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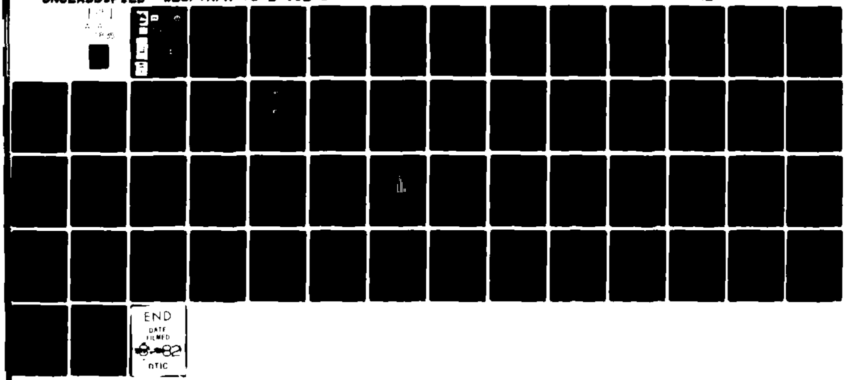

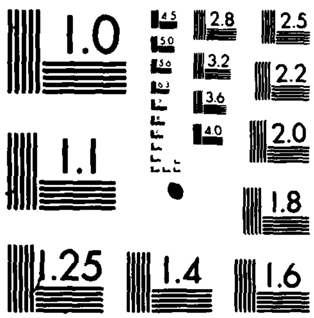

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LARGE-SCALE OPERATIONS MANAGEMENT TEST OF USE OF THE WHITE AMUR FOR CONTROL OF PROBLEM AQUATIC PLANTS

Report 1

BASELINE STUDIES

Volume VIII

Summary of Baseline Studies and Data

By Eldon C. Blancher, Eugene G. Buglewicz

Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station,
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Report 1 of a Series

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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

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This report summarizes the baseline environmental conditions in Lake Conway, Florida, for the 20-month period, January 1976-August 1977. A brief history of the Large-Scale Operations Management Test--Lake Conway (LSOMT) is presented. Investigations dealing with the aquatic macrophytes, fish, mammals, waterfowl, plankton, benthos, water quality, herpetofauna, and mathematical modeling efforts to describe the lake's ecosystem prior to the introduction of the white amur are summarized.

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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, U. S. Army.

This is the last of eight volumes that constitute the first of a series of reports documenting a Large-Scale Operations Management Test of the use of the white amur for control of problem aquatic plants in Lake Conway, Florida. Report 1 presents the results of the baseline studies of Lake Conway; subsequent reports will present the annual poststocking results.

This volume was written by Dr. Eldon C. Blancher, II, and Mr. Eugene G. Buglewicz of the Environmental Laboratory (EL) of the WES. The authors wish to acknowledge the efforts of the various scientists who were involved with the Large-Scale Operations Management Test and whose works are incorporated herein.

The work was monitored at WES in the Waterway Habitat and Monitoring Group, Dr. T. D. Wright, Chief, under the general supervision of Mr. B. O. Benn, Chief, Environmental Systems Division (ESD). Mr. J. L. Decell is Manager of the APCRP. The ESD and APCRP are a part of the EL, Dr. John Harrison, Chief.

Commander and Director of WES during the period of study was COL Nelson P. Conover, CE. Technical Director was Mr. F. R. Brown.

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BASELINE STUDIES

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PART I: INTRODUCTION

Purpose of the Summary Report

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 technologies. A large-scale test for introducing the white amur fish (*Ctenopharyngodon idella*) into a field environment was initiated at Lake Conway near Orlando, Fla., to study the effectiveness of the fish as a biological macrophyte control agent. 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 (see U. S. Army Engineer Waterways Experiment Station 1976, 1977, 1978).

2. The purpose of this document is to summarize the results of the baseline studies conducted at Lake Conway by various contractors for the period January 1976 through September 1977. It is the purpose of the baseline studies to fully describe the physical, chemical, and biological attributes of Lake Conway prior to introduction of white amur and establish criteria upon which the effectiveness of the fish as a macrophyte control agent can be evaluated. Additionally, this information will be used to identify any environmental changes in the ecosystem that may be attributed to the fish.

3. This report is divided into five major sections. The introduction (Part I) presents the history of the Large-Scale Operations Management Test (LSOMT) at Lake Conway and summarizes the overall objectives of the study. Part II presents brief summaries of the reports by the

various investigators involved with the data collection effort during the baseline period. Part III describes the progress made on the development of a general Stocking Rate Model and the Ecological Response Model which will be used to test the applicability of the white amur as a plant control agent in other lake systems. An overall description of Lake Conway during the baseline period is presented in Part IV, and Part V presents the research priorities to be addressed during the post-stocking period.

History of the Lake Conway LSOMT

4. In 1975, the Office of the Chief of Engineers (OCE) directed that the Corps' APCRP become more responsive to user needs. In short, 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. Subsequently, the research program restructuring began.

5. Past and present efforts were critically reviewed in the light of the new program approach. Personnel of the APCRP sought to answer the following question: What research, if any, has matured to the point that it can be tested on a large scale and has a potential operational capability?

6. On 19 February 1975, a meeting was held at WES to review past research in an effort to determine the most promising research results in terms of operational potential. Representatives of the South Atlantic Division Office, Jacksonville District Office, OCE, U. S. Fish and Wildlife Service, and U. S. Department of Agriculture were present. The search for an operational tool was directed towards biological control agents since biological control offers the most promising long-term, permanent solution to many of the Nation's aquatic plant problems.

7. The consensus at that time was that the white amur fish presented the most operational potential. It was also decided to present the general concept of such a test to interested agency representatives in the State of Florida. Florida was chosen because it had the most

intense, continual aquatic plant problems; Florida State agencies devote more resources to research on aquatic plant problems than do other states; Florida and the Corps' Jacksonville District have a rapidly spreading problem with the submerged aquatic plant *Hydrilla verticillata*; and the white amur, through small pond studies in Florida, had been proven effective in controlling hydrilla.

8. In late May 1975, a meeting was held with Dr. Earle Frye, Director of the Florida Game and Fresh Water Fish Commission (FGFWFC), and COL Emmett Lee, then District Engineer, Jacksonville District, to discuss the proposed test concept. Dr. Frye informed WES that the decision as to whether or not a lake could be stocked for the test would have to be made by the FGFWF Commissioners. At the June 1975 Commissioners meeting, the concept of the test was presented. 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 stocking. The Commissioners also suggested that the Corps meet with the FGFWFC staff and recommend a test site at the July meeting. Subsequently, Corps personnel met several times with Mr. John Woods, Chief, Fisheries Division, and his staff. The Lake Conway-Little Lake Conway-Lake Gatlin chain was selected for the test. In July, the site and test plan were presented to the Commissioners. They ruled unanimously to permit the stocking and directed Dr. Frye to transmit a letter granting permission. This letter was issued on 4 September 1975.

9. Subsequently, the test design was initiated. Several meetings were held with potential contractors to determine the level of detail and scope for the data collection phase of the program. From these meetings, the data to be collected and the frequency of the collection were identified. Contracts for the baseline and poststocking periods were negotiated in late 1975 and the first sampling in Lake Conway commenced in early January 1976. Due to problems in the construction and delivery of specialized sampling equipment for the aquatic macrophyte sampling effort, collection of the first macrophyte samples was delayed until the summer of 1976. Since a full year of baseline data was required, and since the stocking effort would be most effective if

performed after the summer to reduce heat stress to the fish, September 1977 was chosen as the best date for introducing the fish. On 9 September 1977, 7611 white amur averaging 0.32 kg in weight were released into Lake Conway, thus ending the baseline study period.

Study Objectives

Overall

10. The first objective of the LSOMT was to establish relationships pertaining to the response of the various components of an aquatic ecosystem to the presence of the white amur. Second, the test was to provide scientists at WES with enough information to extrapolate the results of this test to other aquatic ecosystems in a meaningful way. Finally, through a better understanding of the response of the ecosystem to the white amur's presence, this study was designed to provide a basis for determining both the feasibility and effectiveness of using the white amur on an operational scale for aquatic macrophyte management.

Specific

11. The concepts employed in studying the impact of a plant control technology on an ecosystem are derived from the established fields of limnology, botany, water chemistry, and aquatic biology. Since the required expertise spans several disciplines, specific study objectives were formulated for individual contractors so that distinct research areas would receive the proper attention. The research areas listed below detail the major objectives that were to be researched by the various investigators:

- a. Water and sediment chemistry. Describe temporal water quality and sediment chemical and physical parameters to detect significant changes possibly caused by the introduction of the white amur.
- b. Hydrology and nutrient sources. 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 nutrients under the potential influence of the white amur.
- c. Aquatic macrophytes. 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 effect on the remaining plant community.

Plankton and benthic invertebrates. Determine plankton (phytoplankton and zooplankton), benthic, and periphytic community response to the loss or change of the aquatic macrophyte community.

Fish, waterfowl, and aquatic mammals. Describe the fish community in the Lake Conway system and evaluate any shifts in species dominance brought about by direct competition for food, cover, or displacement of fish species as a result of herbivore grazing.

Herpetofauna. Describe the herpetofaunal community in the Lake Conway system and evaluate changes to herpetofauna populations resulting from a change in littoral habitat characteristics as a result of aquatic macrophyte loss or change in community structure.

Stocking Rate Model. Continue development and verify a white amur Stocking Rate Model to provide a capability for selecting, on a rational basis, the size and number of white amur to be stocked, given specific environmental parameters and operational objectives. Previously developed at WES for the APCRP, the LSOMT was the first verification of the accuracy of the model and provided information that will make refinement of simulation predictions possible.

Ecosystem Response Model. Conceptualize and develop an Ecosystem Response Model to provide a means of simulating the response of the aquatic ecosystem to the introduction of the white amur through the simulation of the interactions occurring between the chemical, physical, and biological processes in Lake Conway. Verify the simulation results using Lake Conway field data.

Data Management

of sampling gement

heduling and coordination of LSOMT data collection were naintained by WES through contracts and periodic conferences vidual investigators. Every attempt was made to keep each informed of the sampling schedule of the other investigaiting in the project.

Control transects and data collection stations

13. The scientists at WES established a system of 14 control transects for Lake Conway. Placement of the transects was based on general characteristics of the lake as revealed by aerial photographs and onsite inspection. Eleven permanent data collection stations were established at selected points along the transects (Figure 1). These stations were designated as control data stations and were to provide reference points to be used throughout the period of the LSOMT. In addition, individual investigators established supplementary data stations to correspond with their particular sampling requirements. All sampling points used were referenced on a blank map provided by WES as part of the required periodic data report.

Data processing

14. The WES acted as the central clearinghouse for all data collected during the LSOMT: all data collected were sent to WES where they were placed on the WES data processing system. To ensure that all data generated in the sampling programs were compatible with the storage and processing system, each contractor was required to submit their respective data on standardized data forms.

