Base from U.S. Geological Survey
1:500,000 State Base Map, 1973

SCALE 1:750,000

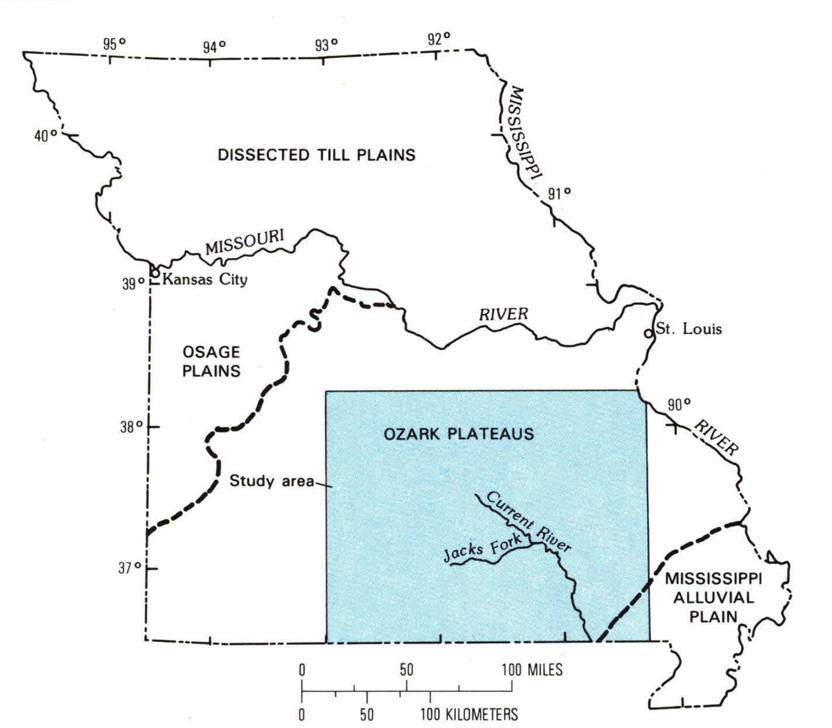
Figure 1. Location of the study area, Ozark National Scenic Riverways, and selected streamflow-gaging stations.

EXPLANATION

△29 Streamflow-gaging station and map number

—··— Current River drainage divide

— — — Boundary of Ozark National Scenic Riverways



INDEX MAP

CONVERSION FACTORS

Factors for converting inch-pound units to metric (SI) units:

Multiply inch-pound unit	By	To obtain SI unit
inch (in.)	0.0254	meter (m)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
gallon (gal)	3.785	liter (L)
square mile (mi^2)	2.590	square kilometer (km^2)
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

INTRODUCTION

This is the first in a series (Chapter A) of U.S. Geological Survey Hydrologic Investigations Atlases to supplement the National Park Service general management and development concept plan for the Ozark National Scenic Riverways (National Park Service, 1981) in southeastern Missouri (fig. 1).

The Ozark National Scenic Riverways, administered by the National Park Service, is an extensively used recreational area where approximately 2 million visitors per year (M. E. Hunter, National Park Service, oral commun., 1985) participate in a wide range of river-use and land-based activities. Visitor areas along the 134 mi of the current River and its principal tributary, Jacks Fork, range from major-developed areas mainly located along the upper Current River to primitive camping areas and river accesses located along the Jacks Fork and downstream reach of the Current River. Most Facilities at these developments are in or near potential flood-prone areas; therefore, because of visitor safety a major consideration of the National Park Service is the implementation of a flood-warning system.

PURPOSE AND SCOPE

The purpose of this atlas report is to present critical factors such as the 100- and 500-year flood discharges and elevations, and the duration of flooding at selected heavy-use areas along the Current and Jacks Fork Rivers. Knowledge of the complex hydrology within the study area (fig. 1) is vital in planning future developments, protecting existing facilities, and ensuring the saftey of visitors. This hydrologic analysis included: (1) assembling available data, (2) transfer of data to hydrologically similar areas, (3) evaluating and extending these data in time, and (4) presenting the results of these evaluations for use in estimating potential flood damages within the Ozark National Scenic Riverways.

