University of Arkansas, Fayetteville
ScholarWorks@UARK

Technical Reports | Arkansas Water Resources Center

1-1-1976

The Fishes of Washinton County, Arkansas

Donald G. Cloutman
University of Arkansas, Fayetteville

Larry L. Olmsted
University of Arkansas, Fayetteville

Follow this and additional works at: https://scholarworks.uark.edu/awrctr

 Part of the Fresh Water Studies Commons, and the Water Resource Management Commons

Recommended Citation
Cloutman, Donald G. and Olmsted, Larry L.. 1976. The Fishes of Washinton County, Arkansas. Arkansas Water Resources Center, Fayetteville, AR. PUB039. 112

This Technical Report is brought to you for free and open access by the Arkansas Water Resources Center at ScholarWorks@UARK. It has been accepted for inclusion in Technical Reports by an authorized administrator of ScholarWorks@UARK. For more information, please contact scholar@uark.edu, ccmiddle@uark.edu.

The Fishes of Washington County, Arkansas

by

Donald G. Cloutman & Larry L. Olmsted

ARKANSAS WATER RESOURCES RESEARCH CENTER

No. 39

University of Arkansas

Fayetteville, Arkansas

1976

THE FISHES OF WASHINGTON COUNTY, ARKANSAS

By

Donald G. Cloutman and Larry L. Olmsted

Department of Zoology

University of Arkansas

Fayetteville, Arkansas 72701

1976

TABLE OF CONTENTS

INTRODUCTION

Washington County is located in the Ozark Mountains of Northwest Arkansas. The Ozark Uplands support a rich array of fishes, including many species endemic to the region, and Washington County is no exception. The county serves as a headwaters area for two major drainage systems- the White River and the Illinois River. Ninety-eight fishes have been found within its boundaries. In spite of high species richness, there has been no previous attempt to compile and analyze the distribution of fishes in Washington County. The objectives of the present study are:

1) To summarize current knowledge concerning the present distribution and abundance of Washington County fishes,

2) To interpret the distribution patterns in terms of drainage systems, environmental conditions, and historic events, and

3) To serve as a basis of comparison for determining the effects of future habitat alterations in respect to the distribution and abundance of Washington County fishes.

DESCRIPTION OF WASHINGTON COUNTY

Washington County is located in northwestern Arkansas (Map 1) and is situated in the Ozark Plateau Province of the Interior Highlands Division (Fenneman 1938). It is bordered by Benton County on the north, Madison County on the east, Crawford County on the south, and Adair County, Oklahoma on the west. The area of Washington County is 2494 km^2. The northern portion of the county is situated in the Springfield Plateau while the southern part is in the Boston Mountains. The Springfield Plateau is characterized by solution weathering of limestone which has

left a mantle of insoluble chert. Most of the Springfield Plateau has a natural covering of Oak-Hickory forest but portions in the west and northwest have had prairie vegetation. Much of the forest, as well as grassland, has been destroyed by agricultural activities. The Boston Mountains are a deeply dissected plateau with flat-topped summits. The rock formations are primarily sandstone and shale (Borengasser 1968). The Boston Mountains are the most rugged region in Washington County and are covered by Oak-Hickory forest.

Most of the eastern portion of Washington County is drained by the White River system while most of the western portion is drained by the Illinois River system. The southern part of the county is drained by the Lee Creek and Frog Bayou drainage systems. All the streams in Washington County are part of the Arkansas River system.

The headwater streams of the White River system originate in the Boston Mountains and flow northward. The three major headwater tributaries (West Fork, Middle Fork, and East Fork) join to form the mainstream of the White River in the Springfield Plateau east of Fayetteville. The substrate of the White River system in Washington County is primarily gravel. There are numerous riffles and pools. Except for periods of flooding after high rainfall the waters are typically clear. Aquatic vegetation is limited and is represented primarily by water willow, Dianthera americana Vahl, in riffle areas. The White River is impounded shortly after the confluence of the East and Middle Forks by Lake Sequoyah. The White River in the northern portion of the county is inundated by the upper part of Beaver Reservoir.

The Illinois River originates in the Boston Mountains in Washington County and flows northward into the Springfield Plateau region. The substrate is primarily gravel although some sections have exposed bedrock

and the lower portion in the county has some areas where siltation occurs. Well-defined riffles and pools are found throughout most of the drainage in Washington County. Numerous spring runs are present in the Springfield Plateau. These small streams are typically cool, clear, and are often choked with watercress (Nasturtium). The Illinois River is typically a clear stream, however, some sections become slightly turbid because of organic enrichment from cattle and poultry farms. Several small impoundments are present in Washington County.

The Lee Creek and Frog Bayou drainages originate in the Boston Mountains and flow southward to the Arkansas River in Crawford County. These streams in Washington County are small, cool, clear headwater tributaries with high gradients. The substrate is mostly gravel and bedrock.

Washington County has a moderate climate. There are about seven months of frost-free weather from early April to late October. The average temperature is 15 C. It drops below freezing about 90 days per year and rises above 32 C about 58 days during the year. Average rainfall is about 122 cm per year and the sky is clear about 150 days a year (Vizzier 1969).

For further descriptions of Washington County geology and streams see Borengasser (1968).

HISTORICAL REVIEW OF ICHTHYOLOGY IN WASHINGTON COUNTY

The first scientific records of fishes from Washington County were compiled by Seth Meek (1893, 1894). At that time, comprehension of fish systematics was rudimentary and fish taxonomy was somewhat chaotic. The exact number of species reported in these early studies is uncertain

because some of the reported species are no longer valid or were composites of two or more recognized species. In spite of these shortcomings, much useful information is in Meek's writings.

Almost 50 years passed until further information was gathered on Washington County fishes by John Black. Black made numerous collections in Washington County for his doctoral dissertation on fishes of Arkansas (1940). During the period between 1940 and 1960 very little information was gathered on Washington County fishes except for some museum specimens collected by Dr. Carl E. Hoffman and his students at the University of Arkansas.

In the 1960's Dr. Kirk Strawn and his students gathered much information concerning fishes in the area. Many specimens resulting from these efforts are deposited in the University of Arkansas Museum. The most comprehensive work on fishes in Washington County was part of a preimpoundment survey of the Beaver Reservoir watershed by William E. Keith (1964) under the direction of Dr. Strawn. After Dr. Strawn left the University of Arkansas most of the information concerning Washington County fishes was gathered in numerous informal outings by University of Arkansas zoology graduate students, many of whom aided in collection of data in the present study. Members of South Central Reservoir Investigations, Bureau of Sport Fisheries and Wildlife, Department of the Interior have compiled much information on Beaver Reservoir fishes. A recent survey by Kittle (1974) has provided useful information regarding Illinois River fishes.

MATERIALS AND METHODS

Most stream collections made in this study were taken with a 6.1 m, 0.5 cm mesh seine. Angling supplemented seining for game species. A

boat-mounted electroshocker and gill nets were utilized in Beaver Reservoir. In order to yield a comprehensive view of the fishes of Washington County, sites distributed throughout the county were collected. An effort was made to collect all types of habitats in each of the drainage systems in Washington County. When possible, all microhabitat types were collected at each locality. Because of the wide variety of habitats and selectivity of gear, we did not standardize our sampling effort. During this study, a total of 122 collections at 78 different localities was made from the summer of 1970 through fall of 1974.

Records other than our own dating from 1893 to 1974 were derived from appropriate literature, the University of Arkansas Museum, and South Central Reservoir Investigations, Bureau of Sport Fisheries and Wildlife in Fayetteville. A total of 100 localities, including ours, has been collected by the various ichthyological investigators in Washington County (Map 2).

ANNOTATED LIST OF SPECIES

The common and scientific names used in this paper are those recognized by Bailey et al. (1970). University of Arkansas Museum records are listed as UAM and South Central Reservoir Investigations records are denoted as SCRI. Because fish populations fluctuate seasonally (Dewey 1973) and from year to year, and because of differences in sampling effort, the subjective terms rare, uncommon, common, and abundant will be used to describe abundance. These terms are defined as follows:

Rare - Seldom collected even in proper habitat, in small numbers when collected.

Uncommon - May or may not be found in any given collection from suitable habitat, in small numbers when found.

Common - A few specimens almost always found in collections from suitable habitat.

Abundant - Numerous specimens usually collected from suitable habitat, usually one of the predominant species.

Although these terms are admittedly only rough indicators of abundance, we feel that they are useful for comparisons. Similar terminology has been adopted by Trautman and Gartman (1974).

Ichthyomyzon castaneus Girard (Map 3).

Black (1940): *Ichthyomyzon castaneus*.
Buchanan (1973): *Ichthyomyzon castaneus*.
UAM: *Ichthyomyzon castaneus*.

The chestnut lamprey has been collected in both the Illinois and White River drainages of Washington County. All specimens collected by the authors were adults taken during the spring spawning migration in April. The specimens were collected in riffles of moderate depth and swift current. The adults are parasitic on other fishes and ammocoetes live buried in mud or sand of backwaters in small rivers and creeks.

Ichthyomyzon gagei Hubbs and Trautman (Map 4).

Keith (1964): *Ichthyomyzon gagei*.
Buchanan (1973): *Ichthyomyzon gagei*.

The nonparasitic southern brook lamprey was reported from Washington County by Keith (1964). Most specimens collected by Keith were ammocoetes and they were rare to common in his survey.

Polyodon spathula (Walbaum) (Map 5).

Meek (1893): Polyodon spathula.
Meek (1894): Polyodon spathula.
Black (1940): Polyodon spathula.
Buchanan (1973): Polyodon spathula.

All references of the paddlefish in Washington County are based on one individual reported originally by Meek (1893) at Oxford Bend on the White River. It is doubtful that this species now exists in the county.

Lepisosteus osseus (Linnaeus) (Map 6).

Meek (1894): Lepisosteus osseus.
Black (1940): Lepisosteus osseus oxyurus.
Keith (1964): Lepisosteus osseus.
Kittle (1974): Lepisosteus osseus.
SCRI: Lepisosteus osseus.

Longnose gar have been collected in the Illinois and White River drainages of Washington County. Keith (1964) reported longnose gar as being sporadic and uncommon in the White River drainage. Longnose gar are most often observed during the summer near the surface of deep pools. The longnose gar is the only gar found in the high gradient streams of Washington County. The construction of impoundments on many of the streams has probably increased the abundance of this species in the county.

Dorosoma cepedianum (Lesueur) (Map 7).

Meek (1894): Dorosoma cepedianum.
Black (1940): Dorosoma cepedianum.
Keith (1964): Dorosoma cepedianum.
Buchanan (1973): Dorosoma cepedianum.
Kittle (1974): Dorosoma cepedianum.
UAM: Dorosoma cepedianum.
SCRI: Dorosoma cepedianum.

Gizzard shad are common in the larger streams of Washington County, usually selecting deep pools or areas of slight current. This species

is particularly abundant in impoundments in this region. Immature individuals constitute important forage for several of the game fishes in the area.

Dorosoma petenense (Gunther) (Map 8).

Buchanan (1973): Dorosoma petenense.
SCRI: Dorosoma petenense.

Threadfin shad have been collected only in Beaver Reservoir where they were introduced. This species has proven to be a valuable forage fish for several of the game fishes of Beaver Reservoir (Ball 1973, Olmsted 1971). Large scale winter kills are common for threadfin shad and this has been cited as the reason for several unsuccessful attempts to introduce this fish in other impoundments in this area.

Hiodon tergisus Lesueur (Map 9).

Keith (1964): Hiodon tergisus.
Buchanan (1973): Hiodon tergisus.
SCRI: Hiodon tergisus.

There have been only three records of mooneye in Washington County. One record was by Keith (1964) in his preimpoundment survey of Beaver Reservoir, and the others by SCRI in gill nets after impoundment. The species appears to be rare in Washington County.

Aphyocharax rubripinnis Pappenheim (Map 10).

One specimen of the bloodfin tetra was collected by the authors from the Illinois River near Moffit. This is undoubtedly the result of an introduction from an aquarium. We have seen this species on sale in local variety stores and pet shops. The present status of this species in Washington County is unknown. The chances of collecting the only specimen or specimens released into the river seem very remote, but it

is also doubtful that a viable breeding population can exist because of cold winter conditions. The Mexican tetra, Astyanax mexicanus (Filippi), has been introduced into Lake Tenkiller on the Illinois River in Oklahoma but it is doubtful that the species can maintain itself there (Miller and Robison 1973).

Salmo gairdneri Richardson (Map 11).

Black (1940): Salmo gairdnerii irideus.
Buchanan (1973): Salmo gairdneri.

No native rainbow trout exist in Arkansas. The only records of rainbow trout in Washington County are related to commercial use of this species. Following heavy rains trout can sometimes be taken in local streams near trout farms, but it is doubtful any permanent wild populations have been established due to high summer temperatures.

Esox lucius Linnaeus

SCRI: Esox lucius.

Northern pike have been introduced into Beaver Reservoir. Although we have not collected this species, it has been caught by fishermen in Washington County (Al Houser, pers. comm.). Exact locations of these catches are unknown so no distribution map is provided.

Anguilla rostrata (Lesueur) (Map 12).

Meek (1894): Anguilla chrysypa.
Black (1940): Anguilla bostoniensis.
Buchanan (1973): Anguilla rostrata.

The American eel has been reported twice from the White River in Washington County. This species probably does not occur in Washington County now because of mainstream impoundments downstream on the White River.

Ctenopharyngodon idellus Cuvier and Valenciennes (Map 13).

Buchanan (1973): Ctenopharyngodon idellus.

The white amur or grass carp has been introduced into Lake Weddington by the Arkansas Game and Fish Commission for control of aquatic macrophytes. It has also been introduced into lakes draining into the White River near Washington County. Although natural reproduction in the county is probably limited, future increases in abundance can be anticipated due to the liberal stocking program of this species by the Game and Fish Commission.

Cyprinus carpio Linnaeus (Map 14).

Keith (1964): Cyprinus carpio.
Buchanan (1973): Cyprinus carpio.
Kittle (1974): Cyprinus carpio.
UAM: Cyprinus carpio.
SCRI: Cyprinus carpio.

The carp is most abundant in large streams and impoundments in Washington County, especially in areas of high organic enrichment. This species is the most successful exotic in Washington County. In Washington County they are seldom sought after as a commercial or recreational fish.

Carassius auratus (Linnaeus) (Map 15).

Buchanan (1973): Carassius auratus.
SCRI: Carassius auratus.

Goldfish in Washington County are the result of bait and aquarium introductions. Whether these records represent self-sustaining populations is not known at present. Goldfish are constantly being added to Beaver Reservoir through their use as bait on trot lines. According to Al Houser (pers. comm.) goldfish are present throughout Beaver Reservoir. This species is probably more common than our distribution maps indicate.

Generally, goldfish have been much less successful in establishing significant populations in the United States than has their close relative, the carp.

Notemigonus crysoleucas (Mitchill) (Map 16).

Keith (1964): Notemigonus crysoleucas.
Buchanan (1973): Notemigonus crysoleucas.
Dewey (1973): Notemigonus crysoleucas.
Olmsted and Cloutman (1974): Notemigonus crysoleucas.
UAM: Notemigonus crysoleucas.
SCRI: Notemigonus crysoleucas.

The golden shiner appears to be widespread throughout the county, but is sporadic in its occurrence. Keith (1964) reported golden shiners to be rare in the White River drainage. This species has probably increased in abundance in Washington County since settlement by modern man. Meek (1893, 1894) and Black (1940) did not report N. crysoleucas from any of their Washington County collections. The construction of impoundments has probably caused the golden shiner to be locally abundant. Evidence of this is the fact that golden shiners have become common in cove rotenone samples performed by SCRI on Beaver Reservoir. N. crysoleucas is probably the most commonly used bait minnow in Washington County.

Semotilus atromaculatus (Mitchill) (Map 17).

Meek (1893): Semotilus atromaculatus.
Meek (1894): Semotilus atromaculatus.
Black (1940): Semotilus atromaculatus atromaculatus.
Keith (1964): Semotilus atromaculatus.
Buchanan (1973): Semotilus atromaculatus.
Dewey (1973): Semotilus atromaculatus.
Olmsted and Cloutman (1974): Semotilus atromaculatus.
UAM: Semotilus atromaculatus.

Creek chubs are locally common in headwater areas but sporadic in occurrence elsewhere in Washington County. This species prefers headwater habitats where few other species of fishes occur.

Hybopsis amblops (Rafinesque) (Map 18).

Meek (1893): Hybopsis amblops.
Meek (1894): Hybopsis amblops.
Black (1940): Hybopsis amblops amblops.
Keith (1964): Hybopsis amblops.
Buchanan (1973): Hybopsis amblops.
UAM: Hybopsis amblops.

The bigeye chub is widespread in Washington County but of sporadic occurrence. Collections from a locality may produce several specimens during one collection and no specimens during the next. The bigeye chub appears to be less common in Washington County than reported by earlier workers. Quantitative data is lacking but a comparison of collection sites of the present work with previous records would indicate that this species is becoming increasingly uncommon. Black (1940) stated that H. amblops was abundant in many streams and considered it as one of the species characteristic of the Ozark Upland fauna. Trautman (1957), Cross (1967), and Larimore and Smith (1963) have also reported declining abundance of H. amblops in Ohio, Kansas, and Illinois, respectively. The decline in abundance of this species seems attributable to recent accumulations of silt over stream bottoms that were formerly composed of gravel. We have most often found H. amblops at the head or foot of riffles, but rarely in the main current.

Hybopsis dissimilis (Kirtland) (Map 19).

Keith (1964): Hybopsis dissimilis.
Buchanan (1973): Hybopsis dissimilis.
UAM: Hybopsis dissimilis.

The streamline chub has not been collected in Washington County since Keith's (1964) preimpoundment survey of Beaver Reservoir. He described the species as being rare to common in the White River. Most of Keith's collection sites for H. dissimilis have been inundated by Beaver Reservoir. The present status of this species is uncertain, but it appears to be extremely rare. The streamline chub inhabits moderately large clear streams with continuous strong flow over clean gravel or rocky bottom. The present lack of this type of habitat in Washington County could seriously restrict the abundance of H. dissimilis.

Hybopsis x-punctata Hubbs and Crowe (Map 20).

Kittle (1974): Hybopsis x-punctata.

The gravel chub is rare in the Illinois River in Washington County because of its preference for small rivers with well-defined riffles and pools. This species is most often found in deep, swift riffles over clean gravel substrate. Although H. x-punctata has been collected from the lower White River (Buchanan 1973) none have been taken from seemingly suitable habitat from this drainage in Washington County. It appears to be replaced by H. dissimilis, which has very similar habitat requirements. Pflieger (1971) reported that the distribution of H. x-punctata tends to complement that of H. dissimilis in Missouri, and Trautman (1957) indicated that the two are competitive and tend to occupy different habitats where they occur together in Ohio.

Nocomis asper Lachner and Jenkins (Map 21).

Meek (1893): Hybopsis kentuckiensis.
Meek (1894): Hybopsis kentuckiensis.
Black (1940): Nocomis biguttatus.
Lachner and Jenkins (1971): Nocomis asper.

Buchanan (1973): Nocomis asper.
Dewey (1973): Nocomis asper.
Olmsted and Cloutman (1974): Nocomis asper.
UAM: Hybopsis biguttata.

Nocomis asper is endemic to the western slope of the Ozark Mountains in the Arkansas River drainage, except for a relict population in the Red River system of southern Oklahoma. The redspot chub is common in small upland tributaries with clear flowing water and gravel substrate. This species is often found in association with Notropis pilsbryi and Dionda nubila in flowing pools at the head or base of riffles.

Nocomis biguttatus (Kirtland) (Map 22).

Black (1940): Nocomis biguttatus.
Keith (1964): Hybopsis biguttata.
Lachner and Jenkins (1971): Nocomis biguttatus.
Buchanan (1973): Nocomis biguttatus.
UAM: Hybopsis biguttata.

The horneyhead chub is widely distributed in the White River drainage of Washington County but is relatively uncommon in occurrence. This species has apparently always been uncommon as indicated by Meek's (1893, 1894) failure to report this species from Washington County. Keith (1964) found N. biguttatus common only in the Middle Fork of the White River. The present study is in agreement with this finding. Habitat preference of this species is basically identical to that of the preceding species. Previous records of N. biguttatus in the Illinois River drainage should be relegated to N. asper (Lachner and Jenkins 1971).

Pimephales notatus (Rafinesque) (Map 23).

Meek (1893): Pimephales notatus.
Meek (1894): Pimephales notatus.
Black (1940): Hyborhynchus notatus.

Keith (1964): Pimephales notatus.
Buchanan (1973): Pimephales notatus.
Dewey (1973): Pimephales notatus.
Olmsted and Cloutman (1974): Pimephales notatus.
Kittle (1974): Pimephales notatus.
UAM: Pimephales notatus.

The bluntnose minnow is generally distributed within Washington County and is common to abundant in most streams. They are most abundant in small streams with rocky bottom and permanent flow and tend to occupy pools. P. notatus is found in local impoundments but is usually uncommon in such habitats.

Pimephales promelas Rafinesque (Map 24).

Meek (1893): Pimephales promelas.
Meek (1894): Pimephales promelas.
Black (1940): Pimephales promelas confertus.
Buchanan (1973): Pimephales promelas.
UAM: Pimephales promelas.

The fathead minnow appears to be rare in Washington County, but has been reported from both the White and Illinois Rivers. This species has proclivity for more sluggish, muddy conditions, and this is believed to account for its rarity within the county.

Pimephales tenellus (Girard) (Map 25).

Black (1940): Ceratichthys tenuis parviceps.
Hubbs and Black (1947): Ceratichthys tenellus parviceps.
Keith (1964): Pimephales tenellus.
Buchanan (1973): Pimephales tenellus.

The slim minnow is rare in Washington County, having been found only in the White River drainage. In his account on this species, Pflieger (1971) stated that the subspecies found in the White River (P. t. parviceps) inhabits clear streams with high gradient and is rare in its area of occurrence. He stated this subspecies may now be absent

from the upper White River, since most localities from which it has been recorded are covered by Bull Shoals and Table Rock Reservoirs. Beaver Reservoir has undoubtedly further restricted this species in the upper White River, including parts of Washington County. Although it has become restricted, it is likely that the slim minnow still occurs upstream from Beaver Reservoir in small numbers. Another subspecies, P. t. tenellus has been collected in the Illinois River and Barren Fork in eastern Oklahoma (Hubbs and Black 1947, Moore and Padden 1950), so it is possible that this subspecies is present in these streams in Washington County.

Campostoma anomalum (Rafinesque) (Map 26).

Meek (1893): Campostoma anomalum.
Meek (1894): Campostoma anomalum.
Black (1940): Campostoma anomalum pullum.
Keith (1964): Campostoma anomalum.
Buchanan (1973): Campostoma anomalum.
Dewey (1973): Campostoma anomalum.
Olmsted and Cloutman (1974): Campostoma anomalum.
Kittle (1974): Campostoma anomalum.
UAM: Campostoma anomalum.

The central stoneroller, Campostoma anomalum pullum, may be found in almost every stream in Washington County and can be regarded as common to abundant. Although this species prefers riffles or flowing water with gravel substrate, it can be found in a variety of habitats.

Campostoma oligolepis Hubbs and Greene (Map 27).

Black (1940): Campostoma anomalum oligolepis.
Buchanan (1973): Campostoma oligolepis.
UAM: Campostoma anomalum.
SCRI: Campostoma oligolepis.

The largescale stoneroller was first reported from the Driftless Area of Wisconsin by Hubbs and Greene (1935) as Campostoma anomalum

oligolepis, and was subsequently found to occur also in the White River drainage in Arkansas (Black 1940). Pflieger (1971) reported the occurrence of the oligolepis form from the White River drainage in Missouri and presented evidence that oligolepis is distinct from anomalum and should be regarded as a separate species. Therefore, two species of Campostoma (C. oligolepis and C. anomalum pullum) are now considered to occur sympatrically in the White River. Thus, many previous records of C. anomalum reported from the White River drainage in Washington County (Meek 1893, 1894; Keith 1964) undoubtedly represent both species. Our collections support the conclusion of Pflieger that there are two distinct species of Campostoma in the White River. Our scale counts revealed no evidence of intergradation between the two forms. The largescale stoneroller is common in Washington County, and is most frequently encountered in swift riffles. C. oligolepis avoids headwater areas where C. anomalum may be common, but may outnumber the latter downstream. The two species are often collected together.

Chrosomus erythrogaster (Rafinesque) (Map 28).

Black (1940): Chrosomus erythrogaster.
Keith (1964): Chrosomus erythrogaster.
Buchanan (1973): Phoxinus erythrogaster.
UAM: Chrosomus erythrogaster.

The southern redbelly dace is locally abundant in small spring runs in the Illinois River drainage, but is rare in the White River. This species typically inhabits clear backwater areas with watercress or organic debris. C. erythrogaster is frequently associated with Semotilus atromaculatus, Nocomis asper, and Notropis pilsbryi in Washington County.

Dionda nubila (Forbes) (Map 29).

Meek (1893): Hybognathus nubila.
Meek (1894): Hybognathus nubila.

Black (1940): Dionda nubila.
Keith (1964): Dionda nubila.
Swift (1970): Notropis nubila.
Buchanan (1973): Dionda nubila.
Dewey (1973): Dionda nubila.
Olmsted and Cloutman (1974): Dionda nubila.
Kittle (1974): Dionda nubila.

The Ozark minnow is generally common to abundant in Washington County, preferring clear, high gradient streams with gravel or rubble bottoms. D. nubila was uncommon at the beginning of this study in 1970 but increased in abundance to become one of the most abundant fishes in Washington County in 1973. Ozark minnows were often collected with Notropis pilsbryi in pools just above and below riffles. In late May and early June, 1972, Ozark minnows were seen breeding over Nocomis asper nests below riffles in Clear Creek. Swift (1970) contended that the Ozark minnow has more affinity to the subgenus Hydrophlox of Notropis than to Dionda found in the southwestern United States and Mexico. Although Swift's concept may be correct, we will retain the Ozark minnow in the genus Dionda until a more definite study of the group shows that a change is warranted.

Notropis atherinoides Rafinesque (Map 30).

Black (1940): Notropis atherinoides dilectus.
Buchanan (1973): Notropis atherinoides.

A single record (Black 1940) of the emerald shiner has been reported from Washington County. N. atherinoides prefers large river habitats and its avoidance of headwater areas restricts it from the county. This single record probably represents a stray individual from the lower stretches of the Illinois River where N. atherinoides is common (Moore and Padden 1950).

Notropis boops Gilbert (Map 31).

Meek (1893): Notropis boops, Notropis heterodon.
Meek (1894): Notropis shumardi.
Black (1940): Notropis boops.
Keith (1964): Notropis boops.
Buchanan (1973): Notropis boops.
Dewey (1973): Notropis boops.
Olmsted and Cloutman (1974): Notropis boops.
Kittle (1974): Notropis boops.
UAM: Notropis boops.

The bigeye shiner is one of the most widely distributed and abundant fishes in Washington County. It is most abundant in pools of clear, moderate-sized streams with high gradient and gravel or rubble substrate. In 1973, the population of N. boops declined drastically in both the White and Illinois River drainages. This decline coincided with a tremendous increase in Dionda nubila. Since little is known about the biology of either of these species, the factors influencing their abundance are unknown.

Notropis camurus (Jordan and Meek) (Map 32).

Black (1940): Notropis camurus.
Gibbs (1961): Notropis camurus.
Buchanan (1973): Notropis camurus.
UAM: Notropis camurus.

The bluntface shiner has been collected from Washington County on two separate occasions, both from the Illinois River. Since no recent records of this species exist from Washington County, it is possible that it no longer occurs in the county. However, it may still be present but rare. N. camurus prefers small and medium-sized streams with moderately fast, clear water with rocky substrate (Cross 1967, Pflieger 1971).

Notropis chrysocephalus (Rafinesque) (Map 33).

Meek (1893): Notropis megalops.
Meek (1894): Notropis cornutus.
Black (1940): Notropis cornutus chrysocephalus.
Gilbert (1964): Notropis chrysocephalus.

Keith (1964): Notropis chrysocephalus.
Buchanan (1973): Notropis chrysocephalus.
Dewey (1973): Notropis chrysocephalus.
Olmsted and Cloutman (1974): Notropis chrysocephalus.
Kittle (1974): Notropis chrysocephalus.
UAM: Notropis chrysocephalus.

The striped shiner is a common inhabitant of the Illinois and White River drainages in Washington County where it is found most often in pools or backwater areas. This species attains the largest size of any of the Notropis found in the county.

Notropis galacturus (Cope) (Map 34).

Meek (1893): Notropis galacturus.
Meek (1894): Notropis galacturus.
Black (1940): Notropis galacturus.
Gibbs (1961): Notropis galacturus.
Keith (1964): Notropis galacturus.
Buchanan (1973): Notropis galacturus.
UAM: Notropis galacturus.

The white-tail shiner is limited to the White River drainage in Washington County. It inhabits swift sections of clear, high gradient streams with permanent strong flow and gravel or rubble bottoms. It appears to avoid small headwater streams. Most of its areas of occurrence in Washington County have been inundated by Beaver Reservoir, and it has not been collected in the county since Keith's (1964) preimpoundment survey.

Notropis greenei Hubbs and Ortenburger (Map 35).

Black (1940): Notropis greenei.
Keith (1964): Notropis greenei.
Buchanan (1973): Notropis greenei.

The wedgespot shiner prefers clear, high gradient streams with permanent strong flow and gravel or rubble bottoms. It is often associated with emergent vegetation growing in or near riffles. N. greenei

is of limited distribution in Washington County because of its avoidance of headwater areas. The only locality where it was collected in the White River in Washington County has been inundated by Beaver Reservoir. All recent collections of this species in Washington County have been in tributaries of the Arkansas River near the southern border of the county. N. greenei is often taken with N. boops.

Notropis lutrensis (Baird and Girard) (Map 36).

UAM: Notropis lutrensis.

The red shiner is represented from Washington County by a single specimen from Osage Creek. N. lutrensis can survive in a wide variety of habitats, but is generally rare in clear, gravel bottomed, high gradient streams. It is most numerous in turbid prairie streams where few other kinds of fishes occur (Cross 1967). Competition from other species may be an important factor in limiting its distribution (Pflieger 1971).

Notropis ozarcanus Meek (Map 37).

Keith (1964): Notropis ozarcanus.
Buchanan (1973): Notropis ozarcanus.

