DUKE POWER COMPANY, CHARLOTTE, N C

A SUMMARY OF BIOLOGICAL STUDIES ON LAKES KEOWEE AND JOCASSEE

OCTOBER 1971

Fish Population Studies by South Carolina Wildlife Resources Department

Six one-acre coves on Lake Keowee have been sampled during two different periods. The accepted rotenone sampling method was used with all fishes being collected, weighed and measured. The first sampling period July 1, 1968 to June 30, 1969 revealed "a young expanding fish population, with 65% by weight being composed of the fingerling size group. The dominate species were carp (Cyprinus carpio) and largemouth bass (Micropterus salmoides). The largemouth bass recruitment was exceptionally high with an average of 242 young bass per acre averaging 4.1 inches in total length. The carp population accounted for 36% of the total population by weight which illustrates a tremendous reproductive capacity. In May of 1969 the lake was stocked with a total of 120,758 largemouth bass fingerlings (75/acre) and one million walleye were also introduced." [1]

The second sampling period July 1, 1969 to June 30, 1970 illustrated "a maturing fish population with 70% of the population by weight being composed of the intermediate size non-predatory species. Largemouth bass reproduction dropped significantly but was replaced by an exploding crappie population. It was recommended that the lake be allowed to mature and its fish population to stabilize at that stage of management without further introduction of non-resident species including walleye."[2]

Inventory of Aquatic Species

An inventory of the fish species currently comprising the population of Lake Keowee is provided by the South Carolina Wildlife Resources Department in the report entitled "Population Studies Lake Keowee." The sampling period covered in the report is July 1, 1969 - June 30, 1970.[2] The species of fishes collected in that study are listed as follows:

Black Crappie	Pickerel	Green Sunfish
Bluegill	Redbreast Sunfish	Hog Sucker
Carp	Redear	Hornyhead
Flat Bullhead	Redhorse Sucker	Madtom
Golden Shiner	Shiner	Spotted Sucker
Largemouth Bass	Grass Pickerel	Walleye
Warmouth	White Crappie	Whitetail Shiner
Yellow Perch		

The results of rotenone cove samples by the South Carolina Wildlife Department yielded a total fish standing crop of 99.2 lbs/acre for the year 1969. Mr Robert M Jenkins, Director of the National Reservoir Research Program, U S Bureau of Sport Fisheries and Wildlife, has predicted total fish standing crops for Lakes Keowee and Jocassee of 73 lbs/acre and 20 lbs/acre respectively.

Inventory of Terrestrial Species (Flora)

The 18,372 acres prior to inundation by Lake Keowee consisted of about 14,000 acres in wood land and the balance, about 4,400 acres, in open fields and pastures. Harvest records show that yellow pine (Pinus echinata) was the dominant softwood with an admixture of white pine (Pinus strobus). Principal hardwood species were tulip poplar (Liriodendron tulipifera) and oaks (Quercus rubrum, alba, etc.). In fragments of wooded communities along streams common trees such as sweet gum (Liquidambar styraciflua) and sycamore (Platanus occidentalis) and river birch (Betula nigra) occurred in typical riverbank shrub thicket communities composed of alder (Alnus serrulata) and dense tangle of alder associates.

In the wooded areas, and in fragments of wooded communities, understory species typical of this region, such as dogwood (Cornus florida), sourwood (Oxydendrum aboreum) and mountain laurel (Kalmia latifolia) were found in a rather common vegetation of heterogenous nature.

In the Lake Jocassee area 7,270 acres were wooded and 230 acres were open fields and pasture. Tree species mentioned in the Lake Keowee basin are also indigenous to contiguous Lake Jocassee. One exception was the importance of hemlock (Tsuga canadensis). Yellow pine, white pine and hemlock comprised about 38 percent of timber harvested. Oak species are next accounting for about one-third of timber harvested. Perhaps the

most unique species of flora in the Jocassee area is the southern Appalachian endemic Oconee Bells (Shortia galacifolia) which occurs in many coves up to elevation 1500 feet or sometimes higher. Although several natural Shortia planations were flooded by Lake Jocassee, by no means does the project threaten extinction of this species. It is interesting to note that Perry C Holt states "Vivian (1967) points out that the occurrence of Shortia is an exclusive ground cover, the poverty of the understory species, the frequent canopy openings and the young age of the dominant trees all suggest that Shortia is most commonly associated with disturbed sites. In addition, most Shortia sites showed physical evidences of disturbances such as lumbering, earth-slides, windfall and stream erosion."[4]

The publication by Dr C Leland Rogers, Chairman, Department of Biology, Furman University, entitled "Flowers, Ferns, Shrubs and Trees Found at Keowee-Toxaway" illustrates the flora is typical of the upper piedmont bordering the southeast escarpment of the Blue Ridge and that the Keowee-Toxaway Project poses no danger of extinction to any unique species of flora.

Environmental Studies

Duke Power is presently conducting research programs to gain data for its environmental analyses of Lake Keowee. In January 1971 eight water monitoring stations were established on Lake Keowee to determine baseline data to assess the effects of Oconee Nuclear Plant's condenser cooling water on the lake. The locations of these stations were also established in order to predict any effects from possible future steam-electric plants on the lake. The synoptic water quality samples are collected monthly in order to analyze the following parameters:

Temperature	Total Fe	Ortho-Phosphate
Dissolved Oxygen	Turbidity	Nitrate Nitrogen
Secchi Disc	BOD	Total Phosphate
pH	Total Alkalinity	Silica
Mn	Ammonia Nitrogen	Conductivitiy

Water Temperature Monitoring Stations

Duke Power has installed two continuous water temperature monitoring stations on Lake Keowee. The stations will record water temperatures in an eleven point vertical profile on the open lake; one is installed in the connecting canal and the other on the lake side of the skimmer wall.

Productivity Studies

Duke Power plans to conduct a productivity study as measured by biomass accumulation (Periphyton). The use of Periphyton (attached organisms) as biological monitors of an aquatic habitat is generally accepted. "The rate of accumulation of organic matter on artificial substrates by the attachment, growth and reproduction of colonizing organisms has been widely used to estimate the productivity of streams and reservoirs."[3] This technique can provide a useful tool in assessing the effects of thermal additions and pumped storage operations upon the lake.

Periphyton samples will be collected on plexiglass slides measuring 3" x 3". The slides will be positioned vertically in the water and set at a depth of five feet at strategic locations within the lake. The slides will be retrieved at either monthly or bi-monthly intervals depending upon the amount of time necessary for a reasonable accumulation of biomass. Dry and ash-free weights of each sample, which represent relative productivity values, will be determined according to the procedures described in "Standard Methods for the Examination of Water and Waste-Water."[3] Thus, variations in the productivity for various locations within the lake can be determined.

Proposed Study by the U S Bureau of Sport Fisheries and Wildlife

A fish study is proposed by the U S Bureau of Sport Fisheries and Wildlife. Approximately five years ago interest was expressed in studying the effects of the Oconee Nuclear Station and the Jocassee pumped storage operations upon the fishes of Lakes Keowee and Jocassee by Mr Robert M Jenkins, Director of the National Reservoir Research Program, U S Bureau of Sport Fisheries and Wildlife. It now appears that upon approval of funding a research project on Lakes Keowee and Jocassee will be initiated. In Mr Jenkins' memorandum of March 5, 1971, to the Director, Bureau of Sport Fisheries and Wildlife he says that: "The primary aim is to determine the effects - both detrimental and beneficial - of the heated water on the fish population throughout the reservoir." This will be accomplished by determining the effects of heated water effluent on distribution, movements, growth, production and harvest of the principal fishes and on production and utilization of plankton and benthos when the nuclear generating plant is in operation. The effects of the Jocassee hydro and pumped storage operations will be included in a study of the effects of large-scale pumpback operations (currents,

STATE South Carolina

PROJECT NO. F-9-R-8

PERIOD COVERED: July 1, 1966

through June 30, 1967

COMBINED QUARTERLY AND ANNUAL PROGRESS REPORT

As Required By

FEDERAL AID IN FISH AND WILDLIFE RESTORATION ACTS

1. Title of Project: Fisheries Investigations in Lakes and Streams--District II

2. Project Leader: Otho D. May, Jr.

3. Report of Progress:

INTRODUCTION

The major objective of fisheries work in South Carolina is to improve sport fishing in the public waters of the State. This project, and this segment of the project, is only a part of the overall fisheries plan.

This project is concerned with the investigations of several aspects of the fish populations in Lake Greenwood and Lake Hartwell and with finding a feasible means of rearing striped bass larvae to fingerling size before stocking them in lakes already containing established fish populations. During this segment, population studies and creel censusing were continued on the project lakes. The walleye stocking and evaluation program was continued in Lake Greenwood and Lake Murray. An age-growth study of the white bass in Lake Greenwood was made and efforts were continued to determine the extent of survival of striped bass fry stocked in the lakes.

Progress of the studies conducted this segment is as follows:

JOB I POPULATION STUDIES IN RESERVOIRS

The purpose of this job is to keep abreast of changes which have or which may be occurring in the fish populations of Lakes Greenwood and Hartwell. Work

plans specified six studies on each of these lakes during the period August 1 - September 15; however, difficulty encountered in obtaining rotenone caused the delay of the studies until October 10. Due to this difficulty in obtaining rotenone, the prescribed number of studies were not conducted. Only one study was conducted on each lake, and while the surface area was increased from that set forth in the job outline as the maximum and minimum size for a study area, the total surface area sampled was less than the total minimum area prescribed for each lake in the job outline.

The 1966 studies were the first fish population studies conducted in the State in which a block-off net was employed. It should be pointed out that the 1966 studies vary from previous studies in that "pick-up" and processing was through the third day following the initial "kill".

