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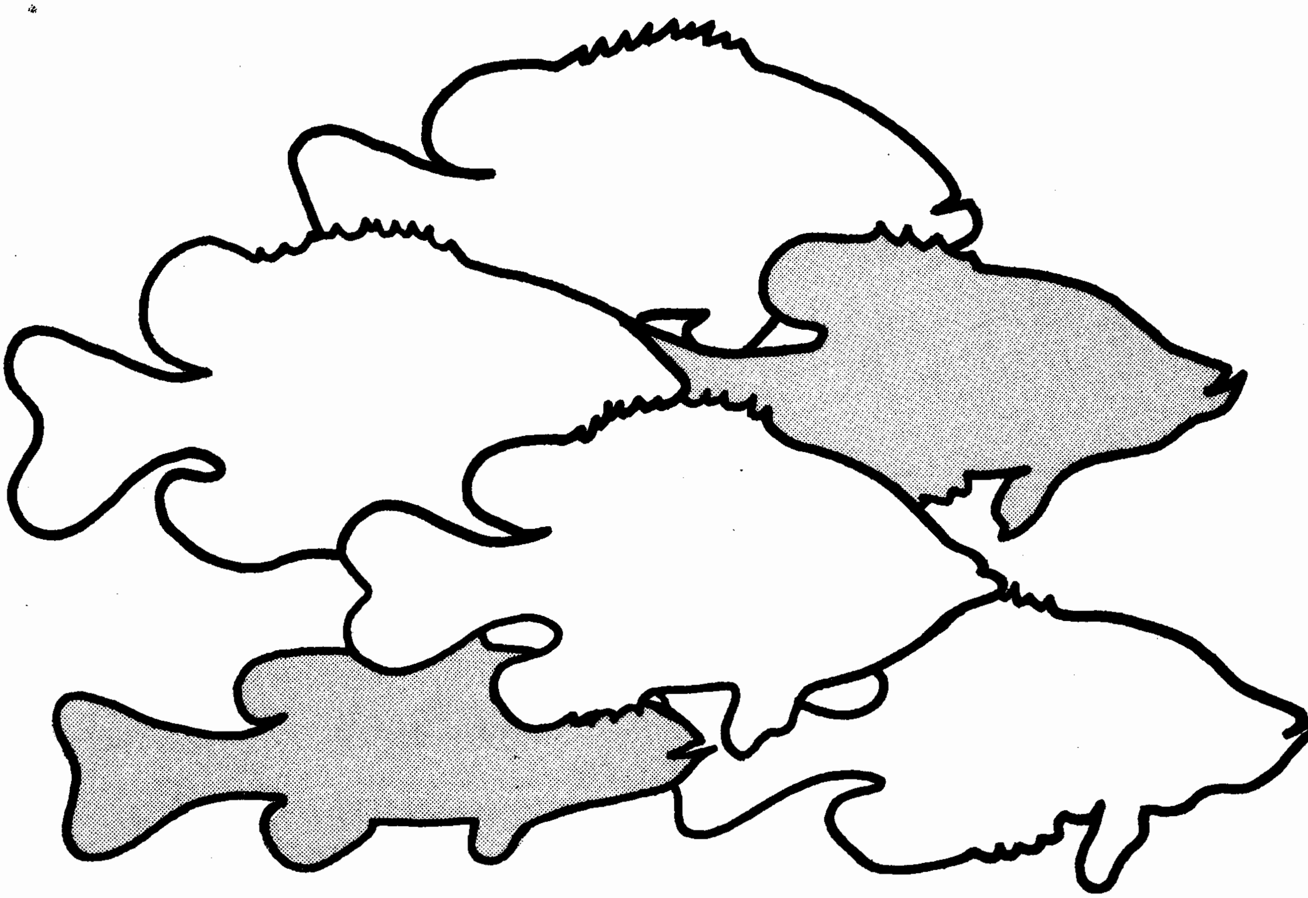
AMERICAN FISHERIES SOCIETY

PROCEEDINGS

ANNUAL MEETING
MISSISSIPPI CHAPTER



VOL. II 1978

PROCEEDINGS

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AMERICAN FISHERIES SOCIETY

FEBRUARY 16, 1978

UNIVERSITY, MISS.

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PREFACE

The fourth annual meeting of the Mississippi Chapter of the American Fisheries Society was held February 16th, 1978, on the campus of the University of Mississippi, Oxford, Mississippi. The purpose of this, and other annual meetings, is the exchange of information pertinent to fisheries in Mississippi. The attainment of this purpose was evidenced by the attendance at the meeting. The Game and Fish Commission, three universities, seven federal agencies and various private industries in the state were represented.

The Chapter is young, but active and growing. Membership has again increased by one third over the proceeding year. Since our future success is dependent on our present and past performance, the Chapter is indebted to the authors and speakers, local arrangement personnel, and all who lent support through their participation in the meeting.

This is the second Proceedings attempted by the Chapter. Since publication procedures have not yet been determined by the Chapter, the papers presented herein have been reproduced in the same form in which they were received. No editorial corrections have been made.

Cost for publication of the Proceedings has been met by the Mississippi Game and Fish Commission. This publication was compiled by John Burris, Jack Herring, Clara Johnston, and Hal Schramm.

Mississippi Chapter
American Fisheries Society
October, 1978

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CORPS OF ENGINEERS' ECOLOGICAL STUDY OF THE MISSISSIPPI RIVER

by

Harold L. Schramm, Jr.
Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
Vicksburg, Mississippi 39180

The Waterways Experiment Station (WES) is conducting a six year, nationwide program of applied research to investigate selected, high priority environmental quality problems associated with the Civil Works activities of the Corps of Engineers. This study is entitled Environmental and Water Quality Operational Studies (EWQOS).

The principle goal of the EWQOS project is to develop new or improved methodologies for planning, design, construction, and operation of Corps of Engineers' projects, so that project purposes are achieved while environmental quality is maintained or enhanced.

During the early planning phase of EWQOS, WES personnel visited Corps of Engineers' Division Offices to identify and assess environmental quality problems associated with Civil Works projects. One major problem area identified was the effects of dikes and revetments on the ecology of navigable waterways.

Dikes, constructed of pilings or, more commonly, rock rip-rapping, are used for channel alignment, adjustment of channel width and depth, and bank stabilization. The configuration of dikes varies with purpose. Transverse dikes extend perpendicularly from the bank to the main channel. L-head and vane dikes are usually parallel with the bank. Dikes commonly form slackwater habitats and sandbars downstream of the dike. Revetments, constructed of rock rip-rap, asphalt pavement, or articulated concrete mats, are used for bank stabilization. Although both dikes and revetments alter the natural habitats in rivers, these navigation structures also provide habitats. The ecological effects of these structures are poorly known.

Dikes and/or revetments have been constructed in many U. S. waterways but occur most commonly in the Mississippi River. In the Lower Mississippi River there are presently 393 dikes totaling over 276 linear kilometers, and almost 1200 linear kilometers of revetment.

A research project was established within the framework of EWQOS to conduct a comprehensive investigation of the effects of dikes and revetments on the aquatic ecology of the Mississippi River. Based on the existence of extensive hydraulic and hydrologic data, a representative variety of dike and revetment designs, and the diversity of riverine and floodplain macrohabitats, the Mississippi River from below Greenville, MS, to above Lake Providence, LA, was selected for study. Specifically the study site includes the Mississippi River from levee to levee from mile 510 AHP to mile 530 AHP.

The goal of the long-term field study of dikes and revetments is to assess the relative ecological importance of these channel alignment and bank stabilization structures to the riverine ecosystem and formulate environmental quality guidelines to be used in the design and planning of new structures and modifications of existing ones. To reach this goal, five specific objectives will be accomplished.

1. Quantitatively define riverine macrohabitats of the study reach. For each macrohabitat, this will include such parameters as size, current velocity, substrate type, and associated riparian vegetation at various river stages and times of year.
2. Quantitatively describe the physiochemical characteristics of the water and sediments in each macrohabitat at various river stages and times of year, so that these variables can be related to the distribution and abundance of aquatic organisms.
3. Quantitatively describe the composition of the particulate organic matter in riverine macrohabitats at various river stages and times of year. Particulate organic matter includes phytoplankton, zooplankton, and detritus.
4. Quantitatively describe the species diversity, abundance, distribution, and production of benthic macroinvertebrates in riverine macrohabitats at various river stages and times of year.
5. Quantitatively describe the species diversity, abundance, and distribution of fishes in riverine macrohabitats, including the use of these habitats as spawning, nursery, and feeding areas.

The physiochemical, particulate organic matter, benthic macroinvertebrate, and fish parameters will be compared between macrohabitats. In the study reach, the following types of macrohabitats will be investigated: main channel, permanent secondary channel, temporary channel, natural steep bank, revetted bank, dikes and dike fields, oxbow lakes, abandoned river channels, levee borrow pits, and sandbars.

A Pilot Study will be conducted commencing in March, 1978, and continuing through September, 1978. The objectives of the Pilot Study are:

1. To collect data to improve the habitat map, including such parameters as currents, substrate types, river stages, and shoreline vegetation.
2. To determine efficient and valid methods for collecting physical, chemical, and biological data. This will include both evaluation of current methods and sampling devices, and the design and/or implementation of new methods or sampling devices.
3. Document temporal and spatial variation of physical, chemical, and biological parameters.
4. Last, a valid experimental design for the ensuing four-year field study will be formulated.

The goal of the fisheries team is to quantitatively describe the species diversity, abundance, and distribution of fish in riverine macrohabitats, including the use of these habitats as spawning, nursery, and feeding areas. We have a long way to go, because the problems of assessing the fishery of the Mississippi River are numerous. For example, most fish are highly mobile and species composition in a reach of the river can change with seasons of the year and river flow stage.

There have been very few studies which have attempted to describe the various habitats which exist in the river and how they are used by fish. Further, there is disagreement among fishery biologist on the choice of sampling gear, and so forth.

During the Pilot Study the fishery team will use and evaluate a wide variety of sampling gears to determine the catchability, i.e. both selectivity and efficiency, of gear types in different macrohabitats and at different river stages. Many standard freshwater gears will be used: seines, push nets, trawls, meter nets, gill and trammel nets, hoop nets, slat traps, box-type minnow traps, and electrofishing. Hydroacoustics have recently proved useful in marine fisheries. We will evaluate the use of hydroacoustics for estimating fish biomass and movement. If successful, hydroacoustic sampling may provide very informative data about fish in the main channel.

Several specific research problems will be addressed throughout the study. Food habits of selected commercial, sport, forage, and predatory fishes will be investigated. This data, coupled with the benthic and particulate organic matter data, will allow determination of food preferences. Age and growth parameters will be compared between habitats by species as a possible indicator of suitability of different macrohabitats for different species. Because the success of a species is partly determined by reproduction, the suitability of different habitats as spawning and nursery habitats will be investigated. Information about reproduction will be based on data for both larval and adult fish. Suitability of different habitats as nursery areas will consider abundance of larval and juvenile fish and food habits of selected species of juvenile fish. Interpretation of all the above results are, to some extent, dependent on movement patterns of different fish species. Mark-recapture and one-way capture techniques may provide some information about fish movements, and we are hoping that hydroacoustic techniques will augment our knowledge. We also look forward to telemetry studies; however, this technique is very manpower intensive and will not be attempted during the Pilot Study phase.

SPECIAL ANIMAL SPECIES IN MISSISSIPPI WATERS

by

John W. Burris[1/]

The Endangered Species Act of 1973, Public Law 92-205, is the official protective law for plants and animals in the United States. To meet the requirements for inclusion on the list of special organisms, each must undergo a special process. First, the candidate must be submitted by recognized authority such as the Smithsonian Institution. Official notice of the proposed inclusion is then disseminated in the Federal Register. Subsequently, the Governor of the state must be apprised if the organism is indigenous to his area. Comments from the scientific community, various State, Federal agencies, industry groups, other special interest groups and the general public result. The information is compiled and data gathered from all relevant sources.

Section 4(a) of the Act states that the Secretary of Interior may then determine a species to be Endangered Species or a Threatened Species because of any of the five factors following:

(1) The present or threatened destruction, modification, or curtailment of its habitat or range;

(2) Overutilization for commercial, sporting, scientific, or educational purposes;

(3) Disease or predation;

(4) The inadequacy of existing regulatory mechanisms; or

(5) Other natural or mandate factors affecting its continued existence. (1)

In Mississippi, a committee consisting of top state authorities was convened in 1973 under the direction of William H. Turcotte for the purpose of establishing a list of non-game endangered species in the state. The endangered species categories are based on federal criteria and adapted for state use. The five categories are:

1/ Research Specialist, Mississippi Natural Heritage Program, Jackson, Mississippi.

