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REPORT

STATEWIDE FISHERIES INVESTIGATIONS

F-21-1, STUDIES V through XII

July 1, 1968 through June 30, 1969

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F-21-1

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EVALUATION OF SLOT BASKETS FOR TAKING SUCKERS IN LAKE SEMINOLE

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Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. V

EVALUATION OF SLAT BASKETS FOR TAKING SUCKERS IN LAKE SEMINOLE

Job No. 1

Technical Personnel:

Herbert Wyatt

C. B. O'Neal, Jr.

Major Johns

Daniel R. Holder

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1 Project Title: Statewide Fisheries Investigations

Job No.: V-1 Study Title: Evaluation of Slat Baskets for Taking Suckers in Lake Seminole

Period Covered: July 1, 1968 to February 28, 1969

Summary:

A study to develop a method for harvesting spotted suckers without harvesting game fish was conducted on Lake Seminole. Catches of fish in slat baskets set from December 1968 through February 1969 were compared to catches of fish in gill nets set in the same area on the same days of sampling. Suckers did not enter the baskets throughout sampling. The nets yielded catches of spotted suckers ranging from 35.0 to 51.3 percent by weight of the total sample. Channel catfish and crappie were the main game fish caught in the nets.

Objective:

To develop a practical means of harvesting spotted suckers in Lake Seminole that will not be detrimental to the game fish population.

Procedure:

Three baskets were constructed of wooden slats. The baskets were 40 inches long, 12 inches wide, and 12 inches high. The opening to the basket was rectangular shaped with an orfice approximately 3.5 inches high and 2.5 inches wide to permit entering by relatively large fusiform fish such as the sucker and to prevent entering by similar size or larger fish of other shapes. A tapered throat was attached on the inside at one end of each basket to prevent exit of fish after they entered. The slat strips were spaced 3/4 inch apart. These spaces allowed thin bodied game fish to escape.

Sampling began December 1, 1968 and continued to March 1, 1969. Near each site where baskets were set, two inch gill nets were also set along the bottom to establish the presence of suckers in that area and to compare utilization of the baskets to the nets. The baskets and nets were set in various positions on the bottom and at various locations.

<u>Results</u>:

The results for the three months of sampling are summarized in Table 1. No suckers were found in the baskets even though a high population of suckers existed in the area, as reflected by the 43.2 percent by weight catch in the nets. Four fish were caught in the baskets. They consisted of one carp, one bullhead catfish, and two channel catfish. Main rough-fish captured in the nets in addition to the spotted sucker were the skip-jack, gizzard shad, and carp. Channel catfish made up 6.3 percent by weight and crappie made up 4.2 percent by weight. Largemouth bass comprised 2.3 percent by weight.

<u>Discussion</u>:

The results clearly show that suckers did not use these baskets even though a high population of suckers existed in the area. The low number of baskets set per day is not a sufficient sample size due to the low chance of fish entering the small opening into the basket and due to increased variation associated with the low sample size. The low number of baskets used during this study resulted from limited manpower to design, construct, and set the baskets during this report period. Despite the low number of baskets set, the high number of days that the baskets were compared to the nets should be reliable for establishing that suckers do not utilize this particular basket design.

The catch of channel catfish and crappie demonstrates why gill netting

Table 1

Comparison of Fish Captured in Baskets to Fish Captured in Two Inch Gill Nets from 43 Days of Sampling in Lake Seminole

Species in Baskets	Number	Average Wt. (lbs.)	% of Total Weight
Carp	1	3.12	32.8
Bullhead catfish	1	1.40	14.7
Channel catfish	2	2.50	52.5
Total	4	2.38	100.0
Species in Gill Nets			
Spotted suckers	404	1.73	43.2
Other suckers	21	1.49	1.9
Skipjack	123	1.53	11.7
Shad	176	1.20	13.1
Carp	22	5.56	7.6
Bowfin	9	3.58	2.0
Gar	6	3.25	1.2
Channel catfish	58	1.76	6.3
Other catfish	74	1.18	5.4
Largemouth bass	24	1.58	2.3
Crappie	54	1.27	4.2
Chain pickerel	8	2.10	1.0
Total	979	1.65	99.9

does not need to be legalized in public waters. If the slat basket project is continued, new basket designs and a larger number of baskets need to be incorporated into the study, and the baskets should possibly be tested with various kinds of bait.

Recommendations:

1. That the slat basket project be discontinued until adequate personnel are available to properly carry out this segment of the project.
2. That if the project is continued, new designs in the construction of the basket be made and evaluated for utilization by the spotted suckers.
3. That the number of baskets set for evaluation be increased to reduce variation from the limited sample size.
4. That various kinds of bait be tested in the baskets.

does not need to be investigated in any [illegible]

[illegible]

[illegible]

[illegible]

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. VI

Applied Management in Warmwater Streams

Job No. 1

SURVEY AND INVENTORY

Technical Personnel:

Daniel R. Holder

Herbert Wyatt

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder
Project Supervisor

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1

Project Title: Statewide Fisheries Investigations

Job No.: VI-1

Study Title: Applied Management in Warmwater Streams

Job Title: Survey and Inventory

Period Covered: July 1, 1968 through June 30, 1969

Summary:

The roughfish removal program on the Suwannee River was less productive during F-21-R-1 than during F-19-R-3. A lower population of bowfin and movement of the bowfin in and out of the area were variables affecting the success and evaluation of roughfish removal. High water checked the sampling interval for obtaining reliable Petersen population estimates of the bowfin population in the river. The Petersen estimates were lower than the F-19-R-3 population estimate and the difference between the two estimates was greater than 42,000. Probable factors accounting for this variation are population dispersal from stress and repeated electrofishing of the sample area. The evaluation of fish removal by electrofishing showed that species of large size and abundance were readily removed. Small fish were difficult to hold in shock. A high percent by weight of bowfin, Florida gar, and lake chubsucker were removed from the sample area. The block off net was effective in this high rate of removal.

Creel regulation on largemouth bass, chain pickerel, sunfish, and channel catfish were imposed on the Suwannee River as a possible management tool. The success of the regulations will be evaluated by changes in the population and in the creel over a period of years.

Two hundred and forty-four largemouth bass, nine hundred and fifty redbreast, and two hundred and fifty bluegill were released in the Suwannee River. Survival could not be determined due to unfavorable water level for sampling. Discussion is presented on the problems of stocking fish in the Suwannee River.

A study of fish movements over the Okefenokee spillways into the Suwannee River from February 1969 through June 1969 showed definite movement of bowfin, flier, warmouth, chain pickerel, and bullhead catfish. Bowfin made up 70 percent by weight of fish caught in the nets. Relationships are indicated between fish movements and spillway location, time of year, depth of water discharge, and water temperature. Estimated number of bowfin moving into the river from the swamp was 1,393 fish. Studies of fish movement over the spillway will continue through the spring of 1970 to verify indicated relationships. Implications concerning the fish movements are withheld until completion of field sampling and data analysis.

Objectives:

To reduce the population of bowfin in the Suwannee River and to increase population of largemouth bass and chain pickerel.

To apply fishing restrictions as a management tool.

To strengthen weak year classes of largemouth bass by supplemental stocking of fingerling bass.

To re-establish redbreast and channel catfish in the upper Suwannee River.

To study the fish movements over the Okefenokee Sill and to evaluate implications of the Okefenokee Sill in relation to fish movements and management applications.

Background:

Roughfish Control

Studies conducted on the Suwannee River during F-19-R revealed a high predatory population of fish with bowfin alone making up 80 percent of the total weight in the Suwannee River from the Okefenokee Sill to Fargo. Indications are that the bowfin can maintain this dominance for years unless some mechanical, chemical, or biological control is developed that will reduce the bowfin to a more desirable level. It was reasoned that, if a significantly high poundage could be removed by any one or combination of methods, piscivorous species such as the largemouth bass or the chain pickerel, could be increased somewhat.

A roughfish removal program was included with F-19-R-3 to take advantage of the low water conditions for collecting life history samples and to alleviate local complaints about the high poundage of bowfin in the Suwannee River. Also, as described in the F-19-R-3 report, the favorable conditions provided an opportunity to alter the bowfin population structure and to evaluate such an alteration. In connection with the removal, a downstream fish kill during May 1968 from ineffective neutralization of rotenone with potassium permanganate demonstrated that bowfin in the Suwannee River were extremely sensitive to low concentrations of rotenone, perhaps more so than any of the important game fish in the river. Seventeen tons of roughfish were removed during the F-19-R-3 project. Roughfish removal is an active phase of this job whenever field conditions are optimum for removal.

Population Estimates

The Petersen Estimate made on the bowfin population during F-19-R-3 gave a population of 61,000 fish. The percentage of bowfin taken from the stream during this intensive roughfish removal program was estimated to be

25 percent. This population estimate was consistent throughout sampling; however, all of the recaptures were taken out of the upper half of the river in Georgia. Also as reported in the F-19-R-3 report, the bowfin exhibited profound movement up and down the river. The assumption was made that , if the bowfin, in the process of their movement after being marked for recapture, redistributed themselves in proportion to the population density of bowfin along the river and if during sampling these recaptures came from the areas of heavy concentrations, a reliable estimate could be established.

It was desired that a current and more reliable estimate be made for comparison with the original estimate and to determine the present bowfin population in the river. The population estimate could be easily made during the process of removing the bowfin and gar. Based on the number of recaptures taken out in proportion to the total population estimated to be in the river, the percent of removal would also be known.

Creel Restrictions

Another approach to altering the population is biological control through the use of creel restrictions. The attempt to manage fisheries by means of fishing restrictions has been in existence for many years. Most restrictions, when passed, were based on the theory that the fewer fish caught now, the more that will be available for creel at a later time. Unfortunately, many of the creel regulations were enacted without biological implications, especially on bodies of water that had a high sunfish population and that needed more fishing. Creel regulation does play a role in fisheries management as has been reported by Surber (1968)[1]. Streams that

[1]Surber, Eugene E. 1968. Effects of a 12-inch Size Limit on Smallmouth Bass Populations and Fishing Pressure in the Shenandoah River, Virginia. Presented at 22nd. Annual Conference of Southeastern Game and Fish Commissioners. Baltimore, Maryland.

contain a high predatory population and that have long periods of low flows with heavy fishing during the low flows are subject to over-exploitation of certain species. Thereby, regulations on the number and size of the creel may be necessary to maintain, protect, or restore the fishery of interest. Creel regulations is one of the management applications that is included with this job.

Fish Stocking

Largemouth bass

Following the downstream fish kill of May 15, 1968 population study (F-19-R-3 Report), 50,000 largemouth bass fingerlings that averaged 33 mm in total length were acclimated and released along the upper 24 miles of the Suwannee River. Survival was noted the following week. The bass were stocked to strengthen the young-of-the-year class so that, through utilization of food organisms normally consumed by the bowfin and through utilization of expected increased fry and fingerling forage, a young-of-the-year predator would be available to complement a portion of the void created from the roughfish removal phase of the project. Bass stocking is continued under this job.

Redbreast sunfish and channel catfish

Local fishermen claim that a fairly good number of redbreast sunfish and channel catfish existed in the Suwannee River in Georgia ten or fifteen years ago. Chemical data collected during F-19-R has indicated that pH may be the limiting factor on the abundance and distribution of redbreast sunfish and channel catfish; however, habitat changes may also be related to their status in the river. The legalizing of basket fishing in the public waters of Georgia from 1955 to 1964 may have resulted in the decline of channel catfish in the Suwannee River.

Harvestable size channel catfish and fingerling size redbreast were stocked during F-19-R-3 to determine if low pH was a limiting factor to them and to establish a population of each in the upper Suwannee River. Survival of both of these species was evident from catches of channel catfish the following week and from the presence of redbreast in minnow seine hauls. The fish were stocked at a time when water levels were low making them more vulnerable to predation. The pH during this period of low water ranged from 4.5 to 4.9 which was slightly higher than recorded during F-19-R-1 and F-19-R-2 when the river was frequently flooding. Stockings of redbreast are planned to determine survival, movements, growth, and reproduction of this important species.

Movement over Okefenokee Sill

In 1960 the Suwannee River was separated from the Okefenokee Swamp by the construction of a dike, 4.73 miles long, to retard the flow of water out of the swamp during low water periods and to prevent further erosion of the southwestern corner of the swamp where the Suwannee River leaves the Okefenokee Swamp. The dike has a 200 foot spillway that drains the East Prong of the Suwannee River and a 108 foot spillway that drains the North Prong of the Suwannee River.

Before the dike was constructed, fish could move freely from the river into the swamp and from the swamp into the river. The construction of the dike limited fish movement from the river into the swamp. It may well be that the high population of bowfin in the river is the result of bowfin moving over the spillway into the river, but as a result of the barrier created by the sill are not able to move back into the swamp. The movement of bowfin over the Okefenokee Sill from the swamp into the Suwannee River, if it occurs, will not only explain the high population of bowfin in

the river, but it will also pose a potential limitation to any management attempt designed to alter the bowfin population. In order to determine the influence of the swamp on the Suwannee River fisheries and to ascertain if management at the sill is needed, a study of fish movements over the spillways at the Okefenokee Dike is included with this job.

Procedure:

Roughfish Removal

Bowfin and Florida gar were removed from the Suwannee River during F-21-1 as long as water levels were favorable for massive removal of fish. Most of the fish were collected by electro-narcotizing them with a 400 volt A.C. electrofishing assembly with electrodes mounted out front of the boat. One inch bar mesh dip nets were used to take the fish out of the water. Fyke nets were used to remove roughfish in certain areas of the river. All game fish other than those used for life history purposes were returned to the stream immediately after recovery. A record was maintained on the number and weight of roughfish taken out.

Population Estimate

From December 9, 1968 to January 10, 1969, bowfin were captured by electrofishing in areas containing concentrations, fin clipped and released at three different locations along the river. The right pectoral fin was removed on 27 of the bowfin. These were released at Lem's Landing 2.81 miles downstream from the Okefenokee Dike. After the left pectoral fin had been clipped, 131 bowfin were released at Burnt Bridge Lake which is located 17 miles downstream from the Okefenokee Dike. Efforts to collect bowfin below Fargo were futile. In order to have marked fish in this vicinity, 70 bowfin were collected from Burnt Bridge Lake and transported to Noah's Ark, which is 29 miles below the Okefenokee Dike and 5 miles above the

Florida line. Before release, both pelvic fins were clipped from these fish.

Different fin clips were employed to have three separate population estimates for overall averaging, giving a more refined estimate of the bowfin population. The different fin clip would also make it possible to follow movement patterns from each area of release.

Twelve days were allowed to elapse from the date of the last release to give the fish time to redistribute themselves along the river. Sampling for recaptures began January 22, 1969 and continued until February 13, 1969. All bowfin collected were checked individually for a fin clip. A record was maintained on the number and weight of bowfin taken out of the river during the population estimate. The river during the three weeks of sampling had been fairly low and was favorable for electrofishing. No further sampling was attempted on the river for population estimates after February 13, 1969 when high water made sampling impractical.

Evaluation of Electrofishing

A slough area was blocked off with a 3/8 inch net and heavily electrofished. The slough was .69 acres, had an average depth of 2.68 feet, and had several cypress trees interspersed along the upper end and along the shoreline. Most of the area was open and accessible by the shocking boat. Effort was made to remove all fish possible with the dip nets. The following day the same area was treated with 5% emulsifiable rotenone at the rate of 2 ppm. All collected fish were summarized according to Surber's Standard Method of Reporting Reservoir Populations.

The objective here was to compare, for species represented, the efficiency of electrofishing under conditions considered optimum.

Fishing Regulations

Effective April 5, 1969, a limit of 5 largemouth bass, 5 chain pick-

erel, and 25 sunfish of any or a combination of bluegill, warmouth, spotted sunfish, flier, and redbreast was imposed on the Suwannee River from the Okefenokee Sill to the Florida line. No channel catfish were to be taken out of the river. All bass 12 inches or smaller were to be returned to the river and, if possible, unharmed. All pickerel 15 inches or smaller were to be returned to the river and, if possible, unharmed. No size limitation was placed on the sunfish species. Notices on the creel restrictions were posted at access landings along the river.

Fish Stocking

Largemouth bass

Two hundred and seventeen largemouth bass were transported from the Cordele Fish Hatchery to the Suwannee River and released above Fargo, Georgia.

The bass were gradually tempered to the 4.5 pH of the river. No mortalities were observed during tempering nor after release. The bass averaged 6.8 inches in length and 79 grams in weight. Before release, the bass were marked by clipping one of the pectoral fins. Survival of these bass was to be established from recaptures by later sampling. Sampling was to be done by electrofishing, seining, and hook and line. The water level in the river at the time of stocking was at full bank stage.

Twenty seven, two and three year old bass were caught out of the swamp by hook and line and released along the river below the Okefenokee Dike. All bass were stocked to strengthen the population in the river.

Redbreast and Bluegill

June 11, 1969, 1,900 redbreast and bluegill sunfish were seined from the redbreast pond at the Bowen Mill Fish Hatchery, loaded on a stocking truck, and transported to the Suwannee River above Fargo, Georgia. Bluegills were in the redbreast pond and since the Suwannee River contained an

extremely low population of bluegills, no effort was made to separate the redbreast from the bluegills. During transport, ice was added at Fitzgerald, Georgia to maintain the water temperature below 70°F. In route to the river, fish began dying in each tank, even when the oxygen agitators were on. The remaining live fish were tempered at the river to the pH of 4.5 and were released into the river.

Twelve hundred of the 1900 were alive during release and consisted of 950 redbreast and 250 bluegill. The redbreast averaged 59 mm in length and 15.0 grams in weight. The bluegills had an average length of 72 mm and an average weight of 29 grams. The redbreast were in poor body condition and this is apparently why so many died on the way to the river. The bluegill mortalities were extremely low. Information on survival of these redbreast was to be obtained by electrofishing and seining.

The hatchery redbreast pond was later found to contain green sunfish; however, no green sunfish were seen in the batch that was stocked. Since the pond was contaminated with green sunfish, the pond was renovated twice in July with 5% emulsifiable rotenone. Redbreast brood stock will be collected from the Satilla River prior to the next spawning and released in the pond to rear a new supply of redbreast fingerlings for future releases.

Channel Catfish

Three thousand channel catfish were designated to be marked and released into the river. Limited personnel and time prevented catfish stocking in the river.

Fish Movement over the Okefenokee Sill

The dike that separates the bulk of the Okefenokee Swamp from the Suwannee River has two spillways for the discharge of water out of the swamp. One spillway is located on the East Prong of the Suwannee River and is 200

feet wide. The other spillway is located on the North Prong of the Suwannee River and is 108 feet wide.

Each spillway has parallel concrete partitions one foot wide, 12 feet long and eleven feet apart. These partitions supported a concrete bridge across the spillway overhead. The lip of the spillway itself consisted of grooved concrete buttresses, roughly one foot square and five feet apart and of wooden sections that were composed of five foot long planks, four inches deep and six inches wide. The lip then between each partition consisted of one concrete buttress, one five foot series of planks, one concrete buttress, another five foot series of planks, and another concrete buttress.

It was decided that the best way to sample movements of large fish over the spillway was to devise a frame trap that would sample the five foot wooden areas between the concrete supports. The bottom of the frame would be supported by pipes resting over the lip of the spillway and the top supported by the concrete base of the bridge overhead.

Description of each frame was as follows: To a 5 foot 3/4 inch threaded pipe, elbow joints were connected at each end and turned downward. A 40 inch pipe was threaded into each of the elbow joints and connected at the lower extremity by another elbow joint. The lower elbow joints were turned to the upstream side. A 10 inch joint was attached to each of the lower elbow joints and was connected at its upstream end with a tee coupler. The tee couplers were connected together by a 69 inch pipe completing the frame. To hold the frame of the pipe in place on the spillway, an elbow was attached on the upstream side of each joint and to it a six inch joint, pointing downward, was attached.

A 3/4 inch square mesh nylon webbing, shark style of 45 pound test

was sewed to each frame using #6 or #8 nylon twine. Enough excess webbing was allowed to create a bag hanging three feet below the frame so that the fish could not leave once they entered the bag.

Wire was considered for the trap, and one trap was made using ½ inch diameter aluminum wire. The use of wire was ruled out when attempts to remove the frame from the sill failed due to the excessive vegetation that had accumulated after the trap was set 12 hours. The force of water pushing the vegetation against the wire mesh was great enough to cause the frame to separate at one of the joints when efforts were made to remove the frame.

The netting material was pliable and durable and fitted over the frame easily. Its advantages far outweighed that of the wire mesh. Four traps were constructed for sampling. Figures 1 through 4 illustrate the net design, the net being lowered into position, view of the swamp above the dike, and view of the river below the dike.

The sample areas were randomly determined for each day of sampling. The nets were set weekly, at interval periods ranging from one to four days. Effort was made to sample at least two days of each week; however, sampling occasionally was for one day periods whenever the nets or frames had to be repaired or replaced. The traps were checked a minimum of twice a day, depending upon water temperature and depth of water discharge.

During each day of sampling, water temperature, depth of water discharge, sample area, and species of fish caught were recorded in the field. Whenever the fish were not too decomposed, length, weight, and sex were recorded. Dissolved oxygen, pH, hardness, and carbon dioxide were determined periodically using a Hach chem kit. The day of sampling was recorded according to the day that the traps were checked, not when they were set.