DESCRIPTION OF THE AREA

The Current River drainage basin (fig. 1) is characterized by narrow, cherty dolostone ridges that break abruptly to steep side slopes of mostly narrow, wooded valleys 200 to 500 ft deep. During excessive rainfall, the rapid surface runoff from the surrounding steep valley slopes causes frequent flash flooding.

Karst features and interbasin diversions of surface- and ground-water flow are common throughout the area. The many large springs, streams with large base flows, scenic caves, and rugged uplands offer many opportunities for outdoor activities, such as camping, floating, fishing, and hiking, especially where public assesses and facilities are provided by the National Park Service.

Studies that describe the physiographic setting of the area (Ozark Plateaus province), its ground-water conditions, its water quality, and availability of surface-water are found in Gann and others, 1976; Barks, 1978, p. 5-35; and Harvey, 1980, p. 3-53.

STUDY-AREA FLOOD ANALYSIS

Data from 33 U.S. Geological Survey streamflow-gaging stations within the study area (table 1) were selected for this analysis. The selection of stations was based on physiographic area (Ozark Plateaus province), drainage-area size, and proximity to the Current River drainage divide (fig. 1). Most stream reaches within the Current River basin have little or no rainfall or runoff data available; thus, the flood frequencies were estimated by use of selected streamflow data from within the study area. A statistical flood-frequency analysis of annual peak discharges at each of the 33 streamflow-gaging stations was made by using the log-Pearson Type III distribution, according to procedures adopted by the U.S. Water Resources Council (1981, p. 1-28). The 100- and 500-year discharges (table 1) were determined from this analysis for each streamflow-gaging station. The 100-year flood is defined as a discharge that is equaled or exceeded an average of once during 100 years. The 100- and 500-year discharges are useful in evaluating and interpreting flood elevations within the Ozark National Scenic Riverways.

Regional estimating equations for determining the magnitude of flood discharges in Missouri were developed by Hauth (1974). However, estimates of the 100-year discharge from the regional equation (Hauth, 1974, p. 4) are smaller than the 100-year discharge computed from streamflow-gaging station records. Therefore, the 100- and 500-year station data were selected for use in the study area. The 100- and 500-year discharges for the 33 streamflow-gaging stations (table 1) were related graphically to their respective drainage-area size (figs. 2 and 3). The resultant lines were fitted by eye to the plotted points (additional weight was given to station data within the Current River drainage divide, map numbers 21-28), thus providing a graphical means of determining the 100- and 500-year discharges.

Basin lag, as used in this study, is an average time, in hours, between the time of occurrence of the center of mass of effective rainfall and the resulting peak discharge and is important in the development of a flood warning system. Because of the limited continuous-rainfall and streamflow data, an average basin lag time for 23 of the streamflow-gaging stations (table 1) was determined and related graphically by eye to their respective drainage area size as shown in figure 4 (additional weight was given to station data within the Current River drainage divide, map numbers 21-28). The basin lag times computed by selecting the largest annual maximum discharges (U.S. Geological Survey, 1971-84) for the 23 stations were used exclusively in this study. For Current River drainage areas within the Ozark National Scenic Riverways, an average basin lag time for tributary or mainstem drainage area can be estimated from figure 4 (the nearly vertical offset represents the Current River mainstem below the confluence of the Jacks Fork). This knowledge of flood discharge and basin lag will assist the National Park Service in posting flood warnings within the Ozark National Scenic Riverways.

PROCEDURES FOR SITE-SPECIFIC FLOOD ANALYSIS

The 100- and 500-year water-surface profiles for this series of hydrologic atlases were computed for site-specific developments within the Ozark National Scenic Riverways by use of the step-backwater or the slope-conveyance method. Where valley-geometry data were obtained, the step-backwater method was used. This method mathematically balances energy losses and discharge between valley cross sections along a stream reach (Davidian, 1984, p. 1-43). Otherwise, the slope-conveyance method was used, where the energy-gradient, water-surface, and friction slopes are assumed to be parallel and become constant at the higher water-surface elevations (Rantz and others, 1982, p. 334-337). These two methods are the most common approaches used to determine elevations of specific floods and thereby delineate inundated areas. Most site-specific developments are located partly in the 100-year flood area. The National Park Service states "Under existing National Park Service policy, such areas might typically be relocated." (National Park Service, 1981, p. 56). Therefore, the area inundated by the 100-year flood was delineated for each site-specific area.

