tested were not as productive of midges as the sheet materials and in addition, were much more difficult to handle in the pond.

Unfortunately, no samples were taken for comparison of normal midge production and midge production from the block and sheet materials. It appears, however, that midges produced by adding materials to a pond for increased midge attachment area, is production above and beyond the normal midge production and would subsequently increase fish production.

SUMMARY

1. Midges constituted the greatest percentage of food volume in largemouth bass fingerlings ranging from 20 to 55 millimeters in length.
2. Highest midge production was obtained from ponds having a dominant blue-green algae bloom.
3. The sheet materials oriented at a 45-degree slant in the pond produced the most midges and total periphyton.
4. Highest midge production was obtained from the 1/8-inch masonite boards placed at the 45-degree slant.
5. The use of building blocks as attachment area to increase the midge crop did not appear to be either practical or productive.

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PARASITE EPIDEMICS AFFECTING CHANNEL CATFISH

RAY ALLISON
Agricultural Experiment Station
of
Auburn University
Auburn, Alabama

ABSTRACT

The prevalence of parasitic epidemics is dependant, to a large extent, upon the density of the host population. Through the application of recent research, up to 2,400 pounds of channel catfish can be produced per acre of water, thus placing their commercial culture on a basis comparable to production of other farm animals. Since fish are confined to a limited environment in ponds without flowing water, they are surrounded by their own metabolic wastes throughout the production period. Such an environment is ideal for the propagation and development of parasitic populations.

The great majority of epidemics are caused by external protozoan and helminth parasites that are transferred by contact and have simple life cycles. The species causing epidemics in channel catfish production ponds in Alabama are presented in Table I.

These epidemics can be controlled in ponds with the application of low concentrations of certain chemicals. These treatments are

economically feasible in high production ponds operated as a commercial enterprise. Ponds on the Agricultural Experiment Station, ranging in size from 1 to 22 acres, have been treated with the chemicals suggested in Table I. However, certain precautions must be taken when these chemicals are applied. When 10 ppm or more of formalin is used, low oxygen is likely to develop two to three days after treatment. The oxygen shortage may become sufficiently acute to kill fish, if the pond water had a heavy growth of plankton at the time of treatment. Consequently, if the formalin treatment is used in ponds, the oxygen should be checked in the early morning, afternoon and evening for at least three days following treatment. If the oxygen in the top three feet drops below three ppm at noon or evening, pumps should be started to aerate the water throughout the night or if available, fresh water should be run into the pond.

The use of potassium permanganate for parasite control in ponds has no deleterious effect upon the oxygen concentration. In ponds with a heavy plankton growth, however, the permanganate is rapidly decomposed and is less effective than in clean water.

TABLE 1. SPECIES, SITE OF INFECTION, AND MOST EFFECTIVE CONTROL METHOD OF PARASITES CAUSING EPIDEMICS IN CHANNEL CATFISH

Species	Name of Disease	Site Infection	Control in Ponds by
Ichthyophthirus multifiliis	Ichthyophthiriasis or white spot disease	Skin and gills	Malachite green—0.1 ppm.
Scyphidia macropodia	None	Gills	Formalin 10-15 ppm
Costia necatrix	Costiasis	Skin and gills	Formalin 10-15 ppm
Chilodon cyprini	Chilodoniasis	Skin and gills	Formalin 10-15 ppm
Trichodina spp.	Trichodiniasis	Skin and gills	Formalin 10-15 ppm Potassium permanganate 3 ppm
Trichophyra ictaluri	None	Gills	Formalin 10-15 ppm
Cleidodiscus pricei	Dactylogyriasis	Gills	Formalin 10-15 ppm
Gyrodactylus spp.	Gyrodactyliasis	Body	Formalin 10-15 ppm Potassium permanganate 3 ppm

AN EVALUATION OF FISHERY MANAGEMENT TECHNIQUES UTILIZING WINTER DRAWDOWNS [1]

PHILLIP C. PIERCE
JOHN E. FREY
AND
HENRY M. YAWN
Georgia Game and Fish Commission
401 State Capitol
Atlanta, Georgia

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ABSTRACT

Data is presented on 15 small impoundments ranging from two acres to 500 acres in size where different fishery management techniques

[1] This work was undertaken with Federal Aid to Fish Restoration Funds under Dingell-Johnson Project F-11-R, Pond Management Evaluations.

were utilized in conjunction with winter drawdowns. All ponds were lowered for approximately 80 days between October 1 and January 15.

Nine small impoundments were lowered to approximately one-fourth their original sizes to evaluate the effect on fish populations crowded with intermediate bluegill. In each case heavy bass reproduction was observed the following spring. No significant improvement on bluegill growth was evident in five of these ponds even though the numbers of intermediate bream had been reduced. Bluegill reproduction the following summer was light and inadequate for good growth of the heavy bass reproduction produced as a result of the drawdown. Only the relatively infertile ponds or those containing high populations of intermediate bass prior to the drawdown produced definite improvements on bream growth and balance the following summer.

Three small ponds heavily crowded with intermediate bluegill were lowered during the winter months and seined with a 60-foot, one-half inch mesh, bag seine. A definite improvement on bream growth and balance was found the following summer in one pond that contained a high population of intermediate-sized bass. Of the other two ponds where 153 and 80 pounds of intermediate bream per acre were removed, the former came into balance the following summer, but bream growth was only moderately improved. The latter pond did not come into balance nor did bream growth improve after 80 pounds of intermediate bream per acre had been removed. Both of these ponds were low in intermedliate-sized bass which appears to be determinate in success for this type management.