Ozark shiners have not been collected in Washington County since Keith's (1964) preimpoundment survey of Beaver Reservoir, although they are probably still present in the lotic portion of War Eagle Creek where suitable habitat still exists. N. ozarcanus probably never was widespread or common in Washington County, and inundation by Beaver Reservoir appears to have further restricted its distribution. The Ozark shiner is endemic to the White River system, preferring large, clear streams having high gradients and strong flow (Pflieger 1971).

Notropis pilsbryi Fowler (Map 38).

Meek (1893): Notropis zonatus.
Meek (1894): Notropis zonatus.
Black (1940): Notropis zonatus pilsbryi.
Hubbs and Moore (1940): Notropis zonatus pilsbryi.
Gilbert (1964): Notropis pilsbryi.
Keith (1964): Notropis pilsbryi.
Buchanan (1973): Notropis pilsbryi.
Olmsted and Cloutman (1974): Notropis pilsbryi.
Kittle (1974): Notropis pilsbryi.
UAM: Notropis pilsbryi.

The duskystripe shiner is widely distributed in Washington County and is often the predominant shiner, especially in upland creeks. N. pilsbryi is most numerous in pools just above or below riffles in clear waters with rocky substrate. It is often associated with Dionda nubila. In 1973, the duskystripe shiner experienced a drastic decline in abundance compared to the first years of this study. Reasons for this decline are unknown.

Notropis rubellus (Agassiz) (Map 39).

Meek (1893): Notropis rubrifrons.
Meek (1894): Notropis dilectus.
Black (1940): Notropis rubricorpus rubricorpus, Illinois River; Notropis rubricorpus retrovelis, White River.
Keith (1964): Notropis rubellus.
Buchanan (1973): Notropis rubellus.
Kittle (1974): Notropis rubellus.
UAM: Notropis rubellus.

The rosyface shiner prefers medium sized streams with moderate to swift current. It is most abundant in rocky pools just above or below riffles. In Washington County, N. rebellus is most common in the Illinois River drainage. In the White River, N. rubellus is relatively uncommon, and has not been collected from the West Fork.

Notropis telescopus (Cope) (Map 40).

Meek (1893): Notropis telescopus arcansanus.
Meek (1894): Notropis telescopus arcansanus.
Black (1940): Notropis ariommus arcansanus.
Keith (1964): Notropis ariommus.
Gilbert (1969): Notropis telescopus.
Buchanan (1973): Notropis telescopus.
UAM: Notropis ariommus.

In Washington County, the telescope shiner is found only in the White River system where it is sporadic in occurrence but locally common. It is most common in clear, high gradient streams with moderately swift current over gravel or rubble bottom.

Notropis umbratilis (Girard) (Map 41).

Buchanan (1973): Notropis umbratilis.
Dewey (1973): Notropis umbratilis.
Kittle (1974): Notropis umbratilis.
Snelson and Pflieger (1975): Notropis umbratilis umbratilis.
UAM: Notropis umbratilis.

In Washington County, the redfin shiner is found only in the Illinois River drainage where it is locally abundant. It seems to be more tolerant of turbidity and warmer temperatures than most other shiners in the county and is most often found in sluggish pools. N. umbratilis is most common in moderate sized streams and is rarely collected in small headwater streams. It is noteworthy that earlier investigators did not report this species. It is possible that the redfin shiner has increased in abundance in the county because of increased siltation and turbidity caused by man. N. u. umbratilis is the subspecies found in Washington County (Snelson and Pflieger 1975).

Notropis whipplei (Girard) (Map 42).

Meek (1893): Notropis whipplei.
Meek (1894): Notropis whipplei.

Black (1940): Notropis whipplii.
Gibbs (1963): Notropis whipplei.
Keith (1964): Notropis whipplei.
Buchanan (1973): Notropis whipplei.
UAM: Notropis whipplei.
SCRI: Notropis whipplei.

The steelcolor shiner is widespread and often common to abundant in the White River in Washington County. N. whipplei avoids headwater areas but can be found in a wide variety of habitats. It seems to prefer swift riffles in clear, moderate sized streams with rocky substrate. It is one of the few Notropis which has been able to sustain a population in Beaver Reservoir. N. whipplei is also present in tributaries draining southward into the Arkansas River, but is absent from the Illinois River.

Carpiodes cyprinus (Lesueur) (Map 43).

Black (1940): Carpiodes carpio carpio.
Keith (1964): Carpiodes cyprinus.
Buchanan (1973): Carpiodes cyprinus.
SCRI: Carpiodes cyprinus.

In Washington County, the quillback carpsucker has been found only in the White River. Keith (1964) reported it as rare but it has probably increased in abundance in the impounded area of the White River. This species is now collected all over Beaver Reservoir by SCRI (Al Houser, pers. comm.). A record of Carpiodes carpio by Black (1940) at Oxford Bend was probably C. cyprinus (see species of doubtful occurrence).

Carpiodes velifer (Rafinesque) (Map 44).

Meek (1893): Ictiobus velifer.
Keith (1964): Carpiodes velifer.
Buchanan (1973): Carpiodes velifer.
SCRI: Carpiodes velifer.

All specimens of the high-fin carpsucker from Washington County are from the White River. Keith (1964) reported this species as common

in War Eagle Creek but rare elsewhere in the county. Al Houser (pers. comm.) has informed us that C. velifer is now taken all over Beaver Reservoir by SCRI.

Ictiobus bubalus (Rafinesque) (Map 45).

Kittle (1974): Ictiobus bubalus.
SCRI: Ictiobus bubalus.

The smallmouth buffalo is a rare resident of the Illinois River in Washington County (Kittle 1974). It has also been taken in the Pine Creek area of Beaver Reservoir by SCRI. I. bubalus is more preferential toward small and larger rivers than creeks.

Ictiobus cyprinellus (Valenciennes) (Map 46).

SCRI: Ictiobus cyprinellus.

The bigmouth buffalo has recently been collected by SCRI from the Pine Creek area of Beaver Reservoir. This species was probably rare in the White River before impoundment of Beaver Reservoir and has apparently increased slightly in abundance after impoundment. The bigmouth buffalo prefers large river habitat.

Catostomus commersoni (Lacepede) (Map 47).

Meek (1893): Catostomus teres.
Meek (1894): Catostomus teres.
Black (1940): Catostomus commersonnii commersonnii.
Buchanan (1973): Catostomus commersoni.
Olmsted and Cloutman (1974): Catostomus commersoni.
UAM: Catostomus commersoni.

The white sucker has been collected sporadically in Washington County. It appears to be uncommon in the Illinois River and rare in the White River drainage. C. commersoni is typically found in pool habitats of large creeks and small rivers.

Hypentelium nigricans (Lesueur) (Map 48).

Meek (1893): Catostomus nigricans.
Meek (1894): Catostomus nigricans.
Black (1940): Hypentelium nigricans.
Keith (1964): Hypentelium nigricans.
Buchanan (1973): Hypentelium nigricans.
Olmsted and Cloutman (1974): Hypentelium nigricans.
Kittle (1974): Hypentelium nigricans.
UAM: Hypentelium nigricans.

The northern hogsucker is widely distributed and common in Washington County. This species prefers clear, high gradient streams with moderate to swift flow over gravel substrate. It is frequently found in deep riffles.

Moxostoma carinatum (Cope) (Map 49).

Meek (1893): Placophyarynx carinatus.
Keith (1964): Moxostoma carinatum.
Buchanan (1973): Moxostoma carinatum.
Kittle (1974): Moxostoma carinatum.
SCRI: Moxostoma carinatum.

In Washington County, the river redhorse is uncommon in the Illinois and White River drainages. It prefers the main river channel and does not extend towards the headwaters as far as the other species of redhorse found in the county. It seems to be intolerant of turbidity, siltation, and intermittent flow, and has declined over much of its range in the last century (Pflieger 1971). It appears that Beaver Reservoir has been detrimental to M. carinatum in the White River. Al Houser (pers. comm.) stated that river redhorse were taken in early SCRI collections but none have been taken in Beaver Reservoir in the last four years.

Moxostoma duquesnei (Lesueur) (Map 50).

Meek (1893): Moxostoma duquesnei.
Meek (1894): Moxostoma duquesnei.

Black (1940): Moxostoma duquesnii duquesnii.
Keith (1964): Moxostoma duquesnei.
Buchanan (1973): Moxostoma duquesnei.
Olmsted and Cloutman (1974): Moxostoma duquesnei.
Kittle (1974): Moxostoma duquesnei.
UAM: Moxostoma duquesnei.
SCRI: Moxostoma duquesnei.

The black redhorse is found throughout Washington County and appears to be the most common redhorse in clear upland tributaries with high gradient and rocky bottoms. Some of Meek's (1893, 1894) records of M. duquesnei possibly include M. erythrurum because he did not distinguish between these two species (Black 1940).

Moxostoma erythrurum (Rafinesque) (Map 51).

Black (1940): Moxostoma erythrurum.
Keith (1964): Moxostoma erythrurum.
Buchanan (1973): Moxostoma erythrurum.
Dewey (1973): Moxostoma erythrurum.
Olmsted and Cloutman (1974): Moxostoma erythrurum.
Kittle (1974): Moxostoma erythrurum.
UAM: Moxostoma erythrurum.
SCRI: Moxostoma erythrurum.

The golden redhorse appears to be present throughout the county. Adults are more common in the main channel of moderate size streams but immature individuals are often collected in upland tributaries. M. erythrurum prefers larger and warmer pools than M. duquesnei and is more tolerant of turbidity. The golden redhorse is better adapted for impoundment conditions than other species of redhorse in the county. M. erythrurum, like other catostomids, is probably more common than our data indicate because they were poorly sampled due to their large size, habitat preference, and swimming ability.

Moxostoma macrolepidotum (Lesueur) (Map 52).

Kittle (1974): Moxostoma macrolepidotum.

The northern redhorse is a rare inhabitant of the Illinois River in Washington County. This species prefers moderately large rivers (Pflieger 1970), a factor which restricts its abundance in the county. The Ozarkian subspecies, M. macrolepidotum pisolabrum, is the form referred to herein (Trautman and Martin 1951). M. macrolepidotum has been collected from the White River drainage downstream from Washington County (Buchanan 1973) so it may also be present in that drainage in Washington County.

Minytrema melanops (Rafinesque) (Map 53).

Buchanan (1973): Minytrema melanops.
Olmsted and Cloutman (1974): Minytrema melanops.
Kittle (1974): Minytrema melanops.
UAM: Minytrema melanops.

The spotted sucker is an uncommon resident of Washington County. It has been collected sporadically in the Illinois River drainage, and we have taken only one specimen from the White River drainage in the county. This species appears to prefer clear pools with hard substrate.

Erimyzon oblongus (Mitchill) (Map 54).

Black (1940): Erimyzon oblongus claviformis.
Buchanan (1973): Erimyzon oblongus.

The creek chubsucker has been found in Washington County only in upland creeks draining southward into the Arkansas River. It has been collected from the upper East Fork of the White River in Madison County (Keith 1964), so it is possible that it may be found in the East Fork in Washington County.

Ictalurus furcatus (Lesueur) (Map 55).

Meek (1893): Ameiurus nigricans.
Meek (1894): Ameiurus nigricans.
SCRI: Ictalurus furcatus.

The blue catfish is a rare inhabitant of the White River, but is common in Beaver Reservoir in Washington County. This species typically lives in large rivers. Although it is the largest species of fish in the county, I. furcatus is not of great economic importance to sport or commercial fishermen because of its lack of abundance.

Ictalurus melas (Rafinesque) (Map 56).

Meek (1893): Ameiurus melas.
Meek (1894): Ameiurus melas.
Black (1940): Ameiurus melas catulus.
Keith (1964): Ictalurus melas.
Buchanan (1973): Ictalurus melas.
Dewey (1973): Ictalurus melas.
Olmsted and Cloutman (1974): Ictalurus melas.

The black bullhead is widely distributed but uncommon in Washington County. This species dwells in reservoirs and stream pools. Although it has broad environmental tolerances, I. melas is most common in quiet, turbid waters with muddy bottoms. According to Black (1940), Meek was known to have confused the species of bullheads. It is quite possible that some of his records of I. melas also included I. natalis.

Ictalurus natalis (Lesueur) (Map 57).

Black (1940): Ameiurus natalis natalis.
Keith (1964): Ictalurus natalis.
Buchanan (1973): Ictalurus natalis.
Olmsted and Cloutman (1974): Ictalurus natalis.
Kittle (1974): Ictalurus natalis.

The yellow bullhead, like the black bullhead, is widely distributed but uncommon in Washington County. It is often found among aquatic vegetation in pools of clear streams with rocky substrate. This species is not as tolerant of turbidity as the black bullhead.

Ictalurus punctatus (Rafinesque) (Map 58).

Meek (1893): Ictalurus punctatus.
Meek (1894): Ictalurus punctatus.

Black (1940): Ictalurus lacustris punctatus.
Keith (1964): Ictalurus punctatus.
Buchanan (1973): Ictalurus punctatus.
Kittle (1974): Ictalurus punctatus.

The channel catfish is a common resident of reservoirs and low gradient streams in Washington County, but appears to avoid creeks with high gradients. It is commonly caught on trot lines by fishermen in the area, and many regard it as an excellent food fish. Construction of impoundments in recent years has probably increased the abundance of this species in Washington County.

Noturus albater Taylor (Map 59).

Meek (1893): Noturus nocturnus.
Meek (1894): Noturus miurus.
Black (1940): Schilbeodes miurus, Schilbeodes nocturnus, Schilbeodes albater.
Keith (1964): Noturus sp.-Ozark madtom.
Taylor (1969): Noturus albater.
Suttkus (1970): Noturus albater.
Buchanan (1973): Noturus albater.

In Washington County the Ozark madtom is found in moderate to swift riffles of the White River drainage. This species avoids headwater areas but becomes progressively more abundant downstream. It has been eliminated from its area of greatest abundance in the county by Beaver Reservoir.

Noturus exilis Nelson (Map 60).

Meek (1893): Noturus flavus.
Meek (1894): Noturus exilis.
Black (1940): Schilbeodes exilis.
Keith (1964): Noturus exilis.
Taylor (1969): Noturus exilis.
Buchanan (1973): Noturus exilis.
Olmsted and Cloutman (1974): Noturus exilis.
Kittle (1974): Noturus exilis.
UAM: Noturus exilis.

The slender madtom is a common inhabitant of clear, shallow, gravel riffles throughout the county. It is most common in upland creeks with high gradient, becoming less abundant downstream. Although several species of madtoms occur in the Illinois River in Oklahoma (Moore and Padden 1950), N. exilis is the only madtom found in that drainage in Washington County. In the White River, N. exilis is more abundant than N. albater in upland habitats, but the relative abundance of these two species is reversed in downstream areas. This species is nocturnal in its activity pattern and is more susceptable to capture at that time.

Noturus flavater Taylor (Map 61).

Meek (1894): Noturus eleutherus.
Black (1940): Schilbeodes eleutherus.
Keith (1964): Noturus sp.-checkered madtom.
Taylor (1969): Noturus flavater.
Buchanan (1973): Noturus flavater.

Few records of the checkered madtom exist from Washington County. It is most often found in moderately large clear streams. Unlike N. exilis and N. albater, N. flavater prefers quiet pools or backwater areas covered with leaves, sticks, or other organic debris. This species is restricted to the White River system.

Pylodictis olivaris (Rafinesque) (Map 62).

Meek (1893): Leptops olivaris.
Meek (1894): Leptops olivaris.
Black (1940): Pilodictis olivaris.
Keith (1964): Pylodictis olivaris.
Buchanan (1973): Pylodictis olivaris.
Kittle (1974): Pylodictis olivaris.
SCRI: Pylodictis olivaris.

Flathead catfish are most common in reservoirs in Washington County, but are also present in deep pools of large, low gradient streams. Like channel catfish, this species is frequently caught by fishermen using trot lines.

Fundulus catenatus (Storer) (Map 63).

Meek (1893): Fundulus catenatus.
Meek (1894): Fundulus catenatus.
Black (1940): Fundulus catenatus.
Hall (1956): Fundulus catenatus.
Keith (1964): Fundulus catenatus.
Buchanan (1973): Fundulus catenatus.
Olmsted and Cloutman (1974): Fundulus catenatus.
UAM: Fundulus catenatus.

The northern studfish is common in the White River and uncommon in the Illinois River drainages of Washington County. This species was not reported from the Illinois River system until 1951 when G. A. Moore and C. E. Hoffman collected a specimen in Clear Creek five miles north of Fayetteville (Hall 1956). F. catenatus is found in pools of streams having moderate or high gradients, clear water, and bottoms composed of silt-free gravel or rubble.

Fundulus olivaceus (Storer) (Map 64).

Meek (1893): Zygonectes notatus.
Meek (1894): Zygonectes notatus.
Black (1940): Fundulus notatus olivaceus.
Keith (1964): Fundulus olivaceus.
Buchanan (1973): Fundulus olivaceus.
Dewey (1973): Fundulus olivaceus.
Olmsted and Cloutman (1974): Fundulus olivaceus.
Kittle (1974): Fundulus olivaceous.
UAM: Fundulus olivaceus.
SCRI: Fundulus olivaceus.

The blackspotted topminnow is more abundant and widely distributed in Washington County than the northern studfish. This species typically inhabits pools over a wide range of substrates. Although this species was usually common or abundant in summer collections, it was often rare or absent in winter samples from the same areas. F. olivaceus is capable of maintaining populations in many of the impoundments in the area.

Gambusia affinis (Baird and Girard) (Map 65).

Keith (1964): Gambusia affinis.
Buchanan (1973): Gambusia affinis.
Dewey (1973): Gambusia affinis.
Olmsted and Cloutman (1974): Gambusia affinis.
Kittle (1974): Gambusia affinis.
UAM: Gambusia affinis.
SCRI: Gambusia affinis.

The mosquitofish is common in the Illinois River drainage but has been collected only in and around Lake Sequoyah and Beaver Reservoir in the White River in Washington County. This fish prefers warm pools or backwater areas with aquatic vegetation. Lack of early records of this species from Washington County indicates that it has increased in abundance in recent years, possibly as a result of increased siltation and warming of streams due to clearing of trees along the banks and because of impoundments.

Amblyopsis rosae (Eigenmann) (Map 66).

Buchanan (1973): Amblyopsis rosae.

The Ozark cavefish is endemic to the Ozark region and is considered rare in both Missouri and Arkansas (Miller 1972). Only one record of this species is known from Washington County (Doyne Martin, pers. comm.). Mr. Martin expressed concern about the present status of A. rosae and feared that groundwater pollution and indiscreet collecting might extirpate this already rare species.

Labidesthes sicculus (Cope) (Map 67).

Meek (1893): Labidesthes sicculus.
Meek (1894): Labidesthes sicculus.
Black (1940): Labidesthes sicculus sicculus.
Keith (1964): Labidesthes sicculus.
Buchanan (1973): Labidesthes sicculus.
Dewey (1973): Labidesthes sicculus.
Olmsted and Cloutman (1974): Labidesthes sicculus.

Kittle (1974): Labidesthes sicculus.
UAM: Labidesthes sicculus.
SCRI: Labidesthes sicculus.

The brook silverside is a common inhabitant of pools in streams throughout Washington County, and adapts well to reservoirs in the area. L. sicculus are easily collected with a seine due to their tendency to school near the surface. Seasonal cycles in abundance of this species were noted, being most abundant during summer and least abundant during winter.

Morone chrysops (Rafinesque) (Map 68).

Keith (1964): Roccus chrysops.
Buchanan (1973): Morone chrysops.
SCRI: Morone chrysops.

In Washington County white bass have been reported only from the White River system. They were rare in the White River during Keith's (1964) preimpoundment survey of Beaver Reservoir. This species has increased in abundance since the impoundment of Beaver Reservoir and the subsequent introduction of threadfin shad. White bass are strongly potamodromic during spring spawning and at this time offer an important fishery in streams above Beaver Reservoir.

Morone saxatilis (Walbaum) (Map 69).

SCRI: Morone saxatilis.

Beaver Reservoir is the only location in Washington County where striped bass have been introduced. This species is frequently taken by anglers in Beaver Reservoir and the White River. Striped bass perform spawning runs into the White River but it is not believed that a self-sustaining population has been established and the future occurrence of

this species in Washington County is dependent on continued stocking. Striped bass are typically limnetic and are top predators in the food web in Beaver Reservoir.

Ambloplites rupestris (Rafinesque) (Map 70).

Meek (1893): Ambloplites rupestris.
Black (1940): Ambloplites rupestris.
Keith (1964): Ambloplites rupestris.
Buchanan (1973): Ambloplites rupestris.
Olmsted and Cloutman (1974): Ambloplites rupestris.
Kittle (1974): Ambloplites rupestris.
UAM: Ambloplites rupestris.

The rock bass is a common inhabitant of flowing pools in clear streams with rocky or rubble substrate, but is only a minor element in the fauna of Ozark reservoirs. The rock bass is one species of game fish that is adversely affected by impoundment and turbidity. Future expansion of agricultural, industrial, and municipal activities will likely decrease its abundance and distribution.

Pomoxis annularis Rafinesque (Map 71).

Keith (1964): Pomoxis annularis.
Buchanan (1973): Pomoxis annularis.
Olmsted and Cloutman (1974): Pomoxis annularis.
Kittle (1974): Pomoxis annularis.
SCRI: Pomoxis annularis.

White crappie are rare inhabitants of Washington County streams, but are an important game species in the fishery of reservoirs. Crappie fishing is particularly successful during the spring when mature individuals congregate in shallow brushy areas to spawn, but during the rest of the year they are typically limnetic.

Pomoxis nigromaculatus (Lesueur) (Map 72).

Keith (1964): Pomoxis nigromaculatus.
Buchanan (1973): Pomoxis nigromaculatus.
SCRI: Pomoxis nigromaculatus.

The distribution and abundance of black crappie in Washington County is very similar to that of white crappie. This species is less tolerant of turbidity than white crappie and thus some subtle differences in distribution can be noted. According to Black (1940), black crappie were repeatedly but unsuccessfully introduced into the White River in northwestern Arkansas prior to 1940. However, construction of Beaver Reservoir has provided suitable habitat where this species is now an important sport fish.

Micropterus dolomieui Lacepede (Map 73).

Meek (1893): Micropterus dolomieu.
Meek (1894): Micropterus dolomieu.
Black (1940): Micropterus dolomieu velox, Illinois River; Micropterus dolomieu dolomieu x velox, White River.
Keith (1964): Micropterus dolomieui.
Buchanan (1973): Micropterus dolomieui.
UAM: Micropterus dolomieui.

The smallmouth bass is widely distributed in Washington County, and locally common in clear, permanently flowing streams with high gradient. This species typically inhabits flowing pools, and during crepuscular periods it tends to move into the head or eddy of riffles to feed. M. dolomieui is the most important game fish for stream fishermen but is rarely caught in reservoirs.

Micropterus punctulatus (Rafinesque) (Map 74).

Black (1940): Micropterus punctulatus punctulatus.
Keith (1964): Micropterus punctulatus.
Buchanan (1973): Micropterus punctulatus.
Kittle (1974): Micropterus punctulatus.
UAM: Micropterus punctulatus.
SCRI: Micropterus punctulatus.

The spotted bass is widespread and locally common in Washington County, but generally does not extend as far into headwater regions as

smallmouth bass. It typically inhabits clear, flowing pools in streams with moderate gradient. It can withstand slightly more turbid and warmer waters than smallmouth bass, but is less tolerant of these conditions than largemouth bass. Although populations exist in reservoirs, spotted bass are much more successful in streams. Meek (1893, 1894) did not distinguish between M. punctulatus and M. salmoides, so some of Meek's records of M. salmoides were probably based on specimens of M. punctulatus.

Micropterus salmoides (Lacepede) (Map 75).

Meek (1893): Micropterus salmoides.
Meek (1894): Micropterus salmoides.
Black (1940): Huro salmoides.
Keith (1964): Micropterus salmoides.
Buchanan (1973): Micropterus salmoides.
Dewey (1973): Micropterus salmoides.
Olmsted and Cloutman (1974): Micropterus salmoides.
Kittle (1974): Micropterus salmoides.
UAM: Micropterus salmoides.
SCRI: Micropterus salmoides.

The largemouth bass is abundant in reservoirs and common in deep, quiet pools of streams. This species has probably increased in abundance in Washington County because of its adaptability to reservoirs. It is not nearly as abundant as spotted or smallmouth bass in the smaller, high gradient streams in the county.

Lepomis cyanellus Rafinesque (Map 76).

Meek (1893): Lepomis cyanellus.
Meek (1894): Lepomis cyanellus.
Black (1940): Lepomis cyanellus.
Keith (1964): Lepomis cyanellus.
Buchanan (1973): Lepomis cyanellus.
Dewey (1973): Lepomis cyanellus.
Olmsted and Cloutman (1974): Lepomis cyanellus.
Kittle (1974): Lepomis cyanellus.
UAM: Lepomis cyanellus.
SCRI: Lepomis cyanellus.

The green sunfish can be found in a variety of aquatic habitats from headwater areas to large reservoirs. L. cyanellus is one of the most abundant sunfishes in the county and provides good angling for fishermen seeking panfish.

Lepomis gulosus (Cuvier) (Map 77).

Meek (1893): Chaenobryttus gulosus.
Black (1940): Chaenobryttus gulosus.
Keith (1964): Chaenobryttus gulosus.
Buchanan (1973): Lepomis gulosus.
SCRI: Lepomis gulosus.

The warmouth is a rare stream inhabitant in Washington County but is common in Lake Sequoyah and Beaver Reservoir. Its principal habitat is in still, shallow, often turbid water where bottoms are soft mud and where dense weed beds exist. The conditions accompanying impoundment and agriculture have probably caused an increase in the abundance of this species in the county. Because of its small size and poor fighting ability, L. gulosus is not an important sport fish in the area.

Lepomis humilis (Girard) (Map 78).

Meek (1893): Lepomis humilis.
Meek (1894): Lepomis humilis.
Black (1940): Lepomis humilis.
Buchanan (1973): Lepomis humilis.
UAM: Lepomis humilis.

In Washington County, the orangespotted sunfish has been found only in the Illinois River drainage where it appears to be rare. L. humilis is very tolerant of high turbidity and siltation and avoids streams with high gradient and clear water. Because of its rarity and small size, the orangespotted sunfish is not regarded as a sport fish.

Lepomis macrochirus Rafinesque (Map 79).

Meek (1894): Lepomis macrochirus.
Black (1940): Lepomis macrochirus macrochirus.
Keith (1964): Lepomis macrochirus.
Buchanan (1973): Lepomis macrochirus.
Dewey (1973): Lepomis macrochirus.
Olmsted and Cloutman (1974): Lepomis macrochirus.
Kittle (1974): Lepomis macrochirus.
UAM: Lepomis macrochirus.
SCRI: Lepomis macrochirus.

The bluegill is widespread in Washington County but attains its greatest abundance in reservoirs and large sluggish pools of streams. It generally avoids headwater areas. Meek's (1893, 1894) records suggest that bluegill were uncommon in the nineteenth century. Because of construction of impoundments, the bluegill has probably increased in abundance subsequent to settlement by man. L. macrochirus is prized as a panfish by local fishermen.

Lepomis megalotis (Rafinesque) (Map 80).

Meek (1893): Lepomis megalotis.
Meek (1894): Lepomis megalotis.
Black (1940): Lepomis megalotis breviceps.
Keith (1964): Lepomis megalotis.
Buchanan (1973): Lepomis megalotis.
Dewey (1973): Lepomis megalotis.
Olmsted and Cloutman (1974): Lepomis megalotis.
Kittle (1974): Lepomis megalotis.
UAM: Lepomis megalotis.
SCRI: Lepomis megalotis.

The longear is the most ubiquitous and often most abundant sunfish in Washington County. It prefers clear pools in streams having hard substrates. Although it is found in headwater creeks, large rivers, and reservoirs, L. megalotis is most abundant in medium-sized streams. In spite of its success in a wide variety of habitats, it does not thrive as well in turbid or organically enriched waters as some other sunfishes such as bluegill and green sunfish.

Lepomis microlophus (Gunther) (Map 81).

Buchanan (1973): Lepomis microlophus.
Dewey (1973): Lepomis microlophus.
Olmsted and Cloutman (1974): Lepomis microlophus.
UAM: Lepomis microlophus.
SCRI: Lepomis microlophus.

The redear is the largest sunfish inhabiting Washington County, and is prized as a panfish by local fishermen. The preferred habitat of this species is clear, quiet waters having abundant aquatic vegetation. Because of its habitat preference, L. microlophus is common in local reservoirs and ponds, but is rarely taken in streams. This species frequently hybridizes with other lepomids (particularly L. cyanellus) in Washington County streams, presumably because of its rarity and difficulty in locating a mate. Redear are frequently stocked in ponds as forage for largemouth bass, and are supposedly less likely than bluegill to stunt under such conditions.

Percina caprodes (Rafinesque) (Map 82).

Meek (1893): Etheostoma caprodes.
Meek (1894): Etheostoma caprodes.
Black (1940): Percina caprodes carbonaria.
Keith (1964): Percina caprodes.
Buchanan (1973): Percina caprodes.
Olmsted and Cloutman (1974): Percina caprodes.
Kittle (1974): Percina caprodes.
UAM: Percina caprodes.
SCRI: Percina caprodes.

The logperch is common in deep riffles and pools of clear permanent streams within the county. P. caprodes avoids high gradient and headwater habitats and is one of the few darters that can adapt to impoundments.

Percina copelandi (Jordan) (Map 83).

Black (1940): Cottogaster copelandi.
Buchanan (1973): Percina copelandi.

The channel darter is rare in Washington County. Its preferred habitat is the main channel of clear moderate-sized streams having permanent flow and rocky substrate. P. copelandi is common in lower stretches of several streams flowing south from Washington County into the Arkansas River but its avoidance of headwater conditions limits its abundance within the county.

Percina evides (Jordan and Copeland) (Map 84).

Keith (1964): Percina evides.
Buchanan (1973): Percina evides.
UAM: Percina evides.

The gilt darter has not been collected in Washington County since Keith's (1964) preimpoundment survey of Beaver Reservoir. Since most of the localities have been inundated where this species was collected, it is likely that it has been greatly reduced in the county. Before impoundment of Beaver Reservoir, the gilt darter was restricted in Washington County to the lower gradient section of the White River in fast, rock-gravel riffles (Keith 1964).

Percina nasuta (Bailey) (Map 85).

Keith (1964): Percina nasuta.
Buchanan (1973): Percina nasuta.