Endangered: A species which is in danger of extinction throughout all or a significant portion of its range in the state due to (1) destruction, drastic modification or severe curtailment of habitat, or (2) its over-utilization for commercial or sporting purposes, or (3) effect of disease or pollution, or (4) other natural or man-made factors.

Threatened: A species which may become an endangered species within the foreseeable future in all, or a significant portion of its range in the state for the same reasons as set out above for endangered species.

Rare: A rare species is one that, although not presently threatened with extinction, is in such small numbers throughout its range in Mississippi that it may be threatened or endangered if its environment worsens. Close watch of its status is necessary.

Peripheral: A peripheral species or subspecies is one whose occurrence in Mississippi is at the edge of its natural range and which is rare, endangered or special concern within Mississippi although not necessarily in its range as a whole. Special attention is necessary to assure retention in the fauna or flora in our state.

Special Concern: A species of special concern is one that has been suggested as possibly threatened or endangered, but about which there is not enough information to determine its specific status. More information is needed and is probably difficult to obtain.

The resulting lists of animals meeting any of the above categories were published in the Mississippi Game and Fish Commission document; A Preliminary List of Rare and Threatened Vertebrates in Mississippi (2) The list is designed to be updated periodically as time and conditions dictate.

In 1974, The Nature Conservancy, a major national conservation organization specializing in the preservation of natural land including endangered species habitats,scientific research sites and diverse native ecosystems began organizing State Heritage Programs. One objective of that Program is to inventory every significant natural area in the country. The Mississippi Program, using the computer based methodology of the Conservancy, seeks to derive a registry of natural areas describing its rarest and most threatened ecosystems and natural features. An important part of the inventory is the list of rare and threatened vertebrates compiled by the Game and Fish Commission.

The Special Animal Species in Mississippi waters are listed by endangered species category. They are taken from the original Mississippi Game and Fish Commission list of 1977. Fishes were reviewed by Drs. Glenn H. Clemmer and Royal D. Suttkus and amphibians by Dr. J. William Cliburn. The Mississippi Natural Heritage Program computerized the data and stored it in the state computer at the Research and Development Center in Jackson. Recall can be made either as a Calcomp plot or printout. Data updating is a continuous process as new information is gathered, usually from existing collections, literature references, and extensive field surveys.

CLASSIFICATION SYSTEM - SPECIAL ANIMAL SPECIES IN MISSISSIPPI

ENDANGERED ANIMALS

Fishes	Acipenser oxyrhynchus - Atlantic Sturgeon Ammocrypta asprella - Crystal Darter Phoxinus erythrogaster - Southern Redbelly Dace *Etheostoma rubrum - Bayou Darter Noturus munitus - Frecklebelly Madtom Scaphirhynchus sp. (A) - Tombigbee Sturgeon
Amphibians	Aneides aeneus - Green Salamander Eurycea lucifuga - Cave Salamander
Reptiles	+Alligator mississippiensis - American Alligator Caretta caretta caretta - Atlantic Loggerhead Turtle Chelonia mydas mydas - Atlantic Green Turtle +Dermochelys coriacea coriacea - Atlantic Leatherback Turtle Drymarchon corais couperi - Indigo Snake +Eretmochelys imbricata imbricata - Atlantic Hawksbill Turtle Farancia erytrogramma - Rainbow Snake Graptemys nigrinoda - Black-knobbed Sawback Turtle Heterodon simus - Southern Hognose Snake +Lepidochelys kempi - Atlantic Ridley Pituophis melanoleucus lodingi - Black Pine Snake

THREATENED ANIMALS

Fishes	None recognized
Amphibians	None recognized
Reptiles	Eumeces anthracinus pluvialis - Southern Coal Skink Graptemys oculifera - Ringed Sawback Graptemys flavimaculata - Yellow-blotched Sawback

* On Federal list also (as Threatened)
\+ On Federal list also (as Endangered)

RARE ANIMALS

Fishes

Etheostoma sp. (B) - Yazoo Darter
Ichthyomyzon unicuspis - Silver Lamprey
Notropis welaka - Bluenose Shiner
Percina lenticula - Freckled Darter
Noturus flavus - Stonecat
Noturus stigmosus - Northern Madtom
Leptolucania ommata - Pigmy Killifish
Morone saxatilis - Striped Bass

Amphibians

Ambystoma talpoideum - Mole Salamander
Ambystoma tigrinum tigrinum - E. Tiger Salamander
Cryptobranchus alleganiensis alleganiensis - Hellbender
Eurycea bislineata bislineata - Northern Two-lined Salamander
Eurycea longicauda longicauda - Long-tailed Salamander
Gyrinophilus porphyriticus prophyriticus - Northern Spring Salamander
Hemidactylium scutatum - Four-toed Salamander
Pseudotriton ruber ruber - Northern Red Salamander
Rana areolata sevosa - Dusky Gopher Frog
Rana hecksheri - River Frog

Reptiles

Cemophora coccinea - Scarlet Snake
Deirochelys reticularia - Chicken Turtle
Gopherus polyphemus - Gopher Tortoise
Lampropeltis calligaster rhombomaculata - Mole Snake
Lampropeltis triangulum elapsoides - Scarlet Kingsnake
Macrochelys temmincki - Alligator Snapping Turtle
Micrurus fulvius fulvius - Coral Snake
Natrix rigida sinicola - Gulf Coast Glossy Water Snake
Natrix septemvittata - Queen Snake
Rhadinaea flavilata - Yellow-lipped Snake

PERIPHERAL ANIMALS

Fishes

Acipenser fulvescens - Lake Sturgeon
Ammocrypta clara - Western Sand Darter
Clinostomus funduloides - Rosyside Dace
Cottus carolinae - Banded Sculpin
Enneacanthus gloriosus - Bluespotted Sunfish
Etheostoma sp. (A) - Nameless Darter
Etheostoma blennioides - Greenside Darter
Etheostoma flabellare - Fantail Darter
Etheostoma kennicotti - Stripetail Darter

PERIPHERAL ANIMALS - Continued

Fishes	Etheostoma rufilineatum - Redline Darter Etheostoma squamiceps - Spottail Darter Hiodon alosoides - Goldeye Hybopsis gelida - Sturgeon Chub Hybopsis gracilis - Flathead Chub Hybopsis meeki - Sicklefin Chub Ictiobus niger - Black Buffalo Micropterus dolomieui - Smallmouth Bass Moxostoma duquesnei - Black Redhorse Moxostoma macrolepidotum - Shorthead Redhorse Notropis sp. (C) - Silver Shiner Notropis ardens - Rosefin Shiner Notropis boops - Bigeye Shiner Notropis callistius - Alabama Shiner Notropis chalybaeus - Ironcolor Shiner Notropis petersoni - Coastal Shiner Notropis potteri - Chub Shiner Notropis rubellus - Rosyface Shiner Notropis spilopterus - Spotfin Shiner Notropis whipplei - Steelcolor Shiner Noturus exilis - Slender Madtom Percina caprodes caprodes - Logperch Percina evides - Gilt Darter Percina phoxocephala - Slenderhead Darter Phenacobius mirabilis - Suckermouth Minnow Rhinichthys atratulus - Blacknose Dace Scaphirhynchus albus - Pallid Sturgeon Stizostedion canadense - Sauger Stizostedion vitreum - Walleye
Amphibians	Bufo valliceps - Gulf Coast Toad Necturus maculosus maculosus - Mudpuppy Plethodon dorsalis - Zigzag Salamander Pseudacris brachyphona - Mountain Chorus Frog Rana clamitans melanota - Green Frog
Reptiles	Coluber constrictor latrunculus - Black-masked Racer Graptemys kohni - Mississippi Map Turtle Graptemys pseudogeographica ouachitensis - Ouachita Map Turtle Lampropeltis getulus niger - Black Kingsnake Natrix sipedon sipedon - Northern Water Snake Thamnophis proximus orarius - Gulf Coast Ribbon Snake

SPECIAL CONCERN ANIMALS

Fishes	Cycleptus elongatus - Blue Sucker Ichthyomyzon castaneus - Chestnus Lamprey Polyodon spathula - Paddlefish

SPECIAL CONCERN ANIMALS - Continued

Amphibians	None recognized
Reptiles	Malaclemys terrapin pileata - Mississippi Diamondback Terrapin Natrix fasciata clarki - Gulf Salt Marsh Snake

CLASSIFICATION SYSTEM - SPECIAL INVERTEBRATE SPECIES

SPECIAL CONCERN

ENDANGERED	Epioblasma penita (Conrad, 1834) - Sp. of Mussel Lampsilis perovalis (Conrad, 1834) - Sp. of Mussel Medionidus mcglameriae Van der Schalie, 1939 - Sp. of Mussel Pleurobema curtum Pleurobema decisum (Lea, 1831) - Southern Club Shell (Mussel) Pleurobema marshalli Frierson, 1927 - Sp. of Mussel Pleurobema perovatum (Conrad, 1834) - Sp. of Freshwater Mussel Pleurobema taitianum (Lea, 1834) - Sp. of Mussel Quadrula stapes (Lea, 1831) - Stirrup Shell (Mussel)
THREATENED	Eliptio arcus - Sp. of Mussel Goniobasis cylindrasia - Sp. of Freshwater Snail Medionidus acutissimus (Lea) - Deer Toe Shell (Mussel) Obovaria unicolor Pleurocera hubrichti - Sp. of Freshwater Snail Somatogyrus sp. - Unidentified Freshwater Snail in Buccatuna Creek
PERIPHERAL	Assiminea modesta Gould. - Sp. of Land Snail Carychium nannoides - Sp. of Land Snail Gastrocopta abbreviata (Sterki). - Sp. of Land Snail Gastrocopta pellucida hordeacella (Pils). - Sp. of Land Snail Gastrodonta interna interna - Sp. of Land Snail Mesodon elevatus (Say). - Sp. of Land Snail Mesodon zaletus (Binney). - Sp. of Land Snail Mesomphix anurus Hubricht - Sp. of Land Snail Mesomphix capnodes W. G. Binney - Sp. of Land Snail Mesomphix pilsbryi (Clapp) - Sp. of Land Snail Paravitrea significans (Bland). - Sp. of Land Snail Philomycus togatus (Gould). - Sp. of Slug Polygyra septemvolva - Sp. of Land Snail

PERIPHERAL - Continued

Praticolella lawae (Lewis). - Sp. of Land Snail
Praticolella mobiliana (Lea). - Sp. of Land Snail
Pupisona macneilli - Sp. of Land Snail
Stenotrema spinosum (Lea). - Sp. of Land Snail
Succinea luteola (Gould). - Sp. of Land Snail
Triodopsis albolabris (Say). - Sp. of Land Snail
Triodopsis tridentata (Say). - Sp. of Land Snail
Triodopsis vulgata (Pils). - Sp. of Land Snail
Ventrides gularis - Sp. of Land Snail
Vertigo oscariana Sterki. - Sp. of Land Snail
Vertigo teskeyae Hubricht - Sp. of Land Snail

SUMMARY

With the exception of a few terrestrial reptiles and amphibians, the above list contains the Special Animals of Mississippi normally associated with the aquatic environment. A complete list of all Special Animals (birds, mammals, etc.) is also in the data bank, but was not listed in this paper for the sake of brevity. Regulations with respect to federally endangered and threatened wildlife and plants is contained in the Code of Federal Regulations. (3)

REFERENCES

1. Federal Register, 1976. Vol. 41, No. 117.

2. Mississippi Game and Fish Commission, 1975. A Preliminary List of Rare and Threatened Vertebrates in Mississippi. Director of Conservation, Jackson, Mississippi, 29 p.

3. U. S. Department of Interior, 1976. Regulations Governing Activities Involving Endangered and Threatened Wildlife and Plants. Code of Federal Regulations (CFR) 50, Part 17.

The River Shrimp Genus Macrobrachium and its Aquaculture Potential in Mississippi

by

Gordon Gunter
Gulf Coast Research Laboratory
Ocean Springs, Mississippi 39564

Abstract

S. I. Smith (1874) described the common American shrimp *Macrobrachium ohione* (Smith) of the Mississippi Valley and the South. A small commercial fishery has gone on in the Mississippi River from Cairo, Illinois southward since that time. In the early part of this century, three other species were discovered in the southern United States, Schmitt (1933). McCormick (1933, 1934) and Gunter (1937) studied the life history of *M. ohione*. Hedgpeth (1947, 1949) reviewed the known biological information of the United States species and the whole palaeomonid group of the Americas was monographed by Holthuis (1952). The species found in the United States and Mississippi are *Macrobrachium ohione*, *M. acanthurus*, *M. carcinus* and *M. olfersi*, the latter was known only from Florida until recently when it was found in Louisiana and Mississippi. All of these shrimp are potential aquaculture species and *carcinus* up to 22 inches long and three pounds in weight have been taken in Texas. O. L. Meehean (personal communication) has used *M. ohione* as cultured food for fresh water fishes in a hatchery at Natchitoches, Louisiana. Certain potentialities of these species for aquaculture are discussed. The writer gives reasons why the theory concerning the necessity for the young to be exposed to saltwater is not valid.