Fishing success was greatly improved in a 65-acre, fertilized impoundment following removal of 29 pounds per acre of adult golden shiners (*Notemigonus crysoleucas*) after winter drawdown. Prior to the drawdown and netting program, a one-acre rotenone sample using a block-off net produced 27 pounds of golden shiners per acre. In 90 netting days, using a one-inch mesh gill net (shirt-tail type), 8,148 shiners weighing 1,880 pounds were removed. A post-netting population study a year later in the same area produced only 2.1 pounds of adult shiners giving a 92.8% reduction. Less than 1% of the total poundage removed during the netting operation was comprised of fish other than golden shiners. Virtually, no shiner reproduction was found at the last population study. Predation by large fingerling bass and adult black crappie (*Pomoxis nigromaculatus*) populations was credited with the drastic removal of golden shiner reproduction.

Two ponds, each two acres in size, were supplementally stocked with bass soon after they were lowered during a winter drawdown. One pond was stocked with 75 intermediate bass per acre and the other with 35 fingerling bass per acre. Bream growth had increased slightly in both ponds by fall; however, fishing success was not greatly improved.

INTRODUCTION

A recent survey of hunters and fishermen in Georgia demonstrated the economic importance of sport fishing in ponds and small impoundments. There are an estimated 50,000 farm ponds, averaging 3.5 acres in size, in Georgia with new ones being built at the rate of approximately 2,000 each year. This survey, which was conducted during 1961, showed that approximately 73% of all Georgia fishermen do fish some in these small impoundments. Fishing ranges from poor to excellent, and fishing pressure varies accordingly. Investigations have shown that a well-managed fertilized pond can support four times as many pounds of fish per acre as one that is poorly managed and not fertilized (Swingle & Smith 1939). Invariably fishing pressure exceeds the recruitment capabilities of even the well-managed, fertilized ponds, especially during the first year the pond is opened. This heavy removal tends to produce a crowded bream population within a relatively short period of time. Also, rough fish sometimes infest ponds. These undesirables compete with the bream and bass, reducing their potential status. The pounds of harvestable-sized bream decreases as competition from the intermediate bream or rough fish increases. Approximately 5% of the small impoundments in Georgia are renovated each

year. This means that about 8,750 acres of water annually are taken out of production for 16 months. Many of these renovations would not be necessary if simple, inexpensive means were available for reducing the weight of the size groups or species that crowd the population. Most of the corrective measures presently known are not applicable for general recommendations since they require technical knowledge or assistance and equipment that is not readily available.

In an attempt to find simple, inexpensive means for improving fishing in ponds, winter drawdowns were evaluated in 15 small impoundments located in Central and South Georgia. In conjunction with the winter drawdowns, three population manipulation techniques were evaluated. The study includes impoundments ranging in size from two to 500 surface acres. All but one of these impoundments received varying amounts of commercial fertilizer. The two largest ponds, 65 and 500 surface acres, are commercialized and are open to the general public. The remaining ponds range from two to 45 acres in size and are fished only by the pond owner and his guests. All evaluations are based on pre- and post-drawdown seine checks using a 60-foot, one-half inch mesh, bag seine and a 15-foot minnow seine. Three to 10 balance checks, comprised of four to 12 seine hauls each, were made on all experimental ponds before and after drawdown. In the larger impoundments where effective seining was impossible, a one-acre rotenone sample utilizing a block-off net was used for determining balance.

WINTER DRAWDOWN ALONE

Eight small, fertilized impoundments were lowered to between 75% and 25% of their original sizes during the period from October through January. The volume of water in each lowered pond varied considerably because of the difference in the topography of each pond's bottom. Seine checks were made before and after each drawdown experiment to determine the effect this confinement had on the fish population.

The following discussions explain specific changes that took place within the fish population in each impoundment before and after winter drawdown.

Henry McArthur Pond: This 2.5-acre pond located in the Middle Coastal Plain Province was lowered to approximately .5 acres for a period of 80 days.

An average of 140 intermediate bream per large seine haul was taken during the spring and summer prior to the drawdown compared to 60 per seine drag the following year. Bass reproduction during the spring of 1962 ranged from less than one per small seine drag to two during 1963. Bream reproduction during 1962 was very light compared to that observed during the late summer following the drawdown. Fishing improved after the drawdown; however, the bream sizes were about the same. The general condition of the bream population improved as the summer progressed.

Bryan Whitekurst Pond: This 3-acre pond located in the Piedmont Plateau Province was lowered to approximately two acres for a period of 80 days.

Pre-drawdown balance checks made during 1962 produced an average of 200 intermediate bream per large seine drag compared to 40 intermediates taken the following summer. An average of 13 bass ranging from seven inches to 18 inches in length was captured and released while seining this pond when it was down. These fish are credited with significantly reducing the bream population over the winter. Bass reproduction was about the same before and after the drawdown; however, bream reproduction greatly increased the following summer even though it came later than in other ponds checked in that area. Fishing improved considerably in 1963, and the condition of the bream also improved as the summer progressed. Shallow bottom samples taken from this pond during the month of August following the drawdown produced *2.64* ml. per sq. m. of *Tendipedidae* larvae, the most found in any of the ponds experiencing winter drawdown. This volume, however, is only one-third of the average volume of bottom organisms found during

a recent study on similar ponds that were not lowered prior to the sampling.* Bottom organism data are available for this pond in Table 1.

Hugh Perkins Pond: This 6-acre pond located in the Upper Coastal Plain Province was lowered to approximately three acres for a period of 80 days.

Prior to 1962 this pond was difficult to manage because of excessive water. Also, the shallow edges became infested with *Chara sp.* since adequate fertilization was impractical. Bottom fishing along these edges was therefore very difficult and unrewarding even though seine checks indicated that the pond was in balance. During the fall of 1961 the writer recommended that the pond be lowered, the edges deepened, and a dam be constructed across the upper end of the pond. This dam removed one acre of very shallow water from the pond proper and allowed the excess water to be diverted around the lower pond when desired. Seine checks made the following summer indicated a reduction of intermediate bream, approximately the same numbers of bass fry, but a definite increase in bream reproduction. Bream fishing improved that summer but could have been partly attributed to the reduced *Chara* problem and increased fertility once the pond was properly fertilized. Also, many mobile invertebrates were known to exist in the *Chara* beds prior to the draining. These important fish-food organisms probably migrated with the receding water, thereby providing an abundant food supply for the bream during the winter drawdown. During 1963 the bream fishing in this pond improved even more than it had during 1962. Fisherman interviews revealed that bream weighing between eight ounces and 12 ounces each were commonplace during the 1963 fishing season.

