


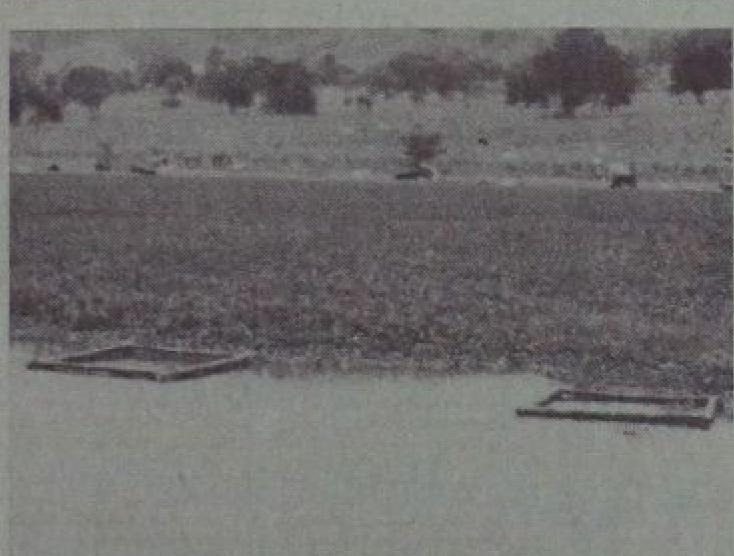

TECHNICAL REPORT A-78-2

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

Report 1

BASELINE STUDIES

Volume II

The Fish, Mammals, and Waterfowl of Lake Conway, Florida

By Vincent Guillory

Florida Game and Fresh Water Fish Commission
5950 West Colonial Drive
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Report 1 of a Series

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

This report presents the results of studies intended to provide baseline information in preparation for measuring the effect of the white amur on the aquatic vegetation of Lake Conway, Florida. It includes ecological conditions in Lake Conway from May 1976 to August 1977 for fish populations, waterfowl and aquatic mammal populations, fish food habits, waterfowl food habits, and conditions of the sport fishery. Temporal fluctuations in the parameters previously described were emphasized to facilitate future comparisons which will be made between baseline and poststocking data.

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PREFACE

The work described in this volume was performed under Contract No. DACW39-76-C-0081 between the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and the Florida Game and Fresh Water Fish Commission, Orlando, Fla. 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 second of eight volumes that constitute the first of a series of reports documenting a large-scale operations management test of 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 Mr. Vincent Guillory. The majority of the field work and data summarization was performed by project assistants Roy Land, Mike Rebel, and Dale Jones. Mr. Bob Gasaway provided technical input at the inception of the study. Messrs. Jerry Banks and Forrest Ware, Chief and Assistant Chief of the Fisheries Division, provided continued support. Messrs. Dennis Holcomb, Scott Hardin, and David Nixon reviewed a preliminary version of this volume.

The work was monitored at WES in the Mobility and Environmental Systems Laboratory (MESL) by Mr. R. J. Theriot under the general supervision of Mr. W. G. Shockley, Chief of MESL, and Mr. B. O. Benn, Chief of the Environmental Systems Division (ESD), and under the direct supervision of Mr. J. L. Decell, Chief of the Aquatic Plant Research Branch (APRB), ESD. The ESD and APRB are now part of the Environmental Laboratory of which Dr. John Harrison is Chief.

Director of WES during the period of the contract was COL J. L. Cannon, 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 volume 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*
feet	0.3048	metres
inches	2.54	centimetres
pounds (mass)	0.45359237	kilograms

* 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

BASELINE STUDIES

The Fish, Mammals, and Waterfowl of Lake Conway, Florida

PART I: INTRODUCTION

Background

1. Many aquatic habitats in the United States, especially those in Florida, have serious aquatic weed infestations which often interfere with water-oriented recreational activities. As a result, regulatory agencies have been under public pressure to control or eradicate vegetation on a quick, short-term basis rather than to correct the basic causes of vegetation proliferation; i.e., increased nutrient inputs and stabilization of water levels.

2. The prohibitive expense and frequent impracticality of mechanical control and the fact that use of chemical herbicides has been discouraged because of potential toxicity and long-term effects have made biological control of aquatic vegetation increasingly attractive. The classic approach to biological control has been the introduction of a biotic agent into the area to be controlled with the expectation that once the agent has been well established and widely disseminated it will provide perpetual control. Recently, increased attention has been paid to the control of aquatic vegetation by annual inoculative or inundative releases of either exotic or native organisms (Blackburn et al. 1971).

3. Although the role of fish in controlling aquatic vegetation has long been recognized (Black 1946), attempts to manipulate species solely for the control of undesirable plants have been made only recently. Several herbivorous species have been investigated as potential weed control agents. The white amur (*Ctenopharyngodon idella*), a

species native to the large rivers of South China, was recommended by Swingle (1957) for importation into the United States for weed control. The low rate of assimilation of vegetation by the white amur (due to the absence of enzymes necessary for cellulose digestion, a short digestive tract, and a tendency to gorge on vegetation, followed by poor digestion of the tightly compacted mass) coupled with its serrated pharyngeal teeth for masticating plant material accounts for its tremendous capacity for ingesting vegetation (Provine 1975).

4. However, in recent years, the white amur has been the subject of more controversy within the scientific community than any other fish species. As pointed out by Martin (1976), the white amur most clearly epitomizes both the potential benefits and the potential problems posed by exotic introductions; i.e., low-cost, efficient weed control versus possible environmental degradation. However, although there have not been adequate cost-benefit or environmental impact studies, the white amur has achieved nationwide distribution through widely scattered research projects at universities and state agencies, stockings to ameliorate weed problems due to public pressure, illegal importations from Arkansas-based private hatcheries, and finally by Arkansas' stocking policy, which has exposed the entire Mississippi River system to invasion by the species (this will be discussed in detail in Appendix C to this volume).

5. In view of the potential weed control capability and possible detrimental effect of the white amur, the U. S. Army Engineer Waterways Experiment Station (WES) began planning in 1975 for a multiorganizational project involving monosex white amur. This study was termed the Large-Scale Operations Management Test (LSOMT). Agencies involved in the Lake Conway project include the Florida Game and Fresh Water Fish Commission (in studies of fish, waterfowl, and aquatic mammals); the Florida Department of Natural Resources (aquatic plants); the Orange County Water Pollution Control Department (water quality); the University of Florida (plankton and macroinvertebrates); and the University of South Florida (amphibians and reptiles).

6. The primary objectives of the LSOMT are to determine the environmental effects of white amur introduction on the aquatic

ecosystem and to provide a basis for use of the species as an agent for the control and management of hydrilla. Forming an integral part of the latter objective are mathematical modeling efforts, including the white amur stocking model, the ecosystem response model, and the operations model. The stocking model is intended to provide the capability for determining the size and number of white amur to be stocked in a given area, given specified environmental parameters. The ecosystem response model is intended to provide a means for simulating the response of an aquatic system to white amur introduction through modeling of the interactions between the various components of the ecosystem. Finally, the operations model is intended to provide the user with a method for specifying a problem condition and obtaining realistic techniques that will be cost-effective within the user's resource constraints.

7. Selection of a test site was based on three qualifying criteria. First, the test site had to be relatively large. Second, the target plant species (Hydrilla) had to pose a problem. Finally, the test site had to constitute a definable, relatively closed ecosystem, such that the inflows and outflows could be controlled. The site selected was a complex of three small lakes, collectively referred to as Lake Conway, located just south of Orlando in Orange County, Fla. This system was one of the few lakes in central Florida which met the qualifying criteria.

8. An important aspect of the LSOMT is the security plan involving the use of fish-proof barriers at potential escape routes from the lake. Barriers were placed at two sites: (a) the main outlet control structure for the Lake Conway system under Daetwyler Drive and (b) an inlet canal between West Pool and Lake Jessamine. In addition, a backup barrier was placed at the outlet structure of Lake Mare Prairie, located downstream from the Lake Conway system.

9. Monosex (all female) white amur are being used in the test program to minimize the chance of natural reproduction. The monosex approach is believed to be superior to other currently used methods of studying exotic fishes, although there is a remote chance that reproduction might occur either by natural gynogenesis (which would require

courtship of the white amur by another species) or by mating with a male white amur should spontaneous differentiation of XX genotype females to males occur (Stanley 1976).

10. Artificial gynogenesis was used at the Fish Farming Experiment Station at Stuttgart, Ark., to produce the monosex fish for the LSOMT at Lake Conway. Gynogenesis is the development of the ovum after penetration by a spermatozoan but with no genetic contribution from the male. The usual procedure is to destroy sperm chromosomes by denaturation of the DNA with ultraviolet light (Thomas 1976). Israeli carp (Cyprinus carpio) males are used for the sperm donor because their sperm size is similar to that of the white amur and any chromosomal material not destroyed by the ultraviolet irradiation will produce a lethal hybrid. Only the diploid female fry survive beyond 24 hours.

11. White amur were stocked in the lake on 9 September 1977 at locations in each pool. These fish were transported by truck from the Fish Farming Experiment Station at Stuttgart with a travel time of approximately 20 hours. Upon arrival at the release site, load mortality was estimated. In addition, a representative sample of the fish was taken to the Florida Game and Fresh Water Fish Commission's Richloam Hatchery for subsequent determination of long-range mortality.

12. Given the total area of the lake, water temperature, area infested by vegetation, weight per unit volume of vegetation, average depth of infested area, maximum time to achieve control, weight of individual fish to be stocked, and growth and mortality rate of the fish, it was calculated (using the white amur stocking model) that a total of 7000 fish (3.9 fish per acre*) 0.5 to 1.5 lb in size would achieve vegetation control in 4 years. Using this approach, the vegetation would not be eliminated.

13. The data collected by each agency involved in the study (see paragraph 5) are coded and submitted to WES to be keypunched and computerized. All data are available to cooperating agencies on a

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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.

continuing basis during the LSOMT. Baseline data were gathered for at least 1 year prior to introduction of the fish. After stocking, the system will be monitored for at least 3 additional years. Prestocking and poststocking conditions will then be compared, thus identifying any environmental impacts, whether adverse or beneficial, associated with the introduction of the white amur.

14. The Fisheries Division of the Florida Game and Fresh Water Fish Commission is involved in the following studies:

a. Fish populations. Six sampling methods (blocknet, gill net, electroshocker, 20-ft seine, 10-ft seine, and Wegener ring) are being used to determine the species composition, diversity, and abundance of fishes.

b. Waterfowl and aquatic mammal populations. Visual counts are being used to sample these groups.

c. Creel census. The sport fishery is being measured by a stratified random roving creel survey utilizing nonuniform probability sampling.

d. Native fish life history. Life history information is being derived from four species of divergent trophic levels and ecological habits, including chain pickerel, bluefin killifish, bluegill, and largemouth bass.

e. Waterfowl food habits. Food habits of selected waterfowl are being analyzed.

15. Results of these studies are presented herein as Parts II-VI, respectively. Additional data are reported in Appendices A-E. These additional data, although not part of the contracted research, were obtained during the conduct of the five above-mentioned studies and are believed to constitute significant expansions of the study data.

16. The overall objective of the Florida Game and Fresh Water Fish Commission's portion of the Lake Conway project is to evaluate any changes in the fish, waterfowl, and aquatic mammal populations due to stocking of white amur. The purpose of this volume is to present baseline information on the above parameters for the period of May 1976-August 1977. To facilitate comparisons of baseline and poststocking data, temporal variations will be emphasized.

Literature Review

17. A considerable body of speculative literature, both popular and scientific, indicates that there is a great deal of controversy associated with white amur introductions. The proponents and opponents of use of this species vigorously stress the potential benefits and problems posed by this species. It is beyond the scope of this volume to review in detail all white amur literature, but a brief summary of the benefits and adverse impacts of the species seems appropriate.

18. Use of the white amur offers several advantages:

a. The economics of potential sustained vegetation control and manipulation with the fish are especially attractive when compared with the costs of chemical or mechanical control.

b. It eliminates the necessity of utilizing chemical control which leads to environmental contamination. (Careless application of herbicides can lead to acute oxygen depletion and a reduction in primary production.)

c. In polyculture situations, increased standing crops of all species can be obtained due to more efficient utilization of food resources resulting from rapid cycling of nutrients by the white amur.

d. The white amur is a potential food and sport fish.

e. Indirect control of larval mosquitoes may be achieved as a result of aquatic plant elimination.

19. Martin (1976) has cautioned that the successful introduction of any exotic species into a given biological community cannot be accomplished without some possible consequence. The inproper use of biological management tools in the form of nonindigenous or exotic species may be potentially as serious as the improper use of chemical or physical additives (Lachner et al. 1970). The addition of either nonbiological or biological agents can be reduced or terminated at any time; however, both forms are difficult to remove once introduced. For instance, white amur are particularly elusive to conventional fish capture techniques except selective chemical renovation, which is expensive in large systems. They must complete their life cycle before their presence ceases, assuming reproduction does not take place.

20. Scientists have long recognized the need for aquatic macrophytes in the environment to protect water quality and to provide food and habitat, both directly and indirectly, for fish and wildlife. The following adverse effects may be associated with the introduction of white amur:

a. Although the white amur will remove aquatic vegetation when stocked in sufficient numbers, both beneficial and problematic plant species will be reduced.

b. White amur recycle nutrients bound in aquatic macrophytes, possibly increasing the nutrient level in the water so that problems of eutrophication, plankton blooms, and filamentous algae are aggravated.

c. Sport fish population production may decline due to simple displacement, direct competition for food by young white amur with game fish, reduction of fish food organisms, and physical destruction of shallow, heavily vegetated habitats used for cover and spawning.

d. The increased fish production in hatchery ponds may manifest itself in natural situations in trophic levels adapted for planktivorous feeders such as clupeids or may result in overcrowded, stunted panfish populations.

e. White amur may escape from stocking sites by accidental release, deliberate movement by the public, or simple dispersal.

f. The fish is clearly an edible species, but most Americans, unlike Europeans and Asians, will not accept a cyprinid species as a food item.

g. White amur are very strong and thrash wildly when seined in hatchery ponds, damaging other fishes as well as posing a hazard for crew personnel.

h. Harmful fish parasites and diseases associated with the species may be transferred with their hosts from state to state.

Study Area

21. The study site is located on Lake Conway, Orange County, Fla. This area is in the Central Highlands physiographic unit (Cooke 1945). Average altitude of this area is between 50 and 85 ft above mean sea level. The surface is blanketed with a layer of highly permeable marine sand and is usually separated from the porous limestone of the

Florida aquifer by impervious sediments.

22. Orange County has a subtropical climate with only two pronounced seasons--winter and summer. The average annual temperature is 72°F and the annual rainfall is 51.4 in. (Lichtler et al. 1968). Summer thunderstorms account for most of the rainfall.

23. The Lake Conway chain is a complex of three small natural lakes, Gatlin, Conway, and Little Lake Conway, totaling 1820 acres in area. This system lies in the uppermost portion of the Kissimmee River drainage, emptying via Little Mare Prairie and Boggy Creek to the lower lakes region. The shoreline has been noticeably altered by urbanization and associated shoreline development and vegetation removal; however, some areas have a narrow fringe of emergent *Panicum*, *Typha*, or *Fuirena*. Dominant submergent vegetation includes *Vallisneria*, *Potamogeton*, *Nitella*, and *Hydrilla*. The substrate is primarily sand, except in areas of extremely thick vegetation where a thick layer of organic detritus has been deposited. The lake is mesotrophic. The bottom contours are rather steep in many areas as compared to the gradually sloping shorelines characteristic of other central Florida lakes.

PART II: FISH POPULATIONS

24. The objective of this portion of the study was to characterize baseline conditions in Lake Conway fish populations for the period May 1976-August 1977.

Materials and Methods

Field sampling

25. Six sampling techniques, employing blocknet, gill net, electroshocker, 20-ft seine, 10-ft seine, and Wegener ring, were used to describe the species composition, abundance, and diversity of the Lake Conway fish community. Sampling sites for each technique are shown in Figure 1. Preliminary aspects of the sampling program began in May 1976. By July 1976, all sampling techniques were being used. Data collected after August 1977 are not included in this volume.

26. Blocknet samples were taken semiannually in deeper littoral habitats at three stations. Samples were taken in June and October 1976 and in May 1977. The remaining five methods were used monthly. Six stations were established for the 10-ft seine, 20-ft seine, and Wegener ring. Two Wegener ring samples were taken at each station in shallow, heavily vegetated habitats. Two seine collections accompanied the Wegener ring efforts. One seine collection of five hauls was taken in unvegetated beach habitats with a 20-ft seine; the other collection of five hauls was taken adjacent to emergent vegetation with a 10-ft seine. One hour of nocturnal electrofishing at each of three stations was undertaken in littoral areas, with each station subdivided into vegetated and beach habitats and electrofished for 30 min. Two 150-ft gill nets of various mesh sizes were set overnight at each of two stations.

27. In general, field and laboratory procedures used during this study for each gear type are identical with those currently utilized by other fishery projects in Florida.

Data analysis

28. A measurable characteristic of any collection of organisms

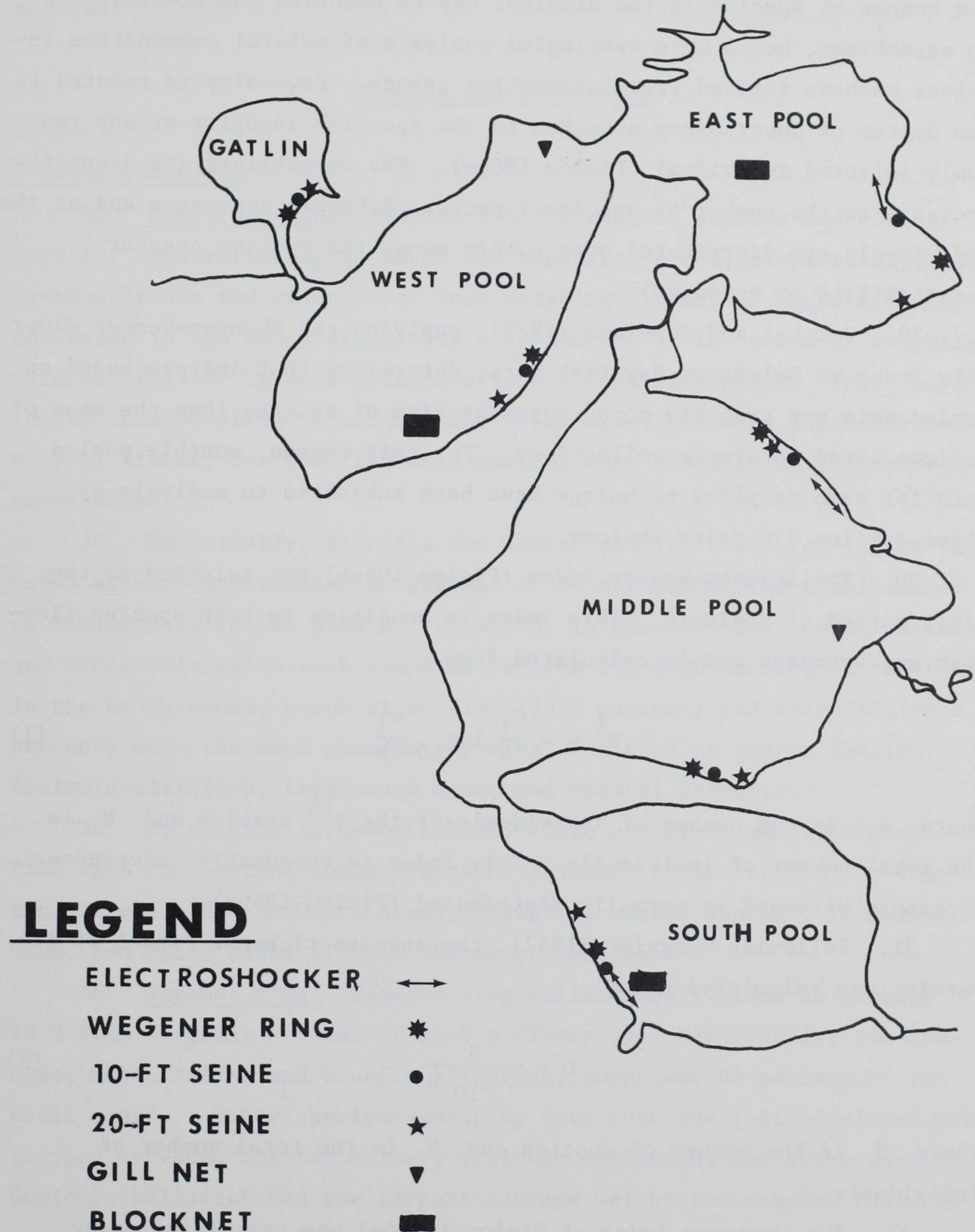

Figure 1. Locations of sampling stations

containing one or more species is its species diversity (Pielou 1966a). The number of species is the simplest way to describe the diversity of an assemblage, but a more meaningful analysis of natural communities involves methods derived from information theory. Diversity is related to the degree of uncertainty attached to the specific identity of any randomly selected individual (Pielou 1966a). The uncertainty and diversity increase as the number of species (species richness) increases and as the individuals are distributed more evenly among the species present (equitability or evenness).

29. Betchel and Copeland (1970), applying the Shannon-Weaver diversity index to Galveston Bay fish data, determined that indices based on pooled data are probably more representative of an area than the mean of indices based on single collections. For this reason, monthly pooled data for each sampling technique have been subjected to analysis by three species diversity indices.

30. The Shannon-Weaver index (Pielou 1966b) was selected as the first method of analysis. This index is sensitive to both species richness and evenness and is calculated from

$$H^1 = - \frac{n_i}{N} \log_{10} \frac{n_i}{N} \quad (1)$$

where n_i is the number of individuals of the i^{th} species and N is the total number of individuals. This index is reasonably independent of sample size and is normally distributed (Pielou 1966a).

31. Following Margalef (1957), the species richness aspect of diversity was calculated using

$$D = \frac{S}{\log_{10} N} \quad (2)$$

where S is the number of species and N is the total number of individuals.

32. The evenness index of Pielou (1966a) was calculated using

$$J = \frac{H^1}{H_{max}} = \frac{H^1}{\log_{10} S} \quad (3)$$

where H^1 is the Shannon-Weaver index value and S is the number of species.

Results and Discussion

Overall abundance

33. Electrofishing. Tables 1 and 2 present numeric and biomass data for electrofishing in beach and vegetated areas, respectively. An average of 436 individuals per hour weighing a total of 12.25 kg were collected in the beach areas, while an average of 165 per hour weighing a total of 17.42 kg were collected in the vegetated areas. Thus, according to this sampling technique, the beach areas harbored a greater density of fishes, but the fish were smaller than those found in the vegetated areas.

34. Numerically, bluegill and redear sunfish dominated in the vegetated areas, constituting an average of 56 percent of the total number of individuals in the sample. Warmouth, largemouth bass, chain pickerel, and brook silverside each comprise between 5 and 10 percent of the total. In the beach areas, brook silverside (33.4 percent) and bluegill (29.8 percent) were the most abundant species, followed by redear sunfish, Seminole killifish, largemouth bass, and coastal shiner.

35. By weight, largemouth bass, chain pickerel, and redear sunfish each had percent compositions of at least 10 percent in the vegetated areas. In the beach areas, bluegill, redear sunfish, largemouth bass, and chain pickerel were the major species.

36. Wegener ring. Wegener ring collections yielded an average of 20.9 fish weighing a total of 11.5 g (Table 3). Numerically, two species, mosquitofish and bluefin killifish, comprised 68 percent of the total sample. Other species averaging more than one individual per collection included coastal shiner, Seminole killifish, and swamp darter. Seminole killifish had the largest average weight per sample, followed by mosquitofish, bluefin killifish, warmouth, and bluegill.

37. 20-ft seine. An average of 57.0 fish weighing 237.2 g were taken in each 20-ft seine sample (Table 4). Seminole killifish was the

dominant fish captured, comprising 82 and 71 percent of the total number and weight per sample, respectively. The only other species of significance in these seine collections were coastal shiner, bluegill, redear sunfish, and largemouth bass.

38. 10-ft seine. This method yielded a mean of 24.4 fish weighing a total of 34.2 g for each collection (Table 5). In decreasing order, the most numerous species were mosquitofish, bluegill, bluefin killifish, coastal shiner, and Seminole killifish. Bluegill comprised the greatest percentage by weight, with Florida gar, Seminole killifish, and mosquitofish following.

39. Gill net. An average of 31.4 individuals per day weighing a total of 17.8 kg were taken in gill nets (Table 6). Florida gar, gizzard shad, and largemouth bass were the three dominant species in terms of both biomass and numbers.

40. Blocknet. Blocknet collections in Lake Conway yielded an average per hectare of 27,180 fish weighing a total of 114.13 kg, 22,484 fish weighing 113.97 kg, and 60,787 fish weighing 91.64 kg in spring 1976, fall 1976, and spring 1977, respectively (Table 7). The most abundant species included bluespotted sunfish, bluegill, redear sunfish, bluefin killifish, and largemouth bass. Redear sunfish, largemouth bass, bluegill, chain pickerel, bluespotted sunfish, and warmouth contributed the most biomass in blocknet samples.

41. Table 8 presents the average yields of three categories of fish (sport, forage, and other) for the three blocknet sampling periods. Forage species dominated samples numerically, averaging 29,364 fish per hectare or 79.8 percent of the total. By weight, the six sport fish comprised a major portion of the blocknet samples, yielding 82.67 kg per hectare (68.6 percent). Forage fish ranked second in biomass, and sport fish were second in number. The "other" category ranked last in both numbers and biomass.

42. Comparison of the blocknet data for the three categories reveals some interesting changes. The fall 1976 samples yielded fewer numbers for all three categories but slightly greater biomass for sport and forage fish as compared to the spring 1976 samples. Biomass of

sport and "other" fishes declined from spring 1976 to spring 1977.

43. Average yields of harvestable size sport fish per hectare are presented in Table 9. An average of 215 fish weighing a total of 48 kg were collected per hectare. Total number and biomass declined with each sampling period from the inception of the study. Largemouth bass yielded the greatest biomass (17.62 kg), followed by redear sunfish and chain pickerel. Numerically, redear sunfish and bluegill were the dominant species.

44. Length-frequency distribution data for sport fish species are presented in Table 10 for the three blocknet sampling periods. Excepting black crappie, all species showed strong 1976 and 1977 year classes. The dominance of small fish is especially evident for bluegill and redear, of which a great majority were young-of-the-year and juveniles of less than harvestable size.

Seasonal variations

45. Most of the analyses thus far have emphasized monthly variations in those parameters most likely to identify fish population changes associated with introduction of the white amur. Any environmental perturbation should be reflected in these parameters in a comparison of baseline and poststocking data. The following parameters, including number and biomass per unit effort, number of species, Shannon-Weaver index, species richness index, and species evenness index, have been subjected to monthly analysis.

46. Numbers. The catch per unit effort in terms of number of individuals for each sampling technique is illustrated in Figure 2. Results varied from technique to technique.

47. Twenty-foot seine samples showed peaks in May, November, and March, with minimal values observed for August-October 1976, during February 1977, and for June-August 1977. Electrofishing beach and vegetated area data were relatively consistent except for higher values in February and March for the former and in May and June 1977 for the latter. Wegener ring and 10-ft seine data showed trends similar to each other, with peaks in the fall, minimal numbers in the winter, and another peak in the spring and summer. The number of fish

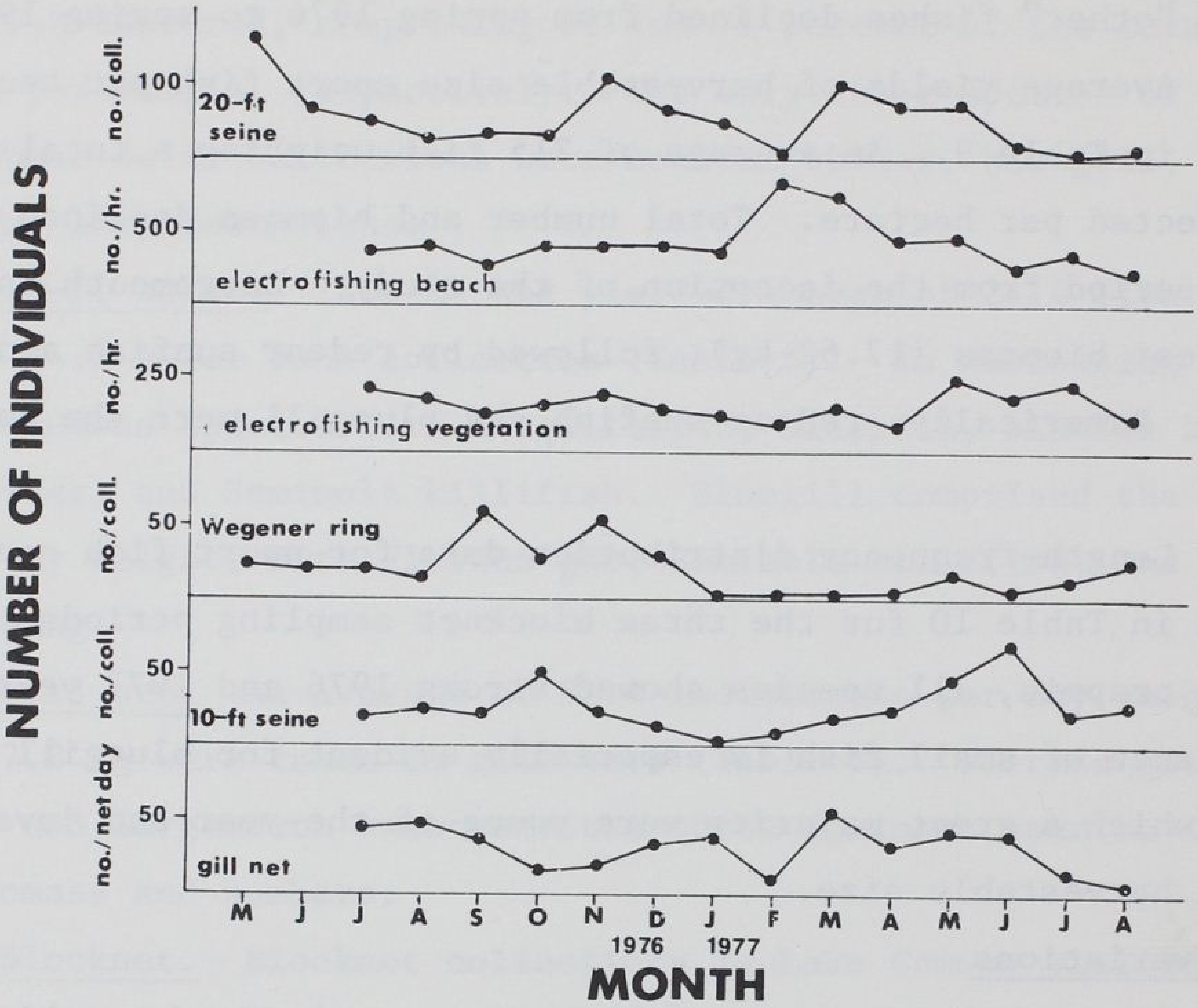

Figure 2. Monthly variation in number of individual fish

collected by gill nets varied substantially.

48. Biomass. Figure 3 illustrates the mean weight of fish collected per unit effort for each month. Temporal variation in mean biomass was erratic with respect to sampling technique.

49. Electrofishing beach and vegetated area biomass values were relatively consistent except for peaks in October for the former and in February and March for the latter. Biomass from 20-ft seine samples declined steadily from a high in May 1976 to a low in February 1977, increased through May 1977, and dwindled thereafter. Wegener ring values peaked in September 1976 and again in March 1977. Gill net samples had higher values in July and August 1976, lower ones for October-February, values of greater than 20 kg for March-June, and reduced values in July and August.

50. Number of species. A total of 34 species were collected or observed in Lake Conway during May 1976-August 1977 (Table 11). Thirty species were collected during regularly scheduled sampling, with the

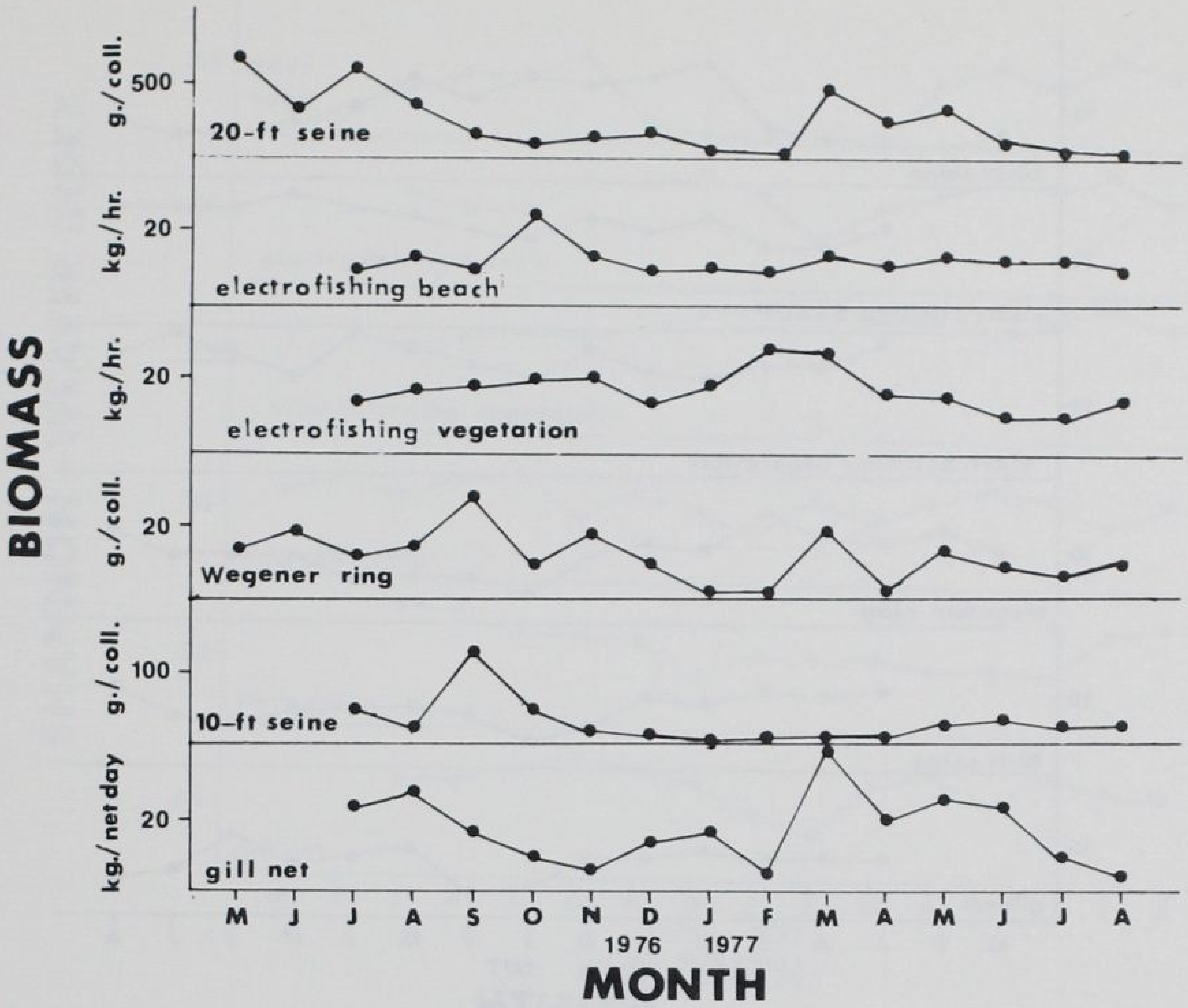

Figure 3. Monthly variation in fish biomass

remainder collected or observed in supplemental sampling. Redfin pickerel and redbreast sunfish were taken by electrofishing in canals connected to the main lakes, and Everglades pygmy sunfish were collected by dip net in waterhyacinth mats. A single specimen of American eel was observed in a commercial fisherman's catch.

51. Figure 4 shows monthly variation in number of species collected using the various sampling techniques. For two methods, electrofishing in beach areas and electrofishing in vegetated areas, there was no discernible trend in number of species. Three methods, Wegener ring, 10-ft seine, and gill net, were all characterized by minimal numbers during January-March, with increases both before and after this period. Conversely, 20-ft seine samples displayed a higher number of species during October 1976-March 1977.

52. <u>Diversity indices.</u> In the foregoing analyses, the number of species and the number of individuals have been considered as separate entities, and there has been no accounting of how numbers are distributed in species categories. The latter consideration, population

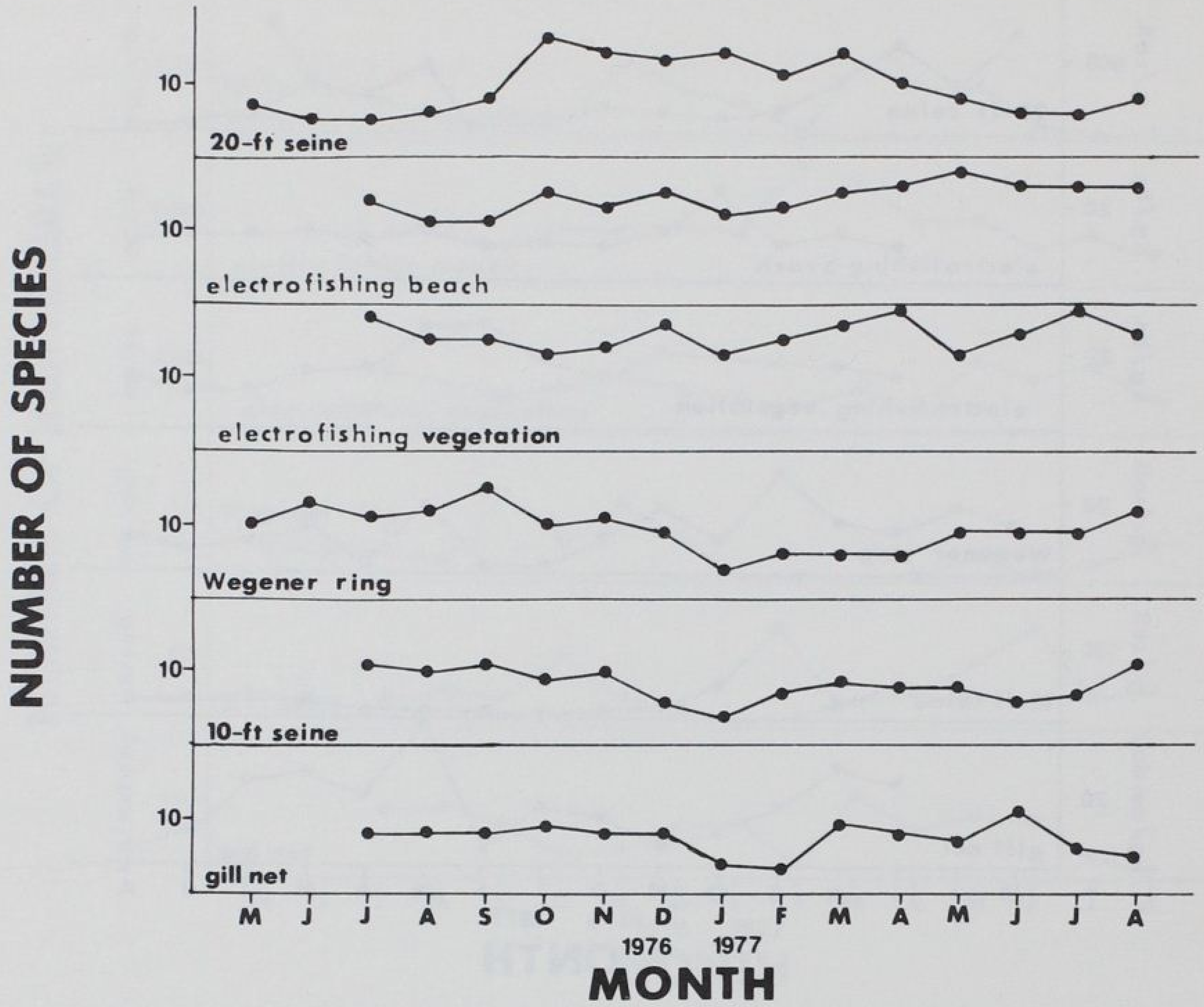

Figure 4. Monthly variation in number of fish species

structure, is an important characteristic of natural assemblages. Frequently, the net result of any environmental stress is a redistribution of numbers among the various species. This may occur because sensitive or specialized forms undergo reduction or elimination while tolerant or generalized species increase in number. The overall effect is a changed population structure, which can be monitored most efficiently by species diversity indices.

53. Figures 5-7 give the monthly variations in the indices for Shannon-Weaver diversity, species richness, and species evenness, respectively. The graphs describing the richness and evenness components of diversity show not only the synergistic effect that these two factors have on Shannon-Weaver diversity but also the damping effect either component can have on Shannon-Weaver diversity.

54. The Shannon-Weaver index is sensitive to both the number of species present (richness) and the numerical distribution of these species (evenness). The Shannon-Weaver index values fluctuated with respect to sampling technique. Twenty-foot seine samples displayed the

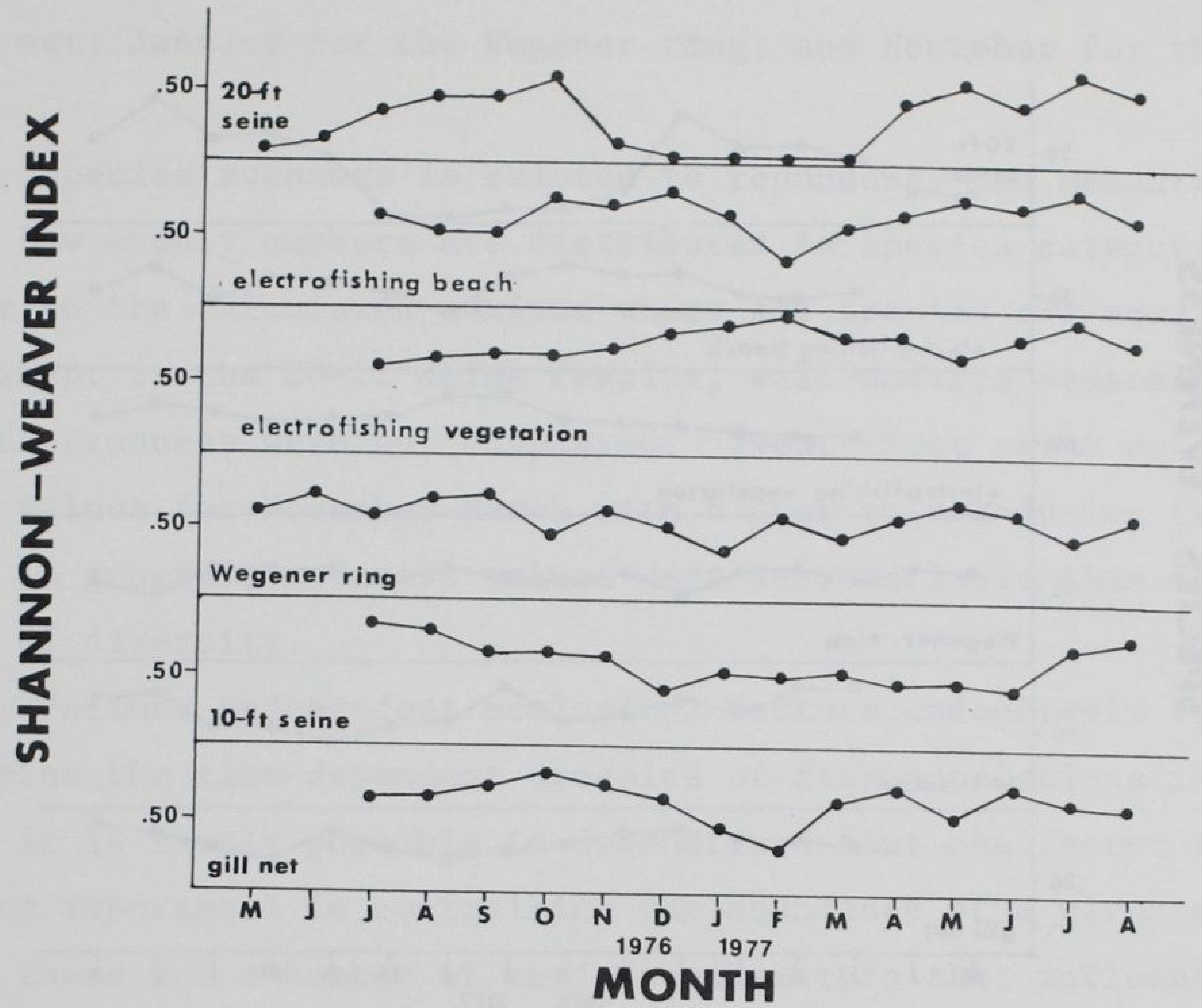

Figure 5. Monthly variation in Shannon-Weaver index for fish

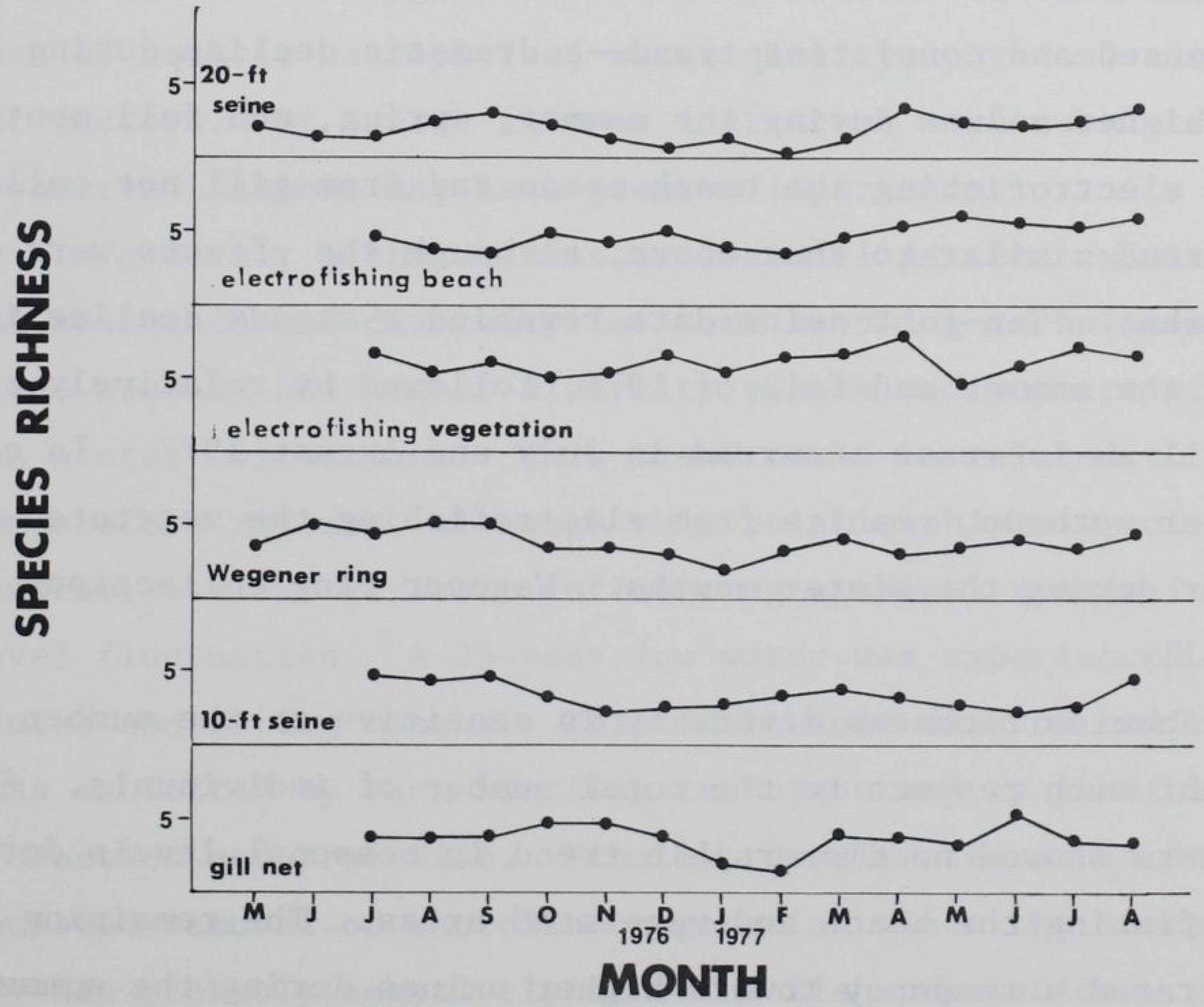

Figure 6. Monthly variation in species richness for fish

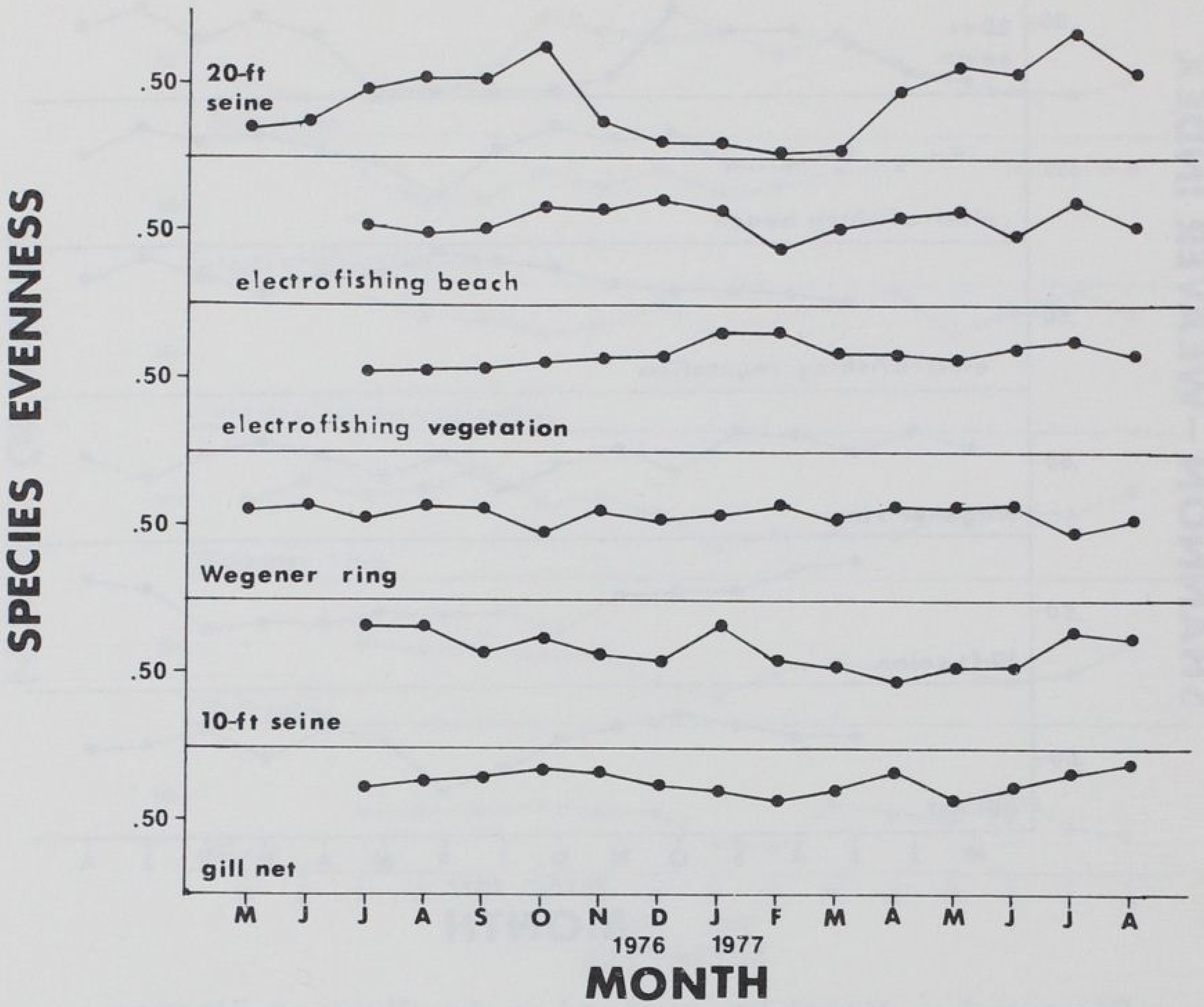

Figure 7. Monthly variation in species evenness for fish

most pronounced and consistent trend--a dramatic decline during November-March and higher values during the summer, spring, and fall months. Results from electrofishing the beach areas and from gill net collections showed a trend similar to that above, although the effects were diminished somewhat. Ten-foot seine data revealed a steady decline in values throughout the summer and fall of 1976, followed by relatively constant values until an increase occurred in July and August 1977. In constrast to the other methods, results from electrofishing the vegetated areas were higher during the winter months. Wegener ring collections varied substantially.