In Washington County, the longnose darter appears to be limited to the White River drainage where it is rarely collected. Inundation by Beaver Reservoir has reduced the range of this species in the county. The longnose darter avoids headwaters and is most often found in streams with moderate gradients. It prefers pools with gravel or rubble substrate and emergent vegetation just above riffles. P. nasuta is present in tributaries flowing south to the Arkansas River, but its avoidance of headwaters accounts for its absence from these streams in Washington County.

Etheostoma blennioides Rafinesque (Map 86).

Meek (1893): Etheostoma blennioides.
Meek (1894): Etheostoma blennioides.
Black (1940): Etheostoma blennioides newmanii.
Keith (1964): Etheostoma blennioides.
Miller (1968): Etheostoma blennioides newmanii.
Buchanan (1973): Etheostoma blennioides.
Kittle (1974): Etheostoma blennioides.
UAM: Etheostoma blennioides.

The greenside darter is common in moderate to deep swift riffles over gravel or rubble substrate of clear permanent streams. They avoid headwaters and appear intolerant of turbidity.

Etheostoma caeruleum Storer (Map 87).

Meek (1894): Etheostoma coeruleum spectabile.
Black (1940): Poecilichthys caeruleus.
Keith (1964): Etheostoma caeruleum.
Buchanan (1973): Etheostoma caeruleum.
UAM: Etheostoma caeruleum.

In Washington County the rainbow darter is restricted to the White River drainage. E. caeruleum avoids headwater regions but becomes the most abundant darter in moderate-sized stretches of the White River. The preferred habitat of the rainbow darter is moderate to swift riffles over gravel substrate, although juveniles and females are often found in flowing pools.

Etheostoma euzonum Hubbs and Black (Map 88).

Meek (1893): Etheostoma uranidea.
Black (1940: Imostoma uranidea, Poecilichthys euzonus euzonus.
Keith (1964): Etheostoma euzona.
Buchanan (1973): Etheostoma euzonum.

The Arkansas saddled darter is now rare in Washington County. Impoundment of Beaver Reservoir has severely diminished the preferred habitat for this species. Prior to impoundment of Beaver Reservoir, E. euzonum was present in swift riffles over gravel or rubble substrate in moderate to large-sized sections of the White River.

Etheostoma flabellare Rafinesque (Map 89).

Meek (1893): Etheostoma flabellare.
Meek (1894): Etheostoma flabellare.
Black (1940): Catonotus flabellaris lineolatus.
Buchanan (1973): Etheostoma flabellare.
Dewey (1973): Etheostoma flabellare.
Olmsted and Cloutman (1974): Etheostoma flabellare.
Kittle (1974): Etheostoma flabellare.
UAM: Etheostoma flabellare.

The fantail darter is common in the Illinois River drainage in Washington County. It achieves its greatest abundance in shallow riffles of small clear upland tributaries.

Etheostoma juliae Meek (Map 90).

Meek (1893): Etheostoma juliae.
Meek (1894): Etheostoma juliae.
Black (1940): Poecilichthys juliae.
Keith (1964): Etheostoma juliae.
Hill (1968): Etheostoma juliae.
Buchanan (1973): Etheostoma juliae.
UAM: Etheostoma juliae.

The yoke darter was the most abundant darter found in Keith's (1964) preimpoundment survey of Beaver Reservoir, but its distribution is now quite restricted in the county. Presently, E. juliae is commonly found only in the lower portions of the East Fork and War Eagle Creek in Washington County. The yoke darter resides in swift clear riffles over gravel or rubble bottoms.

Etheostoma microperca Jordan and Gilbert (Map 91).

Buchanan (1973): Etheostoma microperca.
UAM: Etheostoma microperca.

The least darter is rare in the Illinois River drainage in Washington County. It is typically found in clear, quiet pools of upland creeks having bottoms consisting of organic debris.

Etheostoma punctulatum (Agassiz) (Map 92).

Meek (1894): Etheostoma punctulatum.
Hubbs and Ortenburger (1929): Poecilichthys punctulatus.
Black (1940): Poecilichthys punctulatus.
Keith (1964): Etheostoma punctulatum.
Buchanan (1973): Etheostoma punctulatum.
Olmsted and Cloutman (1974): Etheostoma punctulatum.
Kittle (1974): Etheostoma punctulatum.
UAM: Etheostoma punctulatum.

Although widespread in Washington County, the stippled darter is seldom collected in large numbers. It is most common in spring runs or upland creeks with clear, cool water where it prefers pools or backwater areas with emergent vegetation or organic debris. E. punctulatum seems to be more common in the Illinois River drainage than in the White River drainage.

Etheostoma spectabile (Agassiz) (Map 93).

Meek (1893): Etheostoma coeruleum spectabile.
Meek (1894): Etheostoma coeruleum spectabile.
Black (1940): Poecilichthys spectabilis spectabilis x pulchellus, White River; Poecilichthys spectabilis pulchellus x squamagenus, Illinois River; Poecilichthys spectabilis pulchellus, Frog Bayou.
Keith (1964): Etheostoma spectabile.
Distler (1968): Etheostoma spectabile squamosum, Illinois River; Etheostoma spectabile pulchellum, Arkansas River tributaries; Etheostoma spectabile spectabile, White River.
Buchanan (1973): Etheostoma spectabile.
Dewey (1973): Etheostoma spectabile.
Olmsted and Cloutman (1974): Etheostoma spectabile.
Kittle (1974): Etheostoma spectabile.
UAM: Etheostoma spectabile.

The orangethroat darter is the most ubiquitious and abundant darter in Washington County. It occupies a wide variety of habitats, but is most abundant in clear shallow riffles and flowing pools over gravel substrate in upland tributaries. Three subspecies are present in the county (Distler 1968). E. s. squamosum is present in the Illinois River

drainage, E. s. pulchellum is found in the streams draining southward into the Arkansas River, and E. s. spectabile inhabits the White River drainage. E. s. spectabile is the most abundant darter in the headwaters of the White River but is replaced as the dominant darter downstream by the closely related E. caeruleum. E. spectabile is the only local Etheostoma that can tolerate reservoir conditions.

Etheostoma stigmaeum (Jordan) (Map 94).

Meek (1894): Etheostoma saxatile.
Black (1940): Doration oklahomae.
Keith (1964): Etheostoma stigmaeum.
Buchanan (1973): Etheostoma stigmaeum.

The speckled darter is common in the White River and rare in the Illinois River drainages of Washington County. They are most easily collected during spring when they move into riffle areas to spawn. During the remainder of the year this species most commonly inhabits pools near riffles.

Etheostoma whipplei (Girard) (Map 95).

Black (1940): Poecilichthys whipplii whipplii, Illinois River;
Poecilichthys whipplii montanus, Frog Bayou.
Hubbs and Black (1941): Poecilichthys whipplii whipplii, Illinois River;
Poecilichthys whipplii montanus, Frog Bayou.
Buchanan (1973): Etheostoma whipplei.
UAM: Etheostoma whipplei.

The redfin darter is rarely collected in the Illinois River, but is common in tributaries of the Arkansas River in the southern part of the county. Two subspecies are found within the county. E. w. montanus is endemic to the Clear Creek (Frog Bayou) drainage (Hubbs and Black 1941) while E. w. whipplei is distributed elsewhere within the county. Redfin darters are most common in gravel riffles of clear headwaters and upland creeks.

Etheostoma zonale (Cope) (Map 96).

Meek (1893): Etheostoma zonale.
Meek (1894): Etheostoma zonale.
Black (1940): Poecilichthys zonalis arcansanus.
Keith (1964): Etheostoma zonale.
Buchanan (1973): Etheostoma zonale.
Olmsted and Cloutman (1974): Etheostoma zonale.
Kittle (1974): Etheostoma zonale.
Tsai and Raney (1974): Etheostoma zonale zonale.
UAM: Etheostoma zonale.

The banded darter is common in moderate to deep swift riffles over gravel or rubble substrate in clear permanent streams. The preferred habitat is very similar to E. blennioides, and the two species are frequently collected together.

Stizostedion vitreum (Mitchill) (Map 97).

Keith (1964): Stizostedion vitreum.
Buchanan (1973): Stizostedion vitreum.
SCRI: Stizostedion vitreum.

In Washington County the walleye appears to be restricted to the White River drainage. It is most abundant in Beaver Reservoir except during its annual spawning runs into tributary streams. Although this prized game fish is occasionally taken by anglers in Beaver Reservoir, heaviest fishing pressure occurs during the spawning period in streams. Lake Wilson, located near Fayetteville, is a nursery for walleye which are periodically released into the West Fork.

Aplodinotus grunniens Rafinesque (Map 98).

Keith (1964): Aplodinotus grunniens.
Buchanan (1973): Aplodinotus grunniens.
SCRI: Aplodinotus grunniens.

Drum are rarely taken in Washington County, and they appear to be restricted to the White River drainage. The preferred habitat for this species is large rivers and impoundments.

Cottus carolinae (Gill) (Map 99).

Meek (1893): *Cottus richardsoni*.
Meek (1894): *Cottus bairdi*.
Black (1940): *Cottus williamsoni*.
Keith (1964): *Cottus carolinae*.
Buchanan (1973): *Cottus carolinae*.
Kittle (1974): *Cottus carolinae*.
UAM: *Cottus carolinae*.

The banded sculpin is an inhabitant of clear, moderate to swift riffles with gravel bottom in the Illinois and White River drainages in Washington County. During the present study, *C. carolinae* was much more common in the Illinois drainage than the White River. This species is absent from the streams draining southward to the Arkansas River.

FISHES OF POSSIBLE OCCURRENCE IN WASHINGTON COUNTY

Some fishes, although not yet collected in Washington County, have been reported from such close proximity to the county that future collections might reveal their presence.

Esox americanus vermiculatus Gmelin

The grass pickerel was reported by Keith (1964) from the East Fork of the White River in Madison County. It is not unlikely that this species occurs in the East Fork in Washington County.

Notropis spilopterus (Cope)

A record of the spotfin shiner from the Illinois River in Benton County was shown by Buchanan (1973). This species appears to be more common downstream in Oklahoma (Moore and Padden 1950), but tends to avoid the headwaters in Arkansas. Although preferential to larger streams it is likely that a few specimens will eventually be collected in Washington County.

Ictalurus catus (Linnaeus)

The white catfish, a native of Atlantic coast drainages, has been introduced into Crystal Lake in Benton County. Escapees from Crystal Lake may lead to establishment of this species in the Illinois River drainage. The possibility also exists that *I. catus* has been or will be stocked in some local farm ponds.

Percina phoxocephala (Nelson)

The slenderhead darter has been reported from the Illinois River in Oklahoma (Moore and Padden 1950) and Benton County, Arkansas (Kittle 1974). *P. phoxocephala* is preferential to small rivers with swift current over gravel or sand substrate. Its habitat preference limits its abundance in Washington County but some specimens would be expected to be found in the county.

Cottus bairdi Girard

Keith (1964) found the mottled sculpin in cold spring areas of Monte Ne Branch and Prairie Creek, tributaries of the White River in Benton County. These areas were inundated by Beaver Reservoir, and Keith predicted that *C. bairdi* would possibly be eliminated from the upper White River drainage in Arkansas. Although Beaver Reservoir has reduced the distribution of *C. bairdi*, it is still possible that it will be found in spring areas of the upper White River drainage, including Washington County.

SPECIES OF DUBIOUS OR DOUBTFUL OCCURRENCE IN WASHINGTON COUNTY

Several old records of some species from Washington County seem doubtful in light of present knowledge of distribution patterns of

fishes. These records may have been the result of misidentifications, erroneous locality data, or mixing of specimens from two or more localities.

Hybognathus nuchalis Agassiz

Meek (1893) reported the silvery minnow from Jordan's Creek at Dutch Mills and the Illinois River at Ladd's Mill. No other records of H. nuchalis exist for the Illinois River drainage (Moore and Padden 1950, Miller and Robison 1973). In view of known distribution and habitat preferences it is almost certain that Meek's records of this species are misidentifications.

Hybognathus placitus Girard

The only records of H. placitus from Washington County are those of Meek (1893). Concerning Meek's record of H. placitus in the White River, Black (1940) stated he thought it impossible for the specimen to be H. placitus and improbable that it was H. nuchalis. It is known that Meek was at times not completely cognizant of his exact whereabouts, and if he was indeed in Washington County at the time of the collection in question, this record most likely represents a misidentification. The Illinois River record is perhaps accurate, but in all probability, an error. Although H. placitus has been found in the Illinois River drainage in Oklahoma (Moore and Padden 1950), its preference for sandy plains streams limits it from typical Ozark streams. It is possible that wandering individuals may have strayed into Washington County in the past, but since the mainstream of the Illinois River has been impounded near the Arkansas border, it is unlikely that the plains minnow has occurred in Washington County in recent years.

Notropis heterodon (Cope)

Meek (1893) reported N. heterodon from the Illinois River at Prairie Grove and the Main Fork of the White River near Fayetteville. These records are probably misidentifications of N. boops (Black 1940). The blackchin shiner is a northern species, not found south of Iowa and Indiana (Moore 1968).

Notropis shumardi (Girard)

The silverband shiner was reported by Meek (1894) from the Illinois River at Prairie Grove and Ladd's Mill, Jordan Creek at Dutch Mills, and Clear Creek at Johnson. Black (1940) stated that Meek sometimes used the name N. shumardi for N. boops. N. shumardi typically inhabits large silty rivers and its presence in clear, high-gradient headwater areas seems doubtful. There are no records of N. shumardi from the Illinois River drainage in Oklahoma (Moore and Padden 1950, Miller and Robison 1973).

Carpiodes carpio carpio (Rafinesque)

Black (1940) listed Meek's (1893) record of Ictiobus velifer (Rafinesque) from Oxford Bend in the White River as Carpiodes carpio carpio. There are no other records of C. carpio from the upper half of the White River (Buchanan 1973, Pflieger 1971). Meek's record of I. velifer is most likely a representation of C. velifer or C. cyprinus, the two species of carpsuckers found in this area.

Noturus eleutherus Jordan

Meek (1894) reported N. eleutherus from the Main Fork of the White River near Fayetteville. According to Taylor (1969), this was a specimen of N. flavater.

Noturus flavus (Rafinesque)

Meek (1893) reported N. flavus from the Illinois River at Prairie Grove and at Jordan's Creek and Barren Fork at Dutch Mills. Taylor (1969) considered these records to be specimens of N. exilis.

Noturus miurus Jordan

N. miurus was listed by Meek (1894) from the Middle Fork, Main Fork, and Oxford Bend in the White River. Taylor (1969) stated that these records are specimens of N. albater.

Noturus nocturnus Jordan and Gilbert

Meek (1893) reported N. nocturnus from the Middle Fork of the White River near Fayetteville and White River at Oxford Bend. According to Taylor (1969) these records are specimens of N. albater.

Fundulus notatus (Rafinesque)

Meek (1893, 1894) reported F. notatus as Zygonectes notatus (Rafinesque) from the Illinois River at Prairie Grove and Ladd's Mill, and Main and Middle Forks of the White River at Fayetteville. Meek did not distinguish between F. notatus and its sibling species, F. olivaceus. All of Meek's records of F. notatus from Washington County are undoubtedly specimens of F. olivaceus. F. notatus has not been found in the upper White River or Illinois River in Arkansas.

Percina uranidea (Jordan and Gilbert)

Meek (1893) reported Etheostoma uranidea Jordan and Gilbert from the White River at Oxford Bend. Black (1940) reported Meek's record of this form as Imostoma uranidea (Jordan and Gilbert). In all probability,

this record is actually Etheostoma euzonum. Percina uranidea has been collected in the White River only in the lower portion in large streams (Buchanan 1973, Pflieger 1971).

Etheostoma proeliare (Hay)

Black (1940) reported this species as Microperca proeliaris Hay from the West Fork of the White River, but stated that it probably resulted from an accidental mixing of specimens. This form typically inhabits lowland streams, and other records are not known from the Ozark uplands (Buchanan 1973, Pflieger 1971).

DISTRIBUTION OF WASHINGTON COUNTY FISHES RELATED TO DRAINAGE SYSTEMS

Within the boundaries of Washington County are the headwaters of two major drainage systems (White and Illinois Rivers) and several minor tributaries of Lee Creek and Clear Creek (Frog Bayou) flowing south into the Arkansas River. Although these drainages have several species in common, each also has forms which the others do not have (Table 1). Qualitative differences in fish distribution among the different drainage systems is probably more of a reflection of past geologic events than habitat differences among the drainages.

Few streams of comparable size in the United States have a fish fauna as diverse as the White River. There are 81 species in this drainage in Washington County and many more are found further downstream. Many of the fishes found in the White River are widely distributed in the eastern United States, but the White River is noted mainly for its Ozarkian elements, including several White River endemics. The White River endemics in Washington County are Notropis ozarcanus, Noturus

albater, Noturus flavater, Etheostoma euzonum, and Etheostoma juliae. Notropis greenei, Notropis pilsbryi, and Etheostoma punctulatum are Ozark endemics found in the White River. These fishes without exception are clear water forms. Other species which are Ozark elements or have Ozarkian affinities but have populations elsewhere include Campostoma oligolepis, Dionda nubila, Hybopsis dissimilis, Hybopsis amblops, Nocomis biguttatus, Notropis boops, Notropis galacturus, Notropis telescopus, Chrosomus erythrogaster, Pimephales tenellus, Noturus exilis, Fundulus catenatus, Percina evides, Percina nasuta, Etheostoma blennioides, Etheostoma caeruleum, and Etheostoma zonale. Several of these species display northern relationships and were probably dispersed into the White River during Pleistocene glaciation (Black 1940).

Sixty-six species of fish have been found in the Illinois River drainage in Washington County. In addition to many fishes which are widely distributed in the eastern United States, the Illinois River has several species which have Ozarkian affinities, including Dionda nubila, Hybopsis amblops, Nocomis asper, Chrosomus erythrogaster, Notropis boops, Notropis camurus, Notropis pilsbryi, Noturus exilis, Fundulus catenatus, Etheostoma flabellare, Etheostoma punctulatum, and Etheostoma whipplei. Prairie elements including Notropis lutrensis and Lepomis humilis also exist but are rare in Washington County. Although several other prairie and lowland forms occur further downstream in Oklahoma (Moore and Padden 1950, Miller and Robison 1973), they are notably lacking in Washington County because of the headwater nature of the streams. Although several differences exist between the Illinois and White Rivers, these two systems resemble each other more than the Illinois resembles the Arkansas River system in Arkansas. The distributional patterns of Notropis

pilsbryi, Dionda nubila, and the sibling species Nocomis asper and Nocomis biguttata present a strong argument for a former connection between the Illinois and White Rivers. Evidence that such a connection did not persist long is the absence of several forms from either system. At one time, creeks feeding the Illinois River were among the clearest in the nation (Black 1940). The small creeks feeding the Illinois River have numerous spring runs where watercress is locally abundant.

Since the tributaries of Lee Creek and Clear Creek (Frog Bayou) which drain southward into the Arkansas River are mostly headwater areas, their fish fauna in Washington County is rather depauparate and consists mainly of species typically found in Upland Creeks. The most prominent species found in the Washington County portions of these streams are minnows and darters, primarily Campostoma anomalum, Pimephales notatus, Notropis boops, Etheostoma punctulatum, Etheostoma spectabile, and Etheostoma whipplei. Near the southern border of the county Notropis greenei and Notropis whipplei become common in some of the larger streams. These streams support a greater variety of fishes downstream in Crawford County (Buchanan 1973). Frog Bayou appears to be a minor center of endemism. The occurrence of Etheostoma whipplei montanus and a race of Campostoma anomalum pullum with elongation of the urosome and an increased number of lateral line scales was noted by Black (1940). A detailed study of this drainage and comparisons with similar adjacent streams such as Lee Creek and headwater tributaries of the Mulberry River are warranted but will be hampered by relatively poor access.

There are numerous underground streams in northwestern Arkansas. These drainages are often independent of surface streams and have

depauparate but unique, highly modified and adapted faunas. The only subterranean fish in Washington County is Amblyopsis rosae.

ECOLOGICAL ASSOCIATIONS

Washington County presents a wide diversity of aquatic habitats, although large rivers and natural lakes are notably absent. Each of the major habitat types offers a different set of environmental factors. Fishes occurring in these habitats have developed specific ecological associations with regard to these environmental factors and other fishes occurring in the habitat. Most instances of the association of different species of fishes are explained satisfactorily by similar environmental preferences rather than dependence of one species on another.

Species richness of stream fishes in Washington County generally tends to increase from headwaters to downstream areas. The main factors involved in this phenomenon appear to be stream gradient (Trautman 1942) and size (Shelford 1911, Thompson and Hunt 1930). The combination of gradient and size determine volume and rate of flow, pool-riffle ratios, and amount of silt deposition. In Washington County, stream gradient is highest in headwater areas and gradually decreases downstream (Keith 1964, Borengasser 1968). Because of their importance gradient and size are the primary criteria used to determine the different stream habitats in Washington County, although other factors may also be used to characterize the habitats.

There are seven major types of aquatic habitats in Washington County. Although the dividing line between some of these habitats is sometimes arbitrary, each habitat type has its characteristic ecological

associations. The general abundance of each species in an ecological association can generally be predicted within reasonable limits (Table 2).

Spring Runs. Most spring runs in Washington County are in the Illinois River drainage. They are characterized by small size; high gradient; clear, cool water; gravel or organic substrate; and abundant vegetation (mostly watercress). The forest canopy entirely covers many of the spring runs in Washington County. Most of the energy budget of spring runs is derived from allochthonous materials, e.g., leaves and sticks falling into the stream. Species richness is generally low to moderate in this type of habitat (Table 3). The ichthyofauna of this habitat type is usually dominated by certain species of minnows and darters (Table 2). Most of the catostomids and centrarchids which occupy these areas are juveniles.

Small Creeks. Small, high-gradient streams, usually with gravel substrate, which become intermittent during periods of low flow are classified as small creeks. The communities of small creeks are similar to those of spring runs but usually more diverse. These creeks are dominated by certain minnows and darters, Noturus exilis, Lepomis cyanellus, and Lepomis megalotis (Table 2).

Large Creeks. Large creeks are small high-gradient streams which usually maintain flow throughout the year although great fluctuations in discharge occur. Large creeks offer a greater variety of habitats than spring runs and small creeks, which results in greater species richness (Table 3).

Small Rivers. The difference between small rivers and large creeks is somewhat arbitrary. The small rivers in Washington County are larger

and have lower gradients than the large creeks, although great fluctuations in discharge still occur. In small rivers, pools are larger and deeper, and riffles are swifter than in large creeks. More siltation may occur in the pools of small rivers than large creeks. Two areas in Washington County may be classified as small rivers - the White River between Lake Sequoyah and Beaver Reservoir, and the Illinois River below the confluence of the Muddy Fork and main fork of the Illinois. Beaver Reservoir has eliminated most of the small river habitat from the White River in Washington County and has resulted in massive reduction of several lotic fishes from that drainage in the county. The greatest diversity of fishes is found in small rivers in Washington County (Table 3).

Reservoirs. Numerous reservoirs of varying sizes have been built in Washington County for water supplies, flood control, and hydroelectric power. Lake Sequoyah and Beaver Reservoir are the two major impoundments on the White River in Washington County. In the Illinois River system, several small reservoirs including Lake Fayetteville, Lake Weddington, Lake Prairie Grove, Lake Lincoln, and Lake Elmdale have been built. Construction of reservoirs has probably had more impact on aquatic environments in Washington County than any other activity of man. Because of reservoirs, species composition has changed markedly in the past few years. Numerous species of fish characteristic of clear, lotic waters have been depleted in the county and replaced by fishes which thrive in lentic waters. Fishes associated with reservoirs include largemouth bass, sunfish, crappie, catfish, and carp (Table 2). Reservoirs have provided for management of game species.

Farm Ponds. Over 4500 farm ponds totaling approximately 607 ha have been constructed in Washington County primarily for livestock water supplies (Joe L. Gaston, pers. comm.). Most of the ponds containing fish have been stocked. Fishes most frequently stocked in local farm ponds are largemouth bass, bluegill, redear, and catfish. Stunting often occurs in farm ponds because of overpopulation due to improper management.

Subterranean Streams. Several caves and their associated underground drainages occur in the Springfield Plateau area of Washington County. Although these streams are clear and have relatively constant environments, the aquatic communities are generally depauparate. Specialized adaptations for total darkness are necessary to live in cave habitats. Since no light is available for primary production, the entire community is heterotrophic and energy flow is dependent upon allochthonous materials. Only one truly troglobitic fish, Amblyopsis rosae, exists in Washington County, and it has been found at only one location. Groundwater pollution has posed a serious threat to the known cavefish population in Washington County. Since underground streams are often independent of surface drainages, movement and dispersal of cavefish can not be monitored easily. It is not known if refugia exist for the local cavefish population.

CHANGES IN ABUNDANCE OF WASHINGTON COUNTY FISHES RELATED TO ACTIVITIES OF MAN

There is evidence that the first people to inhabit northwestern Arkansas were Paleo-Indians which may have migrated into the area as early as 9500-9000 B.C. (Scholtz 1969). It is doubtful that these early

residents had any significant impact on fishes since they were small, nomadic bands which relied mainly on large mammals for sustenance. From 7000 B.C. to 1000 A.D., Indians of the Archaic stage inhabited northwestern Arkansas. This stage is marked by an apparent growth in population and increase in exploitation of natural resources. Pottery-making Indians possibly entered northwest Arkansas in the period approximately 500-1000 A.D. Animal remains apparently representing food show that they were hunting and collecting nearly all of the mammals, larger birds, fish, mussels and turtles that are present in this area today. Nearly 40 species have been identified from these remains (Cleland 1965). Although fishes were being utilized as food at that time, it is doubtful that these Indians had any significant influence on local fish populations.

Northwest Arkansas seems to have been largely abandoned by its Indian occupants by the time of white man's expansion into the area in the early 1800's, although Osage hunting parties are known to have been using the western Ozark area by federal treaties in 1808 and 1818 and continued to harass early white settlers and Cherokee immigrants in the Arkansas Ozarks. Removal of Cherokee Indians in the first half of the nineteenth century terminated Indian occupancy in the northern part of the state (Scholtz 1969).

The territory including Washington County was opened for settlement by white man in 1828. Population growth was slow but steady for many years (Vizzier 1969). It is doubtful that man had yet exerted a significant impact on the streams of Washington County prior to the turn of the twentieth century although forest clearing and farming were being

done. There are no references to any kind of pollution in Meek's (1891, 1893, 1894) writings. In fact, Meek (1894) stated that "the White River is one of the clearest and most beautiful streams in the Mississippi Basin", and that War Eagle Creek "is reported to be the best stream for fish in northwestern Arkansas". In addition, collections made downstream at Eureka Springs by Jordan and Gilbert (1886) reflected the high water quality of the White River at that time. Their collections included the hairlip sucker, Lagochila lacera Jordan and Brayton, a fish requiring very high water quality. This fish is probably now extinct.

From 1900 to 1930 the population of Washington County increased very little (Vizzier 1969). However, development of tractors and other farm implements created a boom in agriculture subsequent to 1920. During the 1930's, the number of farms rose. By 1940, the land in farms was more than 50% of the land in the county (Northwest Arkansas Regional Planning Commission 1972) (Table 4). In 1940, Black noted that fishing in northwest Arkansas had been less satisfactory in the last 15 or 20 years than before. Black related this phenomenon primarily to increased dessication and flooding resulting from the stripping of many of the small watersheds of their protective covering of trees and underbrush and from lumbering and agricultural activities.

After 1940, urbanization started to occur and a trend toward decrease in number of farms and farm area occurred. In spite of this decline in farms, organic pollution of streams started to increase due to larger numbers of livestock and poultry (Table 4). At present, most of the pollution in Washington County is derived from drainage of wastes from cattle and poultry into the streams. Sewage from treatment plants

from Fayetteville and Huntsville sometimes add a significant amount of organic pollution to the White River and War Eagle Creek, respectively. Although most streams in Washington County still run relatively clear and have gravel substrates, water quality has generally been reduced and local silting and increased turbidity have occurred. The abundance of Notemigonus crysoleucas, Notropis umbratilis, Gambusia affinis, and Lepomis macrochirus in the present survey, and the absence or rarity of these forms in studies by Meek and Black suggest that there has been some increase in turbidity since 1940. Organic pollution does not appear to be critical yet although species such as Hybopsis amblops have probably declined in abundance due to increased siltation or turbidity (Table 5). Quantitative water quality data are lacking, but Dr. Douglas James (Pers. Comm.), Professor of Zoology at the University of Arkansas, has stated that diversity of fishes collected during his Natural History of the Vertebrates class in Clear Creek has decreased in the last few years, presumably as a result of pollution from poultry farms.

Presently, very little industrial pollution exists in Washington County. We do not know of any recurring kills due to chronic pollution and no fishes have been eliminated from the county because of pollution. However, occasional spills of toxic substances into local streams have occurred. Three acute, short-term fish kills occurred in Washington County during this study. An oil spill near Johnson affected approximately 3 km of Clear Creek. Although few fish were killed, the creek bank was lined with unsightly oil deposits. A total kill (approximately 6000 fishes) occurred in a 1.4 km section of Mud Creek as a result of pesticide pollution (Olmsted and Cloutman 1974), and groundwater pollution resulted in a massive kill in a trout farm at the mouth of a

cave near Johnson. Although these kills were localized and temporary, such massive destruction of fisheries resources should not be tolerated.

Very little stream channelization or dredging has been done in Washington County. All projects of this nature have been performed by private landowners, and figures regarding the extent of such projects are not available. We have seen short channelized segments (approximately 200 m or less) in Richland Creek, Middle Fork, and East Fork of the White River. Although channelization tends to lower standing crop and diversity (Tarplee, Louder, and Weber 1971), these projects have probably not significantly affected the fish populations in Washington County as a whole because of their limited extent.

The most significant impact of man on Washington County fishes is the impoundment of several streams. These impoundments have been justified on the basis of power production, flood control, water supply and recreation. Although these projects have greatly expanded the lentic habitat within the county, they have eliminated many kilometers of prime pool and riffle habitat required by numerous non-game fishes. At least six species of fishes have been severely depleted or possibly eliminated from Washington County due to habitat destruction resulting from impoundments. In addition, dams have depleted species by blocking migration routes. This is particularly true for the eel, Anguilla rostrata. Numerous other species have been eliminated in inundated stretches, although populations exist elsewhere within the county (Table 5). With the exception of Beaver Reservoir, most Washington County impoundments, because of their small size and location, have exerted little stress upon fish populations. Beaver Reservoir, on the

other hand, because of its large size (approximately 40.7 river kilometers in Washington County) and its location in an area previously possessing a diverse stream ichthyofauna (Keith 1964), has significantly affected the distribution and abundance of numerous Washington County fishes within the White River. Reservoirs have increased the populations of most game fishes within the county and have allowed for more efficient management of these species by state and federal agencies.