L. L. Barnes Pond: This 6-acre pond located in the Lower Piedmont Plateau Province was lowered to approximately 1.5 acres for a period of 90 days.

This pond is well constructed and has received proper fertilization for the past five years. Intermediate bream have crowded this population since a bass die-off in 1959. The following year the pond went out of balance and conditions did not improve greatly even though a fall partial kill removed approximately 150 pounds of intermediate bream per surface acre. Bass fry were added the following spring but failed to produce any significant changes. Each year prior to the drawdown bass reproduction was very light or non-existent. Also, bream reproduction came late in the summer, thereby allowing many small bream to survive since most of the bass fry had perished by that time. Seine checks made during 1961 produced an average of 600 intermediate bream per large seine drag. Since the pond owner did not wish to poison out his pond, the writer proposed a winter drawdown in conjunction with a seining operation to reduce the intermediate bream population. Once the pond was down, seining success was poor because of excessively deep water and stumps. The seining operation did, however, reveal a relatively high population of bass large enough to feed upon the intermediate bream; therefore, the pond was not poisoned out but was left down to determine if the bream population could be brought back into balance by the bass predation during the drawdown period. It is believed that these intermediate-sized bass were the fish stocked following the 1960 partial kill.

Seine checks made the following spring indicated a heavy bass spawn, the first since the bass die-off in 1959. Also, the intermediate bream population was reduced to an average of 175 per large seine haul, which, of course, was still very high. Bream reproduction again came too late to support the bass fry that was found during the spring. Even though bream fishing the following summer did not improve significantly, bass fishing was very good. For this reason the writer felt that the pond might come back into balance the following year. To increase possible bass predation, bass fishing was closed during 1962 and was restricted to bass over two pounds in 1963. Bream fishing

* "The Effects of Lime Applications on the Standing Crop of Benthis Organisms in Georgia Farm Ponds," a thesis submitted to the Graduate Faculty of The University of Georgia in partial fulfillment of the requirements for the Degree of Master of Science by Michael Lyle Bowling, B.S.F., The University of Georgia, 1960.

improved during 1963; however, seine checks indicated that the population was still overcrowded with intermediate bream. Bass reproduction was lighter during 1963, but bream reproduction greatly improved. Again the bream reproduction came too late to adequately support the young-of-the-year bass. Shellcrackers were not stocked in this pond. The writer believes that these fish would help support the bass reproduction since this species spawns earlier than do the bluegill.

A. O. B. Sparks Pond: This 7-acre pond located in the Upper Coastal Plain Province was lowered to 2.5 acres for a period of 80 days.

Bream fishing has been relatively poor in this pond since 1959 when golden shiners *(Notemigonus crysoleucas)* were found in abundance during a balance check. Because re-infestation would be inevitable, complete renovation was not recommended. Seine checks made during 1962 indicated that bass reproduction was adequate, and that the pond was not badly crowded with intermediate bream. Bream reproduction was very light; however, in addition, an average of ten 6-inch to 8-inch golden shiners was captured per seine haul. These fish were apparently in competition with the bream, indicated by the few intermediate bream taken and the light bream spawn. Seining records made during the summer after the drawdown revealed a great increase in the number of intermediate bream with a corresponding decrease in the number of golden shiners. Bream reproduction was also found to be much heavier during that period. Apparently the bass population preferred golden shiners to bream during the drawdown, thereby greatly reducing their numbers, which in turn allowed the intermediate bream population to carry over to the next summer. Bream and bass fishing improved in this pond during 1963. Data on bottom organism is available for this pond in Table 1.

Julian Webb Pond: This 7-acre pond located in the Upper Coastal Plain Province was lowered to approximately two acres for a period of 80 days.

Bream fishing was reported to be poor in this pond for the past three years. Seine checks did, however, indicate a balanced condition. The summer preceding the winter drawdown, seine checks showed moderate bass and bream reproduction. Also, an average of 57 intermediate bream was collected per 60-foot seine drag. Population sampling after drawdown indicated an increase in bass reproduction, reduced bream reproduction, and reduced intermediate bream population. Bream and bass fishing did not improve in this pond during the following year. A competitive species that is not readily taken by seining or a reduced bottom organism population is suspected to have interfered with the normal recruitment and associated reproduction experienced in other drawdown programs. Bottom organism data are available for this pond in Table 1.

V. F. W. Lake: This 35-acre lake located in the Piedmont Province was lowered to approximately 10 acres for a period of 80 days.

Black crappie infested this pond in 1959, two years after it was built. Fishing has been relatively poor since 1961. Several ponds containing black crappie are located on this impoundment's watershed; therefore, complete renovation was not considered feasible. Prior to the 1962 winter drawdown, seine checks indicated light bass and bream reproduction and an even lighter intermediate bream population. No crappie were captured while seining; however, fishermen interviews and a creel census indicated their numbers to be high. During the drawdown period large catches of small black crappie, 6 inches to 8 inches long, were reported to have been made by hook and line. The following summer seine checks indicated that the bass reproduction had increased slightly, bream reproduction was a little lower, and the intermediate bream population had greatly expanded. Creel checks indicated that most of the crappie that were caught during the spring after the drawdown were 7 to 9 inches in length. Apparently the heavy harvest of the competitive small crappie during the drawdown allowed many of the previous year's bream reproduction to recruit into the intermediate size group. The slight reduction in the bream reproduction the following summer was probably attributed to the piscivorous nature of the large crappie. This changing food habit of large crappie might also account

