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LARGE-SCALE OPERATIONS MANAGEMENT TEST OF USE OF THE WHITE AMUR FOR CONTROL OF PROBLEM AQUATIC PLANTS

Report 5
SYNTHESIS REPORT

by

Andrew C. Miller, Robert H. King

Environmental Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631
Vicksburg, Mississippi 39180

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Environmental Laboratory

LARGE-SCALE OPERATIONS MANAGEMENT TEST OF
USE OF THE WHITE AMUR FOR CONTROL OF
PROBLEM AQUATIC PLANTS

Report 1: Baseline Studies

Volume I: The Aquatic Macrophytes of Lake Conway, Florida

Volume II: The Fish, Mammals, and Waterfowl of Lake Conway, Florida

Volume III: The Plankton and Benthos of Lake Conway, Florida

Volume IV: Interim Report on the Nitrogen and Phosphorus Loading Characteristics of the Lake Conway, Florida, Ecosystem

Volume V: The Herpetofauna of Lake Conway, Florida

Volume VI: The Water and Sediment Quality of Lake Conway, Florida

Volume VII: A Model for Evaluation of the Response of the Lake Conway, Florida, Ecosystem to Introduction of the White Amur

Volume VIII: Summary of Baseline Studies and Data

Report 2: First Year Poststocking Results

Report 3: Second Year Poststocking Results

Report 4: Third Year Poststocking Results

Report 5: Synthesis Report

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On 9 September 1977, nearly 8000 white amur (*Ctenopharyngodon idella*) were stocked in Lake Conway, a five-pool, 1800-acre lake system near Orlando in Orange County, Florida. Stocking rate in each pool varied from 3 to 5 fish per surface acre; the fish weighed from 0.25 to 0.61 kg. The white amur were stocked to control the aquatic plant hydrilla (*Hydrilla verticillata*) and other macrophytes which had reached nuisance levels in the lake.

The U. S. Army Engineer Waterways Experiment Station, under sponsorship from the U. S. Army Engineer District, Jacksonville, and the Office, Chief of Engineers, conducted a 5-year study on the effects of stocking white amur on certain biotic and abiotic variables in the lake ecosystem. Studies on the various

(Continued)

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components of Lake Conway were conducted under contractual arrangement with selected universities and State and local agencies in Florida. The study consisted of a baseline period prior to stocking (January 1976-September 1977), and at least three poststocking years (October 1977-September 1980). Additional studies were conducted on fish and herpetofauna in 1981 and 1982.

The results of the Lake Conway project were complicated to some extent by two factors unrelated to the white amur. The most dramatic was uncharacteristically low water levels caused by below average rainfall from 1974 through the end of the study. As water levels declined, the pools became more isolated from one another and some chemical variables became more concentrated. The second factor which influenced the study was a dramatic increase in residential development around the lake. A considerable amount of shallow water habitat with large amounts of aquatic vegetations was lost because of new home construction.

As a result of stocking white amur in the lake, three of the four most common aquatic plants (hydrilla, nitella (*Nitella* sp.), and potamogeton (*Potamogeton* sp.)) were reduced as much as 90 percent within 18 months. A fourth plant, vallisneria (*Vallisneria* sp.), which is not readily eaten by white amur, was not dramatically affected by presence of the fish. Introduction of white amur and the subsequent reduction of aquatic vegetation did not affect water chemistry at Lake Conway. In addition, the number and diversity of waterfowl observed during the study declined. However, it was determined that the reduction in numbers was caused by local conditions and by fewer migrants (in the state) than by reduction of vegetation in the lake. In addition, aquatic mammals (Florida water rat (*Neofiber alleni*) and hispid water rat (*Sigmodon hispidus*)) were affected more by removal of peripheral emergent plants as a result of residential development than by introduction of white amur. Reptiles and amphibians were also affected by clearing along the shores of the lake. However, herbivorous turtles (*Pseudemys floridana* and *P. nelsoni*) as well as the turtle *Sternotherus odoratus*, which feeds primarily on snails that use plants as substrate, were affected by loss of vegetation.

Bottom dwelling or benthic species were relatively unaffected by the presence of the white amur. Noticeable changes were observed in the plankton population. In general, the species diversity decreased and total numbers of blue-green algae increased following the stocking of white amur and the decline of aquatic macrophytes. Following an increase in numbers of phytoplankton, the zooplankton community experienced an increase in numbers and a decrease in diversity. The reduction in diversity of algae and numbers of macrophytes and increase in numbers of zooplankton and phytoplankton had no noticeable effect on the water or sediment chemistry.

The Lake Conway fishery is dominated by bass, although other harvestable species include sunfish (various species) and chain pickerel (*Esox niger*). Additional fish species significant to the ecology of Lake Conway include brook silverside (*Labidesthes sicculus*), mosquito fish (*Gambusia* sp.), and assorted minnows. As a result of stocking white amur, the success of anglers for largemouth bass increased dramatically. In addition, small-sized sport fish and forage fish decreased in numbers.

The overall objective of the Lake Conway Large-Scale Operations Management Test (LSOMT) was to achieve control of the problem plant population with no detrimental environmental effects. The approach was one of effecting control over a 2- to 3-year period, resulting in a system that would generally maintain itself at a nonproblem level thereafter. At the outset of the Lake Conway study, it was the belief of many that the stocking rates were the errors that resulted in adverse system responses, not the white amur per se. The data from Lake Conway have significantly contributed to substantiating this belief.

The Lake Conway study, as well as studies prior to this one, has shown that the white amur can be an effective environmentally compatible control agent when stocked at rates that reflect both the immediate and predictive long-term conditions of the water body. The white amur is not, and should not be viewed as, an agent that provides immediate relief such as chemical control. Stocking rates that provide such short-term response are usually those high enough to cause adverse responses once the macrophytes are absent from the system.

The white amur is a biological control agent. It is the nature of these agents to provide slower response, with longer lasting results, than other methods of control. Manipulating their members to compress time should only be done within those boundaries that define long-term compatibility of the variations within the system.

PREFACE

The work described in this volume was performed by the Aquatic Plant Control Research Program (APCRP) of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss. The work was sponsored by the U. S. Army Engineer District, Jacksonville, and by the Office, Chief of Engineers (OCE), U. S. Army. The principal OCE Technical Monitor for the APCRP was Mr. Dwight L. Quarles.

This is the final report describing the results of a Large-Scale Operations Management Test (LSOMT) on use of the white amur for control of problem levels of aquatic plants in Lake Conway, Florida. During the conduct of this study many reports were published pertaining to the prestocking and poststocking data and other aspects of the LSOMT Lake Conway study. A complete list of these reports is presented in Appendix A of this document.

This volume was written by Dr. Andrew C. Miller and Dr. Robert H. King of the Environmental Laboratory (EL) of the WES. Dr. Miller works for the EL Environmental Systems Division (ESD). Dr. King is an aquatic ecologist with Central Michigan University (CMU) in Mt. Pleasant, Mich. He worked in the EL from 1 August 1981 to 31 July 1982 and participated in data analysis and interpretation for the LSOMT Lake Conway study while on an Inter-governmental Personnel Act agreement between WES and CMU.

The authors would like to acknowledge the expertise of the following individuals who provided significant background information, review of the draft report, or assistance with analysis of data:

Dr. Eldon Blancher, Taxonomic Associates, Mobile, Ala.
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Mr. Jeff Schardt, Florida Department of Natural Resources, Tallahassee, Fla.
Mr. Ray Kaleel, Orange County Pollution Control Board, Orlando, Fla.
Dr. Roy McDiarmid, National Fish and Wildlife Laboratory, National Museum of Natural History, Washington, D. C.
Ms. Deborah Fairly, WES
Mr. Fred Johnson, Florida Game and Fresh Water Fish Commission, Okeechobee, Fla.

The work was monitored at WES in the Aquatic Habitat Group, Dr. T. D. Wright, Chief, under the general supervision of Mr. B. O. Benn, Chief, ESD. Mr. J. L. Decell was Manager of the APCRP. Dr. John Harrison was Chief, EL.

Commander and Director of WES during the period of study and preparation of this report was COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

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CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	4046.873	square metres
Fahrenheit degrees	5/9	Celsius degrees or Kelvins*
inches	2.54	centimetres
square miles	2.589998	square kilometres

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

LARGE-SCALE OPERATIONS MANAGEMENT TEST OF USE OF THE WHITE AMUR FOR CONTROL OF PROBLEM AQUATIC PLANTS

Synthesis Report

PART I: INTRODUCTION

Background

1. The Aquatic Plant Control Research Program (APCRP) of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., is responsible for the development of various aquatic plant control techniques. This responsibility includes research on chemical methods, use of mechanical harvesting equipment, environmental management, and biological control techniques such as the use of plant pathogens, insects, or fish that feed on aquatic vegetation. This report deals specifically with a large-scale test of the white amur or grass carp (*Ctenopharyngodon idella*), an herbivorous fish native to the Amur River in Eastern China.

2. In January 1976, the WES initiated a comprehensive field study at Lake Conway near Orlando, Fla., to assess the overall effectiveness of the white amur as a biological macrophyte control agent. This Large-Scale Operations Management Test (LSOMT) consisted of basically three major phases: (a) collect approximately 12 months of baseline physical, chemical, and biological data; (b) stock Lake Conway with enough white amur to control, but not totally eradicate, the aquatic plants; and (c) continue collecting environmental data for at least three poststocking years.

3. The primary purposes of the LSOMT were:

- a. Test the effectiveness of the white amur on an operational scale.
- b. Document the responses of various portions of a large ecosystem to the presence of the white amur.
- c. Provide information to enable potential users to extrapolate the results of this study to other aquatic ecosystems.

4. Information on the development of the LSOMT and its part in the APCRP can be found in Decell (1976). A detailed description of the overall test plan was presented in a previous report by Addor and Theriot (1977). Additional discussions of various aspects of the project have also been

presented at several APCRP conferences; for a complete list, see Appendix A.

Purpose and Scope

5. For the LSOMT physicochemical variables, certain species of aquatic plants, vertebrates, and invertebrates were identified and examined critically through time. Data on habitat preferences, temporal and spatial variability, home range, and feeding characteristics were gathered during a series of concurrently conducted but separate studies. The primary objective of this document is to synthesize the component parts of the LSOMT Lake Conway Study. This report will examine and describe results of specific studies, not as separate entities, but in the context of the entire project.

6. The information presented herein applies specifically to Lake Conway; some aspects have applicability only for Florida. However, the white amur has been introduced into more than 30 states and the aquatic plant hydrilla (*Hydrilla verticillata*) is found in many southern states. Aquatic plant infestation consisting of macrophytes eaten by white amur are found throughout the United States and southern Canada. Furthermore, the driving forces behind a functioning ecosystem such as predator/prey relationships, utilization of an area for food and cover by aquatic and terrestrial organisms, nutrient cycling, fluctuating water levels, and the effect of habitat modification by man are fairly similar throughout the United States.

History of the Lake Conway Study

7. In 1975, the Office of the Chief of Engineers (OCE) directed that the Corps' APCRP become more responsive to user needs. The transfer of technology needed to be both expanded and accelerated such that operationally usable plant control tools and techniques were placed in the user's hands in the shortest time possible. Personnel of the APCRP critically reviewed and, as necessary, restructured the program. As part of this process, a meeting was held at WES on 19 February 1975 to identify research areas whose results demonstrated the most promising operational potential. Representatives of the South Atlantic Division, Jacksonville District, OCE, U. S. Fish and Wildlife Service, and U. S. Department of Agriculture were present. The discussions centered in the general area of biological control agents since it

was felt that this type of control offered the most promising long-term solution to many of the Nation's aquatic plant control problems.

8. The consensus at that time was that the white amur presented the most potential for success for future use as an operational control method. It was decided to develop and present the concept of conducting a comprehensive operational-scale test of the white amur to representatives in the State of Florida. Florida was chosen because it had a history of extensive and chronic aquatic plant problems. In addition, Florida and the Jacksonville District of the U. S. Army Corps of Engineers had a rapidly spreading problem with the submersed aquatic plant hydrilla. Finally, the white amur, through various tests conducted in ponds and lakes in Florida and Arkansas, was known to be effective in controlling hydrilla, but had yet to be tested on a large scale for total system control.

9. In May 1975 a meeting was held with Dr. Earle Frye, Director of the Florida Game and Fresh Water Fish Commission (FGFWFC); COL Emmett Lee, then District Engineer, Jacksonville District; and Mr. Lewis Decell, Manager, APCRP, WES, to discuss the proposed concept. Dr. Frye informed WES that the decision as to whether or not a large lake could be stocked for the test would have to be made by the FGFWFC Commissioners. The concept was subsequently presented at the June 1975 Commissioners' meeting. The Commission recommended that a presentation of the proposed test and stocking be placed on the agenda for their July meeting, at which time they could legally rule on the proposed work. The Commissioners also suggested that the Corps meet with the FGFWFC staff and be prepared to recommend a study site at the July meeting. As a result, Mr. Decell met several times with Mr. John Woods, Chief, Fisheries Division, FGFWFC, and his staff, and Lake Conway in central Florida was selected for this work. In July, the plan and site were presented to the Commissioners. They ruled unanimously to permit the stocking and directed Dr. Frye to transmit a letter to WES granting permission. The letter was issued on 4 September 1975.

10. Subsequently, WES personnel initiated development of a detailed test plan. Because of the previous research and testing efforts conducted in small lakes by various personnel in Florida, it was decided to contract the bulk of the work to proper responsible State agencies. All interested persons and agencies were invited to a meeting to discuss the proper level of detail and scope for the data collection phase of the project. As a result, a test

plan was developed and contracts for collecting baseline and poststocking environmental data were negotiated in late 1975. The first data were collected in January 1976, and various aspects of the study continued until June 1982. The white amur were stocked in Lake Conway on 9 September 1977, 19 months after the initiation of the initial phases of the baseline study (Table 1).

Data Sources

11. Below is a list of major areas of study, objectives of that work, and contractors who executed the tasks:

a. Water and sediment chemistry. The purpose of this work was to describe temporal water chemistry and sediment chemical and physical parameters, and identify significant changes possibly caused by introduction of the white amur. This work was conducted by the Orange County Pollution Control Board, Orlando, Fla.

b. Hydrology and nutrient sources. This work was designed to quantify the sources of external nutrient loading, describe internal nutrient cycling, and determine the loss rate of macronutrients in the Lake Conway system emphasizing those compounds potentially influenced by the white amur. This was studied by the Department of Environmental Engineering, University of Florida, Gainesville, Fla.

c. Aquatic macrophytes. In this study, the purpose was to describe the distribution, biomass, and species composition of the major aquatic plant species in Lake Conway; determine the rate of removal of the target species; and describe the effects on the remaining plant community. This work was conducted by the Florida Department of Natural Resources, Tallahassee, Fla.

d. Fish, waterfowl, and aquatic mammals. The objectives of this study were to describe the fish community in Lake Conway and evaluate any possible shift in species dominance brought about by introduction of white amur. This aspect of the project was conducted by the Florida Game and Fresh Water Fish Commission, Tallahassee, Fla.

e. Herpetofauna. The objective of this work was to monitor and evaluate the reptiles and amphibians in Lake Conway and possible changes in population dynamics resulting from the introduction of white amur. This work was conducted by the University of South Florida, Tampa, Fla.

f. Plankton and benthic invertebrates. The objectives of this work were to determine plankton (phytoplankton and zooplankton), benthic, and periphytic community responses to the changes in the aquatic macrophyte community. These studies were conducted by the Department of Environmental Engineering, University of Florida, Gainesville, Fla.

12. Each contractor collected and analyzed data, conducted physical and chemical analyses, and identified organisms for their respective areas of expertise. At the onset of the study, all raw data were sent to WES where they were stored on tape for access by the WES computer. However, after the second year of study, it was decided that individual contractors would update and manage their own data using a computer system of their choice. At the termination of the study, data from all of the contractors were gathered and are now stored on a single data tape at WES. This tape, with attendant species codes and programs to retrieve and perform summary statistics on the data, is available to interested parties and is described more fully by Blancher and Miller (1983).

13. During this study each contractor was required to prepare a summary report (for a complete list of LSOMT reports see Appendix A) detailing the results of their work for each of the four study years (one baseline and three poststocking years). This synthesis report is based in part on these documents. However, as appropriate, raw data were examined and analyzed at WES and results of these analyses incorporated into this document.

PART II: DESCRIPTION OF THE STUDY AREA

The Lake Conway System

14. Lake Conway consists of five interconnected pools located in Orange County in central Florida (Figures 1 and 2) on the southeast edge of the city limits of Orlando. Orange County consists of about 1000 square miles* with roughly 10 percent of its area covered with lakes or waterways.

15. From north to south the pools in Lake Conway are: Lake Gatlin, East and West Pools (Little Lake Conway), then Middle and South Pools. Middle Pool is the largest with a surface area of 2.99 km^2 and an average depth of 5.98 m. The smallest pool is Lake Gatlin, which has a total surface area of 0.28 km^2 and an average water depth of 4.18 m. Compared to many southern lakes these pools are fairly deep. From 51.3 to 78.4 percent of the area in the lake is below 3 m deep and from 16.7 to 36.9 percent is below 6 m deep (see Table 2 and Figure 3).

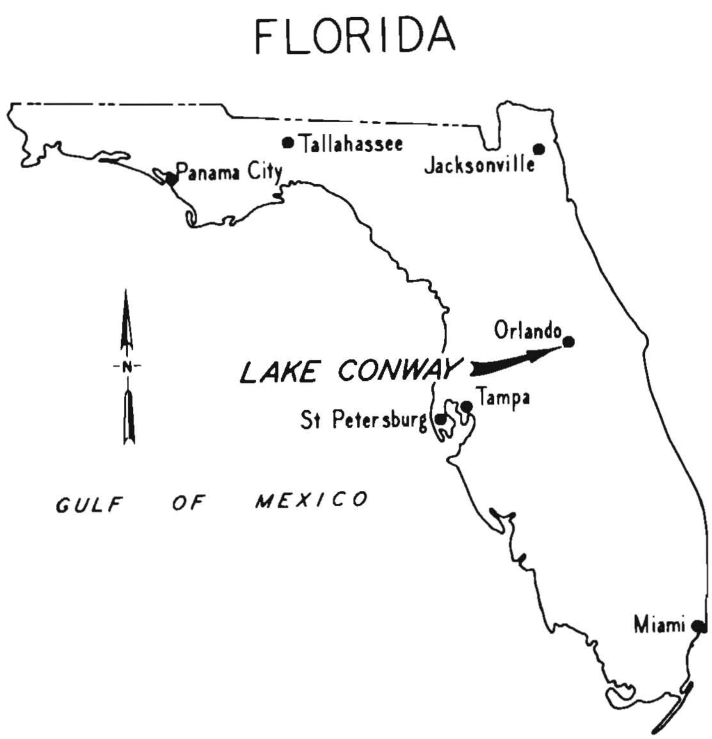

Figure 1. Lake Conway site map

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 5.

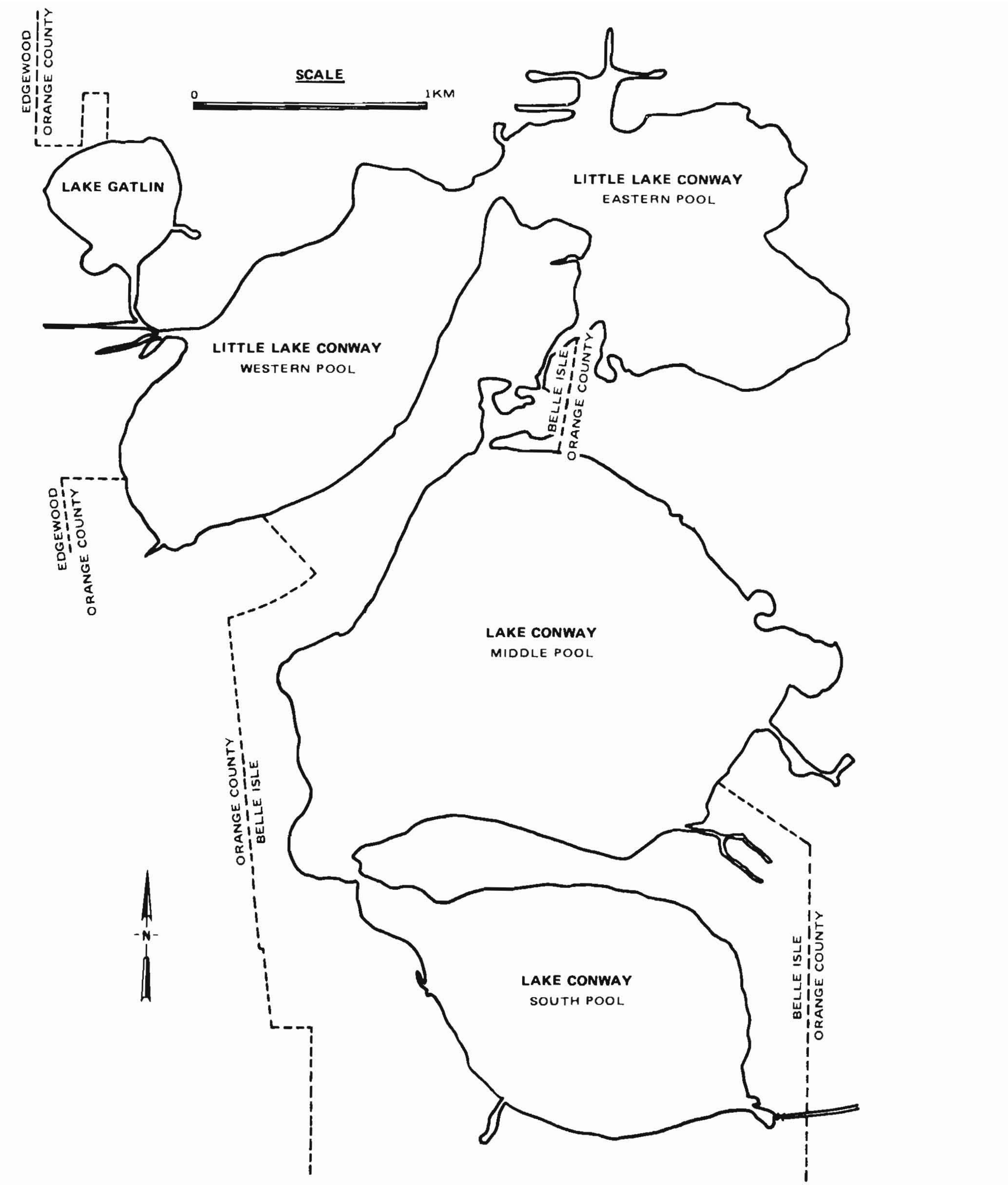

Figure 2. The five pools of Lake Conway, Florida

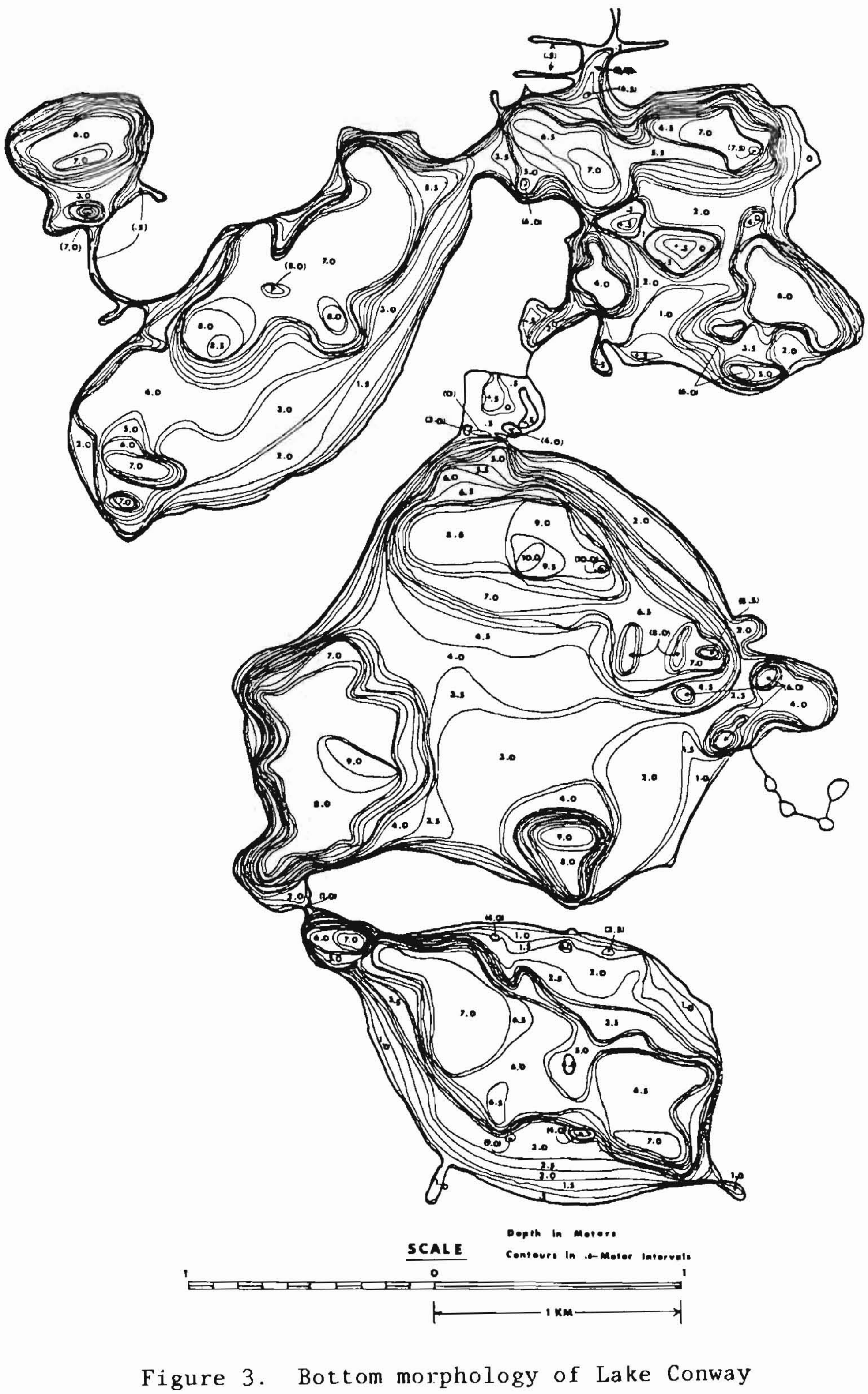

Figure 3. Bottom morphology of Lake Conway

16. This system forms the upper part of the Boggy Creek drainage basin, which is part of the Kissimmee River basin. The average elevation of the surface water is 26.2 m above mean sea level (msl). The lake level is regulated to some extent by a concrete and wooden dam located at the southeast corner of South Pool. Water from South Pool flows a short distance to Lake Warren and then to Boggy Creek through a canal. Because all pools are connected, Lake Conway is a single system. However, as described in more detail below, during this study the pools became isolated when water levels declined because of diminished rainfall. This phenomena took place during the last 2 years of the study and (to some extent) influenced results of the biological and physicochemical studies.

Geology and Physiography of the Area

17. The eastern portion of the State of Florida lies in the Florida Peninsular Sedimentary Province which has been strongly influenced by past rises and falls of sea level. From the Cretaceous to the end of the Oligocene, sediments containing calcium and magnesium carbonate were deposited from overlying ocean waters. After the Oligocene Period, streams began to encroach from the mainland and deposited large amounts of clastics over the calcareous sediments. During the Pleistocene Period, deposition consisted mainly of sand, while recently alluvium, freshwater marl, peats, muds, and phosphorus-enriched estuarine material has been laid down.

18. The entire state is characterized by relatively flat land; elevations range from sea level to a high of only about 105 m. Of the three major physiographic zones within Florida, Orange County lies in the Central Zone. This area is characterized by discontinuous highlands containing subparallel ridges separated by broad valleys. Typically, the ridges are above the piezometric surface* and the valley floors are below. Sinkhole lakes are typically found along the ridges while the lakes along the valley floors are broad and shallow (Lichtler, Anderson, and Joyner 1968; Puri and Vernon 1964; White 1970).

19. In Seminole County and north-central Orange County is an area of high ground referred to as the Orlando Ridge. This is one of twenty unique

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* The elevation reached by water when a well is drilled into the substratum.

regions located within the Central and Southern physiographic zones of Florida. The Orlando Ridge is characterized by karstic topography and numerous sinkhole lakes. Deposits of the Fort Preston formation dominate this region, although calcareous sandy deposits are fairly common. Lakes on the Orlando Ridge are clean, alkaline waters. The dominant cations are calcium, magnesium, biocarbonate, and sulfate which have leached from sedimentary deposits. Total nitrogen ranges from 401 to 777 mg/m^3 and total phosphorus from 13.1 to 53.3 mg/m^3. When compared with other lakes on the Orlando Ridge (Lake Baldwin, Lake Fairview, and Lake Jessamine), Lake Conway water contains less calcium hardness although slightly higher concentrations of dissolved sodium, potassium, and chloride (Canfield 1981).

20. Orange County and Orlando are among the fastest growing sections of the United States. Numerous private residences and commercial developments have been and are still being constructed along lakeshores throughout the county. Because of this, all lakes on the Orlando Ridge are probably affected to some degree by nutrient input from point and nonpoint source discharges from the populated sections of the region. However, relatively warm waters, a long growing season, and an ample supply of dissolved carbonate have also contributed to the productivity of these waters.

21. Soils surrounding Lake Conway are of the Blanton, Charlotte, and Orlando units and consist mainly of moderately to excessively drained fine sand. Infiltration into these soils is immediate and complete, resulting in little or no surface runoff. However, under the pervious surficial soils lies a discontinuous formation of Eocene Age. Known as the Hawthorne layer, this deposit consists of clay-rich sand which retards the vertical flow of surface water. Beneath this layer is the Florida aquifer which is composed of porous limestone. The piezometric surface of this aquifer around Lake Conway averages 6.8 m msl which is about 9 m below the surface of the lake. For water to flow from the aquifer to the lake, the surface of Lake Conway would have to fall below the peizometric surface of the aquifer. Since this never occurs, Lake Conway water chemistry is not affected by input from waters in the aquifer. However, because the Hawthorne layer is discontinuous in Orange County, it is very probable that water from the bottom of Lake Conway recharges the aquifer to some extent (Blancher 1979).

Land Use at Lake Conway

22. Based on a study conducted in 1974 (Blancher 1979), from 44 to 77 percent of the Lake Conway watershed is residential and from 11 to 50 percent is devoted to citrus groves or is undeveloped (Table 3). In a more recent study, the majority of land immediately surrounding the lake was found to be residential, followed by citrus groves and a category consisting of streets, roads, and utilities (Table 4). The major development that took place at the lake in the 1970's was construction of homes. For example, in January 1975, a total of 565 new residents were noted. In June of 1977, that number had climbed to 701 and by June 1979, it reached 750. Most of the new homes were along East and Middle Pools, while fewest were along Lake Gatlin. Along with the influx of new residences came nutrient input, via septic tanks and storm sewers. Approximately 75 percent of the Lake Conway residences now utilize septic tanks with absorption fields. The remainder, living in areas east of East Pool and north of Middle Pool, use a sewer system (Williams, Brown, and Buglewicz 1982).

23. Blancher (1979) identified 15 possible sources of nitrogen and phosphorus coming into the lake system. These included precipitation on the water surface, runoff from developed and underdeveloped areas, septic tank seepage, decomposition of plants and animal waste, sediment recycling, and nitrogen fixation. He concluded that the major sources of nutrients to Lake Conway were from aerial loadings, urban runoff, and subsurface seepage. In neither his study nor related work by Fellows (1978) were large point or non-point sources of nitrogen or phosphorus identified or considered as a large part of the nutrient budget of Lake Conway.

Local Meteorologic Conditions

24. Because the area surrounding Orlando has such a high percentage of surface water, relative humidities remain high throughout the year. During the summer afternoons, humidity ranges from 40 to 50 percent and can go up to as high as 90 percent at night. Summer air temperatures in the 90's are fairly common, although monthly averages are usually in the low 80's. Average air temperatures in January are in the high 50's or low 60's; while freezing temperatures can occur, by afternoon the air often warms to the 60's or 70's.

25. The period of maximum rainfall at Lake Conway extends from June through September. During this time scattered afternoon showers are common. Mean annual rainfall (1940-1981) is 50 in.; the maximum annual total (in 40 years of record) was 68.7 in. and the minimum was 38.1 in. in 1977. Precipitation in the form of snowflakes, snow pellets, or sleet is rare, although hail is fairly common during storms (National Oceanic and Atmospheric Administration (NOAA) 1980).

Water Level Fluctuations at Lake Conway

26. Water levels (U. S. Geological Survey (USGS) 1982) at Lake Conway declined during the 1970's (Figure 4). In water year 1976, the mean elevation of the lake was 85.1 ft msl; in water year 1981, the mean was 82.62 ft msl. Although mean annual precipitation is about 50 in., the 40-year minimum (38.1 in.) was recorded in 1977, the year the fish were stocked. In addition,

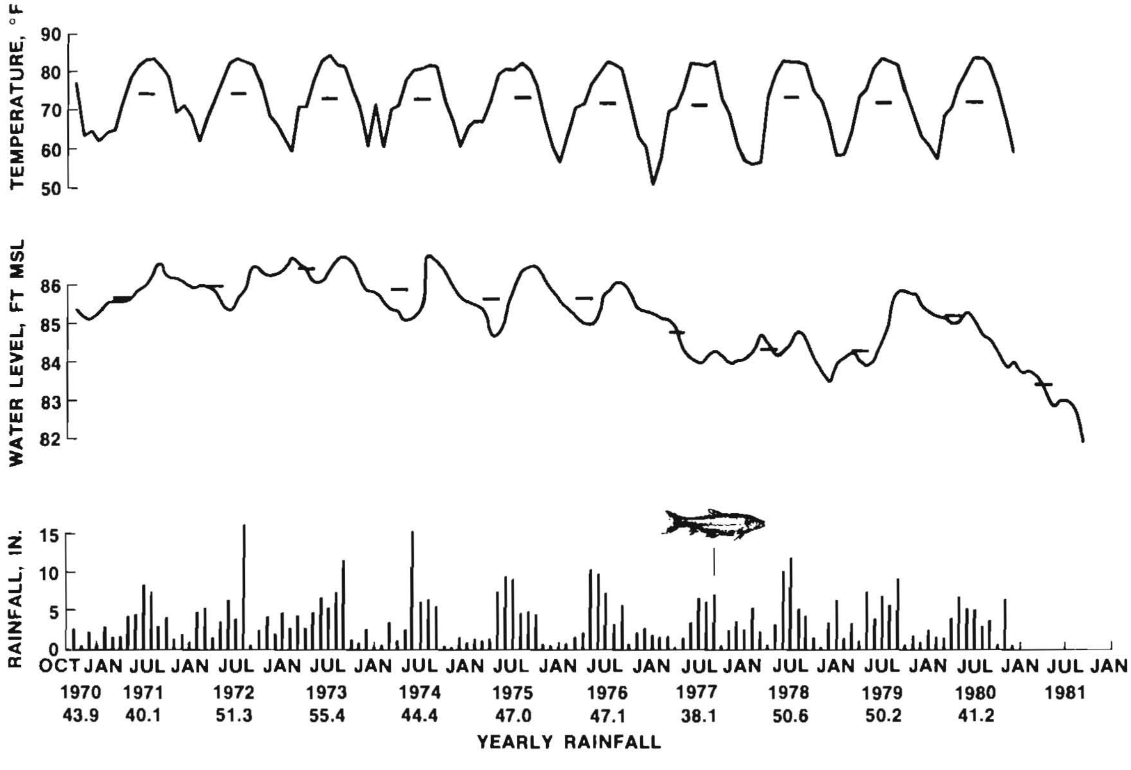


Figure 4. Average monthly values for air temperature (°F), water level (feet msl), and total rainfall (inches) for Lake Conway and surrounding area. Horizontal bars denote yearly averages for air temperature and lake height. Values below the year are the total rainfall (inches) for that year

the previous 4 years (see Figure 4) were all characterized by below average rainfall. In 1978 and 1979, after the white amur were stocked, the annual rainfall was only a few tenths above the anual average. In 1980, the yearly rainfall was about 9 in. below normal. These below average rainfall readings in the late 1970's affected water levels at the lake.