Prior to the studies, a suitable area was selected on each lake and the surface area and average depth of each was determined. The block-off net was set in place the evening of the day before the study was scheduled. The piscicide used in the studies was emulsified rotenone, "Nox-Fish", at the rate of 0.75 to 1.25 ppm. A malfunction of the gasoline driven pump used for dispersing the rotenone necessiated the use of a Venturi Tube attachment on the outboard motor for dispersing the toxicant. Buckets were used to treat the littoral zone.

When fish began surfacing, they were collected and carried to a "sorting" table for processing. The recovered fish were separated as to species and each species was further separated to one-inch size groups--the ½ inch mark being the dividing line between the size groups. The number of individuals in each size group was determined and the entire group was weighed. This routine was followed through the third day except, following the first day only those size groups not start represented the first day in sufficient numbers for good average weights were weighed.

The 1966 studies yielded 15 and 17 species of fish from the respective

lakes--excluding miscellaneous minnows. Included in the group listed as miscellaneous minnows were representatives of the following genera: Labidesthes, Etheostoma, Gambusia, Notropis, Hybopsis, etc. The common and scientific name of each species mentioned in this report are listed in Table1.

The following are the results of the 1966 studies:

LAKE GREENWOOD:

One area was sampled in Lake Greenwood during 1966--October 10 through 12. The area sampled had a surface area of 2.0 acres and had an average depth of 4.0 feet--maximum depth in the area was 26 feet. The sample area was located approximately two-thirds the distance up the lake from the dam, at the junction of the Saluda and Reedy Rivers.

The 1966 study yielded 17 species of fish--excluding miscellaneous minnows. The predominant species, based on total weight, in desending order of abundance were: gizzard shad (73.89 percent), bluegill (9.57 percent),pumpkinseed (4.60 percent), largemouth bass (3.53 percent), yellow perch (2.78 percent), carp (2.05 percent) and white catfish (1.26 percent). These seven species made up 97.68 percent of the total weight of fish recovered. Eight other species plus miscellaneous minnows made up the remaining 2.32 percent of the total weight of fish recovered.

E values and total weight contributed by the fingerlings, intermediates and adults of the various species taken in the study are tabulated in Table 2. Length-frequency distribution is tabulated in Table 3. Population dynamics for the years 1961 through 1966 are tabulated in Table 4.

The 1966 population dynamics indicate the following:

F/C - Forage species to carnivorous species ratio:

The F/C ratio for the 1966 study was 17.5. This ratio indicates a population that is overcrowded with forage species.

Y/C - Fish of a size readily available as food for the carnivorous species:

Table 1.--A list of the common and scientific names of the various species of fishes mentioned in this report

Common name	Scientific name
Walleye	Stizostedion vitreum vitreum (Mitchill)
Yellow perch	Perca flavescens (Mitchill)
Black crappie	Pomoxis nigromaculatus (LeSueur)
White crappie	Pomoxis annularis Rafinesque
Largemouth bass	Micropterus salmoides (Lacepede)
Redeye bass	Micropterus coosae Hubbs and Bailey
Redear sunfish	Lepomis microlophus (Gunther)
Bluegill	Lepomis macrochirus Rafinesque
Orangespotted sunfish	Lepomis humilis (Girard)
Pumpkinseed	Lepomis gibbosus (Linnaeus)
Green sunfish	Lepomis cyanellus Rafinesque
Redbreast sunfish	Lepomis auritus (Linnaeus)
Warmouth	Chaenobryttus gutosus (Cuvier)
Flier	Centrarchus macropterus (Lacepede)
Striped bass	Roccus saxatilis (Walbaum)
White bass	Roccus chrysops (Rafinesque)
Channel catfish	Ictalurus punctatus (Rafinesque)
Flat bullhead	Ictalurus platycephalus (Girard)
Brown bullhead	Ictalurus nebulosus (LeSueur)
White catfish	Ictalurus catus (Linnaeus)
Golden redhorse	Moxostoma erythrurum (Rafinesque)
Spotted sucker	Minytrema melanops (Rafinesque)
Northern hog sucker	Hypentelium nigricans (LeSueur)
River carpsucker	Carpiodes carpio (Rafinesque)
Common shiner	Notropis cornutus (Mitchill)
Carp	Cyprinus carpio Linnaeus
Chain pickerel	Esox niger LeSueur
Threadfin shad	Dorosoma petenense (Gunther)
Gizzard shad	Dorosoma cepedianum (LeSueur)
Longnose gar	Lepisosteus osseus (Linnaeus)
Misc. minnows	Labidesthes, Etheostoma, Gambusia, Hybopsis, etc.

The Y/C value for the 1966 study was 0.9. This value, viewed alone and with no consideration of the time it was obtained, indicates a population overcrowded with carnivorous species. Theoretically, highest Y/C values will occur shortly after the spring spawning season and will then decline, under normal conditions, until they reach their lowest point just prior to the following spring spawning season. Considering the time elapsed since the spring spawn, the Y/C value of the 1966 study is considered satisfactory.

A_T - Percentage of harvestable size fish:

Table 2.--Lake Greenwood: The total pounds and the E values contributed to the total weight of the population by the adult, intermediate and fingerling size fish of each species taken in a population sample during October, 1966

Species	Adults		Intermediate		Fingerling		Totals	
	Pounds	E value	Pounds	E value	Pounds	E value	Pounds	E value
Yellow perch	3.78	1.10	5.69	1.66	--	--	9.47	2.76
Black crappie	1.78	0.52	0.72	0.21	0.12	0.04	2.62	0.77
White crappie	0.28	0.08	0.09	0.03	0.16	0.04	0.53	0.15
Largemouth bass	7.50	2.20	3.65	1.06	0.91	0.26	12.06	3.52
Bluegill	10.59	3.09	8.16	2.39	13.91	4.06	32.66	9.54
Orangespotted sunfish	--	--	0.40	0.12	0.19	0.05	0.59	0.17
Pumpkinseed	9.00	2.63	6.46	1.89	0.25	0.07	15.71	4.59
Green sunfish	--	--	0.34	0.10	T	--	0.34	0.10
Redbreast sunfish	0.69	0.20	0.03	0.01	--	--	0.72	0.21
Warmouth	0.47	0.14	0.15	0.04	T	--	0.62	0.18
White bass	--	--	0.09	0.03	--	--	0.09	0.03
Flat bullhead	0.50	0.15	0.25	0.07	0.28	0.08	1.03	0.30
White catfish	4.29	1.25	--	--	T	--	4.29	1.25
Golden redhorse	1.19	0.34	0.09	0.03	--	--	1.28	0.37
Common shiner	0.06	0.02	0.09	0.03	0.06	0.02	0.21	0.07
Carp	7.00	2.04	--	--	--	--	7.00	2.04
Gizzard shad	220.88	64.50	31.40	9.17	--	--	252.28	73.68
Miscellaneous minnows	--	--	--	--	0.97	0.28	0.97	0.28
Totals	268.01	78.26	57.61	16.84	16.85	4.90	342.47	100.00

T = Trace

Table 3.--Lake Greenwood: Length-frequency distribution of the various species taken in one population study during October, 1966

Inch class	Largemouth bass	White bass	White crappie	Black crappie	Bluegill	Pumpkinseed	Green sunfish	Redbreast
1				1	159			
2	1			1	2,214	41	2	
3	49				443	269	11	
4	26		5	5	110	81	2	1
5	30			1	111	104		1
6	14	1	1	7	25	8		2
7	2			1	5			
8	3		1	2				1
9	5			3				
10	1							
11								
12								
13	2							
15								
17								
20	1							
22								
Totals	134	1	7	20	3,067	503	15	5

Table 3.--Lake Greenwood: (Continued)

Inch class	OS.S.*	Warmouth	Yellow perch	Flat bullhead	Redhorse sucker	Carp	White catfish	Gizzard shad	Common shiner	Misc. minnows
1										5
2	17	3					2			26
3	13	3		3					3	38
4	4	2	181	7				18	1	17
5		3	71	1				7	2	
6		2	35	2	1			42	1	
7			11	2	7		2	273		
8				1	2		2	106		
9							3	391		
10							2	263		
11							4	46		
12								18		
13								7		
15								4		
17						1				
20										
22						1				
Totals	34	13	298	16	10	2	15	1,175	7	86

* = Orangespotted sunfish

Table 4.--Lake Greenwood: Population dynamics, as indicated by rotenone samples, for the years 1961 through 1966