Distributions and Some Species Characters

The family _Palaemonidae_ of the Crustacea Decapoda _Natantia_ is divided into three subfamilies of which one is the Palaemoninae. Holthuis (1952) lists 14 genera in the Americas. One of these is the genus _Macrobrachium_. Related genera are _Palaemon_ and _Palaemonetes_, the latter, as grass shrimp, being more familiar to most laymen because of their common use as fishbait over much of the fresh waters of North America.

There were 26 species in both Americas recognized when Holthuis published 26 years ago. He stated that most _Macrobrachium_ were divided into eastern and western species essentially by the cordillera of both continents. He went on to say that there were 10 eastern forms not directly related to western coast species but that all western coast species were clearly closely related to eastern species except two. There are no western species north of Mexico.

Four species of the genus _Macrobrachium_ are endemic over the southern half of the United States from Virginia southward to Florida and the Rio Grande, three of these extend into the Antilles, Mexico and much of South America. The fourth one extends northward to the Ohio Valley. The genus is also found in Asia and, in fact, the chief shrimp of aquaculture, _Macrobrachium rosenbergii_, is an Asiatic species. It is utilized in Hawaii for aquaculture and as a study species in this country as well. This situation comes about in part because workers do not know the North American native fauna. Thus, I call attention to the native _Macrobrachium_ of the United States and in Mississippi in particula

In order of size the United States species are M. carcinus 300 mm T.L., and about 3 lbs. weight, M. acanthurus, 166 mm, M. ohione 70 mm ♀ ♂110 mm, and M. olfersi, 90 mm. Thus, although M. ohione was originally called the Big River Shrimp it is a small species and is only large when compared to Palaemonetes.

There are two large and two small species in the country. Holthuis (1952) says that Macrobrachium acanthurus is the color of yellow wax with reddish speckles. He also says that the largest animal seen by him was 166 mm long. According to Hedgpeth (1947, 1949) the other big species, M. carcinus, is greenish in color with a muddy orange stripe down the middle of the back. My observations have been that the spination along the arms of this species is almost coal black. There are records from the Miami River, from St. Augustine to Georgia and Ocean Springs on down into Texas and Brazil. The largest one seen by me was approximately two feet long with the arms outstretched and I take it that the body from the tip of the rostrum to the telson must have been close to 300 mm. This animal was taken from the Colorado River in Austin, Texas and was kept alive in the physiology laboratory for several weeks in 1938. This is truly the big river shrimp.

Macrobrachium ohione (Smith) is a small river shrimp and is probably the most common species. It ranges from Virginia to Texas and in the Mississippi Valley as far north as Ohio and Indiana where it was first described. Holthuis (1952) listed specimens 110 mm long but on the Mississippi at Port Allen I never caught one longer than 93 mm.

The little shrimp with the swollen palm, M. olfersi, has been reported formally only from Florida, with recent unpublished notices from Mississippi and Louisiana. Quite probably it is endemic. In any case, it is the smallest Macrobrachium currently found in North America, with a total length size limit of about 90 mm, which limits its use as human food.

The really large river shrimp, M. carcinus of Holthuis (1952), formerly called M. jamaicense following Schmitt (1933) is only found occasionally. It goes to 3 pounds weight (1.4 kg.). It is not seen often and usually only when some surprised pole and line fisherman pulls it up from the river, and seeks identification. No doubt many specimens are never reported. There is no known reason why this shrimp cannot be cultivated and preliminary experiments have been carried on in Florida.

The second largest shrimp in the United States is Macrobrachium acanthurus, which has an upper total length of around 160 mm. This shrimp is thought to be rare but it is locally abundant in certain places and the late Percy Viosca (1957) has reported it in abundance near the mouth of the Mississippi River. On various occasions he has supplied this shrimp as comestibles for various professional gatherings and groups of his friends. This shrimp would seem to be of ideal size for aquaculture.

Some workers have speculated that among the North American river shrimp only M. ohione is abundant enough for a small fishery, but that it is too small for aquaculture. That may well be true so long as the larger Penaeidae of estuarine and marine waters are available. But ohione is available, at least in small quantities, in many somewhat isolated fresh water areas.

The Fishery

These animals (M. ohione) used to support a commercial fishery all up and down the Mississippi from New Orleans to Cairo, Illinois and up into the Ohio itself. They are sometimes caught by merely weighting willow boughs and dropping them in the water. They swim up into these things and stay there for protection especially at night. They are also caught in screen traps with funnels sticking in from the ends. These traps are baited with rotten fish or with cottonseed oil cake which makes a very foul mess when it rots. The fishermen at Port Allen, Louisiana in 1934 maintained that decaying fish is the best bait and when I was studying these animals the fishermen there would catch their shrimp on rotten fish but then when they took them to the market they sprinkled them over with pieces of fresh cottonseed cake, a small deceit which may be practiced even today. The fishery used to produce approximately several thousand pounds per year and you could see small ramshackle restaurants near the levees which advertised river shrimp. They were supposed to be better than the marine shrimp according to some people for, like all local products, they were preferred by some people, and according to Viosca (1957) these were the original gourmet shrimp of the lower Mississippi and New Orleans. The late Mississippi leader, Mr. Walter Sillers, Speaker of the House of Representatives in this state for some 40 years or so, told me that near his home at Rosedale all the river shrimp had disappeared from the Mississippi River. This was 20 years ago or more. I have no doubt because the Mississippi itself has been turned into a sluiceway which has become more and more polluted as time goes on.

Throughout the years there have been references to the Mississippi river shrimp, *M. ohione*, as food, (Forbes 1876, O. P. Hay 1882, Ortmann 1918, McCormick 1933, 1934, Viosca 1957 and others). Old "receipts" for gumbo and shrimp dishes in Vicksburg and inland river towns were written long before marine shrimp were made available by the refinements of transportation, refrigeration and the marine fisheries in general. The impression has been given of considerable abundance in the early days with, 10,000 pounds a day available by seining to a decline with settlement of the country. There is increased reference to use of this shrimp as fishbait.

When S. I. Smith (1874) first described the river shrimp *Macrobrachium ohione* on the basis of preserved specimens from the Ohio River he stated that it was used for food although there is no evidence that he saw a live specimen. No doubt this use was passed down from the Indians and various writers have described the taking of shrimp by the use of limbs from willow trees stuck in the mud and broken over so that the leaves were under the water. The shrimp hide in this material for shelter and can be shaken out after some few hours. O. P. Hay (1882) stated that he collected in Arkansas along the river where it would not have been a great deal of trouble to seine 10,000 pounds of this shrimp. This occurred in the days when the river was relatively uninfluenced by pollution, levees, etc.

A few thousand pounds a year of river shrimp have been reported in fishery statistics of the United States and its predecessors. It is my opinion that this was a small fraction of the actual consumption because at many towns along the river these shrimp were peddled from house to house by various denizens of the river who live between the levees and are often on the move. There is a veritable society which lives up and down the river and which conducts its affairs quite distinctly from the other people nearby.

But the river shrimp fishery has received little public notice and is barely mentioned in the federal fishery statistics, and reported high catches have been suspected of being confused with the bait shrimp, Palaemonetes. The true situation was revealed when the Louisiana Department of Wild Life and Fisheries began reporting the production of the lower Atchafalaya River. It has been over 2,000,000 pounds per year for several years, see Mermilliod (1976). Characteristically with this fishery collection these catch statistics were stopped in 1972. It appears, however, that the Atchafalaya Basin fishery remains productive and this raises the question of the potentiality of other southern rivers that remain in a somewhat pristine condition.

Mississippi Species

The Mississippi river shrimp Macrobrachium ohione is an isolate and is the only species in North America without further distribution to the southward. The other shrimp are large compared to M. ohione and most of them are close to the sea. In any case, three species of Macrobrachium have been taken at Ocean Springs during flood years and insofar as M. olfersi has been reported in Louisiana it is quite possible that this species will be recorded from Ocean Springs. And so, we have four species of Macrobrachium native to Mississippi waters and one of them is probably found over the whole state.

Zoogeography

North American *Macrobrachium* came evidently from South America and possibly they arose in Africa when it was still a part of Pangaea. As the continents moved away to the west and finally drifted closer together Isthmus America and the Antilles Islands rose and to some extent could have been connecting avenues for the Macrobrachiums to move to North America. It would seem that a very high percentage of this group moved from the fresh waters of one continent to the other distinctly faster than the fresh water fishes in which a minuscule percentage of species have moved. It is quite possible that some of these species moved through the Antilles because they are somewhat tolerant of saltwater. On the other hand, the primary fresh water fishes are not tolerant of saltwater and it is only when interlocking bays become fresh that purely fresh water fish can move coastwise into another river system. However, this is easily accomplished by our most inland *Macrobrachium*.

Whether the genus *Macrobrachium* arose in Africa or Asia is unclear, but certainly the 26 species of the Americas came from Africa originally and their ancestors rode the South American plate as it pulled away from Pangaea some 200 million years ago. Presumably, the South American species began to move northward with the formation of the unbroken Isthmus America in the Pliocene about 5.7 million years ago or possibly even before by island hopping. In this regard it should be noted that *M. ohione* can go into water as high as 14.2 parts per thousand salt with its eggs (Gunter 1937). The smallest shrimp I have seen were 13 mm long. They were taken at Baton Rouge and they could not have made their way upriver. I have never seen a small *Macrobrachium* of any species in salt or brackish water and I think they only go there as eggs carried by the mother shrimp. Furthermore, it is certainly impossible for the shrimp from the Ohio and the upper Mississippi to make their way to and from the Gulf.

Many fresh water fishes which undergo visits to low salinity water never have young raised there. The implication of such a sojourn in saltwater in the river shrimp shows that saltwater tolerance was probably an ancestral trait and that they could have moved by island hopping. Similarly they could have moved from watershed to watershed along the coast by enduring a little saltwater, a thing which primary fresh water fishes cannot do. This is probably the explanation why M. ohione has invaded North America almost to the Great Lakes, but the fresh water fishes have come only to the Texas border since the Isthmus closed in the mid-Pliocene, (cf. Gunter, Ms.).

Some workers (cf. Holthuis 1952, p. 64) have stated that the various American river shrimp larvae live in higher salinities than the adults do. Jones (1978) has shown that 250 parts per million of sodium chloride enhances the development of shrimp in plastic pools. However, there are no data or evidence showing that any species of American shrimp has to go into saltwater to bring about development of the young. In fact, the very young are never taken in the bays or estuaries so far as I know and the associated animals listed by Jones in the San Barnard River of Texas are all fresh water except for the blue crab which is euryhaline. The real cycle is an invasion of adults carrying eggs of the common river shrimp during periods of floods and freshets in the spring. It is often accompanied by acanthurus and carcinus in the Ocean Springs area. Then they retreat back to fresh water and during the fall, saltwater animals encroach far into the bays and the blue crabs will go into very low salinity or even fresh water where they become predators and enemies of the river shrimp which cannot compete with the sturdier and stronger crabs. The distribution of the fresh water shrimp running far inland precludes the coming and going to saltwater for spawning.

Reimer, Strawn and Dixon (1974) showed that *Macrobrachium ohione* migrated into the upper waters of Galveston Bay in March and left in June. The males appeared first followed by eggless females. They were not taken in water above 30°C or in salinities above *circa* 15 ppt. This corresponds to the information given by Gunter (1937). It would appear that this migration of the common river shrimp into low salinity waters is an annual thing and takes place every year. Furthermore, the other species of river shrimp in the same area apparently move into the low salinity waters of the estuaries during the spring. We need more information on this phenomenon which seems to be parallel to some extent to similar cyclic movements of certain fishes such as *Dorosoma cepedimanum* and *D. mexicana* (Gowanloch 1933, p. 215). There are other fishes which come into fairly high salinities in the spring but spawn far back in fresh water. Thus, the movement of the North American river shrimp into low salinity waters is no indication that the breeding cycle of the animal is tied to saltwater.

LITERATURE CITED

Forbes, S. A. 1876. List of Illinois Crustacea, with descriptions of a new species. Bull. Illinois Mus. Nat. Hist., 1876, pt. 1, pp. 3-25, pl. 1.

Gowanloch, James Nelson. 1933. Fishes and Fishing in Louisiana. Bulletin No. 23, Dept. of Conservation, pp. 638, New Orleans, La.

Gunter, Gordon. 1937. Observations on the river shrimp, Macrobrachium ohionis (Smith). The American Midland Naturalist, 18(6): 1038-1042.

Gunter, Gordon. Marine fishes of Panama as related to the canal. Manuscript, 22 typed pages.

