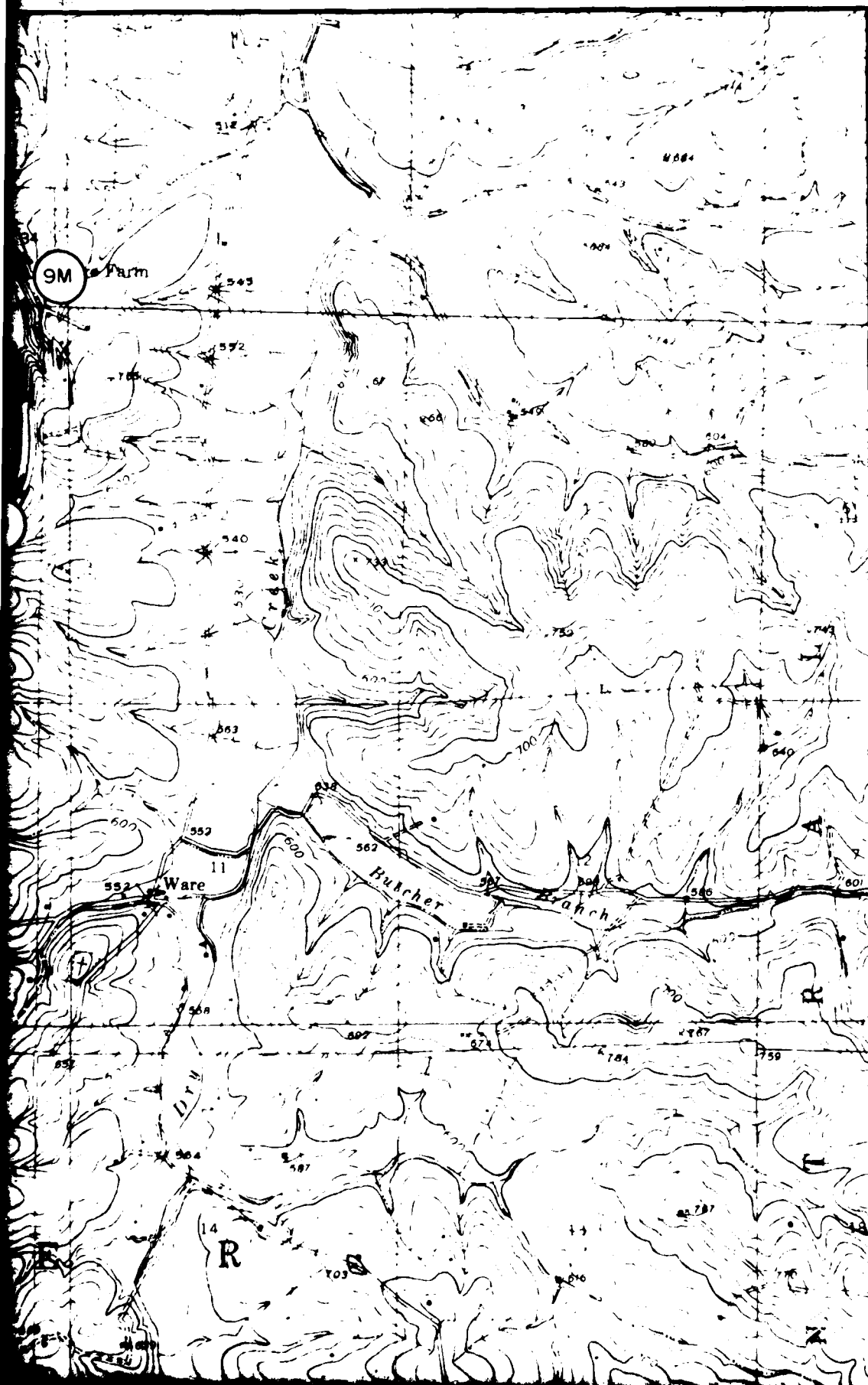
12 30



AD 3

This is a detailed topographic map of a mountainous region. The map features numerous contour lines indicating elevation, with labels such as 500, 550, 600, 650, 700, 750, and 800. A river, labeled 'RIVER', flows from the upper left towards the center. A road, labeled 'PINE ROAD', runs horizontally across the middle. A 'Farm' is located in the upper right, and a 'Ware' area is in the lower right. A 'Butcher Ranch' is also indicated. A 'Ditch' and a 'Dry' area are shown in the lower right. The map includes several circled labels: '11M' near the river, '10' near the pine road, '9M' near the farm, and '11' near the ware area. The letters 'V', 'E', and 'R' are visible at the bottom of the map.