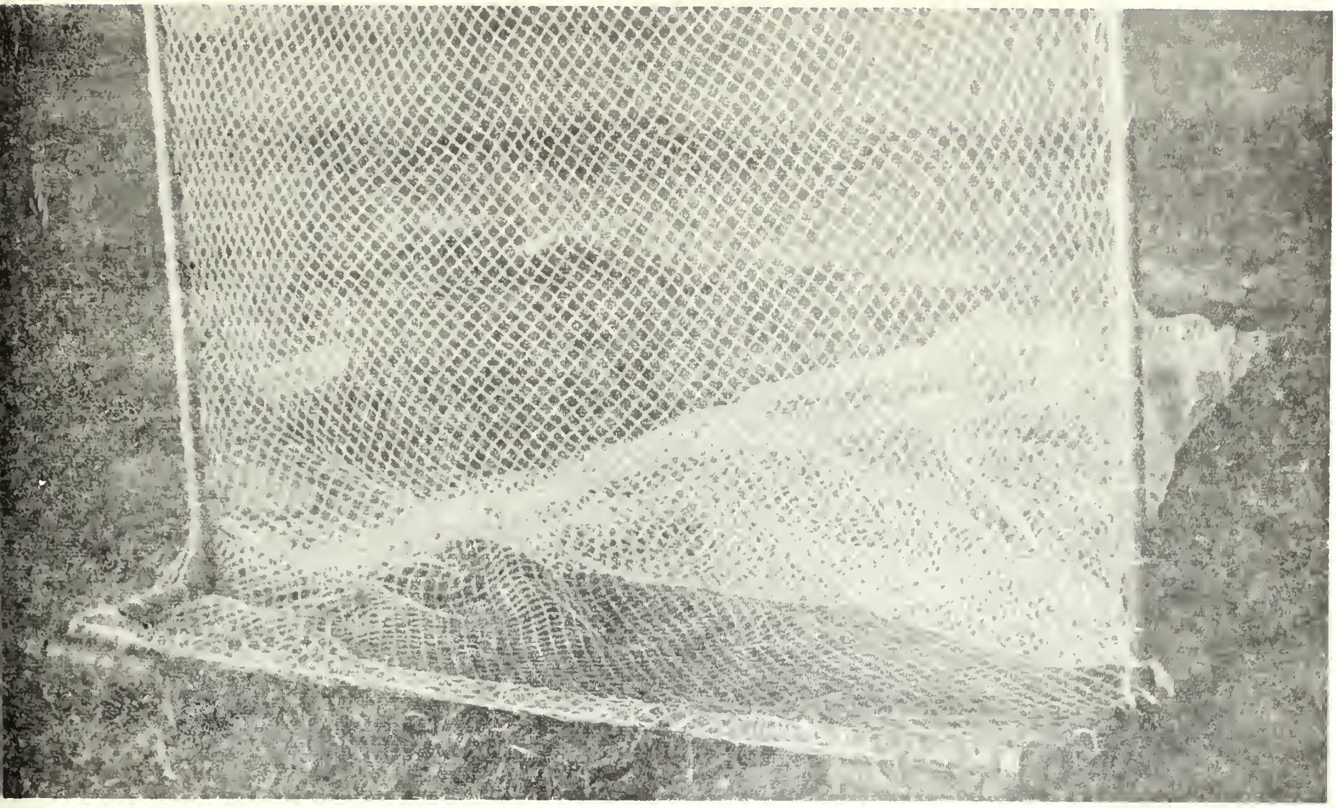

Figure 1

Illustration of Net and Frame Design

Figure 2

Illustration of Sill Trap being Lowered into Position for Sampling

Figure 3

View of Okefenokee Swamp above the Dike

Figure 4

View of Suwannee River below the Dike

It was anticipated that 10 percent of the spillway area would be sampled; however, due to breakage or losses of the frames, it usually was 5 percent. Problems encountered with the net traps were the periodic discharges of aquatic vegetation and tupelo gum leaves that matted the webbing, difficulty in removing the nets during high water discharges, and breakage of the frames at the joints. The matting of the net with vegetation interfered with the passing of water through the net and created an additive force from water hitting the matted area. Another problem that was related to the matting effect was the difficulty in pulling the nets out after sampling. The bag of the traps originally extended from three to four feet down. This had the water falling directly against the bag before reaching the water in the stream and consequently made removal under high discharges difficult. Two people were usually required to remove the frames whenever the water depth was 10 inches or higher. At lesser water depths and if the nets were not too matted, one man could remove the nets.

An improvement to the net design was the extension of the bag five to six feet below the frame. The change had the bag in the water on the downstream side. The improvements were cushioning effect of the downstream water against the water coming over the spillway through the bag, reduction of water force on the webbing, frame, and fish caught, and greater facility in the removal of the traps from the spillway.

While the netting material held against considerable water force, even at discharges of 15 inches, the fittings around the frame frequently cracked or separated, sometimes causing the trap to be lost downstream. Two traps were lost from the joints breaking and others, after they had broken, had to be welded around the joints to reinforce the frame.

The time interval for each day of sampling was to be recorded on a

24 hour basis; however, the sampling interval occasionally was less than twenty-four hours. If so, the daily movement was corrected to 24 hour estimates according to the time actually sampled per sampling day.

Results:

Roughfish Removal

The number and pounds of bowfin and gar taken from the Suwannee River from July 1968 to June 1969 are presented in Table 1. The 1,822 bowfin removed had an average weight of 2.20 pounds and the 319 Florida gar taken out averaged 1.11 pounds each.

Population Estimate and Movements

The statistics on the bowfin marked, released, and recaptured in the Suwannee River are summarized in Table 2. Nine of the twelve recaptures collected were fish with the left pectoral fin clipped and eight of these nine were collected in the same general area where they were released. The other left pectoral recapture clipped in this manner was collected above Lem's Landing which was 15 miles upstream from where this bowfin was released. One of the bowfin that had both pelvic fins clipped was recaptured 12 miles upstream at Burnt Bridge Lake.

Since the fish were removed from the river during sampling, Petersen's population estimates were used to determine the bowfin population.

$$P = \frac{MC+1}{R+1}$$

Where P= Population estimate

M= Number of marked fish

C= Total Number of fish collected

R= Number of fish recaptured

Table 1

Number, Weight, and Average Weight of Bowfin and Florida Gar Taken from the Suwannee River from July 1968 to June 1969

Species	Number	Weight (lbs.)	Average Weight
Bowfin	1822	4011.6	2.20
Florida gar	319	355.42	1.11
Total	2141	4367.02	2.04

Table 2

Type of Fin Clip, Number Marked, Location Released, Number of Recaptures, and Number of Recaptures of Bowfin in Each Major Section in the Suwannee River

				Location of Recaptures by Section		
Fin Clip	Number Marked	Location Downstream from Okefenokee Dike	Number Recaptured	Upstream	Middle	Downstream
Right pectoral	27	2 miles	2	2	0	0
Left pectoral	131	17 miles	9	1	8	0
Both pelvics	70	29 miles	1	0	1	0

The population estimates are summarized in Table 3. The estimates ranged from 4,620 to 17,572; however, the 17,572 estimate is higher due to the low number taken out of the downstream (lower) area. Only two bowfin came out of this section during the estimate and these were not recaptures. Since the downstream estimate was biased by the low sample size and low recovery from the section, population estimates were also made of the combined recaptures that had the right and left pectoral fin removed. Using the right pectoral mark, left pectoral mark, and the combined right and left pectoral marks, the three estimates were 4,620, 6,534, and 6,559 bowfin in the section of the Suwannee River studied.

Evaluation of Electrofishing

The results of fish taken out by electrofishing compared to the total population after rotenone treatment are summarized by species in Table 4.

Three hundred and two bowfin weighing 1049.6 pounds were taken out by electrofishing and made up 66.1 percent by number and 78.1 percent by weight of the bowfin in the area. The 110 gar removed by electrofishing weighed 101.5 pounds and made up 56.1 percent by number and 58.9 percent by weight of the gar in the sample area.

Thirty-six chubsuckers weighing 32.6 pounds were removed by electrofishing. The lake chubsuckers made up 43.9 percent by number and 59.5 percent by weight of the suckers in the sample area.

Less abundant fish taken by electrofishing were chain pickerel, spotted sucker, spotted sunfish, flier, and black crappie. All of the harvestable size chain pickerel were removed. Brown bullhead catfish, largemouth bass, redfin pickerel, and redbreast were not captured by electrofishing.

Fishing Regulations

Fishermen acceptance to the regulations was above expectations and

Table 3

Statistics on Petersen Population Estimates on the Bowfin in the Suwannee River

Type of Mark	Number Marked	Number Recaptured	Percent Recaptured	Total Number Sampled	Total Number Sampled by Sections	Population Estimate
Right Pectoral	27	2	7.40	495	124	4,620
Left Pectoral	131	9	6.87	495	369	6,534
Both Pelvics	70	1	1.43	495	2	17,572
Combined Marks	228	12	5.26	495	495	8,719
Right & Left Pectoral	158	11	6.96	495	493	6,559

Table 4

Comparison of Fish Removed by Electrofishing to Total

Population of Same Species after Rotenone Treatment

Species	Electrofishing		Total Population		Percent of Each Species Removed by Electrofishing	
	Number	Weight (lbs.)	Number	Weight (lbs.)	Number	Weight
Bowfin	302	1049.6	457	1344.7	66.1	78.1
Florida gar	110	101.5	196	172.4	56.1	58.9
Lake chubsucker	36	32.6	92	54.8	43.9	59.5
Spotted sucker	2	5.0	2	5.0	100.0	100.0
Spotted sunfish	4	T	99	.4	4.0	T
Warmouth	1	T	698	3.2	.1	T
Chain pickerel	2	1.1	3	1.1	66.0	100.0
Flier	2	.3	15	1.2	13.3	25.0
Black crappie	1	.9	1	.9	100.0	100.0
Bullhead catfish	0	0.0	12	14.0	0.0	0.0
Largemouth bass	0	0.0	14	.3	0.0	0.0
Redfin pickerel	0	0.0	1	T	0.0	0.0
Redbreast	0	0.0	5	T	0.0	0.0

little illegal fishing was seen by the creel clerk. Many of the fishermen were cooperative in returning the under size chain pickerel and largemouth bass back to the river unharmed. The full bank stage of the river during these months scattered the fish over the floodplain and discouraged fishermen from fishing which actually contributed to the objectives intended by the creel regulations.

The greatest use of the regulations would be during periods of low water conditions when the fish are concentrated in a small volume of water, making them highly susceptible to heavy fishing. By cutting back on the creel and by having a size limit on the chain pickerel and bass, fewer fish would be harvested per day of fishing during these low water conditions. That way, more fish of sub-harvestable and harvestable size would be remaining in the water to grow larger, to become sexually mature for spawning, and to be caught later. The number of fishermen days would also be increased from the increased number of fish remaining to be taken out at a later date. The idea is to control an over exploited fish population and ultimately establish a better fish population that will provide a higher creel.

Largemouth Bass

The full bank or higher stage on the river limited field sampling. Seining and electrofishing indicated a strong population of the young-of-the-year bass and a weak intermediate and adult size population, apparently from over-harvest during the drought of 1967 and 1968. No marked bass were collected nor reported by the fishermen. Few bass were creeled by fishermen during this high water period since the bass were scattered over the floodplain.

The number of bass released into the river during this job is not considered large enough to have made any significant changes in the bass

population. Assuming that these bass did survive, the only advantage served by the stocking was to supplement or replace a few of the bass that were reported creeled by fishermen.

Redbreast

High water prevented sampling of the river for redbreast survival. Survival is not known. One was seined from Mud Lake Slough, which is 3 miles above Fargo, Georgia, on May 13, 1969 before the stocking in 1969 and is believed to have been released in May 1968. The fish was 97 mm long and weighed 17 grams.

Fish Movements over the Okefenokee Sill

Tables 5 and 6 give the number, average length, average weight, total weight, and percentages of total by number and weight of fish caught in the nets at North Prong and East Prong Spillways from February 1969 through June 1969. The sample area, time interval, depth of water discharge, water temperature, and number of fish caught for each individual day of sampling are summarized in Tables 7 and 8.

Nine species of fish were caught in the nets. Four of these were game fish and consisted of flier, chain pickerel, warmouth, and largemouth bass. The non-game fish were bowfin, yellow and brown bullhead catfish, (combined together as bullhead catfish), lake chubsucker, and Florida gar. Sex ratios of fish caught were generally one to one.

East Prong Spillway had profound movement at certain periods and under certain conditions. Sixty-five fish, averaging 236 mm in length and 284 grams in weight, were caught in the nets during 35 individual days of sampling at this spillway.

Making up 30.8 percent of the total fish caught, flier were netted the most frequently. They were also the smallest size fish to come over. Bowfin

were the next numerous fish to be caught and made up 20.0 percent by number and 72.2 percent by weight. Eleven of the 65 fish caught were warmouth which made up 16.9 percent of the number and 10.5 percent of the weight. Bullhead catfish, consisting primarily of yellow bullhead catfish, was the next numerous fish to come over. The bullheads made up 15.4 percent by number and 7.8 percent by weight. Chain pickerel and largemouth bass came over less frequently and made up 7.7 percent each by number and 3.6 percent by weight for the chain pickerel and 1.3 percent by weight for the largemouth bass. One lake chubsucker was caught in the net at this spillway and could not be measured due to its decomposed state.

Twenty-four days of sampling at North Prong Spillway yielded 9 fish and indicated that movement at this spillway was sporadic. The fish averaged 226 mm in length and had an average weight of 271 grams. Warmouth, lake chubsucker, and chain pickerel appeared to come over the spillway more frequently. The number of fish caught at this spillway was too low to make any comparisons among the fish.

The water quality during this sampling period was typical of the drainage. Water temperature varied from 51°F. on February 20, 1969 to 86°F. on June 27, 1969. Dissolved oxygen ranged from 4.5 to 7.5. The pH range was 4.4 to 4.9. Total hardness varied from 5 to 6 ppm.

Definite patterns of movement were shown and appeared to be related to time of year, water depth, and water temperature. Flier and bowfin came over during February and March when the water temperatures varied from 52° to 56°F. The flier were ripe and apparently were moving downstream to spawn. Bowfin gonadal development for spawning began in October and continued into March and April. The bowfin movement over the spillway coincides with this period of gonadal maturation. Bowfin reproduction was not observed in the

Table 5

Number, Average Length, Average Weight, Total Weight, and Percentages of Total by Number and Weight of Each Species of Fish Caught in the Nets at East Prong Sill from February 2, 1969 through June 28, 1969

Species	Number	Average Length (mm)	Average Weight (gm)	Total Weight (gm)	Percent of Total Number	Percent of Total Weight
Bowfin	13	483	1,024	13,312	20.0	72.2
Warmouth	11	184	176	1,936	16.9	10.5
Flier	20	129	42	840	30.8	4.6
Chain pickerel	5	266	131	655	7.7	3.6
Bullhead catfish	10	208	144	1,440	15.4	7.8
Largemouth bass	5	161	49	245	7.7	1.3
Lake chubsucker	1	--	--	--	1.5	T[1]
Total	65	236	284	18,428	100.0	100.0

[1] Does not include weight of Lake chubsucker.

Table 6

Number, Average Length, Average Weight, Total Weight, and Percentages of Total by Number and Weight of Fish Caught in the Nets at North Prong Sill from February 28, 1969 through June 27, 1969

Species	Number	Average Length (mm)	Average Weight (gm)	Total Weight (gm)	Percent of Total Number	Percent of Total Weight
Warmouth	2	220	211	422	22.2	17.3
Chain pickerel	3	228	43	129	33.3	5.3
Bullhead catfish	1	150	66	66	11.1	2.7
Florida gar	1	642	1,346	1,346	11.1	55.1
Lake chubsucker	2	212	239	478	22.2	19.6
Total	9	260	271	2,441	99.9	100.0

river during the spring; however, the existing high water during this period limited sampling and some reproduction may have occurred.

The yellow and brown bullheads did not exhibit any definite pattern of movement. Bullhead movement occurred in March, April, May, and June at various temperatures and depths of water discharge; however, greatest movement appeared to be during March when water temperature ranged from 52°F. to 56°F. and depth of discharge was dropping from 8 to 5 inches.

Warmouth began moving during March and terminated movement during the first week of April, except for movement on May 28, 1969 when depth of water discharge increased from 5 inches to 9 inches. During greatest warmouth movement, water temperature ranged from 60-67°F., coinciding closely to the temperature that warmouth begin spawning, and the depth of water discharge ranged from 10-12 inches. Some of the males were ripe and the females were almost flowing. Ripe males were caught at each spillway by fishermen during this same time period.

Chain pickerel movement coincided closely with warmouth movement and appeared to be related to the flushing of the swamp during the high water period. Depth of water discharge ranged from 10-12 inches which was the highest water discharge in two years.

Largemouth bass showed sudden movement April 2-3, 1969 during falling water levels and at temperatures ranging from 67°F. to 70°F. The bass were one year old and averaged 161 mm in length and 49 grams in weight. Although the bass were sexually immature, the bass movement corresponded close to the time of bass spawning.

The lake chubsucker movement occurred at East Prong Spillway on April 8, 1969 and at North Prong Spillway on April 17 and 18, 1969. This movement occurred at water temperatures ranging from 70°to 76°F. and on falling depth

Table 7

Sample Area, Time Interval, Depth of Water Discharge, Water Temperature, and Number of Fish by Species in the Nets at the East Prong Spillway for each day of Sampling from February 2, 1969 to June 27, 1969

Sampling Days	%Sample Area to Total Area	Time Interval (hrs.)	Depth Water Discharge (inches)	Water Temp. (F.)	Total Number of Fish	Bowfin	Flier	Bullhead Catfish	Warmouth	Chain Pickerel	Largemouth Bass	Lake Chubsucker
2 Feb.	5.0	5	6	51	0	0	0	0	0	0	0	0
26 Feb.	7.5	24	7	55	8	2	6	0	0	0	0	0
27 Feb.	7.5	24	7	55	4	1	3	0	0	0	0	0
28 Feb.	5.0	24	7	56	2	0	2	0	0	0	0	0
1 Mar.	2.5	24	7	56	4	1	2	1	0	0	0	0
2 Mar.	7.5	24	7	56	4	0	3	1	0	0	0	0
5 Mar.	7.5	24	6	56	3	0	2	0	1	0	0	0
6 Mar.	7.5	24	6	54	0	0	0	0	0	0	0	0
13 Mar.	7.5	24	5	52	6	1	1	4	0	0	0	0
14 Mar.	5.0	24	8	56	1	1	0	0	0	0	0	0
19 Mar.	5.0	17	10	58	6	5	0	0	0	1	0	0

24 Mar.	5.0	24	12	60	1	0	0	0	1	0	0	0
25 Mar.	5.0	24	12	60	1	0	0	0	0	1	0	0
28 Mar.	5.0	24	12	62	7	1	0	0	5	1	0	0
1 Apr.	5.0	24	10	68	0	0	0	0	0	0	0	0
2 Apr.	5.0	24	10	67	7	0	0	0	2	1	4	0
3 Apr.	5.0	24	9	70	1	0	0	0	0	0	1	0
8 Apr.	5.0	24	8	70	1	0	0	0	0	0	0	1
9 Apr.	5.0	24	8	70	0	0	0	0	0	0	0	0
16 Apr.	5.0	18	6	72	0	0	0	0	0	0	0	0
17 Apr.	5.0	24	6	77	0	0	0	0	0	0	0	0
18 Apr.	5.0	24	6	76	0	0	0	0	0	0	0	0
24 Apr.	5.0	24	5	78	0	0	0	0	0	0	0	0
25 Apr.	5.0	24	5	78	0	0	0	0	0	0	0	0
28 May	7.5	18	9	77	7	1	1	2	2	1	0	0
29 May	5.0	20	9	76	1	0	0	1	0	0	0	0
30 May	5.0	24	8	80	0	0	0	0	0	0	0	0
11 Jun.	5.0	24	7	80	0	0	0	0	0	0	0	0
12 Jun.	5.0	24	7	80	0	0	0	0	0	0	0	0
13 Jun.	5.0	24	6	82	0	0	0	0	0	0	0	0
18 Jun.	5.0	24	8	84	0	0	0	0	0	0	0	0
19 Jun.	5.0	24	8	85	0	0	0	0	0	0	0	0
26 Jun.	5.0	24	7	86	0	0	0	0	0	0	0	0
27 Jun.	5.0	24	7	86	1	0	0	1	0	0	0	0

Table 8

Sample Area, Time Interval, Depth of Water Discharge, Water Temperature, and Number of Fish by Species in the Nets at the North Prong Spillway for each Day of Sampling from February 28, 1969 to June 27, 1969

Sampling Days	% Sample Area To Total Area	Time Interval (hrs.)	Depth Water Discharge (inches)	Water Temp. (F°.)	Total Number of Fish	Warmouth	Chain Pickerel	Bullhead Catfish	Florida Gar	Lake Chubsucker
28 Feb.	5	24	5	56	0	0	0	0	0	0
1 Mar.	10	24	5	56	0	0	0	0	0	0
14 Mar.	10	24	6	56	0	0	0	0	0	0
19 Mar.	5	24	10	58	0	0	0	0	0	0
25 Mar.	5	24	12	60	1	1	0	0	0	0
1 Apr.	5	24	9	69	0	0	0	0	0	0
2 Apr.	5	24	9	67	0	0	0	0	0	0
3 Apr.	5	24	9	71	1	0	1	0	0	0
8 Apr.	5	24	7	70	1	0	1	0	0	0
9 Apr.	5	24	7	71	1	1	0	0	0	0

Table 8 Continued

16 Apr.	5	18	5	72	0	0	0	0	0	0
17 Apr.	5	24	5	76	1	0	0	0	0	1
18 Apr.	5	24	5	76	2	0	0	1	0	1
22 Apr.	5	24	4	76	0	0	0	0	0	0
23 Apr.	5	24	4	77	0	0	0	0	0	0
28 May	10	20	9	76	1	0	0	0	1	0
29 May	5	20	9	75	0	0	0	0	0	0
30 May	5	24	8	75	0	0	0	0	0	0
11 Jun.	5	24	6	78	0	0	0	0	0	0
12 Jun.	5	24	6	80	0	0	0	0	0	0
13 Jun.	5	24	6	81	0	0	0	0	0	0
18 Jun.	5	24	8	84	0	0	0	0	0	0
26 Jun.	5	24	7	86	0	0	0	0	0	0
27 Jun.	5	24	7	86	1	0	1	0	0	0

of water discharge.