TABLE NUMBER 1
MILLILITERS OF BOTTOM ORGANISMS PER SQUARE METER PRESENT DURING THE MONTH OF AUGUST IN SIX SMALL IMPOUNDMENTS EXPERIENCING WINTER DRAWDOWNS THE PREVIOUS WINTER

Pond	Per cent of Bottom Exposed	Period of Drawdown	Chaoborus		Other Diptera		Oligochaeta		Others		Total Benthos	
			Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow
A. O. B. Sparks*	50%	Oct. 1962-Jan. 15, 1963	3.000	.120	.120	.240	—	.024	—	—	3.120	.384
Bear Camp Lake	50%	Oct. 1962-Jan. 15, 1963	.120	.120	.002	.360	—	—	—	—	.122	.480
V. F. W. Lake	50%	Oct. 1962-Jan. 1963	1.800	.012	—	.190	—	.144	—	—	1.800	.346
J. E. Taylor*	75%	Oct. 1962-Jan. 1963	1.200	.300	—	.017	—	—	—	—	1.200	.317
Julian Webb	75%	Oct. 1962-Jan. 1963	.480	.120	—	.460	—	.002	—	.010	.480	.592
Bryan Whitehurst	30%	Oct. 1962-Jan. 1963	.012	—	—	2.160	—	.480	—	.002	.012	2.642
TOTALS			6.612	.672	.122	3.427	—	.650	—	.012	6.734	4.761
AVERAGES			1.102	.112	.020	.517	—	.108	—	.002	1.122	.793

* Sufficient O_2 found in deepest water.

for the only slight increase of the available small bass found during the spring checks. Fishing for all species improved during the 1963 season. Bottom organism data are available for this pond in Table 1.

Paul Hill Pond: This 7-acre pond located in the Upper Coastal Plain Province was lowered to approximately 4.5 acres for a period of 80 days.

This pond was restocked with bream during the month of November, 1961. The following fall the pond was lowered approximately 33% to expose mats of needlerush (*Eleocharis acicularis*) so that they could be treated with a herbicide. The pond was left down until March 1, 1963. When the pond was opened for fishing on June 1, 1963, bream catches were very small; however, the individual bream weight was above average. Seining during June of 1963 showed an average of eight bass fingerling per drag, with bream reproduction scarce and only a few intermediates taken. Bream catches continued to be small during the summer but maintained their high quality. The unusually heavy bass spawn was attributed to a readily available food supply since the pond had been lowered concentrating the fish together. Also, this increased predation probably reduced the numbers of bream that would have normally recruited into harvestable size the following summer. As of August, 1963, bream fishing had improved slightly and seine checks indicated that the fingerling bass population had dwindled or had recruited into sizes difficult to capture in a seine. The scarcity of bream reproduction was probably due to heavy predation by the small bass. The reduced numbers of intermediate bream indicated that these fish were moving into the harvestable size group and were not being sufficiently replaced since predation was heavy on small bream. This drawdown was not recommended by the writer; however, the results were reported to show that unfavorable conditions can develop if a newly stocked pond is lowered before the normal standing crop has had time to develop.

Houston Lake: This 500-acre lake located in the Upper Coastal Plain Province was lowered to approximately 50 acres for a period of 100 days

The writer was not consulted on management of this impoundment until the summer of 1962, therefore, pre-drawdown data are not available. The past history of this lake is known, however, since weed control experiments had been conducted prior to the 1961 drawdown. This large impoundment is located on a relatively infertile watershed. Normally, a constant flow of water leaves the lake over the spillway. Over the years a heavy aquatic weed problem has developed in the shallow areas of the lake which has interfered greatly with fishing. Prior to the 1961 winter drawdown, approximately 100 acres of the lake was infested with *Eleocharis acicularis*, *Hydrotrida caroliniana*, *Utricularia*, and *Nuphar advena*. During the year following the drawdown all species re-appeared but were restricted to the very shallow water, three feet deep or less; and their growth was less rank than before. During the month of August, 1962, a typical one-acre area was blocked off and poisoned out with 5% liquid rotenone. A total of 33.0 pounds of fish were taken during the study. By weight, 11% of the population was comprised of largemouth bass, 26% bluegill, 40% shellcrackers, 6% suckers, and 17% miscellaneous species. Large black crappie were known to exist; however, only a few small members of this species were taken during the study. Fishing was reported to be better in 1962 than it was prior to the drawdown; however, it is not certain whether the population improved because of a positive shift in balance or because of the increased fishing area made available by the reduction in aquatic weed growth. During July, 1963, a similar population study was conducted. A total of 32.4 pounds of fish was collected compared with the 33.0 pounds taken during the 1962 study. The amazing similarity in these weights leads the writer to believe that the comparisons made in Tables 2 and 3 relative to the 1962-63 studies are valid. Bottom organism data are available for this pond in Table 1.

The preceding data generally show that bass reproduction was increased in all ponds following drawdown. An average of 1.2 bass fry per small seine drag was collected during the spring prior to the drawdown compared to 2.8 bass fry collected the same time after winter

TABLE NUMBER 2
POPULATION DYNAMICS OF ONE ACRE ROTENONE SAMPLES CONDUCTED ON HOUSTON LAKE DURING THE FIRST AND SECOND YEARS AFTER A WINTER DRAWDOWN