Another important influence man has exerted on local aquatic habitats is the introduction of exotic fish species. Carp and trout were introduced into Washington County prior to 1894 (Meek 1894). Trout have proven to be of great commercial importance and have had practically no ecological significance because of their restriction to a few springs where they are raised. On the other hand, enthusiasm for carp declined rapidly and they are now generally regarded as a nuisance. Most recent introductions have been for management purposes. Threadfin shad have proven to be a valuable forage fish in Beaver Reservoir. Northern pike, white bass, and striped bass have been introduced as sport fishes in Beaver Reservoir. Recently, grass carp have been introduced into some local impoundments for aquatic weed control. The ecological impact of grass carp introductions is yet to be determined. Although probably native to Washington County, golden shiners have apparently increased in abundance partly because of bait introductions. Goldfish have been introduced into Washington County via bait and aquarium releases. A specimen of the blood-fin tetra, presumably an aquarium introduction, was taken in the Illinois River during this study. It is doubtful that this species will establish a reproducing population in the county.

THREATENED FISHES INHABITING WASHINGTON COUNTY

Several species of fishes which inhabit Washington County are threatened to varying degrees. Some are threatened throughout their range but most are threatened only in Arkansas. Some are threatened because they naturally inhabit restricted ranges and others have become threatened because of habitat degradation by man. Most of those threatened in Arkansas are in the periphery of their range in the state and have viable populations elsewhere.

At present, the only fish in Washington County with threatened status throughout its entire range is Amblyopsis rosae, a species endemic to caves in the Ozark region. It is on the rare and endangered list printed by the Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior (1973), and Miller (1972) listed A. rosae as rare in both Missouri and Arkansas. Buchanan (1974) considered the Ozark cavefish rare and endangered in Arkansas. Groundwater pollution has probably depleted this species in recent years, and special effort should be made to preserve its habitat.

Etheostoma whipplei montanus inhabits such a restricted range that it should be considered threatened. This subspecies of the redfin darter has been found only in the Clear Creek (Frog Bayou) drainage in Washington and Crawford Counties, Arkansas. The mountain redfin darter is most abundant in headwater brooks and is the only species of fish which penetrates to the extreme source of certain tributaries of Clear Creek (Hubbs and Black 1941). The headwater streams commonly inhabited by this darter dry up every few summers but seem to be repopulated by

migrants from downstream. Lake Shephard Springs and Lake Fort Smith have probably reduced E. w. montanus from the main channel of Clear Creek and could possibly have resulted in reduction of individuals for repopulation of the upland creeks after dry periods.

The following species are threatened in Arkansas regardless of their status elsewhere. The bluntface shiner, Notropis camurus, is considered by Buchanan (1974) to be rare and vulnerable in Arkansas although it is common in some other parts of its range. Buchanan (1974) considered the white sucker, Catostomus commersoni, to be vulnerable (rare) in Arkansas, where it is restricted to the Ozark region. In spite of its rarity in Arkansas, the white sucker is one of the most widespread suckers in North America and there is no immediate threat to the species as a whole. The least darter, Etheostoma microperca, was listed as vulnerable (rare) in Arkansas by Buchanan (1974). Although it is locally common, especially in the northern portion of its range, its abundance has probably declined in many parts of its range because of habitat destruction.

Some species which inhabit Washington County have an undetermined status in Arkansas. Included in this category are Ichthyomyzon castaneus, Ichthyomyzon gagei, Moxostoma macrolepidotum, Etheostoma juliae, and Percina evides (Buchanan 1974). In addition to these species listed by Buchanan, we feel that several other fishes which inhabit Washington County have been depleted in portions of their ranges, including Washington County, and should be closely monitored. Most notable among these are several White River endemics (Notropis ozarcanus, Noturus albater, Noturus flavater, and Etheostoma euzonum) which have

been depleted by several impoundments on the White River. Other species which have been significantly reduced in the Ozarks in recent years include Hybopsis amblops, Hybopsis dissimilis, Pimephales tenellus, Notropis galacturus, Notropis greenei, Notropis telescopus, and Percina nasuta. Although these species are not threatened at the present time, further habitat destruction should be avoided.

ACKNOWLEDGMENTS

The Office of Water Resources Research, U. S. Department of the Interior is acknowledged for their printing assistance through The Arkansas Water Resources Research Center as authorized under The Water Resources Research Act of 1964, P. L. 88-379 as amended by P. L. 89-404 and P. L. 92-175. We thank Mike Dewey, Mike Dombeck, Mike Geihsler, John Heuer, Gary Hickman, Jeff Hogue, Paul Kittle, Ralph Roseburg, Ed Short, and Bob Wallus for their valuable assistance with field collections, and the Department of Zoology, University of Arkansas for use of equipment. Al Houser, SCRI, provided useful information on Beaver Reservoir fishes. Mr. Joe L. Gaston, Soil Conservation Service, U. S. Department of Agriculture, Fayetteville, graciously provided information on channelization and farm ponds in Washington County. We are grateful to Drs. James S. Chase and Walter L. Brown, Department of History, University of Arkansas, and Michael P. Hoffman, Curator of Anthropology, University of Arkansas Museum, for helping to compile information regarding the history of man in Washington County. The Northwest Arkansas Regional Planning Commission, Springdale, provided useful information concerning activities of man in Washington County. We thank Dr. Thomas M. Buchanan, Westark Junior College, Fort Smith, Arkansas and members of SCRI, Fayetteville, Arkansas, for critical review of the manuscript.

LITERATURE CITED

Bailey, R. M., J. E. Fitch, E. S. Herald, E. A. Lachner, C. C. Lindsey, C. R. Robins, and W. B. Scott, 1970. A list of common and scientific names of fishes from the United States and Canada. 3rd. ed. Amer. Fish. Soc. Spec. Publ. 6: 1-150.

Ball, R. L. 1972. The feeding ecology of the black crappie, Pomoxis nigromaculatus and the white crappie, Pomoxis annularis, in Beaver Reservoir, Arkansas. Master's Thesis, University of Arkansas, Fayetteville. 181 pp.

Black, J. D. 1940. Fishes of Arkansas. Ph. D. Dissertation. Univ. of Michigan. 243 pp.

Borengasser, M. J. 1968. The physical geography of Washington County, Arkansas. Master's Thesis, Univ. of Arkansas. 113 pp.

Buchanan, T. M. 1973. Key to the fishes of Arkansas. Arkansas Game and Fish Commission. 68 pp. + 198 maps.

_____. 1974. Threatened native fishes of Arkansas. Pages 67-92 in Arkansas Department of Planning, C. T. Crow, Director. Arkansas Natural Area Plan. Little Rock, Arkansas.

Cleland, C. E. 1965. Faunal remains from bluff shelters in northwest Arkansas. The Arkansas Archeologist. 6(2-3): 39-63.

Cross, F. B. 1967. Handbook of fishes of Kansas. Univ. Kansas Mus. Natur. Hist., Misc. Publ., 45: 1-357.

Dewey, M. R. 1973. Movement of fishes in an Ozark stream. Master's Thesis, Univ. of Arkansas. 60 pp.

Distler, D. A. 1968. Distribution and variation of Etheostoma spectabile (Agassiz) (Percidae, Teleostei). Univ. Kansas Sci. Bull. 48(5): 143-208.

Fenneman, N. 1938. Physiography of eastern United States. McGraw-Hill Book Co., New York. 632 pp.

Gibbs, R. H., Jr. 1961. Cyprinid fishes of the subgenus Cyprinella of Notropis. IV. The Notropis galacturus-camurus complex. Am. Mid. Nat. 66(2): 337-354.

_____. 1963. Cyprinid fishes of the subgenus Cyprinella of Notropis. The Notropis whipplei-analostanus-chloristius complex. Copeia, 1963(3): 511-528.

Gilbert, C. R. 1964. The American cyprinid fishes of the subgenus Luxilus (Genus Notropis). Florida State Mus., Bull. 8(2): 95-194.

_____. 1969. Systematics and distribution of the American cyprinid fishes Notropis ariommus and Notropis telescopus. Copeia, 1969(3): 474-492.

Hall, G. E. 1956. Additions to the fish fauna of Oklahoma with a summary of introduced species. Southwest. Natur. 1(1): 16-26.

Hill, L. G. 1968. Inter- and intrapopulational variation of vertebral numbers of the yoke darter, Etheostoma juliae. Southwest. Natur. 13(2): 175-191.

Hubbs, C. L., and J. D. Black. 1941. The subspecies of the American percid fish, Poecilichthys whipplii. Occ. Pap. Mus. Zool. Univ. Michigan. 429: 1-27.

_____, and _____. 1947. Revision of Ceratichthys, a genus of American cyprinid fishes. Misc. Publ. Mus. Zool. Univ. Michigan. 66: 1-56.

_____, and C. W. Greene. 1935. Two new subspecies of fishes from Wisconsin. Trans. Wisconsin Acad. Sci., Arts, and Letters. 29: 89-101.

_____, and G. A. Moore. 1940. The subspecies of Notropis zonatus, a cyprinid fish of the Ozark Upland. Copeia, 1940(2): 91-99.

_____, and A. I. Ortenburger. 1929. Fishes collected in Oklahoma and Arkansas in 1927. Biol. Surv., Univ. Oklahoma, Publ. 1(3): 45-112.

Jordan, D. S., and C. H. Gilbert. 1886. List of fishes collected in Arkansas, Indian Territory, and Texas, in September, 1884, with notes and descriptions. Proc. U. S. Nat. Mus. 9(549): 1-25.

Keith, W. E., Jr. 1964. A pre-impoundment study of the fishes, their distribution and abundance, in the Beaver Lake drainage of Arkansas. Master's Thesis, Univ. of Arkansas. 94 pp. + 72 maps.

Kittle, P. 1974. Fish studies. Pages 120-140. In P. Kittle, E. Short, and R. Rice. A preliminary study of the water quality of the Illinois River in Arkansas. Final Report to the Illinois River Property Owners of Arkansas, Inc. Univ. of Arkansas, Fayetteville. 158 pp.

Lachner, E. A., and R. E. Jenkins. 1971. Systematics, distribution, and evolution of the Nocomis biguttatus species group (Family Cyprinidae: Pisces) with a description of a new species from the Ozark upland. Smithsonian Contributions to Zoology. 91: 1-35.

Larimore, R. W., and P. W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream changes. Illinois Nat. Hist. Surv. Bull. 28(2): 295-382.

Meek, S. E. 1891. Report of explorations made in Missouri and Arkansas during 1889, with an account of the fishes observed in each of the river basins examined. Bull. U. S. Fish. Comm. 1889, 9: 113-141.

_____. 1893. A catalogue of the fishes of Arkansas. Arkansas Geological Survey Annual Report. 2(1891): 215-276.

_____. 1894. Report of investigations respecting the fishes of Arkansas, conducted during 1891, 1892, and 1893, with a synopsis of previous explorations in the same state. Bull. U. S. Fish. Comm. 14: 67-94.

Miller, R. J., and H. W. Robison. 1973. The fishes of Oklahoma. Oklahoma State Univ. Press. Oklahoma State Univ. Mus. Nat. and Cultural History Nat. Hist. Series, Number 1. 246 pp.

Miller, R. R. 1972. Threatened freshwater fishes of the United States. Trans. Amer. Fish. Soc. 101(2): 239-252.

Miller, R. V. 1968. A systematic study of the greenside darter, Etheostoma blennioides Rafinesque (Pisces: Percidae). Copeia, 1968(1): 1-40.

Moore, G. A. 1968. Fishes. Pages 21-165 in W. F. Blair, A. P. Blair, P. Brodkorb, F. R. Cagle, and G. A. Moore. Vertebrates of the United States. 2nd. ed. McGraw-Hill Book Co., N. Y. 616 pp.

_____, and J. M. Padden. 1950. The fishes of the Illinois River in Oklahoma and Arkansas. Am. Mid. Nat. 44(1): 76-95.

Northwest Arkansas Regional Planning Commission. 1972. Rural land use study. Northwest Arkansas Regional Planning Commission, Springdale, Ark. 26 pp.

Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, U. S. Dept. of the Interior. 1973. Threatened wildlife of the United States. Resource Publ. 114. Bur. Sport Fish. Wildl. U. S. Govt. Printing Office, Washington D. C. 289 pp.

Olmsted, L. L. 1971. Ecological life history and population dynamics of white bass, Roccus chrysops (Rafinesque) in Beaver Reservoir. Master's Thesis, Univ. of Arkansas. 118 pp.

_____, and D. G. Cloutman. 1974. Repopulation after a fish kill in Mud Creek, Washington County, Arkansas following pesticide pollution. Trans. Amer. Fish. Soc. 103(1): 79-87.

Pflieger, W. L. 1971. A distributional study of Missouri fishes. Univ. Kansas Publ. Mus. Nat. Hist. 20(3): 51-60.

Scholtz, J. A. 1969. A summary of prehistory in northwest Arkansas. The Arkansas Archeologist. 10(1-3): 51-60.

Shelford, V. E. 1911. Ecological succession. I. Stream fishes and the method of physiographic analysis. Biol. Bull. 21: 9-34.

Snelson, F. F., and W. L. Pflieger. 1975. Redescription of the redfin shiner, Notropis umbratilis, and its subspecies in the central Mississippi River basin. Copeia, 1975(2): 231-249.

Suttkus, R. D. 1970. Type specimens of fishes in the Tulane University collection with a brief history of the collection. Tulane Stud. in Zoology and Botany. 16(3): 116-130.

Swift, C. C. 1970. A review of the eastern North American cyprinid fishes of the Notropis texanus species group (subgenus Alburnops), with a definition of the subgenus Hydrophlox, and materials for a revision of the subgenus Alburnops. Ph. D. Dissertation, Florida State University. 476 pp.

Tarplee, W. H., D. E. Louder and A. J. Weber. 1971. Evaluation of the effects of channelization on fish populations in North Carolina coastal streams. North Carolina Wildl. Res. Comm. Publ. 13 pp.

Taylor, W. R. 1969. Revision of the catfish genus Noturus Rafinesque, with an analysis of higher groups in the Ictaluridae. Bull. U. S. Nat. Mus. 282: 1-315.

Thompson, D. H., and F. D. Hunt. 1930. The fishes of Champaign County: a study of the distribution and abundance of fishes in small streams. Illinois Nat. Hist. Surv. Bull. 19(1): 1-101.

Trautman, M. B. 1942. Fish distribution and abundance correlated with stream gradients as a consideration in stocking programs. Trans. 7th North American Wildlife Conference. pp. 211-223.

_____. 1957. The fishes of Ohio. Ohio State Univ. Press, Columbus. 683 pp.

_____, and D. K. Gartman. 1974. Re-evaluation of the effects of man-made modifications on Gordon Creek between 1887 and 1973 and especially as regards its fish fauna. Ohio J. Sci. 74(3): 162-173.

_____, and R. G. Martin. 1951. Moxostoma aureolum pisolabrum, a new subspecies of sucker from the Ozarkian streams of the Mississippi River system. Occ. Pap. Mus. Zool. Univ. Michigan. 534: 1-10.

Tsai, C., and E. C. Raney. 1974. Systematics of the banded darter, Etheostoma zonale (Pisces: Percidae). Copeia, 1974(1): 1-24.

Vizzier, J. A. 1969. Northwest Arkansas regional resources. Northwest Arkansas Regional Planning Commission, Springdale, Ark. 40 pp.

APPENDIX

Table 1. Distribution of Washington County fishes related to drainage systems.

Species	White	Illinois	Arkansas Tributaries
Ichthyomyzon castaneus	x	x	
Ichthyomyzon gagei	x		
Polyodon spathula	x		
Lepisosteus osseus	x	x	
Dorosoma cepedianum	x	x	
Dorosoma petenense	x		
Hiodon tergisus	x		
Aphyocharax rubripinnis		x	
Salmo gairdneri		x	
Esox lucius	x		
Anguilla rostrata	x		
Ctenopharyngodon idellus		x	
Cyprinus carpio	x	x	
Carassius auratus	x	x	
Notemigonus crysoleucas	x	x	
Semotilus atromaculatus	x	x	x
Hybopsis amblops	x	x	x
Hybopsis dissimilis	x		
Hybopsis x-punctata		x	
Nocomis asper		x	
Nocomis biguttatus	x		
Pimephales notatus	x	x	x
Pimephales promelas	x	x	
Pimephales tenellus	x		
Campostoma anomalum	x	x	x
Campostoma oligolepis	x		
Chrosomus erythrogaster	x	x	x
Dionda nubila	x	x	x
Notropis atherinoides		x	
Notropis boops	x	x	x
Notropis camurus		x	
Notropis chrysocephalus	x	x	
Notropis galacturus	x		
Notropis greenei	x		x
Notropis lutrensis		x	
Notropis ozarcanus	x		
Notropis pilsbryi	x	x	x
Notropis rubellus	x	x	
Notropis telescopus	x		
Notropis umbratilis		x	
Notropis whipplei	x		x
Carpiodes cyprinus	x		
Carpiodes velifer	x		
Ictiobus bubalus	x	x	
Ictiobus cyprinellus	x		
Catostomus commersoni	x	x	
Hypentelium nigricans	x	x	x
Moxostoma carinatum	x	x	
Moxostoma duquesnei	x	x	x
Moxostoma erythrurum	x	x	x
Moxostoma macrolepidotum		x	

Species	White	Illinois	Arkansas Tributaries
Minytrema melanops	x	x	
Erimyzon oblongus			x
Ictalurus furcatus	x		
Ictalurus melas	x	x	x
Ictalurus natalis	x	x	
Ictalurus punctatus	x	x	
Noturus albater	x		
Noturus exilis	x	x	x
Noturus flavater	x		
Pylodictis olivaris	x	x	
Fundulus catenatus	x	x	
Fundulus olivaceus	x	x	x
Gambusia affinis	x	x	
Labidesthes sicculus	x	x	x
Morone chrysops	x		
Morone saxatilis	x		
Ambloplites rupestris	x	x	
Pomoxis annularis	x	x	
Pomoxis nigromaculatus	x	x	
Micropterus dolomieui	x	x	x
Micropterus punctulatus	x	x	x
Micropterus salmoides	x	x	
Lepomis cyanellus	x	x	x
Lepomis gulosus	x	x	
Lepomis humilis		x	
Lepomis macrochirus	x	x	x
Lepomis megalotis	x	x	x
Lepomis microlophus	x	x	
Percina caprodes	x	x	
Percina copelandi		x	x
Percina evides	x		
Percina nasuta	x		
Etheostoma blennioides	x	x	x
Etheostoma caeruleum	x		
Etheostoma euzonum	x		
Etheostoma flabellare		x	x
Etheostoma juliae	x		
Etheostoma microperca		x	
Etheostoma punctulatum	x	x	x
Etheostoma spectabile	x	x	x
Etheostoma stigmaeum	x	x	
Etheostoma whipplei		x	x
Etheostoma zonale	x	x	
Stizostedion vitreum	x		
Aplodinotus grunniens	x		
Cottus carolinae	x	x	

Table 2. Abundance of Washington County fishes related to major habitat types.

- Absent (Not collected)
r Rare
u Uncommon
c Common
a Abundant

	Spring Runs	Small Creeks	Large Creeks	Small Rivers	Impoundments	Farm Ponds	Subterranean
Ichthyomyzon castaneus	-	-	r	r	r	-	-
Ichthyomyzon gagei	-	-	r	r	-	-	-
Polyodon spathula	-	-	-	r	-	-	-
Lepisosteus osseus	-	-	r	u	c	-	-
Dorosoma cepedianum	-	r	u	c	a	-	-
Dorosoma petenense	-	-	-	c	a	-	-
Hiodon tergisus	-	-	-	r	r	-	-
Aphyocharax rubripinnis	-	-	r	-	-	-	-
Salmo gairdneri	r	r	-	-	-	-	-
Esox lucius	-	-	-	-	r	-	-
Anguilla rostrata	-	-	-	r	-	-	-
Ctenopharyngodon idellus	-	-	-	-	u	-	-
Cyprinus carpio	-	-	u	u	c	-	-
Carassius auratus	-	-	-	r	u	-	-
Notemigonus crysoleucas	-	r	u	u	c	-	-
Semotilus atromaculatus	c	c	r	r	-	-	-
Hybopsis amblops	-	r	c	u	-	-	-
Hybopsis dissimilis	-	-	-	r	-	-	-
Hybopsis x-punctata	-	-	-	r	-	-	-
Nocomis asper	u	u	c	u	-	-	-
Nocomis biguttatus	u	u	c	u	-	-	-
Pimephales notatus	r	c	c	c	u	-	-
Pimephales promelas	-	-	r	-	-	-	-
Pimephales tenellus	-	-	r	r	-	-	-
Campostoma anomalum	c	c	a	c	r	-	-
Campostoma oligolepis	-	r	c	c	r	-	-
Chrosomus erythrogaster	a	c	r	r	-	-	-
Dionda nubila	u	c	a	a	-	-	-
Notropis atherinoides	-	-	-	r	-	-	-
Notropis boops	u	c	a	c	-	-	-
Notropis camurus	-	-	r	-	-	-	-
Notropis chrysocephalus	u	c	c	u	-	-	-
Notropis galacturus	-	-	-	u	-	-	-
Notropis greenei	-	-	r	u	-	-	-
Notropis lutrensis	-	-	r	-	-	-	-
Notropis ozarcanus	-	-	-	r	-	-	-
Notropis pilsbryi	c	a	a	c	-	-	-
Notropis rubellus	-	-	c	c	-	-	-
Notropis telescopus	-	u	c	u	-	-	-
Notropis umbratilis	r	u	c	c	-	-	-
Notropis whipplei	-	r	c	a	u	-	-
Carpiodes cyprinus	-	-	-	r	u	-	-
Carpiodes velifer	-	-	r	u	c	-	-
Ictiobus bubalus	-	-	-	r	r	-	-
Ictiobus cyprinellus	-	-	-	-	r	-	-

	Spring Runs	Small Creeks	Large Creeks	Small Rivers	Impoundments	Farm Ponds	Subterranean
Catostomus commersoni	-	r	u	u	-	-	-
Hypentelium nigricans	-	u	c	c	-	-	-
Moxostoma carinatum	-	-	r	u	r	-	-
Moxostoma duquesnei	r	u	c	c	u	-	-
Moxostoma erythrurum	-	r	c	c	c	-	-
Moxostoma macrolepidotum	-	-	-	r	-	-	-
Minytrema melanops	-	r	u	u	-	-	-
Erimyzon oblongus	u	r	-	-	-	-	-
Ictalurus furcatus	-	-	-	r	u	-	-
Ictalurus melas	-	r	u	u	r	u	-
Ictalurus natalis	-	r	u	u	u	c	-
Ictalurus punctatus	-	-	u	c	c	c	-
Noturus albater	-	-	u	c	-	-	-
Noturus exilis	u	c	c	c	-	-	-
Noturus flavater	-	-	r	r	-	-	-
Pylodictis olivaris	-	-	r	u	c	-	-
Fundulus catenatus	r	u	c	u	-	-	-
Fundulus olivaceus	r	u	c	c	u	-	-
Gambusia affinis	r	u	c	c	u	-	-
Amblyopsis rosae	-	-	-	-	-	-	r
Labidesthes sicculus	-	u	c	c	c	-	-
Morone chrysops	-	-	u	c	a	r	-
Morone saxatilis	-	-	-	r	c	-	-
Ambloplites rupestris	-	u	c	c	r	-	-
Pomoxis annularis	-	-	r	u	a	u	-
Pomoxis nigromaculatus	-	-	r	u	a	-	-
Micropterus dolomieui	u	u	c	c	r	-	-
Micropterus punctulatus	r	u	c	c	u	-	-
Micropterus salmoides	r	u	c	c	a	a	-
Lepomis cyanellus	u	c	a	a	c	a	-
Lepomis gulosus	-	-	-	r	c	-	-
Lepomis humilis	-	-	r	r	-	-	-
Lepomis macrochirus	r	u	c	a	a	a	-
Lepomis megalotis	c	c	a	a	c	-	-
Lepomis microlophus	-	-	r	u	c	c	-
Percina caprodes	-	r	u	c	c	-	-
Percina copelandi	-	r	r	-	-	-	-
Percina evides	-	-	-	r	-	-	-
Percina nasuta	-	-	r	r	-	-	-
Etheostoma blennioides	-	r	c	c	-	-	-
Etheostoma caeruleum	-	r	a	a	-	-	-
Etheostoma euzonum	-	-	-	r	-	-	-
Etheostoma flabellare	c	c	c	u	-	-	-
Etheostoma juliae	-	-	r	c	-	-	-
Etheostoma microperca	-	-	r	-	-	-	-

	Spring Runs	Small Creeks	Large Creeks	Small Rivers	Impoundments	Farm Ponds	Subterranean
Etheostoma punctulatum	c	u	u	r	-	-	-
Etheostoma spectabile	a	a	a	c	u	-	-
Etheostoma stigmaeum	-	r	u	u	-	-	-
Etheostoma whipplei	c	u	r	-	-	-	-
Etheostoma zonale	-	r	c	c	-	-	-
Stizostedion vitreum	-	-	r	u	c	-	-
Aplodinotus grunniens	-	-	-	r	u	-	-
Cottus carolinae	c	c	c	c	-	-	-

Table 3. Comparison of diversity of Washington County fishes in the major habitat types.

- Absent
r Rare
u Uncommon
c Common
a Abundant

Habitat	-	r	u	c	a	Total Present
Spring Runs	69	10	9	8	2	29
Small Creeks	49	18	17	12	2	49
Large Creeks	26	24	14	26	8	72
Small Rivers	15	24	23	30	6	83
Impoundments	52	10	14	14	7	46
Farm Ponds	89	1	1	4	3	9
Subterranean	97	1	0	0	0	1

Table 4. Statistics showing trends of the activities of man which probably have the most impact on abundance and distribution of Washington County fishes.

	1930	1940	1950	1960	1970
Human Population*	39255	41114	49929	55797	77370
Number of Farms*	4836	5213	4903	3351	2639
Land in Farms (ha)*	183675	187005	182501	150524	147863
Harvested Cropland (ha)*	57117	50744	35274	22559	22310
Number of Livestock*	54922	55080	74388	77729	158199
Number of Chickens*				39050000	96669000
Number of Turkeys*				328000	1209000
Number of Major Impoundments	0	1	1	4	7
River Kilometers Impounded	0	2.0	2.0	10.8	56.6

*Data derived from Northwest Arkansas Regional Planning Commission (1972).

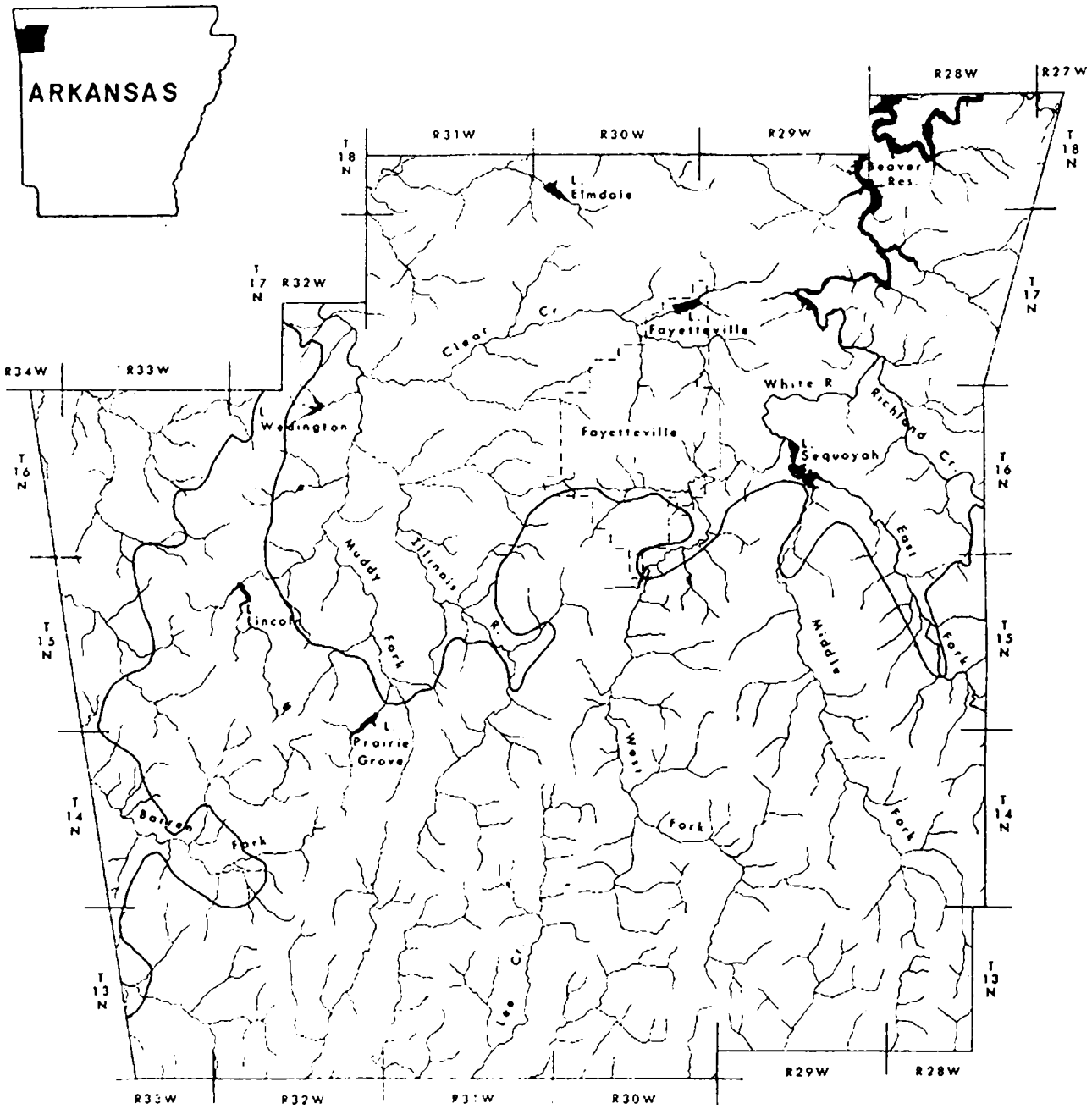
Table 5. Probable changes in abundance of fishes in Washington County due to activities of man.