55. Species richness diversity is sensitive to the number of species present with respect to the total number of individuals. Species richness data showed no discernible trend in seasonal levels determined by electrofishing the beach and vegetated areas. The remaining methods all illustrated a tendency toward higher values during the summer months and lowest values during the colder months--February for the 20-ft seine

and gill net; January for the Wegener ring; and November for the 10-ft seine.

56. Species evenness is related to redundancy and measures dominance or how evenly numbers are distributed in species categories in reference to the calculated maximum where all species are equally abundant. Except in the 20-ft seine results, well-defined seasonal trends in species evenness were not displayed. Twenty-foot seine data resulted in lower values for November-March with higher values during the other months. In general, evenness values were less variable than the other measures of diversity.

57. Various independent ecological factors undoubtedly operated to determine the time-dependent dynamics of fish populations in Lake Conway. It is rarely possible to demonstrate that one factor is of overriding importance in controlling the abundance of a given species. However, there are a number of obvious parameters that influence temporal succession in fish populations; i.e., seasonal partitioning of reproduction of many species, intraspecific competition and predation, water temperature, dissolved oxygen level, water level fluctuations, seasonal succession of aquatic macrophytes, water quality, physical alterations, and other factors. Of course in some instances, more subtle and less readily observed factors may have greater importance.

58. In general, a characteristic seasonal pattern existed in numerical abundance and diversity for some sampling techniques. Summer collections usually had higher diversity values and numbers of individuals than winter collections. This trend could be related to seasonal water temperature regimes, although this relationship may not be causative. Another obvious variable influencing seasonal trends in data was water level fluctuation. A 25-year low water was experienced during the later winter and spring months. This influenced data by modifying sampling bias exhibited by each sampling technique and by possibly affecting reproduction and predation. Finally, accelerated urban development and associated removal of shoreline vegetation since the inception of the study has probably negatively affected fish populations.

59. More detailed analysis would be required to fully identify the

extent to which each environmental factor influences seasonal variations in Lake Conway fish populations. Nevertheless, seasonal patterns in numbers, biomass, number of species, and diversity indices presented will facilitate comparisons of baseline and poststocking data in later reports.

PART III: WATERFOWL AND AQUATIC MAMMALS

60. The objective of this portion of the study was to characterize waterfowl and aquatic mammal populations for the period July 1976-August 1977.

Materials and Methods

61. Waterfowl and other aquatic-oriented birds were sampled by simple direct counts during July 1976-August 1977. An airboat or outboard-powered boat was driven along the shoreline, and the birds were counted as they flushed. Aerial and open-water individuals were also noted. The entire Lake Conway system was surveyed in this manner.

62. An attempt was made to observe aquatic mammals during each phase of the field work (i.e., creel census, fish sampling, and waterfowl counts). Several dozen museum special traps were set along undeveloped shorelines and checked daily for the week of 7-11 March 1977.

Results and Discussion

63. Monthly pooled bird data are presented in Table 12. Fifty-one species and an average of 1472 individuals per month were observed. The 10 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 averaged more than 20 individuals per month, and collectively they comprised 89.64 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.

64. Considerable seasonal variation existed in waterfowl populations for both number of species and total number of individuals (Figures 8 and 9, respectively). The number of species ranged from 18 in July 1976 to 30 in both January and February 1977. Likewise, the number

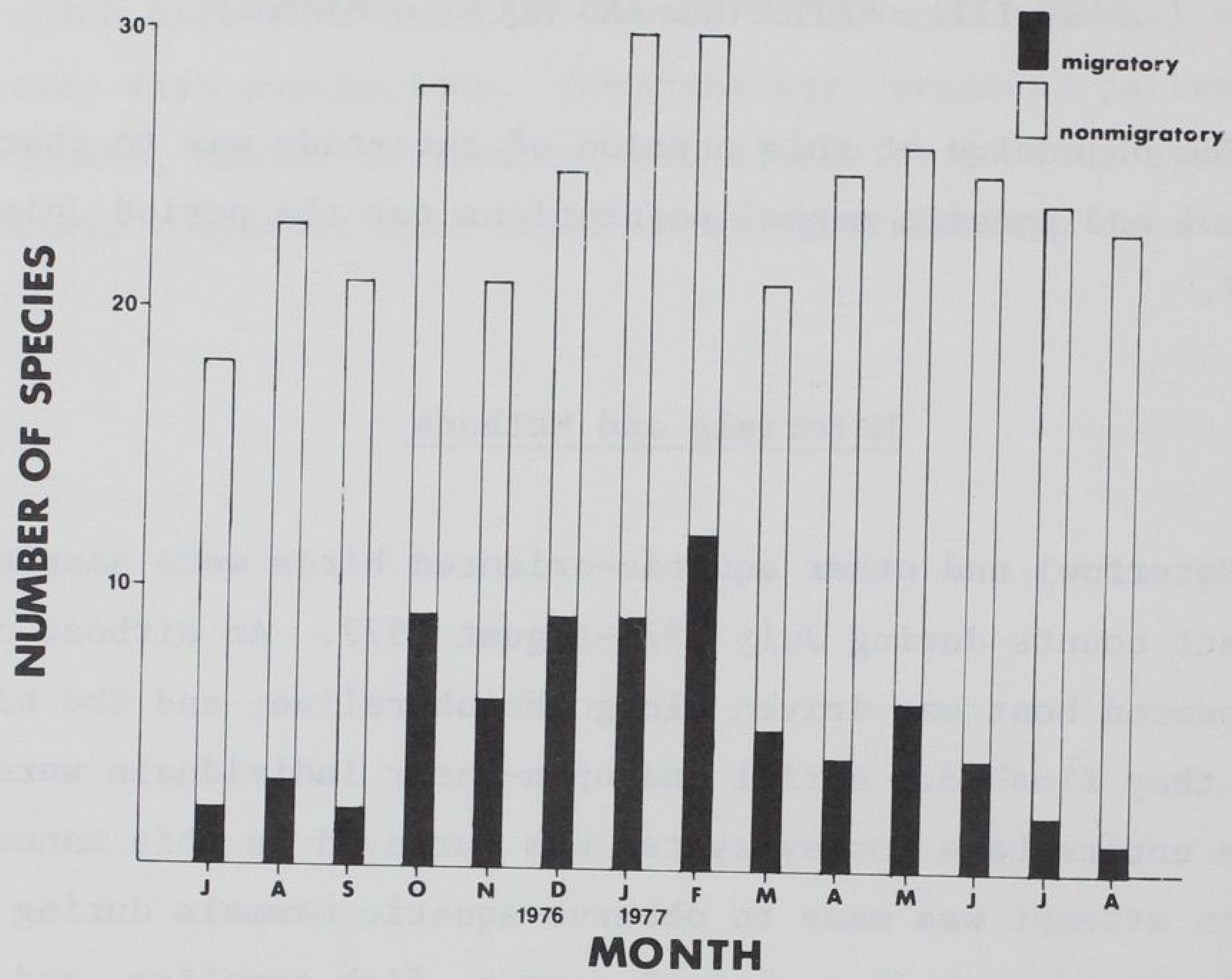

Figure 8. Monthly variation in number of bird species

of individuals varied from 421 in July 1976 to 3590 in December 1977. The greatest number of individuals were encountered during November-February; these months each yielded at least 2000 individuals.

65. The seasonal influx of migratory birds largely accounts for the previously mentioned variation in numbers and diversity (Table 12). Migratory species found only for October-February included lesser scaup duck, baldpate, redhead duck, canvasback, ring-billed gull, blue-winged teal, Forster's tern, chimney swift, and barn swallow. Other migratory species found in other months but reaching their greatest abundance in this same period were horned grebe, American coot, herring gull, and tree swallow. As a group, migratory species attained their greatest abundance in Lake Conway during November-February. The only abundant migratory bird outside this time span was the American coot (Figure 10).

66. Large numbers of aquatic-oriented birds utilize the island in East Pool as a roosting site. Birds observed moving to this area at dark included cattle egret, white ibis, glossy ibis, little blue heron, snowy egret, American egret, and water turkey.

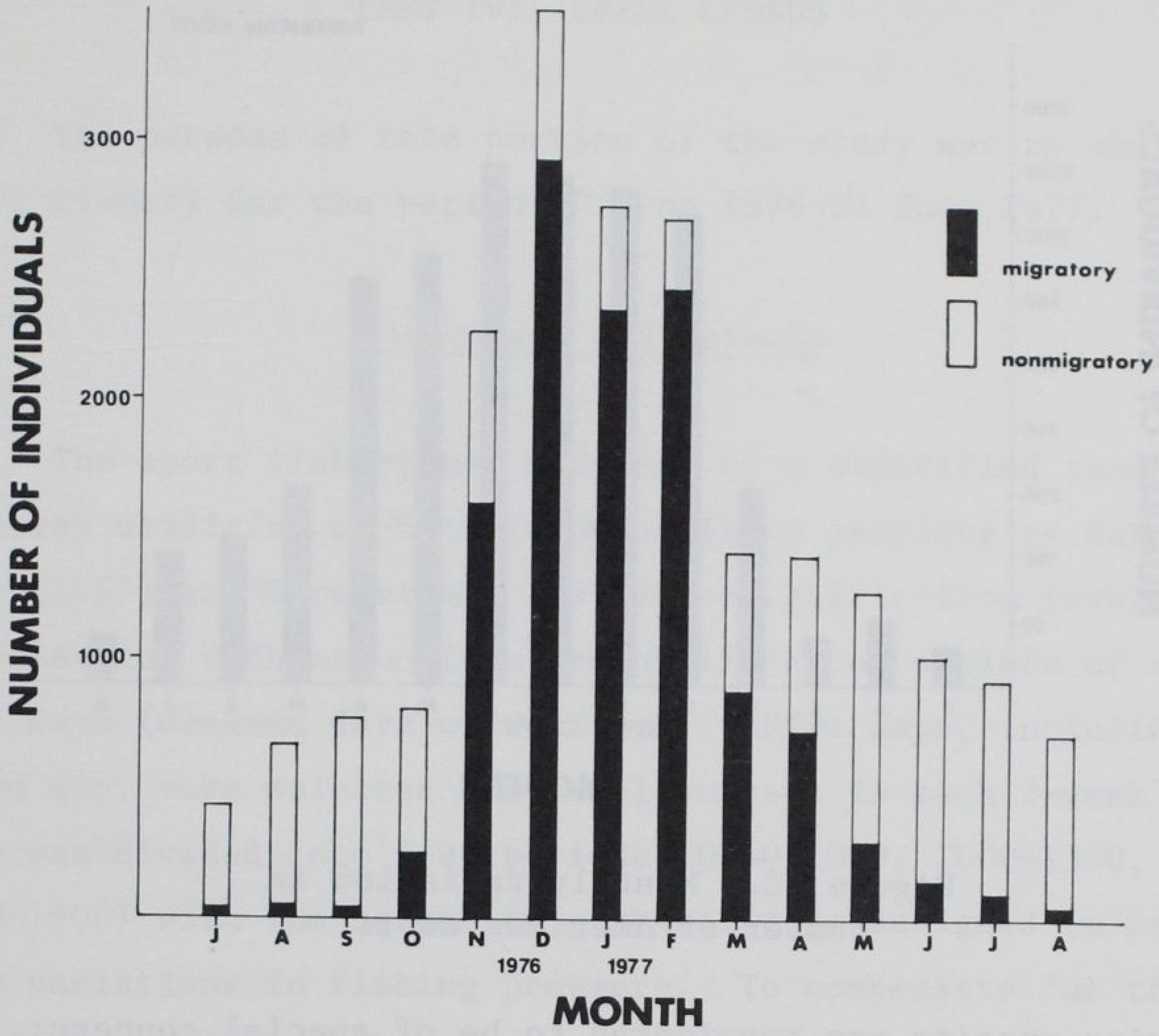

Figure 9. Monthly variation in number of individual birds

67. Aquatic mammals observed in or adjacent to Lake Conway included opossum (Didelphis marsupialis), racoon (Procyon lotor), river otter (Lutra canadensis), Florida water rat (Neofiber alleni), and marsh rabbit (Sylvilagus palustris). Three hispid cotton rats (Sigmodon hispidus) were the only mammals captured by traps during the week of 7-11 March 1977.

68. Little is known about the population densities of these mammals. There appears to be a family of otters (4 to 5 individuals) inhabiting East and West Pools. The Florida water rat, based on the appearance of nests, seems to be common in Panicum marsh areas in South and Middle Pools.

69. 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 a species of special concern. Ospreys are considered threatened in Florida, while

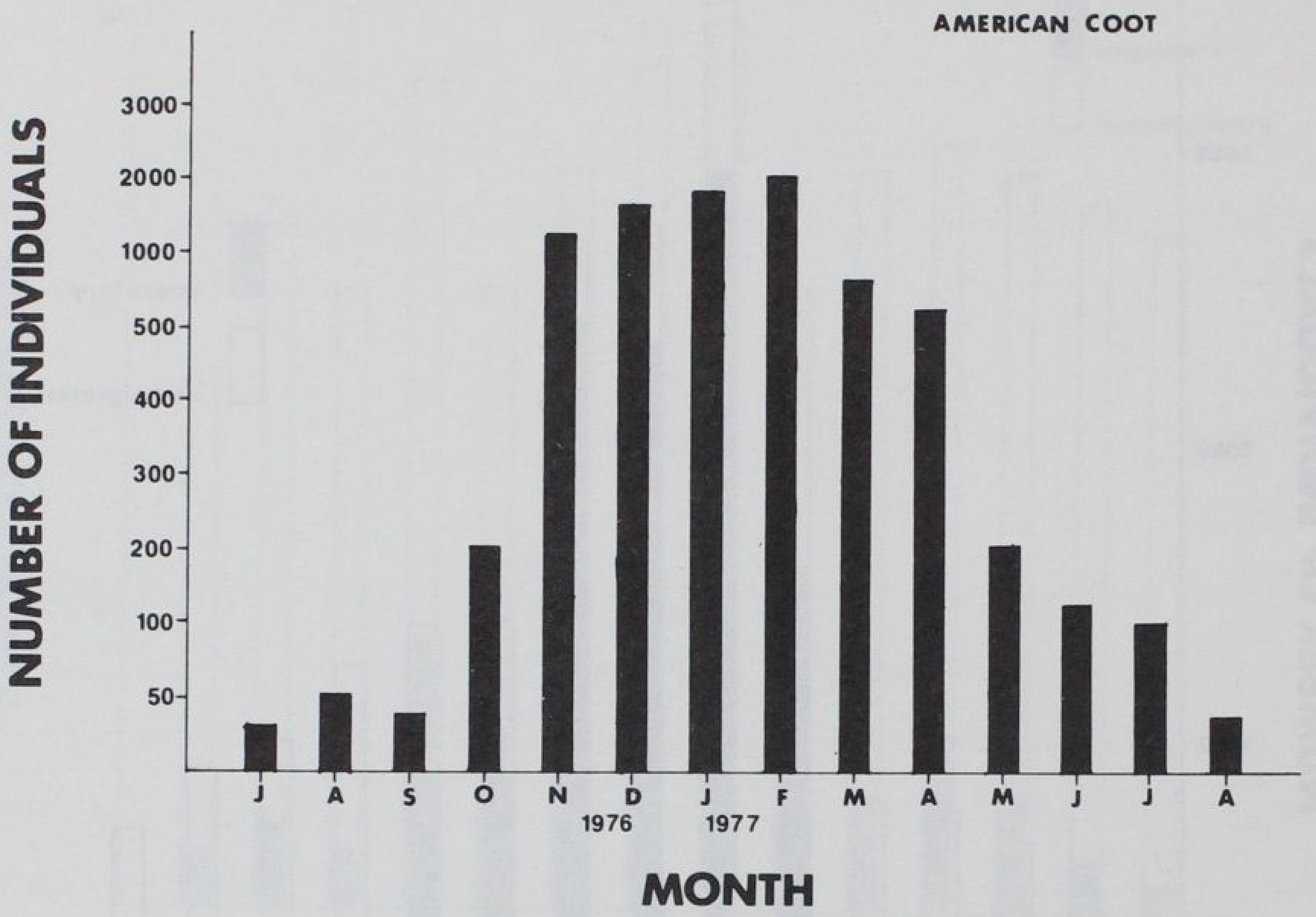

Figure 10. Monthly variation in number of American coots

the following species are considered to be of special concern: great white heron, Louisiana heron, and least bittern. With the exception of the osprey, all of the aforementioned species occupy shallow shoreline habitats, an area greatly exploited in Lake Conway.

PART IV: CREEL CENSUS

70. The purpose of this portion of the study was to characterize the sport fishery for the period 30 June 1976-14 June 1977.

Materials and Methods

71. The sport fishery was measured by a stratified random roving creel survey utilizing nonuniform probability sampling as described by Pfeiffer (1967) and Ware et al. (1972). Stratification involves the random selection with nonuniform probabilities of periods of time and kinds of days (weekend days or weekdays). Five days, including at least 1 weekend day, were selected for creel surveys in each 2-week period. Each day was divided into four periods (0700-1000, 1000-1300, 1300-1600, and 1600-1900) with the selection probabilities assigned in proportion to daily variations in fishing pressure. To compensate for the reduction in daylight during the winter months, the mid-afternoon survey was shortened to 2 hours, with the sunset survey encompassing the period 1500-1800. During each survey, a randomized instantaneous count of the number of fishermen was made.

72. Interviewed anglers were asked to supply the following information: time spent fishing (effort), number and kind of fish caught (harvest), and species sought. Five categories of fish were arbitrarily designated for analysis: largemouth bass, black crappie, chain pickerel, bream (bluegill and redear sunfish), and other species (miscellaneous species rarely caught or sought such as golden shiner, Seminole killifish, brown bullhead, and channel catfish).

73. The creel survey program commenced on 30 June 1976. For this volume, the first four quarters of survey were included. Each quarter encompassed the following time span: summer, 30 June 1976-21 September 1976; fall, 22 September 1976-28 December 1976; winter, 29 December 1976-22 March 1977; spring, 23 March 1977-14 June 1977.

74. Creel survey data were coded, keypunched, and sent to the Southeastern Cooperative Statistics Project at North Carolina State

University for computer analysis. The computer program gives estimates of fishing pressure (effort) in man-hours for each species or category, total numerical catch (harvest) by species, and fishing success (number of fish per man-hour of effort) for both total and species-directed options.

Results and Discussion

75. Quarterly and annual estimates of effort, harvest, and total and species-directed success rates are presented in Table 13. During the sampling interval, the sport fishery produced a total harvest of 23,447 fish in 59,423 man-hours of fishing effort. These figures yielded a total success estimate of 0.39 fish per man-hour and an annual yield of 12.7 fish per acre. Annual fishing pressure was 33 man-hours per acre.

76. Overall, the sport fishery was dominated by largemouth bass fishermen, who exerted 87 percent (51,754 man-hours) of the total effort and 53 percent (12,395 fish) of the total harvest. Black crappie followed largemouth bass in effort with 5,936 man-hours (10 percent), while bream ranked second in harvest with 5,362 fish (23 percent). Chain pickerel and "other species" fisheries were relatively insignificant in terms of fishing pressure. A total harvest of 1,791 chain pickerel, however, was realized, with the majority incidentally caught while fishing for largemouth bass or black crappie.

77. Bream (bluegill and redear sunfish) were most susceptible to anglers, yielding an average of 0.98 fish per man-hour. The "other species" category, a miscellaneous assemblage of species such as golden shiner, Seminole killifish, channel catfish, and brown bullhead, had a catch rate of 0.96 fish per man-hour for the four quarters. The largemouth bass success rate of 0.24 fish per man-hour ranked last, with black crappie and chain pickerel catch rates falling in the middle.

78. The sport fishery for individual species or species categories varied both quantitatively and qualitatively with respect to seasons. Largemouth bass harvest and effort were greater in the summer 1976 and

spring 1977 quarters. Species-directed catch rate for the species was highest during the spring quarter, when an average of 0.35 fish per man-hour was realized. Large numbers of bream were harvested only during the summer quarter, when a harvest of 4,727 fish was produced. That same quarter also resulted in an inflated success rate--5.58 fish per man-hour. The harvest of black crappie was of significance only during the fall and winter quarters, when 98 percent of the total black crappie harvest was taken and 95 percent of the effort expended.

79. The total success rate for all species combined varied little between quarters, ranging from 0.33 to 0.45 fish per man-hour. With the exception of the summer quarter, which had almost double the effort and harvest of any other quarter, total effort and harvest remained fairly constant throughout the year.

80. The quality of a sport fishery may be expressed in terms of catch per unit effort. This value is independent of the number of anglers who fish a given body of water and of the total yield; it represents the rate at which the statistically average angler catches fish. If it is accepted, somewhat arbitrarily, that the standard for fishing success is a catch rate of at least one harvestable fish per man-hour (Bennett 1962), qualitative values can be assigned to a sport fishery.

81. Based on the above criterion, a number of Florida lakes and rivers provide good sport fisheries (Bass 1974). Lake Conway, however, does not meet the minimum standard for a statistically good sport fishery since the total catch rate was only 0.39 fish per man-hour. Although the bream, black crappie, and chain pickerel catch rates are good, the dominance of bass fishermen on Lake Conway and their associated lower catch rate tend to depress the overall success rate; i.e., if the fishing pressure were to be equally divided among all species, the overall catch rate would be higher. The largemouth bass fishery, while producing the lowest catch rates, had an average success rate of 0.24 fish per man-hour, slightly above the national average of 0.20 fish per man-hour.

PART V: FISH LIFE HISTORY

82. The purpose of this portion of the study was to identify food habits of bluefin killifish, chain pickerel, bluegill, and largemouth bass and condition factors and length-weight regressions of the latter three species.

Materials and Methods

83. The four species selected for life history study were collected monthly. All specimens were weighed to the nearest 0.1 g, and total length (TL) was measured to the nearest millimetre.

84. At least 10 specimens of each species were selected for food habit analysis each month. After dissection of the stomachs, contents were weighed to the nearest 0.01 g and food organisms identified and enumerated.

85. Individual fish dissected for stomach analysis were identified as to sex and reproductive status. Stages of gonad maturation were made according to Nikolsky (1963): I--immature; II--resting; III--mature; IV--gravid; and V--spent.

86. Condition factors, a measure of the robustness of an individual, were calculated for the chain pickerel, bluegill, and largemouth bass according to the formula presented by Lagler (1956):

$$K_{TL} = \left(\frac{W}{L^3}\right)100,000 \qquad (4)$$

where W is the weight in grams and L is the total length in millimetres. The mean was determined monthly for the following categories: all chain pickerel; 0- to 125-mm bluegill; >125-mm bluegill; 0- to 300-mm largemouth bass; >300-mm largemouth bass.

87. Length-weight regressions were determined quarterly for chain pickerel, bluegill, and largemouth bass. The length-weight relationships of fishes may be expressed by the formula (Ricker 1958)

$$W = aL^n \quad (5)$$

Since the relationship is seldom linear (Carlander 1969), the above expression can be transformed to

$$\log W = \log a + b \log L \quad (6)$$

The mathematical relationship between total length and total weight was calculated by substituting the general formula for linear regression ($Y = a + bx$) for the above formula and deriving the regression line by the method of least squares (Tesch 1968). The regression coefficient, or slope, is b, while $\log a$ is the intercept of the line with the Y-axis.

88. After the regression line was determined, the degree of association, or correlation coefficient, was calculated according to Weber (1973). A perfect correlation (all points falling on a straight line with a nonzero slope) is indicated by a correlation coefficient of -1 or +1. A positive value implies a direct relationship between two variables; conversely, a negative value results from an inverse relationship. A value of zero is found when there is no relationship.

Results and Discussion

Food habits

89. Chain pickerel. Seasonal variation in chain pickerel food habits is presented in Table 14. Sixteen fish species, three invertebrate species, one turtle, and vegetation were found. An overall rate of 66.44 prey organisms weighing a total of 295.87 g was found per 100 individuals.

90. Based on the seasonal values for number of prey organisms per 100 fish, feeding intensity increased during the summer and fall quarters until a peak was reached in the winter quarter and then declined in the spring and summer quarters. A positive correlation ($r = +0.68$) was found between the percentage of empty stomachs and mean monthly water

temperature (Appendix E). Apparently chain pickerel feed more actively in cooler weather. Other than feeding intensity, food habits did not vary to a large extent from season to season.

91. Adult chain pickerel are primarily piscivorous, with fish comprising 86.1 percent by number and 94.8 percent by weight of all food items. The most common prey fish were brook silverside, bluegill, threadfin shad, redear sunfish, and largemouth bass. Fish remains represented a sizeable portion of the diet--29.5 percent by number and 12.6 percent by weight.

92. The only invertebrate prey of significance was Procambarus, which comprised 8.5 and 4.1 percent of the total by number and weight, respectively. Other invertebrates consumed included Palaemonetes and Goniobasis. Other miscellaneous food items included a musk turtle and vegetation which was probably incidentally taken in the course of pursuing prey. For more details on the food habits of chain pickerel in Lake Conway, see Appendix E.

93. Largemouth bass. Seasonal food habit data for largemouth bass are presented in Table 15. Fourteen fish species, Palaemonetes, Procambarus, Gomphidae, and Physidae were consumed by largemouth bass. An average of 106.90 prey organisms weighing 470.42 g were found per 100 fish.

94. Fish remains comprised the largest category of food items--43.2 percent by number and 14.4 percent by weight. As a group, fish totaled 80.6 percent by number and 85.7 percent by weight. The most common fish prey, in order of numerical abundance, included threadfin shad, bluespotted sunfish, largemouth bass, Seminole killifish, and brook silverside.

95. Procambarus and Palaemonetes were important invertebrate food items, with Gomphidae, Physidae, and Insecta being of little significance. Procambarus ranked third in biomass, second in numerical abundance, and first in frequency of occurrence for all identified categories.

96. Considerable quantitative and qualitative seasonal differences existed in food habits for largemouth bass. Excepting fish remains, the

only food item that was encountered in every season was Procambarus. Twelve food categories were present in only one season. Palaemonetes, Insecta, threadfin shad, Seminole killifish, bluespotted sunfish, largemouth bass, and Lepomis spp. were preyed upon by largemouth bass in two or three seasons. Mean numbers and weights of all prey organisms also varied substantially from season to season.

97. Bluegill. Bluegill food habit data are presented in Table 16. Twenty-seven taxonomic categories, based on the lowest level of identification, were found. An average of 12,141 food organisms were found per 100 individuals.

98. Dominant groups of food organisms by number were Trichoptera (36.9 percent), Chironomidae (26.9 percent), eggs (21.6 percent), and Cladocera (13.4 percent). Other common dietary items included vegetative matter, Protozoa, Ostracoda, Gastropoda, Amphipoda, and Culicidae.

99. In addition to the sporadic occurrence of minor food items, considerable seasonal variations existed in food habits. Overall, the mean number of food organisms increased until a peak was reached in the winter quarter and declined thereafter. More specifically, Cladocera, Amphipoda, and eggs peaked in the winter but declined to lowest values thereafter. The following groups peaked in the fall but declined steadily afterwards: Ostracoda, Odonata, Trichoptera, Anisoptera, Zygoptera, and Planorbidae. Chironomidae and Hydracarina reached highest values in the summer in 1976 and declined thereafter.

100. Bluefin killifish. Quarterly food habit data for bluefin killifish are presented in Table 17. A total of 23 food categories were found. An average of 2023 food organisms were found per 100 fish.

101. Cladocera dominated in stomachs, yielding 1019 organisms per 100 fish (50.46 percent). The only other groups which comprised more than 10 percent of the total were Ostracoda and Chironomidae. Other common food organisms included Copepoda, Amphipoda, Hydracarina, and eggs. The remaining 16 food groups were of minor importance in the diet of bluefin killifish and were encountered in only one or two of the five quarters.

102. The total number of prey organisms found peaked in fall 1976,

declined during the winter quarter, and increased to another peak in summer 1977. Cladocera, Ostracoda, and Chironomidae, the three dominant groups, exhibited essentially the same pattern, hence largely accounting for the overall trend in total number of organisms. Copepoda were more common the first two quarters. The fall 1976 quarter had the most food categories (15), while the remaining quarters ranged from 9 to 11.

Condition factors

103. Seasonal variations in condition factors were determined to discern changes in body condition due to changing feeding regimes and spawning. Figure 11 presents monthly means in condition factors K_{TL} for chain pickerel, ≤125-mm bluegill, >125-mm bluegill, ≤300-mm largemouth bass, and >300-mm largemouth bass.

104. Chain pickerel. Monthly condition factors for chain pickerel ranged from 0.47 to 0.53. Monthly means gradually increased throughout the summer to a peak in November, declined to a low in January, steadily

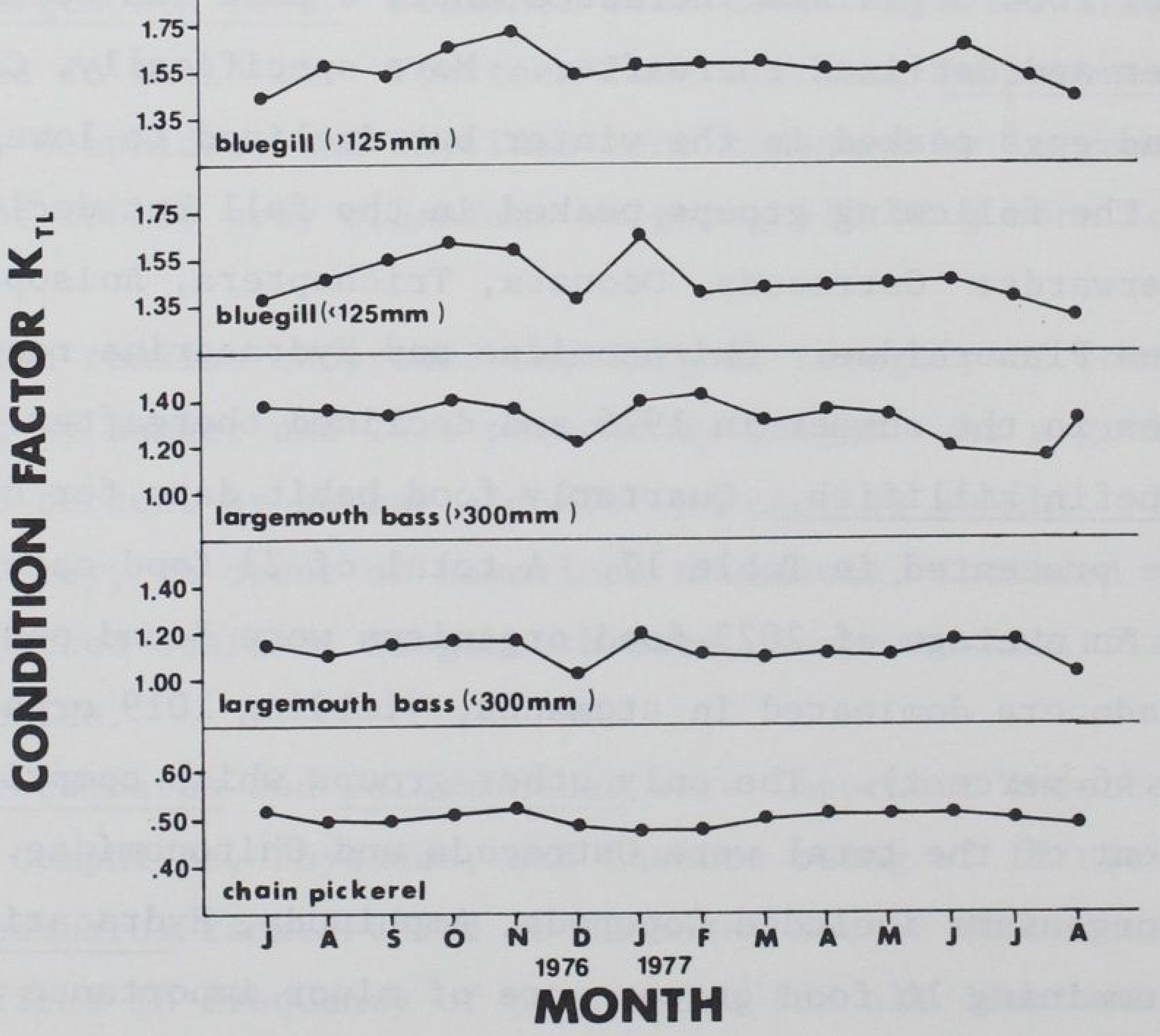

Figure 11. Monthly variation in mean condition factor for largemouth bass, bluegill, and chain pickerel

increased until a plateau was reached for April-June, and again declined slightly in July and August.

105. Bluegill. Condition factors for the $\leq$125-mm bluegill ranged from 1.37 to 1.60, whereas the >125-mm bluegill had values of 1.39 to 1.74 (Figure 11). Larger bluegill were consequently in better condition than the smaller individuals. Both size groups exhibited the same general trend--an increase in values for June-October or November, a dramatic declined in December, and an increase thereafter.

106. Largemouth bass. Largemouth bass condition factors ranged from 1.20 to 1.41 and from 1.00 to 1.20 for the >300-mm and $\leq$300-mm size groups, respectively. Neither size group showed the same variation with respect to time although each exhibited a peak in the fall, a drastic decline in December, a temporary increase in January and/or February, and, finally, another drop in March. Thereafter, the values for the larger size group continued to drop while the smaller size group showed an increase in condition factors.

Length-weight regressions

107. Seasonal length-weight regressions for largemouth bass, bluegill, and chain pickerel are presented in Table 18. As pointed out by Tesch (1968), the slope or coefficient b will often be nearly constant throughout the year for the same developmental stage or growth stanza; this value indicates whether a fish grows isometrically or allometrically, with a value of 3.0 indicating the former and values of other than 3.0 reflecting the latter. A value of greater than 3.0 implies that the fish becomes "heavier for its length" as it grows larger. The Y-intercept value a will often vary seasonally; thus, these values are of importance in delineating seasonal population changes in condition. A length-weight regression with a smaller absolute Y-intercept value implies that the fish are in better condition than in populations with a larger Y-intercept.

PART VI: WATERFOWL FOOD HABITS

108. The purpose of this portion of the study was to characterize the food habits of selected waterfowl in Lake Conway.

Materials and Methods

109. A total of 50 birds with various feeding habits were collected randomly for stomach analysis during the winter of 1976-1977 and summer of 1977. Shotguns were used to collect these birds.

Results and Discussions

110. Food habits of selected waterfowl in Lake Conway are presented in Table 19. Five species (mallard duck, ring-necked duck, American coot, Florida gallinule, and least tern) contained either seed or vegetative parts such as leaves and stems in their stomachs. The remaining seven species were either empty or contained fish and/or macroinvertebrates.

111. Obviously, more intensive analysis of waterfowl food habits is needed to identify species which may be affected by reduction of aquatic vegetation by the white amur. However, the necessity of sampling with guns near highly developed residential areas precluded the attainment of large samples of birds for food habit study.

PART VII: RECOMMENDATIONS

112. Based on the literature and findings from this study, the following recommendations are offered

- a. Sampling, data analysis, and laboratory procedures currently in use should in general be followed in future studies to evaluate any changes in fish, waterfowl, and aquatic mammal populations after white amur introduction. The number of waterfowl examined for food habits should be increased.
- b. A life history evaluation of monosex white amur should be undertaken. Growth, body condition, and food habits should be described in line with operational constraints. Low stocking rates and the inherent elusiveness of the white amur may influence the emphasis placed on this study segment.
- c. Based on accelerated shoreline development and associated removal of emergent littoral vegetation on Lake Conway, it is recommended that a public information pamphlet be prepared illustrating the importance of emergent vegetation to the aquatic resources. Profound differences have been found in the fish communities occupying vegetated and beach habitats in Lake Conway (see Appendix A). Also, several "threatened" or "of special concern" birds and mammals inhabit vegetated shoreline habitats.

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Table 1

Average Yields Per Hour Determined from Electrofishing Beach Areas

During the Period July 1976-August 1977

Species		July		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.	
		No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)
Longnose gar	I	-	-	.67	18.76	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	.16	.15	-	-	-	-	-	-	-	-	-	-	-	-
Florida gar	I	.67	290.38	-	-	.67	454.26	.67	32.16	1.34	770.50	.67	931.30	-	-	-	-
	II	.18	3.01	-	-	.21	4.65	.17	.13	.33	5.64	.16	8.62	-	-	-	-
Bowfin	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gizzard shad	I	-	-	-	-	.67	387.26	2.68	1604.65	-	-	-	-	-	-	-	-
	II	-	-	-	-	.21	3.97	.67	6.65	-	-	-	-	-	-	-	-
Threadfin shad	I	12.06	39.86	6.70	39.66	4.69	29.48	10.05	74.10	1.34	4.09	-	-	-	-	-	-
	II	3.15	.41	1.64	.31	1.45	.30	2.54	.31	.33	.01	-	-	-	-	-	-
Chain pickerel	I	2.01	799.71	3.35	1058.40	3.35	956.76	6.70	2310.43	3.35	1313.20	2.01	592.08	7.37	2182.93	6.03	2124.30
	II	.52	8.29	.82	8.40	1.04	9.80	1.69	9.58	.83	9.60	.49	5.48	2.06	19.55	.70	21.68
Golden shiner	I	1.34	59.90	7.37	313.42	6.67	215.07	11.39	100.50	1.34	169.78	2.68	193.90	1.34	19.83	2.01	221.77
	II	.35	.62	1.81	2.48	2.06	2.20	2.88	.42	.33	1.24	.65	1.80	.37	.18	.23	2.26
Coastal shiner	I	10.05	12.33	-	-	-	-	18.09	14.07	6.03	5.96	10.05	7.91	16.08	14.00	18.76	14.40
	II	2.63	.13	-	-	-	-	4.57	.06	1.50	.01	2.45	.07	4.49	.12	2.17	.15
Lake chubsucker	I	1.34	874.08	.67	277.05	2.01	377.88	2.68	683.20	.67	104.52	2.01	1212.36	.67	569.50	2.68	1884.71
	II	.35	9.06	.16	2.19	.62	3.87	.67	2.83	.17	.76	.49	11.23	.19	5.10	.31	19.24
Yellow bullhead	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	I	-	-	-	-	-	-	.67	152.76	-	-	-	-	-	-	.67	90.45
	II	-	-	-	-	-	-	.17	.63	-	-	-	-	-	-	.08	.92
Tadpole madtom	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seminole killifish	I	7.37	67.34	8.71	104.32	2.68	28.74	-	-	86.43	708.52	46.23	427.86	49.58	388.40	95.14	670.00
	II	1.93	.70	2.14	.83	.83	.29	-	-	21.43	5.18	11.29	3.96	13.86	3.49	10.99	6.84
Bluefin killifish	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.67	.20
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.08	.01
Mosquitofish	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brook silverside	I	52.93	62.85	2.01	1.34	2.01	1.00	67.00	58.62	35.51	41.41	154.10	177.42	155.44	187.94	683.40	950.80
	II	13.84	0.65	.49	.01	.62	.01	16.92	.24	8.80	.30	37.64	1.64	43.44	1.68	79.00	9.71
Bluespotted sunfish	I	.67	.33	-	-	-	-	-	-	.67	1.34	4.02	4.22	-	-	-	-
	II	.18	.01	-	-	-	-	-	-	.17	.01	.98	.04	-	-	-	-
Warmouth	I	1.34	.94	-	-	-	-	4.02	31.22	2.68	18.36	2.68	46.50	2.68	23.65	-	-
	II	.35	.01	-	-	-	-	1.01	.13	.66	.13	.65	.43	.75	.21	-	-
Bluegill	I	203.01	3389.80	244.55	3806.40	195.64	3473.75	164.82	13766.42	152.76	3377.40	101.84	2279.81	95.14	2928.57	28.81	873.34
	II	53.06	35.12	60.03	30.21	60.46	35.59	41.62	57.08	37.87	24.70	24.88	21.12	26.59	26.23	3.33	8.91
Dollar sunfish	I	.67	2.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	.18	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redear sunfish	I	62.98	3130.31	87.77	2785.59	71.69	2121.15	48.91	1658.65	64.32	2915.84	53.60	2980.63	18.76	1415.44	16.75	1080.59
	II	16.46	32.43	21.55	22.20	22.15	21.73	12.35	6.88	15.95	21.33	13.09	27.61	5.24	12.68	1.93	11.03
Spotted sunfish	I	-	-	-	-	-	-	-	-	-	-	.67	21.31	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	.16	.20	-	-	-	-
Largemouth bass	I	26.13	920.78	43.55	4109.78	33.50	1715.40	32.83	3092.92	46.90	4237.78	26.80	1736.91	8.71	3269.53	6.70	1532.29
	II	6.83	9.54	10.69	32.62	10.35	17.58	8.29	12.82	11.63	30.99	6.55	16.09	2.43	29.28	.77	15.64
Black crappie	I	-	-	2.01	73.97	-	-	1.34	314.23	-	-	1.34	183.78	1.34	166.16	2.01	352.42
	II	-	-	.49	.59	-	-	.34	1.30	-	-	.33	1.70	.37	1.49	.23	3.60
Swamp darter	I	-	-	-	-	-	-	-	-	-	-	.67	.74	.67	.34	1.34	1.34
	II	-	-	-	-	-	-	-	-	-	-	.16	.01	.19	.01	.15	.01
Total		382.57	9651.15	407.36	12588.69	323.58	9760.75	371.85	23893.93	403.34	13668.70	409.37	10791.72	357.78	11166.29	864.97	9796.60

(Continued)

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

Table 1 (Concluded)