27. Blancher (1979) calculated that, for water year 1976 (October 1975 through September 1976), evaporation from the lake (163.3 cm) exceeded precipitation (120.5 cm). Evaporation for that period of time may be considered typical since mean monthly temperatures have been quite uniform for the last 10 years (Figure 4). Based upon calculations conducted by the Soil Conservation Service (Blancher 1979), a rain event of at least 4.6 cm is required before surface runoff occurs. It is apparent from these data that the LSOMT was conducted during a period of unusually low water levels resulting from a paucity of rainfall. It is also apparent that soil characteristics, high evaporation rates, and absence of permanent inflowing waterways combine to make Lake Conway very dependent on rain to maintain water levels.

28. As the water levels declined during the study, the pools became more and more isolated from one another. For example, the narrow canal between Lake Gatlin and West Pool at the beginning of the study was passable via a small boat. However, in 1980 and 1981, it was choked with cattails and operation of a boat in the canal was practically impossible. Likewise, the connection between East and Middle Pools could not be navigated by a boat during the latter part of the period. However, the connections between South and Middle Pools and between East and West Pools (see Figure 2) were open throughout the study.

Summary

29. Diminished rainfall coupled with typically high evaporation rates and rapid infiltration of rainwater caused a noticeable drop in Lake Conway water levels during the latter part of the 1970's. This caused the pools to become more isolated from one another; the connections between Lake Gatlin and West Pool and between Middle and East Pools were no longer navigable by boat. At the same time there was a considerable increase in the rate of residential development around the lake and in the Orlando area. Although this could have caused a dramatic influx of nutrients into the lake, it appears that, for the

most part, this did not take place although subsurface seepage from septic tanks and storm water runoff cannot be discounted as sources of nutrient input; however, these were relatively minor. In general, the water chemistry of lakes in the Orlando area appears to be influenced in large part by leaching from sedimentary deposits that were laid down after the Oligocene Period and affected only slightly by nutrient input from residential or commercial development.

PART III: CHARACTERIZATION OF BASELINE CONDITIONS AT LAKE CONWAY

Water and Sediment Chemistry
Baseline Period January 1976 - September 1977

Background

30. Baseline water and sediment chemistry were monitored at Lake Conway from January 1976 through September 1977. Water chemistry data were collected at 15 stations and sediment samples were collected at 11 stations in the five pools. The water samples were obtained with a Kemmerer sampler at discrete depth intervals and sediment samples were obtained with an Ekman dredge. Raw water was returned to the laboratory and tested for major cations and anions. Temperature, specific conductance, dissolved oxygen, pH, and redox potential were measured in situ using a Hydrolab surveyor. The Secchi disk reading was taken when water samples were collected. Sediment samples were returned to the laboratory and analyzed for nitrogen, phosphorus, iron, copper, lead, total organic carbon, and chemical oxygen demand.

31. All water and sediment samples were analyzed using standard laboratory procedures (U. S. Environmental Protection Agency (USEPA) 1973; American Public Health Association (APHA) 1976).

Water chemistry

32. Water in the Lake Conway system can be described as moderately hard with low levels of dissolved nitrogen and phosphorus and slightly elevated sodium, potassium, and chloride (Table 5). Based upon a classification system proposed by Dufor and Becker (1964), waters less than 60 mg/ℓ of hardness as $CaCO_3$ are soft, and those from 61 to 120 mg/ℓ are moderately hard. Lake Conway waters can be classified as moderately hard; hardness in South Pool ranged from 34.0 to 81.0 mg/ℓ. Dissolved calcium (9.0-22.0 mg/ℓ) constituted the majority of the carbonate hardness; dissolved magnesium ranged from 5.6 to 7.6 mg/ℓ and was the second most abundant cationic constituent of these waters.

33. Specific conductance (180 to 235 μmhos in South Pool, 230 to 300 in Lake Gatlin), a measure of the ability of water at 25° C to conduct like values for hardness and alkalinity, may be described as moderate. In natural waters with hardness greater than 150 mg/ℓ, specific conductants of 400 to 500 μmhos are not unusual. In South Pool, Secchi disk transparency ranged from 1.5 to 5.8 m. Secchi disk values can range from 1.0 to 40 m in lakes (Cole 1979).

34. Turbidity values in South Pool were low (0 to 4.5 Nephelometric Turbidity Units (NTU's)) and inversely related to Secchi disk values. Turbidity in rivers can commonly exceed 100 mg/ℓ; however, in lakes they are usually lower. Continuous high turbidity readings were not experienced in the Lake Conway system during the study period.

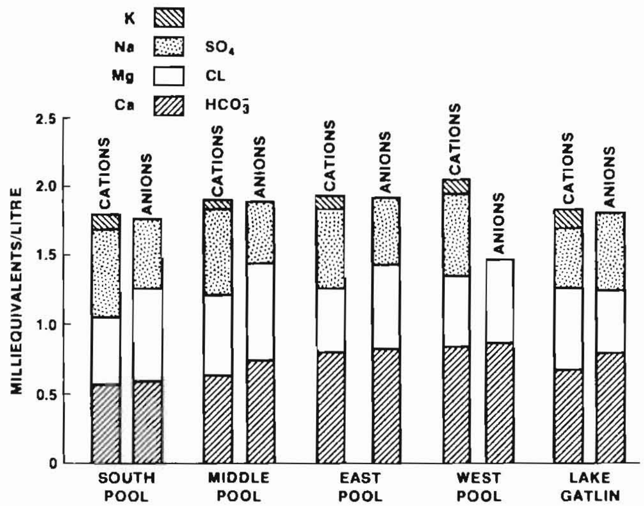
35. Nitrate nitrogen and total phosphorus values in Lake Conway remained at or below 0.1 mg/ℓ throughout the study.

36. Blancher (1979) calculated nutrient budgets for Lake Conway and determined that the annual input to the lake for water year 1976 was 2.53 and 0.224 g/m^2/year for nitrogen and phosphorus, respectively (Table 6). The nitrogen and phosphorus losses from the lake were the result mainly of sedimentation, with only minor amounts removed by way of the canal exiting South Pool. The high nutrient input into Lake Conway by way of seepage is the result of the fairly low (0.25) ratio of surface area to shoreline length. This subsurface seepage accounted for about 17.5 percent of the total nutrient input in Lake Conway.

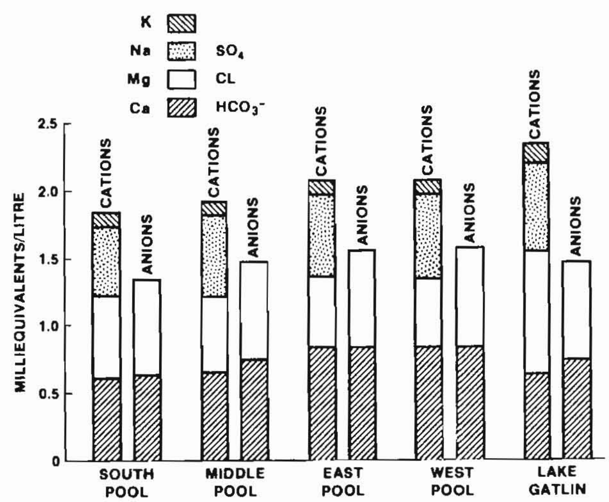
37. In South Pool, dissolved oxygen ranged from 0.2 to 11.4 mg/ℓ. In general, Lake Conway water was 70 to more than 100 percent saturated with dissolved oxygen, although a value as low as 12.6 percent saturation was recorded in Lake Gatlin at 4.0-m depth interval on 26 October 1979. Dissolved oxygen levels for the most part were high throughout the system, and not stressful to the majority of aquatic life.

38. The total ions in Lake Conway ranged from 3.0 to 4.0 milliequivalents/ℓ (Figure 5). The ratio of sodium to chloride approximated 1.0, indicating that crystalline sodium chloride was probably the source of these ions. The bicarbonate ion exceeded calcium by only 5 to 10 percent in most samples; magnesium, although found in low levels, was probably also associated with carbonates. In addition, calcium and magnesium ions may be associated with sulfate-containing deposits.

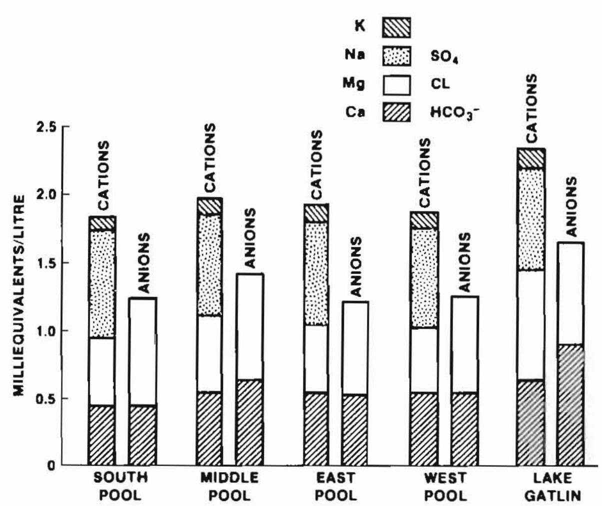
39. There were few significant chemical differences among three major depth intervals in Lake Conway. Total solids (as well as chemical and biological oxygen demand), total phosphorus, nitrate nitrogen, organic nitrogen, turbidity, total hardness, and sodium (as well as potassium) were essentially homogeneous throughout the water column. In West Pool, a significant difference was noted between water 2.5 to 5.4 m deep and water deeper than 5.5 m for chloride, total alkalinity, and specific conductance. In addition, dissolved



a. July 1976



b. September 1976



c. September 1980

Figure 5. Major cations and anions for Lake Conway

oxygen and, to some extent, pH showed considerable differences among depths in the five pools. As would be expected, the deeper waters demonstrated slightly lower dissolved oxygen and more acidic conditions indicative of heterotrophic and not photosynthetic activities.

40. In shallow (>2.5 m) water (Table 7) total phosphorus and dissolved oxygen showed no significant differences among pools at Lake Conway. However, a general trend of increasing water hardness, when moving from South Pool to Lake Gatlin, was a significant trend in Lake Conway. For example, mean values for total solids, calcium, magnesium, total hardness, and alkalinity and specific conductance were higher in Lake Gatlin than in the other pools. In addition, mean values for sodium, potassium, and chloride were higher in Lake Gatlin than the other pools, although not by the same degree as the former parameters.

41. In general, deep water (>2.5 and $\leq$5.5 m) stations, when compared for selected chemical constituents, did not display the same degree of variability among pools as the more shallow sites. While potassium, sodium, and chloride levels differed among pools in deep water, the among-pool differences for hardness and alkalinity were not as dramatic. The elevated values for total hardness and divalent cations (in both deep and shallow waters) in Lake Gatlin and the elevated values noted while progressing north through the chain was a trend noted throughout the study.

Sediment chemistry

42. Sodium, the most abundant alkali earth metal in surface deposits (Henn 1971), represented the second most abundant cation in the Lake Conway system (14.0 to 20.0 mg/ℓ in South Pool). In sedimentary deposits, sodium is usually present as impurities in cementing material, or as free crystals. Based upon data in Canfield (1981), sodium levels in lakes along the Orlando Ridge exhibited concentrations from one half to two thirds the readings taken at Lake Conway during this study. Potassium is usually more abundant in sedimentary deposits than sodium. In South Pool, which was typical of the entire system, potassium levels averaged about 25 percent of sodium levels. The next most common anion following bicarbonate was chloride (22 to 3 mg/ℓ in South Pool). Chloride in igneous rocks is usually unavailable to natural water; however, chloride is common in sedimentary rocks and evaporites.

43. Aerial coverage, biomass, species composition, phenology, stem density, and height profile of the aquatic macrophytes were measured from October 1976 through the summer of 1981. Monthly samples were obtained at 100-m intervals from 18 transects, using a prototype biomass sampling barge. Plants were analyzed to determine species composition, biomass, and reproductive state. Additional data were obtained by random sampling techniques, employing both 0.25-m^2 underwater samplers using SCUBA and biomass barge samples, by performing visual observations at six plots, and by photographic techniques.

44. A total of 24 species of aquatic macrophytes were collected and identified from the Lake Conway system during the transect studies. The four most common macrophyte species were hydrilla, nitella (*Nitella* sp.), potamogeton (*Potamogeton* sp.), and vallisneria (*Vallisneria* sp.). Plants considered to be common included *Ceratophyllum demersum*, *Najas guadalupensis*, and *Sagittaria graminea*. Uncommon macrophytes included *Utricularia gibba*, *Panicum hemitomon*, *Fuirena scirpoides*, and *Mayaca fluviatalig.* The majority of the macrophytes were found in water 6 m deep or less. In addition to the submersed aquatic macrophytes, approximately 30 additional plants were identified living along the margin of the lake. These included cattails (*Typha* sp.), sedges (*Andropogon virginicus*, *Cyperus* sp.), two species of primrose willow (*Ludwigia* sp.), bladderworts (*Utricularia* sp.), two species of pennywort (*Hydrocotytle* sp.), and sawgrass (*Cladium jamaicensis*). For a list of aquatic and terrestrial plants identified at Lake Conway during the study, see Table B1 of Appendix B.

45. The distribution of the four major aquatic plants (hydrilla, nitella, potamogeton, and vallisneria) was not uniform among the pools of Lake Conway (Table 8). For example, average hydrilla weights were greatest in South and West Pools and practically absent in Middle Pool and Lake Gatlin. Nitella was most abundant in South, Middle, and East Pools and less common in West Pool, and uncommon in Lake Gatlin. Vallisneria was most abundant in Lake Gatlin and practically nonexistent in Middle Pool. In general, all species of plants were most abundant in Middle Pool, less abundant in South and East Pools, and practically nonexistent in West Pool and Lake Gatlin (Figure 6).

46. Hydrilla was found in small isolated patches in Lake Gatlin and

South and East Pools during the baseline year. In West Pool the northern two thirds (with the exception of a single weed-free deep pocket) contained almost exclusively hydrilla. Potamogeton was found along the periphery of South, Middle, and West Pools, and nitella was most common in the deeper waters of South and Middle Pools. Vallisneria is a shallow water species and was taken along the edge of the pools in small patches. This species was most common in Lake Gatlin but uncommon in the other pools.

47. A summary of the wet weight (grams per square metre) of the four major plant species at four pools of Lake Conway during the baseline year (from Nall and Schardt 1978) appears below:

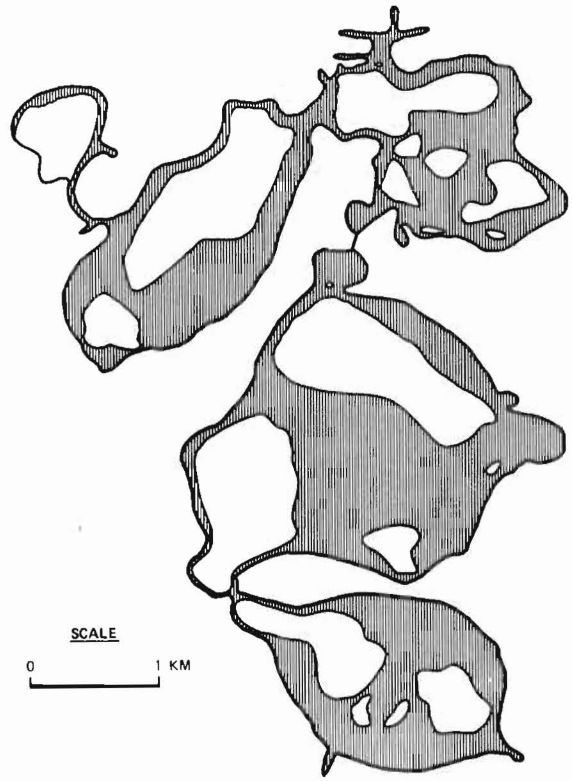


Figure 6. Aquatic vascular plant distribution prior to stocking white amur. Hatched area denotes presence of vegetation

	South Pool	Middle Pool	East Pool	West Pool
Hydrilla	40.3	--	15.6	296.9
Potamogeton	64.6	59.0	301.8	74.3
Nitella	460.7	657.9	91.5	190.4
Vallisneria	0.05	--	153.8	51.9
Total	565.6	716.9	562.7	613.5

Plankton
Baseline Period April 1976 - August 1977

Phytoplankton

48. A total of 242 species of phytoplankton representing five divisions were collected and identified from Lake Conway during the study period (Table B2). The most diverse division was Chlorophyta (110 taxa) followed by

Cyanophyta or blue-green algae (93 taxa), and the Chrysophyta which consisted primarily of diatoms and was represented by 45 taxa. The remaining taxa were in the Pyrrophyta and Euglenophyta which comprised 7 and 5 taxa, respectively. Although the green algae were characterized by the greatest number of species, the majority of these taxa were represented by relatively few individuals at any one time. The blue-green algae were less diverse although when species were present numbers were high.

49. During the baseline study period the majority of phytoplankton species were collected from shallow-water stations (Table 9). Lake Gatlin displayed fewest species and greatest number of individuals in both shallow (littoral) and deepwater (limnetic) stations. This same trend was noted with average numbers of individuals from the three most abundant groups of phytoplankton. Lake Gatlin supported a higher number of individuals than the other pools. Especially noteworthy are the large numbers of blue-green algae (an average of 26,952/mℓ) in this pool. These data demonstrate that there was a trend of increasing water quality as one proceeds from the northernmost pool down the chain to South Pool. This latter pool was characterized by slightly lower dissolved ions and higher diversity (with greater numbers) of phytoplankton.

50. In general, the density of phytoplankton was lowest in winter and highest during summer and fall. This pattern held for all pools even though the density, species composition, and timing of the increased numbers of individuals as blooms varied among pools. In the fall of 1976, the maximum algal abundance was caused by filamentous blue-green algae such as *Oscillatoria limnetica*, *O. angustissima*, *Lyngbya limnetica*, and *Spirulina layissima*. The diatoms were most abundant in late spring and early summer. *Cyclotella stelligeria*, a centric diatom, was the most predominant diatom, but two pennate forms, *Achnanthes minutissima* and *Synedra rumpens*, were also common. During winter 1977, *Chroomonas minuta* and two other cryptomonads were abundant.

<u>Zooplankton</u>

51. A total of 58 species of zooplankton were collected and identified from Lake Conway during the study period (Table B3). The most diverse group was the Rotifera (29 taxa), followed by Cladocera (14 taxa), and Copepoda (9 taxa). The remaining species were protozoans, chlorophytes (*Volvox* sp.), and ostracods. Three copepods (*Diaptomus floridanus*, *Cyclops varicans*,

Tropocylops prasinus), four cladocerans (*Bosimina longirostris*, *Ceriodaphnia* sp., *Diaphanosoma brachyurum*, *Daphnia ambigua*), and four rotifers (*Conochiloides bossvarius*, *Asplanchna* sp., *Keratella cochlearis*, *Conochilus unicornis*) dominated the zooplankton assemblage of the Lake Conway system during this period.

52. During the baseline year Shannon-Weaver diversity indices (0.8 to 2.46) were low when compared with phytoplankton and benthic communities. However, low zooplankton diversity is characteristic for Florida (Nordlie 1976) and North American lakes in general (Pennak 1962). Typically, the greatest number of animals were present during the warmer months although all pools showed a precipitous drop from May through July 1977. This decline was the result of either predation or lack of available food.

53. Total number of species was similar in limnetic and littoral stations (Table 10), although Lake Gatlin displayed the fewest number of zooplankton taxa. Total number of individuals averaged from 20,000 to more than $50,000/m^3$. As with phytoplankton, the northernmost pool, Lake Gatlin, exhibited fewer species and more individuals than the more southern pools. This correlates well with the previously described higher trophic state (more available nutrients) in Lake Gatlin than the southern pools.

54. In general, the copepods, which are relatively long lived and specialized feeders, were fewer in numbers in the northern pools. Typically, these organisms are most abundant in oligotrophic systems, which exhibit more stability and diversity (Allan 1976). However, the cladocerans and rotifers are unspecialized feeders, have relatively short life cycles, and are more common in eutrophic systems. Based upon previous studies (Hrabacek et al. 1961; Brooks 1969; Cowell, Dye, and Adams 1975), oligotrophic systems are characterized by large populations of copepods. However, as depicted in Table 10, these latter two groups do not dominate in the southernmost (more oligotrophic) pools of the Lake Conway system.

Benthos

55. A total of 73 macroinvertebrate taxa were collected during the study period at Lake Conway (Table B4). The organisms were distributed over a wide variety of groups, including some usually associated with clean water habitats such as bryozoans (moss animals), trichopterans (caddisflies), and zygopterans. Other groups such as the oligochaetes (aquatic earthworms) and chironomids (midges) have a fairly high tolerance for stress and are often

taken from polluted or eutrophic conditions (USEPA 1973). The macroinvertebrates were dominated by the class Insecta which had 50 taxa. The Chironomidae were the most diverse group and had 25 taxa, followed by the Odonata (dragonflies and damselflies) with 11 taxa.

56. One of the more common invertebrates collected was *Chaoborus punctipennis*, a free swimming dipteran larva, as well as other genera of dipterans such as *Tanypus* sp., *Prochadius* sp. (a group of predacious larvae), and *Cladotanytarsus* sp. The small amphipod *Hyalella azteca* was common to abundant, and the larger sized grass shrimp *Palaeomonetes paludosus* was fairly common. Gastropods or snails (*Gryaulus* sp., *Pomaea* sp., and *Goniobasis* sp.) were common to abundant on plant stems. The asiatic clam *Corbicula* was common to abundant, and two unidentified bivalve mollusks were abundant at selected sites in the Lake Conway system. These latter species formed a significant portion of the diet of wading birds, the freshwater drum, and a species of turtle, *Sternotherus odoratus*, which feeds principally on snails at Lake Conway (McDiarmid, Bancroft, and Godley 1982).

57. In most pools a greater number of benthic species and individuals were collected in the deepwater stations (Table 11). The trend of increasing abundance and reduced diversity of species moving north in the chain of pools is apparent with benthos as well as with zooplankton and phytoplankton. However, at certain shallow-water stations in the system, abundance of oligochaete worms was as high as $10,000/m^2$. The chironomidae were not as abundant as the aquatic earthworms, although they comprised a more diverse group and had a greater number of species. The Gastropoda, comprised of three species, were only about 10 percent as dense as the previously mentioned groups.

Plant pigments

58. Chlorophyll concentrations during the baseline period tended to be higher during the summer and fall and lower during winter and spring. Lake Gatlin was unique in the system in that the magnitude of seasonal fluctuations for this pool exceeded that of the other four pools. It was noted that Secchi disk transparency was inversely related to chlorophyll levels; evidently the low readings were caused by high numbers of suspended algae and not particulate or detrital material.

59. The trophic index of Carlson (1977), which is based upon chlorophyll *a* concentrations, was applied to data collected from each pool. Chlorophyll concentrations, and the calculated trophic index values for

the baseline year at Lake Conway, are summarized below:

	South	Middle	East	West	Gatlin
Chlorophyll a, mg/m^3	3	4	4	5	12
Trophic index	41	44	44	46	55

Based upon Wetzel (1975), these pools (those which exhibit chlorophyll concentrations between 2 and 15 mg/m^2) may be classified as mesotrophic, a condition between eutrophic and oligotrophic. It is evident from the above data that Gatlin exhibited a more enriched condition than the other four pools.

Fish
Baseline Period April 1976 - August 1977

Background

60. Fish populations at Lake Conway (Table B5) were assessed using block nets at three stations and gill nets, 10- and 20-ft seine hauls, Wegener rings, and electrofishing shocking techniques at representative habitats. Block nets were set quarterly from June 1976 to June 1981 on a regular basis in all pools except Lake Gatlin, which was surveyed from 1979 through the end of the study. The other techniques for capturing fish (Wegener rings, 10- and 20-ft seines, electrofishing gear, and gill nets) were used in all pools from the summer of 1976 through the summer of 1980. In most cases, sampling was conducted on a monthly basis, although certain months were omitted, especially towards the end of the study. The sportfishery was characterized by using a Stratified Random Roving Creel Survey utilizing nonuniform probability sampling.

Electrofishing

61. Vegetated areas in Lake Conway (see Table 12) yielded large numbers of bluegill, brooksilverside, and redear sunfish, with high numbers of threadfin shad, chain pickerel, and Seminole killifish during the baseline year.* By weight, the largemouth bass, chain pickerel, and redear sunfish each comprised 10 percent of the catch. At Lake Conway, nonvegetated or beach areas generally supported greater numbers of smaller fish than the vegetated sites. For example, in 1976 an average of 436 individuals per hour, weighing a total of 12.2 kg, were collected in nonvegetated sites, while areas with plants

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* Latin names for all species are included in Appendix B.

yielded an average of 165 per hour, weighing a total of 17.4 kg. The sandy sites were dominated by brook silverside, although the coastal shiner was also common. During 1977, sportfish* comprised 65 percent by weight of the total population in these areas; largemouth bass, redear sunfish, bluegill, and chain pickerel were the most abundant taxa.

Wegener ring

62. Wegener rings were utilized to make quantitative collections of small fish in heavily vegetated areas. During 1976, an average of 20.9 fish, weighing a total of 11.5 g, was collected. Dominant species throughout the study were mosquito fish, bluefin killifish, and Seminole killifish. In September of 1979, bluefin killifish (6.6 for a total weight of 1.3 g/ring) were dominant with fewer number of bluegill (1.2 for a total weight of 2.7 g/ring). Other fish taken with the Wegener ring in vegetated sites included dollar sunfish, swamp darter, bluespotted sunfish, and coastal shiner.

Seine

63. Both 10- and 20-ft seines were used to collect fish throughout the study. The coastal shiner, bluegill, redear sunfish, and largemouth bass typically dominated, although Florida gar, Seminole killifish, and mosquito fish were also common. During 1976 and 1978, the seine captured from 5 to over 100 fish per pool, as compared with numbers approaching 1000 using electrofishing apparatus.

Gill nets

64. During 1976 and 1977, Florida gar, gizzard shad, and chain pickerel dominated gill net samples. In March of 1977, 24 Florida gar, weighing a total of 23.2 kg, were taken; gizzard shad were minimal in May of the same year. During this period, only 21.5 individuals, weighing a total of 14.7 kg, were collected. Other species taken in gill nets were black crappie, bluegill, chain pickerel, golden shiner, warmouth, and yellow bullhead.

Block nets

65. Using block nets in the spring of 1976, it was estimated that Lake Conway supported 27,180 fish per hectare, weighing a total of 114.13 kg. Fish

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* Sportfish consisted of largemouth bass, black crappie, bluegill, redear sunfish, warmouth, and chain pickerel. Forage fish consisted of gizzard shad, thread shad, golden shiner, coastal shiner, tadpole madtom, Seminole killifish, flagfish, bluefin killifish, least killifish, brook silverside, bluespotted sunfish, dollar sunfish, and swamp darter.

that were abundant in these samples included bluespotted sunfish, bluegill, redear sunfish, bluefin killifish, and largemouth bass. The redear sunfish, largemouth bass, bluegill, chain pickerel, bluespotted sunfish, and warmouth generally contributed the greatest biomass to block net samples. From the spring of 1976 through the spring of 1977, a total of 7227 sportfish, weighing 82.6 kg, were collected.

Catch success

66. The majority of forage fish in Lake Conway were collected from West Pool using block nets (Table 13). However, using electrofishing gear forage fish were mainly collected at Lake Gatlin. In East Pool an average of 13.8 centrachids (more than any other pool) were taken and the majority of the forage fish (62.6 percent) were taken from Lake Gatlin using electrofishing gear. There were no significant differences in centrachid populations among pools using the Wegener ring, although this technique captured more forage fish in Lake Gatlin than in any other pool. In general, the variability between pools at Lake Conway is probably the result of isolated differences in habitat at specific sites rather than physical or chemical differences among pools.

Waterfowl
Baseline Period April 1976 - August 1977

67. Direct counts using either an airboat or a small boat powered with an outboard motor were used to survey the entire Lake Conway system for waterfowl. In the baseline year (1976 to 1977), 51 species of birds (Table B6) were observed. During this time the ten most abundant species were ring-necked duck, muscovy duck, American coot, Florida gallinule, herring gull, mallard duck, least tern, tree swallow, red-winged blackbird, and boat-tailed grackle. Each of these ten species averaged more than 20 individuals per month and collectively they comprised 89.6 percent of the total avifauna. Other common species, averaging between 5 and 20 individuals per month, included canvasback duck, limpkin, pied-billed grebe, great blue heron, green heron, least bittern, and fish crow. Many migratory species utilized Lake Conway during October through February of this (and subsequent) years. These included lesser scaup, bald pate, redheaded duck, canvasback, ring-billed gull, bluewinged teal, Forester's tern, chimney swift, and barn swallow, as well as horned grebe, American coot, herring gull, and tree swallow.

68. In general, fewer species of waterfowl were observed along Lake Gatlin, which was smaller and had less available habitat than the other pools. Most of the waterfowl were observed at West Pool and East Pool, which had two small islands that provided perching sites for egrets and herons, and shallow water for sandpipers and long-legged wading birds.

Aquatic Mammals
Baseline Period April 1976 - August 1977

69. The aquatic mammals noted at Lake Conway during 1976 through 1977 included opossum, raccoon, river otter, Florida water rat, and marsh rabbit, as well as the hispid cotton rat. The majority of these species were seen or collected in undisturbed areas, although the hispid cotton rat was collected often in developed areas. Water rat nests were typically constructed in emergent vegetation; in general, waterhyacinth was the preferred plant species. However, nests were also built in pickerel weed and cattail, although it appears that water rats avoided maiden cane.

Herpetofauna
Baseline Period June 1977 - August 1977

70. Studies of reptiles and amphibians in Lake Conway were initiated in June of 1977, only three months prior to stocking the lake with white amur. Both shoreline and deepwater sampling sites were selected in pools of the Lake Conway system. Data were collected from the shoreline sites by use of funnel traps, "herp-patrol" (visual reconnaissance), drift fence, and mark and recapture methods. The deep areas of the lake were sampled by funnel traps, supplemented by information supplied by the Florida Game and Fresh Water Fish Commission's electrofishing and gill netting studies.

71. Beginning in June 1977 and continuing through September 1980, a total of 11,928 individuals of 12 species of amphibians, and 17 species of reptiles, were recorded at Lake Conway (Table B7). All 29 species were taken in the lake or along the shore. The stinkpot turtle was the most common species encountered during the survey, and made up 29.5 percent of the total sample. The next most abundant species were the green tree frog, Florida cricket frog, pennisula cooter, and southern leopard frog, which comprised 22.0, 11.4, 7.5, and 4.1 percent of the samples, respectively. The other 24 species were uncommon, representing less than 3.5 percent of the total.

The most common salamander collected on the Lake Conway system was the two-toed amphiuma (N = 381), followed by the greater siren (N = 238). Alligators were not abundant on the lake, but because of their size and easy detection, they accounted for 283 observations during the study. The population of herpetofauna of Lake Conway includes a breeding population of the redear turtle, which probably originated as escaped or released pets. The total herpetofauna of the Lake Conway system includes four species of salamander, eight anurans, one crocodilian, nine turtles, and seven snakes (McDiarmid, Bancroft, and Godley 1982).

72. During the first sampling period* of the herpetofaunal survey, 5386 reptiles and amphibians were collected from Lake Conway. The majority, 24.5 percent (28 species), were collected at permanent sites in the South Pool. A total of 24 species and 1218 individuals (20.8 percent) were taken from Middle Pool. East and West Pools and Lake Gatlin supported 23.2, 15.2, and 16.2 percent individuals, respectively. Differences among pools, with respect to various species, were variable. For example, 60.3 percent of all two-toed amphumas, and 50.4 percent of the greater siren, were taken from East Pool, while 61.1 percent of the Florida cricket frog and 68.2 percent of the southern toad were taken from permanent sites in South Pool and East Pool, respectively (Godley, Bancroft, and McDiarmid 1981). Among-pool differences in species composition were the result of localized habitat differences, and not specific characteristics of each pool.

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* June 1977 through September 1978.

PART IV: EFFECTS OF WHITE AMUR INTRODUCTION AT LAKE CONWAY, FLORIDA

Introduction

73. The following paragraphs summarize changes that occurred through time (January 1976 through the summer of 1982) at Lake Conway, Florida. General descriptions of the various sampling sites, as well as a discussion of differences among pools and water depths, can be found in this part. The primary purpose of this part is to describe temporal changes at Lake Conway and to determine whether or not such changes were brought about by introduction of the white amur.

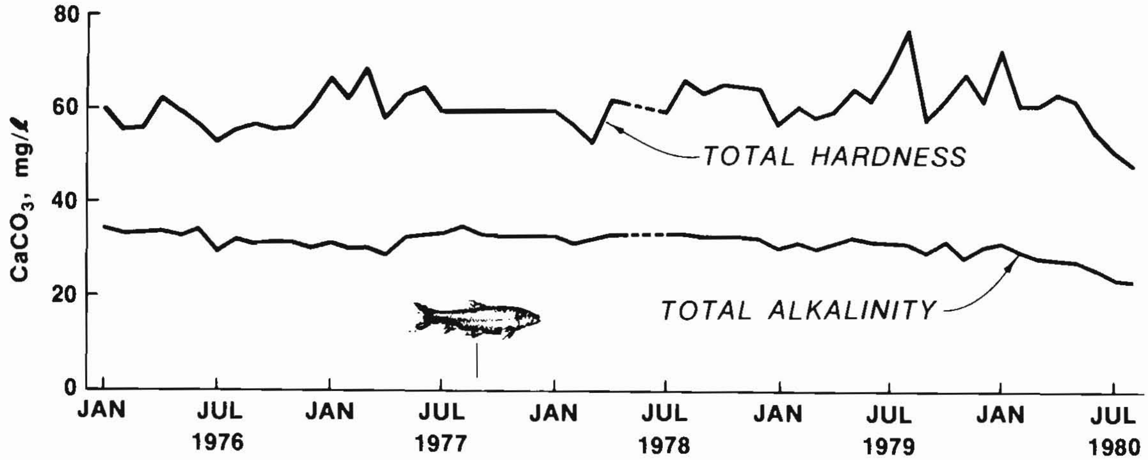
Water and Sediment Chemistry
Poststocking Period September 1977 - October 1980

Water chemistry

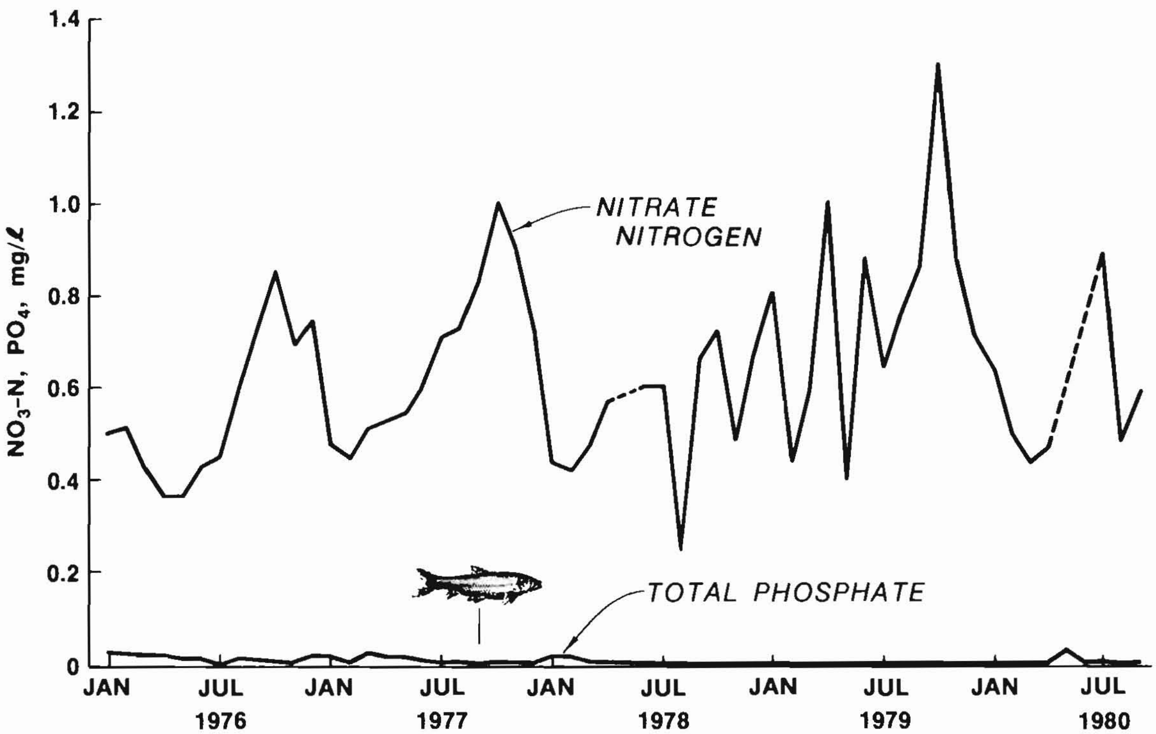
74. Total hardness and alkalinity decreased by late 1980 (Figure 7a), white total phosphorus showed little change (Figure 7b). Sodium, chloride, and potassium demonstrated a gradual increase during the study (Figure 8a). In South Pool, however, milliequivalent ratios of sodium to chloride (Figure 8b) remained uniform throughout the reporting period, indicating that these two ions fluctuated in a related manner.