+ Increase
- Decrease
n No apparent or significant change
? Unknown

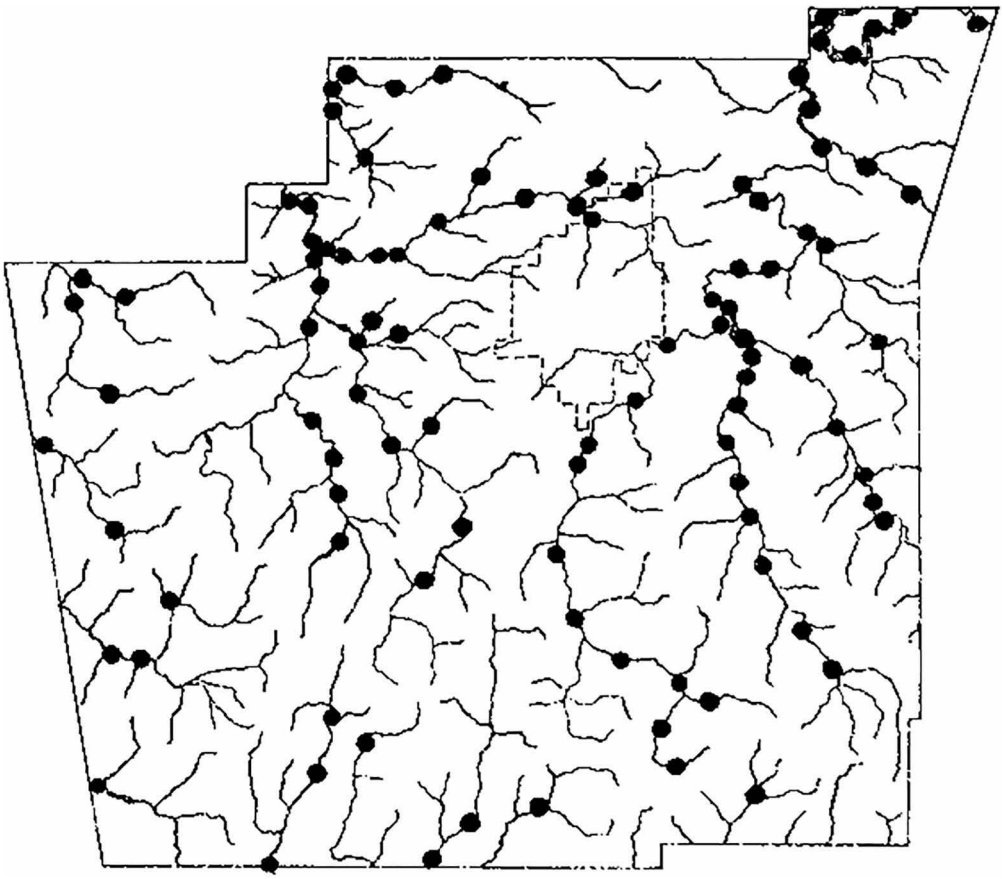
Species	Type of Change	Cause of Change
Ichthyomyzon castaneus	n	
Ichthyomyzon gagei	?	
Polyodon spathula	-	Impoundment
Lepisosteus osseus	+	Impoundment
Dorosoma cepedianum	+	Impoundment
Dorosoma petenense	+	Introduction, Impoundment
Hiodon tergisus	n	
Aphyocharax rubripinnis	+	Introduction
Salmo gairdneri	+	Introduction
Esox lucius	+	Introduction
Anguilla rostrata	-	Impoundments blocking migration
Ctenopharyngodon idellus	+	Introduction
Cyprinus carpio	+	Introduction, Impoundment
Carassius auratus	+	Introduction
Notemigonus crysoleucas	+	Bait introduction, Siltation
Semotilus atromaculatus	n	
Hybopsis amblops	-	Increased siltation, Impoundment
Hybopsis dissimilis	-	Impoundment, Increased siltation
Hybopsis x-punctata	n	
Nocomis asper	n	
Nocomis biguttatus	-	Impoundment
Pimephales notatus	n	
Pimephales promelas	n	
Pimephales tenellus	-	Impoundment
Campostoma anomalum	n	
Campostoma oligolepis	n	
Chrosomus erythrogaster	n	
Dionda nubila	-	Impoundment
Notropis atherinoides	?	
Notropis boops	-	Impoundment
Notropis camurus	?	
Notropis chrysocephalus	-	Impoundment
Notropis galacturus	-	Impoundment
Notropis greenei	-	Impoundment
Notropis lutrensis	?	
Notropis ozarcanus	-	Impoundment
Notropis pilsbryi	-	Impoundment
Notropis rubellus	-	Impoundment
Notropis telescopus	-	Impoundment
Notropis umbratilis	+	Increased siltation and turbidity
Notropis whipplei	n	
Carpiodes cyprinus	+	Impoundment
Carpiodes velifer	+	Impoundment
Ictiobus bubalus	+	Impoundment
Ictiobus cyprinellus	+	Impoundment
Catostomus commersoni	n	
Hypentelium nigricans	-	Impoundment
Moxostoma carinatum	-	Siltation, Impoundment
Moxostoma duquesnei	-	Impoundment
Moxostoma erythrurum	n	
Moxostoma macrolepidotum	n	
Minytrema melanops	n	
Erimyzon oblongus	n	

Species	Type of Change	Cause of Change
Ictalurus furcatus	+	Impoundment
Ictalurus melas	n	
Ictalurus natalis	n	
Ictalurus punctatus	+	Impoundment
Noturus albater	-	Impoundment
Noturus exilis	-	Impoundment
Noturus flavater	-	Impoundment
Pylodictis olivaris	+	Impoundment
Fundulus catenatus		
White River	-	Impoundment
Illinois River	+	?
Fundulus olivaceus	n	
Gambusia affinis	+	Impoundment, Increased temperature due to clearing of streambank vegetation
Amblyopsis rosae	?	
Labidesthes sicculus	n	
Morone chrysops	+	Impoundment, Stocking
Morone saxatilis	+	Introduction, Impoundment
Ambloplites rupestris	-	Impoundment
Pomoxis annularis	+	Impoundment, Stocking
Pomoxis nigromaculatus	+	Impoundment, Stocking
Micropterus dolomieui	-	Impoundment
Micropterus punctulatus	-	Impoundment
Micropterus salmoides	+	Impoundment, Stocking
Lepomis cyanellus	n	
Lepomis gulosus	+	Impoundment
Lepomis humilis	n	
Lepomis macrochirus	+	Impoundment, Stocking, Increased siltation and turbidity
Lepomis megalotis	n	
Lepomis microlophus	+	Impoundment
Percina caprodes	n	
Percina copelandi	n	
Percina evides	-	Impoundment
Percina nasuta	-	Impoundment
Etheostoma blennioides	-	Impoundment
Etheostoma caeruleum	-	Impoundment
Etheostoma euzonum	-	Impoundment
Etheostoma flabellare	n	
Etheostoma juliae	-	Impoundment
Etheostoma microperca	n	
Etheostoma punctulatum	-	Impoundment
Etheostoma spectabile	n	
Etheostoma stigmaeum	-	Impoundment
Etheostoma whipplei	n	
Etheostoma zonale	-	Impoundment
Stizostedion vitreum	+	Impoundment, Stocking
Aplodinotus grunniens	+	Impoundment
Cottus carolinae	-	Impoundment

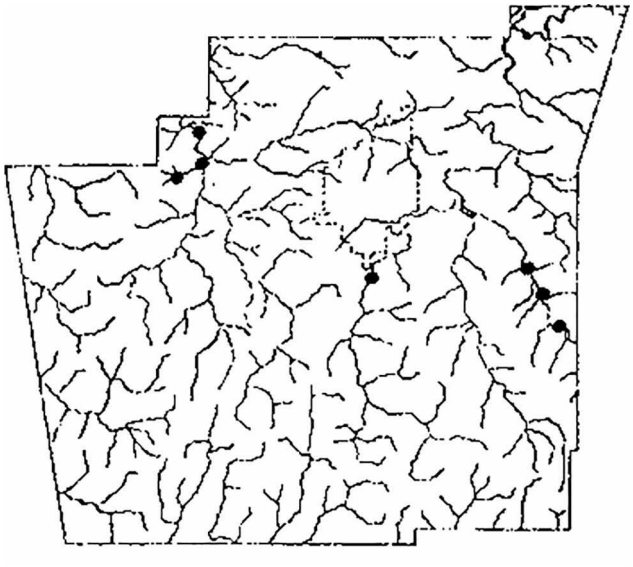
Map 1. Map of Washington County, Arkansas showing drainage patterns. The crooked line transversing the county depicts the boundary between the Springfield Plateau and Boston Mountains.


ARKANSAS
R34W
R33W
R32W
R31W
R30W
R29W
R28W
R27W
T 18 N
T 17 N
T 16 N
T 15 N
T 14 N
T 13 N
L. Elmdale
Beaver Res.
Clear Cr
L. Fayetteville
Fayetteville
White R
Richland Cr.
L. Sequoyah
L. Wedington
Muddy Fork
Illinois R.
Lincoln
L. Prairie Grove
Middle Fork
West Fork
East Fork
Borum Fork
Lee Cr

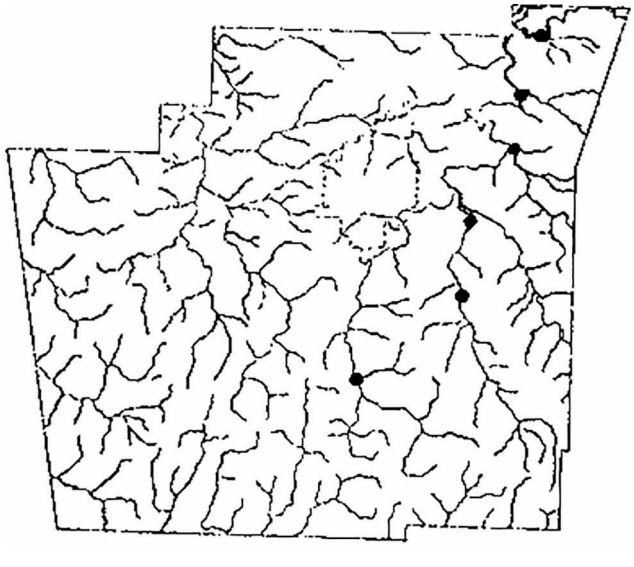
Map 2. Fish collection localities in Washington County, Arkansas, 1893 - 1974.



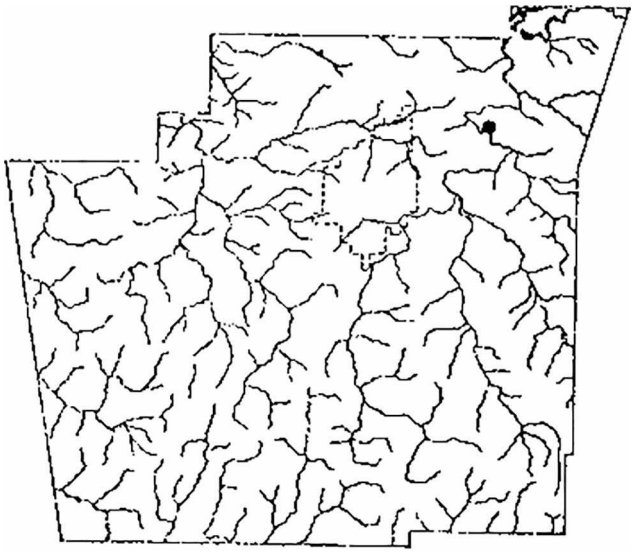
Maps 3-99. Distribution of Washington County fishes.



