CAGE CULTURE OF CATFISH IN RESERVOIR LAKES[1]

by

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INTRODUCTION

Cage culture of fish refers to that method in which fish stocked at high density are fed in a cage-like enclosure suspended at the surface of a body of water. Cages usually do not extend to the bottom of a body of water except when the cages are placed in shallow streams (Collins, 1970a; Hickling, 1962). Hickling (1962) described a situation in which caged carp in a sewage stream exhibited growth purely as a result of feeding on benthic organisms that drift into the cages.

The culture of fish in cages began in Asia in the early part of this century (Hickling, 1962) and has been studied and applied in other parts of the world only during the past decade or so. Even in Asia the practice of cage culture has been limited because of the unavailability of properly balanced feeds in sufficient quantity. Research on and some commercial production of various species of fishes in cages are currently being done in Japan (Brown, 1969), Thailand (Swingle, *et al.*, 1970), Cambodia, Indonesia, and Java (Hickling, 1962), Russia (Gribanov, *et al.*, 1968), and in the United States (Collins, 1970a, 1970b, 1970c; Lewis, 1969; Schmittou, 1970).

In the United States, three species of catfish have been cultured in cages, the channel, *Ictalurus punctatus* (Rafinesque), the blue, *I. furcatus* (LeSueur), and the white *I. catus* (Linnaeus) (Collins, 1970a; Lewis, 1970; Schmittou, 1970). Lewis cultured caged catfish in strip mine ponds and fish culture ponds, and Schmittou researched this method in fish culture ponds.

The present project was conducted to:

1. Compare the growth rate, feed conversion efficiency, and general adaptability of two species of catfishes, the blue and the channel, when grown in cages in a reservoir lake.
2. Compare the results of growing these two species as single and as mixed populations in cages.
3. Compare the results of feeding caged fish once each day and twice each day.

METHODS AND MATERIALS

This research project was conducted in a 1/10 acre bay on the south side of Lake Beaverfork, a water supply reservoir for the city of Conway, Arkansas. Lake Beaverfork is a relatively clear reservoir lake of approximately 750 acres. The depth of the water in the bay ranged from 4 to 7 feet. The lake was used extensively by persons water skiing, boating and fishing.

Six platforms and 18 cages were constructed according to the design illustrated in Figure 1. The platforms containing the cages were floated and anchored in the 1/10 acre bay. Blue and channel catfish fingerlings were obtained from the state fish hatchery at Lonoke, Arkansas. The fingerlings were graded through a 36/64 grader so that no fish placed in a cage could get through the ½ inch mesh wire. The blue fingerlings averaged 0.6 ounces and 5.5 inches total length and the channel fingerlings averaged 0.5 ounces and

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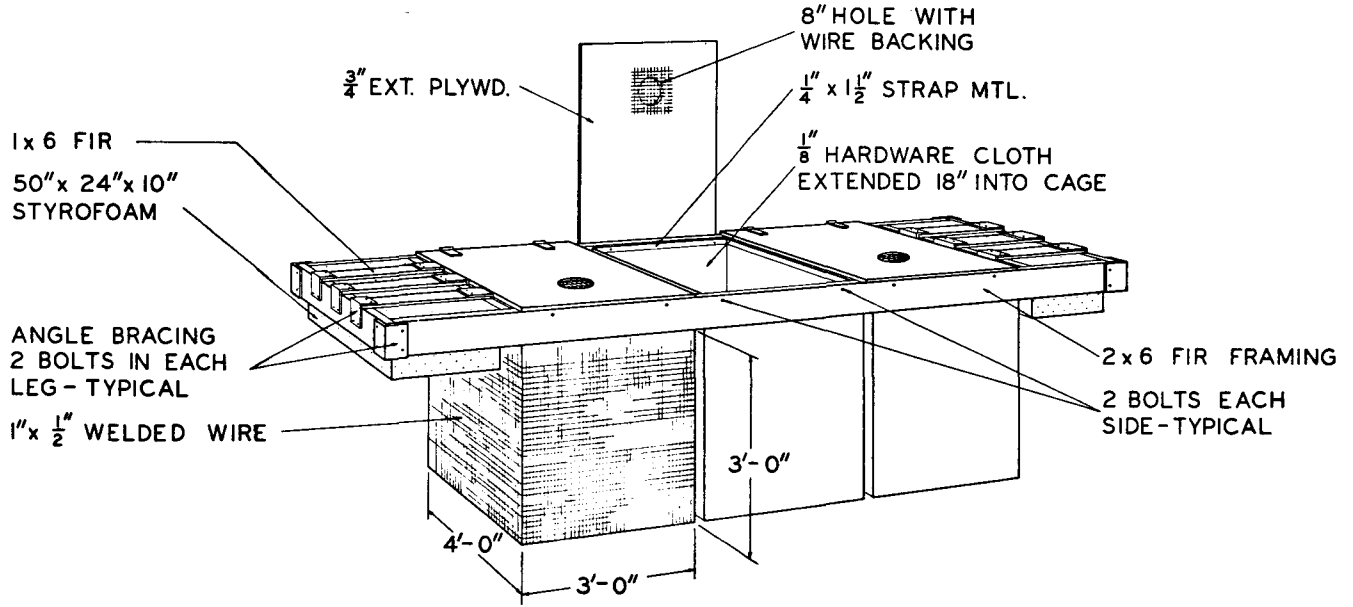

