Pond and Cage Culture of Channel Catfish in Virginia

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ABSTRACT

Experimental pond and cage culture of channel catfish *(Ictalurus punctatue)* (1970 and 1971) were used to predict if marketable-size (>340 g) fish could be successfully grown in existing south-central and western Virginia ponds in one growing season. Results from pond culture experiments indicate that marketable-size channel catfish can be raised in one growing season if the initial stocking size is at least 150 mm. Cage culture showed promise as a catfish rearing method, but several problems were encountered. Most fish did not reach marketable size in one growing season partly because they were less than 150 mm when stocked. The lack of a nutritionally-complete feed hindered growth in 1970, but this problem appeared to be solved in the 1971 growing season with the use of Purina Cage Catfish Chow. Low dissolved oxygen and poor quality cages were other problems. Although this work is experimental, it is probable that marketable-size catfish can be grown in the piedmont region of Virginia using cages.

INTRODUCTION

Farm ponds have been used to culture channel catfish in the southern United States for many years. Recently, many land owners have been converting idle or unproductive crop land into catfish rearing ponds in addition to using existing ponds. As a result annual catfish production has risen from 12,500,000 kg in 1968 to 35,400,000 kg in 1972. Reports of successful catfish operations have led many farmers outside catfish-producing states to seriously consider channel catfish as a supplemental cash crop.

Currently, there is no commercial production of pond or cage cultured channel catfish in Virginia, and relatively limited production occurs in adjacent states. However, channel catfish might be easily raised in existing irrigation ponds at a relatively low cost, and farmers could benefit from the extra income catfish farming could bring. Use of cage culture in some of these ponds might be especially advantageous because harvest is often difficult due to bottom irregularities and lack of drainage facilities.

Various biological and physical factors must be considered before commercial channel catfish production in Virginia is attempted. Therefore, experimental research on pond and cage culture of channel catfish was conducted for two growing seasons (1970 and 1971). The objectives were: (1) to determine whether marketable-size catfish can be produced by the pond or cage culture method in one growing season; (2) to determine the growth rate of channel catfish in Virginia; (3) to determine the effects of pond location (elevation) on the growth rate of channel catfish; and (4) to determine the optimum stocking size for cage production.

METHODS

Several ponds were selected in order to compare results from different elevations for the 1970 growing season. Four ponds were stocked with channel catfish fingerlings in October and November, 1969. Farmer and Dalton Ponds were located in Pittsylvania County at elevations of 255 m and 225 m respectively. Hoge Pond (elevation 580 m) was located in Montgomery County and McGinnes Pond was situated in Giles County at an elevation of 700 m. Two of the ponds selected for the 1970 experiments (Farmer and Dalton) were also used for cage culture studies. The third pond used for cage culture (Kessinger) was located in Montgomery County in the montane region at an altitude of 605 m, nearly three times that of the other two ponds. All ponds were approximately 0.5 ha in surface area. Cages used in the 1970 experiments measured 2.7 x 1.2 x 1.1 m and were covered with 6.4 mm mesh nylon. Stocking rates varied between cages and ponds.

Three ponds were used during the 1971 growing season and were stocked in November, 1970. Dalton and Farmer Ponds were used again and Salem Pond (elevation 315 m), Roanoke County, was added. In 1971, cages were tested only in Dalton and Farmer Ponds. Three of the five cages used were built with an internal partition, forming two cages, each 0.9 x 1.2 x 1.0 m. Cages were covered with 12.7 mm mesh hardware cloth. Each section was considered to be one cage. The remaining two cages were commercially manufactured, measured 0.9 x 1.2 x 1.1 m, and were covered with 12.7 mm mesh galvanized wire. The two manufactured cages were used in Dalton Pond and the other three in Farmer Pond.

In 1970, fingerlings were stocked in cages in the piedmont ponds in June and in the montane pond in July. Average fingerling weight in 1970 was about 60 g, but individuals varied greatly. In March, 1971, fingerlings were stocked in all cages, averaged approximately 20 g, and varied between 5 and 90 g.