75. As the above paragraph indicates, there were minor fluctuations in certain chemical variables at Lake Conway. However, none of these changes were dramatic and none were related to introduction of the fish or removal of aquatic macrophytes.

76. In Lake Conway dissolved oxygen values occasionally dropped below 2.0 mg/ℓ in deep water during warm periods in certain pools (Figure 9b). Typically the deeper waters exhibited diminished oxygen values during the summer months. To some extent dissolved oxygen was inversely related to turbidity (Figure 9c). Elevated turbidity readings, especially when coupled with increased warmer temperatures, usually coincided with diminished dissolved oxygen values. However, none of these low values can be correlated with removal of aquatic plants (compare Figure 9 with Figures 10-13 and see the next section).

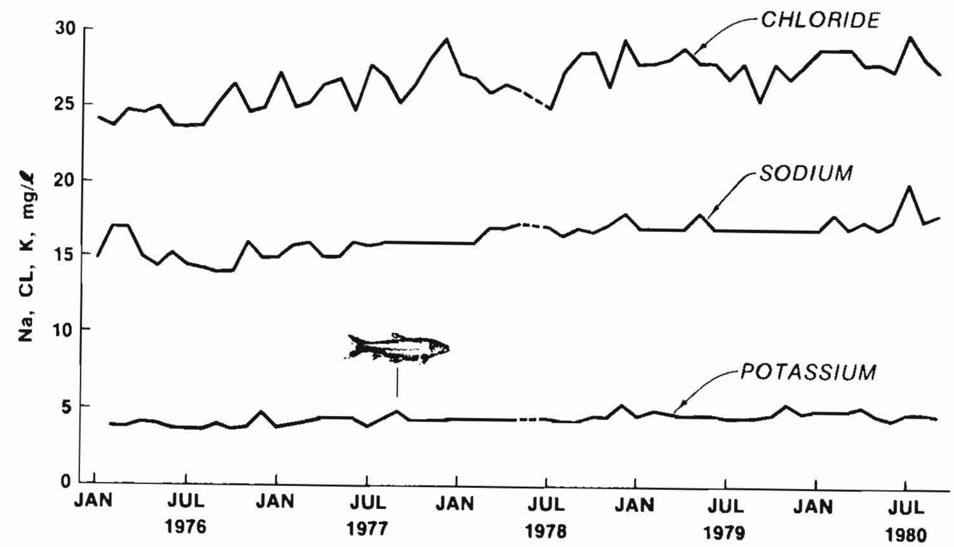


a. Total hardness and total alkalinity

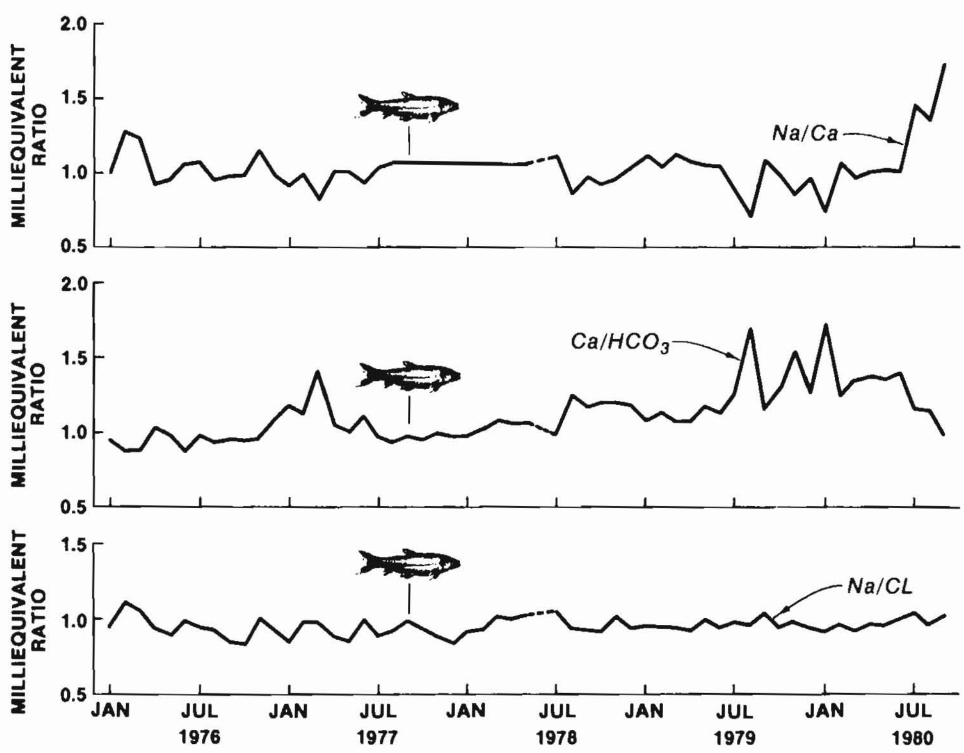


b. Nitrate nitrogen and total phosphorus

Figure 7. Total hardness, total alkalinity, nitrate nitrogen, and total phosphorus, January 1976 through July 1980

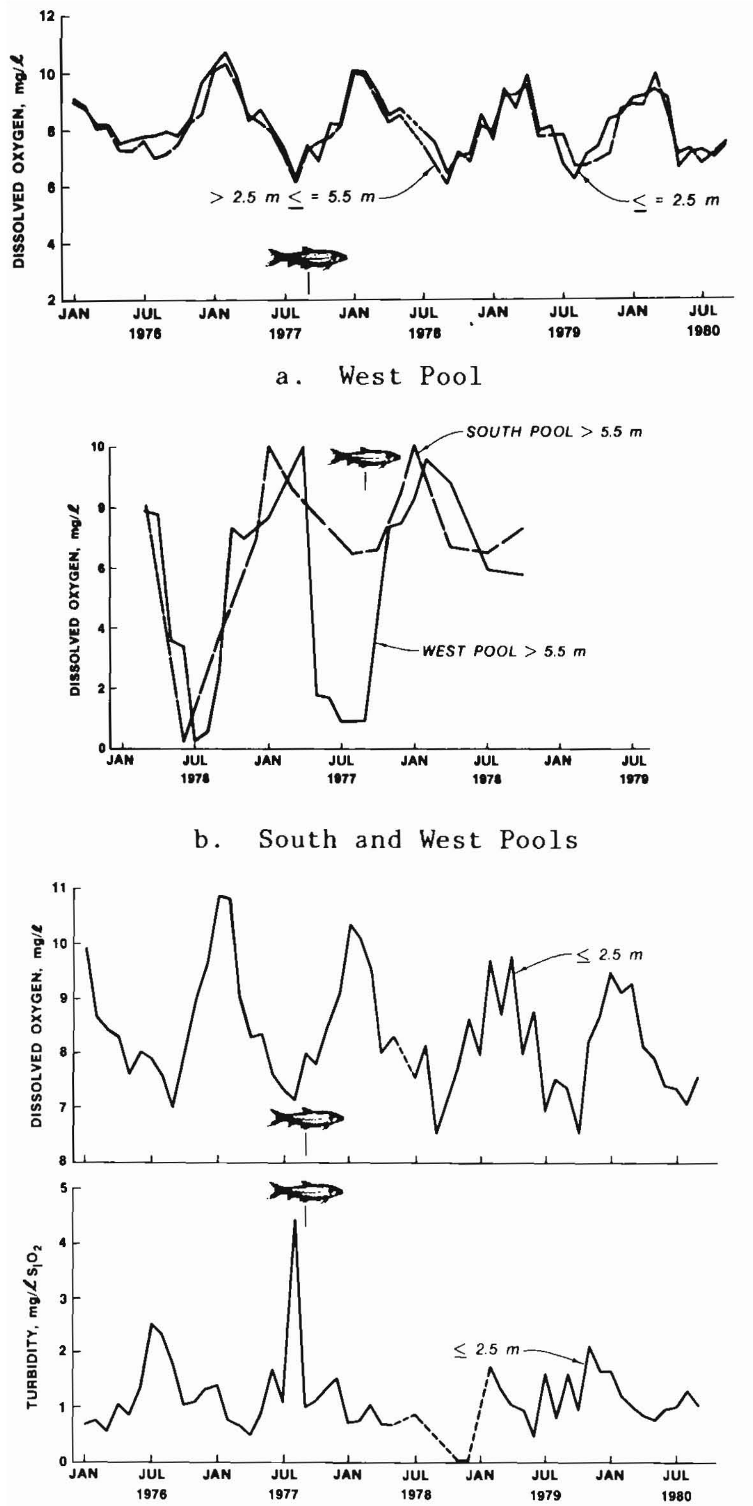


a. Chloride, sodium, and potassium



b. Milliequivalent ratios

Figure 8. Chloride, sodium, and potassium concentrations for all five pools, and selected milliequivalent ratios at South Pool, January 1976 through August 1980

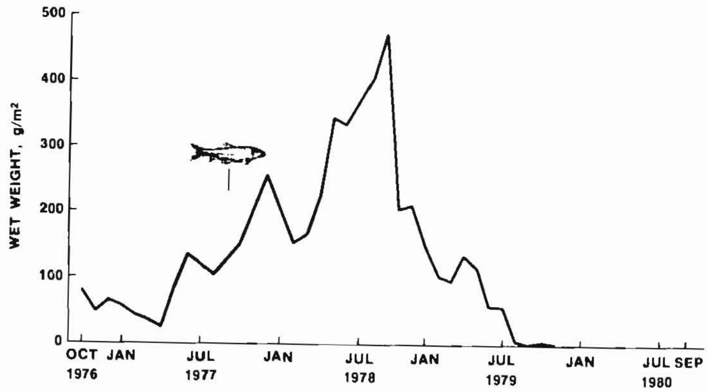


a. West Pool

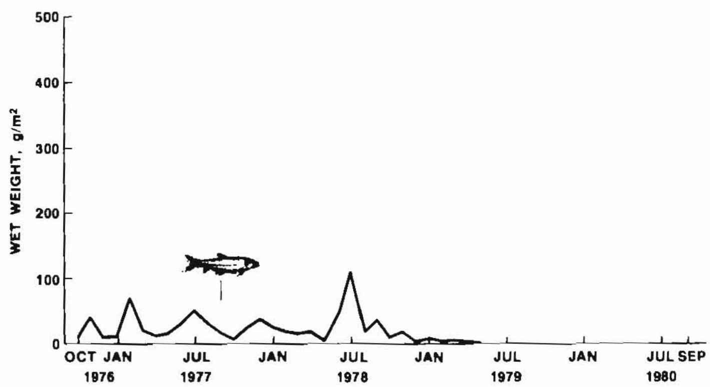
b. South and West Pools

c. Middle Pool

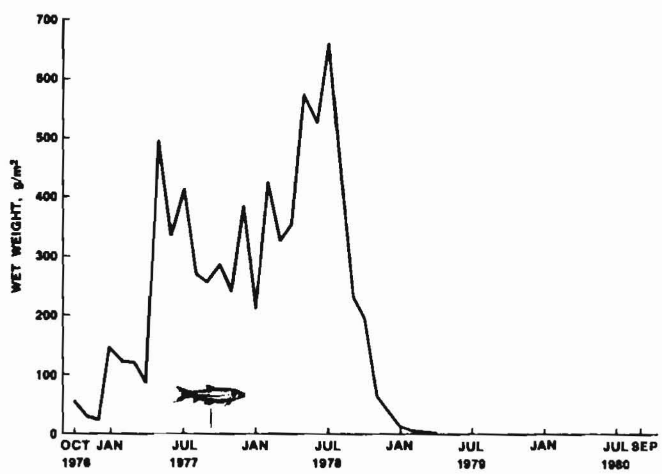
Figure 9. Dissolved oxygen and turbidity at selected pools of Lake Conway



a. South Pool

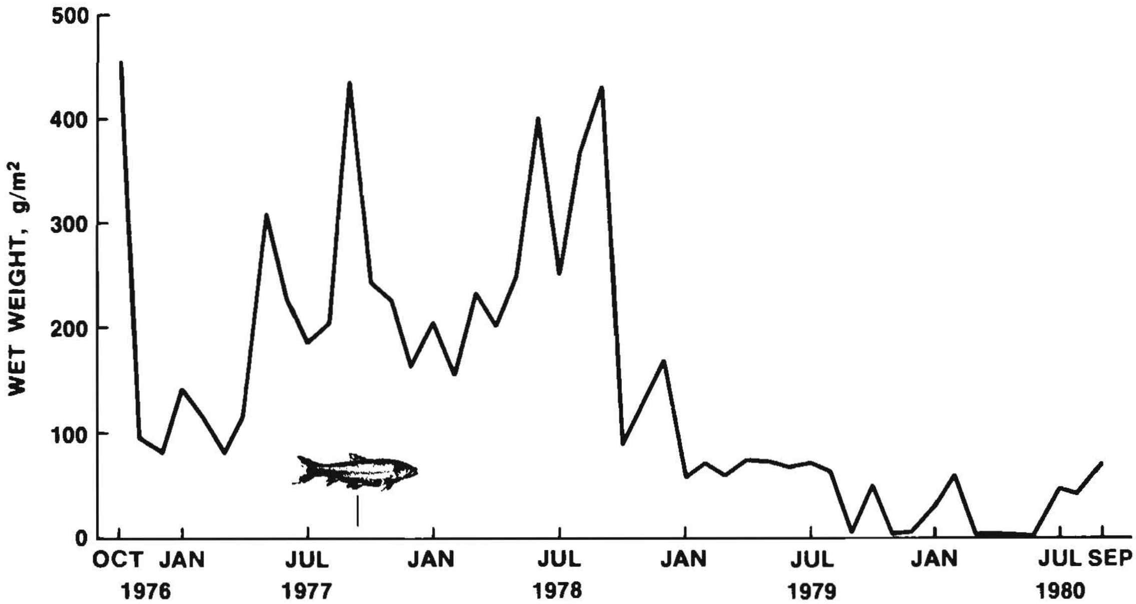


b. East Pool

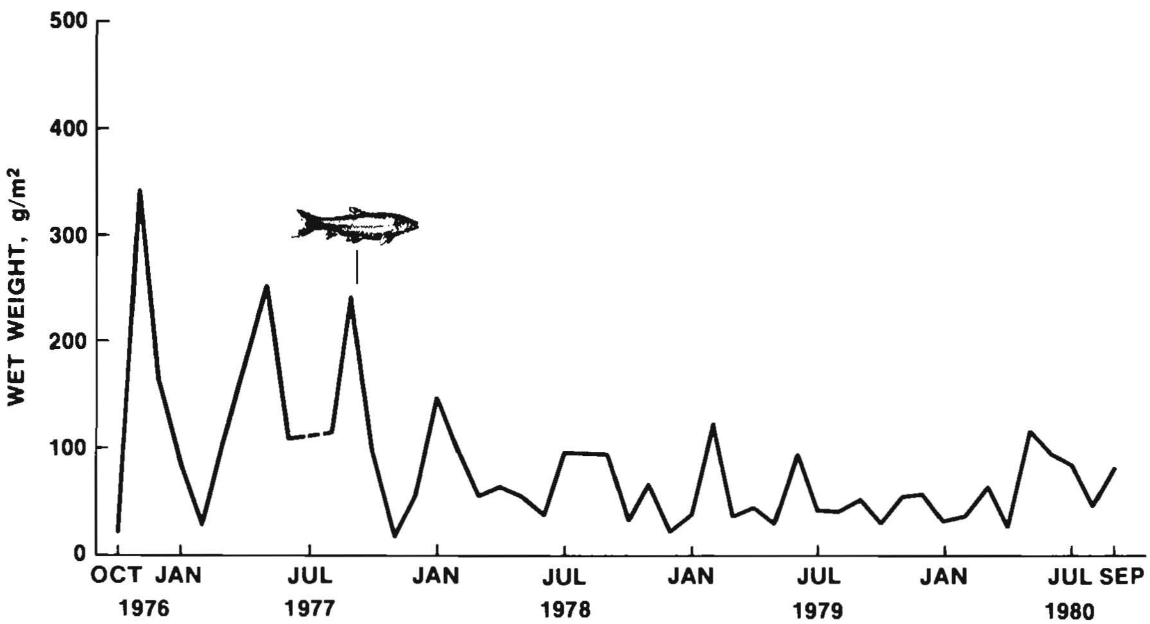


c. West Pool

Figure 10. Wet weight of hydrilla in South, East, and West Pools

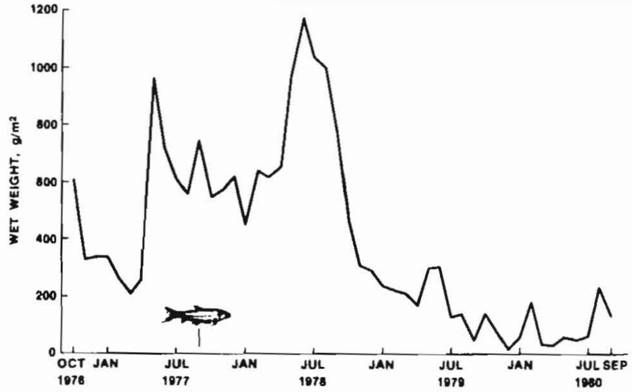


a. Nitella, West Pool

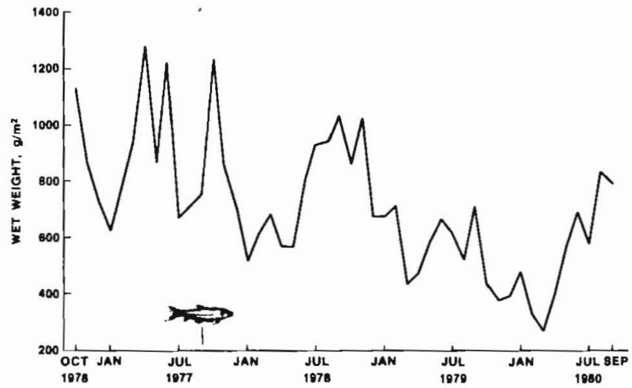


b. Vallisneria, East Pool

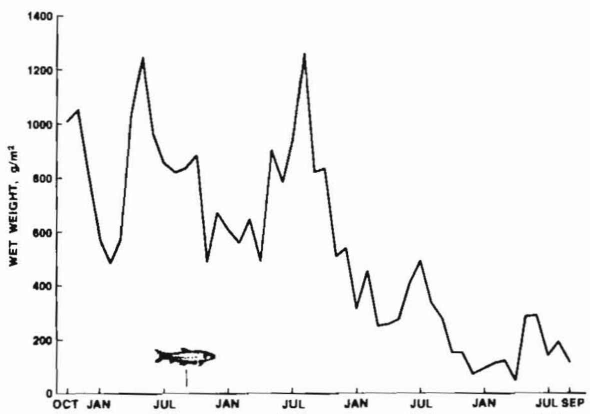
Figure 11. Wet weight of nitella in West Pool and vallisneria in East Pool



a. South Pool

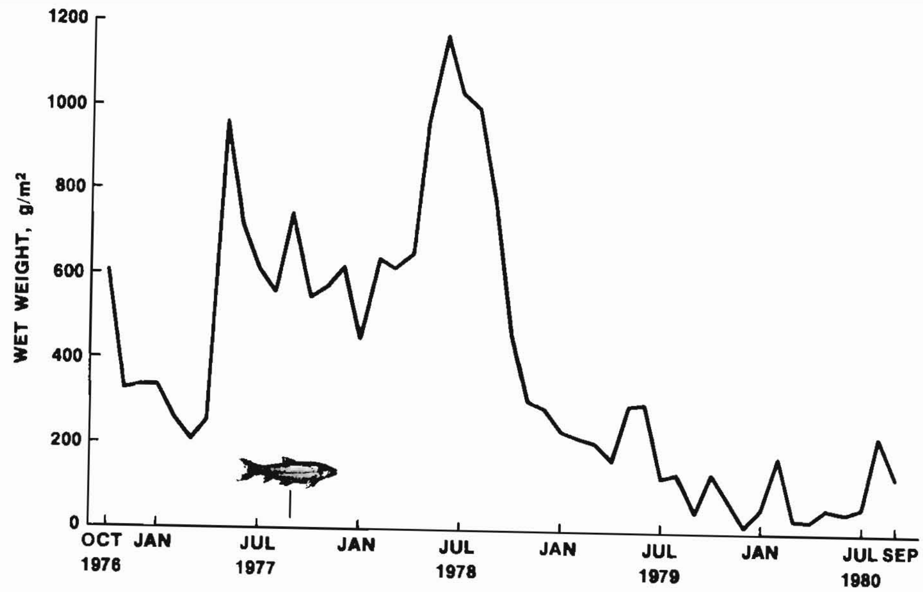


b. Middle Pool

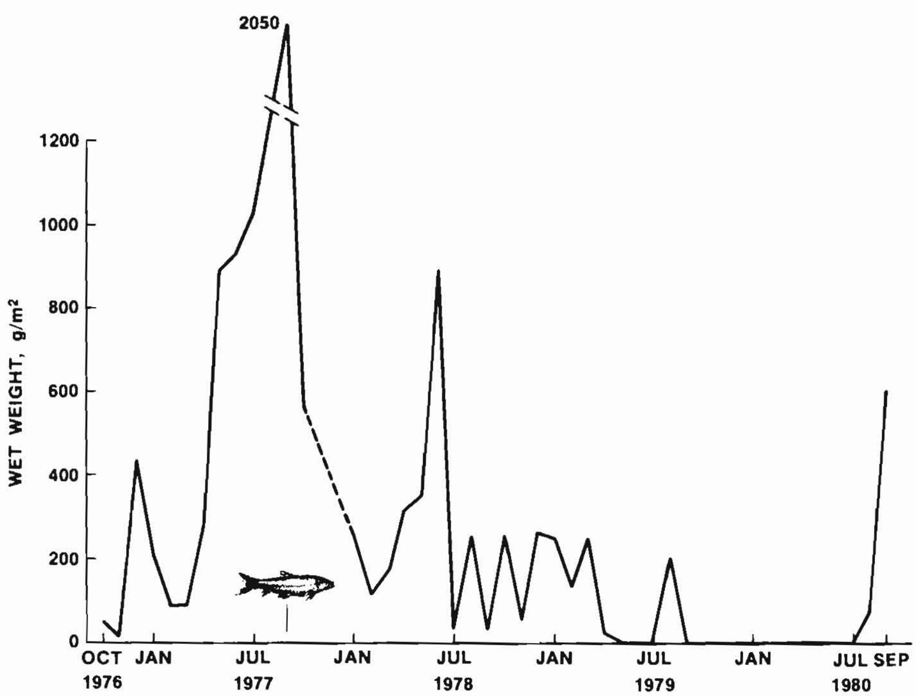


c. East Pool

Figure 12. Wet weight of total aquatic plants in South, Middle, and East Pools



a. West Pool



b. Lake Gatlin

Figure 13. Wet weight of total aquatic plants in West Pool and Lake Gatlin

Sediment chemistry

77. Chemical characteristics of sediment samples collected from stations in each pool (Table 14) exhibited no significant trends throughout the study. The standard deviation values, which frequently exceeded the mean, illustrate the high variability in these data.

Aquatic Macrophytes
Poststocking Period September 1977 - October 1980

78. Although white amur were stocked in September of 1977, the effects of the fish on the vegetation were not measurable until late spring or summer of 1979 (Figures 10 and 11). For example, maximum values for the hydrilla had been measured in South Pool in October 1978 (470 g/m^2) and in West Pool in July 1978 (665 g/m^2). However, by late summer 1979, hydrilla was practically undetectable in all pools. Nitella, the most abundant macrophyte in Lake Conway, was removed at about the same rate as hydrilla. Vallisneria, a nonpreferred species for the white amur, was not dramatically affected by the fish. Levels of this plant in East Pool fluctuated considerably throughout the study and then exhibited a gradual decline from prestocking values during 1979 and 1980 (Figure 11). Fish fed on vallisneria as the preferred plants became scarce.

79. A comparison of total plant densities (Figures 12 and 13) indicates that, in general, the white amur affected the entire macrophyte community. As previously described, the majority of the biomass of Lake Conway consisted of three preferred species: hydrilla, nitella, and potamogeton, in addition to vallineria. Total plant biomass in South and West Pools had decreased considerably by August and June of 1978, and by the spring of 1979 biomass values had diminished to prestocking levels. Middle and East Pools exhibited peaks in wet weights in both 1977 and 1978, although biomass declined practically to zero by 1980.

Plankton
Poststocking Period September 1977 - October 1980

Phytoplankton

80. The total number of species of phytoplankton and the diversity of the community declined following introduction of white amur (Figure 14). The reduction in diversity and number of species was most rapid between the first

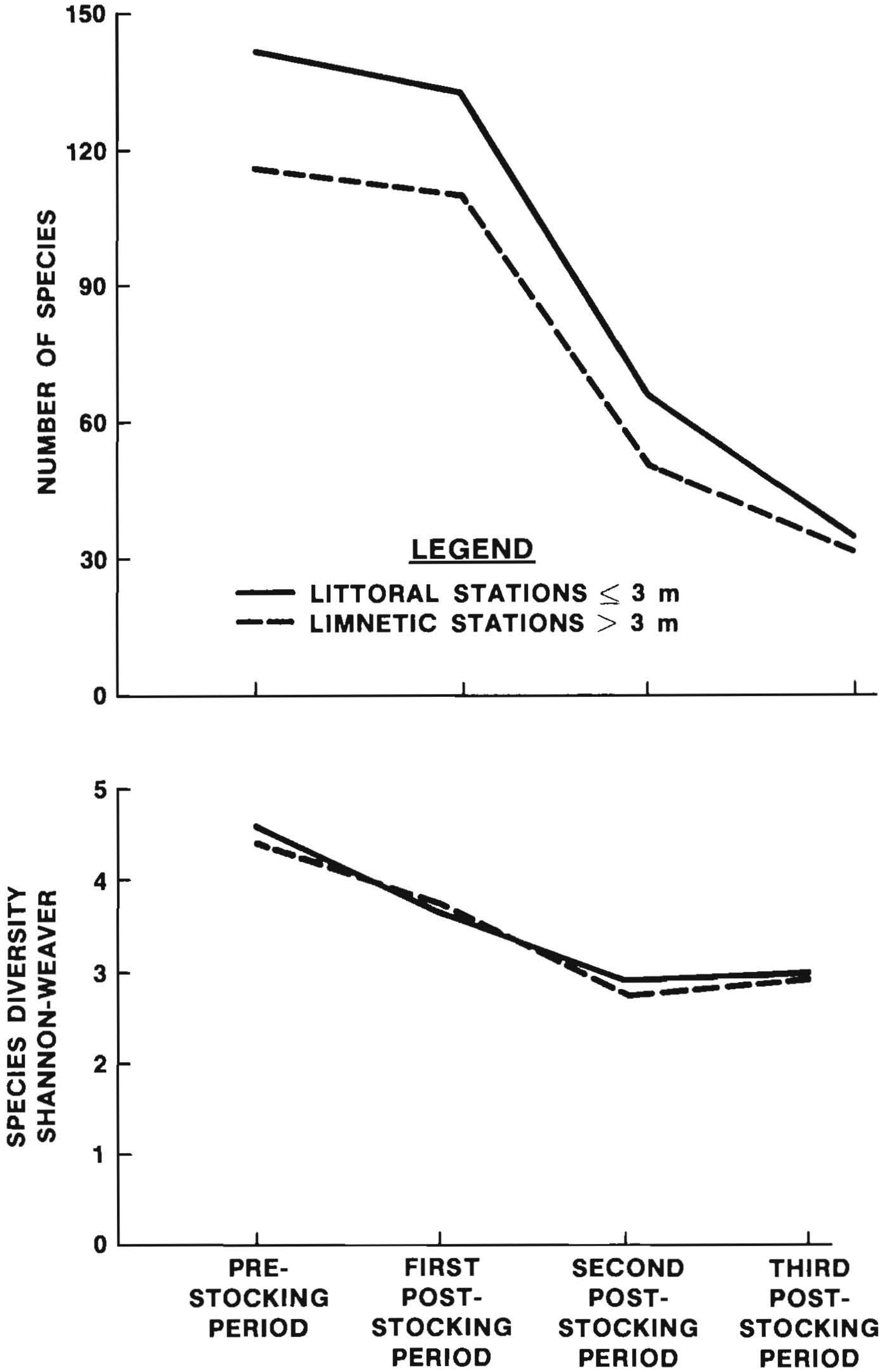


Figure 14. Number of species and species diversity of phytoplankton

and second poststocking periods. The decline in diversity was indicative of an increase in eutrophication, which was accompanied by higher numbers of total plankton cells. Prior to stocking white amur at Lake Conway, phytoplankton numbers peaked in summer or late fall and were lowest in the winter at both littoral (Figure 15) and limnetic stations (Figure 16). Following stocking,

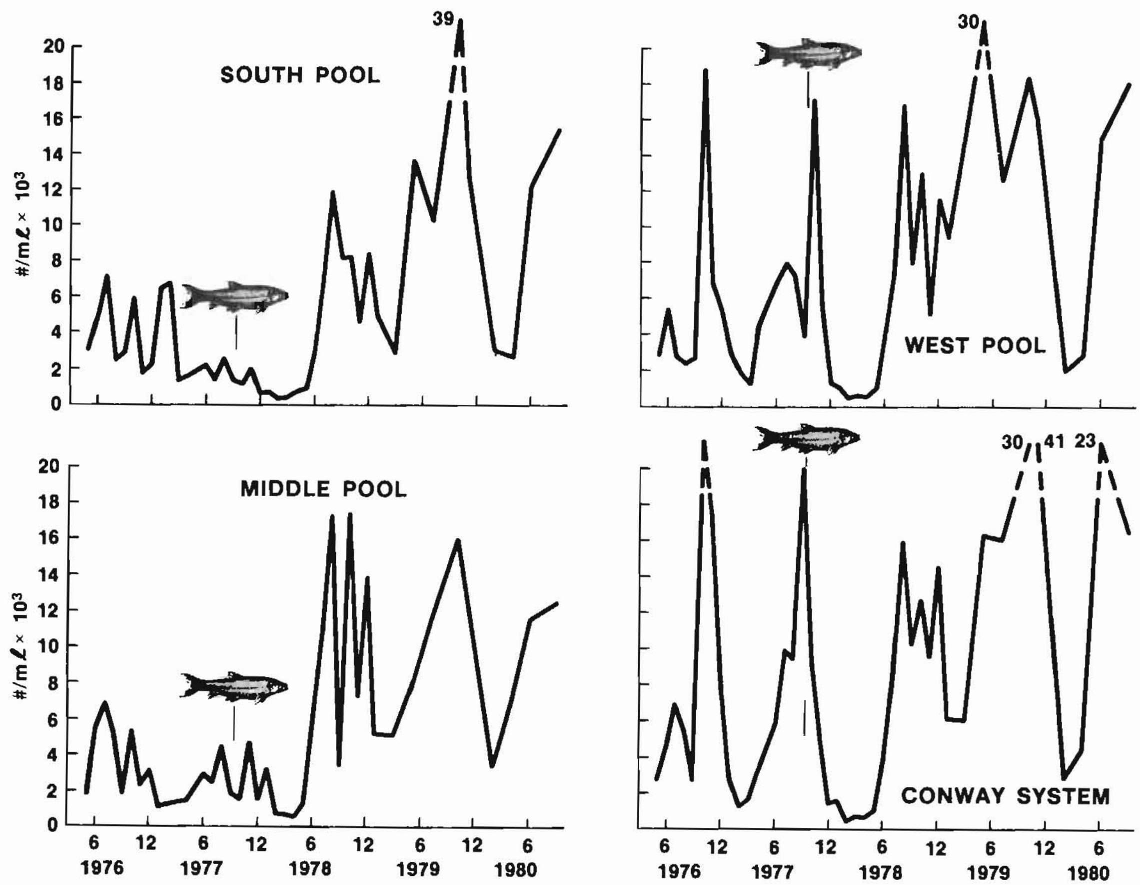


Figure 15. Total number of phytoplankton from littoral stations

seasonality was lost at both littoral and limnetic sites in the pools at Lake Conway. Winter numbers were higher than at prestocking times and the summer peaks were higher and occurred more frequently.

81. During the poststocking period there was a distinct species shift from dominance by green algae to dominance by Cyanophyta or blue-green algae (Figure 17). The percentage of Chlorophyta cells decreased from about 40 percent to 20 percent of the total. At the same time the blue-green algae rose from about 40 to 60 percent of the total to about 80 or 90 percent of total cells.

82. Although blue-green algae increased following white amur introduction, among-pool differences (as tested with Duncan's multiple range test) did decrease slightly through time (Table 15). Total numbers of Chrysophyta or diatoms decreased and total numbers of green algae (Chlorophyta) increased slightly following the stocking of white amur. During the prestocking period, *Selenastrum minutum* (green alga), *Cyclotella* sp. (diatom), and *Chroomonas* sp.

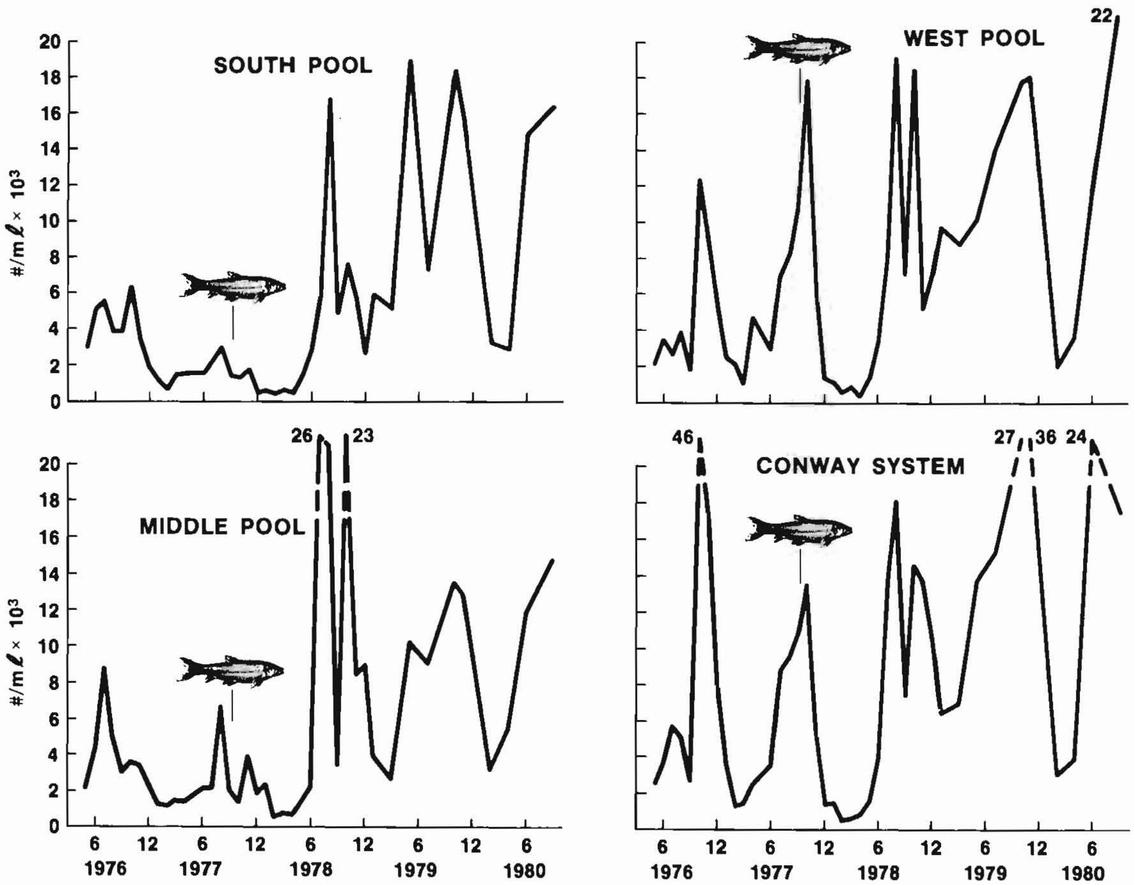


Figure 16. Total number of phytoplankton from limnetic stations

(pyrrophyte) were common in all pools, with the exception of Lake Gatlin. However, these species were uncommon (less than 1 percent) in all pools during the second poststocking period. Changes in phytoplankton community structure continued to take place in the third poststocking period. After stocking white amur, the dominant phytoplankton in South, Middle, East, and West Pools were the flagellated green *Chlamydomonam* sp. and the blue-green *Aphanocapsa delicatissima*, *Aphanocapsa* sp., *Spirulina laxissima*, *Lynbgya limnetica*, and *Schizothrix calcicola*. During this period, three taxa (*Schizothrix calcicola*, *Spiralina laxissima*, *Lyngbya limnetica*) comprised approximately 86 percent of the abundance in Lake Gatlin samples.