Decreased movement of all species occurred at water temperatures greater than 70°F. except for increased movement on May 28, 1969 when the water depth increased to 9 inches. Of particular interest was the number of species that came over during this date. Bowfin, flier, warmouth, chain pickerel, and bullhead catfish came over the spillway while the largemouth bass and lake chubsucker did not come over.

The estimated number of fish that came over each spillway for each day of sampling was determined by taking the ratio of the total surface area across the spillway to the sample area and multiplying this ratio to the number of fish by species caught in the traps for that day. The estimated number of fish of each species that came over during the sampling days of each weekly interval were totaled and divided by the number of days sampled during that interval to give the average daily movement over the spillway during each week of sampling. This average movement is summarized in Tables 9 and 10. Table 11 gives the total estimated movement for species of fish that came over the spillway from February through June, which is derived by multiplying the seven days of the week to this average daily movement for each week of movement and adding the weekly product.

Discussion:

Roughfish Removal

This removal was low compared to that of the previous year. High water limited the days of favorable sampling conditions and the catch per effort was considerably less than the previous year, apparently as a result of fewer bowfin in the area as indicated by the population estimate.

While the declining catch rate may be from the effect of removal, other factors to consider are the mobility of the bowfin and the inducement

Table 9

Estimated Daily Number of Fish to Come over Spillway at East Prong Suwannee River

Species of Fish	20 Feb.	26 Feb.-2 Mar.	5-6 Mar.	13-14 Mar.	19 Mar.	24-25 Mar.	28 Mar.	1-3 Apr.	8-9 Apr.	16-18 Apr.	24-25 Apr.	28-30 May	11-13 Jun.	18 Jun.	26-27 Jun.
Bowfin	0	16	0	16	141	0	20	0	0	0	0	6	0	0	0
Flier	0	58	13	7	0	0	0	0	0	0	0	6	0	0	0
Bullhead Catfish[1]	0	11	0	26	0	0	0	0	0	0	0	18	0	0	0
Warmouth	0	0	7	0	0	10	100	13	0	0	0	12	0	0	0
Chain Pickerel	0	0	0	0	28	10	20	7	0	0	0	6	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0
Lake Chubsucker	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0

[1] Includes brown and yellow bullhead catfish.

Table 10

Estimated Daily Number of Fish to Come over Spillway at North Prong Suwannee River

Species of Fish	28 Feb. - 1 Mar.	14 Mar.	19 Mar.	25 Mar.	1-3 Apr.	8-9 Apr.	16-18 Apr.	22-23 Apr.	28-30 May	11-13 Jun.	18 Jun.	26-27 Jun.
Warmouth	0	0	0	21	0	10	0	0	0	0	0	0
Chain Pickerel	0	0	0	0	7	10	0	0	7	0	0	0
Bullhead Catfish[1]	0	0	0	0	0	0	7	0	0	0	0	0
Florida Gar	0	0	0	0	0	0	0	0	7	0	0	0
Lake Chubsucker	0	0	0	0	0	0	14	0	0	0	0	0

[1] Includes brown and yellow bullhead catfish.

Table 11

Estimated Movement of Fish over Both Spillways of the Okefenokee

Sill from February 2, 1969 through June 28, 1969

Species of Fish	Number
Bowfin	1,393
Warmouth	1,204
Chain Pickerel	665
Flier	588
Bullhead Catfish	434
Largemouth Bass	231
Lake Chubsucker	168
Florida Gar	49

of movement from these areas of concentration from the repeated electro-fishing in the river. These variables are discussed in more detail in the discussion on population estimates.

At the present time, the only conclusion on removal that can be made is that under optimum low water conditions, a high number and a high poundage of bowfin can be removed. It is speculative to say that such removal may or may not have a short term effect upon the stream fish population. If water conditions became favorable, removal efforts should be continued for possible evaluation as a management tool in this stream.

Population Estimates

The author feels that a reliable estimate would have been obtained had high water not disrupted sampling. The sample size for most of the estimates had exceeded 5 percent from 6 actual days of sampling and the population was consistently dropping. Unfortunately, sampling was not practical during or after the high water condition for obtaining a larger sample size.

The estimates except for the one based on the pelvic fin mark were fairly close and indicate that the population was somewhere between 4,000 to 8,000 bowfin at that time. The estimates differed from the 61,000 estimate made during F-19-R by more than 42,000 fish, and points out either the large sampling error of the Petersen estimate in mobile fish populations or the change in the population density in the river from the time the original estimate was obtained.

Assuming that both estimates did represent within a certain range the actual population, the next question in mind is, what changed the population abundance during the time interval between the two estimates? Applying ecological principles known for wildlife populations, the theory is that the

bowfin dispersed themselves downstream away from the center of the stress in the population during this time interval.

The bowfin population at the time of removal made up 80 percent by weight of the total population in the Suwannee River. The water flow at the time of the removal was the lowest in 14 years. During the drought period, the high bowfin population in the river was confined to a small volume of water which subjected them to considerable stress from increased competition, less food, and reduced space. (See food habits on bowfin, in F-19-R-3 Annual Report). The stress in the population caused an outward movement away from the center of the stress. In this situation, since the Okefenokee Sill is an upstream barrier during low water between the Suwannee and the Okefenokee Swamp, downstream movement was stimulated. The profound mobility and the decreasing catch of bowfin in areas known to have high concentration would also support this theory.

The other major variable that could have affected the change in the estimates is the repeated electrofishing that occurred in the stream, inducing the bowfin to move downstream. A natural fish kill of bowfin in the river was not reported nor seen during this study.

Since the estimates from the two periods of sampling are inconsistent and since it is tenable that downstream movement of the population may have occurred, no comparison is made on the percent of removal. If sampling conditions become favorable soon, it is recommended that a similar population estimate be made on the bowfin population for further evaluation.

Comparison of Electrofishing to Total Population

The results were basically similar to those reported in the F-19-R-3 report. Again the large fish, especially the predatory species, were easily captured with the exception of the brown bullhead. The brown bullheads,

apparently were buried in the mud at a depth that the electric field around the electrodes of the shocker did not reach. The low number of warmouth, spotted sunfish, bluegill, largemouth bass, and redbreast was more the result of these small specimens falling through the one inch bar mesh dip nets; however, even then these fish were not seen in the abundance that they were in the total sample. Smaller fish are not as effectively electro-narcotized and are harder to dip. Also their smaller size makes it easier for them to hide.

The high number of all the roughfish, especially the bowfin and gar demonstrates the effective removal that is possible under the most favorable conditions. The use of set nets contribute to this high removal. The catch would be lower if the area was not closed off. The results showed that more than two-thirds of the bowfin population and that more than one-half of the gar population in the sample area were removed, especially when nets or fyke nets are used to confine the fish.

The Suwannee River contains many pools in the upper 18 miles. During low water, these pools have high concentrations of bowfin and gar. If nets are set across the shallow river bed at the extremities of these pools, a significant percentage of each can be removed from the sample area.

The success of such efforts, even, if this high rate of removal is possible, will be determined by the height, duration, and timing of the water level fluctuation. If the frequency and the duration of optimum low water conditions are often enough and over a long enough time to sample the areas having the high population of roughfish, the roughfish population, perhaps, can be temporarily altered. However, if the river is frequently flooding, limiting conditions for removal and favoring population expansion of all species, such efforts will likely be useless.

Like the results in F-19-R-3, greater than 98 percent of the bowfin were removed in the upper 18 miles which would be the equivalent of 244.74 pounds per mile. The removal per mile during F-19-R-3 in this same area was 845.6 pounds. This weight plus the 244.74 pounds during F-21-R-1 gives an effective removal of 1090.34 pounds of bowfin removed per mile of river.

The amount of recruitment during the removal segment of the job is not known. However, certain facts can be mentioned that are pertinent. Recruitment that occurred in the mainstream during this time period would consist primarily of adult fish. Reproduction of bowfin was not observed in the mainstream during F-19-R and no progeny were seen during this job.

It was established during F-19-R-3 that bowfin were mobile. A certain amount of movement of large bowfin from the connecting tributaries probably occurred. A significant movement of adult bowfin into the Suwannee did occur at the Okefenokee Sill. (See results on fish movement over spillway in this job.) The movement at the spillways from February 1969 to June 1969 was estimated to be 1393 bowfin which replaced 77 percent of the 1822 bowfin removed during F-21-R-1. Such movement certainly shows that removal during F-21-R had little effect on the bowfin population structure in the Suwannee River.

Another point of interest that needs to be mentioned is the catch per hour. When the roughfish removal began during F-19-R, high concentrations of bowfin were found along the river, including the lower 15 miles of the Suwannee River. As the bowfin were removed, bowfin concentrations were harder to locate and the catches were smaller. For example, during November 1967, 202 pounds of bowfin were removed per hour of effort. During February 1969, the catch rate was 51.4 pounds per hour.

Fishing Regulations

The effectiveness of the creel regulations cannot be evaluated in one year nor in two years. Several years of following changes in the stream population and in the creel are required before any conclusions or recommendations can be directed on the use of creel regulations in managing the fisheries of the river.

Fish Stocking

The author feels that stocking of bass and other species of fish with the exception of redbreast should be discontinued on the Suwannee River until after other management approaches have been explored and evaluated. The application of several management techniques during the same time interval may alter the stream population; however, the drawback to this approach is that evaluation of cause and effect mechanisms is useless since so many variables are operating at one time. The stocking of redbreast can be evaluated in the Suwannee above Fargo since this species has been almost non-existent in that area.

Future releases of fish in the Suwannee are not proposed for the time being. An alternative to the fish stocking in the Suwannee would be to release fish species in another stream that shows definite need of fish stocking and to evaluate effects of such releases on the stream population. That way, one variable is being introduced at the time, and cause and effect relationships can be better defined and compared.

Fish Movements over Okefenokee Sill

Definite relationships and implications are indicated from this study of fish movements over the spillway. The first major point of interest is the fact that significant fish movements did occur at the East Prong Spillway and little fish movement occurred at the North Prong Spillway. The only

explanation that can be mentioned here is that the North Prong of the Suwannee River drains the northwestern corner of the Okefenokee Swamp. This section is smaller, receives water from many tributaries flowing into the swamp on the northwesterly side, and has fewer still, open water areas. The North Prong of the Suwannee drains the interior of the swamp, has a larger surface area of the swamp itself, and has more still, open water areas. Also, the rate of fall per mile in North Prong is probably greater than the East Prong, making the water swifter. Measurements on the physical differences of each area and population studies will be necessary to better account for the differences in the fish movements over each spillway.

Another point of significant interest was the high movements during the spring. Most species of fish spawn in the spring. The timing of the fish movements appeared to occur at or near temperatures and seasons that spawning occurs. The exceptions to this time and temperature of movement were the chain pickerel, which appeared to move on rising water, and bull-head catfish, which seemed to be more random in their movement pattern.

So far, indications are that fish tend to be less active in movement at high temperatures and more active at low temperatures. Ninety-three (93) percent of all fish by number that were caught in the nets came over the spillway at temperatures less than 78°F. Rising water appeared to induce movement of the more mobile fish in the swamp.

These movements over the spillway establishes that the swamp contributes to fishery of the Suwannee River and implies that the dike influences the population of the Suwannee River by permitting fish to come over the spillway and by limiting movement into the spillway from the Suwannee. The high percentage of bowfin that came over the spillway certainly explains, in part, how this predatory species became so abundant in the Suwannee River as

was reported during F-19-R.

Several implications result from this study of fish movements. One is that management efforts need not be attempted on the Suwannee River without consideration of the effects of the fish movements from the swamp into the river. Another implication is the need to develop a management control at the spillways that permits movement of desirable fish into the river and prevents movement of the undesirable fish over the spillway.

The last major point of consideration deals with the question of whether the fish movements are beneficial to the swamp and to the river in respect to the overall fisheries of that area.

Further discussion is withheld until completion of sampling and data analysis and will be presented in the F-21-R-2 report or in a technical paper.

Recommendations:

Roughfish Removal and Population Estimates

1. That the roughfish removal remain a part of the project for possible consideration during the next low water condition.
2. That a comprehensive population estimate be conducted on bowfin during the next low water condition.

Stocking

1. That stockings in the Suwannee River be discontinued, except for redbreast, unless proper evaluations on these stockings can be carried out for cause and effect relationships.
2. That redbreast be released above Fargo, Georgia, in the future and evaluated for survival, growth, movements, and reproduction to determine if the limiting factor on the redbreast is water quality or habitat requirements.
3. Other streams be considered for feasibility in stocking species

of fish that need strengthening or maintaining and proper evaluation be conducted for each release for cause and effect relationship on the species in the river.

Movements over Spillway

No recommendations are made at this time since sampling and data analysis is continuing to follow the movement pattern over an annual cycle and to see if movement of the previous year will be duplicated.

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. VII

Benthos Studies in Warmwater Streams

Job No. 1

SURVEY AND INVENTORY

Technical Personnel:

Daniel R. Holder

Herbert Wyatt

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder
Project Supervisor

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

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Project Title: Statewide Fisheries Investigations

Job No.: VII-1

Study Title: Benthos Studies in Warmwater Streams

Job Title: Survey and Inventory

Period Covered: July 1, 1968 through June 30, 1969

Summary:

A study of the composition, abundance, and seasonal changes of benthos in the Suwannee River was conducted from July 1968 to June 1969. Sampling stations consisted of eight mainstream stations and one slough station. For habitat comparison, the mainstream stations consisted of two fast slide stations and two pool-like stations in the upper (upstream) 18 miles of the Suwannee River and two fast slide and two pool-like stations in the lower (downstream) 15 miles of the Suwannee River in Georgia.

Oligochaetes were not abundant. *Progomphus* and *Molanna* were the most frequent insects in the upstream fast slide stations. *Gomphus*, *Macronemum*, Chironomidae, *Molanna*, and *Sialis* were the most frequent forms in the upstream pool-like stations. *Progomphus* and Ceratopogonidae were the most abundant insects in the downstream fast slide stations, and *Progomphus*, Ceratopogonidae, and Chironomidae were the most abundant forms at the downstream pool-like stations. The dominant insects at the slough station were Chironomidae and *Sialis*.

Molanna were most abundant during the months of July 1968 to November 1968. Chironomids increased during the months of November 1968 to March 1969.

Average number of benthos for the mainstream stations was 9.76 organisms per square foot and average volumetric displacement was .066 ml. per

square foot. Benthos was more abundant and diverse in the pool-like stations. Benthos biomass was greater in the upstream stations than in the downstream stations. The downstream pool-like stations had a greater number of benthos and a lower biomass than the upstream pool-like stations. Major differences in benthos between each station is related to habitat characteristics of the area.

Benthos composition and abundance were greater during periods of low flows and lower during periods of high flows.

Background:

Fish life history and basic limnological studies have been conducted on the Suwannee River since July 1965. The results of these studies are described in F-19-R Reports. Several population studies were carried out from the summer of 1963 to the summer of 1968. The studies on the Suwannee River revealed a high bowfin population that made up 80 percent by weight of the total population and an extremely low population of forage fish. These studies are described in the F-19-R Reports.

To understand more about the ecology of the Suwannee River, accessment of the benthic organisms was needed. This report covers information on benthos in the mainstream and in one slough of the Suwannee River.

Objectives:

To determine the composition, abundance, and seasonal changes of benthos in the Suwannee River.

To compare benthos production between major habitat types.

Procedure:

The Suwannee River from the Okefenokee Dike to the Florida line has two major ecological types. The first ecological type is located in the upper 18 miles of the Suwannee River from the Okefenokee Dike to Fargo and

consists of deep long pools with slow moving water. These pool areas are intermitted with shallow, swifter stretches called slides. Many sloughs abound in this region. The river banks are low and the floodplain is frequently covered with water during the rainy seasons. The standing crop of fish is high from fish production during the high water levels and from fish coming into the river from the swamp.

The other major ecological type occurs in the 15 mile stretch from Fargo to the Florida line and is characterized by swift waters, high banks, and less frequency of pools and sloughs. The water is not over the floodplain as frequently, nor as long as the upstream section. The standing crop of fish in this region is low.

For comparison of benthos, two fast slide stations were sampled in the upper 18 mile section and two fast slide stations were sampled in the lower 15 mile section. Also two pool-like stations were sampled in the upper and lower sections to give a total of eight mainstream sampling stations. Another station was located in a slough with a mud bottom type. A brief description of each station was as follows:

Station One

Station one was a fast slide area approximately 5 miles downstream from the Okefenokee Dike. The bottom was mostly fine sand with scattered pockets of twigs and bark and other small debris. The area was shallow and the water flow was fairly swift.

Station Two

This station was approximately 5.5 miles downstream from the Okefenokee Dike and consisted of a deep long pool with sluggish moving water at low flows. The bottom was a mixture of sand, mud, and detritus and was heavily covered with twigs, limbs, tree trunks, and other debris.

Station Three

Located near the lower end of station two, station three was a mud bottom slough that contained water even during low flows in the river. The bottom was a mixture of mud, detritus, and decayed *Juncus rapens*, an aquatic rush.

Station Four

Station four may be characterized as a fast slide station. The area is shallow and the current is swift. The bottom type was primarily fine sand with scattered pockets of bark, twigs, and other vegetative remains. This station was approximately 12 miles from the Okefenokee Dike.

Station Five

Located downstream from station four, this station was a pool-like in nature. The area was moderately deep. The current was slow at low flows and swift at high flows. The bottom was composed of sand with patches of mud and detritus. The area had few fallen trees and limbs and was fairly open.

Station Six

Station six is classified as a fast slide area. The area was relatively shallow, the current was swift, and the bottom was clean. The bottom type was a mixture of fine and coarse sand. Station six was located approximately 23 miles downstream from the Okefenokee Dike.

Station Seven

This station was in an area that during low flows was pool-like and during high flows was fast slide-like. The bottom was a mixture of fine sand, coarse sand, and detritus. The location of this station was approximately 24 miles downstream from the Okefenokee Dike.

Station Eight

This station, similar to station 6, consisted of a fast slide that was shallow in depth and swift in water velocity. The bottom type was composed of fine and coarse sand and was clean. This station was 28 miles downstream from the Okefenokee Dike.

Station Nine

Located downstream from station eight, station 9, during low flows, exhibited pool-like characteristics and at high flows changed to the fast slide habitat type. The bottom type was predominantly fine and coarse sand, except for a patch of sand, mud, leaves, twigs below a dead cypress tree that was located in the channel. Apparently the nature of water currents below the cypress tree created a settling effect of these materials.

At the time that the stations were selected, the water levels were extremely low. Changing water levels throughout sampling altered the characteristics of each area from period to period. Stations that were pool-like on low water became fast slides on high water, particularly in the lower 15 miles. The slough station at low or normal water levels did not have any flow passing through. At full bank flows or higher, a rapid flow passed through it. In spite of the changing river characteristics, the same locations were sampled throughout the schedule to be consistent.

Preliminary sampling with a Petersen Dredge in the pool areas and a Surber sampler in the slide area showed an extremely low number of organisms per square foot. It was decided that three samples in a transect across the mainstream and two samples in a transect across the slough would be collected for each sampling period. The samples for each station would be pooled and averaged to better represent what was present at each station.

Sampling was carried out monthly from July 1968 through June 1969.

During the first three months of sampling, the Surber sampler was used to collect the samples from the slide areas and the Petersen dredge was used to collect the samples from the pool and slough stations. Rising water levels after September led to the use of the Petersen dredge at all stations.

The samples at each station were strained through a nylon net that had 23 meshs to the inch to retain the aquatic organisms and materials too large to pass through as the sand and mud was sifted through the net. The contents remaining in the net were emptied into a white metal pan, and the organisms were picked out with hand tweezers and placed in labeled bottles containing 10% formalin.

Ray Lott, graduate of University of Georgia with a minor in entomology, processed the samples. The insects were counted in each bottle, volumetrically measured by water displacement, and identified, if possible, to genera. Number of organisms and milliliters (ml) of water displacement per square foot was obtained by dividing the mainstream samples by three and the slough sample by two. Samples that averaged less than .03 ml per square foot were listed as trace. Needham and Needham (1962)[1], Usinger (1963)[2], and Ward and Whipple (1945)[3] were the references used for identification.

<u>Results</u>:

Table 1 gives the composition of benthos collected during the 12 month period. Tables 2 through 10 summarize the composition and abundance of bottom organisms at each station monthly.