Species	Per Cent of Population By Weight 1962	Per Cent of Population By Weight 1963	Small 1962	Small 1963	1963 Pounds Increase or Decrease	Intermediate 1962	Intermediate 1963	1963 Pounds Increase or Decrease	Harvestable 1962	Harvestable 1963	1963 Pounds Increase or Decrease	1963 Total lbs. Increase or Decrease
			Changes Based on Pounds of Each Size Group Collected During the Two Population Studies									
Largemouth Bass	11.0	17.0	1.60	1.16	− .44	.40	1.12	+ .72	1.70	3.25	+1.55	+1.83
Black Crappie	.1	.8	.30	.23	− .07	0.00	.51	+ .51	0.00	0.00	0.00	+ .44
Chain Pickerel	3.2	6.2	.20	.53	+ .33	.40	0.00	− .40	.50	1.50	+1.00	+ .93
Bluegill	26.0	29.0	1.30	.31	− .99	6.20	7.29	+1.09	1.60	1.83	+ .23	+ .33
Shellcrackers	40.0	23.0	0.00	.01	+ .01	1.10	.85	− .25	12.80	6.71	−6.09	−6.33
Spotted Sucker	6.0	3.0	0.00	0.00	0.00	0.00	0.00	0.00	2.10	.69	−1.41	−1.41
Chub Sucker	0.0	11.0	.01	.02	+ .01	0.00	0.00	0.00	0.00	3.87	±3.87	+3.88
Misc. Species	13.7	10.0	1.39	.91	− .48	1.43	1.65	+ .22	0.00	0.00	0.00	− .26
TOTALS	100.0	100.0	4.80	3.17	−1.63	9.53	11.42	+1.89	18.70	17.85	− .85	− .59

	1962	1963
Total Pounds Per Acre	33.00	32.40
F/C	7.00	3.31
Y/C	.75	.20
At	58.3%	55.0%

drawdowns. In most instances the average number of intermediate bream decreased after the drawdown; however, the general condition and growth rate of the bream was poor the following spring. This generally poor condition of the adult bream could explain the delayed spawning and light reproduction found during the summer months. This, in turn, caused the numbers of bass fry to decrease sharply due to starvation and cannibalism. In each case where an increase in numbers of intermediate bream was noted, a competitive species existed. As the bream numbers increased, golden shiners decreased. When black crappie were present, their numbers and weight were greatly reduced by winter fishing, thereby allowing the small bream population to expand accordingly. Post-drawdown checks indicated that the F/C and particularly the Y/C values greatly influenced the outcome of the operation. Fish ponds with high bass populations at the time of the drawdown improved more significantly than did those having fewer bass. Even though the bass-bream relationship was considered to be the main deciding factor (Lawrence 1956), the standing crop (fertility) of each pond appeared to contribute greatly to the success or failure of the operation. As previously mentioned, an estimated four times as many pounds of fish are confined per unit of area in a fertilized pond as in one that is not fertilized. It is believed that the forage species suffered from lack of adequate and space during the drawdowns in proportion to their standing crops.

Air temperatures vary greatly during the fall and winter months in Georgia, particularly in the central portion along the fall line that separates the lower Piedmont from the upper Coastal Plain. Generally, winter drawdowns were initiated in October and lasted until around the middle of January. During this period air temperatures ranged from 92° F to 5° F. Mid-winter air temperature readings varied as much as 50° F in four days with 30° temperature fluctuations being commonplace. Even though water temperatures do not fluctuate as drastically, it is obvious that such air temperature changes would stimulate or suppress the need for food. Since fish digestion is regulated by water temperature, it is understandable the influence these fluctuations had on the crowded fish populations. During periods of relatively warm water, the forage fish (bream) suffered greatly since an inadequate food supply prevailed causing the fish to become emaciated. The bass population, however, with food plentiful, grew rapidly, formed many eggs, and spawned heavily the following spring. If the bass population was high enough to substantially reduce the bream population during the periods of peak digestion, the drawdown was successful in improved fishing the following summer. As mentioned previously, the more fertile ponds contained many more pounds of fish in proportion to their confined areas, therefore requiring much heavier bass predation than ponds having the lower poundage of forage species. Experience has

TABLE NUMBER 3
HOUSTON LAKE
A COMPARISON OF THE INDIVIDUAL GROWTHS OF HARVESTABLE-SIZED BREAM BASED ON AVERAGE WEIGHT OF EACH INCH GROUP

Species	Length	Ounces 1962	Ounces 1963	Ounces Increase or Decrease
Bluegill				
	5″	1.14	1.14	0.00
	6″	2.00	2.00	0.00
	7″	No Specimens	4.50	+ 4.50
Shellcracker				
	5″	.96	1.30	+ .34
	6″	2.40	No Specimens	− 2.40
	7″	3.20	3.50	+ .30
	8″	5.28	7.10	+ 1.82
	9″	7.04	9.00	+ 1.96

shown that the F/C ratio is usually much higher in unbalanced fertilized ponds that in those less fertile since increased fertility is more advantageous to the prolific forage fish, which feed lower on the food chain, than it is to the piscivorous members of the population.

Another factor that was considered to greatly affect the final results of the drawdown program was the obvious effect the drawdown had on the benthos community present in the ponds at the time of the draining. It was found that the invertebrate population that existed in the managed, fertilized ponds was different from those that inhabited ponds having rank growths of higher aquatic vegetation. In the well-fertilized ponds, where underwater vegetation was virtually non-existent, the insect fauna inhabiting the sublittoral zone was comprised of relatively non-mobile forms of Diptera larvae, particularly the members of the *Tendipedidae* group. In the less fertile ponds containing varying amounts of submerged aquatic vegetation, highly mobile forms of aquatic invertebrates were found in conjunction with the non-mobile varieties. It has been noted that the relatively non-mobile or burrowing forms are left to die on the exposed mud flats when the water is lowered. However, the mobile invertebrates, particularly the dragonfly larvae, damselfly larvae, and decopods, were found moving from the protective cover of the aquatic vegetation to the water as these areas were being exposed. Each drawdown exposed the submerged aquatic vegetation, therefore no cover was available for the mobile invertebrates once they re-entered the water. Since the water temperature was relatively high (75° F) during the period when the ponds were being lowered, the bream population still required normal amounts of food for adequate growth. The invertebrates that were able to move with the receding water fulfilled this requirement. No such food was made available to the confined bream populations in weedless ponds where non-mobile invertebrate forms prevailed. The latter is believed to be the primary cause of the emaciated condition of the bream population witnessed the following spring after drawdown.