Feeding in all ponds in 1970 was done manually six days per week using Purina Floating Catfish Chow. The fish in the ponds were fed by broadcasting the feed for up to thirty minutes or for as long as the fish continued to feed. The caged fish were fed by simply placing into the cage as much food as the fish would consume. During 1971, feeding in Dalton and Farmer Ponds was done in the same manner as 1970, but at Salem Pond, food was distributed twice daily.

Sampling during 1970 entailed taking initial weight and length measurements on approximately 100 fish at the time of stocking. A total count and weight were recorded for all harvested fish. Sampling during 1971 to determine growth rates for the pond cultured fish was accomplished by angling in the ponds with non-selective artificial lures. Harvest sampling was conducted in the same manner as in 1970.

Results

Catfish fingerlings used for the pond experiments began feeding in early May in Dalton and Farmer Ponds and were feeding in Hoge Pond by late June, 1970. (See Table 1). Food was offered to the fish in Hoge Pond early in May, but they did not feed actively until June when the water temperature reached 26°C. Catfish in McGinnes Pond winterkilled, apparently due to low water levels and lack of natural food.

Water temperature (see Table 2) was an important factor in food consumption. Generally, the amount of feed used per month in all ponds varied with water temperature. As water temperatures increased, feed consumption increased. With lower water temperatures feed consumption decreased (see Figure 1 and Table 2). Growth rates of the fish in Farmer and Dalton Ponds showed substantial increases throughout the growing season, while the fish in Hoge Pond gained weight slowly due to lower water temperature and the greater elevation (see Figure 2).

Ponds were harvested in late October and early November, 1970. Harvested fish varied considerably in size, with some fish reaching 800 g while others were below 100 g. The percentage of marketable fish was highest in Dalton ond Pand lowest in Hoge Pond (see Table 3.)

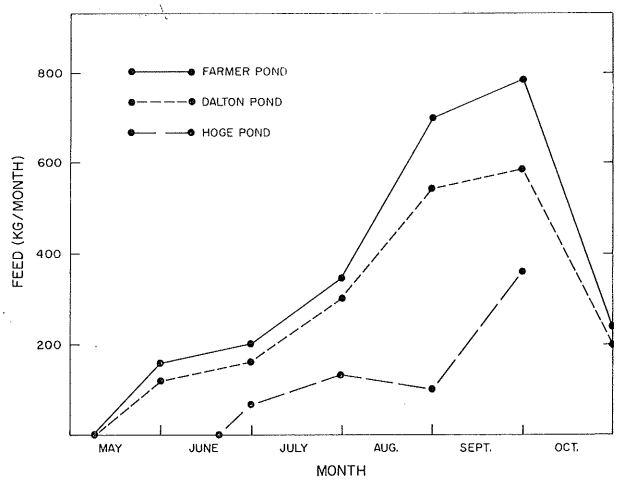

FIG. 1: *Amount of feed provided to channel catfish in three Virginia farm ponds (1970)*

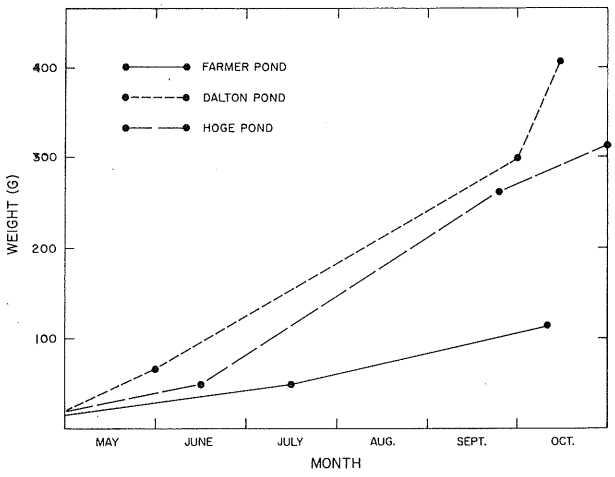

FIG. 2: *Growth of channel catfish in three Virginia farm ponds (1970)*

TABLE 1: *Experimental pond culture of channel catfish in Virginia ponds during 1970 and 1971*