Species	1961	1962	1963	1964	1965	1966
E Values for:						
Yellow perch	--	0.24	0.35	0.55	0.25	2.76
Black crappie	0.04	11.76	1.13	0.64	1.39	0.77
White crappie	0.01	7.13	--	0.29	0.31	0.15
Largemouth bass	0.37	8.82	4.10	2.79	0.74	3.52
Redeye bass	--	--	--	0.01	0.01	--
Bluegill	4.88	17.46	17.49	8.54	8.40	9.54
Orangespotted sunfish	0.01	0.20	0.06	0.03	0.13	0.17
Pumpkinseed	0.94	10.21	11.92	4.91	2.42	4.59
Green sunfish	--	--	--	--	--	0.10
Redbreast sunfish	--	0.22	--	--	--	0.21
Warmouth	0.36	1.78	1.61	1.05	0.23	0.18
Striped bass	--	--	--	--	**	--
White bass	0.13	3.26	1.57	0.93	0.31	0.03
Flat bullhead	0.05	0.73	0.12	0.12	0.11	0.30
Brown bullhead	--	--	1.07	0.04	**	--
White catfish	0.07	1.78	2.85	0.45	0.86	1.25
Golden redhorse	0.14	1.22	--	0.25	0.10	0.37
Common shiner	**	0.14	0.01	0.06	0.03	0.07
River carpsucker	--	5.39	--	0.20	0.61	--
Carp	0.11	11.91	--	5.54	0.82	2.04
Gizzard shad	92.86	17.75	57.72	75.57	83.22	73.67
Longnose gar	0.01	--	**	0.03	0.04	--
Miscellaneous minnows	--	--	--	**	0.02	0.28
F/C	159.9	2.3	9.6	22.4	54.6	17.5
Y/C	21.6	0.1	0.2	0.5	0.4	0.9
A_T	6.9	69.3	82.3	77.2	85.6	78.3
A_H	3.7	57.7	25.0	18.7	9.8	13.8
A_N	3.2	11.6	57.3	58.5	75.8	64.5
A_F	6.7	61.3	86.8	74.5	85.7	78.5
I_F	79.8	33.2	11.1	19.1	13.6	16.6
S_F	13.5	5.5	2.1	2.2	0.7	4.9
Pounds per acre	1,087.62	102.27	219.36	327.18	679.22	171.24

** = Less than 0.005 percent

The A_T value for the 1966 study was 78.2. This value fell within the most desirable range for balanced populations; however, when the A_T value is broken down to its component parts, the production of harvestable size fish in the lake leaves much to be desired. Fron a strictly biological standpoint, the A_T value is very satisfactory.

A_H - Normally harvested species:

Those species normally harvested by the sport and/or commerical fishermen made up only 13.8 percent of the total fish population. This indicates that the majority of the fish production in the lake is tied-up with species having little or no economic value and only limited biological value.

A_N - Normally unharvested species:

This is the one factor that most nearly describes the condition of the fish population in the lake. The 1966 study indicates that 64.5 percent of the entire weight of the existing fish population is made up of harvestable size fish of a species (chiefly gizzard shad) not normally harvested by either the sportsman or the commerical fisherman.

A_F - Adult forage fish:

The A_F value for the 1966 study was 78.5, which falls within the optimum range--60.0 to 80.0--for balanced populations; however,it is approaching the point--above 80.0--which indicates an overcrowded carnivorous population.

S_F - Small forage fish:

The weight of the small forage fish recovered during the study made up 4.9 percent of the total forage fish weight. This value, also, indicates a population overcrowded with carnivorous species.

LAKE HARTWELL

One area was sampled on Lake Hartwell during 1966--October 13 through October 15. The area sampled had a surface area of 2.5 acres and had an average depth of 8.1 feet. The area is located approximately mid-way between the dam

and the headwaters--near the mouth of Coneross Creek.

The study yielded 15 species of fishes--excluding miscellaneous minnows. The predominant species, based on total weight recovered, in descending order of abundance were: bluegill (40.53 percent), green sunfish (9.48 percent), yellow perch (9.36 percent), gizzard shad (9.12 percent), largemouth bass (8.37 percent), threadfin shad (7.39 percent), redbreast sunfish (4.96 percent), warmouth (4.85 percent), carp (1.66 percent) and flat bullhead (1.20 percent). These ten species made up 96.92 percent of the total weight of fish recovered. Five other species plus miscellaneous minnows (each contributing less than 1.0 percent to the total) made up the remaining 3.08 percent of the sample.

E values and the total weight contributed by the adults, intermediates and fingerlings of the various species taken in the study are tabulated in Table 5. Length-frequency distribution is tabulated in Table 6 and the population dynamics for the years 1961 through 1966 are tabulated in Table 7.

The 1966 population dynamics indicate the following:

F/C:

The F/C ratio of the 1966 study was 9.8 and while this value does not fall within the optimum range--3.0 to 6.0--for a balanced population, it does fall within the overall range for balanced populations.

Y/C:

The Y/C value for the 1966 study was 2.2--well within the optimum range for balanced populations.

A_T:

The percentage of harvestable size fish in the population was calculated as 34.3. This value is just inside the range for balanced populations and indicates an inefficient population.

A_H and A_N:

These values were 25.2 and 9.1 respectively in the 1966 study. Albeit the

Table 5.--Lake Hartwell: The total pounds and the E values contributed to the total weight of the population by the adult, intermediate and fingerling size fish of each species taken in a population study during October, 1966

Species	Adults		Intermediates		Fingerlings		Totals	
	Pounds	E value	Pounds	E value	Pounds	E value	Pounds	E value
Yellow perch	--	--	7.78	5.64	5.13	3.72	12.91	9.36
Black crappie	0.12	0.09	--	--	0.06	0.04	0.18	0.13
Largemouth bass	9.35	6.79	1.41	1.02	0.77	0.56	11.53	8.37
Bluegill	11.29	8.19	35.19	25.54	9.37	6.80	55.85	40.53
Pumpkinseed	0.06	0.04	0.78	0.57	T	--	0.84	0.61
Green sunfish	1.97	1.43	9.88	7.17	1.22	0.88	13.07	9.48
Redbreast sunfish	5.56	4.04	1.15	0.83	0.12	0.09	6.83	4.96
Warmouth	1.81	1.31	4.19	3.05	0.68	0.49	6.68	4.85
Channel catfish	1.00	0.72	--	--	--	--	1.00	0.72
Flat bullhead	0.97	0.70	0.34	0.25	0.34	0.25	1.65	1.20
Brown bullhead	1.18	0.86	--	--	--	--	1.18	0.86
White catfish	--	--	--	--	0.09	0.06	0.09	0.06
Carp	1.38	1.00	0.91	0.66	--	--	2.29	1.66
Threadfin shad	--	--	--	--	10.18	7.39	10.18	7.39
Gizzard shad	12.57	9.12	--	--	--	--	12.57	9.12
Spottail shiner	--	--	--	--	0.96	0.70	0.96	0.70
Totals	47.26	34.29	61.63	44.73	28.92	20.98	137.81	100.00

T = Trace

Table 6.--Lake Hartwell: Length-frequency distribution of the various species taken in one population study during October, 1966

Inch class	Largemouth bass	Black crappie	Bluegill	Redbreast	Green sunfish	Pumpkinseed	Yellow perch	Warmouth
1			325		35	1	35	37
2	4	2	2,123	19	298	1	298	169
3	17	5	1,375	13	257	15	255	108
4	18	1	674	22	185	17	186	88
5	4		113	41	27	1	27	31
6	4		34	19				
7	1	1	8	4				
8	1							
9	3							
10	5							
11	3							
12	1							
13	1							
14	1							
15								
16	1							
Totals	64	9	4,652	118	802	35	801	433

Table 6.--Lake Hartwell: (Continued)

Inch class	Flat bullhead	Brown bullhead	Carp	Channel catfish	White catfish	Gizzard shad	Threadfin shad	Misc. minnows
1	1							
2	26				2		677	46
3	25				3		905	93
4	2				2		35	15
5	3							
6	4						2	
7	2							
8	2							
9	2					3		
10						2		
11		1				13		
12		1				4		
13			1			1		
14						2		
15			1	1				
16								
Totals	66	2	2	1	7	25	1,619	154

Table 7.--Lake Hartwell: A comparison of the population dynamics, as indicated by rotenone samples, for the years 1961 through 1966

Species	1961	1962	1963	1964	1965	1966
E Values for:						
Walleye	--	0.08	--	0.16	0.17	--
Yellow perch	1.70	10.05	4.04	2.77	2.75	9.36
Black crappie	37.87	6.47	8.72	2.50	12.95	0.13
White crappie	--	0.47	0.16	2.20	1.31	--
Largemouth bass	10.07	9.86	5.19	3.77	2.28	8.37
Redeye bass	--	--	--	--	0.01	--
Redear sunfish	--	--	--	1.68	--	--
Bluegill	1.00	10.88	26.40	26.65	22.23	40.53
Orangespotted sunfish	--	--	**	--	--	--
Pumpkinseed	0.63	2.41	3.39	0.41	0.32	0.61
Green sunfish	0.60	1.84	2.03	3.22	2.12	9.48
Redbreast sunfish	2.18	5.28	6.92	7.50	2.42	4.96
Warmouth	3.53	4.70	2.99	5.54	5.20	4.85
Flier	0.76	0.06	0.05	0.50	0.04	--
White bass	--	0.38	0.88	0.10	0.02	--
Channel catfish	--	0.05	--	0.22	2.40	0.72
Flat bullhead	3.03	0.91	0.21	1.08	0.83	1.20
Brown bullhead	9.94	2.57	0.49	0.52	0.22	0.86
White catfish	--	--	--	0.28	0.18	0.06
Golden redhorse	--	0.52	--	1.03	0.18	--
Spotted sucker	--	0.25	--	0.12	0.12	--
Northern hog sucker	--	0.08	--	--	0.01	--
Common shiner	12.58	1.40	0.92	0.31	0.07	--
River carpsucker	--	--	--	0.94	--	--
Carp	10.14	27.56	6.83	5.49	10.90	1.66
Chain pickerel	0.63	4.95	3.09	0.67	0.14	--
Threadfin shad	--	0.01	2.28	7.88	2.03	7.39
Gizzard shad	5.34	9.22	25.32	24.77	30.61	9.12
Miscellaneous minnows	--	**	0.09	0.19	0.16	0.70
F/C	5.3	4.6	7.6	14.0	7.1	9.8
Y/C	2.4	0.2	1.3	2.9	0.8	2.2
A_T	15.1	37.8	44.3	36.7	36.1	34.3
A_H	14.6	33.0	22.2	17.2	19.4	25.2
A_N	0.5	4.8	22.1	19.5	16.7	9.1
A_F	45.3	62.0	39.5	41.0	60.1	48.1
S_F	45.7	4.2	17.5	19.2	11.7	22.5
Pounds per acre	104.08	66.09	63.95	129.29	169.24	55.12

** = Less than 0.005 percent

A_H value is below the satisfactory level, the ratio of A_H to A_N is satisfactory.