MAP OF BUTCHER QUADRANGLE



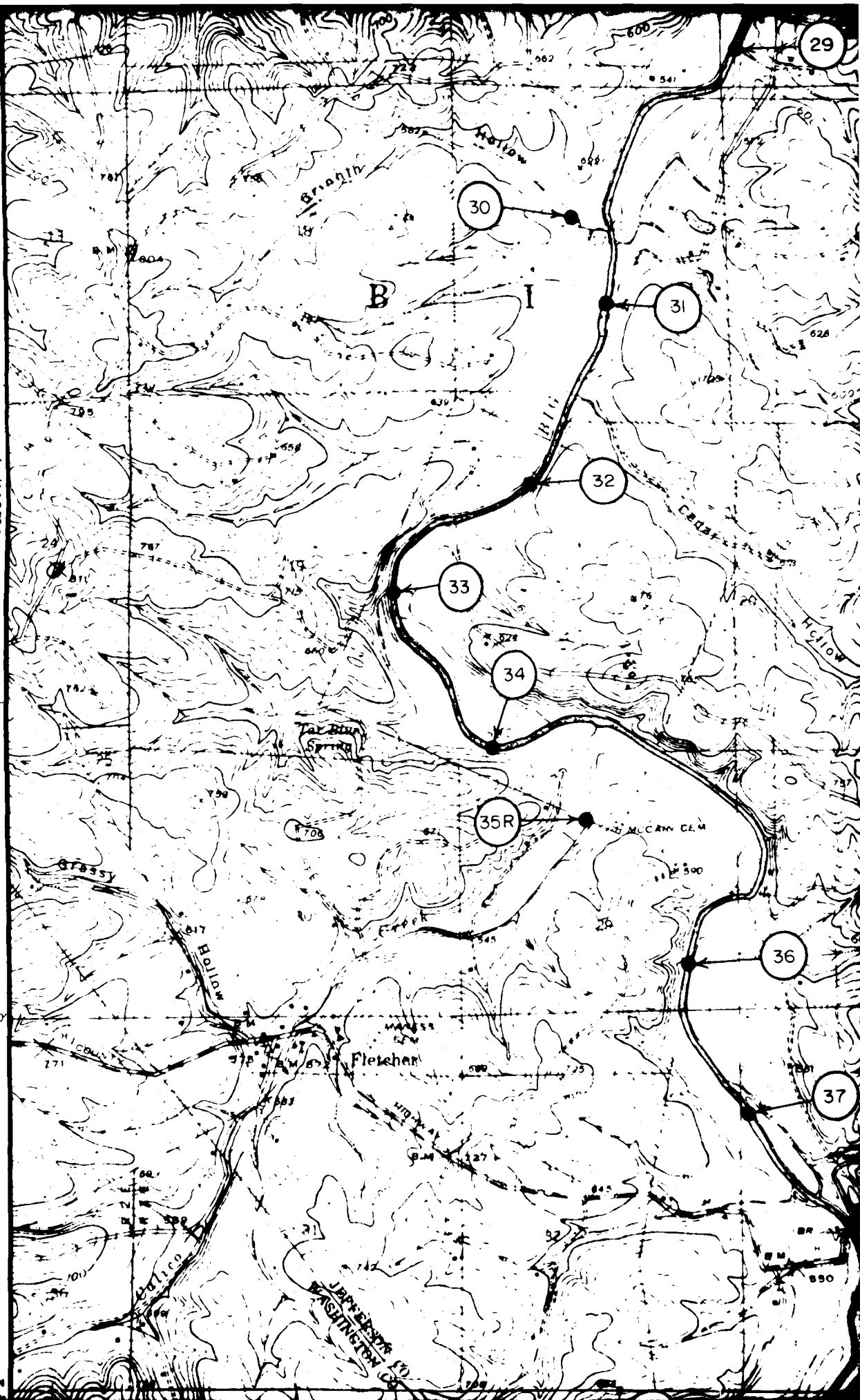
14

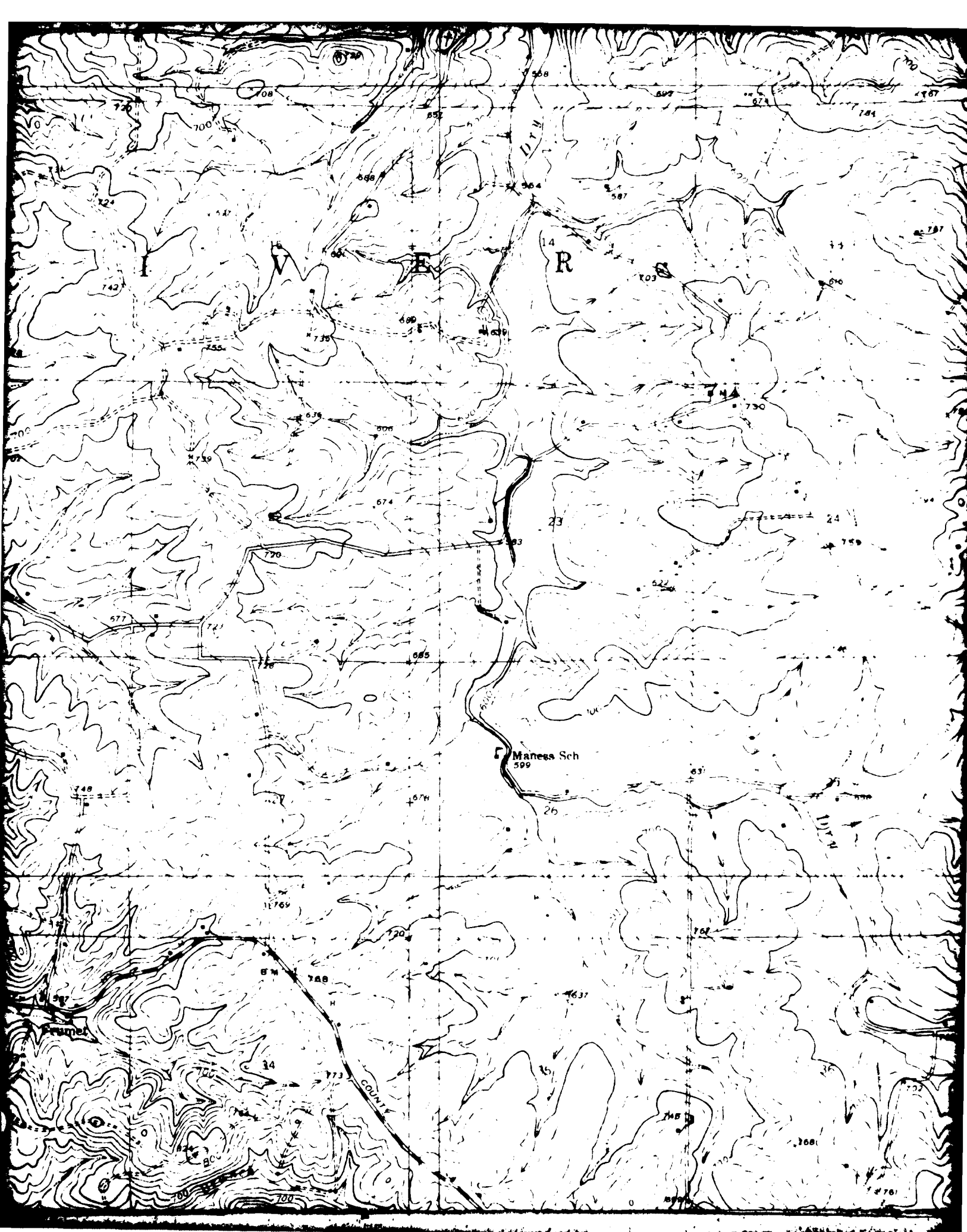
Richwoods 162500

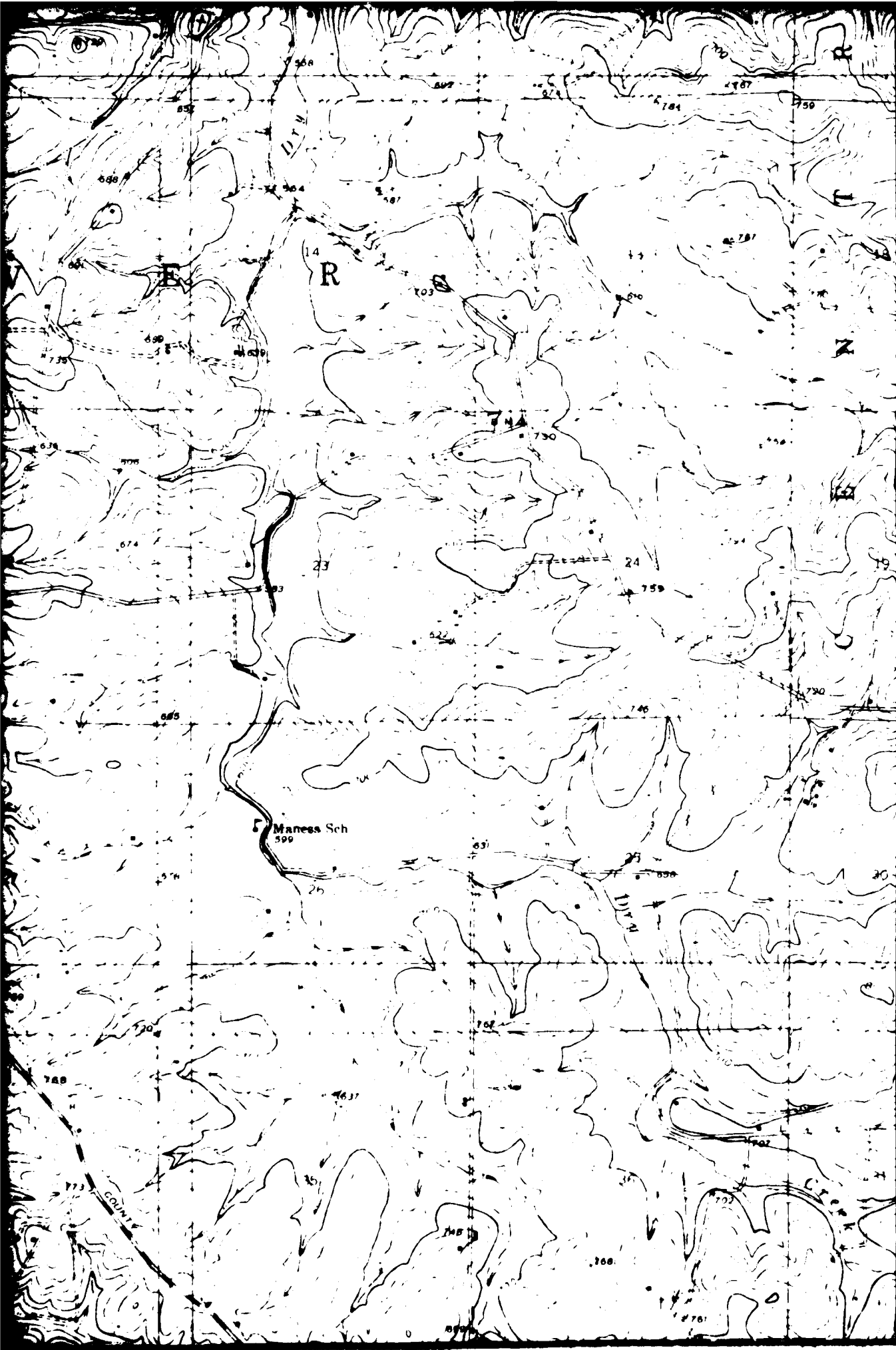
12° 10'

10'

T 40 N



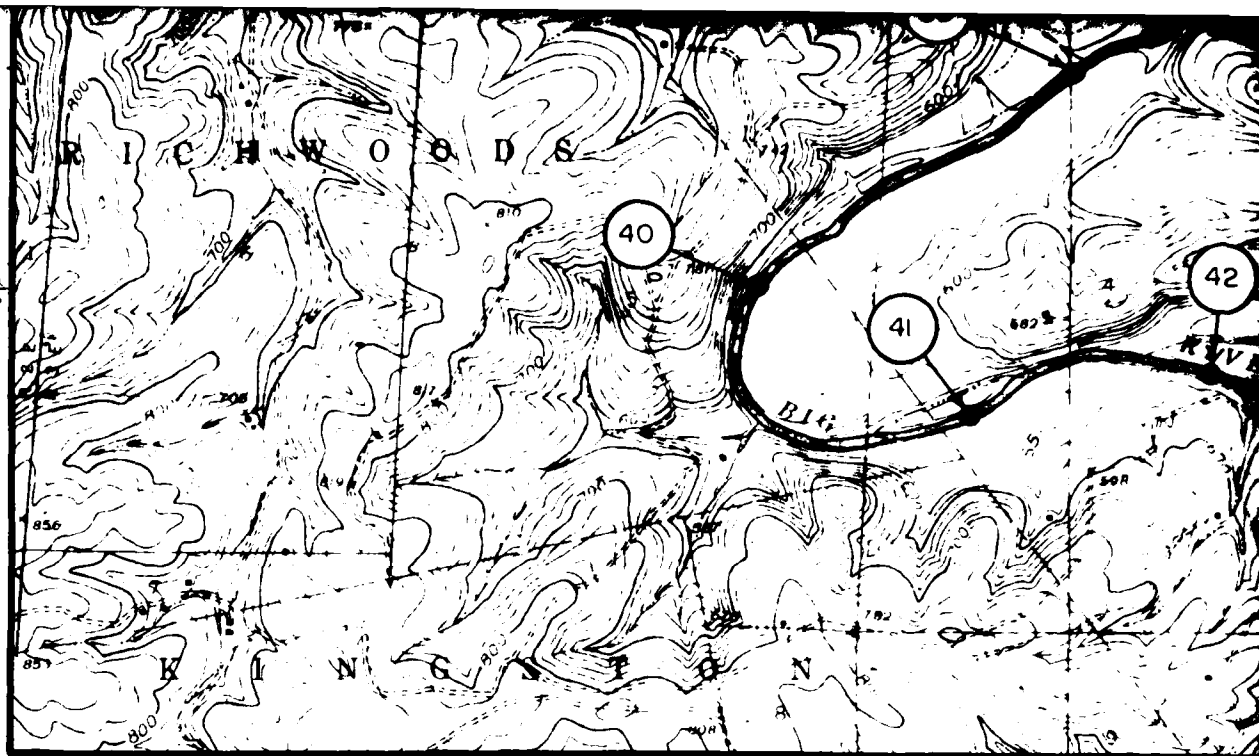




(De Soto)

6

Richmonds
1 625 001



457
Glen S. Smith, Division Chief,
Topography and Geomorphology, U.S. Geological
Survey, 1936-1937

Figure 1 shows a gel electrophoresis experiment. The top row of bands is labeled 'p53' and the bottom row is labeled 'p53 + 1,2-EDT'. The lanes are labeled 'DNA', 'p53', and 'p53 + 1,2-EDT'. The 'DNA' lane shows a single band. The 'p53' lane shows a single band. The 'p53 + 1,2-EDT' lane shows a single band. The 'p53 + 1,2-EDT' lane shows a single band. The 'p53 + 1,2-EDT' lane shows a single band.

FOR SALE BY U.S. AND
A FOLD

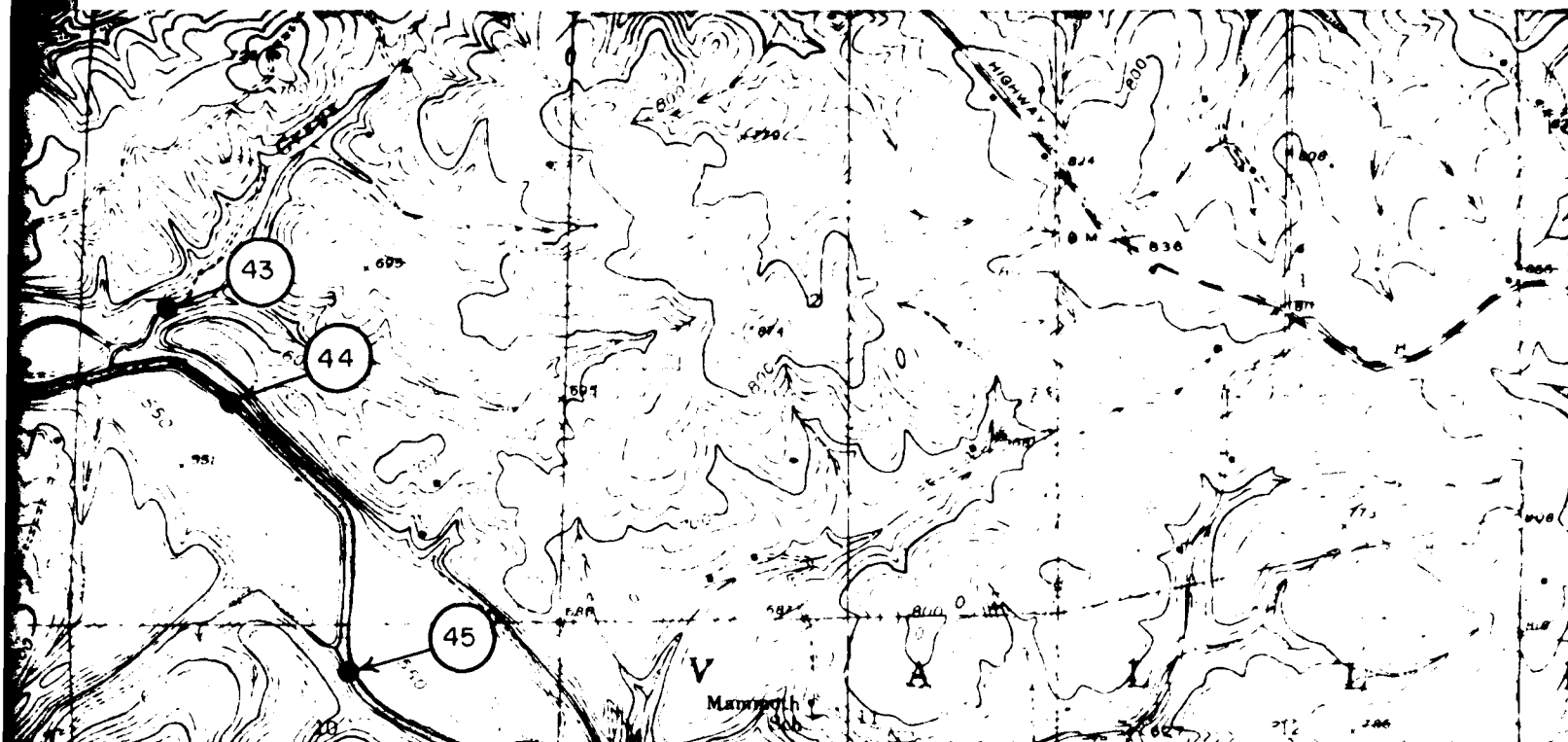
LEGEND



TRAP SITE NUMBER AND LOCATION

NOTES :

1. SI
NA
2. TH
3. TH
EN



SCALE 1:24000

Contour interval 20 feet
10 foot contours added in dashed lines
Datum is mean sea level