Species		March No.	March Wt. (g.)	April No.	April Wt. (g.)	May No.	May Wt. (g.)	June No.	June Wt. (g.)	July No.	July Wt. (g.)	Aug. No.	Aug. Wt. (g.)	Mean No.	Mean Wt. (g.)
Longnose gar	I	-	-	-	-	-	-	-	-	-	-	-	-	.05	1.34
	II	-	-	-	-	-	-	-	-	-	-	-	-	.01	.01
Florida gar	I	.67	444.54	-	-	.67	309.54	.67	406.02	-	-	.67	45.90	.48	263.18
	II	.08	3.24	-	-	.14	2.74	.25	3.29	-	-	.31	.62	.11	2.15
Bowfin	I	-	-	-	-	-	-	-	-	-	-	.67	1333.30	.05	95.23
	II	-	-	-	-	-	-	-	-	-	-	.31	17.91	.01	.78
Gizzard shad	I	1.34	893.98	-	-	-	-	-	-	-	-	-	-	.34	206.13
	II	.17	6.52	-	-	-	-	-	-	-	-	-	-	.08	1.68
Threadfin shad	I	1.34	22.58	-	-	.67	4.02	.67	.94	1.34	6.70	.67	2.28	2.82	15.95
	II	.17	.16	-	-	.14	.03	.25	.01	.37	.05	.31	.03	.65	.13
Chain pickerel	I	1.34	519.52	6.03	2393.58	2.01	2803.40	7.37	2085.58	4.69	1104.50	2.68	1189.58	4.16	1530.99
	II	.17	3.79	1.32	21.43	.41	8.30	2.72	16.92	1.30	8.95	1.24	15.98	.95	12.50
Golden shiner	I	6.03	426.92	10.72	240.53	2.68	43.55	-	-	11.39	64.32	5.36	111.62	5.02	155.79
	II	.76	3.11	2.34	2.15	.55	.38	-	-	3.15	.52	2.48	1.50	1.15	1.27
Coastal shiner	I	27.47	18.09	13.40	12.13	44.89	40.87	12.06	10.45	8.04	7.30	.67	1.01	13.26	11.32
	II	3.47	.13	2.92	.11	8.42	.36	4.46	.08	2.22	.06	.31	.01	3.04	.09
Lake chubsucker	I	2.01	1619.39	1.34	515.23	1.34	1139.67	2.01	1249.75	.67	184.92	-	-	1.44	753.73
	II	.25	11.81	.29	4.61	.28	10.08	.74	10.14	.18	1.50	-	-	.33	6.23
Yellow bullhead	I	-	-	-	-	-	-	-	-	-	-	.67	69.61	.05	4.97
	II	-	-	-	-	-	-	-	-	-	-	.31	.93	.01	.04
Brown bullhead	I	.67	478.04	1.34	507.93	.67	473.69	-	-	1.34	660.62	.67	337.68	.43	192.94
	II	.08	3.49	.29	4.55	.14	4.19	-	-	.37	5.35	.31	4.53	.01	1.58
Tadpole madtom	I	-	-	-	-	-	-	-	-	-	-	.67	.34	.05	.02
	II	-	-	-	-	-	-	-	-	-	-	.18	.01	.01	.01
Seminole killifish	I	84.42	772.11	29.48	240.53	55.61	542.72	19.43	151.62	29.48	172.86	2.68	16.28	36.95	306.81
	II	10.68	5.63	6.43	2.15	11.46	4.83	7.18	1.23	8.15	1.40	1.24	.22	8.47	2.50
Bluefin killifish	I	.67	.07	3.35	1.41	6.03	3.40	2.01	1.27	-	-	-	-	.91	.45
	II	.08	.01	.73	.01	1.24	.01	.74	.01	-	-	-	-	.21	.01
Mosquitofish	I	-	-	2.01	1.01	.67	.01	1.34	.54	1.34	1.68	-	-	.38	.23
	II	-	-	.44	.01	.14	.01	.50	.01	.37	.01	-	-	.09	.01
Brook silverside	I	469.67	628.26	156.78	274.70	113.23	239.68	43.55	58.69	99.16	87.44	2.68	2.68	145.53	198.06
	II	59.41	4.58	34.21	2.46	23.34	2.12	16.09	.48	27.41	0.71	1.24	.04	33.37	1.62
Bluespotted sunfish	I	-	-	2.01	2.14	-	-	1.34	.94	.67	.67	-	-	.67	.69
	II	-	-	.44	.01	-	-	.50	.01	.18	.01	-	-	.15	.01
Warmouth	I	.67	64.99	5.36	58.76	2.68	90.38	5.36	131.32	4.02	76.65	3.35	42.34	2.49	41.79
	II	.08	.47	1.17	.53	.55	.80	1.98	1.07	1.11	.62	1.55	.57	.57	.34
Bluegill	I	92.94	1695.37	113.90	1862.94	117.92	1739.05	106.53	4606.45	92.46	1435.07	105.86	1651.95	129.73	3349.02
	II	11.69	12.36	24.85	16.68	24.31	15.38	39.36	37.38	25.56	11.63	49.07	22.19	29.75	27.34
Dollar sunfish	I	-	-	1.34	5.03	3.35	10.05	5.36	16.48	6.70	23.78	2.01	6.70	1.39	4.61
	II	-	-	.29	4.01	.69	.09	1.98	.13	1.85	.19	.93	.09	.32	.04
Redear sunfish	I	85.09	3698.00	95.14	3594.35	109.21	3419.80	50.92	2924.55	67.67	3225.58	63.65	1920.75	64.03	2633.66
	II	10.76	26.96	20.76	32.19	22.51	30.24	18.81	23.73	18.70	26.14	29.50	25.80	14.68	21.50
Spotted sunfish	I	-	-	-	-	.67	65.66	-	-	-	-	1.34	12.93	.19	7.14
	II	-	-	-	-	.14	.58	-	-	-	-	.62	.17	.04	.06
Largemouth bass	I	16.75	2433.84	15.41	1456.11	22.10	2056.10	11.39	679.31	32.16	5287.30	22.11	700.95	24.65	2373.50
	II	2.12	17.74	3.36	13.04	4.56	18.18	4.21	5.51	8.89	42.85	10.25	9.41	5.65	19.38
Black crappie	I	-	-	-	-	.67	190.95	-	-	-	-	-	-	.62	91.53
	II	-	-	-	-	.14	1.69	-	-	-	-	-	-	.14	.75
Swamp darter	I	-	-	.67	.67	-	-	.67	.27	-	-	-	-	.29	.24
	II	-	-	.15	.01	-	-	.25	.01	-	-	-	-	.07	.01
Total		791.08	13715.70	458.28	11167.05	485.07	13176.54	270.68	12324.18	361.80	12339.72	216.41	7445.56	436.05	12249.76

Table 2

Average Yields Per Hour Determined from Electrofishing Vegetated Areas

During the Period July 1976-August 1977

Species		July		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.	
		No.	Wt. (g)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)
Florida gar	I	2.01	1124.06	.67	428.80	1.34	385.92	.67	205.02	2.01	586.92	2.01	280.13	-	-	.67	28.94
	II	.94	7.97	.38	2.56	1.00	2.15	.44	1.00	1.00	2.92	1.37	2.20	-	-	.70	.10
Bowfin	I	.67	1787.10	1.34	2519.20	.67	3242.80	-	-	.67	1299.80	.67	255.60	1.34	2978.15	1.34	3477.30
	II	.32	12.67	.76	15.03	.50	18.09	-	-	.33	6.47	.46	2.00	1.09	15.86	1.41	12.40
Gizzard shad	I	.67	435.17	-	-	-	-	-	-	-	-	.67	329.64	-	-	-	-
	II	.31	3.09	-	-	-	-	-	-	-	-	.46	2.59	-	-	-	-
Threadfin shad	I	6.70	26.60	1.34	20.10	3.35	50.25	-	-	.67	2.68	-	-	-	-	-	-
	II	3.12	.19	.76	.12	2.50	.28	-	-	.33	.01	-	-	-	-	-	-
Chain pickerel	I	6.03	1969.33	10.72	2516.59	11.39	3326.55	14.74	4600.42	8.71	2570.39	9.38	3856.72	12.06	4917.46	10.05	5469.41
	II	2.81	13.97	6.08	15.02	8.46	18.56	9.73	22.33	4.32	12.79	6.39	30.31	9.84	26.18	10.56	19.50
Golden shiner	I	3.35	390.41	3.35	322.94	2.68	258.62	1.34	13.27	3.35	36.05	6.70	195.91	1.34	171.52	4.02	544.71
	II	1.56	2.77	1.90	1.92	1.99	1.44	.88	.06	1.66	.18	4.57	1.54	1.09	.91	4.22	1.94
Coastal shiner	I	.67	.67	-	-	-	-	-	-	-	-	1.34	.60	-	-	.67	.13
	II	.31	.01	-	-	-	-	-	-	-	-	.91	.01	-	-	.70	.01
Lake Chubsucker	I	1.34	725.14	2.01	1013.77	1.34	633.82	10.05	5570.92	5.36	3161.06	1.34	751.74	-	-	3.35	2206.31
	II	.62	5.14	1.14	6.05	1.00	3.54	6.64	27.04	2.66	15.73	.91	5.90	-	-	3.52	7.87
Yellow bullhead	I	.67	151.96	.67	145.19	-	-	-	-	-	-	.67	52.26	-	-	-	-
	II	.31	1.08	.38	.86	-	-	-	-	-	-	.46	.41	-	-	-	-
Brown bullhead	I	-	-	.67	303.24	1.34	346.39	.67	185.26	-	-	.67	462.30	-	-	-	-
	II	-	-	.38	1.81	1.00	1.93	.44	.90	-	-	.46	3.63	-	-	-	-
Golden topminnow	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seminole killifish	I	1.34	1.07	-	-	2.01	12.06	2.01	17.76	2.01	13.40	2.01	19.03	4.02	34.50	1.34	11.79
	II	.62	.01	-	-	1.49	.07	1.33	.09	1.00	.07	1.37	.14	3.28	.18	1.41	.04
Bluefin killifish	I	-	-	-	-	-	-	-	-	-	-	.67	.07	-	-	.67	.07
	II	-	-	-	-	-	-	-	-	-	-	.46	.01	-	-	.70	.01
Mosquitofish	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brook silverside	I	2.68	5.23	-	-	.67	.01	-	-	6.03	6.70	9.38	9.11	15.41	21.17	12.06	16.82
	II	1.25	0.04	-	-	.50	.01	-	-	2.99	.03	6.39	.01	12.57	.11	12.68	.06
Bluespotted sunfish	I	.67	1.61	-	-	-	-	1.34	2.08	-	-	-	-	5.35	7.04	-	-
	II	.31	.01	-	-	-	-	.88	.01	-	-	-	-	2.73	.04	-	-
Warmouth	I	12.06	59.36	8.04	230.55	.67	11.39	3.35	16.88	14.07	361.59	9.38	68.88	16.75	584.37	4.69	343.31
	II	5.62	.42	4.56	1.38	.50	.06	2.21	.08	6.98	1.80	6.39	.54	13.66	3.11	4.92	1.22
Bluegill	I	112.56	2001.22	102.51	2933.53	70.35	1973.15	79.73	2801.14	93.80	2518.93	61.64	1747.63	36.18	1427.03	25.46	1157.89
	II	52.50	14.19	58.17	17.50	52.24	11.01	52.65	13.60	46.51	12.53	42.01	13.73	29.51	7.60	26.76	4.13
Dollar sunfish	I	-	-	1.34	5.03	-	-	-	-	-	-	-	-	4.02	8.71	-	-
	II	-	-	.76	.03	-	-	-	-	-	-	-	-	3.28	.05	-	-
Redear sunfish	I	45.56	2606.84	24.79	1498.05	21.44	1946.22	21.44	1798.28	38.86	2402.68	29.48	2410.19	15.41	1925.65	12.06	1236.22
	II	21.25	18.49	14.07	8.94	15.92	10.86	14.16	8.75	19.27	11.95	20.09	18.94	12.57	10.25	12.37	4.41
Spotted sunfish	I	1.34	11.73	3.35	123.01	.67	6.77	.67	1.94	3.35	64.99	.67	14.74	.67	13.60	1.34	59.09
	II	.62	.08	1.90	.73	.50	.04	.44	.01	1.66	.32	.46	.11	.55	.07	1.41	.21
Largemouth bass	I	13.40	2111.64	14.07	4526.72	15.41	5186.54	14.74	5147.28	19.43	6846.46	10.05	2266.68	10.72	6315.62	15.41	12699.85
	II	6.25	14.98	7.98	27.01	11.44	28.93	9.73	24.99	9.63	34.06	6.84	17.81	8.74	33.63	16.19	45.28
Black crappie	I	2.68	691.11	1.34	172.53	1.34	547.39	.67	237.85	3.35	227.66	-	-	1.34	374.20	2.01	795.96
	II	1.25	4.90	.76	1.03	1.00	3.05	.44	1.15	1.66	1.13	-	-	1.09	1.99	2.11	2.84
Swamp darter	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		214.40	14100.25	176.21	16759.25	134.67	17927.88	151.42	20598.10	176.21	20099.31	146.73	12721.23	122.61	18779.02	95.14	28047.81

(Continued)

Note Entries in "I" rows are numerical values, those in "II" rows are percent composition values.

Table 2 (Concluded)

Species		March		April		May		June		July		Aug.		Mean	
		No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)
Florida gar	I	10.05	5396.85	6.03	2170.13	8.04	3563.10	.67	251.25	-	-	1.34	317.78	2.54	1059.21
	II	7.11	19.96	5.56	13.23	3.13	15.54	.33	2.38	-	-	1.15	2.18	1.54	6.08
Bowfin	I	.67	1340.00	1.34	4609.60	-	-	.67	2010.00	-	-	-	-	.67	1679.97
	II	.47	4.96	1.23	28.11	-	-	.33	19.01	-	-	-	-	.41	9.64
Gizzard shad	I	1.34	885.07	-	-	-	-	-	-	-	-	-	-	.19	115.70
	II	.95	3.27	-	-	-	-	-	-	-	-	-	-	.12	.06
Threadfin shad	I	-	-	-	-	-	-	8.71	23.12	3.35	14.07	-	-	1.72	9.77
	II	-	-	-	-	-	-	4.29	0.22	1.42	.13	-	-	1.04	.66
Chain pickerel	I	10.05	3858.53	13.40	3563.19	18.76	6768.50	6.03	2484.63	8.04	1940.86	12.73	3211.91	10.86	3646.75
	II	7.11	14.27	12.35	21.73	7.31	42.98	2.97	23.50	3.40	18.51	10.98	22.03	6.60	20.94
Golden shiner	I	1.34	136.01	2.01	26.80	1.34	13.33	.67	5.36	5.36	34.17	.67	1.94	2.68	153.65
	II	.95	0.50	1.85	.16	.52	.08	.33	.05	2.27	.33	.58	.01	1.63	.88
Coastal shiner	I	.67	.07	-	-	3.35	1.61	5.36	5.56	4.69	6.03	-	-	1.20	1.05
	II	.47	.01	-	-	1.30	.01	2.64	.05	1.98	.01	-	-	.73	.01
Lake Chubsucker	I	4.69	2915.17	2.68	1361.31	-	-	-	-	1.34	374.33	.67	253.93	2.44	1354.82
	II	3.32	10.78	2.47	8.30	-	-	-	-	.57	3.57	.58	1.74	1.48	7.78
Yellow bullhead	I	.67	40.87	1.34	20.44	-	-	.67	65.59	.67	115.24	.67	255.27	.43	60.49
	II	.47	.15	1.23	.12	-	-	.33	.62	.28	1.10	.58	1.75	.26	.35
Brown bullhead	I	1.34	1097.80	2.01	1163.12	.67	304.18	-	-	.67	2.01	1.34	109.21	.67	283.82
	II	.95	4.06	1.85	7.09	.26	1.93	-	-	.28	.01	1.15	.75	.41	1.63
Golden topminnow	I	-	-	.67	3.08	-	-	-	-	-	-	-	-	.05	.22
	II	-	-	.62	1.01	-	-	-	-	-	-	-	-	.03	.01
Seminole killifish	I	.67	8.71	2.01	16.68	-	-	5.36	20.57	10.05	69.81	.67	5.76	2.39	16.51
	II	.47	.03	1.85	.10	-	-	2.64	0.19	4.25	.67	.58	.04	1.45	.09
Bluefin killifish	I	.67	.27	1.34	.74	-	-	2.68	1.54	1.34	.60	-	-	.53	.24
	II	.47	.01	1.23	.01	-	-	1.32	0.01	.57	.01	-	-	.32	.01
Mosquitofish	I	-		.67	.60	4.02	3.22	1.34	1.54	2.01	1.01	-	-	.57	.46
	II	-		.62	.01	1.57	.02	.66	.01	.85	.01	-	-	.35	.01
Brook silverside	I	4.69	7.70	5.36	10.52	16.75	33.90	48.91	34.71	24.79	26.81	1.34	0.74	10.58	12.39
	II	3.32	.03	4.94	.01	6.53	.22	24.09	.33	10.48	0.26	1.15	.01	6.43	.07
Bluespotted sunfish	I	-	-	1.34	.67	-	-	-	-	3.35	4.29	-	-	.72	1.12
	II	-	-	1.23	.01	-	-	-	-	1.42	.01	-	-	.44	.01
Warmouth	I	2.68	244.01	2.68	182.51	131.99	407.43	3.35	206.49	10.05	269.41	5.36	305.72	16.08	235.14
	II	1.90	.90	2.45	1.11	51.44	2.59	1.65	1.95	4.25	2.57	4.62	2.10	9.77	1.35
Bluegill	I	33.50	980.54	34.17	963.33	42.88	1210.82	60.97	1138.87	80.40	1094.18	40.20	884.74	62.45	1630.93
	II	23.70	3.63	31.48	5.88	16.71	7.69	30.02	10.77	33.99	10.44	34.68	6.07	37.93	9.36
Dollar sunfish	I	.67	3.35	4.69	12.13	2.68	7.17	2.68	7.10	8.71	32.56	1.34	5.23	1.87	5.81
	II	.47	.01	4.32	.01	1.04	.04	1.32	.07	3.68	.31	1.15	.04	1.14	.03
Redear sunfish	I	48.91	2120.88	25.46	1894.69	19.43	904.63	42.21	2113.45	46.90	2230.90	32.83	2719.26	30.34	1986.28
	II	34.60	7.84	23.46	11.55	7.57	5.74	20.79	19.99	19.83	21.28	28.32	18.65	18.43	11.40
Spotted sunfish	I	-	-	.67	54.94	.67	69.68	-	-	3.35	150.35	1.34	32.16	1.29	43.07
	II	-	-	.62	2.09	.26	.44	-	-	1.42	1.43	1.15	.22	.78	.25
Largemouth bass	I	18.76	7997.59	.67	342.97	6.03	2371.00	12.73	2202.22	20.10	3742.96	14.07	6228.52	13.26	4856.15
	II	13.27	29.58	.62	2.09	2.35	15.05	6.27	20.83	8.50	35.70	12.14	42.73	8.05	27.88
Black crappie	I	-	-	-	-	-	-	-	-	1.34	373.66	.67	244.28	1.05	261.76
	II	-	-	-	-	-	-	-	-	.57	3.56	.58	1.67	.64	1.50
Swamp darter	I	-	-	-	-	-	-	-	-	-	-	.67	.27	.05	.10
	II	-	-	-	-	-	-	-	-	-	-	.40	.01	.03	.01
Total		141.37	27033.42	108.54	16397.45	256.91	15748.57	203.01	10572.00	236.51	10483.27	115.91	14576.72	164.63	17417.44

Table 3

Averaged Yields Determined from Wegener Ring Collections

During the Period May 1976-August 1977

Species		May		June		July		Aug.		Sept.		Oct.	
		No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)
Florida gar	I	-	-	.08	.01	-	-	-	-	.08	.03	-	-
	II	-	-	.42	02	-	-	-	-	.13	.11	-	-
Chain pickerel	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Coastal shiner	I	2.16	1.53	.08	.14	.08	.07	1.00	.59	2.25	1.05	.33	.16
	II	9.55	10.96	.42	.70	.39	.55	6.99	3.96	3.65	3.76	1.15	1.60
Brown bullhead	I	-	-	.33	.15	.08	.12	.08	.04	-	-	-	-
	II	-	-	1.69	.75	.39	.94	.56	.27	-	-	-	-
Golden topminnow	I	.75	.52	-	-	1.08	1.83	.08	.03	.92	.82	1.58	.66
	II	3.30	3.71	-	-	5.21	14.39	.56	.20	1.49	2.94	5.48	6.61
Seminole killifish	I	1.83	2.61	4.66	5.78	1.25	1.42	1.58	2.43	2.42	2.43	1.08	1.48
	II	8.08	18.62	23.72	29.15	6.03	11.16	11.05	16.30	3.93	8.70	3.75	14.01
Flagfish	I	-	-	-	-	-	-	-	-	.08	.02	-	-
	II	-	-	-	-	-	-	-	-	.13	.07	-	-
Bluefin killifish	I	3.42	1.28	4.83	2.95	3.16	1.56	1.92	.74	16.17	2.82	2.33	.70
	II	15.07	9.18	24.57	14.86	15.25	12.26	13.43	4.96	26.23	10.10	8.09	7.01
Mosquitofish	I	13.16	3.15	7.00	1.53	12.50	3.03	7.42	2.15	26.75	5.46	21.00	4.35
	II	58.08	22.48	35.59	7.69	60.33	23.82	51.74	14.42	43.39	19.55	72.89	43.54
Least killifish	I	-	-	-	-	-	-	.16	.03	1.66	.03	.08	.01
	II	-	-	-	-	-	-	1.16	.20	2.69	.11	.28	.01
Brook silverside	I	-	-	-	-	-	-	-	-	.08	.06	-	-
	II	-	-	-	-	-	-	-	-	.13	.22	-	-
Bluespotted sunfish	I	.08	.32	.92	1.07	.75	.65	.16	.44	.42	.28	.08	.01
	II	.36	2.28	4.66	5.43	3.62	5.11	1.16	2.95	.68	1.00	.28	.10
Warmouth	I	.08	1.65	.25	2.35	-	-	.58	7.72	1.75	1.00	-	-
	II	.36	11.76	1.27	11.84	-	-	4.06	51.78	2.84	3.58	-	-
Bluegill	I	.16	2.26	.33	2.32	.08	3.04	.08	.01	2.08	8.30	1.08	.51
	II	.73	16.16	1.69	11.71	.39	23.90	.58	.01	3.37	29.72	3.75	5.11
Dollar sunfish	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Redear sunfish	I	-	-	.33	3.01	.08	.03	-	-	1.08	.55	.33	1.63
	II	-	-	1.69	15.18	.39	.24	-	-	1.75	1.97	1.15	16.32
Spotted sunfish	I	-	-	.08	.01	-	-	-	-	-	-	-	-
	II			.42	.02	-	-	-	-	-	-	-	-
Largemouth bass	I	.58	.56	.33	.33	.58	.46	.08	.13	.58	2.58	-	-
	II	2.57	4.04	1.69	.67	2.80	3.62	.58	.84	.97	9.25	-	-
Swamp darter	I	.42	.10	.42	.19	1.08	.51	1.16	.60	5.33	2.50	.92	.56
	II	1.83	.77	2.11	.94	5.21	4.01	8.11	4.03	8.65	8.95	3.19	5.61
Total		22.66	14.03	19.67	19.84	20.72	12.72	14.30	14.91	61.65	27.93	28.81	9.99

(Continued)

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

Table 3 (Continued)

Species		Nov. No.	Nov. Wt. (g.)	Dec. No.	Dec. Wt. (g.)	Jan. No.	Jan. Wt. (g.)	Feb. No.	Feb. Wt. (g.)	March No.	March Wt. (g.)	April No.	April Wt. (g.)
Florida gar	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Chain pickerel	I	-	-	-	-	-	-	.08	.08	-	-	-	-
	II	-	-	-	-	-	-	2.78	4.20	-	-	-	-
Coastal shiner	I	12.75	3.38	-	-	-	-	-	-	.08	.04	-	-
	II	23.79	19.44	-	-	-	-	-	-	3.57	.43	-	-
Brown bullhead	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Golden topminnow	I	.16	.03	.25	.64	.17	.18	-	-	.08	.17	.17	.33
	II	.31	.14	.86	6.65	7.14	16.80	-	-	3.57	1.72	4.26	10.24
Seminole killifish	I	4.92	5.25	.33	.53	.33	.29	.75	1.17	1.67	9.22	1.67	2.23
	II	9.18	30.16	1.15	5.53	14.28	27.00	25.00	65.42	71.43	95.10	42.53	70.08
Flagfish	I	.08	.01	.08	.02	-	-	-	-	-	-	.17	.06
	II	.16	.05	.28	.17	-	-	-	-	-	-	4.26	1.83
Bluefin killifish	I	8.16	.92	9.25	1.77	-	-	.17	.11	.08	.02	.58	.17
	II	15.24	5.26	31.89	18.32	-	-	5.56	6.07	3.57	.17	14.89	5.25
Mosquitofish	I	25.00	6.09	15.92	2.48	1.75	.55	1.75	0.35	.25	.18	1.25	.38
	II	46.65	34.99	54.88	25.75	75.00	52.20	58.33	19.63	10.71	1.89	31.91	12.07
Least killifish	I	.50	.05	.25	.02	-	-	.17	.02	.08	.03	.08	.02
	II	.93	.29	.86	.17	-	-	5.55	1.40	3.57	.26	2.13	.52
Brook silverside	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Bluespotted sunfish	I	.58	.41	1.50	.98	.08	.02	.08	.06	-	-	-	-
	II	1.09	2.35	5.17	10.19	3.57	2.40	2.78	3.27	-	-	-	-
Warmouth	I	.16	.54	.58	2.73	-	-	-	-	-	-	.25	1.26
	II	.31	3.11	2.01	28.26	-	-	-	-	-	-	1.49	8.81
Bluegill	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Dollar sunfish	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Redear sunfish	I	.16	.18	-	-	-	-	-	-	-	-	-	-
	II	.31	1.01	-	-	-	-	-	-	-	-	-	-
Spotted sunfish	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Largemouth bass	I	-	-	-	-	-	-	-	-	-	-	1.08	.85
	II	-	-	-	-	-	-	-	-	-	-	6.47	5.95
Swamp darter	I	1.08	.56	.83	.48	-	-	-	-	-	-	1.5	.7
	II	2.02	3.21	2.87	4.92	-	-	-	-	-	-	8.96	4.9
Total		53.55	17.42	28.99	9.65	2.33	1.04	3.00	1.78	2.32	9.70	3.92	3.18

(Continued)

Table 3 (Concluded)

Species		May No.	May Wt. (g.)	June No.	June Wt. (g.)	July No.	July Wt. (g.)	Aug. No.	Aug. Wt. (g)	Mean No.	Mean Wt. (g.)
Florida gar	I	-	-	-	-	-	-	-	-	.01	.01
	II	-	-	-	-	-	-	-	-	.05	.09
Chain pickerel	I	-	-	-	-	-	-	-	-	.01	.01
	II	-	-	-	-	-	-	-	-	.05	.09
Coastal shiner	I	3.08	1.49	.08	.08	.08	.06	-	-	1.37	.54
	II	18.41	10.44	.96	.71	.64	.82	-	-	6.56	4.69
Brown bullhead	I	-	-	-	-	-	-	-	-	.03	.01
	II	-	-	-	-	-	-	-	-	.14	.09
Golden topminnow	I	.17	.18	-	-	-	-	.25	.23	.35	.35
	II	1.00	1.23	-	-	-	-	.90	2.30	1.68	3.04
Seminole killifish	I	1.67	7.02	1.75	6.36	1.75	2.90	.75	1.99	1.78	3.32
	II	9.95	49.12	20.19	60.03	13.38	40.70	2.70	19.59	8.53	28.82
Flagfish	I	-	-	-	-	-	-	.33	.35	.05	.03
	II	-	-	-	-	-	-	1.20	3.44	.24	.26
Bluefin killifish	I	3.33	1.27	4.33	1.02	9.42	1.72	15.75	2.61	5.18	1.23
	II	19.90	8.87	50.00	9.68	71.97	24.09	56.76	25.65	24.82	10.68
Mosquitofish	I	5.17	1.43	1.25	.33	.08	.02	5.08	1.93	9.08	2.09
	II	30.85	9.98	14.42	3.15	.64	.23	18.32	19.02	43.51	18.14
Least killifish	I	.50	.10	.08	.01	-	-	.08	.02	.23	.02
	II	2.99	.70	.96	.08	-	-	.30	.16	1.10	.17
Brook silverside	I	-	-	-	-	-	-	-	-	.01	.01
	II	-	-	-	-	-	-	-	-	.05	.09
Bluespotted sunfish	I	-	-	-	-	-	-	.67	.48	.33	.30
	II	-	-	-	-	-	-	2.40	4.75	1.58	2.60
Warmouth	I	.08	0.94	-	-	-	-	.08	.43	.24	1.16
	II	.96	8.89	-	-	-	-	.30	4.18	1.15	10.07
Bluegill	I	-	-	.25	1.10	-	-	.92	.20	.31	1.11
	II	-	-	1.91	15.44	-	-	3.30	1.97	1.49	9.64
Dollar sunfish	I	-	-	-	-	.08	.21	-	-	.01	.01
	II	-	-	-	-	.64	2.92	-	-	.05	.09
Redear sunfish	I	.08	1.36	.67	1.85	-	-	.08	.14	0.53	.48
	II	.96	12.82	5.10	11.93	-	-	.30	1.39	2.54	4.17
Spotted sunfish	I	-	-	-	-	-	-	-	-	.01	.01
	II	-	-	-	-	-	-	-	-	.05	.09
Largemouth bass	I	.50	.28	.08	.04	-	-	.25	.52	.25	.36
	II	5.77	2.68	.64	.58	-	-	.90	5.08	1.20	3.13
Swamp darter	I	.50	.21	.67	.23	-	-	3.50	1.27	1.09	.49
	II	5.77	1.97	5.10	3.27	-	-	12.61	12.46	5.22	4.25
Total		16.85	14.26	8.65	10.59	13.08	7.12	27.75	10.17	20.87	11.52

Table 4

Average Yields Determined from 20-ft Seine Collections in Beach Areas During the Period May 1976-August 1977

Species		May No.	May Wt. (g)	June No.	June Wt. (g)	July No.	July Wt. (g)	Aug. No.	Aug. Wt. (g)	Sept. No.	Sept. Wt. (g)	Oct. No.	Oct. Wt. (g)
Coastal shiner	I	8.16	6.52	.50	.53	-	-	-	-	6.33	2.22	4.33	1.78
	II	5.05	.97	.77	.17	-	-	-	-	17.59	1.33	15.48	2.03
Chain pickerel	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Golden topminnow	I	-	-	-	-	-	-	-	-	.16	.88	-	-
	II	-	-	-	-	-	-	-	-	.46	.53	-	
Seminole killifish	I	148.17	622.40	58.17	274.67	42.33	248.05	17.50	92.55	24.83	91.36	12.17	48.05
	II	91.55	92.28	90.18	86.56	77.91	46.80	61.40	24.54	68.98	54.94	43.45	54.61
Flagfish	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Bluefin killifish	I	.83	.35	-	-	-	-	-	-	-	-	-	-
	II	.51	.05	-	-	-	-	-	-	-	-	-	-
Mosquitofish	I	.83	.19	-	-	.17	.17	.33	.08	.16	.03	.50	.17
	II	.51	.02	-	-	.31	.03	1.17	.02	.46	.01	1.79	.19
Brook silverside	I	.17	.39	.33	.01	-	-	.17	.25	.83	.98	8.50	5.55
	II	.10	.06	.51	.01	-	-	.58	.07	2.31	.59	30.36	6.31
Bluegill	I	1.83	26.64	3.33	38.66	6.33	125.23	2.83	71.83	1.66	39.23	1.67	20.00
	II	1.13	3.95	5.17	12.19	11.66	23.63	9.94	19.04	4.62	23.56	5.95	22.73
Redear sunfish	I	-	-	-	-	4.83	130.15	7.17	209.58	1.16	19.16	-	-
	II	-	-	-	-	8.90	24.56	25.15	55.56	3.24	11.52	-	-
Largemouth bass	I	1.83	18.00	2.17	3.43	.66	26.43	.50	2.90	1.16	13.36	.83	12.43
	II	1.13	2.67	3.36	1.08	1.22	4.99	1.75	.77	3.24	8.03	2.98	14.13
Swamp darter	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Total		161.83	674.49	64.50	317.30	54.33	530.03	28.50	377.19	36.00	167.22	28.00	87.98

(Continued)

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

Table 4 (Continued)

Species		Nov.		Dec.		Jan.		Feb.		March		April	
		No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)
Coastal shiner	I	3.00	1.25	.33	.13	-	-	-	-	1.00	0.55	1.67	.52
	II	2.84	.76	.51	.07	-	-	-	-	1.01	0.11	2.15	.22
Chain pickerel	I	-	-	-	-	-	-	-	-	-	-	.33	1.22
	II	-	-	-	-	-	-	-	-	-	-	.43	.52
Golden topminnow	I	-	-	-	-	.17	.32	-	-	-	-	-	-
	II	-	-	-	-	.35	.69	-	-	-	-	-	-
Seminole killifish	I	98.33	154.62	64.66	155.71	47.00	43.35	11.50	8.02	97.67	487.03	50.67	200.57
	II	93.05	94.96	98.73	85.55	98.26	94.07	100.00	100.00	98.65	99.38	65.24	85.00
Flagfish	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
Bluefin killifish	I	-	-	-	-	.33	.15	-	-	-	-	.17	.08
	II	-	-	-	-	.70	.32	-	-	-	-	.21	.04
Mosquitofish	I	4.00	1.73	-	-	-	-	-	-	-	-	.17	.10
	II	3.78	1.06	-	-	-	-	-	-	-	-	.21	.04
Brook silverside	I	-	-	-	-	-	-	-	-	-	-	2.00	5.10
	II	-	-	-	-	-	-	-	-	-	-	2.58	2.16
Bluegill	I	-	-	-	-	-	-	-	-	.17	.65	3.10	16.42
	II	-	-	-	-	-	-	-	-	.17	.13	3.86	6.96
Redear sunfish	I	-	-	-	-	-	-	-	-	-	-	.17	3.10
	II	-	-	-	-	-	-	-	-	-	-	.21	1.31
Largemouth bass	I	.33	5.22	.66	26.16	.33	2.27	-	-	.17	1.82	19.33	8.78
	II	.31	3.20	1.02	14.37	.70	4.92	-	-	.17	.37	24.89	3.72
Swamp darter	I	-	-	-	-	-	-	-	-	-	-	.17	.07
	II	-	-	-	-	-	-	-	-	-	-	.21	.03
Total		105.66	162.82	65.67	182.00	47.83	46.09	11.50	8.02	99.00	490.05	77.67	235.96

(Continued)

Table 4 (Concluded)

Species		May		June		July		Aug.		Mean	
		No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)
Coastal shiner	I	12.00	11.18	5.00	.70	-	-	1.17	.50	2.71	1.62
	II	15.00	3.44	22.56	.71	-	-	6.73	1.66	4.76	.68
Chain pickerel	I	.33	5.22	-	-	-	-	-	-	.04	.40
	II	.42	1.91	-	-	-	-	-	-	.07	.17
Golden topminnow	I	-	-	-	-	-	-	-	-	.02	.08
	II	-	-	-	-	-	-	-	-	.04	.03
Seminole killifish	I	46.33	171.18	14.17	77.83	1.83	3.33	11.50	24.95	46.68	168.98
	II	57.92	52.58	63.91	79.16	16.18	5.33	63.35	82.80	81.95	71.24
Flagfish	I	-	-	-	-	-	-	.17	.02	.01	.01
	II	-	-	-	-	-	-	.96	.06	.02	.01
Bluefin killifish	I	2.00	.98	-	-	.33	.10	.33	.16	.25	.11
	II	2.50	.30	-	-	2.94	.16	1.92	.50	.44	.05
Mosquitofish	I	-	-	-	-	.83	.10	2.00	.75	.56	.21
	II	-	-	-	-	7.35	.16	11.54	2.49	.98	.09
Brook silverside	I	3.17	1.58	1.17	2.48	-	-	.33	.25	1.04	1.04
	II	3.96	.49	5.26	2.52	-	-	1.92	.83	1.82	.44
Bluegill	I	1.00	8.98	.33	5.85	2.67	28.77	-	-	1.56	23.89
	II	1.25	2.76	1.50	5.95	23.53	45.98	-	-	2.74	10.07
Redear sunfish	I	4.83	99.44	.33	10.67	1.00	24.35	.17	.25	1.23	31.04
	II	6.04	30.54	1.50	10.85	8.82	38.92	.96	.83	2.16	13.09
Largemouth bass	I	10.33	25.98	1.17	.78	4.67	5.92	1.67	3.27	2.86	9.80
	II	12.92	7.98	5.26	.80	41.18	9.46	9.62	10.84	5.02	4.13
Swamp darter	I	-	-	-	-	-	-	-	-	.01	.01
	II	-	-	-	-	-	-	-	-	.02	.01
Total		79.99	324.54	22.17	98.31	11.33	62.57	17.33	30.15	56.96	237.19

Table 5

Average Yields Determined from 10-ft Seine Collections in Vegetated Areas

During the Period July 1976-August 1977

Species		July		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.	
		No.	Wt. (g)	No.	Wt. (g)	No.	Wt.(g)	No.	Wt.(Kg)	No.	Wt. (g)	No.	Wt.(g)	No.	Wt.(g)	No.	Wt.(g)
Florida gar	I	-	-	-	-	.17	98.50	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	.74	71.15	-	-	-	-	-	-	-	-	-	-
Chain pickerel	I	.17	2.38	-	-	.17	7.95	-	-	-	-	-	-	.67	.33	.66	.30
	II	.85	4.29	-	-	.74	5.74	-	-	-	-	-	-	30.77	18.87	5.55	2.02
Golden shiner	I	-	-		-	-	-	.33	.98	-	-	-	-	-	-	-	-
	II	-	-		-	-	-	.64	1.93	-	-	-	-	-	-	-	-
Coastal shiner	I	5.00	5.00	5.50	3.72	7.50	2.28	4.00	1.65	.17	.08	-	-	-	-	.17	.07
	II	25.64	9.00	21.42	14.73	33.09	1.65	7.69	3.24	.78	.46	-	-	-	-	1.39	.45
White catfish	I	.17	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	.85	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Golden topminnow	I	-	-	.17	.50	-	-	-	-	-	-	-	-	-	-	.17	.08
	II	-	-	.64	1.98	-	-	-	-	-	-	-	-	-	-	1.39	.56
Seminole killifish	I	2.50	14.02	.67	2.58	.33	1.72	3.66	7.32	2.17	3.55	4.67	11.45	.17	.92	7.33	11.43
	II	12.82	25.23	2.59	10.23	1.47	1.24	7.05	14.38	10.08	19.43	29.78	72.54	7.69	51.87	61.11	72.16
Bluefin killifish	I	2.50	1.31	5.00	1.93	3.33	.75	5.33	1.40	2.00	.52	.17	.03	.33	.12	2.67	.88
	II	12.82	2.37	19.48	7.66	14.70	.54	10.25	2.75	9.30	2.83	1.06	.21	15.38	6.60	22.22	5.96
Mosquitofish	I	3.50	0.73	3.50	1.28	1.00	.25	19.16	4.81	12.00	3.23	9.83	2.45	1.00	.04	-	-
	II	17.94	1.32	13.63	5.08	4.41	.18	36.85	9.46	55.81	17.70	62.76	15.52	46.15	22.64	-	-
Least killifish	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brook silverside	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluespotted sunfish	I	.67	.20	1.50	1.17	.33	.38	1.16	.92	.33	.62	.17	.05	-	-	-	-
	II	.85	.36	5.84	4.62	1.47	.28	2.24	1.80	1.55	3.38	1.06	.31	-	-	-	-
Warmouth	I	-	-	-	-	.17	.52	.33	.36	-	-	.50	1.53	-	-	-	-
	II	-	-	-	-	.74	.37	.64	.72	-	-	3.19	9.71	-	-	-	-
Bluegill	I	2.67	19.05	7.17	5.73	8.67	13.88	17.00	32.93	3.50	6.10	-	-	-	-	.83	1.95
	II	13.67	34.29	27.92	22.72	38.24	10.03	32.69	64.74	16.28	33.39	-	-	-	-	6.94	13.16
Redear sunfish	I	.83	.23	1.00	.52	-	-	-	-	.33	1.40	-	-	-	-	-	-
	II	4.27	.42	3.89	2.04	-	-	-	-	1.55	7.66	-	-	-	-	-	-
Spotted sunfish	I	-	-	-	-	-	-	-	-	.17	.30	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	.78	1.64	-	-	-	-	-	-
Largemouth bass	I	1.83	11.46	.50	1.63	.50	2.73	-	-	.33	2.15	-	-	-	-	-	-
	II	9.40	20.64	1.94	6.47	2.20	1.97	-	-	1.55	11.77	-	-	-	-	-	-
Black Crappie	I	.17	1.12	.67	6.17	.50	9.48	-	-	-	-	-	-	-	-	-	-
	II	.85	2.01	2.59	24.43	2.20	6.85	-	-	-	-	-	-	-	-	-	-
Swamp darter	I	-	-	-	-	-	-	1.00	.48	.50	.32	.33	.24	-	-	.17	.10
	II	-	-	-	-	-	-	1.92	.95	2.32	1.73	2.12	1.68	-	-	1.39	.67
Total		20.01	55.53	25.68	25.23	22.67	138.44	51.97	50.87	21.50	18.27	15.67	15.7	2.17	1.41	12.00	14.81

(Continued)

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

Table 5 (Concluded)

Species		March No.	March Wt. (g)	April No.	April Wt. (g)	May No.	May Wt. (g)	June No.	June Wt. (g)	July No.	July Wt. (g)	Aug. No.	Aug. Wt. (g)	Mean No.	Mean Wt. (g)
Florida gar	I	-	-	-	-	-	-	-	-	-	-	-	-	.01	7.04
	II	-	-	-	-	-	-	-	-	-	-	-	-	.04	20.59
Chain pickerel	I	.67	1.30	.17	.73	-	-	-	-	-	-	-	-	.18	.93
	II	3.03	9.44	.66	4.95	-	-	-	-	-	-	-	-	.74	2.72
Golden shiner	I	-	-	-	-	-	-	-	-	-	-	-	-	.02	.07
	II	-	-	-	-	-	-	-	-	-	-	-	-	.08	.20
Coastal shiner	I	1.50	.53	19.00	4.87	.50	.47	.33	.25	.67	.85	-	-	3.17	1.41
	II	6.82	3.87	75.00	32.85	1.04	1.38	1.21	.59	2.92	3.19	-	-	12.99	4.12
White catfish	I	-	-	-	-	-	-	-	-	-	-	-	-	.01	.01
	II	-	-	-	-	-	-	-	-	-	-	-	-	.04	.02
Golden topminnow	I	.17	.20	-	-	.17	.45	-	-	-	-	.33	.43	.07	.12
	II	.76	1.45	-	-	.35	1.33	-	-	-	-	1.36	1.66	.29	.35
Seminole killifish	I	1.33	3.75	.83	4.38	.67	2.45	3.50	20.40	1.67	4.73	1.00	4.63	2.17	6.67
	II	6.06	27.24	3.29	29.58	1.38	7.22	12.73	47.94	7.30	17.76	4.08	17.71	8.89	19.51
Bluefin killifish	I	1.50	.65	1.50	.43	8.0	3.13	-	-	7.83	3.18	6.50	1.43	3.33	1.13
	II	6.82	4.72	5.92	2.92	16.61	9.23	-	-	34.31	11.94	26.53	5.48	13.65	3.31
Mosquitofish	I	15.33	6.77	1.67	.72	31.67	21.12	19.33	9.73	5.50	2.65	8.33	3.43	9.42	4.09
	II	69.70	49.15	6.58	4.84	65.74	62.23	70.30	22.88	24.09	9.94	34.01	12.13	38.61	11.96
Least killifish	I	1.00	.22	-	-	1.0	.25	-	-	-	-	-	-	.14	.03
	II	4.55	1.57	-	-	2.08	.74	-	-	-	-	-	-	.57	.09
Brook silverside	I	.17	.03	-	-	-	-	-	-	-	-	-	-	.01	.01
	II	.76	.24	-	-	-	-	-	-	-	-	-	-	.04	.02
Bluespotted sunfish	I	.33	.32	.17	.12	-	-	-	-	-	-	.33	.37	.36	.30
	II	1.52	2.30	.66	.79	-	-	-	-	-	-	1.36	1.40	1.47	.87
Warmouth	I	-	-	-	-	-	-	-	-	.17	2.43	.33	1.33	.11	.44
	II	-	-	-	-	-	-	-	-	.73	9.13	1.36	5.10	.45	1.29
Bluegill	I	-	-	1.17	3.13	.50	1.48	2.67	6.80	3.33	7.95	2.67	9.70	3.58	7.76
	II	-	-	4.61	21.15	1.04	4.37	9.70	15.98	14.60	29.83	10.88	37.07	14.67	22.70
Redear sunfish	I	-	-	-	-	-	-	.83	5.02	-	-	.17	.23	.23	.53
	II	-	-	-	-	-	-	3.03	11.79	-	-	.68	.89	.94	1.55
Spotted sunfish	I	-	-	-	-	-	-	-	-	-	-	-	-	.01	.02
	II	-	-	-	-	-	-	-	-	-	-	-	-	.04	.06
Largemouth bass	I	-	-	.83	.43	5.67	4.58	.83	.35	3.67	4.85	1.33	2.32	1.11	2.18
	II	-	-	3.29	2.92	11.76	13.51	3.03	.82	16.06	18.20	5.44	8.85	4.55	6.38
Black Crappie	I	-	-	-	-	-	-	-	-	-	-	3.33	2.20	.33	1.36
	II	-	-	-	-	-	-	-	-	-	-	13.61	8.41	1.35	3.98
Swamp darter	I	-	-	-	-	-	-	-	-	-	-	.17	.08	.14	.09
	II	-	-	-	-	-	-	-	-	-	-	.68	.32	.57	.26
Total		22.00	13.77	25.33	14.82	48.18	33.93	27.49	42.55	22.83	26.63	24.50	26.17	24.40	34.19

Table 6

Average Yields Per Day Determined from Gill Net Collections

During the Period July 1976-August 1977

Species		July		Aug.		Sept.		Oct.		Nov.	
		No.	Wt.(Kg)	No.	Wt.(Kg)	No.	Wt. (Kg)	No.	Wt.(Kg)	No.	Wt.(Kg)
Florida gar	I	17.5	10.424	10.0	7.725	9.5	8.252	2.5	2.758	4.5	3.354
	II	41.17	47.15	20.83	29.52	24.67	46.59	13.88	25.25	20.93	44.33
Gizzard shad	I	13.0	8.834	20.5	13.532	8.5	2.919	2.0	.789	.5	.135
	II	30.58	39.96	42.70	51.70	22.07	16.48	11.11	7.22	2.33	1.78
Chain pickerel	I	2.0	.836	2.0	.910	.5	.499	2.0	1.360	2.0	1.316
	II	4.70	3.78	4.16	3.47	1.29	2.81	11.11	12.45	9.30	17.39
Golden shiner	I	2.0	.242	.5	.110	.5	.088	.5	.114	.5	.102
	II	4.70	1.09	1.04	.42	1.29	.50	2.77	1.04	2.33	1.35
Lake chubsucker	I	-	-	-	-	-	-	1.0	.578	-	-
	II	-	-	-	-	-	-	5.55	5.28	-	-
Yellow bullhead	I	-	-	-	-	2.5	.729	-	-	-	-
	II	-	-	-	-	6.49	4.12	-	-	-	-
Brown bullhead	I	-	-	-	-	-	-	1.5	.652	2.0	.760
	II	-	-	-	-	-	-	8.33	5.96	9.30	10.04
Warmouth	I	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-
Bluegill	I	1.5	.182	4.5	.312	.5	.046	-	-	-	-
	II	3.52	.82	9.38	1.19	1.29	.26	-	-	-	-
Redear sunfish	I	.5	.117	0.5	.030	-	-	.5	.140	.5	.145
	II	1.17	.52	1.04	.11	-	-	2.77	1.29	2.33	1.92
Largemouth bass	I	.5	.121	6.0	2.330	8.0	3.592	6.5	4.194	5.5	.233
	II	1.17	.54	12.5	8.90	20.77	20.28	36.11	38.40	25.58	3.08
Black crappie	I	5.5	1.350	4.0	1.220	8.5	1.584	1.5	.336	6.0	1.522
	II	12.94	6.10	8.33	4.66	22.07	8.94	8.33	3.08	27.90	20.11
Total		42.50	22.106	48.00	26.169	38.50	17.710	18.0	10.992	21.5	7.567

(Continued)

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

Table 6 (Continued)

Species		Dec.		Jan.		Feb.		March		April	
		No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)
Florida gar	I	1.0	1.134	1.5	1.375	-	-	24	23.220	12.0	11.532
	II	3.03	7.69	3.79	7.94	-	-	42.10	58.56	37.50	56.90
Gizzard shad	I	2.0	.719	-	-	-	-	11.5	6.206	4.0	2.040
	II	6.06	4.87	-	-	-	-	20.18	15.65	12.50	10.07
Chain pickerel	I	3.0	1.842	2.0	1.588	2.5	1.372	.5	.505	4.5	3.158
	II	9.09	12.49	5.06	9.17	25.00	21.67	.88	1.27	14.06	15.58
Golden shiner	I	3.5	.814	2.0	.816	.5	.124	1.5	.339	2.5	.547
	II	10.61	5.51	5.06	4.71	5.00	1.96	2.63	.85	7.81	2.70
Lake chubsucker	I	.5	.397	-	-	-	-	.5	.522	.5	.340
	II	1.51	2.69	-	-	-	-	2.63	1.32	1.56	1.68
Yellow bullhead	I	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-
Brown bullhead	I	-	-	-	-	-	-	1.5	.300	-	-
	II	-	-	-	-	-	-	.88	.76	-	-
Warmouth	I	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-
Bluegill	I	-	-	-	-	-	-	1.5	.198	.5	.340
	II	-	-	-	-	-	-	2.63	.50	1.56	.18
Redear sunfish	I	.5	.068	-	-	-	-	-	-	-	-
	II	1.51	.45	-	-	-	-	-	-	-	-
Largemouth bass	I	14.0	7.713	22.0	11.185	7.0	4.833	14.0	7.898	5.0	1.680
	II	42.42	52.32	55.69	64.65	70.00	76.36	24.56	19.92	15.62	8.29
Black crappie	I	8.5	2.056	11.5	2.335	-	-	2.0	0.462	3.0	.934
	II	25.75	13.94	29.11	13.49	-	-	3.51	1.17	9.38	4.61
Total		33.0	14.742	39.5	17.299	10.00	6.329	57.00	39.650	32.00	20.267

(Continued)

Table 6 (Concluded)

Species		May No.	May Wt. (Kg.)	June No.	June Wt. (Kg)	July No.	July Wt. (Kg)	Aug. No.	Aug. Wt. (Kg)	Mean No.	Mean Wt. (Kg.)
Florida gar	I	11.50	8.785	6.5	6.208	4.0	4.880	1.0	.804	7.5	6.461
	II	28.40	35.45	16.67	25.33	32.00	50.36	12.50	16.23	23.88	36.34
Gizzard shad	I	21.5	14.746	17.5	10.748	2.5	1.384	3.0	2.112	7.6	4.583
	II	53.09	50.44	44.87	43.86	20.00	14.28	37.50	42.65	24.20	25.78
Chain pickerel	I	1.5	1.063	1.5	.990	.5	.274	-	-	1.8	1.122
	II	3.7	4.29	3.85	4.04	4.00	2.82	-	-	5.73	6.31
Golden shiner	I	-	-	1.5	.340	1.5	.329	-	-	1.1	.283
	II	-	-	3.85	1.39	12.00	3.40	-	-	3.50	1.59
Lake chubsucker	I	-	-	2.0	1.157	-	-	-	-	.4	.214
	II	-	-	5.13	4.72	-	-	-	-	1.27	1.20
Yellow bullhead	I	.5	.414	.5	.278	-	-	-	-	.4	.102
	II	1.23	1.67	1.28	1.14	-	-	-	-	1.27	.57
Brown bullhead	I	-	-	.5	.276	-	-	-	-	.2	.142
	II	-	-	1.28	1.13	-	-	-	-	.64	.80
Warmouth	I	-	-	.5	.070	-	-	-	-	.1	.005
	II	-	-	1.28	.29	-	-	-	-	.32	.03
Bluegill	I	2.0	.235	1.0	.860	-	-	.5	.078	.08	.084
	II	4.94	.95	2.56	.35	-	-	6.25	1.56	2.56	.47
Redear sunfish	I	-	-	-	-	-	-	-	-	.2	.036
	II	-	-	-	-	-	-	-	-	.64	.20
Largemouth bass	I	2.5	1.570	6.0	4.036	3.5	2.740	2.5	1.710	7.4	3.845
	II	6.17	6.33	15.38	16.47	28.00	28.27	31.25	34.54	23.57	21.62
Black crappie	I	1	.215	1.5	.315	.5	.084	1.0	.248	3.9	.904
	II	2.47	.87	3.85	1.29	4.00	.87	12.50	5.02	12.42	5.08
Total		40.50	27.028	39.00	24.504	12.50	9.691	8.00	4.952	31.4	17.81

Table 7

Average Yields Per Hectare Determined from Blocknet Collections

During Spring and Fall 1976 and Spring 1977

		Spring 1976							
		West		Middle		South		Mean	
		No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)
Longnose gar	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Florida gar	I	2.8	1.40	-	-	-	-	.90	.46
	II	.01	1.45	-	-	-	-	.01	.41
Gizzard shad	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Threadfin shad	I	167.8	.76	-	-	-	-	55.9	.25
	II	.53	.80	-	-	-	-	.20	.22
Chain pickerel	I	79.8	12.27	200.3	35.47	74.2	24.40	118.1	24.05
	II	.25	12.73	1.41	25.48	.21	22.88	.43	21.07
Golden shiner	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Coastal shiner	I	-	-	-	-	409.8	.41	136.6	.13
	II	-	-	-	-	1.14	.39	.50	.12
Lake chubsucker	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Yellow bullhead	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Brown bullhead	I	60.5	7.86	91.6	5.63	60.6	.69	70.9	4.72
	II	.19	8.15	.64	4.04	.17	.65	.26	4.14
Tadpole madtom	I	-	-	4.9	.01	-	-	1.6	.01
	II	-	-	.03	.01	-	-	.01	.01
Seminole killifish	I	93.5	.45	7.4	.083	2.8	.01	34.6	.18
	II	.30	.47	.05	.06	.01	.01	.13	.16
Flagfish	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Bluefin killifish	I	1658.2	.85	2820.7	1.711	8184.0	3.13	4221.0	1.64
	II	5.25	.08	19.94	1.23	22.84	2.93	15.53	1.44
Least killifish	I	-	-	-	-	137.5	.01	45.8	.01
	II	-	-	-	-	.38	.01	.17	.01
Brook silverside	I	115.5	.01	-	-	275.0	.02	130.2	.01
	II	.36	.01	-	-	.77	.02	.48	.01
Bluespotted sunfish	I	23694.0	15.09	5910.7	6.69	18810.0	11.46	16138.2	11.08
	II	75.06	15.64	41.76	4.81	52.51	10.75	59.37	9.71
Warmouth	I	1575.8	6.35	69.2	.90	662.9	5.09	769.3	4.11
	II	4.99	6.59	.49	.65	1.85	4.77	2.83	3.60
Bluegill	I	976.2	15.75	2010.5	28.43	572.0	9.14	1186.2	17.77
	II	3.09	16.33	14.21	20.42	1.60	8.57	4.36	15.57
Dollar sunfish	I	-	-	4.9	..01	-	-	1.6	.01
	II	-	-	.03	.01	-	-	.01	.01
Redear sunfish	I	1102.8	11.89	2079.7	47.57	734.3	26.35	1305.6	28.60
	II	3.49	12.33	14.70	34.16	2.05	24.70	4.80	25 06
Largemouth bass	I	1988.2	24.50	649.6	12.668	5602.2	24.41	2746.7	20.52
	II	6.30	25.40	4.59	9.10	15.64	22.88	10.10	17.98
Black crappie	I	-	-	28.65	.045	299.8	1.52	195.4	.52
	II	-	-	2.02	.03	.84	1.43	.72	.46
Swamp darter	I	52.2	.01	12.4	.01	-	-	21.5	.01
	II	.16	.01	.08	.01	-	-	.08	.01
Total		31567.2	96.47	14148.4	139.23	35825.1	106.69	27180.3	114.13

(Continued)

Note: Entries in "I" rows are numerical values per 100 individuals; those in "II" rows are percent composition values.