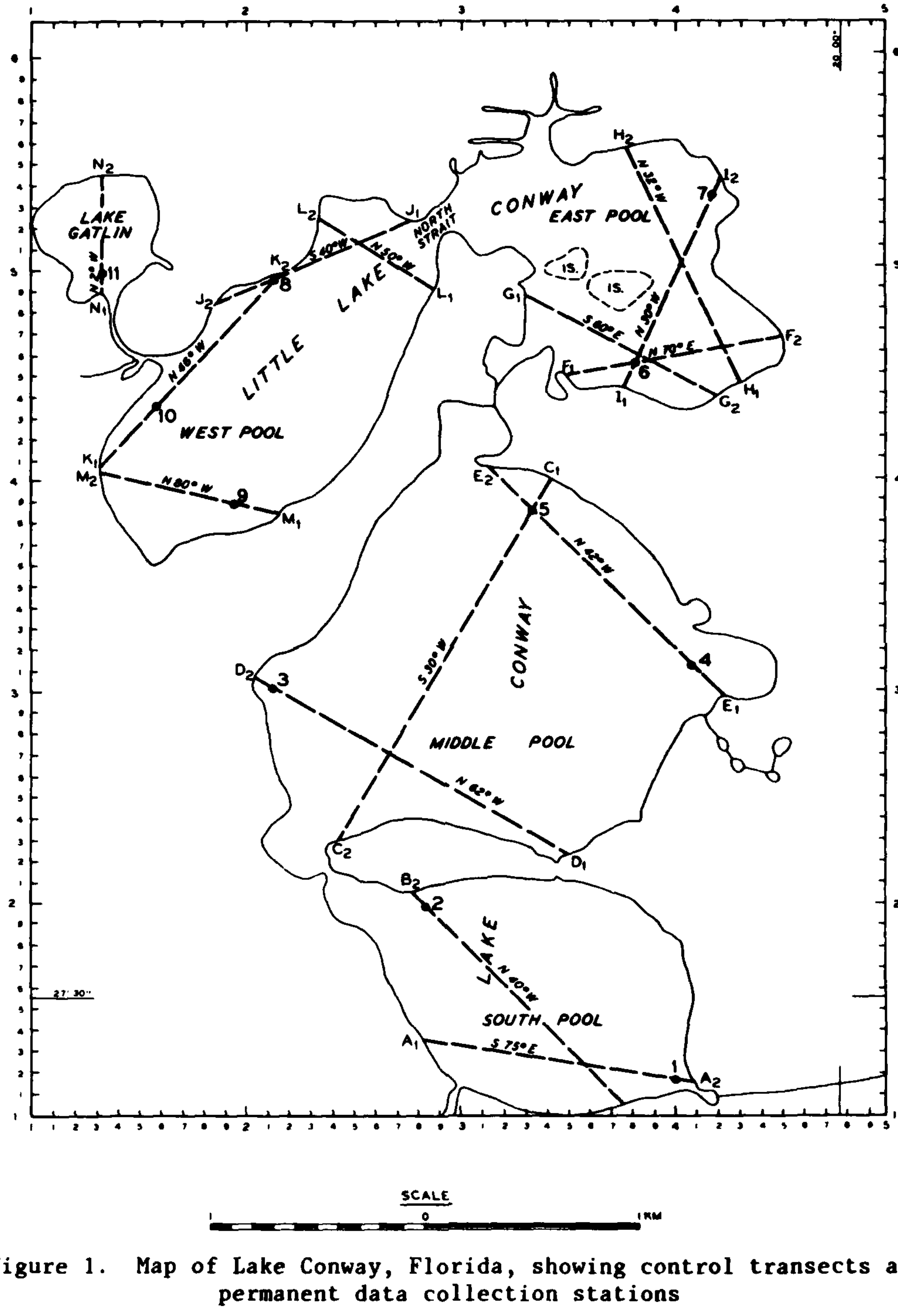

Figure 1. Map of Lake Conway, Florida, showing control transects and permanent data collection stations

PART II: DATA COLLECTION

Water and Sediment Chemistry

15. The Orange County Pollution Control Department (OCPCD) has been performing comprehensive water quality analyses on Orange County lakes since 1972. In January 1976, the OCPCD initiated a more intensive study of Lake Conway for the LSOMT data collection effort. The results of the OCPCD baseline investigations are presented in Volume VI of this series (Miller et al. 1981).

Methodology

16. Eleven sampling stations, corresponding to the eleven control data stations designated by WES, have been monitored in the Lake Conway complex on a monthly basis since January 1976. Water samples were obtained by a Kemmerer sampler at discrete depth intervals and sediment samples were obtained by an Ekman dredge. Monthly water samples were returned to the laboratory and tested for the following parameters:

Turbidity	Volatile suspended solids
Total phosphorus	Fixed suspended solids
Orthophosphorus	Biochemical oxygen demand
Organic nitrogen	Copper
Nitrate nitrogen	Iron
Nitrite nitrogen	Lead
Ammonia nitrogen	Sodium
Alkalinity	Potassium
Acidity	Functional chlorophyll *a*
Chloride	Nonfunctional chlorophyll *a*
Hardness	Carotenoids
Total solids	

Temperature, conductivity, dissolved oxygen, pH, and redox were measured in situ using a Hydrolab® Surveyor. A Secchi disk reading was taken at the time of sampling.

17. Sediment samples were returned to the lab and analyzed for the following parameters:

Total nitrogen	Lead
Total phosphorus	Total organic carbon
Iron	Chemical oxygen demand
Copper	

All water and sediment samples were analyzed using standard laboratory procedures (U. S. Environmental Protection Agency (USEPA) 1976, American Public Health Association (APHA) 1975).

Summary of results

18. Analysis of water quality data showed little parameter variability within individual pools of the Lake Conway system, but indicated some differences between pools. From Lake Gatlin southward through the Lake Conway chain, a trend of decreasing parameter values was noted, particularly for conductivity, chlorophyll *a*, pH, and turbidity (Figure 2).

19. Seasonal differences for temperature, dissolved oxygen, total filterable phosphorus, and chlorophyll *a* generally followed expected temporal intervals for season and maximum biological activity patterns. Increased temperatures and chlorophyll *a* and a concomitant decrease in dissolved oxygen and dissolved filterable phosphorus were characteristic of the Lake Conway system during the summer. Figure 3 illustrates this relationship for a Middle Pool sampling station. Table 1 summarizes the mean prestocking parameter values by sampling station.

Hydrology and Nutrient Sources

20. The University of Florida's Department of Environmental Engineering Sciences was responsible for describing the hydrology of Lake Conway and determining the major sources of nutrients to the system. Detailed information is presented in Volume IV of this report series (Blancher and Fellows 1979). A description of the Lake Conway nutrient balance was intended to provide information useful in determining whether the feeding activities of white amur would have significant

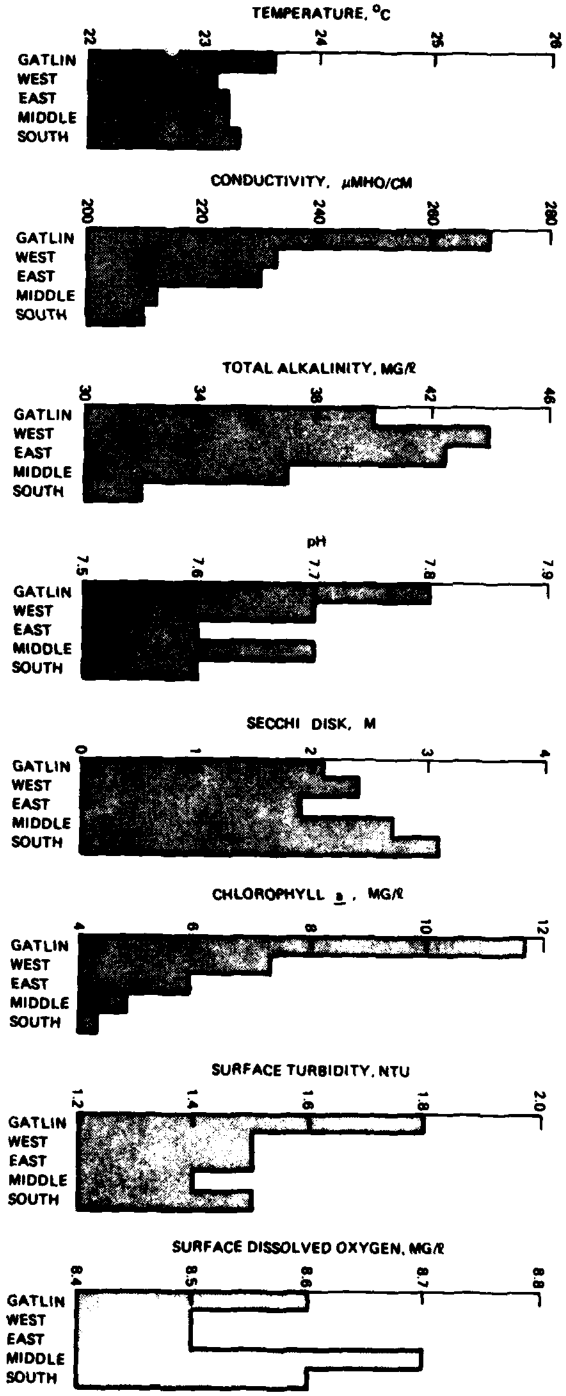

Figure 2. Trends of decreasing parameter values for Lake Gatlin southward to South Pool (Miller et al. 1981)

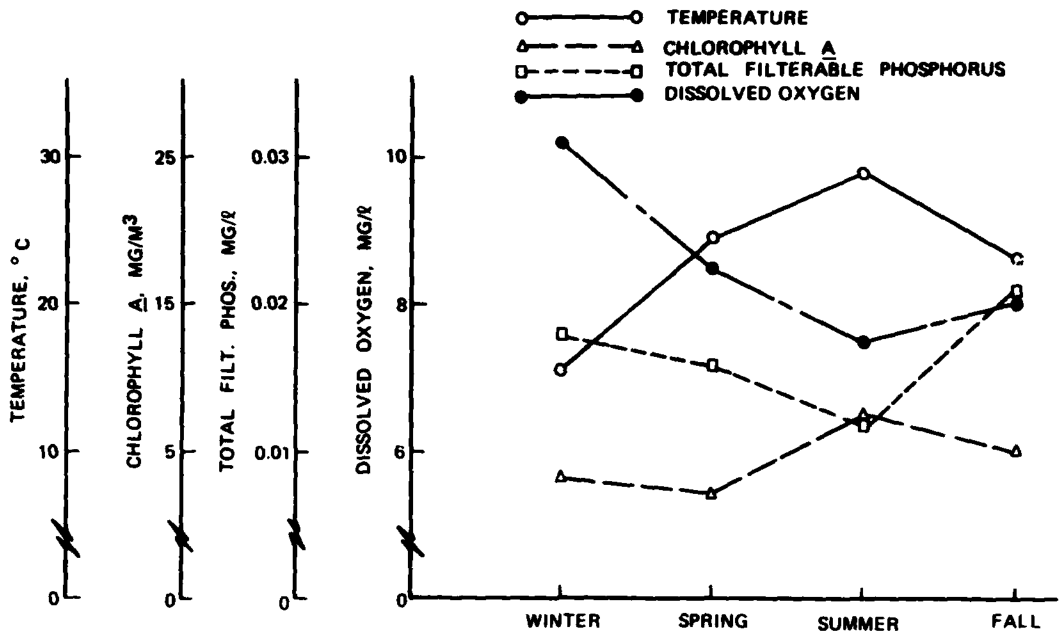

Figure 3. Seasonal trends of selected parameters from Middle Pool, Lake Conway, Florida (Miller et al. 1981)

impact on the nutrient cycling of the ecosystem.

Methodology

21. Hydrologic inputs to the lake system were defined by applying acceptable engineering methodologies (Chow 1964, U. S. Department of Agriculture 1975) to available data sources such as U. S. Geological Survey (USGS) hydrologic data and National Weather Service climatological records. Samples of rainfall, surface runoff, and subsurface runoff were analyzed for nutrient forms (nitrogen and phosphorus) using standard laboratory methods (APHA 1975, USEPA 1976), and nutrient loading rates were calculated by multiplying the volume of the inflows by their respective nutrient concentrations. Additional analyses were also performed to determine nutrient limitations within the lake.

Summary of results

22. The hydrology of the Lake Conway system is dominated by precipitation and evaporation, which account for approximately 70 percent

of the hydrologic inputs and outputs of the lake. Subsurface seepage flows and stormwater runoff account for the remainder of hydrologic inputs to the lake.

23. Preliminary measurements made during the baseline studies resulted in estimates of nitrogen and phosphorus loadings of 3.88 g/m^2/yr and 0.214 g/m^2/yr, respectively. Major external sources of nitrogen were from aerial inputs and subsurface seepage flows, while phosphorus inputs were dominated by aerial loadings and urban runoff. The magnitude of nitrogen loading exceeds the critical loading levels indicated by both Vollenweider (1968) for North American and Swiss Lakes, and Brezonik and Shannon (1971) for Florida lakes. Phosphorus inputs lie between permissible and critical levels, indicating that the lake system should exhibit mesotrophic conditions (Figure 4).

24. Lake Conway exhibited symptoms of phosphorus limitation during the spring and early summer of 1977 due to decreased loadings caused by a scarcity of rainfall. This observation was supported by results from algal bioassay and alkaline phosphatase experiments. No indications of nitrogen limitation were found.