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN
DECLINATION

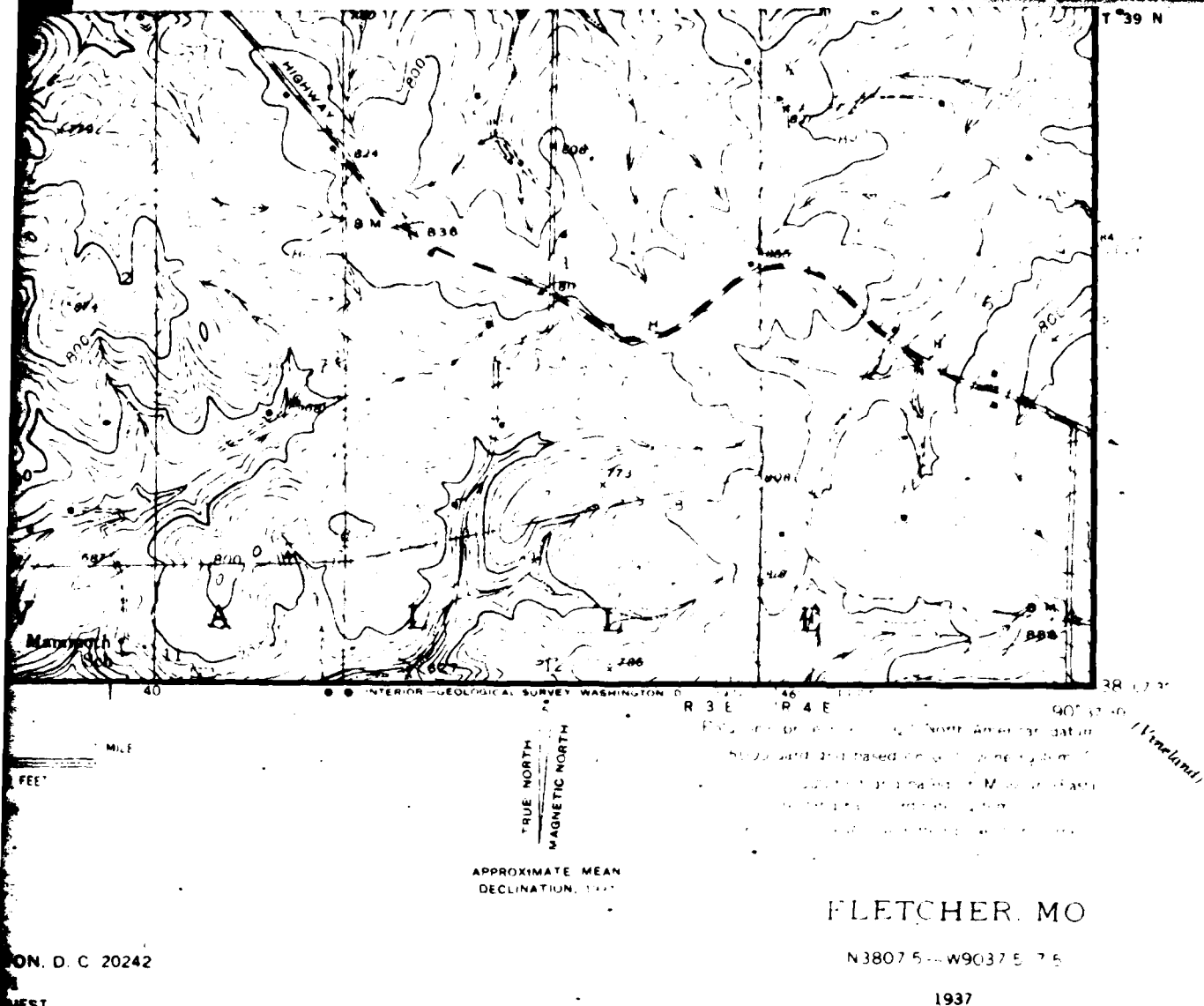
U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D. C. 20242
BY THE MISSOURI GEOLOGICAL SURVEY, ROLLA, MISSOURI 65401
A DESCRIPTION OF TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

THE NUMBERS DO NOT CORRESPOND TO THE ORDER IN WHICH SITES WERE TRAPPED. THEY
WERE NUMBERED CONSECUTIVELY FOR EASE OF REFERENCE WITHIN TEXT.

THE M NUMBERS REFER TO SITES THAT WERE ONLY MONITORED AND NOT TRAPPED.

THE R NUMBERS REFER TO SITES THAT WERE TRAPPED TWICE DUE TO PREVIOUS CAPTURE
OF DANGEROUS SPECIES.

9



THE ORDER IN WHICH SITES WERE TRAPPED. THEY ARE
REFERENCE WITHIN TEXT.

WERE ONLY MONITORED AND NOT TRAPPED.

WERE TRAPPED TWICE DUE TO PREVIOUS CAPTURE OF

Richwoods
162500

90

Gen S Smith Division Engineer
Topography and Surveying
Surveyed in 1948-1949

Scale: 1" = 1000'
Meters: 1" = 30.48'

LEGEND



TRAP SITE NUMBER AND LOCATION

NOT

PREPARED BY:

KENWILL, INC.

P.O. BOX 450
JACKSBORO, TN. 37757

UNDER DOD CONTRACT DACW 43-81-C-01

SCALE 1:24,000

Contour interval 20 feet
10 foot contours added in dashed lines
Datum is mean sea level

APPROXIMATE
DECLINATION

FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D. C. 20242
AND BY THE MISSOURI GEOLOGICAL SURVEY, ROLLA, MISSOURI 65401
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

NOTES:

1. SITE NUMBERS DO NOT CORRESPOND TO THE ORDER IN WHICH SITES WERE TRAPPED. SITES WERE NUMBERED CONSECUTIVELY FOR EASE OF REFERENCE WITHIN TEXT.
2. THE M NUMBERS REFER TO SITES THAT WERE ONLY MONITORED AND NOT TRAPPED.
3. THE R NUMBERS REFER TO SITES THAT WERE TRAPPED TWICE DUE TO PERMANENTLY ENDANGERED SPECIES.

FIGURE:

2. TRAP SITES LOCATED IN THE PORTION OF THE

C-0103

TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN
DECLINATION: 1937

Polyconic projection 1927 North American datum

(Vandal)

FLETCHER, MO

N3807.5 W9037.5

1937

ER IN WHICH SITES WERE TRAPPED. THEY ARE
NCE WITHIN TEXT.

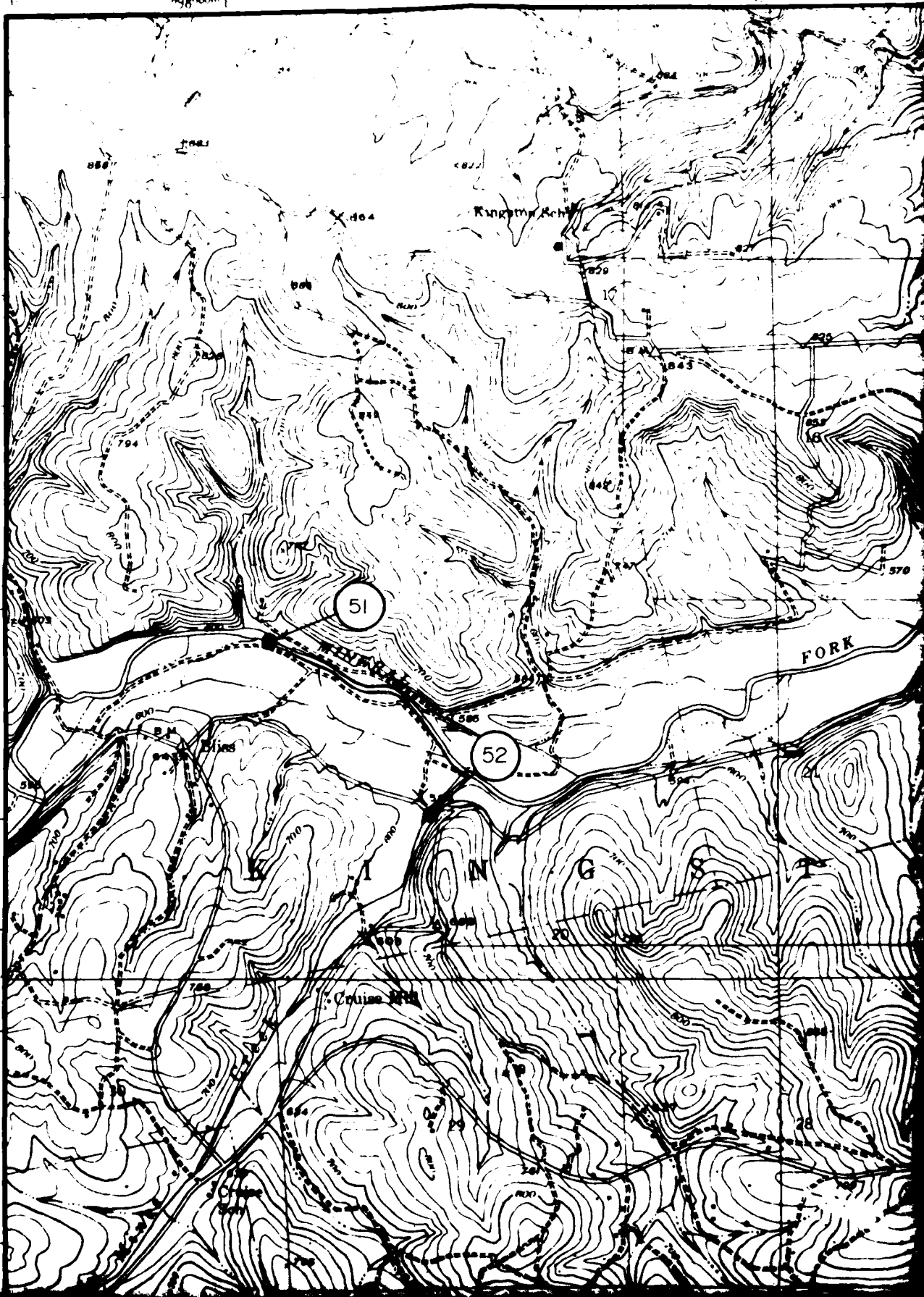
ONLY MONITORED AND NOT TRAPPED.

TRAPPED TWICE DUE TO PREVIOUS CAPTURE OF

FIGURE:

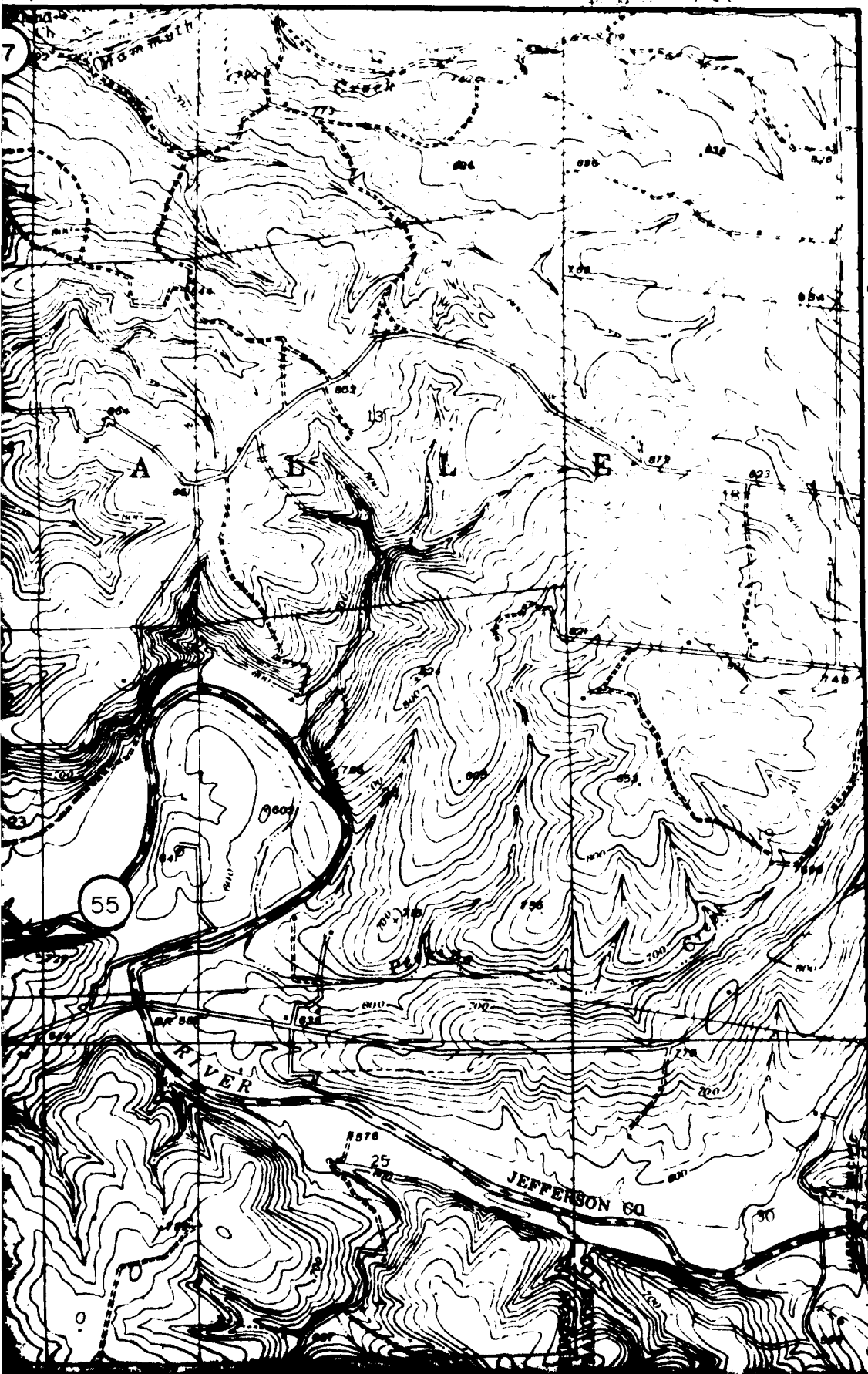
2. TRAP SITES LOCATED WITHIN THE CENTRAL
PORTION OF THE PINE FORD STUDY AREA.

