INCREASING THE YIELD OF CHANNEL CATFISH REARING PONDS BY PERIODIC DIVISION OF THE STOCK

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ABSTRACT

Stocking of small fingerling catfish into rearing ponds at a density to give the optimum number and weight for harvest at edible size gives a low gain per acre per day during the first half of the grow-out period. Use of a much heavier stocking rate initially, with periodic division or splitting of the stock shows promise of significantly increasing the gain per acre per day. Use of two divisions gave a gain per acre per day of about 25 pounds for the first phase and 10 pounds for the second. A hypothetical example is presented which should make a gain of 12 pounds per acre per day possible over a 360 day calendar year period under central Alabama conditions. Several possible ways the growing stock could be divided are listed.

The extent and nature of channel catfish production for sport and food applications has been documented by several investigators (Prather 1960, Davis and Hughes 1970, Foster and Waldrop 1972, Bailey et al. 1974, McCoy and Crawford 1975, Lovell et al., in press). Although rearing can be done in raceways (Hill, et al. 1974) or cages suspended in ponds, lakes or streams (Schmittou, 1970), practically all production at present is from earthen ponds (Bailey, et al. 1974). Early research to develop methods of culture was done in small ponds usually less than 5 acres in size (Swingle, 1959). As commercial producers adapted the research to modern agricultural technology size of the production unit also increased to 40 acres or more (Foster and Waldrop, 1972). In fact, this hypothetical study by Foster and Waldrop indicated that the most efficient size pond unit was one of 20 to 80 acres.

While pond size and other cultural aspects have undergone modification in the 15-year period since Swingle (1959) published the results of research on growing fingerling channel catfish to marketable size in ponds, the basic approach is still the same.

Swingle stocked commercial catfish production ponds with fingerling channel catfish either in the spring or in the fall. Prior to stocking the fingerlings prophylactic treatment for parasites and disease was given. The ponds were fertilized and the fish fed a mixed pelleted feed at varying rates dependent upon the weight and size of the fish and the condition of the pond. Fish were periodically sampled to give a basis for changing the amount of feed supplied.

The rate of stocking was governed by the number which could be grown to a desirable size for food or sport. In the range of 1,000 to 5,000 fingerlings per acre, total weight produced per acre and gain in weight per acre per day (Meehean, 1942) rose with increased stocking density, while the average size decreased. Rates of 2,000-3,000 fingerlings per acre gave fish of usable size (0.82-0.96 lb.) in one growing season with acceptable yield and rate of gain.

Harvesting was done at any convenient time after the fish reached usable size. Ponds were drained to facilitate complete recovery of the fish crop if it was sold as food fish. Spring-stocked fingerlings were more profitable than fall-stocked ones. Harvest was more readily accomplished in the cool season months and where runoff water was used to refill the pond, winter harvest made best use of available water supplies.

Limitations of the system

Cool-season harvesting tended to make an oversupply of fish available for the processors during the winter months. Research into methods of harvest without the need for complete draining of the pond (Greenland and Gill, 1974) however, made possible the removal of the larger fish in the pond for sale when the market demanded a supply or when a substantial number reach usable size (Lovell, et al., in press).

Yield of channel catfish generally varied from 1,000 to 3,000 pounds per acre per growing season with a feed conversion (S-value) of 1.3-1.5. Assuming a growing season of

200 days and a yield per acre of 2,000 pounds, average gain per acre per day would be 10 pounds. If a net profit of $0.10 per pound could be obtained for this gain, the rearing pond would return $200 per acre per growing season. While the gain per acre per day averaged 10 pounds, considerable difference existed between the rate of gain during the first 100 and the last 100 days of the growing period. To obtain a harvestable (0.75-1.25 pound) size fish in 200 days, a stocking rate of about 2,500 5-inch fingerlings would be required. Five-inch channel catfish fingerlings could be expected to number about 29 per pound. Thus a weight of 86 pounds of fish would be stocked to give 2,500 fingerlings per acre. Feeding at a rate of 3 per cent of the body weight of fish present initially would require 2.6 pounds of feed the first day. At a conversion of 1.3, a gain of 2.0 pounds (per acre-per day) would be realized. Assuming a change in feeding rate every two weeks, and a conversion of 1.3, 34 days would be needed for the stock to double in weight from 86 to 172 pounds. During this period, gain per acre per day could be expected to vary from 2.0 to 3.5 pounds. Obviously, this rate of return is somewhat marginal although an increase of more than 1 inch in length should have occurred. Also at such a low initial rate of gain it is apparent that gain per acre per day must be substantially above 10 pounds during the latter portion of the growing period in order to average this figure.