Aquatic Macrophytes

25. The Florida Department of Natural Resources was responsible for monitoring aquatic macrophytes in Lake Conway. Areal coverage, biomass, species composition, phenology, stem density, and height profile were measured for 1 year before stocking. The results of these studies are documented in Volume I of this report (Nall and Schardt 1978).

Methodology

26. Monthly samples were obtained at 100-m intervals from 18 transects using a prototype biomass sampling barge for determining species composition, plant biomass, and reproductive state. Fresh wet and dry weights were determined on all samples. Additional data were obtained by random sampling techniques employing both 0.25-m^2 underwater samplers (SCUBA) and biomass barge samples; performing visual observations at fixed plots; and photographic monitoring in exclosure plots. Detailed

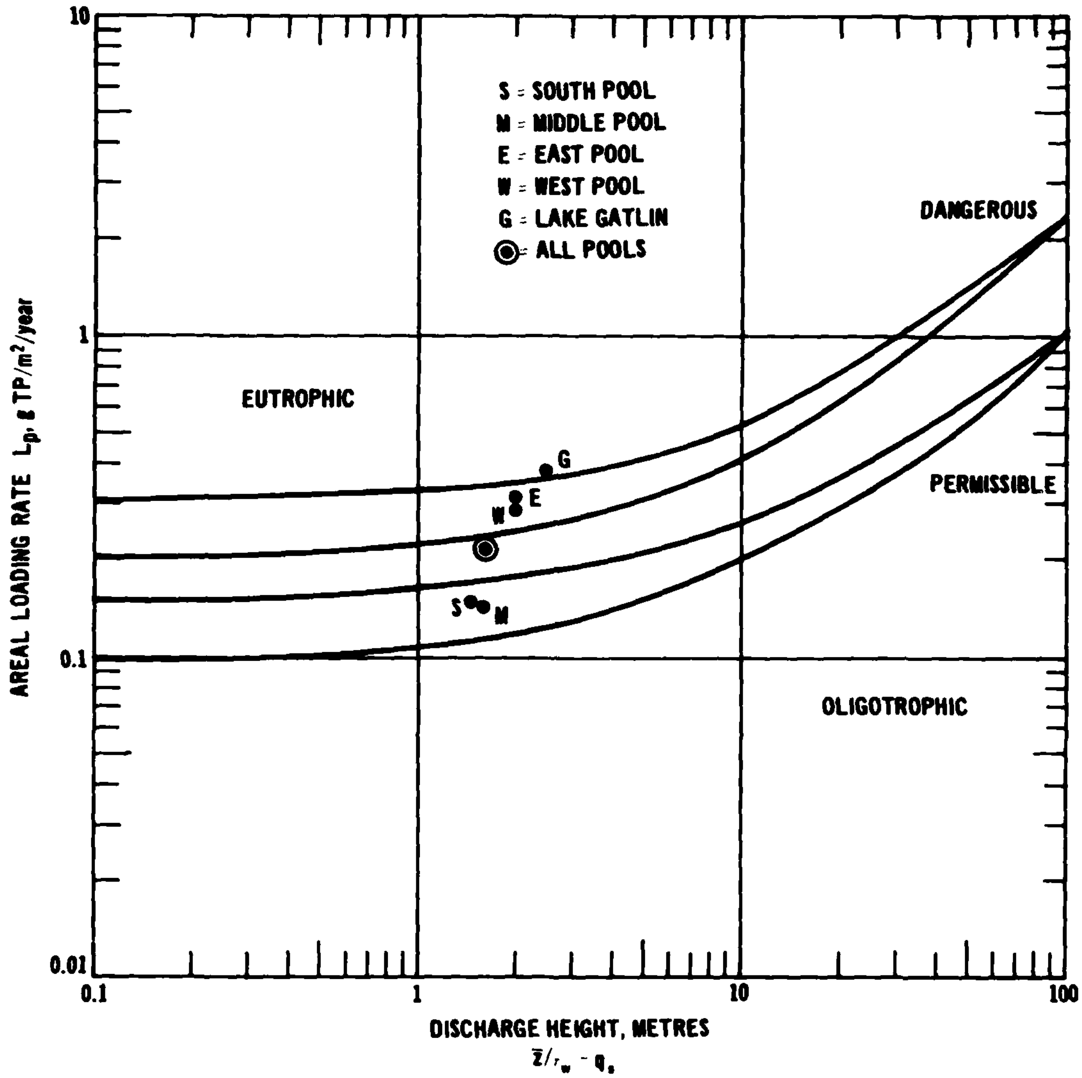

Figure 4. Areal phosphorus loadings for Lake Conway, Florida, compared to the criteria of Vollenweider (Blancher and Fellows 1979)

descriptions of all sampling methodologies are presented in Volume I (Nall and Schardt 1978).

Summary of results

27. During the prestocking period, hydrilla,* pondweed, nitella,

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* Scientific names of species mentioned in this report are listed in Appendix A.

and American eelgrass were the only species found in abundance in the lake. Cabomba, naiad, and coontail and other species were detected in the random samples but occurred at low frequency. A noteworthy exception was the weight attained by arrowhead (2218 g/m^2 dry wt) in Lake Gatlin. This was the largest single standing crop value for any species measured during the baseline period; however, this density was attained only in a limited area. Figure 5 shows the distribution of vegetation in Lake Conway during the baseline period.

28. Hydrilla was present in the West, East, and South Pools with average standing crops of 296.9, 15.6, and 40.3 g/m^2, respectively, while it occurred in the Middle Pool only in trace amounts. The percent frequency of occurrence, determined by transect sampling, varied seasonally from 15 to 35 percent in the West Pool, 6 to 21 percent in the East Pool, and from 10 to 38 percent in the South Pool. Hydrilla showed a slight annual overall biomass increase in the East and South Pools (75 and 81 g/m^2, respectively), whereas the West Pool showed an overall increase of 676 g/m^2. Figure 6 shows the distribution of hydrilla in Lake Conway during the baseline period.

29. Pondweed was commonly found in all pools of the system with the standing crops averaging 65 g/m^2 in the South Pool, 59 g/m^2 in the Middle Pool, 302 g/m^2 in the East Pool, and 74 g/m^2 in the West Pool. Pondweed occupied 78 percent of the 0- to 2-m depth zone in the South Pool, 40 percent in the Middle Pool, 62 percent in the East Pool, and 43 percent in the West Pool. The Middle and West Pools showed negative annual net changes in biomass of -72 and -132 g/m^2, respectively, whereas the East and South Pools showed increases of 188 and 450 g/m^2, respectively.

30. Nitella was the most common macrophyte in South and Middle Pools but was less common in the East and West Pools. The average standing crop of nitella was 658 g/m^2 in the Middle Pool and 461 g/m^2 in the South Pool which exceeded the average standing crop of any species in the lake system. The Middle and East Pools showed annual net biomass losses of nitella (-669 and -1272 g/m^2, respectively), whereas the South and West Pools showed increases (774 and 686 g/m^2, respectively).

Figure 5. Aquatic vascular distribution in Lake Conway, Florida, during the baseline period. Clear area denotes presence of vegetation (Nall and Schardt 1978)

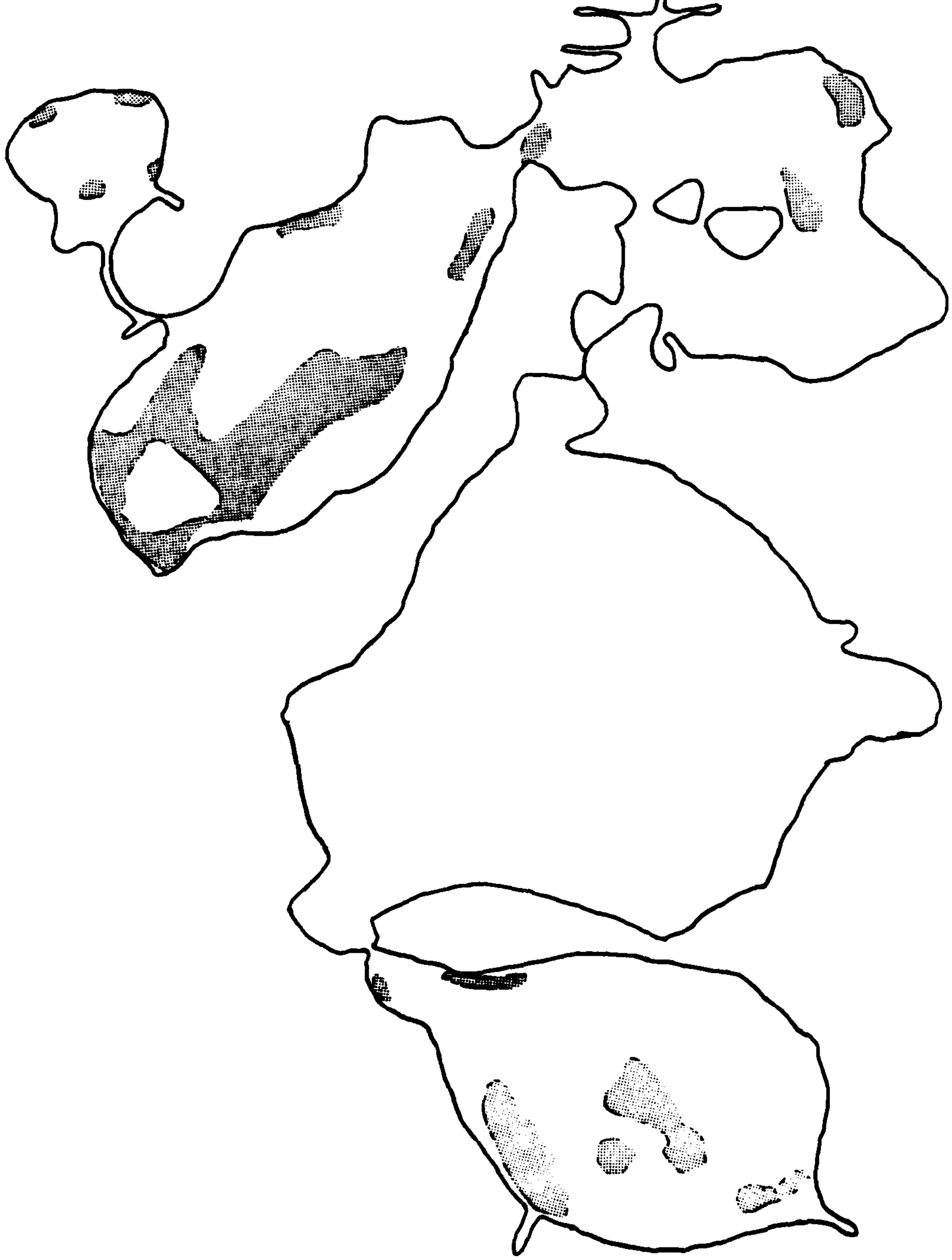


Figure 6. Hydrilla distribution in Lake Conway, Florida, during the baseline period. Hatched area denotes presence of hydrilla (Nall and Schardt 1978)

31. American eelgrass was found in low frequencies in all the pools of Lake Conway. Its greatest occurrence was in the East Pool where it exhibited a 19 percent frequency of occurrence and a substantial annual net biomass increase of 803 g/m^2.

32. Random sampling of Lake Conway showed that the actual standing crop of total vegetation per unit area was approximately equal in the major pools; however, the areal coverage of plants was greatest in the South Pool and decreased as one proceeded northward through the lake chain. Other investigators in the project also noticed the same trend of increasingly eutrophic conditions when proceeding northward (Blancher and Fellows 1979). This reverse correlation between vegetation cover and eutrophic conditions may be due to lower light penetration in the more eutrophic waters.

33. Hydrilla, pondweed, nitella, and eelgrass were the only abundant submerged plants in the lake during the baseline study. Hydrilla, pondweed, and nitella are in the highly preferred category of white amur feeding preferences. Nitella, which is the lake's most abundant plant, is the most highly preferred species. Eelgrass is the lake's only abundant plant that is in the "will not control effectively" category.

34. Prior to the start of the LSOMT, Lake Conway had a severe hydrilla problem. Nitella was present in small quantities. In the fall of 1974, the lake was treated with "System L," a selective herbicide that does not affect algae or nitella (which is a macroalga). After vascular competition was removed, nitella was able to densely colonize the lake. As a result, nitella, with a high profile and tremendous stem density, shaded the bottom and thus prevented other plants from reestablishing. There has been concern that the white amur will remove the nitella first which will allow hydrilla to populate those areas. Wood (1952) states that the charophytes are opportunistic plants that may colonize an area which is disturbed, but that they are transitional and are gradually displaced by other species unless conditions remain very stable. Considering the competitiveness of hydrilla and the increases in other species, it appears that nitella could be eventually replaced by hydrilla under natural conditions.