Year	Pond	Elevation (m)	Stocking Rate	Total Food Used (kg)	Days Fed	Average Wt. (g)	Conversion Rate	Gain/ Acre(kg)	Recovery (%)
1970	Dalton	225	5,000 (7,200/ha)	1845	138	375	1.76	700	75.5
	Farmer	255	5,000 (7,200/ha)	2330	141	335	1.77	875	82.6
	Hoge	580	6,000 (6,000/ha)	660	83	140	1.41	230	75.5
	McGinnes	700	5,000 (7,200/ha)	W	W	W	W	W	W
1971	Dalton	225	3,000 (4,400/ha)	1135	171	281	3.06	—	44.3
	Farmer	255	3,000 (4,400/ha)	1415	171	165	6.90	—	41.4
	Salem	315	6,000 (4,288/ha)	1645	170	301	2.00	—	45.3

W = Winterkilled

TABLE 2: *Average monthly temperature (Centigrade) in Virginia ponds used for cage and pond culture**

Year	Pond	Month						
		April	May	June	July	August	September	October
1970	Dalton	19.0	23.5	27.5	27.0	27.0	26.5	20.5
	Farmer	19.0	24.5	27.5	27.5	27.0	26.5	20.5
	Hoge	—	—	26.0	26.0	24.0	24.5	—
	Kessinger	—	—	—	23.5	22.5	23.0	—
1971	Dalton	16.0	18.5	24.5	28.0	26.0	24.5	—
	Farmer	15.5	18.5	23.5	26.5	25.5	23.5	18.5
	Salem	—	—	20.0	26.0	24.5	23.0	20.0

* Temperatures were recorded at one meter depth.

TABLE 3: *Percentage of channel catfish in five weight classes from experimental pond culture, 1970 and 1971*

Pond	Year	Weight classes in grams (%)				
		0-115	115-230	230-340	340-450	>450
Dalton	1970	7.3	33.9	19.7	20.3	18.7
	1971	0.6	25.7	48.3	18.9	6.4
Farmer	1970	9.7	45.4	28.3	13.4	3.1
	1971	19.2	59.0	8.1	4.4	9.2
Hoge	1970	38.7	39.3	17.0	5.0	0.0
Salem	1971	0.4	30.9	30.9	19.1	18.8
MEAN		12.6	39.0	25.4	13.5	9.4

In 1970 catfish in two cages were lost when the nylon mesh detiorated (see Table 4). The fish in the other three cages suffered a total mortality from oxygen depletion. However, food conversion rates and average final weights were determined for these caged fish as soon as the fishkill was discovered. Food conversion rates were similar among all cages, but final weight were significantly higher (t test $a = 0.05$) in the piedmont (Dalton) than the montane pond (Kessinger). Final average weights were not especially impressive, but there was a large size range, with the heaviest fish reaching 400 g.

In 1971 *Chondrococcus columnaris*, a bacterial infection, was detected in all three ponds. Salem Pond was treated with 1.5 mg/1 copper sulfate, which was broadcast over the surface of the pond. The treatment proved effective in decreasing the mortality rate. A large number of fish were infected in Farmer and Dalton Ponds and cages, but were not treated due to neutral pH and low water hardness.

The overall monthly feed consumption during 1971 again increased with temperature. With the occurrence of low water temperatures, total feed consumption decreased in all ponds (see Figure 3).

TABLE 4: *Results of channel catfish cage culture in three Virginia ponds*

Year	Pond	Elevation (m)	Days Fed	Stocking Density/Cage	Survival	Conversion Rate	Av. Final Weight (g)
1970	Dalton	225	96[a]	500	.99	2.28	161
			96[a]	500	.96	2.50	139
	Farmer	255	53[b]	350	—	—	—
	Kessinger	605	47[b]	350	—	—	—
			47[a]	350	.20	2.18	71
1971	Dalton	225	222	200	.74	2.31	232
				250	.78	2.56	187
				300	.93	2.25	244
				350	.61	1.97	227
	Farmer	255	227	200	.45	5.60	68
				250	.43	6.80	88
				300	.31	2.29	113
				350	.59	3.50	133

a = Complete mortality due to oxygen depletion
b = All fish escaped through deteriorated nylon mesh