FIGURE 1. Experimental Cages

TABLE 1

DESIGN OF STOCKING CHANNEL AND BLUE CATFISH FINGERLINGS[1] AS SINGLE AND AS MIXED POPULATIONS IN FLOATING CAGES.

ONCE—A—DAY FEEDING			TWICE—A—DAY FEEDING		
Platform No.	Cage No.	Species	Platform No.	Cage No.	Species
	1	Channel		10	Channel
1	2	Mixed-population	4	11	Mixed-population
	3	Blue		12	Blue
	4	Blue		13	Blue
2	5	Channel	5	14	Channel
	6	Mixed-population		15	Mixed-population
	7	Channel		16	Mixed-population
3	8	Blue	6	17	Blue
	9	Mixed-population		18	Channel

[1]The fingerlings were stocked at the rate of 200 per m^3 cage.

5.0 inches. Two hundred fingerlings were placed in each cage according to the design in Table 1.

The fish were stocked June 12, 1969, and feeding records were begun on June 19. Half the fish were fed during the first hour of daylight and all were fed the last hour of daylight each day, six days each week. Purina Trout Chow number 4 was used during the first three weeks of feeding and number 5 was used during the remainder of the experiment. After all cages were fed, some physical conditions of the air and water were determined and recorded, and then each cage was inspected to determine if all the feed had been consumed. Approximately 30 minutes were allowed between feeding and inspection of the cages. If all feed had been consumed in a cage, the amount was then increased at the next feeding. If a small amount of feed remained, then the same quantity was fed at the next time of feeding. If more than an ounce of feed (approximated) remained for two days in succession, then the amount of feed was reduced at the next feeding. This method of feeding allowed for providing all the feed the fish would consume without using an excess, and the quantity of feed could be increased as the fish grew and consumed more.

Samples of the fish were weighed and measured on July 30, and all the fish were harvested and data gathered during the first week in November. At the time of harvest, 1200 of the fish were restocked at the rate of 200 per cage, and these fish were held during the winter.

RESULTS

The fish adapted quickly to feeding in cages. The second day that feed was offered, the majority of the fish fed. The fish adjusted to the fishing and boating activity on the lake and they fed actively each day during the feeding period. The number of days from the beginning to the end of the feeding period was 118, and since the fish were fed only six days each week there were 101 actual feeding days.

The average temperatures (° F.) of the water during the feeding period were as follows: June—84.2, July—90, August—84, September—78.1, first half of October—70.9. During the second week in July, the temperature of the water

attained 95° on four days and the fish fed well on these days. On October 15, a strong northwest wind caused the temperature of the water to drop to 55° and the fish abruptly ceased active feeding. During the week following the sudden drop in temperature, feed was placed in the cage but very little was consumed. Feeding was then discontinued until the fish were harvested.

Even though the blue catfish were larger than the channels when stocked, the channels grew more rapidly and had a greater total weight at the end of the 118 days (Table 2). The channels consistently grew more rapidly than the blues whether they were stocked together or separately. The difference in weights between the channels and blues was greater when they were fed twice each day than when they were fed once each day.