Table 7 (Continued)

		Fall 1976							
		West		Middle		South		Mean	
		No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)
Longnose gar	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Florida gar	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Gizzard shad	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Threadfin shad	I	-	-	17.5	.10	946.0	5.30	321.2	1.80
	II	-	-	.13	.07	5.34	4.11	1.43	1.58
Chain pickerel	I	17.5	6.31	45.0	33.66	41.30	8.66	34.60	16.21
	II	.05	8.10	.33	24.94	.23	6.72	.15	14.22
Golden shiner	I	2.5	.10	-	-	22.0	1.43	8.2	.51
	II	.01	.12	-	-	.12	1.11	.04	.45
Coastal shiner	I	27.5	.04	-	-	57.8	.01	28.4	.02
	II	.08	.05	-	-	.33	.01	.13	.01
Lake chubsucker	I	-	-	5.0	3.45	-	-	1.7	1.15
	II	-	-	.04	2.55	-	-	.01	1.01
Yellow bullhead	I	2.5	.16	2.5	.01	-	-	1.7	.06
	II	.01	.20	.02	.01	-	-	.01	.05
Brown bullhead	I	20.0	.38	97.5	.86	-	-	39.2	.41
	II	.06	.49	.72	.64	-	-	.17	.36
Tadpole madtom	I	-	-	12.5	.02	-	-	4.2	.01
	II	-	-	.09	.01	-	-	.02	.01
Seminole killifish	I	627.5	2.77	20.0	.05	44.0	.27	230.5	1.03
	II	1.74	3.55	.15	.04	.25	.20	1.02	.90
Flagfish	I	25.0	.04	-	-	-	-	8.3	.01
	II	.07	.05	-	-	-	-	.04	.01
Bluefin killifish	I	202.5	.10	402.5	.11	110.0	.03	238.3	.08
	II	.56	.13	2.95	.08	.62	.02	1.06	.07
Least killifish	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Brook silverside	I	-	-	-	-	16.5	.01	5.5	.01
	II	-	-	-	-	.09	.01	.02	.01
Bluespotted sunfish	I	32610.0	16.25	7465.0	3.56	12383.3	9.58	17486.1	9.80
	II	90.29	20.84	54.87	2.64	69.85	8.20	77.77	8.60
Warmouth	I	605.0	1.82	707.5	4.17	237.5	1.11	556.7	2.37
	II	1.68	2.33	5.20	3.09	2.02	.86	2.48	2.08
Bluegill	I	1195.0	15.91	1720.0	11.78	2304.5	28.56	1739.8	18.75
	II	3.31	20.40	12.64	8.73	13.00	22.16	7.74	16.45
Dollar sunfish	I	10.0	.04	255.0	.34	5.5	.02	90.2	.13
	II	.03	.05	1.87	.25	.03	.01	.40	.12
Redear sunfish	I	350.0	9.58	2042.5	50.61	880.0	26.46	1090.8	28.88
	II	.97	12.28	15.01	37.50	4.96	20.53	4.85	25.34
Largemouth bass	I	317.5	24.45	810.0	26.26	385.0	45.15	504.2	31.95
	II	.88	31.36	5.95	19.46	2.17	35.02	2.24	28.04
Black crappie	I	-	-	-	-	123.8	2.31	41.3	.77
	II	-	-	-	-	.70	1.79	.18	.68
Swamp darter	I	105.0	.03	2.5	.01	52.3	.01	53.3	.02
	II	.29	.04	.02	.01	.29	.01	.24	.01
Total		36117.5	77.97	13605.0	134.99	17729.20	128.91	22484.2	113.97

(Continued)

Table 7 (Concluded)

		Spring 1977							
		West		Middle		South		Mean	
		No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)	No.	Wt. (Kg)
Longnose gar	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Florida gar	I	2.5	0.97	-	-	-	-	.8	.32
	II	.01	1.10	-	-	-	-	.01	.35
Gizzard shad	I	-	-	-	-	12.5	6.46	4.2	2.15
	II	-	-	-	-	.02	4.87	0.01	2.35
Threadfin shad	I	275.0	1.28	-	-	-	-	91.7	.43
	II	.39	1.45	-	-	-	-	.15	.47
Chain pickerel	I	142.5	3.56	140.0	5.67	480.0	17.37	254.2	8.87
	II	.20	4.03	.24	10.45	.92	13.11	.42	9.68
Golden shiner	I	-	-	-	-	15.0	1.18	5.0	.39
	II	-	-	-	-	.03	.89	.01	.42
Coastal shiner	I	-	-	-	-	2.50	.01	.8	.01
	II	-	-	-	-	.01	.01	.01	.01
Lake chubsucker	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Yellow bullhead	I	2.5	.03	-	-	-	-	.8	.01
	II	.01	.01	-	-	-	-	.01	.01
Brown bullhead	I	27.5	.05	-	-	1655.0	6.52	560.8	2.19
	II	.01	.01	-	-	3.16	4.92	.92	2.39
Tadpole madtom	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Seminole killifish	I	2.50	.02	5.0	.05	10.0	.06	8.3	.04
	II	.01	.01	.01	.01	.02	.01	.01	.04
Flagfish	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Bluefin killifish	I	637.50	.33	325.0	.12	2.5	.01	321.7	.15
	II	.90	.38	.55	.23	.01	.01	.53	.16
Least killifish	I	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-
Brook silverside	I	25.0	.03	-	-	20.0	.02	15.0	.02
	II	.01	.01	-	-	.04	.01	.02	.02
Bluespotted sunfish	I	55330.0	38.01	48047.5	19.28	40975.0	23.54	48117.50	26.94
	II	78.27	43.14	80.97	35.53	78.30	17.77	79.16	29.40
Warmouth	I	457.5	2.33	462.5	4.19	525.0	3.30	481.7	3.27
	II	.65	2.64	.78	7.71	1.00	2.49	.79	3.57
Bluegill	I	1022.5	7.76	582.5	10.27	3070.0	27.51	1558.3	15.18
	II	1.45	8.81	.98	18.92	5.87	20.77	2.56	16.56
Dollar sunfish	I	-	-	25.75	.39	520.0	1.11	259.2	.50
	II	-	-	.43	.73	.99	.84	.43	.54
Redear sunfish	I	560.0	9.13	860.0	5.43	3215.0	24.64	1545.0	13.07
	II	.79	10.37	1.45	10.01	6.14	18.60	2.54	14.26
Largemouth bass	I	12205.0	24.63	8630.0	8.85	1745.0	20.13	7526.7	17.87
	II	17.27	27.93	14.54	16.30	3.33	15.20	12.38	19.50
Black crappie	I	-	-	25.0	.02	55.0	.64	26.70	.22
	II	-	-	.01	.01	.10	.48	.04	.24
Swamp darter	I	-	-	-	-	25.0	.01	8.30	.01
	II	-	-	-	-	.05	.01	.01	.01
Total		70692.00	88.12	59342.5	54.27	52080.0	132.51	60786.7	91.64

Table 8

Average Yields of Sport, Forage, and Other Fish Per Hectare Determined from Blocknet Collections During Spring and Fall 1976 and Spring 1977

		Sport Fish*		Forage Fish**		Other Fish†	
		No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)
Spring 1976	I	6321.3	95.60	20787.0	13.33	71.8	5.20
	II	23.24	83.74	76.48	11.70	0.27	4.55
Fall 1976	I	3967.4	98.93	18474.2	13.42	42.6	1.62
	II	17.64	86.81	82.17	11.77	0.19	1.42
Spring 1977	I	11392.6	58.48	48831.7	30.64	562.4	2.52
	II	18.73	63.81	80.34	33.42	0.94	2.75
Mean	I	7227.1	82.67	29364.4	19.13	225.62	18.70
	II	19.62	68.60	79.76	15.88	0.61	15.52

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

* 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, least killifish, brook silverside, bluespotted sunfish, dollar fish, and swamp darter.

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

Table 9

Average Yields of Harvestable Sport Fish Per Hectare Determined from Blocknet Collections During Spring and Fall 1976 and Spring 1977

Species		Spring 1976		Fall 1976		Spring 1976		Mean	
		No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)	No.	Wt. (kg)
Chain pickerel (≥30.0 cm)	I	63.6	22.27	17.3	7.36	17.5	6.34	32.9	11.99
	II	0.08	0.65	0.02	2.15	0.01	2.31	0.03	3.75
Warmouth (≥12.5 cm)	I	9.2	0.79	5.0	0.36	5.8	3.14	6.7	1.43
	II	0.01	0.02	0.01	0.10	0.01	1.14	0.01	0.45
Bluegill (≥15.0 cm)	I	91.4	8.00	38.4	3.18	38.3	3.09	56.0	4.76
	II	0.11	0.23	0.06	0.93	0.01	1.12	0.05	1.49
Redear sunfish (≥150.0 cm)	I	119.2	14.88	98.2	17.53	40.8	4.24	86.4	12.22
	II	0.15	0.43	0.14	5.13	0.02	1.54	0.08	3.82
Black crappie (≥22.5 cm)	I	--	--	--	--	0.8	0.12	0.03	0.04
	II	0	--	--	--	0.01	0.04	0.01	0.01
Largemouth bass (≥25.0 cm)	I	23.5	14.60	43.6	25.04	30.8	13.21	32.6	17.62
	II	0.03	0.43	0.06	7.32	0.02	4.80	0.03	5.51
Total	I	306.09	60.54	202.5	53.47	134.0	30.14	214.98	48.06
	II	0.38	1.76	0.29	15.63	0.09	10.95	0.21	15.03

Note: Entries in "I" rows are numerical values; those in "II" rows are percent composition values.

Table 10

Frequency Distribution Per Hectare of Selected Sport Fish Determined from Blocknet Collections During Spring and Fall 1976 and Spring 1977

Length 2.54-cm Multiples	Largemouth Bass Spring 1976	Largemouth Bass Fall 1976	Largemouth Bass Spring 1977	Bluegill Spring 1976	Bluegill Fall 1976	Bluegill Spring 1977	Black Crappie Spring 1976	Black Crappie Fall 1976	Black Crappie Spring 1977	Redear Sunfish Spring 1976	Redear Sunfish Fall 1976	Redear Sunfish Spring 1977	Warmouth Spring 1976	Warmouth Fall 1976	Warmouth Spring 1977	Chain Pickerel Spring 1976	Chain Pickerel Fall 1976	Chain Pickerel Spring 1977
1	2450.5	--	17892.5	--	284.7	2.5	286.5	--	--	--	125.0	2.5	13.8	86.0	292.5	--	--	--
2	4896.2	152.5	4425.0	89.11	2340.4	1839.7	269.5	--	5.0	427.4	1875.0	2302.5	1477.5	1073.3	525.0	--	--	2.5
3	724.2	613.5	--	1267.1	485.1	1930.0	27.5	--	--	1753.5	345.0	1885.0	743.1	409.7	472.5	--	--	140.0
4	40.3	386.8	12.5	609.3	1472.2	425.0	--	71.5	--	924.5	320.0	215.0	45.9	76.0	137.5	7.7	--	120.0
5	2.8	96.8	107.5	517.1	522.0	362.5	--	49.5	--	454.2	242.5	107.5	8.2	20.0	10.0	20.6	--	255.0
6	25.8	59.5	17.5	204,1	71.5	77.5	2.8	2.5	--	159.3	80.0	70.0	5.5	--	7.5	63.8	--	147.5
7	13.5	18.5	17.5	44.2	27.8	22.5	--	--	--	92.0	75.0	12.5	8.2	5.0	--	40.6	8.1	32.5
8	5.3	17.8	10.0	14.8	2.8	7.5			2.5	37.2	42.5	15.0	5.6	--		28.0	2.8	5.0
9	11.0	36.7	--	8.2	10.6	7.5			--	37.2	45.0	15.0	--			--	23.6	--
10	16.6	18.0	12.5	2.8	2.5	--			2.5	26.2	27.5	10.0				2.8	10.0	--
11	2.8	28.5	20.0	--	--				--	2.8	10.0	--				--	7.8	5.0
12	5.5	15.6	17.5							2.8	5.0					15.2	2.5	5.0
13	18.4	21.5	25.0							--	--					44.5	2.8	5.0
14	15.9	16.0	5.0													37.6	--	7.5
15	2.8	5.0	2.5													13.5	15.9	5.0
16	--	2.5	2.5													14.8	2.5	--
17	--	2.5	7.5													36.5	10.5	7.5
18	--	10.3	--													23.4	10.0	7.5
19	5.6	2.8														5.3	2.5	2.5
20	--	--														--	5.3	7.5
21	--	--															--	--
22	--	2.8																
23	2.8	2.5																
24	--	2.8																

Table 11

Checklist of Fishes Known to Occur in Lake Conway

LEPISOSTEIDAE
- *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)
- *Noturus gyrinus* (tadpole madtom)

CRYPRINODONTIDAE
- *Fundulus chrystotus* (golden topminnow)
- *Fundulus seminolis* (seminole killifish)
- *Jordanella floridae* (flagfish)
- *Lucania goodei* (bluefin killifish)

POECILIIDAE
- *Gambusia affinis* (mosquitofish)
- *Heterandria formosa* (least killifish)

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)
- *Pomoxis nigromaculatus* (black crappie)

PERCIDAE
- *Etheostoma fusiforme* (swamp darter)

Table 12
Monthly Variation in Waterfowl Counts During the Period July 1976-August 1977

	July		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Common loon	-	-	-	-	2	.26	2	.25	-	-	5	.14	-	-	-	-
Horned grebe	-	-	2	.30	-	-	3	.38	-	-	1	.03	1	.04	1	.04
Pied-billed grebe	12	2.85	11	1.64	17	2.22	22	2.78	41	1.81	22	.61	18	.65	15	.55
Water turkey	-	-	-	-	-	-	-	-	3	.31	1	.03	1	.04	1	.04
Great blue heron	6	1.42	3	.45	5	.65	2	.25	4	.17	6	.17	7	.25	6	.22
American bittern	-	-	1	.15	-	-	-	-	-	-	-	-	1	.04	-	-
Cattle egret	-	-	-	-	14	1.82	-	-	-	-	-	-	-	-	-	-
Green heron	21	4.99	9	1.35	7	.91	13	1.65	2	.09	5	.14	2	.07	2	.07
American egret	6	1.42	6	.90	5	.65	6	.76	5	.22	3	.08	2	.07	2	.04
Snowy egret	1	.24	-	-	-	-	-	-	-	-	-	-	-	-	1	.04
Little blue heron	1	.24	1	.15	2	.26	4	.51	3	.13	3	.08	1	.04	1	.04
Louisiana heron	1	.24	3	.45	1	.13	3	.38	6	.26	8	.22	-	-	1	.04
Least bittern	21	4.99	11	1.64	4	.52	6	.76	-	-	2	.06	2	.07	-	-
Night heron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buff goose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Embden goose	2	.48	-	-	-	-	-	-	-	-	-	-	2	.07	-	-
Wood duck	2	.48	1	.15	4	.52	5	.63	-	-	-	-	-	-	2	.07
Blue-winged teal	-	-	-	-	-	-	4	.51	-	-	-	-	-	-	-	-
Mallard	106	25.18	45	6.73	111	14.99	97	12.27	137	6.05	124	3.45	64	2.31	47	1.71
Peking duck	3	.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lesser scaup	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	.22
Redhead duck	-	-	-	-	-	-	1	.13	-	-	-	-	-	-	-	-
Ring necked duck	1	.24	1	.15	1	.13	1	.13	68	3.00	297	8.27	178	6.46	163	6.03
Canvasback duck	-	-	-	-	-	-	-	-	2	.09	15	.42	202	7.30	7	.26
Muscovy	51	12.11	150	22.42	146	19.06	89	11.27	158	6.98	109	3.00	63	2.30	50	1.85
Baldpate	-	-	-	-	-	-	2	.25	2	.09	-	-	-	-	-	-
Bald eagle	-	-	-	-	-	-	-	-	-	-	1	.03	-	-	-	-
Osprey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limpkin	18	4.28	14	2.09	20	2.61	12	1.52	10	.44	13	.36	8	.22	7	.26
American coot	34	8.08	50	7.47	39	5.09	206	26.08	1265	55.95	1612	44.90	1840	66.80	2048	75.82
Florida gallinule	133	31.59	168	25.11	119	15.54	100	12.66	129	5.71	95	2.60	48	1.74	60	2.22
Purple gallinule	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sora rail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Killdeer	-	-	-	-	2	.26	2	.26	-	-	-	-	2	.07	-	-
Wilson snipe	-	-	-	-	-	-	1	.13	-	-	-	-	1	.04	-	-
Least sandpiper	-	-	1	.15	-	-	-	-	-	-	-	-	2	.07	-	-
Herring gull	-	-	-	-	-	-	23	2.91	259	11.45	66	1.83	55	2.00	22	.81
Ring-billed gull	-	-	-	-	-	-	-	-	-	-	-	-	5	.18	27	1.0
Bonapartes gull	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Least tern	-	-	2	.30	-	-	-	-	24	1.06	52	1.45	20	.74	2	.07
Forster's tern	-	-	-	-	-	-	-	-	3	.13	6	.17	9	.33	3	.11
Common tern	-	-	-	-	-	-	-	-	-	-	-	-	1	.04	6	.22
Chimney swift	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	.37
Belted kingfisher	2	.48	3	.45	16	2.09	5	.63	11	.48	4	.11	4	.14	2	.07
Barn swallow	-	-	-	-	-	-	6	.76	-	-	-	-	-	-	-	-
Tree swallow	-	-	-	-	-	-	6	.76	-	-	930	25.9	63	2.3	130	4.81
Purple martin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	.37
Fish crow	no count		17	2.54	19	2.48	42	5.32	-	-	-	-	6	.29	17	.63
Red-winged blackbird	no count		120	17.94	59	7.70	102	12.91	49	2.16	167	4.65	75	2.72	1	.04
Boat-tailed grackle	no count		33	4.93	173	22.58	25	3.16	80	3.53	43	1.20	71	2.58	50	1.85
Purple grackle	no count		17	2.54	-	-	-	-	-	-	-	-	-	-	-	-
Total	421		669		766		790		2261		3590		2754		2700	

(Continued)

Table 12 (Concluded)

	March		April		May		June		July		Aug.		Mean		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	% Freq.
Common loon	-	-	-	-	-	-	-	-	-	-	-	-	.64	.05	21.4
Horned grebe	-	-	-	-	-	-	-	-	-	-	-	-	.57	.06	35.7
Pied-billed grebe	22	1.56	17	1.12	30	2.36	26	2.56	9	1.04	11	1.57	19.50	1.67	100.0
Water turkey	-	-	-	-	-	-	1	.01	-	-	-	-	.50	.02	35.7
Great blue heron	-	-	7	.46	9	.71	8	.79	11	1.27	6	.86	5.71	.55	92.9
American bittern	-	-	1	.06	3	.24	-	-	-	-	-	-	.21	.03	28.6
Cattle egret	-	-	-	-	1	.08	-	-	-	-	-	-	1.07	.14	14.3
Green heron	4	.28	7	.46	19	1.49	15	1.48	19	2.19	13	1.86	9.86	1.22	100.0
American egret	-	-	-	-	-	-	1	.01	3	.35	7	1.00	3.29	.40	85.7
Snowy egret	-	-	-	-	-	-	1	.01	1	.12	-	-	.29	.04	28.6
Little blue heron	-	-	1	.06	-	-	1	.01	-	-	1	.14	1.36	.13	78.6
Louisiana heron	5	.36	1	.06	1	.08	2	.20	3	.35	7	1.00	3.00	.27	85.7
Least bittern	12	.85	20	1.30	27	2.12	26	2.56	29	3.34	-	-	12.00	1.38	78.6
Night heron	-	-	-	-	-	-	-	-	1	.12	-	-	.07	.01	7.1
Buff goose	-	-	-	-	-	-	1	.01	-	-	-	-	.07	.01	7.1
Embden goose	-	-	-	-	-	-	-	-	2	.23	2	.29	.43	.07	21.4
Wood duck	2	.14	-	-	-	-	-	-	11	1.27	1	.14	2.00	.24	57.1
Blue-winged teal	-	-	-	-	-	-	-	-	-	-	-	-	.07	.01	7.1
Mallard	116	8.24	151	10.00	171	13.45	233	22.93	160	18.43	251	35.86	129.50	12.94	100.0
Peking duck	5	.36	9	.60	15	1.18	12	1.18	13	1.50	10	1.43	4.79	.46	50.0
Lesser scaup	-	-	-	-	-	-	-	-	-	-	-	-	.43	.02	7.1
Red head duck	-	-	-	-	-	-	-	-	-	-	-	-	.07	.01	7.1
Ring necked duck	1	.07	-	-	1	.08	1	.01	1	.12	-	-	51.00	1.77	85.7
Canvas-back duck	-	-	-	-	-	-	-	-	-	-	-	-	16.14	.58	28.6
Muscovy	90	6.40	104	7.00	216	16.99	128	12.60	88	10.14	112	16.00	111.00	10.58	100.0
Baldpate	-	-	-	-	-	-	-	-	-	-	-	-	.29	.02	14.3
Bald eagle	-	-	-	-	-	-	-	-	-	-	-	-	.07	.01	7.1
Osprey	-	-	-	-	1	.08	-	-	-	-	-	-	.07	.01	7.1
Limpkin	13	.92	3	.20	6	.47	18	1.77	12	1.38	16	2.29	12.14	1.34	100.0
American coot	804	57.14	645	42.70	240	18.88	133	13.09	100	11.52	38	5.43	646.71	31.35	100.0
Florida gallinule	70	4.98	78	5.17	89	7.00	102	10.04	87	10.02	97	13.86	98.21	10.59	100.0
Purple gallinule	2	.14	-	-	3	.24	11	1.08	6	.69	1	.14	1.64	.16	35.7
Sora rail	-	-	2	.13	-	-	-	-	-	-	-	-	.14	.01	7.1
Killdeer	-	-	4	.26	4	.31	4	.39	5	158	4	.57	1.93	.19	57.1
Wilson snipe	3	.21	10	.66	-	-	-	-	-	-	-	-	1.07	:07	28.57
Least sandpiper	-	-	7	.46	9	.71	-	-	-	-	10	1.43	1.36	.10	28.57
Herring gull	42	3.00	45	2.98	14	1.10	-	-	-	-	-	-	37.57	.86	57.1
Ring-billed gull	1	.07	-	-	-	-	-	-	-	-	-	-	2.36	.09	21.4
Bonapartes gull	-	-	-	-	1	.08	-	-	-	-	-	-	.07	.01	7.1
Least tern	41	2.91	36	2.30	2	.15	22	2.17	103	11.87	29	4.14	23.79	1.94	78.6
Forester's tern	-	-	-	-	-	-	-	-	-	-	-	-	1.50	.05	28.6
Common tern	-	-	1	.06	-	-	23	2.26	-	-	-	-	2.21	.18	28.6
Chimney swift	-	-	-	-	-	-	-	-	-	-	-	-	.71	.03	7.1
Belted kingfisher	-	-	-	-	-	-	-	-	1	.12	2	.29	3.57	.35	71.4
Barn swallow	-	-	-	-	-	-	-	-	-	-	-	-	.43	.06	7.1
Tree swallow	35	2.49	14	.93	29	2.28	-	-	-	-	-	-	86.21	1.16	50.0
Purple martin	-	-	-	-	5	.39	14	1.38	-	-	-	-	2.07	.15	21.4
Fish crow	13	.92	1	.06	13	.94	2	.20	7	.81	1	.14	10.54	1.10	84.62
Red-winged blackbi	61	4.34	51	3.38	82	6.45	49	4.82	62	7.14	26	3.71	69.54	9.33	100.00
Boat-tailed grackl	65	4.62	180	11.90	281	22.11	182	17.91	134	15.48	47	6.71	104.92	9.12	100.0
Purple grackle	-	-	-	-	-	-	-	-	-	-	-	-	1.21	.18	7.1
Total	1407		1395		1272		1016		868		692				

Table 13

Quarterly Sport Fishery Estimates for Total (S) and Species-Directed (S^1) Success Rates, Effort (E), and Harvest (H)

	Largemouth Bass	Bream	Black Crappie	Chain Pickerel	Other Species	Total
			Summer 1976			
S^1	0.19	5.58	0.00	N.A.	0.00	
S	0.17	0.24	0.00	0.03	0.00	0.45
E	18,038.00	647.00	156.00	0.00	120.00	18,961.00
H	3,348.00	4727.00	0.00	545.00	0.00	8,620.00
			Fall 1976			
S^1	0.24	1.65	0.68	1.00*	0.83*	
S	0.18	0.02	0.14	0.02	0.01	0.37
E	9,688.00	155.00	2686.00	35.00	28.00	12,592.00
H	2,375.00	257.00	1825.00	167.00	42.00	4,666.00
			Winter 1976-77			
S^1	0.17	0.27	0.61	0.69*	0.36*	
S	0.14	0.01	0.14	0.05	0.01	0.33
E	10,140.00	212.00	2940.00	136.00	36.00	13,464.00
H	1,875.00	38.00	1883.00	681.00	28.00	4,505.00
			Spring 1977			
S^1	0.35	0.81	0.40*	0.17*	3.33*	
S	0.33	0.02	0.01	0.03	0.01	0.39
E	13,888.00	276.00	154.00	71.00	17.00	14,406.00
H	4,797.00	340.00	57.00	64.00	64.00	5,656.00
			Total			
S^1	0.24	0.98	0.63	0.60	0.96	
S	0.21	0.09	0.06	0.03	0.01	0.39
E	51,754.00	1290.00	5936.00	242.00	201.00	59,423.00
H	12,395.00	5362.00	3765.00	1791.00	134.00	23,447.00

* No estimate given by computer.

Table 14

Seasonal Variation in Number (A), Weight (B), and Occurrence (C) of Chain Pickerel Food Organisms

Food organisms		Jun-Aug 1976 A	Jun-Aug 1976 B (g)	Jun-Aug 1976 C	Sep-Nov 1976 A	Sep-Nov 1976 B (g)	Sep-Nov 1976 C	Dec 1976-Feb 1977 A	Dec 1976-Feb 1977 B (g)	Dec 1976-Feb 1977 C
Palaemonetes	I	1.06	.32	1.06	.97	.10	.97	-	-	-
	II	2.44	.16	1.06	1.89	.06	.97	-	-	-
Procambarus	I	2.12	.21	2.12	.97	1.46	.97	12.60	35.56	6.39
	II	4.88	.11	2.12	1.89	1.01	.97	8.74	3.75	6.39
Goniobasis	I	3.18	1.06	1.06	-	-	-	-	-	-
	II	7.32	.55	1.06	-	-	-	-	-	-
Threadfin shad	I	3.18	11.66	1.06	-	-	-	5.60	11.76	1.42
	II	7.32	6.05	1.06	-	-	-	3.88	1.24	1.42
Golden shiner	I	-	-	-	.97	1.84	.97	1.40	33.60	.71
	II	-	-	-	1.89	1.28	.97	.97	3.54	.71
Coastal shiner	I	-	-	-	.97	.19	.97	1.40	.70	.71
	II	-	-	-	1.89	.13	.97	.97	.07	.71
Brown bullhead	I	-	-	-	-	-	-	1.40	32.90	.71
	II	-	-	-	-	-	-	.97	3.47	.71
Lake chubsucker	I	1.06	17.49	1.06	-	-	-	-	-	-
	II	2.44	9.08	1.06	-	-	-	-	-	-
Golden topminnow	I	1.06	1.48	1.06	-	-	-	-	-	-
	II	2.44	.77	1.06	-	-	-	-	-	-
Seminole killifish	I	-	-	-	4.85	30.80	5.82	-	-	-
	II	-	-	-	11.32	21.42	5.82	-	-	-
Bluefin killifish	I	3.18	.95	3.18	2.91	.68	1.94	-	-	-
	II	7.32	.50	3.18	5.66	.47	1.94	-	-	-
Mosquitofish	I	1.06	.53	1.06	2.91	1.26	.97	-	-	-
	II	2.44	.28	1.06	5.66	.88	.97	-	-	-
Brook silverside	I	-	-	-	2.91	1.75	2.92	23.80	23.52	3.55
	II	-	-	-	5.66	1.21	2.92	16.50	2.48	3.55
Bluespotted sunfish	I	1.06	1.59	1.06	2.91	2.33	2.92	2.80	3.36	1.42
	II	2.44	.82	1.06	5.66	1.62	2.92	1.94	.35	1.42
Warmouth	I	1.06	9.33	1.06	.97	1.65	.97	5.60	20.44	2.84
	II	2.44	4.84	1.06	1.89	1.15	.97	3.88	2.15	2.84
Bluegill	I	2.12	47.70	2.12	3.88	42.00	3.88	5.60	144.48	2.84
	II	4.88	24.75	2.12	7.55	29.22	3.88	3.88	15.23	2.84
Redear sunfish	I	2.12	21.42	2.12	1.94	13.19	1.94	4.20	252.98	2.13
	II	4.88	11.12	2.12	3.77	9.18	1.94	2.91	38.49	2.13
Largemouth bass	I	2.12	2.12	2.12	.97	11.83	.97	5.60	42.00	2.84
	II	4.88	1.10	2.12	1.89	8.23	.97	3.88	4.43	2.84
Lepomis spp.	I	6.36	67.78	6.36	3.88	25.22	3.88	14.00	74.06	7.10
	II	14.64	35.18	6.36	7.54	42.77	3.88	9.71	7.81	7.10
Swamp darter	I	-	-	-	.97	.10	.97	4.20	6.44	1.42
	II	-	-	-	1.89	.06	.97	2.91	.68	1.42
Fish remains	I	9.54	8.72	11.66	16.49	9.51	16.49	51.80	154.14	47.60
	II	22.03	4.52	11.66	32.08	6.61	16.49	35.92	16.24	47.60
Musk turtle	I	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-
Unid. remains	I	2.12	.21	2.12	.97	.10	.97	4.20	.42	2.13
	II	4.88	.11	2.12	1.89	.06	.97	2.91	.04	2.13
Vegetation	I	1.06	.11	1.06	-	-	-	-	-	
	II	2.44	.05	1.06	-	-	-	-	-	
Total		43.46	192.68		50.44	144.01		144.20	836.36	

(Continued)

Note: Entries in "I" rows are numerical values per 100 individuals, those in "II" rows are percent composition values.

Table 14 (Concluded)

Food organisms		Mar-May 1977 A	Mar-May 1977 B (g)	Mar-May 1977 C	Jun-Aug 1977 A	Jun-Aug 1977 B (g)	Jun-Aug 1977 C	Mean A	Mean B (g)	Mean C
Palaemonetes	I	-	-	-	-	-	-	.41	.08	.40
	II	-	-	-	-	-	-	.61	.03	.40
Procambarus	I	7.50	12.90	7.24	5.12	10.24	5.13	5.66	12.07	4.37
	II	17.24	4.24	7.24	11.11	7.03	5.13	8.52	4.08	4.37
Goniobasis	I	-	-	-	-	-	-	.64	.21	.20
	II	-	-	-	-	-	-	.96	.07	.20
Threadfin shad	I	6.00	7.80	1.45	-	-	-	2.96	6.24	.79
	II	13.79	2.57	1.45	-	-	-	4.44	2.11	.79
Golden shiner	I	-	-	-	-	-	-	.47	7.09	.34
	II	-	-	-	-	-	-	.71	7.40	.34
Coastal shiner	I	-	-	-	5.12	6.40	5.13	1.50	1.46	1.36
	II	-	-	-	11.11	4.39	5.13	2.25	.49	1.36
Brown bullhead	I	1.50	12.45	1.45	-	-	-	.58	9.07	.43
	II	3.45	4.10	1.45	-	-	-	.87	3.06	.43
Lake chubsucker	I	-	-	-	-	-	-	.21	3.50	.21
	II	-	-	-	-	-	-	.32	1.18	.21
Golden topminnow	I	-	-	-	-	-	-	.21	.30	.21
	II	-	-	-	-	-	-	.32	.10	.21
Seminole killifish	I	1.50	1.50	1.45	-	-	-	1.27	6.46	1.45
	II	3.45	.49	1.45	-	-	-	1.91	2.18	1.45
Bluefin killifish	I	-	-	-	2.56	1.02	2.56	1.73	.53	1.54
	II	-	-	-	9.55	.70	2.56	2.60	.18	1.54
Mosquitofish	I	-	-	-	-	-	-	.79	.36	.41
	II	-	-	-	-	-	-	1.20	.12	.41
Brook silverside	I	1.50	2.40	1.45	5.12	6.91	5.13	6.67	6.92	2.61
	II	3.45	.79	1.45	11.11	4.73	5.13	10.03	2.34	2.61
Bluespotted sunfish	I	1.50	1.08	1.45	-	-	-	1.65	1.67	1.37
	II	3.45	.36	1.45	-	-	-	2.49	.57	1.37
Warmouth	I	-	-	-	-	-	-	1.52	6.28	.97
	II	-	-	-	-	-	-	2.30	2.12	.97
Bluegill	I	1.50	91.50	1.45	7.68	52.35	5.13	4.16	75.60	3.08
	II	3.45	30.11	1.45	16.67	61.31	5.13	6.76	25.55	3.08
Redear sunfish	I	1.50	15.75	1.45	2.56	13.06	2.56	2.46	63.28	2.04
	II	3.45	5.18	1.45	5.55	8.96	2.56	3.71	21.39	2.04
Largemouth bass	I	1.50	5.85	1.45	-	-	-	2.04	12.36	1.47
	II	3.45	1.92	1.45	-	-	-	3.07	4.18	1.47
Lepomis spp.	I	13.50	26.92	13.04	2.56	9.98	2.56	8.06	40.79	6.59
	II	31.03	43.69	13.04	5.55	6.85	2.56	12.13	13.79	6.59
Swamp darter	I	1.50	.56	1.45	-	-	-	1.33	1.42	7.77
	II	3.45	.18	1.45	-	-	-	2.01	.48	7.77
Fish remains	I	7.50	5.76	7.25	12.80	8.56	12.82	19.62	37.34	19.16
	II	17.24	1.90	7.25	27.78	5.99	12.82	29.54	12.62	19.16
Musk turtle	I	1.50	13.50	1.45	-	-	-	.30	2.70	.29
	II	3.45	4.44	1.45	-	-	-	.45	.91	.29
Unid. remains	I	-	-	-	2.56	.03	2.56	1.97	.15	1.55
	II	-	-	-	5.55	.02	2.56	2.97	.05	1.55
Vegetation	I	-	-	-	-	-	-	.21	.02	.21
	II	-	-	-	-	-	-	.32	.01	.21
Total		48.00	197.97		46.08	108.55		66.44	295.87	

Table 15

Seasonal Variation in Number (A), Weight (B), and Occurrence (C) of Largemouth Bass Food Organisms

Food organism		Jun-Aug 1976			Sep-Nov 1976			Dec 1976-Feb 1977		
		A	B(g)	C	A	B(g)	C	A	B(g)	C
Palaemonetes	I	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-
Procambarus	I	40.0	114.25	30.0	3.3	11.22	3.3	19.8	62.37	19.8
	II	32.00	64.73	30.00	3.13	1.82	3.30	11.32	5.16	19.80
Gomphidae	I	15.0	.05	10.0	-	-	-	-	-	-
	II	12.00	.01	10.00	-	-	-	-	-	-
Physidae	I	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-
Unid. insect	I	5.0	.05	5.0	-	-	-	-	-	-
	II	4.00	.01	5.00	-	-	-	-	-	-
Threadfin shad	I	5.0	22.50	5.0	19.8	44.22	9.9	52.8	92.07	13.2
	II	4.00	12.75	5.00	18.75	7.17	9.90	30.9	7.62	13.20
Brown bullhead	I	-	-	-	-	-	-	3.3	40.92	3.3
	II	-	-	-	-	-	-	1.89	3.37	3.30
Golden topminnow	I	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-
Seminole killifish	I	-	-	-	3.3	17.16	3.3	-	-	-
	II	-	-	-	3.13	2.78	3.30	-	-	-
Bluefin killifish	I	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-
Unid. cyprinodont	I	-	-	-	-	-	-	13.2	3.30	3.3
	II	-	-	-	-	-	-	7.55	.27	3.30
Mosquitofish	I	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-
Brook silverside	I	-	-	-	-	-	-	9.9	6.60	3.3
	II	-	-	-	-	-	-	5.67	.55	3.30
Bluespotted sunfish	I	-	-	-	3.3	5.12	3.3	16.5	16.17	9.9
	II	-	-	-	3.13	.83	3.30	9.43	1.34	9.90
Warmouth	I	-	-	-	-	-	-	3.3	21.45	3.3
	II	-	-	-	-	-	-	1.89	6.50	3.30
Bluegill	I	-	-	-	6.6	20.46	6.6	-	-	-
	II	-	-	-	6.25	3.32	6.60	-	-	-
Redear sunfish	I	-	-	-	6.6	399.30	6.6	-	-	-
	II	-	-	-	6.25	64.70	6.60	-	-	-
Spotted sunfish	I	-	-	-	3.3	39.60	3.3	-	-	-
	II	-	-	-	3.13	6.52	3.30	-	-	-
Largemouth bass	I	-	-	-	-	-	-	6.6	900.90	6.6
	II	-	-	-	-	-	-	3.77	74.55	6.60
Lepomis spp.	I	-	-	-	6.6	5.61	3.3	6.6	14.52	6.6
	II	-	-	-	6.25	.91	3.30	3.77	1.20	6.60
Swamp darter	I	-	-	-	3.3	1.32	3.3	-	-	-
	II	-	-	-	3.13	.21	3.30	-	-	-
Fish remains	I	60.0	39.75	60.0	49.5	72.44	46.2	42.9	60.89	36.3
	II	48.00	22.52	60.00	46.88	11.74	46.20	24.53	5.04	36.30
Total		125.0	176.60	-	105.6	616.45	-	171.6	1,218.32	-

(Continued)

Note: Entries in "I" rows are numerical values per 100 individuals; those in "II" rows are percent composition values.

Table 15 (Concluded)

Food organisms		Mar-May 1977 A	Mar-May 1977 B(g)	Mar-May 1977 C	Jun-Aug 1977 A	Jun-Aug 1977 B(g)	Jun-Aug 1977 C	Mean A	Mean B(g)	Mean C
Palaemonetes	I	19.8	8.58	3.3	3.3	.66	3.3	4.7	1.85	1.3
	II	27.27	6.59	3.33	3.33	.20	3.33	4.40	.46	1.30
Procambarus	I	13.2	43.89	13.2	13.2	43.89	13.2	10.7	55.12	10.5
	II	18.18	11.91	13.20	13.33	13.26	13.20	10.02	13.78	10.50
Gomphidae	I	-	-	-	-	-	-	3.0	.01	2.0
	II	-	-	-	-	-	-	2.81	.01	2.00
Physidae	I	-	-	-	3.3	1.65	3.3	.7	.30	.7
	II	-	-	-	3.33	.50	3.30	.62	.08	.70
Unid. insect	I	-	-	-	3.3	.03	3.3	1.7	.02	1.7
	II	-	-	-	3.33	.01	3.30	1.56	.01	1.70
Threadfin shad	I	-	-	-	-	-	-	14.6	31.76	4.7
	II	-	-	-	-	-	-	13.69	7.94	4.70
Brown bullhead	I	-	-	-	-	-	-	.7	8.18	.7
	II	-	-	-	-	-	-	.62	2.04	.70
Golden topminnow	I	-	-	-	3.3	8.25	3.3	.7	1.65	.7
	II	-	-	-	3.33	2.49	3.30	.62	.41	.70
Seminole killifish	I	-	-	-	9.9	80.85	9.9	2.6	19.43	2.6
	II	-	-	-	10.00	24.42	9.90	.48	4.87	2.64
Bluefin killifish	I	-	-	-	3.3	1.25	3.3	.7	.25	.7
	II	-	-	-	3.33	.50	3.30	1.3	.06	.70
Unid. cyprinodont	I	-	-	-	-	-	-	2.6	.66	.7
	II	-	-	-	-	-	-	2.48	.17	.70
Mosquitofish	I	3.3	2.42	3.3	-	-	-	.7	.48	.7
	II	4.54	1.88	3.30	-	-	-	1.3	.12	.70
Brook silverside	I	-	-	-	-	-	-	2.0	1.32	.7
	II	-	-	-	-	-	-	.62	.33	.70
Bluespotted sunfish	I	-	-	-	-	-	-	3.9	4.26	2.6
	II	-	-	-	-	-	-	2.48	1.06	2.60
Warmouth	I	-	-	-	-	-	-	.7	4.26	.7
	II	-	-	-	-	-	-	.62	1.07	.70
Bluegill	I	-	-	-	-	-	-	1.3	4.09	1.3
	II	-	-	-	-	-	-	1.23	1.02	1.30
Redear sunfish	I	-	-	-				1.3	78.46	1.3
	II	-	-	-				1.23	19.62	1.30
Spotted sunfish	I	-	-	-				.7	7.92	.7
	II	-	-	-				.62	1.98	.70
Largemouth bass	I	3.3	3.60	3.3	6.6	6.60	3.3	3.3	182.22	2.6
	II	4.54	2.76	3.30	6.66	1.99	3.30	3.09	45.56	2.60
Lepomis spp.	I	3.3	31.68	3.3	-	-	-	3.3	10.36	2.6
	II	4.54	24.32	3.30	-	-	-	3.09	2.59	2.60
Swamp darter	I	-	-	-	-	-	-	.7	.26	.7
	II	-	-	-	-	-	-	.62	.07	.70
Fish remains	I	26.4	57.55	26.4	52.8	56.80	46.2	46.3	57.48	43.0
	II	36.36	44.19	26.40	53.33	56.62	46.20	43.20	14.37	43.0
Total		69.3	147.72	-	99.0	199.98	-	106.9	470.42	-

Table 16

Seasonal Variation in Number (A) and Occurrence (B) of Bluegill Food Organisms

Food organisms		Jun-Aug 1976 A	Jun-Aug 1976 B	Sep-Nov 1976 A	Sep-Nov 1976 B	Dec 1976-Feb 1977 A	Dec 1976-Feb 1977 B	Mar-May 1977 A	Mar-May 1977 B	Jun-Aug 1977 A	Jun-Aug 1977 B	Mean A	Mean B
Vegetative matter	I	60.00	60.00	93.03	29.76	53.19	23.13	50.30	50.30	69.93	69.93	65.29	46.62
	II	.70	60.00	.62	29.76	13	23.13	4.55	50.30	2.77	69.93	1.75	46.62
Protozoa (*Volvox*)	I	-	-	186.48	3.33	-	-	-	-	426.24	3.33	122.54	1.33
	II	-	-	1.25	3.33	-	-	-	-	16.89	3.33	3.63	1.33
Bryozoa	I	-	-	3.33	3.33	6.66	6.66	-	-	6.66	6.66	3.33	3.33
	II	-	-	.02	3.33	.02	6.66	-	-	.26	6.66	.06	3.33
Hirudinea	I	5.00	5.00	9.99	6.66	-	-	-	-	3.33	3.33	3.66	3.66
	II	.06	5.00	.07	6.66	-	-	-	-	.13	3.33	.05	3.00
Crustacea (Total)	I	1500.00	60.00	6093.90	100.00	8481.60	100.00	169.05	65.55	39.96	33.30	3256.77	71.77
	II	17.62	60.00	40.74	100.00	25.24	100.00	15.29	65.55	1.58	33.30	20.10	71.77
Cladocera	I	1005.00	20.00	4648.68	49.95	7872.12	36.63	3.45	3.45	13.32	9.99	1838.85	24.00
	II	11.80	20.00	31.08	49.95	23.43	36.63	.31	3.45	.53	9.99	13.43	24.00
Copepoda	I	30.00	5.00	13.32	6.66	99.99	6.66	3.45	3.45			29.35	4.35
	II	.35	5.00	.09	6.66	.30	6.66	.31	3.45	-	-	.21	4.35
Argulus	I	15.00	10.00	-	-	-	-	-	-	6.66	6.66	4.33	3.33
	II	.18	10.00	-	-	-	-	-	-	.26	6.66	.09	3.33
Ostracoda	I	195.00	20.00	1158.84	29.97	96.57	23.31	58.65	24.15	9.99	6.66	652.58	20.82
	II	2.29	20.00	7.75	29.97	.29	23.31	5.30	24.15	.40	6.66	3.21	20.82
Amphipoda (*Gammarus*, *Hyalella*)	I	245.00	40.00	273.06	53.28	402.93	56.61	96.60	27.60	6.66	6.66	204.85	36.83
	II	2.88	40.00	1.83	53.28	1.20	56.61	8.74	27.60	.26	6.66	2.98	36.83
Decapoda (*Palaemonetes*)	I	10.00	5.00	-	-	9.99	9.99	6.90	6.90	3.33	3.33	6.00	5.00
	II	.12	5.00	-	-	.03	9.99	.62	6.90	.13	3.33	.18	5.00
Insecta (Total)	I	6735.00	100.00	4542.11	100.00	5228.10	100.00	700.11	89.46	1515.15	100.00	3766.42	97.89
	II	79.01	100.00	30.37	100.00	15.56	100.00	63.31	89.46	60.03	100.00	49.66	97.89
Ephemeroptera	I	-	-	19.98	6.66	16.65	9.99	-	-	-	-	7.33	3.33
	II	-	-	.13	6.66	.05	9.99	-	-	-	-	.04	3.33
Odonata (Total)	I	15.00	15.00	136.53	33.30	43.29	23.31	6.78	6.78	19.98	19.98	44.32	19.67
	II	.18	15.00	.91	33.30	.13	23.31	.61	6.78	.79	19.98	.52	19.67
Zygoptera	I	5.00	5.00	103.23	13.32	19.98	16.65	-	-	9.99	9.99	27.64	8.99
	II	.06	5.00	.69	13.20	.06	16.65	-	-	.40	9.99	.24	8.97
Anisoptera (Total)	I	10.00	10.00	33.30	19.98	23.31	6.66	6.78	6.78	9.99	9.99	16.68	10.68
	II	.12	10.00	.22	19.98	.07	6.66	.61	6.78	.40	9.99	.28	10.68
Gomphidae	I	5.00	5.00	33.30	19.98	23.31	6.66	3.45	3.45	3.33	3.33	13.68	7.68
	II	.06	5.00	.22	19.98	.07	6.66	.30	3.45	.13	3.33	.16	7.68
Libellulidae	I	5.00	5.00	-	-	-	-	3.33	3.33	-	-	1.67	1.67
	II	.06	5.00	-	-	-	-	.30	3.33	-	-	.07	1.67

(Continued)

Note: Entries in "I" rows are numerical values per 100 individuals; those in "II" rows are percent composition values.