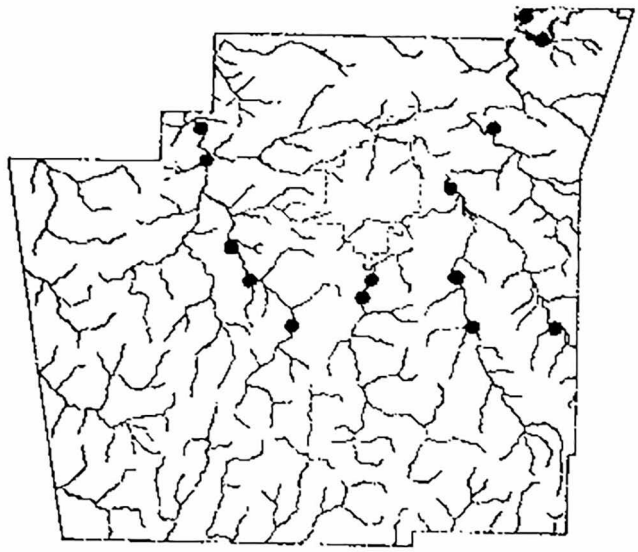
Map 3. Ichthyomyzon castaneus



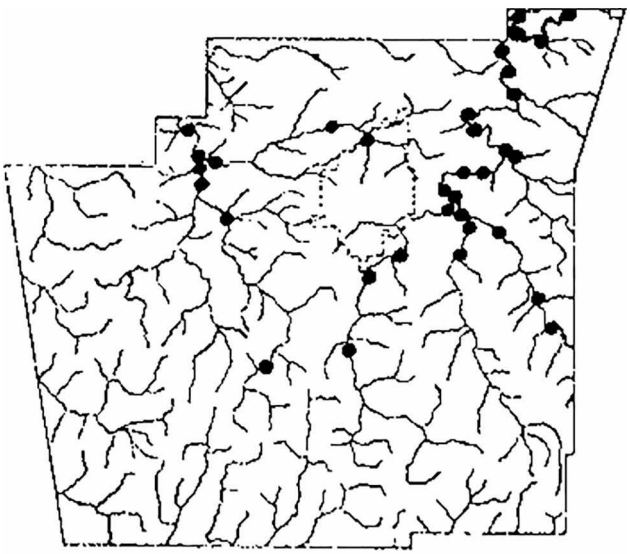
Map 4. Ichthyomyzon gagei



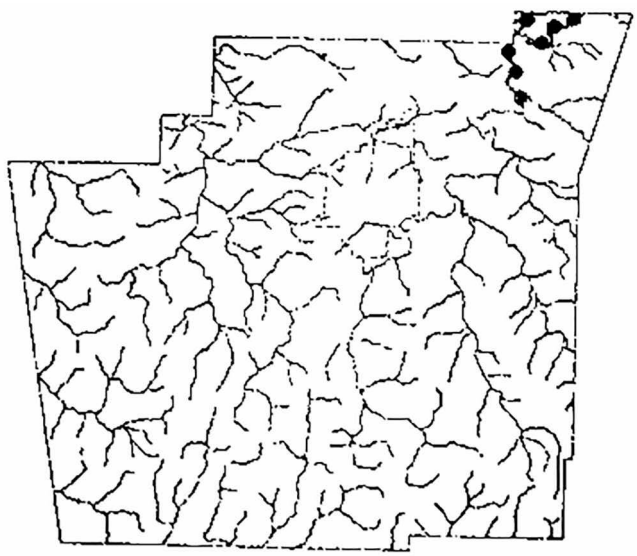
Map 5. Polyodon spathula



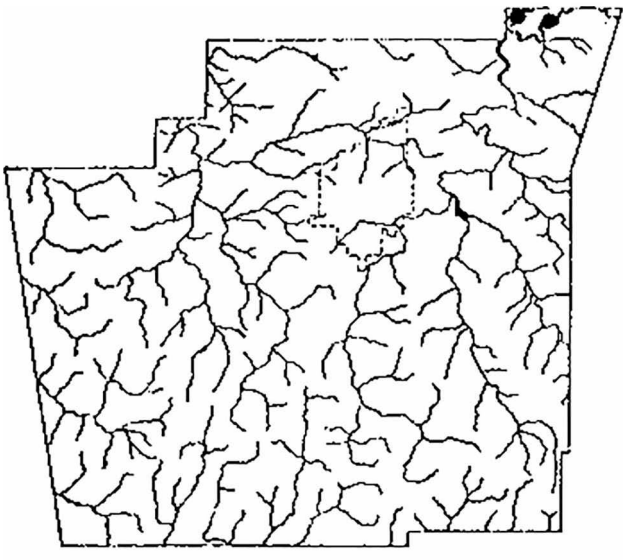
Map 6. Lepisosteus osseus



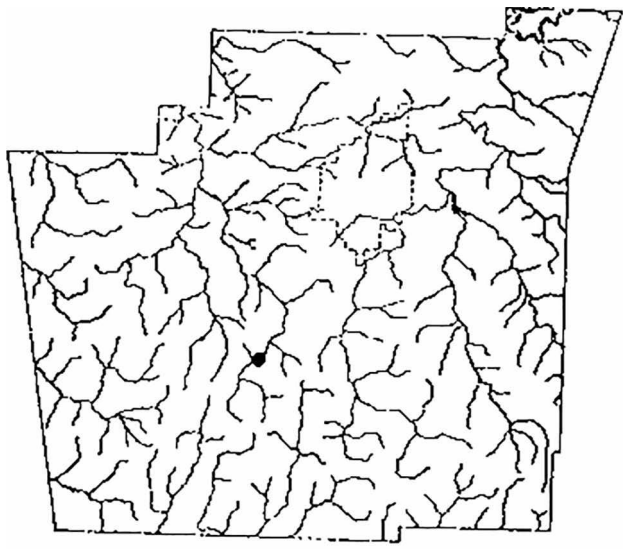
Map 7. Dorosoma cepedianum



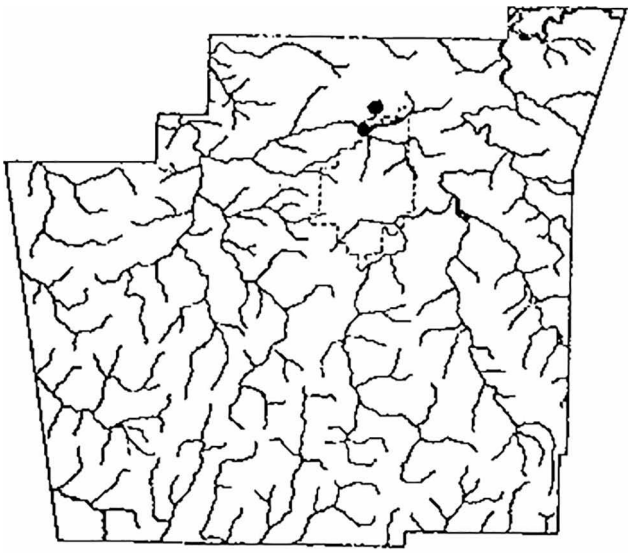
Map 8. Dorosoma petenense



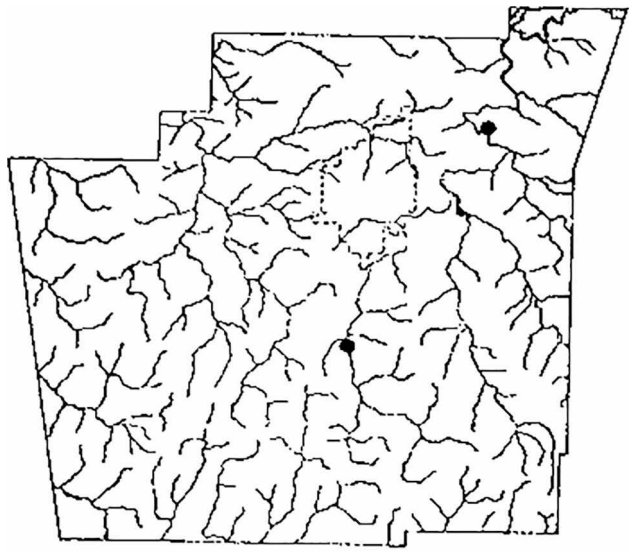
Map 9. Hiodon tergisus



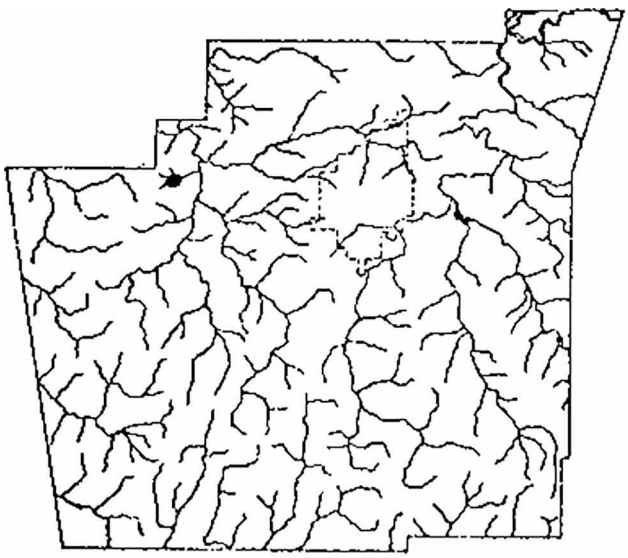
Map 10. Aphyocharax rubripinnis



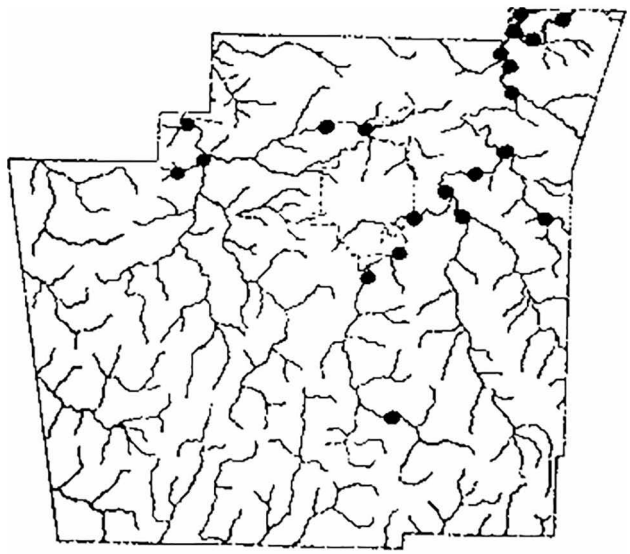
Map 11. Salmo gairdneri



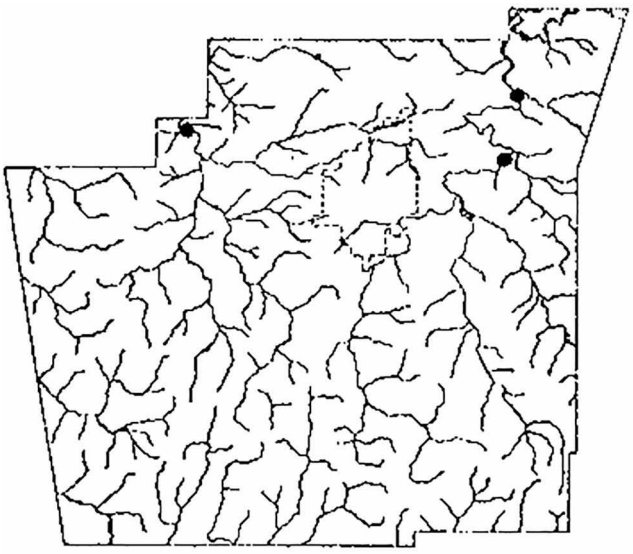
Map 12. Anguilla rostrata



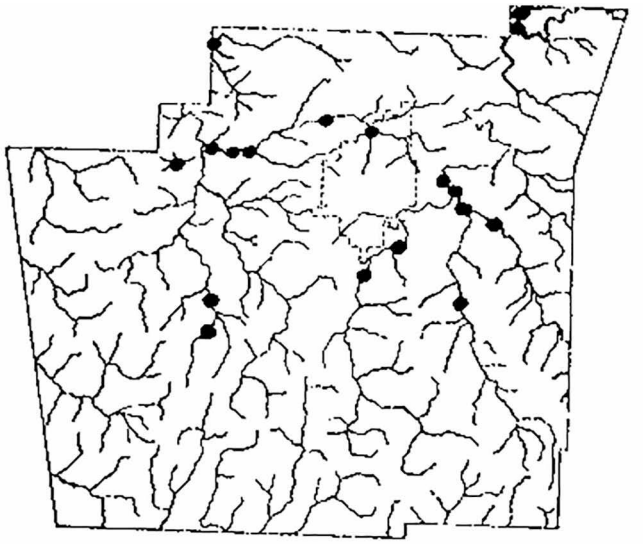
Map 13. Ctenopharyngodon idellus



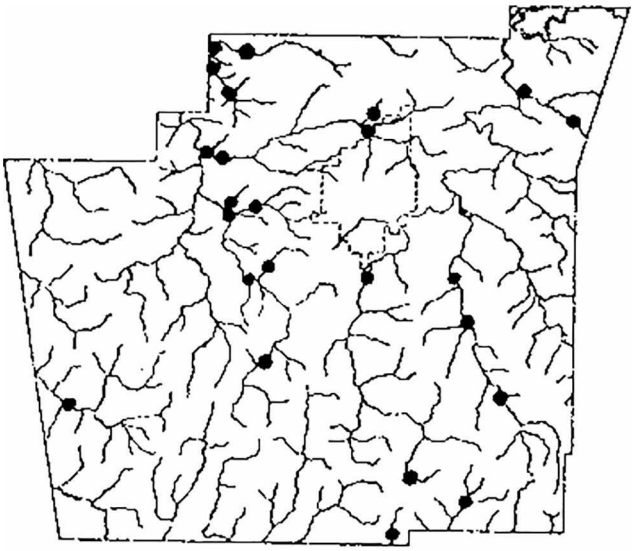
Map 14. Cyprinus carpio



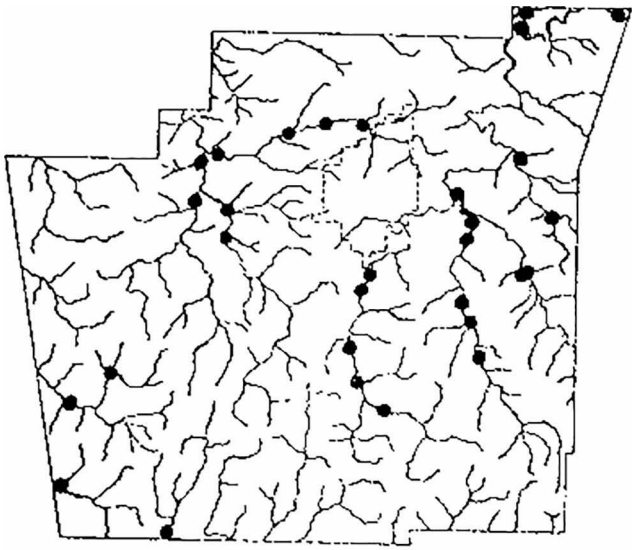
Map 15. Carassius auratus



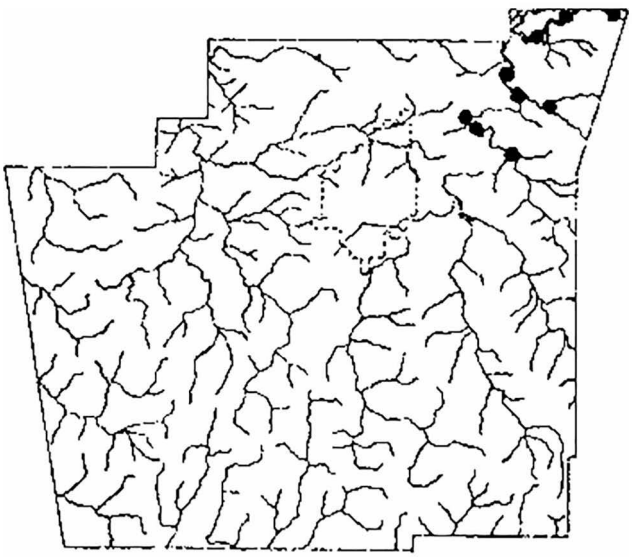
Map 16. Notemigonus crysoleucas



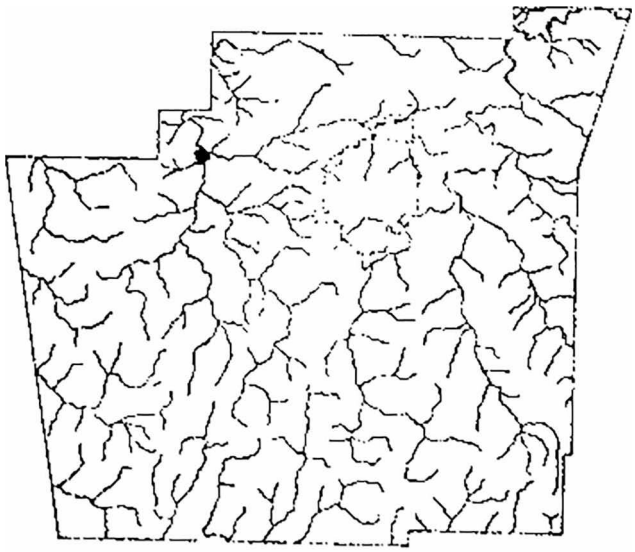
Map 17. Semotilus atromaculatus



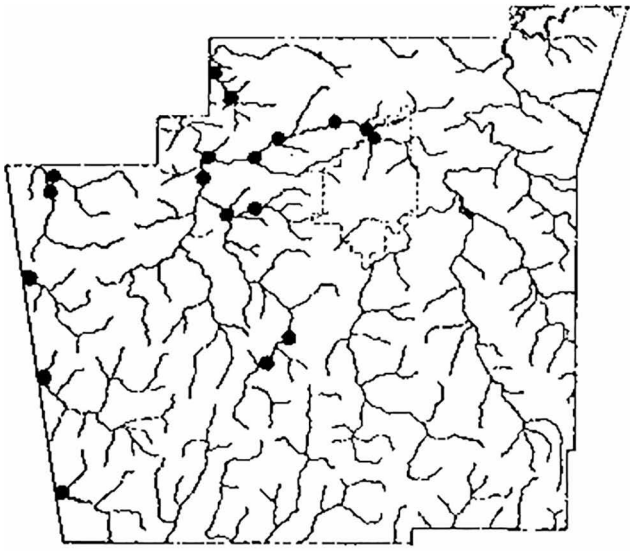
Map 18. Hybopsis amblops



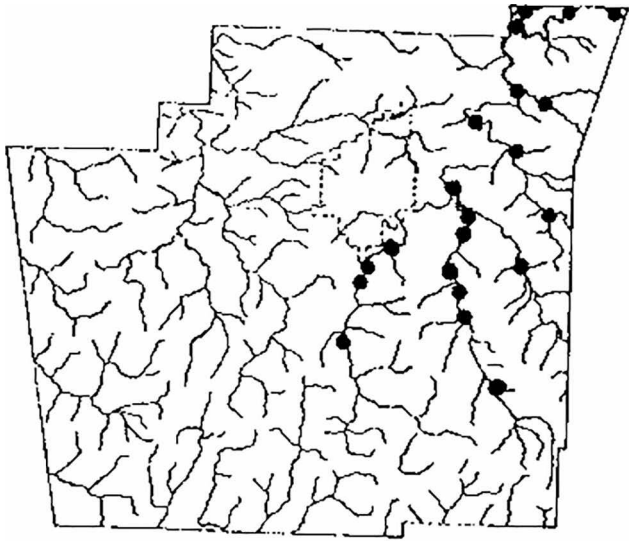
Map 19. Hybopsis dissimilis



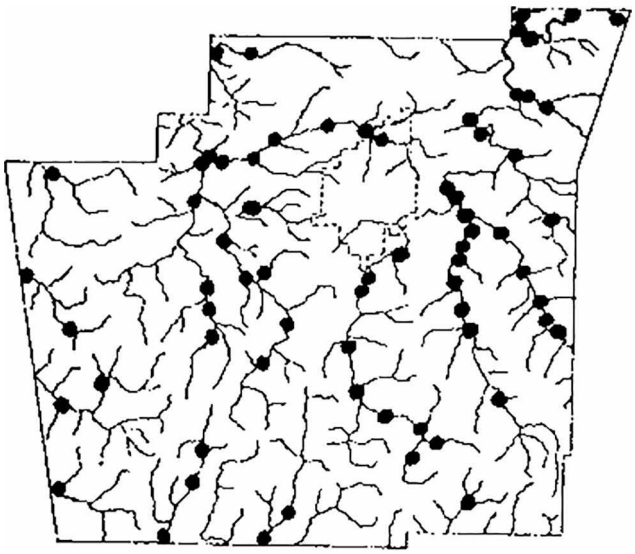
Map 20. Hybopsis x-punctata



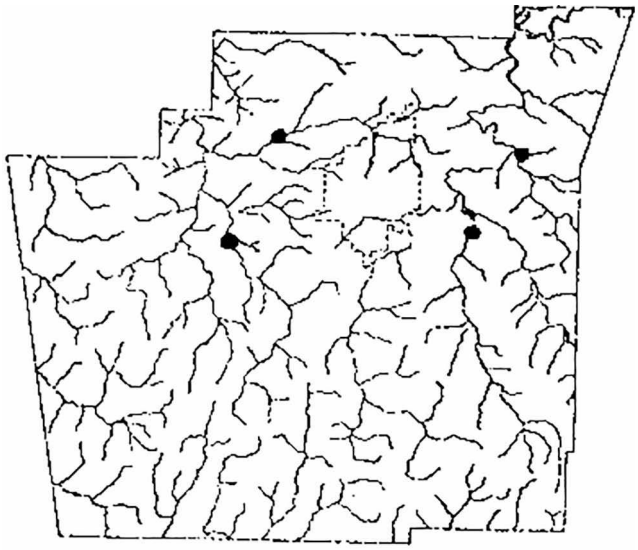
Map 21. Nocomis asper



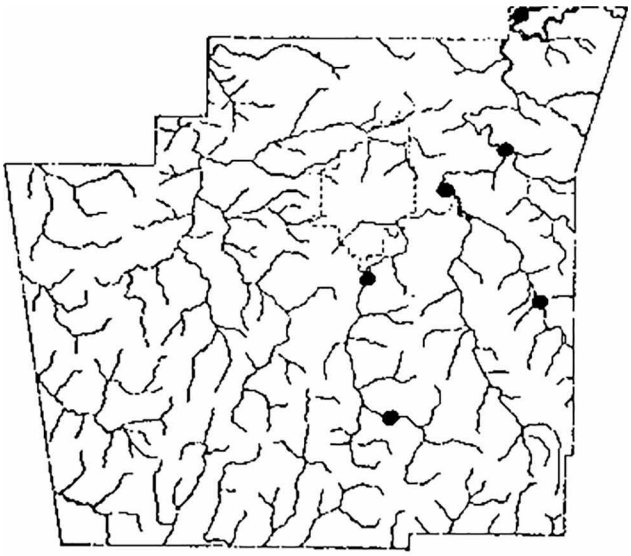
Map 22. Nocomis biguttatus



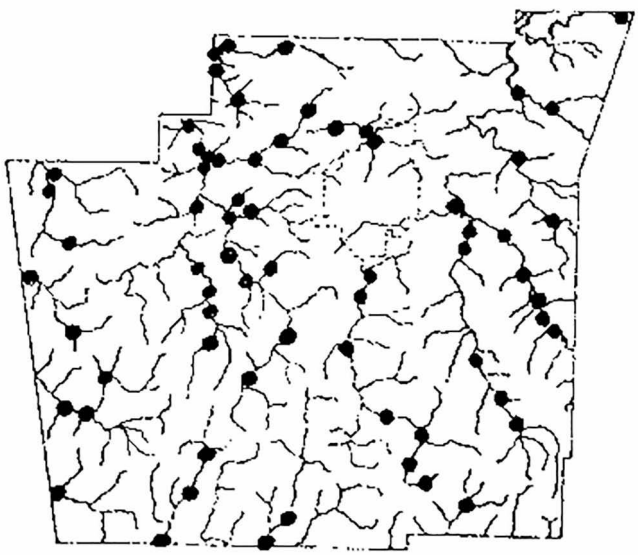
Map 23. Pimephales notatus



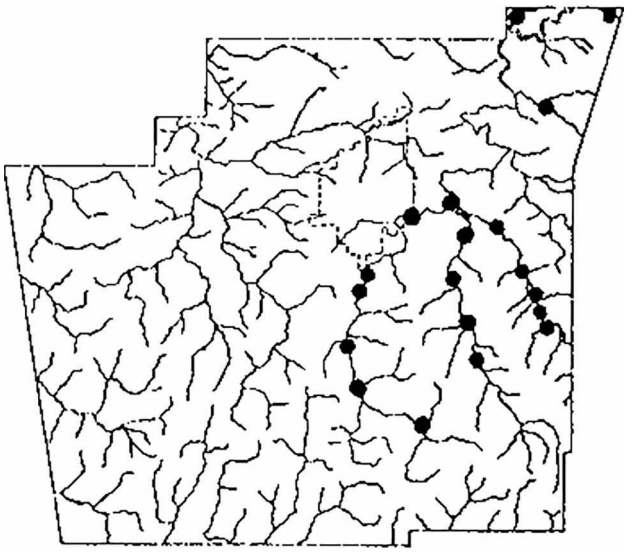
Map 24. Pimephales promelas



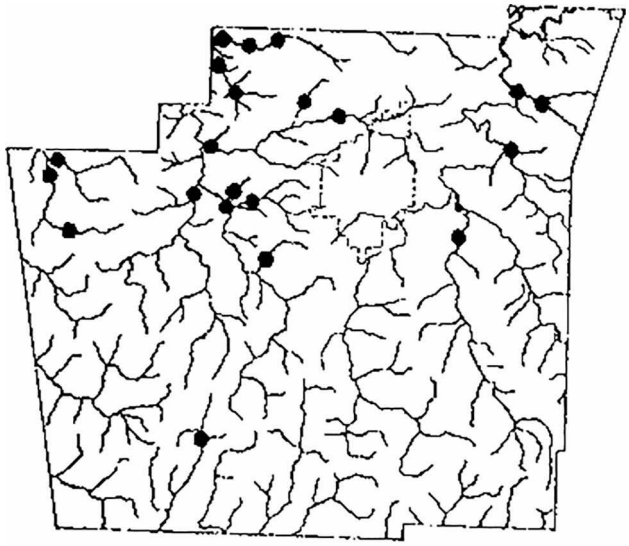
Map 25. Pimephales tenellus



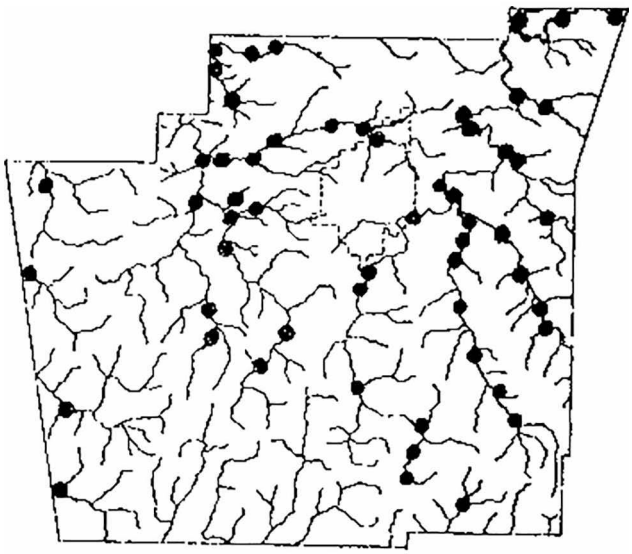
Map 26. Campostoma anomalum



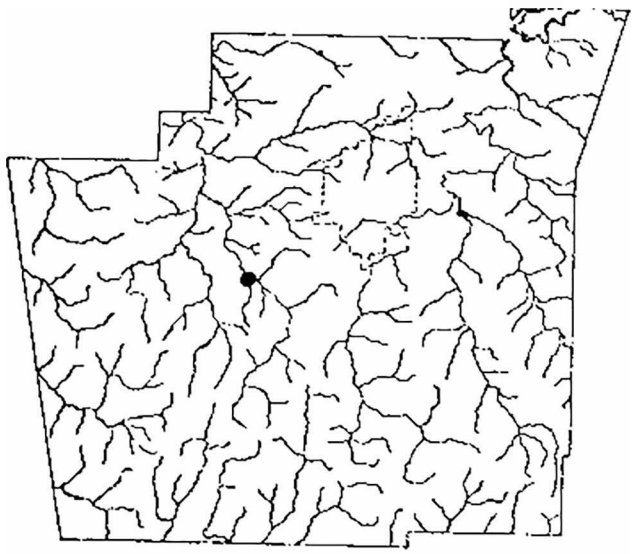
Map 27. Campostoma oligolepis



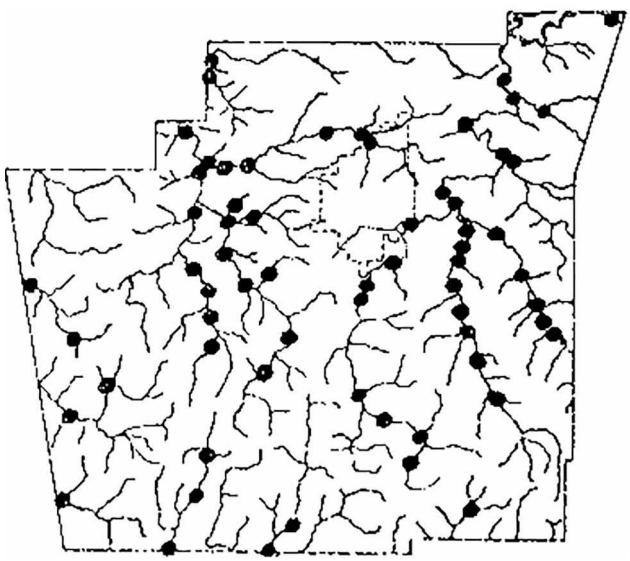
Map 28. Chrosomus erythrogaster



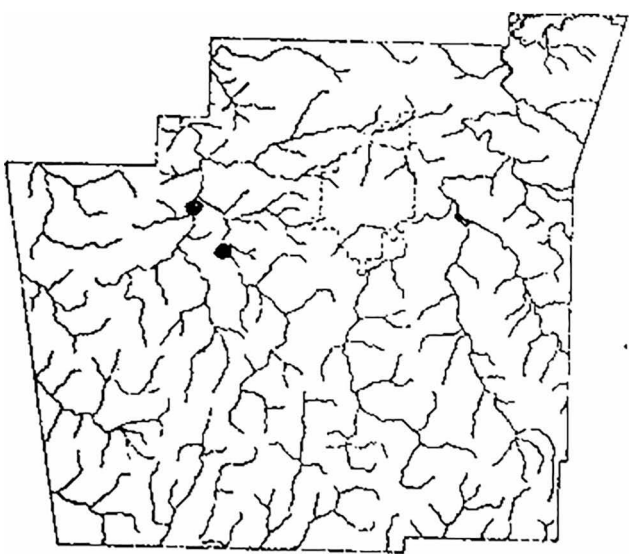
Map 29. Dionda nubila



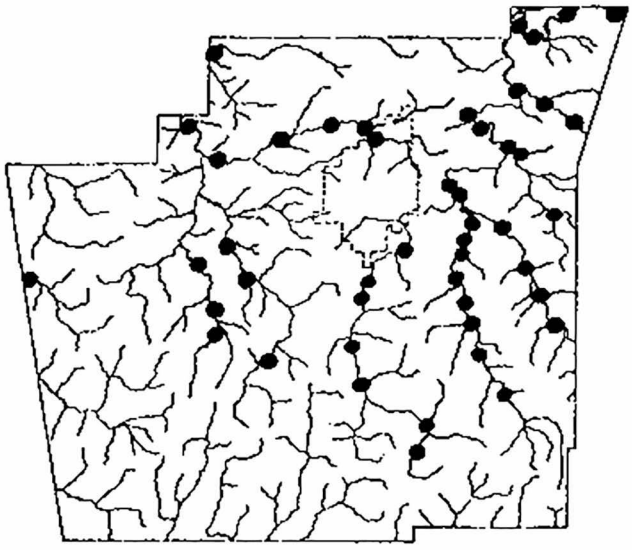
Map 30. Notropis atherinoides



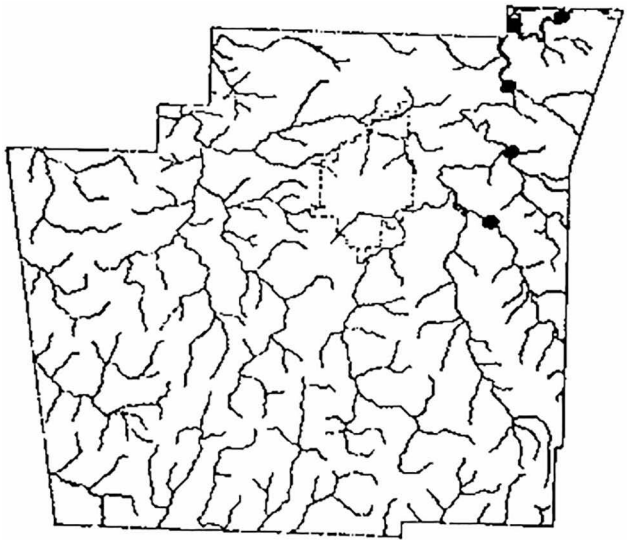
Map 31. Notropis boops



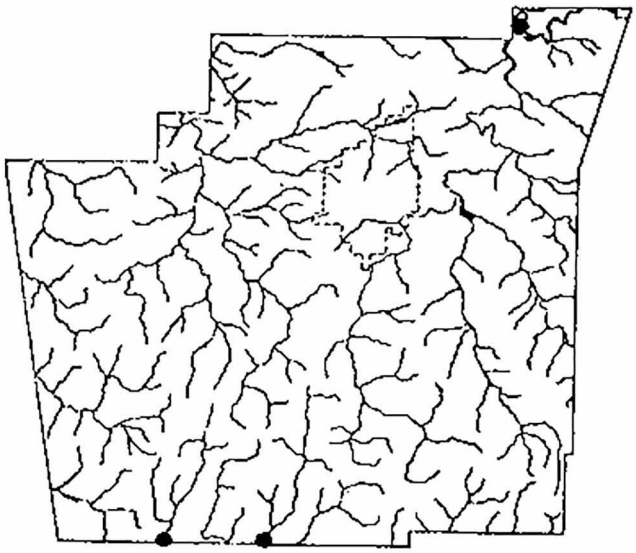
Map 32. Notropis camurus



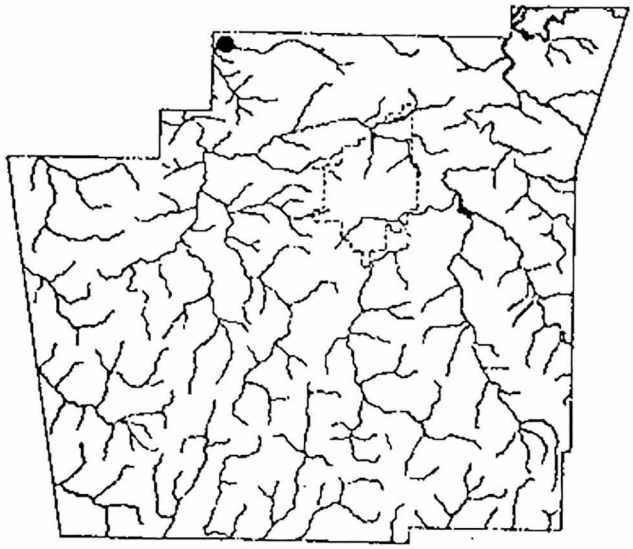
Map 33. Notropis chrysocephalus



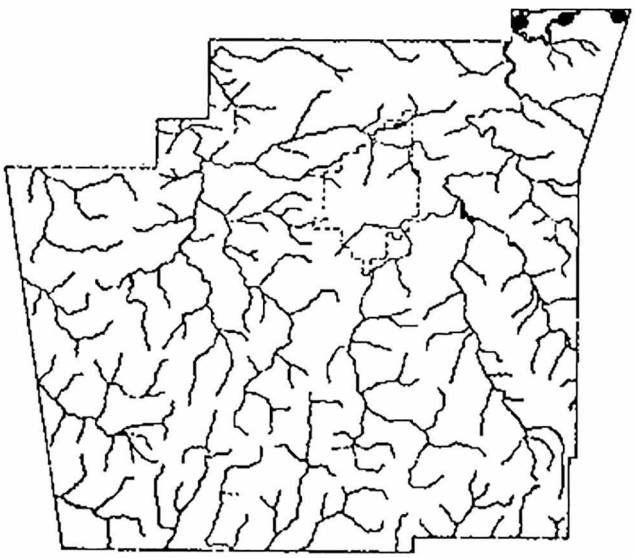
Map 34. Notropis galacturus