To maximize visitor access and use of the Ozark National Scenic Riverways, a method is needed for estimating the duration of flooding at site-specific developments. Such estimates require rainfall data and a valid basin model for converting excess rainfall to an elevation or a discharge hydrograph. The general-purpose, single-event, rainfall-driven, multiparameter watershed-model program, HEC-1 (U.S. Army Corps of Engineers, 1982), was selected for this study. Model characteristics used were drainage-area, triangular rainfall pattern, soil-infiltration rate, and streamflow routing. Statistically estimated rainfall data were the only data available within the site-specific study areas. Therefore, rainfall data from frequency and duration criteria (100-year 30-minutes to 100-year 24-hours) developed by the National Weather Service (Hershfield, 1961, p. 21-105) were used. Each site-specific analysis was divided into subdrainage areas for increased accuracy of basin modeling.

SUMMARY

These Hydrologic Investigations Atlases will provide the National Park Service with flood-management plans for use in evaluating existing developments, developing a flood-warning system, and evaluating future developments at site-specific locations within the Ozark National Scenic Riverways.

Chapter A describes the study area, presents a hydrologic analysis that includes the Ozark National Scenic Riverways (sheet 1), and presents the site-specific flood analysis at Akers (sheet 2) and Alley Spring (sheet 3). Future flood analysis planned for Round Spring and Powder Mill will be presented in a subsequent chapter.

Table 1. ***Selected basin characteristics and flood-frequency data for streamflow-gaging stations***

[USGS, U.S. Geological Survey; WY, water year; mi^2, square miles; ft/mi, feet per mile; ft^3/s, cubic feet per second; h, hours; -- no data available]

Map no. (fig. 1)	USGS station number	Station name	Record used in analysis (WY)	Drainage area (mi^2)	Main-channel slope (ft/mi)	Flood-frequency data: 100-year discharge (ft^3/s)	Flood-frequency data: 500-year discharge (ft^3/s)	Basin lag time (h)
1	06927600	Wheeler Branch near Mountain Grove	1955–69 1972–80	1.34	48.8	1,590	2,020	--
2	06927800	Osage Fork Gasconade River at Drynob	1963–80	404	6.5	28,000	34,100	22
3	06928000	Gasconade River near Hazlegreen	1915–16 1929–71 1973–80	1,250	4	114,000	155,000	35
4	06928200	Laquey Branch near Hazlegreen	1958–72	1.58	87.4	2,900	4,650	2
5	06928500	Gasconade River near Waynesville	1915–71	1,680	3.2	99,400	132,000	57
6	06928700	Beeler Branch near Cabool	1968–79	7.78	--	8,620	10,400	1.5
7	06929000	Coyle Branch at Houston	1950–55 1959–79	1.10	95.9	1,440	2,230	2
8	06930000	Big Piney River near Big Piney	1922–80	560	5.6	41,400	49,300	27
9	06931000	Beaver Creek near Rolla	1949–79	13.7	39.5	9,760	13,100	3.5
10	06931500	Little Beaver Creek near Rolla	1948–79	6.41	65.6	8,090	12,800	2.5
11	06932000	Little Piney Creek at Newburg	1929–83	200	14	39,800	59,600	10
12	07010350	Meramec River at Cook Station	1966–80	199	9.9	51,400	66,500	14
13	07011200	Love Creek near Salem	1955–66 1969–82	0.89	106	560	820	--
14	07011500	Green Acre Branch near Rolla	1948–75	.62	82	1,550	2,300	1
15	07012000	Behmke Branch near Rolla	1949–79	1.05	77	2,250	3,030	--
16	07013000	Meramec River near Steelville	1917–83	781	6.3	60,500	76,800	34
17	07038000	Clark Creek at Patterson	1955–79	37.5	29.4	15,300	18,400	--
18	07061300	East Fork Black River at Lesterville	1961–83	94.5	29.7	14,200	16,500	7
19	07061500	Black River near Annapolis	1939–83	484	10.9	71,600	87,500	18
20	07063200	Pike Creek tributary near Poplar Bluff	1955–69	.28	111	450	575	--
21	07064300	Fudge Hollow near Licking	1957–79	1.72	68.1	800	1,320	.5
22	07064500	Big Creek near Yukon	1950–79	8.36	53.3	8,590	11,600	1
23	07066000	Jacks Fork at Eminence	1922–83	398	9.5	53,500	70,000	18
24	07066500	Current River near Eminence	1922–75	1,272	7.6	123,000	171,000	21
25	07066800	Sycamore Creek near Winona	1955–79	.86	66.4	815	1,120	--
26	07067000	Current River at Van Buren	1913–84	1,667	5.9	139,000	195,000	32
27	07068000	Current River at Doniphan	1919–84	2,038	4.8	113,000	151,000	50
28	07068200	North Prong Little Black River at Hunter	1958–80	1.23	61.7	1,080	1,570	--
29	07069100	Adams Branch near West Plains	1955–79	2.27	44.3	900	1,150	--
30	07070200	Burnham Branch near Willow Springs	1955–66 1968–69 1971 1973–79	1.27	58.6	870	1,180	--
31	07070500	Eleven Point River near Thomasville	1951–76	361	13.7	28,200	36,400	15
32	07071500	Eleven Point River near Bradley	1922–84	793	10.1	56,400	76,700	25.5
33	07071800	Williams Spring Branch near Alton	1955–79	4.24	63.3	3,570	7,230	--