Table 16 (Continued)

Food organisms		Jun-Aug 1976 A	Jun-Aug 1976 B	Sep-Nov 1976 A	Sep-Nov 1976 B	Dec 1976-Feb 1977 A	Dec 1976-Feb 1977 B	Mar-May 1977 A	Mar-May 1977 B	Jun-Aug 1977 A	Jun-Aug 1977 B	Mean A	Mean B
Insects (continued)													
Orthoptera	I	-	-	6.66	6.66	.	-	3.45	10.35	-	-	8.23	3.40
(Gryllidae)	II	-	-	.04	6.66	-	-	.31	10.35	-	-	.07	3.40
Coleoptera	I	-	-	3.33	3.33	-	-	-	-	13.32	13.32	3.33	3.33
	II	-	-	.02	3.33	-	-	-	-	.53	13.32	.11	3.33
Coccinellidae	I	-	-	-	-	-	-	-	-	3.33	3.33	.67	.67
	II	-	-	-	-	-	-	-	-	.13	3.33	.03	.67
Hemiptera	I	-	-	16.65	13.32	3.33	3.33	6.90	6.90	-	-	5.38	4.71
(Corixidae	II	-	-	.11	13.32	.01	3.33	.62	6.90	-	-	.15	4.71
Homoptera	I	-	-	3.33	3.33	-	-	-	-	-	-	1.33	.67
(Cicadellidae)	II	-	-	.02	3.33	-	-	-	-	-	-	.01	.67
Trichoptera	I	460.00	50.00	303.03	59.94	382.95	43.29	272.55	24.15	203.13	39.96	324.33	43.47
	II	5.40	50.00	2.03	59.94	1.14	43.29	24.65	24.15	8.05	39.96	36.93	43.47
Diptera (Total)	I	-	-	4042.62	100.00	4748.58	86.58	369.15	31.05	1252.08	93.24	3329.82	87.15
	II	-	-	27.03	100.00	14.13	86.58	33.38	31.05	49.60	93.24	24.83	87.15
Chironomidae	I	6225.00	100.00	4032.63	100.00	4745.25	83.25	369.15	31.05	935.73	76.59	3261.55	78.82
	II	73.12	100.00	26.95	100.00	14.12	83.25	33.38	31.05	37.07	76.59	26.86	78.82
Ceratopogonidae	I	-	-	6.66	6.66	-	-	-	-	3.33	3.33	2.00	2.00
	II	-	-	.04	6.66	-	-	-	-	.13	3.33	.03	2.00
Culicidae	I	5.00	5.00	9.99	9.99	3.33	3.33	-	-	313.02	13.32	66.27	6.33
	II	.06	5.00	.07	9.99	.01	3.33	-	-	12.40	13.33	2.50	6.33
Hymenoptera (Total)	I	-	-	9.99	9.99	6.66	6.66	3.45	3.45	3.33	3.33	4.69	4.69
	II	-	-	.07	9.99	.02	6.66	.31	3.45	.13	3.33	.11	4.69
Formicidae	I	-	-	3.33	3.33	3.33	3.33	3.45	3.45	-	-	2.00	2.00
	II	-	-	.02	3.33	.01	3.33	.31	3.45	-	-	.07	2.00
Apidae	I	-	-	3.33	3.33	3.33	3.33	-	-	3.33	3.33	2.00	2.00
	II	-	-	.02	3.33	.01	3.33	-	-	.13	3.33	.03	2.00
Arachnida (Total)	I	60.00	20.00	49.95	19.98	29.97	6.66	27.60	13.80	23.31	13.32	38.17	14.75
	II	.70	20.00	.33	19.98	.09	6.66	2.50	13.80	.92	13.32	.91	14.75
Hydracarina	I	60.00	20.00	49.95	19.98	29.97	6.66	24.15	10.35	19.98	9.99	36.81	13.40
	II	.70	20.00	.33	19.98	.09	6.66	2.18	10.35	.79	9.99	.82	13.40
Spider	I	-	-	-	-	-	-	3.45	3.45	3.33	3.33	1.35	1.36
	II	-	-	-	-	-	-	.31	3.45	.13	3.33	.09	1.36

(Continued)

Table 16 (Concluded)

Food organisms		Jun-Aug 1976 A	Jun-Aug 1976 B	Sep-Nov 1976 A	Sep-Nov 1976 B	Dec 1976-Feb 1977 A	Dec 1976-Feb 1977 B	Mar-May 1977 A	Mar-May 1977 B	Jun-Aug 1977 A	Jun-Aug 1977 B	Mean A	Mean B
Mollusca (Total)	I	15.00	15.00	296.37	43.29	426.24	69.93	62.10	20.70	6.66	3.33	160.94	30.45
	II	.18	15.00	1.98	43.29	1.27	69.93	5.62	20.70	.26	3.33	1.86	30.45
Gastropoda (Total)	I	5.00	5.00	296.37	43.29	419.58	63.27	62.10	20.70	6.66	3.33	157.61	27.12
	II	.06	5.00	1.98	43.29	1.25	63.27	5.62	20.70	.26	3.33	1.83	27.12
Ampullariidae (*Pomacea*)	I	5.00	5.00	-	-	-	-	-	-	-	-	.67	.67
	II	.06	5.00	-	-	-	-	-	-	-	-	.01	.67
Physidae (*Physa*)	I	-	-	46.62	9.99	249.75	33.30	44.85	10.35	-	-	68.24	10.73
	II	-	-	.31	9.99	.74	33.30	4.05	10.35	-	-	1.02	10.73
Planorbidae (*Gyraulus*)	I	-	-	249.75	33.30	169.83	29.97	17.25	10.35	6.66	3.33	88.70	15.39
	II	-	-	1.67	33.30	.51	29.97	1.56	10.35	.26	3.33	.80	15.39
Pelecypoda	I	10.00	5.00	-	-	6.66	6.66	-	-	-	-	3.33	2.33
	II	.12	5.00	-	-	.02	6.66	-	-	-	-	.03	2.33
Eggs (Total)	I	140.00	25.00	3609.72	29.97	19353.96	16.65	93.15	3.45	402.93	13.32	4719.95	17.68
	II	1.64	25.00	24.13	29.97	57.60	16.65	8.42	3.45	15.96	13.32	21.55	17.68
Invertebrate egg	I	-	-	-	-	-	-	93.15	3.45	-	-	18.63	.69
	II	-	-	-	-	-	-	8.42	3.45	-	-	1.68	.69
Amphibia egg	I	-	-	-	-	-	-	-	-	3.33	3.33	.67	.67
	II	-	-	-	-	-	-	-	-	.13	3.33	.03	.67
Fish egg	I	115.00	20.00	-	-	3.33	3.33	-	-	-	-	23.67	4.67
	II	1.35	20.00	-	-	.01	3.33	-	-	-	-	.27	4.67
Fish remains	I	-	-	6.66	6.66	9.99	9.99	-	-	3.33	3.33	4.00	4.00
	II	-	-	.04	6.66	.03	9.99	-	-	.13	3.33	.04	4.00
Feather	I	-	-	46.62	9.99	3.33	3.33	-	-	-	-	10.66	3.33
	II	-	-	.31	9.99	.01	3.33	-	-	-	-	.09	3.33
Unid matter	I	-	-	19.98	19.98	9.99	9.99	3.45	3.45	19.98	19.98	10.68	10.68
	II	-	-	.13	19.98	.03	9.99	.31	3.45	.79	19.98	.25	10.68
Bread	I	-	-	-	-	-	-	-	-	3.33	3.33	.67	.67
	II	-	-	-	-	-	-	-	-	.13	3.33	.03	.67
Total		8515.00		14958.14		33603.03		1105.75		25[illegible]4.14		12,141.80	

Table 17

Seasonal Variation in Number (A) and Occurrence (B) of

Bluefin Killifish Food Organisms

Food Organism		Jun-Aug 1976		Sep-Nov 1976		Dec 1976-Feb 1977		Mar-May 1977		Jun-Aug 1977		Mean	
		A	B	A	B	A	B	A	B	A	B	A	B
Vegetation	I	-	-	-	-	6.2	6.25	-	-	-	-	1.2	1.25
	II	-	-	-	-	.48	6.25	-	-	-	-	.10	1.25
Volvox	I	2.6	2.67	-	-	-	-	-	-	-	-	.5	.53
	I	.16	2.67	-	-	-	-	-	-	-	-	.03	.53
Bryozoa	I	-	-	-	-	3.1	3.13	-	-	-	-	.6	.63
	II	-	-	-	-	.24	3.13	-	-	-	-	.05	.63
Annelidae	I	-	-	71.4	6.25	-	-	3.3	3.33	-	-	14.9	1.92
	II	-	-	2.85	6.25	-	-	.16	3.33	-	-	.60	1.92
Cladocera	I	630.5	70.67	1434.3	85.42	812.2	65.63	891.0	73.33	1326.5	73.26	1018.9	73.66
	II	39.50	70.67	57.30	85.42	62.38	65.63	43.13	73.33	50.00	73.26	50.46	73.66
Copepoda	I	158.6	46.67	168.0	39.58	27.9	18.75	79.2	23.33	73.3	33.33	101.4	32.33
	II	9.93	46.67	6.71	39.58	2.14	18.75	3.83	23.33	2.76	33.33	5.07	32.33
<u>Argulus</u>	I	-	-	-	-	6.2	6.25	-	-	-	-	1.2	1.25
	II	-	-	-	-	.48	6.25	-	-	-	-	.10	1.25
Ostracoda	I	261.3	41.33	149.1	39.58	170.5	37.50	742.5	66.67	723.3	39.96	409.3	45.01
	II	16.37	41.33	5.96	39.58	13.10	37.50	35.94	66.67	27.26	39.96	19.73	45.01
Amphipoda	I	6.5	6.67	50.4	14.58	15.5	9.38	23.1	16.67	30.0	19.98	25.1	13.46
	II	.41	6.67	2.01	14.58	1.19	9.38	1.12	16.67	1.13	19.98	1.17	13.46
<u>Procambarus</u>	I	1.3	1.33	-	-	-	-	-	-	-	-	.3	.27
	II	.08	1.33	-	-	-	-	-	-	-	-	.02	.27
Hydracarina	I	24.7	18.67	42.0	27.08	18.6	15.63	39.6	26.67	10.0	6.66	27.0	18.94
	II	1.55	18.67	1.68	27.08	1.43	15.63	1.92	26.67	.38	6.66	1.39	18.94
Gomphidae	I	-	-	2.1	2.08	-	-	-	-	-	-	.4	.42
	II	-	-	.08	2.08	-	-	-	-	-	-	.02	.42

(Continued)

Note: Entries in "I" rows are numerical values per 100 individuals; those in "II" rows are percent composition values.

Table 17 (Concluded)

Food Organism		Jun-Aug 1976		Sep-Nov 1976		Dec 1976-Feb 1977		Mar-May 1977		Jun-Aug 1977		Mean	
		A	B	A	B	A	B	A	B	A	B	A	B
Zygoptera	I	2.6	2.67	-	-	-	-	-	-	-	-	.5	.53
	II	.16	2.67	-	-	-	-	-	-	-	-	.03	.53
Trichoptera	I	-	-	-	-	-	-	-	-	3.3	3.33	.7	.67
	II	-	-	-	-	-	-	-	-	.12	3.33	.02	.67
Chironomidae	I	469.3	69.34	581.7	62.50	232.5	37.50	211.2	53.33	136.6	26.64	326.2	49.86
	II	29.40	69.34	23.24	62.50	17.86	37.50	1.02	53.33	5.15	26.64	15.33	49.86
Ceratopogonidae	I	1.3	1.33	-	-	-	-	-	-	-	-	.3	.27
	II	.08	1.33	-	-	-	-	-	-	-	-	.02	.27
Formicidae	I	1.3	1.33	-	-	-	-	-	-	-	-	.3	.27
	II	.08	1.33	-	-	-	-	-	-	-	-	.02	.27
Unid. insect	I	-	-	-	-	-	-	3.3	3.33	3.3	3.33	1.3	1.33
	II	-	-	-	-	-	-	.16	3.33	.12	3.33	.06	1.33
Aranchnida	I	5.2	2.67	-	-	-	-	-	-	10.0	3.33	3.0	1.20
	II	.32	2.67	-	-	-	-	-	-	.38	3.33	.08	1.20
<u>Physa</u>	I	-	-	4.2	4.17	-	-	-	-	-	-	.8	.83
	II	-	-	.17	4.17	-	-	-	-	-	-	.03	.83
Unid. egg	I	20.8	2.67	-	-	3.1	3.13	72.6	13.33	336.6	23.31	86.6	8.49
	II	1.30	2.67	-	-	.24	3.13	3.51	13.33	12.69	23.31	3.55	8.49
Fish scales	I	5.2	2.67	-	-	-	-	-	-	-	-	1.0	.53
	II	.32	2.67	-	-	-	-	-	-	-	-	.06	.53
Unid. matter	I	5.2	5.34	-	-	6.2	6.25	-	-	-	-	2.3	2.32
	II	.32	5.34	-	-	.48	6.25	-	-	-	-	.16	2.32
Total		1596.4		2503.2		1302.0		2065.8		2649.6		2023.1	

Table 18

Quarterly Length-Weight Regressions for Largemouth Bass, Bluegill, and Chain Pickerel

Largemouth Bass	
Jun-Aug 1976	log W = -5.2028 + 3.1159 log TL (r = +.99)
Sep-Nov 1976	log W = -4.7752 + 2.9403 log TL (r = +.95)
Dec 1976-Feb 1977	log W = -5.5226 + 3.2528 log TL (r = +.99)
Mar-May 1977	log W = -5.1037 + 3.0697 log TL (r = +.97)
Jun-Aug 1977	log W = -5.1374 + 3.0831 log TL (r = +.86)
Bluegill	
Jun-Aug 1976	log W = -5.3052 + 3.2330 log TL (r = +.99)
Sep-Nov 1976	log W = -5.0265 + 3.1114 log TL (r = +.99)
Dec 1976-Feb 1977	log W = -4.6882 + 2.9379 log TL (r = +.87)
Mar-May 1977	log W = -5.1718 + 2.9504 log TL (r = +.99)
Jun-Aug 1977	log W = -5.3615 + 2.2591 log TL (r = +.99)
Chain Pickerel	
Jun-Aug 1976	log W = -5.4055 + 3.0422 log TL (r = +.99)
Sep-Nov 1976	log W = -4.8824 + 2.8342 log TL (r = +.94)
Dec 1976-Feb 1977	log W = -4.8602 + 2.8229 log TL (r = +.94)
Mar-May 1977	log W = -5.0996 + 2.9177 log TL (r = +.82)
Jun-Aug 1977	log W = -4.86864 + 2.8365 log TL (r = +.98)

Table 19

Food Habits of Selected Waterfowl

Species	No. Examined	Food Habits: Food Item	No.	Frequency
Common loon	1	Threadfin shad	3	1
		Fish	1	1
Pied-billed grebe	1	Fish	2	1
Mallard duck	6	Seed	N.A.	6
Widgeon	1	Empty		
Ring-necked duck	8	Seed	N.A.	3
American coot	17	Fish	1	1
		Hydrilla	N.A.	15
		Lemna	N.A.	1
		Seed	N.A.	3
		Eleocharis	N.A.	1
		Chironomidae	1	1
Florida gallinule	3	*Potamogeton*	N.A.	1
		Seed	N.A.	1
		Tettigidae	1	1
Least tern	5	Fish	1	1
		Brook silverside	6	1
		Vegetation	N.A.	2
Common tern	3	Empty		
Bonaparte gull	1	Threadfin shad	10	1
Herring gull	2	Threadfin shad	10	2
Ringbill gull	2	*Lepomis* sp.	2	1
		Fish	1	1
		Coleoptera	1	1

APPENDIX A: A COMPARISON OF FISH COMMUNITIES IN VEGETATED AND BEACH HABITATS*

Abstract

Fish populations were sampled on Lake Conway, Florida, from May through September 1976 by three methods to compare species abundance, composition, and diversity of fishes occupying naturally vegetated and artificial beach habitats. Eleven species had strong affinities for vegetation, whereas seven species were most common on beaches. The ichthyofauna associated with vegetation represented a climax and were more unique, more diverse, more evenly distributed in terms of individuals per species, and more productive in terms of biomass. Beach fishes were a seral community typified by a less distinct and less diverse but more numerous assemblage.

Introduction

Aquatic vegetation is a common characteristic of Florida lakes. Dense stands of littoral emergent vegetation sometimes conflict with water-oriented recreation and reduce property values. As a result, removal of aquatic plant infestations to create sand beaches for aesthetic and recreational purposes is a common occurrence. In densely populated regions, this practice may remove as much as 75 percent of the total shoreline corridor of vegetation.

These shallow littoral zones with dense stands of rooted emergent vegetation are important to the aquatic resources in Florida (Barnett and Schneider 1974; Wegener et al. 1973). Emergent plants, by inducing chemical and physical changes in the aquatic environment, create a more diverse and productive habitat (Gaudet 1974). The purpose of this paper is to compare abundance, composition, and diversity of shore zone fishes collected in naturally vegetated and denuded beach habitats in Lake Conway, Florida.

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* A paper submitted to <u>Florida Scientist</u> by Vincent Guillory, Dale Jones, and Michael Rebel, Fisheries Research, Florida Game and Fresh Water Fish Commission, Orlando, Florida.

Materials and Methods

This research was conducted in the Lake Conway chain of lakes near Orlando, Florida. This system, a part of the Kissimmee River drainage, totals 728 ha. The shoreline has been noticeably altered by urbanization and associated shoreline development and vegetation removal; however, some areas have a narrow fringe of *Panicum*, *Typha*, or *Fuirena*. Dominant submergent vegetation includes *Vallisneria*, *Potamogeton*, *Nitella*, and *Hydrilla*. The substrate is primarily sand, except in areas of extremely thick vegetation where a layer of organic detritus has built up. The lake is mesotrophic. The bottom contours are rather steep in many areas as compared to the gradually sloping shorelines characteristic of other central Florida lakes.

The sampling program was designed to sample both naturally vegetated and artificial beach littoral habitats. Samples were taken from May through September 1976 by seine, Wegener ring, and electroshocker. Six stations were established for each gear type and sampled monthly. Two Wegener ring samples were taken at each station in shallow, heavily vegetated areas. A 20-ft seine collection of five hauls was made in beach zones adjacent to Wegener ring sites. A 30-min nocturnal electrofishing sample was taken in both vegetated and beach areas at each station. The common names utilized follow the American Fisheries Society (1970) checklist.

A chi-square test was used on frequency of occurrence data from electrofishing beach and vegetation samples to assess statistically significant differences in occurrences of each species between habitats. Similarly, a t-test was utilized with electrofishing numeric and biomass data to determine if there were significant differences between beach and vegetation samples.

Species diversity is dependent upon the number of species present (species variety or richness) and the numerical distribution of species among the assemblage (equitability). Information theory indices measure both aspects of diversity. The following formula by Lloyd et al. (1968) was used to calculate the information theory value $\overline{d}$ for pooled monthly data for each gear type: $\bar{d} = C/N (N \log 10N - n_i \log 10 n_i)$, where C equals 3.3219, N is the total number of individuals, and n_i is the number of individuals in species i. Mean diversity, as calculated above, may range from 0.0 to 3.3219 $\log N$.

Species richness was determined by the following formula (Margalef 1957): $D = S/\log N$, where S is the number of species and N is the number of individuals.

To calculate equitability ε, Lloyd and Ghelardi's (1964) method was followed: $\varepsilon = S^1/S$, where S is the number of species in the samples and S^1 is the tabulated number of species that conforms to MacArthur's (1957) broken-stick model based on the information theory $\bar{d}$ value. Equitability may range from 0 to 1 except in the unusual situation where the distribution is more equitable than that resulting from the MacArthur model, which occasionally occurs in samples containing only a few specimens with several taxa represented.

Results

Numerical abundance

Numerical abundance of fishes collected from both habitat types is presented in Table A1. Of species collected by electrofishing both beach and the vegetated stations, coastal shiner, Seminole killifish, brook silverside, bluegill, redear sunfish, and largemouth bass were statistically more abundant in beach areas (Table A2). Florida gar, bowfin, chain pickerel, and black crappie showed a significant preference for vegetation. Other species taken in both habitats either did not show a statistical preference for either habitat or were encountered in such small numbers that statistical methods were not applicable. The total number of fish collected was statistically higher in beach areas.

Differences in numerical abundance of fishes collected by Wegener ring and 20-ft seine were not statistically analyzed due to the difference in sampling techniques; however, a comparison can be made of relative abundance of fishes in each habitat. Of species collected via these methods, golden topminnow, bluefin killifish, and mosquitofish were more common in vegetation (Table A1). Coastal shiner, Seminole killifish, brook silverside, bluegill, redear sunfish, and largemouth bass were more abundant in beach habitats.

Biomass

The biomass per unit effort by species for each gear type is listed in Table A1. Florida gar, bowfin, yellow bullhead, warmouth, and largemouth bass were statistically more abundant in naturally vegetated habitats in electrofishing samples (Table A2). In contrast, coastal shiner, Seminole killifish, and brook silverside exhibited a statistically greater biomass in beach areas. The total biomass collected in vegetated areas was greater than that found on beaches.

The coastal shiner, golden topminnow, bluefin killifish, mosquitofish, and largemouth bass had higher percentage compositions of biomass in vegetated Wegener ring samples (Table A1). Conversely, Seminole killifish, brook silverside, bluegill, and redear sunfish had higher biomass percentages in beach habitats.

Frequency of occurrence

The number of times each species was collected for each gear type is illustrated in Table A1. In electrofishing samples, threadfin shad, Seminole killifish, and brook silverside showed a statistically significant preference for beach habitats (Table A2). Though not significant statistically, golden shiner and coastal shiner were also encountered more frequently on beaches. Only warmouth and spotted sunfish had significant preferences for naturally vegetated habitats. However, five species (Florida gar, chain pickerel, lake chubsucker, bluespotted sunfish, and black crappie) were collected with more regularity in vegetation, and four species (bowfin, brown bullhead, yellow bullhead, and mosquitofish) were taken only in vegetation.

All species collected in beach seines were also taken in vegetated Wegener ring samples; however, five species, including brown bullhead, flagfish, least killifish, bluespotted sunfish, and swamp darter, were taken in Wegener ring but not seine samples (Table A1). Coastal shiner, golden topminnow, bluefin killifish, mosquitofish, and warmouth occurred more frequently in Wegener ring collections, while Seminole killifish, brook silverside, bluegill, redear sunfish, and largemouth bass were encountered more frequently in seine samples.

Diversity

The number of species and the three diversity indices are presented by monthly totals for each gear type in Table A3. Comparison of the diversity indices and number of species collected indicates that the techniques for sampling vegetation yielded consistently higher values than did those sampling beaches. A total of 26 species were collected in vegetation as compared to 22 species on the beaches.

Discussion

Twelve species had strong affinities for vegetation. Bowfin, brown bullhead, yellow bullhead, flagfish, and least killifish were encountered only in vegetated area samples. Golden topminnow, bluefin killifish, bluespotted sunfish, warmouth, spotted sunfish, black crappie, and swamp darter were also strongly associated with vegetation, having been collected less than twice in beach samples. Among the more ubiquitous species, Florida gar, chain pickerel, lake chubsucker, and mosquitofish were found in greater numbers and with greater frequency in vegetation. Conversely, the following seven species, while also common in vegetation, were encountered more frequently in beach habitats: threadfin shad, coastal shiner, Seminole killifish, brook silverside, bluegill, redear sunfish, and largemouth bass. The remaining species appearing in shoreline collections either were encountered in such small numbers that basic habitat preferences could not be established or showed no clear preference for habitat.

The seven species showing preference for beach habitats were among the most abundant and widely distributed species in Lake Conway. They greatly dominated beach samples, representing 99.1 percent of the total number in seines and 97.9 percent in electrofishing samples. The remaining species collected on beaches were rarely encountered.

The beach community was readily identifiable by the numerical distribution of individual species; however, this assemblage was not a well segregated ecological unit. It was a fortuitous congregation of transients from adjacent habitats and a small group of ubiquitous species appearing in large numbers. Conversely, the assemblage of species associated with vegetation was ecologically distinct, as most species in this community were either restricted to vegetated habitats or were only common there.

Due to the greater efficiency of electrofishing in beach zones and the migration of small centrarchids and forage fish to barren beaches at night, the number of fish per collection was enhanced in beach samples. In terms of biomass, however, electrofishing was more productive in vegetation. Thus, smaller individuals utilized beach areas at night as compared to vegetated habitats. Catches per unit effort of daytime seine and Wegener ring samples were not comparable.

A consistent trend in our data was the increased number of species and diversity of samples taken in vegetated stations. This implies that the fish community in vegetated habitats was more stable and more diversified when compared to the community in adjacent sandy bottomed areas. As Wilhlm and Dorris (1968) discussed for macroinvertebrate communities, biotic diversity is dependent upon the number of species (species richness) and the numerical distribution of species among the assemblage (species equitability). In stressed or simple habitats, where a few species tend to be numerically dominant and the overall number of species is relatively low, low diversity indices are characteristic. Conversely, more complex or unstressed habitats are characterized by a larger number of species and more even numerical distribution among the species, thereby resulting in higher diversity indices. It is important to consider both species richness and equitability separately, as the number of species depends primarily on the structural diversity of a habitat whereas equitability is more sensitive to the stability of physical conditions (Lloyd and Ghelardi 1964).

Analysis of community structure theory further suggests that the ichthyofauna of beaches is a seral (or developmental) stage whereas the ichthyofauna of vegetated areas represents the terminal stabilized system or climax. A successional gradient in species diversity is found in vegetated shorelines, unkept beaches where vegetation has encroached to some extent, and denuded beaches. Odum (1969) concluded that development of climax communities is an orderly process that involves changes in species structure and community processes with time; it is reasonably directional and, therefore, predictable.

In summation, the community of fishes occupying vegetative habitats represented a climax with respect to the beach fishes; moreover, it was more unique, more diverse, more evenly distributed in terms of individuals of each species, and more productive in terms of biomass. Beach fishes, on the other hand, were a seral community typified by a less distinct, but more numerous ichthyofauna. A few ubiquitous species dominated the beach habitats.

Acknowledgments

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Table A1. Catch per unit effort in number of individuals (A) and biomass in grams (B) and frequency of occurrence (C) of fishes collected by electrofishing (E), seine (S), and Wegener ring (WR) in vegetated and beach habitats in Lake Conway, May through September 1976. (I and II represent the numerical value and percent composition, respectively.)

Species		Beach				Vegetation			
		E		S		E		WR	
		I	II	I	II	I	II	I	II
Longnose gar	A	0.1	.03						
	B	3.1	0.3						
	C	1	5.55						
Florida gar	A	0.3	.08			1.3	.96	0.1	.12
	B	201.3	2.12			621.6	4.55	0.1	.24
	C	3	16.67			10	55.55	2	3.33
Bowfin	A					0.4	.29		
	B					1251.9	9.16		
	C					3	16.67		
Gizzard shad	A	0.4	.11			0.1	.07		
	B	333.4	3.52			72.2	.53		
	C	1	5.55			1	5.55		
Threadfin shad	A	41.7	11.42			7.2	5.31		
	B	170.1	1.80			44.3	.32		
	C	16	88.88			12	66.67		
Chain pickerel	A	2.0	.55			6.6	4.87		
	B	595.8	6.29			1536.8	11.25		
	C	10	55.55			14	77.78		
Golden shiner	A	3.2	.88			2.0	1.47		
	B	108.7	1.15			179.3	1.31		
	C	10	55.55			9	50.00		
Coastal shiner	A	3.0	.82	3.0	4.39	0.1	.07	1.1	4.06
	B	3.6	.04	1.9	.46	0.1	.01	0.7	2.85
	C	6	33.33	6	20.00	1	5.55	13	21.67
Lake chubsucker	A	0.7	.19			0.8	.59		
	B	253.6	2.68			393.5	2.88		
	C	3	16.67			4	22.22		

(Continued)

Table A1. (Continued)

		Beach				Vegetation			
		E		S		E		WR	
		I	II	I	II	I	II	I	II
Yellow bullhead	A					0.3	.22		
	B					62.3	.46		
	C					3	16.67		
Brown bullhead	A					0.4	.29	0.1	.36
	B					111.2	.81	0.1	.26
	C					3	16.67	4	6.67
Golden topminnow	A			0.1	.14			0.6	2.06
	B			0.2	.05			0.6	2.68
	C			1	3.33			11	18.33
Seminole killifish	A	15.8	4.32	58.32	84.22	0.7	.52	2.3	8.54
	B	102.4	1.08	265.8	64.31	3.4	.02	2.9	12.32
	C	16	88.88	27	90.0	3	16.67	27	45.00
Flagfish	A							0.1	.06
	B							0.1	.01
	C							1	1.67
Bluefin killifish	A			0.2	.28	0.2	.15	13.2	48.58
	B			0.1	.02	0.1	.01	3.0	12.86
	C			5	16.67	1	5.55	37	61.67
Mosquitofish	A			0.3	.43	0.2	.15	13.2	48.53
	B			0.1	.02	0.1	.01	3.0	12.86
	C			5	16.67	1	5.55	42	70.00
Least killifish	A							0.1	.05
	B							0.1	.01
	C							4	6.67
Brook silverside	A	30.19	8.46	0.3	4.63	2.2	1.62	0.1	.06
	B	28.7	.30	0.3	0.7	1.6	.01	0.1	.05
	C	15	83.33	6	20.0	6	33.33	1	1.67

(Continued)

Table A1. (Concluded)

		Beach				Vegetation			
		E		S		E		WR	
		I	II	I	II	I	II	I	II
Bluespotted sunfish	A	0.1	.03			0.3	.22	0.5	1.70
	B	0.1	.01			0.4	.01	0.6	2.32
	C	1	5.55			2	11.11	7	11.67
Warmouth	A	0.2	.05			4.7	3.47	0.5	1.94
	B	0.2	.01			98.1	.72	2.5	10.67
	C	1	5.55			10	55.55	7	11.67
Bluegill	A	177.7	48.64	3.2	3.81	72.2	53.24	0.5	2.0
	B	3151.8	32.28	60.3	14.59	2138.7	15.65	3.1	13.38
	C	18	100.00	15	50.00	18	100.00	8	13.33
Dollar sunfish	A	0.1	.03			0.2	.15		
	B	0.4	.01			0.8	.01		
	C	1	5.55			1	5.55		
Redear sunfish	A	58.6	16.04	2.6	1.83	19.6	14.45	0.3	1.10
	B	2139.3	22.59	71.8	17.37	1298.9	9.51	0.7	3.02
	C	17	94.44	9	30.0	17	94.44	4	6.67
Spotted sunfish	A	0.1	.03			1.2	.88		
	B	6.3	.07			26.0	.19		
	C	1	5.55			7	38.8		
Largemouth bass	A	29.9	8.18	1.3	1.88	14.1	10.49	.04	1.57
	B	2332.0	24.62	12.8	3.10	5562.4	40.71	0.8	3.41
	C	18	100.00	14.0	46.66	18	100.00	18	30.00
Black crappie	A	0.4	.11			1.0	.74		
	B	40	.42			25.98	1.90		
	C	2.	11.11			8	44.44		
Swamp darter	A	0.1	.03					1.7	6.12
	B	0.1	.01					0.8	3.28
	C	1	5.55					21	35.00
Total	A	365.3		69.1		135.8		27.5	
	B	9470.9		413.3		135.6		24.0	

Table A2. Species showing statistically significant greater numbers, biomass, or occurrences in beach or vegetated habitat according to electrofishing samples. (* and ** indicate significance at the 0.05 and 0.01 levels.)

	Beach			Vegetation		
	No.	Wt.	Freq.	No.	Wt.	Freq.
Florida gar				**	*	
Bowfin				*	*	
Threadfin shad			*			
Chain pickerel				*		
Coastal shiner	*	*				
Yellow bullhead					**	
Brown bullhead				*		
Seminole killifish	**	**	**			
Brook silverside	*	*	*			
Warmouth				*	*	*
Bluegill	*					
Redear sunfish	*					
Spotted sunfish				*		**
Largemouth bass	*				*	
Black crappie				**		
Total	**					

Table A3. Variation in number of species and species diversity indices (information theory--machine method, species richness, and species equitability) for monthly pooled samples for each gear type.

	May	Jun	Jul	Aug	Sep	Mean
<u>Wegener ring</u>						
number of species	10	10	13	12	14	11.8
information theory	2.01	1.96	2.43	2.29	2.37	2.21
species richness	4.09	4.18	5.40	5.44	4.93	4.81
species equitability	0.53	0.51	0.57	0.54	0.50	0.53
<u>20-ft seine</u>						
number of species	7	5	6	6	8	6.4
information theory	0.57	0.61	1.05	1.48	1.46	1.03
species richness	2.34	1.93	2.39	2.73	3.43	3.56
species equitability	0.24	0.35	0.42	0.58	0.43	0.40
<u>Electrofishing vegetation</u>						
number of species			21	18	16	18.3
information theory			2.67	2.35	2.48	2.50
species richness			7.73	6.76	6.11	6.87
species equitability			0.43	0.38	0.58	0.46
<u>Electrofishing beach</u>						
number of species			14	13	13	13.3
information theory			1.77	1.83	2.45	2.02
species richness			4.68	4.20	4.24	4.37
species equitability			0.31	0.36	0.57	0.41

APPENDIX B: SPECIES ASSEMBLAGES OF FISH IN A CENTRAL FLORIDA LAKE*

Abstract

A species association index based on presence-absence data was used to identify five species complexes on Lake Conway, Florida. These complexes included *Lepisosteus platyrhincus*-*Pomoxis nigromaculatus*; *Micropterus salmoides*-*Lepomis macrochirus*; *Dorosoma petenense*-*Labidesthes sicculus*; *Gambusia affinis*-*Lucania goodei*; and *Lepomis gulosus*-*Ennecanthus gloriosus* associations, using the names of the two species with the largest index of affinity as the complex name. Although each complex overlapped in distribution with others, all complexes were correlated with basic habitat features. Species with the largest individual affinity indices included *D. petenense*-*L. sicculus*, *G. affinis*-*L. goodei*, and *M. salmoides*-*L. macrochirus*.

Introduction

Ecological studies of species assemblages have traditionally involved the subjective grouping of species having similar distributional patterns. More recent theoretical approaches have emphasized mathematical techniques in analyzing community structure and interspecies relationships. Smith and Fisher (1970) and Stevenson et al. (1974) described species groups by factor analysis for the ichthyofauna of Kansas and western Oklahoma, respectively. On a smaller scale, Smith and Powell (1971) and Echelle and Schnell (1976) analyzed species associations in Brier Creek, Kansas, and Kiamichi River, Oklahoma, respectively.

The species assemblages found in lacustrine habitats have never been determined. The purpose of this paper is to mathematically analyze the species assemblages of fishes inhabiting Lake Conway, Orange County, Florida, and to correlate the distribution of these complexes with basic habitat features.

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* A paper submitted to *Florida Scientist* by Vincent Guillory, Florida Game and Fresh Water Fish Commission, Orlando, Florida.

Study Area

This research was conducted in the Lake Conway chain of lakes near Orlando, Florida. This system, a part of the Kissimmee river drainage, totals 728 ha. The shoreline has been noticeably altered by urbanization and associated shoreline development and vegetation removal; however, some areas have a narrow fringe of emergent Panicum, Typha, or Fuirena. Dominant submergent vegetation includes Vallisneria, Potamogeton, Nitella, and Hydrilla. The substrate is primarily sand, except in areas of extremely thick vegetation where a thick layer of organic detritus has built up. The lake is mesotrophic. The bottom contours are rather steep in many areas as compared to the gradually sloping shoreline characteristic of other central Florida lakes.

Methodology

Six sampling methods were used to collect fishes on Lake Conway from May through September 1976. Five blocknet samples were taken in June 1976. A sinking and floating net 124 m long was set overnight at each of four stations monthly. Six sampling stations were established for each remaining gear type and sampled monthly. Two Wegener ring samples were taken at each station in shallow, heavily vegetated habitats. Two seine collections accompanied Wegener rings at each station. One collection was taken in unvegetated habitats with a 6.1-m seine, while the other collection was taken adjacent to emergent vegetation with a 3.0-m seine. One half hour of nocturnal electrofishing was undertaken monthly at each of three naturally vegetated and three beach areas.

The affinity between pairs of species was measured according to an index of species association C utilizing presence-absence data for all collections: $C = 2a\ J/b\ (a + b)$, where J equals the number of joint occurrences and a and b are the number of times species a and b are encountered, respectively. The value of this index ranges from 0 to 1.0, with 1.0 indicating complete association in all samples and 0 reflecting a negative distribution.

Species groups were then determined after indices of affinity had been calculated between all species pairs. An index of 0.15 was chosen as the minimum value for two species to be considered associated. Formation of species assemblages from species showing affinity was based on the following criteria: 1) every species within a group had to show affinity with all members of the group, thus ensuring that every taxon in a group frequently occurred with every other member; 2) the largest possible groups had to be formed in sequence; and 3) species of the first assemblage were excluded in the determination of the second group, with species of each succeeding group likewise excluded from further grouping. This process was repeated until all possible groups had been identified. Intergroup relationships were expressed by the ratio between the observed number and the maximum possible number of intergroup species which show affinity.

Results and Discussion

Analysis of joint occurrences by the species association index demonstrated five major components, or recurrent groups, of positively associated fishes among the 29 species found on Lake Conway: Group I--*Lepisosteus platyrhincus*, *Dorosoma cepedianum*, *Esox niger*, *Notemigonus crysoleucas*, and *Pomoxis nigromaculatus*; Group II--*Fundulus seminolis*, *Lepomis macrochirus*, *L. microlophus*, and *Micropterus salmoides*; Group III--*Lucania goodei*, *Gambusia affinis*, and *Etheostoma fusiforme*; Group IV--*Dorosoma petenense*, *Notropis petersoni*, and *Labidesthes sicculus*; and Group V--*Ictalurus nebulosus*, *Ennecanthus gloriosus*, and *Lepomis gulosus*. I refer to these as the *platyrhincus-nigromaculatus*, *salmoides-macrochirus*, *affinis-goodei*, *petenense-sicculus*, and *gulosus-gloriosus* associations, respectively, using the names of the two species with the highest index of affinity as the complex name.

Species not grouped in any of the aforementioned species complexes but which showed affinity to one another included the following: *Lepomis punctatus* to *Amia calva* and *Erimyzon sucetta*; *Lepomis marginatus* to E. sucetta and Heterandria formosa; and A. calva to Ictalurus natalis.

Eleven species combinations had index values of 0.40 or greater. D. petenense-L. sicculus, and L. goodei-G. affinis, with 0.67 and 0.64, respectively, had the highest affinity, followed by L. macrochirus-M. salmoides (0.56) and D. petenense-E. niger (0.50). Other combinations included D. petenense-N. crysoleucas (0.42), E. niger-N. crysoleucas (0.41), E. niger-L. sicculus (0.42), F. seminolis-L. macrochirus (0.46), H. formosa-L. marginatus (0.40), E. gloriosus-L. gulosus (0.44), L. microlophus-M. salmoides (0.44), and L. platyrhincus-P. nigromaculatus (0.45).

Much overlap existed among the five species complexes. They were often taken together so that each complex usually occurred with individuals of one or more of the other groups. Two combinations had a low ratio between the observed number and maximum possible number of species showing intergroup affinity: platyrhincus-nigromaculatus and affinis-goodei complexes with a value of 0.00, and salmoides-macrochirus and gulosus-gloriosus associations with a value of 0.08. The highest intergroup relationship were shown by platyrhincus-nigromaculatus and petersoni-sicculus (0.47), and salmoides-macrochirus and affinis-goodei (0.42). Values for other intergroup combinations ranged from 0.22 to 0.33.

It is evident that these species combinations are not discrete, well segregated ecological units; nevertheless, there is a random assortment apparently related to habitat types. In other words, many species occurring in these groups are able to tolerate a considerable range of physical and chemical conditions, but there are some microhabitats more desirable than others.

The discussion of fish distribution in relation to habitat features is hampered by the lack of specific information concerning the environmental tolerances and responses of various species and the range of environmental conditions occurring in different habitats. Furthermore, environmental factors are not independent variables, and it is rarely possible to demonstrate that one factor is of overriding importance in controlling the distribution of a given species. Because of these difficulties, I will attempt to point out correlations between the distribution patterns of each species association and the more obvious habitat features, realizing that in some instances more subtle and less readily observed factors may have greater importance.

The salmoides-macrochirus complex (Group II) included the four most frequently encountered species in the Lake Conway system. Of a total 173 samples for all sampling techniques, M. salmoides was collected 93 times, L. macrochirus 82 times, F. seminolis 81 times, and L. microlophus 58 times. In discussing other species assemblages, I will try to relate their distribution patterns to basic habitat features; however, in discussing the above ubiquitous species, it is appropriate to consider why they are not similarly restricted. It is logical to assume that they have broader environmental tolerances than more restricted species. With the exception of F. seminolis, which attains its peak of abundance in sandy, nonvegetated littoral habitats, these species show no obvious habitat preferences. They occur over all bottom types, at all depths, and in areas devoid of vegetation as well as in densely vegetated areas. Because of the ubiquitous nature of this complex, I have mentioned it first so that when other assemblages characterizing various habitats are denoted, it will be understood that the members of the salmoides-macrochirus complex occur with regularity along with the species group in question.

Members of the primary species group, the platyrhincus-nigromaculatus complex (Group I) are inhabitants of both pelagic, open-water and deeper littoral zones. D. cepedianum, N. crysoleucas, and P. nigromaculatus are species with schooling tendencies and are more characteristic of open water, whereas L. platyrhinchus and E. niger are collected with more regularity in deeper littoral habitats. Six species, not included in this complex because of their infrequent occurrence in collections, have habitat preferences similar to the platyrhincus-nigromaculatus complex. A. calva, E. sucetta, L. marginatus, and L. punctatus are found in deeper littoral habitats adjacent to thick emergent vegetation; Ictalurus catus and I. natalis are most often found in open-water habitats. Lepomis gulosus and

D. petenense, members of other species assemblages, are also indicative of deeper littoral vegetated and pelagic habitats, respectively.

Insofar as their habitat preferences overlap, the *gulosus-gloriosus* (Group V) and *affinis-goodei* (Group III) complexes will be discussed together. Both groups are closely associated with dense stands of aquatic vegetation in shallow littoral habitats. The *gulosus-gloriosus* complex, however, is most often encountered over a bottom of organic detritus with submergent vegetation dominant and water over 30 cm deep. On the other hand, the *affinis-goodei* assemblage is more ubiquitous in densely vegetated littoral habitats, occurring over both sand and organic detritus substrates, in extremely shallow water as well as in deeper littoral zones, and in submergent and/or emergent vegetation. Three other species (*H. formosa*, *F. chrysotus*, *Jordanella floridae*) which occurred at low population densities (thereby not having high correlations with the aforementioned complexes) are also associated with dense stands of littoral vegetation.

Members of the *petenense-sicculus* complex (Group IV) are most characteristic of clean, sandy bottom, wave-washed shorelines frequently devoid of vegetation, but often interspersed with *Potamogeton* or *Panicum*. Although *D. petenense* is generally an open-water species and is often encountered in such areas in Lake Conway, it is more prevalent in the previously described habitat.

While mathematical analyses of species associations allow large sets of data to be reduced to a small, manageable number of components, thereby expediting objective assessments, there are certain limitations in their use (Echelle and Schnell 1976). First, certain species, because of their rarity, may not be mathematically associated with a species complex but may be ecologically associated with same habitat. Second, two competing species may exclude one another from association with a given species group at a sufficient number of localities to depress the correlation with that group. Finally, if a species is difficult to collect, its appearance in collections may not be representative of its actual distribution. Despite these limitations, I feel that species association indices are an objective method of determining the ecological relationships between various species.

Acknowledgments

I would like to acknowledge the U. S. Army Engineer Waterways Experiment Station for financial support and the Florida Game and Fresh Water Fish Commission for administrative support. Special thanks are extended to project personnel, Roy Land, Michael Rebel, and Dale Jones, for their support.

APPENDIX C: ZOOGEOGRAPHY OF THE GRASS CARP IN THE UNITED STATES*

Abstract

Since 1963, the white amur or grass carp, Ctenopharyngodon idella Val., has spread to at least 35 states through stockings and subsequent dispersal. Grass carp have been found in several major river systems and in areas near research sites. Further spread of the species will probably occur with increased research and stocking of grass carp for weed control.

Introduction

Several herbivorous species have been investigated as potential weed control agents. The white amur or grass carp, Ctenopharyngodon idella Val., was recommended by Swingle (1957) for importation into the United States for weed control. The species is endemic to eastern Asia from the Amur River Basin to the West River (Lin 1935). Grass carp have been introduced into more than 20 countries (Provine 1975), thus achieving a wide distribution.

This fish was first introduced in the United States from Malaysia in 1963 at the Fish Farming Experiment Station, Stuttgart, Arkansas, and at Auburn University, Auburn, Alabama (Stevenson 1965). It has spread throughout the United States as a result of widely scattered research projects, stockings to solve aquatic weed problems, interstate importation from private hatcheries, and dispersal from stocking sites. This report traces the spread of grass carp in the United States from 1963 through 1976.