35. Hydrilla has shown tremendous increases in standing crop, height, and stem density in many areas of the lake during the baseline period; hydrilla height profile was nearing the surface in the West Pool during the peak growing season of the baseline collection period.

Plankton and Benthic Invertebrates

36. The Department of Environmental Engineering Sciences of the University of Florida was responsible for assessing the plankton (phytoplankton and zooplankton), periphyton, and benthic macroinvertebrate communities of the Lake Conway system (Conley et al. 1979). Data were collected from April 1976 through August 1977 to ascertain baseline conditions in the lake prior to introduction of the white amur. Since these communities are early indicators of environmental change, close monitoring could provide an early indication of habitat alteration caused by the introduction of the fish.

Methodology

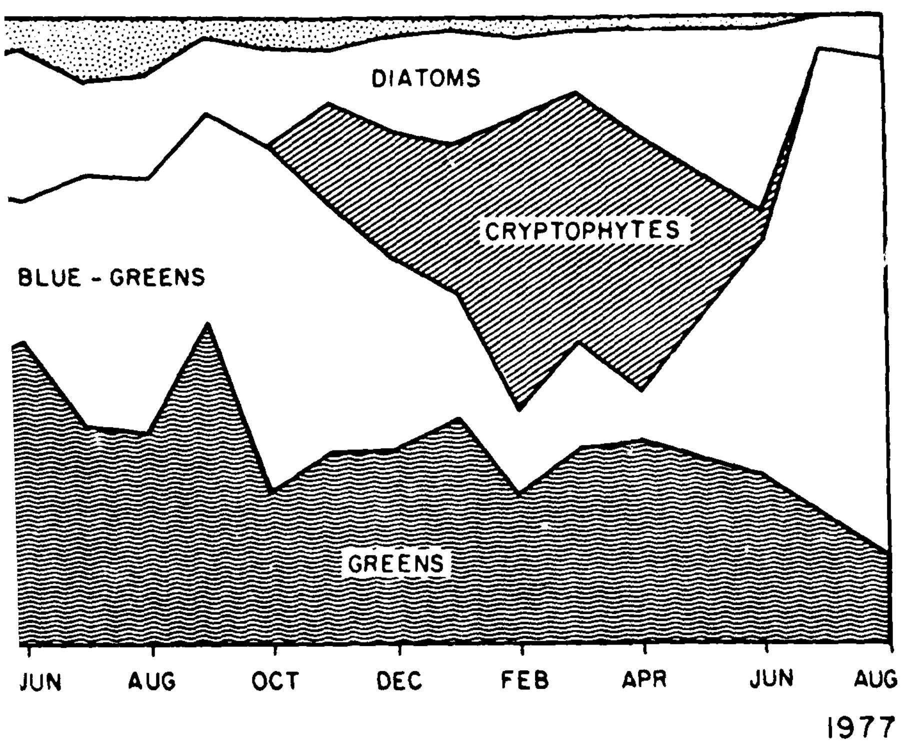
37. Monthly phytoplankton samples were collected at several stations in each of the five pools of Lake Conway. Phytoplankton samples were collected with either a Van Dorn or Kemmerer bottle (littoral stations) or by centrifugal pump (deep stations) and preserved with 5 percent tetraborate buffered formalin. After settling in Utermohl chambers, phytoplankton were identified to species level on an inverted microscope at a magnification of 400 diameters. Monthly zooplankton samples were collected from all pools of the Lake Conway system by the vertical haul technique with a U. S. Standard No. 10 plankton net, placed in collection jars, and preserved with 5 percent formalin for transport to the laboratory. In the laboratory, sample aliquots were placed in shallow dishes and enumerated and identified using a dissecting microscope.

38. Periphyton communities were assessed by quarterly sampling using commercial glass slide periphyton samplers as well as by sampling natural periphyton communities on macrophytes. In addition to counting and identification, aliquots were also obtained for chlorophyll *a* analysis, and dry and ash-free dry weight determination.

enthic macroinvertebrate samples were collected once every m the five pools of the Lake Conway system by replicate . Samples were sieved in the field with a U. S. Standard and fixed in 5 percent formalin with rose bengal. After e laboratory, the samples were sorted, transferred to 70 percent alcohol, counted, and identified to species.

esults

he phytoplankton communities of the Lake Conway system were with the green algae (Chlorophyta) remaining the dominant st of the year (Figure 7). Blue-greens (Cyanophyta) were ghout the year but comprised the dominant fraction during and fall. Diatom populations (Chrysophyta, Bacillariophy- airly constant but tended to be a slightly greater fraction



Relative percentages of phytoplankton taxa in Lake Conway, la, during the baseline period (Conley et al. 1979) of the algal community in late spring and early summer. The remainder of the algae included Pyrrophyta, Euglenophyta, and nondiatom Chrysophyta.

41. Abundance of total zooplankton for the Lake Conway system numbered about 10^5 individuals per square metre of surface area for all pools. Abundance of copepods and cladocerans throughout the system was on the order of 10^5 per square metre, whereas rotifers generally ranged slightly lower (10^4 to 10^5 per square metre). Distinct seasonal trends were not evident for all groups, but higher abundances were noted in spring and early summer.

42. Periphytic algae were dominated by blue-greens during the late spring and summer, whereas diatoms were dominate in the fall and winter. Differences were observed between artificial (glass slides) and natural (macrophyte) substrates with diatoms reaching greater numbers on the artificial substrate samplers. Total periphytic algal abundance was greatest in the fall of both 1976 and 1977.

43. A total of 75 taxa of benthic macroinvertebrates were identified from Lake Conway, including groups that were commonly associated with unstressed environmental conditions such as bryozoans (moss animals), trichopterans (caddisflies), and zygopterans (damselflies). Faunal differences existed between deep (>3 m) and shallow (<3 m) stations with higher total biomass (Figures 8 and 9), abundance, number of species, and species diversity occurring at the shallow stations. Densities at both shallow and deep stations reached a maximum during late fall and winter and a minimum during summer. A similar trend was present for the average species per sample and species diversity (Figure 10).

44. In general, the plankton, periphyton, and benthos of Lake Conway were typical of mesotrophic Florida lakes. The communities exhibited reasonably high diversities and organisms indicative of unstressed environmental conditions. However, blue-green algal blooms and reduction in benthos (abundance and number of species) during the summer hypolimnetic anoxia, and the nuisance growths of aquatic plants and periphyton, were indicative of advancing eutrophic conditions.

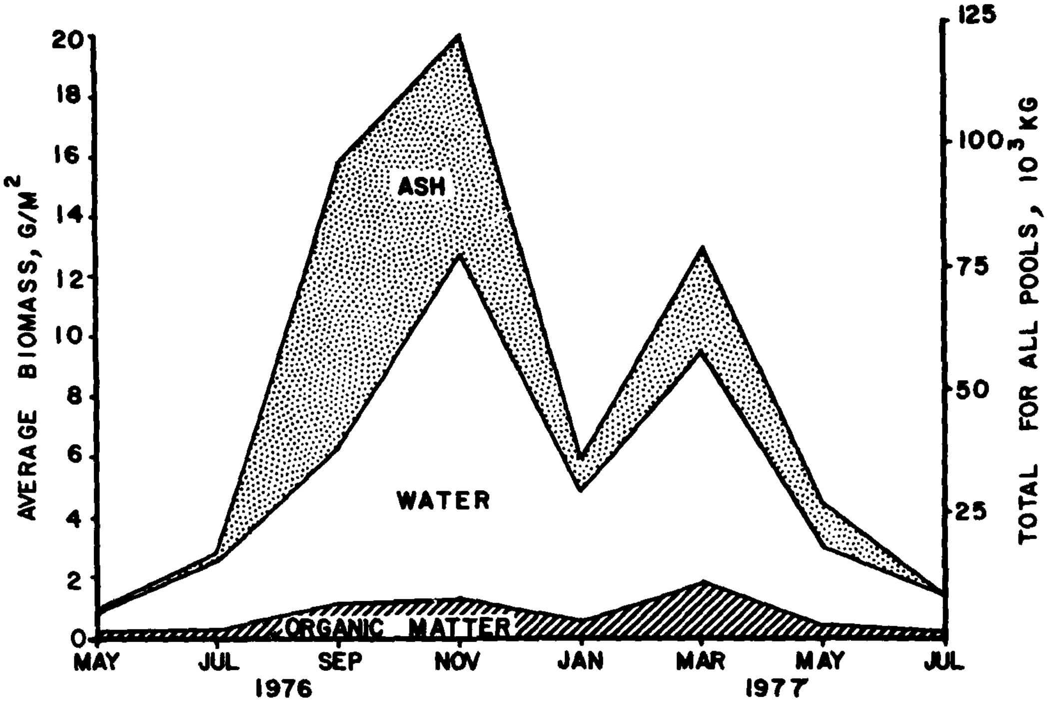


Figure 8. Biomass of benthic macroinvertebrates in areas >3 m deep (Conley et al. 1979)

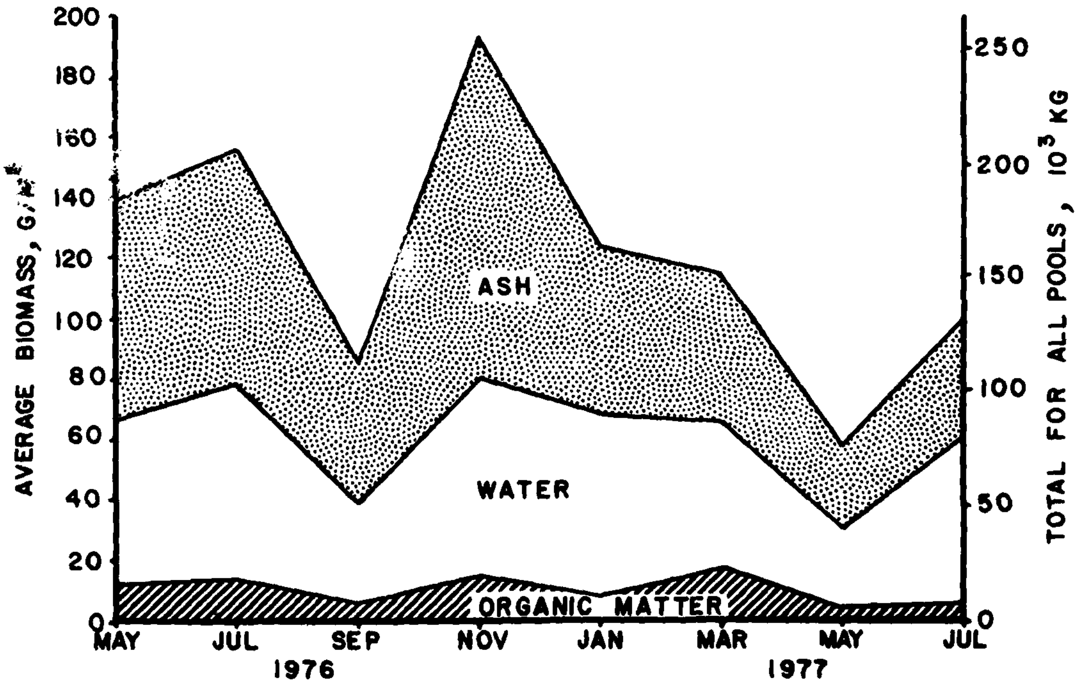


Figure 9. Biomass of benthic macroinvertebrates in areas <3 m deep (Conley et al. 1979)

