CONCLUSIONS

1. Added salinity (1,300 ppm + 200 ppm chlorides) appeared to have contributed to fry survival.
2. Fry survival in the control and added hardness treatments appeared to be dependent on the fry groups rather than on the effects of the treatments.
3. Survival of Cooper River fry appeared to be more variable in water with added hardness of 150 ppm + 25 ppm as $CaCO^3$. Survival of Cooper River fry in the added hardness treatment seemed to be related to parental attributes. Savannah River fry survival was more variable in control water with total hardness of 30 to 40 ppm as $CaCO^3$.
4. The effects of added hardness and added salinity treatments on Savannah River fry survival were similar.

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WINTER FEEDING OF CHANNEL CATFISH

by

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ABSTRACT

On November 24, 1973, pound-size channel catfish, which had previously been fed intensively for 6 months, were weighed and measured and placed back into nine 1/10-acre earthen ponds at the rate of 2,000 per acre. The fish were managed through the winter until the following March 4 on one of three feeding regimes; no feeding; feeding 1% of fish weight on alternate days; and feeding 1% of fish weight only on "warm" days or when water temperature at a 3-foot depth was above 54 F. Fish not fed lost 9% of their weight during the 100-day over-winter period, those fed on alternate days received feed on 51 days and gained 23%, and those fed on the "warm" days received feed on 52 days and gained 19%. Condition factors increased for both groups of fed fish but decreased for the nonfed fish. Length increased slightly for all groups. Although the nonfed fish lost weight, they had the highest percentage of body fat indicating that a significant amount of tissue protein was degraded for energy needs.

INTRODUCTION

Fish culturists limit or restrict feeding of catfish in ponds during the winter. Because a fish's metabolism is a function of temperature, channel catfish grown in temperate regions do not feed as much or as consistently in the cool weather months as during the warm season. Catfish farmers in the United States usually follow a facsimile of one of the following feeding regimes for fish held in ponds overwinter: 1) discontinue feeding when water temperature decreases to a designated level in the fall and resume feeding the following spring; 2) feed only on "warm" days during the cool weather season; or, 3) feed regularly but at a reduced daily allowance.

The most economical feeding program for channel catfish that are held in ponds for a part or for the entire duration of the cool weather season is of great concern to the catfish farmer. To date, no research data are available for comparing weight change, feed conversion or body composition of catfish on various overwinter feeding regimes.

This study was designed to evaluate changes in weight, condition factor, and body composition, and in feed utilization by channel catfish weighing approximately one pound that were held overwinter in earthen ponds at densities of 2,000 fish per acre under one of three feeding regimes. The feed allocations were: 1) no feed; 2) an allowance of 1% of fish weight on alternate days; and 3) an allowance of 1% of fish weight only on "warm" days, or when water temperature at 3-ft depth was above 54 F.

METHODS

The channel catfish used in the overwinter study had previously been fed a high quality feed in earthen ponds for six months during the warm season of the year. Immediately after harvest, on November 24, 1973, 1,800 of the fish weighing near 1 pound each were uniformly selected and stocked in nine 1/10-acre earthen ponds at densities of 200 fish per pond. The experimental ponds contained no fish at the time of stocking, but had been drained on September 15, refilled, and fertilized at two week intervals through November 1.

Then fish from the same source, and of similar size as the experimental fish, were randomly selected for determination of initial body composition. Fifty fish from each of the nine ponds were selected at random and individually weighed and measured to determine the initial condition factor.

The fish in three of the ponds were not fed during the overwinter period from November 24 until the following March 4. In three other ponds, the fish were fed at the rate of 1% of their weight on alternate days which was presumed to be the amount necessary to maintain the weight of the fish during the cool weather period (Swingle, 1958). The remaining three ponds were fed at a rate equal to 1% of their weight only on days when the water temperature was above 54 F at a depth of 3 feet. Previous data from two years of continuous temperature monitoring indicated that 54.5 F was the median temperature at 3-ft depth in 1/10-acre earthen ponds at the Auburn Fisheries Research Unit during the period November 20 through March 15. Thus, it was anticipated that during this experimental period there would be approximately as many days when the water temperature would be above 54 F as there would be 54 F or below. Since water temperature would be the determinant for the feeding schedule, the fish on this feeding regime should be fed about the same number of days as those fed on alternate days.

Temperature was measured daily of the air and at depths of 6 inches and 3 feet in the ponds. Fish from each pond were sampled monthly for weight estimates to adjust feed allowances.

The feed was a 3/16-inch diameter pelleted formulation containing 1,200 kcal of metabolizable energy (estimated from livestock feeding tables) and 35% protein with 1/6 of the protein being supplied by fish meal.

