Copper sulphate was found to be the most effective in elimination of cold water algal mats. It was felt, as with Sodium arsenite, that benefits received from algae control exceeded the much publicized detrimental effects of this material. In a number of instances, a plankton bloom was noted within six days after treatment. Also, other workers have reported the absence of detrimental effects in prolonged uses of Copper sulphate.

Delrad produced good results in control of cold water algae, but was ineffective in the control of Pithophora. Cost was generally prohibitive for use of this chemical in ordinary farm pond management.

Dowpon was the only herbicide used which materially damaged Manna Grass. Spraying the normally exposed foliage resulted in good initial kill, however, considerable regrowth followed. In one eleven acre pond an estimated 98% control was realized from treatment following a four foot drawdown. Dowpon used at the rate of 10 to 15 pounds per acre would probably control most resistant, narrowleafed, emergent grasses.

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EXPERIMENTS ON GROWING FINGERLING CHANNEL CATFISH TO MARKETABLE SIZE IN PONDS

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Commercial warmwater fish farming is in its infancy in the United States, but is slowly developing into an established industry. At present, by far the greatest acreage in commercial ponds has been developed in Arkansas, where idle rice fields could be converted readily into aquatic pastures for fish production. In most of the states in the Southeast, a small acreage is now being tried, and interest in commercial fish farming is rapidly increasing. A slow and orderly development is to be desired as there has been to date insufficient research upon which to base this new industry.

The bigmouth buffalo fish (*Ictiobus cyprinella*) is now raised commercially based on information previously published.* Since this fish sells at a low price, search has been continued for other species suitable for commercial pond culture. In preliminary experiments, the channel catfish (*Ictalurus punctatus*) appeared a promising species and production up to 1,242 pounds per acre was reported.† Further experiments at Auburn on growing fingerling channel catfish to marketable size in ponds are reported in this paper.

The fingerling channel catfish for these experiments were made available by the U. S. Fish and Wildlife Service.

Prior to stocking, the fish were examined and treated for control of parasites. They were then stocked into holding ponds and fed. Subsequently, they were removed from the holding ponds as needed for experiments, treated for the control of parasites and disease, and stocked in varied numbers into the commercial production ponds. The ponds were fertilized and the fish fed a mixed dry feed

* Swingle, H. S. Revised procedures for commercial production of bigmouth buffalofish in ponds in the Southeast. Proc. Ann. Conf. S. E. Assn. Game and Fish Comm. 10:162-165. 1956.

† Swingle, H. S. Preliminary results on the commercial production of channel catfish in ponds. *Ibid* 10:160-162. 1956.

at various rates. Periodically, the ponds were sampled to estimate the rate of growth of the catfish in order to readjust the rate of feeding. At the end of the experiment, the ponds were drained and the fish measured, weighed, and processed for sale.

TREATMENTS FOR PARASITES AND DISEASE

Channel catfish were found infested with external protozoan parasites, gill flukes, tapeworms, and various other intestinal parasites. Gill flukes and external protozoa were controlled by treatment with potassium permanganate followed by treatment with formalin. Tapeworms and various other intestinal parasites were controlled by incorporating di-n-butyl tin oxide in the feed.‡

Columnaris disease was also found to attack fingerling catfish. To prevent its spread, fish were treated with acriflavine before being placed in ponds, and acriflavine was placed in all tanks during transportation of these fish.

Evidence that these treatments were effective in reducing losses from parasites and disease is provided by the percentage of survival of channel catfish stocked into the production ponds. The range of survival was from 79.6 to 99.2 percent, and the average of 13 populations was 94.6 percent. The routine treatments were as follows:

Potassium Permanganate Treatment: Brood fish were held in 10 p.p.m. potassium permanganate for one hour. Small fingerlings could not stand such a high concentration, but were successfully treated with 4 p.p.m. for one hour. Following this period, fresh water was run into the tanks until the pink color of the permanganate disappeared. Exposure to the permanganate for longer than the recommended time may kill the fish.