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[1] Needham, James G. and Paul R. Needham, 1962. <u>A Guide to the Study of Fresh-Water Biology</u>. Holden-Day, Inc., San Francisco, 107 p.

[2] Usinger, Robert L. 1963. <u>Aquatic Insects of California</u>. The Regents of the University of California, 508 p.

[3] Ward, H. B. , and G. C. Whipple. 1945. <u>Fresh-Water Biology</u>. J. Wiley and Sons, New York. 1110 p.

Table 1

Composition of Benthos Collected from

the Suwannee River in Georgia

Class	Order	Family or Genera
Annelida	Oligochaeta	
Insecta	Odonata	*Progomphus*
		Gomphus
		Macronemum
		Macromia
		Didymops
		Tetragoneuria
		Plathemis
		Unknown
		Coenogrionidae
	Diptera	Ceratopogonidae
		Chironomidae
		Chaeborus
		Unknown
	Trichoptera	*Molanna*
		Phylocentropus
		Cheumatopsyche
		Polycentropus
		Chimarra
		Unknown
	Coleoptera	*Stenelmis*
		Berosus
		Pronoterus
		Dineutus
		Emidae
		Unknown
	Megaloptera	*Corydalus*
		Sialis
		Neurocordulia
	Ephemeroptera	*Stenonema*
		Baetisca
		Heptagenia
	Hemiptera	Corixidae
	Hymenoptera	Unknown

Station One

The mean number of benthos was 3.47 organisms per square foot and the average volumetric displacement was .06 ml per square foot. The range in number was from .33 to 9.66 organisms per square foot and the range in volume was from trace to .12 ml per square foot. Oligochaetes, when collected, ranged from .33 to 2.00 organisms per square foot. Five taxonomic insect Orders were represented. The most frequent insects were Progomphus, chironomids, and Molanna. Insects that occurred least frequently were Didymops and Corydalus. Making up 4.33 organisms per square foot, Molanna was the most numerous insect during any one month of sampling.

Station Two

Benthos averaged 7.59 organisms per square foot and .07 ml volumetric displacement per square foot. The range in number was from 2.33 organisms per square foot to 20.01 organisms and the range in volumetric displacement was from trace to .17 ml per square foot. Oligochaetes were found consistently in the samples and ranged from .67 to 7.00 organisms per square foot. Six taxonomic Orders of insects were represented. The more frequent forms were Gomphus, chironomids, Molanna, and Sialis. Insects that occurred least frequently were Macronemum, Berosus, and Heptagenia. Molanna again had the greatest number during any month of sampling, making up 10.67 organisms per square foot in the August sample.

Station Three

The mean number per square foot was 13.62 organisms and the range was from .50 to 46.00 organisms per square foot. The average volume displacement of the insects was .06 ml and varied from trace to .15 ml. Oligochaetes occurred sporadically in the samples and ranged from .50 to 1.00 organisms per square foot. Seven taxonomic known Orders of insects were collected

Table 2

Composition and Abundance of Benthic Organisms at Station One, Fast Slide, Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta		2.00	.33						.67	2.00			
Odonata													
Progomphus	.67	.67	.67	.33	1.00	1.00		.33	.33	.33		.67	
Gomphus	.67	.33											
Macronemum	1.33		.67			.33							
Macromia		.33	.33										
Didymops	.33												
Diptera													
Ceratopogonidae	.33	1.67						.33					
Chironomidae	.67	.33						.67	.33		.33	.33	
Coleoptera													
Stenelmis	1.33	.67	1.67				.33	.33				.33	
Berosus		.33							.33				
Trichoptera													
Molanna	4.33	.33	3.00	1.67	2.00	.67			.67				
Megaloptera													
Corydalus			.33										
Unknown			1.33	.33	1.33								
No /sq. ft.	9.66	6.66	8.33	2.33	4.33	2.00	.33	1.66	2.33	2.33	.33	1.33	3.47
ml vol./sq. ft.	.11	.10	.27	T	.12	.05	T	T	T	T	T	.07	.06

Table 3

Composition and Abundance of Benthic Organisms at Station Two, Pool-like, Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar[1]	Apr	May	June	
Oligochaeta	7.00		.67	.33	.67	.67	2.00	.67		4.00	2.00	2.00	
Odonata													
<u>Gomphus</u>	.67	.33	.67			.33	.33	.33				.33	
<u>Progomphus</u>					1.33					.33			
<u>Didymops</u>						.33	.33						
<u>Macronemum</u>							.67						
Diptera													
Ceratopogonidae	.33						.33						
Chironomidae	3.00	.33	.33	1.00	2.33	1.67	7.00	1.33		.33	.33	.67	
Trichoptera													
<u>Molanna</u>	3.67	10.67	3.67	3.33	.67	3.33	1.00	.67				.67	
<u>Polycentropus</u>	1.00						.33						
Megaloptera													
<u>Sialis</u>	.67	1.00	.33	.33	.67			.67					
Coleoptera													
<u>Stenelmis</u>			.33			.33	.33						
<u>Pronoterus</u>					.33								
<u>Berosus</u>							.67						
Ephemeroptera													
<u>Heptagenia</u>							.33						
Unknown	3.67												Mean
No./sq. ft.	20.01	12.33	6.00	4.99	6.00	6.66	13.32	3.67	--	4.66	2.33	3.67	7.59
ml vol./sq. ft.	.17	.07	.03	.03	.10	.03	.07	.03	--	.10	.07	T	.07

[1] Missing

from this station. Insects that occurred most frequently were chironomids and Sialis. A ceratopogonid, Berosus, an unknown trichopteran, and Baetisca occurred least frequently. Ranging from 10.00 to 42.50 organisms per square foot, chironomids were the most numerous insects during the months of November 1968 to March 1969.

Station Four

The mean number of benthos per square foot was 7.51 organisms and the range was from trace to 17.99 organisms per square foot. The mean volumetric displacement was .14 ml per square foot and varied from trace to .33 ml per square foot. Ranging from .33 to 1.33 organisms per square foot, the oligochaetes were not frequent in the samples. Five taxonomic Orders of insects were collected. Progomphus and Molanna were the most frequent forms. Macronemum, Gomphus, Macromia, Chimarra, Polycentropus, and Neurocordulia were the least frequent insects.

Station Five

The mean number of benthos per square foot was 6.88 organisms and the range was from 1.33 to 12.33 organisms per square foot. The average volumetric displacement per square foot was .14 ml and the range was from trace to .37 ml per square foot. Oligochaetes were collected in six of the monthly samples and ranged from .33 to 2.33 organisms per square foot. Six taxonomic Orders of insects occurred in the samples. Insects that occurred most frequently were Progomphus, Macronemum, ceratopogonids, chironomids,and Molanna. Macromia, Didymops, an unknown dragonfly nymph, an unknown insect dipteran, Berosus, Dineutus, Cheumatopsyche, Chimarra, an unknown trichopteran, Sialis, and Stenonema occurred least frequently. Chironomids increased during the months of November and April. Molanna increased during August, September, and October.

Table 4

Composition and Abundance of Benthic Organisms at Station Three, Mud Bottom Slough

Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta	.50			.50	.50			1.00			1.00		
Odonata													
Gomphus	1.50			1.00	.50								
Tetragoneuria			.50	.50									
Plathemis			.50						.50				
Coenagrionidae							.50						
Diptera													
Ceratopogonidae				.50	.50		.50		.50				
Chironomidae	5.50	.50	5.50	2.50	13.50	28.50	42.50	10.00	19.50	.50		.50	
Chaeborus							.50		1.50				
Coleoptera													
Berosus					.50								
Unknown	.50			1.50	.50								
Trichoptera													
Unknown			.50										
Megaloptera													
Sialis	1.00	.50	4.00	1.50	2.50	1.50	1.00		.50				
Ephemeroptera													
Baetisca							1.00						
Hemiptera													
Corixidae								.50					
Unknown		3.00		.50				.50					
No./sq. ft.	9.00	4.00	11.00	8.50	18.50	30.00	46.00	12.00	22.50	.50	1.00	.50	13.62
ml vol./sq. ft.	.15	T	.10	T	.10	.10	.10	.05	.10	T	T	T	.06

Table 5

Composition and Abundance of Benthic Organisms at Station Four, Fast Slide

Suwannee River from July 1968 through June 1969

Kind	July	Aug*	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta	1.00					.33	.33		.33	1.33			
Odonata													
<u>Progomphus</u>	5.00		4.67	3.33	4.33	5.00	5.00	4.67	4.00	1.33	2.00		
<u>Macronemum</u>	.67		5.33				.33						
<u>Gomphus</u>	.67												
<u>Macromia</u>	.33												
Trichoptera													
<u>Molanna</u>	3.00		.67		1.33	1.00	1.00	2.00	1.33	.33			
<u>Cheumatopsyche</u>	1.00		.33										
<u>Chimarra</u>	.33												
<u>Polycentropus</u>	1.33												
Diptera													
Ceratopogonidae	.33					.67		.67	.67	1.00	1.33		
Chironomidae	1.00						1.00		1.00	.67	.33	.33	
Unknown	.67						.33						
Coleoptera													
<u>Stenelmis</u>	2.33		.33	.33		.33	2.00	2.33					
Megaloptera													
<u>Neurocordulia</u>	.33												
No./sq. ft.	17.99	--	11.33	3.66	5.66	7.33	9.99	9.67	7.33	4.66	4.66	.33	7.51
ml vol./sq. ft.	.27	--	.33	.05	.17	.10	.07	.33	.07	.07	.13	T	.14

*Missing.

Table 6

Composition and Abundance of Benthic Organisms at Station Five, Pool-like Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta	.33	1.67			.33				2.33	1.33		.67	
Odonata													
Progomphus	1.00	.33	1.33	.33		1.00	1.67	1.33	3.00			.33	
Macronemum	1.00		.33	1.00		1.33	5.67	2.33		1.33	.33		
Gomphus	1.67				.33		.33						
Macromia	.33												
Didymops					.33								
Unknown	.33												
Diptera													
Ceratopogonidae	.33			.33	.33			1.33	.33	1.33	.33	.33	
Chironomidae	1.00	.67		1.00	4.67	1.00	.67	1.67	2.00	4.33			
Unknown											.33		
Coleoptera													
Stenelmis	.67			.33		1.00	2.00	2.00		.33			
Berosus							.33						
Dineutus	.33												
Unknown				.33			.33		.33				
Trichoptera													
Molanna	.33	3.67		2.00	3.67	1.00	1.33	.33	.67		.67		
Phylocentropus				.67	.33	.33		.67					
Cheumatopsyche	.33												
Polycentropus		.33								.33	.67		
Chimarra											.33		
Unknown										.33			
Megaloptera													
Sialis	.67												
Ephemeroptera													
Stenonema									.33				
No./sq. ft.	8.32	6.67	1.66	5.99	9.99	5.66	12.33	9.66	8.99	9.31	2.66	1.33	6.88
ml vol./sq. ft.	.27	.13	.05	.13	.07	.07	.30	.17	.37	.07	.07	T	.14

Station Six

The average number of benthos at this station was 3.11 organisms per square foot and the range was from zero to 11.66 organisms per square foot. The volumetric displacement per square foot averaged .03 ml and varied from zero to .17 ml. Oligochaetes were collected during the months of April and May and averaged .33 organisms per square foot. Three taxonomic Orders of insects were represented at this station. Progomphus occurred most frequently. An increase in Progomphus was indicated in the January sample. The ceratopogonids were the next most frequent insect. Stenelmis was the least frequent insect.

Station Seven

The average number of benthos per square foot at this station was 2.75 and the range was from .33 to 9.67 organisms. The volumetric displacement per square foot averaged .05 and varied from trace to .13 ml.

The oligochaete was collected in the October sample and averaged .33 organisms per square foot. Six taxonomic Orders of insects were collected. The most frequent insects were Progomphus and chironomids. Insects that occurred least frequently consisted of Didymops, an unknown coleopteran, and an unknown hymenopteran.

Station Eight

The average number of benthos during the 12 months of sampling was 2.24 organisms per square foot and the range was from .33 to 9.00 organisms per square foot. The volumetric displacement averaged .02 ml per square foot and the range was from trace to .07 ml per square foot. The oligochaetes were collected in the May and June 1969 samples. Three known orders of insects were collected at this station. Progomphus and the ceratopogonids were the most frequent insects. The ceratopogomids showed an increase to

Table 7

Composition and Abundance of Benthic Organisms at Station Six, Fast Slide

Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta										.33	.33		
Odonata													
Progomphus	1.00	.33	.33	.67	.33		7.33		.67		.33		
Diptera													
Ceratopogonidae					2.33	5.67	3.00	.33	5.00	3.67			
Chironomidae					3.67	.67							
Coleoptera													
Stenelmis							1.33						
No./sq. ft.	1.00	.33	.33	.67	6.33	6.34	11.66	.33	5.67	4.00	.66	0	3.11
ml vol./sq. ft.	.03	T	.03	.03	.03	T	.17	T	.03	T	T	0	.03

Table 8

Composition and Abundance of Benthic Organisms at Station Seven, Pool-Slide

Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta				.33									
Odonata													
Progomphus			.33	1.33	1.33	1.00	.33	.67	2.00			.33	
Gomphus	.33			.33	.67								
Macronemum					3.00	1.00							
Didymops				.67									
Diptera													
Ceratopogonidae			.33		2.67								
Chironomidae	1.33	.33			.67	.67	.67		3.00	3.67	.33		
Trichoptera													
Molanna	1.00				.67	.67							
Coleoptera													
Stenelmis					.33	.33							
Emidae				.33									
Megaloptera													
Sialis	.33			.67									
Hymenoptera													
Unknown					.33								
No./sq. ft.	2.99	.33	.66	4.66	9.67	3.67	1.00	.67	5.00	3.67	.33	.33	2.75
ml vol./sq. ft.	.03	T	.03	.07	.13	.05	.03	.03	.05	T	T	.03	.05

7.00 organisms per square foot in the March sample. *Molanna* was the insect that occurred least frequently in the samples.

Station Nine

The average number of benthos per square foot was 21.25 organisms per square foot and the range was from .33 to 111.33 organisms per square foot. The average volumetric displacement was .06 ml per square foot and varied from trace to .37 ml. Oligochates occurred periodically and varied from .33 to 1.00 organisms per square foot. The ceratopogonids and chironomids were the most frequent insects. *Progomphus* and *Molanna* were the next most frequent insects collected at this station. The least frequent insects were *Gomphus* and *Stemelmis*. Peaks in abundance of chironomids occurred in December 1968 and February 1969 when chironomids ranged from 14.33 to 101.00 organisms per square foot.

The average number and volumetric displacement in ml of benthos for each month of mainstream sampling on the Suwannee River is presented in Table 11. The average number for the 12 month period was 9.76 organisms per square foot and the average annual volumetric displacement was .07 ml per square foot. During the months of November 1968 through March 1969, benthos showed an increase and is due to the increased number of chironomids and ceratopogonids produced during this period.

The monthly benthos samples from the fast slide stations were averaged by number and volumetric displacement per square foot for these stations. The same was done for the pool-like stations. Table 12 compares the benthos standing crop between the fast slide stations and the pool-like stations. The average number of benthos at the slide stations was 4.02 organisms per square foot and the volumetric displacement was .066 ml per square foot. The average number of benthos in the pool-like samples was 9.76 organisms

Table 9

Composition and Abundance of Benthic Organisms at Station Eight, Fast Slide

Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Oligochaeta											.33	.33	
Odonata													
Progomphus	1.00	.33	.33	.33	1.00	1.33	1.33	1.00	2.00	1.33	.33		
Diptera													
Ceratopogonidae				.33	.67		.33	.67	7.00	1.33	.33		
Chironomidae		.33				1.00		1.00					
Trichoptera													
Molanna					1.00	.33							
Unknown			.33	1.00		.33							
No./sq. ft.	1.00	.66	.66	1.66	2.67	2.99	1.66	2.67	9.00	2.66	.99	.33	2.24
ml Vol./sq. ft.	T	T	T	T	.03	.05	.03	.03	.07	.05	.03	T	.02

Table 10

Composition and Abundance of Benthic Organisms at Station Nine, Pool-Slide

Suwannee River from July 1968 through June 1969

Kind	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	
Oligochaeta				.33	1.00					.33		.33	
Odonata													
Progomphus				2.00	.67	.33	1.00	.67		.33			
Didymops				.33	.67								
Gomphus				.33									
Diptera													
Ceratopogonidae		.33		.33	6.00	3.00	3.00	9.00	3.33	1.33		.33	
Chironomidae	.33	.67	.67	2.33	11.00	57.33	14.33	101.00	26.33	.33			
Trichoptera													
Molanna	1.67				.33	.33		.33	.33				
Phylocentropus	.33					.33							
Coleoptera													
Stenelmis										.33			
Berosus						.33		.33					
Unknown				.33		.33					.33		
													Mean
No./sq. ft.	2.33	1.00	.67	5.98	19.67	61.98	18.33	111.33	29.99	2.65	.33	.66	21.25
ml vol./sq. ft.	T	T	T	.37	.07	.09	.05	.17	.03	T	T	T	.06

per square foot and the average volumetric displacement was .079 ml per square foot.

Table 13 compares the total number, the average number, total volumetric displacement, and average volumetric displacement of benthos from the fast slide and pool-like stations in the upper 18 miles of the river in Georgia to data for the fast slide and pool-like stations of the lower 15 miles of the river in Georgia. The fast slide stations in the upper section had a total of 124.23 organisms that displaced 2.31 ml and averaged 5.45 organisms per square foot and .10 ml. The slide stations in the lower section totaled 64.27 organisms that displaced .61 ml and averaged 2.69 organisms and .03 ml per square foot. The pool stations in the upper section totaled 164.78 organisms that displaced 2.40 ml and averaged 7.26 organisms and .11 ml per square foot. The pool stations in the lower section totaled 287.90 organisms that displaced 1.29 ml and averaged 11.73 organisms and .05 ml per square foot. The combined stations in the upstream section averaged 6.34 organisms per square foot and .10 ml per square foot. The combined stations at the downstream section averaged 7.21 organisms per square foot and .04 ml per square foot.

Discussion:

The standing crop of benthos in the Suwannee River was low, reflecting the natural low productivity of the Suwannee River. The oligochaetes were not abundant throughout sampling. The sandy sub-strate probably contributed to the low production of these annelids.

The slough station showed the seasonal change in the chironomids and was lower in benthos production than expected. The biomass corresponded fairly close to the average biomass of the mainstream samples. This station had a greater number of orders represented but fewer genera in each

Table 11

Average Number and Volumetric Displacement of Benthic Organisms

in the Suwannee River from July 1968 to June 1969

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Mean
Number/sq. ft.	8.12	4.33	3.74	3.74	7.29	12.14	8.57	17.46	9.66	4.24	1.53	.87	6.81
Milliliters/sq. ft.	.11	.05	.09	.08	.09	.06	.09	.10	.12	.04	.04	.01	.07

Table 12

Compariosn of Benthos Standing Crop between Pool-like Stations and Fast Slide Stations

in the Suwannee River from July 1968 to June 1969

Fast Slide	July	Aug[1]	Sept	Oct	Nov	Dec	Jan	Feb	Mar[2]	Apr	May	June	Mean
Number/sq. ft.	7.41	2.25	5.16	2.08	4.75	4.66	5.91	3.58	6.08	3.43	1.66	1.00	4.02
Milliliters/sq. ft.	.10	.03	.21	.02	.09	.05	.07	.09	.04	.03	.04	.02	.066
Pool-like													
Number/sq. ft.	8.41	5.08	2.25	5.40	11.33	19.49	11.24	31.33	14.66	5.07	1.41	1.51	9.76
Milliliters/sq. ft.	.12	.05	.03	.15	.09	.06	.11	.11	.15	.04	.04	.01	.079

[1] Station 4 missing.
[2] Station 2 missing.

Table 13

Comparison of Benthos Standing Crop between Mainstream Stations from Upper 18 Miles to Stations from Lower 15 Miles of Suwannee River in Georgia

	Fast Slide	Pool-like	Average
Upper 18 Miles			
Total Number per sq. ft.	124.23	164.78	144.50
Average Number per sq. ft.	5.45	7.26	6.35
Total milliliters per sq. ft.	2.31	2.40	2.35
Average milliliters per sq. ft.	.10	.11	.10
Lower 15 Miles			
Total number per sq. ft.	64.27	287.90	176.08
Average number per sq. ft.	2.69	11.73	7.21
Total milliliters per sq. ft.	.61	1.29	.83
Average milliliters per sq. ft.	.03	.05	.04

order. The slough station was made for background information and points out that more slough stations need to be sampled for benthos production.

The increase in chironomids during the months of November 1968 through March 1969 may be from the decay of leaves that fell during the previous fall. It may also be from the natural seasonal change in the population.

The fast slide stations had fewer orders, fewer genera, and a lower number and biomass of benthos than the pool stations. This reduction is attributed to change in the water velocity and to the type of substrate between the fast slide and pool-like stations. The fast slide areas were swifter and were composed of sand and little debris. The bottom was generally clean and had little suitable substrate for the attachment of benthic organisms. The pool-like areas had a slower current of water and the bottom type was usually a mixture of sand, mud, leaves, twigs, limbs, and other debris.