A_F:

The percentage of the total weight of the forage fish population composed of adult fish was 29.4. This value lies within the range for balanced populations but, again, indicates an inefficient population.

S_F:

The S_F value of the 1966 study was 22.5. This value falls within the optimum range for balanced populations.

E values:

E values of the fingerling size fish indicate satisfactory reproduction of most of the species in the lake.

Conclusions and Recommendations

The 1966 population study indicates that Lake Hartwell is supporting a balanced but somewhat inefficient fish population. It is my opinion that this is due, chiefly, to the low basic fertility of the lake. Being located near the head-waters of the Savannah River and having a relatively small watershed on which little farming is carried on, the lake is relatively infertile in comparison to a lake situated further downstream and which has a much larger and more fertile watershed. As basic nutrients accumulate in the lake, the basic fertility will gradually improve and, thus, the fish population should improve.

Present management, and management in the immediate future, of Lake Hartwell should be aimed, chiefly, at converting a portion of the undesirable species in the lake into one that is desirable as a sport fish. Towards this end, I recommend that the lake be stocked annually with the hybrid of the striped bass-white bass.

The 1966 population study on Lake Greenwood indicates, as usual, an extremely large gizzard shad population. This, in itself, might be tolerable to a certain degree if so large a portion of these shad were not composed of in-

dividuals too large to be utilized as food by the averaged sized carnivorous species in the population. The F/C ratio of the lake indicates a population badly overcrowded with forage species; however, other population measurements indicate a population that is on the brink of being overcrowded with carnivorous species.

There is no doubt that the large gizzard shad in the population has a depressing effect on the population as a whole; however, their food habits are such that very little competition for food exists between them and the other forage species in the lake. Further, since the large shad are totally unavailable as food for the carnivorous species in the lake; the lake, in a sense, could very well be on the brink of being overcrowded with carnivorous species. There is little doubt that following the spring spawn and for that period of time until the young shad become too large to serve as food for the average sized carnivorous adult, the implication of the high F/C ratio is a valid one; however, this factor alone cannot measure the true condition of the population. Regardless of the magnitude of the F/C ratio, once the carnivorous population is forced to fall back on the other forage species as a source of food and when these species are not present in sufficient numbers to adequately support the carnivorous population; then, truly, an overcrowded condition of carnivorous species must exist.

To eliminate a portion of this large shad population and to add to the desirable species in the lake, I recommend the continued, heavy stocking of striped bass in the lake. This recommendation appears to be contradictory; however, when viewed in respect to the average size that the striped bass will attain, the addition of striped bass to the population will remove the large shad from the unavailable back to available in the food chain and, thus, give new meaning to the F/C ratio.

If we are to establish a striped bass fishery in any of our reservoirs,

this lake (Lake Greenwood) is the one on which we should concentrate. Here we could truly perform a twofold service--establish a striped bass fishery where none now exists and demonstrate the effectiveness of the striped bass as a biological control of, no doubt, the largest gizzard shad population in the State.

JOB II CREEL CENSUS IN RESERVOIRS

This is a continuing study and is designed to measure the degree of sport fishing success on Lakes Greenwood and Hartwell. The majority of this census was conducted by paid creel clerks who reside on and/or operate fishing camps on the lakes. Information collected by these creel clerks include: date of census, age and sex of the fishermen contacted, total number of fishing hours and a numerical count of the various species in the creels. The fishermen contacted by the creel clerks were contacted at the end of their day of fishing.

Project personnel conducted a census on each lake in addition to that conducted by the creel clerks. Information obtained from this census, in addition to that collected by the creel clerks, included: method and type of fishing, type of license held, time of day that fishing occurred and the number and weight of the various species in the creels. The average weights for the various species obtained by project personnel were used for calculating the total weights appearing in the Tables. Likewise, the percentage of fishermen employing different methods and types of fishing (those contacted by project personnel) were expanded to encompass all the fishermen contacted.

The 1966 creel data from Lakes Greenwood and Hartwell indicate the following:

LAKE GREENWOOD:

During 1966, 3,473 fishermen were contacted by project personnel and by hired creel clerks. These fishermen had fished 9,339 hours and had caught

18,081 fish which weighed approximately 6,755.0 pounds. The length of the average fishing trip was 2.7 hours and the average trip produced 5.24 fish that weighed 1.94 pounds--1.94 fish weighing 0.72 pounds per hour of fishing. Age and sex of the fishermen contacted were as follows: male adults - 66.0 percent, male children - 8.4 percent, female adults - 23.1 percent and female children - 2.5 percent.

The creel data, in respect to the individual species in the creels, indicate the following:

Largemouth bass:

Largemouth bass ranked fourth in both total number and total weight of fish in the creels--making up 2.6 percent of the total number and 7.5 percent of the total weight. September was the best month for taking this species and still fishermen using artifical tackle were, by far, the most successful bass fishermen (Table 8). Percentagewise, the numerical catch of largemouth bass decreased slightly from that of 1965--from 2.7 percent in 1965 to 2.6 percent in 1966.

White bass:

White bass ranked third in total number of fish in the creels and second in total weight. Percentagewise, this species showed a 3.0 percent increase in the 1966 creels from that of 1965. October produced the greatest numerical catches of this species and still fishermen using artifical tackle were the most successful white bass fishermen.

Crappie:

The term "crappie" includes both the black and the white crappies. These two species, combined, were the predominant species in the creels in both number and weight--making up 64.9 percent of the total number and 47.7 percent of the total weight. The 1966 crappie catch dropped approximately 5.0 percent from that of 1965. April and May produced the best crappie catches.

Table 8.--Lake Greenwood: A comparison of the age and sex of fishermen checked during 1966--depicting the number and weight of the various species in the creels and the catch per hour by the various methods* and types* of fishing employed

Method and Type	A-Sh	A-St	A-T	PL-Sh	PL-St	PLA-Sh	PLA-St	Unknown	All methods and types
Male adults	198	829	139	435	93	442	155	--	2,291
Male children	45	92	45	49	--	48	14	--	293
Female adults	47	61	16	379	2	279	18	--	802
Female children	--	21	22	43	--	1	--	--	87
Total number fishermen	290	1,003	222	906	95	770	187	--	3,473
Total hours fished	637	2,563	412	2,797	176	2,050	704	--	9,339
CATCH: NUMBER									
Largemouth bass	2	363	32	72	--	--	5	--	474
White bass	17	1,943	61	7	6	3	57	--	2,094
Striped bass	--	--	--	--	--	--	--	3	3
Crappie	177	890	53	5,480	385	3,093	1,691	--	11,742
Bream	80	1,125	--	1,724	11	318	15	--	3,273
Yellow perch	--	--	--	43	4	--	--	--	47
Catfish	107	6	--	195	6	74	6	--	394
Carp	4	--	--	2	--	6	--	45	57
Total number of fish	387	4,327	146	7,523	385	3,494	1,774	48	18,084
CATCH: WEIGHT									
Largemouth bass	0.5	453.8	33.9	11.5	--	--	5.2	--	504.9
White bass	16.8	2,020.7	60.4	6.9	4.6	3.0	25.1	--	2,137.5
Striped bass	--	--	--	--	--	--	--	2.6	2.6
Crappie	60.2	195.8	13.2	1,479.6	78.8	773.2	625.7	--	3,226.5
Bream	16.0	247.5	--	275.8	2.0	60.4	7.5	--	609.2
Yellow perch	--	--	--	7.3	0.7	--	--	--	8.0
Catfish	32.1	3.0	--	83.8	1.5	28.9	3.0	--	152.3
Carp	8.0	--	--	4.0	--	12.0	--	90.0	114.0
Total weight of fish	133.6	2,920.8	107.5	1,868.9	87.6	877.5	666.5	92.6	6,755.0
Catch/hr: number	0.61	1.69	0.35	2.69	2.19	1.70	2.52	--	1.94
Catch/hr: weight	0.21	1.14	0.26	0.67	0.98	0.43	0.95	--	[illegible]

Method*

A = Artifical tackle
PL = Pole and line
PLA = Pole and line plus artifical tackle

Type*

Sh = Shore
St = Still
T = Trolling

Bream:

Bream (chiefly bluegill) ranked second in total number (18.1 percent) and third in total weight (9.0 percent) in the 1966 creels. The numerical catch increased an approximate 4.8 percent from the 1965 catch. June produced the best bream fishing and fishermen with a pole and line from the shore were the most successful bream fishermen.

Catfish:

Catfish (chiefly white catfish) ranked fifth in the creels in both number and weight. July produced the best catfishing and pole and line fishermen from the shore were most successful.

Carp and yellow perch:

These species contributed less than 1.0 percent to the creels--numerically, 0.3 and 0.2 percent respectively--and are considered insignificant in the creels.

Striped bass:

Striped bass made up only a minute portion of the 1966 creels--three individuals weighing 2.6 pounds--and are significant only in the sense that they represent survivors of the heavy 1965 striped bass fry stocking in the lake.

During the first six months of 1967, 1,878 fishermen were contacted on the lake. These fishermen had fished 5,833 hours and had caught 12,186 fish that weighed approximately 3,499.8 pounds. The length of the average fishing trip was 3.1 hours and the average catch per trip was 6.5 fish weighing 1.8 pounds--2.09 fish weighing 0.59 pounds per hour of fishing (Table 9). Age and sex of the fishermen contacted were as follows: male adults - 68.0 percent, male children - 8.0 percent, female adults - 22.0 percent and female children - 2.0 percent.