Materials and Methods

Data were obtained using a classical literature review as well as letters and telephone calls to state fish and game agencies,

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* A paper submitted to the American Fisheries Society by Vincent Guillory and Robert D. Gasaway, Florida Game and Fresh Water Fish Commission, Orlando, Florida.

universities, and other governmental entities requesting information on grass carp research, stockings, and collection records. Much of the Florida record is based on personal knowledge.

Results and Discussion

Early grass carp history in the United States began with a special meeting held in 1962 at the Fish Farming Experiment Station at Stuttgart to discuss the merits of grass carp introduction (Sneed 1972). It was decided to import the species into the United States for research purposes.

With the assistance of United Nations Food and Agricultural Organization personnel, arrangements were made for securing grass carp from S. Y. Lin of Malaysia for experimental purposes at the Fish Farming Experiment Station (Stevenson 1965). A total of 70 fish were imported in November 1963.

A shipment of fish from Taiwan was also sent to Auburn University in 1963. Grass carp were spawned there in the spring of 1966 (Sills 1970) to obtain fish for research in ponds. In 1967 and 1968, Auburn provided fish to other agencies.

A small number of fish at the Stuttgart Experiment Station were artificially spawned in 1966, producing 1700 fry (Bailey and Boyd 1972). Some of these fish were retained at Stuttgart for research purposes; however, some were distributed to the Arkansas Game and Fish Commission Lonoke hatchery. Grass carp were later released to other researchers in 1967 by the Experiment Station. In 1970 the Arkansas Game and Fish Commission produced 250,000 fry (Bailey and Boyd 1972), and, in 1971, approximately 1 million fry were produced. Meanwhile, Lake Greenlee, a topographically isolated lake near Brinkley, Arkansas, was stocked for weed control evaluation in July 1970. Over the next 6 years, at least 115 lakes and numerous farm ponds were stocked. The first grass carp introduction in an open system in this country occurred when Lake Conway, Arkansas, was stocked in December 1971. Arkansas began supplying out-of-state researchers with fish the same year.

Grass carp were discovered in the White River in Bayou Largrue in Arkansas during 1970 by commercial fishermen (Bailey 1972). The first free-ranging fish outside Arkansas were collected in the Illinois portion of the Mississippi River in February 1971 (Greenfield 1973). All of these fish were of the 1966 age class. They may represent larval or juvenile escapees from the Fish Farming Experiment Station hatchery in Stuttgart, since 1966 was the first year grass carp were spawned there.

The broadcast application of grass carp in Arkansas waters led to invasion of the Mississippi Valley by the species (Figure C1). Free-ranging fish in the Mississippi River system have been taken in the Red and Quachita Rivers in Louisiana, the Yazoo River in Mississippi, the Mississippi River proper as far north as Iowa, the Des Moines River in Iowa, the Illinois River, the Wabash River in Indiana, the Tennessee River in Alabama, and the Missouri River as far north as South Dakota (Figure C1). Most large Arkansas rivers contain grass carp (Bailey, personal communication). There is an unconfirmed report of grass carp in the Ohio River in Kentucky. Pflieger (1975) plotted additional records of grass carp in Missouri, including 25 localities in the Mississippi River, 42 in the Missouri River, 2 in the St. Francis River, 1 in the Gasconade River, and 1 in Shoal Creek.

Grass carp first began to appear frequently in the Mississippi Valley during 1974. Currently, the species is common in the Missouri, middle Mississippi, and Quachita Rivers, and appears in commercial fish markets. All of the above records may not stem from Arkansas stockings, especially the Ohio and Tennessee River records. However, Pflieger (1975) indicated that in 1974, the year of the major influx of grass carp into Missouri, the fish were mostly of the 1971 year class, corresponding to the year in which grass carp were first released in Arkansas open waters (Bailey 1972).

Other free-ranging fish have been collected in the Leaf River in Mississippi, the Altamaha and Chattahoochee Rivers in Georgia, the Coosa and Black Warrior Rivers in Alabama, and North Bay and Econfina Creek in Florida (Figure C2). Except for the Florida fish, which originated from a research site (Deer Point Lake), the origins of the above fish are unknown.

Artificial introductions of grass carp for various reasons have spread the fish throughout the country (Figures C1-C4). Sneed (1972) indicated that private companies have imported grass carp into Louisiana, Oklahoma, Texas, Maryland, and Arkansas. Firms in Escanaba, Michigan, Dublin, Ohio, and Lafayette, Indiana, have also imported grass carp. In one instance, grass carp have been cultured by two private fish farms in New Jersey for use in the New York City restaurant trade.

Several private hatcheries obtained grass carp and spawned the species in 1973. Subsequently, these hatcheries began exporting the fish into surrounding states to interested buyers. A large outflow of grass carp from these hatcheries into surrounding states first occurred in 1974. A total of 31 states have reported instances of grass carp importation from private hatcheries (Table C1). The total number of importations is very high, and many states have found it impossible to locate or even record all cases. Consequently, only a small percentage of the total number of these sites have been located. Similarly, there are probably other states with unknown instances of grass carp importation. As early as 1972, Sneed (1972) noted that grass carp had been shipped into at least 16 states from hatcheries. The widespread interstate importation of this species throughout the country may be attributed to the ease with which grass carp may be obtained from private fish hatcheries which advertise mail-order fish in many farm and fish culture journals. As pointed out by Minckley (1973), the promotional activities surrounding grass carp, including the change in common name to white amur in releases to the public, are almost identical with those used to achieve the nationwide distribution of common carp (Cyprinus carpio) in the 1880's and for the cichlid Tilapia in the 1950's and 1960's.

A large number of organizations have researched grass carp either formally or informally (Table C2). Included are 13 state agencies, 22 universities, and 5 Federal laboratories. The majority of these researchers obtained their fish originally from the Experiment Station, the Lonoke hatchery, or Auburn University. Research efforts have taken place in 20 states (Table C1).

According to our survey, a total of 35 states have harbored grass carp at one time or another (Table C1). However, this estimate is probably conservative due to the difficulty in verifying interstate shipments of grass carp from commercial producers. Sneed (1972) estimated that by 1972 grass carp were in 40 states. The total may be higher at the present time.

The large number of sites where grass carp have been released through importation by individuals and through stocking for research purposes has made their introduction into additional open systems likely. Juvenile fish have escaped from several hatcheries through outflows. Grass carp are also vigorous jumpers and may escape to adjacent waters from ponds with low sides (Ellis 1974). Moreover, fishermen will readily transport exotic fishes which are thought to have sport fish potential from one body of water to another (Courtenay and Robins 1973).

Grass carp are tolerant of a wide range of environmental conditions and are capable of extensive migrations once they are released in open systems. Vinograd and Zolotova (1974) traced the dispersal of grass carp from release in the Volga Delta to the Middle Volga, the lower Ural River, the Dniester, freshened bays of the Aral Seas, the Kiben Lagoon, and the Sea of Azov. Grass carp is a secondary species (Meyers 1938) that tolerates brackish water (Cross 1970), facilitating dispersal of the fish through low-salinity complexes. It is likely that the fish will become generally distributed in river systems where it is now found and move to adjacent coastal rivers via brackish interconnections.

Several major points can be made concerning the zoogeography of the grass carp in the United States. First, the major focal point of free-ranging fish is Arkansas, where the species has been extensively stocked in open systems. Second, most instances of interstate importation of grass carp have occurred in the Central and Southern United States. This is apparently due to the proximity of these regions to hatcheries producing grass carp as well as to the presence of serious aquatic weed problems. Finally, many stockings have been in the proximity of universities and Federal laboratories conducting grass carp research and, similarly, within the political boundaries of states where state agencies are also researching the species.

The spread of an exotic species which has been artificially displaced by man is extremely rapid when compared to native freshwater fishes, many of which are essentially confined to their drainage basins and may pass from one isolated stream system to the next only by stream capture, drainage modifications due to glacial movements, or joining of adjacent drainages during eustatic changes of sea level. The grass carp may be the most rapidly spreading exotic fish in the United States despite the fact that no natural reproduction has been documented. Since 1963 grass carp have become distributed nationwide. Present records indicate the fish have been spread artificially approximately 1770 km south, 4506 km northeast, and 3219 km west from original distribution points. Free-ranging fish have moved about 1690 km up the Mississippi River system from stocking sites. Our data indicate that grass carp presently are free in most large rivers of the Mississippi Valley. Five rivers in the southeast have reported occurrences of grass carp. One reservoir in Florida opens to the Gulf of Mexico and has a large population of grass carp.

Man is probably the most likely means of further spread. Weed control efforts and research by state and Federal agencies will probably be the greatest encouragement for further spread of the fish. Further dispersal of grass carp will undoubtedly occur in river systems where the species is now found.

Acknowledgments

Sincere thanks are extended to the many biologists who have contributed information to this paper, including university, state fish and game, and Federal personnel. Without their input, our paper would not have been possible. The U. S. Army Engineer Waterways Experiment Station financed this study.

Table C1. Summary of grass carp distribution in the United States, 1963 to 1977.

State	I	II	III
Alabama	X	X	X
Arizona	X	X	
Arkansas		X	X
California	X	X	
Colorado	X	X	
Connecticut	X		
Florida	X	X	X
Georgia	X	X	X
Illinois	X	X	X
Indiana	X	X	
Iowa	X	X	X
Kansas			X
Kentucky	X		X
Louisiana	X	X	X
Maryland	X		
Michigan	X	X	
Mississippi	X	X	X
Missouri	X	X	X
Nebraska	X		X
New Hampshire	X		
New Jersey	X		
New Mexico	X		
New York	X		
North Carolina	X		
North Dakota	X	X	

(Continued)

Note: I denotes instances of importation from private hatcheries; II, research efforts; and III, collection records of wild fish.

Table C1. (Concluded)

State	I	II	III
Ohio	X	X	
Oklahoma	X	X	
Oregon		X	
South Carolina	X		
South Dakota			X
Tennessee	X	X	X
Texas	X		
Virginia	X		
West Virginia	X		
Wisconsin	X	X	
Total	31	20	14

Table C2. Organizations which have conducted research on grass carp in the United States.

State Agencies
Alabama Department of Natural Resources
Arizona Game and Fish Department
Arkansas Game and Fish Commission
Florida Department of Natural Resources
Florida Game and Fresh Water Fish Commission
Georgia Department of Natural Resources
Indiana Department of Natural Resources
Iowa Conservation Commission
Louisiana Wildlife and Fisheries Commission
Missouri Department of Conservation
North Dakota Game and Fish Department
Ohio Department of Natural Resources
Tennessee Wildlife Resources Agency

Universities	
Auburn University	Nichols State University
Colorado State University	Northwestern University
Florida Atlantic University	San Francisco State University
Florida Technological University	Southern Illinois University
Illinois Natural History Survey	University of Arizona
Indiana State University	University of California at Davis
Louisiana State University	University of Florida

(Continued)

Table C2. (Concluded)

Universities (Continued)	
University of Georgia	University of Southwestern Louisiana
University of Michigan	
University of Missouri	University of Tennessee
University of Oklahoma	University of Wisconsin
	Wayne State University
Federal Laboratories	
Fish Farming Experiment Station at Stuttgart, Arkansas	
Southeastern Fish Control Laboratory at Warm Springs, Georgia	
U. S. Department of Agriculture at Fort Lauderdale, Florida	
U. S. Fish Hatchery at Marion, Alabama	
U. S. Forest Service at Davis, Mississippi	

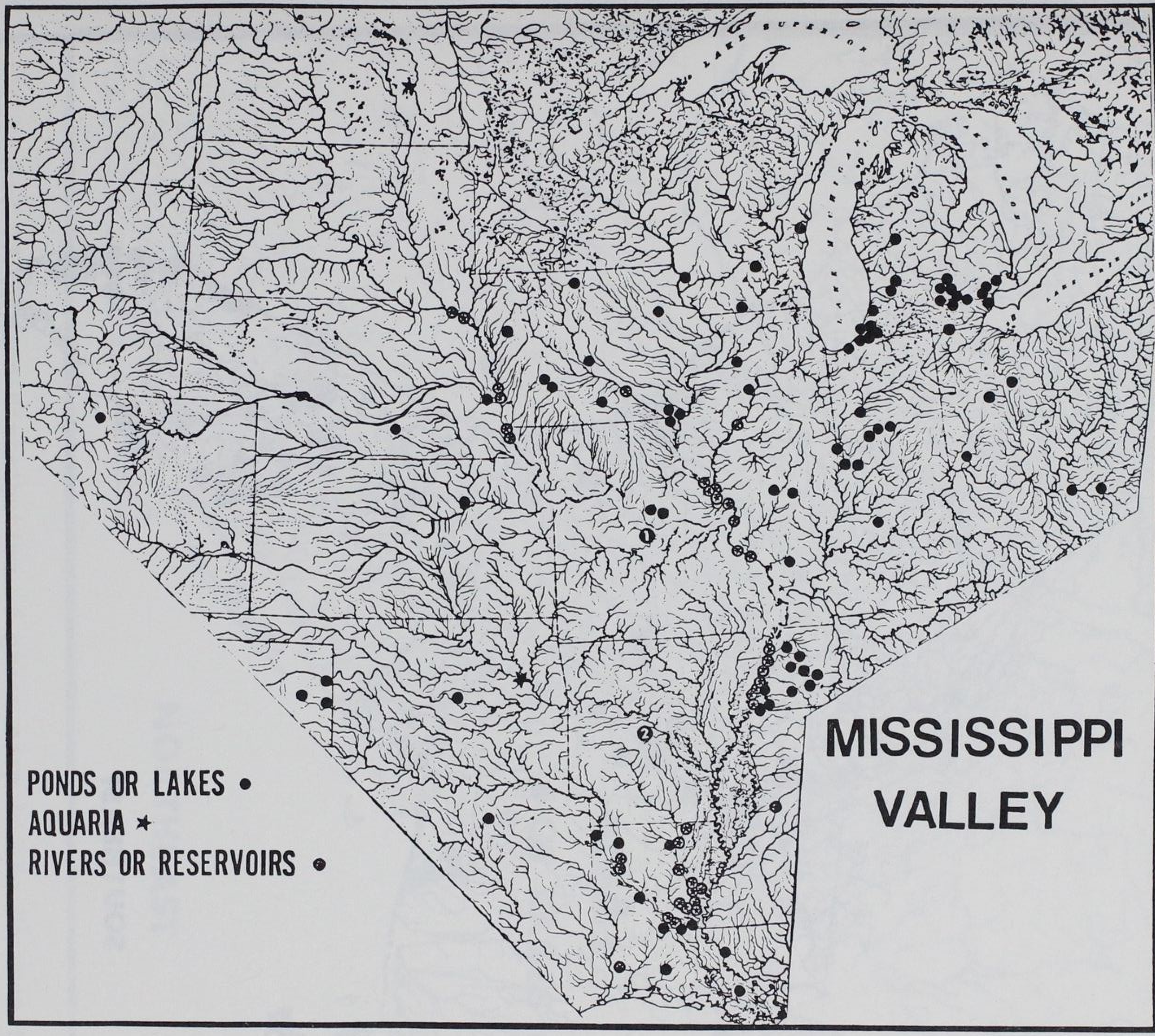

Figure C1. Known distribution of grass carp in the Mississippi Valley. (1 - Missouri records of wild grass carp are presented by Pflieger (1975); 2 - Arkansas stocking sites are too numerous to plot.)

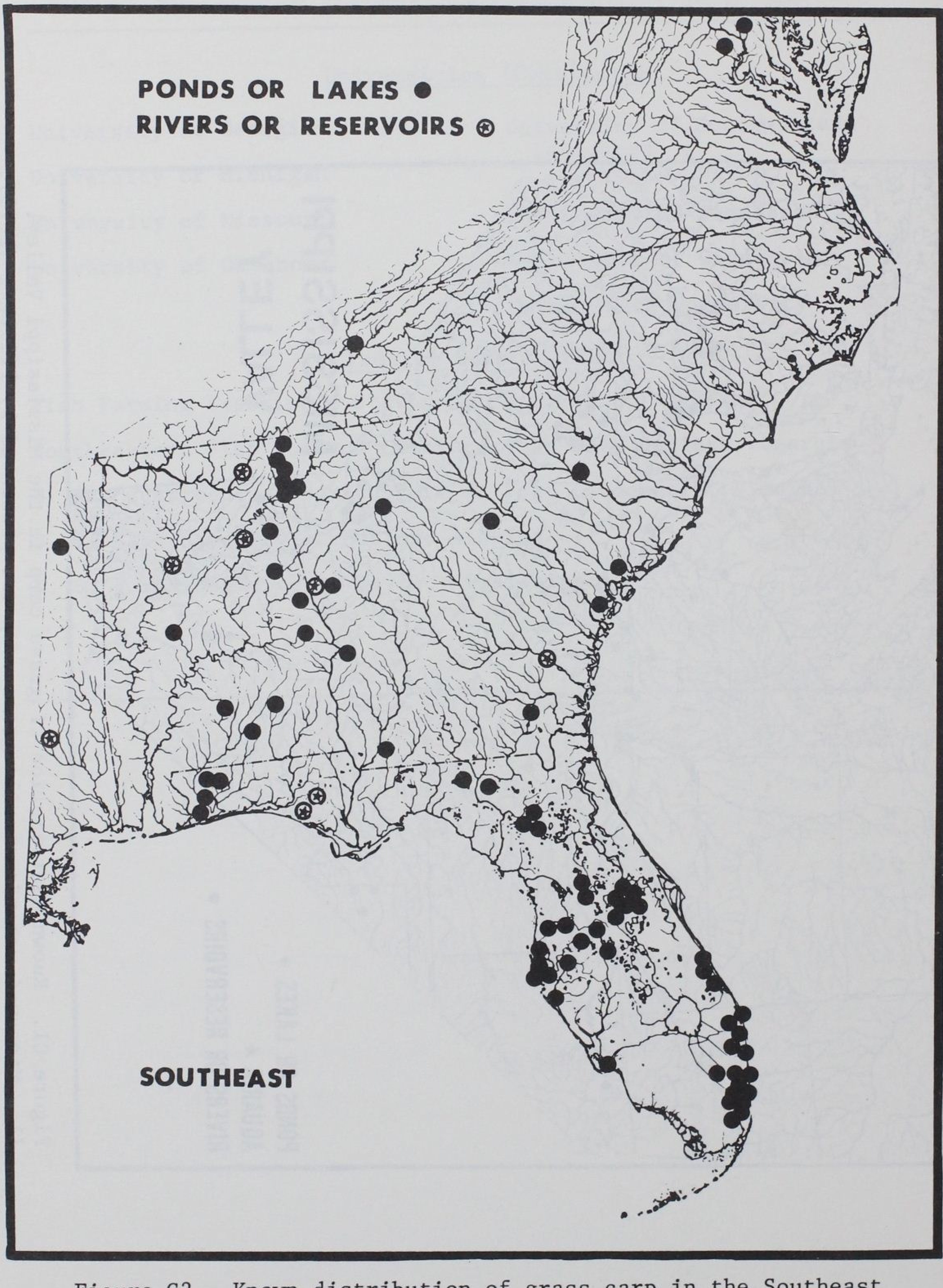

Figure C2. Known distribution of grass carp in the Southeast

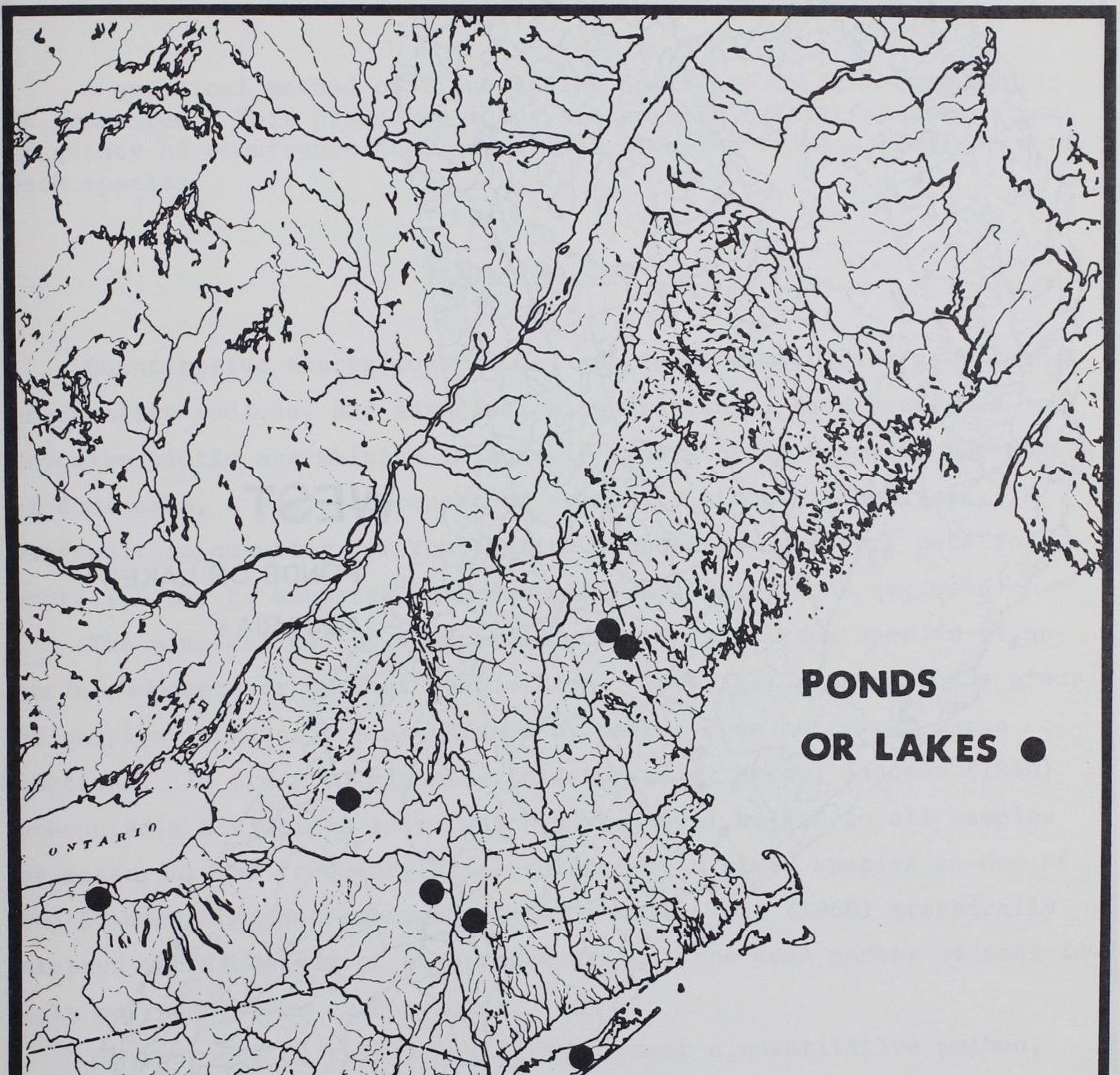

Figure C3. Known distribution of grass carp in the Northeast

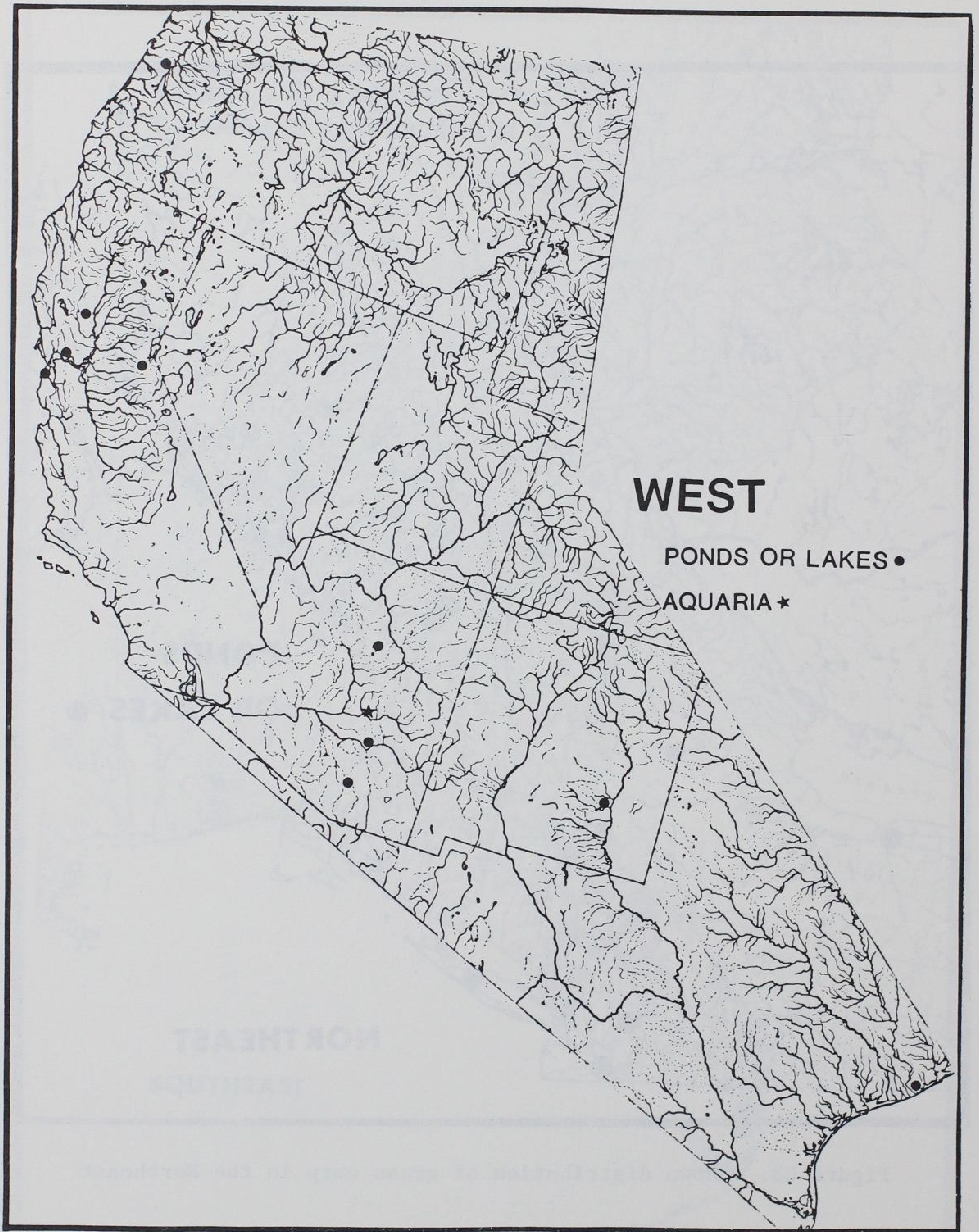

Figure C4. Known distribution of grass carp in the West

APPENDIX D: A GRAPHIC METHOD TO ASSESS FAUNAL DOMINANCE*

Abstract

A graphical method of illustrating dominance in fish communities is presented. This procedure incorporates both numeric abundance and frequency of occurrence data and illustrates the relative dominance of each species.

Introduction

Quantitative expressions (e.g., species diversity indices, faunal homogeneity indices, and association coefficients) have been used to describe biotic assemblages in aquatic ecosystems. However, the degree of dominance, a basic component of community structure analysis, is difficult to quantify for comparative purposes. Moreover, data interpretation may be hampered when several sampling methods are used.

The simplest way to identify dominance is to rank species by numeric abundance or percent composition. Numerical ranking for a group of samples, however, can be biased by one or more extremely large collections. In order to minimize this source of error, Sanders (1960) presented a Biological Index which gives equal weight to all samples by measuring the frequency of appearance of a given species as one of the 10 most abundant species in each sample. Ono (1960) graphically plotted the frequency of occurrence against the mean number of individuals per sample for each species.

The purpose of this paper is to present a quantitative method, modified from the procedures of Sanders and Ono, of analyzing relative abundance and frequency of occurrence data.

Materials and Methods

Fish data generated from the Lake Conway grass carp project were

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* A paper submitted to the Southeastern Association of State Fish and Game Commissioners, Vincent Guillory, Florida Game and Fresh Water Fish Commission, Orlando, Florida.

used to illustrate this graphical method of faunal dominance. Five sampling methods were used, including Wegener ring, electroshocker, gill net, 3.0-m (10-ft) seine, and 6.1-m (20-ft) seine. Two Wegener ring samples were taken monthly at each of six stations in shallow, heavily vegetated areas. Two seine collections accompanied Wegener ring samples at each station. One collection was taken in unvegetated habitats with the 6.1-m seine, while the other collection was taken adjacent to emergent vegetation with the 3.0-m seine. One half hour of electrofishing was undertaken monthly at each of three naturally vegetated and three beach habitats. Two 46-m (150-foot) gill nets were set overnight monthly at each of two stations. Sampling was conducted from May through September 1976.

Ono's (1960) graphical method of dominance assessment, in which are plotted the frequency of occurrence against the mean number of individuals in samples, formed the basis of the present method of analysis. The procedure of Ono was modified in two ways. First, since several sampling methods were used, a modification of Sanders' (1960) Biological Index was used to measure numerical abundance instead of the number of individuals per sample. Second, instead of the absolute number of times each species was encountered in samples, the percent frequency of occurrence for all gear types of each species relative to the most frequently encountered one was determined.

Sanders' (1960) Biological Index measures the frequency of appearance of a given taxon as one of the 10 most abundant species. As used here, its value is obtained by assigning 10 points to the most abundant species, 9 points to the second most abundant species, etc., in pooled monthly data for each gear type. Scores for each species were then summed. Instead of using the absolute pooled numeric value as Sanders did, the relative abundance rank of each individual species as a percentage of the most abundant species was calculated.

The coordinates for each species collected were then determined and placed on a graph (Figure D1) where Sanders' Biological Index was used for the Y-axis and frequency of occurrence data were used for the X-axis. The graph was then divided into three sections by dashed lines.

The 20 and 40 percent values for both the X- and Y-axes were selected because they neatly separate the primary species clusters on the graph. The inner box encloses rare species, the middle enclosure represents common species, and the outer section depicts abundant species.

Results and Discussion

The relative dominance of species collected in Lake Conway is illustrated in Figure D1. Thirteen species had less than 20 percentiles for both abundance and frequency and were considered rare. Eight species were defined as common. The remaining seven species were ranked in at least 40 percentiles for either abundance or frequency.

In this figure, the species become more abundant vertically and more frequent horizontally. Accordingly, the dominant species (i.e., those that occur frequently and in large numbers) appear in the upper right portion of the graph. Similarly, species located near the lower left corner are uncommon in both abundance and frequency.

Recent documentation of biotic changes associated with environmental stresses has emphasized mathematic approaches. Such analyses reduce large sets of data to a common and manageable format. The graphical depiction of faunal dominance as described above or with applicable modifications can be a valuable tool in pollution and impact studies. Construction of the previously described and illustrated graphs for different localities or time periods would permit faunal comparisons to document changes in community structure through shifts in the relative position of species.

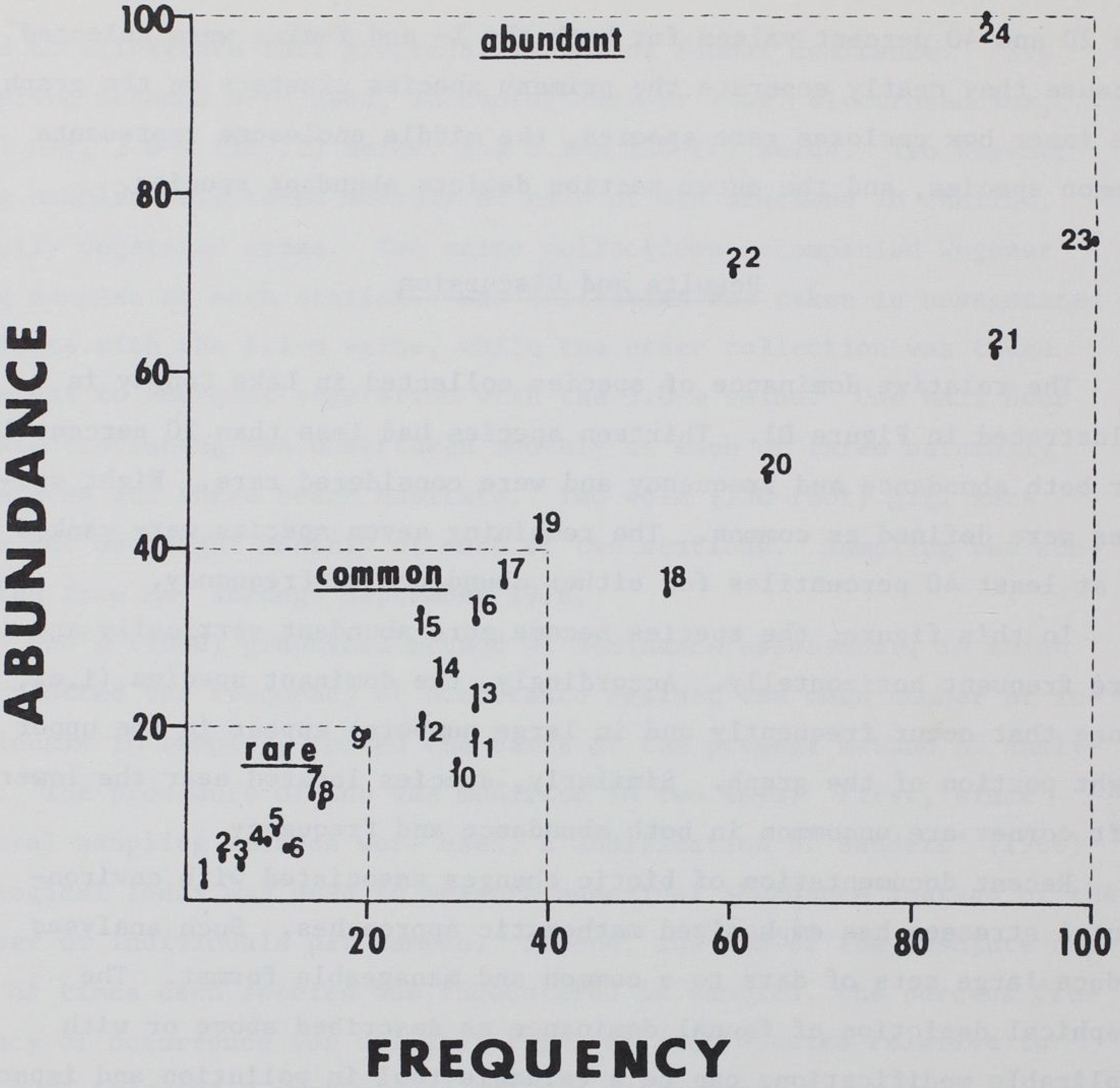

Figure D1. Graphic assessment of dominance of species collected in Lake Conway according to percent relative abundance (Sanders' Biological Index) and percent relative frequency. (1 = longnose gar, bowfin, white catfish, flagfish, and dollar sunfish; 2 = least killfish; 3 = yellow bullhead; 4 = spotted sunfish; 5 = lake chubsucker; 6 = brown bullhead; 7 = bluespotted sunfish; 8 = golden topminnow; 9 = warmouth; 10 = swamp darter; 11 = brook silverside; 12 = gizzard shad; 13 = threadfin shad; 14 = Florida gar; 15 = golden shiner; 16 = black crappie; 17 = chain pickerel; 18 = bluefin killifish; 19 = coastal shiner; 20 = mosquitofish; 21 = Seminole killifish; 22 = redear sunfish; 23 = largemouth bass; and 24 = bluegill.)

APPENDIX E: ECOLOGICAL LIFE HISTORY OF ESOX NIGER IN A CENTRAL FLORIDA LAKE*

Introduction

The chain pickerel, Esox niger LeSueur, the fourth largest of the five species of the holarctic, circumpolar fish family Esocidae, is generally distributed along the Atlantic seaboard of North America from Nova Scotia to central Florida, along the gulf coast westward to Texas, and north in the Mississippi Valley to Missouri. Esox niger has broad environmental tolerances, being found in almost any type of water within its range.

Overall E. niger is an important but controversial part of the North American freshwater fish fauna. Its potential as a sport fish and its role as a predator in the control of unwanted fishes have long been of interest. In the northern part of its range, it is often regarded as a destructive predator of young salmonids; however, in many southern states, the presence of this species is desirable in that overpopulated forage species may be cropped. Conversely, E. niger is a popular game fish in the North but is generally unaccepted by southern anglers.

As a result of the above factors, the literature available on E. niger is extensive and widespread; however, a large number of the available references are semipopular, superficial, and repetitive (Crossman and Lewis 1973). Very little is known about its ecological life history, especially in the South. As Lagler (1956) pointed out, knowledge of the life history of a species is essential to sound management of fish populations.

This paper presents life history information on Esox niger in Lake Conway, a central Florida lake located near Orlando. This study is a portion of a larger project, financed by the U. S. Army Engineer

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Waterways Experiment Station, concerned with an evaluation of the environmental effects associated with grass carp introduction.

Study Area

The study site is located on Lake Conway, Orange County, Florida. This area is in the Central Highlands physiographic unit (Cooke 1945). Average altitude of the area falls between 50 and 85 ft above mean sea level. The surface everywhere is blanketed with a layer of highly permeable marine sand and is usually separated from the porous limestone of the Florida aquifer by impervious sediments.

Orange County has a subtropical climate with only two pronounced seasons--winter and summer. The average annual rainfall is 51.4 in. (Lichtler et al. 1968). Summer thunderstorms account for most of the rainfall.

The Lake Conway chain is a complex of three small natural lakes, Gatlin, Conway, and Little Lake Conway, that totals 728 ha (1820 acres). This system is the uppermost segment of the Kissimmee River drainage, emptying via Little Mare Prairie and Boggy Creek to the lower lakes region. The shoreline has been noticeably altered by urbanization. Shoreline areas have a narrow fringe of emergent *Panicum*, *Typha*, or *Fuirena*. Dominant submergent vegetation includes *Vallisneria*, *Potamogeton*, *Nitella*, and *Hydrilla*. The substrate is primarily sand, except in areas of extremely thick vegetation where a thick layer of organic detritus has been deposited. The lake is mesotrophic. The bottom contours are rather steep in many areas as compared to the gradually sloping shorelines characteristic of other central Florida lakes.

Materials and Methods

Field sampling

Six sampling methods were used to determine the abundance of *E. niger* and to obtain specimens for analysis of food habits, fecundity, reproduction, condition factors, and length-weight relationships.

Three blocknet samples were taken in June and October 1976 and in May 1977. A sinking and floating gill net 124 m long was set overnight at each of four stations monthly. Six sampling stations were established for each remaining gear type and sampled monthly. Two Wegener ring samples were taken at each station in shallow, heavily vegetated habitats. Two seine collections accompanied Wegener rings at each station. One collection was taken in unvegetated habitats with a 6.1-m (20-ft) seine, while the other collection was taken adjacent to emergent vegetation with a 3.0-m (10-ft) seine. One half hour of nocturnal electrofishing was undertaken monthly at each of three naturally vegetated and three beach areas.

All E. niger taken were enumerated, measured to the nearest millimeter, and weighed to the nearest 0.1 g.

Species associations

The affinity between pairs of species was measured according to an index of species association C utilizing presense-absence data for all collections (see Appendix B): $C = 2aJ/b\ (a + b)$, where J equals the number of joint occurrences and a and b are the number of times species a and b are encountered, respectively. The value of this index ranges from 0 to 1.0, with 1.0 indicating complete association in all samples and 0 reflecting a negative distribution.

Species groups were determined after indices of affinity had been calculated between all species pairs. An index of 0.15 was chosen as the minimum value for two species to be considered associated. Formation of species assemblages from species showing affinity was based on the following criteria: 1) every species within a group had to show affinity with all members of the group, thus ensuring that every taxon in a group frequently occurred with every other member; 2) the largest possible groups had to be formed in sequence; and 3) species of the first assemblage were excluded in the determination of the second group, with species of each succeeding group likewise excluded from further grouping. This process was repeated until all possible groups had been identified.

Dominance ranking

Appendix D illustrates graphically the dominance of Lake Conway fishes based on the modification of Ono's (1960) method. Ono plotted frequency of occurrence data against the mean number of organisms per sample in his study. For Lake Conway, Guillory (see Appendix D) determined the relative percent of species rather than the absolute number of times each species was found in samples. Secondly, Sanders' (1960) Biological Index was utilized to measure numerical abundance instead of the mean number of organisms per sample. This index measures the frequency of appearance of a given taxon as 1 of the 10 most abundant species in samples. As used by Guillory, the index value was obtained by assigning 10 points to the most abundant species, 9 points to the second most abundant species, etc., in pooled monthly data for each gear type. Scores for each species were then summed. Instead of using the absolute numeric value as Sanders had, Guillory calculated the relative percentage of each individual index value with reference to the most absolute species. Consequently, the relative numerical abundance of each species as shown by all gear types was described.

The coordinates for each species collected were then determined and placed on a graph where Sanders' Biological Index was used for the Y-axis and frequency of occurrence data were used for the X-axis. The graph was then divided into three sections by dashed lines at the 20 and 40 percent values of each axis. The inner box enclosed rarely encountered species, the middle enclosure represented common species, and the outer section depicted abundant species.

Condition factors

Condition factors, a measure of the robustness of an individual, were calculated according to the formula presented by Lagler (1956): $K_{TL} = (W/L^3) \times 10^5$, where W is the weight in grams and L is the total length in millimeters. The mean and standard deviation were determined for 25-mm size groups and for bimonthly periods for both sexes combined. Means were also determined separately for males and females.

Length-weight relationships

The length-weight relationship of fishes may be expressed by the formula $W = aL^n$ (Ricker 1958). Since this relationship is seldom linear (Carlander 1969), the above expression is transformed to $\log W = \log a + b \log L$. The mathematical relationship between the total length and weight was calculated by substituting the general formula for linear regression ($Y = a + bx$) for the above formula and deriving the regression line by the method of least squares (Tesch 1968). The regression coefficient, or slope, is b , while $\log a$ is the intercept of the line with the Y-axis. Quarterly length-weight regressions were calculated separately for each sex and for both sexes combined.

After the linear regression line was determined, the degree of association, or correlation coefficient, was calculated according to Weber (1973). A perfect correlation (all points falling on a straight line with a nonzero slope) is indicated by a correlation coefficient of -1 or +1. A positive value implies a direct relationship between two variables; conversely, a negative value implies an inverse relationship. A value of zero results when there is no relationship.

Reproduction

Individual fish dissected for stomach analysis were identified to sex and reproductive status. Stages of gonad maturation were made according to Nikolsky (1963): I--immature; II--resting; III--mature; IV--gravid; and V--spent. The percentage of each stage was determined monthly for age Group I and above.

Ovaries were removed from 33 gravid females for analysis of fecundity. Ovaries were preserved in Gilson's fluid, containing the following ingredients in the indicated proportion (Simpson 1951): 100 ml 60 percent alcohol; 880 ml water; 15 ml 80 percent nitric acid; 18 ml glacial acetic acid; and 20 g mercuric acid. This mixture not only hardens the eggs but also helps to liberate them and break down the ovarian tissue.

Ova counts were made by subsampling gravimetrically; i.e., a known weight of eggs was counted with total fecundity estimated by proportion. Ovarian contents included three classes of eggs, but only the mature ova were enumerated. Fecundity was plotted against total length; this was transformed to a straight line by logarithmic transformation, the regression line derived, and the correlation coefficient calculated.

Five mature eggs were measured from each ovary to describe ova diameter. The regression equation and statistical correlation were then determined between egg size and both fecundity and total length.

Population structure and growth

Aging of fish in central Florida is not generally thought to be accurate. Therefore, length frequency histograms were used to obtain a picture of the overall population structure. Theoretically, if the entire population is sampled, there will be clumping of fishes of successive ages about successive lengths, making possible a separation of age groups.

An attempt was made to derive an estimate of growth of Age 0 and Age I *E. niger*. Samples were obtained at progressive intervals to obtain mean total length at various ages.

Food habits

A total of 521 fish were retained for analysis of food habits. Each fish was dissected and stomach contents immediately identified, enumerated, and, where possible, weighed to the nearest 0.1 g. To characterize quantitative and qualitative aspects of feeding, frequency of occurrence, number of specimens, and weight of each food item were determined with respect to fish size and season.

Fishes have a scale of preference for prey organisms in their environment. Some are consumed in large numbers, while others are consumed only moderately. A quantitative electivity index E to evaluate such preferences was proposed by Ivlev (1961): $E = (s - b)/(s + b)$, where s is the percentage composition by number of an organism as a food item and b is the percentage composition of the same organism in the environment. Electivity indices were calculated separately for *E. niger* 100 to 200 mm in length and greater than 200 mm in length. The abundance of fish was derived from blocknet samples.

Possible values of this index range from -1 to +1, with the former value indicating complete selection against an item and the latter indicating exclusive selection of a food item. A value of zero is expected for a food item when no selective processes are operative.

The following regressions and correlations were noted in regard to food habits: the percentage of empty stomachs to size; the percentage of empty stomachs to water temperature; and the size of prey (weight) versus length of E. niger.

Sport fishery

Sport fishing for E. niger was measured by a stratified random roving creel survey utilizing nonuniform probability sampling as generally described by Pfeiffer (1967) and more specifically for Florida by Ware et al. (1972). Stratification of this survey involves random selection with nonuniform probabilities of time and days (weekdays and weekend days). Five days, including at least 1 weekend day, were selected for creel surveys in each 2-week period. Each day was divided into four periods (0700-1000, 1000-1300, 1300-1600, 1600-1900) with probabilities assigned in proportion to daily variations in fishing pressure.

As employed in Lake Conway, interviewed anglers were requested to provide the time spent fishing (effort), the number and kind of fish caught (yield), and the species sought. During each creel period, a count was made of the number of anglers present at a given time. This count is termed an "instantaneous count" and was used in conjunction with other interview data to derive expanded (total) estimates of yield, effort, and catch per unit effort.

Creel census data were coded and submitted to the Southeastern Cooperative Fish and Game Statistics Project at North Carolina State University for computer derived estimates of total and species-directed catch rates, effort, and harvest.

Results and Discussion

Florida synonymy

This following synonymy includes all published literature records of E. niger in Florida. This list will thereby serve as a reference for Esox distributional and/or natural history data within Florida.

Esox niger--Ager 1971; Bailey et al. 1954; Bangham 1940; Buntz 1966; Buress and Bass 1974; Carr 1936; Carr and Goin 1955; Crittenden 1958; Dequine 1948; Dickinson 1949; Dineen 1974; Fowler 1945; Goin 1943; Hellier 1967; Herke 1959; Hubbs and Allen 1944; Kushlan and Lodge 1974; Moody 1954; Moody 1957; Odum 1957; Patrick 1961; Reid 1950a and b; Seehorn 1975; Swift and Yerger 1975; Tagatz 1968; Thomerson 1966; Venard and Bangham 1941; Weed 1925a and b; Wegener and Williams 1974; Wilbur 1969.

Esox phaleratus--Goode 1869; LeSueur 1818.

Esox reticulatus--Bollman 1886; Jordan and Evermann 1905; Lonnberg 1894.

Lucius reticulatus--Evermann and Kendall 1899.

Chain pickerel--Copeland and Huish 1962; Wegener and Clugston 1964; Wegener and Holcomb 1972.

Abundance and habitat

As a piscivorous carnivore, it may be expected that *E. niger* would form only a small percentage of the total fish population. This, however, is not the case in Lake Conway, where this species is quite abundant. According to standing crop estimates by spring blocknet-rotenone samples, an average of 130 fish weighing 19.89 kg were found per hectare. Only *Lepomis microlophus*, *Lepomis macrochirus*, and *Micropterus salmoides* contributed more biomass per hectare than *E. niger*. Numerically, *E. niger* ranked tenth in abundance behind *Ennecanthus gloriosus*, *Lucania goodei*, *Micropterus salmoides*, *Lepomis gulosus*, *Lepomis microlophus*, *Lepomis macrochirus*, *Ictalurus nebulosus*, *Notropis petersoni*, and *Pomoxis nigromaculatus*.

The dominance rank, according to the percent relative abundance and frequency of *E. niger* in reference to other species collected on Lake Conway, is illustrated in Figure E1. *E. niger* ranked sixth in abundance as measured by Sanders' Biological Index and seventh in frequency of occurrence. The species was situated in that area of the graph representing "common" species.