On March 4, following stocking, the ponds were drained and the number and total weight of fish in each were measured. Fifty fish from each pond were randomly collected for determination of individual length and weight, and five fish from each pond were randomly selected for flavor and body composition analysis.

RESULTS

The fish receiving no feed were in generally good condition with 98% survival. The survival percentage for all fish in the experiment was 98.5.

Table 1 shows weight changes and feed conversions for the experimental fish. The fish receiving no feed lost 9.08% of their original weight. Those fed on alternate days had an overall average weight increase of 23.5% as compared to an average weight gain of 18.60% by the fish fed almost an equal amount of feed but only on the "warm" days. The difference between the average gains for the two fed groups of fish was not significant at a probability level of 5%. (The difference in average weight gains between the two treatments is due largely to the unusually large gains by fish in pond 17).

The data indicate that winter feeding of marketable size channel catfish in Alabama resulted in significant growth responses by the fish. However, conditions different from those of this experiment could effect different responses. For example, feed utilization during the winter may be poorer in larger ponds because the fish are not confined to a small, known area of the pond, as they are in 1/10-acre ponds where feed can be made easily accessable to the fish. Also, in wide, shallow ponds where wind action mixes the water readily, there would be more pronounced changes in the water temperature than in sheltered ponds where water mixes slower and perhaps greater benefit for restricting the feeding to the "warm" days.

Table 2 provides an economic comparison of the three overwintering systems. Only returns (or losses) above feed costs were considered; other expenses such as labor, interest on money and additional factors encountered in holding fish overwinter were not evaluated. Feed costs were based on the price paid for the fish feed in November, 1973 of $216 per ton and value of the fish was based on processing plant prices in March, 1974 of $.42 per pound. The fish not fed showed an average loss of $95 per acre. Fish fed 1% of their weight on alternate days yielded a return above feed costs of $65 per acre and those fed at the same rate except on the "warm" days earned $14 per acre. Excluding the exceptional gains made by the fish in pond 17 (Table 2), the returns above feed costs would be about equal for the two feeding systems.

Table 1. Weight changes and feed conversions for Channel Catfish managed overwinter in earthen ponds under three feeding regimes[1].

Treatment	Pond number	No. days fed	Ave. wt. per fish (lb) Stocking	Harvest	Gain	Percentage wt. gain	Feed conversion
No feed	6	0	.97	.88	-.094	- 9.69	--
	8		1.06	.96	-.098	- 9.25	--
	9		1.17	1.07	-.096	- 8.29	--
	Mean		1.07	.97	-.096	- 9.08a	
Feeding on alternate days	17	51	.82	1.15	.327	39.80	1.55
	22		1.05	1.18	.130	12.38	4.21
	25		.89	1.07	.182	20.45	2.65
	Mean		.92	1.12	.213	23.15b	2.80
Feeding on warm days	10	52	.86	1.01	.155	18.02	3.87
	11		1.06	1.23	.180	16.98	4.18
	12		.97	1.17	.202	20.82	2.73
	Mean		.96	1.14	.179	18.60b	3.59

[1]Treatment means with the same superscript are not statistically different at $P < .05$.

Table 2. Returns above feed costs for overwintering harvestable size Channel Catfish in earthen ponds under three feeding regimes.

Treatment	Pond No.	Total gain per acre (lb)	Value of gain[1] ($)	Cost of feed[2] ($)	Return above feed cost per acre ($)	Net benefit of overwinter feeding[3] ($)
No feeding	6	-223	- 98	0	- 93	--
	8	-206	- 87	0	- 87	--
	9	-249	-105	0	-105	--
	Ave.	-226	- 95	0	- 95	
Feeding on alternate days	17	608	255	101	154	249
	22	247	104	112	- 8	87
	25	365	153	104	49	144
	Ave.	407	171	106	65	160
Feeding on warm days	10	270	113	113	0	95
	11	274	115	123	- 8	87
	12	404	170	119	51	146
	Ave.	316	133	118	14	109

[1]Value of fish, $.42 per pound, March, 1974.
[2]Feed cost, $.108 per pound, November, 1973.
[3]Return above feed cost minus the average loss from not feeding.

The net benefit of feeding fish overwinter is based on the economic difference between feeding and not feeding, or, the profit shown by the fed fish minus the loss of the nonfed fish. The values shown in Table 2 indicate a substantial net benefit, in the ponds at the Auburn Fishery Research Unit, from feeding catfish overwinter at a rate of 1% of fish weight on alternate days or on days when the water temperature is above the median (or average) winter water temperature. It should be pointed out that feed and fish prices will significantly influence the economic feasibility of holding catfish overwinter. Also, the additional costs associated with holding catfish overwinter, whether fed or not, must be considered.