The 1966 creels were made up of seven species and the data indicate the following in respect to these species.

Table 9.--Lake Greenwood: A comparison of the age and sex of fishermen checked during March through June, 1967--depicting the number and weight of the various species in the creels and the catch per hour by the various methods* and types* of fishing employed

Method and Type	A-Sh	A-St	A-T	PL-Sh	PL-St	PLA-Sh	PLA-St	Unknown	All methods and types
Male adults	165	496	119	83	--	239	175	--	1,277
Male children	30	45	15	--	--	45	15	--	150
Female adults	88	59	20	59	20	128	39	--	413
Female children	--	--	--	--	--	19	19	--	38
Total number fishermen	283	600	154	142	20	431	248	--	1,878
Total hours fished	644	2,356	556	225	40	928	1,084	--	5,833
CATCH: NUMBER									
Largemouth bass	15	72	15	--	--	14	15	--	131
White bass	185	241	40	--	--	--	--	--	466
Crappie	312	3,791	311	26	389	571	4,024	--	9,424
Bream	559	268	--	470	--	470	45	--	1,812
Yellow perch	--	95	--	--	--	48	--	--	143
Catfish	29	95	--	44	--	37	--	--	205
Carp	--	--	--	--	--	--	--	5	5
CATCH: WEIGHT									
Largemouth bass	16.4	78.5	16.3	--	--	15.3	16.4	--	142.9
White bass	192.4	250.6	41.6	--	--	--	--	--	484.6
Crappie	78.0	947.8	77.8	6.5	97.2	142.8	1,006.0	--	2,356.1
Bream	106.2	50.9	--	89.3	--	89.3	8.6	--	344.3
Yellow perch	--	21.8	--	--	--	11.0	--	--	32.8
Catfish	11.9	39.0	--	18.0	--	15.2	--	--	84.1
Carp	--	--	--	--	--	--	--	5.0	5.0
Catch/hr: number	1.71	1.94	0.66	2.40	9.72	1.23	3.77	?	2.09
Catch/hr: weight	0.63	0.59	0.24	0.50	2.43	0.29	0.95	?	0.59

* See Table 8 footnote

Largemouth bass:

Largemouth bass ranked sixth in number (1.1 percent) and fourth in weight (4.1 percent) in the creels. The 1967 numerical catch declined 0.6 percent from the same period in 1966.

Crappie:

As usual, crappie were the dominant species in the 1967 creels--making up 77.3 percent of the total number and 68.3 percent of the total weight. The 1967 crappie catch increased 8.0 percent over that of the same period in 1966.

White bass:

The 1967 white bass catch ranked third in number (3.8 percent) and second in weight (14.0 percent). The 1967 numerical catch of this species declined by 2.6 percent from that of the same period in 1966.

Bream:

Bream ranked second, numerically, in the 1967 creels and third in total weight (10.0 percent). The 1967 numerical catch of 14.9 percent was a decrease of 4.8 percent from that of the same period in 1966.

Yellow perch:

This species appears to be on the increase in the lake. The numerical catch of this species during the first six months of 1966 was only 0.2 percent of the total catch. The numerical percentage of this species for the same period in 1967 has risen to 1.2 percent of the total catch.

Catfish:

The number of catfish during the first six months of 1967 was 1.7 percent of the total catch. This represents a 0.6 percent decrease from that of 1966.

Carp:

Only five carp were observed during the first six months of 1967 and are considered as insignificant in the creels.

LAKE HARTWELL:

The creels of 2,608 fishermen were checked on Lake Hartwell during 1966. The fishermen contacted had fished 9,290 hours and had caught 7,312 fish weighing approximately 3,367.0 pounds (Table 10). The length of the average fishing trip was 3.6 hours and the average catch per trip was 2.8 fish weighing 1.3 pounds--an average catch of 0.79 fish weighing 0.36 pounds per hour of fishing. Age and sex of the fishermen contacted were as follows: male adults - 80.7 percent, male children - 7.7 percent, female adults - 9.9 percent and female children - 1.7 percent.

Nine species and/or groups of fishes were observed in the 1966 creels and the data indicate the following in respect to these fishes:

Largemouth bass:

Largemouth ranked second both numerically and in total weight in the 1966 creels--8.2 percent of the total number and 29.3 percent of the total weight. Numerically, the percentage of this species in the creels remained about the same in 1965 and 1966--8.2 percent in 1966 as compared to 8.1 percent in 1965. April was the best month for bass fishing and those fishermen using artifical tackle while still fishing were the most successful.

White bass:

This species contributed only 0.7 percent to the total number of fish in the creels. The percentage of this species in the creels has remained virtually the same since 1963--0.6 percent in 1963, 0.5 percent in 1964, 0.5 percent in 1965 and 0.7 percent in 1966. September and October were the best white bass producing months.

Crappie:

Crappie, black and white combined, were the dominant species in the creels--80.1 percent of the total number and 63.5 percent of the total weight. The percentage of crappie in the 1966 creels was slightly greater than in 1965 (78.4 percent). April and may were the best crappie months and those fishermen still

Table 10.--Lake Hartwell: A comparison of the age and sex of fishermen checked during 1965--depicting the number and weight of the various species in the creels and the catch per hour by the various methods* and types* of fishing employed

Method and Type	A-Sh	A-St	A-T	PL-Sh	PL-St	PLA-Sh	PLA-St	Unknown	All methods and types
Male adults	295	902	164	84	110	201	348	--	2,104
Male children	13	82	13	19	7	6	62	--	202
Female adults	58	49	13	27	6	89	15	--	257
Female children	6	6	--	--	16	8	9	--	45
Total number fishermen	372	1,039	190	130	139	304	434	--	2,608
Total hours fished	914	3,349	652	464	458	1,128	2,325	--	9,290
CATCH: NUMBER									
Largemouth bass	19	416	69	--	20	9	63	--	596
White bass	--	--	--	--	--	--	--	51	51
Walleye	--	--	5	--	--	2	--	--	7
Pickerel	--	--	--	--	--	--	--	2	2
Crappie	174	2,594	262	337	1,345	591	551	--	5,854
Bream	14	159	7	65	--	257	76	--	578
Yellow perch	--	--	--	--	--	5	4	2	11
Catfish	--	23	--	--	--	45	45	41	154
Carp	--	--	--	5	5	27	6	16	59
Total number of fish	207	3,192	343	407	1,370	936	745	112	7,312
CATCH: WEIGHT									
Largemouth bass	28.5	736.3	113.8	--	12.4	13.5	83.2	--	987.7
White bass	--	--	--	--	--	--	--	**	**
Walleye	--	--	10.6	--	--	4.4	--	--	15.0
Pickerel	--	--	--	--	--	--	--	**	**
Crappie	62.6	856.0	138.9	87.6	511.1	271.9	209.4	--	2,137.5
Bream	5.3	35.0	2.2	10.4	--	28.3	14.4	--	95.6
Yellow perch	--	--	--	--	--	0.6	0.8	0.3	1.7
Catfish	--	4.4	--	--	--	19.8	18.0	15.2	57.4
Carp	--	--	--	10.0	5.6	30.0	7.1	19.5	72.2
Catch/hr: number	0.23	0.95	0.53	0.88	2.99	0.32	0.32	**	0.79
Catch/hr: weight	0.10	0.49	0.41	0.23	1.16	0.33	0.14	**	0.36

* See Table 8 footnote

** insufficient data

fishing with artifical tackle were the most successful crappie fishermen.

Bream:

The term "bream" includes all the so-called "panfishes" common to the lake except the yellow perch. Bream ranked third in number (7.9 percent) and weight (2.8 percent) in the 1966 creels. The numerical catch decreased some 1.1 percent from that of the previous year. The month of August produced the best bream fishing and those fishermen using a combination of pole and line and artifical tackle from the shore were the most successful bream fishermen.

Catfish:

Catfish (chiefly white catfish) increased in number, percentagewise, in the creels in 1966 (2.1 percent) from that of 1965 (1.4 percent). The weight of the 1966 catfish catch made up 1.8 percent of the total catch. March was the best month for catfish fishing and they were taken more readily by those fishermen using a combination of tackle from the shore.

Carp:

Carp contributed 0.7 percent to the total number of fish in the 1966 creels and 2.1 percent to the total weight. May produced the best carp fishing and still fishing with artifical tackle was most productive.

Walleye:

Walleye contributed only seven fish to the overall catch in 1966 and these seven fish made up 0.4 percent of the total weight. This species is probably more abundant in the lake than is indicated by its presence in the creels. This is a new species to the area and fishermen have not yet become familar with its habits or the correct techniques for catching it. This, in my opinion, accounts for the relative few showing up in the creels.