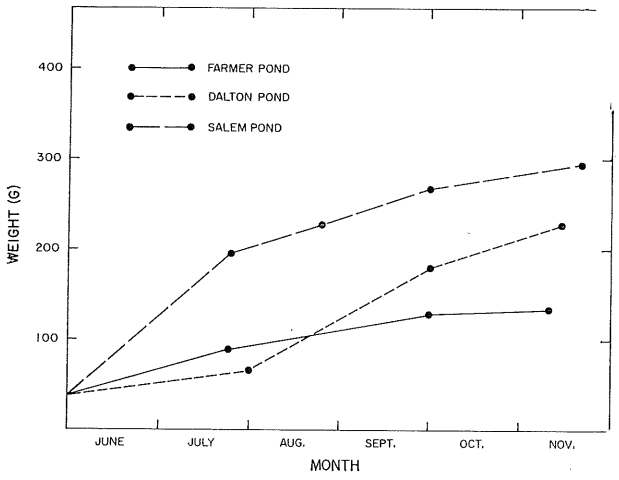

FIG. 4: *Growth of channel catfish in three Virginia farm ponds (1971)*

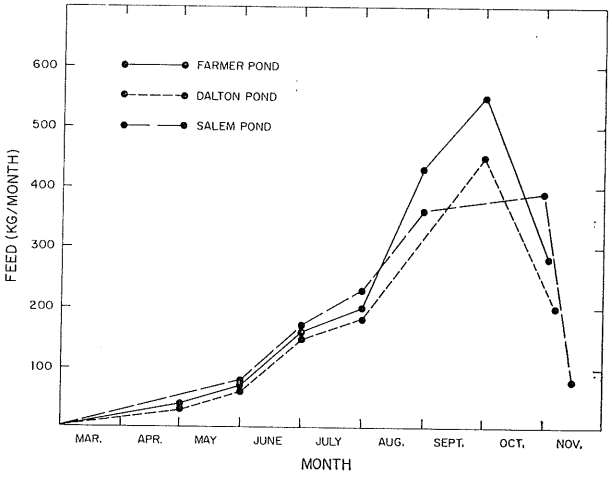

FIG. 3: *Amount of feed provided to channel catfish in three Virginia farm ponds (1971)*

Growth varied considerably between ponds (see Figure 4). The fish in Salem Pond had the fastest growth rates, while those in Farmer Pond had the slowest. This result seems to contradict the fact that at reasonably greater water temperatures growth rate increases, but stress due to the disease in Farmer and Dalton Ponds probably lowered the growth rate. Further, the fish in Salem Pond were fed twice per day which is known to increase growth rate (Collins, 1970).

The 1971 experiments were terminated in late October to early November. The percentage of marketable-size fish decreased in Farmer and Dalton Ponds due to the bacterial infection. The percentage of marketable-size fish in Salem Pond approximated 1970 results from Dalton and Farmer Ponds.

In 1971, high morality occurred in some of the cages. Because of this, a new formulation of Purina Floating Catfish Chow was used starting in July, 1971. Mortality rates decreased after changing to this new feed. A large difference was noted in the final weights of the caged fish in the two ponds. An overall average weight of 222 g was obtained in Dalton cages while an average weight of 100 g was obtained in Farmer cages. Average survival rates were also much higher in Dalton cages (76 per cent) than Farmer cages (44 per cent).

Better growth was obtained in Dalton cages (see Table 5). The percentage of marketable-size fish ($>$ 340 g) in Dalton cages averaged 18.3 per cent. Fish in Farmer Pond did not reach marketable size.