Hay, O. P. 1882. Notes on some fresh-water Crustacea, together with descriptions of two new species. Amer. Nat., Vol. 16, pp. 143-146, 241-243.

Hedgpeth, Joel W. 1947. River shrimps - Interesting crustaceans about which little has been written. Prog. Fish Culturist, pp. 181-184.

Hedgpeth, Joel W. 1949. The North American species of Macrobrachium (River shrimp). Texas Jour. Sci., Vol. 1, pp. 28-38, Figs. 1-5.

Holthuis, Lipke B. 1952. A general revision of the Palaemonidae (Crustacea Decapoda Natantia) of the Americas. II. The subfamily Palaemoninae. Allan Hancock Foundation Publications, Occasional Paper No. 12, pp. 1-396.

Jones, Walter Gary. 1976. Observations on the biology of Macrobrachium ohione (Smith) from the San Bernard River, Braxoria County, Texas. Texas A & M University, (Master's Thesis), pp. V-50, typed.

Mermilliod III, Warren James. 1976. Life history and ecology of the large river shrimp, Macrobrachium ohione (Smith). Louisiana State University, (Master's Thesis), pp. ii-86 typed.

McCormick, Robert Nathaniel. 1933. Studies on Macrobrachium ohionis, the large fresh-water shrimp. Abstracts of Doctor's Dissertation, No. 11, Ohio State University Press, pp. 47-56.

McCormick, Robert Nathaniel. 1934. Macrobrachium ohionis, the large fresh-water shrimp. Proc. Indiana Acad. Sci. 43:218-224.

Ortmann, A. 1918. Higher crustaceans (Malacostraca). In: Ward, H. G. & Whipple, G. C., Fresh-water Biology, pp. 828-850, Figs. 1030-1318.

Reimer, Rollin D., Kirk Strawn and Allen Dixon. 1974. Notes on the river shrimp, Macrobrachium ohione (Smith) 1874, in the Galveston Bay system of Texas. Trans. Amer. Fish. Soc., 103(1): 120-126.

Schmitt, Waldo L. 1933. Notes on shrimps of the genus Macrobrachium found in the United States. Jour. of the Washington Acad. of Sci., 23(6): 312-317.

Smith, S. I. 1874. The Crustacea of the fresh waters of the United States. Rep. U.S. Fish Comm., vol. 2, pp. 637-665, pls. 1-3.

Viosca, Jr., Percy. 1957. Shrimp potpourri. Louisiana Conservationist, 9(7):10-13, 20-21.

ELIMINATION OF THREADFIN SHAD FROM BARNETT AND OKATIBBEE RESERVOIRS DUE TO LOW TEMPERATURE, WINTER, 1976-1977

By

Doug Williams
Mississippi Game and Fish Commission
P. O. Box 451, Jackson, Mississippi

ABSTRACT

Fish population studies indicated threadfin shad (Dorosoma petenense) were present in Barnett Reservoir since impoundment in 1963 through 1976 and in Okatibbee Reservoir since introduction in 1973 through 1976. No threadfin shad were collected in either reservoir in 1977. The absence of this species following a severe winter indicates a total or near-total winterkill of threadfin shad in these two central Mississippi impoundments.

INTRODUCTION AND FINDINGS

Gizzard shad (Dorosoma cepedianum) are recognized as a valuable forage fish for such piscivorous species as largemouth bass (Micropterus salmoides), crappie (Pomoxis spp.) and catfish (Ictalurus spp. and Pylodictus olivaris); however, gizzard shad grow rapidly and quickly become nonvulnerable to predators. Threadfin shad (D. petenense) also provide a valuable forage base for piscine predators; but, unlike gizzard shad, grow to a smaller maximum size and remain vulnerable to predation. A major disadvantage of a threadfin shad forage base in temperate waters is the inability of this species to survive low water temperatures.

Studies by Griffith and Tomljanovich (1976) indicated that as water temperature dropped below 12° C threadfin shad began to show erratic behavior, and death occurred as the temperature dropped lower. Strawn (1963) found threadfin shad could survive in a lake in which water temperature did not drop below 9° C, but that they would quickly die at 5.0° C.

Parson and Kimsey (1954) reported that threadfin shad in the Tennessee River are found only in large, low elevation reservoirs with relatively stable water temperatures. Even in these areas heavy mortality occurred when water temperatures dropped suddenly. The lethal effect of rapid decreases in water temperature is corroborated by the results of tank studies reported by Strawn (1963).

McGee and Griffith (1977) indicated winterkill of threadfin shad occurred in Watts Bar Reservoir Tennessee. The fish were able to survive only in the warm water discharge canal of a power plant.

This paper documents the occurrence of winterkill of threadfin shad in two Mississippi reservoirs.

Barnett Reservoir is a 12,140 ha impoundment of the Pearl River in central Mississippi near Jackson. This reservoir was impounded in 1963. Okatibbee Reservoir is a 1,538 ha impoundment of Okatibbee Creek in east-central Mississippi near Collinsville. Okatibbee Reservoir was completed in 1969.

Threadfin shad populations in the two reservoirs were estimated yearly during August. Population estimates are based on 0.4 ha areas poisoned with 1.0 ppm rotenone (5% emulsifiable). Four 0.4 ha areas on Barnett and three 0.4 ha areas on Okatibbee were sampled annually.

The rotenone samples indicated that threadfin shad were present in Barnett Reservoir continuously since impoundment in 1963 through the summer of 1976 (Table 1). The estimated density fluctuated widely and averaged 7855 individuals/ ha and 12.29 kg/ha during this time. No threadfin shad were recovered in the August, 1977 population samples.

The fish population of Okatibbee Reservoir was sampled annually commencing in August, 1971. Population estimates conducted during 1971-73 indicated that threadfin shad were not present in the reservoir and a stocking program was initiated. A shad control operation was conducted to reduce the excessive numbers of large gizzard shad in the fall of 1973. In early spring of 1974 adult threadfin shad were collected from the Tombigbee River at Demopolis, Alabama and stocked in Okatibbee. Sampling conducted in August, 1974 estimated the threadfin shad population at 1856 individuals/ha, indicating establishment of a reproducing population (Williams 1978). Subsequent sampling during 1975 and 1976 showed the population was increasing (Table 2). No threadfin shad were recovered during the 1977 sampling effort.

Reports from the National Weather Service indicated that January, 1977 was the second coldest January on record since 1909. Climatological data for Jackson, Mississippi was gathered from the National Oceanic and Atmospheric Administration and showed that temperatures in December, 1978 were 2.2° C below the norm (U. S. Department of Commerce 1976). For January, 1977 the temperature was 6.6° C below the norm; the average temperature for the month was 1.9° C. The average temperature for 16-19 January 1977 was -5.5° C (U. S. Department of Commerce 1977). A thin sheet of ice covered a large portion of the Barnett Reservoir during this period. Moribund threadfin shad were observed at the surface of the water during January, 1977.

Prior to 1977 populations of threadfin shad existed continuously in Barnett Reservoir for 14 years and in Okatibbee Reservoir for three years. No threadfin shad were collected from either reservoir in the August, 1977 sampling effort. The absence of this species followed a severe winter with below normal temperatures. This suggests a total or near-total winterkill of threadfin shad from Barnett and Okatibbee Reservoirs. Efforts will be made during the spring of 1978 to restock both reservoirs with adult threadfin shad from the lower Tombigbee River, Alabama.

Table 1. Estimated population of threadfin shad in Barnett Reservoir from 1963-1977.

Year	No./ha	kg/ha
1963	52	0.13
1964	1174	11.68
1965	9988	20.20
1966	12852	26.21
1967	4265	7.33
1968	40	0.12
1969	2889	5.81
1970	400	0.84
1971	2066	4.10
1972	51748	63.77
1973	5607	8.09
1974	1950	2.72
1975	9385	9.07
1976	7561	11.88
1977	0	0
Average (1963-1976)	7855	12.29

Table 2. Estimated population of threadfin shad in Okatibbee Reservoir from 1971-1977.

Year	No./ha	kg/ha
1971	0	0
1972	0	0
1973	0	0
1974	1856	4.66
1975	2184	6.81
1976	13111	53.41
1977	0	0
Average (1974-1976)	5717	21.63

LITERATURE CITED

Griffith, J. S. and D. A. Tomljanovich. 1976. Susceptibility of threadfin shad to impingement. Proc. Annu. Conf. Southeast. Assoc. Game & Fish Comm. 29:223-234.

McGee, M. U. and J. S. Griffith. 1977. Prey selection by sauger in Watts Bar Reservoir, Tennessee as affected by cold-induced mortality of threadfin shad. Proc. Annu. Southeast. Assoc. Game & Fish Comm. 31 (in print).

Parson, J. W. and B. Kimsey. 1954. A report on the Mississippi threadfin shad. Prog. Fish. Cult. 16:179-181.

Strawn, K. 1963. Resistance of threadfin shad to low temperatures. Proc. Annu. Southeast. Assoc. Game & Fish Comm. 17:290-293.

U. S. Department of Commerce. 1976. Local Climatological Data. Monthly summary for December, 1976 at Jackson, Miss. 2p.

U. S. Department of Commerce. 1977. Local Climatological Data. Monthly summary for January, 1977 at Jackson, Miss. 2p.

Williams, D. 1978. Central Mississippi Reservoir survey. Completion Report, F-36-4, 1978. Miss. Game & Fish Comm., Jackson, Miss. 59p.

FISHES AND WATER QUALITY CONDITIONS IN SIX-MILE LAKE BEAR CREEK DRAINAGE, MISSISSIPPI[1/]

Charles M. Cooper and Luther A. Knight, Jr.

ABSTRACT

A survey of fishes in Six-Mile Lake, Bear Creek drainage, Mississippi, was made during the summer of 1977. Twenty species were identified from seine and rotenone samples. Gizzard shad (*Dorosoma cepedianum*) constituted 63% of the weight and 85% of the numbers of fishes collected. A commercially important species was buffalo (*Ictiobus* spp.). Dominant game species were bluegill (*Lepomis macrochirus*) and white crappie (*Pomoxis annularis*). Both bluegill and white crappie had low coefficients of condition.

The lake was thermally stratified during the summer with surface temperatures ranging from 31.1 to 34.4 C, but dissolved oxygen levels were sufficiently high during the entire year to support the fish in the lake. Secchi disk visibility readings ranged from 8 cm in winter to 89 cm in late summer, and conductivity varied from 65 to 153μ mhos/cm in surface waters and from 69 to 266μ mhos/cm near the bottom of the lake. The pH ranged from 6.2 to 7.0 during the summer.

High turbidity, resulting from a heavy sediment load during much of the year, has adversely affected the fisheries in Six-Mile Lake.

INTRODUCTION

To assess the biological productivity of inland waters, detailed investigations of the biota are necessary as well as evaluations of the chemical and physical conditions that influence the aquatic life. We began an assessment and evaluation of the hydrobiological, chemical and biological conditions of Bear Creek watershed in 1976. As a part of that investigation a survey of fishes of the system was made during the summer of 1977. The purposes of the study reported here were to determine fish species composition and condition in Six-Mile Lake, Mississippi and to relate the results to water quality conditions.

DESCRIPTION OF THE WATERSHED

Bear Creek, a tributary of the Yazoo River, whose watershed lies in Leflore, Sunflower and Humphreys counties (Fig. 1) is a typical Mississippi River delta watershed. The conditions existing in the system, along with problems, are considered representative of nearby

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1/ Contribution of the Sedimentation Laboratory, SEA-AR, U. S. Department of Agriculture, and the University of Mississippi.

2/ Ecologist, Oxford, MS 38655 and Assoc. Professor, Biology Dept., University of Mississippi 38677.

delta watersheds. Bear Creek is a series of oxbow lakes, brakes, and sloughs connected by a sluggishly flowing stream. There are six on-line lakes in the series with several others lying off the main stream. The upper one-third of the stream flows intermittently while all lateral streams are ephemeral. All of the lakes are perennial and several are in advanced stages of succession.

Bear Creek drains some 330 km^2 (127.3 mi^2) of relatively flat, highly developed farm land. The watershed contains four major soil types: Dubbs (Thermic Typic Hapludalfs)-Dundee (Thermic Aeric Ochraqualfs)-Forestdale (Thermic Typic Ochraqualfs), Alligator (Thermic Vertic Haplaquepts)-Dowling, Forestdale-Alligator, and Collins (Thermic Aquic Udiflurents)-Falaya (Thermic Aeric Fluvaquents)-Hyman-Ina. The flat terrain and prevalent farming practices of the region have resulted in increased degradation of the system through heavy siltation. In on-line lakes, sediments are presently accumulating at maximum rates of 7 cm/yr., averaging 3.3 cm/yr. (Ritchie, et. al., 1978)

MATERIALS AND METHODS

A 34 m^2 (1 acre) of Six-Mile Lake was blocked off and rotenoned with the assistance and cooperation of the Mississippi Game and Fish Commission. Rotenone (Fishtox) was applied at a rate of 1 liter/9.2 m^2 (1 gal/acre) Fish specimens were recovered, identified and counted after rotenone application and on the next day. Wet weights and total lengths were measured. Other fish samples were collected from various portions of the lake by seining.