Bottom samples taken during the late summer following the drawdowns indicated that a relatively few desirable food organisms existed in the hypolimneon. On an average, *Chaoborus sp.* comprised between 80% and 99% of the total volume of all available food in the hypolimneon. Food habit studies (Geagan & Allen 1960) have indicated that these organisms are not readily eaten by bream even though they may be very abundant. It is also reported (Welch 1935) that approximately 25% to 50% of the *Chaoborus* population migrates to the surface each night. It appears to the authors that if these organisms were attractive to bluegill, their population would be drastically reduced when they left the protection of the oxygen-free hypolimneon to the fish-inhabited epiliminion. Generally, the opposite was found. Large quantities of *Chaoborus* larvae were found even when other forms were very scarce and the general condition of the fish was poor.

During the benthos study mentioned earlier in the report, an average of 7.5 ml. per sq. m. of bottom organisms were found during the month of August in eight typical farm ponds located in Central Georgia. All samples were taken in areas less than five feet deep. In averaging the volume of benthos organisms taken during the month of August from the six ponds that had experienced a drastic drawdown the previous winter, only .78 ml. per sq. m. were found. This is approximately .1 of the volume found in the ponds not having been drawn down. The authors conclude that the bottom organisms present in the shallow water, prior to the drawdown, were killed when they became exposed to the elements and had not re-established their normal volum by the following late summer. Even though it is known that bottom organisms can re-establish themselves within a few weeks after inundation, it is obvious that the total volume of these food organisms would be very slow in reaching their previous status since they are constantly preyed upon by the bream population during the growing season. This constant pressure may not allow the invertebrate population to reach its maximum volume until the following winter when the bream's food requirements are minimal.

DRAWDOWN AND SEINING

Population manipulations using the drawdown and seining method have been tested for several years. The success of such removals usually depended on the degree of imbalance at the time of the drawdown in relation to the pounds of undesirable fish removed. This technique was found to be one of the most economical means of improving fishing and is adapted for non-technical supervision. The main limiting factor encountered was whether or not the impoundment could be effectively seined. Stumps, snags, excessively deep water, and silt greatly affect the seining operations. Most of the ponds in Georgia contain one or more of the above conditions, which greatly limits its use as a feasible general recommendation. Present and prospective pond owners are being urged to construct their ponds to make seining effective during drawdowns.

The following data were obtained from three small impoundments during winter drawdown and seining operations. Each pond, ranging from 3.6 acres to five acres in size, was lowered to approximately one-tenth to one-fourth their original sizes during the month of October. The seining operation was not initiated until the water temperature became 70° F or lower as a safeguard against oxygen depletion when the pond was seined. A 60-foot, one-half inch mesh, bag seine was used in each operation. All bass and harvestable-sized bream were returned to the ponds. Seining continued until the catch became too small to justify additional removal. This ranged from 40 to 153 pounds per acre. Each pond was maintained at low water levels until the following January.

James Kimbro Pond: This 5-acre pond located in the Coastal Plain Province was lowered to approximately 1.5 acres for a period of 80 days.

An average of 156 intermediate bream per large seine haul was taken from this pond during a balance check the summer prior to the drawdown and seining operation. In conjunction with the intermediate bream, an average of two bass, varying from five-12 inches, were taken per seine haul. This condition resulted from a fish kill that took place during the summer of 1959. Bream apparently spawned heavily later on in the summer and again the following spring. Bass also spawned the following spring and were supported by the heavy bream reproduction. The entire margin of the pond was infested with maiden cane (*Panicum hematomon*) which possibly sheltered the small bream creating an overcrowded bream population by the summer of 1961. After seining the pond during the summer of 1961, the pond owner was advised to lower his pond in order to deepen the edges. It was further recommended that an attempt be made to remove some of the small bream by seining while the pond was down.

In four hours of seining, two men removed 40 pounds of intermediate bream per surface acre from the pond. An average of 30 bass per seine drag was observed; therefore, the relatively low poundage of intermediate bream removed was considered sufficient. Some harvestable-sized bream were also observed. All bass and large bream were returned with the exception of 60 pounds of large shellcrackers. These fish were kept since the pond owner planned to reduce the acreage of his pond by one-fifth by construcing a small dam at the upper end of the original pond.

Seine checks made the following summer indicated that the pond was in good balance. An average of 79 intermediate bream per large seine drag was observed, and both bream and bass spawned heavily. Fishing greatly improved during the summer of 1962. Seine checks made during 1963 indicated that the balance had improved even more than during 1962. Large catches of bream and bass were reported and seine checks produced heavy bream and bass reproduction with an average of 54 intermediate bream being taken.

L. B. Golden Pond: This 3.6-acre pond located in the Middle Coastal Plain Province was lowered to approximately 1.5 acres for a period of 80 days.

The year prior to the 1962 drawdown 171 pounds of intermediate bream per acre were removed by seining. Two areas were baited with

commercial fish food for a period of one week. These areas were then seined with a 60-foot bag seine. As many as 40 pounds of intermediate bream were harvested per seine drag. In fifteen hours of seining two men removed the 171 pounds of intermediate bream per acre. The following year the bass failed to spawn successfully, which created another crowded bream population by the fall of 1962. From October 1, 1962, to January 15, 1963, this pond was lowered to approximately 1.5 acres. In seining this pond while drawn down, 80 pounds of intermediate bream per acre were removed. No intermediate bass were taken during the entire seining operation; however, several bass ranging from two to four pounds were captured and released. Bass reproduction was found the following spring; however, no bream reproduction was found as late as August of 1963. By the fall of that year the current bass spawn had been drastically reduced and were still only two inches in length. Fishing had not improved in this lake as of September 1, 1963.