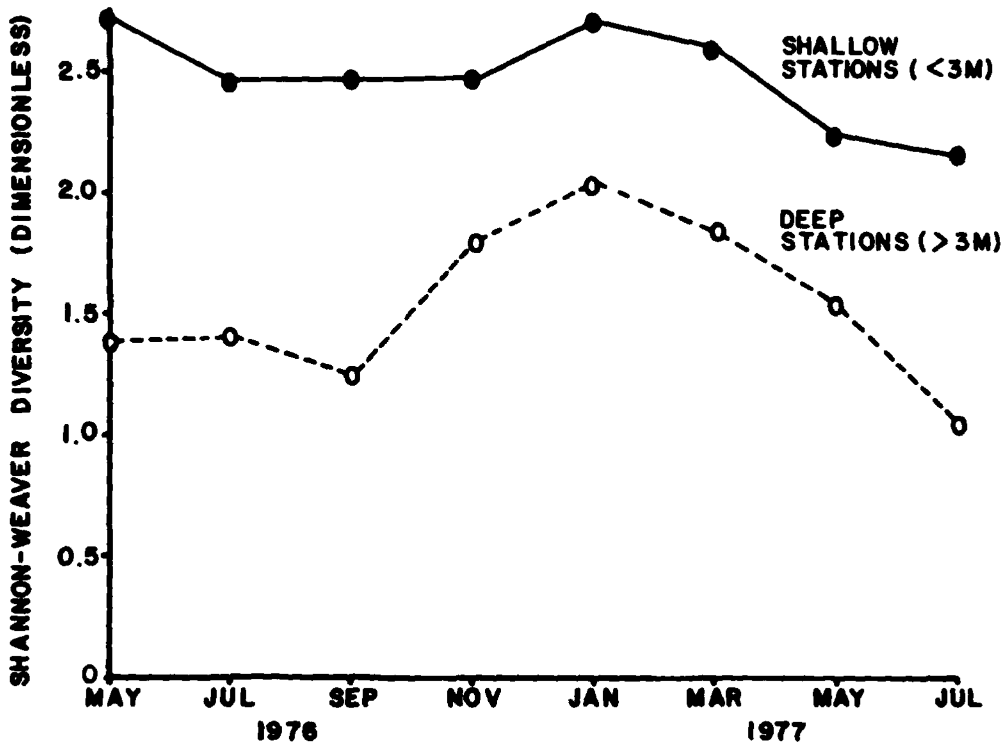


Figure 10. Shannon-Weaver species diversity comparison between shallow and deep stations at Lake Conway, Florida, during the baseline period (Conley et al. 1979)

Fish, Waterfowl, and Aquatic Mammals

45. The FGFWFC was responsible for evaluating changes in the fish, waterfowl, and aquatic mammal populations resulting from the stocking of the white amur. Detailed results of their studies are documented in Volume II of this report series (Guillory 1979).

Methodology

46. Fish populations were assessed using semiannual blocknets at three stations, as well as monthly gill net sets, 20- and 10-ft seine hauls, Wegener ring, and electroshocking techniques at selected representative habitats in Lake Conway. The sportfishery was characterized using a stratified random roving creel survey utilizing nonuniform probability sampling.

47. Waterfowl and aquatic mammal population densities were determined using visual counts and selective trapping techniques. Waterfowl and other aquatic birds were sampled monthly by simple direct counts from July 1976 through August 1977. An airboat or outboard-powered boat was driven along the lake shoreline, and the birds were counted as they flushed. Aerial and open-water individuals were also noted. Attempts were made to observe aquatic mammals during each phase of the fieldwork (i.e., creel census, fish sampling, and waterfowl surveys). Several dozen museum traps were set on undeveloped shorelines and checked daily during March 1977.

48. Preliminary sampling began in May 1976, and, by July 1976, all sampling techniques were employed. In addition to routine displays of data analysis such as frequency tables and abundance plots, three indices were calculated for the fish data: the Shannon-Weaver Index (Pielou 1966a), Margalef's Index of Species Richness (Margalef 1957), and the Evenness Index of Pielou (Pielou 1966b).

Summary of results

49. On an abundance basis, bluegill, blue-spotted sunfish, and redear sunfish dominated the electrofishing and blocknet sampling efforts, whereas Florida gar, gizzard shad, and largemouth bass were most abundant in gillnet samples. Mosquitofish, seminole killifish, bluefin killifish, and bluegill were numerically dominant in the Wegener ring and 10- and 20-ft seine samples.

50. In terms of biomass, largemouth bass, redear sunfish, chain pickerel, and bluegill dominated the electrofishing and blocknet efforts. Seminole killifish contributed the most biomass in the Wegener ring and 20-ft seine samples, while bluegill comprised the greatest percent by weight of fishes taken with the 10-ft seine. Gillnet sampling yielded the greatest biomass figures for Florida gar, gizzard shad, and largemouth bass.

51. Seasonal change in number, biomass, and species diversity varied with the sampling method and indicated no clear trends in Lake Conway (Figures 11-13).

52. Waterfowl. Fifty-one waterfowl species averaging 1472

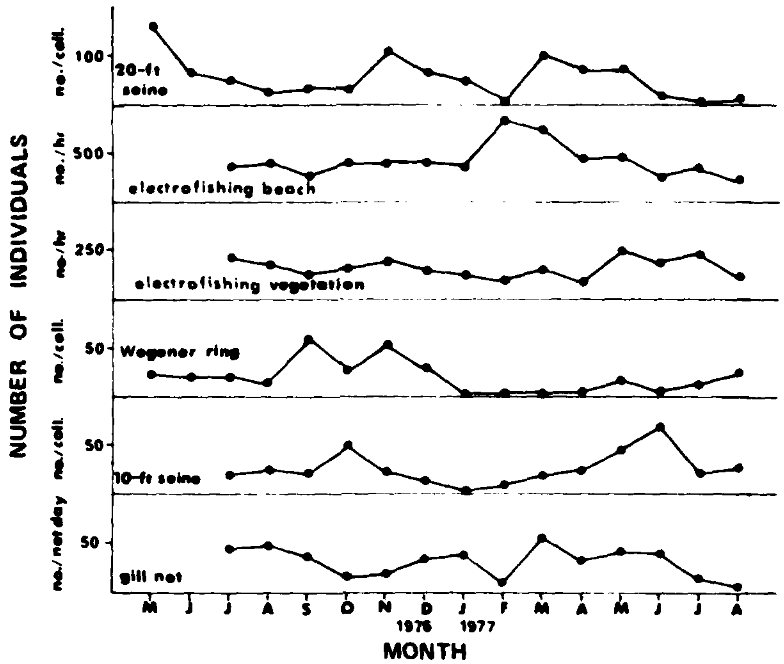


Figure 11. Comparison of number of fish collected by each sampling method in Lake Conway, Florida, during the baseline period (Guillory 1979)

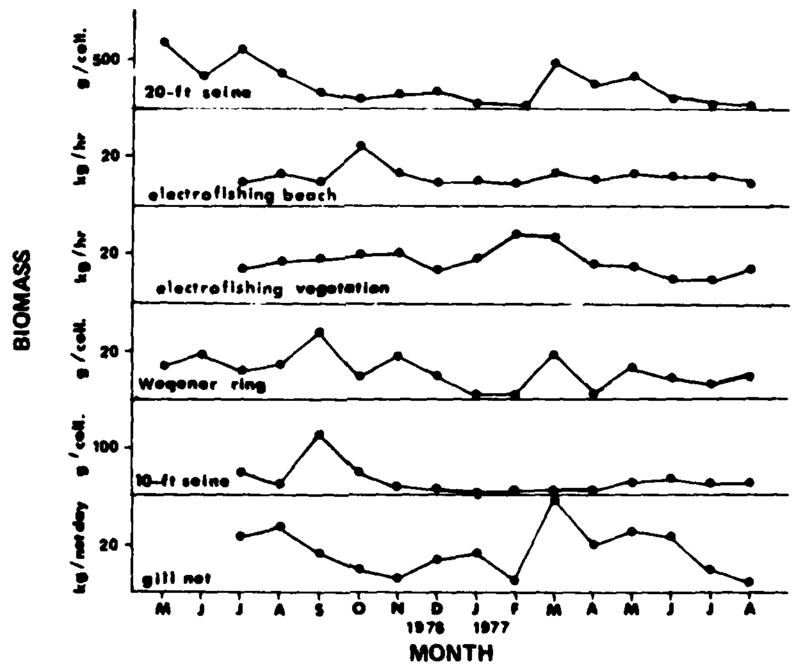


Figure 12. Comparison of biomass of fish collected by each sampling method in Lake Conway, Florida, during the baseline period (Guillory 1979)

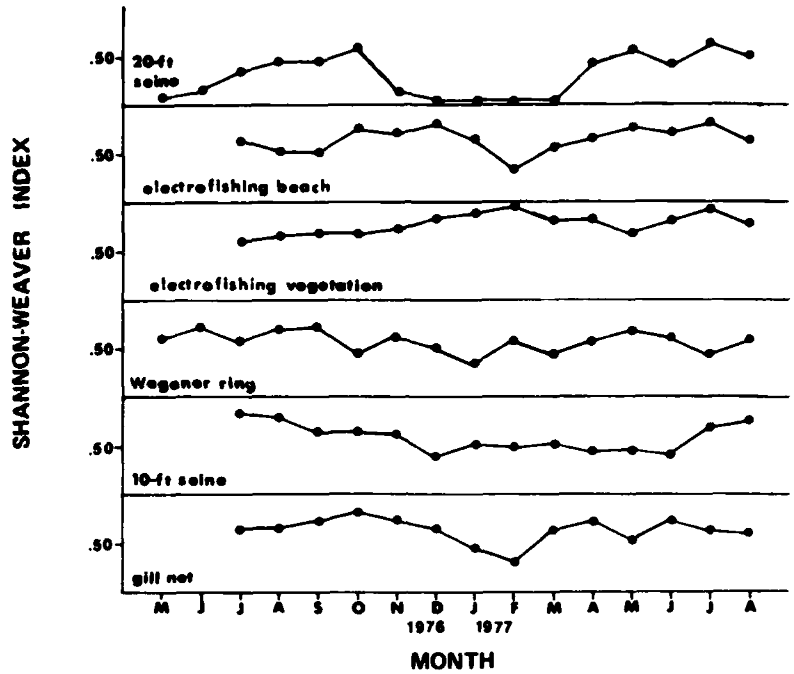


Figure 13. Comparison of Shannon-Weaver species diversity index calculated for each sampling method in Lake Conway, Florida, during the baseline period (Guillory 1979)

individuals per month were observed at Lake Conway. The 10 most abundant species were ringed-neck duck, muscovy duck, American coot, Florida gallinule, herring gull, mallard duck, least tern, tree swallow, red-winged blackbird, and boat-tailed grackle; each averaged more than 20 individuals per month and collectively comprised 89.6 percent of the total avifauna. Other common species averaging between 5 and 20 individuals per month included canvasback, limpkin, pied-billed grebe, great blue heron, green heron, least bittern, and fish crow.

53. Considerable seasonal variation existed in waterfowl populations for both number of species and total number of individuals. The number of species ranged from 18 in July 1976 to 30 in both January and February of 1977. Likewise, the number of individuals varied from 421

in July 1976 to 3590 in December 1977. The greatest number of individuals were encountered during the winter period November-February when a monthly average of 2800 individuals was counted (Figure 14).

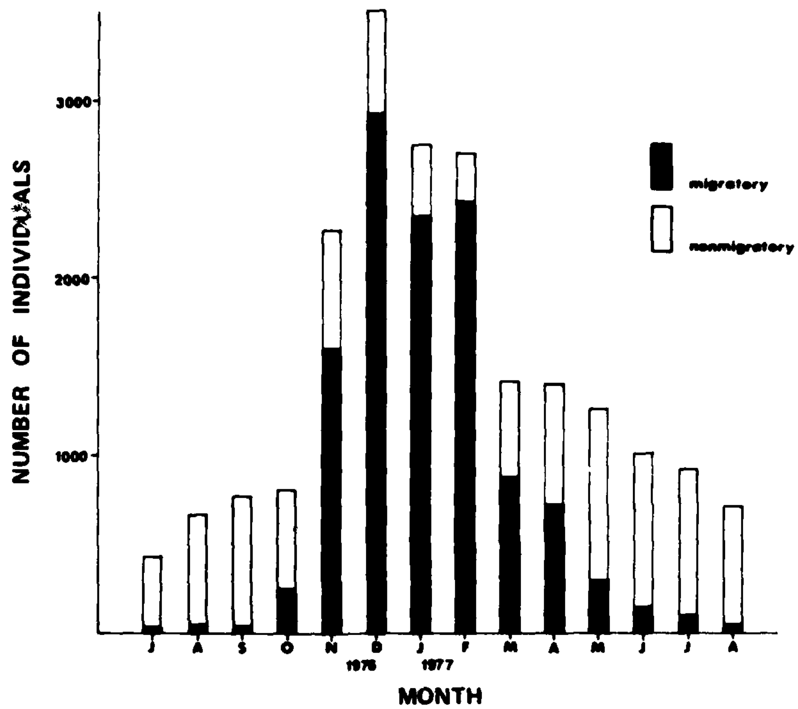


Figure 14. Monthly counts of birds at Lake Conway, Florida, during the baseline period (Guillory 1979)

54. Aquatic mammals. Aquatic mammals observed in or adjacent to Lake Conway included opossum, raccoon, river otter, Florida water rat, and marsh rabbit. Three hispid cotton rats were the only mammals captured by traps during the week of 7-11 March 1977.