Copy available to DTIC does not
permit fully legible reproduction



2



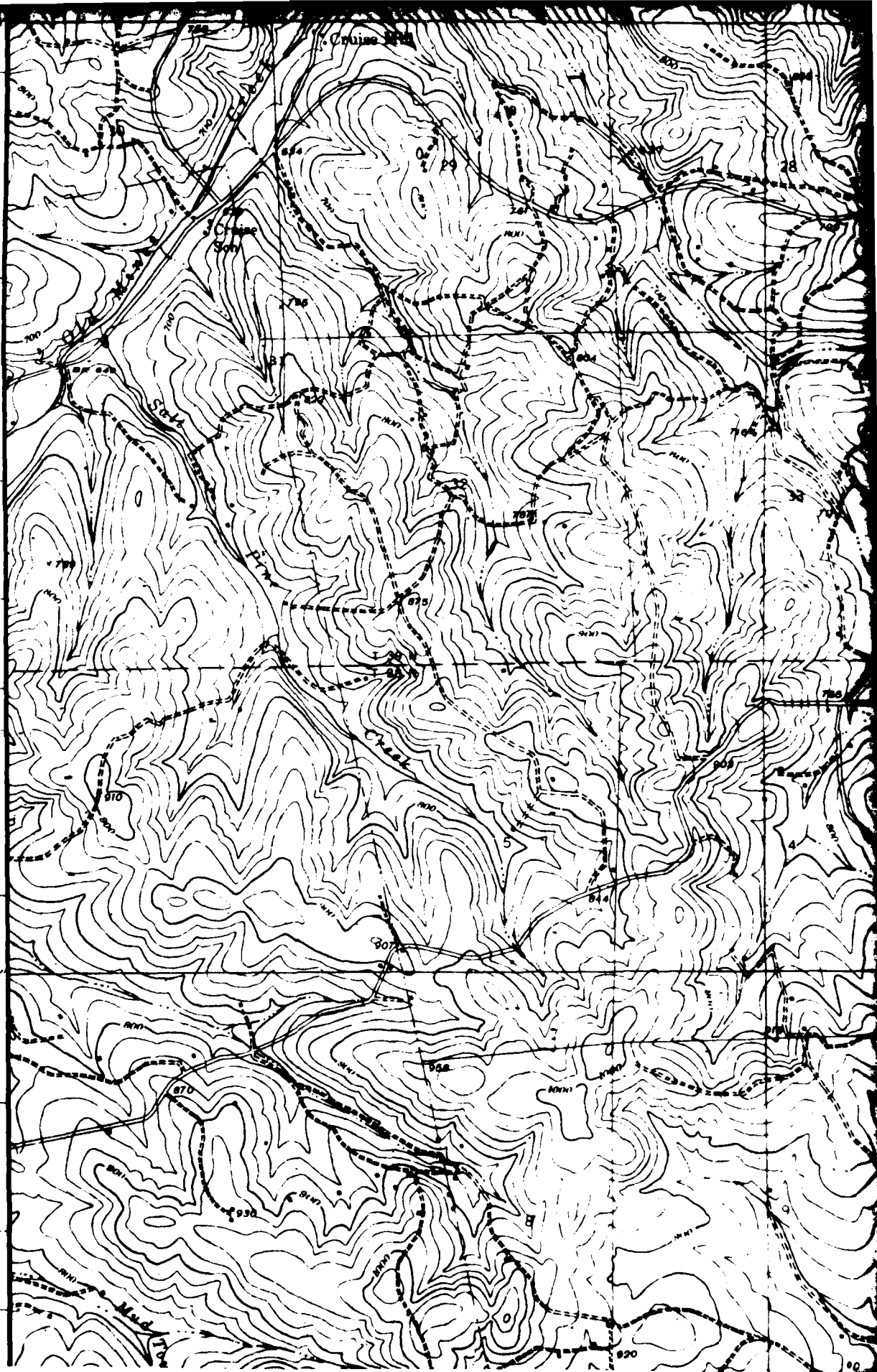


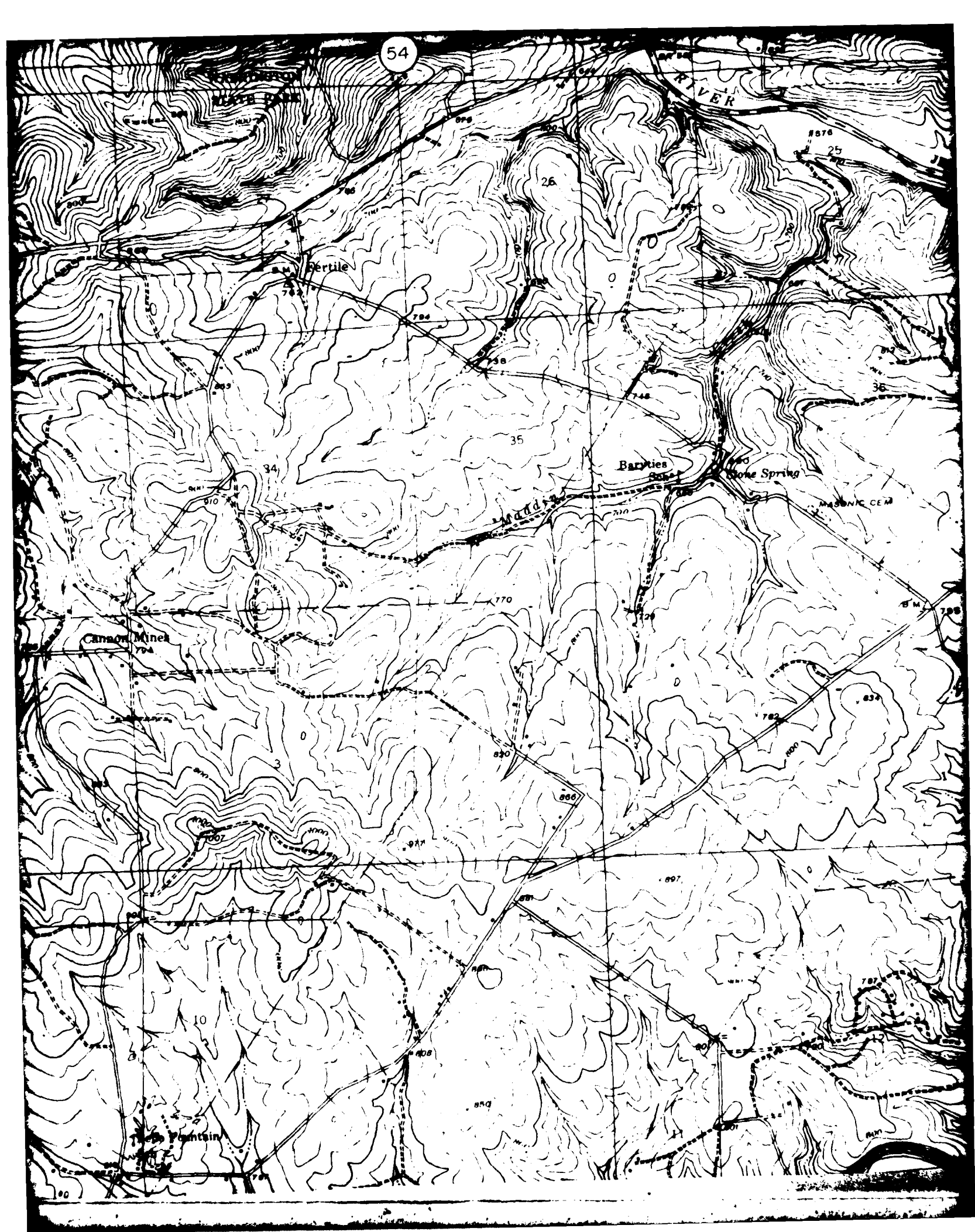
Copy available to DTIC does not
permit fully legible reproduction

(Richwood 1:62,500)

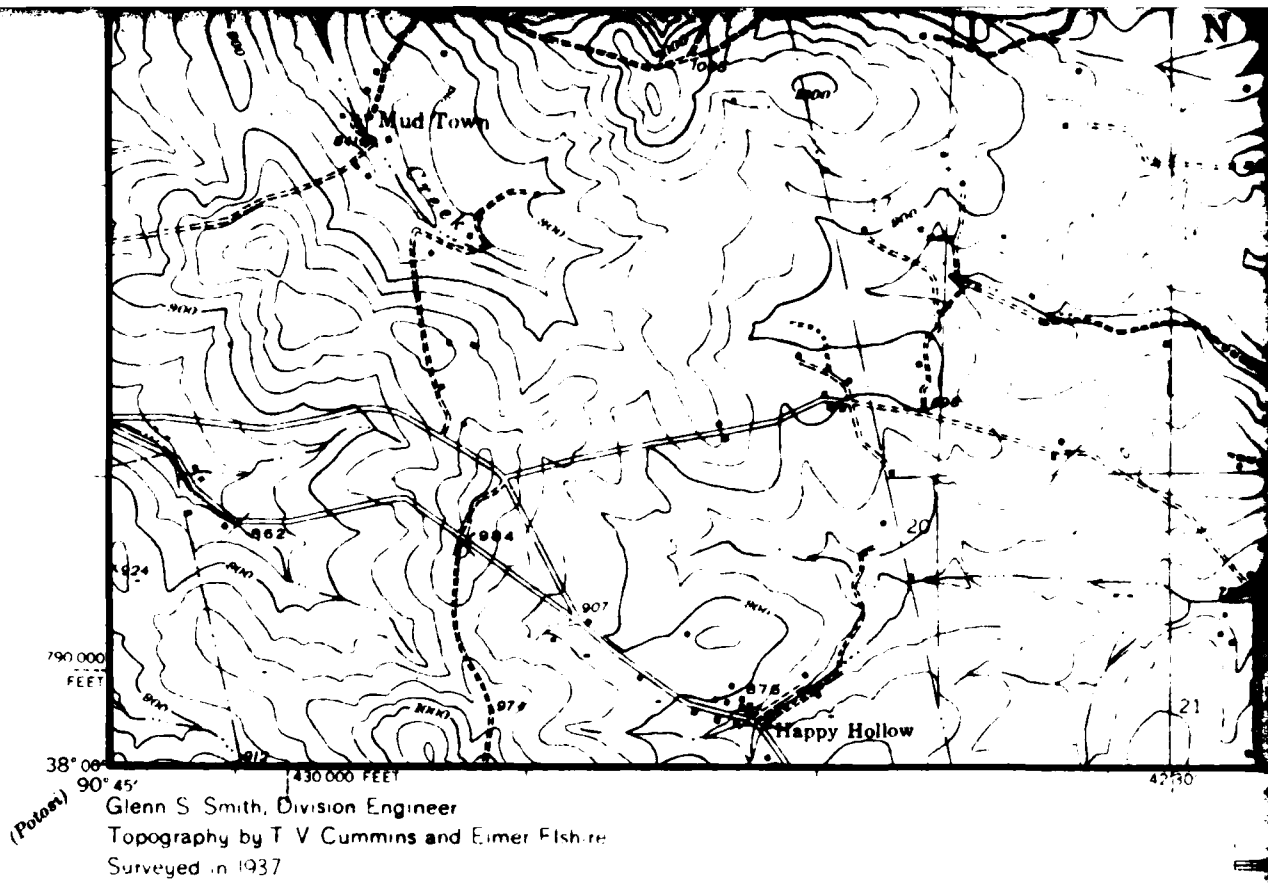
2°30'