During the first six months of 1967, 1,423 fishermen were contacted by census personnel on the lake. These fishermen had fished 5,364 hours and had caught 4,788 fish that weighed an approximate 2,593.7 pounds (Table 11). The

Table 11.--Lake Hartwell: A comparison of the age and sex of fishermen checked during the first six month of 1967--depicting the number and weight of the various species in the creels and the catch by the various methods* and types* of fishing employed

Method and Type	A-Sh	A-St	A-T	PLA-Sh	PLA-St	Unknown	All methods and types
Male adults	182	580	116	50	232	--	1,160
Male children	13	38	26	26	26	--	129
Female adults	35	53	18	--	--	--	106
Female children	9	11	1	3	4	--	28
Total number fishermen	239	682	161	79	262	--	1,423
Total hours fished	641	2,516	475	166	1,566	--	5,364
CATCH: NUMBER							
Largemouth bass	--	220	28	--	227	--	475
White bass	21	11	33	2	8	--	75
Walleye	--	1	5	--	2	--	8
Crappie	476	396	40	486	2,408	--	3,806
Bream	22	352	--	--	22	--	396
Yellow perch	--	--	--	--	--	9	9
Catfish	46	23	--	--	--	--	69
Carp	--	--	--	--	--	39	39
Total number of fish	565	1,003	106	488	2,667	48	4,877
CATCH: WEIGHT							
Largemouth bass	--	281.6	35.8	--	290.6	--	608.0
White bass	18.3	9.6	29.6	1.7	7.0	--	66.2
Walleye	--	1.4	6.8	--	2.7	--	10.9
Crappie	214.2	178.2	18.0	218.7	1,083.6	--	1,712.7
Bream	5.3	84.5	--	--	5.4	--	95.2
Yellow perch	--	--	--	--	--	1.7	1.7
Catfish	40.0	20.0	--	--	--	--	60.0
Carp	--	--	--	--	--	39.0	39.0
Catch/hr: number	0.88	0.40	0.22	2.94	1.70	**	0.91
Catch/hr: weight	0.43	0.23	0.19	1.33	0.89	**	0.48

* See Table 8 footnote

** Insufficient data

average length of a 1967 fishing trip was 3.8 hours and the trip produced an average of 3.4 fish weighing 1.8 pounds--0.91 fish weighing 0.48 pounds per hour of fishing. Age and sex of the fishermen contacted were as follows: male adults - 81.5 percent, male children - 9.1 percent, female adults - 7.4 percent and female children - 2.0 percent.

The data indicate the following in respect to the individual species in the creels.

Largemouth bass:

Largemouth bass ranked second in total number (9.2 percent) and total weight (23.4 percent) in the creels. Numerically, the 1967 percentage of this species increased 0.5 percent over that of 1966.

White bass:

This species made up 1.5 percent of the total number of fish in the creels and 2.6 percent of the total weight in 1967. The 1967 white bass catch increased, numerically, 1.2 percent over that of 1966.

Walleye:

The numerical catch of walleye increased from 0.1 percent of the total catch in 1966 to 0.2 percent in 1967.

Crappie:

These species continue to dominant the creels--78.0 percent of the total number and 66.0 percent of the total weight. The 1967 numerical catch of crappie decreased 6.6 percent from that of 1966.

Bream:

Bream showed a substantial numerical increase, percentagewise, in the 1967 catch over that of 1966--8.1 percent as compared to 2.8 percent. Bream ranked third in both number and weight (3.7 percent) in the 1967 creels.

Yellow perch:

This species contributed only 0.2 percent to the total catch in each 1966

and 1967. The catch of this species is considered as insignificant at this time.

Catfish:

Catfish, chiefly white catfish, made up 1.4 percent of the total number of fish in the creels and 2.3 percent of the total weight. The 1967 numerical catch decreased by 0.6 percent from that of 1966.

Carp:

Carp made up only 0.8 percent of the total catch in each 1966 and 1967. This species is insignificant in the creels at this time.

Conclusions and Recommendations

When we speak of the fishing success in a particular body of water, we make reference to the total catch per unit of effort expended fishing. Since the catch is made up of two distinct variables--the number of fish caught and the weight of the fish caught--how can we compare fishing success on two or more bodies of water? Further, since there are two basic groups of fishermen--those whose primary interest is in the number of fish caught per unit of effort and those whose primary interest is concerned with the size or weight of fish caught per unit of effort--who but the individual fisherman can say which gives the highest degree of fishing success--the number or the size of the fish caught per unit of effort? How can we express fishing success on a body of water, in the light of these two variables, so that it will have a basic meaning to all?

If we use the number of fish and the weight of fish caught per hour as a means of expressing fishing success, we can go a step further and set up an artificial fishing success index that will reflect both variables in one value and, thus, give a basis for comparing fishing success in respect to these two variables. By using the calculated values for the number and weight of fish caught per hour, by disregarding to what these values refer and by giving

these numerical values equal weight; we can set up an artifical fishing success index simply by adding the two values together. Under this method, an index value of 2.0 could represent a catch of one fish weighing one pound per hour, a catch of 0.5 fish weighing 1.5 pounds per hour or any combination of the two variables totaling 2.0. In respect to number and weight of fish caught per hour, it follows that the larger the index number, the greater the fishing success.

This is not the ideal index for measuring fishing success in relation to both number and weight of fish caught per hour of fishing; however, since we are concerned with only hook and line fishing and with fish of a size that is satisfactory to the sport fisherman for harvesting, I beleive that this index will adequately compare the fishing success on the various lakes and for different years.

Using the index described above for comparative purposes, fishing success in Lake Greenwood during 1966 was below that of 1965--2.97 in 1965 as compared to 2.66 in 1966. Lake Greenwood yielded fewer fish per hour of fishing in 1966 (1.94 per hour) than in 1965 (2.26 per hour); however, the weight of fish caught per hour remained virtually the same for the two years--0.71 in 1965 and 0.72 in 1966.

The same trend is noted in the degree of fishing success in Lake Hartwell. Overall fishing success declined from 1.30 in 1965 to 1.15 in 1966. The fishing success index number, also, indicates that fishing was better during the first six months of 1967 (1.39) than during the same period in 1966 (1.24).

Population study data and creel data for the past several years have indicated that those species commonly referred to as "bream" could easily and without harm to the population, support many times the fishing pressure that they now receive. The data also indicate that yellow perch are becoming more numerous in the lakes each year, and since they seldom reach a desirable size

in this portion of their range, they are considered by most fishermen as a "trash" fish and a nuisance in the lakes. An increased harvest of these species, "bream" and yellow perch would be benefical to the lakes. I recommend that the creel limits be removed from these species or, at least, be made more liberal.

Since 1965, pole and line fishermen and/or fishermen using a pole and line in combination with other tackle have harvested 71.8 percent of the total number of fish and 59.9 percent of the total weight of fish taken from Lake Greenwood. In Lake Hartwell, during the same period, the catch of the pole and line fishermen and/or fishermen using pole and line in addition to other tackle made up 47.0 percent of the total number and 42.3 percent of the total weight of the fishes removed by sport fishermen from the lake. The remainder of the catch in each lake was made by fishermen using only artifical tackle.

When the census was set up years ago, artifical tackle was defined as any type of manufactured tackle--artifical bait and/or manufactured rods and reels. It did not take into account that much of this tackle can be used in the same manner and with the same type of bait as can the common pole and line be used. The data would, perhaps, have more meaning had the catch been based on type of bait used--natural or artifical--rather than on type of tackle used. Natural bait is, most commonly, associated with pole and line fishing or with fishing in such a manner that the bait is placed on a hook, cast or dropped into the water and allowed to remain relatively stationary until the fish comes along and takes the bait. Articical bait depends on movement to be effective and, thus, requires the use of a mechanical contrivance (rod and reel) to effectively perform its function. This does not imply that artifical bait is not and cannot be used with a pole and line or that natural bait is not and cannot be used with artifical tackle--it only points out the chief use of each device.

If we look at the species making up the creels and classify them as to the most common type of bait used for taking them, we find that of the total

number of fish taken by sport fishermen on Lake Greenwood since 1965, 89.2 percent of the total were those usually and almost exclusively taken by natural bait. Likewise, this same group of fishes made up 72.3 percent of the total weight of the catch since 1965. Further, this same trend is evident for so far back as creel records are available.

Since natural bait can be used equally well with artifical tackle as with a pole and line, the artifical tackle fisherman could become a pole and line fisherman or a pole and line fisherman could become an artifical tackle fisherman without appreciably altering the total catch. Further, since the pole and line fisherman is required to hold only a lake permit, whereas the artifical tackle fisherman must hold--in addition to a lake permit--an anglers license or in lieu of a lake permit and anglers license, a resident combination license, it is theoretically possible for approximately 70 - 90 percent of the fish harvested from the lake to be harvested by fishermen paying a license fee of only approximately one-third that charged the artifical tackle fisherman. To make this situation more untenable, pole and line fishermen are not required to have any license to fish in most of the streams of the State.

I recommend that the licensing system be changed so that all fishermen, except children and the aged, will be required to hold the same license when fishing in any of the State's public waters.

I recommend that the use of "jugs" be made legal for taking commerical species (carp, suckers, catfish,etc.) from the lakes. Population studies indicate that these species are abundant in the lakes; however, they contribute only a minor portion to the sport fisherman's creel. In addition to more effectively utilization of this resourse, "jugging" will add many hours of recreational use to the lakes.

JOB IV DETERMINING THE SURVIVAL OF STRIPED BASS

This is a continuing, year-to-year study to obtain information which might

indicate the extent of survival of striped bass larvae stocked in large reservoirs already containing established fish populations. Since Lakes Greenwood and Hartwell were the only two reservoirs, in this project, stocked with striped bass larvae, survival checks were limited to these two lakes.

In the past, survival checks were chiefly marginal seining with a 40' by 4', ¼ inch mesh, minnow seine and an electric shocker; however, since these lakes received only token stockings in 1966, the major effort was concentrated on picking up survivors of the heavy 1965 stocking in Lake Greenwood by the use of a 100' by 6', 1 inch bar, gill net.

From mid-December, 1966 through March, 1967, gill nets were set and fished 50 times. A set consisted of setting the net and fishing it in approximately 24 hours. Some sets were made consecutively at one location; however the net was usually moved to a new location once or twice a week. When the net was set consecutively at one location, the depth at which the net was set was usually varied from day to day. Practically all species known to inhabit the lake were captured by the gill net with the exception of striped bass--no stripers were captured.