55. Little is known about the population densities of these mammals in Lake Conway. There appears to be a family of otters (four to five individuals) inhabiting East and West Pools while the Florida water rat is common in *Panicum* spp. marsh areas in South and Middle Pools.

56. Several birds and mammals considered to be "threatened" and "of special concern" (according to the Florida Audubon Society) have been

observed at Lake Conway. The Florida water rat is considered a species of special concern. Ospreys are considered threatened in Florida, while the great white heron, Louisiana heron, and least bittern are considered to be of special concern. With the exception of the osprey, all of these species occupy shallow shoreline habitats. The bald eagle is listed as "endangered" in the State of Florida by the U. S. Department of the Interior.

Herpetofauna

57. In June 1977, the Department of Biology at the University of South Florida initiated a study of the herpetofauna of Lake Conway to establish quantitative baseline data for the white amur project. Since the white amur were introduced only 3 months after the herpetofauna study began, the period from June 1977 through September 1978 is considered "baseline" to which subsequent poststocking periods will be compared. Detailed results of the herpetofauna studies are documented in Volume V of this report series (Godley et al. 1981).

Methodology

58. Both shoreline and deepwater sampling sites were selected in the various pools of the Lake Conway system. Data were collected from the shoreline sites by use of funnel traps, "herp-patrol" or 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 FGFWFC's electrofishing and gill netting efforts.

Summary of results

59. A total of 5836 individuals representing 11 species of amphibians and 16 species of reptiles were observed or captured on Lake Conway during the 15-month baseline study period (June 1977-September 1978). Approximately 93 percent of the sampled herpetofauna were obtained within the first 3000 specimens, and one species identified thereafter. Based on the herptofauna sampling, three species of salamanders, eight anurans, one crocodilian, eight turtles, and seven snakes inhabit the Lake Conway complex and are dependent on Lake Conway for some portion of their life cycle.

60. Herp-patrol and funnel traps accounted for 86.5 percent and 8.1 percent, respectively, of all animals observed or captured on Lake Conway. These two methods also produced the greatest number of captures. Of 2281 individuals sampled by these methods, 71.2 percent were collected during the herp-patrols, and 20.7 percent were captured in funnel traps.

61. The probability of capturing or observing a species also varied by sampling method. Of the 27 amphibian and reptile species known from Lake Conway, 23 species were identified on herp-patrols and three (*Deirochelys reticularia*, *Hyla femoralis*, *H. squirella*) were known only from herp-patrol activities. No species were taken only in funnel traps during the baseline period, but this method did account for a sizeable portion (>30 percent) of the observations for *Amphiuma means* (93.5 percent), *Siren lacertina* (57.8 percent), *Kinosternon subrubrum* (49.1 percent), *Nerodia cyclopion* (31.1 percent), and most anuran larvae. Three species were known only from shoreline censuses, including a salamander (*Eurycea quadridigitata*) and two snakes (*Regina alleni*, *Thamnophia sirtalis*). All other species were taken by at least two sampling methods.

62. Based on the total cumulative species-number curve for Lake Conway (Figure 15) and the total number of observations recorded for each pool, between 70 and 80 percent of the total herpetofaunal species inhabiting each pool have been recorded. South Pool had the greatest total number of observations (1429) and the highest number of recorded species (22); West Pool had the lowest total number of observations (888) and recorded species (14). Other pools had intermediate values, perhaps indicating differences in habitat availability, species evenness, or sampling error.

63. The distribution of herpetofaunal species varied by pool (Table 2). Of the 27 species presently recorded from the Lake Conway system, 11 occur in all pools. These 11 species account for approximately 94 percent of the total observations.

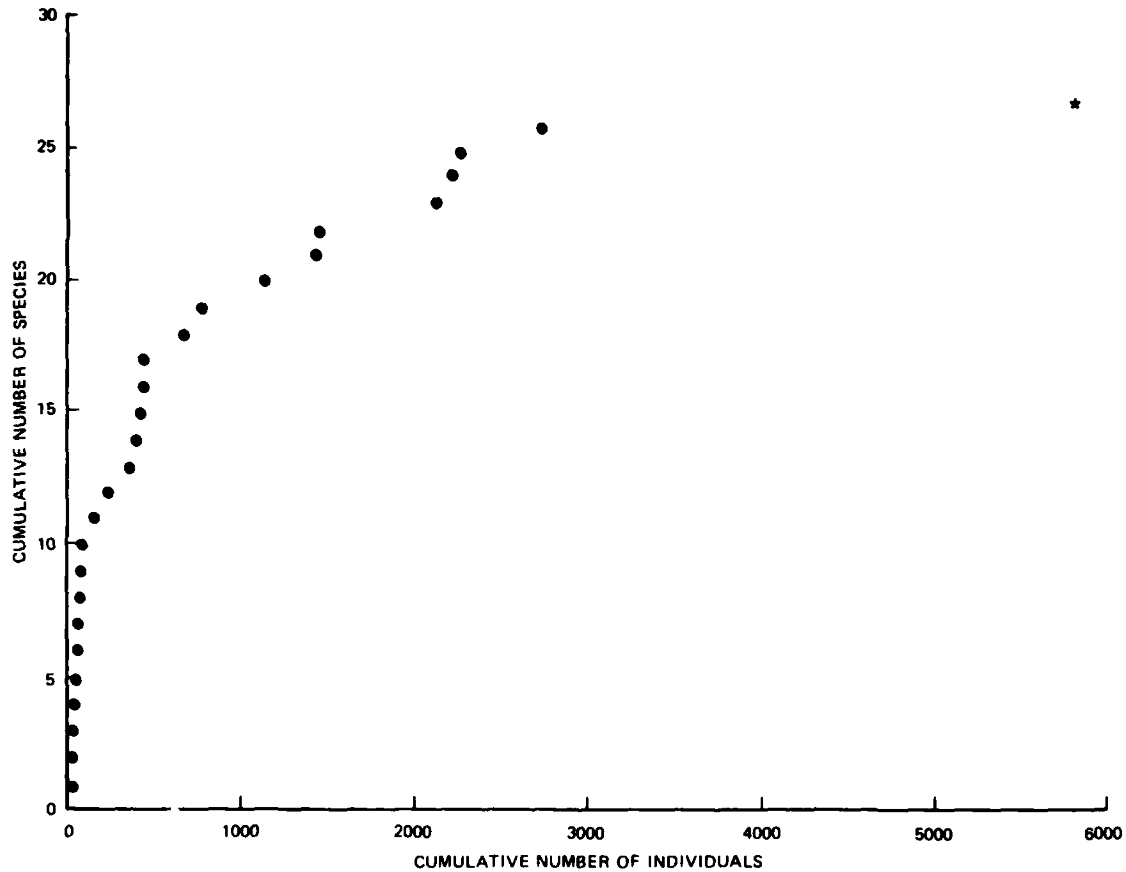


Figure 15. Cumulative species curve for Lake Conway, Florida. Total number of herpetofaunal species is shown as a function of the total number of individuals collected. Asterisk denotes the last individual collected during the baseline period (Godley, McDiarmid, and Bancroft 1981)

PART III: MODEL DEVELOPMENT

Stocking Rate Model

64. Development of the Stocking Rate Model (SRM) resulted from the need to evaluate the effect of white amur on a target macrophyte species and to determine on a rational basis the number of fish required for a desired level of macrophyte control. This model was developed by the scientists at WES and has undergone constant refinement as knowledge of the biology of the white amur and hydrilla has increased.

General concept

65. The SRM is intentionally simple and includes only two important state variables: the biomass of the target plant (hydrilla), and the biomass of the white amur (Figure 16).

66. The initial biomass of aquatic plants is calculated from the area of the lake, portion of the lake infested with hydrilla, average density (weight/unit volume) of hydrilla, and average depth of the lake where the plant occurs. Future biomass of hydrilla is estimated as a function of time based on a best-estimate curve formulation for the model.

67. Number and weight (in kilograms) of white amur selected for stocking are listed as initial input parameters. Numbers of white amur remaining over time are calculated from best-estimate curves for predation rate and natural loss rate. Both predation rate and natural loss rate are calculated as a function of weight of individual fish, with both loss rates decreasing with increasing weight of white amur. The growth rate of the white amur is a function of the weight of the fish at any given time. The curve used to estimate growth rate increases rapidly up to 3 kg, and then gradually decreases to "0" at a weight of 10 kg. Based on best-estimate curves, two factors are used to modify growth rate of white amur. Weight gain of white amur per weight of hydrilla consumed decreases exponentially with increasing weight of fish, while plant biomass to weight of fish conversion efficiency reduces the efficiency of the white amur when additional energy and time

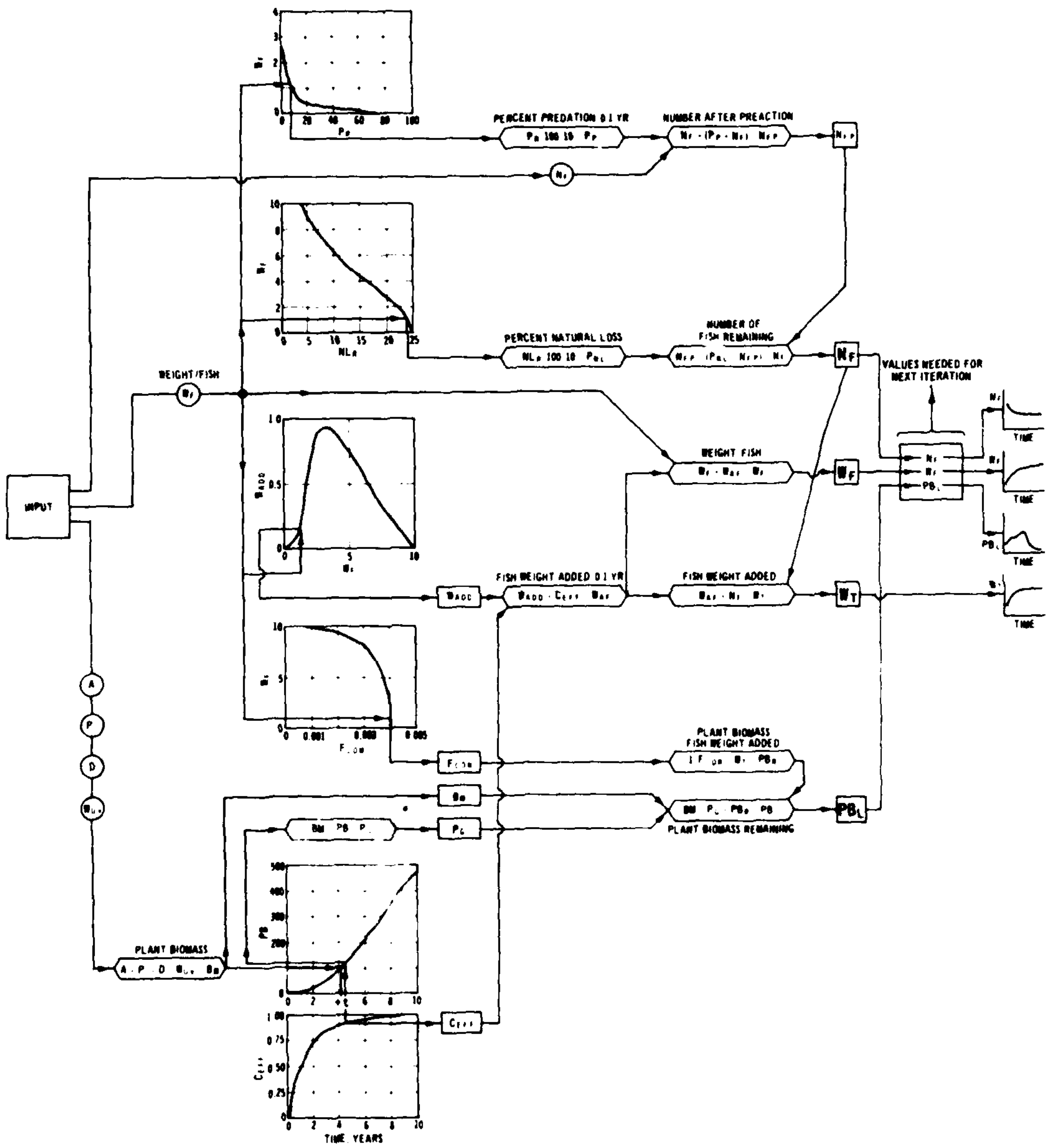


Figure 16. A flow diagram of the white amur Stocking Rate Model

has to be expended while searching for food.