83. This observed shift in community structure to an annual dominance of blue-green algae is typical in lakes where eutrophication has been brought about by domestic, agricultural, and/or industrial pollution (Cole 1979). Also genera such as *Oscillatoria* and *Chlamydomonas*, common in the Conway system during the poststocking periods, are indicators of organic enrichment (Palmer 1968, Taylor et al. 1977). Blue green algae flourish even at low or

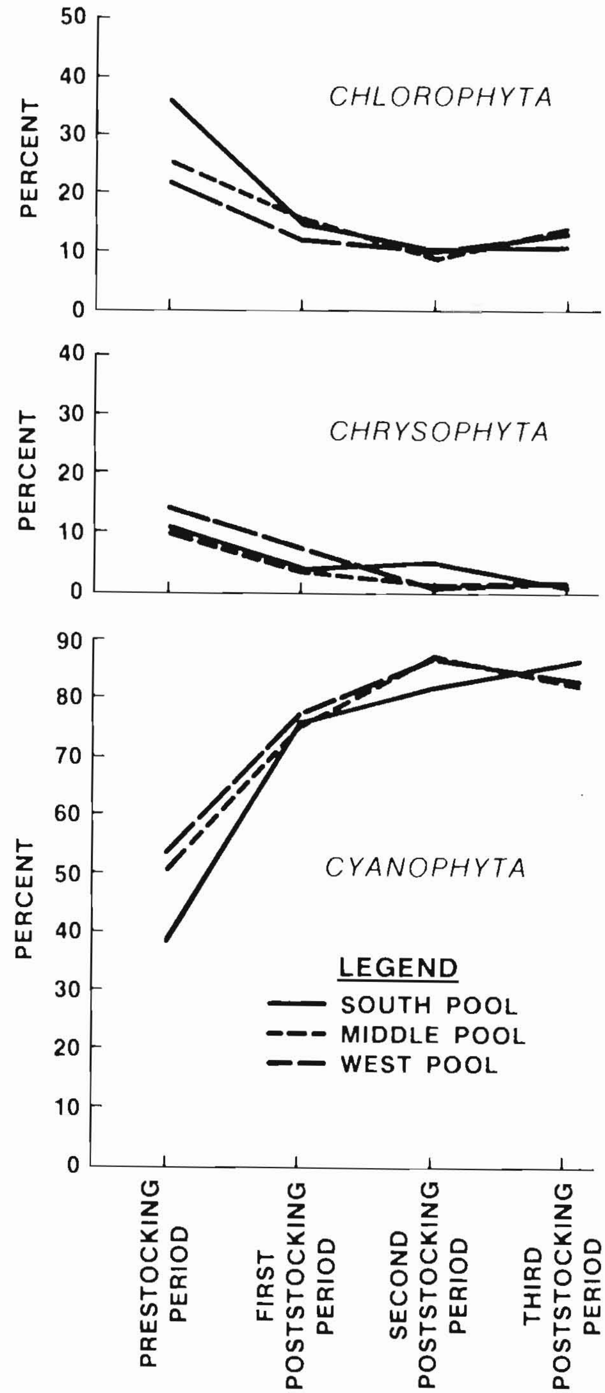


Figure 17. Percent abundance of three major algal groups

unbalanced nutrient levels, partly because of their nitrogen-fixation capabilities (Porter 1977). In addition, all of the blue-green algae common in the Lake Conway system during the third poststocking period were colonial and/or filamentous forms, which are not affected by zooplankton grazing pressures (Porter 1977).

Periphyton

84. During the prestocking period at Lake Conway, the number of periphyton species was lowest in the winter and highest in the summer and fall (Table 16). Following introduction of amur, these trends held; however, numbers of species increased slightly and total numbers of individuals declined after stocking. Based upon a comparison of means of individuals using the T-test, Crisman et al. (1983) found all declines significant at the 5 percent level with the exception of the decline from 1650 to 1297 individuals in the spring. In the majority of cases, the species diversity of periphyton increased (although slightly) during the poststocking period.

Plant pigments

85. Chlorophyll a and trophic index values were highest in Lake Gatlin, the most eutrophic pool (Table 17). Following introduction of white amur, chlorophyll a levels declined in all pools, then gradually increased through

the study until they were close to, or slightly above, prestocking levels. The chlorophyll a values during the second and third poststocking years were not substantially greater than prestocking conditions; however, these slightly elevated values were correlated with the decrease in diversity (Figure 14) and the increase in abundance of the free-floating algae (see Figure 17).

Zooplankton

86. Total numbers of zooplankton species and diversity declined following introduction of white amur (Figure 18). The decrease was not as dramatic as the decline in number and species diversity of phytoplankton (Figure 14). The shallow-water stations typically exhibited fewer species of zooplankters than the deeper sites (Figure 18). The differences in species composition between shallow and deep sites, and among the various pools, gradually decreased following stocking of the amur. This same phenomenon was noted also with phytoplankton.

87. Total numbers of individuals in both littoral and limnetic stations peaked in the second poststocking year (Figure 19) for the Lake Conway system. When examined on a monthly basis, total numbers of zooplankton in the littoral (Figure 20) and limnetic stations (Figure 21) were similar to fluctuations in total number of phytoplankton (Figures 15 and 16). Following introduction of amur, seasonality of annual oscillations diminished; peak abundances were noted in 1978 and, to a lesser extent, in 1979. The pulse in total numbers of zooplankton coincided with increases in numbers of phytoplankton.

88. Numbers of Rotifera increased during the study period in both limnetic and littoral areas of the Conway System (Figure 22). Three copepods (*Diaptomus floridanus*, *Cyclops varicans*, *Tropocylops prasinus*), four cladocerans (*Bosimina longirostris*, *Ceriodaphnia* sp., *Diaphanosoma brachyurum*, *Daphnia ambigua*), and four rotifers (*Conochiloides dossvarius*, *Asplanchna* sp., *Keratella cochlearis*, *Conochilus unicornis*) dominated the zooplankton assemblage of the Conway system during both the prestocking and poststocking periods (Crisman et al. 1983). For these three zooplankton groups, the among-pool differences for total abundance of individuals decreased during the study period (Table 18). The cladocerans and rotifers are relatively unspecialized feeders; they ingest plankton, detritus, and organic matter continually. However, the copepods are more specialized and do not continuously "filter" water to obtain food as do the former two groups (Pennak 1953). As indicated in Table 18, numbers of these organisms increased following introduction of the

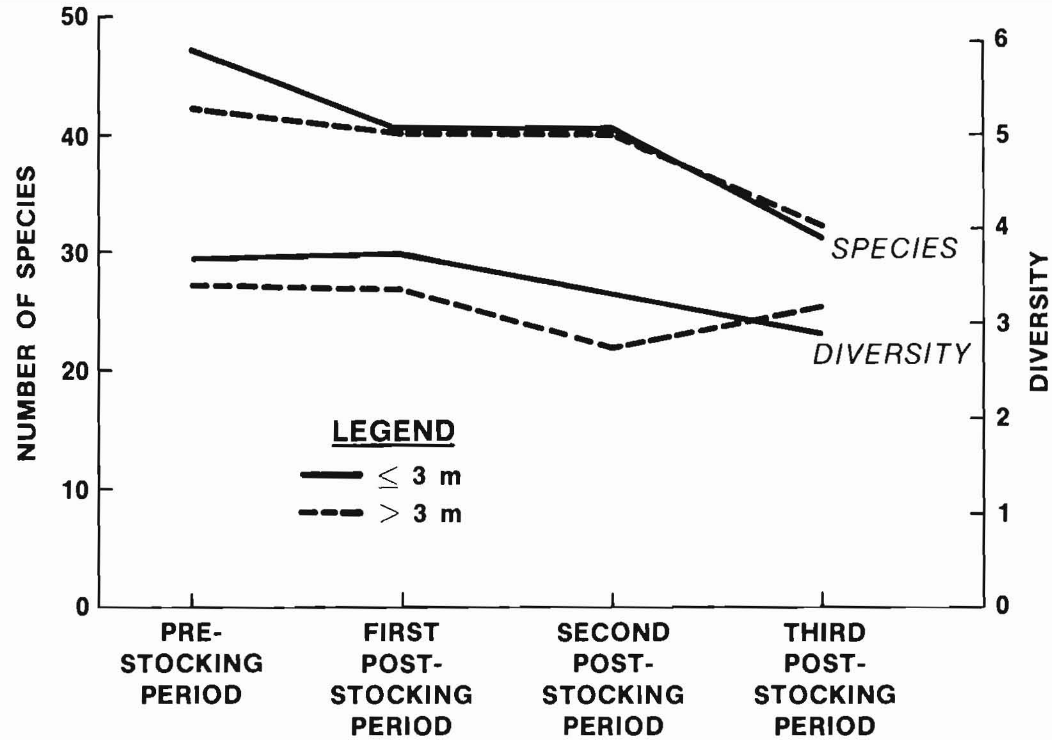


Figure 18. Total species and species diversity of zooplankton

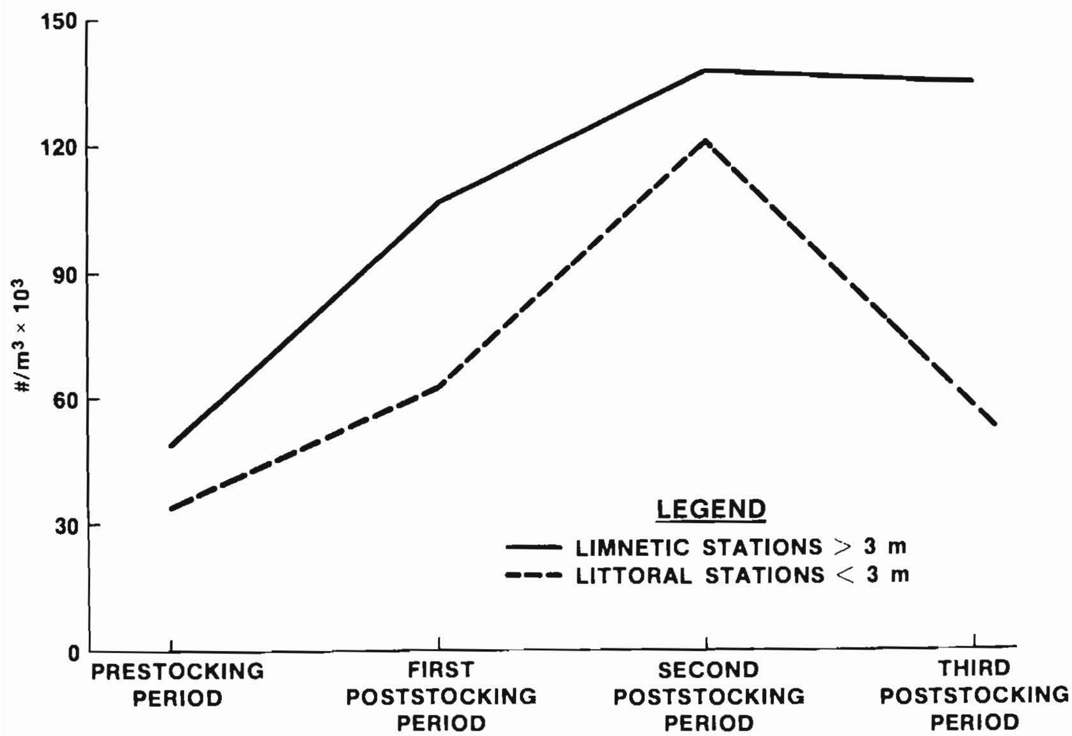


Figure 19. Total numbers of zooplankton

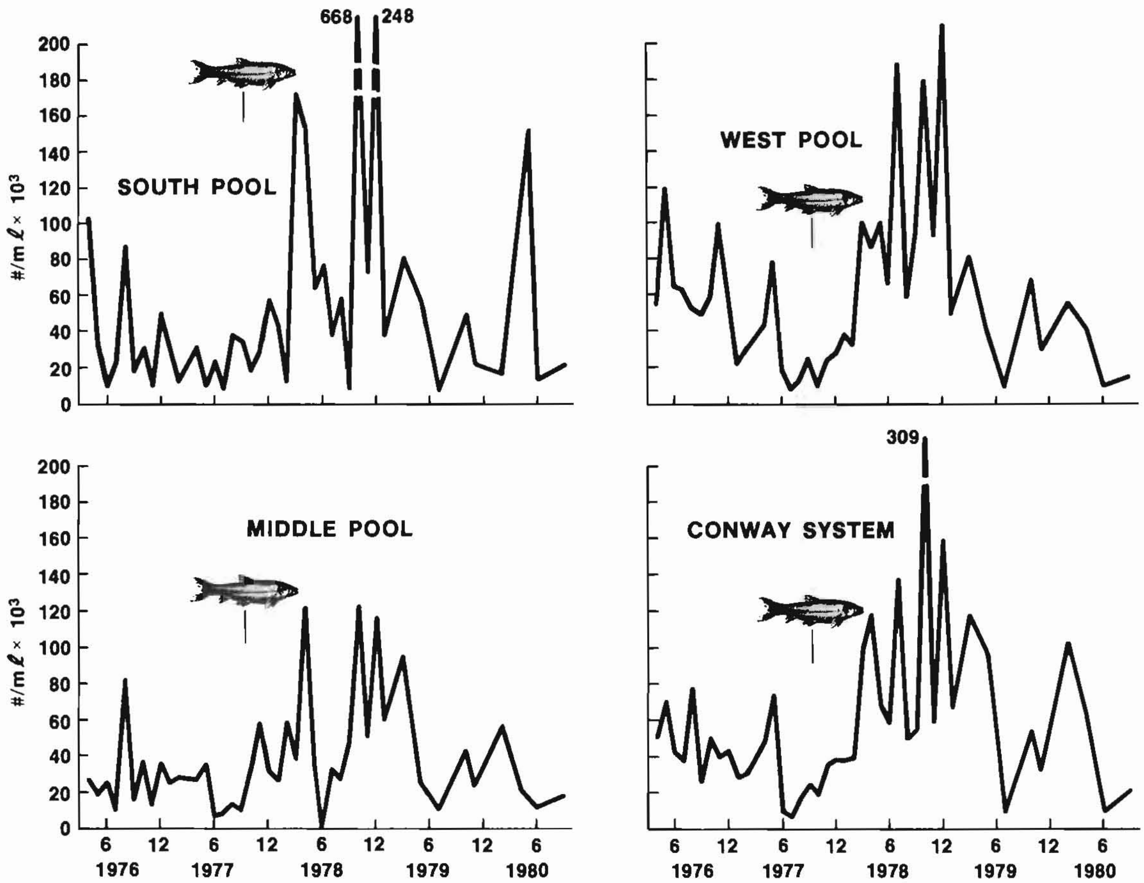


Figure 20. Mean monthly numbers of zooplankton collected from littoral stations

fish and removal of the plants. The increase in numbers of zooplankton was probably in response to increases in numbers of phytoplankton during the warm weather, and to some extent the cooler months.

Benthos

89. Total number of species of benthic macroinvertebrates declined, although species diversity remained relatively stable at Lake Conway during the study period (Figure 23). Shallow-water stations always exhibited a greater abundance of organisms than the deeper water stations (Figure 24). Benthic data exhibited a large amount of seasonal fluctuation; generally, total abundances were lowest in late summer and fall and highest in the spring. This is a natural phenomenon and results from emergence of many benthic organisms in the spring and early summer. There were no specific trends through the study period that can be related to presence of white amur. Although certain benthic organisms (notably many species of chironomids) feed on periphyton and

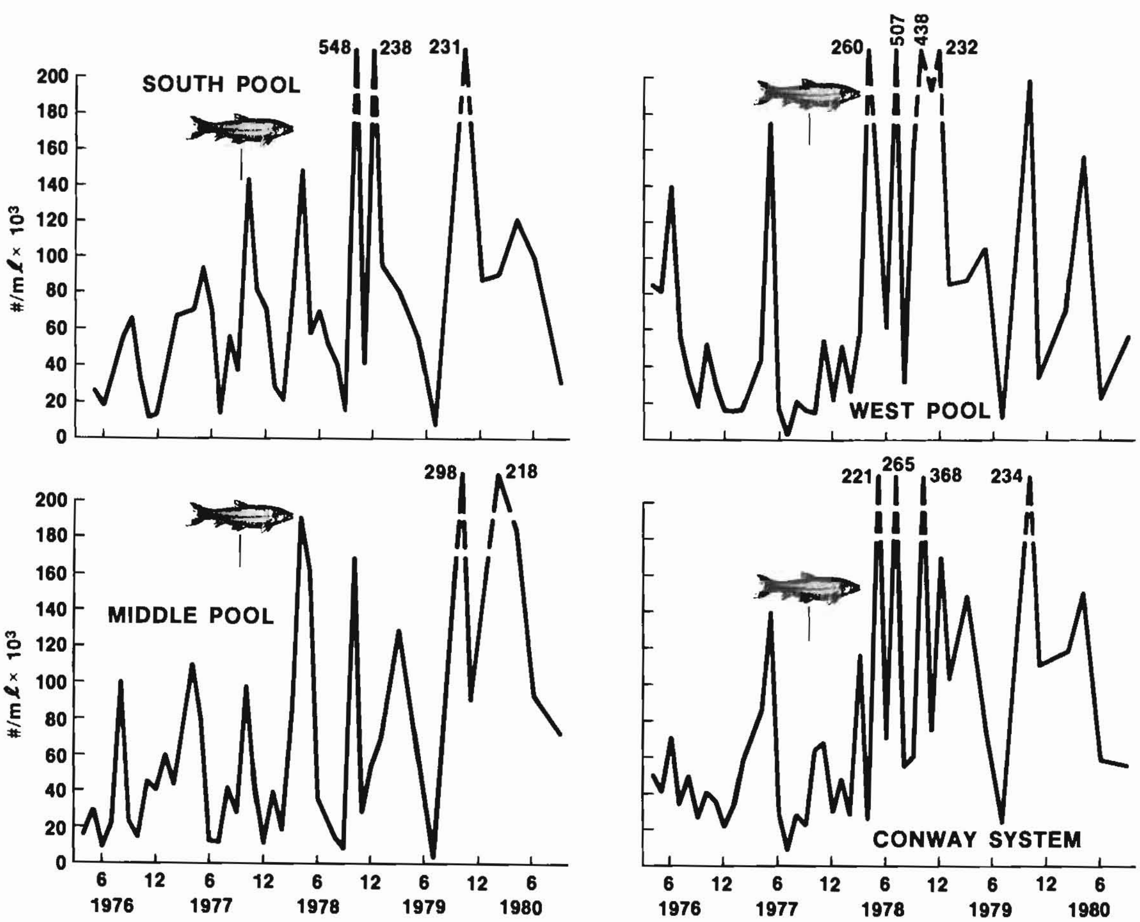


Figure 21. Mean monthly numbers of zooplankton collected from limnetic stations

zooplankton, an increase in prey species had no effect on any predatory invertebrates.

90. The differences in total abundances of benthic organisms among pools declined throughout the study (Table 19) although this was probably the result of natural fluctuations in community structure or sampling error. The most tolerant sediment dwelling genera (*Chironomus*, *Procladius*) displayed no significant between-year differences in abundance, while several genera often associated with macrophytes (*Cladotanytarsus*, *Parachironomus*, *Polypedilum*) displayed significantly greater abundance during the first poststocking year (Table 20). It is notable that all three of these latter groups, which either feed on, or are physically associated with, aquatic plants, exhibited highest numbers during the first poststocking year when plant abundances were high. *Dugesia*, which adheres closely to flat surfaces such as macrophyte leaves, was significantly less abundant during the poststocking period than the

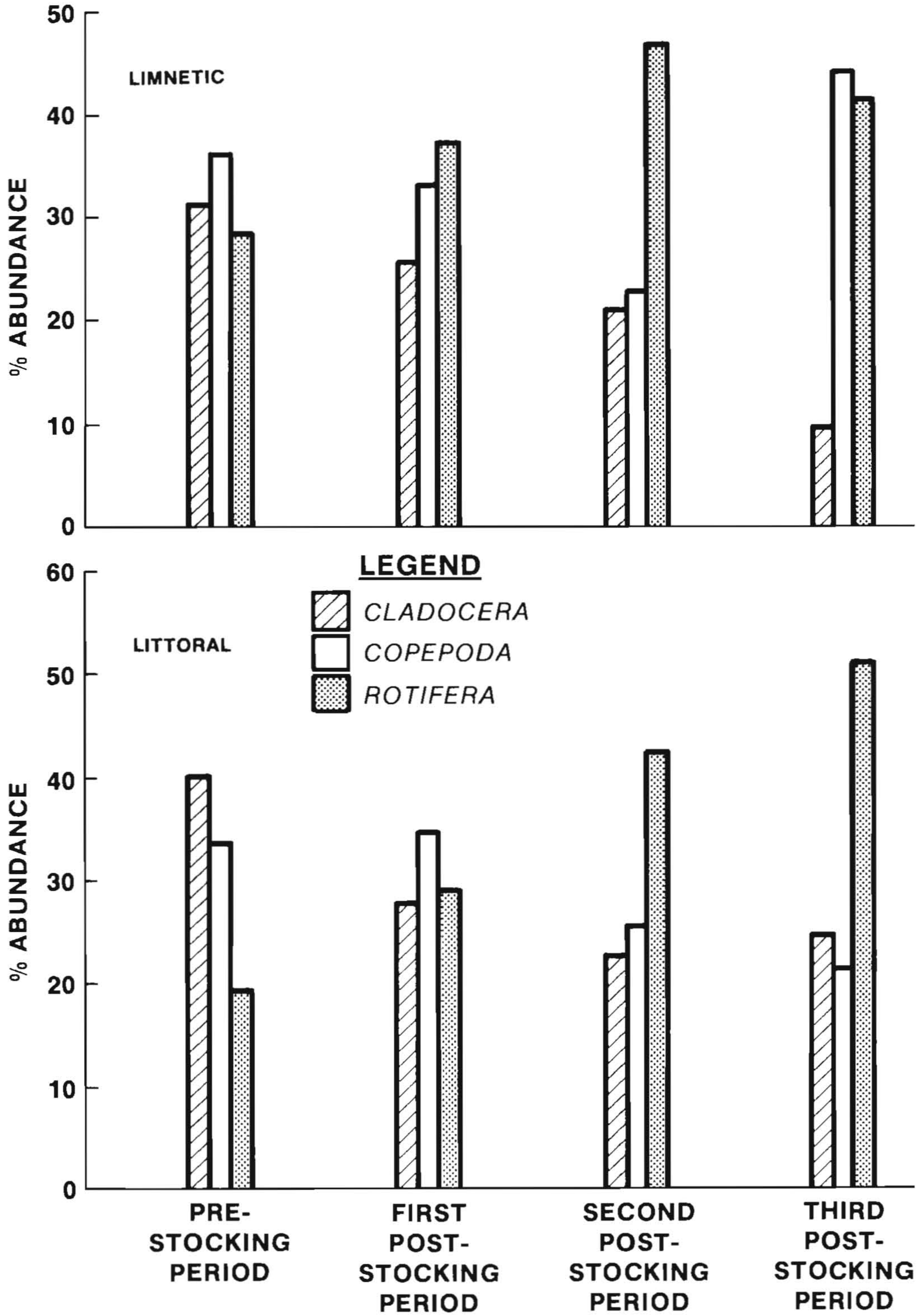


Figure 22. Percent abundance of three major zooplankton groups

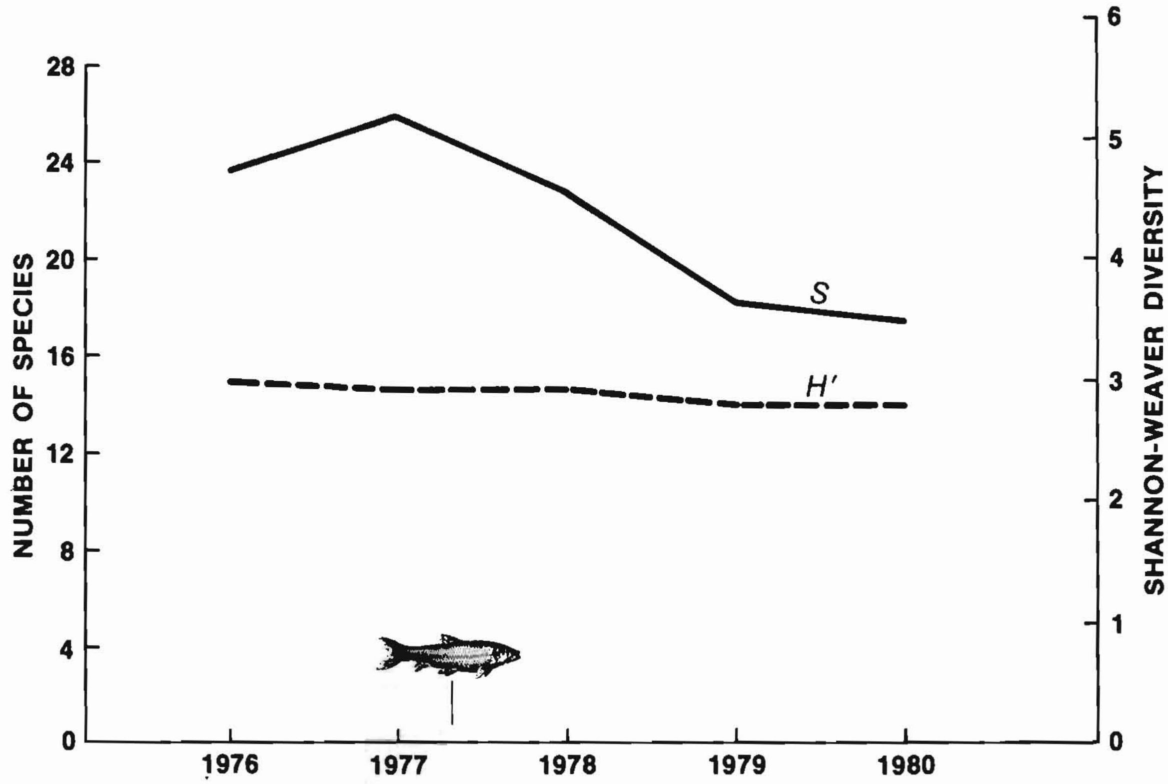


Figure 23. Number of species and species diversity of benthic organisms

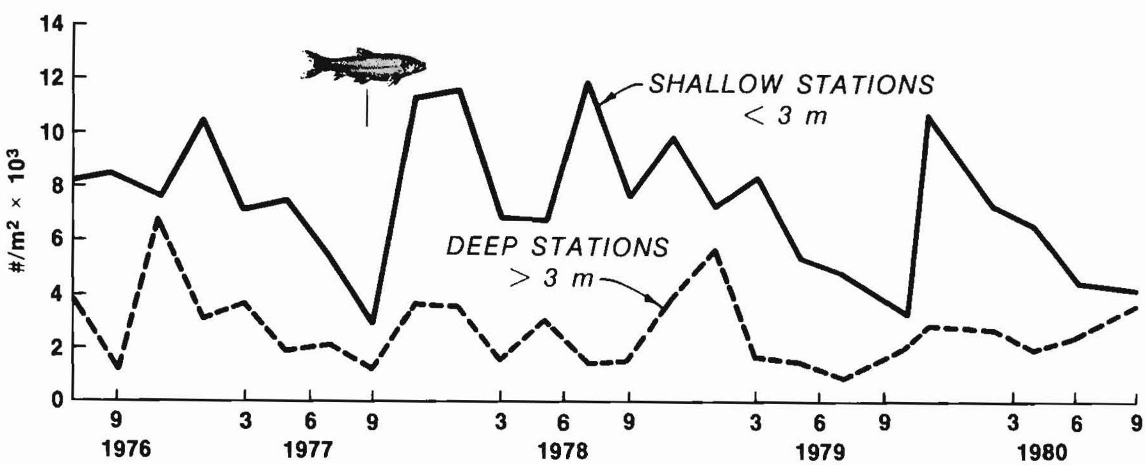


Figure 24. Mean monthly abundances of benthic organisms

prestocking period. During the second poststocking year this genus was limited primarily to depths of less than 3 m, where the broad-leaved macrophyte potamogeton was dominant. *Goniobasis*, a gastropod genus that normally grazes periphyton from macrophyte surfaces, displayed the same reduction as *Dugesia* after the amur were stocked and was virtually absent from depths greater than 6 m during the second poststocking year.

Native fish

91. Total numbers of mosquito fish, a prey fish which feeds on invertebrates, and Shannon weaver species diversity indices for Middle Pool appear in Figure 25. Species diversity ranged from 0.1 to 3.0 and was variable. Total numbers peaked in November 1976 and were substantially less throughout the remaining time. The brook silverside in South Pool (Figure 26) was maximum in October 1979 and diversity ranged from 0.0 to 2.9 with no specific trends which could be related to introduction of white amur.

92. Length-frequency data for bluegill (Figure 27) and largemouth bass (Figure 28) displayed no specific trends as a result of stocking white amur. In general, bluegill had poor recruitment past the 6- or 7-in. size for all years, while the majority of the bass were 4 in. long or smaller. Recruitment to the larger sizes was better in largemouth bass than in bluegill, but showed no specific trends.

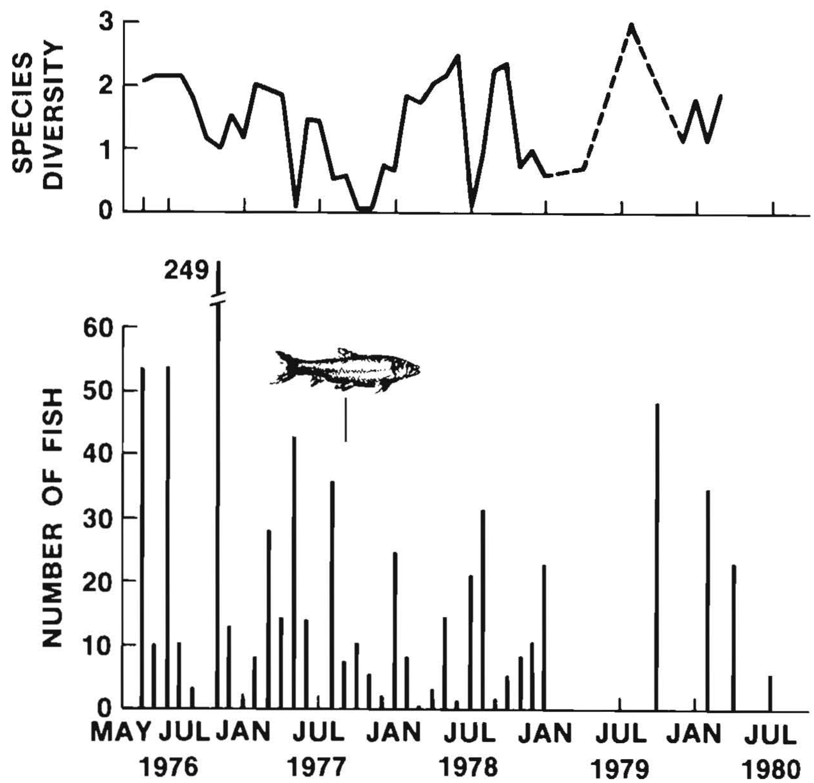


Figure 25. Species diversity and total numbers of mosquito fish collected with Wegner ring from the Middle Pool

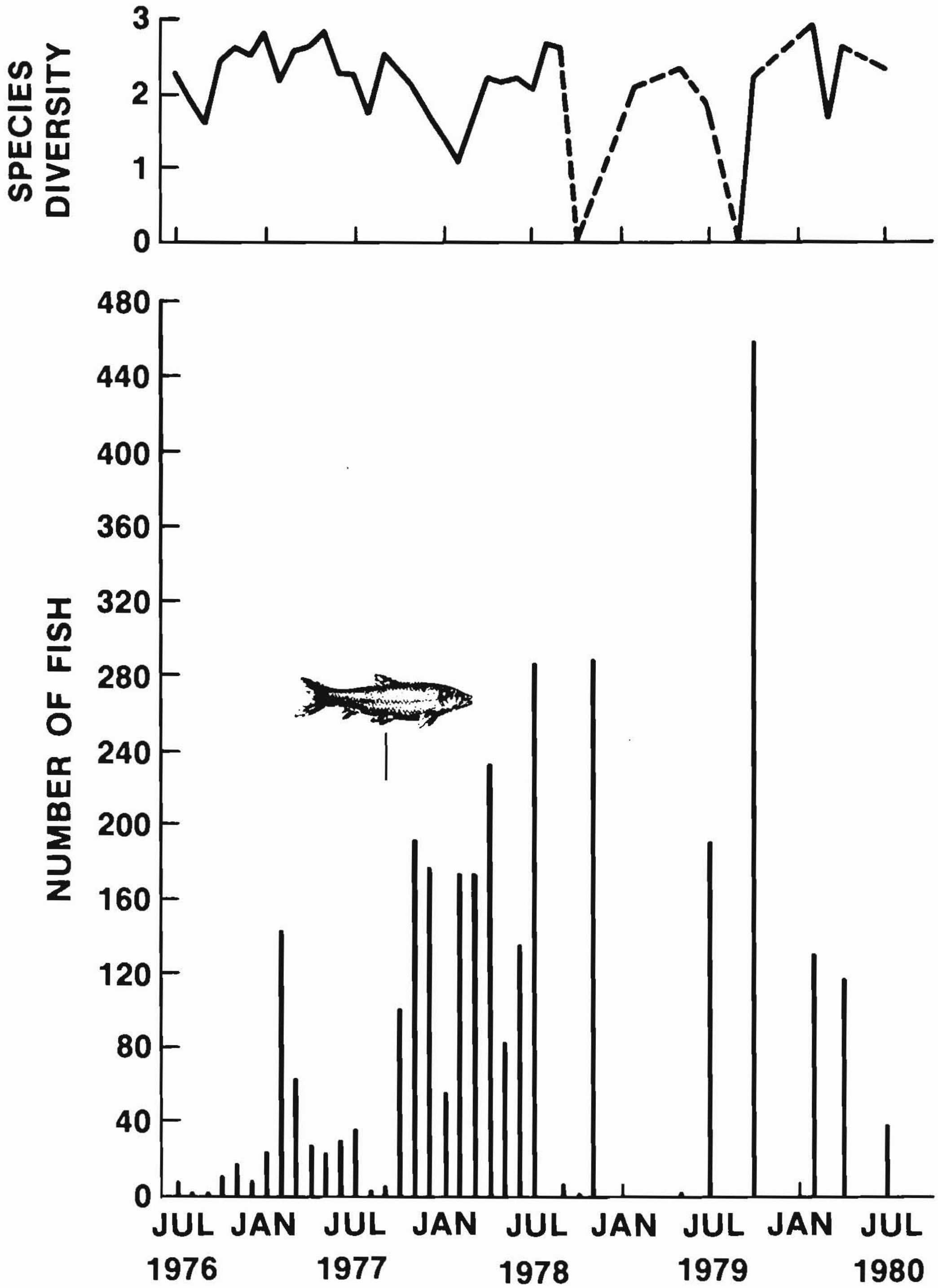
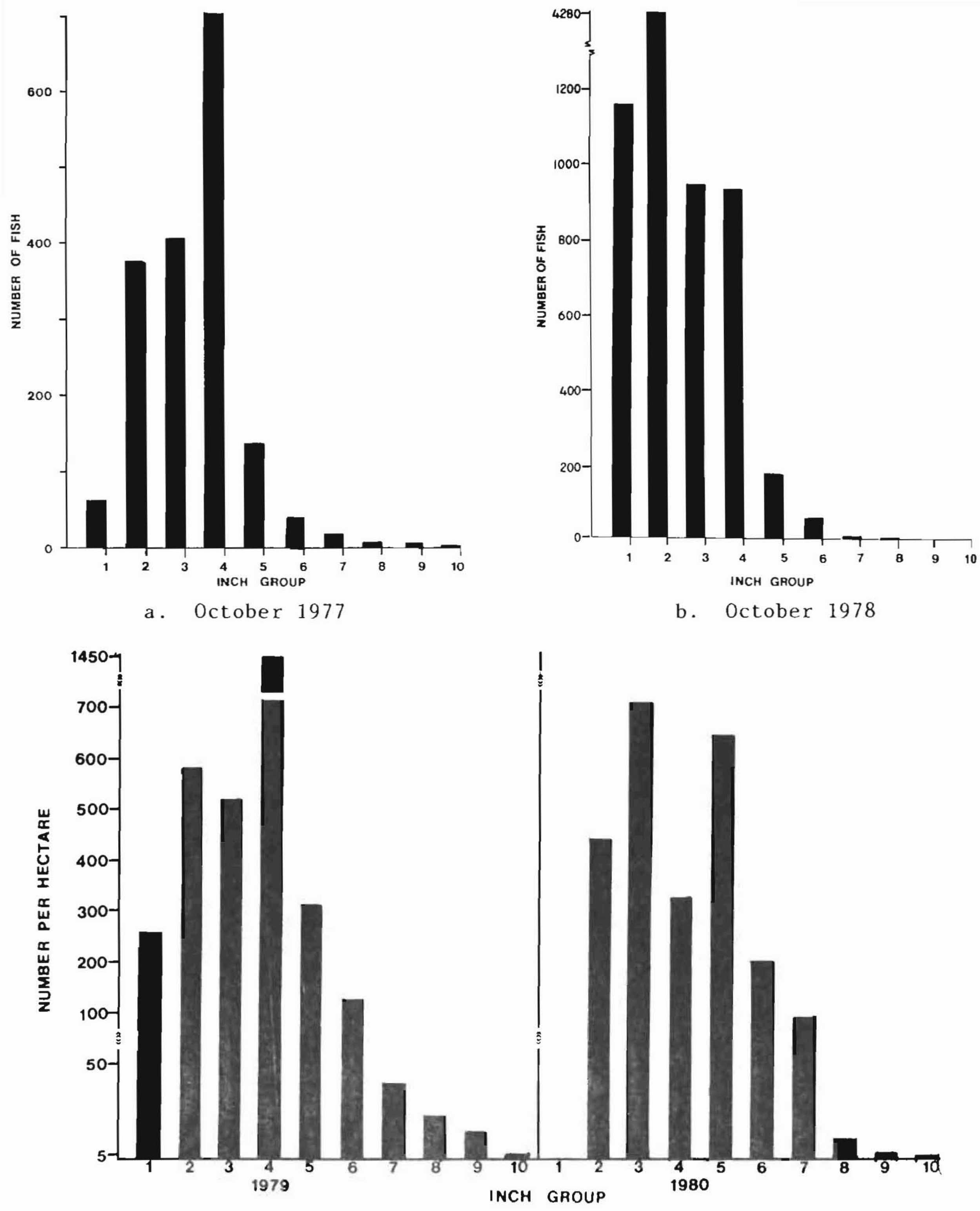