Since these lakes received only token stockings in 1966. only limited effort was expended to pick up survivors with the 40' by 4' minnow seine. These limited checks were also negative in respect to captured striped bass.

Creel checks revealed only three survivors of the 1965 stocking.

Conclusions and Recommendations

Attempts to pick up survivors of the heavy 1965 stocking of striped bass fry in Lake Greenwood were unsuccessful with gill nets. Survivors of the 1965 stocking were observed in the fishermen's creels and white the number observed was not impressive, they do indicate successful survival. Further, since many fishermen cannot readily distinguish these small stripers from white bass, it is quite possible that they were present in the creels in greater numbers than

was indicated by the creel census.

Survival checks should be continued until the different types of stockings, fry and fingerlings--striped bass and hybrids--are fully evaluated.

JOB V DETERMINING THE FEASIBILITY OF REARING STRIPED BASS FRY TO FINGERLING SIZE BEFORE STOCKING

The objective of this study is to determine if it is feasible to rear striped bass fry to fingerling size before stocking them in large reservoirs already containing established fish populations. This was the fifth year in a continuing study concerned with this problem.

As in previous years, the facilities of one of the State's warm-water fish hatcheries, Newberry, were utilized for the study. Five ponds, having a combined surface area of 3.02 acres and varying in size from 0.39 to 0.85 acres, were devoted to the study. During January, the rearing ponds were drained and treated with rotenone to eradicate all fish. The ponds were refilled during February--water entering the ponds through a fine gravel filter--and fertilization was started on March 20. The fertilization program consisted of only one application of cottonseed meal (100 pounds per surface acre) during the entire study. Regular pond fertilizer was not used so as to not build up a heavy phytoplankton "bloom". The one application of cottonseed meal, along with the organic matter already present in the ponds, was sufficient to maintain a good zooplankton population in the rearing ponds throughout the study.

Striped bass fry were obtained from the Moncks Corner Hatchery on April 10 and were stocked in the rearing ponds. The fry were all from the same parents, were approximately five days old when stocked and were stocked in the ponds at the rate of 50,000 per acre. The fry were shipped to the hatchery in plastic bags containing water (pH of 8.5) and pure oxygen. The pH of the water in the rearing ponds at the time of stocking was 6.8.

Prior studies have indicated that death of the fry might possibly result

if they undergo a sudden change in pH. To reduce this possibility, the pH in the bags was lowered, over a period of approximately two hours, to near that of the rearing ponds. This was accomplished by punching a small hole in the top and the bottom of the bags. The punctured bags were floated on the surface of the rearing ponds and allowed to slowly fill with water and sink. The fry were not released from the bags until the bag had completely filled with water and sank.

The ability of the fry to withstand a sudden change in pH of this magnitude was checked by dumping approximately 5,000 fry directly into a vat containing water of pH 6.8. No immediate death or distress of the fry was observed; however, within ten days, all the fry in the vat were dead. This, in itself, does not prove that a sudden change in pH will kill the fry; however, it suggests an area for further investigation.

The feeding experiment was designed to check supplemental feeding against natural food in the ponds and to check the results obtained by feeding different amounts of supplemental food in different ponds. Due to limited facilities available for the experiment, it was decided that the program outlined was not feasible ; therefore, all ponds received supplemental food. Each pond received the same amount of food daily; however, since the ponds varied in size, each pond (except 2 and 3 which are the same size) was fed at different rates per acre (Table 12).

The following are indicated in respect to the results of the individual ponds:

Pond No. 1:

This pond was stocked with 42,500 (hatchery estimate) striped bass fry. The pond was drained 51 days after stocking, when the fish were 56 days old, and 4,491 striped bass fingerlings, ranging in size from 1.50 to 2.00 inches, were recovered. The survival rate in this pond was indicated as 10.6 percent.

Mortality of the fingerlings during draining was 421 fish or 9.4 percent of the total fingerling production.

Pond No. 2:

This pond was stocked with 28,000 striped bass fry. The pond was drained June 3 and no survivors were recovered. The failure in this pond cannot be explained at present.

Pond No. 3:

This pond, also, was stocked with 28,000 striped bass fry. The pond was drained June 1 when the fingerlings were 57 days old and 7,681 striped bass fingerlings were recovered. The survival rate in this pond was 27.4 percent. Fingerling mortality during draining and counting was 1,284 fish or 16.7 percent of the total production.

Pond No. 4:

Pond No. 4 was stocked with 19,500 striped bass fry. The pond was drained June 6 when the fingerlings were 62 days old and 3,853 striped bass fingerlings were recovered. The survival rate was 19.8 percent. Mortality during draining was 372 fish or 9.6 percent of the total production.

Pond No. 5:

This pond was stocked with 33,000 striped bass fry. The pond was drained June 13 when the fingerlings were 69 days old and 11,941 striped bass were recovered--a survival rate of 36.2 percent. Fingerling mortality during draining was higher in this pond than in any other--3,299 fish or 27.6 percent of the pond's total production.

Conclusions and Recommendations

There are still many problems concerning the rearing of striped bass fry to fingerling size before stocking them into established fish populations; e.g., why do we have limited success or complete failure in one pond and good to excellent success in another pond when both ponds, seemingly, have identical

Table 12. Feeding schedule of striped bass fry in rearing ponds--depicting the actual amount (pounds) of ground fish fed per pond per day, the rate per acre per pond per day (approximate) and the survival rate obtained in each pond

		Pond 1		Pond 2		Pond 3		Pond 4		Pond 5	
From	To	Daily	Rate/acre	Daily	Rate/acre	Daily	Rate/acre	Daily	Rate/acre	Daily	Rate/acre
4-10	4-21	None		None		None		None		None	
4-22	4-28	1.00	1.25	1.00	1.75	1.00	1.75	1.00	2.50	1.00	1.50
4-29	5-5	2.00	2.50	2.00	3.50	2.00	3.50	2.00	5.00	2.00	3.00
5-6	5-12	6.00	7.00	6.00	10.00	6.00	10.00	6.00	15.00	6.00	9.00
5-13	5-19	8.00	9.50	8.00	14.00	8.00	14.00	8.00	20.00	8.00	12.00
5-20	end	10.00	12.00	10.00	18.00	10.00	18.00	10.00	25.00	10.00	15.00
Survival rate		10.6		0.00		27.4		19.8		36.2	

physical and chemical characteristics? What specific factor or factors cause these failures or, for that matter, the successes? I feel that we are just as hard pressed to explain the successes as we are to explain the failures.

Be this as it be, success is occurring frequently enough for us to now assume that it is feasible to rear striped bass fry to fingerling size before stocking them in large reservoirs. The big problem facing us at this time is the production of quantities of these fingerlings.

We can look at the problem of producing large numbers of fingerlings from two points of logic: (1) the number of fry we can stock per acre for maximum survival of the fry, and (2) the maximum number of fingerlings we can produce per acre of rearing pond regardless of the stocking rate. We need answers to both of these questions before we can fully evaluate one approach against the other. If maximum fry survival will yield 50,000 fingerlings per acre of rearing pond, would it be more feasible to follow this line of production even though 100,000 fingerlings could be produced per acre by stocking 5 or 10 times the number of fry necessary for maximum survival and by accepting a lower survival rate?

I recommend that the next step in this investigation be conducted along these lines: (1) determine the maximum stocking rate for maximum fry survival, (2) determine the stocking rate for maximum fingerling production and (3) determine which of these approaches are more feasible from the standpoint of attaining out ultimate goal--a striped bass fishery where none now exists.

Total fingerling production at Newberry Hatchery amounted to 27,966 in 1967. Of this total, 5,376 were lost during harvesting. A small portion of this loss can be attributed to handling in the process of "hand counting"; however, the major portion of the loss was due to mud from the pond bottom washing into the catch basin and causing "mud sickness" of the fingerlings. I recommend that the ponds be renovated so that excess mud will not be drawn

into the catch basin when the pond is drained. I, also, recommend that as many of the fingerlings as is possible, be harvested by seining before draining.

JOB X COMPILING, ANALYZING AND REPORTING FINDINGS

No report required under this job.

JOB XI WALLEYE STOCKING AND EVALUATION PROGRAM

The long-range objective of this program is to create a self-sustaining walleye fishery in Lake Greenwood and Lake Murray (not included in this project) and in the event a self-sustaining population cannot be established, to determine the feasibility of maintaining a limited walleye fishery through a continious stocking program.

This was the second year in which Lake Greenwood was stocked with walleye fry--500,000 were stocked in 1966 and 500,000 were stocked in 1967. This year was the third continious year of stocking walleye fry in Lake Murray--750,000 in 1965; 850,000 in 1966 and 2,000,000 in 1967.

At this time, no walleye survivors have been observed from either lake; however, unoffical reports of walleye catches have been received from Lake Greenwood. Efforts to pick up survivors will be continued during ensuing segments of the project--by gill nets, electric shocker and inspection of the fisherman's creel.

I recommend that this program be continued until all possibilities of establishing this species in one or both lakes have been exhausted.

JOB XII AGE-GROWTH STUDIES

The objectives of this study were: to determine the growth rate of the major sport species (chiefly largemouth bass, bluegill, black crappie and white crappie) of the Broad River and to determine the growth rate of the white bass of Lake Greenwood.

Due to public relations, we were not able to use the electric shocker in

the Broad River for collecting scale samples and since gill netting in the river was impractical, no scales were collected from the river. Gill nets were used in Lake Greenwood to collect white bass scale specimens. Scales were also collected from fishermen contacted in the course of creel censusing.