Guillory (see Appendix B) mathematically analyzed the species assemblages found in Lake Conway. *E. niger* was placed in the *platyrhinchus-nigromaculatus* species complex, where species showing affinity were grouped together and the two species with the highest index of affinity were used as the complex name. Other species included in this group were Lepisosteus platyrhinchus, Dorosoma cepedianum, Notemigonus crysoleucas, and Pomoxis nigromaculatus. These species were inhabitants of both pelagic waters and deeper littoral habitats, although E. niger was collected more frequently in the latter adjacent to vegetation. Also indicative of the latter habitat were Amia calva, Erimyzon sucetta, Lepomis gulosus, Lepomis marginatus, and Lepomis punctatus. In littoral habitats devoid of vegetation (where E. niger was less frequently encountered), Dorosoma petenense, Fundulus seminolis, Labidesthes sicculus, and Notropis petersoni were collected together with E. niger. Lepomis macrochirus, Lepomis microlophus, and Micropterus salmoides were associated with E. niger in a variety of habitats.

E. niger had an index of affinity of greater than 0.10 with 12 species. These were as follows (species affinity index in parenthesis): Dorosoma petenense (0.50); Labidesthes sicculus (0.42); Notemigonus crysoleucas (0.41); Notropis petersoni (0.38); Pomoxis nigromaculatus (0.34); Lepisosteus platyrhinchus (0.33); Lepomis microlophus (0.30); Lepomis macrochirus (0.23); Dorosoma cepedianum (0.15); Ennecanthus gloriosus (0.14); and Micropterus salmoides (0.12); and Fundulus seminolis (0.10).

Based on their association with a large number of species showing a wide variety of ecological habits, Lake Conway E. niger appear to have broad environmental tolerances and are found in almost every habitat type in the lake at one time or another. Physical and chemical factors do not seem to be as important in limiting the local distribution of larger E. niger. However, ideal habitat for this species is soft-bottomed, heavily vegetated littoral zones (especially canals connected to the main lake) harboring an abundance of forage fish. In general, E. niger seem to prefer submergent plants with a dense growth, primarily Vallisneria and Potamogeton extending from the bottom to or near the surface, as opposed to emergents or rooted floating plants which cover the surface or extend above it (Panicum spp., Typha, Sagittaria, Scirpus, and Nymphaeaceae). Juvenile E. niger less than

100 mm long were found almost exclusively in shallow *Vallisneria* beds.

The close association of *E. niger* with vegetation is illustrated by the comparison of populations in naturally vegetated and sandy bottom habitats (see Appendix A). This species was found to be statistically more abundant ($p = <0.05$) in vegetative habitats. In electrofishing samples, a total of 13.1 fish per hour weighing a total of 3.07 kg were collected as compared to 4.0 fish weighing 1.49 kg in sandy bottom habitats.

McLane (1955) noted that in the St. Johns River system of Florida, *E. niger* were found only where there was an abundance of submergent vegetation or obstructions of fallen logs along the quieter protected margins of rivers and in coves and bays of lakes. This species was rarely taken in smaller streams, but occurred where they emptied into a larger body of water when the mouth was heavily vegetated. *E. niger* may also exhibit an age-dependent depth distribution (Raney 1942). Young were commonly found along the shallow edges of ponds, seldom being in water more than 2 ft deep, whereas adults and subadults were more widely distributed.

Monthly variations in electrofishing catch per unit effort on Lake Conway were perhaps indicative of seasonal movements. Catches of *E. niger* on shorelines were lowest from November through February. This may have reflected migration from shoreline areas to offshore beds of *Vallisneria*, where the species was concentrated during that time. The latter movement was undoubtedly related to spawning activities as fish collected at that time in *Vallisneria* beds were in gravid condition and young-of-the-year pickerel were first collected there.

Sex ratios

The sex ratio of a sample of 288 individuals was 151 females and 137 males (1.1:1.0). This ratio was not significantly different from a 1.0:1.0 ratio. As shown in Figure E2, males were encountered in slightly greater numbers below 450 mm, whereas above 450 mm females dominated.

The larger number of males in the intermediate size groups and females in the larger size groups is apparently due to the greater growth differential of females over males with increasing age and the greater longevity of females (Crossman 1962). This results in a "piling up" of successive year classes of males at the intermediate sizes as succeeding age groups of males achieve the size of older, slower growing male year classes. The greater life span and continual rapid growth of females results in a dominance of females at the larger sizes as the growth of males slows down and mortality increases.

There was a sex ratio of 1.3 females to 1.0 male of E. niger collected during various Massachusetts surveys (Wich and Mullan 1958). Armbuster (1961) found a sex ratio of 1:1 for Long Lake, New York, but cautioned that it may not have been typical because of the small sample size.

Sex ratios of E. niger in Lake Conway showed a seasonal trend. Females became dominant during the fall and early winter months and declined in the spring and summer (Figure E3). This period of dominance by females roughly corresponded to the time of gonad maturation and spawning. Casselman (1975), who found increased dominance by female Esox lucius during the later winter months, concluded that females require more food than males when they are accumulating reproductive products. The more intensive foraging activity of females at this time makes them more susceptible to capture. Seasonal spawning movements by females into shallower habitats may also play a role in the increased number of females observed during and prior to spawning.

Reproduction

Monthly variation in ovary development is illustrated in Figure E4. A sharply defined winter spawning period is evident. There was a tendency for the dominant (in terms of percent occurrence) ovary stage to progress from undeveloped to mature to gravid to spent. Developed ova were found from September through February. The percentage of mature gonads increased through October but declined to 6 percent in January and 17 percent in February. Gravid gonads were taken from November through February, with this stage dominating from November through February. Spent gonads were detected from December through March only. Adults exhibiting no evidence of reproductive activity were taken from

June through August 1976 and in April and May 1977.

Based on the above data, spawning apparently occurred from November through February. At the time of first spawning, water temperature was approximately 22°C, later dropping to 15°C during January and February when spawning peaked.

Actual time and duration of spawning varies with latitude and with the character of the spring season. In the North, *E. niger* spawn in the spring very shortly after the ice melts, anywhere from March through May with water temperature ranging from 8.3° to 11.1°C (Scott and Crossman 1973). In Alabama, they are reported to spawn at 16°C (DeJean 1951). Embody (1918) reported spawning at temperatures approaching 8.3°C in New York. Armbuster (1961) observed fish spawning in an Ohio fish farm from April 10 to April 25, with water temperatures ranging from 2.2° to 22.2°C. Leach (1927) reported that *E. niger* spawning was of long duration and that the youngest fish spawn first. In one instance, ripe *E. niger* have been observed in the fall (Miller 1962).

E. niger apparently spawned in Lake Conway in *Vallisneria* beds from 2 to 5 ft deep, as gravid females and post-larval fish were concentrated there during spawning season. Electrofishing samples taken in shallow shoreline areas adjacent to emergent vegetation such as *Typha*, *Panicum*, and *Scirpus* showed a reduction in *E. niger* numbers during the spawning season.

Literature on the spawning act and early life history of *E. niger* has been summarized by Scott and Crossman (1973) and Mansuetti and Hardy (1967). Spawning occurs at depths from a few inches to 10 ft in coves, mouths of inlets, swampy streams, and flooded lowlands among submergent vegetation or cattail marshes. Periodically during the daytime a female and a male roll inward slightly in a sharp body flexure so that the vents approximate. The eggs and milt are then shed simultaneously. This is repeated at various intervals for 1 or 2 days. There is an erroneous record, often repeated in the literature, that the eggs are emitted in a long gelatinous string. Fertilized eggs are distributed over a comparatively large area by vigorous spawning activity (no nest is built). Eggs are about 12 mm in diameter, light yellow in color, and demersal, but later become slightly adhesive and stick to vegetation. No care is given to the eggs which hatch in 6 to 12 days. The newly hatched young, 2.2 to 7.0 mm in length, attach to vegetation with an adhesive gland and subsist on yolk for about a week until they are about 10 mm in length. They then begin active feeding.

As is characteristic of the smaller esocids (Crossman 1962), E. niger ovaries contain eggs in three developmental stages, in contrast to the more usual two in E. lucius and E. masquinongy. Primary eggs (those most mature) are large, transparent, and amber yellow in color, while secondary and tertiary eggs are successively smaller in size, pale yellow-white, and opaque. It is difficult to distinguish between eggs in the three stages, thereby making accurate counts difficult. Consequently, little is known about the fecundity of E. niger. Conflicting reports are given in the literature.

Fecundity estimates were made of 33 gravid females from Lake Conway. Ova counts ranged from 342 (397 mm total length TL) to 2604 (509 mm TL) ova per individual, with a mean of 1232. The calculated regression equation between fecundity and length was $\log F = 1.000 + 0.7720 \log TL$ (Figure E5), where F equals the number of ova and TL equals the total length of the fish in millimeters. The correlation coefficient r determined for these data had a value of +0.23.

The low correlation coefficient indicated that there was only a weak relationship between fecundity and total length. This low correlation may be attributed to the wide variation in number of eggs in medium size (less than 500-mm-long) E. niger. However, all six E. niger over 500 mm long that were examined contained more than 1500 eggs. Thus, while only a weak relationship exists between total length and fecundity when considering all size groups, E. niger over 500 mm had increased egg production compared to smaller fish.

Hubbs et al. (1968) reviewed a number of papers showing that fecundity increases geometrically with length. Papers not reviewed by them, however, have indicated that females of equal length produce differing numbers of eggs, depending upon age and growth rate. Krivobok (1961) stated that fecundity of Baltic herring, Clupea harengus membras, of uniform length increased with age. Spanovskaya et al. (1963) considered the differences of fecundity among uniform size roach, Rutilus rutilus, to be inversely proportional to the rate of growth preceding egg development. Potapona et al. (1948) found that in the female stickle-back the quantity of eggs produced was directly related to growth and fat storage in the fish.

In the literature, the number of ripe eggs in E. niger varies from 6,102 to 8,410 for Rhode Island females 305 to 356 mm in length (Saila and Horton 1957) to 30,000 for a 4.4-kg female (Needham 1920). Since eggs of three sizes are present in the ovary at the same time, the latter estimate may have been an estimate of all eggs. Moreover, as fecundity is related to variables other than length, such as population size, growth, diet, and other environmental conditions, comparisons of fecundity between Lake Conway E. niger and those from other areas may not be valid.

It is widely believed that within a species large fish lay larger eggs than do small fish. But, while this general impression is reported in many papers, reliable measurements are scarce (Bagenal 1966). Ova diameters for Lake Conway E. niger ranged from 1.5 to 2.5 mm with a mean of 2.0 mm. The regression equation of egg diameter versus total length is $\log Y = 0.3680 + 0.0252 \log X$, where Y equals the former and X the latter. A very low negative correlation ($r = -0.30$) exists between egg size and total length.

The relationship between egg size and fecundity was also examined. The regression equation between these two variables is as follows: $\log Y = 0.1731 + 0.0432 \log X$, where Y equals egg size in millimeters and X equals fecundity. A very weak positive correlation ($r = +0.18$) was found between fecundity and egg size.

The smallest individual to achieve sexual maturity was a 252-mm male. The smallest mature female was 271 mm in length. A 310-mm female was the smallest individual with gravid ovaries, whereas the smallest ripe male was 345 mm in length. An analysis of length-frequency distributions of E. niger in Lake Conway showed that during the time of spawning Age 0 fish were less than 300 mm in length. Based on this, some Age 0 fish may become sexually mature by the end of their first year but probably do not spawn until Age I, or the end of their second year.

Size at maturity varies considerably and is probably due to differences in growth rates (Wich and Mullan 1958), with slow-growing populations maturing at a smaller size than faster-growing fish. Age of sexual maturity is also related to growth rate and varies at different latitudes as well as at the same locality. In the North, gonads may mature at Age I, but spawning does not occur before Age II (Wich and Mullan 1958) and may not occur until Age III or IV (Underhill 1949). In Alabama, E. niger may spawn when 1 year of age (DeJean 1951). In a study of E. niger in a stream, lake, and pond in New York, Underhill (1949) reported the following observations: in the stream a few 1-year-old females, about half the 1-year-old males, and practically all 2-year-old fish were mature; in the pond most 3-year-old males and a few 3-year-old females spawned; in the lake most 2-year-old fish were mature.

Population structure and growth

It is not possible to determine the age of E. niger from scale readings in central Florida as growth occurs year round, thereby preventing annuli formation. Even in other areas where seasonal variations in growth are more pronounced, the aging of E. niger is difficult, especially for older fish (Wich and Mullan 1958). An attempt will thus be made to illustrate the growth of Age 0 and Age I fish by presenting mean lengths at various sampling dates, to delineate population structure by length-frequency analysis, and to include age and growth data from the literature.

The newly hatched yolk-sac larvae are 5.0 to 7.9 mm TL (mean 7.2 mm). This stage is approximately 6 to 8 days in duration, with the mean size at the end of the stage being 10.1 mm (Underhill 1948). The larval stage ranges in size from 9.8 to 14.0 mm TL. The prejuvenile and juvenile stage follows the larval stage (Mansuetti and Hardy 1967).

The mean length of 1967 year class E. niger at various times is presented in Figure E6. Growth was quite rapid the first year, with the 1976 year class achieving a mean total length of 300 mm by December and 330 mm by May, and the 1977 year class reaching a mean total length of 185 mm by August. According to length-frequency distributions from May to July 1977, the modal lengths for age groups 0, I, and II were 90, 330, and 450 mm, respectively.

After comparing data compiled by Carlander (1969), it appears that Lake Conway *E. niger* grow faster than other populations. Underhill (1949), however, reported that *E. niger* growth varies so much from season to season and within bodies of water that comparisons of growth rates between different bodies of water are difficult.

An analysis of length-frequency distributions of *E. niger* in Lake Conway revealed the presence of at least three age groups (Table E1). Additional age groups are probable but are not discernible in these data. As Rounsefell and Everhart (1953) pointed out, the length-frequency method is adequate only for the first 2 to 4 years because of the increasing overlap in length distributions. This overlap is due to the increased dispersion and to the lessened distances between modes.

The average life span of *E. niger* is 3 or 4 years (Wich and Mullan 1958), although 8 or 9 years may be reached, depending on condition and growth rate. Stroud (1955) cited two males and one female *E. niger* from Massachusetts that were 9 years of age. Chaplin (1954) also documented the occurrence of a 9-year-old *E. niger* in Massachusetts.

An outstanding feature of *E. niger* growth is its variability. Growth in streams, unbalanced ponds, or in strongly acid or infertile waters is less than in ponds that are considered balanced or where acidity, fertility, and other factors are more nearly optimum (Wich and Mullan 1958). Underhill (1948) found significant differences in growth between individuals of the same age and sex in the same pond. Because of these inherent variables, Carlander (1969) could find no regional trend in growth in his tabulated data.

Female *E. niger* exhibit a greater growth differential over males with increasing age. This may be first evident at Age I (Sanderson 1950) or not until Age II or III (Smith and Gross 1955; Stroud 1955).

Length-weight relationships

Quarterly length-weight regressions were determined for *E. niger* in Lake Conway (Table E2). As pointed out by Tesch (1968), the slope, or coefficient b , will often be nearly constant throughout the year for the same developmental stage isometrically or allometrically, with a value of 3.0 indicating the former and values of other than 3.0 reflecting the latter. A value of greater than 3.0 implies that the fish becomes "heavier for its length" as it grows larger. The Y-intercept value a will often vary seasonally; thus, this is of importance in delineating seasonal population changes in condition. A length-weight regression with a smaller absolute Y-intercept value implies that the fish are in better condition than in populations with a larger Y-intercept value. Based on the above, fish taken during the fall and winter are in better condition than those taken during the summer and spring.

A slope of 3.0 or greater in a length-weight regression indicates that the weight increases as a cube function of the length (Carlander 1969). This indicates that fish in a population having a slope of 3.0 become plumper as they grow larger. *Esox* populations usually have slopes of greater than 3.0. Length-weight regressions found by other investigators include the following:

$\log W = -5.510 + 3.130 \log TL$ (Saila 1956)

$\log W = -5.491 + 3.098 \log TL$ (Herke 1959)

$\log W = -7.0805 + 1.3937 \log TL$ (McIlwain 1970)

When separate length-weight regressions were calculated for males and females, the females were found to be slightly heavier at comparable lengths (Figure E7). The formula for males was $\log W = -5.1099 + 2.9300 \log L$, whereas females yielded $\log W = -5.1862 + 2.9638 \log L$. Thus, females are heavier than males of the same length and, according to sex ratio data, also attain greater lengths.

Length-weight data were combined in 25-mm size groups to illustrate the approximate weight at various sizes (Figure E8). The nonlinear relationship between length and weight is evident.

Condition factors were calculated separately for male and female

E. niger; both had a mean value of 0.52 with a standard deviation of 0.07. Because condition factors may vary with size in some species, the relationship between body length and condition factors was examined (Figure E9). Mean condition indices increased steadily with length until a peak of 0.54 was reached in the 301- to 325-mm size class. Condition factors generally decreased with length thereafter. Thus, relative plumpness of E. niger in Lake Conway increased until a length of approximately 325 mm was reached but decreased thereafter.

Seasonal variation of condition factors was also determined to discern changes in body condition due to changing feeding regimes and spawning (Figure E10). Monthly means generally increased throughout the summer to a peak in November, declined to the lowest values in December, January, and February, and then increased in the spring and early summer months. The period of lower values corresponded to the period of spawning; apparently the expenditure of energy involved in the building of gonadal products and subsequent spawning activities resulted in a loss of somatic tissue with a subsequent reduction in condition factors. Changes in feeding habits are probably not related to the seasonal fluctuations in condition factors as E. niger feed more intensively during the winter months.

The largest E. niger collected in Lake Conway was a 625-mm female weighing 1180 g. The largest male was a 545-mm specimen weighing 781 g. As previously discussed under sex ratios, there is a tendency for the percentage of females to increase with length; 64 and 84 percent of all individuals in the 450- to 550-mm and 500- to 550-mm size groups were females. The predominance of females in the larger size groups is due to the greater growth and longevity of female E. niger (Crossman 1962). The largest authenticated E. niger on record is a 9 lb 5 oz, 29.5 in. fish taken by a sport fisherman in Massachusetts in 1954 (Wich and Mullan 1958). The angler record, as recorded by Field and Stream, is an individual 31 in. (787 mm) long which weighed 9 lb 6 oz, caught at Homerville, Georgia, on February 17, 1961 (Crossman and Lewis 1973). Crossman and Lewis also cited an unverified record of an E. niger weighing 19 lb, taken at le Club de Perche in Quebec.

Food habits

E. niger 50 mm and smaller fed predominantly on Cladocera and to a lesser extent on *Hyalella* and unidentified postlarval fish (Table E3). Other food items included Ostracoda, *Palaemonetes*, Chironomidae, Culicidae, Trichoptera, Gomphidae, Copepoda, *Argulus*, and fish remains.

In the next size range (51 to 100 mm), Cladocera and aquatic insects declined in importance (Table E3). Food organisms showing increased dominance included *Hyalella*, *Palaemonetes*, and postlarval fish. Other fish, primarily smaller species such as *Lucania goodei* and *Gambusia affinis*, also began to appear in stomachs. Other species of fish included *Notemigonus crysoleucas*, *Lepomis macrochirus*, *Micropterus salmoides*, and *Etheostoma fusiforme*.

Palaemonetes was the major single food item found in 101- to 200-mm *E. niger* although as a group fish comprised the largest percentage in numbers and biomass (Table E3). Also evident was the increased diversity of fishes found in the stomachs of this group of larger *E. niger*. The most abundant fish were *Lucania goodei*, *Gambusia affinis*, and *Labidesthes sicculus*.

Fish over 200 mm ate primarily fish, which comprised 92.8 percent by number and 96.5 percent by weight of all food items (Table E3). *Procambarus* first appeared in the stomachs of this group and made up 4.7 percent by number and 1.9 percent by weight of the contents. Common fishes included *Fundulus seminolis*, *Lepomis gulosus*, *Lepomis macrochirus*, *Micropterus salmoides*, *Dorosoma petenense*, and *Labidesthes sicculus*.

One *E. niger* over 200 mm contained three gastropods (*Goniobasis*) and unidentified vegetative matter, and another had a leaf in its stomach. Their presence suggests that the items were incidentally taken in the course of pursuing prey rather than in intentional feeding. Another *Esox* had a *Sternothaerus odoratus* in its stomach.

As identified above, the food of *E. niger* is decidedly different during its various life history stages. The change in feeding habits from zooplankton to macroinvertebrates to fish is depicted in Figure E11. Zooplankton dominated in 25- to 50-mm fish but declined thereafter and was absent in fish larger than 75 mm. Macroinvertebrates closely followed zooplankton in 25- to 50-mm fish, dominated in 50- to 125-mm fish, declined and disappeared in the 175- to 200-mm size group, and reappeared again in small numbers in E. niger larger than 300 mm. The sequence of dominant macroinvertebrates is as follows: aquatic insects, 25 to 50 mm; Hyalella, 50 to 75 mm; Palaemonetes, 75 to 175 mm; and Procambarus, 300 mm and up. As Esox niger increased in size, fish were encountered more frequently until they became dominant in 125- to 150-mm E. niger. Mature fish were almost exclusively piscivorous.

An index of selection, termed "electivity" by Ivlev (1961), was employed to determine if E. niger were selective in their feeding with respect to fish. If food items are represented by different ratios in the environment, it is likely that selective processes are operating. Selectivity is defined as the extent to which a predator eats one species of food item rather than another. It depends upon preference of the predator and abundance and accessibility of the prey. Preference is the inherited, instinctive desire to consume one species of food item rather than others. Abundance refers to the number of food items available to the predator, and accessibility is a measure of the degree of difficulty encountered by the predator in locating a particular food item.

Table E4 lists electivity indices for two size groups of E. niger. Seven species (Notropis petersoni, Fundulus chrysotus, Lucania goodei, Gambusia affinis, Labidesthes sicculus, Ennecanthus gloriosus, and Micropterus salmoides) were selected by 100- to 200-mm E. niger and eight species (Dorosoma petenense, Notemigonus crysoleucas, Erimyzon sucetta, Ictalurus nebulosus, Labidesthes sicculus, Lepomis gulosus, Micropterus salmoides, and Etheostoma fusiforme) by larger fish.

Differential selectivity of E. niger for various species of fish was also shown by an analysis of the fish species composition in different sized E. niger. Notropis petersoni, Fundulus chrysotus, Gambusia affinis, and Etheostoma fusiforme were taken only in E. niger smaller than 300 mm. Three other taxa (Lucania goodei, Ennecanthus gloriosus, and Lepomis gulosus) were found primarily in fish less than 300 mm.

Dorosoma petenense, Erimyzon sucetta, and Ictalurus nebulosus were found only in E. niger larger than 300 mm. Other food items, including Fundulus seminolis, Lepomis macrochirus, L. microlophus, Micropterus salmoides, and Lepomis spp., were found in larger proportions in the latter size range.

These data point out the prey selectivity of E. niger but not necessarily preference, because preference could not be separated from differential accessibility. Beyerle and Williams (1968) concluded that in natural environments it is essentially impossible to determine the extent to which each of the above factors is involved in any particular manifestation of selectivity by a predator fish.

Most species of fish present in E. niger habitats are taken as food (Wich and Mullan 1958), but evidence from at least one study seems to indicate that large E. niger are lazy feeders and prefer the slower moving prey species. In this study (Raney 1942), brown bullheads, the least abundant prey species, were eaten in about the same numbers as were golden shiners. It was also found that the majority of the young Esox tended to feed on one kind of organism and variations between individuals were due to feeding habits. Raney (1942) further concluded that food selectivity by E. niger seemed to be based more on relative abundance and/or ease of capture of prey species, rather than preference for one food over another. Lewis (1971) stated that abundance of a species seemed to be the main factor in determining what was eaten by E. niger.

Typical reports on E. niger food habits in the literature are as follows. Flemer (1959) found that Virginia E. niger less than 74 mm fed on aquatic insects 48 percent of the time and fishes 30 percent of the time; larger fish ate primarily fish (63 percent) and, to a lesser degree, insects (16 percent). In West Virginia, E. niger less than 140 mm fed primarily on insects, while larger fish fed primarily on fish (Lewis 1971). Raney (1942) found 47 percent fish, 42 percent crayfish, and 9 percent insects (mostly large dragonfly nymphs) in a New York pond. In Connecticut (Hunter and Rankin 1939), E. niger comprised 73 percent of the diet, with insects, annelids, crustaceans, and amphibians being less important. Dominant food items in south Mississippi waters included Micropterus salmoides, Mugil cephalus and Lepomis macrochirus (McIlwain 1970). Foote and Blake (1945) and Underhill (1948) found a high incidence of crustaceans and amphibians in the diet of New York and Connecticut Esox niger.

A rapid digestive rate in E. niger is indicated by the high percentage of stomachs containing fish remains and by the overall predominance of empty stomachs (57 percent). Many fish were found in which the head and complete outer scale covering were digested away, leaving only the flesh, skeletal system, and the fin rays and/or spines.

Figure E12 illustrates the relationship between percent empty stomachs and size. The first four 25-mm size groups had no instances of empty stomachs. Thereafter, the percentage of empty stomachs steadily increased until percentages of over 75 percent were reached for the larger E. niger. There was a positive correlation (r = +0.92) between size of fish and percent empty stomachs.

Lake Conway data on seasonal variations in empty stomachs collaborate findings of other investigations which showed a higher percentage of stomachs containing food during the winter (Buntz 1966; McIlwain 1970). The higher percentages of empty stomachs in Lake Conway occurred during the summer months of June, July, and August followed by a progressive decline from September through February as the water became cooler and an increase from March through May as the water warmed (Figure E13). There was a positive correlation (r = +0.68) between the percentage of empty stomachs and the mean monthly water temperature.

McIlwain (1970) suggested that the lower percentage of food items found in the summer months might be due to increased digestive rates during warm water. While this may be correct, I support Buntz's (1966) contention that E. niger in central Florida feed more actively in cooler weather. In the Severn River in Maryland, Sanderson (1950) found that the most active feeding occurred between 7° and $15^{\circ}C$, with no active feeding observed at water temperatures above $20^{\circ}C$.

Table E5 presents seasonal variations in food habits of E. niger in Lake Conway. Food habits did not vary qualitatively to a large extent from season to season.

In general, larger E. niger (over 100 mm TL) with food usually contained only one food item. Of the total number of fish containing food, 92.6 percent had eaten only one item, 5.4 percent had eaten two, 1.4 percent three, and 0.5 percent four. The mean number of organisms in stomachs containing food items was 1.09. Smaller fish (less than 100 mm TL), however, tended to have more food items than larger specimens. Of the total number of fish with full stomachs, 37.8 percent contained one item, 17.6 percent two items, 10.6 percent three, 8.7 percent four, 18.4 percent had eaten between 5 and 20 items, and 12.6 percent contained more than 20 food items. An average of 9.94 food items per stomach was found.

There were no cases of natural gorging of fish as reported for Esox americanus by Crossman (1962). However, a small number of specimens procured from blocknet samples were incidentally analyzed, and it was found that these fish had a higher percentage of stomachs containing food (82 compared to 43 percent) and a higher average number of food items per stomach (1.88 compared to 1.09) than in fish used for regular food habit studies. Several specimens had prey stuffed into their mouth and pharyngeal cavity. Obviously, the large numbers of forage fish swimming in distress within the blocknets initiated feeding frenzy by E. niger prior to their demise by rotenone.

The relationship between size of fish and prey weight is shown in Figure E14. As pickerel increased in size they ate correspondingly larger prey. The correlation between pickerel size and prey weight was $r = +0.89$.

Although E. niger are capable of ingesting fish whose body depth is equal to, or less than, their own body depth when the abdomen is distended (Lawrence 1960), their diet in Lake Conway consisted of smaller sized fish. For instance, only two centrarchids consumed were of harvestable size in Lake Conway, although Buntz (1966) observed that 20 percent of the game fish found in E. niger stomachs were of harvestable size. The selection of smaller fish by Lake Conway E. niger is contrary to the theory (Ivlev 1961) that within their capability predatory fishes usually consume the largest available food items.

In E. niger over 100 mm, 51 percent of the prey fish were centrarchids. This dominance of centrarchids as food had been previously noted by DeJean (1951), Buntz (1966), and McIlwain (1970). In Lake Conway, 41 percent of the diet included game species. Other investigators have found 39 percent (McIlwain 1970), 46 percent (Buntz 1966), and 50 percent (DeJean 1951) included game fish. There is an increased dominance of game fish in the diet with respect to increased size of E. niger in Lake Conway (Figure E15).

There were no natural cases of cannibalism in fishes examined from electrofishing samples. One 390-mm male collected from a blocknet sample contained two juvenile E. niger; however, this was not natural as the presence of large numbers of small fish in distress initiated nonselective feeding by E. niger. Possibly habitat segregation of juveniles and adults prevented frequent contact, thereby reducing cannibalism. Crossman (1962) described different habitats occupied by young and adult Esox americanus vermiculatus in Canada which he related to the low incidence of cannibalism.

Sport fishery

E. niger contributed very little to the sport fishery in Lake Conway. Only 1791 individuals (7.6 percent) were harvested from June 30, 1976, to June 14, 1977. Most Esox caught, however, are released and are not included in harvest estimates. My data showed that approximately 80 percent of all Esox caught are released. The major portion of the catch represented fish incidentally caught while fishing for other species such as Micropterus salmoides or Pomoxis nigromaculatus. Only 242 man-hours of fishing pressure, or 0.4 percent of the total, was devoted exclusively to E. niger.

Although the fishery is desregarded by the great majority of sport fishermen, large numbers of Esox are available for exploitation. Interviewed fishermen often speak of the abundance and catchability of the species in Lake Conway. The species-directed catch rate for harvested E. niger was 0.6 fish per man-hour; however, based on a release rate of

80 percent, the overall catch rate was 2.4 fish per man-hour.

E. niger is one of the most susceptible species to angling. Stroud and Bitzer (1955) found a 60 percent return on tagged *E. niger* for Massachusetts waters. In one New Jersey lake, there was a 27.3 percent return (Smith and Gross 1955). Despite ease of capture, the species can withstand heavy fishing pressure if adequate spawning grounds exist (Wich and Mullan 1958). Its rapid growth rate provides sufficient recruitment to offset heavy harvest rates.

The popularity of *E. niger* as a sport fish is regional; in many northern states it is considered one of the more important warmwater species (Wich and Mullan 1958). Its presence in most waters, its ability to reach a comparatively large size, and its ease of capture throughout the year on a variety of gear all contribute to this popularity. In Florida, however, *E. niger* is not fully accepted.

Table E1. Length-frequency distribution of Lake Conway *Esox niger*, May to July 1977.

10-mm Size group	Number	10-mm Size group	Number	10-mm Size group	Number
1		21		41	7
2		22		42	2
3		23		43	10
4		24		44	11
5		25	1	45	16
6		26	2	46	14
7	5	27	2	47	8
8	11	28		48	6
9	32	29	1	49	5
10	17	30	3	50	6
11	12	31	1	51	5
12	25	32	4	52	1
13	24	33	9	53	1
14	27	34	8	54	2
15	25	35	6	55	1
16	9	36	3	56	2
17	5	37	6	57	2
18	2	38	7	58	
19	3	39	3	59	
20		40	2	60	1

Table E2. Seasonal length-weight regressions for <u>Esox niger</u> in Lake Conway.

June - Aug. '76	log W = -5.4055 + 3.0433 log L (r = +.99)
Sept. - Nov. '76	log W = -4.8824 + 2.8342 Log L (r = +.94)
Dec. '76 - Feb. '77	log W = -4,8602 + 2.8229 Log L (r = +.94)
Mar. - May '77	log W = -5.0996 + 2.9177 Log L (r = +.82)

Table E3. Size variation in percent number (A), percent weight (B), and percent occurrences (C) of food organisms for Lake Conway *Esox niger*.

Food organisms	25 - 50 mm (N = 27)*			51 - 100 mm (N = 83)			101 - 200 mm (N = 78)			>200 mm (N = 321)		
	A	B	C	A	B	C	A	B	C	A	B	C
Copepoda	.3	-	7.4	-	-	-	-	-	-	-	-	-
Argulus	.3	-	7.4	-	-	-	-	-	-	-	-	-
Cladocera	94.4	61.3	81.5	17.3	6.8	8.40	-	-	-	-	-	-
Ostracoda	.2	-	3.7	.4	.1	1.2	-	-	-	-	-	-
Hyalella azteca	1.8	13.4	25.9	5.3	8.7	6.0	-	-	-	-	-	-
Palaemonetes paludosus	.3	6.4	7.4	18.7	43.8	42.2	37.5	23.3	19.2	.5	.1	.3
Procambarus	-	-	-	-	-	-	-	-	-	4.7	1.9	2.8
Decapod remains	-	-	-	-	-	-	-	-	-	1.1	.4	.6
Culicidae	.5	11.4	11.1	-	-	-	-	-	-	-	-	-
Chironomidae	.6	-	11.1	-	-	-	-	-	-	-	-	-
Trichoptera	.1	2.5	3.7	.4	.4	1.2	-	-	-	-	-	-
Gomphidae	-	2.7	11.1	-	-	-	-	-	-	-	-	-
Goniobasis	-	-	-	-	-	-	-	-	-	1.6	.1	.3
Dorosoma petenense	-	-	-	-	-	-	-	-	-	5.8	3.6	1.2
Notemigonus crysoleucas		-	-	.4	1.0	1.2	-	-	-	.5	2.5	.3

(Continued)

* N = number of fish examined.

Table E3. (Continued)

Food organisms	25 - 50 mm (N = 27)			51 - 100 mm (N = 83)			101 - 200 mm (N = 78)			>200 mm (N = 321)		
	A	B	C	A	B	C	A	B	C	A	B	C
Notropis petersoni	-	-	-	-	-	-	4.2	5.1	2.6	-	-	-
Ictalurus nebulosus	-	-	-	-	-	-	-	-	-	1.0		.6
Erimyzon sucetta	-	-	-	-	-	-	-	-	-	.5		.3
Fundulus chrysotus	-	-	-	-	-	-	2.1	10.2	1.3	-	-	-
Fundulus seminolis	-	-	-	-	-	-	2.1	.4	1.3	3.7	3.3	1.9
Lucania goodei	-	-	-	4.0	3.1	8.4	6.2	7.9	3.8	2.6	.1	1.2
Gambusia affinis	-	-	-	4.9	14.1	13.3	6.2	17.3	3.8	-	-	-
Labidesthes sicculus	-	-	-	-	-	-	6.2	7.3	3.8	-	-	2.5
Ennecanthus gloriosus	-	-	-	.9	5.8	2.4	4.2	5.1	2.6	2.6	.6	1.6
Lepomis gulosus	-	-	-	-	-	-	-	-	-	3.7	2.7	2.2
Lepomis macrochirus	-	-	-	.4	.9	1.2	-	-	-	5.8	33.1	3.1
Lepomis microlophus	-	-	-	-	-	-	-	-	-	3.2	6.7	1.9
Micropterus salmoides	-	-	-	.9	1.4	2.4	2.1	5.8	1.3	4.7	5.3	2.8
Lepomis spp.	-	-	-	-	-	-	2.1	1.5	1.3	14.2	18.9	8.4
Etheostoma fusiforme	-	-	-		1.0	1.2	-	-	-	2.6	.5	1.2
Post larval fish	1.9	1.7	18.52	43.2	11.0	20.5	-	-	-	-	-	-
Fish remains	.1	.5	3.7	2.2	2.0	6.0	22.9	9.4	14.1	29.5	13.5	16.5

(Continued)

Table E3. (Concluded)

Food organisms	25 - 50 mm (N = 27)			51 - 100 mm (N = 83)			101 - 200 mm (N = 78)			>200 m (N = 321)		
	A	B	C	A	B	C	A	B	C	A	B	C
Sternothaerus odoratus	-	-	-	-	-	-	-	-	-	.5	1.0	.3
Vegetation	-	-	-	-	-	-	-	-	-	.5	.1	.3
Unidentified remains	-	-	-	-	-	-	4.1	.7	1.3	.5	.1	.3

Table E4. Electivity indices of food organisms for two size groups of Lake Conway *Esox niger*.

Species	100-200 mm	>200 mm
Dorosoma petenense	-1.00	.48
Notemigonus crysoleucas	-1.00	.31
Notropis petersoni	.92	-1.00
Erimyzon sucetta	-1.00	.72
Ictalurus nebulosus	-1.00	.50
Fundulus chrysotus	.85	-1.00
Fundulus seminolis	-.57	-.54
Lucania goodei	.28	-.18
Gambusia affinis	.06	-1.00
Labidesthes sicculus	.70	.72
Ennecanthus gloriosus	.35	-.51
Lepomis gulosus	-1.00	.26
Lepomis macrochirus	-1.00	-.40
Lepomis microlophus	-1.00	-.19
Micropterus salmoides	.32	.15
Lepomis spp.	-.49	-.17
Etheostoma fusiforme	-1.00	.55

Table E5. Seasonal variation in percent number (A), percent weight (B), and percent occurrences (C) of food organisms for Lake Conway *Esox niger*, June 1976 to May 1977.

Food organisms	Jun-Aug			Sep-Nov			Dec-Feb			Mar-May		
	A	B	C	A	B	C	A	B	C	A	B	C
Palaemonetes paludosus	2.4	.2	1.1	1.9	.1	1.0	-	-	-	-	-	-
Procambarus	4.9	.1	2.1	1.9	1.0	1.0	8.7	3.8	6.4	17.2	4.2	7.2
Goniobasis	7.3	.6	1.1	-	-	-	-	-	-	-	-	-
Doromoma petenense	7.3	6.0	1.1	-	-	-	3.9	1.2	1.4	13.8	2.6	1.5
Notemigonus crysoleucas	-	-	-	1.9	1.3	1.0	1.0	3.5	.7	-	-	-
Notropis petersoni	-	-	-	1.9	.1	1.0	1.0	.1	.7	-	-	-
Ictalurus nebulosus	-	-	-	-	-	-	1.0	3.5	.7	-	-	-
Erimyzon sucetta	2.4	9.1	1.1	-	-	-	-	-	-	-	-	-
Fundulus chrysotus	2.4	.8	1.1	-	-	-	-	-	-	-	-	-
Fundulus seminolis	-	-	-	11.3	21.4	5.8	-	-	-	3.4	.5	1.5
Lucania goodei	7.3	.5	3.2	5.6	.5	1.9	-	-	-	-	-	-
Gambusia affinis	2.4	.3	1.1	5.7	.9	1.0	-	-	-	-	-	-
Labidesthes sicculus	-	-	-	5.7	1.2	2.9	16.5	2.5	3.6	3.4	.8	1.5
Ennecanthus gloriosus	2.4	.8	1.1	5.7	1.6	2.9	1.9	.4	1.4	3.4	.4	1.5
Lepomis gulosus	2.4	4.8	1.1	1.9	1.2	1.0	3.9	2.2	2.8	-	-	-

(Continued)

Table E5. (Concluded)

Food organisms	Jun-Aug			Sep-Nov			Dec-Feb			Mar-May		
	A	B	C	A	B	C	A	B	C	A	B	C
Lepomis macrochirus	4.9	24.8	2.1	7.8	29.2	3.9	3.9	15.2	2.8	3.4	30.1	1.5
Lepomis microlophus	4.9	11.1	2.1	3.8	9.2	1.9	2.9	38.5	2.1	3.4	5.2	1.5
Micropterus salmoides	4.9	1.1	2.1	1.9	8.2	1.0	3.9	4.4	2.8	3.4	1.9	1.5
Lepomis spp.	14.6	35.2	6.4	7.6	17.5	3.9	9.7	7.8	7.1	31.0	43.7	13.4
Etheostoma fusiforme	-	-	-	1.89	.1	1.0	2.9	.7	1.4	3.5	.2	1.5
Fish remains	22.0	4.5	11.7	32.1	6.6	16.5	35.9	16.2	24.3	17.2	1.9	7.2
Sternotherus odoratus	-	-	-	-	-	-	-	-	-	3.4	4.4	1.5
Unidentified remains	4.9	.1	2.1	1.9	.1	1.0	2.9	.1	2.1	-	-	-
Vegetation	2.4	.1	1.1	-	-	-	-	-	-	-	-	-

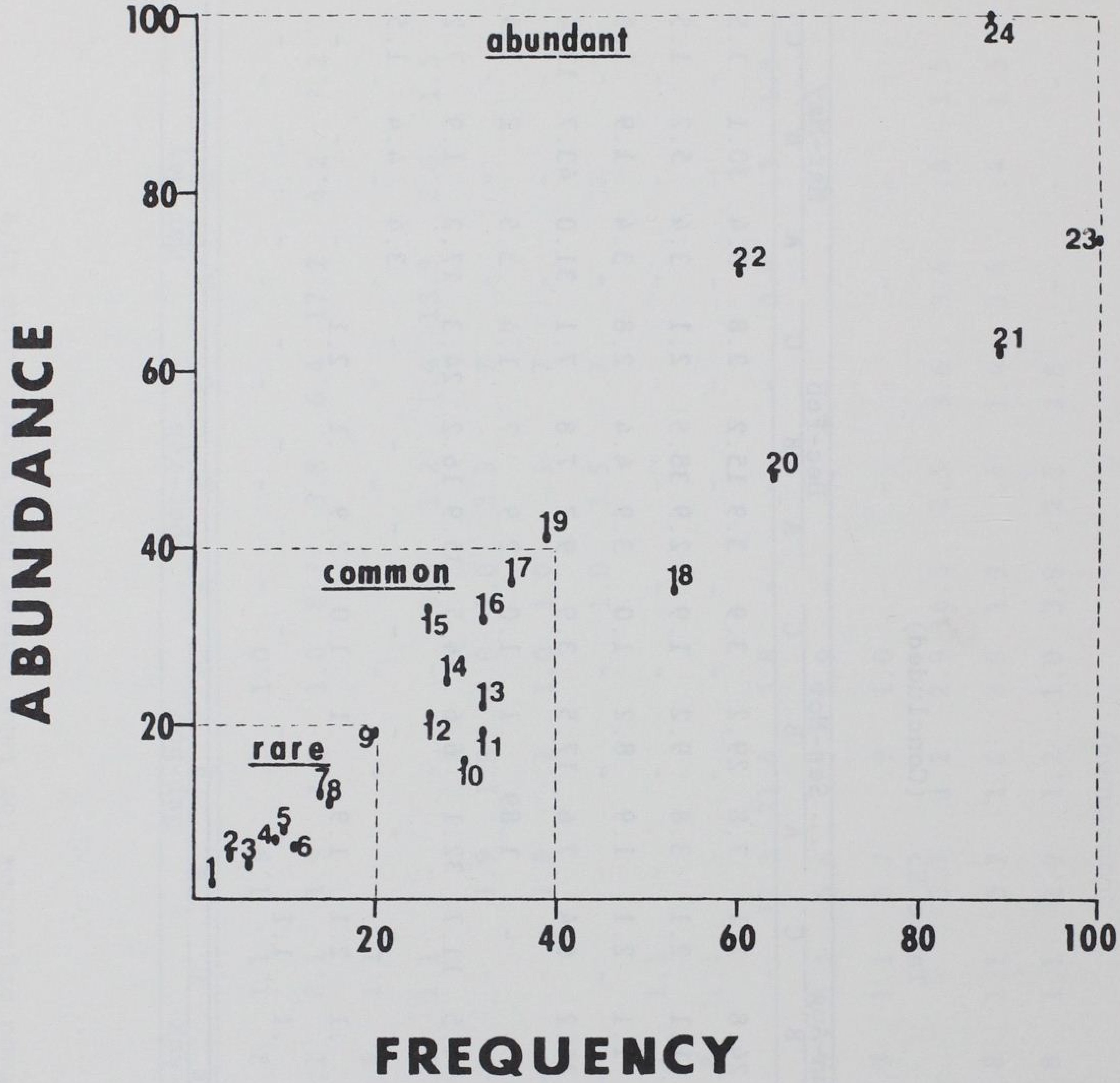

Figure E1. Graphic assessment of species collected in Lake Conway according to percent relative abundance (Sanders' Biological Index) and percent relative frequency. (1 = longnose gar, bowfin, white catfish; 2 = least killifish; 3 = yellow bullhead; 4 = spotted sunfish; 5 = lake chubsucker; 6 = brown bullhead; 7 = bluespotted sunfish; 8 = golden topminnow; 9 = warmouth; 10 = swamp darter; 11 = brook silverside; 12 = gizzard shad; 13 = threadfin shad; 14 = Florida gar; 15 = golden shiner; 16 = black crappie; 17 = chain pickerel; 18 = bluefin killifish; 19 = coastal shiner; 20 = mosquitofish; 21 = Seminole killifish; 22 = redear sunfish; 23 = largemouth bass; and 24 = bluegill.)