Figure 26. Species diversity and total numbers of brook silverside collected by electrofishing from the South Pool



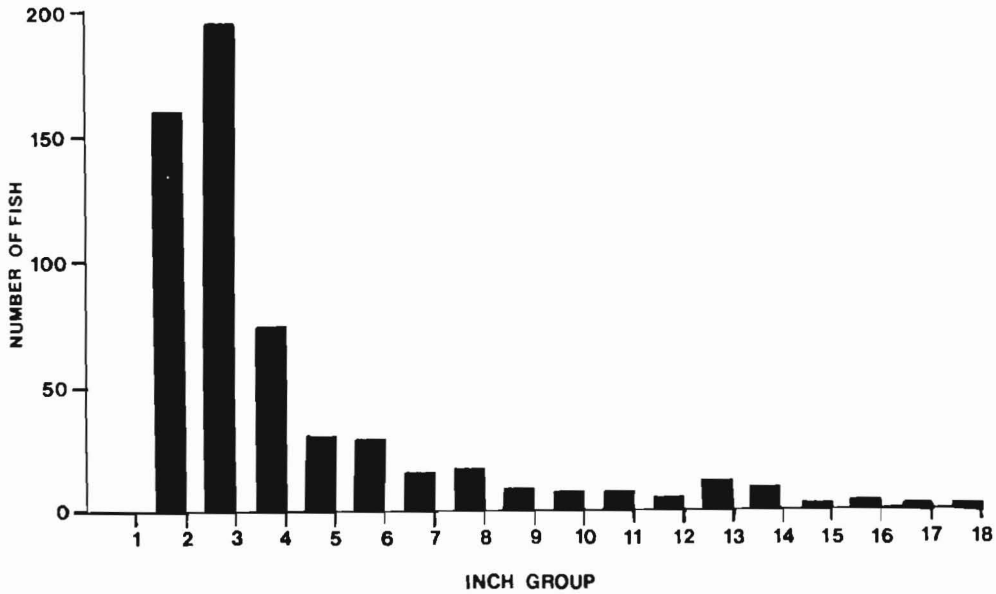
a. October 1977

b. October 1978

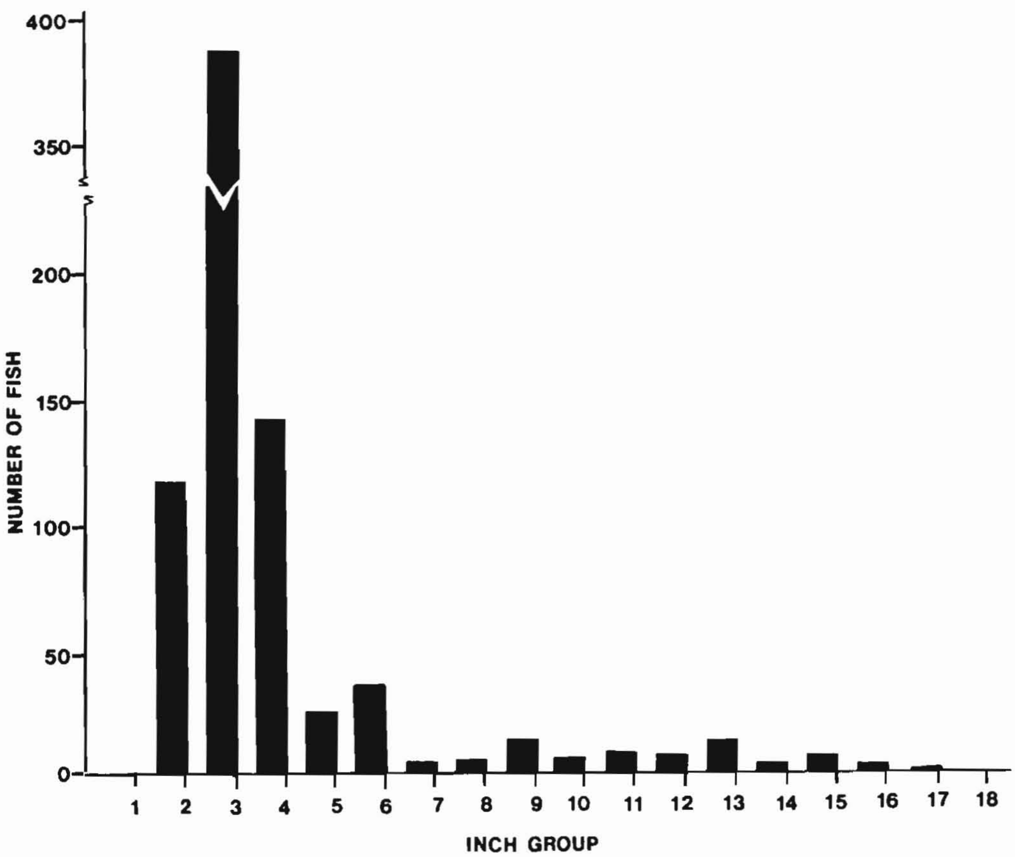
c. October 1979

d. October 1980

Figure 27. Length-frequency data for bluegill collected with a 0.4-ha block net

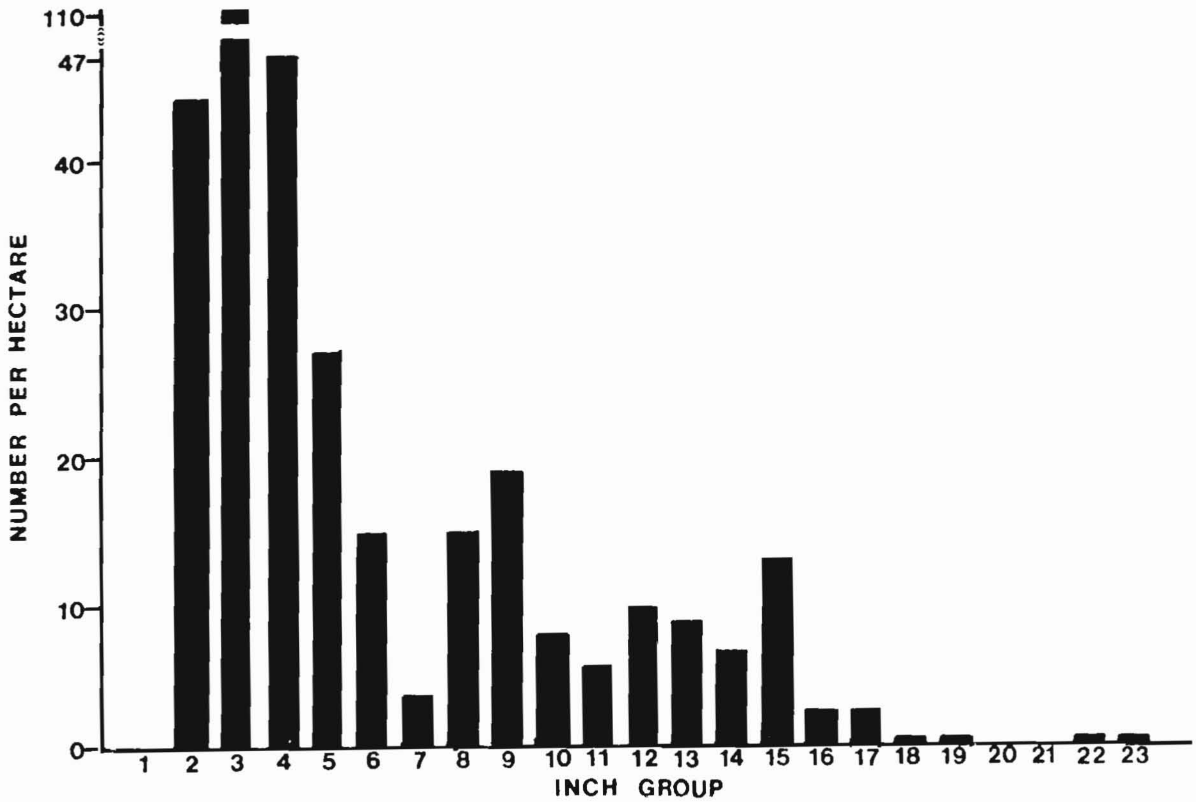


a. October 1977

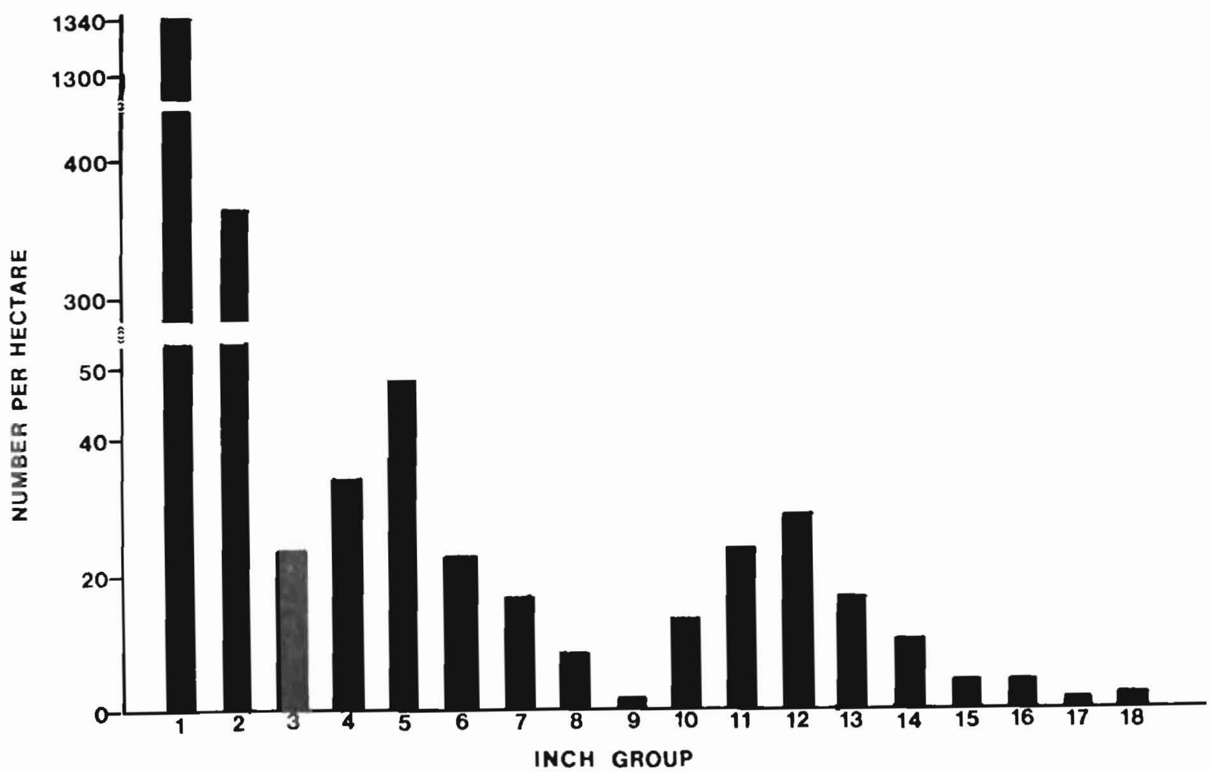


b. October 1978

Figure 28. Length-frequency data for largemouth bass collected with a 0.4-ha block net (Continued)



c. October 1979



d. May 1980

Figure 28. (Concluded)

93. In the spring of 1976, 20,787 forage fish, 6,321 sport fish, and 72 "other" fish were taken from Lake Conway using block nets (Table 21). Throughout the study forage fish were typically more numerous, although sport fish comprised the greatest weight. The highest numbers of sport fish were collected in May of 1978, before the effects of the amur on the vegetation were noticeable (see Figures 10-13), while some low numbers of sport fish were collected in October 1979 and May 1980. The largest number of forage fish was taken in the spring of 1977 (48,832), while the lowest yield was in May 1980 after the plants had been substantially reduced. In summary, the block net data show variable results: the highest yield of a forage fish was in the baseline year (33,773), the highest yield for sport fish was in the second poststocking year (9,099 for 1978-79), and most of the fish in the "other" category were taken in the second poststocking year (Table 21).

94. Number and weight of specific sport fish collected with block nets are presented in Table 22. For three of the species (chain pickerel, bluegill, redear sunfish) the maximum (157.70) number were collected in the spring of 1976. The second poststocking year (1978-1979) exhibited slightly greater (186.1) fish per hectare than the baseline year, although in poststocking year I (1977-1978), the greatest number (201.3 fish per hectare) were collected using block nets. The greatest weight of sport fish collected was during poststocking year I. Numbers of largemouth bass captured with block nets in Lake Conway ranged from 23.5 per hectare in the spring of 1976 to a maximum of 43.6 in the fall of 1976. In the spring of 1976 (more than a year before stocking), there was the highest total number of chain pickerel, bluegill, redear sunfish, and largemouth bass, while the greatest number of warmouth was taken in October 1977 and the greatest number of crappie was collected in October 1978 and May 1979. The greatest weight of fish was taken in the fall and spring of 1976, while the least was collected in the spring of 1976 and October 1978. As with data previously described, fish results are variable and no specific impacts of white amur are evident.

95. Mean condition factors $K_{TL} = W/L^3 \times 10^5$ for all sizes of bluegill (Figure 29) were lowest in 1977 and 1978 except for June through August of 1978. Condition factors for bass less than 300 mm long were consistently lower in 1977 and 1978 than in the previous year, although no specific trend was noted for the larger fish. For chain pickerel the second year showed a slightly higher condition factor than the first year. However, as demonstrated

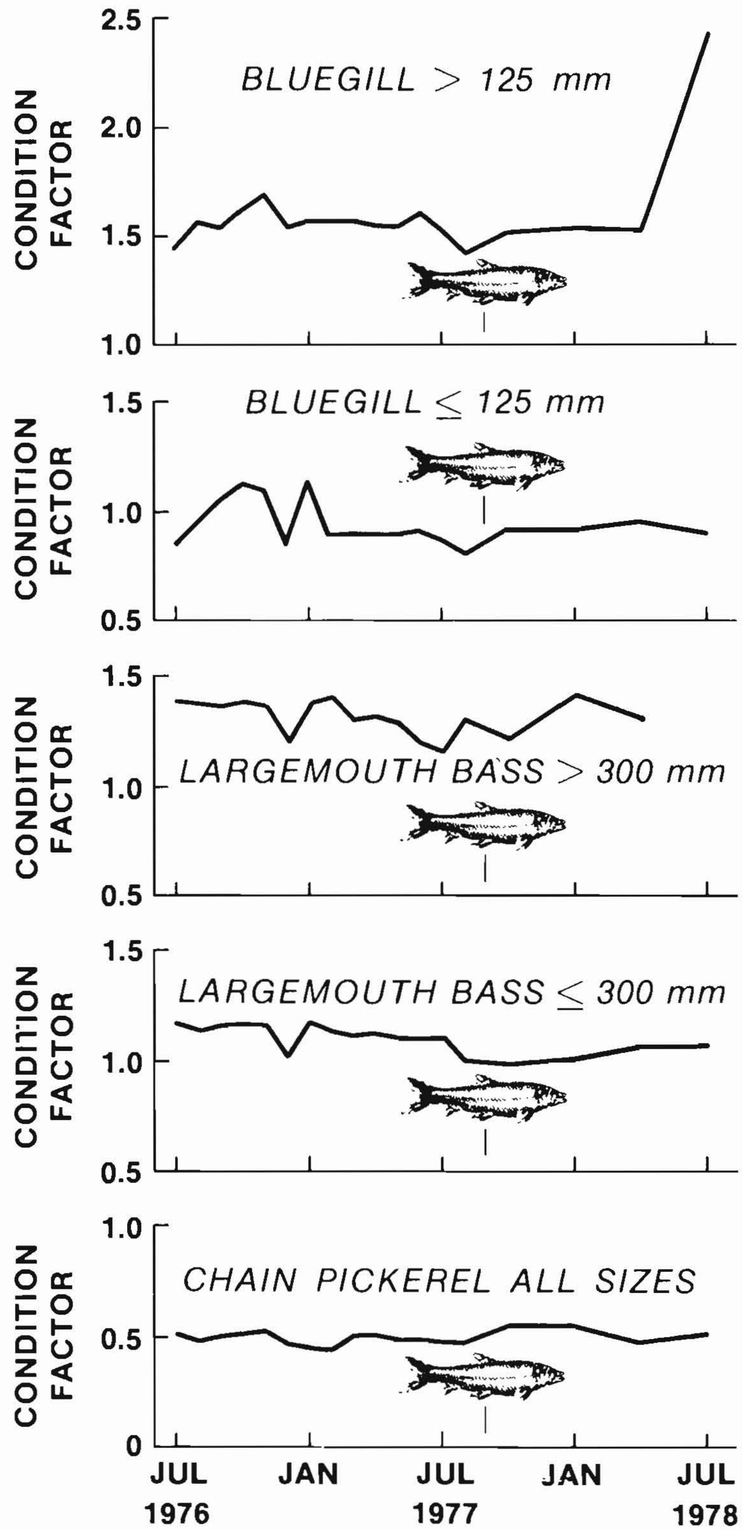


Figure 29. Condition factors for three species of sport fish

by these data, there were no notable changes in condition factors following stocking of the white amur.

96. Length-weight relationships were determined quarterly for largemouth bass, bluegill, and chain pickerel. The relationship can be expressed by the formula (Ricker 1958):

$$W = aL^n$$

where

W = weight, g

L = total length, cm

a and n = constants

The formula was transformed to $\log W = \log a + b \log L$ and the coefficient determined by the method of least squares. The slope of the line (b) is usually consistent throughout the same developmental stage. An intercept greater than 3 implies that the fish is heavy for its length. Based upon data collected at Lake Conway (Table 23), for the majority of the seasons sampled the largemouth bass and bluegill exhibited slopes greater than 3.0.

97. In a study of approximately 500 bluegill from nine ponds near Cornell University, Carlander (1969) reported intercept values that ranged from 3.20 to 3.40; the larger values were taken from fish inhabiting high nutrient waters. The data from Lake Conway, where slopes ranged from 2.93 to 3.42, were more variable, reflecting a heterogeneous system as well as the fact that fish were collected throughout the year. The minimum slope (b) values were calculated from fish collected December 1976 to May 1977; maximum values were found in June and August. Based upon collected data and results of other studies, it appears that the condition of bluegill displayed no specific trends except for slight increases during summer and decreases during winter with no changes directly related to white amur introduction.

98. Carlander (1969) reported that the condition of bass tended to be higher in the northern than in the southern part of their range, although these trends varied depending on other factors. In Lake Conway, however, condition of bass ranged from 2.94 in March through May 1978 to 3.38 in December 1977 through February 1978. In other studies, an extensive and rapid die-off of aquatic plants in the summer caused a decrease in condition factors (Bennett 1948, Bennett 1971). At Lake Conway, the gradual nature of plant

reduction (see Figures 10-13) probably masked changes in condition factors for these fish.

99. Bluegill feed upon both plant and animal material although the bulk of the diet consists of larval and adult insects, crustaceans, and small fish (Clay 1974). This species also feeds on algae, although most often when young. In Lake Conway the highest percentage of food consumed by bluegill were insects, which ranged from 8.5 to 84.6 percent of the total of the stomach (Table 24). This food matter consisted mainly of immature forms of mayflies, dragonflies, caddisflies, and dipterans. Crustaceans comprised the bulk of the diet when insects were not abundant; the common crustaceans were amphipods followed by the macrocrustaceans such as ostracods, copepods, and cladocerans. The grass shrimp (*Palaeomonetes*) was fairly common in the diet of bluegill. Chironomids (the most abundant organism in bottom samples) were the most common insects while ceratopogonids were very uncommon.

100. In general, insects dominated stomach analyses in the spring and summer and declined considerably during winter months. Amphipoda tended to be most abundant in the winter, presumably when the insect populations were low. These groups are strongly thigmotactic* and react negatively to light; during the day they hide in vegetation and debris (Pennak 1953). It is notable that the highest value for this group (42.7 percent) was found in March through May 1979 when plant growth in the pools was considerably reduced. Presumably, the amphipods were unable to find refuge and were preyed upon by bluegill. Cladocerans, the most abundant macrocrustacean in the gut of bluegill, dominated in September and November 1979 as well as March and May 1978. This species, like the Amphipoda, also seeks refuge in stems and leaves of aquatic plants.

101. Largemouth bass take a variety of animal food including crayfish, insect larvae, minnows, frogs, and other animals (Clay 1974). For the period of study, remains of fish and identifiable fish species (from 12.7 to 92.4 percent) were found in the stomachs of largemouth bass (Table 25). The most common prey from June 1976 to August 1977 (the baseline year) by weight were smaller largemouth bass (45.6 percent), redear sunfish (19.6 percent), threadfin shad (7.9 percent), Seminole killifish (4.9 percent), and brown bullhead (2.0 percent) (Guillory 1979). *Procambarus* sp., a crayfish, and

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* React in a positive manner to touch. These organisms seem to prefer to be under or in direct contact with solid items such as plant stems.

Palaemonetes were significant food items; gastropods and aquatic insects were relatively uncommon in the diet of largemouth bass.

102. From 1977 through 1978 (the first poststocking year), numbers of threadfin shad decreased and no cannibalism was observed by largemouth bass. By weight redear sunfish (36.7 percent) were the principal food item followed by bluegill (19.0 percent), unidentified fish, a lesser siren (*Siren lacertina*), and an unidentified *Lepomis*. The weight of redear sunfish and bluegill increased from the baseline year; weight of crayfish declined in largemouth bass stomachs (Hardin et al. 1982).

103. In the second year after stocking, the grass shrimp (*Palaemonetes*) averaged about 1 and 1-1/2 times the number of crayfish in the diet of bass. By weight the redear sunfish (at 12.9 percent) were the most abundant in the stomachs of largemouth bass followed closely by bluegill at 11.4 percent. In the final poststocking year (October 1979 - September 1980), food habits of largemouth bass were very similar to those in the second poststocking year. During the winter, crayfish dominated while bluegill, golden shiners, and Seminole killifish comprised more than 10 percent by weight of the identifiable fish (Land et al. 1982).

104. Using radio tracking equipment (see Schardt and Nall 1981, Keown 1981) personnel from the Florida Department of Natural Resources documented movements of the fish at Lake Conway in response to vegetation removal. It was found that most fish exhibited a definite home range. For example, seven fish remained for 6 months at the junction of East and West Pools where there was a large bed of potamogeton, a preferred plant species. Occasionally fish moved from this area as much as a kilometre; however, they generally returned to the junction of these two pools. One fish was noted to frequent a site in the southern portion of East and West Pools. Schardt and Nall reported that this fish crossed between the pools at least six times during six months. To do this the fish moved over, but did not stop at, several dense stands of nitella and potamogeton. In another instance, a single fish was noted to cross from the north to the south side of South Pool a total of 35 times. However, the majority of the studied fish established a home range in a particular plant bed and remained there until the vegetation was removed.

105. None of the radiotagged fish crossed from South or East Pools into Middle Pool during this study. The tagged fish did routinely move between East and West Pools, which have a well-developed connection. In addition, no

seasonal differences in movement of the tagged fish were noted during the 17 months of study. However, Chi square analysis demonstrated that fish were tracked more frequently in vegetated water less than 3 m deep as opposed to vegetated waters between 3 and 6 m in depth. It was noted also that tagged fish were often observed in schools with untagged fish. Presumably the tagged individuals exhibited behavior patterns similar to the untagged fish.

106. The white amur collected from October 1977 to October 1978 had fed primarily on hydrilla, nitella, and potamogeton (Table 26). Of all the fish sampled, potamogeton ranged from less than 2 percent to more than 99 percent of the total food in the gut. In the last part of the study, from October 1978 (1 year after stocking) until August 1980, a greater variety of food material was identified in the fish stomachs than was found at the beginning of the project. In 1980 these fish were feeding also on cattail, fanwort, and pickerelweed. None of these plants are considered preferred species and all are tough and fibrous. Fish with empty stomachs were collected during 1979 and 1980. Obviously, as the preferred plants were removed, the amur fed upon nonpreferred plants or did not readily eat the available vegetation.

107. In summary it does not appear that introduction of white amur caused significant changes in the food habits of the largemouth bass or bluegill. Bluegill were able to concentrate on Amphipoda and insects following introduction of the amur (Table 24). Stomach analyses indicated a less diverse diet in the second and third years following introduction of white amur. The largemouth bass feeds more heavily on fish than other items (Table 25). Although data are variable, results from the second and third poststocking years indicate that the crustaceans were high in the diet until June through August 1980 when they decreased dramatically. With the lack of plant cover, these invertebrates, as well as members of Insecta, may have been more available to predatory fish.

Sportfishery

108. Based upon Creel survey data, largemouth bass were the most sought after sport fish by anglers (Table 27) at Lake Conway. From 4,055 (summer of 1979) to a maximum of 18,038 hr (summer of 1976) were expended for bass while a maximum of 2,660 (winter 1979-1980) to a minimum of 24 hr (summer 1979) were expended for panfish. Other fish of interest to anglers in Lake Conway were sunfish, chain pickerel, and occasionally golden shiner, catfish, bullhead, and other rough fish. However, the latter groups represent usually no more

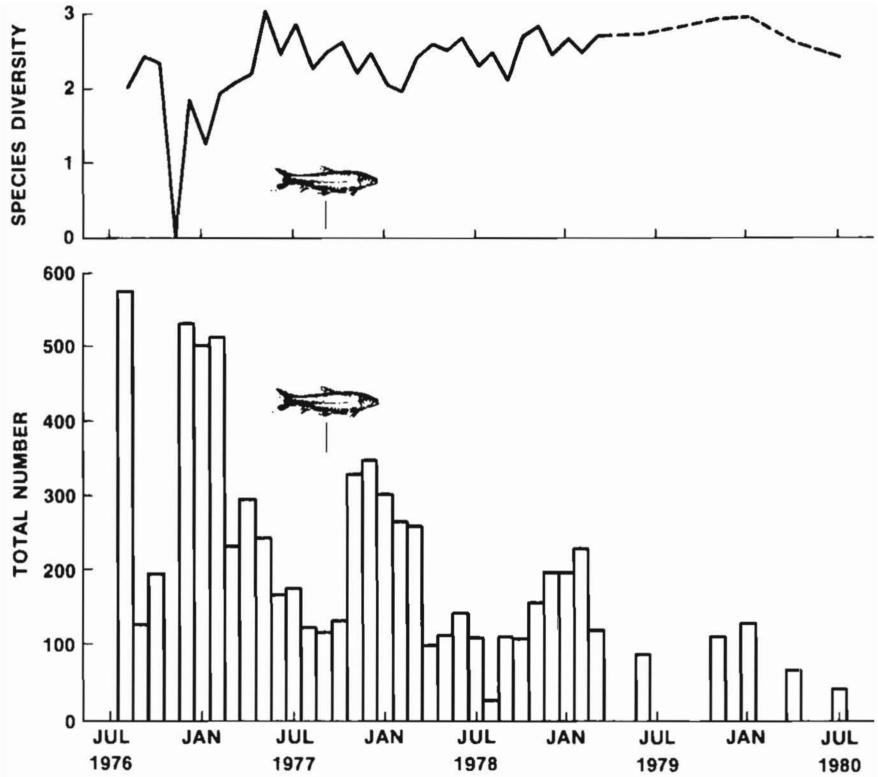
than 10 percent of the effort expended for largemouth bass by fishermen at Lake Conway.

109. The species-directed success rate (fish caught per hour while fishing for that species) for largemouth bass ranged from 0.10 to 0.69 at Lake Conway during the study period. The maximum value for success rate was in the fall of 1978 after the white amur were stocked and the weeds decreased. The maximum success rate for panfish (7.67/hr) was in the summer of 1979 which was the first year weed-free conditions occurred.

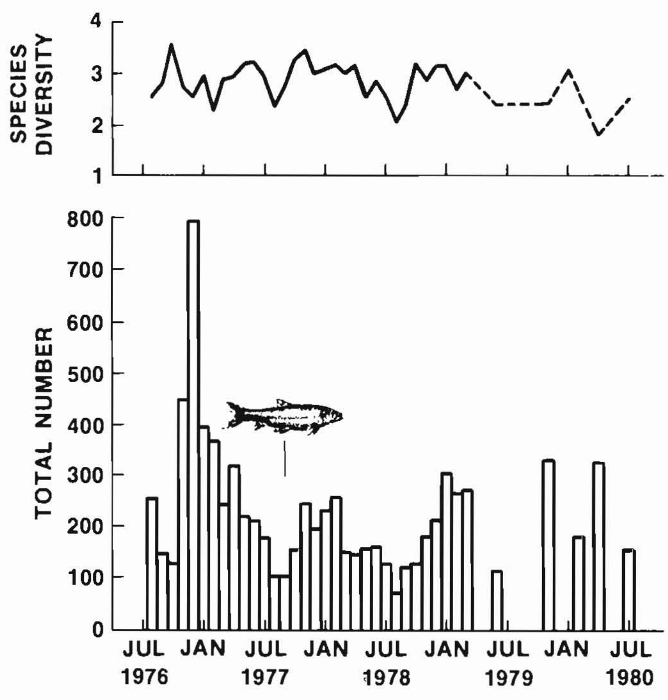
110. As depicted in Table 27, the success rates for three sport fish of interest to anglers were higher in late 1978 and 1979, when the weeds had been significantly reduced. These values were substantially higher than those taken during the baseline year or the first poststocking year. With less vegetation, fishermen were able to more successfully utilize lures, operate boats, etc., to catch fish.

Waterfowl

111. Abundance of waterfowl in all pools of Lake Conway was variable throughout the study period (Figure 30 and Table 28), although numbers were greatest in the winter months and least in the summer because of migrants. With the exception of Lake Gatlin, which exhibited no specific trends during the study year, total birds were greatest in January of the baseline year (1976). Middle and West Pools had a second peak in January 1978, 2 years after stocking, while numbers in South Pool gradually diminished following introduction of white amur. East Pool had high numbers in the winter of 1979 and 1980. Species diversity tended to be lowest when total numbers of birds was greatest (Figure 30), although the August 1977 data from East Pool are an obvious exception. In general, species diversity was variable throughout the year and there were no specific trends as a result of stocking the white amur. Wading birds and all species of ducks (Figure 31) peaked in July 1979 and January 1978, respectively. Both of these groups have representatives which feed directly on vegetation or on fish, crustaceans, and insects which are frequently found among leaves and stems of aquatic plants. In the second year after stocking (July 1979), aquatic plants became greatly reduced (Figures 10 and 11). The numbers of waterfowl, however, were not detrimentally affected.