Water quality variables monitored monthly in the lake during this study include pH, dissolved oxygen, conductivity, Secchi disc visibility and temperature.

Indexes of condition were calculated for white crappie (*Pomoxis annularis*) and bluegill (*Lepomis macrochirus*) using the formula $C = \frac{10{,}000 \times weight}{length^3}$ (Bennett, 1970). A limited number of white crappie was examined for age and growth.

Species composition and the impact of heavy sedimentation on the fish populations were examined during the study. Fishes were collected throughout the drainage system, but those in Six-Mile Lake were examined closely. Other areas (i.e. Mossy Lake, Wasp Lake) have been studied frequently by the Game and Fish Commission (Bingham, 1967a, 1967b, 1969; Herring and Cotton, 1969, 1970a, 1970b, 1974) and the Soil Conservation Service (Cotton, 1976).

PHYSICAL LIMNOLOGY

Six-Mile Lake is the deepest lake in the Bear Creek system, ranging from 3 to 6 m along its centerline. The lake stratifies thermally in summers with the thermocline region beginning 1 or 2 m below the surface. During the rotenone study, the lake was strongly stratified (Table 1).

Although the lake was stratified thermally, dissolved oxygen was never completely depleted during the summer. Dissolved oxygen values ranged from 5 to 10 ppm in the surface waters, but because of large populations of certain phytoplankton at various depths, subsurface concentrations reached 16.5 ppm during the year. Waters in this lake were usually acidic; the pH ranged from 6.2 to 7.2 from June through August.

Secchi disc visibility measurements were indicative of the turbidity of the lake. The lake remained muddy during most of the year with minimum disc readings of 8 cm. Sediment accumulation averaged 3.9 cm/yr (1.5 in/yr).

As a consequence of sediment deposition the flora and fauna of systems such as this may be severely affected. Bottom organisms may be eliminated as their habitats are covered by sediment. Soft-bodied organisms may be eliminated through molar action, and nutrients may be adsorbed by sediments and made unavailable. When any part of the food web is altered, or if the habitat is changed, there may be profound effects upon fish populations of the system.

RESULTS AND DISCUSSION

The fisheries of this system have been declining over the past several years. Many game species have either been reduced in numbers or have disappeared entirely. Because of deteriorating water quality less economically-valuable fishes like shad, bullheads and carp, which are better able to tolerate the poorer conditions, have become very abundant, creating an imbalance in species composition.

Though young gizzard shad (Dorosoma cepedianum) are a good food source for game fishes, maximum length of older gizzard shad is about 45 cm (18 in.) (Blair, et al., 1967). Individuals approaching maximum length are not suitable as food for game fish and compete with them for space. In the study area, 997 (about 49%) of the gizzard shad were longer than 18 cm (7 in.).

In Six-Mile Lake gizzard shad constituted 63.0% of the weight and 85.0% of the numbers of fish in the standing crop collected on June 16, 1977 (Table 2). Smallmouth buffalo constituted 24.8% of the weight of fishes, but only about 9% of the total numbers of fish. All others, including the small numbers of pan fishes, composed the remaining 12.2% of the fish weight per unit area from Six-Mile Lake.

Twenty-six white crappie, taken from the study area, ranged from less than 2.5 cm (1 in) to 33 cm (13 in) total length (Table 3). Scale samples from white crappie were examined and the results of growth at each annulus are given in Table 4. Indexes of condition calculated for harvestable crappie ranging from 23 cm (9 in) to 33 cm (13 in) total length, averaged 4.8 which indicated fish of average to below average conditions (Bennett, 1970). Local fishermen, however, have reported success in catching crappie throughout the area.

Most of the 114 specimens of bluegill were in the 10.0 cm (4 in) to 12.5 cm (5 in) length groups (Table 3) and were in poor general condition with spawning marks and parasites noticeable on the larger individuals. An average index of 6.5 calculated for 14 harvestable bluegills indicated that these specimens were in poor condition, since a value below 7.0 for bluegill represents poor flesh (Bennett, 1970).

There were no largemouth bass in Six-Mile Lake but they are found in nearby Mossy Lake (Miss. Game & Fish Comm., unpub. rep.). Mossy Lake contains much more shallow water habitat, has less turbidity, and has a lower sediment accumulation rate [1.7 cm/yr (.67 in)] 44% of that in Six-Mile Lake.

SUMMARY

A survey of fishes in Six-Mile Lake showed an imbalance of species with gizzard shad constituting most of the fish in weight and number.

The pan fish species, L. macrochirus and P. annularis, were generally in poor condition with a limited number of harvestable specimens. No largemouth bass were taken in the study area although they occur in other parts of the Bear Creek system.

Heavy sediment loads from agricultural lands have caused high turbidity levels and large sediment accumulation rates in Six-Mile Lake. Loss of available habitat and degradation of water quality from sediments have certainly aided in the imbalances in species composition and the generally poor quality of the game fishes present.

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LITERATURE CITED

Bennett, G. W. 1970. Management of lakes and ponds. 2nd ed. Van Nostrand Reinhold Co. New York. 375 p.

Bingham, R. 1976a. Pesticide and chemical studies of two oxbow lakes. Completion Report F-19-R. Mississippi Game and Fish Comm. 79 p.

Bingham, R. 1967b. Bottom fauna of two oxbow lakes. Completion Report F-19-R. Mississippi Game and Fish Comm. 40 p.

Bingham, R. 1969. Comparative study of two oxbow lakes. Completion Report F-19-R. Mississippi Game and Fish Comm. 216 p.

Blair, W. F., A. P. Blair, P. Bradkorb, F. P. Cagle, and G. A. Moore. 1957. Vertebrates of the United States. McGraw-Hill Book Co., Inc. New York. 819 p.

Cotton, D. 1976. Water quality study on Bear Creek watershed Leflore and Humpreys Counties, Mississippi. In report to USDA-SCS. 46 p.

Herring, J., and D. Cotton. 1969. A survey of insecticide levels and chemical quality of twenty randomly selected delta lakes. Completing Report F-24-I. Mississippi Game and Fish Comm. 78 p.

Herring, J., and D. Cotton. 1970a. Pesticide residues of twenty Mississippi delta lakes. (Federal Project F-24-I). Proc. S. E. Game and Fish Comm. 24: 482-488.

Herring, J., and D. Cotton. 1970B. A monitoring of pesticide levels and water quality of the major drainage ditches entering Wolf Lake, Mossy Lake and Broad Lake. Completion Report F-25-I. Mississippi Game and Fish Comm. 46 p.

Herring, J., and D. Cotton. 1974. Determination of water quality, productivity factors, and pesticide residues in Mississippi lakes. Completion Report F-33-I. Mississippi Game and Fish Comm. 103 p.

Ritchie, J. C., C. M. Cooper, and J. R. McHenry. 1978. Recent accumulation of sediment in lakes in the Bear Creek watershed in the Mississippi delta. Journal of the Mississippi Academy of Science, Vol. 23:29 (Abstract).

Table 1. Water quality parameters, Six-Mile Lake, Bear Creek, Mississippi watershed, summer 1977. (Station 12A-Upper and near inflow; 12B-Center of lake; 12C-lower end near outflow)

Stat.	Date	Depth (m)	Secchi (cm)	Temperature (C)	Electrical Conductivity (µ mhos/cm)	DO (ppm)	pH
12A	6/21	0	52	31.5	152	10.3	6.2
		1		29.6	150	10.3	6.4
		2		28.9	149	11.5	6.4
12B	6/21	0	59	32.3	155	10.7	6.5
		1		31.5	155	10.5	6.6
		2		30.7	152	11.4	6.8
		3		27.4	161	11.8	6.7
		4		24.8	228	12.1	6.5
		5		22.1	262	12.4	6.4
12C	6/21	0	63	32.3	160	9.5	6.7
		1		32.9	156	9.3	7.0
		2		31.8	154	9.6	6.9
12A	7/19	0	59	31.8	153	5.1	6.7
		1		32.0	154	6.1	7.1
		2		31.8	154	6.2	7.2
12B	7/19	0	89	31.1	146	8.9	6.5
		1		31.3	147	9.5	6.8
		2		30.8	149	7.5	6.9
		3		28.4	172	4.2	6.6
		4		25.1	238	3.3	6.3
		5		24.0	266	2.4	6.2
12C	7/19	0	58	32.2	150	7.9	6.4
		1		30.9	149	8.3	6.7
		2		30.5	148	8.5	6.8
12A	8/19	0	54	32.6	131	8.1	6.7
		1		31.5	129	9.0	7.0
		2		31.1	128	9.6	7.0
12B	8/19	0	65	33.8	133	6.3	6.8
		1		32.7	133	7.6	7.2
		2		31.8	133	8.7	7.1
		3		28.5	171	7.2	6.6
		4		25.9	223	5.3	6.4
		5		25.2	248	8.3	6.4
12C	8/19	0	56	34.4	136	8.7	6.6
		1		32.4	134	6.4	6.8
		2		31.0	133	3.7	6.8

Table 2. Percentage composition by weight and numbers of fish species per acre ($34m^2$) in Six-Mile Lake, Bear Creek watershed, Mississippi, June 16, 1977.

Species	Percent of Total Weight 1/	Percent of Total number 2/
Dorosoma cepedianum	63.0	84.5
Ictiobus cyprinellus	8.4	0.8
Ictiobus bubalus	16.4	8.3
Pomoxis annularis	2.1	1.1
Lepomis macrochirus	1.6	4.7
Cyprinus carpio	3.5	0.7
Ictalurus natalis	3.9	3.0

1/ Total weight 218.2 kg (480.6 lbs)
2/ Total number 2411 fish

Table 3. Fish population data by rotenone sampling; Six Mile Lake, Bear Creek Watershed, Mississippi. (continued)

Date: June 16, 1977
Area: 1 acre

Class Size (in.)	*Ictiobus bubalus* no.	wt. (kg)	wt. (lbs)	*Ictiobus cyprinellus* no.	wt. (kg)	wt. (lbs)	*Ictiobus niger* no.	wt. (kg)	wt. (lbs)	*Cyprinus carpio* no.	wt. (kg)	wt. (lbs)
1&2												
3												
4												
5												
6												
7												
8												
9	2	0.36	(0.8)									
10	24	5.44	(12.0)							2	0.68	(1.5)
11	44	15.04	(33.2)							4	1.22	(2.7)
12	11	4.67	(10.3)	2	1.13	(2.5)	2	0.82	(1.8)	7	2.58	(5.7)
13	15	7.16	(15.8)	4	2.58	(5.7)	1	0.50	(1.1)	3	1.45	(3.2)
14	2	1.40	(3.1)	7	5.57	(12.3)				1	0.59	(1.3)
15	2	1.59	(3.5)	4	3.94	(8.7)	1	0.73	(1.6)			
16				3	3.62	(8.0)						
17				1	1.59	(3.5)						

Miscellaneous Species:	no.	wt.	(lbs)
Lepisosteus oculatus	1	0.14	(0.3)
Lepomis gulosus	14	0.05	(0.1)
Ictalurus furcatus	1	0.14	(0.3)
Istalurus punctatus	1	T	
Gambusia affinis	1	T	

Table 3. Fish population data by rotenone sampling; Six Mile Lake, Bear Creek Watershed, Mississippi.

Date: June 16, 1977
Area: 1 acre

Class Size (in.)	*Dorosoma cepedianum* no.	wt. (kg)	wt. (lbs)	*Pomoxis annularis* no.	wt. (kg)	wt. (lbs)	*Lepomis macrochirus* no.	wt. (kg)	wt. (lbs)	*Ictalurus natalis* no.	wt. (kg)	wt. (lbs)
1&2	361	0.23	(0.5)	3	0.05	(0.1)	8	0.02	(0.05)			
3	48	16.30	(36.0)				20	0.36	(0.80)	2	0.05	(0.1)
4							41	0.95	(2.10)	1	0.05	(0.1)
5	6	0.05	(0.1)				29	1.78	(2.60)	1	0.05	(0.1)
6	135	7.07	(15.6)	4	0.27	(0.6)	16	0.95	(2.10)	8	0.45	(1.0)
7	491	24.05	(53.1)	6	0.68	(1.5)				12	0.91	(2.0)
8	452	34.66	(76.5)	2	0.23	(0.5)				31	3.44	(7.6)
9	170	16.40	(36.3)	2	0.32	(0.7)				12	1.90	(4.2)
10	218	24.80	(54.7)	1	0.02	(0.5)				3	0.73	(1.6)
11	116	18.90	(41.8)	3	0.82	(1.8)				1	0.41	(0.9)
12	27	6.30	(13.9)	4	1.63	(3.6)				1	0.45	(1.0)
13	10	3.04	(6.7)	1	0.45	(1.0)						
14	4	1.95	(4.3)									
15												
16												
17												

Table 4. Growth and length data for white crappie (*Pomoxis annularis*) from Six Mile Lake, Bear Creek watershed, Mississippi, June 16, 1977.