Comparatively the pool-like stations in the upper 18 miles had a lower number of organisms per square foot than the pool-like stations in the lower 15 miles. The biomass was greater at the upstream pool stations than the downstream pool stations. This increase in number and decrease in biomass at the downstream pool stations was from the increased number of chironomids that came from station nine during the months of November 1968 to March 1969. The chironomids were some of the smallest insects collected but comprised less biomass than the bigger insect forms that occurred less frequently.

The tremendous number of chironomids at station nine probably was atypical for this section of the river. The bottom type throughout this area is predominantly sand. The chironomids were taken from the mud pocket area. While this station may be non-typical, it does show that scattered

areas of the river will contain a high standing crop of benthos.

The slide stations in the upper 18 miles had a greater composition, greater number, and a greater biomass than the slide stations in the lower 15 miles of the river. The differences are again attributed to the characteristics of each area. The water current in the upstream slide stations were not as swift as in the downstream stations. Also the bottom type at the upstream stations contained traces of leaves, bark, and twigs, and debris which provided a stable source for attachment of benthic organisms whereas the downstream slide stations were virtually an all sand substrate.

During low flows, the standing crop and the number of genera were high, and during high flows, the standing crop and the number of genera were low. Looking back at Tables 1 through 9, it is seen that from July 1968 to February 1969, which was during a period of low to normal flows, the benthos were greater in composition and abundance. From March 1969 to June 1969, which was during a period of full bank flows or higher, the benthos composition and abundance were low.

This job on benthos has established the benthos production in the mainstream of the Suwannee River over a twelve month period. The water levels in the Suwannee were not over the floodplain over a long enough duration for floodplain sampling. A comparison of benthos production on the floodplain to the mainstream is needed to better understand the role of benthos to the ecology of the Suwannee River.

Recommendations:

1. That benthos samples be taken from several sloughs on the river.
2. That benthos samples be collected on the floodplain whenever the water level is over the floodplain.

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. VIII

THE EFFECTS OF INSECTICIDE TREATMENTS FOR MOSQUITO CONTROL ON AQUATIC INSECT PRODUCTION IN LAKE SEMINOLE

Job No. 1

Technical Personnel:

C. B. O'Neal, Jr.

Herbert Wyatt

Daniel R. Holder

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1

Project Title: Statewide Fisheries Investigations

Job No.: VIII-1

Study Title: The Effects of Insecticide Treatments for Mosquito Control on Aquatic Insect Production in Lake Seminole

Period Covered: July 1, 1968 to June 30, 1969

Summary:

Treated and non-treated areas were established on the Chattahoochee River Arm, the Flint River Arm, and Spring Creek Arm of Lake Seminole to determine if spraying for mosquito control had any effect on the production of aquatic insects. Insects from one square foot samples of water hyacinth plants were collected monthly from July 1968 to January 1969 at which time project work ceased as a result of personnel losses. Basic physical and chemical data were collected also; however, no data is presented since the samples were not analyzed.

Objective:

To determine if spraying with malathion for mosquito control in Lake Seminole had any effect on the production of aquatic insects.

Procedure:

Areas receiving regular applications of insecticides for mosquito control were compared to areas not receiving treatment. The areas consisted of a treated area and a control area on the Chattahoochee River Arm, the Flint River Arm, and the Spring Creek Arm. Preliminary sampling with an Elkman dredge gave such a low number of organisms per square foot that bottom sampling was ruled out for making the comparisons.

When it was learned that water hyacinth contained a much higher number of insects than found in the benthos samples, it was decided that the sample at each station would consist of insects from the roots of one square foot of water hyacinth plants. The insects were picked in the field and preserved in 10% formalin solution. At each station location, water temperature, dissolved oxygen, and pH were determined at the surface and at the bottom. Samples were collected monthly from July 1968 to January 1969 at which time project work ceased as a result of personnel losses.

Findings: (Results)

Since none of the samples have been analyzed, no data is presented.

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. IX

EVALUATION OF ANTIMYCIN AS A

SELECTIVE FISH TOXIN

Job No. 1

Technical Personnel:

C. B. O'Neal, Jr.

Herbert Wyatt

Daniel R. Holder

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1

Project Title: Statewide Fisheries Investigations

Job No.: IX-1

Study Title: Evaluation of Antimycin as a Selective Fish Toxin

Period Covered: July 1, 1968 to June 30, 1969

Summary:

Population studies were conducted on Lake Worth to determine if a crowded bluegill population existed and to inventory the population for later comparative purposes. It was concluded that the problem of poor fishing in Lake Worth resulted from the excessive harvest of game fish and not from a crowded bluegill population. No evaluation of antimycin was made since Lake Worth was considered an inadequate study site. Alternatives for management of Lake Worth are presented.

Background:

Lake Worth is a 1,500 acre impoundment located in Dougherty and Lee Counties. Population studies have been carried out periodically since 1956. Early studies revealed a high population of gizzard shad and led to a rotenone application in 1958 (F-8-R) to selectively kill the shad without significant loss of game fish. Population studies and creel censusing over a five year period were made after the kill to detect changes in the population and creel. Initially the fish populations were stimulated from the void created by the kill but gradually stabilized to a similar level as before. Reports of declining fishing increased during the past few years and led to the fall population study during F-19-R-3 and to the present study on the evaluation of antimycin on crowded bluegills in Lake Worth. Basic limnological studies were carried out earlier during F-9-R to establish the thermal and chemical stratification pattern in Lake Worth.

Objectives:

To determine if antimycin can be used as an effective and practical method to selectively reduce bluegills in large reservoirs.

To improve fishing in Lake Worth.

Procedures:

Lake Worth, a 1,500 acre impoundment located on the Flint River in Dougherty and Lee Counties, was reported to have poor fishing. Rotenone population studies were conducted to determine if a crowded bluegill population existed and to inventory the population comparisons following the proposed antimycin kill on the bluegill sunfish. During August and September 1968, two cove samples of one surface acre and two shoreline samples of two surface acres were blocked off with a 3/8 inch mesh net and treated with 5% emulsifiable rotenone at a concentration of 2 p.p.m. A second day pick up was made to collect fish that surfaced the following day. The recovery of fish from the study areas was good. The fish were sorted and tabulated according to Surber's Standard Method of Reservoir Population.

Results:

The results of the population studies are summarized in tabular form and are discussed in the attached report by C. B. O'Neal, Jr., who was the project leader on this study. The standing crop of fish per surface acre for the 4 studies averaged 69.3 pounds and ranged from 14.1 pounds to 140.3 pounds. Harvestable size largemouth bass averaged 4.6 fish to the acre. The harvestable bass averaged 7.56 ounces.

Fry and fingerling bluegill and redear sunfish were moderately numerous; yet the number of harvestable fish was low. The average weight of the harvestable bluegill was 1.18 ounces and the average weight of redear sunfish was 2.02 ounces. These two species of sunfish were the dominant fish by

weight in Lake Worth.

The most abundant non-predatory food fish varied by species according to sample location. The brown bullhead was the most abundant species in the cove sample of August 27, 1968, with 157 harvestable sized fish. In the shoreline sample the dominant non-predatory food fish were the spotted sucker and carp. In the shoreline sample of September 11, 1968, only 2.8 percent of the total sample by weight consisted of non-predatory food fish.

Channel catfish were collected at each study area but made up 3.2 percent or less in the samples. Gizzard shad was the most abundant forage species. This species ranged from 4.6 percent to 25 percent by weight. Fairly heavy reproduction of threadfin shad was collected in each of the samples except for the sample that had 25 percent gizzard shad.

Discussion: O'Neal (Unpublished)[1]

The results of these samples indicate that the problem is not due to a stunted intermediate bluegill population. In such a population, reproduction characteristically ceases, the small stunted bluegill are thin, "pop-eyed", and in many instances badly diseased. In the samples from Lake Worth, the intermediate sized bluegill were noted to be in good shape for an impoundment of this type and no disease was evident. In addition to the general condition of the intermediates, the high number of fingerling bluegill and other sunfish spawned this year indicate that the characteristics of the population are not those of a stunted population.

The most striking feature of each of the samples was the low number of harvestable size fish of any species. There was an average of 4.5 bass

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1 O'Neal, C. B. Jr. Lake Worth Report. Unpublished paper. Georgia State Game and Fish Commission. Georgia.

Reservoir Lake Worth Area Cove Sample Date August 27, 1968

1 Acre Sample

Group A - Predatory Game Fish:

	Fingerling			Intermediate			Harvestable			Total			% of Pop.
Species	No.	Wgt.	%Wgt	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Largemouth Bass	31.	.2	4	2.	.2	4	10.	5.3	92	43.	5.7	83	4
Black Crappie	26.	.2	40	0	0	0	1.	.3	60	27.	.5	7	T
Chain Pickerel	0	0	0	1.	.1	20	3.	.4	80	4.	.5	7	T
Redfin Pike	0	0	0	0	0	0	2.	.2	100	2.	.2	3	T
Totals	57.	.4	6	3.	.3	4	16.	6.2	90	76.	6.9	100	4

Group B - Non-Predatory Game Fish:

Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Bluegill	528.	1.4	6	795.	17.4	75	61.	4.3	19	1384.	23.1	56	17
Redbar Sunfish	246.	1.1	41	44.	.9	33	3.	.7	26	293.	2.7	7	2
Warmouth	1606.	4.2	28	613.	8.7	58	17.	2.1	14	2236.	15.	36	11
Redbreast	21.	.5	83	1.	T	T	1.	.1	17	23.	.6	1	T
Yellow Perch	0	0	0	2.	T	T	0	0	0	2.	T	T	T
Totals	2401.	7.2	17.4	1455.	27.	65.2	82.	7.2	17.4	3938.	41.4	100	30

Group C - Non-Predatory Food Fish:

	Fingering			Intermediate			Harvestable			Total			% of Pop.
Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Spotted Sucker	3.	T	T	24.	8.4	80	2.	2.1	20	29.	10.5	19	8
Brown Bullhead	141.	1.6	3	206.	15.5	31	157.	32.2	65	504.	49.3	82	35
TOTALS	144.	1.6	3	230.	23.9	40	159.	34.3	57	533.	59.8	100	43

Group D - Predatory Food Fish:

Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Channel Cat	0	0	0	4.	.8	67	1.	.4	33	5.	1.2	21	1
White Cat	2.	T	T	2.	.2	33	1.	.4	67	5.	.6	11	0
Spotted Gar	0	0	0	4.	.3	100	0	0	0	4.	.3	5	0
Bpwfin	0	0	0	1.	3.5	100	0	0	0	1.	3.5	63	3
TOTALS	2.	T	T	11.	4.8	86	2.	.8	14	15.	5.6	100	4

Reservoir Lake Worth Area Cove Sample Date August 27, 1968

Group E - Forage Fish:

	Fingerling			Intermediate			Harvestable			Total			% of Pop.
Species	No	Wgt.	%Wgt	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Gizzard Shad	0	0	0	307.	12.1	81	38.	2.9	19	345.	15.	56	11
Threadfin Shad	1209.	7.2	100	0	0	0	0	0	0	1209.	7.2	27	5
Golden Shiners	79.	.2	22	14.	.4	44	1.	.3	34	94.	.9	3	1
Top Minnows	38.	T	T	0	0	0	0	0	0	38.	T	T	T
B. Silverside	63.	T	T	0	0	0	0	0	0	63.	T	T	T
Gambusia	19.	T	T	0	0	0	0	0	0	19.	T	T	T
Darters	2.	T	T	0	0	0	0	0	0	2.	T	T	T
Taillight Shiners	272.	.5	100	0	0	0	0	0	0	272.	.5	2	T
Madtoms	54.	.2	100	0	0	0	0	0	0	54.	.2	1	T
Bluespotted Sunfish	45.	.2	100	0	0	0	0	0	0	45.	.2	1	T
Blackbanded Sunfish	136.	.5	100	0	0	0	0	0	0	136.	.5	2	T
Dollar Sunfish	318.	2.1	100	0	0	0	0	0	0	318.	2.1	8	2
Total	2235.	10.9	41	321.	12.5	47	39.	3.2	12	2595.	26.6	100	19
Grand Total	4839.	20.1	19.3	2020.	68.5	65.7	298.	51.7	49.6	7157.	140.3	100	100

Lake Worth - Cove Sample - August 27, 1968

Classification	Total Wgt.	% Wgt.
Group A - Predatory Game Species	6.9	4
Group B - Non-Predatory Game Species	41.4	30
Group C - Non-Predatory Food Fish	59.8	43
Group D - Predatory Food Fish	5.6	4
Group E - Forage Fish	26.6	19
Totals	140.3	100

Classification	Total Wgt.	% Wgt.
Fingerling	20.1	14.3
Intermediate	68.5	48.8
Harvestable	51.7	36.8
Totals	140.3	99.9

Population Study Data "Reported According to Surber, Standard Method of Reservoir Populations"

Reservoir Lake Worth Area Shoreline Date August 27, 1968

2 Acre Sample

Group A - Predatory Game Species:

	Fingerling			Intermediate			Harvestable			Total			% of Pop.
Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt	No.	Wgt.	%Wgt.	% of Wgt.
Largemouth Bass	25.5	.35	19	3.	.3	17	2.5	1.15	64	31.	1.80	69	1.8
Redfin Pike	0	0	0	1.	.15	100	0	0	0	1.	.15	6	.1
Chain Pickerel	0	0	0	.5	T	T	4.0	.65	100	4.5	.65	25	.7
Black Crappie	1.	T	T	.5	T	T	0	0	0	1.5	T	T	T
White Crappie	2.	T	T	0	0	0	0	0	0	2.	T	T	T
Totals	28.5	.35	14	5.	.45	17	6.5	1.80	69	40.	2.60	100.	2.6

Group B - Non-Predatory Game Species:

Species	No	Wgt.	%Wgt.	No.	Wgt.	%Wgt	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Bluegill	1120.	2.4	21	430.	7.45	64	23.5	1.85	15	1573.5	11.70	58	11.8
Redbreast	416.	.6	33	245.	.65	36	8.	.55	31	148.5	1.80	9	1.8
Warmouth	532.	1.55	39	145.5	1.00	25	11.	1.40	36	688.5	3.95	20	4.0
Redear Sunfish	263.5	.40	22	24.5	1.15	64	2.5	.25	14	290.5	1.80	9	1.8
Yellow Perch	41.	.35	47	0	0	0	2.5	.40	53	43.5	.75	4	.8
Spotted Sunfish	15.	.15	100	0	0	0	0	0	0	15.	.15	1	.1
Totals	2387.5	5.45	27	624.5	10.25	51	47.5	4.45	22	3059.5	20.15	100.	20.4

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Reservoir Lake Worth Area Shoreline Date August 27, 1969

2 Acre Sample

Group C - Non-Predatory Food Species:

	Fingerling			Intermediate			Harvestable			Total			% of Pop.
Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt	No.	Wgt.	%Wgt.	% of Wgt.
Snail Cat	5.	.15	50	1.	.15	50	0	0	0	6.	.30	2	.3
Spotted Sucker	33.5	.2	1	82.5	16.1	75	5.5	5.05	24	121.5	21.35	58	21.3
Redhorse Sucker	0	0	0	.5	.20	12	.5	1.50	88	1.	1.7	5	1.7
Carp	0	0	0	0	0	0	11	12.95	100	1.	12.95	35	13.1
Brown Bullhead	3.	T	T	2.	.15	43	1.	.20	57	6.	.35	1	.3
Total	41.5	.35	1.0	86.	16.60	45	8.0	19.70	54	135.5	36.65	101	37.1

Group D - Predatory Food Species:

Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt	No.	Wgt.	%Wgt.	% of Wgt.
Channel Catfish	1.5	T	T	2.5	.2	57	.5	.15	43	4.5	.35	4	.3
White Catfish	9.0	.15	75	.5	.05	25	0	0	0	9.5	.20	2	.2
Spotted Gar	0	0	0	0	0	0	1.	.05	100	1.0	.05	1	T
Bowfin	0	0	0	0	0	0	1.5	8.55	100	1.5	8.55	93	8.8
Totals	10.5	.15	2	3.0	.25	3	3.0	8.75	96	16.5	9.15	100	9.3

Reservoir Lake Worth Area Shoreline Date August 27, 1968

Group E - Forage Fish

	Fingerling			Intermediate			Harvestable			Total			% of Pop
Species	No	Wgt.	%Wgt	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt	% of Wgt
Gizzard Shad	0	0	0	128.5	5.15	27.	19.5	14.25	73	148.	19.40	64.	19.6
Threadfin Shad	1094.5	5.65	100	0	0	0	0	0	0	1094.5	5.65	19.	5.7
Taillight Shiners	478.5	.95	100	0	0	0	0	0	0	478.5	.95	3.	.9
Dollar Sunfish	128.5	.30	66.7	15.5	.15	33.3	0	0	0	144.	.45	1.0	.5
Pigmy Sunfish	1.5	T	T	0	0	0	0	0	0	1.5	T	T	T
Blackbanded Sunfish	20.5	T	T	34.5	1.7	100.	0	0	0	55.	1.7	6.	1.7
Bluespotted Sunfish	94.	.3	100	0	0	0	0	0	0	94.	.3	1.	.3
Brooks Silverside	7.	T	T	6.5	T	T	0	0	0	13.5	T	T	T
Madtom	81.	.25	100	0	0	0	0	0	0	81.	.25	1.	.3
Darters	5.	T	T	0	0	0	0	0	0	5.	T	T	T
Pirate Perch	1.	T	T	0	0	0	0	0	0	1.	T	T	T
Golden Shiner	26.	1.6	100	0	0	0	0	0	0	26.	1.6	5.	1.6
Gambusia	1.	T	T	0	0	0	0	0	0	1.	T	T	T
Starhead Top Minnow	3.	T	T	0	0	0	0	0	0	3.	T	T	T
Total	1941.5	9.05	30.	185.	7.0	23.	19.5	14.25	47	2146.0	30.3	100.	30.6
Grand Total	4409.5	15.35	13.	903.5	34.55	30.	34.5	66.6	57	5397.5	98.85	100.	100.

Lake Worth - Shoreline - August 27, 1968

Classification	Total Wgt.	% Wgt.
Group A - Predatory Game Species	2.6	2.6
Group B - Non-Predatory Game Species	20.15	20.4
Group C - Non-Predatory Food Fish	36.65	37.1
Group D - Predatory Food Fish	9.15	9.3
Group E - Forage Fish	30.3	30.6
Totals	98.85	100.0

Classification	Total Wgt.	% Wgt.
Fingerling	15.35	15.5
Intermediate	34.55	35.0
Harvestable	48.95	49.5
Totals	98.85	100.0

Reservoir Lake Worth Area Cove - Upper End Date September 11, 12, 1968

Group A - Predatory Game Fish

1 acre sample

	Fingerling			Intermediate			Harvestable			Total			% of Pop
Species	No	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Largemouth Bass	2.	T	T	2.	.3	11.5	6.	2.3	88.5	10.	2.6	86.7	3.5
Black Crappie	7.	T	100.	0	0	0	0	0	0	7.	T	T	T
White Crappie	2.	T	100.	0	0	0	0	0	0	2.	T	T	T
Chain Pickerel	0	0	0	3.	.4	100.	0	0	0	3.	.4	13.3	.5
Total	11.	T	T	5.	.7	23.3	6.	2.3	76.7	22.	3.0	100.	4.0

Group B - Non-Predatory Game Fish:

Species	No	Wgt.	%Wgt.	No.	Wgt	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Bluegill	324.	.5	3.8	568.	10.4	80.	28.	2.1	16.2	920.	13.	35.1	17.7
Warmouth	990.	2.9	21.5	420.	6.7	49.6	28.	3.9	28.9	143.	13.5	36.5	18.3
Redbreast	18.	T	T	16.	.4	66.7	3.	.2	33.3	37.	.6	1.6	.8
Redear Sunfish	315.	1.0	11.2	207.	5.6	62.9	18.	2.3	25.8	540.	8.9	24.	12.1
Spotted Sunfish	3.	T	T	21.	.5	100.	0	0	0	24.	.5	1.4	.7
Yellow Perch	43.	.4	80.	6.	.1	20.	0	0	0	49.	.5	1.4	.7
Totals	1693.	4.8	12.	1238.	23.7	64.	77.	8.5	23.	3008.	37.	100.	50.3

Reservoir Lake Worth Area Cove - Upper End Date September 11, 12, 1968

Group C - Non-Predatory Food Fish 1 acre sample

	Fingerling			Intermediate			Harvestable			Total			% of Pop.
Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Yellow Bullhead	4.	T	100.	0	0	0	0	0	0	4.	T	T	T
Spotted Sucker	56.	.6	10.2	16.	3.9	66.1	2.	1.4	23.7	74.	4.9	86.8	8.0
Brown Bullhead	1.	T	T	1.	.1	14.3	4.	.4	85.7	6.	.7	10.3	.9
Snail Catfish	9.	.1	50.	2.	.1	50.	0	0	0	11.	.2	2.9	.3
Totals	70.	.7	10.3	19.	4.1	60.3	6.	2.0	29.4	95.	6.8	100.	9.2

Group D - Predatory Food Fish

Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Channel Catfish	1.	T	33.3	1.	.1	33.3	1.	.2	66.7	3.	.3	7.3	.4
Spotted Gar	0	0	0	0	0	0	2.	3.4	100.	2.	3.4	82.9	4.6
Longnose Gar	0	0	0	1.	.1	100.	0	0	0	1.	.1	2.5	.1
White Catfish	3.	T	T	8.	.3	100.	0	0	0	11.	.3	7.3	.4
Total	4.	T	T	10.	.5	12.2	3.	3.6	87.8	17.	4.1	100.	5.5