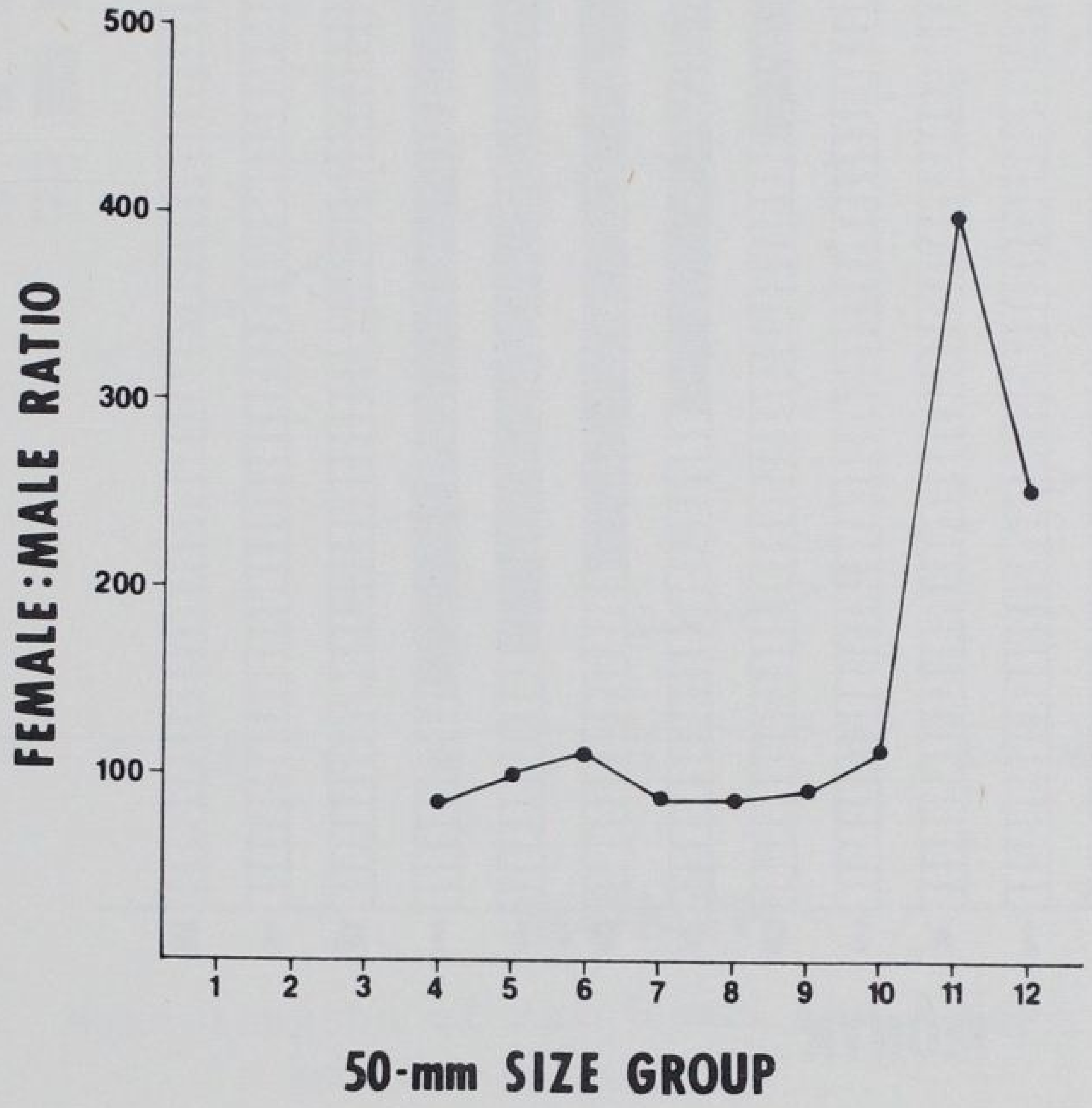

Figure E2. Size variation in female:male sex ratios in Lake Conway *Esox niger*

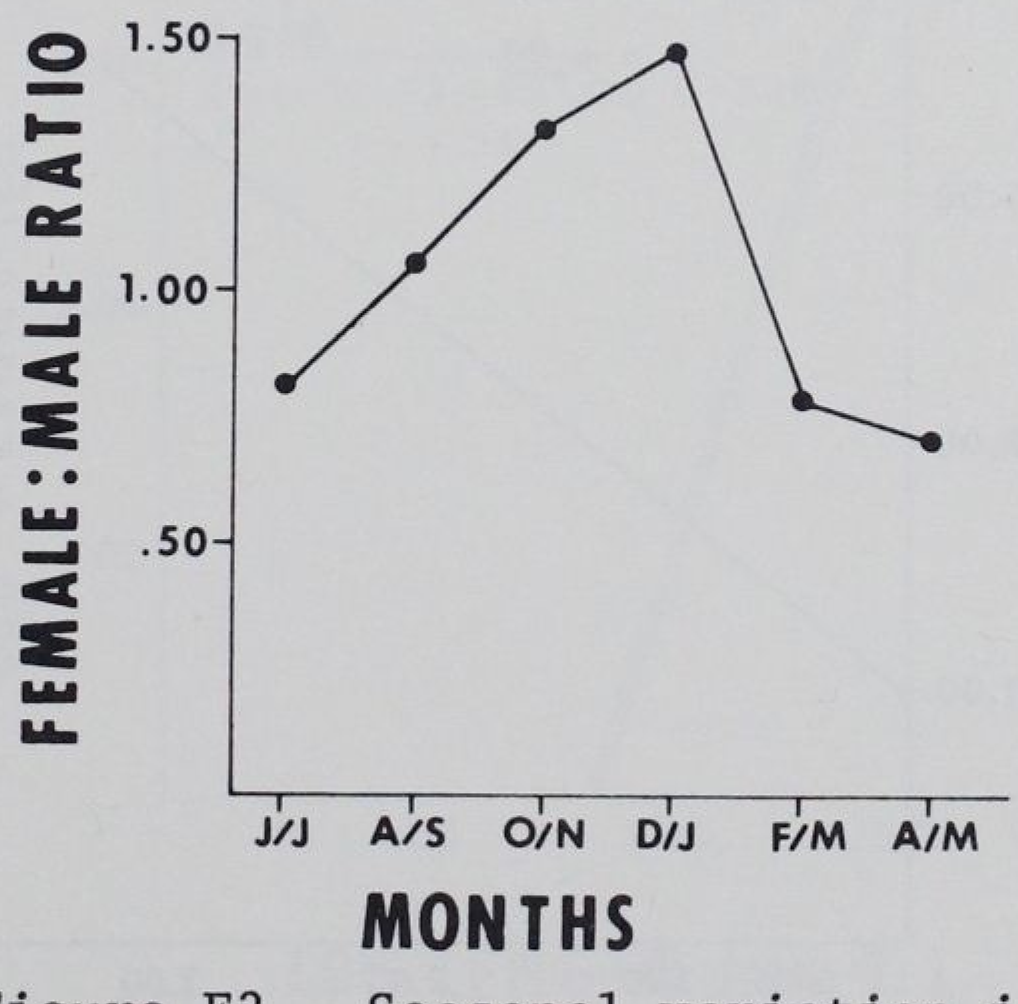

Figure E3. Seasonal variation in female:male sex ratios in Lake Conway *Esox niger*

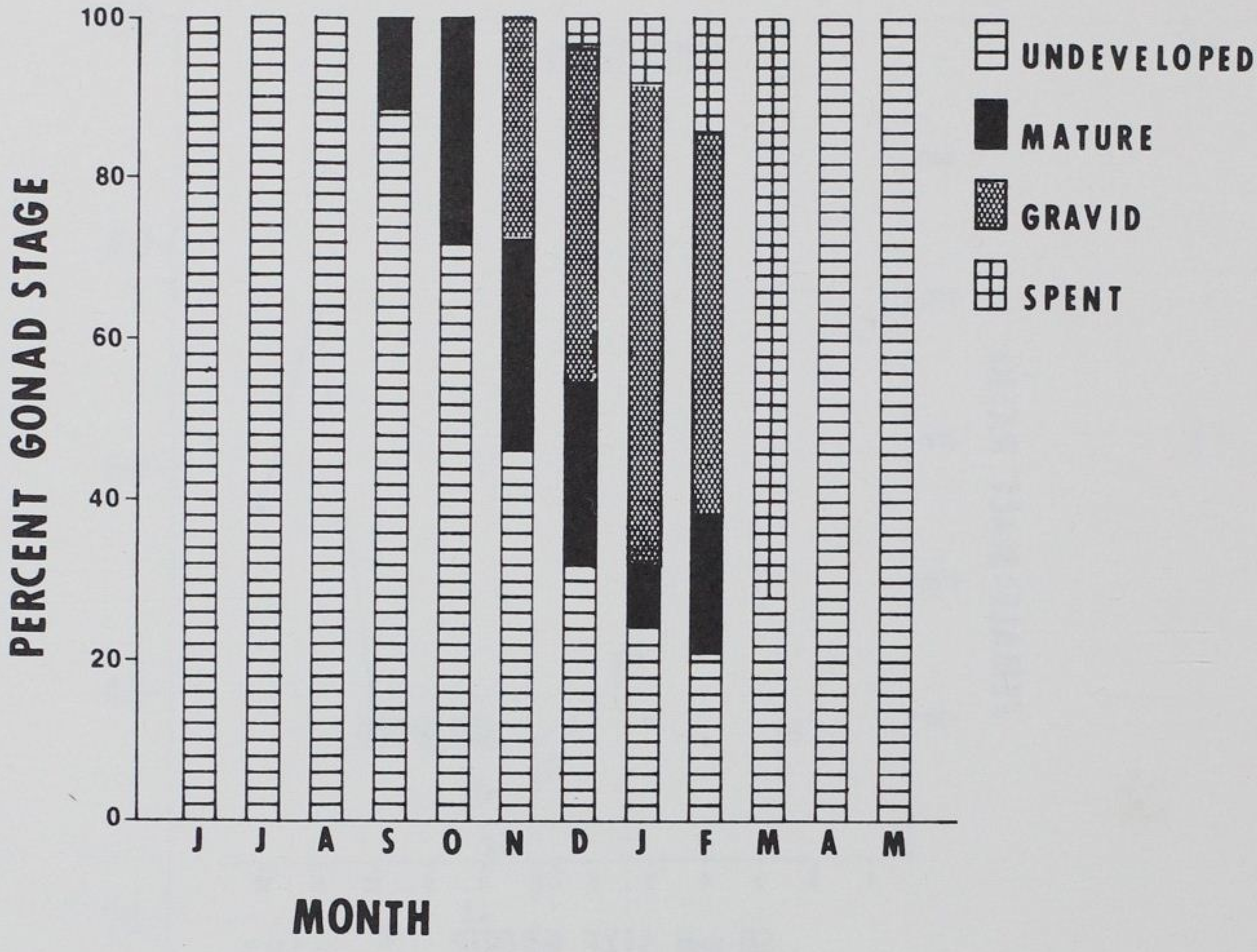

Figure E4. Monthly variation in gonadal development in Lake Conway *Esox niger*

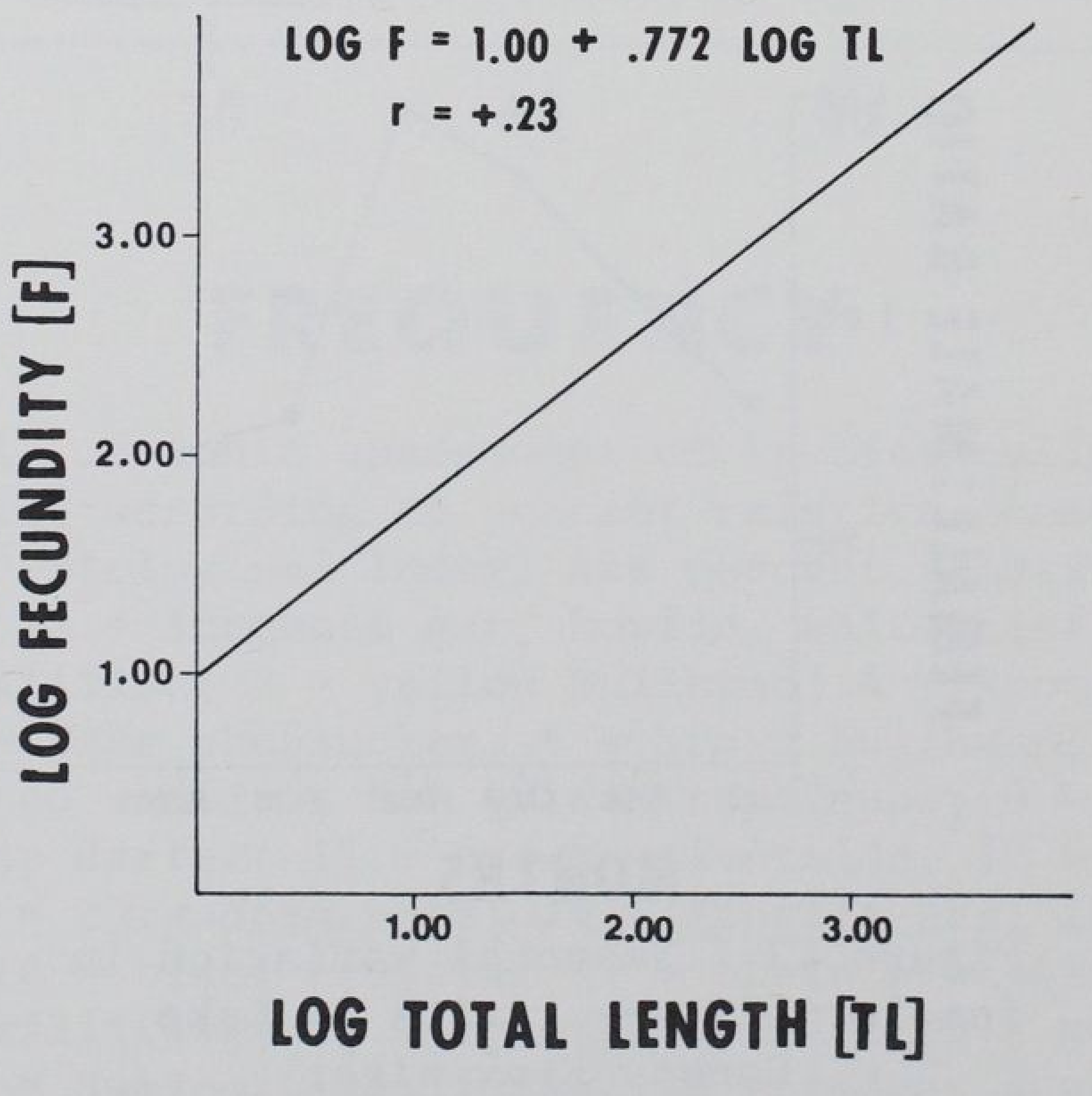

Figure E5. Relationship between fecundity and length in Lake Conway *Esox niger*

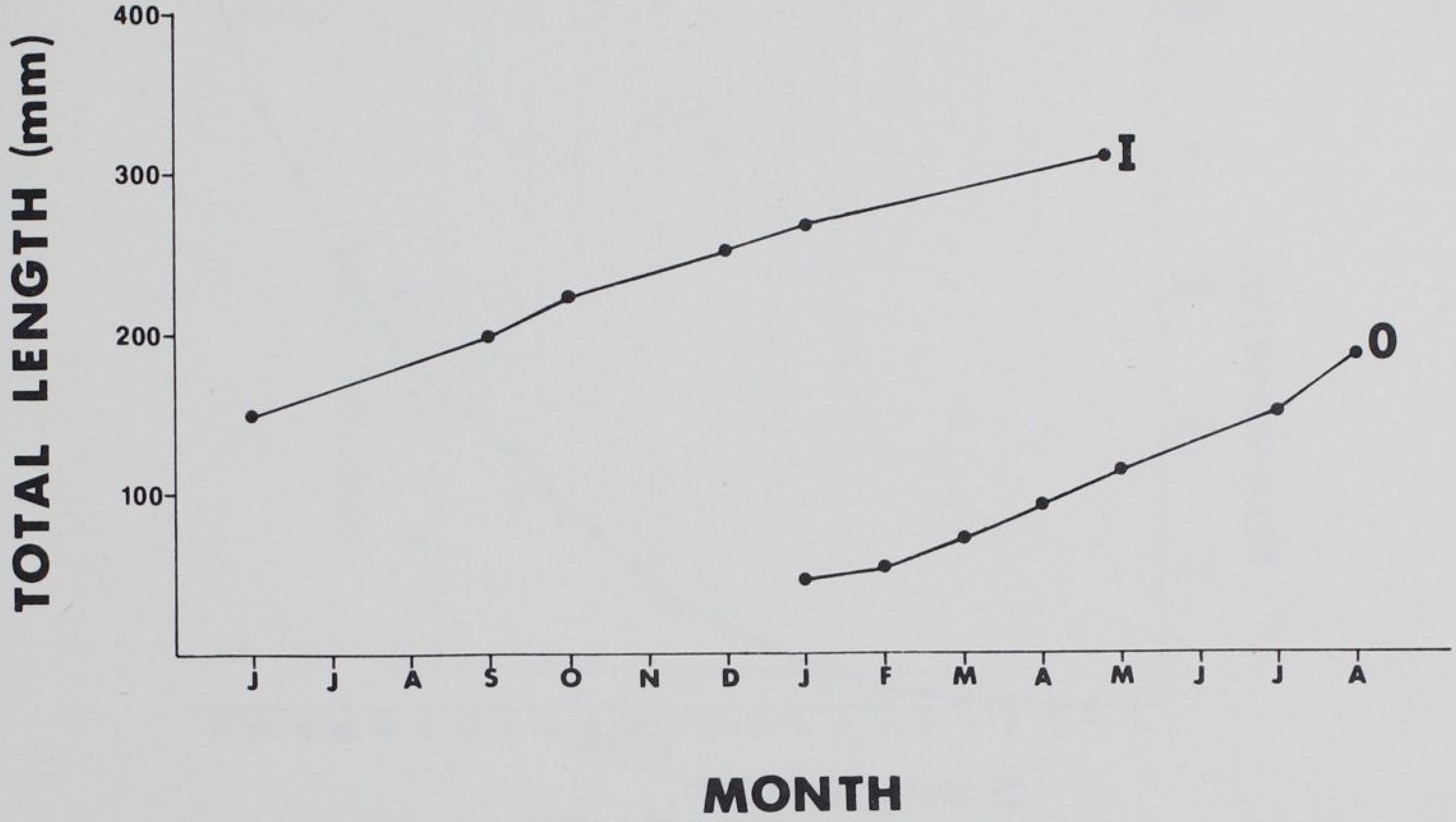

Figure E6. Mean lengths of Age 0 and Age I Esox niger for months indicated

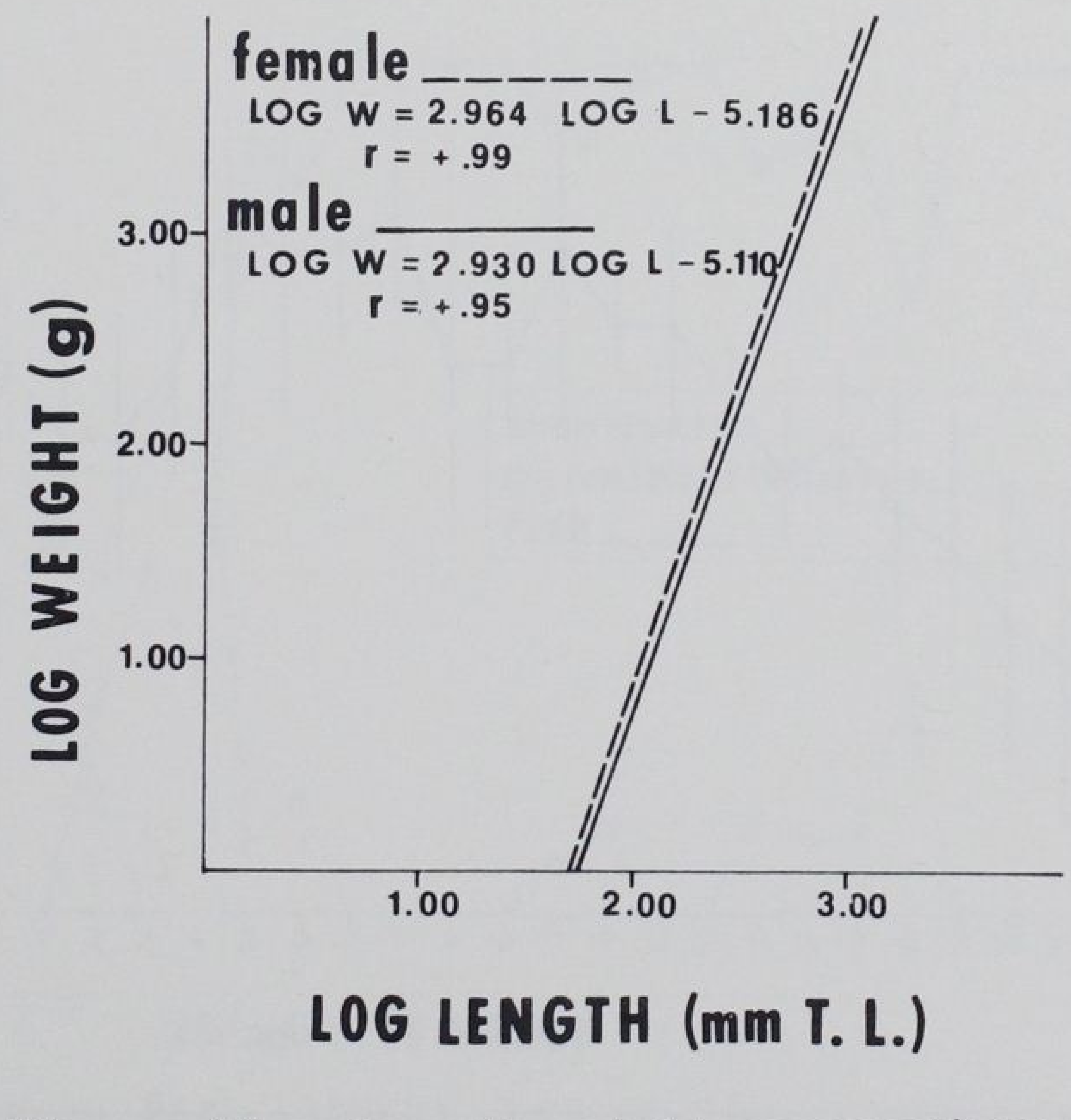

Figure E7. Length-weight regressions of male and female Esox niger from Lake Conway

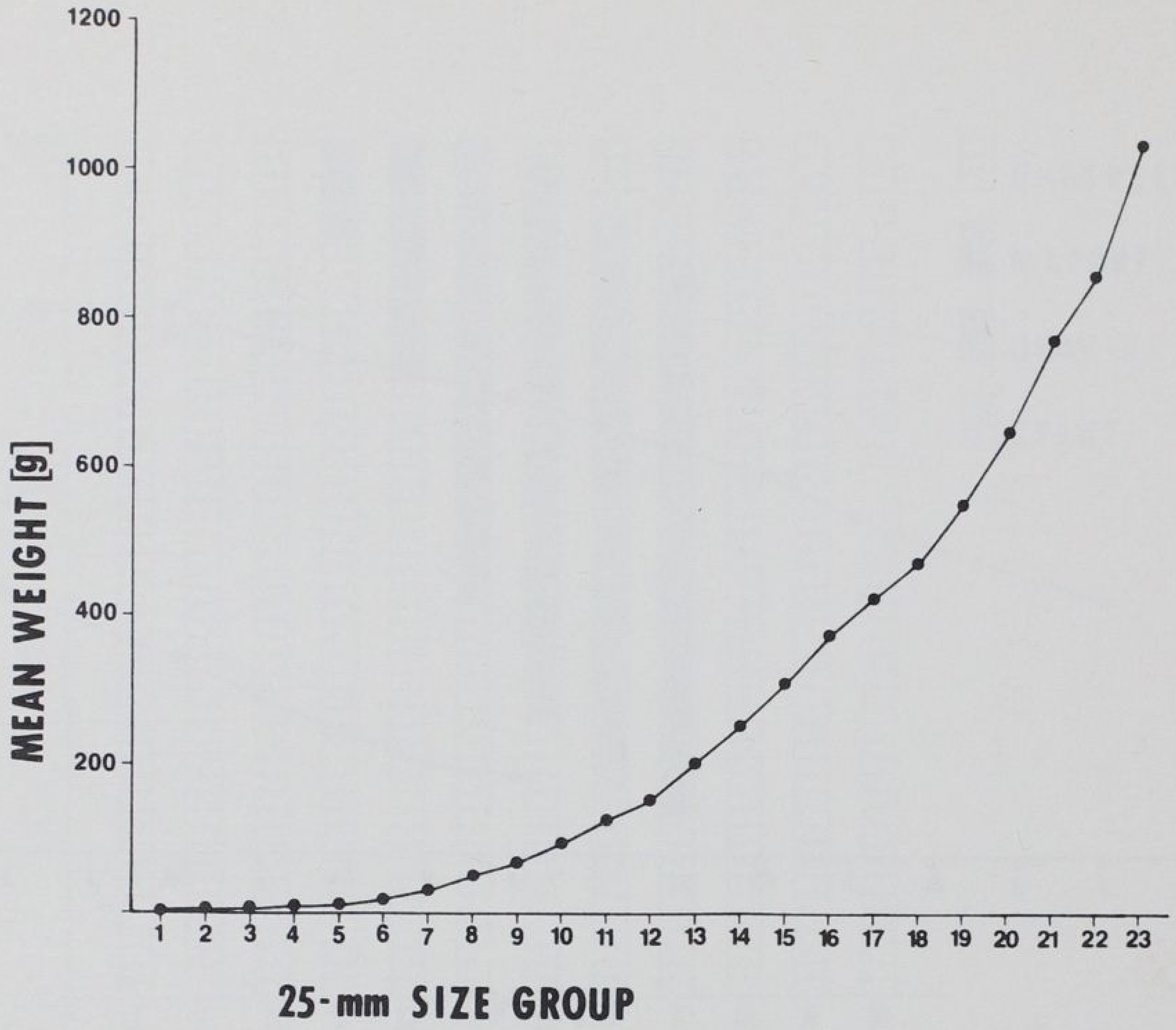

Figure E8. Length-weight relationship of Esox niger from Lake Conway

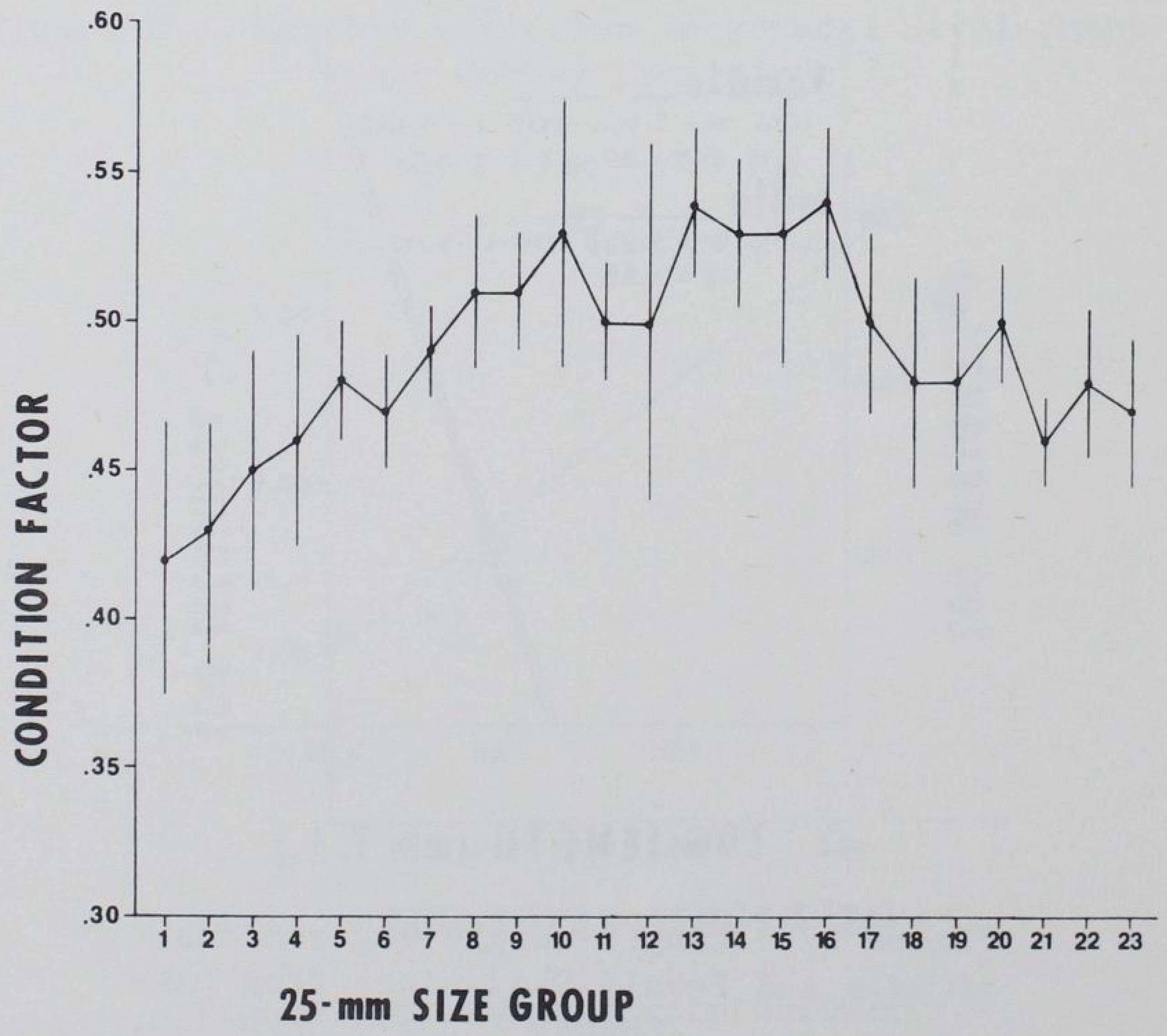

Figure E9. Size variation in condition factors K_{TL} of Lake Conway Esox niger

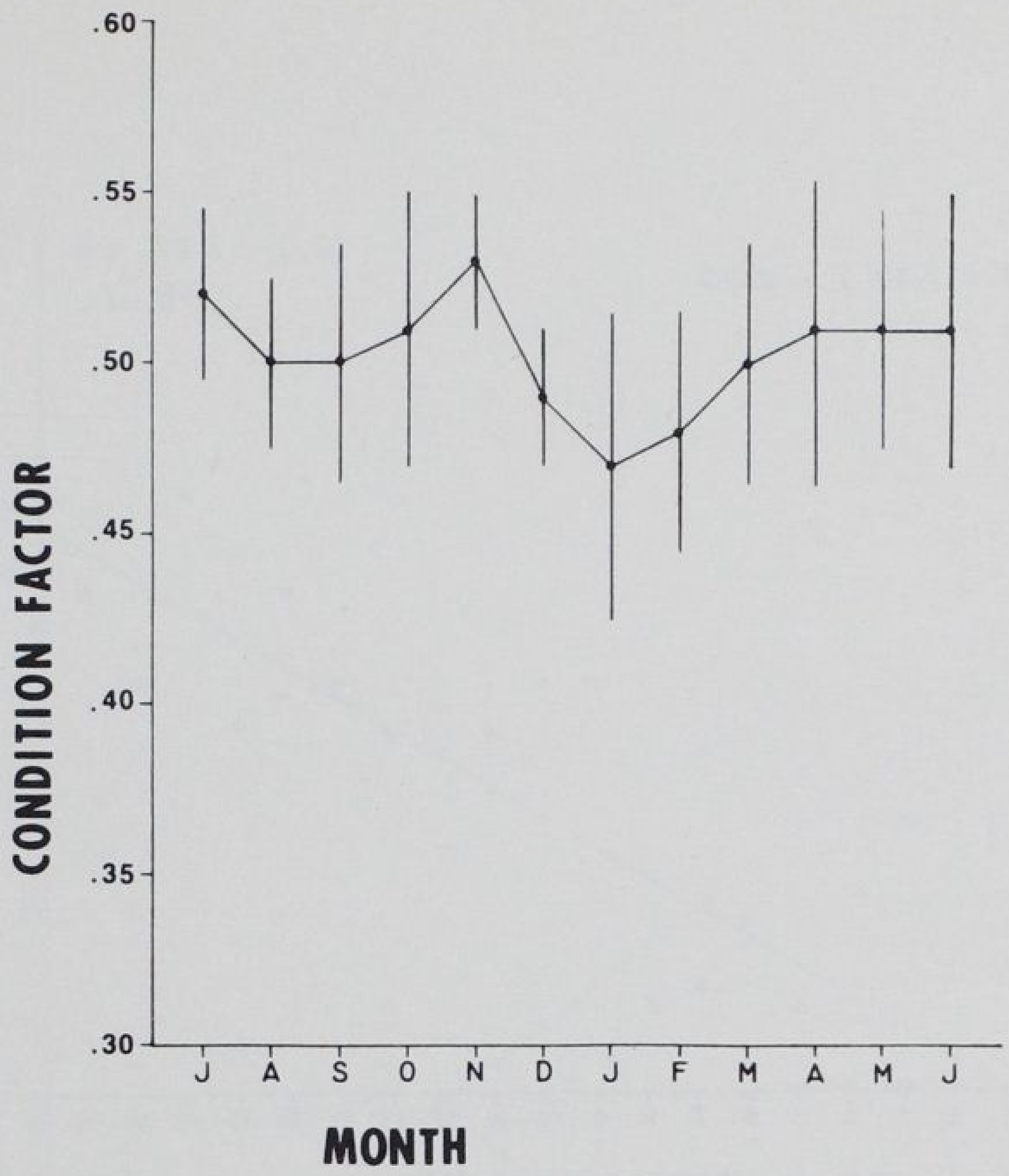

Figure E10. Monthly variation in condition factors K_{TL} of Lake Conway <u>Esox niger</u>, July 1976 to June 1977

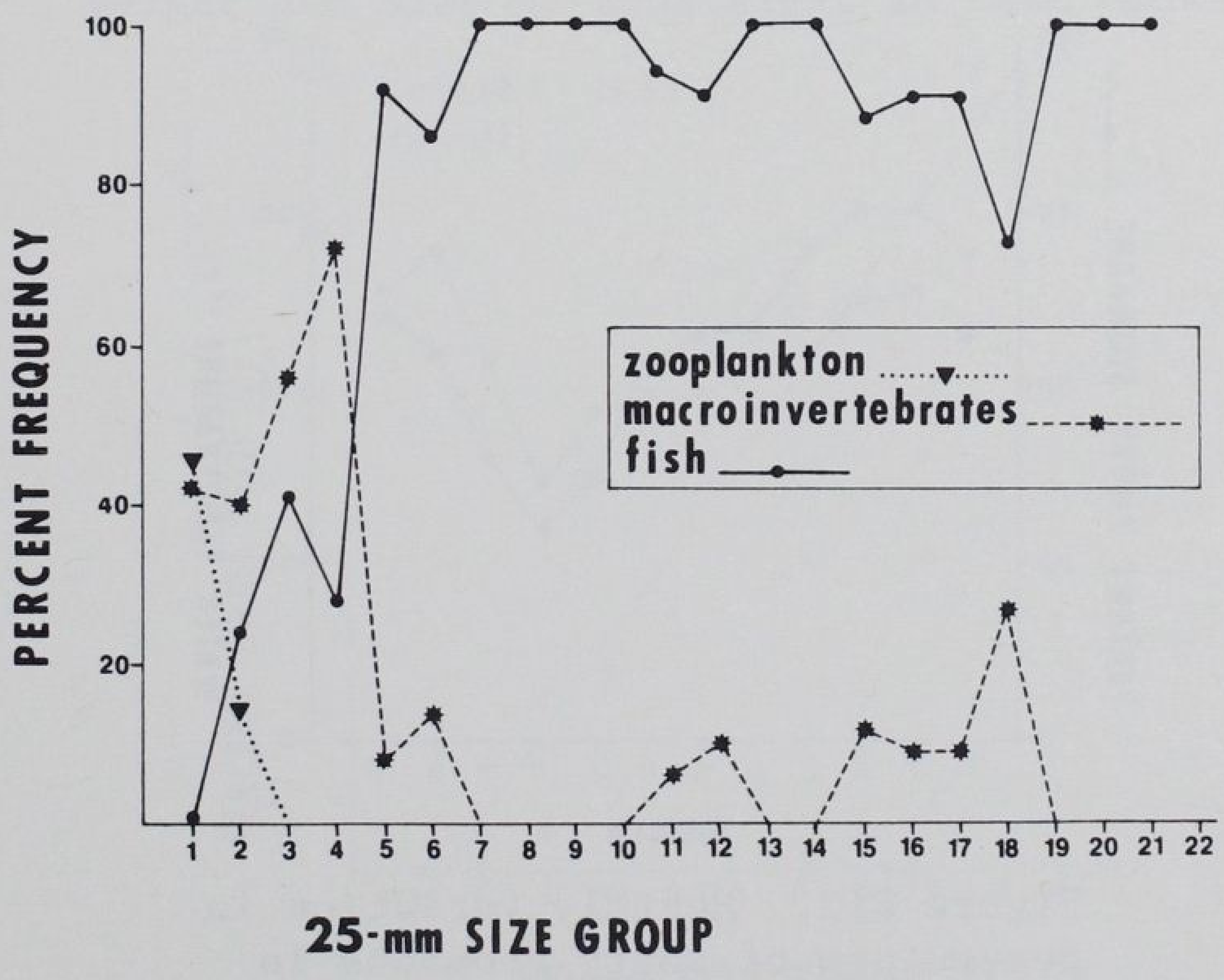

Figure E11. Utilization of zooplankton, macroinvertebrates, and fish by various sizes of Lake Conway <u>Esox niger</u>

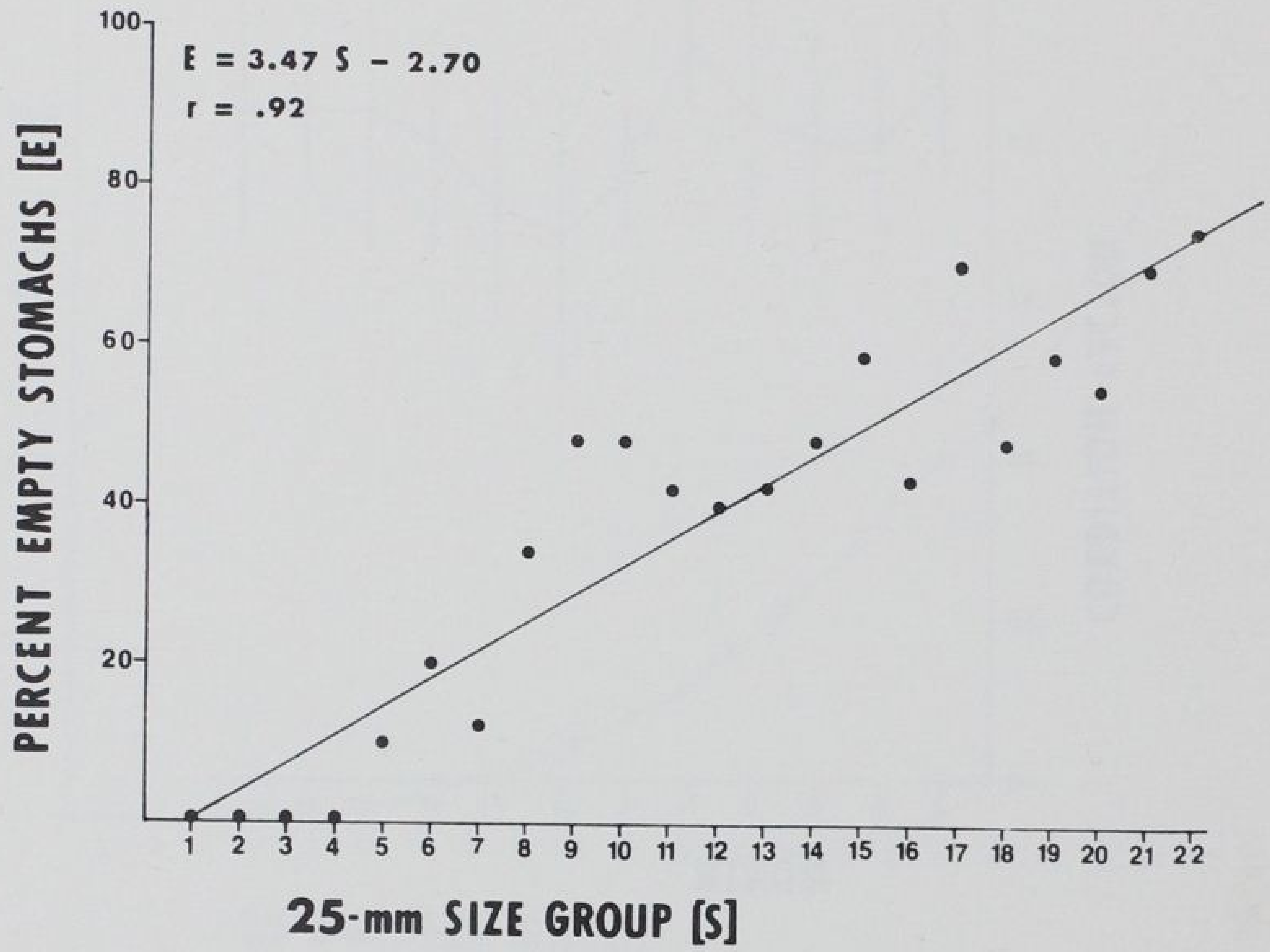

Figure E12. Relationship between percent empty stomachs and size in Lake Conway Esox niger

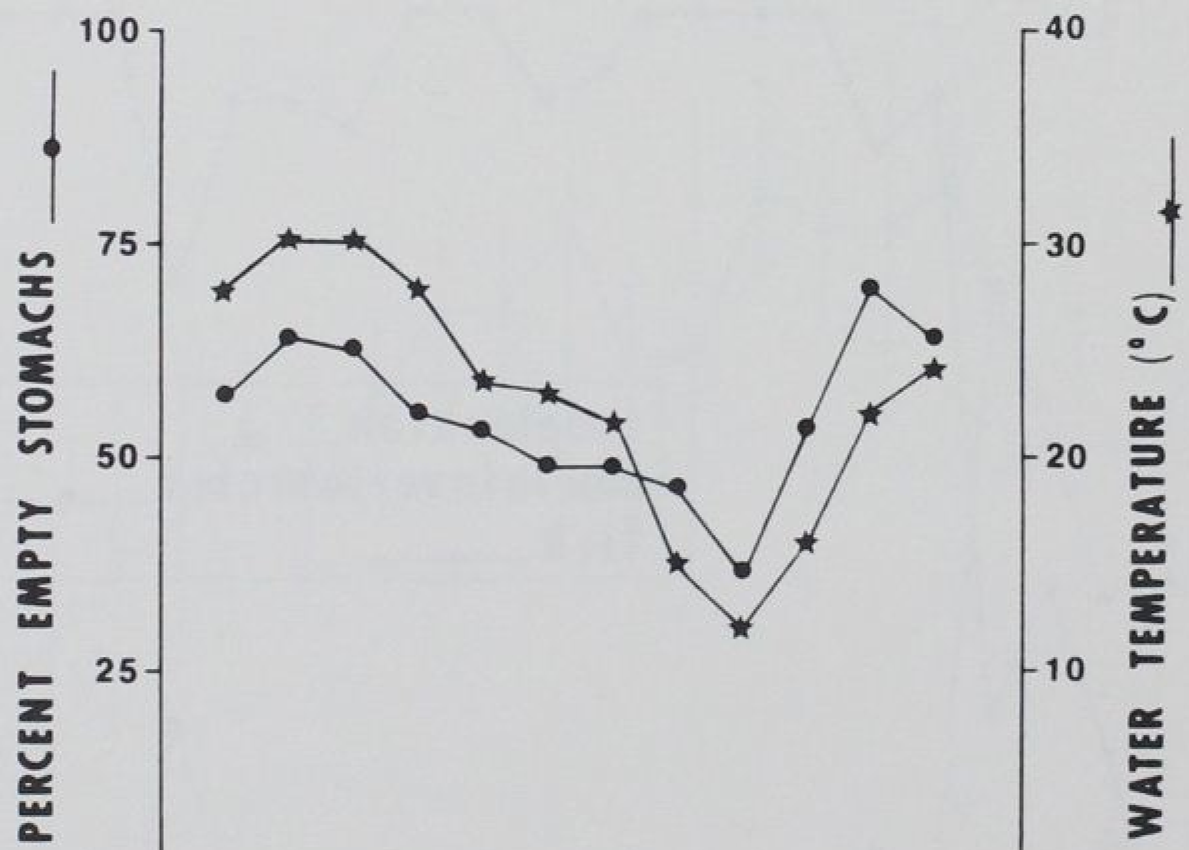

Figure E13. Monthly variation in percentage of empty stomachs in Esox niger and water temperatures in Lake Conway, July 1976 to May 1977

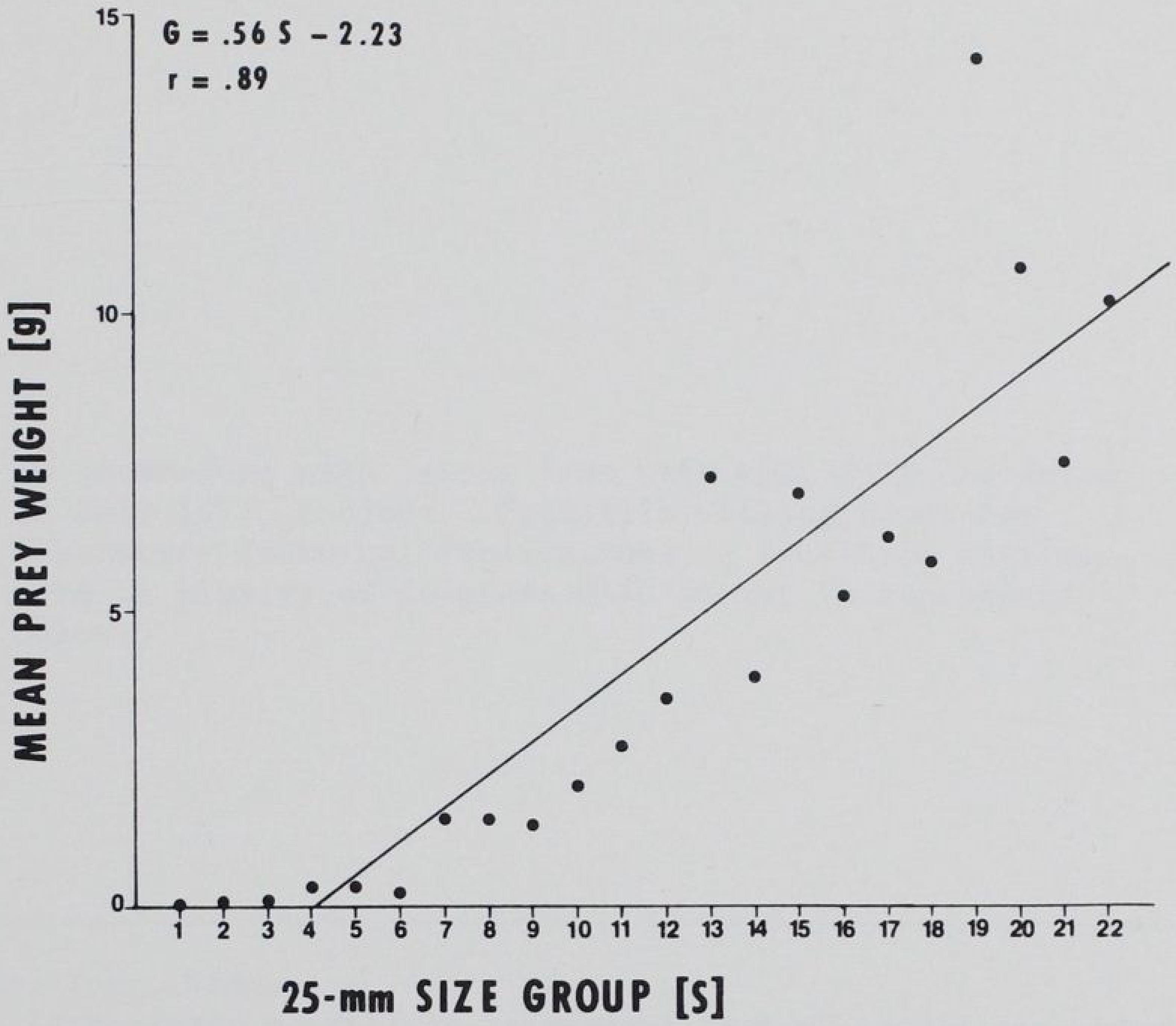

Figure E14. Relationship between mean prey weight and size of Esox niger in Lake Conway

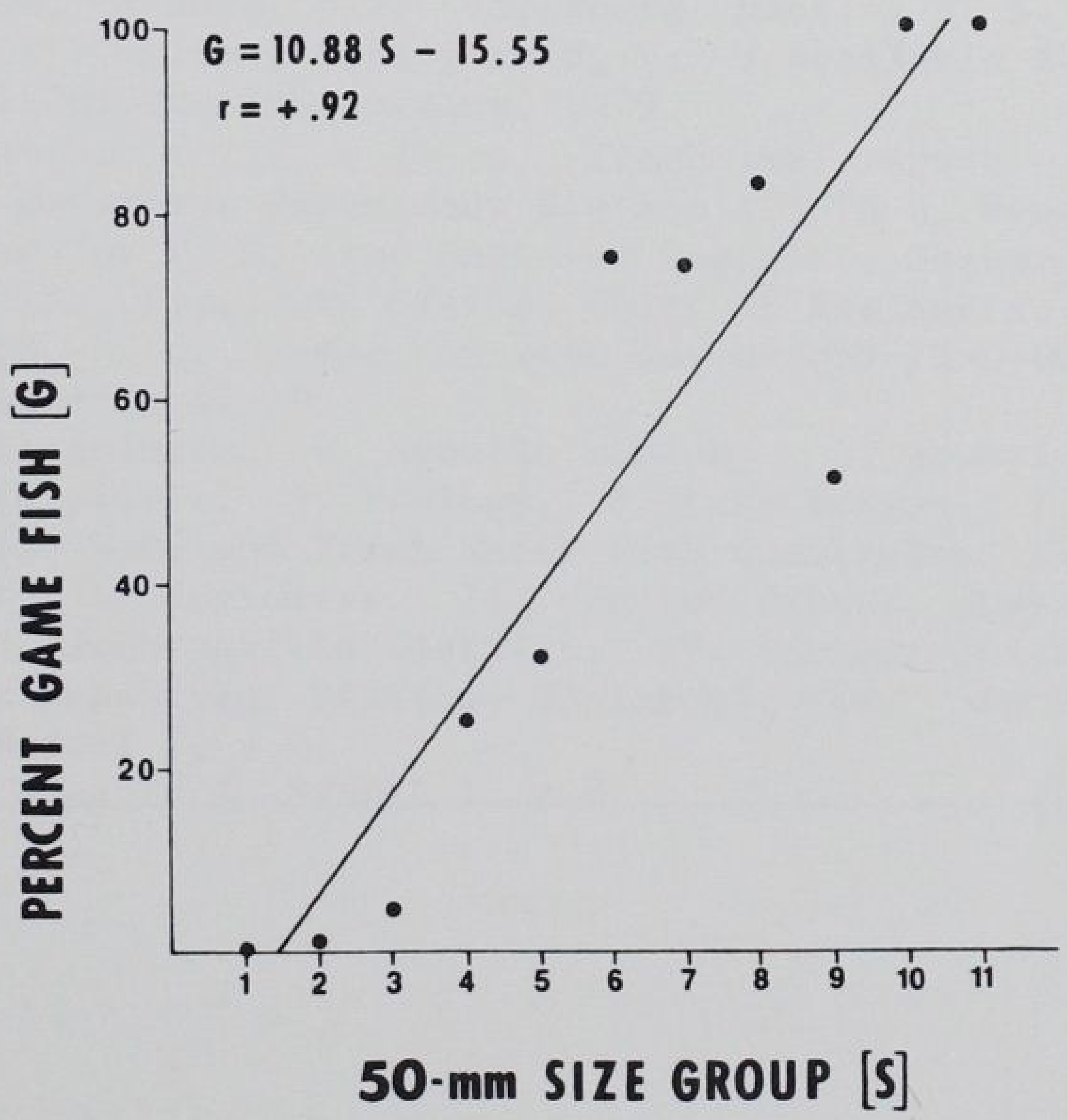

Figure E15. Relationship between percent game fish in stomachs and size of Lake Conway Esox niger