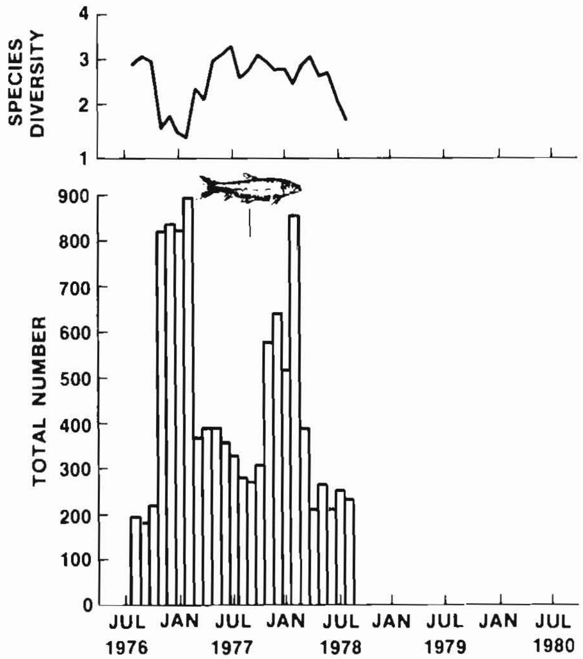


a. South Pool

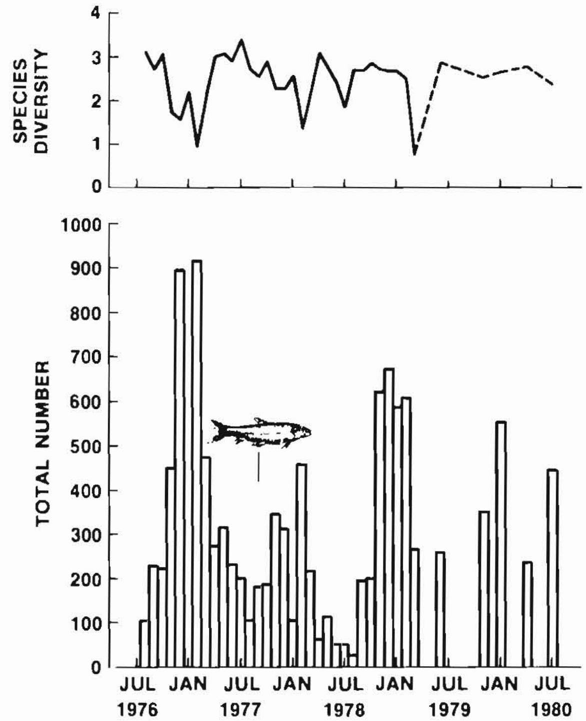


b. Middle Pool

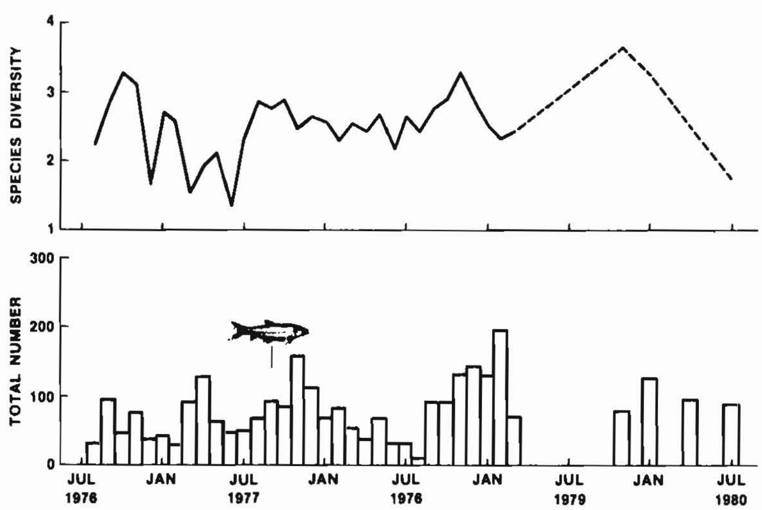
Figure 30. Species diversity and total numbers of waterfowl (Continued)



c. East Pool

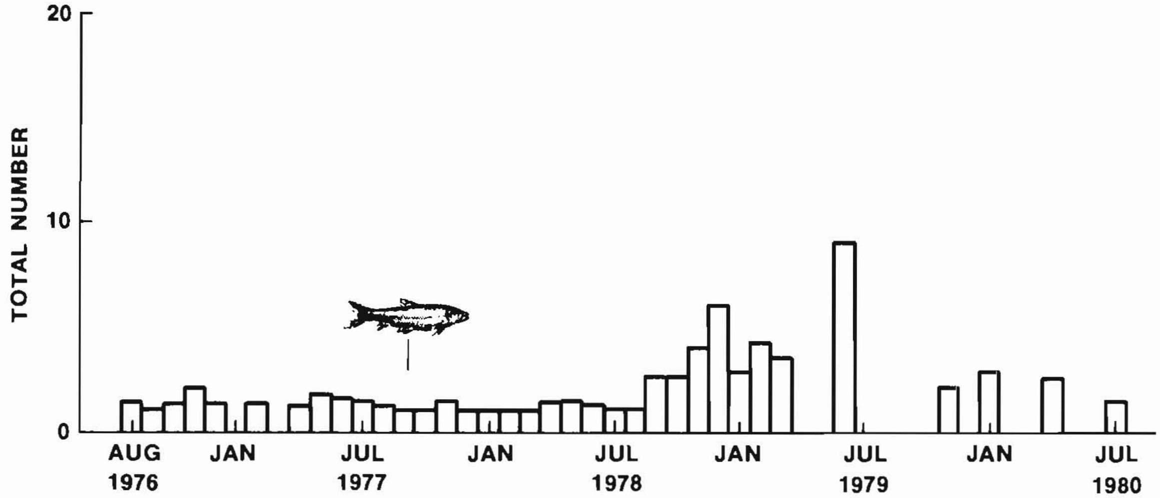


d. West Pool

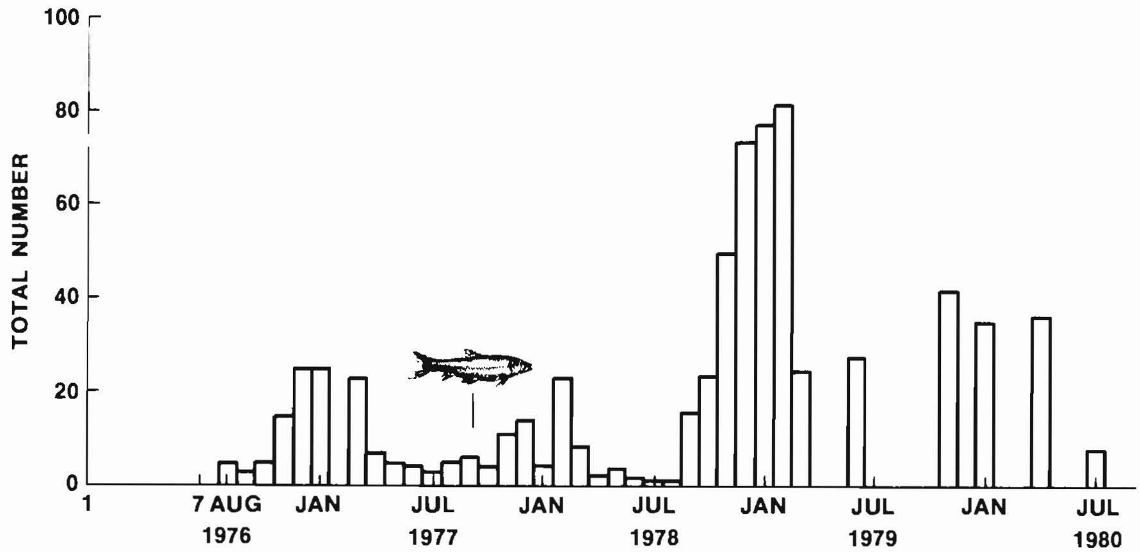


e. Lake Gatlin

Figure 30. (Concluded)



a. Wading birds



b. Ducks

Figure 31. Total numbers of wading birds and ducks in West Pool

112. The Florida Game and Fresh Water Fish Commission collected waterfowl data from the entire state each January; while these data have minimal value as absolute estimates of population sizes, they do have utility in delineating January waterfall densities and are a rough index to yearly population changes (Johnson, FGFWFC, personal communication). It is evident that 1980 (Figure 32) was a very low year for American coot (a very common species at the lake) as well as other species. For this 10-year period, waterfowl numbers in the state were reduced and are reflective of conditions at Lake Conway. Changes in populations at Lake Conway were related more to state

trends and local meteorologic conditions than they were to stocking white amur.

113. Food habits of the ring-necked duck and the American coot appear in Tables 29 and 30. In the ring-necked duck, grit represented a major portion of the gut contents, followed by aquatic plants. Two prey groups, mollusks and crustaceans, which depend heavily on aquatic plants for cover, were very abundant in stomach analysis following removal of plants (after January 1979). Presumably these organisms could no longer hide effectively following loss of the plants and were preyed upon by the bass as well as the ring-necked duck.

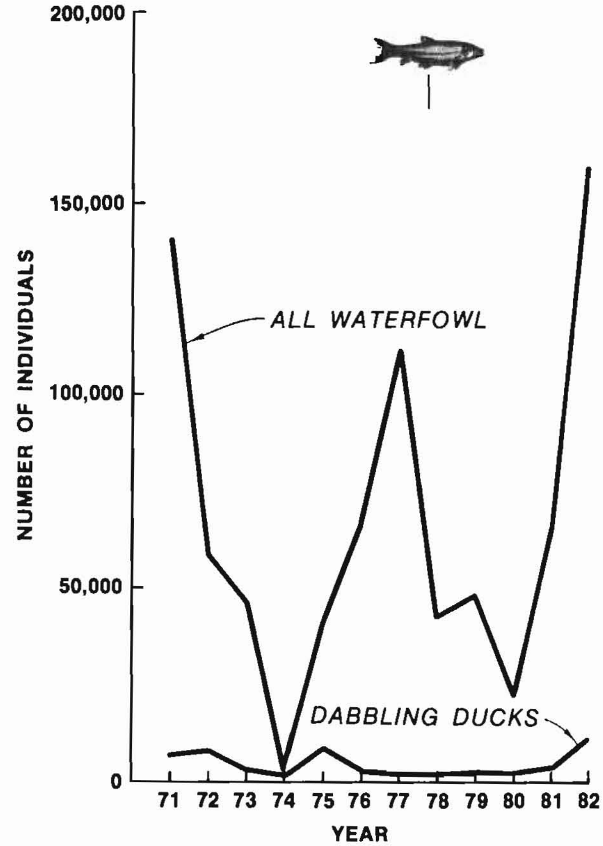


Figure 32. Waterfowl data collected by the Florida Game and Fresh Water Fish Commission for the central portion of the State of Florida

Aquatic Mammals

114. Aquatic mammals observed in or adjacent to Lake Conway during the study included opossum, raccoon, river rat, Florida water rat, and marsh rabbit. The Florida water rat, based on observations of nests, appeared to be common in *Panicum* marsh areas south of the Middle Pool. As a result of studies conducted by the FGFWFC, these aquatic mammals were detrimentally affected by residential development. Terrestrial vegetation and emergent plants growing along the water's edge were cleared during the second and third poststocking years for homes. In general, the amur fed on vegetation in the lake and it was only toward the end of the study that cattail and other nonpreferred plant species were found in stomach analyses. However, these fish did not affect vegetation utilized by the Florida water rat and other aquatic mammals. These aquatic mammals were impacted by residential development and decreases in water levels and not by introduction of white amur.

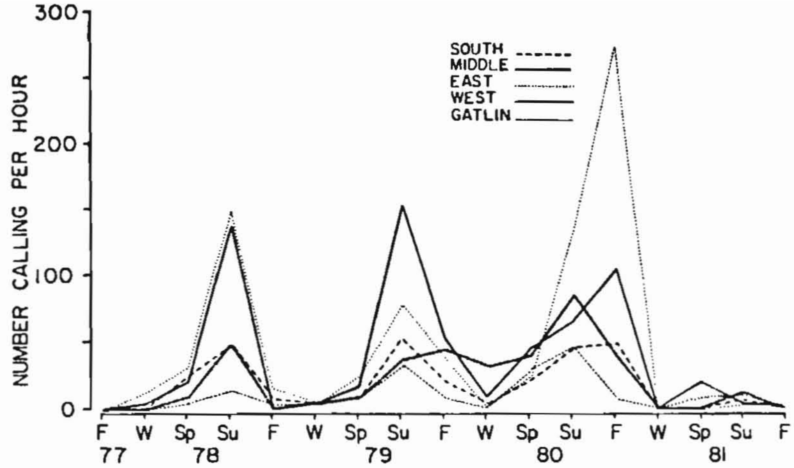
Herpetofauna

115. Total numbers of species and individuals of reptiles and amphibians declined throughout the study period at Lake Conway (Table 31). During the study period, a total of six species (three each year) were lost. Middle Pool experienced the greatest loss in total individuals; South Pool experienced the least decline. The majority of these changes occurred between the first and second sampling year.

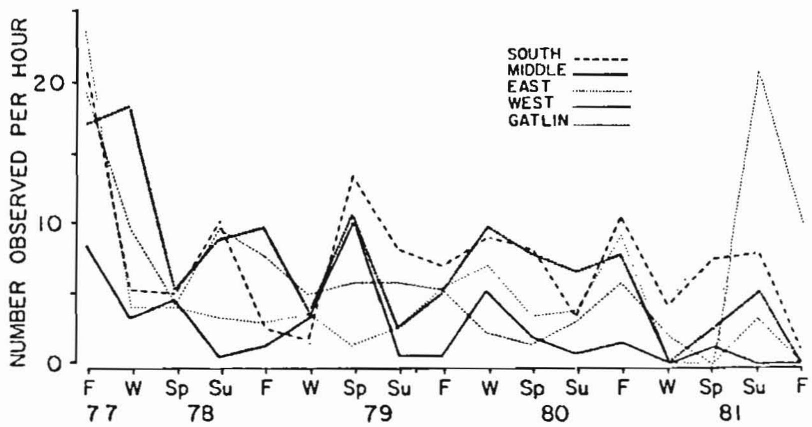
116. Nine organisms exhibited significant yearly changes in relative densities at Lake Conway (Table 32): two salamanders, larvae of two frogs, two turtles, one snake (as sampled with funnel traps), and an additional turtle and frog sampled by herp-patrol. The stinkpot turtle (*Sternotherus odoratus*) was very common during the first part of the study but exhibited a dramatic decline in East Pool and Gatlin Canal and a smaller decline in Middle and West Pools. The snapping turtle (*Chelydra serpentina*) was uncommon to absent in all but East Pool; its numbers stayed relatively the same in this pool and the West Pool, but exhibited an overall decline at Lake Conway during the study. The mud turtle (*Kinosternon subrubrum*) was common in the lake and showed a dramatic decline (to 0) in all pools. Larvae of two frogs that were common at the onset of the study were either absent (*Hyla cinerea*) or greatly reduced (*Rana utricularia*) by the final study year. In addition, two large salamanders, which were quite common in Lake Conway and are very dependent upon vegetation for food and cover, exhibited declines during the study. Of the two, *Amphiuma means* had been the most common and exhibited dramatic losses in all pools, especially East and West Pools. Numbers of *Siren lacertina* were less than *A. means* although this species also decreased during the study. The green water snake species was quite common in the lake but demonstrated a sharp decline in all pools during the last study years.

117. For each permanent shoreline site on Lake Conway, Figure 33 summarizes quarterly changes in the relative abundance of herpetofaunal species as determined by the two major sampling methods: herp-patrol (mean number/hour) and funnel trapping (mean number/100 trap days). It should be noted that, prior to winter 1981, each data point represents the mean of six evenly spaced samples for each 3-month period, whereas after this date each point represents the mean of only two samples for each season.

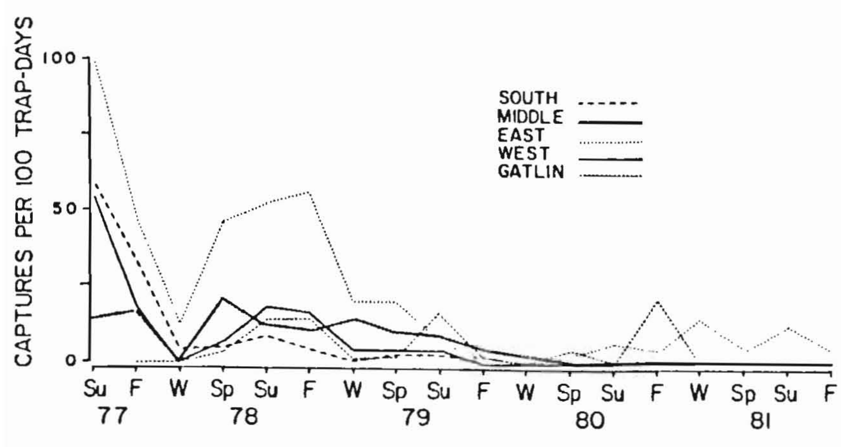
118. The number of male frogs identified during herp-patrols showed the



a. Male frogs



b. Salamanders and reptiles



c. Amphibians and reptiles

Figure 33. Relative density of male frogs heard calling on herp-patrols of the permanent shoreline sites, salamanders and reptiles observed on herp-patrols of permanent shoreline sites, and amphibians and reptiles captured in funnel traps on permanent sites

greatest change of any major group during the fourth study year (Figure 33a). The summer peak in calling activity, particularly of *Hyla cinerea* and *Acris gryllus*, which characterized the previous 3 years, was not recorded in 1981. In addition, no individuals of a previously common species (*Bufo terrestris*) were heard calling during the quarterly samples. However, this probably represents decreased frog calling activity during the quarterly sampling periods rather than true reduction in frog populations on Lake Conway. Both summer and fall 1981 sampling trips were characterized by dry weather, which generally inhibits frogs from calling.

119. Salamanders and frogs (Figure 33b), which included two species of aquatic salamanders and twelve species of reptiles, exhibited less seasonality and greater variability than frogs. The general trend was a gradual decrease in the relative abundance of these species on the permanent sites. This trend continued during the fourth study year. Species that showed significant reductions on at least some permanent sites included *Kinosternon subrubrum*, *Nerodia cyclopion*, *Pseudemys floridana*, and *Sternotherus odoratus*. No species consistently increased in relative density at these sites.

120. The relative density of amphibians and reptiles captured in funnel traps on permanent shoreline sites decreased significantly after the second year and this trend continued for the remainder of the study (Figure 33c). Significant reductions in the relative abundance of five common species (*Amphiuma means*, *Siren lacertina*, *Kinosternon subrubrum*, *Sternotherus odoratus*, and *Nerodia cyclopion*) were primarily responsible for this trend.

121. Although declines in aquatic turtle populations on Lake Conway were, to some extent, confounded by declining water levels and clearing for residential development, this group showed the clearest density response to vegetation removal by white amur. Of all major herpetofaunal groups, turtles probably are the most dependent on aquatic macrophyte productivity, and most susceptible to its removal. Two common herbivorous species (*Pseudemys floridana* and *P. nelsoni*) are direct competitors with amur for aquatic plants, and another, *Sternotherus odoratus*, feeds primarily on snails which depend on macrophytes as a substratum. Although the responses of these turtle species in particular were noticeable, the low stocking rate of amur on Lake Conway and the continued presence of macrophytes ameliorated the effects of fish on these species of turtles (Godley, Bancroft, and McDiarmid 1981).

122. The above results indicate that significant density changes

occurred in a number of herpetofaunal species at Lake Conway. The causes of these density fluctuations were numerous and complex, varying with both the species and the sampling site. Although most reductions in amphibians and reptile populations at Lake Conway can be correlated with decreases in aquatic plant biomass as the result of white amur feeding activity, these reductions are unfortunately confounded by other factors. Human disturbance, primarily through destruction of littoral zone habitats, had a significant negative effect on all the herpetofaunal species at Lake Conway. Reduced water levels during the final year of the study decreased the available littoral zone habitat, especially for frogs and salamanders. Reduced capture success of aquatic salamanders and snakes in funnel traps correlated with habitat destruction in South and Middle Pools and Gatlin Canal. In summary, although reptile and amphibian populations decreased during the study period at Lake Conway, these changes were not a direct result of introduction of the white amur.

PART V: SUMMARY AND CONCLUSIONS

Background

123. The overall effectiveness of the white amur as a macrophyte control agent and the impacts of vegetation removal were assessed during the 5-year study. The purpose of this work was to identify changes in the ecosystem through the poststocking period and to determine whether or not these were related to introduction of white amur. This monitoring consisted of a baseline study period prior to stocking (January 1976 to September 1977) and at least three poststocking years (October 1977 through September 1980). A list of the contractors and the reports detailing their particular work appears in Appendix A of this publication. A list of species collected during the study is in Appendix B, and photographs of the area and selected techniques used and organisms collected by the contractors are in Appendix C.

124. Lake Conway is a clear, moderately hard water system low in dissolved nutrients that exhibits moderate summer stratification with high dissolved oxygen levels in the surface waters and reduced levels close to the bottom. The fishery is dominated by bass, chain pickerel, brook silverside, crappie, and blue-spotted sunfish. At the onset of the study, the common aquatic plants in the lake were hydrilla, nitella, and potamogeton (succulent and readily eaten by the white amur) as well as vallisneria (tough and not readily eaten by white amur). The lake supports a diverse assemblage of zooplankton and phytoplankton; numbers range from less than 10,000 to over $100,000/m^3$. The benthic community is diverse and dominated mainly by chironomids. Waterfowl are common all year, although during the winter the lake is used by large numbers of wintering species; populations are dominated mainly by ducks, particularly the American coot. Early in the study reptiles and amphibian populations were extensive in shallow, vegetated areas in the lake. Dominant species of herpetofauna were the stinkpot turtle and two species of frogs, *Acris gryllus* and *Hyla cinerea*.

125. Lake Conway has considerable residential development around its shores. Many of the homes were built during the study period. This development resulted in the removal of shoreline vegetation that had provided habitat for aquatic mammals, reptiles, and amphibians. Water chemistry studies

indicated that this development did not appear to have any effect on nutrient content of the lake water.

126. From 1970 through 1980 the lake experienced a dramatic decrease in water levels caused by a period of reduced rainfall, particularly in 1977. Rainfall during that year was 38.1 in., considerably below the average of 50 in. and lowest recorded for the 40-year period of record. As water levels decreased, littoral habitat was lost and the pools became more and more isolated from one another. Normal evaporation at Lake Conway caused the concentration of certain ions in the water column and probably had a greater effect on overall chemistry than introduction of white amur.

System Components

Water chemistry

127. Dissolved calcium, total hardness, and total alkalinity decreased in certain pools, and sodium and potassium increased in the lake through time. However, these changes were the result of diminished rainfall and reduced water levels and not presence of the white amur.

Sediment chemistry

128. No changes in nutrients or trace elements in sediments were evident as a result of the introduction of white amur at Lake Conway.

Aquatic macrophytes

129. White amur stocked at the rate of three to five fish per surface acre substantially (more than 90 percent) reduced levels of three common aquatic plants, hydrilla, nitella, and potamogeton. The fourth common plant, vallisneria, which is not readily eaten by amur, was consumed to some extent but increased slightly in one of the pools by the end of the study.

Plankton

130. Phytoplankton. All pools had significantly fewer phytoplankton species during the second and third poststocking years than during the prestocking year. Lake Gatlin had significantly fewer species than all other pools during the prestocking period; however, this pool became very similar to the rest of the system during the first and second poststocking years. One of the most dramatic shifts in the phytoplankton community following white amur introduction was the elimination of the summer dominance of *Chlorophyta* and *Chrysophyta*. These were replaced by high levels (greater than 75 percent) of

Cyanophyta (blue-green algae) throughout the entire year. Phytoplankton diversity gradually decreased in all pools throughout the poststocking study; the greatest change occurred in South and Middle Pools.

131. With the exception of Lake Gatlin, total numbers of phytoplankton were significantly greater in all pools during the second and third poststocking periods than during either the prestocking or first poststocking periods.

132. Chlorophyll a. For the prestocking and first poststocking periods, chlorophyll a concentrations were not significantly different among South, Middle, East, and West Pools; however, Lake Gatlin exhibited significantly higher levels. During the second and third poststocking periods, chlorophyll a values were not significantly different among pools. The Carlson Trophic Index values for South, Middle, East, and West Pools exhibited maximum levels during the third poststocking period while highest values for Lake Gatlin occurred during the prestocking period.

133. Periphyton. With the exception of the fall samples, populations of attached algae (periphyton) were significantly lower after stocking white amur at Lake Conway. During the poststocking period, total periphyton species increased in each pool. With the exception of East Pool, mean annual diversity was greater for this group after the removal of the plants. Because aquatic plants provide a substrate for attached algae, removal of macrophytes substantially reduced periphyton. However, as total numbers decreased, diversity values increased as a larger number of niches became available.

134. Zooplankton. Although the total number of zooplankton species in each pool declined during the entire study period, the mean number of species per sample for South, Middle, and West Pools, and Lake Gatlin during the poststocking period was not significantly different from the prestocking period.

135. Mean annual zooplankton Shannon-Weaver diversity values for littoral stations at the Conway system were lower in the third poststocking period than in the prestocking period. Considering the system as a whole, annual means for the limnetic stations declined slightly during the poststocking study. While significant between-pool differences in zooplankton density were noted during each of the first 3 years of the study, no significant among-pool differences were noted during the third poststocking period.

Benthos

136. Number of species of benthic macroinvertebrates did not change significantly in any one pool during the poststocking study. Significant

differences between pools evident during the prestocking period largely disappeared during the second and third poststocking periods. In addition, very little change in species composition or species diversity was evident in the Conway system during the study period. However, significant reductions in density occurred during the poststocking period for the flatworm *Dugesia* and the snail *Goniobasis*. Both of these invertebrates are associated with surfaces of aquatic macrophytes, and numbers were probably reduced along with decline in numbers of plants. Mean annual macroinvertebrate density for the Conway system declined after introduction of the white amur. Macroinvertebrate biomass decreased progressively at shallow stations from winter of the first poststocking year through the second poststocking year, but deep stations remained relatively constant throughout the study. With the exception of changes in numbers of *Dugesia* and *Goniobasis*, the benthic community appeared to be unaffected by white amur.

Fish

137. Native fish. As plants were removed at Lake Conway, largemouth bass and other forage fish did not utilize shallow-water habitats but became concentrated in deepwater areas. Fish dependent upon vegetation, such as the blue-spotted sunfish, declined following plant removal, although total numbers of harvestable fish increased. Although data were somewhat variable, it appears that the robustness of large (>300 mm) largemouth bass increased slightly.

138. Sportfishery. The species-directed success rate improved as a result of macrophyte removal by the white amur at Lake Conway. During 1979, when plant removal was quite noticeable, the bass success rate was almost double, sunfish rate was 19 percent higher, and crappie success rate was higher than during the previous year.

139. White amur. White amur fed preferentially on nitella, hydrilla, and potamogeton. When these plant species became scarce, the fish ate filamentous algae, cattail, and various other nonpreferred food items. There was no evidence that they fed upon fish, aquatic insects, or other invertebrates.

Waterfowl

140. Waterfowl numbers declined during the poststocking period. Although potential food sources were removed by fish, changes in populations of birds reflected state-wide conditions.

Ducks

141. The ring-necked duck and the American coot fed on crustaceans, aquatic insects, and plants throughout the study. As the vegetation declined, large numbers of amphipods were found in the stomachs of ducks. Presumably, these invertebrates were more available to predators as plant cover was removed.

Aquatic mammals

142. The water rat and other mammals such as otters, raccoons, and opossum depend on aquatic plants in the littoral habitat at Lake Conway. Residential development, not the presence of the amur, affected these plants and reduced the numbers of mammals.

Herpetofauna

143. As a group, these animals were affected more by clearing of littoral vegetation for residences than removal of aquatic macrophytes by white amur. However, three species of turtles, two herbivorous (*Pseudemys floridana* and *P. nelsoni*) and a snail eater (*Sternotherus odoratus*), decreased in numbers and probably were affected to some extent by macrophyte removal.

Influencing Factors

Rainfall

144. In 1977 total rainfall was 38.1 in., considerably less than the average annual of 50 in. Decreased rainfall caused water levels to drop dramatically in the lake during the latter part of the study period.

Diminished water levels

145. Sodium and potassium, which originate from solution of sedimentary deposits, increased (because of concentration) as water levels declined. However, calcium, which was pumped into the uppermost pool of the system, declined in the lower pools during the study. This was the result of the lakes becoming more isolated from one another and calcium-rich waters not circulating throughout the system.

Residential development

146. Many new homes were built on the shores of Lake Conway during the study. While these effects were not quantified, the major impact of this action was loss of littoral habitat. Nutrient input to the lake did not appear to be dramatically increased (based on chemical studies) by residential development during the study.

Discussion of Major Findings

147. Because white amur stocking rates were designed to control excess aquatic macrophyte growth at Lake Conway, there were no apparent adverse effects to the other biota that could be attributed to introduction of white amur. Decreasing water levels and removal of shoreline habitat for residences caused greater habitat loss than introduction of the fish. The water and sediment chemistry exhibited no changes which could be attributable to macrophyte control by white amur. Changes in numbers of waterfowl paralleled state-wide trends; the decline in mammal observations was the result of shoreline clearing. Benthic organisms exhibited no particular change during the study period. Sportfishing was enhanced as a result of plant removal, with negligible effects to the native fish population. Although reptiles and amphibians exhibited significant declines during the study period, in general, their changes could not be related to introduction of the fish.

148. The most notable change that occurred following amur introduction and plant removal was an increase in phytoplankton abundance. The increase may be the result of elimination of competition by macrophytes and possibly release of low levels of nutrients from fecal pellets. However, as discussed by Hestand and Carter (1978), much of the phosphorus from amur fecal material may not be readily available for uptake by plankton. Regardless of the degree of nutrient release following stocking of amur in Lake Conway, the macrophytes were replaced by phytoplankton. The increase in zooplankton density during the first and second poststocking periods was in response to elevated numbers of phytoplankton. The abrupt decrease during the third poststocking year was the result of large numbers of phytoplankton cells which are not readily eaten by zooplankters.

149. Aquatic macrophytes are dependent on nutrients in the sediments (Wetzel 1975, Barko and Smart 1980) although they can also remove phosphorus from the water. Barko and Smart (1980) reported that *Egeria densa*, *Hydrilla verticillata*, and *Myriophyllum spicatum* are capable of deriving phosphorus exclusively from the sediments. They reported that, in phosphorus-limited systems, macrophytes can enhance phytoplankton productivity by returning phosphorus to the water column that might otherwise remain immobilized in the sediments. However, Lake Conway is not a phosphorus-limited system, and

macrophytes did not play a significant role in making nutrients available for phytoplankton growth.

150. At Lake Conway, it was determined that the objective would be to effect control over a relatively long period of time, rather than quickly irradicate the aquatic macrophytes within a few months. As a result, plants were reduced over a 2-year period until their numbers were barely detectable. This caused minimal impacts to the native biota in the system. Disruptions to the nutrient regimen, native fish, and sportfishery that have been documented at other studies when fish were stocked at many times the density used at Lake Conway were not noted during this project.

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Table 1

Stocking Rates, Weights of the White Amur, and Edible Vegetation Present in Lake Conway, Florida

	Pool					
	South	Middle	East	West	Gatlin	Overall
$\bar{x}$ weight, kg	0.25	0.25	0.25	0.61	0.61	0.61
No./acre	5.00	5.00	3.00	3.00	3.00	4.00
No. of fish/ vegetated acre	12	17	7	7	7	--
Weight/acre, kg	1.25	1.25	0.75	1.83	1.83	2.44
Total acres	352.4	741.0	317.2	356.9	65.7	1833.2
Vegetated acres	150	219	150	168	28	899
Total fish	1762	3705	952	1070	197	7686
Total weight, kg	440.5	926.2	237.9	217.7	120.2	1942.5
Edible vegetation, g/m^2	565.0	717.0	409.0	561.6	--	--
Total edible vegetation, kg, in each pool	200	531	130	200	--	--

Table 2

Morphometric Features of Lake Conway*

	Area km^2	Volume $m^3 \times 10^6$	Mean Depth m	Percent Below 3 m	Percent Below 6 m
South Pool	1.37	8.24	6.01	65.9	34.6
Middle Pool	2.99	17.90	5.98	78.4	36.9
East Pool	1.27	5.76	4.54	51.3	16.7
West Pool	1.48	8.46	5.72	75.3	33.1
Lake Gatlin	0.28	1.18	4.18	68.5	27.3
Total	7.39	41.54	5.29	--	--

* Based on data in Blancher (1979) and Nall and Schardt (1978).

Table 3

Features of the Lake Conway Drainage Basin*

	Total Watershed Area	Watershed Area (Less Lake)	Percent Residential	Percent Citrus or Undeveloped Areas
South Pool	3.12	1.75	77.3	22.6
Middle Pool	6.14	3.15	68.2	31.8
East Pool	15.8	14.49	44.3	50.0
West Pool	16.0	14.56	69.3	14.3
Lake Gatlin	4.86	4.57	74.8	11.1
Total	45.92	38.52	66.8	26

* Areas reported in square kilometres. Data from Blancher (1979).

Table 4

Comparison of Land Use for the Lake Conway Area, 1974 to 1978*

Land Use	1974 ha	Percent	1978 ha	Percent
Water surface	836.0	47.4	807.5	47.2
Streets, roads, plus utilities	145.0	8.2	145.0	8.4
Undeveloped land	87.0	4.9	56.0	3.3
Forest (with residences)	93.0	5.2	92.3	5.4
Citrus groves	178.0	10.1	126.0	7.4
Residential--single homes	360.0	20.4	411.0	24.0
Apartments	8.0	0.5	10.8	0.6
Mobile homes	1.3	0.07	1.9	0.1
Shoreline	33.0	1.9	32.0	1.9
Commercial and industrial	21.0	1.2	29.0	1.7
Total land	926.3		104.0	

* From Williams, Brown, and Buglewicz 1982.

Table 5

Summary of Major Physicochemical Variables Collected at Lake Gatlin and South Pool of Lake Conway, January 1976-September 1980

Variable	South Pool N	South Pool $\bar{X}$	South Pool SEM*	South Pool Min	South Pool Max	Lake Gatlin N	Lake Gatlin $\bar{X}$	Lake Gatlin SEM	Lake Gatlin Min	Lake Gatlin Max
Dissolved oxygen	352	8.0	0.07	0.2	11.4	126	7.7	0.15	1.1	9.9
Water temperature, °C	103	23.3	0.5	0.0	30.0	44	24.3	0.75	15.3	30.0
Secchi disk, m	165	3.3	0.08	1.5	5.8	72	2.0	0.08	0.7	3.4
Specific conductance, μmho	243	216.3	0.71	180.0	235.0	98	271.6	1.1	230.0	300.0
Turbidity, mg/ℓ S_1O_2	302	1.1	0.04	0.0	4.5	129	2.0	0.09	0.6	4.4
pH	348	--	--	6.5	9.0	144	--	--	6.4	8.9
Calcium	353	13.7	0.09	9.0	22.0	150	15.0	0.20	10.0	22.0
Magnesium	353	6.3	0.02	5.6	7.6	150	10.6	0.09	0.60	13.0
Sodium	353	16.3	0.06	14.0	20.0	150	17.1	0.08	15.0	20.0
Potassium	353	4.4	0.02	3.2	5.4	150	5.4	0.03	3.4	6.4
Nitrate	345	0.40	0.002	0.00	0.16	148	0.23	0.02	0.0	0.97
Total phosphorus	349	0.01	0.0004	0.00	0.10	152	0.01	0.0005	0.0	0.03
Chloride	353	26.6	0.10	22.0	31.0	150	27.7	0.13	24.0	34.0
Amonium	339	0.06	0.001	0.00	0.14	145	0.06	0.006	0.0	0.62
Organic nitrogen	341	0.49	0.0009	0.04	1.6	148	0.6	0.02	0.14	1.4
Total solids	353	136.7	0.86	61.0	229.0	150	170.0	2.2	70.0	330.0
Biological oxygen demand (BOD)	341	1.1	0.03	0.0	3.6	146	1.4	0.05	0.0	4.1
Chemical oxygen demand (COD)	309	17.9	0.89	2.0	223.0	146	18.8	0.9	0.0	90.0
Total hardness	347	60.2	0.29	34.0	81.0	152	82.0	0.4	59.0	95.0
Total alkalinity	352	31.5	0.12	22.0	38.0	152	40.9	0.2	34.0	46.0

Note: All values in mg/ℓ unless otherwise noted.

* SEM = standard error of the mean.

Table 6

Annual Nitrogen and Phosphorus Budgets (g/m^2/year) for Lake Conway for Water Year 1976*

Input		Nitrogen	Phosphorus
Wet and dry precipitation		0.93	0.125
Urban stormwater		0.84	0.069
Subsurface seepage		0.66	0.024
Septic tanks		0.10	0.006
	Total	2.53	0.224
Output			
Surface outfalls		0.22	0.006
Sedimentation		2.31	0.218
	Total	2.53	0.224

* Blancher (1979).

Table 7

A Comparison of Means (Using Duncan's Multiple Range Test) for Selected Physicochemical Variables Measured in Shallow-Water Stations (<2.5 m) at Lake Conway

	Total Phosphorus	NO_3	Specific Conductance	Turbidity	Dissolved Oxygen	Total Alkalinity	Total Hardness	pH	Sodium	Potassium	Chloride	COD	BOD	Organic Nitrogen	Total Solids
Pool															
South	0.012_A	0.04_B	215.9_D	1.07_C	8.3_A	31.6_E	60.4_D	7.49_C	16.1_B	4.4_C	26.6_B	16.9_A	1.1_{DC}	0.49_C	137.7_B
Middle	0.012_A	0.04_B	216.8_D	1.19_C	8.4_A	36.1_D	62.3_C	7.65_B	15.9_C	3.9_D	26.0_C	15.0_B	1.0_D	0.47_C	133.3_C
East	0.013_A	0.04_B	228.0_C	1.39_B	8.2_A	38.2_C	66.0_B	7.48_C	15.8_C	4.4_C	25.0_D	17.9_A	1.3_{AB}	0.52_B	137.8_B
West	0.012_A	0.05_B	232.9_B	1.34_B	8.2_A	39.3_B	66.9_B	7.54_C	16.0_C	4.5_B	25.2_D	17.1_A	1.2_{BC}	0.52_B	138.7_B
Lake Gatlin	0.013_A	0.24_A	271.5_A	2.05_A	8.3_A	40.7_A	81.9_A	7.75_A	17.1_A	5.4_A	27.8_A	18.9_A	1.4_A	0.61_A	168.8_A
Year															
1976	0.014_A	0.05_B	222.8_B	1.57_A	8.3_B	39.9_A	65.8_{AB}	7.58_B	15.0_D	3.9_D	24.2_D	16.5_C	1.3_B	0.51_B	136.5_C
1977	0.014_A	0.11_A	230.7_A	1.30_B	8.5_A	37.9_B	66.2_A	7.64_A	15.6_C	4.3_C	26.1_C	14.0_D	1.1_C	0.50_B	146.9_A
1978	0.012_B	0.05_B	230.5_A	0.76_D	8.3_B	36.7_C	65.1_B	7.57_B	16.9_{AB}	4.5_B	26.4_B	18.2_{AB}	0.9_D	0.49_B	140.1_B
1979	0.010_C	0.04_B	--	1.46_A	8.1_B	34.1_D	66.3_A	7.48_C	16.8_B	4.7_A	26.6_B	17.7_{BC}	1.5_A	0.56_A	136.5_{DC}
1980	0.011_{BC}	0.03_B	--	1.11_C	8.0_B	31.0_E	63.6_C	7.53_{BC}	17.0_A	4.7_A	27.4_A	20.3_A	1.2_{BC}	0.51_B	132.3_D

Note: Means with the same letter are not significantly different (alpha level = 0.05).