Age Class	No. of Fish	Mean calculated total length in cm. (in) at annulus 1		2		3		4		Length at Capture
I	0									
II	6	4.83	(1.9)	11.43	(4.5)					15.0 (5.9 in)
III	5	4.83	(1.9)	9.14	(3.6)	16.0	(6.3)			19.8 (7.8 in)
IV	1	4.83	(1.9)	8.38	(3.3)	12.45	(4.9)	22.10	(8.7)	30.5 (12.0 in)

CONDITIONS INFLUENCING FISH PRODUCTION

IN SMALL MISSISSIPPI IMPOUNDMENTS

Luther A. Knight, Jr.
Department of Biology
University of Mississippi
University, Mississippi 38677

Jack Herring
Fisheries Division
Mississippi Game and Fish Commission
Jackson, Mississippi 39205

Bill Anderson[1]
Fisheries Division
Mississippi Game and Fish Commission
Jackson, Mississippi 39205

ABSTRACT

Physico-chemical conditions in 14 small Mississippi impoundments showed generally acid water with low total hardness and conductivity. During summer thermal stratification, dissolved oxygen was often virtually depleted below a depth of 1 to 3 m.

The percentage of harvestable fish was adequate although overall fish production was low. Neither largemouth bass nor bluegills were over exploited.

Plankton crops at times contained "blooms" of <u>Anabaena</u> sp., but appeared sufficient for fish production. Zooplankton was dominated by the Rotifera.

Largemouth bass and bluegill growth was similar to that found in large Mississippi reservoirs.

[1]Present address:
St. Louis Globe-Democrat
Edwardsville, Illinois 62025

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INTRODUCTION

Fishing pressure on Mississippi's public fishing impoundments has been steadily increasing and fishermen are demanding quality fishing. In order to effectively manage an impoundment for fishing, knowledge of water quality, potential productivity and other background data must be known. Prior to 1972, accurate data on small public lakes in Mississippi was lacking. Cotton and Herring (1973) found these impoundments to be free of significant pesticides and mercury pollution. Herring and Cotton (1974) conducted water quality studies, plankton and benthos analyses, and fish population studies on several of these impoundments.

The present study evaluates fish populations and measures several parameters related to fish production in selected Mississippi lakes.

METHODS

Water samples for physico-chemical and plankton analyses were taken at 1-m intervals with a Kemmerer water sampler. One station, in deep water near the dam, was sampled in each of 14 lakes four times during the year. Temperature, free CO_2, pH, dissolved oxygen and light transparency were measured in the field. Conductivity and total hardness were run in the laboratory the following day. Methods outlined in American Public Health Association (Standard Methods, 1971) were followed.

Analyses of calcium, magnesium, iron, manganese and sodium concentrations were made with an atomic absorption system. Physico-chemical conditions were measured on these impoundments: Claude Bennett, Lamar Bruce, Columbia, Mike Conner, Mary Crawford, Jeff Davis, Tom Bailey, Ross Barnett, Monroe, Little Oktibbeha, Perry, Simpson County, Tippah County and Walthall (Fig. 1). These lakes vary in size from 25 to 134 ha.

Plankton samples were collected from Lamar Bruce, Mary Crawford, Jeff Davis and Monroe Lakes. Procedures outlined in A.P.H.A. (1971), Lind (1974), and Knight and Herring (1977) were followed for plankton analyses. A length of 300 μ represented a unit of filamentous algae. All other plankters, including single cells and colonies, were counted as individual units.

Seven fish population studies were conducted on five impoundments during July, 1974. Study areas consisting of 0.40 ha were performed on Lakes Columbia, Monroe, Jeff Davis, and Claude Bennett, and two 0.40 ha studies and a 0.46 ha study were conducted on Lamar Bruce. Except for the 0.46 cove study on Lamar Bruce, in which a 12.7 mm mesh block-off net was stretched across the cove, all studies were performed using a block-off net to enclose three sides of a 0.40 ha area while a straight portion of shoreline formed the fourth side. Five percent emulsifiable rotenone (Nox-Fish) was applied to the study area through a pressurized system so that the water contained 1 ppm. Fish were collected, sorted by species, placed in size groups, counted, weighed and recorded. Second day pickup was processed in the same manner. F/C, Y/C, A_T, A_F, and S_F values were calculated according to Swingle (1950). Names of fishes in this study are those listed in American Fisheries Society (1970).

Two hundred seventy-six largemouth bass (Micropterus salmoides) and 320 bluegill (Lepomis macrochirus) were collected from Lakes Lamar Bruce, Jeff Davis and Mike Conner to determine age and growth. Fish were collected by rotenone sampling, electro-fishing and angling from July 1 through December 9, 1974. Length, weight, sex and date of capture were recorded for each fish. Scales were removed from the right side of each fish, below the origin of the dorsal fin and above the lateral line. Five scales from each fish were wet mounted and examined at 40X magnification. The age of each specimen was estimated by two researchers. The direct proportion method of back calculation was used.

RESULTS

The majority of the impoundments are acid and exhibit low conductivity and total hardness (Table 1). Water quality in 1974 was similar to that reported for 1973 (Herring and Cotton, 1974). Surface pH ranged from 5.7 in Lake Perry during January, 1974 to 9.3 in Lake Monroe during August, 1974. Generally, pH in all impoundments varied from 6.0 to 7.0 in surface waters, except during heavy plankton blooms when values ranged from 8.0 to 9.0. Hypolimnion pH was often near or below 6.0.

Total hardness varied from 4 to 72 ppm, with only Lakes Monroe, Claude Bennett and Tippah County exhibiting hardness greater than 20 ppm.

Surface water conductivity varied from 16 to 123 μ mho/cm, but was typically between 20 and 40. Four impoundments exhibiting consistently high conductivity in epilimnion waters were Claude Bennett, Monroe, Tippah County and Tom Bailey.

Impoundments in the southern portion of the state were 2 to 3 C warmer than northern lakes. The lowest surface temperature was 7.5 C in Tippah County in January, 1975. The highest temperature, 33.6 C, occurred in the epilimnions of Lakes Mary Crawford and Monroe during July and August, 1974. Water temperatures were influenced by colder climatic conditions in 1974 and averaged 2 to 5 C lower than in 1973 (Herring and Cotton, 1974). Thermal mixing also occurred earlier in the autumn of 1974 than in 1973.

Oxygen in the thermocline and hypolimnion was virtually depleted during the summer in all the impoundments. Oxygen levels too low (<0.5 ppm) to sustain fish life existed at depths below 1 to 3 m. High levels of free CO_2 were associated with areas of oxygen devoid water. The high level of free CO_2 and low levels of D. O. are characteristic of sub-tropical lakes and are not necessarily indicative of entrophic waters (Ruttner, 1953).

Trace and essential element concentrations for 1974 (Table 2) were comparable to those recorded during 1973 (Herring and Cotton, 1974).

Plankton studies are presented in Table 3. Plankton from Monroe and Jeff Davis was studied in 1973 and early 1974 (Herring and Cotton, 1974). Data from these previous investigations may be compared with present results. It should be noted that six series of samples were collected in the first study, but only four were taken in the present study. In addition, periodicity of plankton, use of low magnification for enumeration and small sample size may result in some smaller forms being overlooked. The data appear, however, to be adequately representative of populations in all four impoundments.

Zooplankton populations of all four reservoirs are dominated by rotifers; these include such forms as Polyarthra vulgaris, Keratella cochlearis, and Trichocerca similis. Lake Monroe contained numerous members of Anuraeopsis which were not observed in the 1973 studies

(Herring and Cotton, 1974). These rotifers were also not found in Jeff Davis in 1973, although a few isolated individuals were collected in these waters during the present study. Microcrustaceans included Cyclops, Diaptomus, and Daphnia. Nauplii were present in the majority of samples from all four small impoundments.

Lake Mary Crawford is shallow (5 m) and contained fewer kinds of zooplankters than the other impoundments. Typical of this impoundment were large numbers of Difflugia and Didinium.

Lamar Bruce zooplankton was characterized by a greater variety of rotifers than was found in the other lakes. Common genera included Brachionus, Keratella, Kellicottia, Trichocerca, Polyarthra, and Hexarthra. Copepods occurred more frequently and in larger numbers in this impoundment than in the others in the present study.

The Chlorophyta and Cyanophyta in Lamar Bruce were abundant, and frequently constituted blooms. Large numbers of Anabaena sp. (517,000 units/l) were observed in surface waters of Lamar Bruce in October.

Lakes Mary Crawford and Lamar Bruce supported dense populations of Ceratium. In October, 1974 and January, 1975, the members of Ceratium numbered 7,794 and 19,866 individuals/l, respectively. Herring and Cotton (1974) noticed that Ceratium was abundant in Lake Monroe from spring through late fall, but only in May and October were pulses of sufficient magnitude to be considered "blooms". In the present study, the epilimnion of Lake Monroe contained approximately 53,000 individuals/l.

In their completion report on investigations of fisheries resources in Mississippi, Herring and Anderson (1975) list counts for common plankters in Lakes Monroe, Mary Crawford, Jeff Davis and Lamar Bruce. Table 3 lists net plankters from Lakes Monroe and Mary Crawford for a winter and summer series of plankton samples.

Fewer kinds and numbers of diatoms were found in Jeff Davis and Monroe during the present study than were expected. This may be attributed to sampling on fewer dates.

Total kg of fish per ha from all population studies showed considerable variation from Lake Lamar Bruce (Table 4). This variation in one lake can be explained by the differing habitats of the studies; two samples were conducted along a relatively straight, barren shoreline, while one sample was taken in a cove containing underwater trees. The variation points out the difficulty in accurately determining the standing crop of a lake from a 0.40 ha sample. In contrast, Swingle's ratios of balance gave similar results for the three Lamar Bruce studies (Swingle, 1950).

A sufficient number of largemouth bass from age I through III were collected from Lakes Lamar Bruce, Mike Conner and Monroe to allow good estimates of growth (Table 5). The small number of fish collected from age IV and V precludes drawing conclusions from these age groups. Jeff Davis bass exhibited the best growth, followed by Lamar Bruce. Largemouth bass growth in Mike Conner was the poorest of the three small impoundments. Jeff Davis bass also grew larger during the first three years than did largemouth bass from Ross Barnett Reservoir (Barkley, 1971) and Sardis, Enid and Grenada Reservoirs (Towery and Schultz, 1966). Trends in Lamar Bruce and Mike Conner are not as clear. Largemouth bass in Lamar Bruce generally grew better than did bass in the reservoirs, while largemouth bass in Lake Mike Conner exhibited growth equal to or poorer than bass in the four large reservoirs. In terms of weight at time of capture, Jeff Davis bass averaged 0.64 kg between ages two and three, while bass in Mike Conner and Lamar Bruce did not exceed 0.45 kg until they reached age three.

Sufficient numbers of bluegill from one to three years old were collected from each impoundment (Table 5) to estimate growth trends. Bluegill from the three impoundments exhibit a highly similar rate of growth. Specimens showed better growth at one year of age than did bluegill from Ross Barnett Reservoir (Barkley, 1971) and Sardis Reservoir (Towery and Schultz, 1966). Growth during the second and third years was similar for bluegill from the three impoundments and the two reservoirs. In the three impoundments, two year old fish weighed just over 0.11 kg, and none reached 0.23 kg during their third year.

DISCUSSION

With the methods used to evaluate plankton organisms in this study, much nannoplankton may have been overlooked. However, the net plankton in these impoundments indicated a tendency toward the eutrophic conditions. Kalff (1972) and others have correlated eutrophic conditions with waters dominated by net plankton. No doubt nutrients, in the forms of commercial fertilizer carried into the impoundments with runoff and deliberate applications of fertilizers, have influenced the trophic conditions of all four impoundments from which plankton studies were made.

In general, zooplankton and phytoplankton populations appear to be adequate for fish production and growth, assuming all other water quality parameters are suitable. Carmichael, Biggs, and Gorham (1974) have shown that various organisms, including gold fish, die of respiratory arrest from certain substances in Anabaena flos-aquae. The possible adverse effects of certain blue-green algae suggest that conditions should be altered to control these algae if increased fish production is to be obtained.