There was no consistent difference in the growth rates of the fish in mixed populations compared to single populations. Likewise, there was no significant difference in conversion rates between the two species regardless whether they were grown as mixed or as single populations (Table 2). The conversion rates ranged from 1.23 to 1.43, with the higher rates being in those cages of fish that had some losses due to disease. The average conversion rate for all fish was 1.32

The blues and channels responded differently to being fed once each day as opposed to twice each day. A summary of data in Table 2 reveals that channels fed twice each day averaged 0.2 pounds more than those fed once each day. However, the blues fed twice each day averaged 0.05 pounds less than those fed once each day. The average conversion rates by the fish were identical between the two feeding regimes.

A growth curve was plotted from the three known average weights; at the time of stocking, when the fish were sampled July 30, and when the fish were harvested during the first week in November. From this curve and known amounts of feed used each day, it was determined how much feed was consumed expressed as a percentage of body weight. During the first two weeks that the fish were fed, the daily amount of feed consumed averaged 11% of their body weight. The amount gradually declined to 2.5% per day during August and averaged 3% during September and October. During the first two weeks of feeding, those fish fed twice each day consumed 11.3% and those fed once each day consumed 10.6%. After the first two weeks, there was no difference in percentage of feed consumed by the fish on the two feeding regimes.

One month after feeding began, a few channel catfish began to die in cages 9 and 18. The dead fish appeared to have suffered from a bacterial disease or parasitic infestation, but by the time the dead fish floated they were too decomposed to determine the cause of death. When the fish were sampled on July 30, some diseased fish were found in cages 1, 9, 16, and 18. The fish were infected with *Aeromonas* sp. The bacterium was sensitive to Terramycin, so the fish were treated with soluble Terramycin. The Terramycin was dissolved in water and sprayed over the feed at the rate of 0.83 gms. of active Terramycin per pound of feed. After feeding the fish for one week with the antibiotic-treated feed, the fish ceased dying and no further disease problem was encountered. Total mortality was 3%, or 164 fish, of which 120 were channels and 44 were blues. In addition to losses to disease, a few fish were lost to snakes and a few were dropped in the lake during sampling.

An interesting aspect of the disease was that only channel catfish seemed to contract it. Cages 1 and 18 contained only channels whereas cages 9 and 16 contained mixed populations. No blue catfish in any cage were found to be suffering from the disease. Generally, blue catfish are more susceptible to diseases than channels, as evidenced by the mortality obtained when blues are cultured in ponds or when they are transported.

During the period of one week after sampling the fishes, the mortality increased significantly, but only in the cages containing diseased fish. Only one non-diseased fish died as a result of handling. All of the fishes appeared to be in

a good state of health and none had any skinned areas or other wounds as a result of abrasion from the wire cages or from fighting.

There was never a measurable difference in dissolved oxygen in a cage compared to outside a cage. The bay in which the cages were located maintained the same level of dissolved oxygen as other similar bays in the lake.

There was a dense population of bluegill and redear sunfishes around the cages and they tended to follow the boat during the time of feeding to feed upon any pellets dropped on the outside of the cages. Catfish were also attracted to the cages and they could be seen feeding upon pellets that the caged fish swept out of the cages.

Sampling the fishes caused them to cease feeding for about three days. A period of two weeks was required before some of the cages of fish resumed feeding to the extent that they had before sampling.

The 1200 fish that were restocked during the first week in November fed only rarely during the winter. It was not possible to determine how much feed was consumed because the fish did not feed on the surface. There was 100% survival of the fish through March 6, 1970, at which time the fish appeared to be healthy and had resumed feeding. The average weight of the fish was one-half ounce less on March 7, than on the previous November 7.

DISCUSSION

Blue and channel catfish occupy different niches in nature, and possibly in still-water culture ponds, and they apparently have no effect on each other when raised as mixed populations in cages. Neither antagonism nor complementation was observed. One explanation for these observed results could be that when fish are crowded in cages, and fed a prepared feed, only one niche results. Since food and oxygen are not limiting factors, there is no competition and each species can attain a growth rate commensurate with its genetic capacity and independent of each other. Apparently then, the channel has an innate capacity to grow more rapidly than the blue during the first two years of life. This difference in growth rate has been observed by others when the blue and channel are grown in ponds.