Discussion

The number of feeding days is important in producing a marketable-size ($>$ 340 g) fish in both ponds and cages. In addition, stocking rate, water temperature, and initial size of the fish must be taken into consideration (Schmittou, 1969). During the 1970 growing season, the weight gained by the fish in Farmer and Dalton Ponds compared favorably with Swingle's data (Swingle, 1958). The weight gained by the fish in Hoge Pond did not compare with Swingle's data because of the lower prevailing water temperatures. During 1971 the number of feeding days increased and the stocking rates decreased in Farmer and Dalton Ponds; however, no appreciable differences in weight gains of harvested fish were evident. Elevation appears to affect growth in that it influences water temperature Lower water temperatures and lower growth rates were experienced at higher elevations. However, fish initially 150 mm in length can be grown to a marketable-size in one growing season in the Piedmont region (Dalton and Farmer Ponds) while those in montane region (Hoge Pond) might require two years to attain marketable size.

TABLE 5: *Percentage of catfish in five weight classes cultured in cages, 1971*

		Weight classes in grams				
	Cage	<115	115-225	225-340	340-454	>454
Dalton Pond	A	4.2	43.1	29.2	19.4	4.2
	B	18.3	46.2	20.4	13.9	1.1
	C	5.3	40.8	28.9	11.8	13.2
	D	0.0	50.0	40.4	7.7	1.9
	Mean	6.9	45.0	29.7	13.2	5.1
Farmer Pond	A	80.0	16.9	3.1	0.0	0.0
	B	62.5	35.0	2.5	0.0	0.0
	C	33.3	52.8	13.9	0.0	0.0
	D	48.6	37.1	14.3	0.0	0.0
	Mean	58.3	33.2	8.5	0.0	0.0

An important problem encountered in this study was the size variation of the fingerlings. Hastings (1969) found that catfish grow at a rate commensurate with their initial stocking size; that is, smaller fish grow at a slower rate up to a certain age. The extreme variation in fingerling size may have accounted for the small size of some of the harvested fish. Furthermore, competition for food in the ponds and cages between large and small fish was observed. The smaller fish seemed to obtain less food which probably reduced their growth rate.

The food conversion rate is an indication of the efficiency of converting food to flesh. Food conversion rates obtained in the 1970 segment of the experiment compare favorably with other research. Adrian and McCoy (1971) report that an average food conversion rate for commercially grown channel catfish is 1.90. Conversion rates of the fish in 1971 were poor in two of the three ponds. The fish in Salem Pond were the only ones which had an acceptable food conversion rate. The large numbers of wild fish present in Farmer and Dalton Pond offers a partial explanation for the higher food conversion rates. Hatcher (1969) states that wild fish lower the food conversion efficiency of channel catfish because they compete for food. Salem Pond had a much lower rate, probably due in part, to a smaller wild fish population. Water temperature, influenced by elevation, also affects food conversion rate. At lower temperatures the metabolic rate of the fish is lower resulting in both a lower food conversion rate and growth rate.

The recovery rates in the ponds (1970) were slightly higher than those obtained by commercial producers in Tennessee (S. Teneri, personal communication). The average recovery rates obtained by these producers were from 60 to 70 per cent. The recovery rates in 1971 were poor in all of the ponds due to the bacterial infection.

The major problem limiting the success of caged catfish production in this research was the type of feed used, mesh size, and low dissolved oxygen concentrations in the ponds. Small weight gains and high mortality rates were probably partially attributable to feed limitations. Commercial feed formulated for pond culture, where food could be supplemented with natural items, was not nutritionally-complete for caged fish (B.A. Simco, personal communication).

With the introduction of a new feed type especially designed for use in cages in the summer, 1971, increased fish vigor and decreased mortality, were observed. Over the last three months of the 1971 growing season, impressive weight gains were made by the fish in Dalton Pond. An average of 18.3 per cent of the harvested fish in these cages were over 340 g. These fish undoubtedly represented the larger fish at stocking, since 20 per cent of the stocked fish were 150 mm or longer.

Another factor which contributed to the poor condition of the fish in 1970 was small mesh size. The 6.4 mm mesh restricted the water flow through the cages and lowered the quality of the cage water (Schmittou, 1969). This condition did not occur in 1971 when the larger cage mesh was used. Finally, the complete mortality due to low oxygen may have been due, in part, to the poor condition of the catfish.

Acknowledgements

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