Formalin Treatment: The fish were then held in water containing 15 p.p.m. formalin 5 to 12 hours. Catfish lived indefinitely in this solution without harm.

Acriflavine (neutral): The channel cats were then treated with 1 p.p.m. acriflavine for 5 to 12 hours. This can be done subsequent to the formalin treatment, or concurrently with it as acriflavine and formalin can both be added to the same tank of water with good results. Acriflavine should not be added to water containing potassium permanganate.

When catfish were to be transported, 1 p.p.m. acriflavine was added to the water. This treatment kills, or inhibits the growth of bacteria in water and on fish.

Di-n-butyl Tin Oxide: This chemical was incorporated in the fish feed to the extent of 0.3 percent for control of tapeworms and other intestinal parasites. The medicated feed was then fed for 3 consecutive days at the rate of 3 percent of body weight of the fish each day.

FEED CONVERSION: C AND S VALUES

The efficiency of a feed or rate of feeding is often expressed as the C value, or the pounds of feed required to produce a pound of fish or other animal. In the case of trout or other fish raised in troughs or raceways, this is easily calculated because no, or very little, natural feeds are available, and,

$$C = \frac{\text{Pounds feed used}}{\text{Pounds fish produced}}$$

Where fish are raised in ponds, however, variable amounts of natural food organisms are available and when supplemental feed is added, the pounds of fish produced is not all due to the feed added. In this case,

$$C = \frac{\text{Pounds feed added}}{\text{Total pounds fish produced minus pounds that would have been produced without feeding}}$$

The pounds of fish that would have been produced without feeding is difficult to calculate, since it depends upon fertility of the water, temperature, rate of stocking, survival, days in experiment, and many other factors. Its determination

‡ Allison, Ray. A preliminary note on the use of di-n-butyl tin oxide for removing tapeworms from fish. Progressive Fish Culturist 19 (3):128-130. 1957.

would require more experimental pond space than the results would justify in many cases. As a result, in literature dealing with pond culture, the C reported is often calculated without the necessary correction, and this causes considerable misunderstanding.

Consequently, it appears desirable to use a different symbol to represent conversion where no correction can be, or is, made for "natural" production. It is suggested that when supplemental feeds are being compared that the letter S be used where:

$$S = \frac{\text{Pounds feed added}}{\text{Total pounds fish produced by natural plus added feeds}}$$

In the case of both the C and S values, the pounds fish produced equals the pounds fish recovered at the end of an experiment minus the pounds originally stocked. Obviously, in pond experiments the resulting figure is always lower than it should be, because part of the fish stocked always die and part of the pounds produced may be lost due to natural mortality before end of the experiment. Since these dead fish are very seldom found, no corrections are possible. It is evident that as the weight of fish per acre increases because of supplemental feeding, the value of S approaches the value of C.

In this paper the S conversion values for channel catfish were determined without correction for presence of wild fishes or tadpoles that consumed part of the feed supplied. The S value thus gives a measure of efficiency of a particular method for production of the species of fish stocked, in this case, the channel catfish.

FISH FEEDS

The feed used from 1955 to 1958 was the Auburn No. 1 fish feed § containing 42 percent protein. Because the peanut oil meal used in this feed was found to be diluted with ground shells, a fibre that the fish did not utilize, ground peanut cake was substituted for oil meal in the Auburn No. 2 fish feed. This resulted in a feed containing approximately 46 percent protein, 25 percent carbohydrates, and 5 percent fat. The composition was as follows:

Soybean Oil Meal	(44 percent protein)	35 percent
Peanut Cake	(53 percent protein)	35 percent
Fish Meal	(60 percent protein)	15 percent
Distillers Dried Solubles	(24 percent protein)	15 percent

The feed was prepared as a dry mix meal and in the form of dry pellets ⅜ inch in diameter and 1 inch long.