Stocking rate predictions

68. After initial field surveys on Lake Conway gathered the required model input information for the SRM, a stocking rate was sought which would allow for control of the target plant in a reasonable time without jeopardizing other components of the lake's ecological system. Drawing from the experiences with other stockings of white amur in Florida lakes and initial model simulations with the SRM, it was obvious that too many fish stocked for the available vegetation would lead to complete elimination of aquatic macrophytes, while stocking a small-sized fish would lead to excessive predation with possible elimination of the entire stock. Likewise, too few fish stocked would be ineffective.

69. By simulating various combinations of numbers and sizes of fish for the existing hydrilla infestation, an optimum stocking rate was selected which provided for control of hydrilla in a realistic time frame which, in the judgment of the scientists at WES, would minimize any damage to the Lake Conway ecosystem and still provide the desired level of control of hydrilla. An initial stock of 7600 white amur weighing an average of 0.32 kg was predicted to eliminate hydrilla in 4-1/2 years (Figure 17). The stocking rate was four fish per surface acre of lake, or, 28 white amur per acre of hydrilla infestation.

70. On 9 September 1976, 7611 white amur averaging 0.32 kg were stocked in Lake Conway ending the prestocking test period.

Ecological Response Model

71. The Ecological Response Model has been formulated to represent the main biological components and interactions believed to be important in the ecosystem of Lake Conway and other southeastern lakes. The model was developed at the University of Florida and is described in detail in Volume VII of this report series (Ewel and Fontaine 1979).

General model description

72. The Lake Conway Ecosystem Response Model is a detailed model with 15 state variables and 94 constants and parameters. The major state

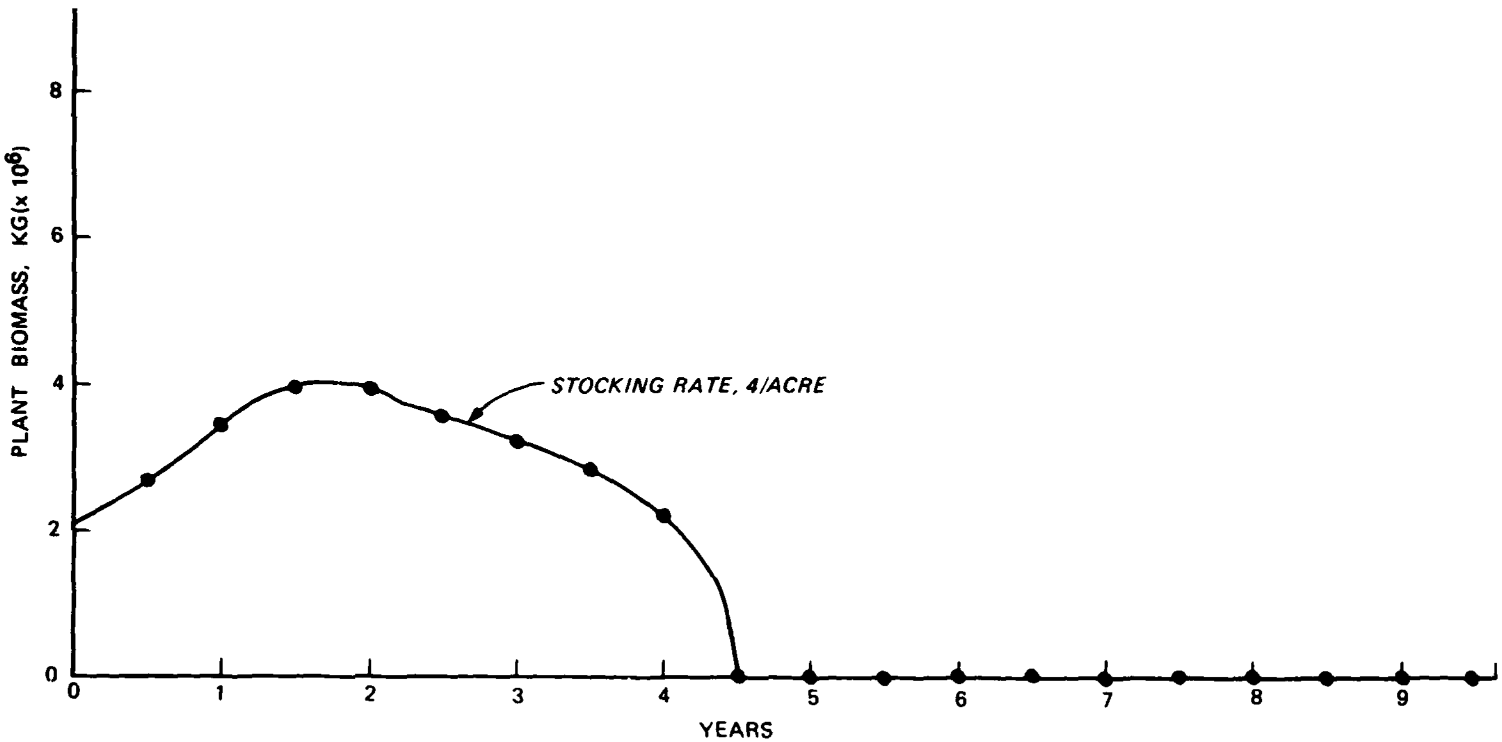


Figure 17. Stocking Rate Model prediction for Lake Conway, Florida

ariables are macrophytes and epiphytic algae, phytoplankton, epipelic lgae, zooplankton, benthic invertebrates, fishes, detritus, and phosphous. The white amur component of the model is designed so the model can perate with or without the fish in the lake in order to simulate pretocking and poststocking conditions in the lake.

73. Relationships between the various state variables are based n three sources of information: (a) productivity rates, respiration ates, and relationships among submersed plants summarized by Ewel and ontaine (1979); (b) data collected by other researchers participating n the Lake Conway project; and (c) estimates and assumptions obtained rom an extensive literature survey.

74. The model is designed to simulate the aquatic ecosystem for a 0-year period. The model itself is nonlinear and is programmed in SMP (Continuous System Modeling Program), a language that permits the olution of difference equations on a digital computer.

75. All macrophytes and their associated epiphytic algae are conidered as a complex. This assumption in the model is necessary beause of two limitations. The first is that productivity data were not btainable for individual macrophyte or algal species, so separation nto individual species in the model would be arbitrary. Secondly, the ack of specificity in the food habits of the white amur does not reuire distinction between plants by species in the model.

nitial results of the model

76. The Lake Conway ecosystem was simulated for a 10-year period sing January 1976 measurements for initial conditions. Simulation of e summer biomass of the macrophyte-epiphytic algae complex did not ow the biomass to reach nearly to the extreme that was shown by the ta collected by the Florida Department of Natural Resources, but was ll within the range of expected yearly variations. The plankton simutions (phytoplankton and zooplankton) showed seasonal changes in bioss that compared reasonably well with the observed values. An inability in the zooplankton pattern occurred early in the simulation. is instability also occurred in the benthic invertebrate simulation

and was probably a product of the instability in the zooplankton component of the model.

77. Simulations of herbivorous and predator fishes also showed an instability that could be attributed to the zooplankton-benthos instability. Even with the instability, fish populations seemed to exhibit a reasonable pattern given the limited data for comparison during the time this initial version of the model was operating.

78. The simulated introduction of the white amur showed some interesting results. Biomass of white amur increased rapidly until the second year. Decreases in the biomass of vascular plants, phytoplankton, and zooplankton were noted in the simulation, while epipelic algae, benthos, and secondary predator fish showed an increase in biomass over the 10-year period.

79. Many of the discrepancies between field data and simulation are attributed by the model's developers to nutrient-productivity relationships. Other discrepancies will be tested when more data from the other research teams become available.

PART IV: BASELINE DESCRIPTION OF LAKE CONWAY

80. Lake Conway is comprised of a series of fused dolines, typical of the lakes found in the karst topography of Florida. Soils of the surrounding watershed are classified as moderately and excessively drained fine sands. Infiltration of rainfall into these soils is immediate and complete, resulting in little or no surface runoff.

81. Since no surface streams of any consequence drain into the Lake Conway system, the water budget of the lake is dominated by evaporation-precipitation events. Rainfall accounts for 70 percent of incoming waters. Seepage and surface runoff (17 and 13 percent, respectively) from the surrounding basin constitute the balance of the water budget.

82. During part of the baseline period, from January 1976 through December 1976, total annual rainfall was near the mean annual rainfall expected for that area (52 in. (132.1 cm)). However, from January through August of 1977, rainfall was considerably lower than normal, and measured 18.08 in. (45.9 cm) from January through July 1977 compared to 32.39 in. (82.3 cm) for the same period during the previous year. Rainfall during the period immediately preceding the stocking of white amur in Lake Conway was considerably lower than usual. This was reflected in the water level of the lake which fell to its lowest point in 5 years during July 1977.

Nutrient Loading

83. Three major sources of nitrogen and phosphorus were identified during the baseline period (Blancher and Fellows 1979). Airborne sources of nutrients (rainfall and dry fallout) were the most significant sources contributing 71 percent of nitrogen and 52 percent of phosphorus loading. Nutrients in surface runoff comprised 6.9 percent of nitrogen and 36.9 percent of phosphorus loading whereas subsurface seepage sources contributed 19 and 8 percent of the nitrogen and phosphorus totals,

respectively. These figures were based on the 1976 water budget and not on the atypical 1977 water year.

84. Lake outflow accounted for less than 6 percent of the output of nitrogen and phosphorus from Lake Conway. The remainder of the nutrients are assumed to be losses due to sedimentation. While this loss does not represent complete removal from the system, sedimentation, considered a nutrient sink, essentially eliminates them from biological and chemical cycling within the lake.

85. Several bioassay procedures were performed to determine whether either nitrogen or phosphorus was potentially limiting in Lake Conway. Based on the results of the assays, it was concluded that phosphorus was probably limiting primary production in Lake Conway during part of the year. No indications of nitrogen limitation were observed.

86. Assuming proportions of nutrients from the major input sources are constant, the dry spell occurring during the spring and early summer of 1977 should have resulted in a significant decrease of nutrient loading to the lake. Future interpretations of changes in nutrient regimes or nutrient cycling should consider the possibility of lower than normal nutrient loadings during part of the baseline period.

87. Based on the nutrient loading data, Lake Conway is expected to exhibit the characteristics of a mesotrophic lake. Since the lake is probably phosphorus limited during a portion of the year, and substantial phosphorus input comes from surface runoff (36 percent), it is likely that increases in loadings from runoff may advance the trophic condition of the system to a more eutrophic system. Since the amount of impervious surface in the Lake Conway watershed dramatically affects the quantity and quality of surface runoff the lake receives (U. S. Department of Agriculture 1975), and the amount of impervious surfaces increases with increasing urban development, some consideration should be given to estimating the rate of housing development in the watershed during the study. By so doing, increases in loadings from these sources can be estimated.

Water Quality

88. Analysis of water chemical and physical data did not show excessive biochemical oxygen demand, nutrients, dissolved solids, or heavy metals. With the possible exception of transient oxygen depletion in the hypolimnia, analysis of the seasonal water quality data did not indicate acute water quality problems during the baseline period.