Some plankters (rotifers, microcrustacea) are relatively large (100 u to 2.5 mm) and on a volume basis must provide considerably more food value than would be available from large numbers of smaller phytoplankters. Simple counts therefore, may be misleading, and the reader is cautioned to consider volume as well as numbers in evaluating plankton samples.

Swingle's ration (Table 4) indicate that Lakes Columbia, Jeff Davis and Lamar Bruce have an adequate percentage of harvestable fish, but that the bass are overcrowded and the forage species are dwindling under predation. The fish population in Lake Claude Bennett is balanced, according to Swingle's ratios.

The data from Lake Monroe appears somewhat confusing, but can be interpreted as follows: 86% (by weight) of the fish collected were bluegill and the majority of these were large bluegill. Thus, there is a large amount of forage present but very little that is available to the predator species. The number of large bluegill present accounts for the excellent percentage of harvestable size fish. Bass populations did not appear to be over exploited in any of the study impoundments.

Growth of bass and bluegill in the three small impoundments, although similar to that found in larger Mississippi Reservoirs, is less than anticipated.

Depositional patterns indicate that both iron and manganese play an important role in precipitation of phosphorus to the sediment and its retention therein (Bortleson and Lee, 1974). They further showed that iron may be the dominant factor affecting phosphorus levels in lake sediments. It may be postulated that, with maxima of 18.6 ppm iron and 12.2 ppm manganese in the waters, a considerably higher content of the metals is found in sediments of impoundments in this study. If this is true, fertilizing with phosphorus without altering pH, redox conditions and other variables, would have little effect on the amount of phosphorus available to the biota.

Bennett (1971) stated that in water containing less than 10 ppm total hardness, the addition of lime may be followed by a large increase in fish production. Zeller and Montgomery (1957) demonstrated that under acid conditions, phosphorus is tied up in insoluble compounds in the bottom mud and is unavailable for production. The addition of lime to these impoundments could shift the pH toward neutrality and release insoluble phosphorus from the sediments. Adding lime to shift pH toward alkalinity and to increase calcium levels may be the most effective management tool available to improve fish growth and production in several of these impoundments.

CONCLUSIONS

Water quality in the majority of these impoundments indicates low productivity with many of the essential substances needed for productivity occurring in low concentrations. The addition of lime would provide a more optimum pH and would also add needed calcium and magnesium. All of the reservoirs studied showed severe oxygen depletion during the summer months regardless of productivity.

Fish growth in small fertilized impoundments is similar to that in the large flood control reservoirs. The percentage of harvestable fish was adequate although overall fish production was low.

Anabaena sp. was the dominant phytoplankter and the Rotifera the dominant zooplankters.

LITERATURE CITED

American Fisheries Society. 1970. A list of common and scientific names of fishes from the United States and Canada. Spec. Pub. No. 6, 150 p.

American Public Health Association. 1971. Standard methods for the examination of water and waste water, 12th. ed. APHA, 874 p.

Barkley, Harry. 1971. Ross R. Barnett Reservoir fisheries investigation. Completion report. F-12-R. Miss. Game & Fish Comm. 80 p.

Bennett, George W. 1971. Management of lakes and ponds. Van Nostrand, New York. 375 p.

Bortleson, G. C. and G. F. Lee. 1974. Phosphorus, iron and manganese distribution in sediment cores of six Wisconsin Lakes. Limnol. Oceanogr. 19 (5): 794-801.

Carmichael, W. W., D. F. Biggs, and P. R. Gorham. 1974. Toxicology and pharmacological action of *Anabaena flos-aquae* toxin. Science. 187: 542-544.

Cotton, D. and J. Herring. 1973. A survey of mercury and pesticide residues in fish from locations outside the Delta region in Mississippi. Completion report. F-30-1. Miss. Game & Fish Comm. 31 p.

Herring, J. and B. Anderson. 1975. Lake investigations, Study I: investigation of state lakes' fishery resources. Completion report. F-37-1. Miss. Game & Fish Comm. 96 p.

Herring, J. and D. Cotton. 1974. Determination of water quality, productivity factors, and pesticide residues in Mississippi lakes. Completion report. F-33-1. Miss. Game & Fish Comm. 103 p.

Kalff, J. 1972. Net plankton and nanoplankton (sic) production and biomass in a north temperate zone lake. Limnol. Oceanogr. 197 (5): 712-720.

Knight, Luther, Jr. and Jack Herring. 1977. Plankton production in a small Mississippi impoundment, Lake Lamar Bruce. Miss. Water Resources Conf. 97-118 p.

Lind, O. T. 1974. Handbook of common methods in limnology. C. V. Mosby Company. 153 p.

Ruttner, F. 1953. Fundamentals of limnology. (Trans. D. G. Frey & F. E. Fry). Univ. of Toronto Press, Toronto, Canada. 307 p.

Swingle, H. S. 1950. Relationship and dynamics of balanced and unbalanced fish populations. Bull. No. 274. Agricult. Exper. Sta., Auburn Univ., Auburn, Ala. 74 p.

Towery, Bobby A. and C. A. Schultz. 1966. Fisheries investigations on flood control reservoirs. Completion report. F-6-R. Miss. Game & Fish Comm. 171 p.

Zeller, H. D. and A. B. Montgomery. 1957. Preliminary investigations of chemical soil and water relationships and lime treatment of soft water in Georgia farm ponds. Proc. S. E. Assn. Game & Fish Comm. 11: 71-76.

Table 1. Selected physico-chemical data from Lakes Mary Crawford and Monroe during 1974 - 1975

	Depth (m)	Temperature C	D.O. ppm	Free CO_2 ppm	pH	Conductivity µ mho/cm	Total Hardness ppm
Mary Crawford	0	33.6	11.6	0.0	9.1	43	8
7/29/74 - 4:10 PM	1	33.1	12.2	0.0	9.1	39	8
Secchi Disc	2	29.6	2.2	3.0	8.0	38	8
32"	3	26.1	0.2	14.0	*	93	8
	4	24.2	0.1	27.0	*	130	8
	5	20.2	0.1	31.0	*	154	8
1/9/75 - 8:30 AM	0	12.6	8.5	3.0	6.2	26	12
Secchi Disc	1	12.5	8.3	4.0	6.2	26	12
27"	2	12.5	8.2	4.0	6.2	26	12
	3	12.5	8.1	4.0	6.1	26	12
	4	12.4	7.4	4.0	6.0	26	12
	5	11.9	5.5	4.0	6.0	26	12

*No reading due to equipment failure.

Table 1. (Continued)

	Depth (m)	Temperature C	D.O. ppm	Free CO_2 ppm	pH	Conductivity µ mho/cm	Total Hardness ppm
Lake Monroe	0	33.6	11.9	0.0	9.3	50	20
8/12/74 - 1:25 PM	1	28.2	7.3	0.0	9.3	49	20
Secchi Disc	2	27.7	1.1	0.0	8.8	48	20
12"	3	25.4	0.0	6.0	6.5	56	20
	4	22.8	0.0	24.0	6.5	127	36
	5	19.1	0.0	43.0	6.5	158	36
	6	17.6	0.0	46.0	6.6	158	26
1/7/75 - 11:00 AM	0	8.9	8.0	2.0	6.5	48	20
Secchi Disc	1	8.7	7.7	2.0	6.4	48	20
42"	2	8.6	7.6	3.0	6.4	48	20
	3	8.6	7.6	3.0	6.4	48	20
	4	8.6	7.5	4.0	6.4	48	20
	5	8.6	7.4	4.0	6.4	48	20
	6	8.5	7.4	4.0	6.4	48	20

Table 2. Concentrations of certain trace and essential elements for Lakes Mary Crawford and Monroe, 1974 - 1975.

	Calcium ppm	Magnesium ppm	Sodium ppm	Manganese ppm	Iron ppm
Lake Mary Crawford					
Date: 7/29/74					
Surface	1.0	1.1	1.5	<0.3	<0.5
3 m	1.9	1.4	1.5	0.8	0.5
5 m (bottom)	1.6	1.7	1.5	12.2	9.7
Date: 1/9/75					
Surface	0.5	0.3	1.4	<0.3	1.1
3 m	0.5	0.3	1.4	<0.3	1.1
5 m (bottom)	0.5	0.3	1.5	0.3	1.2
Lake Monroe					
8/12/74					
Surface	3.1	1.2	1.0	0.3	<0.5
3 m	3.8	1.3	1.1	0.5	<0.5
6 m	7.6	1.8	1.4	2.1	9.0
1/7/75					
Surface	1.8	0.7	0.9	<0.1	1.0
3 m	1.8	0.6	1.2	<0.1	1.0
6 m	1.9	0.7	0.9	<0.1	1.0

Table 3. Plankton organisms found in Lakes Monroe and Mary Crawford from summer and winter samples--1974 and 1975. The first column under each impoundment indicates summer occurrence; the second winter occurrence.

	Lake Monroe		Lake Mary Crawford	
Phytoplankton				
Chlorophyta				
Arthrodesmus sp.		X		
Closterium sp.	X	X		
Dictyosphaerium sp.		X		X
Dimorphococcus sp.				X
Gonium sp.		X		
Kirchneriella sp.		X		
Melosira sp.	X	X	X	X
Pediastrum sp.			X	X
Scenedesmus sp.		X	X	
Staurastrum sp.	X	X	X	
Zygnema sp.		X		
Euglenophyta				
Euglena sp.	X		X	
Phacus sp.	X	X	X	X
Chrysophyta				
Asterionella sp.		X		
Diatomella sp.		X		

Table 3. (Continued)

	Lake Monroe		Lake Mary Crawford	
Gyrosigma sp.		X		
Navicula sp.				X
Synedra sp.		X	X	X
Cyanophyta				
Anabaena sp.	X		X	X
Lyngbya sp.	X			
Oscillatoria sp.	X	X	X	
Phormidium sp.	X			
Polycystis sp.	X	X	X	
Pyrrophta				
Ceratium sp.	X	X		X
Peridinium sp.	X	X		
Zooplankton				
Protozoa				
Actinosphaerium sp.	X			
Ciliate sp.			X	
Didinium sp.	X		X	X
Difflugia sp.		X		X
Epistylis sp.		X		
Protozoa sp.	X	X	X	X
Tinitnnidium sp.				X
Vorticella sp.	X			

Table 3. (Continued)

	Lake Monroe		Lake Mary Crawford	
Rotifera				
Anaeuropsis sp.	X		X	
Asplanchna sp.			X	
Cephalodella sp.		X		
Conochiloides sp.				X
Conochilus sp.	X	X	X	X
Brachionus havanaensis			X	
Brachionus sp.			X	
Filinia longiseta	X		X	
Hexarthra mira	X		X	
Kellicottia bostoniensis		X	X	
Keratella cochlearis	X	X	X	X
Keratella crassa				X
Polyarthra euryptera				X
Polyarthra vulgaris		X	X	X
Rotifer sp.	X		X	X
Trichocerca longiseta			X	
Trichocerca similis	X		X	X
Trichocerca sp.	X		X	
Copepoda				
Cyclops	X	X	X	X
Nauplius	X	X	X	X

Table 3. (Continued)

	Lake Monroe	Lake Mary Crawford
Cladocerca		
Daphnia sp.	X	
Gastrotricha		
Gastrotricha sp.		X
Insecta		
Chaoborus sp.	X	X

Table 4. Swingle's balance ratios for five Mississippi lakes.

Lake	F/C	Y/C	A_T	A_F	S_F	Total kg/ha
Claude Bennett	5.3	0.8	51.8	56.0	14.0	106.08
Lamar Bruce (cove)	1.4	0.1	81.9	82.0	9.0	163.10
Lamar Bruce	0.3	0.1	73.4	39.0	26.0	22.01
Lamar Bruce	1.9	0.2	80.0	84.0	8.0	20.19
Columbia	1.5	0.3	49.8	56.0	17.0	47.78
Jeff Davis	1.6	0.3	63.5	47.0	21.0	68.85
Monroe	11.2	0.5	83.9	90.0	5.0	64.52

Table 5. Growth of largemouth and bluegill from selected Mississippi lakes and reservoirs.