4





7

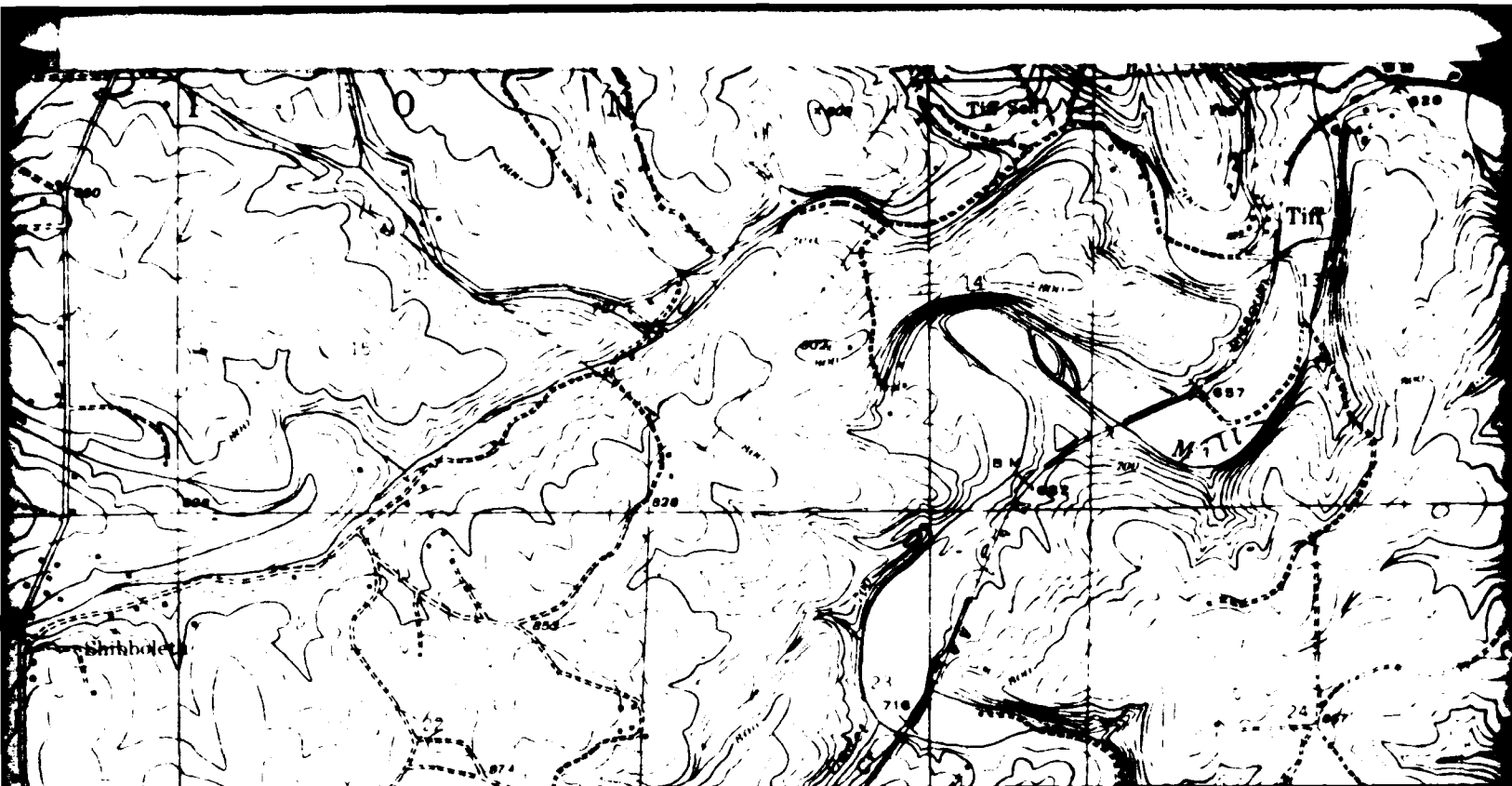


LEGEND



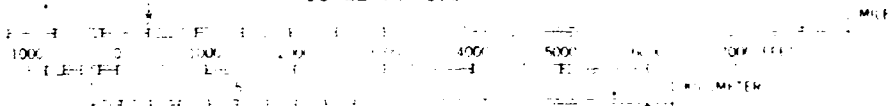
TRAP SITE NUMBER AND LOCATION

NOTES:



(Mineral Point)

SCALE : 24000



Contour interval 20 feet
Datum is mean sea level

TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN
DECLINATION 1911

Pol
10
rect
100
zone
To jo

SALE BY U. S. GEOLOGICAL SURVEY, DENVER 25, COLORADO OR WASHINGTON 25, D. C.
AND BY THE MISSOURI GEOLOGICAL SURVEY, ROLLA, MISSOURI
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

38° 00' 45" 430 000 FEET
(Potomac) Glenn S. Smith, Division Engineer
Topography by T. V. Cummins and Elmer Elshire
Surveyed in 1937

LEGEND



TRAP SITE NUMBER AND LOCATION

NOTE

PREPARED BY:

KENWILL, INC.

P.O. BOX 450

JACKSBORO, TN. 37757

UNDER DOD CONTRACT DACW 43-81-C-0103

SCALE 1:24,000

MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 2 3 4 5 6 7 8 9 10 KILOMETER

TRUE NORTH
5°
MAGNETIC NORTH

Polys
10 G
recta
1000
zone
To ja

Contour interval 20 feet
Datum is mean sea level

APPROXIMATE MEAN
DECLINATION, 1937

SALE BY U. S. GEOLOGICAL SURVEY, DENVER 25, COLORADO OR WASHINGTON 25, D. C.
AND BY THE MISSOURI GEOLOGICAL SURVEY, ROLLA, MISSOURI
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

1. SITE NUMBERS DO NOT CORRESPOND TO THE ORDER IN WHICH SITES WERE TRAPPED. NUMBERED CONSECUTIVELY FOR EASE OF REFERENCE WITHIN TEXT.
2. THE M NUMBERS REFER TO SITES THAT WERE ONLY MONITORED AND NOT TRAPPED.
3. THE R NUMBERS REFER TO SITES THAT WERE TRAPPED TWICE DUE TO PREVIOUS ENDANGERED SPECIES.

FIGURE:

3. TRAP SITES LOCATED WITHIN PORTION OF THE PINE FOREST

Polyconic projection. 1927 North American datum
10 000 foot grid based on Missouri (East)
rectangular coordinate system
1000 meter Universal Transverse Mercator grid ticks
zone 15. shown in black

To join Vineland map use dotted projection corners

TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN
DECLINATION, 1937

TIFF, MO.

N3800—W963740.75

1937

D. C.

ORDER IN WHICH SITES WERE TRAPPED. THEY ARE
REFERENCE WITHIN TEXT.

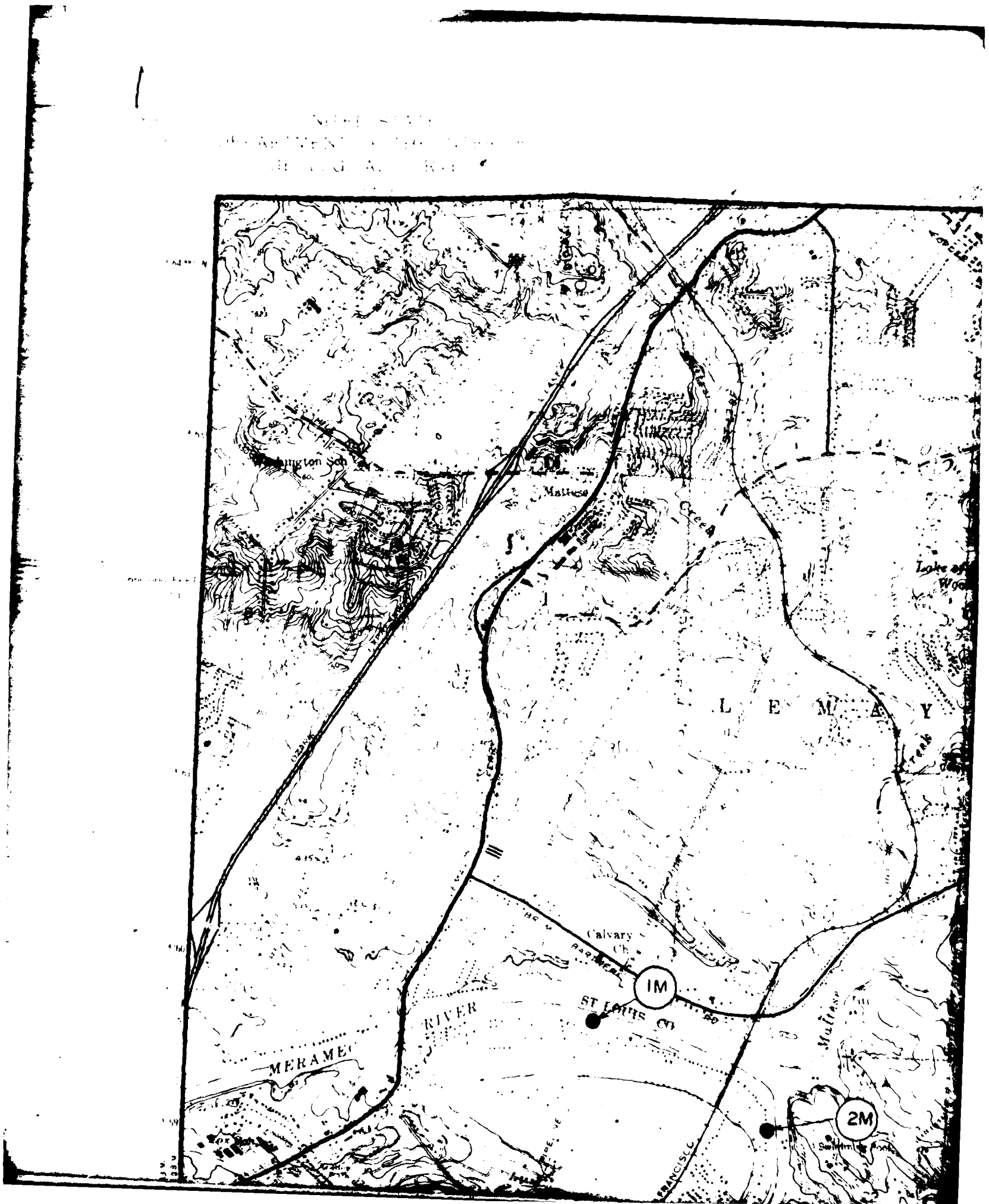
WERE ONLY MONITORED AND NOT TRAPPED.

WERE TRAPPED TWICE DUE TO PREVIOUS CAPTURE OF

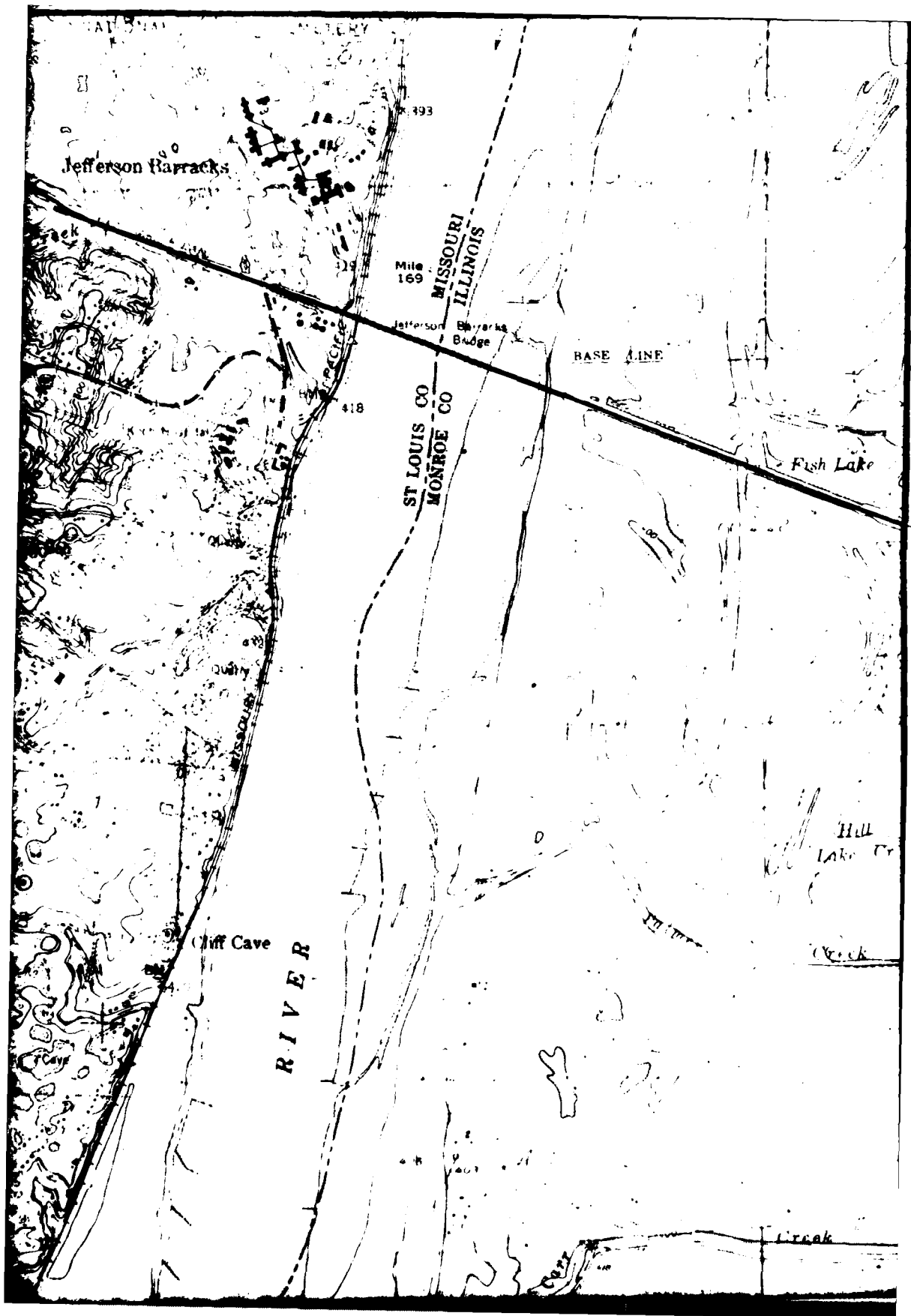
FIGURE:

3. TRAP SITES LOCATED WITHIN THE SOUTHERN
PORTION OF THE PINE FORD STUDY AREA.

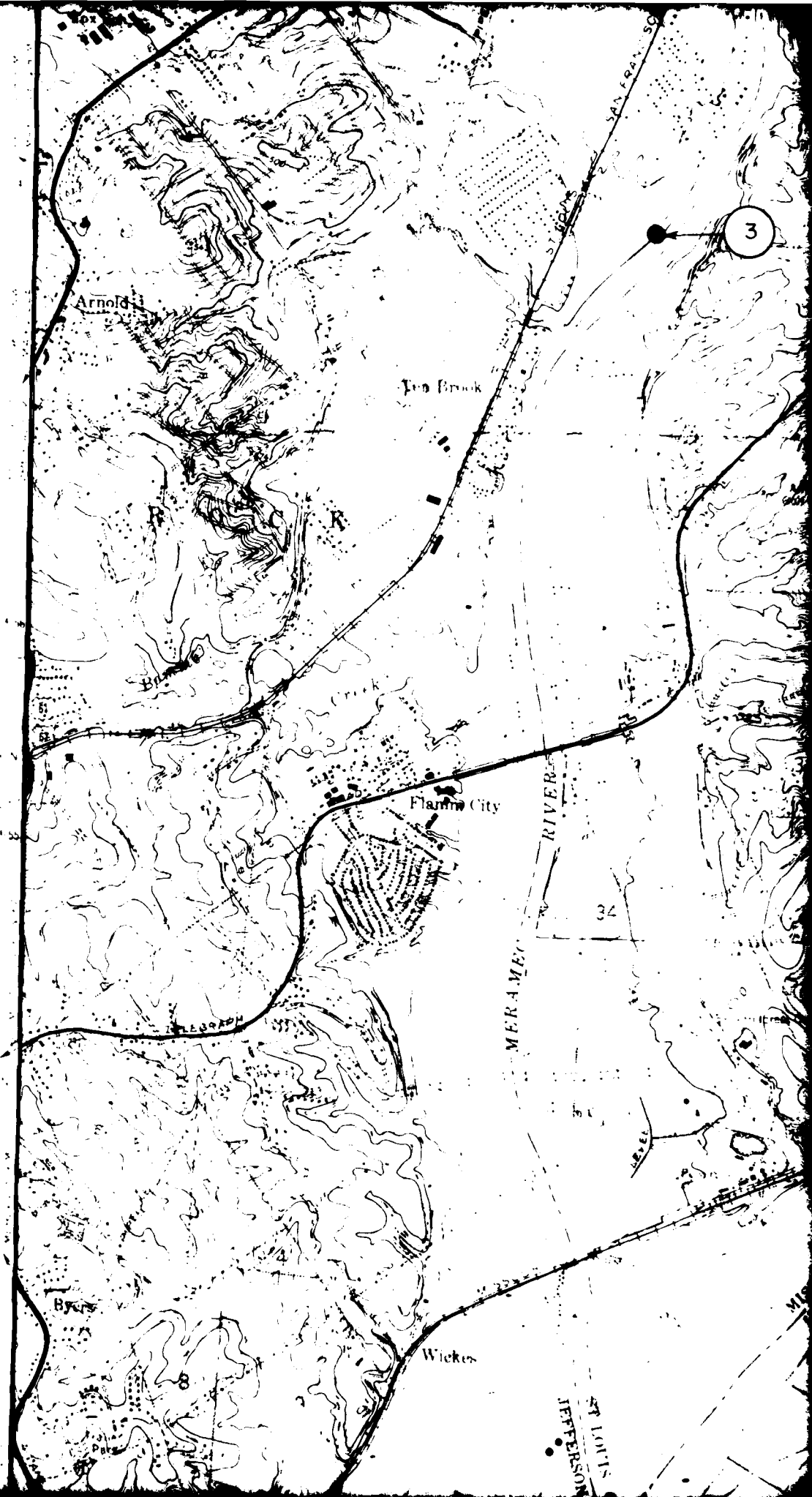
Copy available to DNR
Permit fully legible reproduction