REFERENCES

Barks, J. H., 1978, Water quality in the Ozark National Scenic Riverways, Missouri: U.S. Geological Survey Water-Supply Paper 2048, 57 p.

Davidian, Jacob, 1984, Computation of water-surface profiles in open channels: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A15, 48 p.

Gann, E. E., Harvey, E. J., and Miller, D. E., 1976, Water resources of south-central Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-550, 4 sheets.

Harvey, E. J., 1980, Ground water in the Springfield-Salem Plateaus of southern Missouri and northern Arkansas: U.S. Geological Survey Water-Resources Investigations Report 80-101, 66 p.

Hauth, L. D., 1974, Technique for estimating the magnitude and frequency of Missouri floods; Rolla, U.S. Geological Survey Open-File Report, 20 p.

Hershfield, D. M., 1961, Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years: National Weather Service, U.S. Weather Bureau Technical Paper 40, 115 p.

National Park Service, 1981, Draft general management plan and development concept plan, Ozark National Scenic Riverways: U.S. Department of the Interior, 132 p.

Rantz, S. E., and others, 1982, Measurement and computation of streamflow—Volume 2. Computation of discharge: U.S. Geological Survey Water-Supply Paper 2175, 346 p.

U.S. Army Corps of Engineers, 1982, Hydrologic analysis of ungaged watersheds using HEC-1: Davis, Calif., Water Resources Support Center, Training Document No. 15, 122 p., 1 app.

U.S. Geological Survey, 1971-84, Water resources data for Missouri, water years 1971-84: Rolla, U.S. Geological Survey Water-Data Report MO-71 to MO-84-1 (Published annually).

U.S. Water Resources Council, 1981, Guidelines for determining flood flow frequency (revised): U.S. Water Resources Council Bulletin 17B, 28 p., 14 app.