89. In terms of classifying the lake's trophic state, the mean annual values of three trophic state indicators (total phosphorus, chlorophyll a, and Secchi disk visibility) all were within the mesotrophic range of the National Eutrophication Survey guidelines (Gakstatter, Allum, and Omernik 1975). On a pool by pool basis, the South and Middle Pools were on the oligotrophic side of mesotrophy, the East and West Pools were decidedly mesotrophic, and Lake Gatlin was on the eutrophic side of mesotrophy. This analysis indicates a trend of increasing trophic state moving north through the various pools.

90. Sediment chemical parameters were within the range of other central Florida lake sediment concentrations and showed no indication of problem areas in the lake.

Plankton, Periphyton, and Benthos

91. The plankton, periphyton, and benthos of Lake Conway are typical of mesotrophic Florida lakes. The communities exhibit reasonably high diversities and include organisms indicative of unstressed environmental conditions. During the baseline period, the phytoplankton community was dominated by green algae (Chlorophyta) for most of the year with blue-greens (Cyanophyta) becoming numerically more important in late summer and fall. The zooplankton community was dominated by copepods during most of the year with vernal peaks of cladocerans and rotifers. Periphytic algae were dominated by blue-greens during late spring and summer and by diatoms (Chrysophyta) in fall and winter. Benthic macroinvertebrates exhibited diverse populations throughout the year with the occurrence of several species indicative of unstressed environmental conditions.

92. There are indications of advancing trophic state (toward eutrophy) such as periodic blue-green algal blooms, a loss of benthic macroinvertebrate diversity during summer hypolimnetic anoxia, and nuisance growths of periphyton. These observations suggest that the Lake Conway ecosystem is possibly in a state of advancing eutrophy.

Aquatic Macrophytes

93. Hydrilla, nitella, pondweed, and eelgrass were the dominant submerged macrophytes in the Lake Conway system during the baseline period. Of these species, only eelgrass is classified in the white amur's "will not effectively control" category.

94. Random sampling of the lakes has shown that the standing crop of vegetation per unit area was approximately equal in the major pools, but the area covered by macrophytes was greatest in the South Pool and decreased northward through the pools.

95. At the initiation of the baseline study, Lake Conway did not have a severe hydrilla infestation. This was probably due to the previous treatment of the lake with "System L," a selective herbicide. During the baseline investigations, however, hydrilla exhibited substantial increases in standing crop, height, and stem density in many parts of the lake, with the hydrilla height profile nearing the surface in the West Pool during the peak of the growing season in 1977. Thus, there were indications that hydrilla could again become the problem it had been prior to herbicide treatment.

Fish, Waterfowl, and Aquatic Mammals

96. The fish communities in Lake Conway are comprised of warmwater species typical of Central Florida lakes. Bluegill, blue-spotted sunfish, redear sunfish, largemouth bass, Florida gar, gizzard shad, mosquitofish, seminole killifish, and bluefin killifish are dominant bot in numbers and biomass.

97. In terms of a sportfishery, the catch rate for all species

was 0.39 fish per man-hour, considerably below the standard of 1.0 fish per man-hour commonly used to define a good sportfishery. The large-mouth bass catch rate was 0.24 fish per man-hour, slightly above the national average of 0.20 fish per man-hour. Continued monitoring of fish populations and fishing success should provide information useful in determining what changes, if any, will occur in the Lake Conway system.

98. Populations of mammals and waterfowl in or adjacent to Lake Conway exhibited both abundances and diversities typical of a Central Florida aquatic system. Several birds and mammals considered to be "threatened" and "of special concern" in the State of Florida by the Florida Audubon Society have been observed at Lake Conway. However, with the exception of the bald eagle, no species were observed that are currently on Federal lists of threatened or endangered species.

Herpetofauna

99. A total of 11 species of amphibians and 16 species of reptiles were observed or captured on Lake Conway during the baseline study. Since there are no published studies documenting amphibian and reptile communities in large aquatic habitats in Florida, comparison with similar herpetofaunal assemblages or populations is not possible. However, most amphibian and reptile species inhabiting Lake Conway are restricted to the littoral zone or depend to some extent on the littoral zone for some portion of their life cycle. Of the 27 species recorded for Lake Conway, 11 species accounted for approximately 94 percent of the total population sampled and occurred in all lake pools. The greatest diversity and abundance of organisms were sampled in areas supporting an abundance of aquatic vegetation.

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Table 1

Mean ($\bar{x}$) and Standard Deviation (s) of Water Quality Parameters at 11 Sampling Stations in Lake Conway, Florida*

Parameter	Station									
	South Pool				Middle Pool					
	1		2		3		4		5	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Temperature, °C	23.2	5.8	23.3	5.7	23.4	5.7	23.2	5.8	23.1	5.0
Conductivity, μmho/cm	210.0	12.0	210.0	12.0	210.0	9.0	210.0	10.0	215.0	8.0
Alkalinity, mg/ℓ	32.0	1.4	32.0	1.7	37.0	1.3	37.0	1.1	37.0	1.3
Hardness, mg/ℓ	60.0	5.8	59.0	4.1	61.0	3.9	62.0	3.5	62.0	3.4
Calcium, mg/ℓ	13.0	1.8	13.0	1.3	13.0	1.2	14.0	1.4	14.0	1.2
Sodium, mg/ℓ	15.0	0.9	15.0	0.9	15.0	1.0	15.0	1.1	15.0	1.1
Potassium, mg/ℓ	4.0	0.3	4.0	0.3	3.5	0.2	3.5	0.2	3.5	0.3
Magnesium, mg/ℓ	6.5	0.4	6.5	0.4	6.8	0.4	6.8	0.3	6.8	0.4
Secchi Disk, m	2.9	0.7	3.3	1.1	2.9	0.6	3.1	0.8	2.1	0.4
Organic nitrogen, mg/ℓ	0.49	0.07	0.49	0.07	0.43	0.08	0.43	0.08	0.44	0.08
Biochemical oxygen demand, mg/ℓ	1.1	0.4	1.1	0.4	1.0	0.5	1.1	0.5	1.2	0.5
Chemical oxygen demand, mg/ℓ	16.0	4.0	15.0	5.0	14.0	4.0	15.0	4.0	14.0	3.0
Total solids, mg/ℓ	130.0	6.0	130.0	8.0	130.0	8.0	130.0	9.0	125.0	12.0
Total phosphorus (filtered), mg/ℓ	0.01	0.007	0.01	0.007	0.01	0.007	0.01	0.007	0.15	0.005
Total phosphorus (unfiltered), mg/ℓ	0.02	0.009	0.02	0.008	0.02	0.007	0.02	0.009	0.02	0.008
Volatile suspended solids, mg/ℓ	1.7	1.2	1.8	1.2	1.5	0.9	1.3	0.8	1.5	0.9
Carotenoids, mg/m^3	3.1	2.8	3.0	2.7	3.2	2.6	3.4	2.4	3.2	2.7

(Continued)

* Miller et al. (1981)

Table 1 (Concluded)

Parameter	East Pool 6 $\bar{x}$	East Pool 6 s	East Pool 7 $\bar{x}$	East Pool 7 s	West Pool 8 $\bar{x}$	West Pool 8 s	West Pool 9 $\bar{x}$	West Pool 9 s	West Pool 10 $\bar{x}$	West Pool 10 s	Gatlin 11 $\bar{x}$	Gatlin 11 s
Temperature, °C	23.1	5.6	23.3	5.7	23.2	5.7	23.2	5.7	22.9	5.5	23.6	5.7
Conductivity, µmho/cm	230.0	7.0	230.0	6.0	230.0	7.0	235.0	8.0	235.0	7.0	270.0	12.0
Alkalinity, mg/ℓ	42.0	2.8	43.0	2.3	44.0	2.3	44.0	2.5	44.0	2.5	40.0	3.6
Hardness, mg/ℓ	68.0	4.6	69.0	4.4	70.0	4.5	70.0	4.4	71.0	4.1	82.0	4.8
Calcium, mg/ℓ	17.0	1.2	17.0	1.7	18.0	1.6	17.0	1.6	18.0	1.6	14.0	1.8
Sodium, mg/ℓ	[illegible]	1.0	15.0	1.0	15.0	0.9	15.0	0.9	15.0	1.1	16.0	2.5
Potassium, mg/ℓ	4.1	0.3	4.1	0.3	4.2	0.3	4.3	0.2	4.3	0.3	5.3	0.3
Magnesium, mg/ℓ	6.4	0.4	6.3	0.4	6.4	0.4	6.4	0.3	6.4	0.4	11.0	0.7
Secchi Disk, m	1.3	0.2	2.4	0.5	2.5	0.8	2.3	0.5	2.4	0.9	2.1	0.7
Organic nitrogen, mg/ℓ	0.54	0.04	0.54	0.04	0.54	0.05	0.53	0.06	0.54	0.04	0.56	0.13
Biochemical oxygen demand, mg/ℓ	1.5	0.4	1.5	0.8	1.5	0.6	1.3	0.3	1.3	0.4	1.3	0.5
Chemical oxygen demand, mg/ℓ	18.0	4.0	16.0	4.0	15.0	4.0	16.0	3.0	16.0	3.0	15.0	5.0
Total solids, mg/ℓ	140.0	12.0	140.0	10.0	14.0	9.0	140.0	13.0	140.0	13.0	170.0	16.0
Total phosphorus (filtered), mg/ℓ	0.01	0.007	0.01	0.007	0.01	0.007	0.01	0.006	0.01	0.005	0.01	0.006
Total phosphorus (unfiltered), mg/ℓ	0.02	0.012	0.02	0.011	0.02	0.008	0.02	0.007	0.02	0.008	0.02	0.009
Volatile suspended solids, mg/ℓ	2.1	1.0	2.0	1.0	2.1	0.9	1.9	1.1	1.6	0.7	2.5	1.8
Carotenoids, mg/m^3	3.8	2.1	4.6	2.6	5.4	3.3	5.2	3.6	5.4	3.5	6.5	4.8

Table 2

Distribution and Relative Abundance by Pool of Amphibians and Reptiles Observed or Captured During the Lake Conway Baseline Period*

Class/Order	Number of Species Observed					
	South Pool	Middle Pool	East Pool	West Pool	Lake Gatlin	Total
Amphibia	9	9	8	7	8	11
Caudata	2	2	3	2	2	3
Anura	7	7	5	5	6	8
Reptilia	13	10	9	7	11	16
Crocodilia	1	1	1	1	1	1
Testudinata	6	6	5	5	8	8
Serpentes	6	3	3	1	2	7
Total individuals observed	1429	1216	1355	888	948	5836
Percent of total observed individuals	24.5	20.8	23.2	15.2	16.2	99.9

* Godley, McDiarmid, and Bancroft (1981).

APPENDIX A: SPECIES NAMES USED IN THIS REPORT

Common Name	Scientific Name
Flora	
n eelgrass	Vallisneria americana
ad	Sagittaris graminea
	Cabomba spp.
l	Ceratophyllum demersum
a	Hydrilla verticillata
	Najas ssp.
	Nitella megacarpa
d	Potamogeton illinoensis
Fauna	
n coot	Fulica americana
gle	Haliaeetus leucocephalus
killifish	Lucania goodei
.	Lepomis macrochirus
otted sunfish	Ennea canthus gloriosus
led grackle	Cassidix mexicanus
ck	Aythya valisinera
Florida) gallinule	Gallinula chloropus
w	Corvus ossifragus
gar	Lepisosteus platyrhincus
water rat	Neofiber alleni
shad	Alosa sapidissima
ue heron	Ardea herodias
ron	Butorides virescens
gull	Larus argentatus
otton rats	Sigmodon hispidus
ch bass	Micropterus salmoides
tern	Ixobrychus e[illegible]lis
n	Sterna albifrons

(Continued)

Common Name	Scientific Name
Fauna (Continued)	
kin	Aramus guarauna
ard duck	Anas platyrhynchos
h rabbit	Sylvilagus palustris
uitofish	Gambusia affinis
ovy duck	Cairina moschata
sum	Didelphis marsupialis
-billed grebe	Podilymbus podiceps
oon	Procyon lotor
ar sunfish	Lepomis microlophus
vinged blackbird	Agelaius phoeniceus
ed-neck duck	Aythya collaris
r otter	Lutra canadensis
nole killifish	Fundulus seminolis
swallow	Iridoprocne bicolor

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