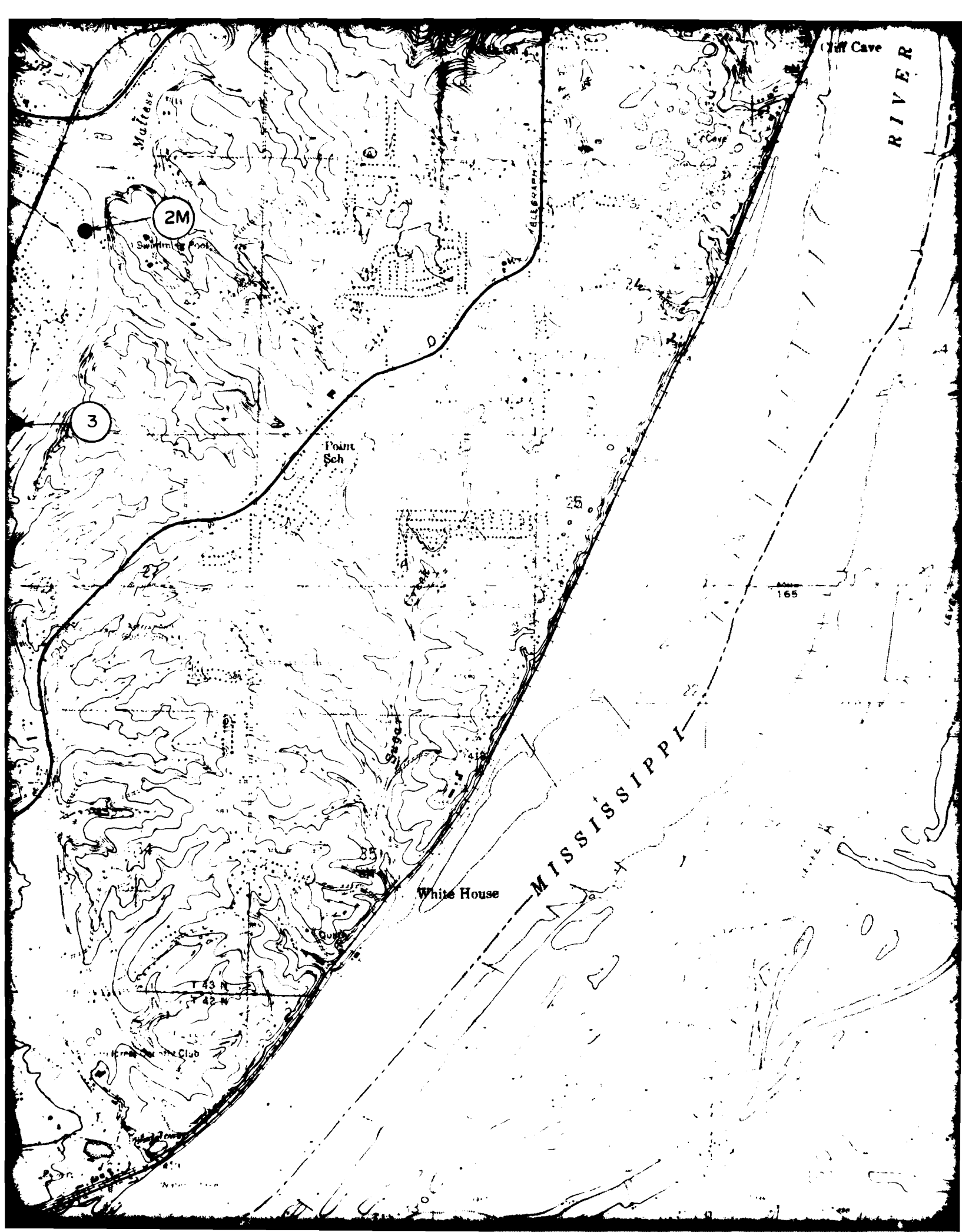


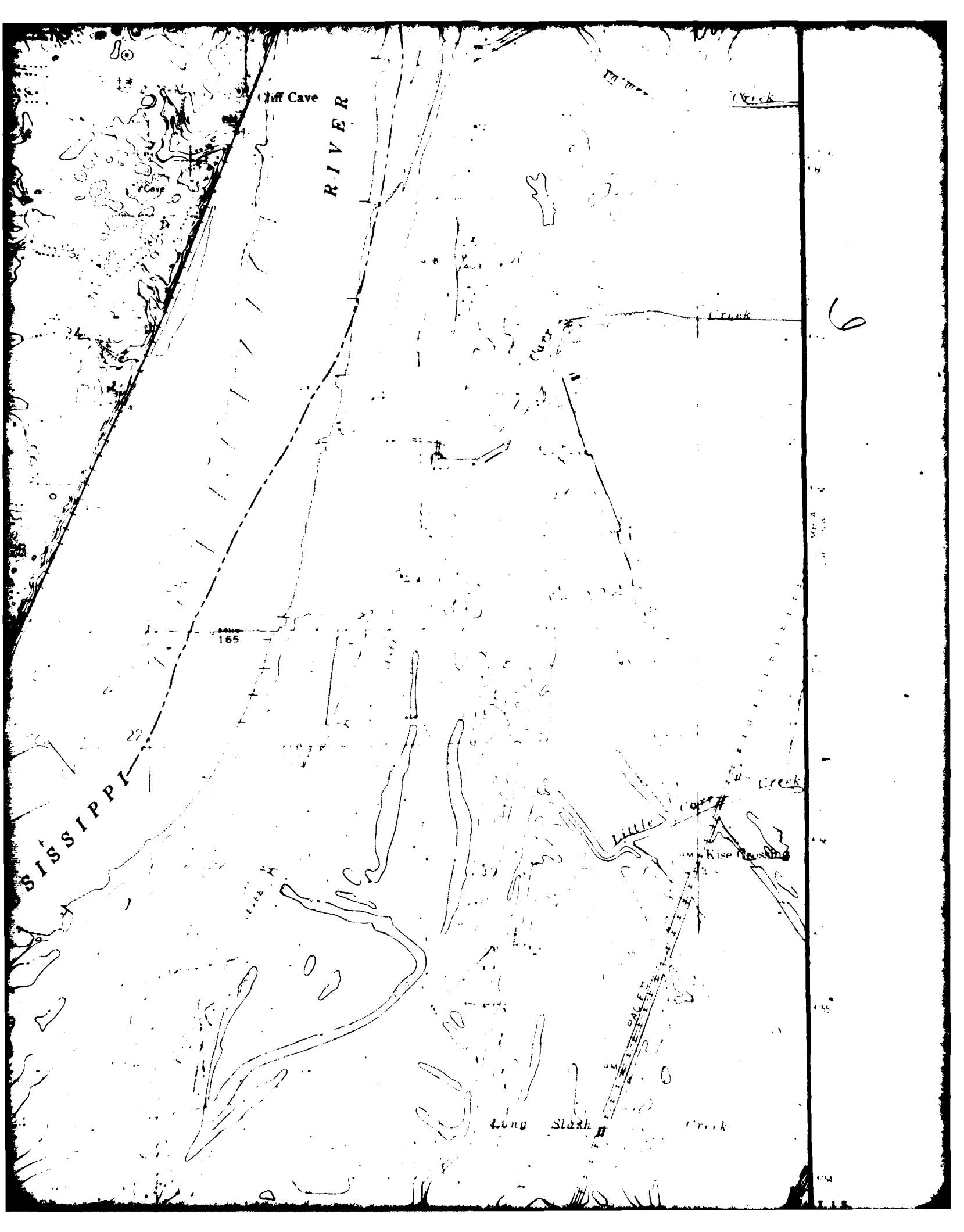




4







MISSISSIPPI

Cliff Cave
RIVER

165

Little

Creek

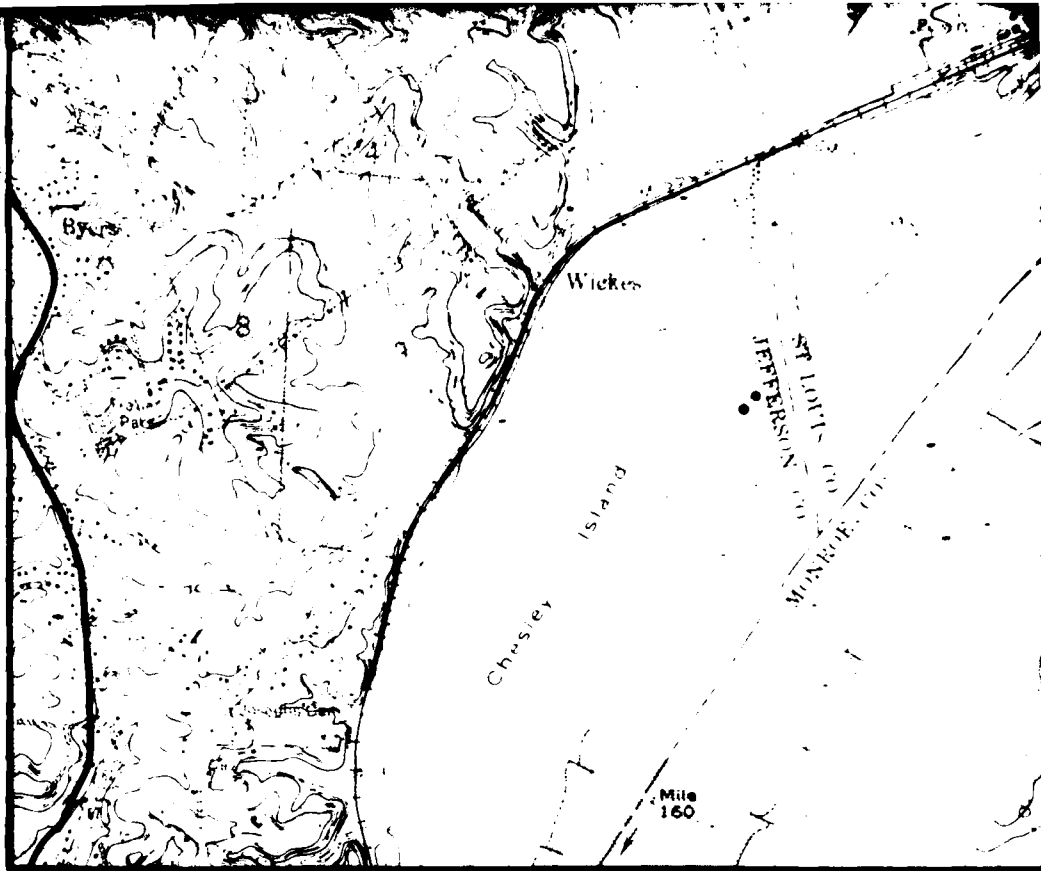
Camp Kise

Long Slough

Creek

6

7-

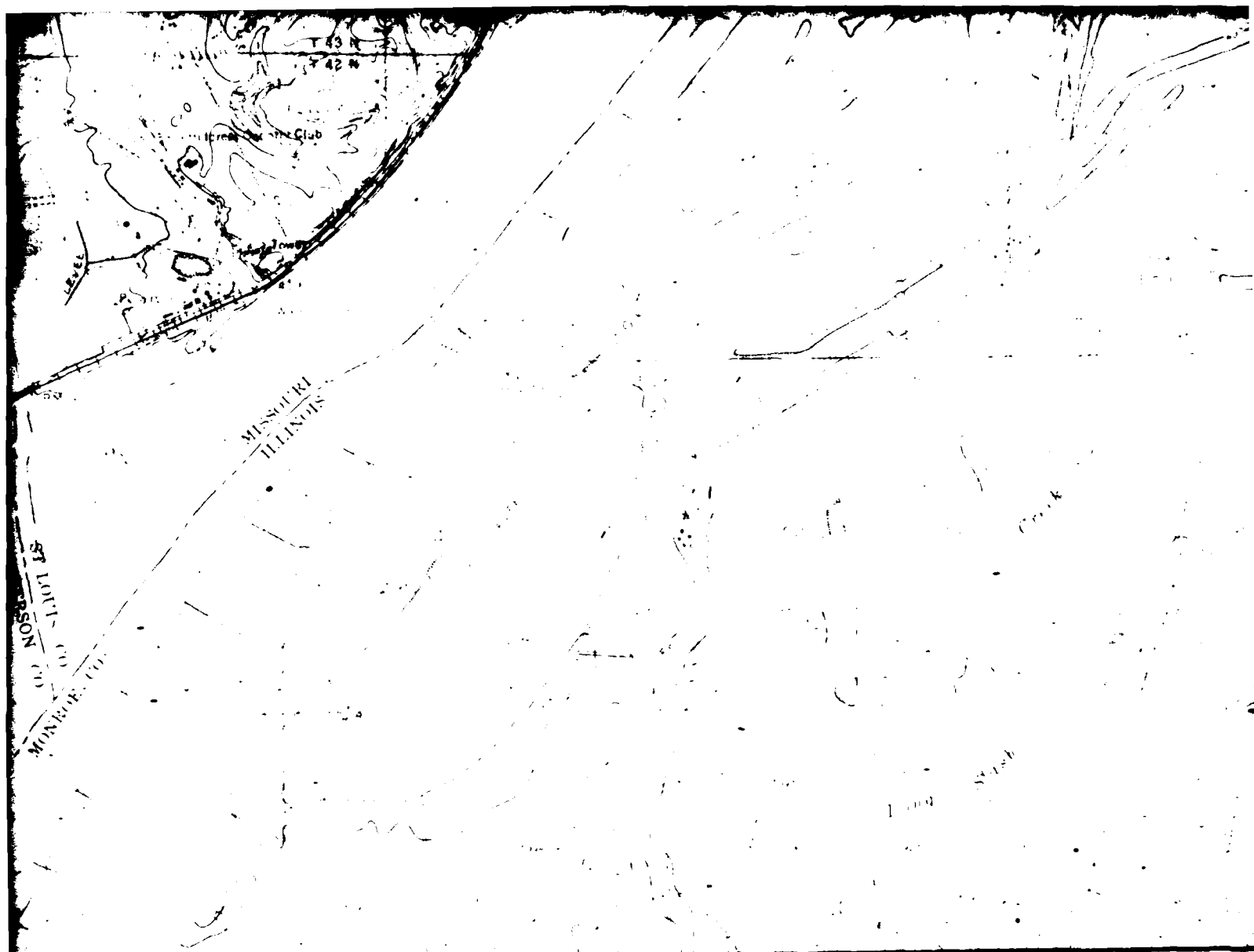


LEGEND



TRAP SITE NUMBER AND LOCATION

NO



MISSOURI TELLANDER
ST LOUIS CO
MONROE CO



<u>LEGEND</u>	NOTES:
 TRAP SITE NUMBER AND LOCATION	1 2 3

PREPARED BY:

KENWILL, INC.

P.O. BOX 450
JACKSBORO, TN. 37757

UNDER DOD CONTRACT DACW 43-81-C-0103

1. SITE NUMBERS DO NOT CORRESPOND TO THE ORDER IN WHICH SITES WERE TRAPPED. NUMBERED CONSECUTIVELY FOR EASE OF REFERENCE WITHIN TEXT.
2. THE M NUMBERS REFER TO SITES THAT WERE ONLY MONITORED AND NOT TRAPPED.
3. THE R NUMBERS REFER TO SITES THAT WERE TRAPPED TWICE DUE TO PREVIOUS ENDANGERED SPECIES.

ORDER IN WHICH SITES WERE TRAPPED. THEY ARE
REFERENCE WITHIN TEXT.

RE ONLY MONITORED AND NOT TRAPPED.

RE TRAPPED TWICE DUE TO PREVIOUS CAPTURE OF

LITERATURE CITED

- Barbour, R.W. and W.H. Davis. 1969. Bats of America. Univ. Press of Kentucky, Lexington, 286 pp.
- Cope, J.B. and S.R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana bat, Myotis sodalis, J. Mammal., 58: 93-98.
- _____, A.R. Richter, and D.A. Seerley. 1978. A survey of the bats in the Big Blue Lake Project Area in Indiana. Report to the U.S. Army Corps of Engineers, Louisville District, 51 pp.
- Gardner, J.E. 1978. Activity patterns of bats in the Delta region of north-east Arkansas. M.S. Thesis. Arkansas State University, 62 pp.
- _____ and T.L. Gardner. 1980. Determination of presence and habitat suitability for the Indiana bat (Myotis sodalis) and gray bat (Myotis grisescens) for portions of the lower 6.6 miles of McKee Creek, McKee Creek Drainage and Levee District, Pike County, Illinois. Report to the Army Corps of Engineers, St. Louis District, 22 pp.
- Hall, E.R. and K.R. Kelson. 1959. The mammals of North America. The Ronald Press Company, New York, 1:1-546.
- Humphrey, S.R. 1978. Status, winter habitat and management of the endangered Indiana bat, Myotis sodalis. Florida Sci., 41: 65-76.

- _____, A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, Myotis sodalis. J. Mammal., 58: 334-346.
- Kunz, T.H. 1973. Resource utilization: Temporal and spatial components of bat activity in central Iowa. J. Mammal., 54: 14-32.
- LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats with emphasis on cave-dwelling species. Terrestrial Series #8. Missouri Department of Conservation, Jefferson City, Missouri, 53 pp.
- _____, R.L. Clawson, M.L. LaVal, and W. Caire, 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species Myotis grisescens and Myotis sodalis. J. Mammal., 58: 592-599.
- Mills, P.A., Jr., C.H. Hocutt, and J.R. Stauffer, Jr. 1978. The pre-impoundment fish fauna of Big River (Meramec Drainage, Missouri). Transactions Missouri Acad. of Sci. 25-35.
- Mohr, C.E. 1972. The status of threatened species of cave-dwelling bats. Bull. Natl. Soc., 34: 33-47.
- _____. 1976. The world of the bat. J.B. Lippincott Comp., New York, 162 pp.

Rabinowitz, A.R. 1978. Habitat use and prey selection by the endangered gray bat, Myotis grisescens, in East Tennessee. M.S. Thesis. Univ. of Tennessee, Knoxville, 56 pp.

_____ and M.D. Tuttle, 1980. Status of summer colonies of the endangered gray bat in Kentucky. J. Wildl. Management., 44: 955-960.

Shannon, C.E. and W. Wiener. 1963. The mathematical theory of communication. Univ. of Illinois Press, Urbana.

Tuttle, M.D. 1975. Population ecology of the gray bat (Myotis grisescens): Factors influencing early growth and development. Occ. Papers Mus. Nat. Hist., Univ. of Kansas, Lawrence., 36: 1-24 pp.

_____. 1976. Population ecology of the gray bat (Myotis grisescens): Philopatry timing and patterns of movement, weight loss during migration and seasonal adaptive strategies. Occ. Papers Mus. Nat. Hist., Univ. of Kansas, Lawrence, 54: 1-38 pp.