EFFECTS OF PELLETING THE FEED

Pelleting the feed resulted in more efficient utilization by the fish. In one series of tests (Table IV), two ponds were stocked each with 3,000 channel catfish fingerlings per acre, and each fed during a 252-day period with 3,705 pounds of Auburn No. 1 fish feed per acre. The feed was fed in the form of a dry-mix flour for one pond, and in the form of pellets for the other. The relative efficiency of each form of feed was compared by determining the yields and by calculating the S conversion values.

The pelleted feed yielded 2,363 pounds of channel cats per acre with $S = 1.6$, while the dry-mix flour yielded 1,113 pounds of fish per acre with $S = 3.3$ (Table IV). Although these were unreplicated experiments, the differences were so great that there appeared little doubt of the value of pelleting. Similar results were obtained in feeding experiments with carp (unpublished data).

In addition, pelleting the feed resulted in less water pollution. Consequently, higher rates of feeding were possible without causing oxygen deficiencies.

RATES OF FEEDING

Insufficient research has been done to determine the most efficient rates of feeding for channel catfish of different sizes and at different temperatures. Since for supplemental feeding the research must be conducted in a limited number

§ Prather, E. E. Experiments on the commercial production of golden shiners. Proc. Ann. Conf. S. E. Game and Fish Comm. 10:150-155.

of ponds, a considerable number of years will be required to obtain adequate data. However, experiments to date have yielded a considerable amount of useable information.

Best response to feeding the channel cat was obtained in the period when the temperature of the surface waters rose above 70° F., that is, during the period April to October at Auburn, Alabama. Feeding produced comparatively little growth while the water temperatures were below 60° F. Consequently, in the commercial ponds it is believed that feeding should be stopped when the temperatures drop below 60° F., during the period of November to March at Auburn, Alabama. It is known, however, that the catfish do feed to some extent during this period and will lose weight if no feed is available. Therefore, it is probable that additional experimentation may demonstrate that a very low rate of feeding is desirable in the winter period to maintain good condition.

Brood fish and small fingerlings that are being held at high concentrations in ponds should be fed at low rates during the winter. For example, in a holding pond containing 60,000 fingerling catfish per acre supplemental feeding was omitted from November to February, with the result that nutritional deficiencies developed, many fish died, and the remainder were too weak to stock into ponds. After feeding had been resumed for 2 weeks at the rate of 2 percent of their body weight per day, the remaining fish recovered.

Where fingerling fish were held for a considerable period of time, they were fed at the rate of 1 percent of their body weight daily. This allowed the fish to grow slowly and kept them in good condition. Feeding was withheld only during the periods when the water temperatures remained below 45° F.

Brood fish in wintering ponds were fed 2 percent of their body weight daily, and feeding was discontinued when the water temperatures dropped below 50° F. However, further experimentation is needed to deterime the best feeds and rates of feeding of the brood fish.

In the commercial production ponds during the growing period when the water temperatures were above 60° F., rates of feeding varied principally between 2 and 5 percent of the body weight of the fish daily for 6 days per week. These limits were set largely by three factors. First, inefficient conversion values were obtained at feeding rates in excess of 5 percent, and most efficient utilization of the feed occurred at rates between 2 and 4 percent. Second, the rates of growth decreased gradually as the rates of feeding were reduced from 5 to 1 percent per day, thus increasing the length of time feeding was required to raise the fish to marketable size. Third, in ponds without inflowing water, the maximum daily amount of feed that could be fed the channel catfish safely during the summer period without mortality due to oxygen deficiency, was 25 pounds per acre of the dry-mix meal and 30 pounds per acre of the pelleted feed.

As a result, a sliding scale of rates of feeding was necessary. As the size of the fish and the pounds of fish per acre increased, the pounds of feed was increased up to the maximum safe poundage per acre, and this rate of feeding was continued until the catfish reached the desired size. The average rates of feeding used are given in Table I.

The estimated total weight of catfish per acre in each pond was determined at approximately monthly intervals from the average weights of fish obtained by seining, assuming a survival of 90 percent of the fish that were stocked. Typical records are given in Table II.