Cecil Jones Pond: This 4-acre pond located in the Upper Coastal Plain Province was lowered to approximately 1.5 acres for a period of 80 days.

Pre-drawdown seine checks produced an average of 260 intermediate bream per large seine haul. No bream reproduction and only one two-inch bass were observed. During October, 1962, this four-acre pond was lowered to approximately one-acre and was seined in an attempt to remove a high poundage of intermediate bream. In eight hours of seining, two men removed 153 pounds of intermediate bream per acre. An average of one bass per drag was taken, indicating a relatively low bass population. Heavy bass reproduction was encountered the following spring. Bream reproduction was light and came too late in the summer to recruit the current bass reproduction above the three-inch group. Even though the average numbers of intermediate bream taken in the large seine had been reduced from 260 to 47 per haul, fishing did not improve greatly during the following summer. Mid-summer seine checks indicated a general improvement in the overall condition, however.

Post-drawdown balance checks made on the three ponds mentioned above the following spring indicated that the bass had spawned successfully; however, bream reproduction came later than usual in two of the three ponds seined. Bream recruitment was slow until late summer. The authors believe that the inadequate food supply during the drawdown and the associated reduction in bottom organisms the following summer interfered with normal growth.

The above information indicates that an additional poundage of bream should have been removed in the two ponds where bream growth and reproduction was inadequate. It was found that approximately 26 pounds of bream per man-hour were removed by seining. At this rate two men could remove 150 pounds of intermediate bream from a one-acre pond in less than half a day. As mentioned previously in this report, this is one of the most simple, economical, and effective means of reducing a large poundage of small bream if the structure of the pond bottom is suitable for this type of operation.

DRAWDOWN AND SUPPLEMENTAL BASS STOCKING

Two ponds, each two acres in size, were supplementally stocked with bass (*Micropterus salmoides*) during winter drawdowns. One pond received 75 bass, six to 12 inches long per acre, while the other was stocked with 35 bass, four to five inches long per acre. Pre-stocking seine checks indicated that these bass were large enough to feed upon the sizes of bream that crowded the population. (Lawrence 1956). The following discussions pertain to data based on pre- and post-stocking seine checks in these two impoundments.

J. E. Taylor Pond: This 2-acre pond located in the Upper Coastal Plain Province was lowered to approximately .5 acre for a period of 80 days.

During the summer of 1962 an average of 150 intermediate bream per 60-foot seine haul was found. No bass reproduction and only a very light bream spawn were indicated. In October, 1962, the pond

was lowered to approximately one-half acre. Efforts to seine this pond were unsuccessful because of excessively deep water and stumps. Consequently, 35 bass three and four inches long were added per acre to determine if they could help reduce the crowded bream population under drawdown conditions. Seine checks made the following spring and summer produced an average of 22 intermediate bream per large seine haul. Bass reproduction was exceptionally heavy averaging 12 bass per small seine drag. No bream spawn was observed until the last of July, 1963. By that time most of the current bass spawn had perished. None of these bass had grown larger than four inches by September 1, 1963. Even though bream fishing had not greatly improved, the general condition of the bream had.

ABAC Pond: This 2-acre pond located in the Middle Coastal Plain Province was lowered to approximately .75 acre for a period of 45 days.

This pond became heavily infested with *Pithophora* during 1960 and 1961. After removing this algae by chemical means, a crowded bream population was found to exist. An average of 190 intermediate bream per large seine haul was taken during 1962, and no bream or bass reproduction was found during that period. In November, 1962, this pond was lowered to approximately one-half acre and was stocked with 75 bass, six to 12 inches long per acre with most of the fish in the eight-inch group. Both bass and bream spawned successfully the following season; however, the bream spawn came too late to recruit the bass above the three-inch group by late summer. Bream fishing did not improve significantly during 1963 even though the average numbers of intermediate bream taken in the large seine was only 41 compared to the 190 collected during the same period the previous year.

The addition of effective predators during a winter drawdown did not prove to be beneficial for increasing the (At) value of the two ponds the following summer. Bream growth may improve during the following fall and early winter as a result of increased benthos populations and additional predation on the intermediate bream from the stocked bass. It appears unlikely that the current bream spawn will recruit to intermediate size since heavy predation from young bass is expected.

DRAWDOWN AND NETTING

Bear Camp Lake: In 1962 a population study was conducted on this 65-acre fertilized pond located in the Upper Coastal Plain Province to determine why fishing success had decreased over the past four years. On July 31, 1962, a one-acre cove averaging five feet deep was blocked off and poisoned out with 5% liquid rotenone. In analyzing the data collected it was found that 15% (27 pounds) of the 187 pounds taken in the sample was comprised of six-inch to 10-inch golden shiners. Bluegills comprised 53% of the population with most of them occupying the five to seven-inch group. Black crappie occupied 4.5% of the total poundage with 58% of these being current reproduction. The population was found to contain 14.2% black bass ranging from three to 19 inches in length. It was obvious that fishing success would become even worse if the golden shiners were allowed to expand further, particularly since the heavy crappie spawn would soon be competing with the bream population for food. The pond owner was advised to lower the impoundment approximately 50% during October and attempt to reduce the shiners and small crappie population by using one-inch mesh gill nets (shirt-tail type). In 90 netting days between November 11, 1962, and January 15, 1963, a total of 8,148 shiners weighing 1,880 pounds was removed. Less than 1% of the total poundage taken during the netting operation was comprised of fish other than golden shiners. Each of the five nets used were periodically moved when the catch had greatly decreased. The pond owner stated that each time the nets were re-set the catch picked up significantly, indicating the shiners were more or less territorial. Netting success also followed significant temperature changes. See Figure 1. The catch increased during warm weather periods and decreased as it became colder. In addition to the

TABLE NUMBER 4
POPULATION DYNAMICS OF ONE ACRE ROTENONE SAMPLES CONDUCTED BEFORE AND AFTER A WINTER DRAWDOWN AND SHINER NETTING PROGRAM ON BEAR CAMP LAKE