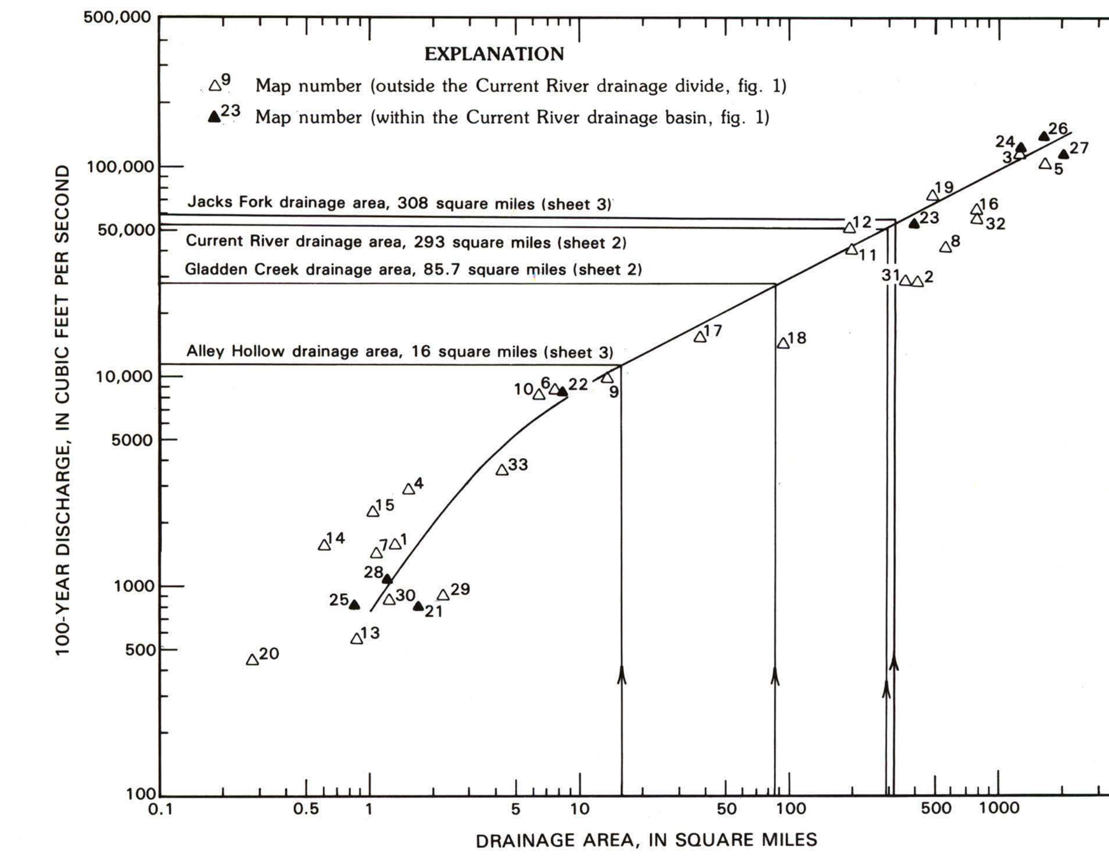


Figure 2. Relation between the 100-year flood discharge and drainage area.