From the estimated total weight of catfish per acre, a new rate of feeding for the following month was established by reference to the information in Table I. The following month, the population was again estimated and the feeding readjusted. For additional help in estimation of total weights, length-weight measurements of pond-produced channel cats are given in Table III.

As this information plus the rate of feeding is recorded for a pond, it is possible to calculate the S conversion values periodically throughout the experiment. In pond No. E-8 (Table II), the high values of S were due to the presence of wild fishes and tadpoles which were competing for the feed.

Table I

Recommended Rates of Feeding Channel Cats with Auburn No. 1 or No. 2 Fish Feeds

Estimated Total Weight of Channel Cats Per Acre Pounds	*Dry-Mix Meal* *Pounds/A/Day* *	*Pelleted Feed* *Pounds/A/Day* *
10–30	1	1
50	3	3
100	5	5
200	10	10
300	12	12
400	16	16
500	20	20
700	23	25
800	25	30
900	25	30
1,200	25	30

* Fed 6 days per week.

Table II

Typical Record of Rates of Growth and Rates of Feeding of Channel Catfish in a Pond

Species: Channel Catfish Pond: E-8 Acres: 1 Date: 1957-1958

Type of Feed: Auburn No. 2 Pellets

		Fish Sample			*Estimated*		*Days*		*Pounds of Feed*			
	Date	*By*	*No. Fish*	*Avg. Lbs.*	*Total Lbs.*	*% Mortality*	*Since Last Samp.*	*Gain/A Lbs./Day*	*Per A/Day*	*For Period*	*Total to Date*	*Cumulative S*
1957	8–8	Stock	2,000	0.011	22.0	..	..	..	..	...	...	..
	12–9	...	...	...	...	..	..	..	1–10	658	658	..
1958	3–10	Trap	2	0.15	270	10	..	..	10	70	728	2.93
	3–25	Seine	52	0.152	274	10	229	1.06	10	130	858	3.4
	4–28	Seine	151	0.22	396	10	34	3.2	10–15	410	1,268	3.4
	6–25	Seine	29	0.37	666	10	58	4.0	15–20	930	2,198	3.4
	7–25	Seine	54	0.45	810	10	30	4.2	20–25	610	2,808	3.5
	10–6	Drain	1,902	0.733	1,470.6	4.1	73	9.0	25–30	1,580	4,388	3.03
		For Total Period . .				424	Days	3.42				

Table III

Lengths and Average Weights Per Thousand of Channel Catfish Grown in Ponds

Total Length *Inches*	*Average Weight Per Thousand Fish* *Pounds*
1	1.3
2	3.5
3	10
4	20
5	32
6	60
7	93
8	112
9	180
10	328
11	395
12	509
13	656
14	850
15	1,090
16	1,290
17	1,432
18	1,750
19	2,200

The most efficient conversion, S = 1.24, was obtained in pond F-2 (Table IV). With the maximum correction value of 200 pounds channel catfish per acre for a 188-day period with fertilization, the true conversion value would be estimated as C = 1.4. Additional S values of 1.35, 1.41, and 1.55 are reported in the same table. These figures indicate that the Auburn No. 2 pelleted feed is very efficiently utilized by the channel catfish under proper conditions.