The condition of the nonfed fish deteriorated overwinter wheras that of the two fed groups actually improved (Table 3). Condition factors (CF) for 50 individual fish from each pond of 200 were based upon length and weight measurements and calculated from the formula:

$$CF = \frac{WT \times 10^5}{LN^3}$$

Table 3. Changes in condition factor and length of Channel Catfish managed overwinter in earthen ponds under three feeding regimes.

Treatment	Pond No.	Condition factor: Stocking	Condition factor: Harvest	Probability test	Length change (cm)	Probability test
No feed	6	966	820		+ .01	
	8	957	842		+1.37	
	9	932	873		+ .50	
	Ave.	952	845	$P<.01$	+ .63	$P<.05$
Feeding on alternate days	17	831	1142		+ .67	
	22	859	990		+ .22	
	25	865	960		+1.21	
	Ave.	852	1031	$P<.01$	+ .70	$P<.05$
Feeding on warm days	10	900	90$		+ .'0	
	11	871	948		+1.45	
	12	962	955		+1.17	
	Ave.	911	935	$P<.01$	+1.17	$P<.01$

All treatment groups showed statistically significant ($P \leq .01$) changes in condition overwinter. The fish fed on alternate days increased their weight in proportion to length more than did the other fed group of fish.

All treatment groups showed increases in length. The length increase in the nonfed fish, which lost weight, is not easy to understand. Perhaps the fish made some growth soon after they were placed in the overwintering ponds from available natural food, then ceased growing and subsequently lost weight during the late winter. Nichelson and Larson (1974) reported that weight loss of starved cutthroat trout was accompanied by a decrease in length; however, they found that only a small percentage of the fish showed length reduction at the lower water temperature.

The weight increases by the two groups of fed fish represented appreciable muscle growth, as indicated by the high percentage of protein in the fish carcasses (Table 4). The nonfed fish had the lowest percentage of protein and highest percentage of fat in their carcasses. This is indeed difficult to evaluate in view of their overwinter weight loss. The body composition of this group was more similar to that of the fish in the fall when the ponds were stocked, than were the body protein and fat contents of the groups of fed fish. These data present strong evidence that during cool weather, fasting catfish catabolize body protein for their metabolic energy needs in preference to, or with the same affinity as, depot fat.

Dressing percentage was not statistically ($P < .05$) different among the three overwintered groups of fish (Table 4). Taste evaluations indicated that all fish had satisfactory flavor.

Table 4. Dressing percentage and carcass composition of Channel Catfish managed overwinter in earthen ponds under three feeding regimes[1].

Treatment	Pond No.	Dressing percentage[2]	Carcass composition[2] Protein	Fat
No feed	6	59.2	15.71	11.41
	8	59.3	16.35	9.32
	9	60.9	15.09	9.43
	Mean	59.8a	15.71a	10.06a
Feeding on alternate days	17	60.4	17.51	7.70
	22	61.3	18.97	7.57
	25	60.9	17.57	9.27
	Mean	60.9a	18.02b	8.18b
Feeding on warm days	10	61.2	17.05	8.18
	11	61.4	17.12	8.62
	12	61.0	17.55	10.18
	Mean	61.2a	17.24b	8.99b

[1]Treatnent means with the same superscript are not statistically different at $P < .05$.

[2]Five fish from each pond were collected for determination of dressing percentage and carcass composition.

Table 5 shows that the anticipated median temperature in the winter of 1973-74 of 54 F, based on the median temperature for the winter of 1951-52, proved to be an accurate approximation for alloting feed to fish on approximately one-half of the days. The fish fed on alternate days received feed on 51 days during the experiment whereas those fed when the temperature was above 54 F received feed on 52 days.

Table 5. Median and range of daily temperature in 1/10-acre earthen ponds, measured at 3 pm, from November 24 to March 4 in 1951-52 and 1973-74 at the Auburn University Agricultural Experiment Station.

Year	Criterion	Temperature, ° F		
		Air	Water, 6 inches	Water, 3 feet
1973-74	Range	37.4-78.8	44.6-69.8	41.0-66.6
	Median	61.1	57.5	54.5
1951-52[1]	Range	39.5-76.5	46.0-74.0	46.0-64.5
	Median	60.9	57.8	54.5

CONCLUSION

The data from this experiment indicate that in Alabama when marketable size channel catfish are held in ponds overwinter (approximately mid-November until the following mid-March) without supplemental feeding, the fish will lose 9 or 10% of their weight but maintain satisfactory appearance, flavor and dressing percentage. In 1/10-acre ponds, feeding at the rate of 1% of the fish weight either on alternate days or on days when water temperature at 3-ft depth was above 54 F resulted in approximately 20% weight increase during this period. Larger ponds or larger quantities of feed could effect significantly different responses from overwintered channel catfish, and should be evaluated.

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