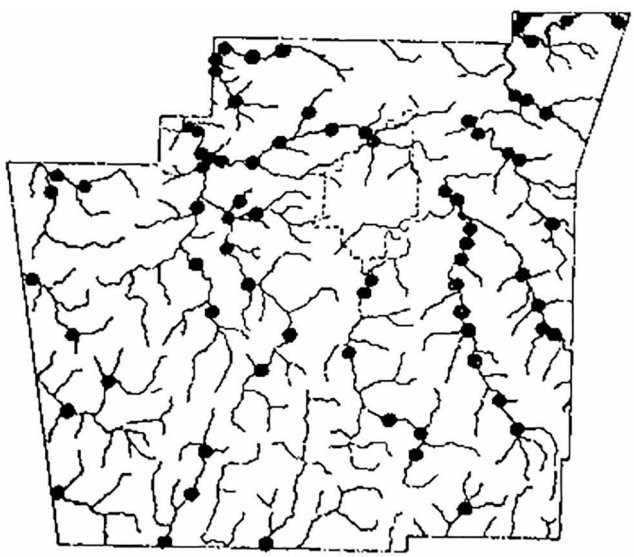
Map 35. Notropis greenei



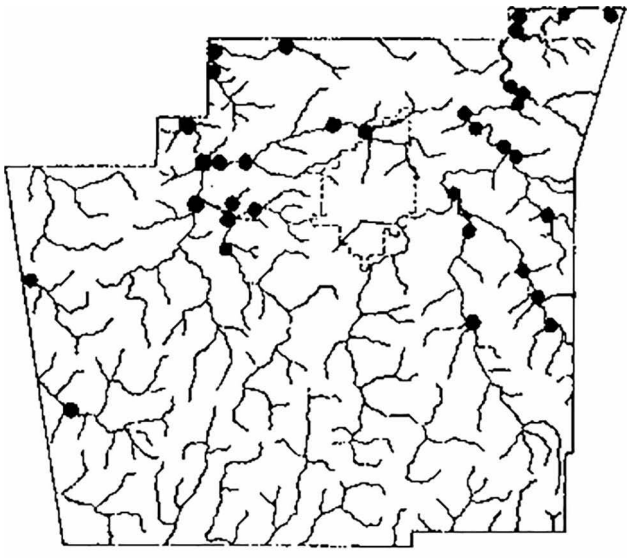
Map 36. Notropis lutrensis



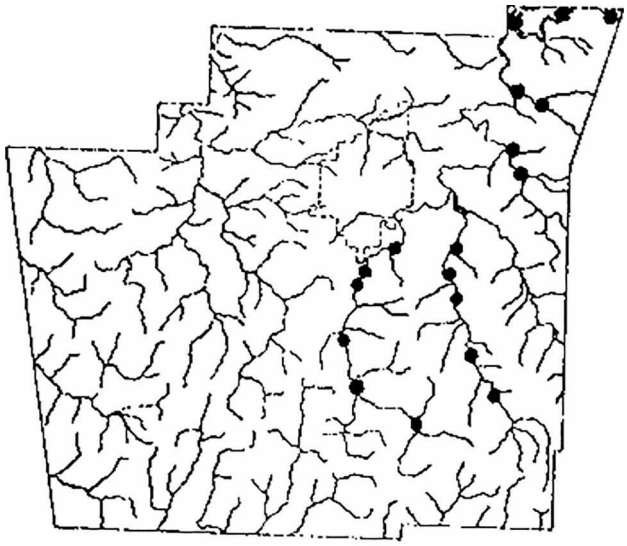
Map 37. Notropis ozarcanus



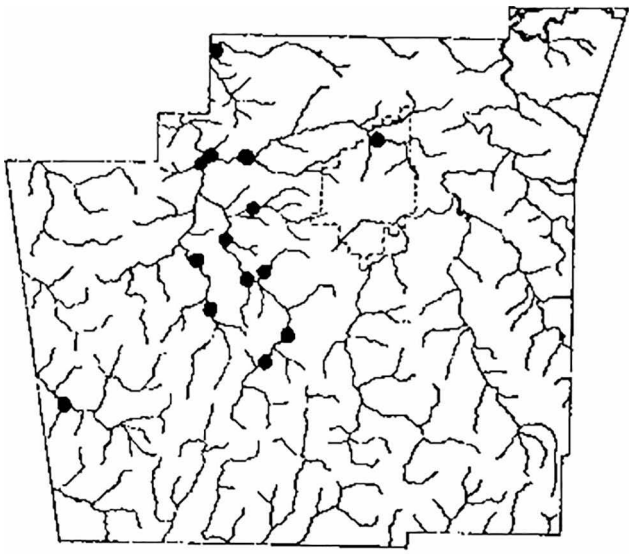
Map 38. Notropis pilsbryi



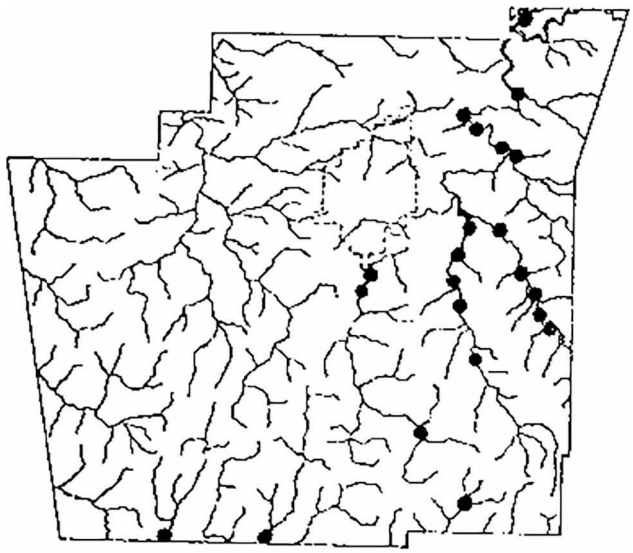
Map 39. Notropis rubellus



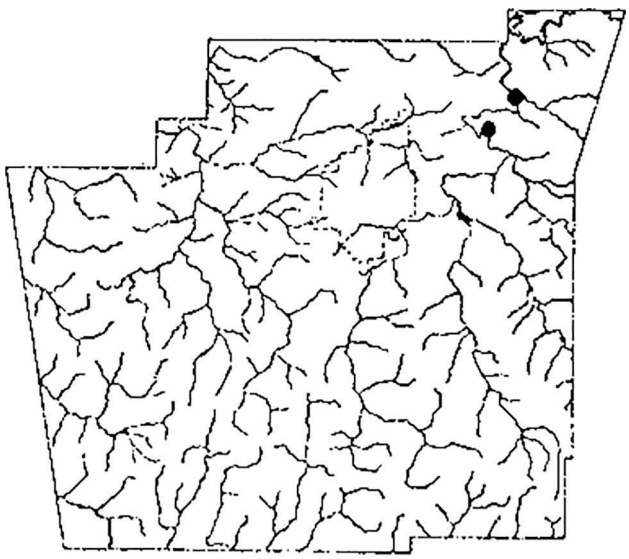
Map 40. Notropis telescopus



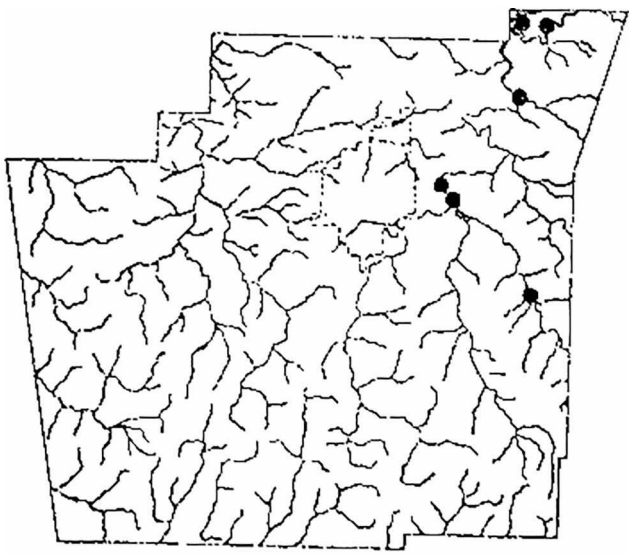
Map 41. Notropis umbratilis



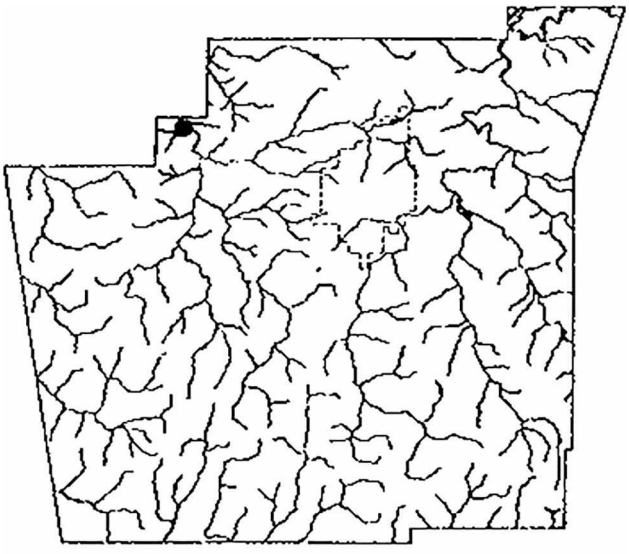
Map 42. Notropis whipplei



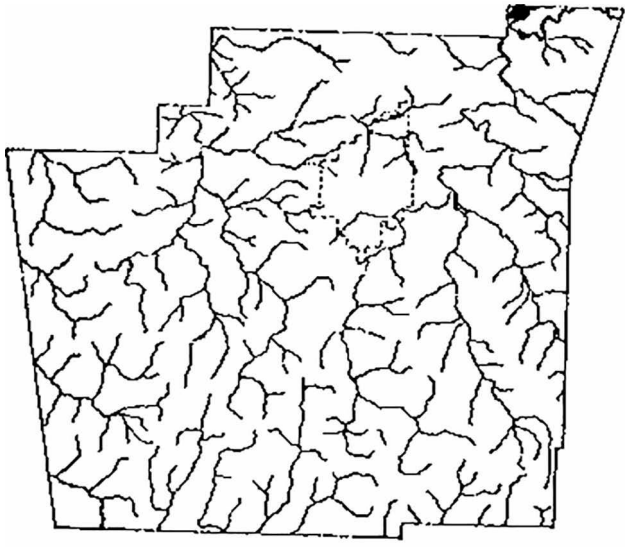
Map 43. Carpiodes cyprinus



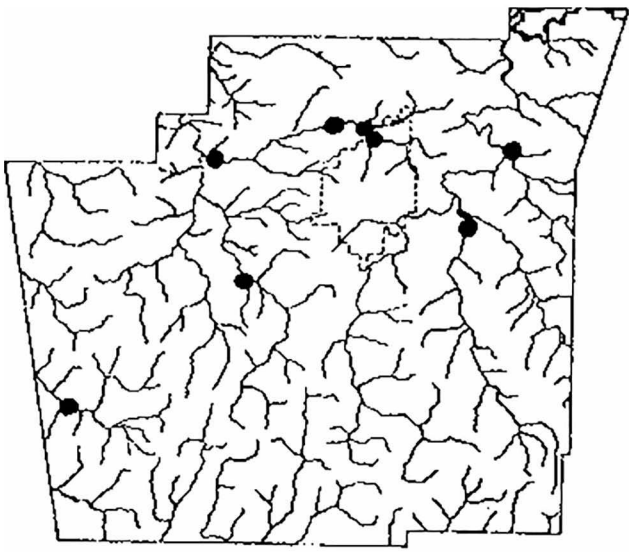
Map 44. Carpiodes velifer



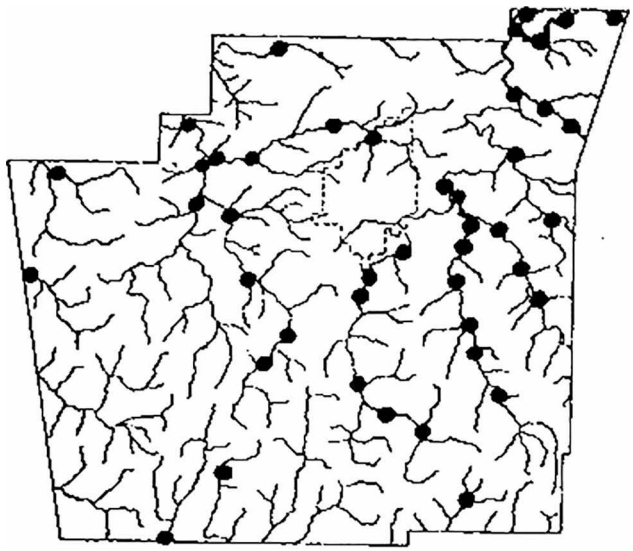
Map 45. Ictiobus bubalus



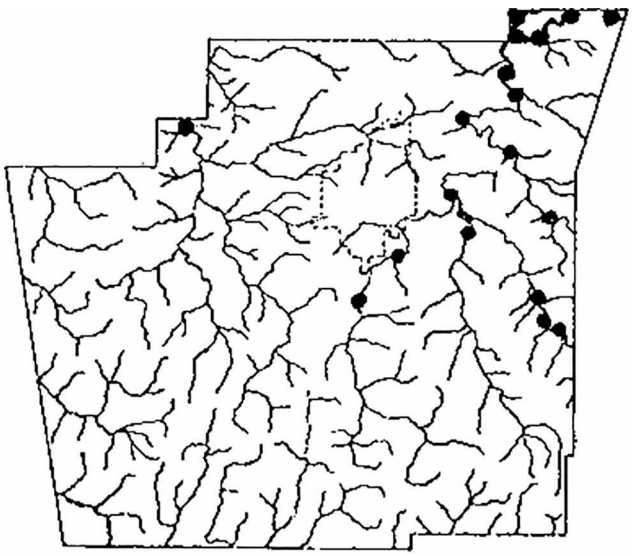
Map 46. Ictiobus cyprinellus



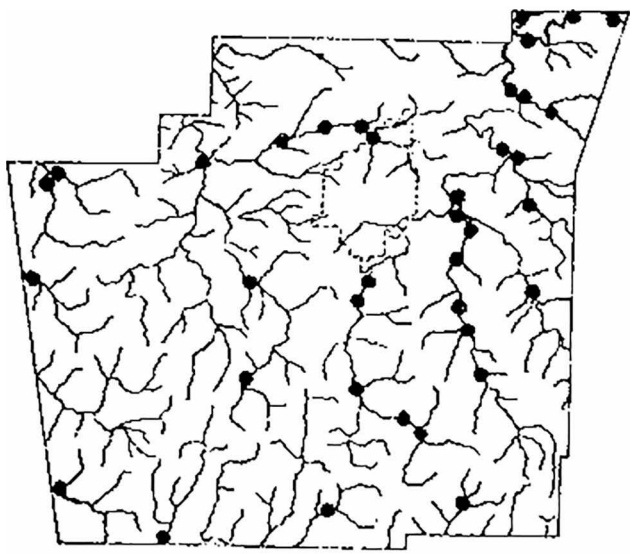
Map 47. Catostomus commersoni



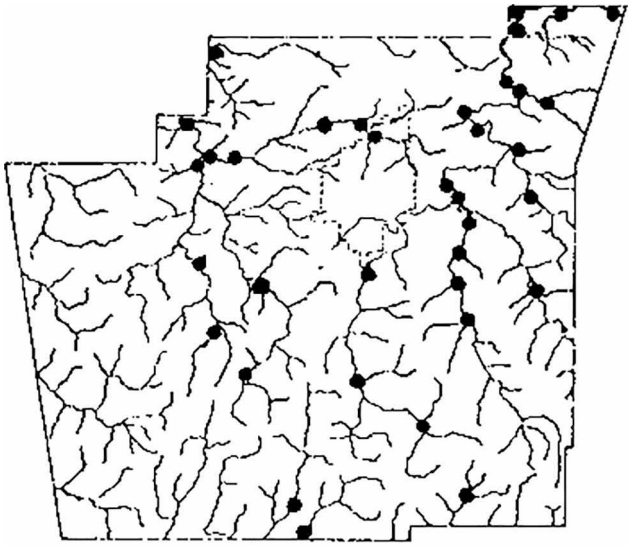
Map 48. Hypentelium nigricans



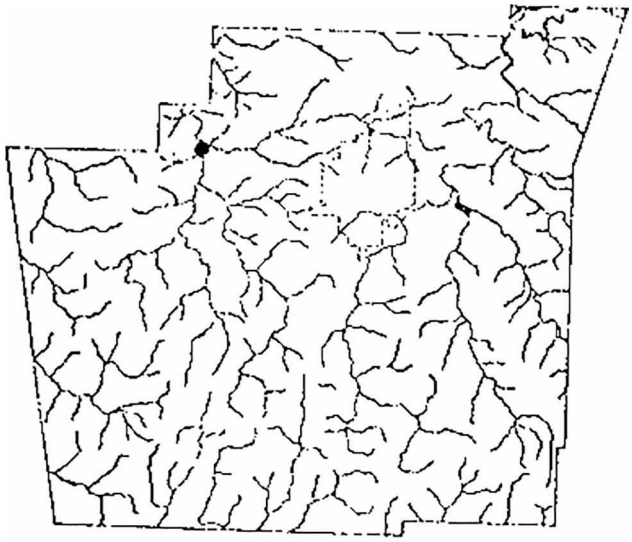
Map 49. Moxostoma carinatum



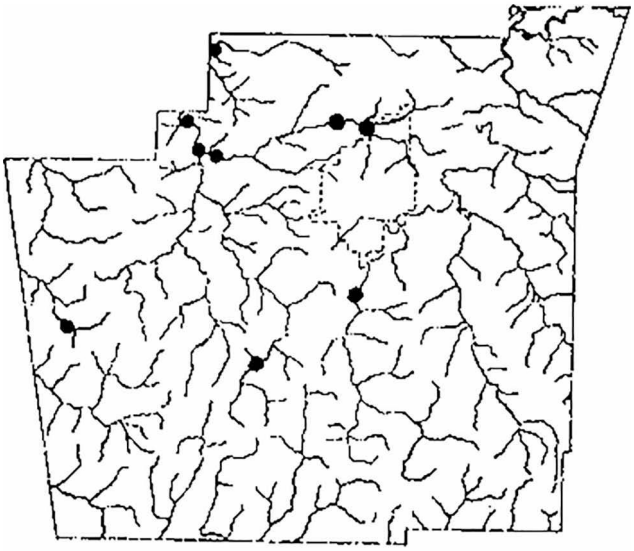
Map 50. Moxostoma duquesnei



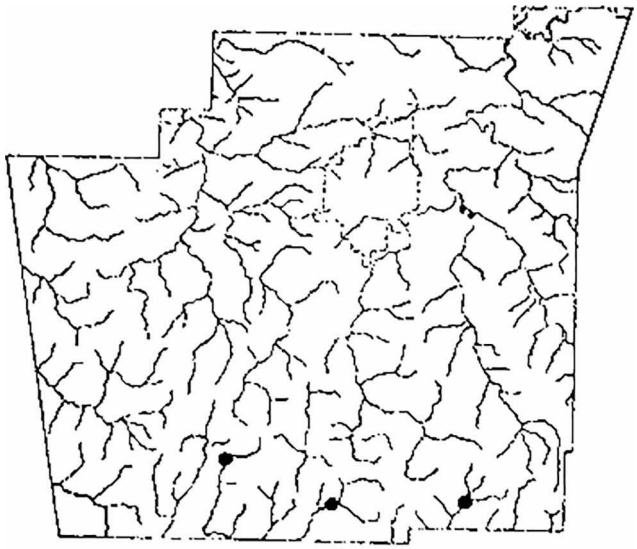
Map 51. Moxostoma erythrurum



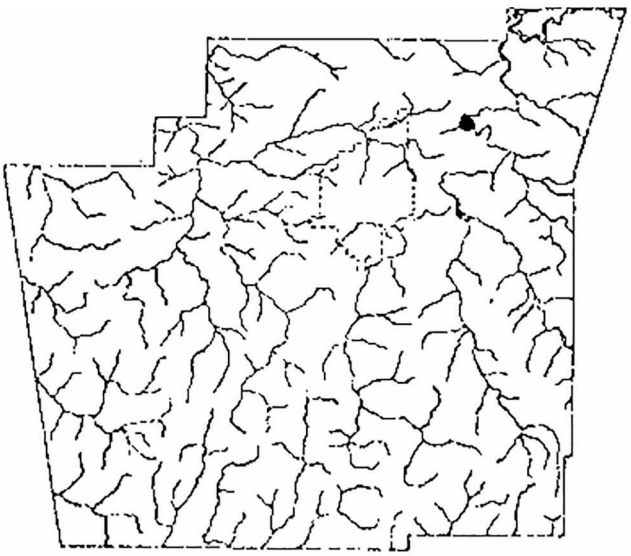
Map 52. Moxostoma macrolepidotum



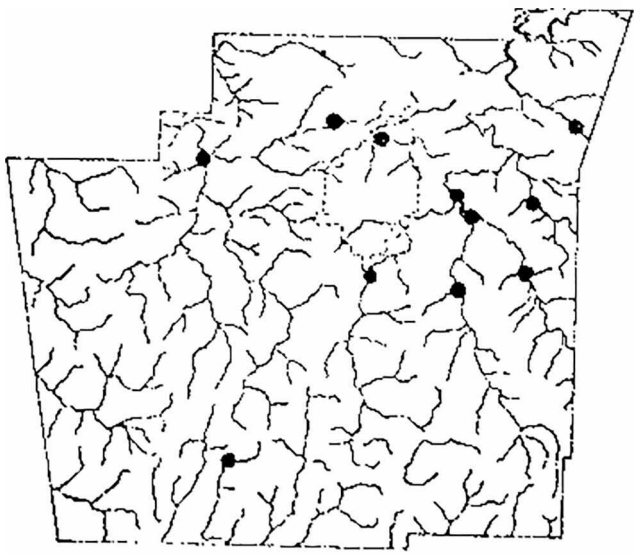
Map 53. Minytrema melanops



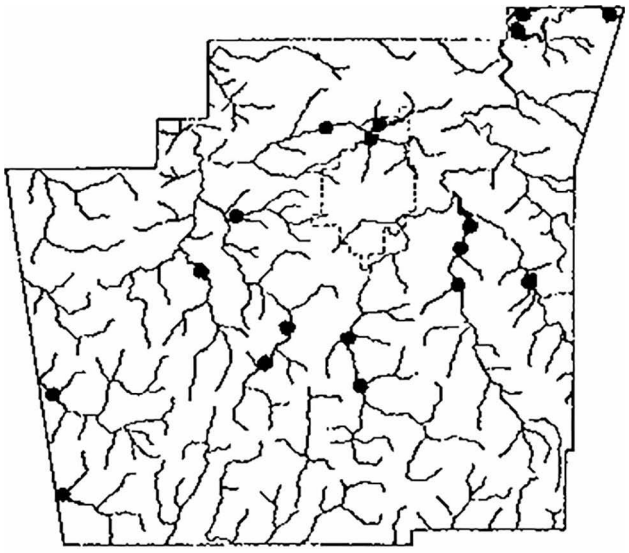
Map 54. Erimyzon oblongus



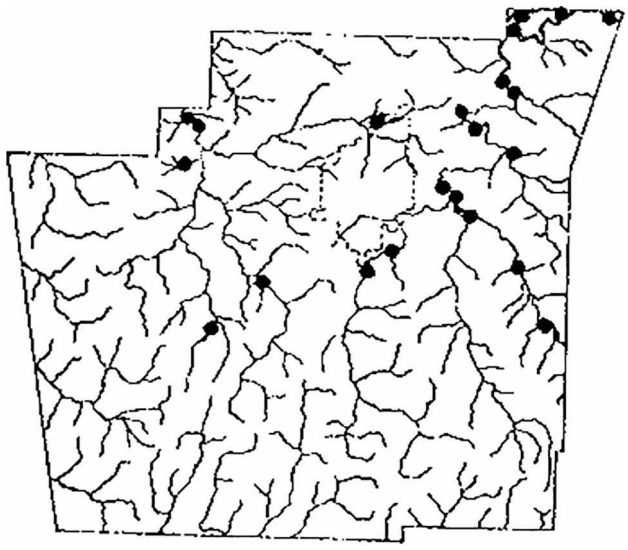
Map 55. Ictalurus furcatus



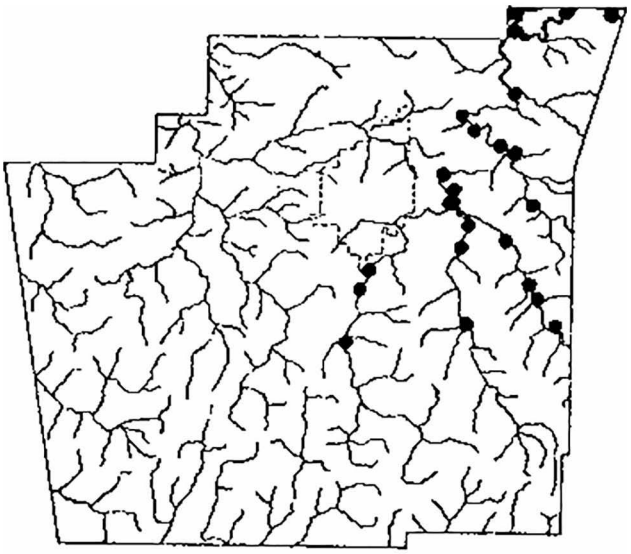
Map 56. Ictalurus melas



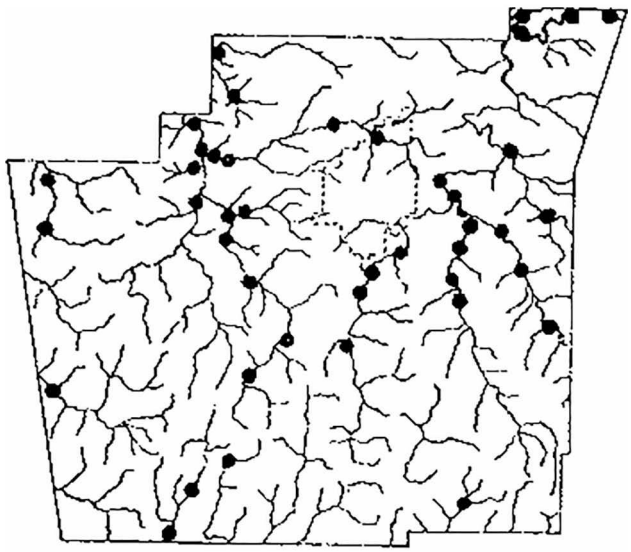
Map 57. Ictalurus natalis



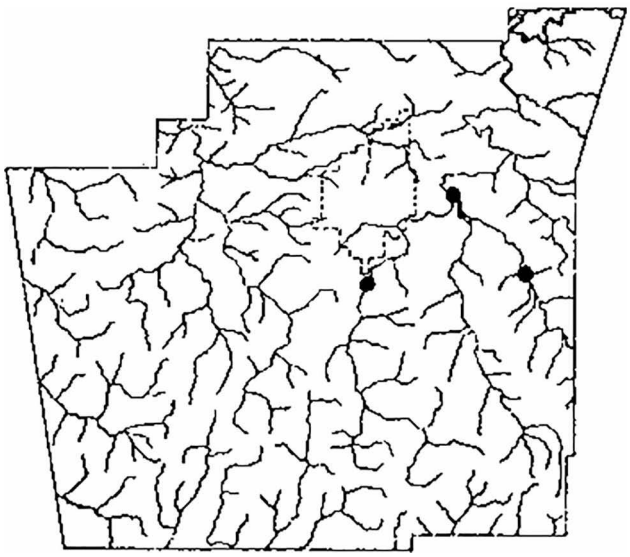
Map 58. Ictalurus punctatus



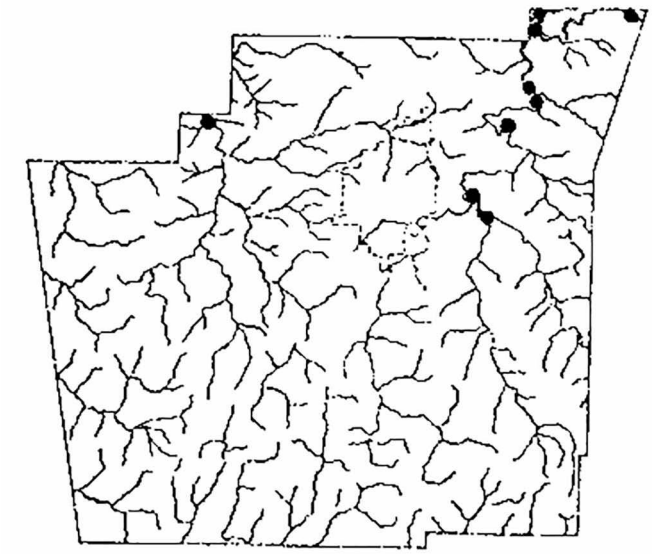
Map 59. Noturus albater



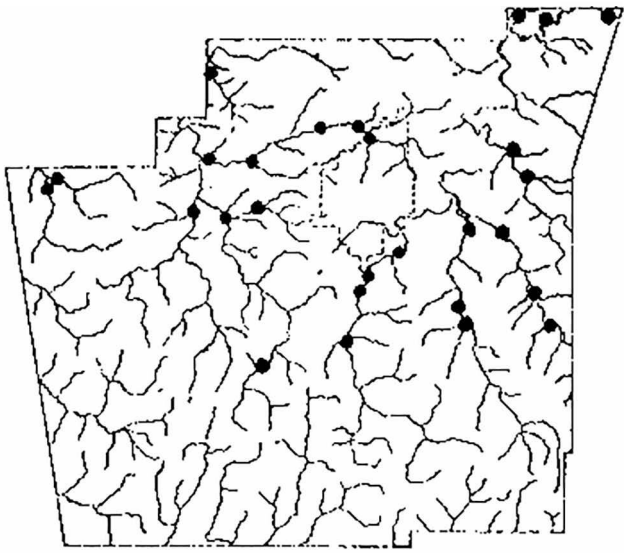
Map 60. Noturus exilis



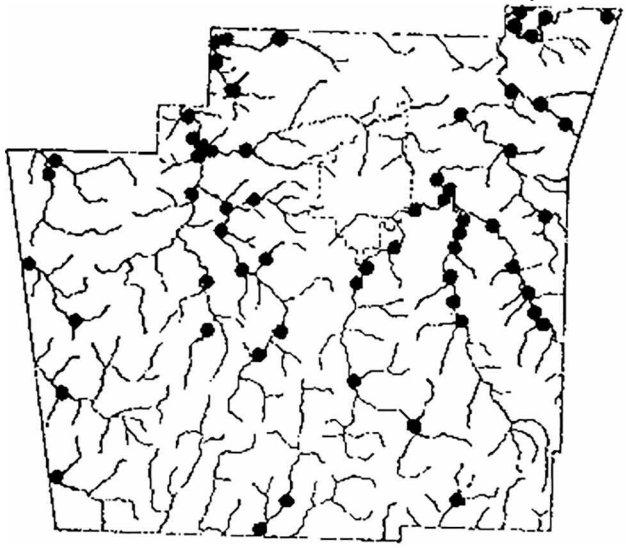
Map 61. Noturus flavater



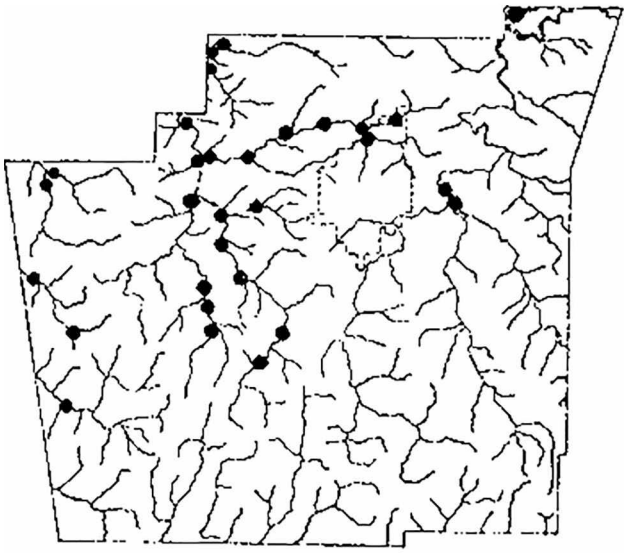
Map 62. Pylodictis olivaris



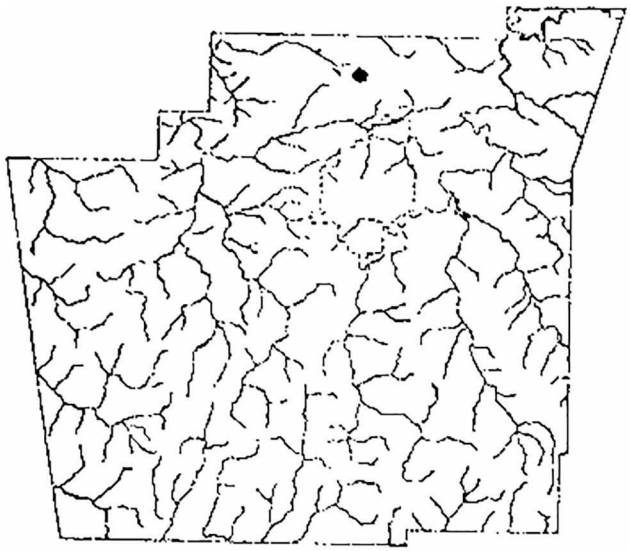
Map 63. Fundulus catenatus



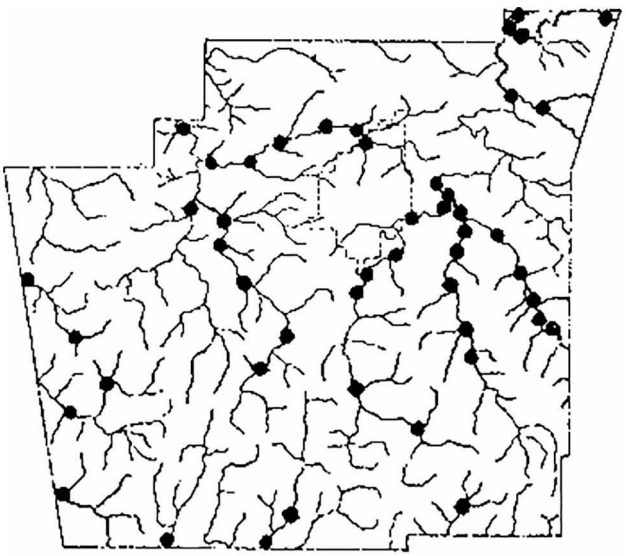
Map 64. Fundulus olivaceus



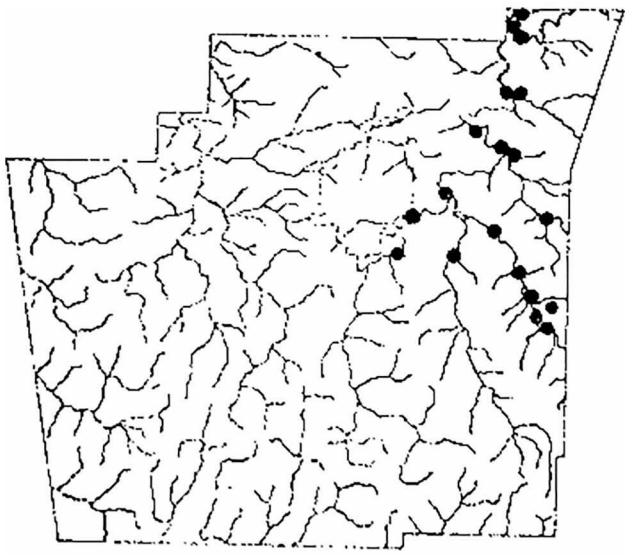
Map 65. Gambusia affinis



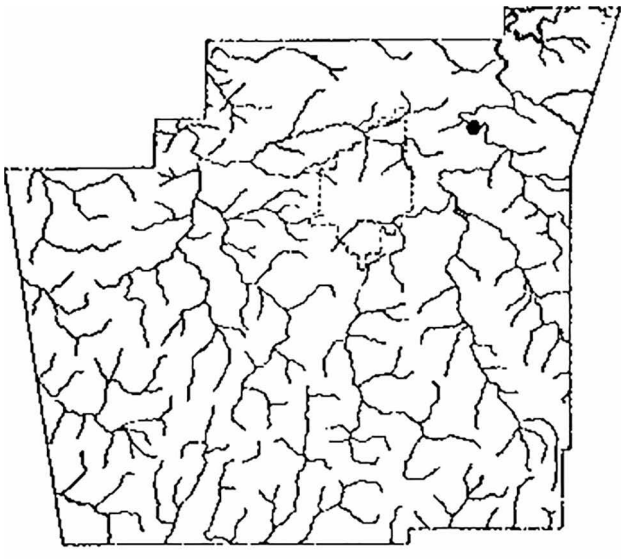
Map 66. Amblyopsis rosae