TABLE IV

PRODUCTION PER ACRE OF CHANNEL CATFISH IN PONDS STOCKED IN THE SPRING

	Results in Pond No.						
	F-2	*F-9*	*F-3*	*T-1*	*E-1*	*S-12*	*T-2*
S Conversion	1.24	1.35	1.41	1.56	1.94	2.3	3.3
Date of Stocking	4-4-58	4-4-58	4-4-58	3-19-57	3-18-57	3-18-57	3-19-57
No. of Channel Cats Stocked	3,000	5,000	4,000	3,000	2,000	1,000	3,000
Average Size, Pounds	0.013	0.014	0,013	0.005	0.005	0.005	0.005
Days in Experiment	188	188	188	252	259	273	252
Applications Fertilizer	5	5	5	7	7	7	7
Total Pounds Feed	2,000	2,535	2,711	3,705	3,230	2,236	3,705
Type Auburn Feed	No.2 Pellet	No. 2 Pellet	No. 2 Pellet	No. 1 Pellet	No. 1 Pellet	No. 1 Pellet	No.1 Dry Meal
Recovered on Draining:							
Cats, Pounds	1,646.4	2,074.4	1,837.2	2,363.0	1,526.6	961.4	1,113.0
Other Fish, Pounds	66.4	107.2	15.1	0.0	185.0	0.3	104.0
Channel Catfish:							
Survival, Percent	98.0	97.4	99.2	96.3	79.6	94.5	86.0
Gain: Pounds/A/Day	8.6	10.6	10.0	9.3	5.8	3.5	4.4
Cost/Pound Fertilizer ¢ *	0.6	0.5	0.6	0.6	0.9	1.4	1.3
Cost/Pound Feed ¢ *	*7.5*	*8.1*	*8.5*	*9.6*	*11.6*	*12.7*	*18.1*
Cost/Pound Combined ¢	8.1	8.6	9.1	10.2	12.5	14.1	19.4
Final Average Pounds	0.56	0.43	0.46	0.82	0.96	1.02	0.45

* Cost of fertilizer and feed per pound live weight of channel catfish produced. Fertilizer cost $2.00 per acre per application, and the cost of the feed was 5.5 cents per pound for dry meal, and 6 cents per pound for pellets.

FERTILIZATION OF PONDS RECEIVING SUPPLEMENTAL FEEDING

In a series of 13 ponds receiving supplemental feeding, fertilization was varied from 2 to 13 applications, each equivalent to 100 pounds 8-8-2 per acre (Tables IV and V). No relationship between the number of fertilizer applications and the total production or the S conversion values could be found.

Where heavy supplemental feeding was used, heavy plankton growth resulted even in the absence of inorganic fertilization. Consequently from these tests, it does not appear profitable to fertilize during periods of heavy feeding. Until additional experimentation demonstrates otherwise, it appears best to fertilize only for a few weeks following initial stocking of catfish.

EFFECT OF TIME OF STOCKING

Stocking of fingerling channel catfish into the experimental production ponds at Auburn was principally at two seasons—spring and fall. Stocking in March or April resulted in lower S conversion values, lower costs per pound of fish produced, and higher average gains in pounds per acre per day than the fall stocking (Tables IV and V). The average figures for spring and fall stocking were:

Item	*Spring Stocking*	*Fall Stocking*
Food Conversion (S)	1.87	3.0
Average Gain Per Acre Per Day, Pounds	7.5	3.2
Cost Feed Plus Fertilizer Per Pound Catfish	11.7¢	18.8¢
Days to Grow Catfish to Marketable Size	228	394

Table V

Production Per Acre of Channel Catfish in Ponds Stocked in Late Summer and Fall

	Results in Pond No.					
Item	*T-1*	*T-2*	*E-8*	*E-7*	*E-6*	*F-5*
S Conversion	2.3	2.5	3.0	3.2	3.4	3.9
Date of Stocking	10-1-55	10-1-55	8-8-57	8-8-57	8-8-57	10-1-55
No. of Channel Catfish Stocked	1,000	2,000	2,000	2,000	2,000	1,032
Average Size, Pounds	0.06	0.06	0.011	0.011	0.011	0.06
Days in Experiment	327	327	424	426	420	438
Applications Fertilizer	9	9	2	2	2	13
Total Pounds Feed	1,765	3,165	4,388	4,232	4,136	5,112
Type Auburn Feed	No. 1 Dry Meal	No. 1 D. Meal	No. 2 Pellet	No. 2 Pellet	No. 2 Pellet	No. 1 D. Meal
Recovered on Draining:						
Cats, Pounds	773.0	1,242.0	1,470.6	1,345.4	1,225.9	1,301.6
Other Fish, Pounds	131.0	60.0	291.3	139.0	344.0	20.6
Channel Catfish:						
Survival, Percent	95.0	98.0	95.1	98.3	98.0	95.4
Gain: Pounds/A/Day	2.36	3.8	3.4	3.1	2.9	3.0
Cost/Pound Fertilizer ¢ *	*2.3*	1.4	0.3	0.3	0.5	2.0
Cost/Pound Feed ¢ *	*12.7*	*13.8*	*18.2*	*19.2*	*20.4*	*21.4*
Cost Combined ¢	15.0	15.2	18.5	19.5	20.9	23.4
Final Average Pounds	0.81	0.63	0.77	0.68	0.63	1.32