Scales were collected from 84 white bass from Lake greenwood during the month of April, 1967. These scales were "aged" by the standard scale "reading" methods (Eberbach projector) and calculated lengths at each annulus were obtained by using the Direct Porportion Method. The scales were collected from fish that ranged from 7.2 inches to 16.3 inches in length and these fishes included four year classes (Table 13). The fish ranged in weight from 0.12 pounds to 2.00 pounds.

Table 13. Four year growth history of 84 white bass from Lake Greenwood--expressed as average calculated lengths (inches) attained by each year class

		Average calculated lengths at each annulus							
		1		2		3		4	
Year	Class	C.L.	No.	C.L.	No.	C.L.	No.	C.L.	No.
1966	I	7.32	28						
1965	II	7.27	20	12.16	20				
1964	III	6.37	32	12.68	32	14.49	32		
1963	IV	8.10	4	12.65	4	14.85	4	15.55	4
Grand average calculated length		6.98		12.49		14.53		15.55	
Grand average annual increment of growth		6.98		5.51		2.04		1.02	
Total number of fish			84		56		36		4

The white bass of Lake Greenwood exhibited an unusally uniform growth rate--for the year class I through year class IV. Greatest growth occurred during the first year of life and was progressively less each following year.

The calculated length for year classes I through IV were: 6.98 inches, 12.49 inches, 14.53 inches and 15.55 inches. Annual increment of growth for the four year classes were: 6.98 inches, 5.51 inches, 2.04 inches and 1.02 inches.

JOB XIII A SURVEY OF EXISTING CONDITIONS ON THE BROAD RIVER WHICH MIGHT EFFECT SPORT FISHING SUCCESS

This job was designed to determine the species composition and the extent of natural reproduction in the Broad River through the use of an electric shocker, to make monthly qualitative and quantatative study of the bottom fauna of the river and to catalog possible sources of pollution for reference in determining the cause of future fish "kills" on the river.

Due to reasons already mentioned, an estimate of the fish population with the electric shocker was not made. Possible sources of pollution, those within this District, were sought out and recorded; however, since much of this river ststen lies within another District and due to the complexity of the river system, this list is not complete. A complete list of the sources of pollution entering the river are, however, on file with the State Water Pollution Control Board and are available if needed.

Samples of the bottom fauna were collected monthly at three stations on the Broad River, and at one station on each the Pacolet, Tyger and Enoree Rivers. Samples were taken with an Ekman dredge and organisms collected are reported as number of organisms per square foot of river bottom (Table 14).

Identification of the bottom organisms was not carried below that of Family except when the organism was readily identifiable.

Conclusions and Recommendations

Members of the Family Naididae were, by far, the predominant bottom organisms--75.9 percent of the total organisms collected. Chironomus larvae were second in abundance followed by: Tipulidae, Ephemeridae, Tubificidae and the other Families making up the remainder of the sample.

Table 14. Bottom organisms collected per square foot of river bottom from the Broad, Pacolet, Tyger and Enoree Rivers with an Ekman Dredge. Samples were collected from July, 1966 through June 1967

Month	Naididae	Tubificidae	Dero	Tendipedidae pupae	Tipulidae	Gyptotendipes	Ephemeridae	Lumbriculidae	Anisoptera	Trichoptera	Chironomus	Ptychopteridae	Total No. organisms
Location: Broad River above Lockhart													
July	12	-	-	-	-	-	-	-	-	-	-	-	12
Aug.	72	4	4	-	-	-	-	-	-	-	-	-	80
Sept.	20	-	-	-	-	-	-	-	-	-	-	-	20
Oct.	12	-	-	-	-	-	-	-	-	-	-	-	12
Nov.	16	-	-	-	-	-	-	-	-	-	-	-	16
Dec.	20	-	-	-	-	-	-	-	-	-	-	-	20
Jan.	-	-	-	-	-	-	-	-	-	-	-	-	--
Feb.	4	-	-	-	-	-	-	-	-	-	-	-	4
March	16	-	-	-	-	-	-	-	-	-	-	-	16
April	-	-	-	-	-	-	-	-	-	-	-	-	--
May	-	-	-	-	-	-	-	-	-	-	-	-	--
June	-	-	-	-	-	-	-	-	-	-	-	-	--
Location: Broad River below mouth of Pacolet River													
July	-	-	-	-	-	-	8	4	-	-	-	-	12
Aug.	-	-	-	-	-	-	16	-	4	-	-	-	20
Sept.	16	-	-	-	-	-	8	-	-	-	-	-	24
Oct.	-	-	-	-	-	-	8	-	-	-	-	-	8
Nov.	4	-	-	-	-	-	8	-	-	4	-	-	16
Dec.	8	-	-	-	-	-	-	-	-	-	4	-	12
Jan.	4	-	-	-	-	-	-	-	-	-	-	-	4
Feb.	-	-	-	-	-	-	-	-	-	-	12	-	12
March	-	-	-	-	-	-	-	-	-	-	8	-	8
April	4	-	-	-	-	4	-	-	-	-	8	-	16
May	-	-	-	-	-	-	-	-	-	-	-	-	--
June	-	-	-	-	-	4	-	-	-	-	-	-	4

Table 14. (Continued)

Month	Naididae	Tubificidae	Dero	Tendipedidae pupae	Tupulidae	Gyptotendipes	Ephemeridae	Lumbriculidae	Anisoptera	Trichoptera	Chironomus	Ptychopteridae	Total No. organisms
Location: Broad River at S.C. Highway 34 bridge													
July	24	-	-	-	-	-	-	-	-	-	-	-	24
Aug.	24	-	-	-	-	-	4	-	-	-	-	-	28
Sept.	20	12	-	-	-	-	4	-	4	-	-	-	40
Oct.	4	-	-	-	8	-	-	-	-	-	4	-	16
Nov.	36	-	-	-	20	-	-	-	-	-	-	-	56
Dec.	16	-	-	-	-	-	-	-	-	-	-	-	16
Jan.	32	-	-	-	-	-	-	-	-	-	-	-	32
Feb.	4	-	-	-	-	-	-	-	-	-	-	-	4
March	20	-	-	-	-	-	-	-	-	-	-	-	20
April	-	4	-	-	-	-	-	-	-	-	-	-	--
May	-	-	-	-	-	-	-	-	-	-	-	-	--
June	-	-	-	-	-	-	-	-	-	-	-	-	--
Location: Pacolet River													
July	-	-	-	12	-	-	-	-	-	-	16	-	28
Aug.	20	-	-	-	-	-	-	-	-	-	-	-	20
Sept.	32	8	-	-	-	-	-	-	-	-	-	-	40
Oct.	44	-	-	-	4	-	-	-	-	-	-	-	48
Nov.	20	-	-	-	-	-	-	-	-	-	-	-	20
Dec.	36	-	-	-	-	-	-	-	-	-	-	-	36
Jan.	68	-	-	-	4	-	-	-	-	-	-	-	72
Feb.	8	-	-	-	-	-	-	-	-	-	-	-	8
March	20	-	-	-	-	-	-	-	-	-	-	-	20
April	-	4	-	-	-	4	-	-	-	-	16	-	24
May	-	-	-	-	-	-	-	-	-	-	-	-	--
June	8	-	-	-	4	-	-	-	-	-	-	-	12
Location: Tyger River													
July	20	-	-	-	-	-	-	-	-	-	-	-	20
Aug.	4	-	-	-	-	-	-	8	-	-	-	-	12
Sept.	48	-	-	-	-	-	-	-	-	-	-	-	48
Oct.	-	-	-	-	8	-	-	-	-	-	-	-	8
Nov.	56	-	-	-	-	-	-	-	-	-	-	-	56
Dec.	20	-	-	-	-	-	-	-	-	-	-	-	20
Jan.	4	-	-	-	4	4	-	-	-	-	-	4	16
Feb.	20	-	-	-	-	-	-	-	-	-	-	-	20
March	8	-	-	-	-	-	-	-	-	-	-	-	8
April	8	-	-	-	-	-	-	-	-	-	-	-	8
May	-	-	-	-	-	-	-	-	4	-	-	-	4
June	12	-	-	-	-	-	-	-	-	-	-	-	12

Table 14. (Continued)

Month	Naididae	Tubificidae	Dero	Tendipedidae	Tupulidae	Gyptotendipes	Ephemeridae	Lumbriculidae	Anisoptera	Trichoptera	Chironomus	Ptychopteridae	Total No. organisms
					Location: Enoree River								
July	4	-	-	-	-	-	-	-	-	-	8	-	12
Sept.	12	-	-	-	4	-	-	-	4	-	4	-	24
Oct.	4	-	-	-	-	-	-	-	-	-	-	-	4
Nov.	12	-	-	-	-	-	-	-	-	-	-	-	12
Dec.	16	-	-	-	-	-	-	-	-	-	-	-	16
Jan.	20	-	-	-	-	-	-	-	-	-	-	-	20
March	8	-	-	-	-	-	-	-	-	-	-	-	8
April	8	-	-	-	-	-	-	-	-	-	-	-	8
May	-	-	-	-	4	-	-	-	-	-	-	-	4
June	4	-	-	-	-	-	-	-	-	-	-	-	4

Since we were unable to make an estimate of the fish population in the Broad River, no conclusions can be drawn as to possible effects pollution in the river might have on the fish population.

I recommend that this study, population estimate, be rescheduled and completed as soon as practical.

Submitted by:

Otho D. May, Jr.
Otho D. May, Jr. Project Leader

Reviewed by:

Jeffrey C. Fullerton
Chief of Fisheries

Approved by:
SOUTH CAROLINA WILDLIFE RESOURCES DEPT., DIVISON OF GAME

James W. Webb
Director