Table 8

A Comparison of Means (Using Duncan's Multiple Range Test) for Wet Weights of Selected Aquatic Plants by Pool and Year at Lake Conway 1976-1980

	Vallisneria americana	*Hydrilla verticillata*	*Nitella megacarpa*	*Potamogeton illinoensis*	*Najas guadalupensis*	Total Aquatic Plants
Pool						
South	34.0_{C}	152.4_{B}	350.5_{B}	58.0_{B}	0.85_{B}	530.6_{B}
Middle	3.3_{D}	0.5_{C}	656.2_{A}	39.2_{B}	0.75_{B}	709.6_{A}
East	84.1_{B}	18.2_{C}	320.1_{B}	119.6_{A}	4.03_{B}	543.9_{B}
West	61.9_{B}	202.9_{A}	143.6_{C}	40.1_{B}	3.53_{B}	393.4_{C}
Lake Gatlin	348.3_{A}	1.0_{C}	33.0_{C}	97.3_{A}	23.00_{A}	335.1_{C}
Year						
Oct 76-Sep 77	68.0_{A}	71.8_{B}	443.7_{A}	116.1_{A}	7.12_{AB}	661.8_{A}
Oct 77-Sep 78	44.5_{A}	212.0_{A}	444.3_{A}	102.8_{A}	10.67_{A}	682.8_{A}
Oct 78-Sep 79	64.8_{A}	44.2_{B}	359.4_{B}	35.5_{B}	1.25_{B}	427.4_{B}
Oct 79-Sep 80	46.2_{A}	0.0_{B}	192.2_{C}	7.3_{C}	1.57_{B}	231.6_{C}

Note: Means with the same letter are not significantly different (alpha level = 0.05).

Table 9

Total Number of Species, Total Density, and Density of Three Major Divisions of Phytoplankton Collected During the Baseline Year (September 1976-August 1977) at Lake Conway

	South	Middle	East	West	Gatlin
Number of species					
$\leq$3 m	156	143	157	150	106
>3 m	110	101	124	129	114
Total density, #/mℓ					
$\leq$3 m	2369	2528	4910	5516	36,232
>3 m	2100	2501	3729	6108	27,550
Chlorophyta, #/mℓ	780_A	817_A	935_{AB}	1211_B	$2,452_C$
Cyanophyta, #/mℓ	685_A	944_A	1673_A	2569_A	$26,952_B$
Chysophyta, #/mℓ	308_A	382_A	511_{AB}	721_B	$2,160_C$

Note: Means with the same letter are not significantly different (alpha level = 0.05).

Table 10

Total Number of Species, Total Density, and Density of Three Major Groups of Zooplankton Collected During the Baseline Year (September 1976-August 1977) at Lake Conway

	South	Middle	East	West	Gatlin
Number of species					
$\leq$3 m	54	47	54	47	34
>3 m	41	44	45	45	37
Total density, $\#/m^3$					
$\leq$3 m	53,740	46,439	39,218	40,738	60,492
>3 m	25,761	22,797	44,869	41,102	37,105
Copepoda, $\#/m^3$	$17,400_A$	$12,500_B$	$13,700_B$	$10,600_B$	$11,500_B$
Cladocera, $\#/m^3$	$9,200_A$	$13,800_A$	$11,800_A$	$15,200_A$	$39,300_B$
Rotifera, $\#/m^3$	$5,000_A$	$70,000_B$	$16,700_C$	$14,400_C$	$19,700_C$

Note: Means with the same letter are not significantly different (alpha level = 0.05).

Table 11

Total Number of Species, Total Density, and Density of Three Major Groups of Benthic Invertebrates Collected During the Baseline Year (September 1976-August 1977) at Lake Conway

	South	Middle	East	West	Gatlin
Number of species					
$\leq$3 m	22	19	22	17	11
>3 m	6	22	6	11	9
Total density, #/m^2					
$\leq$3 m	8270	12,787	14,055	18,404	9316
>3 m	9006	8,759	1,845	1,333	3869
Chironomidae, #/m^2					
$\leq$3 m	2729	5,409	1,658	1,896	1435
>3 m	3167	5,959	4,090	4,288	1191
Gastropoda, #/m^2					
$\leq$3 m	389	396	323	258	2161
Oligochaeta, #/m^2					
$\leq$3 m	2969	4,859	4,933	10,104	4462
>3 m	3386	736	155	485	217

Table 12

Average Number and Weights of Fish Caught with Various Sampling Techniques During the Baseline Year at Lake Conway

	Wegener Ring		Electrofishing (Vegetated Area)		10-ft Seine (Vegetated Area)		Gill Net		Block Net	
	No.	Wt, g	No.	Wt, g	No.	Wt, g	No.	Wt, g	No.	Wt, g
Florida gar	0.01	0.01	2.5	1,059	0.01	7	7.5	6.4	0.8	0.32
Chain pickerel	0.01	0.01	10.8	3,646	0.18	0.93	1.8	1.1	254	8.9
Coastal shiner	1.37	0.54	1.2	1.0	3.17	1.41	--	--	0.8	0.01
Brown bullhead	0.03	0.01	0.67	284	--	--	0.2	0.2	561	2.2
Golden topminnow	0.35	0.35	0.05	0.22	0.07	0.12	--	--	--	--
Seminole killifish	1.78	3.32	2.4	16.5	2.17	6.67	--	--	8.3	0.04
Flagfish	0.05	0.03	--	--	--	--	--	--	--	--
Bluefin killifish	5.18	1.23	0.53	0.24	3.33	1.13	--	--	322	0.15
Mosquito fish	9.08	2.09	0.57	0.46	9.42	4.1	--	--	--	--
Least killifish	0.23	0.02	--	--	0.14	0.03	--	--	--	--
Brook silverside	0.01	0.01	10.6	12.4	0.01	0.01	--	--	15	0.02
Blue-spotted sunfish	0.33	0.30	0.72	1.12	0.36	0.30	--	--	48,117	26.9
Warmouth	0.24	1.16	16	235	0.11	0.44	0.1	0.005	481.7	3.3
Bluegill	0.31	1.11	62	1,631	3.6	7.8	0.08	0.084	1,558	15.2
Dollar sunfish	0.01	0.01	1.8	5.8	--	--	--	--	259	0.5
Redear sunfish	0.53	0.48	30.3	1,986	0.2	0.5	0.2	0.036	1,545	13.1
Spotted sunfish	0.01	0.01	1.3	43	0.01	0.02	--	--	--	--
Largemouth bass	0.25	0.36	13.3	4,856	1.11	2.18	7.4	3.8	7,527	17.8
Swamp darter	1.09	0.49	0.05	0.10	0.14	0.09	--	--	8.3	0.01
Bowfin	--	--	0.67	1,680	--	--	--	--	--	--
Gizzard shad	--	--	0.19	115	--	--	7.6	4.6	4.2	2.15
Threadfin shad	--	--	1.72	9.77	--	--	--	--	92	0.43
Golden shiner	--	--	2.68	153	0.02	0.07	1.1	0.3	5.0	0.39
Lake chubsucker	--	--	2.4	1,355	--	--	0.4	0.2	--	--
Yellow bullhead	--	--	0.43	60	--	--	0.4	0.1	0.8	0.01
Black crappie	--	--	1.0	262	0.33	1.36	3.9	9.0	26.7	0.22
Total	20.9	11.5	163.9	17,413	24.4	34.2	30.7	25.8	60,787.6	92

Table 13

A Comparison of Means (Using Duncan's Multiple Range Test) for Average Number of Selected Fish Species Using Different Sampling Techniques at Lake Conway, 1976-1981

	Sunfish 10- and 20-ft Seine	Forage Fish 10- and 20-ft Seine	Sunfish Wegener Ring	Forage Fish Wegener Ring	Sunfish Gill Net	Sunfish Electro-fishing	Forage Fish Electro-fishing	Sunfish Block Net	Forage Fish Block Net
Pool									
South	3.3_{B}	16.5_{BC}	1.4_{A}	4.7_{BC}	3.5_{A}	6.3_{B}	21.6_{B}	196.4_{AB}	93.4_{AB}
Middle	2.8_{B}	16.6_{BC}	2.6_{A}	4.9_{BC}	1.9_{B}	7.6_{B}	31.1_{B}	142.7_{B}	54.2_{AB}
East	5.1_{B}	13.1_{C}	1.3_{A}	4.0_{C}	--	13.8_{A}	18.1_{B}	--	--
West	4.2_{B}	30.0_{AB}	1.6_{A}	6.5_{BA}	3.3_{A}	3.1_{C}	15.2_{B}	369.3_{A}	164.4_{A}
Lake Gatlin	11.8_{A}	30.6_{A}	2.0_{A}	6.9_{A}	1.6_{B}	4.1_{C}	62.6_{A}	31.3_{B}	30.3_{B}
Year									
1976	6.5_{A}	28.5_{A}	1.8_{B}	6.1_{A}	--	20.9_{A}	10.2_{C}	231.0_{AB}	200.3_{A}
1977	1.4_{A}	19.4_{B}	1.9_{B}	4.9_{A}	--	14.5_{B}	20.9_{C}	413.7_{A}	52.0_{AB}
1978	6.7_{A}	12.3_{B}	1.3_{B}	4.7_{A}	1.0_{B}	3.6_{C}	24.3_{BC}	413.8_{A}	191.1_{A}
1979	--	--	3.3_{A}	5.3_{A}	3.7_{A}	2.9_{C}	39.5_{AB}	35.6_{B}	29.7_{B}
1980	--	--	1.9_{B}	4.9_{A}	3.9_{A}	4.9_{C}	60.0_{A}	34.6_{B}	30.0_{B}
1981	--	--	--	--	--	--	--	26.4_{B}	15.0_{B}

Note: Means with the same letter are not significantly different (alpha level = 0.05).

Table 14

Mean Values and Standard Deviation for Selected Chemical Constituents in Sediments at Lake Conway, 1976-1980

Parameter	Baseline Year 1976-1977		Poststocking Year I 1977-1978		Poststocking Year II 1978-1979		Poststocking Year III 1979-1980	
	Mean Value	Standard Deviation	Mean Value	Standard Deviation	Mean Value	Standard Deviation	Mean Value	Standard Deviation
Total nitrogen, mg/g	2.66	2.69	3.3	3.4	2.6	3.3	3.2	5.1
Total phosphorus, mg/g	0.44	0.37	0.37	0.21	0.31	0.22	0.21	0.12
Copper, μg/g	13.49	22.60	36.0	48.0	30.0	86.0	48.0	75.0
Lead, μg/g	9.08	13.65	28.0	40.0	14.0	11.0	21.0	34.0
Chemical oxygen demand, mg/g	88.3	99.5	95.0	108.0	82.0	136.0	99.0	149.0
Iron, μg/g	727.0	670.0	817.0	773.0	375.0	562.0	553.0	745.0
Manganese, μg/g	--	--	23.0	23.0	11.0	14.0	16.0	17.0

Table 15

Mean Annual Abundances (#/mℓ) for the Three Principal Algal Divisions for the Prestocking and Poststocking Years at Lake Conway*

	Prestocking	Poststocking I	Poststocking II	Poststocking III
		Chlorophyta		
South Pool	780^{24}_{WG}	436^{134}_{MG}	738^{24}_{WG}	$1,221^{123}_{G}$
Middle Pool	817^{4}_{WG}	716^{4}_{SG}	947^{4}_{G}	$1,664^{123}$
East Pool	935^{24}_{G}	566^{134}_{G}	$1,029^{124}_{G}$	$1,527^{123}$
West Pool	$1,211^{24}_{SMG}$	617^{134}_{G}	$1,301^{2}_{SG}$	$1,690^{12}$
Lake Gatlin	$2,452^{2}_{SMEW}$	1046^{134}_{SMEW}	$1,869^{2}_{SMEW}$	$2,159^{2}_{S}$
		Cyanophyta		
South Pool	685^{34}_{G}	2084^{34}_{G}	$5,830^{124}_{WG}$	$16,367^{123}_{G}$
Middle Pool	944^{234}_{G}	3430^{134}_{G}	$6,690^{12}_{G}$	$8,719^{12}_{G}$
East Pool	$1,673^{234}_{G}$	3492^{134}_{G}	$6,993^{124}_{G}$	$9,598^{123}_{G}$
West Pool	$2,569^{34}_{G}$	4064^{34}_{G}	$8,736^{12}_{SG}$	$10,410^{12}_{G}$
Lake Gatlin	$26,952^{24}_{SMEW}$	9436^{14}_{SMEW}	$14,680^{4}_{SMEW}$	$50,065^{123}_{SMEW}$
		Chrysophyta		
South Pool	308^{234}_{WG}	89^{1}_{EWG}	150^{1}_{G}	166^{1}_{G}
Middle Pool	382^{234}_{WG}	144^{1}_{WG}	143^{1}_{G}	132^{1}_{G}
East Pool	511^{234}_{G}	181^{1}_{SWG}	98^{1}_{G}	156^{1}_{G}
West Pool	721^{234}_{SMG}	283^{13}_{SMEG}	118^{12}_{G}	174^{1}_{G}
Lake Gatlin	$2,160^{234}_{SMEW}$	516^{1}_{SMEW}	452^{1}_{SMEW}	688^{1}_{SMEW}

* Value(s) to the upper right of mean indicate year(s) from which the annual mean was significantly different (1 = prestocking, 2 = poststocking I, etc.). Letters to the lower right of mean indicate pool(s) from which the mean was significantly different. Means were compared with Duncan's multiple range test ($P < 0.05$).

Table 16

Mean Seasonal Number, Mean Annual Abundance, and Median Seasonal Diversity for Periphyton During the Prestocking (1976-1977) and Poststocking Periods at Lake Conway

	Prestocking			Poststocking		
	Species	Individuals	Diversity	Species	Individuals	Diversity
Winter	19	1293	2.24	25	783	2.98
Spring	20	2382	2.78	28	1734	3.34
Summer	32	1974	2.88	29	1010	3.72
Fall	23	1650	2.48	31	1297	3.38
South	22	2538	2.48	26	532	3.16
Middle	24	1169	3.16	27	1670	3.22
East	27	1741	3.35	28	797	3.27
West	22	1680	3.20	32	1104	3.34
Lake Gatlin	22	2102	2.54	27	1954	3.35

Table 17

Mean Annual Chlorophyll *a* Concentrations and Carlson Trophic State Indices (TSI_{CHL}) for Prestocking and Poststocking Periods for Lake Conway

	Prestocking		Poststocking I		Poststocking II		Poststocking III	
	Chl. *a*	TSI_{CHL}	Chl. *a*	TSI_{CHL}	Chl. *a*	TSI_{CHL}	Chl. *a*	TSI_{CHL}
South	2.74	40	1.95	37	3.02	41	3.82	43
Middle	3.50	43	2.36	37	2.64	40	5.41	47
East	4.00	44	2.19	37	4.16	45	4.27	45
West	4.47	45	2.31	37	4.74	46	4.75	46
Lake Gatlin	10.52	54	8.03	51	6.74	49	7.35	50

Table 18

Mean Annual Abundances ($\#/m^3 \times 10^3$) for the Principal Zooplankton Groups for the Prestocking and Poststocking Years at Lake Conway*

	Prestocking	Poststocking I	Poststocking II	Poststocking III
		Copepoda		
South Pool	17.4^{3}_{MWG}	25.2^{3}	38.3^{12}	27.9
Middle Pool	12.5^{23}	26.6^{1}	27.0^{1}_{E}	23.2
East Pool	13.7^{23}	31.0^{13}	49.2^{124}_{M}	29.5^{3}
West Pool	10.6^{23}	22.9^{13}	43.1^{124}	20.4^{3}
Lake Gatlin	11.5^{23}	35.6^{1}	43.0^{1}	27.4
		Cladocera		
South Pool	9.2^{23}_{G}	22.5^{134}_{MG}	37.0^{124}_{M}	8.6^{23}
Middle Pool	13.8_{G}	11.0_{SEWG}	16.7_{S}	5.1_{E}
East Pool	11.8^{23}_{G}	19.0^{1}_{MG}	23.2^{14}	12.0^{3}_{M}
West Pool	15.2^{3}_{G}	15.3^{3}_{MG}	24.6^{124}	9.0^{3}
Lake Gatlin	39.3_{SMEW}	36.6_{SMEW}	23.3	8.7
		Rotifera		
South Pool	5.0^{3}_{EG}	28.6	51.3^{1}_{E}	38.1
Middle Pool	70.0^{234}	14.8^{13}_{E}	24.5^{12}_{EW}	22.0^{1}
East Pool	16.7^{23}_{G}	51.7^{13}_{M}	97.3^{124}_{SM}	48.4^{3}
West Pool	14.4^{3}	42.1^{3}	73.3^{124}_{M}	21.8^{3}
Lake Gatlin	19.7_{SE}	37.8	58.5	35.3

* Value(s) to the upper right of mean indicate year(s) from which the annual mean was significantly different (1 = prestocking, 2 = poststocking I, etc.). Letter(s) to the lower right of mean indicate pool(s) for which the mean was significantly different. Means were compared with Duncan's multiple range test ($P < 0.05$).

Table 19

Mean Annual Abundances of Macroinvertebrates (#/m^2) for the Prestocking and Poststocking Period at Lake Conway*

	Prestocking	Poststocking I	Poststocking II	Poststocking III
South Pool	11.3_{WG}	11.8_{WG}	9.7	10.1
Middle Pool	12.1_{WG}	12.1_{WG}	10.4	6.2_{W}
East Pool	11.3_{WG}	10.4	10.7	10.7
West Pool	8.4_{WME}	8.9_{SM}	10.0	12.3_{M}
Lake Gatlin	7.4_{SME}	8.8_{SM}	8.9	11.3

* Letters to the lower right of mean indicate pool(s) from which the mean was significantly different. Means were compared with Duncan's multiple range test ($P < 0.05$).

Table 20

Mean Annual Abundances (#/m^2) for Specific Groups of Macroinvertebrates During the Prestocking and Poststocking Period at Lake Conway*

	Prestocking	Poststocking I	Poststocking II	Poststocking III
Chironomus	225	259	176	144
Cladotanytarsus	360^{2}	1140^{134}	458^{2}	199^{2}
Endochironomus	140^{4}	82	116	30^{1}
Glyptotendipes	462^{34}	320	184^{1}	218^{1}
Nimbocera	99^{34}	51	32^{1}	0^{1}
Parachironomus	68^{2}	104^{14}	75	51^{2}
Polypedilum	435^{23}	660^{134}	381^{2}	171^{12}
Procladius	87	109	127	93
Tanytarsus	43^{234}	107^{1}	104^{1}	131^{1}
Dugesia	453^{234}	155^{1}	218^{1}	162^{1}
Goniobasis	146^{234}	16^{1}	3^{1}	9^{1}
Hyalella	594^{4}	572^{4}	914	1063^{12}
Psychomyidae	23^{3}	34^{3}	85^{14}	44^{3}
Chaoborus	336	300	256^{4}	432^{3}

* Value(s) to the upper right of mean indicates year(s) from which the annual mean was significantly different (1 = prestocking, 2 = poststocking I, etc.). Means were compared with Duncan's multiple range test ($P < 0.05$).

Table 21

Average Yields of Sport, Forage, and Other Fish per Hectare from Lake Conway as Determined with Block Net Samples

	Sport Fish*		Forage Fish**		Other Fish†	
	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg
Spring 1976	6,321.3 (23.2)	95.60 (83.7)	20,787.0 (76.5)	13.33 (11.70)	71.8 (0.3)	5.20 (4.5)
Fall 1976	3,967.4 (17.6)	98.93 (86.8)	18,474.2 (82.2)	13.42 (11.77)	42.6 (0.2)	1.62 (1.4)
Spring 1977	11,392.6 (18.7)	58.48 (63.8)	48,831.7 (80.3)	30.64 (33.42)	562.4 (0.9)	2.52 (2.8)
Oct 1977	3,359.60 (16.7)	63.60 (63.4)	16,765.90 (82.2)	36.20 (36.0)	19.20 (0.1)	0.48 (0.5)
May 1978	12,135.90 (21.9)	89.80 (75.6)	43,062.60 (77.8)	27.40 (23.1)	133.30 (0.2)	1.50 (1.2)
Oct 1978	11,977.9 (34.7)	88.76 (70.6)	22,452.3 (65.1)	20.24 (16.1)	56.0 (0.2)	16.40 (13.0)
May 1979	6,221.1 (15.2)	76.89 (67.8)	34,396.4 (84.3)	35.07 (30.9)	181.1 (0.4)	1.40 (1.2)
Oct 1979	3,832.6 (43.8)	98.0 (62.8)	4,896.4 (56.0)	21.9 (14.0)	20.6 (0.24)	36.2 (23.2)
May 1980	4,898.0 (36.3)	113.5 (76.1)	3,582.0 (63.6)	18.1 (12.2)	18.9 (0.14)	17.5 (11.7)
Mean 1979-80	4,365.3 (39.2)	105.8 (69.3)	6,739.4 (60.6)	20.0 (13.1)	19.8 (0.2)	26.8 (17.6)
Mean 1978-79	9,099.5 (24.2)	82.88 (69.4)	28,424.4 (75.5)	27.66 (23.2)	118.6 (0.3)	8.9 (7.4)
Mean 1977-78	7,747.8 (19.3)	76.70 (69.5)	29,914.2 (80.5)	31.80 (29.6)	76.2 (0.2)	0.99 (0.8)
Mean 1976-77	7,545.0 (18.1)	77.20 (75.1)	33,772.6 (81.1)	23.52 (22.9)	302.8 (0.7)	2.08 (2.0)

Note: Data in parentheses are percentages.

* Largemouth bass, black crappie, bluegill, redear sunfish, warmouth, and chain pickerel.

** Gizzard shad, threadfish shad, golden shiner, coastal shiner, tadpole madtom, Seminole killifish, flagfish, bluefin killifish, lease killifish, brook silverside, blue-spotted sunfish, dollar fish, and swamp darter.

† Florida gar, lake chubsucker, brown bullhead, and yellow bullhead.

Table 22

Average Yields for Selected Species of Harvestable Sport Fish per Hectare from Block Net Collections at Lake Conway

Species	Spring 1976		Fall 1976		Spring 1977		October 1977		May 1978	
	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg
Chain pickerel (≥30.0 cm)	63.6	22.27	17.3	7.36	17.5	6.34	6.6	2.5	29.6	11.3
Warmouth (≥12.5 cm)	9.2	0.79	5.0	0.36	5.8	3.14	16.5	0.74	18.9	1.5
Bluegill (≥15.0 cm)	91.4	8.00	38.4	3.18	38.3	3.09	59.3	6.0	54.3	4.0
Redear sunfish (≥150.0 cm)	119.2	14.88	98.2	17.53	40.8	4.24	47.7	7.8	99.6	15.9
Black crappie (≥22.5 cm)	--	--	--	--	0.8	0.12	--	--	--	--
Largemouth bass (≥22.5 cm)	23.5	14.60	43.6	25.04	30.8	13.21	38.7	23.6	31.3	16.2
Total	306.9	60.54	202.5	53.47	134.0	30.14	168.8	40.6	233.7	48.9

Species	October 1978		May 1979		Mean 1978-79		Mean 1977-78		Mean 1976-77	
	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg	No.	Wt, kg
Chain pickerel (≥30.0 cm)	19.76	8.49	37.05	12.07	28.40	10.28	18.10	6.90	16.90	6.70
Warmouth (≥12.5 cm)	11.54	0.78	15.64	0.92	13.59	0.85	17.70	1.10	2.60	0.35
Bluegill (≥15.0 cm)	48.58	2.81	78.22	5.59	63.40	4.20	56.80	5.00	37.40	3.10
Redear sunfish (≥150.0 cm)	38.70	9.94	50.22	6.40	44.46	8.17	73.70	11.90	67.10	10.40
Black crappie (≥22.5 cm)	0.82	0.21	0.82	0.16	0.82	0.18	--	--	0.40	0.50
Largemouth bass (≥22.5 cm)	36.23	16.01	34.58	17.31	35.40	16.66	35.00	19.90	33.30	17.70
Total	155.63	38.24	216.53	42.45	186.07	40.34	201.30	44.80	157.70	38.75

Table 23

Length-Weight Relationships for Largemouth Bass, Bluegill, and Chain Pickerel Collected at Lake Conway, 1976-1978

	Largemouth Bass
Jun-Aug 1976	log W = -5.2028 + 3.1159 log TL (r = +0.99)
Sep-Nov 1976	log W = -4.7752 + 2.9403 log TL (r = +0.95)
Dec 1976-Feb 1977	log W = -5.5226 + 3.2528 log TL (r = +0.99)
Mar-May 1977	log W = -5.1037 + 3.0697 log TL (r = +0.97)
Jun-Aug 1977	log W = -5.1374 + 3.0831 log TL (r = +0.86)
Sep-Nov 1977	log W = -5.34 + 3.15 log TL
Dec 1977-Feb 1978	log W = -5.83 + 3.38 log TL
Mar-May 1978	log W = -5.50 + 3.24 log TL
Jun-Aug 1978	log W = -4.89 + 2.96 log TL
	Bluegill
Jun-Aug 1976	log W = -5.3052 + 3.2330 log TL (r = +0.99)
Sep-Nov 1976	log W = -5.0265 + 3.1114 log TL (r = +0.99)
Dec 1976-Feb 1977	log W = -4.6882 + 2.9379 log TL (r = +0.87)
Mar-May 1977	log W = -5.1718 + 2.9504 log TL (r = +0.99)
Jun-Aug 1977	log W = -5.3615 + 2.2591 log TL (r = +0.99)
Sep-Nov 1977	log W = -5.19 + 3.17 log TL
Dec 1977-Feb 1978	log W = -5.22 + 3.18 log TL
Mar-May 1978	log W = -5.08 + 3.17 log TL
Jun-Aug 1978	log W = -5.73 + 3.42 log TL
	Chain Pickerel
Jun-Aug 1976	log W = -5.4055 + 3.0422 log TL (r = +0.99)
Sep-Nov 1976	log W = -4.8824 + 2.8342 log TL (r = +0.94)
Dec 1976-Feb 1977	log W = -4.8602 + 2.8229 log TL (r = +0.94)
Mar-May 1977	log W = -5.0996 + 2.9177 log TL (r = +0.82)
Jun-Aug 1977	log W = -4.86864 + 2.8365 log TL (r = +0.98)
Sep-Nov 1977	log W = -5.12 + 2.93 log TL
Dec 1977-Feb 1978	log W = -3.09 + 2.12 log TL
Mar-May 1978	log W = -5.03 + 2.95 log TL
Jun-Aug 1978	log W = -5.42 + 3.05 log TL

Table 24

Percentage Occurrence of Food Items of Bluegill Collected from Lake Conway (June 1976-August 1980) Expressed as Percentage per 100 Fish

	Jun-Aug 1976	Sep-Nov 1976	Dec 76-Feb 77	Mar-May 1977	Jun-Aug 1977	Sep-Nov 1977	Dec 77-Feb 78	Mar-May 1978	Jun-Aug 1978	Dec 78-Feb 79
Vegetative material	0.70	0.62	0.13	4.55	2.77	0.03	0.42	0.14	0.41	0.26
Bryozoa	--	0.02	0.02	--	0.26	--	--	--	--	--
Protozoa	--	1.25	--	--	16.89	--	--	--	--	--
Worms	0.06	0.07	--	--	0.13	--	--	--	--	--
Total Crustaceae	17.62	40.74	25.24	15.29	1.58	24.29	29.13	90.25	29.03	19.78
Amphibia	--	--	--	--	--	0.13	--	--	--	--
Total insects	79.01	30.37	15.56	63.31	60.03	72.89	51.03	8.55	61.24	56.44
Eggs	1.64	24.13	57.60	8.42	15.96	--	0.57	--	2.53	1.27
Arachnids	0.70	0.33	0.09	2.50	0.92	2.13	2.43	0.74	5.97	15.79
Mollusca	0.18	1.98	1.27	5.62	0.26	0.54	16.48	0.32	0.82	5.08
Fish remains	--	0.04	0.03	--	0.13	--	--	--	--	--
Unidentified material	--	0.13	0.03	0.31	0.79	--	--	--	--	--
Bread	--	--	--	--	0.13	--	--	--	--	--
Feathers	--	0.31	0.01	--	--	--	--	--	--	--
Amphipoda	2.9	1.8	1.2	8.7	0.3	13.4	14.0	0.2	16.6	11.1
Cladocera	11.8	31.1	23.4	0.3	0.5	8.5	11.9	49.3	2.0	23.1
Chironomidae	73.1	26.9	14.1	33.4	37.1	69.5	38.3	3.6	51.2	46.1

	Mar-May 1979	Jun-Aug 1979	Sep-Nov 1979 <150 mm	Sep-Nov 1979 >150 mm	Dec 79-Feb 80 <150 mm	Dec 79-Feb 80 >150 mm	Mar-May 1980 <150 mm	Mar-May 1980 >150 mm	Jun-Aug 1980 <150 mm	Jun-Aug 1980 >150 mm
Vegetative material	--	--	--	--	0.58	--	0.33	4.67	0.27	0.22
Bryozoa	--	--	--	--	--	--	--	--	--	--
Protozoa	--	--	--	--	--	--	--	--	--	--
Worms	--	--	--	--	--	--	--	--	--	--
Total Crustaceae	45.92	9.81	67.02	72.98	41.78	11.87	27.7	23.72	72.95	38.66
Amphibia	--	--	--	--	--	--	--	--	--	--
Total insects	50.61	84.61	27.98	32.8	48.35	32.44	65.52	66.15	23.55	47.40
Eggs	--	0.64	--	--	--	48.43	--	--	0.64	--
Arachnids	0.28	2.98	1.19	--	2.90	0.97	4.48	0.47	1.84	0.90
Mollusca	2.63	1.92	3.69	1.98	6.38	5.57	1.83	5.12	1.33	12.81
Fish remains	--	--	0.12	0.28	--	0.73	0.17	--	--	--
Unidentified material	--	--	--	--	--	--	--	--	--	--
Bread	--	--	--	--	--	--	--	--	--	--
Feathers	--	--	--	--	--	--	--	--	--	--
Amphipoda	42.7	8.1	2.7	1.1	0.6	9.9	2.5	4.6	32.4	7.4
Cladocera	0.9	0.2	46.5	--	3.9	0.7	18.9	1.5	--	--
Chironomidae	45.0	77.6	21.7	5.6	42.8	28.8	40.1	60.5	15.6	42.5

Table 25

Prey Organisms (Weight in Grams per 100 Fish) for Largemouth Bass Collected in Lake Conway (June 1976-August 1980)

	Jun-Aug 1976	Sep-Nov 1976	Dec 76-Feb 77	Mar-May 1977	Jun-Aug 1977	Sep-Nov 1977	Dec 77-Feb 78	Mar-May 1978	Jun-Aug 1978
Total fish	12.75	86.44	92.36	37.31	29.99	89.4	57.55	69.91	73.42
Total Gastropoda	--	--	--	--	--	5.00	--	--	--
Total Crustaceae	64.7	1.82	5.2	18.5	13.40	0.7	3.94	24.28	26.32
Fish remains	22.52	11.74	4.99	44.19	56.62	--	--	--	--
Total insects	0.02	--	--	--	--	--	--	5.81	0.26
Total Amphibia	--	--	--	--	--	9.88	38.51	--	--
Procambarus	64.7	1.8	5.2	11.9	13.3	0.7	3.7	22.4	26.3
Bluegill	--	3.3	--	--	--	21.5	--	26.6	26.3
Redear	--	64.7	--	--	--	48.0	--	--	--
Lepomis sp.	--	76.3	9.04	24.3	--	75.7	16.2	30.1	34.0

	Sep-Nov 1978	Dec 78-Feb 79	Mar-May 1979	Jun-Aug 1979	Sep-Nov 1979	Dec 79-Feb 80	Mar-May 1980	Jun-Aug 1980
Total fish	87.1	93.2	92.3	67.7	32.52	16.29	71.69	67.41
Total Gastropoda	--	--	--	0.2	0.10	--	--	0.27
Total Crustaceae	17.8	12.4	6.8	30.9	5.99	51.33	4.65	0.07
Fish remains	--	--	--	--	61.29	32.38	13.20	32.25
Total insects	3.6	0.1			0.1	--	10.46	--
Total Amphibia	--	--	--	--	--	--	--	--
Procambarus	12.2	4.4	5.6	29.6	3.2	51.3	0.6	0.1
Bluegill	--	5.7	47.3	--	--	--	3.4	38.3
Redear	38.9	--	--	--	--	--	--	--
Lepomis sp.	26.9	52.4	60.3	16.4	23.9	15.1	8.6	44.1

Table 26

Food Habits of White Amur, Lake Conway (October 1977-August 1980)

	Hydrilla	Nitella	Potomogeton	Vallisneria	Filamentous Algae	Unidentified Vegetation	Sagittaria	Aquatic Invertebrates	Detritus	Cattail	Fanwort	Pickerel Weed	Movgeotia	Number of Empty Fish
Oct 77	40.0	--	57.5	--	2.5	--	--	--	--	--	--	--	--	--
Nov 77	--	1.6	98.3	--	--	--	--	--	--	--	--	--	--	--
Dec 77	28.4	69.7	1.9	--	--	--	--	--	--	--	--	--	--	--
Jan 78	69.0	7.7	11.2	6.7	5.3	--	--	--	--	--	--	--	--	--
Feb 78	4.6	tr	84.7	--	tr	10.4	--	--	--	--	--	--	--	--
Mar 78	0.5	--	99.5	--	--	--	--	--	--	--	--	--	--	--
Apr 78	40.0	--	60.0	--	--	--	--	--	--	--	--	--	--	--
May 78	8.4	47.9	43.4	--	tr	0.04	--	tr	--	--	--	--	--	1
Jul 78	--	--	100.0	--	--	--	--	--	--	--	--	--	--	--
Aug 78	--	65.1	26.7	--	--	8.0	--	--	--	--	--	--	--	--
Sep 78	tr	--	39.9	--	60.0	--	--	--	--	--	--	--	--	--
Oct 78	22.4	46.9	29.3	1.2	--	--	--	tr	--	--	--	--	--	--
Apr 79	--	0.7	--	--	99.3	--	--	--	--	--	--	--	--	--
May 79	8.0	30.9	6.0	--	49.3	--	--	tr	5.8	--	--	--	--	--
Jun 79	21.5	46.3	11.5	0.8	1.3	--	--	tr	18.3	--	--	--	--	--
Jul 79	6.7	93.3	--	--	--	--	--	--	--	--	--	--	--	--
Aug 79	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Sep 79	--	--	55.7	--	--	--	--	--	--	--	--	--	--	2
Oct 79	--	38.8	54.0	6.4	--	--	--	--	0.7	--	--	--	--	--
Feb 80	--	3.6	32.9	57.0	6.3	--	--	tr	--	--	--	--	--	--
Mar 80	--	--	--	--	99.7	0.3	--	tr	--	--	--	--	--	--
Apr 80	0.4	54.1	11.3	0.4	26.4	--	--	tr	--	--	--	--	7.1	1
Jun 80	--	--	--	--	100.0	--	44.3	--	--	--	--	--	--	1
Jul 80	0.9	3.3	--	--	74.6	--	--	--	--	21.1	--	--	--	1
Aug 80	0.6	8.7	16.0	3.7	3.7	--	--	tr	--	19.4	30.0	19.8	--	1

Note: Values are percentage of gut contents for all fish sampled.