* Cost of fertilizer and feed per pound live weight of channel catfish produced. Fertilizer cost $2.00 per acre per application, and the cost of the feed was 5.5 cents per pound for dry meal, and 6 cents per pound for pellets.

The differences above are principally due to the long period of low water temperatures during the winter months. During this period, the channel catfish grew at a very slow rate, or failed to grow at all. However, a certain amount of feed was necessary to maintain weight.

It is probable that cheaper production and lower S values would be obtained with fall stocking if the ponds were fertilized only during the fall months and feedings were delayed until the following spring. Further experimentation will be necessary to develop more efficient methods of management for fall-stocked ponds.

Cheapest production can apparently be obtained by holding the fingerling catfish in holding ponds over winter, and stocking them into the commercial production ponds the following March.

EFFECT OF RATES OF STOCKING

The production of channel catfish per acre and the gain in pounds per acre per day rose with increasing rates of stocking from 1,000 to 5,000 (Table IV). The summarized results per acre from ponds stocked in the spring and receiving pelleted feeds were as follows:

Catfish Stocked Number	*Net Production Pounds*	*Avg. Gain Lbs./A/Day*	*Days in Experiment*	*Avg. Size Catfish Pounds*
1,000	955.9	3.5	273	1.02
2,000	1,516.2	5.8	259	0.96
3,000	2,347.6	9.3	252	0.82
3,000	1,607.6	8.6	188	0.56
4,000	1,798.4	10.0	188	0.46
5,000	2,003.6	10.6	188	0.43

As the rates of stocking increased, the average sizes of the harvested catfish decreased. They could, however, have been grown to a somewhat larger size by increasing the number of days before harvest.

The most profitable rate of stocking will depend upon the cost of the fingerling fish and the cost of processing the various numbers of fish for market. It costs about the same amount to dress a 0.2-pound fish and a 1-pound fish; thus, the cost of dressing per pound of small fish is proportionally greater than the cost for large fish.

EFFECT OF THE PRESENCE OF TADPOLES AND WILD FISH ON CHANNEL CATFISH PRODUCTION

In most commercial and experimental ponds, it is practically impossible to keep tadpoles or unwanted species of fishes from gaining entrance to the ponds. To minimize trouble from these species, the ponds were all poisoned with 2 p.p.m. Noxfish before they were stocked. The water ran through gravel filters before entering the ponds. In spite of these precautions, the pounds of wild fishes found upon draining the ponds varied from 0 to 344 pounds per acre. The spring-stocked ponds averaged 68.3 pounds wild fish per acre, whereas the fall-stocked ponds averaged 164.3 pounds.

In addition to the wild fish, thousands of tadpoles were present in the spring and summer months in some ponds and were absent in others. The channel catfish was found to feed on an occasional tadpole, but these were not important in their diet. Thousands of tadpoles grew rapidly on the supplemental fish feed, transformed to adults and left the ponds. There was, however, no clear-cut reduction in channel catfish production or in the S conversion values in ponds containing the heaviest tadpole production. Further experimentation will be needed to clarify the effect of tadpoles on catfish production.

The presence of wild fishes, however, did reduce channel catfish production and increased the S conversion values.

Stocking largemouth bass in commercial channel catfish ponds is a possible method of controlling both wild fish and tadpoles. In pond F-5 (Table V) 100 largemouth bass were stocked with the catfish. The survival of bass was 96 percent and 18.2 pounds was produced per acre. At draining there was only 2.4 pounds wild fish per acre remaining. In this case, the rate of stocking was too high to produce harvestable bass. Probably 50 per acre would be sufficient, and this would give larger bass. It is probable that a considerable market for these bass could be developed for use in correcting overcrowded bluegill populations.