The rate of food consumption in this experiment indicates that the old "rule-of-thumb" that fish should be fed an amount equal to 3% of their body weight is not the most efficient method of feeding. Fish weighing less than one-fourth of a pound should be fed considerably more than 3% of their body weight. It is obvious that more research is needed to determine the most satisfactory percentages to feed throughout a growing season.

The apparent inability of blues to effectively utilize two feedings each day, whereas the channels can, cannot be readily explained. One can only assume that the distinction is an inherent difference between the two species.

After the fish attained one-half pound and more, their feeding activity caused a loss of a considerable amount of feed. As a result of the feed loss, future cages should contain a feeding well similar to the one illustrated in the commercial cage design (Figure 2). If feed is swirled out of a feeding well, most of it will remain inside a cage where the fish can still feed upon it. In the case of a cage designed as those in Figure 1, when feed is swept outside the retainer screen it is lost because the fish gathered around the outside of a cage consume every pellet.

The survival of caged fish through the winter should be of importance to anyone with a commercial operation. Harvesting fish from large ponds always presents a problem in that handling and utilizing large quantities of fish in a short period is difficult. Since caged fish can survive an entire winter, the fish can be harvested a few at a time and the harvest period can be spread over a longer period of time.

TABLE 2

GROWTH, SURVIVAL, AND FOOD CONVERSION OF BLUE AND CHANNEL CATFISHES FED FOR A PERIOD OF 118 DAYS[1] IN CAGES LOCATED IN A 750 ACRE RESERVOIR LAKE.

Cage no.	Species	No. of fish surving	Weight of fish (lbs.)	Average weight	Weight gained	Total feed (lbs)	Conversion
FISH FED ONCE EACH DAY							
1	Channel	193	142.4	0.73	136.5	179	1.31
5	Channel	192	165.1	0.86	159.2	212	1.33
7	Channel	96[2]	80.3	0.84	77.4	111	1.43
3	Blue	195	142.4	0.73	135.1	180	1.33
4	Blue	196	157.0	0.80	149.7	202	1.35
8	Blue	198	161.4	0.82	154.0	199	1.29
2	Channel	95	77.9	0.82	146.3	189	1.30
	Blue	100	75.1	0.75			
6	Channel	97	74.4	0.77	139.1	176	1.27
	Blue	97	71.3	0.74			
9	Channel	179[3]	140.0	0.78	199.5	260	1.30
	Blue	97	68.7	0.71			
Totals & Avgs.		1735	1356	0.78	1296.8	1708	1.32
FISH FED TWICE EACH DAY							
10	Channel	193	182.5	0.95	176.6	236	1.34
14	Channel	190	185.8	0.98	179.9	226	1.26
18	Channel	174	157.7	0.91	152.3	211	1.39
12	Blue	199	155.0	0.77	147.5	198	1.34
13	Blue	185	128.2	0.69	121.3	154	1.37
15	Blue	101[2]	69.9	0.69	66.1	81	1.23
17	Blue	190	141.1	0.74	134.0	171	1.28
11	Channel	97	114.9	1.18	178.9	231	1.29
	Blue	100	70.7	0.71			
16	Channel	74	70.6	0.95	128.4	183	1.42
	Blue	98	63.8	0.65			
Totals & Avgs.		1601	1340	0.84	1285.0	1691	1.32

[1]The fish were fed six days each week for a total of 101 days during the 118 day period.
[2]Only 100 fish stocked in cages 7 and 15.
[3]300 fish were stocked in cage 9.