Reservoir Lake Worth Area Cove-Upper End Date September 11, 12, 1968

Group E - Forage Fish 1 acre sample

	Fingerling			Intermediate			Harvestable			Total			% of Wgt.
Species	No.	Wgt.	%Wgt	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Gizzard Shad	3.	T	T	274.	14.1	76.6	5.	4.3	23.4	282.	18.4	81.1	25.
Threadfin Shad	215.	1.5	93.9	7.	.1	6.2	0	0	0	222.	1.6	7.0	2.2
Golden Shiners	1.	T	T	10.	.1	33.3	20	.2	66.8	13.	.3	1.3	.4
Minnows	155.	.1	100.	0	0	0	0	0	0	155.	.1	.4	.1
Madtoms	145.	.3	100.	0	0	0	0	0	0	145.	.3	1.3	.4
Shiners	282.	.3	100.	0	0	0	0	0	0	282.	.3	1.3	.4
Black Banded Sunfish	14.	T	100.	0	0	0	0	0	0	14.	T	T	T
Dollar Sunfish	581.	1.4	83.4	39.	.3	17.6	0	0	0	620.	1.7	7.5	2.3
Totals	1396.	3.6	16.	330.	14.6	64.	7.	4.5	20.	1733.	22.7	99.9	30.8
Grand Total	3174.	9.1	12.4	1602.	43.6	59.2	99	20.9	28.4	4875.	73.6	100.	99.8

Lake Worth - Cove - Upper End - September 11, 12, 1968

Classification	Total Wgt.	% Wgt.
Group A - Predatory Game Species	3.0	4.0
Group B - Non-Predatory Game Species	37.0	50.3
Group C - Non-Predatory Food Fish	6.8	9.2
Group D - Predatory Food Fish	4.1	5.5
Group E - Forage Fish	22.7	30.8
Totals	73.6	99.8

Classification	Total Wgt.	% Wgt.
Fingerling	9.1	12.4
Intermediate	43.6	59.2
Harvestable	20.9	28.4
Totals	73.6	100.0

Reservoir Lake Worth Area Shoreline Date September 11, 1968

Group A - Predatory Game Fish 2 acre

	Fingerling			Intermediate			Harvestable			Total			% of Pop.
Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Largemouth Bass	1.	T	T	6.	.4	100.	0	0	0	7.	.4	66.7	1.4
White Bass	0	0	0	1.	T	T	0	0	0	1.	T	.7	T
Chain Pickerel	0	0	0	2.	.1	100.	0	0	0	2.	.1	16.7	.4
Black Crappie	9.	.1	100.	0	0	0	0	0	0	9.	.1	16.7	.4
Total	10.	.1	16.7	9.	.5	83.3	0	0	0	19.	.6	100.	2.2

Group B - Non-Predatory Game Fish

Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Bluegill	68.	.1	18.	150.	3.0	55.6	30.	2.3	42.6	248.	5.4	28.4	19.1
Warmouth	175.	.5	23.8	26.	.9	42.9	6.	.7	33.3	207.	2.1	11.1	7.4
Redbreast	26.	T	T.	31.	.4	80.	2.	.1	20.	59.	.5	2.6	1.8
Redear Sunfish	92.	1.1	10.6	180.	3.5	33.6	66.	5.8	55.8	638.	10.4	54.7	36.9
Spotted Sunfish	2.	T	T	0	0	0	0	0	0	2.	T	T	T
Yellow Perch	78.	.5	83.3	5.	T	T	2.	.1	16.7	85.	.6	3.2	2.1
Totals	741.	2.2	11.6	392.	7.8	41.	106.	9.0	47.4	1239.	19.	100.	67.4

Reservoir Lake Worth Area Shoreline Date September 11, 1968

Group C - Non-Predatory Food Fish 2 acre

	Fingerling			Intermediate			Harvestable			Total			% of Pop
Species	No	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Spotted Sucker	33.	.2	50.	1.	.2	50.	0	0	0	34.	.4	50.	1.4
Yellow Bullhead	1.	T	T	0	0	0	0	0	0	1.	T	T	T
Sanil Catfish	30.	.1	25.	0	0	0	1.	.3	75.	31.	.4	50.	1.4
Total	64.	.3	37.5	1.	02	25.	1.	.3	37.5	66.	.8	100.	2.8

Group D - Predatory Food Fish

Species	No	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
White Catfish	10.	T	T	0	0	0	0	0	0	10.	T	T	T
Channel Catfish	7.	.1	11.0	7.	.8	88.9	0	0	0	14.	.9	16.1	3.2
Bowfin	0	0	0	0	0	0	1.	4.7	100.	1.	4.7	83.9	16.7
Totals	17.	.1	1.8	7.	.8	88.9	1.	4.7	83.9	25.	5.6	100.	19.9

Reservoir Lake Worth Area Shoreline Date September 11, 1968

Group E - Forage Fish 2 acre

	Fingerling			Intermediate			Harvestable			Total			% of Pop
Species	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	No.	Wgt.	%Wgt.	% of Wgt.
Gizzard Shad	0	0	0	14.	.5	38.5	2.	.8	61.5	16.	1.3	59.1	4.6
Threadfin Shad	36.	.2	100.	1.	T	T	0	0	0	37.	.2	9.1	.7
Golden Shiners	3.	T	T	2.	T	T	2.	T	T	7.	T	T	T
Pirate Perch	16.	T	T	0	0	0	0	0	0	16.	T	T	T
Brooks Silverside	11.	T	T	0	0	0	0	0	0	11.	T	T	T
Darters	4.	T	T	0	0	0	0	0	0	4.	T	T	T
Notropis	314.	.7	100.	7.	T	0	0	0	0	321.	.7	31.8	2.5
Banded Sunfish	3.	T	T	0	0	0	0	0	0	3.	T	T	T
Dollar Sunfish	6.	T	T	3.	T	0	0	0	0	9.	T	T	T
Total	393.	.9	40.9	27.	.5	22.7	4.	.8	36.4	424.	2.2	100.	7.8
Grand Total	1225.	3.6	12.8	436.	9.8	34.7	112.	14.8	52.5	1773.	28.2	100.	100.1

Lake Worth - Shoreline - September 11, 1968

Classification	Total Wgt.	% Wgt.
Group A - Predatory Game Species	.6	2.2
Group B - Non-Predatory Game Species	19.0	67.4
Group C - Non-Predatory Food Fish	.8	2.8
Group D - Predatory Food Fish	5.6	19.9
Group E - Forage Fish	2.2	7.8
Totals	28.2	100.1

Classification	Total Wgt.	% Wgt.
Fingerling	3.6	12.8
Intermediate	9.8	34.7
Harvestable	14.8	52.5
Totals	28.2	100.0

and 32.0 bluegills in the harvestable size category. The average number of harvestable size bass, pickerel, and sunfish species were 59.5 per acre.

The small number of harvestable size fish in this impoundment would most likely be due to one of two causes. The first would be that intermediates are not moving up into the harvestable size range due to over population and stunting. The evidence obtained thus far, as has already been indicated, does not support this as the cause. The second cause would be the cropping or harvesting of the harvestable size fish at a rate equal or nearly equal to the rate that the intermediates can move into the harvestable size range. Disease is a possibility, but at present there is no visible evidence to support this.

The theory is that there is a more rapid harvesting of fish than the impoundment can stand. Of the 1500 acres of water impounded in Lake Worth, probably not more than 700 to 800 acres are productive fish waters. A large portion of the impoundment consists of deep river and creek channel water. The waters are too deep for reproduction and are lower in productivity than the shallow back waters.

This impoundment is subjected to the fishing pressure of Albany, Georgia with a population of 68,000 people. In addition to this, there are several smaller communities such as Dawson, Leesburg, Newton, and Sylvester which contribute to the fishing pressure. Considerable illegal fishing, especially baskets, has been reported by local citizens.

The findings indicate that the problem in Lake Worth is due to overharvesting by combined legal and illegal methods in relation to the productivity of the water, that the harvestable size population is weak, and that Lake Worth does not have an overcrowded bluegill population as was earlier believed to be the case.

Since the population studies showed Lake Worth to be unsuitable for evaluation of antimycin, no further work related to antimycin was carried out. Other management alternatives were proposed to improve fishing in Lake Worth.

Recommendations:

1. Since Lake Worth is an inadequate site for the evaluation of antimycin, this job be deleted from F-21-2 until a more desirable site is located.
2. That another impoundment be considered for future evaluation of antimycin.
3. That a 3 foot draw-down by the Georgia Power Company be requested as soon as possible for the removal of illegal gear from Lake Worth.
4. That Lake Worth be patrolled regularly to check illegal measures on the lake.
5. That for at least 1 year a creel limit of 25 sunfish of all species per person per day be placed on Lake Worth, with signs posted to that effect.
6. That for at least 1 year, a creel limit of 5 largemouth bass of no less than 12 inches be placed on Lake Worth, with signs posted to that effect.
7. That future population studies be taken in the same four areas for later comparison on the changes in the fishery following any of the management efforts.

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. X

INVESTIGATIONS OF ASPECTS OF THE

LIFE HISTORY OF LARGEMOUTH BASS

Job No. 1

Tebhnical Personnel:

C. B. O'Neal, Jr.

Herbert Wyatt

Daniel R. Holder

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1 Project Title: Statewide Fisheries Investigations

Job No.: X-1 Study Title: Investigations of Aspects of the Life History of Largemouth Bass

Period Covered: July 1, 1968 to June 30, 1969

Summary:

Incomplete sampling from over extended project work and lack of personnel prevented the objectives of this job from being obtained.

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. XI

EVALUATION OF STRIPED BASS INTRODUCTIONS IN

LAKES BLACKSHEAR AND SEMINOLE

Job No. 1

Technical Personnel:

C. B. O'Neal, Jr.

Herbert Wyatt

Daniel R. Holder

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1 | Project Title: Statewide Fisheries Investigations

Job No.: XI-1 | Study Title: Evaluation of Striped Bass Introductions in Lakes Blackshear and Seminole

Period Covered: July 1, 1968 to October 31, 1969

Summary:

Fry striped bass were reared in the spring of 1969 in ponds at the Dawson Hatchery and in the nursery pond at Lake Seminole. Recruitment of fry to fingerlings occurred in each pond; however, fry survival in all ponds was extremely low. Lake Blackshear received 11,001 fingerling striped bass from July 1, 1968 to October 31, 1969. The nursery pond concept needs to be re-evaluated from the economical and practical viewpoint. Personnel turnover limited the success of this job.

Background:

Lake Seminole was filled in 1958 and consisted of 38,000 surface acres. Creel censusing and population studies were initiated during 1959 under F-9-R to gain information about the reservoir fishery.

The results of these studies showed that a landlocked population of striped bass existed in the reservoir. To determine the status of the landlocked striped bass, extensive netting, electrofishing, population sampling, egg net sampling, and creel censusing were carried out during the early 1960's. A fairly large population of stripers existed and some natural reproduction occurred. At the time of impoundment, netting was legal and reports of 12 to 40 pound stripers caught in nets were frequent. Catches of striped bass by creel and in nets decreased each year afterwards. The striper population was drastically reduced by 1964, largely from the detri-

mental effects of netting. Seasons on 2 inch mesh netting were established during 1963 and 1964 and in 1966 netting was illegal in Lake Seminole.

Basic limnology was conducted during F-9-R to determine the thermal and chemical stratification pattern in Lake Seminole. Aquatic plant surveys in screening herbicides against certain aquatic plants were a part of F-9-R and F-14-R. It was concluded that in limited areas aquatic weed control was economically feasible.

In 1965 emphasis to build up the striped bass population in Seminole was centered on the nursery pond concept where fry striped bass were to be shipped from Moncks Corner, South Carolina, raised to fingerling size in the nursery pond, and released into the main portion of Lake Seminole. Excellent results on raising striped bass fry to fingerlings were obtained in 1966 from a 4 acre nursery pond.

Efforts on Lake Seminole since 1966 have been sporadic and have consisted of creel censusing, netting, rotenone studies, and rearing of striped bass in nursery ponds. Introductions of striped bass using the nursery pond concept, an evaluation of slat basket utilization by suckers, population studies, and an evaluation of insecticides on aquatic organisms are the jobs on Lake Seminole that are included in the F-21-R report.

Lake Blackshear

See Job No. XVI-1 for background information on Lake Blackshear.

Objectives:

To continue introductions of striped bass into Lake Blackshear and Lake Seminole and to evaluate such releases.

To evaluate the nursery pond technique as a method of rearing striped fry to fingerling size.

Procedures:

Dawson Hatchery

Two hundred thousand striped bass fry were shipped by airplane to Walton Hatchery and then shipped by vehicle to Dawson Hatchery April 21, 1969. The fry were stocked in four ponds ranging from 0.8 to 1 surface acre. Before release, the fry were tempered from 72° to 74°.

The ponds had been renovated prior to shipment of fish. On April 18, 1969, each of the ponds were treated once with two gallons of diesel oil mixed with one gallon of kerosene to kill aquatic insects. Well water was frequently pumped into these ponds to maintain the desired water levels. Soybean meal was applied April 9, 1969, to establish zooplankton bloom. All ponds received from .5 to 1.0 pounds of Pay Day A-2 47% protein pellets (1/8 inch diameter) every other day until June 8, 1969. Bluegills were released into the ponds and tadpole production was abundant. The ponds were drained during the summer for stocking of the bass fingerlings into Lake Blackshear.

Lake Seminole Nursery Pond

Previous studies of a 4 acre pond (F-19-R) on Lake Seminole showed that nursery ponds may be useful in raising striped bass to fingerling size before their release. During the fall of 1968, a 38 acre body of water was impounded in the immediate watershed of Lake Seminole by an earth dam. In February the pond was treated with one gallon of 5% emulsifiable rotenone per 3.5 feet of water to eradicate the fish. Live fish were seen after the kill. March 8, 1969, sodium cyanide was applied over the pond at the rate of 2 ppm and gave a strong kill. Later observations showed live fish in the area. The vast volume of water and limited manpower made renovation unsuccessful.

During April, hydrated lime was added at the rate of 100 pounds per acre and one application of 20-20-5 was made over the pond. The lake was stocked April 17, 1968, with 1 million four day old fry that were shipped by air from Moncks Corner, South Carolina. Before release, the fish were tempered from 71° to 74°F. water. Fathead minnows and brood threadfin shad were released the following week to provide a source of forage for the fry when they shifted their diet to fish. Periodic sampling with scuba gear, hook and line, rotenone, and gill nets were conducted to see if stripers were in the pond and to determine their growth. The nursery pond was to be opened to the main portion of Lake Seminole during the fall of 1969.

Results:

Dawson Hatchery

Table 1 summarizes the stocking rate, feeding program, and production for each of these ponds. Ponds # 2 and # 4 were drained in July after 79 days of production. Three hundred and twenty striped bass were recovered out of pond # 2 and two bass came out of pond # 4. The stripers were loaded on a stocking truck and released after tempering into Lake Blackshear on the same day. No mortalities were observed after release.

Ponds # 8 and # 13 were drained in August 1969 after 136 and 137 days of growth. Pond #8 had 565 striped bass and about 150 pounds of tadpoles and bluegills. The bass averaged 3.98 inches. Three striped bass, averaging 6.02 inches, were recovered from pond # 13. Tadpoles were abundant in this pond. The fingerlings were transported in a stocking truck to Lake Blackshear and released at the boat ramp of the Veterans Memorial State Park. Two fish died during transport. No other mortalities were observed. In October, 38 more striped bass were seined from the Dawson Hatchery ponds and released into Lake Blackshear. These bass averaged from 10 to 11 inches.

Table 1

Statistics on the Rearing of Striped Bass in Ponds at Dawson Fish Hatchery

Pond[1,2]	Surface Acres	Period Pond Filled	Date Fry Released	Number	Days Production	Number[3] Harvested
#2	0.8	4/4-4/9	4/21	50,000	79	320
#4	0.8	4/6-4/9	4/21	50,000	79	2
#8	0.8	4/6-4/9	4/21	50,000	137	565
#13	1.0	4/6-4/9	4/21	50,000	136	3

[1] All ponds received 625 pounds of soybean meal April 9, 1969.

[2] All ponds received ¼ to ½ pound of Pay Day A-2 47 percent protein pellets (1/8 inch diameter) every other day until June.

[3] Thirty-eight more stripers were removed from the ponds during October 1969.

Lake Blackshear Stocking

In addition to the 928 striped bass that were released in the Dawson ponds during 1969, 1273 fingerlings were released from the Dawson Hatchery during the fall of 1968 and are discussed in F-19-R-3 report. In December of 1968, 5,000 bass ranging from 5 to 10 inches were transported from Arrowhead Hatchery, Armuchee, Georgia and released in Lake Blackshear. In January, 3,800 striped bass, ranging from 5 to 10 inches, were brought from Arrowhead Hatchery and released in Lake Blackshear. From July 1, 1968 through October of 1969, a total of 11,001 striped bass ranging from 3-11 inches were released in Lake Blackshear. This number of bass stocked in Lake Blackshear was approximately 1.3 striped bass per surface acre of water. Catches of striped bass have been reported. Personnel limitations prevented field sampling on the status of these stripers except for the routine creel censusing and population studies that were carried out.

Lake Seminole

Only one striped bass was taken from the nursery pond. This bass was caught in November 1969 in a 2 inch bar mesh gill net and had a length of 11.5 inches. Other reports of striped bass in the nursery pond could not be confirmed.

Discussion:

Dawson Hatchery--Lake Blackshear

The turnover of personnel and the lack of proper records severely limited the success and evaluation of rearing striped bass in ponds. While the results do show that stripers were produced, one cannot draw any reasonable conclusions since conditions associated with each pond were not adequately recorded. If proper emphasis and manpower can be devoted to this segment of the project with a prescribed method of record keeping at each

hatchery or facility, massive rearing of striped bass can be accomplished. Such success in raising striped bass to fingerling size has been reported for Oklahoma by Ron Jarman and Harper (1969).[1]

Lake Seminole

The results indicate that a few striped bass survived in the nursery pond. Again, personnel limitations hampered proper evaluation of the fry that were released in the pond. Nevertheless, the efforts on the nursery pond pointed out several problems. These problems are (1) inability to completely renovate the nursery pond of fish prior to the stocking of striped bass fry, (2) tremendous cost of materials and manpower, and (3) difficulty in evaluating success of the stocking program. Before future fry stockings are made in the nursery pond, a complete re-evaluation on the feasibility of the nursery pond concept needs to be made by all involved personnel.

Recommendations:

1. Sufficient personnel be staffed to handle the striped bass rearing operations at Dawson Hatchery.
2. That a standard method of record keeping be maintained to follow what was happening in each pond.
3. That a greater effort be made to evaluate the status of the striped bass in the reservoirs after their release.
4. That the nursery pond concept be re-evaluated from the economical and practical standpoint.

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[1] Jarman, Ron and Jack L. Harper. 1969. Production of Striped Bass Fingerlings, Roccus saxatilis (Walbaum), on Oklahoma State Fish Hatcheries. Presented at 23rd. Meeting of Southeastern Association of Game and Fish Commissioners. Mobile, Alabama.

Annual Progress Report

Statewide Fisheries Investigations

F-21-1

July 1, 1968 - June 30, 1969

Study No. XII

LIFE HISTORY STUDIES OF

STREAM FISHES

Job No. 1

Technical Personnel:

Daniel R. Holder

Herbert Wyatt

W. D. Hill, Jr.

Prepared by:

Daniel R. Holder
Project Supervisor

Approved by:

Leon Kirkland
Federal Aid Coordinator

State: Georgia

Cooperator: State Game and Fish Commission

Project No.: F-21-R-1

Project Title: Statewide Fisheries Investigations

Job No.: XII-1

Study Title: Life History Studies of Stream Fishes

Period Covered: July 1, 1968 to June 30, 1969

Summary:

Tagging studies on largemouth bass, chain pickerel, bluegill, Florida gar, and bowfin using orange colored F-67 anchor tags yielded extremely low returns. No change in growth of recaptures were observed except for a slight gain in one fish. The low tag returns are attributed to mortality of tagged specimens. Less obvious and smaller tags are needed.

The annual growth of largemouth bass after one year of growth was 138 mm and 32.5 grams and after two years of growth was 58 mm and 74.1 grams. The size class distribution of chain pickerel for year class 0 and year class I were established. Year class II was not discernible. The wide dispersion in size of chain pickerel in age class 0 was largely a result of long spawning period of this species. The presence of a large number of chain pickerel in year class 0 and I was primarily due to movement of pickerel into the river from the Okefenokee Swamp and from connecting tributaries. Fish was the most frequent food item in stomachs of chain pickerel.

Warmouth appeared to become sexually mature after one growing season and appeared to have a long spawning season beginning at water temperatures above 62°F. Crayfish was the most frequent food item consumed by warmouth. The dragonfly nymph was the next most frequent food item found. Fish were found only in 8 and 9 inch warmouth. The general time period of spawning,

water temperature, and sexual maturity of flier were indicated.

The size class distribution of bowfin continued to show the crowded condition of the bowfin in the Suwannee River and little recruitment of young-of-the-year bowfin. The reproductive development of bowfin gonads was similar to the pattern described in the F-19-R-3 report, except for an increased percentage of males with well developed testes and females with ovaries containing well formed eggs. The increased gonadal development is attributed to the reduced stress in the population from the bowfin removal during F-19-R. Crayfish was the most frequent food item in the stomachs of bowfin. Dragonfly nymphs were the most frequent insect in the bowfin stomachs. Fish occurred in 34.8 percent of the stomachs containing food items. Bowfin larger than 21 inches preyed almost entirely on fish.