LOSS ON DRESSING AND COST OF DRESSING

Little market could be found for the sale of live fish, and it was thus necessary to dress and pack the fish for sale.

In dressing, spring-harvested channel cats lost from 43 to 45 percent of their live weight, whereas fall-harvested cats lost 38.5 to 41 percent. This difference was probably due to the presence of eggs in some catfish harvested in the spring.

In dressing, the fish were skinned, and the heads and entrails were removed. The fish were then washed and packed in plastic bags. Records were kept on cost of labor for dressing and packaging 1,952 channel catfish weighing 1,222 pounds live weight. The dressed weight was 751.9 pounds (61.5 percent), and 84.5 manhours were required. At a cost of 50 cents per hour, the labor costs of dressing and packaging were:

Per Fish	2.16 cents
Per Pound Live Weight	3.46 cents
Per Pound Dressed Weight	5.7 cents

RETURNS PER ACRE

The dressed and packaged fish were frozen and held until sold. They were sold on a sliding scale from 50 to 65 cents per pound, varying with the amount purchased.

The average cost of feed and fertilizer to produce 1 pound live weight of channel catfish in the spring-stocked experiments was 11.7 cents. The loss on dressing (40 percent) brings this to 19.5 cents per pound of dressed fish. Adding 5.7 cents for labor of dressing plus 0.2 cent for the package and packing, brings the cost to 25.4 cents per pound of packaged fish. When sold at 55 cents, the return to the grower for capital and other costs would be 29.6 cents. At a stocking rate of 2,000 fish, approximately 900 pounds of packaged fish per acre were obtained. This would give a return of $266.40 per acre. Since these other costs would include cost of the fingerling fish for stocking, it is evident that these must be available to the grower at low cost if he is to realize a profit on commercial channel catfish production.

The return from the fall-stocked fish at 2,000 per acre would be only 17.8 cents per pound of packaged fish, or approximately $140.00 per acre to cover capital and other costs, based on the average production figures reported in Table IV. Further experimentation, however, should result in savings in costs of production.

The returns per acre from the production of channel catfish may be expected to be rather variable until various management problems are solved by research. The most important problem in the establishment of a channel catfish industry is how to produce fingerling channel catfish in large numbers at a low price for stocking.

SUMMARY

Gill flukes and other external parasites were controlled on fingerling channel catfish by treatment with 4 p.p.m. potassium permanganate for 1 hour and with 15 p.p.m. formalin for 5 to 10 hours. Tapeworms and other intestinal parasites were controlled by use of feed containing 0.3 percent di-n-butyl tin oxide. The medicated feed was fed at 3 percent of the body weight of the fish each day for 3 days. Spread of disease during transportation and handling was reduced by holding the fish in 1 p.p.m. acriflavine.

It was suggested that feed conversion values where supplemental feeding is practiced in ponds be designated by the letter S, where:

$$S = \frac{\text{Pounds feed supplied}}{\text{Total pounds of the stocked fish produced in the pond}}$$

with no correction applied for the pounds of fish that might have been produced without feeding, and no correction for the presence of wild fish. The C conversion, then would be used only where natural feeds and competing species were absent or proper corrections had been made in the production figures for their presence.

Dry mixed feeds, designated as Auburn No. 1 and No. 2 fish feeds were used. Pelleting the dry feed resulted in more efficient usage, gave higher production, and resulted in less pollution of the water.

A tentative sliding scale of rates of feeding for production ponds was developed based on the estimated pounds of catfish present. Estimates were made monthly from seining samples and the rates of feeding readjusted when necessary.

Feeding was discontinued in the production ponds when water temperatures fell below 60° F. The main growing period for channel catfish was during the period when water temperatures remained above 70° F.