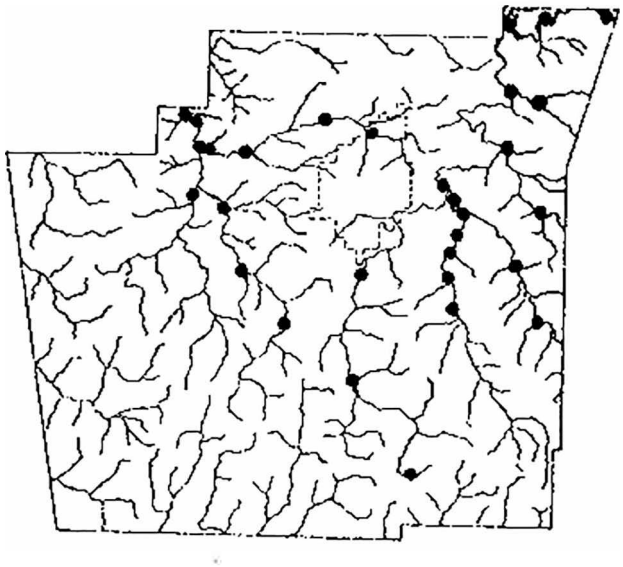
Map 67. Labidesthes sicculus



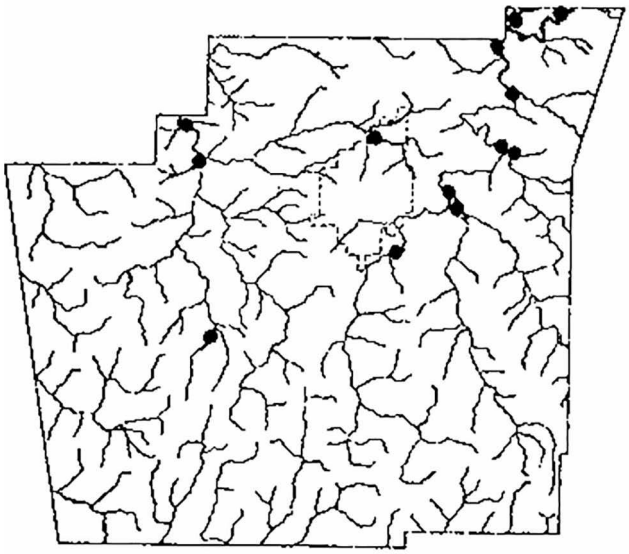
Map 68. Morone chrysops



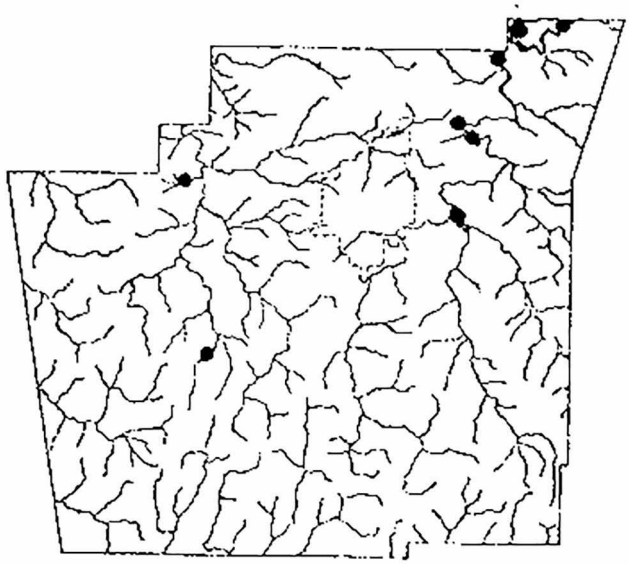
Map 69. Morone saxatilis



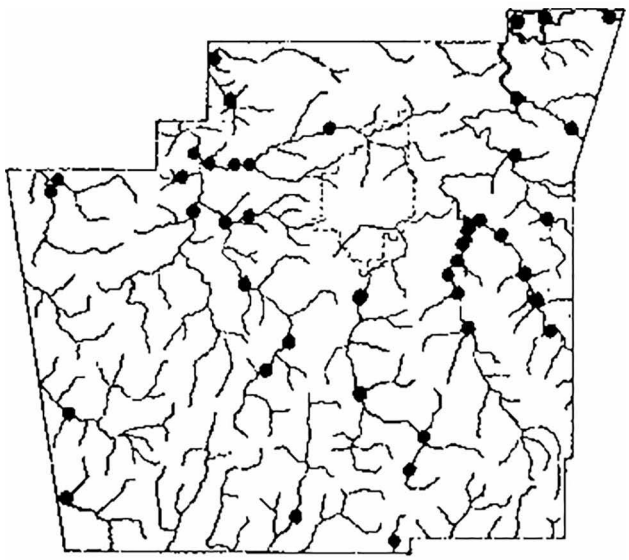
Map 70. Ambloplites rupestris



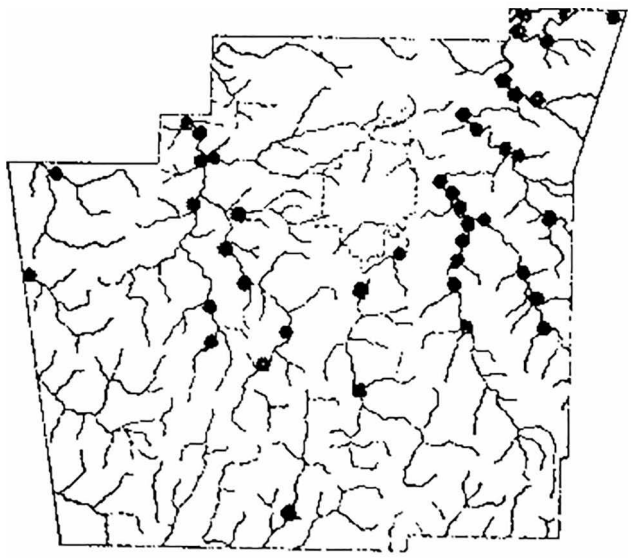
Map 71. Pomoxis annularis



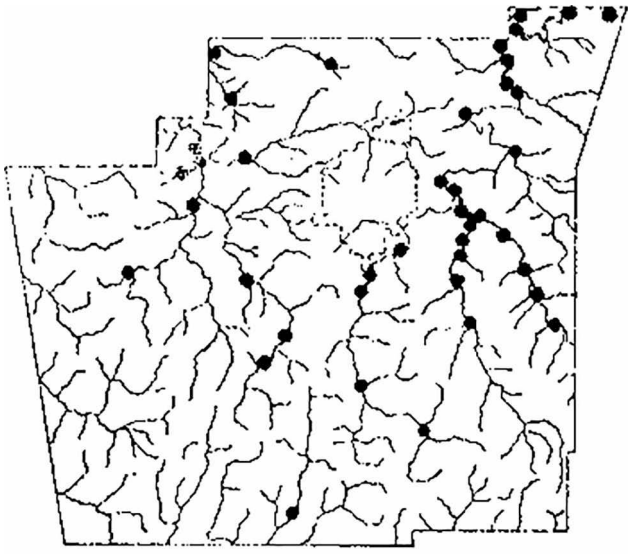
Map 72. Pomoxis nigromaculatus



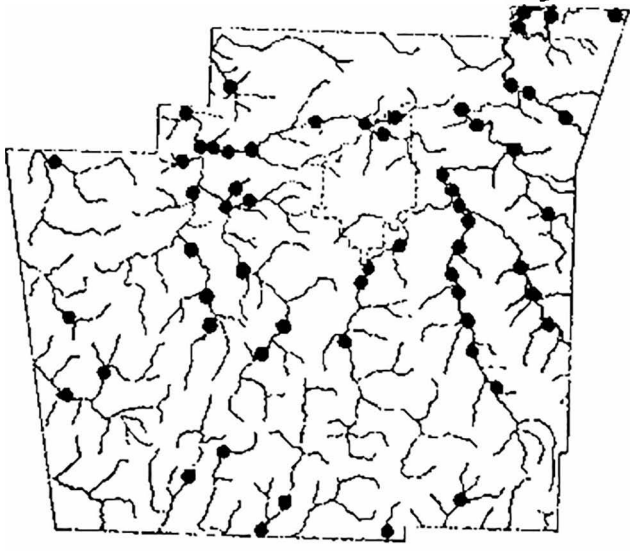
Map 73. Micropterus dolomieui



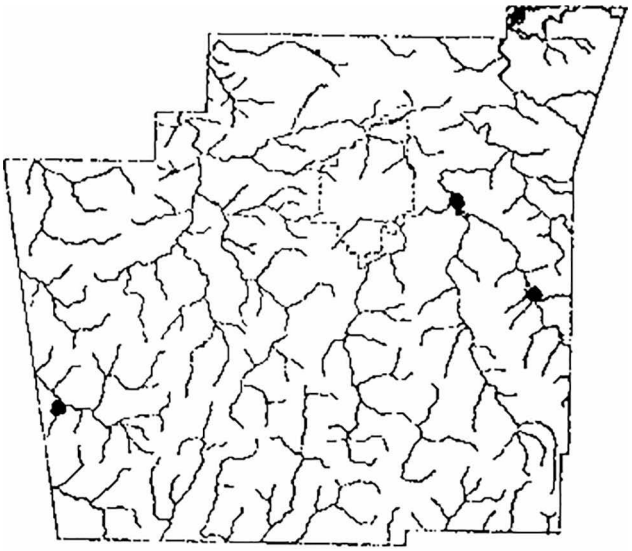
Map 74. Micropterus punctulatus



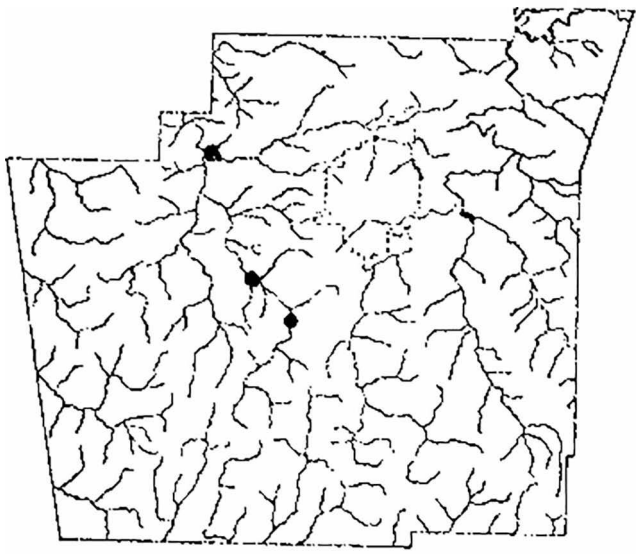
Map 75. Micropterus salmoides



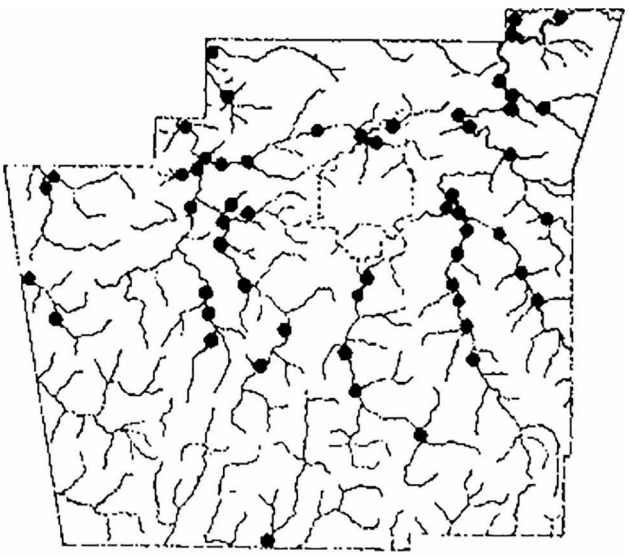
Map 76. Lepomis cyanellus



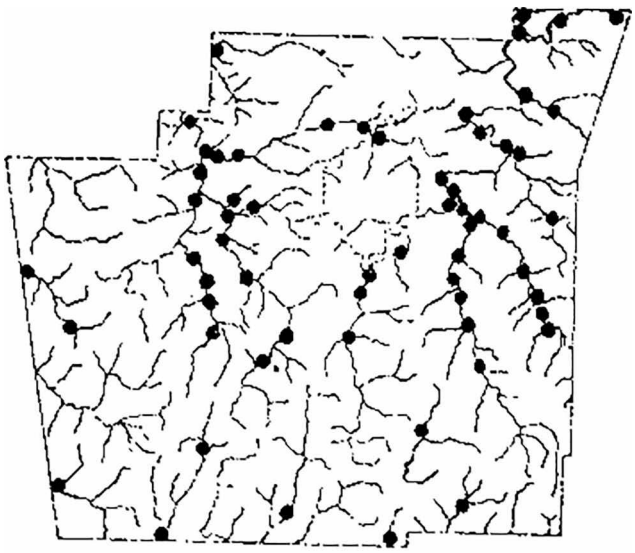
Map 77. Lepomis gulosus



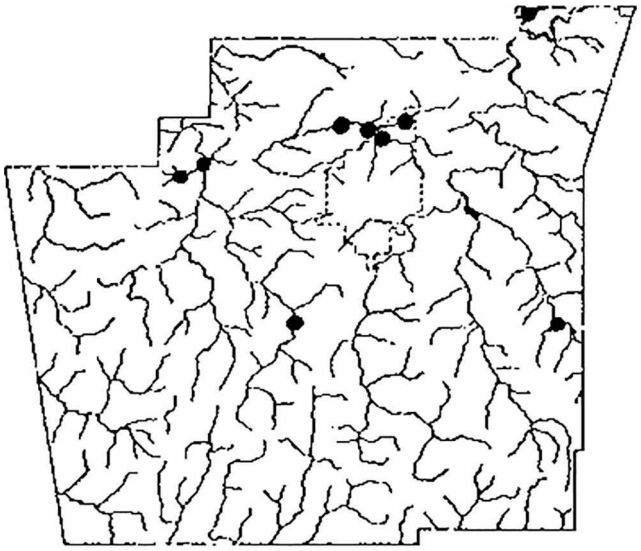
Map 78. Lepomis humilis



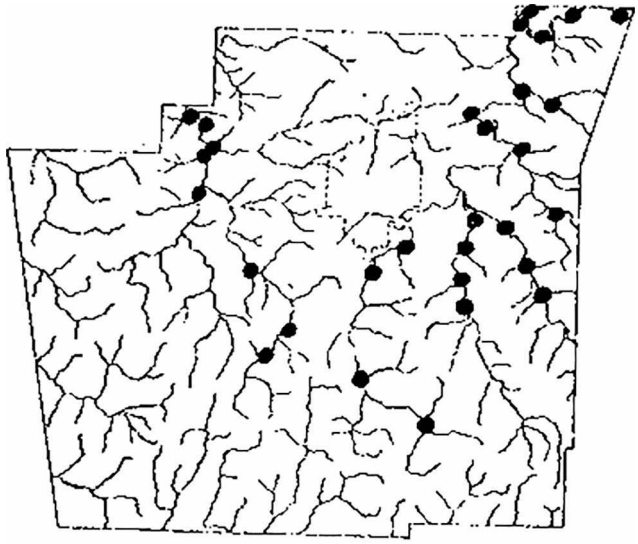
Map 79. Lepomis macrochirus



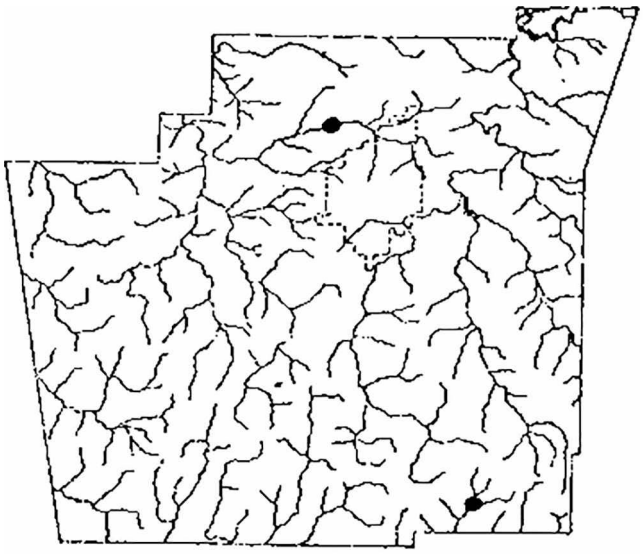
Map 80. Lepomis megalotis



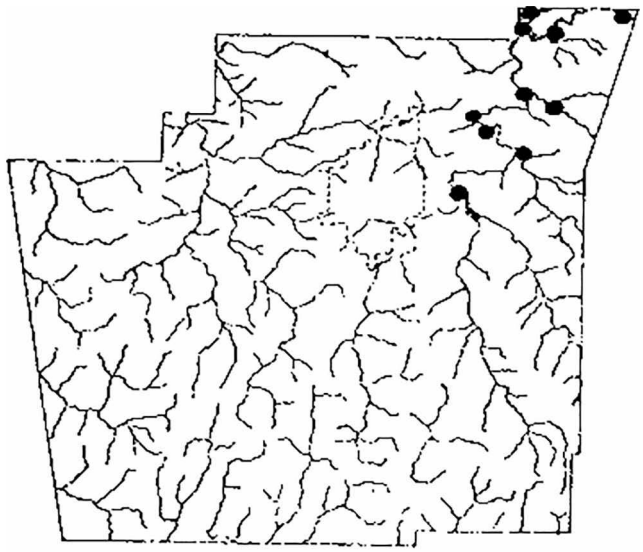
Map 81. Lepomis microlophus



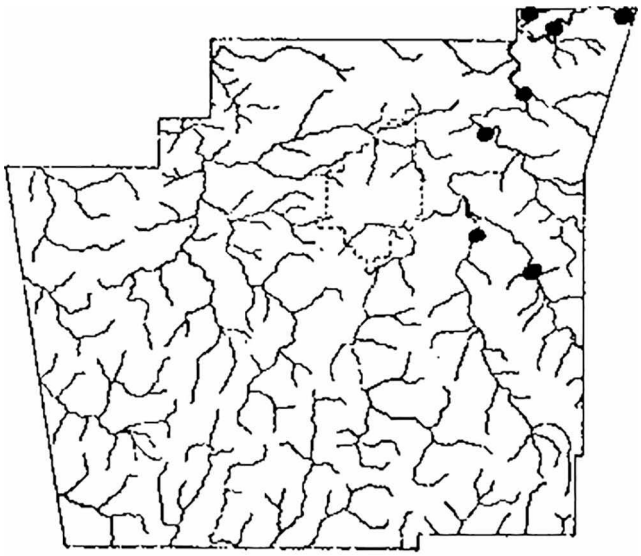
Map 82. Percina caprodes



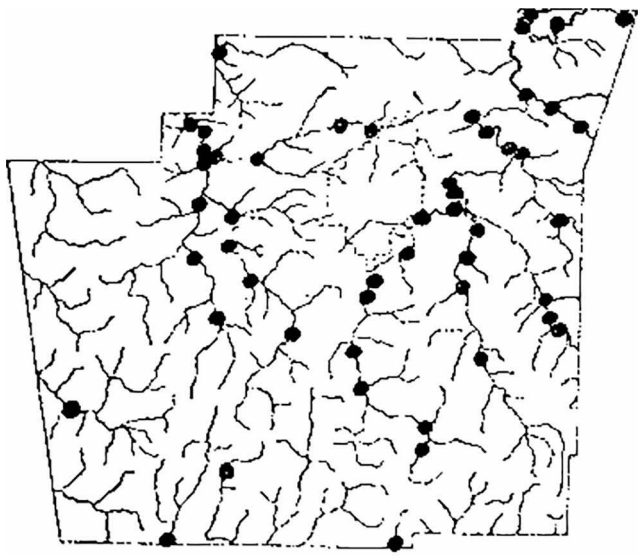
Map 83. Percina copelandi



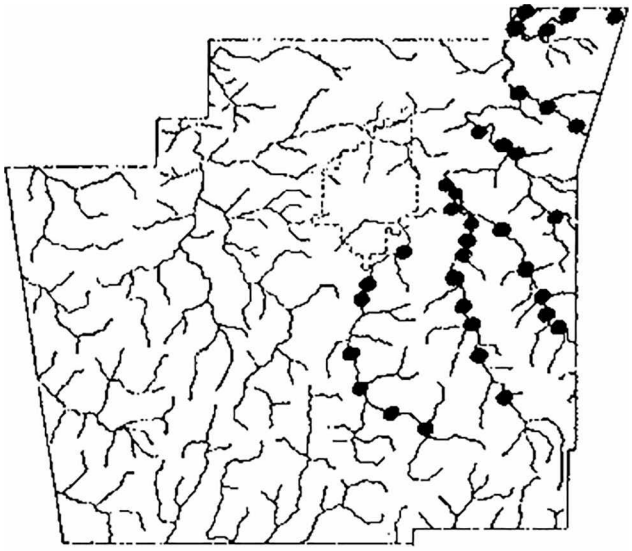
Map 84. Percina evides



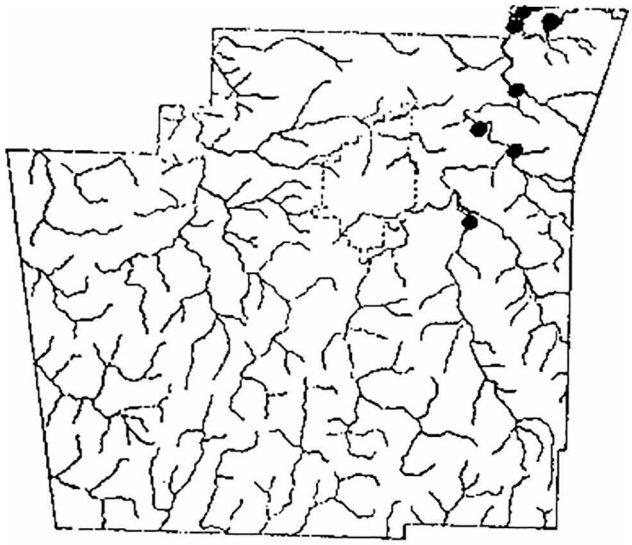
Map 85. Percina nasuta



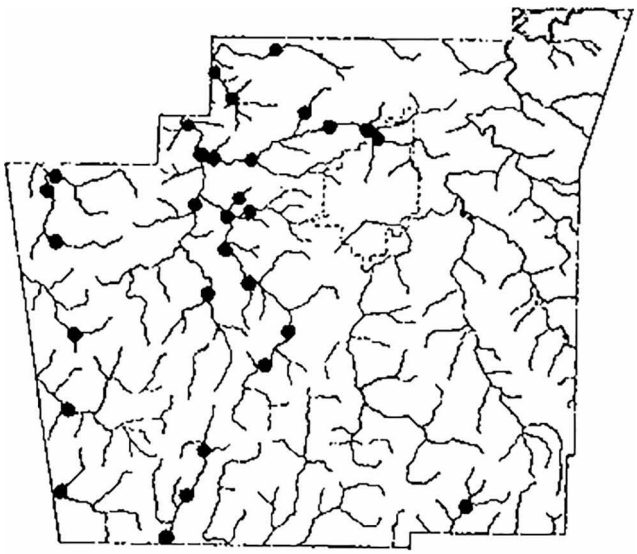
Map 86. Etheostoma blennioides



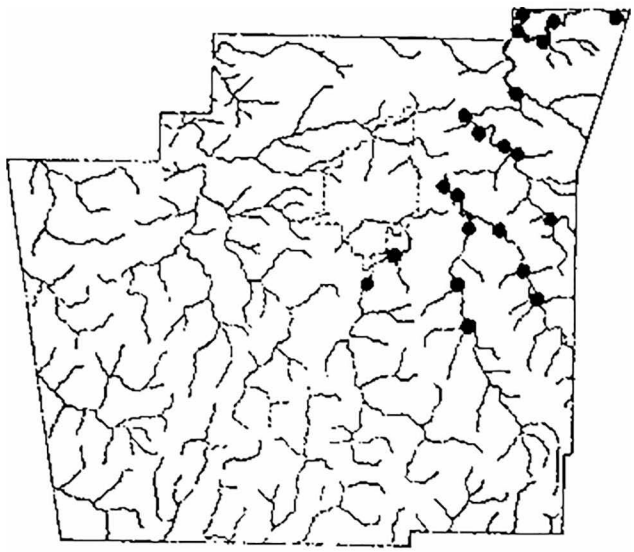
Map 87. Etheostoma caeruleum



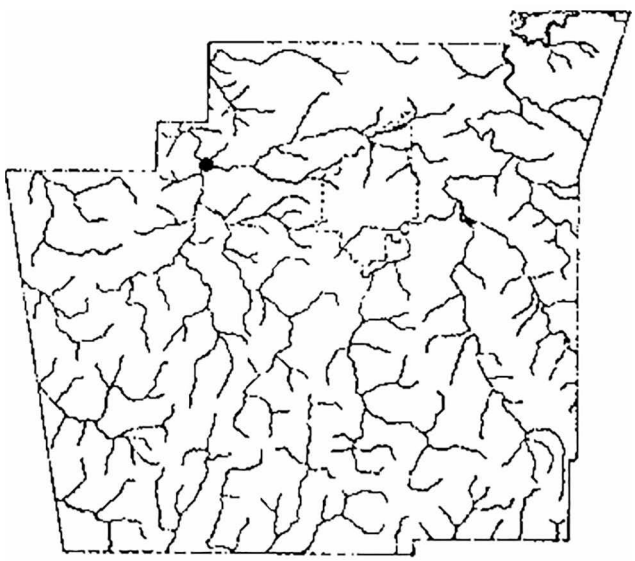
Map 88. Etheostoma euzonum



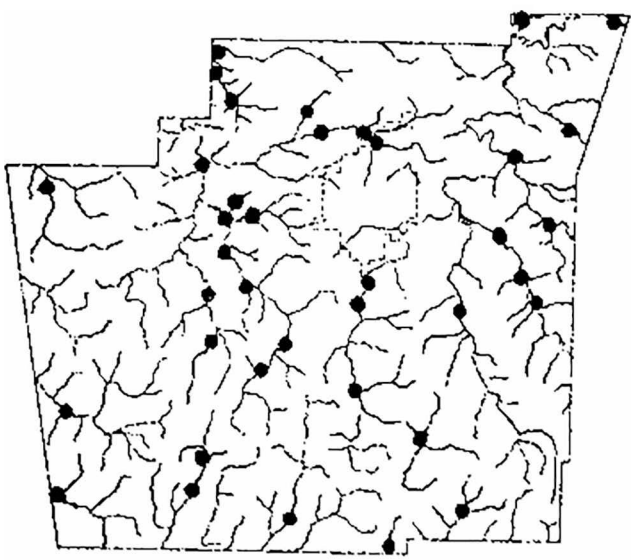
Map 89. Etheostoma flabellare



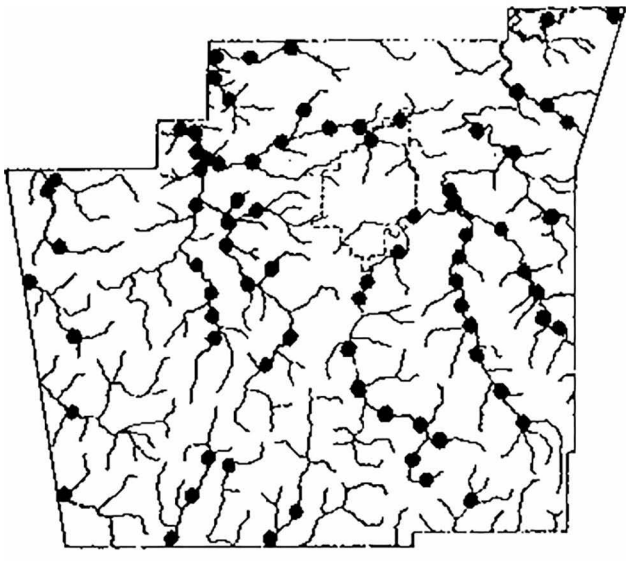
Map 90. Etheostoma juliae



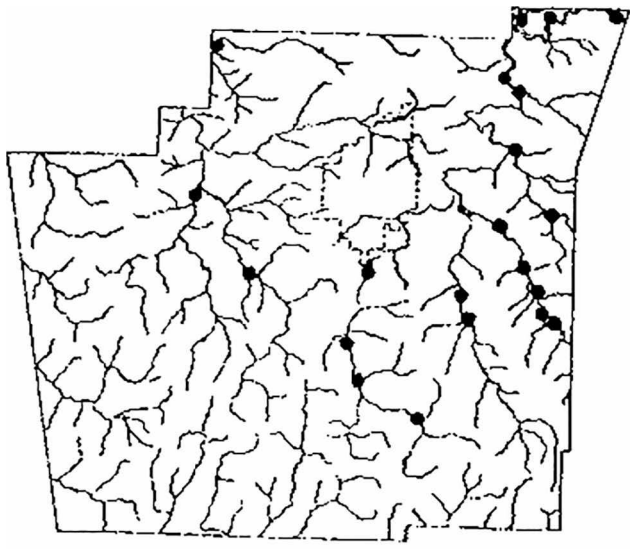
Map 91. Etheostoma microperca



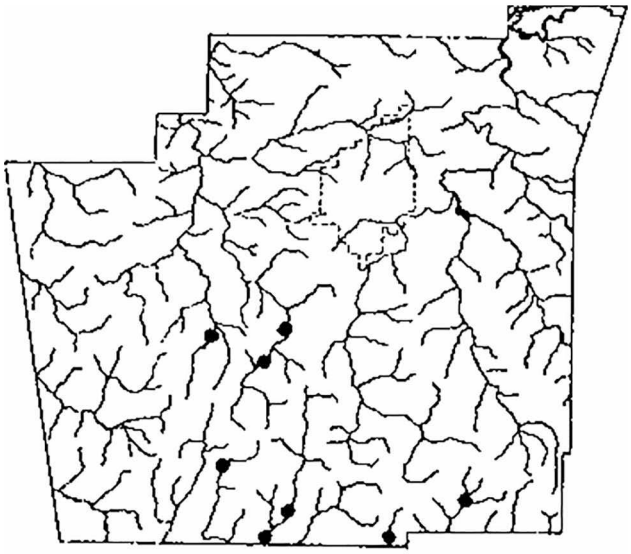
Map 92. Etheostoma punctulatum



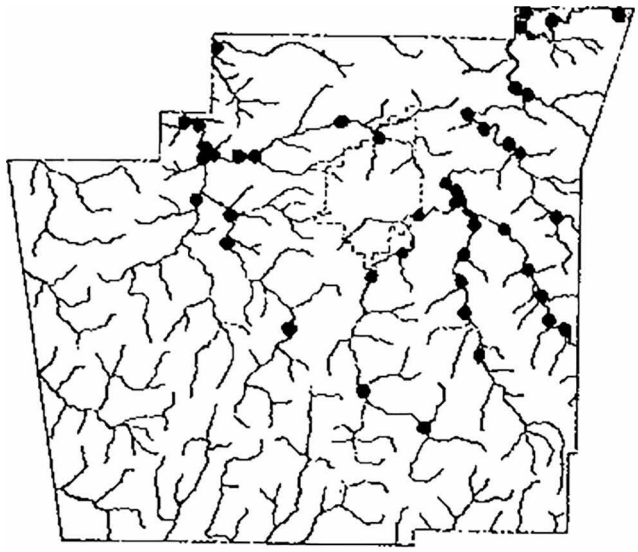
Map 93. Etheostoma spectabile



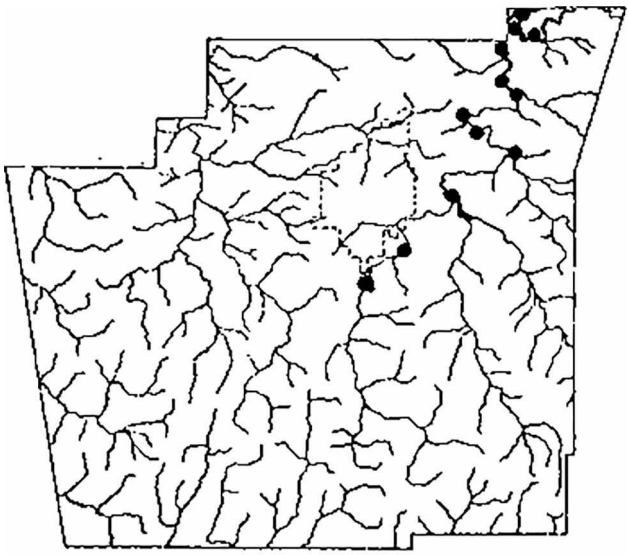
Map 94. Etheostoma stigmaeum



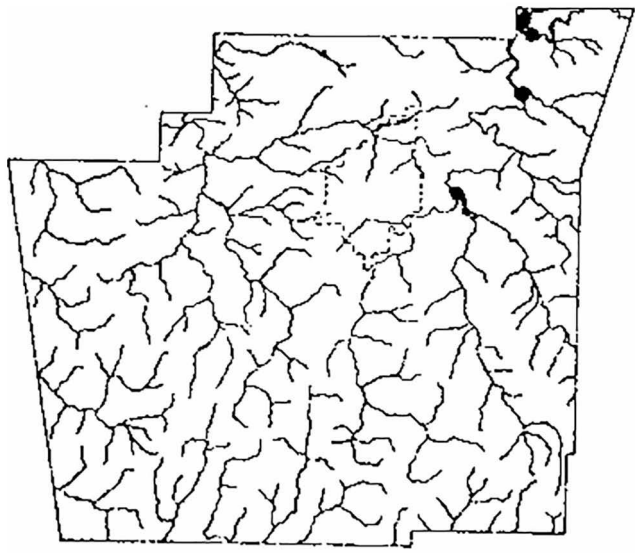
Map 95. Etheostoma whipplei



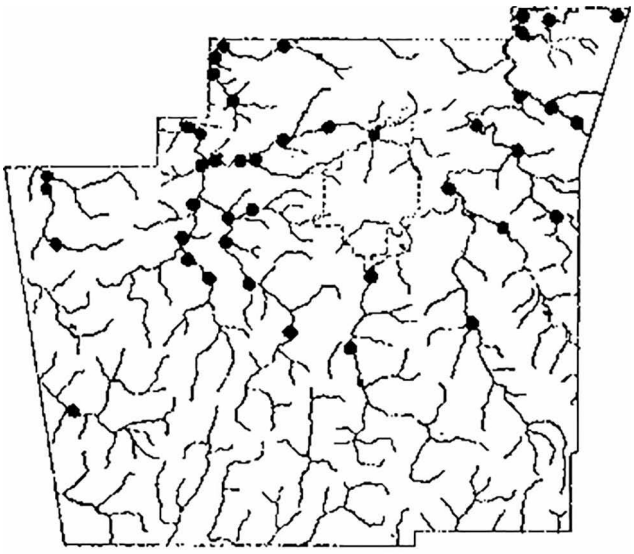
Map 96. Etheostoma zonale

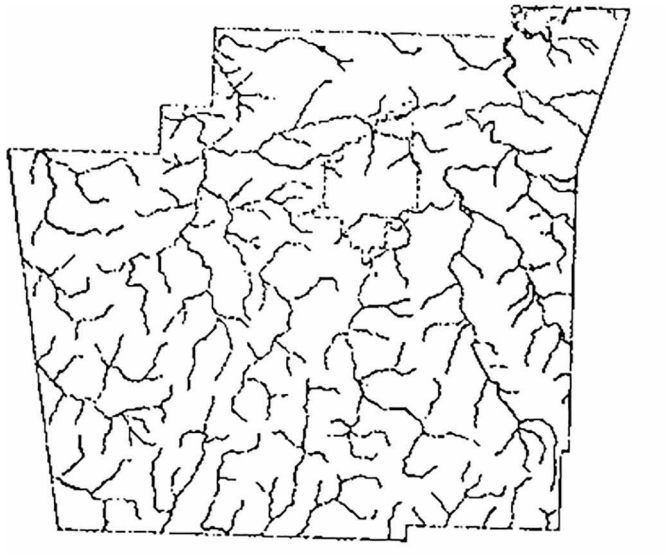


Map 97. Stizostedion vitreum



Map 98. Aplodinotus grunniens





Map 99. Cottus carolinae