A strong young-of-the-year lake chubsucker population occurred during the spring of 1969. Most of the gar that were collected in or near patches of needlerush contained food items in their stomachs. The basic physical and chemical determinations on the river are summarized.

Life history studies need to continue to obtain necessary background data on various species under various environmental conditions.

Background:

Population studies were conducted in 1963, 1966, 1967, and 1968 on the Suwannee River and have been described. The population studies showed an 80 percent by weight bowfin population and a low forage fish population. Basic limnological parameters were inventoried during F-19-R-1 through F-19-R-3 and are summarized in the annual reports. Life history studies were an objective of the F-19-R project on streams and considerable data was collected on certain species of fish.

The continuation of warm water stream studies to determine methods of

management need to be based on a thorough knowledge of the life history of the species concerned. Although much insight has been gained in this little known area of warm-water fisheries, the reaction of the various species to seasonal climatic changes, to periods of droughts and floods, and their inter-relationships within the ecosystem are factors necessitating long-range evaluations in streams.

The basis of the approach used in the Suwannee River pilot study was to determine the effects of limnological and biological changes in the population over an extended period of time so that the reaction of the species may be related to the various environmental conditions.

Objectives:

To study certain life history aspects of stream fish.

To determine relationships between the life history of certain species and limnological conditions.

Procedure:

Fish from the Suwannee River were sampled from July 1, 1968 to June 30, 1969 for life history information. The species of fish examined were largemough bass, chain pickerel, warmouth, flier, bluegill, bowfin, lake chubsucker, and Florida gar. Most of the specimens were collected by electrofishing. Rotenone, hook and line, and seines were also used. Sampling was conducted monthly or more often if water conditions were favorable or if time permitted sampling. Few game species were collected due to the greater abundance of the non-game species in the river.

Varying with species, method of collection, and information desired, the data that were collected consisted of any one or all of the following: total length, weight, gonadal state of development, stomach content, and general remarks. The total length of each fish was measured in millimeters

and the weight was usually measured in grams for specimens smaller than one pound. Dial-o-gram scales were used for the gram weights. Specimens larger than one pound were usually weighed in ounces using a Hansen platform scales. The size class distribution for establishing age classes was determined from length frequency measurements since aging by scales or other meristic characters has been unreliable in this section of Georgia. From December 6, 1968 to January 29, 1969, largemouth bass, chain pickerel, bluegill, Florida gar, and bowfin were tagged to show changes in the growth of these fish following later recapture.

The tagging procedure consisted of injecting F-67 Floy anchor tags into the muscle of the dorsal inter-neural region of the fish, except for the Florida gar, using a tagging applicator made by the Floy Tag and Manufacturing, Inc. of Seattle, Washington. The tag was 67 mm long with an anchor 10 mm wide. The gar were tagged by injecting the anchor tag at the base of the anal fin between the ganiod scale and the anal fin. Each tagged fish was dipped in a 1% roccal solution to help prevent bacterial infection and placed in a live well for ten minutes. All fish that were not in distress at the end of the ten minute period were released into the river. Species, total length, weight, tag number, location, and date were recorded for each tagged fish.

The stage of gonadal development was determined in the field and recorded for each sex, if known, as immature; mature, with poorly developed or with well-developed testes for the males; developed, without egg formation or with egg formation for the females; ripe or flowing for both sexes; spent for both sexes, or reabsorbed for both sexes. If fish were not examined internally, they were checked for gonadal maturation by applying pressure on the abdomen for release of milt and eggs. Reproduc-

tion was verified by presence of young-of-the-year fish in rotenone or seine samples or by visual observations during electrofishing.

Stomachs were examined in the field for the presence and kind of food item. All specimens that were collected by rotenone were not used in the food habits analysis since distressed fish are readily consumed by other fish in the same area during the rotenone application and would greatly bias the food habit interpretations of each species.

Basic water quality parameters were determined monthly and consisted of air temperature, water temperature, dissolved oxygen, pH hardness, carbon dioxide, and turbidity. Water temperature was checked more often, especially during the spring when most of the fish were spawning.

Results:

Tagging Study

The number of each species tagged and the number of recaptures are presented in Table 1. One bass recapture was reported. The bass was tagged February 7, 1967 in Suwannochee Creek (Tributary of the Suwannee) and was caught April 24, 1969 on hook and line by a local fisherman. A change in size could not be verified. The other tagged bass was found dead two weeks after tagging which may have been due to the tag injection.

The Florida gar recapture was collected May 15, 1969, five miles upstream from point of release on January 30, 1969. The gar was 369 mm long and weighed 172 grams. The gar was 371 mm long and weighed 172 grams when tagged.

Of the 194 bowfin tagged, only three were recaptured at a later date. One was collected February 7, 1969 from Big Lake of Suwannochee Creek, which was where the specimen was tagged 58 days ago. The bowfin weighed 28 grams less than when it was tagged. The body was bruised and was heavily infected

with either Pseudomonas or Aeromonas bacteria. The tail appeared chewed. One bowfin recapture was collected January 15, 1969 in the Suwannee River in the same area that it was tagged 22 days earlier. No change in length nor weight had occurred. The last bowfin recapture was collected on January 22, 1969, 17 days after tagging and 14 miles upstream. The bowfin had a length of 418 mm and weighed 681 grams. The weight increase was 28 grams. This specimen appeared to be in good condition.

Largemouth bass

Growth

Few bass were sacrificed for life history since the bass were more valuable to the stream at this time. (See the segment on bass stocking in job V-1 of the F-21-R-1 report concerning the bass population in the Suwannee River.) Seven bass in age class I and four bass in age class II were collected by electrofishing on May 13, 1969 to establish the average annual growth for the two year classes. The bass for year class 1968 (I) averaged 138 mm in length and 32.5 grams in weight. Their range in length was from 120 mm to 144 mm and their range in weight was from 22 grams to 51 grams. The bass for year class 1967 (II) averaged 196 mm in length and 106.6 grams in weight. Their range in length was from 192 mm to 204 mm and their range in weight was from 88 grams to 134 grams. Their average annual increase from May 1967 to May 1968 would be somewhere around 58 mm and 74.1 grams.

Reproduction

One female bass was collected on May 13, 1968 that appeared spent. Bass fry were not observed nor collected during the spring of 1969; however, high water limited sampling on the river specifically for reproduction.

Table 1

Number of Fish Tagged and Recaptures by Species in the Suwannee River System from December 6, 1968 to February 13, 1969

Species	Number Tagged	Recaptures
Largemouth bass	24	1 (1)[1]
Chain pickerel	5	0
Bluegill	10	0
Florida gar	61	1
Bowfin	219	3
Total	319	5 (1)[1]

[1] Largemouth bass found dead two weeks later.

Chain pickerel

Size Class Distribution

A large number of young-of-the-year chain pickerel were collected in minnow seines during April and May. The size class distribution of 32 chain pickerel examined from April 15, 1969 to May 15, 1969 is shown in Figure 1. Year class 0 was distinct and ranged from 1.5 inches to 4.5 inches. Year class I was also discernible and fish ranged from 5.5 inches to 10.5 inches. Year class III was not distinct; however, it appeared to be from 12.5 inches to 15.5 inches or from 12.5 inches to 17.5 inches.

Reproduction

Ripe pickerel were examined from December 24, 1968 to February 27, 1969, again showing the long spawning season of chain pickerel. (See F-19-R-3 report for time interval and water temperature that chain pickerel spawned in the Suwannee River.)

Chain pickerel reproduction was collected in sloughs on January 15, 1969. The pickerel were from 15 mm to 29 mm long, indicating a fairly recent hatch. The water temperature on the day of collection was 49°F. Minnow seine tows during the month of April and May along the edge of sloughs and the shoreline yielded an abundant number of young-of-the-year pickerel and year old pickerel, indicating pickerel recruitment in the Suwannee River to be strong. The average number per seine tow varied from zero to greater than 17 pickerel, depending upon location. Twelve seine tows on May 8, 1969 averaged 10 young-of-the-year pickerel per tow.

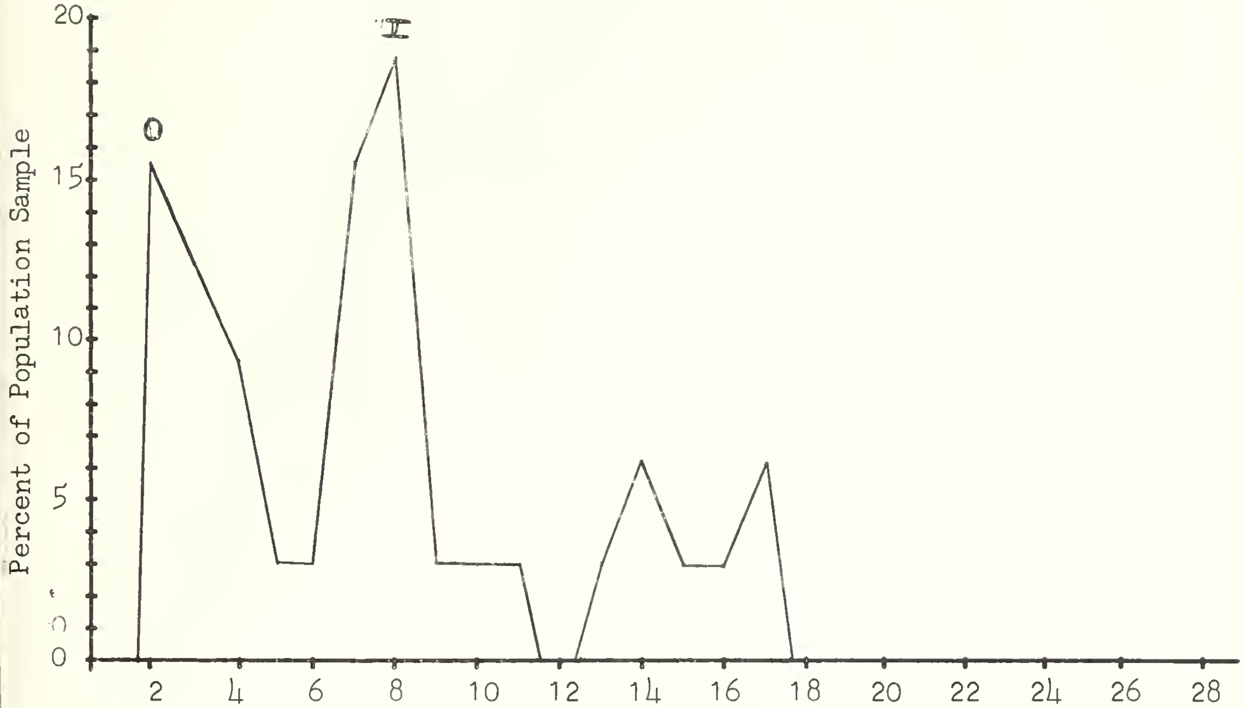
Food Habits

Few chain pickerel were sacrificed for stomach analyses and these consisted primarily of smaller size fish since they were abundant during the spring of 1969. Table 2 shows the major food items of 24 chain pickerel

Figure 1

Size Class Distribution of 32 Chain Pickerel

Examined from April 15, 1969 to May 15, 1969



Chain pickerel (inch group)

that were examined from July 1, 1968 to June 30, 1969. Ten (41.7%) of the stomachs had food items. Of those stomachs with food items, decapods occurred in four (40.0%) of the stomachs. Fresh-water shrimp occurred in three (30.0%) of the four stomachs with decapods and were found in pickerel that ranged from 88 to 214 mm in total length. Fish were present in 9 (90.0%) of the stomachs. The redfin pickerel and the chain pickerel food items were in the 195 to 215 mm range and were consumed by chain pickerel that ranged from 295 mm to 468 mm in total length. A mosquito fish was taken from the stomach of a 118 mm pickerel and a dollar sunfish from a 478 mm pickerel. Known game fish occurred in 3 (30.0%) of the stomachs and known non-game fish occurred in 2 (20.0%) of the stomachs.

Warmouth

Reproduction

Seventy-eight warmouth were examined for gonadal development from July 1, 1968 to June 30, 1969. Forty-one were males, thirty-three were females, and four could not be sexed. The males averaged 188 mm in length and 216 grams in weight. Their range in length was from 59 mm to 245 mm and their range in weight was from 4 grams to 440 grams. The females averaged 157 mm in length and 125 grams in weight. Their range in length was from 41 mm to 247 mm and their range in weight was from .8 grams to 438 grams. The higher male sex ratio is probably from greater sampling of the larger size males which apparently were preparing the beds for spawning at the time that most of the warmouth were collected.

Table 3 summarizes the reproductive condition of warmouth by inch group. Immature males were examined as large as 4.5 inches and immature females were examined as large as 6.5 inches. Mature males occurred in the 5 inch size group and mature females were collected from the 5 inch class

Table 2

Food Items from Stomachs of 24 Chain Pickerel

from the Suwannee River

Total number with stomach contents 10 (41.7%)

Total number without stomach contents 14 (58.3%)

Frequency of Occurrence

Food Item	Number	Percent
Decapoda	4	40.0
crayfish	1	10.0
freshwater shrimp	3	30.0
Pisces	9	90.0
Game fish	3	30.0
redfin pickerel	1	10.0
chain pickerel	2	20.0
Non-game fish	2	20.0
mosquito fish	1	10.0
dollar sunfish	1	10.0
Unid. Fish Remains	4	40.0

up to the 11 inch class. The mature females had well developed eggs and were almost flowing in some specimens. Ripe males were collected in the four inch class and from the 8 to 10 inch class. Spent males were collected from the 6 inch group to the 9 inch group. Ripe females were collected in the 7 to 9 inch group. One spent female was collected. A female with reabsorbed (matrix) gonads was collected February 10, 1969.

The general period for warmouth spawning and water temperature are indicated in Table 4 by following the reproductive changes in the gonads and in water temperature over a period of time.

On July 7, 1968, a ripe male and a flowing female were collected in addition to three spent males, implying that some spawning occurred over a prolonged period. On September 25, 1968 only one warmouth was collected and consisted of a spent male.

On February 10, 1969, when the water temperature was 52°F., the ovaries of a female warmouth examined consisted of a reddish matrix. By March 5, 1969, gonadal development was observed in two males and in one female and by March 27, 1969 one ripe male was observed. Sexual maturation continued into April, as indicated by the April 2, 1969 and April 15, 1969 samples. The water temperature during this period of development ranged from 56°F. to 72°F. An increased number of ripe males and flowing females were collected April 15, 1969. Ripe specimens were collected from March 27, 1969 to May 30, 1969. The water temperature during the period that ripe or flowing warmouth were collected ranged from 62°to 87°F., including the warmouth examined July 7, 1968. Spent warmouth were collected April 15, 1969 and May 30, 1969, indicating that spawning had occurred. Warmouth were not collected during June 1969. Recently hatched warmouth fry were not seen nor collected during this job.

Table 3

Reproductive Condition by Inch Group of 78 Warmouth from the Suwannee River

Inch Group	Unknown	Immature		Mature(Developed)		Ripe		Spent		Reabsorbed	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
2	4	1	3								
3		1	4								
4			2			1					
5					2						
6		1	1	2	2			1			
7				1	5	2	1	2	1		
8				1	5	5	2	2			
9					1	16	4	2			1
10						2					

Food Habits

From July 1, 1968 to June 30, 1969, forty-six warmouth, ranging from 141 mm to 235 mm and from 56 grams to 332 grams, were examined for stomach contents. Thirty-five (76.1%) of the stomachs contained food items and eleven (23.9%) did not contain food items. (Table 5). Decapods occurred in 21 (60.0%) of the stomachs. Crayfish occurred in 20 (57.1%) of the stomachs while fresh water shrimp was found in only one (2.8%) stomach. Insects occurred in 18 (51.4%) of the stomachs. The dragonfly nymph was the most frequent insect observed and occurred in 12 (34.3%) of the stomachs. Occurring less frequently, fish were found in 4 (11.4%) of the stomachs and consisted of two (5.7%) American eels, one (2.8%) eastern mudminnow, and one (2.8%) unidentified fish remains. Detritus and vegetation were present in two (5.7%) of the stomachs. Due to the high number of warmouth examined in the 8 and 9 inch category, no attempt was made to compare food habits of the various size warmouth except to say that fish were found only in the 8 and 9 inch specimens.

Flier

Twenty-four flier were examined from February 28, 1969 to March 28, 1969 for gonadal development whenever ripe flier were found coming over the spillway from the Okefenokee Swamp into the Suwannee River (Table 6). Eighteen were females and twelve were males. The females averaged 109 mm in length and ranged from 62 mm to 162 mm. Their average weight was 29.6 grams and their range in weight was from 5 grams to 74 grams. All of the females with the exception of one spent fish were flowing with eggs. The males averaged 113 mm in total length and ranged from 63 mm to 170 mm. Their average weight was 31.5 grams and their range was from 7 grams to 71 grams. All of the males were ripe. The water temperature during this time

Table 4

Relationship of Date and Water Temperature to Reproductive

Condition of 55 Warmouth from the Suwannee River

Date	Water Temperature F^{o}	Mature		Ripe or Flowing		Spent		Reabsorbed	
		Male	Female	Male	Female	Male	Female	Male	Female
July 26, 1968	87			1	1	3			
September 25, 1968	78					1			
February 10, 1969	52								1
March 5, 1969	56	2	1						
March 27, 1969	62	1	5	1					
April 2, 1969	67	1	2						
April 15, 1969	72		5	12	5		1		
May 13, 1969	77		2	3					
May 30, 1969	77			9	1	2	1		

Table 5

Food Items Found in Stomachs of 41

Warmouth from the Suwannee River

Total number with stomach contents 35 (76.1%)

Total number without stomach contents 11 (23.9%)

Frequency of Occurrence

Food Item	Number	Percent
Decapoda	21	60.0
Fresh water shrimp	1	2.8
Crayfish	20	57.1
Insects	18	51.4
Dragonfly nymph	12	34.3
Caddisfly nymph	1	2.8
Aquatic beetle	1	2.8
Unid. insect remains	4	11.4
Pisces	4	11.4
American eel	2	5.7
East. mudminnow	1	2.8
Unid. fish remains	1	2.8
Detritus & Vegetation	2	5.7

interval ranged from 54°F. to 62°F. which apparently is at or near the optimum temperature for flier spawning. Flier were not collected before February 27, 1969 nor after March 27, 1969. Thus, the duration of this spawning condition was not established. Flier reproduction was not collected during the spring of 1969, since high water limited successful sampling on the river.

Food Habits

The number of flier examined for stomach contents is considered too low for establishing food habits and is not included with this job.

Bluegill

Only 9 bluegills were examined for size class distribution, food habits, and gonadal condition. These are considered too few for establishing patterns and relationships to be included with this job.

Bowfin

Size Class Distribution

The size class distribution of 462 bowfin collected from a rotenone sample of a slough (Mud Lake) on September 15, 1968 is illustrated in Figure 2. The smallest bowfin was in the 15 inch group and the largest bowfin was in the 30 inch group. The average total length was 497 mm and the average weight was 2.91 pounds. This distribution was similar to the size class distribution for the previous year and again shows that bowfin with this population structure cannot be aged by length frequency measurements. The distribution chart also indicates that young-of-the-year recruitment did not occur in the river during the past spring.

Reproduction

Three hundred and seven bowfin were examined for state of gonadal development from July 1, 1968 to June 30, 1969. One hundred and sixty-seven (45.1%) were males and two hundred and three (54.9%) were females.