_____. 1979. Status, causes of decline and management of endangered gray bats. J. Wildl. Management, 13: 1-17.

APPENDIX

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. C	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE	TOTAL ^d
33	81	6/29/81	36.6	0.91	Combo	20	19.8	4	Sy, Be	<u>M. grisescens</u> <u>L. borealis</u>	1 0	0 1	1 1
47	93	7/1/81	9.0	0.15	Gravel	95	15.0	4	Sy, Be, M	<u>M. sodalis</u>	No bats captured		
488	94	7/1/81	33.0	0.60	Combo	20	22.5	4	Sy, M	<u>M. subflavus</u>	2	1	3
49	95	7/2/81	21.0	0.75	Combo	30	22.5	3	Be, M	<u>P. subflavus</u> <u>H. tucifugus</u>	3 2	2 0	5 2
50	96	7/2/81	33.0	1.20	Combo	5	15.0	3	Sy, Be	<u>P. subflavus</u> <u>H. humeralis</u>	0 0	1 1	1 1
12	61	7/3/81	24.0	0.90	Gravel	10	21.0	3	Sy, M	<u>L. cinereus</u> <u>P. subflavus</u>	1 0	0 1	1 1
14	63	7/5/81	21.0	0.90	Combo	20	19.5	4	Sy, M	<u>E. fuscus</u> <u>H. humeralis</u>	1 0	0 1	2 1
15	64	7/5/81	36.0	0.90	Combo	--	21.0	4	M	<u>P. subflavus</u>	0	1	1
18	67	7/6/81	30.0	0.90	Combo	25	13.5	3	Sy	No bats captured			
19	68	7/6/81	31.5	0.90	Combo	5	22.5	4	Sy, M	<u>L. cinereus</u> <u>N. humeralis</u> <u>H. tebbii</u>	0 1 0	1 1 1	1 2 1

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. ^c	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE	TOTAL ^d
51	N/A	7/7/81	27.0	0.3	Gravel	40	18.0	3	Sy	M. keenii P. subflavus L. borealis M. lucifugus	0 0 4 2	1 3 2 0	1 3 6 2
37	85	7/8/81	30.0	1.2	Combo	--	----	3	Sy, Be, H	L. borealis P. subflavus	2 2	0 0	2 2
36	84	7/8/81	33.0	0.3	Combo	20	22.5	4	Sy, M	P. subflavus N. humeralis L. borealis	1 1 1	3 0 0	4 1 1
3	44	7/9/81	45.8	0.9	Gravel	8	30.0	3	Sy, Be	L. borealis	1	1	2
42	90	7/9/81	30.0	0.6	Combo	45	18.0	3	M	L. borealis M. lucifugus	1 0	0 2	1 2
23	71	7/10/81	48.0	0.9	Combo	10	24.0	3	Sy, M	P. subflavus L. borealis N. humeralis	1 1 1	0 1 3	1 2 4
22R	71	7/10/81	12.6	0.2	Gravel	98	28.5	4	M	L. borealis M. sodalis N. humeralis	1 1 0	2 0 10	6 1 13
6	55	7/12/81	30.0	1.2	Combo	0	18.0	3	Sy		No bats captured		
8	56	7/12/81	36.0	0.6	Combo	5	19.5	3	M		No bats captured		
4	53	7/13/81	31.5	0.9	Combo	10	18.0	2	M	P. subflavus L. borealis	0 0	1 1	1 1

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. ^c	BAT SPECIES	BAT CAPTURE	
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE TOTAL ^d
5	54	7/13/81	33.0	0.4	Combo	5	22.5	3	Sy	<u>L. borealis</u>	1	1 2
40	88	7/14/81	25.5	0.9	Combo	10	28.5	3	M	<u>P. subflavus</u> <u>L. borealis</u>	1 1	1 2
41	89	7/14/81	33.0	0.9	Combo	25	23.4	3	M	<u>L. borealis</u> <u>N. humeralis</u>	0 1	4 4 1
26	75	7/16/81	33.0	1.2	Combo	25	30.0	4	Sy, M	<u>E. fuscus</u> <u>P. subflavus</u> <u>N. humeralis</u> <u>L. borealis</u>	1 1 1 1	0 1 2 3 1
27	76	7/16/81	33.0	0.9	Combo	80	21.0	4	Sy, Be	<u>L. borealis</u> <u>P. subflavus</u> <u>N. humeralis</u> <u>E. fuscus</u>	0 0 0 1	2 1 1 1 3
29	78	7/17/81	27.0	0.6	Combo	60	21.0	4	M	<u>P. subflavus</u> <u>N. humeralis</u> <u>L. borealis</u>	1 0 2	1 3 3 2 4
28	77	7/17/81	30.0	0.6	Combo	55	----	4	Sy, M	<u>L. borealis</u> <u>N. humeralis</u> <u>P. subflavus</u> <u>M. lucifugus</u> <u>E. fuscus</u>	8 2 0 1 1	1 2 1 1 1 11
78	55	7/22/81	7.5	0.9	Mud	100	16.5	3	M	<u>P. subflavus</u> <u>L. cinereus</u> <u>M. keeni</u> <u>M. sodalis</u>	1 0 1 1	0 1 0 1 1 1

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. C	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE	TOTAL ^d
52	N/A	7/22/81	8.1	0.3	Combo	9	12.0	3	Sy, Elm	<u>L. borealis</u>	0	2	2
1M	50	7/23/81	42.0	3.0	Combo	5	----	3	Sy	Monitored Only			
43	91	7/26/81	7.5	0.3	Combo	100	16.5	3	Sy, M	<u>L. borealis</u>	1	1	2
35R	82	7/26/81	15.0	0.2	Combo	90	19.5	3	Be	<u>N. humeralis</u> <u>H. grisescens</u> <u>E. fuscus</u> <u>L. borealis</u> <u>M. keeni</u> <u>P. subflavus</u>	1 1 1 4 1 0	6 0 0 5 0 0	7 1 1 11 1 1
35R	82	7/29/81	39.0	1.2	Combo	60	13.5	3	Sy, M	<u>L. borealis</u> <u>N. humeralis</u> <u>P. subflavus</u> <u>H. keeni</u> <u>M. sodalis</u>	2 0 1 1 1	1 1 1 1 0	4 1 2 2 1
30	79	7/30/81	6.0	0.9	Gravel	100	19.5	3	Sy	<u>L. borealis</u>	1	0	1
7R	55	7/30/81	Re-trap site-see 7/22/81							<u>L. borealis</u> <u>P. subflavus</u>	0 1	2 0	3 1
55	99	7/31/81	33.0	0.6	Combo	5	18.0	3	Sy, M	<u>L. borealis</u>	0	2	2
54	98	7/31/81	30.0	0.8	Gravel	40	----	3	Sy	<u>P. subflavus</u> <u>L. borealis</u> <u>E. fuscus</u>	0 5 1	0 2 0	1 7 1

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. ^c	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE	TOTAL ^d
34	82	8/2/81	31.5	0.9	Gravel	40	15.0	3	Sy, M	<u>P. subflavus</u> <u>L. borealis</u> <u>N. griseescens</u> <u>M. lucifugus</u> <u>N. humeralis</u>	1 3 1 1 0	1 1 0 0 1	2 9 1 1 1
53	97	8/2/81	24.0	0.9	Rock	55	24.0	3	Sy	<u>L. borealis</u> <u>P. subflavus</u> <u>E. fuscus</u>	10 3 2	5 1 0	17 6 2
38	86	8/3/81	39.0	0.6	Gravel	30	-----	3	Sy, M	<u>L. borealis</u> <u>P. subflavus</u>	5 0	5 2	12 2
39	87	8/3/81	54.0	0.9	Sand	35	19.5	3	Be, M	<u>N. humeralis</u> <u>L. borealis</u> <u>P. subflavus</u>	0 2 1	1 3 2	1 5 3
24	73	8/4/81	45.0	1.0	Gravel	25	24.0	4	Sy, Be, M	<u>P. subflavus</u> <u>L. borealis</u> <u>N. humeralis</u>	1 2 0	2 2 3	3 5 3
25	74	8/4/81	30.0	0.9	Gravel	20	19.5	3	Sy, M	<u>L. borealis</u> <u>P. subflavus</u> <u>N. humeralis</u>	2 0 0	3 1 3	8 2 3
2	51	8/5/81	36.0	0.9	Gravel	50	24.0	4	Sy	<u>L. borealis</u> <u>P. subflavus</u>	1 0	2 1	4 1

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. ^c	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^d						MALE	FEMALE	TOTAL ^d
45	92	8/7/81	33.0	0.6	Gravel	30	----	4	Sy, M	P. subflavus L. borealis N. humeralis	3 5 0	0 1 3	5 6 3
46	93	8/7/81	36.0	0.6	Gravel	100	24.0	4	Sy	L. borealis P. subflavus N. humeralis E. fuscus	5 1 1 1	9 1 2 1	26 4 3 2
32	80	8/8/81	33.0	0.8	Gravel	25	22.5	3	Sy, M	P. subflavus L. borealis N. humeralis L. cinereus	1 2 0 1	2 4 1 0	3 6 1 1
31	79	8/8/81	30.0	0.6	Combo	55	19.5	3	Sy, M	L. borealis P. subflavus M. lucifugus M. sodalis	2 0 2 1	2 1 0 0	4 1 2 1
17	66	8/9/81	30.0	0.8	Combo	100	22.5	3	Sy	L. borealis E. fuscus P. subflavus	1 1 0	4 1 1	6 3 1
16	65	8/9/81	22.5	0.9	Gravel	60	19.5	4	Sy, Oak	L. borealis M. sodalis	2 1	2 0	5 1
11M	60	8/10/81	33.0	2.0+	Gravel	60	15.0	3	Sy		Monitored Only		
10	59	8/10/81	36.0	0.6	Gravel	10	22.5	4	Sy, Be		No bats captured		

AD-A111 414

KENHILL INC JACKSBORO TN

DETERMINATION OF PRESENCE AND HABITAT SUITABILITY FOR THE INDIA--ETC(U)

JAN 82 A R RABINOWITZ

F/O 6/3

DACW63-81-C-0103

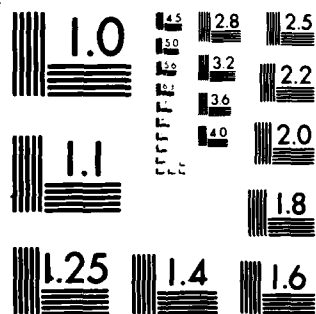
ML

UNCLASSIFIED

2 of 2
A 4 4



END
DATE
FILMED
8-82
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

SITE DATA FOR BIG RIVER AND ITS TRIBUTARIES

SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. ^c	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE	TOTAL ^d
21	70	8/11/81	18.0	0.2	Combo	80	16.5	3	Sy, Be, Elm	<u>L. borealis</u>	2	0	2
20	69	8/11/81	36.0	0.9	Combo	30	18.0	4	M	<u>L. borealis</u> <u>M. sodalis</u> <u>P. subflavus</u> <u>N. humeralis</u>	3 1 1 0	7 0 0 1	11 1 1 1
22R	71	8/12/81	Re-trap site-See 7/10/81							<u>L. borealis</u>	0	2	2
48R	94	8/12/81	Re-trap site-See 7/1/81							<u>L. borealis</u> <u>E. fuscus</u> <u>M. griseus</u>	2 3 2	3 0 1	7 3 3
10	59	8/13/81	Re-trap site-See 8/10/81								Monitored Only		
9M	58	8/13/81	48.0	1.5+	Combo	15	22.5	3	Sy, M		Monitored Only		
16	65	8/13/81	54.0	0.3	Gravel	10	----	3	M	<u>L. borealis</u>	0	0	1

^aCombo refers to a substrate composition of a mud, gravel, sand combination.

^bAge class 1 = 0.0" to 4.9" dbh

Age class 2 = 5.0" to 10.9" dbh

Age class 3 = 11.0" to 15.9" dbh

Age class 4 = 16.0" + dbh

^cSy = Sycamore

Be = Box Elder

M = Maples

^dBats which were identified but escaped before being sexed, are included in the total count. Thus totals may be greater than the sum of the individual sexes.

SITE DATA FOR THE MERAMEC RIVER													
SITE NO.	RIVER km	DATE	MAJOR STREAM CHARACTERISTICS			CANOPY COVER (%)	CANOPY HEIGHT (m)	DOMINANT AGE CLASS ^b	DOMINANT TREE SP. ^c	BAT SPECIES	BAT CAPTURE		
			WIDTH (m)	DEPTH (m)	SUBSTRATE ^a						MALE	FEMALE TOTAL ^d	
1M		8/14/81	75.0	2.0+	Mud	10	19.5	3	M	<u>L. borealis</u>	1	0	1
2M		8/14/81	No data taken. Conditions similar to Site #1.										
3		8/14/81	No data taken. Conditions similar to Site #1.										

46

^aCombo refers to a substrate composition of a mud, gravel, sand combination.

^bAge class 1 = 0.0" to 4.9" dbh

Age class 2 = 5.0" to 10.9" dbh

Age class 3 = 11.0" to 15.9" dbh

Age class 4 = 16.0" + dbh

^cSy = Sycamore

Be = Box Elder

H = Maples

^dBats which were identified by escaped before being sexed, are included in the total count. Thus totals may be greater than the sum of the individual sexes.

**DATA
FILM**