Lake & Date	No. of Fish	Mean calculated total length in mm at each annulus Largemouth Bass I	II	III	No. of Fish	Bluegill I	II	III
Jeff Davis 1974	56	191	323	401	94	84	130	168
Lamar Bruce 1974	82	175	274	358	96	74	145	163
Mike Conner 174	91	145	269	328	61	86	140	170
Barnett Res. 1963-1968	390	124	254	328	591	66	137	170
Sardis Res. 1955-1966	362	160	287	345	57	51	127	160
Enid Res. 1955-1966	338	173	300	348				
Grenada Res. 1955-1966	495	155	269	330				

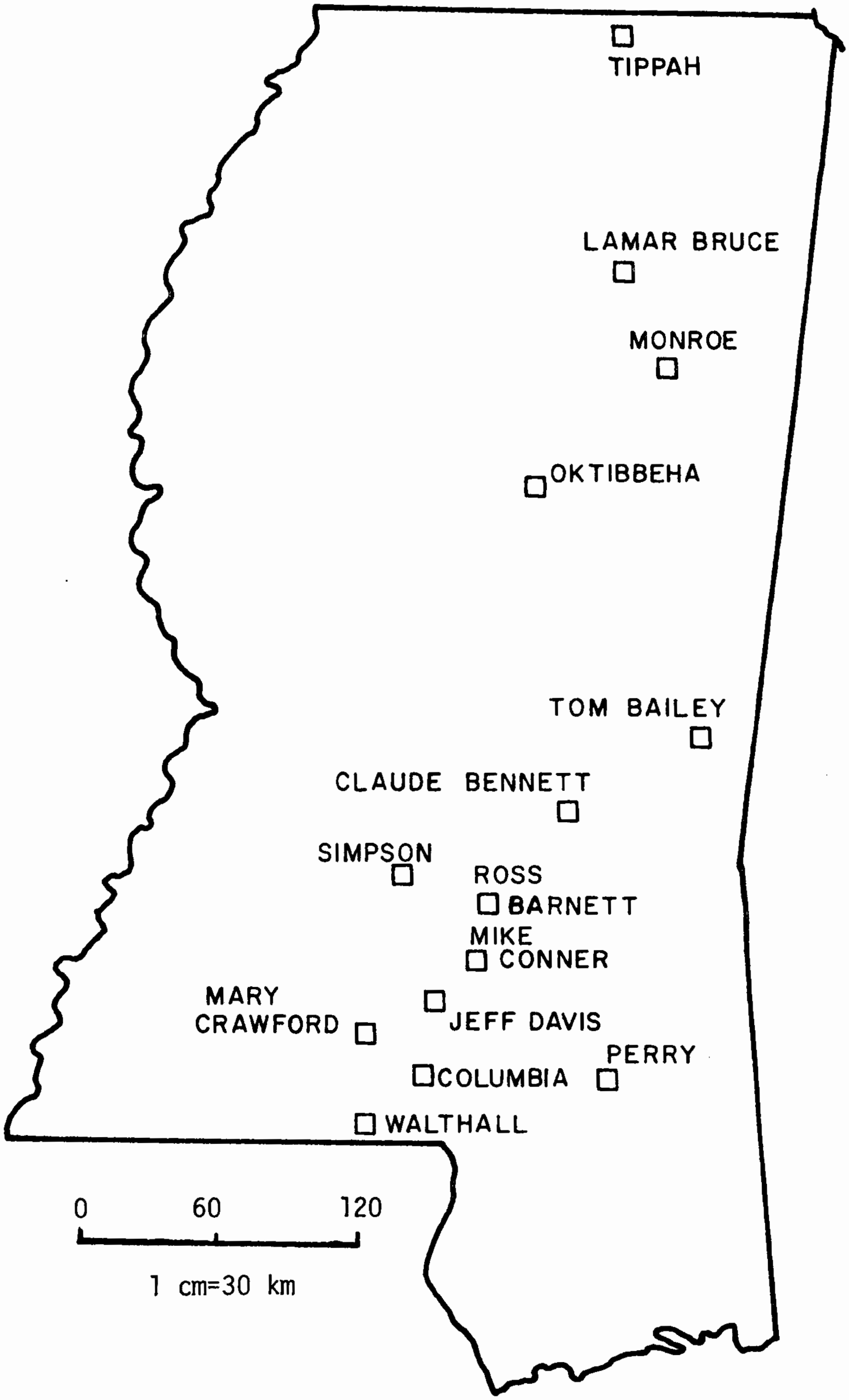

Figure 1. Location of small Mississippi impoundments selected for study of conditions influencing fish productions.

STATUS OF THE CATFISH FARMING INDUSTRY IN MISSISSIPPI - 1977

by

Richard E. Coleman
Area Extension Fish & Wildlife Specialist
Mississippi Cooperative Extension Service
Mississippi State University

Catfish farming is a relatively new agricultural enterprise. Although the use of catfish for food is not new, the intensive culture of catfish for food and profit is barely over 10 years old. It began in the early 1960's in the Delta areas of Mississippi, Arkansas, Louisiana and Tennessee. Today there are an estimated 45,000 acres of catfish in production in the United States.

Mississippi has clearly emerged as the nation's number one state in catfish production. There are more than 20,000 acres currently in production and we expect at least an additional 10-20% increase in catfish production acreage in 1978. Virtually, all of this expansion is occurring in the Delta area where favorable terrain, climate, soil types and abundant water are available.

Catfish farming has allowed the Mississippi farmer the opportunity to diversify his farming operation, and in many cases catfish are emerging as the principal money-making crop of the farming operation. The estimated value of production of the catfish industry in Mississippi in 1977 stands at 38 million dollars. The value of production refers to money generated by the producer and does not include turn-over at the processing plant or other sales outlets.

Humphreys County, Mississippi, realized more than $16 million dollars from the catfish industry in 1977. With more than 7,500 acres in production, including the world's largest catfish farm of 1,800 acres, it's no surprise that Humphreys County is known as the catfish capital of the world. In April, 1977, more than 8,000 people gathered on the courthouse lawn in Belzoni, county seat of Humphreys County, to celebrate the 2nd annual catfish festival and to consume more than one ton of crispy fried farm-raised catfish. This annual event has received national acclaim. The prime mover behind the entire show is Mr. Tommy Taylor, county agent in Humphreys County and a strong supporter of the catfish industry in Humphreys County and Mississippi.

The beginning of any catfish operation is construction of facilities. Pond construction is extremely important, and a properly constructed pond will provide the best opportunity for maintaining high sustained yields over the long term, with minimum maintenance requirements. A completed pond may be used for rearing fingerlings, holding brood fish or growing food fish.

Individual catfish ponds may contain different species on algae and plankton. Although the precise relationships of these plants to fish production is yet unknown, it is a fact that presence or absence of species can affect production, and that ponds which are adjacent to each other may have entirely different characteristics. A fish manager must be able to recognize these differences and adjust his management plans accordingly.

Channel catfish brood fish are stocked in the springtime when water temperatures reach about 60^{O}F. Brood fish should be carefully selected and stocked at rates of 30-50 pair per acre. Some catfish farmers prefer a "pond spawn" in which fish are allowed to spawn in the pond. This technique is popular since it requires less labor, however, the farmer does not know the number of fish spawned.

A more precise estimate of spawning success can be obtained in a fish hatchery. Brood fish are stocked in the same numbers in the ponds, but eggs are removed daily from spawning containers and placed in hatching troughs. This technique requires more skill and knowledge, and considerably more labor, but will enable the fish farmer to more accurately assess his spawning success and the numbers of fingerlings available for future use.

Fingerlings spawned during the spring will be placed in rearing ponds throughout the remainder of the year, and will be used as stockers for food fish ponds the following spring. A good stocker fingerling should be between 5-10 inches long. Food fish ponds may be stocked at rates of 2,500 - 4,000 fish per acre, depending on fingerling size, pond characteristics, and expertise of the manager. Average annual yields will vary from 2,500 lbs. up to 4,500 lbs. per acre, depending on these same factors.

Both fingerling ponds and food fish ponds are fed a high quality, high protein diet daily, which is largely responsible for the superior taste of farm-raised fish relative to wild fish. Various types of feeders are used depending on the desires of the manager. Some farmers even use airplanes during certain periods of the year to insure fish receive their daily ration of quality feed. Fingerlings are normally fed at the rate of 5% of body weight daily, while food fish are fed at 3% of body weight.

The average lifespan of a farm-raised catfish is approximately 18 months. This time could vary, depending on the management practices used by the fish farmer, but generally it takes about 18 months for the fish to reach an average of 1 1/4 - 1 1/2 pounds, which is the desired size for harvesting.

Harvesting is accomplished by seining, usually with two tractors on each end of the seine dragging it through the pond. A farmer can grade his fish by varying the mesh size on the harvest seine. This capability of size selection at harvest has generated an intensive management practice called "topping" -

where a manager can stock large numbers of different sized fish, feed appropriately, and seine at frequent intervals to remove harvest sized fish. This topping technique has allowed some farmers to substantially increase their annual yields per acre.

Harvested fish may be sold on the farm, particularly on smaller farms in the hill section of the state, or they may be transported to one of the four catfish processing plants located in the Mississippi Delta. Plants are currently located at Belzoni, Tippo, Isola and Hollandale.

A considerable number of farm-raised catfish are sold each year to live-haulers, who transport the fish to pay lakes or fee fishing lakes usually located around densely populated areas in the midwest.

Processed fish are marketed in a variety of product forms, and may be either fresh or frozen. Major markets at this time include those sections of the nation located near the Mississippi River and its tributaries. Marketing efforts are being expanded significantly as production expands, and many markets are springing up outside of traditional market areas. Catfish processors and producers remain optimistic concerning expansion into new market areas, and the future looks good.

There are multitudes of problems in the production of catfish which can kill fish outright or otherwise hamper production - and reduce profits. A list of the more common problems would include: (a) presence of undesirable fish species; (b) weed problems; (c) water quality problems; (d) parasites and other diseases; and (e) environmental problems. All of these problem areas require attention by the fish manager, and lack of knowledge in any of these areas may result in reduced profits at year end.

Specialists from the Extension Wildlife and Fisheries Department have worked closely with the catfish industry from the beginning, providing old and new producers with the latest knowledge available. Fish disease laboratories at Mississippi State and Stoneville have provided a valuable service to the industry, offering on-site evaluation of problems and diagnostic services for fish diseases. Since 1974 more than 400 fish kills have been handled by the two facilities. Subsequent treatment recommendations from these cases have undoubtedly saved untold numbers of fish and reduced monetary losses considerably.

The potential of the catfish farming industry in Mississippi in the future appears unlimited, but to insure steady progress there is an urgent need for additional research in a number of problem areas. Recognizing this, the state legislature this year is considering approval of funds for the establishment of an experimental fish farm at the Delta Branch Experiment Station at Stoneville. Such a facility would be a tremendous asset to the catfish industry in the state.

MISSISSIPPI CHAPTER OF

AMERICAN FISHERIES SOCIETY

1978 ANNUAL MEETING - FEBRUARY 16th.

PROGRAM

8:00-9:00 AM	Arrival and coffee
9:00-9:10 AM	Welcome to University by Dr. Kieser, Chairman, Dept. of Biology
9:10-9:30 AM	Introduction and brief review of activities being done by members
9:30-9:45 AM	Comments by Chapter President
9:45-10:00 AM	Schramm, Harold L., Jr. Corps of Engineers' Ecological Study of the Mississippi River
10:00-11:30 AM	General Business Session
11:00-12 Noon	Lorio, Wendell presented film on Atchafalaya River Basin
12:00-1:00 PM	Lunch Break
1:00-1:20 PM	Burris, John W. Special Animal Species in Mississippi Waters
1:20-1:40 PM	Gunter, Gordon. The River Shrimp Genus *Macrobrachium* and Its Aquaculture Potential in Mississippi
1:40-2:00 PM	Rohr, Bennie. Fishery Resource Research Activities of the Pascagoula Lab, Southeast Fisheries Center National Marine Fisheries Service (a general talk, no paper presented)
2:00-2:20 PM	Williams, Doug. Elimination of Threadfin Shad from Barnett and Okatibbee Reservoirs Due to Low Temperature, Winter, 1976-1977.
2:20-2:30 PM	Short Break
2:30-2:50 PM	Cooper, Charles M. and L. A. Knight, Jr. Occurance of Fishes in Six-Mile Lake, Bear Creek Drainage, Mississippi as Related to Certain Water Quality Conditions
2:50-3:10 PM	Knight, L. A., Jr., Jack Herring & Bill Anderson. Conditions Influencing Fish Production in Small Mississippi Impoundments
3:10-3:30 PM	Coleman, Richard E. Status of the Catfish Farming Industry in Mississippi - 1977

Highlights of the 1978 Annual Meeting of the Mississippi Chapter of the American Fisheries Society

The 1978 meeting was held at the University of Mississippi campus in Oxford, MS. During the meeting Tom Wellborn called attention to the possible introduction of grass carp in Ross Barnett Reservoir. Following discussion Luther Knight moved that the chapter oppose stocking of this species in Mississippi waters. An ad hoc committee of Tom Wellborn, Harry Barkley and Randall Robinette was charged with writing and distributing a resolution. This resolution was quickly provided and circulated. It rapidly gained the support of other concerned agencies including the Mississippi Academy of Science and the Southeastern Fishes Council to name only several. Through the prompt action of our chapter and the support of other groups, the current attempt to stock grass carp in Mississippi waters was halted. This outcome should make us all aware of the important role that we can have in managing our states resources.