Table 6

Date and Temperature that Ripe or Spent Flier

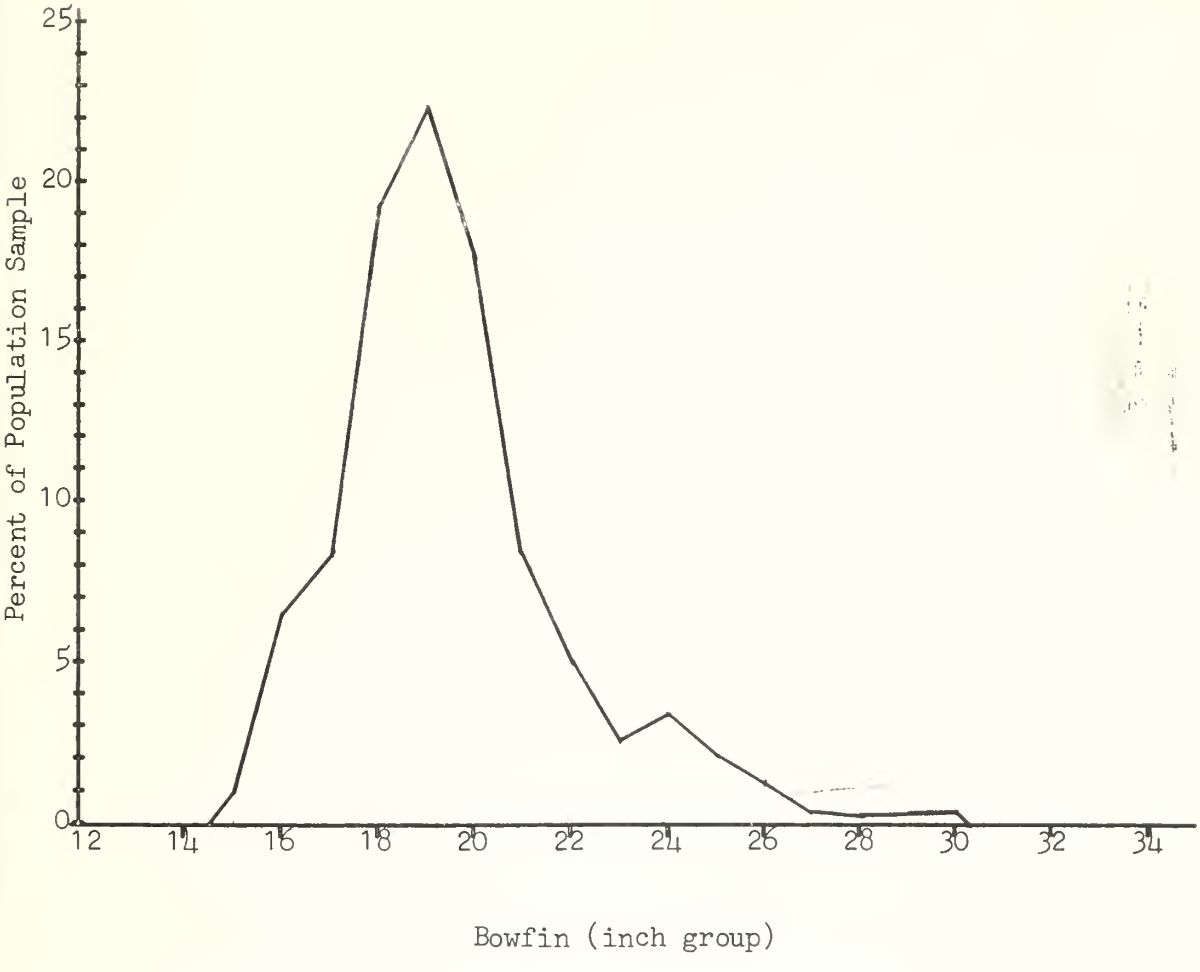
were Collected from the Suwannee River

Date	Water Temperature F°	Ripe or Flowing Males	Ripe or Flowing Females	Spent Males	Spent Females
February 28, 1969	57		2		
March 1, 1969	55		2		
March 13, 1969	60	5	7		1
March 27, 1969	62		3		

Figure 2

Size Class Distribution of 462 Bowfin from a

Rotenone Slough Sample in the Suwannee River September 15, 1968



The males averaged 458 mm in total length and 1.64 pounds in weight. Their range in length was from 354 mm to 621 mm, and their range in weight was from .75 pounds to 4.31 pounds. The females averaged 520 mm in total length and 2.96 pounds in weight. Their range in length was from 372 mm to 803 mm, and their range in weight was from .69 pounds to 12.28 pounds.

The observed development of bowfin gonads was similar to the pattern established for the previous year. (See job on life history in F-19-R-3 report for a detail description on the reproductive condition of bowfin from the Suwannee River). The condition of the gonads of 136 bowfin collected from December 9, 1968 to January 31, 1969 are summarized by inch group in Table 7. The obvious changes were the percentages of males with with well developed testes compared to males with poorly developed testes and of females with developed ovaries that had well formed eggs compared to females with developed ovaries that did not have egg development. Of the 65 males examined, 5 (7.7%) had testes that were classified as poorly developed and 60 (92.3%) had testes that were classified as well developed. The males with poorly developed testes were in the 15 to 16 inch group and may have been sexually immature. However, well developed testes were observed in males in the 14 and 15 inch group.

Of the 71 females that were examined, 25 (35.2%) contained ovaries without egg development and 45 (64.8%) had ovaries with well-developed eggs. Females smaller than 16.5 inches did not exhibit egg development which indicates that these females were sexually immature. Of particular interest was still the lack of egg development in females as large as 25.5 inches. All females larger than 25.5 inches showed egg formation in the ovaries.

Changes in the bowfin gonads leading to well developed testes and to ovaries with well developed eggs were observed from August 1968 to

February 1969. By March, the male testes appeared to be almost ripe with portions of the testes turning milky white and flowing when ruptured. The eggs in the female ovaries were well formed by April and appeared to be almost ready to be released; however, no flowing females or spent females were collected. In April and May, many of the specimens examined had begun reabsorbing the gonads.

Sampling for young-of-the-year bowfin was confined to visual observation and to seining along the edge of the river and floodplain since the water levels were not ideal for electrofishing. No signs of progeny were seen.

Food Habits

Food habit analyses were continued on bowfin to study changes in food habits under various environmental conditions. Table 8 presents the frequency of occurrence of food items from the stomachs of 293 bowfin by inch group. Stomachs in the 15 to 21 inch group contained decapods, insects, and fish. Bowfin in the 22 inch group or larger, except for a specimen in the 26 inch group, contained fish in their stomachs. Bowfin in the 19 inch group had the greatest variety of food items which was the same size group to consume warmouth and largemouth bass.

Table 9 also summarizes the major food items found in the stomachs of the 293 bowfin. Sixty-six (22.5%) of the bowfin had food items in their stomachs and 222 (77.5%) had empty stomachs. Decapods were the most frequent group found in the stomachs and occurred in 43 (65.1%) of the stomachs with food items. Crayfish was the most frequent decapod and occurred in 37 (56.1%) of the stomachs. Insects occurred in 35 (56.1%) of the stomachs. Dragonfly nymph were the most frequent insects and occurred in 23 (34.8%) of the stomachs. Caddis fly nymphs were the next most frequent insect and

Table 7

Reproductive Condition by Inch Group of 136 Bowfin in the Suwannee River

that were Examined from December 9, 1968 to January 31, 1969

Inch Group	Males: Poorly Developed	Males: Well Developed	Females: Developed Without Eggs	Females: Developed With Eggs
14		5	1	
15	2	2	4	
16	3	11	8	
17		10	2	3
18		12	4	5
19		6	1	6
20		9	3	8
21		3		5
22		1		3
23				3
24		1	1	2
25			1	6
26				
27				1
28				3
29				
30				
31				1
Total	5	60(92.3%)	25(35.2%)	45(64.8%)

occurred in 10 (15.1%) of the stomachs. Fish occurred in 23 (34.8%) of the 66 stomachs that had food items. Identifiable game fish consisted of warmouth and largemouth bass and occurred in 3 (4.5%) of the stomachs. Identifiable non-game fish occurred in 7 (10.6%) stomachs. Yellow bullhead catfish was the most frequent non-game fish consumed. Unidentifiable fish remains occurred in 13 (19.7%) of the stomachs. Two (3.0%) stomachs contained unidentifiable remains, five (7.6%) contained inert material, and six (9.1%) contained detritus and vegetation.

Lake Chubsucker

Reproduction

On May 8, 1969, lake chubsucker fry were collected by seining along the mouth of several sloughs. The fry were from 12 to 13 mm long and were seen in schools of roughly 150 to 300 fry. The water temperature at the time of collection was 77°F. Electrofishing on the same day showed many schools of these fry in or near other sloughs and indicated that most of the fry were probably hatched in these areas.

Florida Gar

Reproduction

No obvious change in the reproductive condition of Florida gar from the Suwannee River was observed from July 1, 1968 to June 30, 1969. (See job on life history of F-19-R-3 report for discussion on gar gonadal development and reproduction.)

Food Habits

Table 10 shows the frequency of occurrence of food items in the stomachs of 37 Florida gar that were collected from July 1, 1968 through June 30, 1969. Seven (18.9%) of the stomachs had food items in their stomach and thirty (81.1%) were empty. Six of the seven gar that contained stomach

Table 8

Frequency of Occurrence of Food Items in Stomachs

of 293 Bowfin by Inch Group from the Suwannee River

Inch Group	Total	Empty	Freshwater shrimp	Crayfish	Caddisfly nymph	Dragonfly nymph	Damselfly nymph	Unid. Insect Remains	Warmouth	Largemouth bass	Yellow bullhead	American eel	Madtom	Unid. Fish Remains	Unid. Remains	Inert Material	Detritus & Vegetation
13																	
14	4	4															
15	15	12		2										1			
16	33	23	1	6	5	2	1									4	4
17	28	22		3		8					1						
18	50	40	3	7	2	1								3	1		
19	46	26	1	13	2	4			1	2	1		3	3	1	1	2
20	34	28	1	3	1	5								1			
21	22	19		3		2		1									
22	19	18									1						
23	9	7										1		1			
24	7	7															
25	8	8															
26	4	3				1								1			
27	2	2															
28	6	5												1			
29	3	1												1			
30	1													1			
31	2	2															

Table 9

Major Food Items in Stomachs of 293 Bowfin

from the Suwannee River

Total number with stomach contents 66 (22.5%)

Total number without stomach contents 227 (77.5%)

	Frequency of Occurrence	
Food Item	Number	Percent
Decapoda	43	65.1
crayfish	37	56.1
fresh water shrimp	6	9.1
Insecta	35	53.0
Dragonfly nymph	23	34.8
Damselfly nymph	1	1.5
Unid. insect remains	1	1.5
Pisces	23	34.8
Game fish	3	4.5
Warmouth	1	1.5
Largemouth bass	2	3.0
Non-game fish	7	10.6
Yellow bullhead	3	4.5
American eel	1	1.5
Madtom	3	4.5
Unid. fish remains	13	19.7
Unid. remains	2	3.0
Inert material	5	7.6
Detritus and Vegetation	6	9.1

contents were collected during May 1969 in grass beds of needlerush, *Eleocharis acicularis*. The number of gar with food in their stomachs is too low for establishing their major food-take but does indicate that small fish are a major source of their diet whenever the gar are feeding in the grass beds of needlerush.

Physical and Chemical Determinations

Table 11 summarizes monthly basic physical and chemical parameters for the Suwannee River and their range from July 1, 1968 to June 30, 1969. Flow data on the Suwannee River for this report period is to be provided later by the U. S. Geological Survey.

Discussion:

Tagging Study

The number of recaptured specimens was lower than anticipated, especially since a higher number of fish marked by fin clipping (see job VI-1 on management techniques of F-21-R-1 report) were recaptured in the same areas during the same time period. For example, from January 29, 1969 to February 15, 1969, twelve fin clipped bowfin were recaptured of the 228 that were marked by fin clipping compared to three tagged recaptures of 194 bowfin tagged during the same period. This suggests that mortality may have occurred in the tagged fish or that the tagged specimens may have moved out of the area from the effects of tagging. The dead tagged bass and the bruised bowfin indicate that the tags were probably causing some mortality. A more concise evaluation of the effects of the type tag used would facilitate this phase of the study and possibly explain this variation. A smaller, less conspicious vinyl tag, perhaps colorless, will be tested in the future. Tagging bowfin in the membraneous tissue around the gular plate in a less obvious place may result in less injury and higher survival of the bowfin.

Table 10

Major Food Items in Stomachs of 37 Florida Gar

from the Suwannee River

Total number with stomach contents 7 (18.9%)

Total number without stomach contents 30 (81.1%)

	Frequency of Occurrence	
Food Item	Number	Percent
Decapoda	3	18.7
crayfish	2	12.5
freshwater shrimp	1	6.2
Amphibia	1	6.2
Toadfrog	1	6.2
Pisces	6	37.5
Brooksilversides	1	6.2
Redfin pickerel	1	6.2
Unid. Fish remains	4	25.0
Detritus	2	12.5

Table 11

Physical and Chemical Determinations for the

Suwannee River from July 1968 to June 1969

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Range
Air Temp. (F^{o})	88	82	83	75	64	46	60	59	65	78	84	92	46-92
Water Temp. (F^{o})	87	83	79	67	57	51	54	54	62	70	74	86	51-87
Dissolved Oxygen (ppm)	7.0	6	5.5	7.0	8.5	7.8	7.5	7.5	7.0	7	7.0	4.5	5.5-8.5
pH	4.7	4.9	4.5	4.9	4.4	4.1	4.6	4.6	4.9	4.6	4.4	4.9	4.1-4.9
Hardness (ppm)	4	5	5	6	3	5	5	5	5	6	6	5	3-6
Carbon Dioxide (ppm)	10	20	--	16	14	20	25	16	16	18	20	22	10-25
Turbidity (JTU)	50	95	50	--	40	51	50	50	30	40	--	40	30-95

Largemouth bass

Growth

The Suwannee River was low from May 1967 to February 1969 and may have limited the growth of these smaller bass under these low water conditions. Following the incremental growth of young-of-the-year bass during successive periods of low and high water will show if water conditions affect the growth of these small bass.

Chain pickerel

Size Class Distribution

The size class distribution of chain pickerel in the F-19-R-3 report for age class I and II was not discernible. One age class was indicated at 8 inches and another was indicated at 10 inches. However, the number of pickerel examined in these two size groups was low, making it uncertain if the two size groups represented year class I or year class I and II. Emphasis during the spring of 1969 was to collect many small and intermediate size pickerel to better define 0, I, and II year classes. The distribution pattern in Figure 1 does establish that pickerel in the 6-10 inch group are year class II. The pickerel in the 9 and 10 inch groups may be growth from an early hatch or from a late hatch of pickerel.

Pickerel apparently have a spawning season of about two to two and a half months. (F-19-R-3). The hatching of pickerel during this long time interval coincident with the amount of spawning from day to day during this period of spawning will give the pickerel size class a wide dispersion in length. Evidence of this wide range in size is also illustrated for year class 0 in Figure 1. The initial wide dispersion of pickerel in the age class 0 should lead to a wider dispersion in length for each successive year of growth. If so, the age class II is probably in the 14 inch group.

Further sampling is needed to verify year class II since the number of specimens collected in the 10-18 inch size during this job was low.

Reproduction

The population of harvestable size pickerel in addition to the young-of-the-year pickerel in the river were low during 1968 (See population study at Mud Lake September 15, 1968 under job XVI-2 on stream population studies of F-21-R-1 report). Yet, the seine tows during the spring of 1969 yielded an abundance of young-of-the-year and year old pickerel.

Young pickerel were observed coming over the Okefenokee Spillway on May 5, 1969. The results of the fish movement over the spillways under job VI-1 of F-21-R-1 showed pickerel movement into the river. These findings led to the conclusion that the bulk of the pickerel recruitment in the Suwannee River during the spring of 1969 resulted from pickerel movement from the Okefenokee Swamp and from connecting tributary streams. This movement occurred during the high water period in the spring of 1969 and indicates that the headwater swamps and creeks play a significant role as nursery areas for the chain pickerel population in the Suwannee River.

Food Habits

The food habits of pickerel show that they are predominantly piscivorious. Of the 14 food items that occurred in 10 pickerel stomachs, 9 were of fish origin. The pickerel in the 3 to 9 inch group appeared to rely heavily on fresh water shrimp and small fish. The 8 to 9 inch pickerel were consumed during May 1969 at the time that young pickerel movement into the river from the swamp occurred. Game fish were reported in the F-19-R-3 report to be the most frequent food item consumed by chain pickerel. Similar findings are indicated from this small sample. Food habit studies on chain pickerel under various stream conditions need to continue to

accumulate a significant background of data for establishing their role in streams.

Warmouth

Reproduction

Assuming that warmouth are from one to three inches long by the time they reach age class I (January 1) and are from four to six inches by the time they reach age class II, (which is indicated in the F-19-R-3 report) the two to four inch warmouth in Table 2 were less than two years old and have not reached sexual maturity. The immature warmouth were collected in September. Warmouth in the three and four inch group may become sexually mature sometime during the next growing season. If so, this means that sexual maturity will occur sooner than was pointed out in the F-19-R-2 report. The presence of mature or ripe gonads in warmouth from 5 to 10 inches long supports this implication. The presence of immature gonads in some fish in the six inch group is not completely defined from the present data and may be warmouth in age class II that will not become sexually mature until they reach age class III.

The study on changes in appearance of the warmouth gonads indicate that they begin maturation for spawning around or just before March 5. Maturation of gonads may continue into May and perhaps may last throughout the summer. The sampling of ripe males, flowing females, or spent specimens from March 27, 1969 to May 30, 1969 and on July 7, 1968 for the previous year establishes that warmouth have a long spawning period in the Suwannee River. Just how long this spawning period is and at what water temperatures it ceases remains unknown. Assuming that spawning ceases at about the same water temperature that warmouth begin spawning (April 15, 1969), warmouth spawning would cease around October 15, 1969 whenever the water temperature

dropped below 72°F. This long interval of spawning would also explain the wide dispersion in the length of warmouth that were identified as age class I in the F-19-R-3 report.

Food Habits

The food items found in warmouth stomachs have varied from year to year of sampling. The F-19-R-2 report showed fish occurring more frequently in the stomachs than crayfish and insects and is from warmouth feeding on fish in distress during a rotenone population study. The warmouth examined during F-19-R-3 tended to prey more frequently on insects; however, the number of warmouth examined was too low for establishing conclusions. Most of the warmouth examined during this job were collected in the spring and during high flows. So under these environmental conditions, crayfish were the most frequent food item consumed. Additional studies on the food habits of warmouth are needed to better determine their role in the Suwannee River.

Flier

Reproduction

Ripe flier were examined from February 28, 1969 to March 27, 1969 at a water temperature range of 55°F. to 62°F. and establishes the general time period and water temperature that flier spawn. The length of the spawning period remains unknown and will require further sampling in the spring months. The fact that ripe males and flowing females were collected as small as 62 mm indicates that some flier become sexually mature in one year. Further sampling is necessary to establish specifically the size class that most become sexually mature.

Bowfin

Size Class Distribution

Figure 2 shows that the bowfin population is a crowded one and that

young-of-the-year recruitment did not occur. Problems in studying the life history of bowfin that were discussed in the F-19-R-3 report existed during this job. Until a young-of-the-year bowfin population can be located and followed in the Suwannee River, information on the growth, age, and sexual maturity will continue to be incomplete.

Reproduction

Similar problems existed in classifying the state of gonadal development as was described for the previous year; however, one change recognized is worth commenting on. That change was the percentage of males showing well developed testes compared to males showing poorly developed gonads and the percentage of female showing developed ovaries with well formed eggs compared to females having ovaries without egg development. Of the males that were examined for gonadal development from November 1967 through March 1968, (F-19-R-3), 58.3 percent had well developed gonads. This well developed gonadal percentage was increased to 92.3 percent in the males examined from December 1968 through January 1969. Of the females that were examined for egg development from November 1967 through March 1968, (F-19-R-3), 27.6 percent had ovaries developed with eggs; whereas, during this report period, 64.8 percent of the females examined from December 1968 through January 1969 had ovaries with well formed eggs.

The question in mind then is what accounted for this increased gonadal development. Two possibilities exist. One is that since young-of-the-year recruitment did not occur in the river, the resident population of bowfin in the river was another year older with a great number of the smaller size (13-16 inches) bowfin reaching sexual maturity. The other possibility is that a portion of the stress on the crowded bowfin population was alleviated by the massive bowfin removal during F-19-R-3 (See job VI-1 in manage-

ment techniques on discussion of bowfin removal).

The first possibility may hold true for the smaller size specimens but will not be the case for the larger specimens since as many of the larger size specimens exhibited the poorly developed state as did those with well developed gonads during F-19-R-3. The latter possibility is believed to account for the increased gonadal development. At the time that bowfin removal was instigated on the Suwannee River, the bowfin population was 80 percent by weight of the total fish population (F-19-R-3). Also the water flow in the Suwannee during this period was the lowest in 12 years, subjecting the crowded bowfin population to greater stress. This stress condition probably led to the low percentage of gonads showing development and to the failure of bowfin to spawn in the river during the spring of 1968 (F-19-R-3). So apparently the removal of bowfin lowered the stress factor on the population, stimulating gonadal development according to the stress relieved by the removal operation. The absence of bowfin spawning in the river during the spring of 1969 (F-21-R-1) is attributed to physiological stress on the population from the previous year's drought despite the increased gonadal development stimulated by the removal program.

One similarity between the bowfin examined during F-19-R-3 and F-21-R-1 period was the inch group size of females that showed only developed ovaries without eggs. The size groups fitted closely and further indicate that females 16 inches or smaller are sexually immature. This 16 inch size will be used as an indicator of sexual maturity in the future.

Food Habits

The results of the bowfin food habits studies during the past two years have been consistent. Even the size that bowfin go to an all fish diet were similar. Bowfin larger than 21 inches except for one specimen preyed on

fish. Most of the bowfin that had food in their stomachs were collected near or in beds of needlerush _Eleocharis accicularis_. Frequently, all of the bowfin that were collected from areas of high densities had empty stomachs.

The lack of bowfin in the stomachs of other bowfin which was reported in F-19-R-3 is attributed to the lower number of bowfin larger than 25 inches that were sampled and to the lower density of forage sized (12-15 inches) bowfin in the river from the removal efforts. The increased percentage of bowfin with food items in their stomachs is due to the reduced number of bowfin and to the increased flow of water in the river leading to less competition among the bowfin for food.

Lake Chubsucker

Reproduction

A strong young-of-the-year population of lake chubsucker occurred during the spring of 1969. Changes in the density, growth, and gonadal condition should now be closely followed.

Florida Gar

Food Habits

The major point of significance is that gar collected in schools of high numbers had empty stomachs and that gar collected in grass beds of needlerush had a high number of stomachs with food items.

Recommendations:

1. That uncolored tags of smaller size be attempted and evaluated in future tagging operations on the Suwannee River.
2. That life history studies be continued on the major species of concern to accumulate the background information for each species and to follow changes or relationships that might occur from the various environmental conditions.

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