Table 27

Quarterly Sportfishery Estimates from Roving Creel Survey Data, Lake Conway, 1976-1980

		Largemouth Bass	Sunfish	Black Crappie	Total Effort	Total Harvest
Summer 1976	S	0.19	5.58	0	18,841	8,075
	E	18,038	647	156		
	H	3,348	4727	0		
Fall 1976	S	0.24	1.65	0.68	12,529	4,457
	E	9,688	155	2686		
	H	2,375	257	1825		
Winter 1976-77	S	0.17	0.27	0.61	13,292	3,796
	E	10,140	212	2940		
	H	1,875	38	1883		
Spring 1977	S	0.35	0.81	0.40	14,318	5,194
	E	13,888	276	154		
	H	4,797	340	57		
Summer 1977	S	0.10	0.83	0	7,976	1,526
	E	6,709	1097	170		
	H	844	682	0		
Fall 1977	S	0.31	0.54	0.40	15,164	5,022
	E	13,095	442	1627		
	H	3,976	314	732		
Winter 1977-78	S	0.59	1.28	1.08	10,310	4,598
	E	7,712	364	2234		
	H	2,579	41	1978		
Spring 1978	S	0.49	1.54	1.24	13,916	8,132
	E	12,330	1167	419		
	H	6,039	1355	738		
Summer 1978	S	0.41	1.03		8,251	3,671
	E	7,341	910	0		
	H	3,172	499	0		
Fall 1978	S	0.69			11,979	8,685
	E	10,526	204	1249		
	H	7,400	327	968		
Winter 1978-79	S	0.62		1.45	14,831	11,831
	E	10,714	288	3829		
	H	6,026	1096	4709		
Spring 1979	S	0.49			12,123	7,074
	E	11,284	839	0		
	H	5,868	1160	46		
Summer 1979	S	0.56	7.67	1.56	4,310	2,812
	E	4,055	24	221		
	H	2,284	184	344		
Fall 1979	S	0.39	0.94	0.79	8,668	4,002
	E	7,536	982	150		
	H	2,963	921	118		
Winter 1979-80	S	0.55	0.82	3.32	11,461	8,028
	E	8,716	2660	85		
	H	4,917	2829	282		
Spring 1980	S	0.51	0	1.60	16,257	8,463
	E	15,956	112	189		
	H	8,160	0	303		
Summer 1980	S	0.26	0.04	0.53	16,016	4,780
	E	14,346	166	1504		
	H	3,982	6	798		

Note: S = species-directed success or the number of fish per hour while fishing for that species; E = effort in hours; H = harvest, or actual number of fish caught.

Table 28

Comparison of Means of Numbers of Selected and Total Waterfowl (Using Duncan's Multiple Range Test) for Lake Conway

	Wading Birds	Ducks	Gulls Terns	All Waterfowl
1976	1.2_{C}	9.9_{B}	20.5_{AB}	8.3_{B}
1977	1.4_{C}	9.0_{B}	7.2_{B}	6.2_{C}
1978	1.7_{B}	8.6_{B}	14.2_{AB}	6.0_{C}
1979	2.5_{A}	27.2_{A}	24.3_{A}	13.7_{A}
1980	1.9_{B}	10.8_{B}	30.8_{A}	8.9_{B}
South	1.2_{C}	8.5_{CB}	8.7_{B}	6.7_{B}
Middle	1.7_{AB}	6.9_{C}	13.4_{AB}	5.7_{B}
East	1.6_{B}	10.6_{B}	15.5_{AB}	7.1_{B}
West	1.8_{A}	15.6_{A}	26.9_{A}	10.3_{A}
Lake Gatlin	1.5_{BC}	5.8_{C}	6.4_{B}	4.6_{C}

Note: Means with the same letters are not significantly different (alpha level = 0.05).

Table 29

Food Habits of the Ring-Necked Duck, Lake Conway

(January 1978-March 1980)

	Jan 78	Feb 78	Jan 79	Jan 80	Mar 80
Grit	38.0	29.8	23.7	6.5	11.9
Insects	tr	tr	tr	0.2	tr
Mollusks	tr	tr	1.0	11.8	tr
Crustaceae	--	--	--	--	2.5
Seeds	0.6	0.4	tr	tr	tr
Vegetation	1.1	0.3	10.5	4.0	9.5
Hydrilla	--	tr	2.0	--	0.1
Illinois pondweed	1.6	0.5	13.0	4.5	2.5
Nitella	3.0	1.5	1.0	--	1.5
Total	44.3	32.5	51.2	27.0	28.0

Note: Numbers are total grams for all birds studied.

Table 30

Food Habits of the American Coot, Lake Conway

(December 1977-March 1980)

	Dec 77	Jan 78	Feb 78	Mar 78	Apr 78	Feb 79	Jan 80	Mar 80
Grit	74.2	83.4	56.9	31.2	30.8	46.5	18.7	22.0
Insects	tr	--	--	tr	--	tr	tr	--
Mollusks	tr	tr	--	--	--	--	tr	--
Seeds	tr	tr	--	tr	--	tr	tr	2.0
Vegetation	1.7	tr	tr	--	--	21.5	7.0	39.5
Hydrilla	1.1	17.4	32.0	0.8	7.5	--	--	--
Illinois pondweed	7.5	tr	--	3.3	0.5	3.0	22.8	2.0
Nitella	tr	1.0	--	8.5	tr	tr	tr	3.5
Total	84.5	101.8	88.9	43.8	38.8	71.0	48.5	69.0

Note: Numbers are total grams for all birds studied.

Table 31

Total Number of Individuals and Species of Reptiles and Amphibians Collected from Lake Conway (June 1977-September 1980)

Sampling Time	Post-stocking Year	South Pool Individuals	South Pool Species	Middle Pool Individuals	Middle Pool Species	East Pool Individuals	East Pool Species
Jun 77-Sep 78	I	1396	21	1212	19	1,352	17
Oct 78-Sep 79	II	1019	21	448	16	480	14
Oct 79-Sep 80	III	949	17	424	16	639	17
	Total	3364	23	2084	20	2,471	20

Sampling Time	Post-stocking Year	West Pool Individuals	West Pool Species	Lake Gatlin and Gatlin Canal Individuals	Lake Gatlin and Gatlin Canal Species	Total for Lake Conway Individuals	Total for Lake Conway Species
Jun 77-Sep 78	I	887	14	948	19	5,795	27
Oct 78-Sep 79	II	813	17	497	19	3,257	24
Oct 79-Sep 80	III	446	12	418	16	2,876	21
	Total	2146	17	1863	20	11,928	29

Table 32

Comparison of Distribution and Mean Relative Densities of Selected Amphibians and Reptiles in Lake Conway (June 1977-September 1980). Data Include Mean Number/Hour and Chi Square Values to Compare Differences Among Pools and Among Years (* = P < 0.05; ** = P < 0.01)

	Year	South Pool	Middle Pool	East Pool	West Pool	Gatlin Canal	Among Pools	Among Years
Sternotherus odoratus	I	6.21_{A}	8.69_{A}	5.63_{B}	2.44_{B}	6.61_{A}	18.63**	
	II	5.45_{A}	5.48_{A}	0.65_{B}	2.48_{BC}	1.89_{C}	28.42**	15.25**
	III	6.30_{A}	6.84_{A}	0.51_{B}	1.38_{B}	0.68_{B}	37.60**	
	Total	5.99_{A}	7.02_{A}	2.15_{B}	2.10_{B}	3.03	73.87**	
Hyla cinerea (larvae)	I	0.11_{A}	0.00_{A}	2.07	0.16_{A}	0.00_{A}	37.69**	
	II	0.00	0.00	0.00	0.00	0.00		22.6**
	III	0.00	0.00	0.00	0.00	0.00		
	Total	0.03_{A}	0.00_{A}	0.45	0.04_{A}	0.00_{A}	28.67**	
Rana utricularia (larvae)	I	0.11_{A}	1.18_{B}	0.92_{B}	0.00_{A}	0.00_{A}	17.39**	
	II	0.37_{A}	5.25_{B}	2.63_{B}	0.24_{A}	0.44_{A}	76.57**	60.9**
	III	0.00	0.00	0.00	0.00	0.23		
	Total	0.16_{A}	2.13	0.80_{B}	0.09_{A}	0.23_{AB}	90.53**	
Amphiuma means	I	2.26_{A}	2.83_{A}	30.41	9.45	1.67_{A}	371.1**	
	II	0.09	0.66_{A}	8.33	2.63_{B}	1.31_{AB}	112.4**	333.8**
	III	0.00_{A}	0.00_{A}	1.43_{B}	0.37_{A}	0.45_{AB}	27.23**	
	Total	0.68_{A}	1.10_{A}	9.25	3.68	1.14_{A}	361.99**	
Siren lacertina	I	0.00	2.83_{A}	6.91	1.63_{AB}	0.71_{B}	79.74**	
	II	0.28_{A}	0.66_{AB}	2.19_{B}	0.84_{AB}	0.66_{AB}	15.17**	68.9**
	III	0.00	0.21	0.18	0.00	0.23		
	Total	0.09	1.18_{AB}	2.09_{A}	0.75_{B}	0.53_{B}	65.78**	
Kinosternon subrubrum	I	2.59	0.47_{A}	0.00_{A}	0.00_{A}	0.24_{A}	39.44**	
	II	0.09	0.00	0.00	0.00	0.22		62.1**
	III	0.00	0.00	0.00	0.00	0.00		
	Total	0.78	0.15_{A}	0.00_{A}	0.00_{A}	0.15_{A}	39.77**	
Chelydra serpentina	I	0.00	0.00	0.23	0.00	0.00		
	II	0.00_{A}	0.00_{A}	0.44_{A}	0.12_{A}	1.09	18.54**	6.71*
	III	0.00	0.00	0.18	0.12	0.00		
	Total							
Nerodia cyclopion	I	2.59_{AB}	1.65_{AB}	3.46_{A}	0.16_{C}	0.95_{BC}	20.95**	
	II	0.09	0.22	0.66	0.12	0.44		76.2**
	III	0.08_{A}	0.00_{AB}	0.62_{B}	0.00_{A}	0.23_{AB}	12.15*	
	Total	0.81_{A}	0.59_{A}	1.24_{A}	0.09	0.53_{A}	23.07**	
Rana grylio	I	0.00_{A}	2.16	2.29_{A}	0.00_{A}	0.08_{A}	9.51*	
	II	0.00	2.16	3.96	4.14	1.66		11.3**
	III	0.00_{A}	15.43_{C}	7.27_{BC}	0.00_{A}	5.05_{B}	31.47**	
	Total	0.00_{A}	6.58_{B}	4.51_{B}	1.38_{A}	2.26_{B}	33.82**	

Note: All organisms counted by funnel traps except *Rana grylio* adults and *Sternotherus odoratus*, which were counted using "herp-patrols."
Year I Jun 77 - Sep 78.
Year II Oct 78 - Sep 79.
Year III Oct 79 - Sep 80.

APPENDIX A: WES PUBLICATIONS PERTAINING TO THE LAKE CONWAY STUDY

Addor, E. E., and Theriot, R. F. 1977. "Test Plan for the Large-Scale Operations Management Test of the Use of the White Amur to Control Aquatic Plants," Instruction Report A-77-1, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

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APPENDIX B: PLANTS AND ANIMALS IDENTIFIED FROM LAKE CONWAY, FLORIDA

Table B1

Flora of Lake Conway System, Orange County, Florida

Scientific Name	Common Name	Habitat*	Occurrence**
Andropogon virginicus	Broom sedge	B	R
Bacopa caroliniana	Lemon bacopa	S-E	C
Bacopa monnieri	Water hyssop	S-E-F	C
Bidens bipinnata	Water beggar tick	E	R
Cabomba caroliniana	Fanwort	S	U
Ceratophyllum demersum	Coontail	S-F	U
Chara sp.	Muskgrass	S	U
Cladium jamaicensis	Sawgrass	E	R
Colacasia antiquorum	Elephant ears	B-E	C
Cyperus lecontei	Sedge	E-B	U
Cyperus odoratus	Sedge	E-B	C
Cyperus papyrus	Papyrus sedge	E-B	U
Cyperus pseudovegetus	Sedge	E-B	A
Cyperus rotundus	Sedge	E-B	C
Cyperus strigosus	Nutgrass	E-B	A
Eichornia crassipes	Waterhyacinth	F-E	C
Eleocharis acicularis	Slender spikerush	S-E	C
Eleocharis baldwinii	Hairgrass	S-E	C
Eupatorium capillifolium	Dog fennel	E	C
Fimbristylis sp.	Sedge	E-B	R
Fuirena scirpoides	Lake rush	E	A
Fuirena squarrosa		E	C
Habenaria repens	Water orchid	E	R
Hydrilla verticillata	Hydrilla	S	A
Hydrocotyle umbellata	Pennywort	E-F	A
Hydrocotyle verticulatus	Pennywort	E-F	R
Hypericum petiolatum	St. John's wort	E	U
Juncus acuminatus	Rush	B	U
Juncus scirpoides	Rush	B	U
Ludwigia octavalis	Primrose willow	E-B	C
Ludwigia peruviana	Primrose willow	E-B	C
Mayaca fluviatalia	Bogmoss	S	U
Najas guadalupensis	Southern naiad	S	U
Nitella megacarpa	Stonewort	S	A
Nitella sp.	Stonewort	S	R
Nuphar macrophyllum	Spatterdock	F	C
Nymphaea odorata	Fragrant waterlily	F	C
Panicum hemitomon	Maidencane	E	A
Panicum purpurascens	Paragrass	E	C
Panicum repens	Torpedo grass	E-B	A

(Continued)

* B = bank; E = emergent; F = floating; S = submerged.
** A = abundant; C = common; R = rare; U = uncommon.

Table B1 (Concluded)

Scientific Name	Common Name	Habitat	Occurrence
Pluchea purpurascens	Fleubane	E	C
Polygonum punctatum	Smartweed	B	U
Pontederia lanceolata	Pickerel weed	E	A
Potamogeton illinoensis	Illinois pondweed	S	A
Potamogeton puscillus	Slender pondweed	S	R
Rhyncospora cephalantha	Beakrush	B	U
Rhyncospora milaea	Beakrush	B	U
Salvinia rotundifolia	Salvinia	F	U
Sagittaria candifolia	Arrowhead	E	C
Sagittaria graminea	Slender arrowhead	E-S	C
Typha latifolia	Cattail	E	A
Utricularia gibba	Bladderwort	F-S	U
Utricularia foliosa	Leafy bladderwort	S-E	R
Utricularia inflata	Big floating bladderwort	S-E	U
Utricularia purpurea	Purple bladderwort	S-E	R
Utricularia resupinana	Lavender bladderwort	S-E	R
Vallisneria americana	Eelgrass	S	A

Table B2

Phytoplankton Taxa in the Lake Conway System,

Orange County, Florida

CYANOPHYTA

Agmenellum punctata
Agmenellum sp.
Agmenellum tenuissima
Anabaena affinis
Anabaena limnetica

Anabaena sp.
Anabaena wisconsinense
Aphanocapsa sp.
Aphanocapsa sp. A
Aphanocapsa delicatissima

Aphanocapsa elachista
Aphanothece nidulans
Aphanothece sp.
Chamaesiphon incrustans
Chroococcus dispersus

Chroococcus limnetica
Chroococcus minimus
Chroococcus minor
Chroococcus minutus
Chroococcus muticus

Chroococcus sp.
Coelosphaerium sp.
Coelosphaerium naegelianum
Coelosphaerlum pallidium
Gloeocapsa planktonica

Gloeocapsa punctata
Gloeocapsa sp.
Gloeothece rupestris
Gloeothece sp.
Gomphosphaeria aponina

Gomphosphaeria lacustris
Gomphosphaeria
Lyngbya C.F. *limnetica*
Lyngbya contorta
Lyngbya epiphytica

Lyngbya sp.
Microcystis aeruginosa
Microcystis incerta
Microcystis sp.
Oscillatoria amphibia

CYANOPHYTA (Continued)

Oscillatoria angusta
Oscillatoria angustissima
Oscillatoria articulata
Oscillatoria C.F. *limnetica*
Oscillatoria geminata

Oscillatoria limosa
Oscillatoria sp.
Oscillatoria splendida
Oscillatoria tenuis
Phormidium sp.

Schizothrix calcicola
Schizothrix sp.
Spirulina laxissima
Spirulina major
Spirulina sp.

Synechococcus aeruginosa
Synechococcus sp.
Synechocystis aquatilis
Synechocystis sp.

CHLOROPHYTA

Ankistrodesmus braunii
Ankistrodesmus convolutus
Ankistrodesmus falcatus
Anakistrodesmus sp.
Anakistrodesmus spiralis

Carteria sp.
Chaetosphaeridium globosum
Characium ambiguum
Characium falcatum
Characium gracilipes

Characium sp.
Chlamydomonas sp.
Chlorella sp.
Chodatella ciliata
Chodatella citriformis

Chodatella longiseta
Chodatella sp.
Chodatella sp. A
Chodatella subsalsa

(Continued)

(Sheet 1 of 4)

CHLOROPHYTA (Continued)

Closteriopsis longissima
Closteriopsis sp.
Closterium gracile
Closterium sp.
Coelastrum cambricum

Coelastrum microporum
Coelastrum sp.
Coelastrum spaericum
Cosmarium granatum
Cosmarium impressulum

Cosmarium lapponicum
Cosmarium margaritatum
Cosmarium regnesi
Cosmarium sp.
Cosmarium sp.B

Cosmarium sp.C
Cosmarium sp.E
Cosmarium tenue
Cosmarium trilobulatum
Crucigenia apiculata

Crucigenia crucifera
Crucigenia lauterbornei
Crucigenia quadrata
Crucigenia rectangularis
Crucigenia sp.

Crucigenia tetrapedia
Dactylococcopsis acicularis
Dactylococcopsis sp.
Desmidium bailey
Dictyosphaerium ehrenbergianum

Dictyosphaerium pulchellum
Dictyosphaerium sp.
Elakatothrix gelatinosa
Elakatothrix sp.
Euastrum pulchellum

Euastrum sp.
Eudorina elegans
Franceia droescheri
Gloeocystis gigas
Gloeocystis planktonica

CHLOROPHYTA (Continued)

Gloeocystis sp.
Gloeocystis vesiculosa
Golenkinia paucispina
Golenkinia radiata
Golenkinia sp.

Gonium sociale
Gonium sp.
Kirchneriella contorta
Kirchneriella elonga
Kirchneriella lunaris

Kirchneriella obesa
Kirchneriella sp.
Kirchneriella subsolitaria
Micractinium pusillum
Micractinium sp.

Micrasterias radiata
Micrasterias sp.
Mougeotia sp.
Mougeotia sp.A
Mougeotia sp.B

Oedogonium sp.
Onchonema laeve
Onchonema sp.
Oocystis borgei
Oocystis elliptica

Oocystis gigas
Oocystis lacustris
Oocystis parva
Oocystis pusilla
Oocystis solitaria

Oocystis sp.
Pandorina morum
Pediastrum duplex
Pediastrum obtusum
Pediastrum simplex

Pediastrum sp.
Pediastrum tetras
Planktosphaeria gelatinosa
Pleodorina sp.
Protosiphon botryoides

(Continued)

Table B2 (Continued)

CHLOROPHYTA (Continued)

Quadrigula lacustris
Quadrigula sp.
Quadrigula tetrapedia
Scenedesmus abundans
Scenedesmus acutiformis

Scenedesmus arcuatus
Scenedesmus bijuga
Scenedesmus brasiliensis
Scenedesmus denticulatus
Scenedesmus dimorpha

Scenedesmus incrassatulus
Scenedesmus obligus
Scenedesmus obliqus
Scenedesmus opoliensis
Scenedesmus perforatus

Scenedesmus quadricauda
Scenedesmus sp.
Selenastrum minutum
Selenastrum sp.
Selenastrum sp.A

Sphaerocystis schoeteri
Sphaerocystis sp.
Spirogyra sp.
Staurastrum cuspidatum
Staurastrum gracile

Staurastrum hexacerum
Staurastrum inflexum
Staurastrum leptocladum
Staurastrum obesa
Staurastrum paradoxum

Staurastrum sp.
Staurastrum sp.B
Staurastrum tetracerum
Staurastrum turgescens
Tetraedron caudatum

Tetraedron enorme
Tetraedron gracile
Tetraedron limneticum
Tetraedron minimum
Tetraedron muticum

CHLOROPHYTA (Continued)

Tetraedron planktonicum
Tetraedron regulare
Tetraedron sp.
Tetraedron trigonium
Tetralantos lagerheimii

Tetralantos sp.
Tetrastrum sp.
Tetrastrum staurogeniaeforme
Treubaria setigerum
Trochiscia granulata

Trochiscia reticularis
Trochiscia sp.
Ulothrix sp.
Ulothrix subtillissima

CHRYSOPHYTA

XANTHOPHYCEAE

Bottryococcus cf. *sudeticus*
Bottryococcus sp.
Ophyocytium capitatum
Ophyocytium sp.
Stipitococcus sp.A

CHRYSOPHYCEAE

Asterococcus limneticus
Asterococcus spinosus
Dinobryon bavaricum
Dinobryon sertularia
Dinobryon sociale

Dionbryon sp.
Dinobryon divergens

BACILLARIOPHYCEAE

Achnanthes sp.
Achnanthes exigua
Achnanthes minutissima
Cocconeis placentula
Cocconeis sp.

Cyclotella meneghiniana
Cyclotella pseudostelligera
Cyclotella stelligera
Cyclotella sp.
Cymbella sp.

(Continued)

(Sheet 3 of 4)

Table B2 (Concluded)

CHRYSOPHYTA (Continued)

BACILLARIOPHYCEAE (Continued)

Eunotia sp.
Fragillaria crotonensis
Fragillaria sp.
Gyrosigma sp.
Melosira cf. *italica*

Melosira sp.
Navicula accomoda
Navicula cryptocephala
Navicula rhynchocephala
Navicula sp.

Navicula subtilissima
Nitzschia acicularis
Nitzschia palea
Nitzschia sp.
Pennales sp.

Rhizosolenia sp.
Stauroneis sp.
Synedra delicatissima
Synedra radians
Synedra rumpens

Synedra sp.
Synedra tabulata

EUGLENOPHYTA

Euglena sp.
Phacus sp.

CHRYSOPHYTA (Continued)

EUGLENOPHYTA (Continued)

Trachelmonas crebea
Trachelmonas sp.
Trachelmonas volvocina

PYRROPHYTA

Ceratium hirundinella
Ceratium sp.
Glenodinium sp.
Gymnodinium sp.
Peridinium inconspicuum

Peridinium sp.
Peridinium wisconsinense

CHRYPTOPHYCEAE

Chroomonas sp.
Crypotomonad sp.A
Crypotomonad sp.B
Crypotomonad sp.

UNKNOWN PHYTOPLANKTON

Unidentified small coccoids
Unidentified sp.
Unidentified sp.A
Unidentified sp.B
Unidentified sp.C
Unidentified sp.D

(Sheet 4 of 4)

Table B3

Zooplankton Taxa in the Lake Conway System, Orange County, Florida

ROTIFERA

Ascormorpha sp.
Asplanchna sp.
Branchionus havanaensis
Branchionus quadridentata
Branchionus sp.

Chydorus sp.
Chydorus spaericus
Conochiloides sp.
Conochilus unicornis
Conochilus unicornis var. *solitarius*

Enteroplea lacustris
Epiphanes sp.
Euchlanis sp.
Filinia longiseta
Hexartharta sp.

Kellicotia sp.
Keratella cochlearis
Lecane sp.
Lepadella sp.
Monostyla sp.

Platyias patulus
Polyarthra sp.
Sinantherina sp.
Trichocerca multicrinis
Trichocerca sp.
Trochosphaera solstitialis

Unknown Rotifera sp.A
Unknown Rotifera sp.B
Unknown Rotifera sp.C

CLADOCERA

Alona rectangula
Alona sp.
Bosmina longirostris
Camptocercus rectirostris
Ceriodaphnia sp.

Daphnia ambigua
Diaphanosoma brachyurum
Ilyocryptus sordidus
Latonopsis occidentalis
Leydigia sp.

CLADOCERA (Continued)

Macrothrix hirsutocornis
Pleoroxus sp.
Simocephalus sp.
Unknown cladocera

COPEPODA

Cyclops bicuspidatus
Cyclops vernalis
Cyclops sp.
Diaptomus floridanus
Ergasilus sp.

Mesocyclops edax
Tropocyclops prasinus
Unknown copepoda adult
Unknown nouplii

PROTOZOA

Unknown Rhizopoda
Vorticella sp.A
Vorticella sp.B

CHLOROPHYTA

Volvox sp.

OSTRACODA

Unknown sp.A
Unknown sp.B

Table B4

Macroinvertebrate Taxa in the Lake Conway System, Orange County, Florida

BRYOZOA

Plumatella repens var. *appressa*

NEMERTEA

Prostoma rubrum

PLANARIIDAE

Dugesia tigrina

HIRUDINEA

Placobdella phalera
Helobdella papillata
Helobdella stagnalis
Helobdella sp.

OLIGOCHAETA

Dero nivea
Pristina breviseta
C.F. *limnodrilus hoffmeisterii*
Lumbriculus sp.
Unknown aeolosomatidae

GASTRODODA

Goniobasis sp.
Ferrissia sp.
Gryraulus sp.
Physa sp.
Pomacea sp.
Viuiparus sp.
Unknown Planorbidae

AMPHIPODA

Hyallela ayteca

DECAPODA

Palaemonetes paludosus
Unknown Cambarinae

ARACHNOIDEA

Unknown Hydracarina

INSECTA

ODONATA

Anomalagrion hastatatum
Enallagma signatum
Ischnura sp.
Unknown Zygoptera
Celithernis pasciata

Epicordulia regina
Gomphoides williamsoni
Gomphus sp.
Macrothemis sp.
Somatochlora filosa
Tauriphila australis

EPHEMEROPTERA

Baetis sp.
Neocloeon sp.

INSECTA (Continued)

EPHEMEROPTERA (Continued)

Coenis diminuta
Ephemerella sp.
Hexagenia

TRICHOPTERA

Leptocella sp.
Hydroptila sp.
Unknown Hydroptilidae
Unknown Psychomyiidae

LEPIDOPTERA

Nymphula sp.

COLEOPTERA

Haliplus sp.
Pelocoris sp.

DIPTERA

CERATOPOGONIDAE

Bezzia sethlosa

CHAOBORIDAE

Chaoborus albipes

CHIRONOMIDAE

Ablabesmyia pleensis
Clinotanytarsus sp.
Coelotanypus sp.
Procladius sp.
Tanypus sp.

CHIRONOMIDAE

Lobodiamesa sp.
Brillia par
Corynoneura scutellata
Cricotopus sp.
Eukiefferiella sp.

Psectrocladius vernalis
Cladotanytarsus sp.
Nimbocera sp.
Tanytarsus sp.
Chironomus attenuatus

Cryptochironomus juluus
Dicrotendipes leucoscelis
Endochironomus nigricans
Glyptotendipes senilis
Harnischia C.F. *viridulus*

Parachironomus hirtulatus
Paralauterbormiella nigrohalteralis
Polypedilum halterale
Stictochironomus devinctus
Tribelos sp.

Table B5

Fish from the Lake Conway System, Orange County, Florida

Scientific Name	Common Name
LEPISOSTEIDA	
Lepisosteus osseus	Longnose gar
Lepisosteus platyrhincus	Florida gar
AMIIDAE	
Amia calva	Bowfin
ANGUILLIDAE	
Anguilla rostrata	American eel
CLUPEIDAE	
Dorosoma cepedianum	Gizzard shad
Dorosoma petenense	Treadfin shad
ESOCIDAE	
Esox americanus	Redfin pickerel
Esox niger	Chain pickerel
CYPRINIDAE	
Notemigonus crysoleucas	Golden shiner
Notropis petersoni	Coastal shiner
CATOSTOMIDAE	
Erimyzon sucetta	Lake chubsucker
ICTALURIDAE	
Ictalurus catus	White catfish
Ictalurus netalis	Yellow bullhead
Ictalurus nebulosus	Brown bullhead
Ictalurus punctatus	Channel catfish
Notorus gyrinus	Tadpole madtom
CRYPRINODONTIDAE	
Fundulus chrystotus	Golden topminnow
Fundulus seminolis	Seminole killifish
Jordanella floridae	Flagfish
Lucania goodei	Bluefin killifish
POECILIIDAE	
Gambusia affinis	Mosquito fish
Heterandria formosa	Least killifish

(Continued)

Table B5 (Concluded)

Scientific Name	Common Name
ATHERINIDAE	
Labidesthes sicculus	Brook silverside
CENTRARCHIDAE	
Elassoma evergladei	Everglades pygmy sunfish
Ennecanthus gloriosus	Bluespotted sunfish
Lepomis auritus	Redbreast sunfish
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis marginatus	Dollar sunfish
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Micropterus salmoides	Largemouth bass
PERCIDAE	
Etheostoma fusiforme	Swamp darter

Table B6

Birds from the Lake Conway System, Lake Conway, Florida

GAVIIFORMES

Gaviidae - loons

Common loon *Gavia immer*

PODICIPERIFORMES

Podicipedidae - grebes

Horned grebe *Podiceps auritus*

Pied-billed grebe *Podilymbus podiceps*

PELECANIFORMES

Anhingidae - darters

Water turkey *Anhinga anhinga*

CICONIIFORMES

Ardeidae - herons and bitterns

Great blue heron *Ardea herodias*
American bittern *Botaurus lentiginosus*
Cattle egret *Bubulcas ibis*
Green backed heron *Butorides striatus*
Great egret *Casmerodius albus*
Snowy egret *Egretta thula*
Little blue heron *Egretta caerulea*
Tricolored heron *Egretta tricolor*
Least bittern *Ixobrychus exilis*
Night heron *Nycticorax* sp.

ANSERIFORMES

Anatidae - waterfowl

Wood duck *Aix sponsa*
American wigeon *Anas americana*
Blue-winged teal *Anas discors*
Mallard *Anas platyrhynchos*
Lesser scamp *Aythya affinis*
Redhead *Aythya americana*
Ring-hecked duck *Aythya collarie*
Canvasback *Aythya valisineria*
Muscovy *Cairina moschata*

FALCONIFORMES

Accipitridae - hawks, eagles, kites, osprey

Bald eagle *Haliaeetus leucopephalus*
Osprey *Pandion haliaetus*

(Continued)

GRUIFORMES

Aramidae - Limpkins

Limpkin *Aramus guarauna*

Rallidae - rails and gallinules

American coot *Fulica americana*
Common gallinule *Gallinula chloropus*
Purple gallinule *Porphyrula martinica*
Sora *Porzana carolina*

CHARADRIIFORMES

Charadriidae - plovers

Killdeer *Charadrius vociferus*

Scalopacidae - sandpipers and allies

Least sandpiper *Calidris minutilla*
Common snipe *Gallinago gallinago*

Laridae - Gulls and terns

Herring gull *Larus argentatus*
Ring-billed gull *Larus delawarensis*
Bonapartes gull *Larus philadelphia*
Least tern *Sterna antillarum*
Forster's tern *Sterna forsteri*
Common tern *Sterna hirundo*

APODIFORMES

Apodidae - swifts

Chimney swift *Chetura pelagica*

CORACIFORMES

Alcedinidae - kingfishers

Belted kingfisher *Ceryle alcyon*

PASSERIFORMES

Hirundinidae - swallows

Barn swallow *Hirundo rustica*
Purple martin *Progne subis*
Tree swallow *Tachycineta bicolor*

Corvidae - Jays and crows

Fish crow *Corvus assifragus*

Emberizidae - wood warblers, blackbirds, orioles, sparrows

Red-winged blackbird *Agelaius phoeniceus*
Boat-tailed grackle *Quiscalus major*
Common grackle *Quiscalus quiscula*

Table B7

Amphibians and Reptiles from the Lake Conway System, Orange County, Florida

Scientific Name	Common Name
AMPHIBIA	
CAUDATA	
SIRENIDAE	
Pseudobranchus striatus	Dwarf siren
Siren lacertina	Greater siren
AMPHIUMIDAE	
Amphiuma means	Two-toed amphiuma
PLETHODONTIDAE	
Eurycea quadridigitata	Dwarf salamander
ANURA	
BUFONIDAE	
Bufo terrestris	Southern toad
MICROHYLIDAE	
Gastrophryne carolinensis	Eastern narrow-mouthed toad
RANIDAE	
Rana grylio	Pig frog
Rana utricularia	Southern leopard frog
HYLIDAE	
Acris gryllus	Florida cricket frog
Hyla cinerea	Green treefrog
Hyla femoralis	Pinewoods treefrog
Hyla squirella	Squirel treefrog
REPTILIA	
CROCODILLIA	
DROCODILIDAE	
Alligator mississippiensis	American alligator
TESTUDINATA	
CHELYDRIDAE	
Chelydra serpentina	Florida snapping turtle
KINOSTERNIDAE	
Kinosternon baurii	Striped mud turtle
Kinosternon subrubrum	Eastern mud turtle
Sternotherus odoratus	Stinkpot

(Continued)

Table B7 (Concluded)

Scientific Name	Common Name
TESTUDINATA (Continued)	
EMYDIDAE	
*Chrysemys picta**	Painted turtle
Pseudemys floridana	Peninsular cooter
Pseudemys nelsoni	Florida red-bellied turtle
*Pseudemys scripta**	Red-eared turtle
Deirochelys reticularia	Chicken turtle
TRIONYCHIDAE	
Trionyx ferox	Florida softshell
SQUAMATA	
COLUBRIDAE	
Coluber constrictor	Black racer
Farancia abacura	Mud snake
Nerodia cyclopion	Green water snake
Nerodia fasciata	Florida water snake
Regina alleni	Striped swamp snake
Thamnophis sauritus	Peninsula ribbon snake
Thamnophis sirtalis	Eastern garter snake

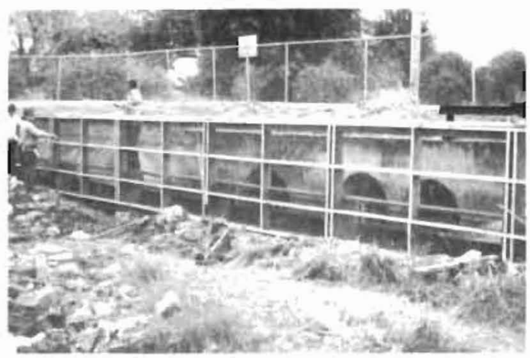
* Indicate introduced species.

APPENDIX C: PHOTOGRAPHS OF THE LAKE CONWAY, FLORIDA, AREA DURING THE PERIOD OF STUDY

a. Undeveloped shoreline (1981)

b. Developed shoreline (1981)

c. Gatlin Canal (1981)



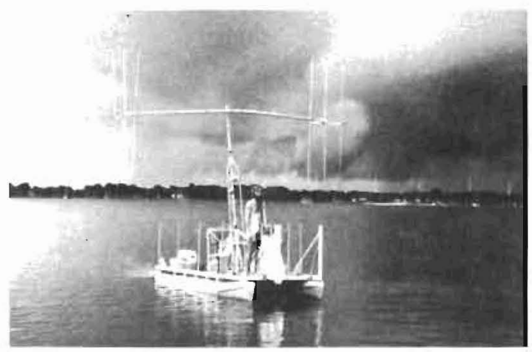
d. Construction of fish barriers (1975)

Figure C1. The Lake Conway area

a. Use of the Wegener ring

b. Use of the block net

c. Inserting a transmitter in white amur



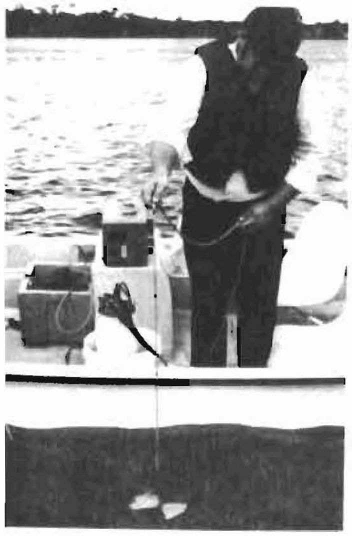
d. The fish tracking boat

Figure C2. Fishery studies at Lake Conway, Florida (photographs a and b are courtesy of the Florida Game and Fresh Water Fish Commission; photographs c and d are courtesy of the Florida Department of Natural Resources)

a. The biomass sampler for aquatic plants

b. The sampling barge for aquatic plants

Figure C3. Sampling for aquatic plants at Lake Conway, Florida (photographs courtesy of Florida Department of Natural Resources)



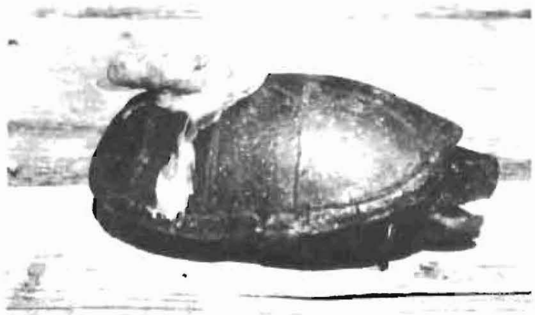
a. Use of the Secchi disk

b. Conducting chemical analyses

c. Use of the plankton net

d. The white amur

Figure C4. Aquatic studies at Lake Conway (photographs a and b are courtesy of Orange County Pollution Control Board; photograph c is courtesy of the Department of Environmental Engineering; photograph d is courtesy of the Florida Game and Fresh Water Fish Commission)



a. A radiotagged turtle

b. Water snake

Figure C5. Herpetological studies at Lake Conway, Florida (photographs courtesy of University of South Florida)