Species	Per Cent of Population By Weight 1962	1963	Changes Based on Pounds of Each Size Group Collected During the Two Population Studies: Small 1962	Small 1963	1963 Pounds Increase or Decrease	Intermediate 1962	Intermediate 1963	1963 Pounds Increase or Decrease	Harvestable 1962	Harvestable 1963	1963 Pounds Increase or Decrease	1963 Total Pounds Increase or Decrease
Largemouth Bass	14.0	28.5	.80	1.38	+ .58	.60	2.31	+1.71	25.30	66.27	+40.97	+43.26
Black Crappie	4.5	23.5	4.90	1.20	−3.70	0.00	8.40	+8.40	3.60	47.90	+44.30	+49.00
Bluegill	53.5	44.2	9.80	9.63	− .17	13.90	13.35	− .55	76.60	87.89	−11.29	+10.57
Red Ear	.1	1.8	.01	.01	0.00	.10	0.00	− .10	0.00	4.37	+ 4.37	+ 4.27
Warmouth	9.6	1.4	.20	.78	+ .58	2.70	.49	−2.21	15.50	1.47	−14.03	−15.66
Brown Bullhead	3.0	.1	.40	0.00	− .40	.01	.06	+ .05	5.40	0.00	− 5.40	− 5.75
Yellow Bullhead	0.0	.1	0.00	.06	+ .06	0.00	0.00	0.00	0.00	0.00	0.00	+ .60
Golden Shiner	15.0	.4	.50	.01	− .49	.60	0.00	− .60	26.10	1.07	−25.03	−26.12
Misc. Species	.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	.56	0.00	− .56	− .56
TOTALS	100.0	100.0	16.61	13.07	−3.54	17.91	24.61	+6.70	153.06	208.97	+55.91	+59.11

	1962	1963
Total Pounds Per Acre	187.75	246.65
F/C	4.30	2.88
Y/C	.05	.10
At	81%	85%
At with Harvestable-Sized Golden Shiners Omitted	68%	85%

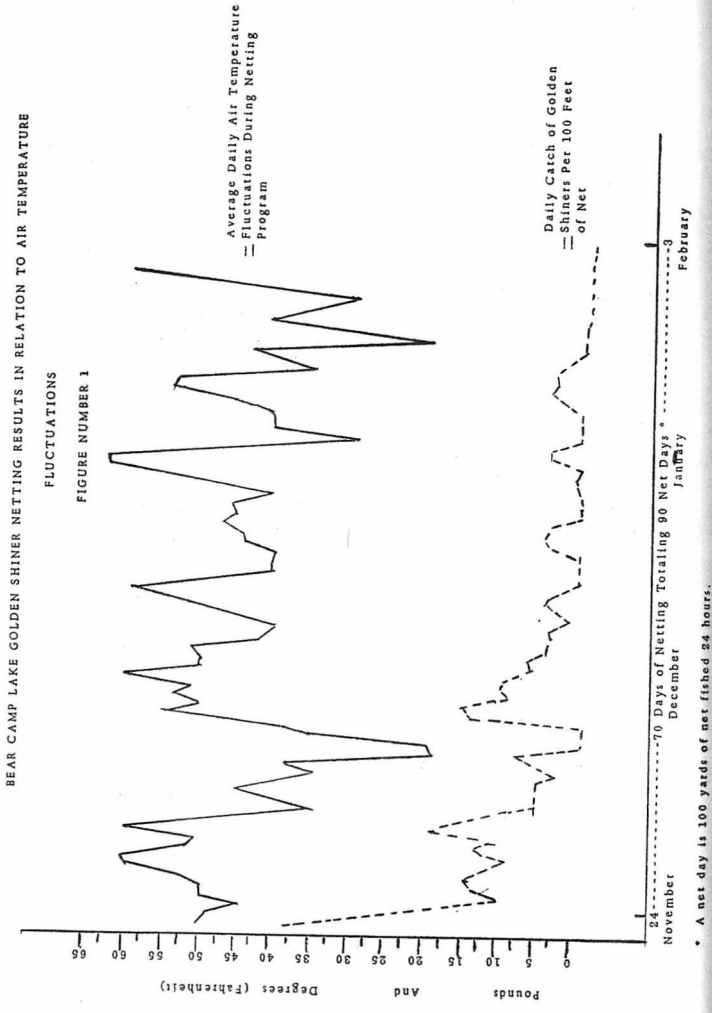

TABLE NUMBER 5
BEAR CAMP LAKE
A COMPARISON OF THE INDIVIDUAL GROWTH OF HARVESTABLE BLUEGILL AND BLACK CRAPPIE BASED ON AVERAGE WEIGHT OF EACH INCH GROUP

Species	Length	Ounces 1962	Ounces 1963	Ounces Increase or Decrease
Bluegill	5″	1.30	1.48	+ .18
	6″	2.20	2.42	+ .22
	7″	3.60	3.80	+ .20
Black Crappie	7″	3.00	2.44	− .56
	8″	3.80	3.70	− .10

the poundage of small bream removed in relation to the standing bass population.

6. Supplemental stocking of bass large enough to feed on the sizes of bream crowding a given population was found to be ineffective for improving bream growth the following year. Late summer seine checks indicated, however, that the balance had greatly improved over the current growing season, thereby indicating that increased bream growth may be forthcoming.
7. Gill-netting a pond during a winter drawdown proved to be a very effective and selective means of reducing a large golden shiner population. In 90 net days, using a one-inch mesh gill net (shirt-tail type), 8,148 shiners weighing 1,880 pounds were captured in a 65-acre impoundment which was lowered to approximately 35 acres and netted for approximately 70 days. Catches increased with rising temperature and decreased when it became colder. Netting success also increased each time the nets were moved to different locations.

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