Fingerling channel catfish stocked in the spring grew to marketable size in an average of 228 days and gave an average S conversion of 1.87. Fall-stocked fingerlings required an average of 394 days to grow to marketable size, with an average S conversion of 3.0.

Rates of stocking were varied from 1,000 to 5,000 fingerling catfish per acre. The gain in pounds per acre per day and the total production per acre increased with increasing rates of stocking, while average size of the catfish at harvest decreased. The maximum production of 2,343 pounds per acre in a 252-day experiment was obtained from a stocking of 2,000 fingerlings. The maximum production of 2,003 pounds catfish per acre in a 188-day experiment was obtained with a stocking rate of 5,000 fingerlings.

The presence of wild fish decreased the production of channel catfish and resulted in high S conversion values, with correspondingly increased costs per pound of catfish produced.

Loss on dressing catfish harvested in the spring was from 43 to 45 percent, and the loss on fall-harvested fish was from 39.5 to 41 percent. Labor costs of dressing and packing, at 50 cents per hour for labor, averaged 2.16 cents per fish. Where sold at 55 cents per pound of packaged fish, and subtracting the cost of feed, fertilization, and the labor of dressing and packing, the return for spring-stocked fish was $266.40 per acre for capital and other costs of produc-

tion. These other costs includes the costs of the fingerling fish required for stocking. Fall stocking yielded a comparable $240.00 per acre.

The most important problem in the establishment of a commercial channel catfish industry is how to produce large numbers of fingerling channel catfish for stocking at a low price.

LENGTH AT MATURITY OF CHANNEL CATFISH (Ictalurus lacustris) IN LOUISIANA

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INTRODUCTION

Many fisheries biologists are faced with the problem of recommending mesh sizes and nets for the control of commercial fish. As the size of fish to be caught is directly proportional to the mesh size, the length of a fish at maturity is an important factor. If the harvest of commercial fish is to be perpetuated large numbers of immature fish must escape the nets to spawn. Conversely, if the mesh size is too large the crop will be inadequately harvested.

During the spring of 1956 and 1957, a large number of channel catfish were examined at fish markets within the State of Louisiana. In addition catches of channel catfish in commercial gear used by Dingell-Johnson Project F-5-R were also examined. Fish were taken from these bodies of water: Mississippi River, Ouachita River, Atchafalaya River, Eagle Lake, Lake Providence, and Lake Bruin. The data presented below are a composite of samples from all of these areas.

MATERIALS AND METHODS

Fish were taken by gill nets, trammel nets, hoop nets, wire traps and trot lines. No attempt was made to differentiate between the sizes of fish taken with different gear.

Each specimen was measured (total length to the closest tenth inch) and weighed (in pounds and tenths). The fish were carefully examined to determine their sex and gonadal development. The classification of degree of maturity was somewhat arbitrary and was set up to meet the circumstances at hand.

Field classification was into five groups: Immature, undeveloped, developing, ripe, and spent. For the purposes of this paper only two classifications will be used: Undeveloped and Mature.

"Undeveloped" includes all immature fish and those mature fish which would not spawn during the year examined. In the former the gonads show no signs of development, the ovaries are seen to be present only upon close examination and the testis is barely distinguishable. In the latter field classification, undeveloped, the ovaries and testis are readily distinguishable but show no expansion of sperm or ovum cells.

"Mature" contains the three field classification of developing, ripe and spent. Careful checks with field personnel indicated that this field classification of males was particularly hard. Therefore the "mature" classification includes all fish in which the ovaries or testis are fully swollen and developed. All of the fish spawned or would have spawned during the present season. As examinations were made during the spring this classification of mature was considered very accurate.

RESULTS

The data at hand show fairly well the length of fish as they reach sexual maturity. The majority of females taken in the study were mature at 10.5 through 11 inches. Males apparently matured a bit later at 12.0 through 12.5 inches in length.

There is considerable overlap in the lengths of undeveloped and mature fish. One female was found to be ripe at seven inches in length while another at 15.5 inches showed no signs of development. For males the overlap was equally as