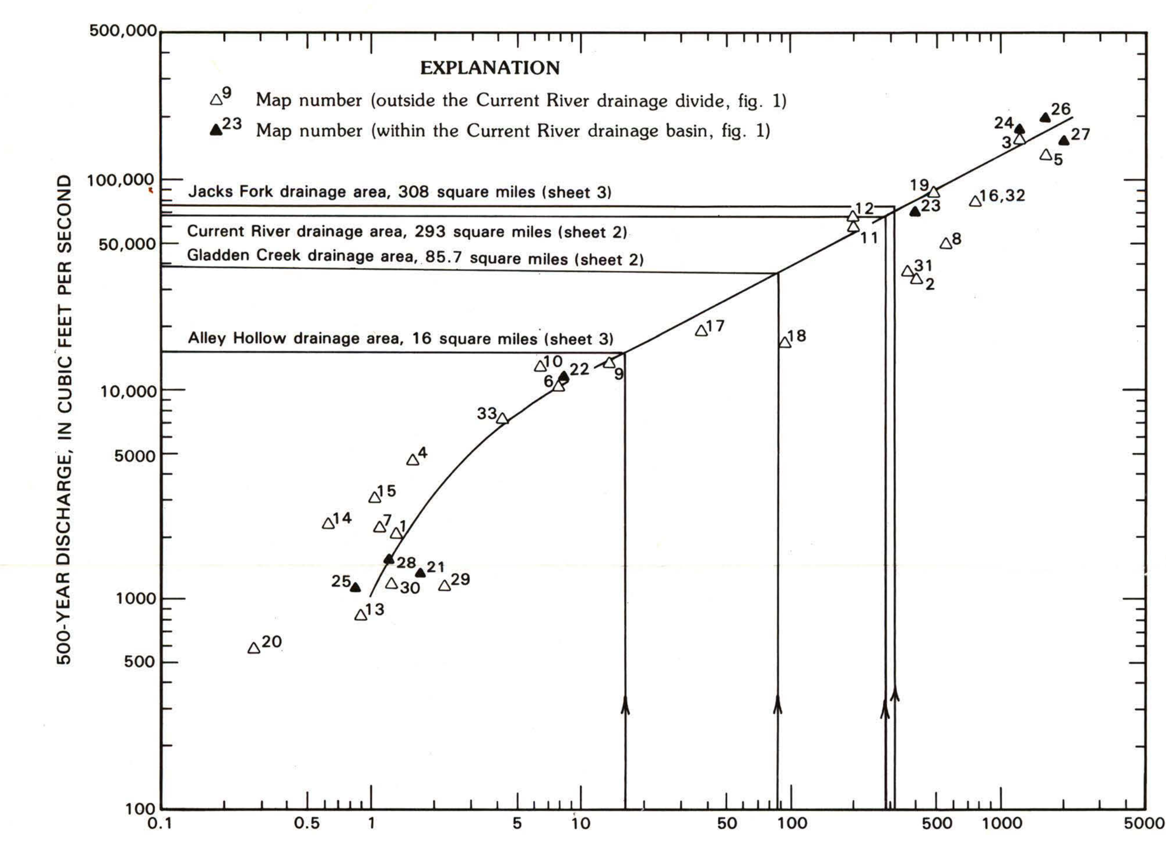


Figure 3. Relation between the 500-year flood discharge and drainage area.

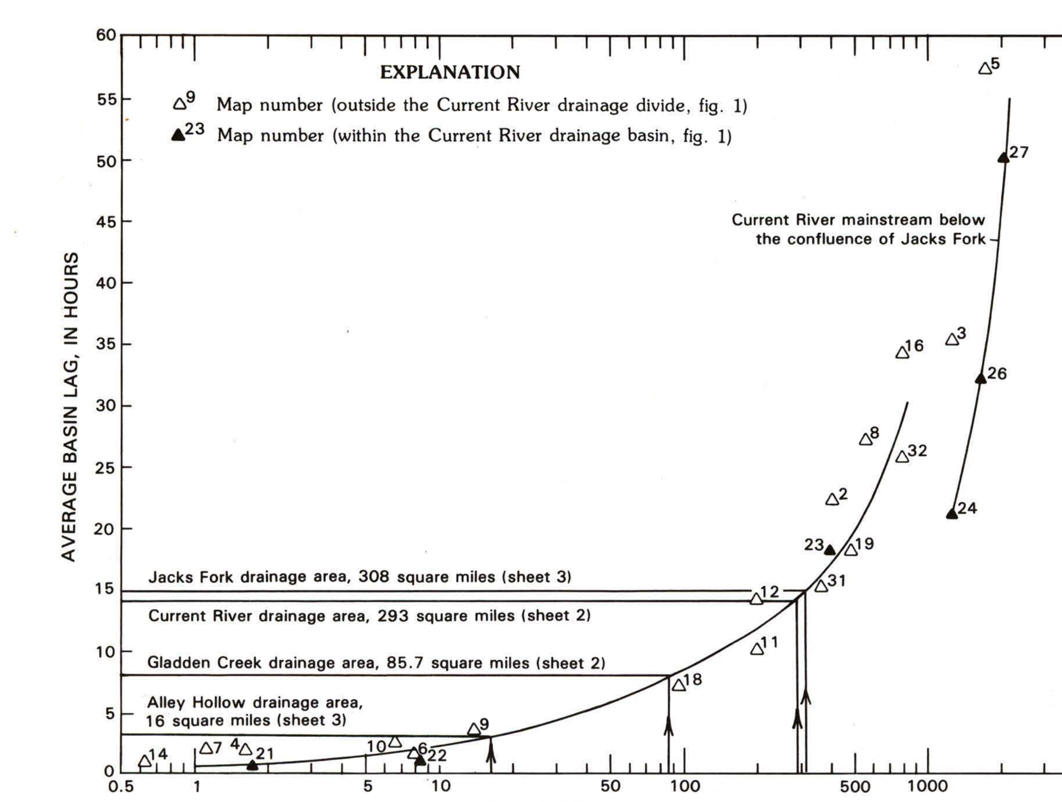


Figure 4. Relation between the basin lag time and drainage area.

DELINEATION OF FLOODING WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS IN SOUTHEASTERN MISSOURI—AKERS AND ALLEY SPRING

By
Terry W. Alexander
1990

For sale by U.S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225