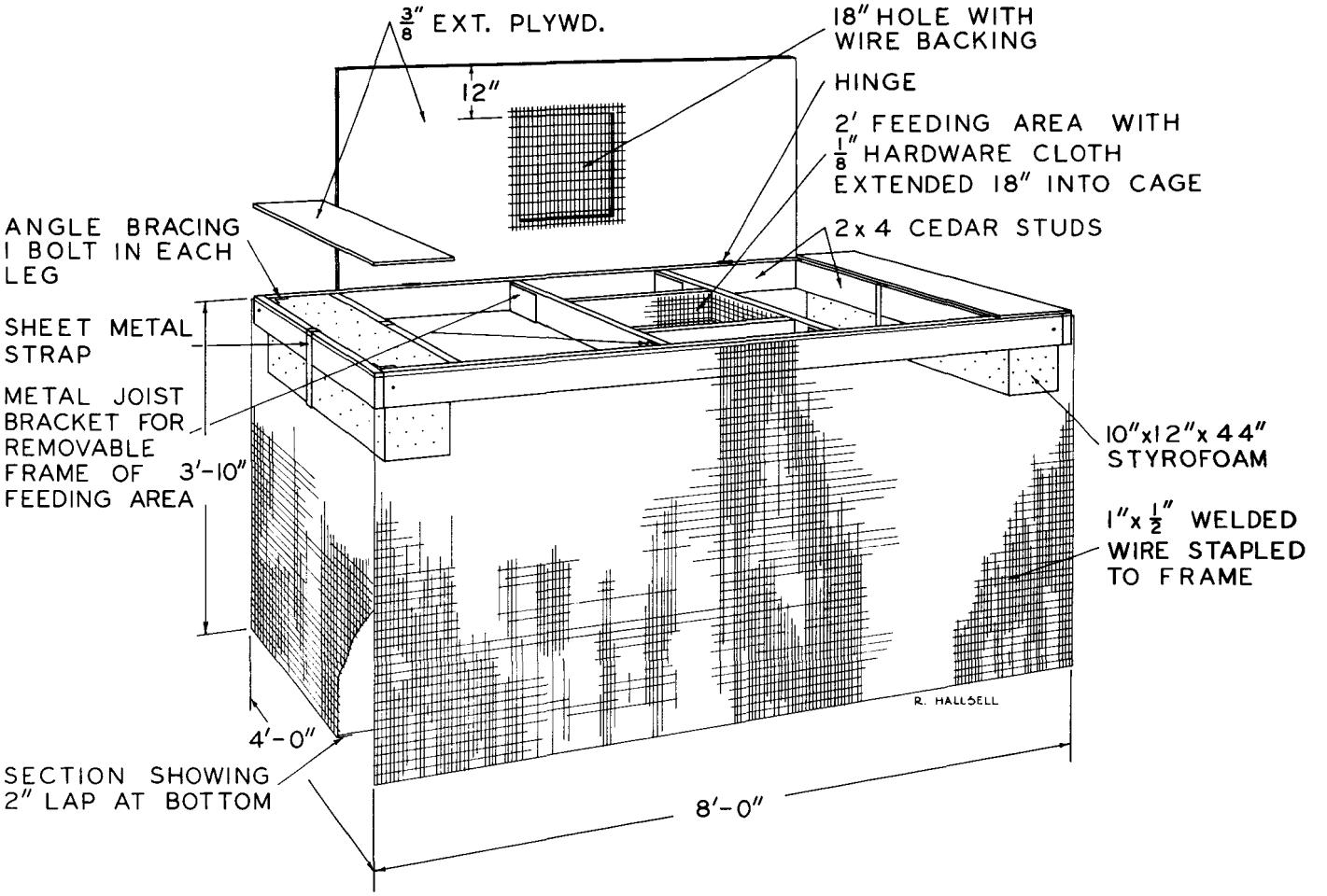

FIGURE 2. Commercial Model Cage

Channel catfish apparently grow more rapidly when fed twice each day than when they are fed once each day, but whether the increased growth rate is sufficient to economically justify feeding twice each day is doubtful. It is possible that the most economical method of feeding to get near optimum growth is to feed fish twice each day until they attain a weight of ¼ pound and then reduce the feeding to once each day.

SUMMARY

Catfish can be grown successfully in cages in large lakes in the presence of fishing and boating activity, and the channel is the more desirable species for this type of fish culture. The fish can tolerate temperatures of at least 95° F. without any adverse effects. The fish enter an arrested growth period when the temperature of the water is about 55° F. or lower, but the fish survive these winter temperatures exceptionally well. A conversion rate of approximately 1.3 can be obtained routinely. Channels grow more rapidly when fed twice each day than when they are fed once each day, but blues do not show an increased growth rate when fed twice each day. There is no difference in growth or conversion rates when blues and channels are grown as single populations compared to mixed populations. Bacterial disease occurs among caged fish, but disease may be controlled by feeding antibiotics. Excessive distrubance of caged fish, such as dipping into a cage, will retard the feeding activity for a period of time.

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