An important factor in feeding catfish in ponds is the maximum amount of feed that can be supplied without depleting the oxygen supply. A safe level was set by Swingle (1959) as being 30 pounds of feed per acre per day. Considering a conversion of 1.3, the maximum gain per acre per day from this feeding rate would be 23 pounds. During the first half of the growing season, feeding rate is considerably below the maximum safe level resulting in the rearing space being used less efficiently. This in turn gives a lower return to the pond operator. Use of 3-inch fingerlings for stocking the pond as is often done, would prolong the time during which the gain per acre per day is low. Conversely, use of 10-inch fingerlings as stockers would return a relatively high gain per acre per day throughout the time required for the fish to reach a size of 1 pound (15 inches total length). Catfish 10 inches in length number 3-3.5 per pound. Total weight of fish stocked for a density of 2,500 per acre would be 717-833 pounds. Feeding this weight at a rate of 2 percent of their weight per day would require 14.3-16.7 pounds of feed. At a conversion of 1.3, initial growth would be 11.0-12.8 pounds per acre per day as contrasted to a daily gain of 2.0 pounds where 5-inch stockers were used.

Increasing the gain per acre per day

The purpose of this paper is to suggest that a system of management be developed by the producer to take advantage of the principle outlined above. To illustrate the way growth actually occurred under pond conditions, results of a feeding trial at the Marion Alabama National Fish Hatchery are given. The trial was designed to compare two methods of determining the amount of feed to provide catfish grown in a pond. One method was based on the size of the fish with the percent of body weight fed being reduced as the stock grew, from 5 percent at 3 inches to 2 percent at 8-14 inches. The second method involved changing the amount of feed according to water temperature the previous day along with the size of the fish being fed. The experiment covered the time for growth from size of 4 inches to one of about 14 inches. Two phases were included. The first lasted 83 days with fingerlings numbering 60-65 (4 inches total length) per pound being reared to a size of 8 per pound. The second lasted 166 days during which the 8 per pound fish grew to an average size of one pound.

Rearing for phase 1 was done in 0.1 acre earthen ponds stocked at a rate of 20,000 fish per acre. Each method was replicated three times. Results when the ponds were drained and the fish inventoried are shown in Table 1. While method 2 resulted in overfeeding and a higher "S" value, gain per acre per day averaged about the same in each treatment. Since there was no limitation on the amount of feed supplied per acre per day, gain was higher than if such a limitation had been necessary. Initial gain for the two methods was about 11 pounds per acre per day at the 20,000 stocking rate. Had the feeding period consisted of a single phase stocking at 2,500 fish per acre initial gain would have been about 1.4 pounds per acre per day. For the first phase of the experiment, the six ponds averaged 25 pounds gain per acre per day.

Table 1. Results of phase 1 feeding trial comparing two methods of determining amount to feed channel catfish.

	Ponds							
Item	*C-6*	*C-8*	*C-19*	*Average*	*C-7*	*C-12*	*C-20*	*Average*
Method	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*
Wt. fish stocked	34.7	34.7	32.3	33.9	34.7	34.7	32.3	33.9
Wt. fish recovered	228.2	246.3	236.7	237.0	269.1	225.6	228.9	241.2
Gain, lb.	193.5	211.6	204.4	203.2	234.4	190.9	196.6	207.3
Amt. feed, lb.	247.0	249.9	246.7	247.9	324.5	286.7	312.6	307.9
"S" conversion	1.28	1.18	1.21	1.22	1.38	1.50	1.59	1.49
Gain/acre/day[a]	22.8	25.8	24.9	24.8	28.6	23.3	24.0	25.3
Stocking rate	2,000	2,000	2,000		2,000	2,000	2,000	

[a] Conditions of this experiment did not limit maximum amount of feed per acre per day to 30 pounds.
[b] Pond size 0.1 acre thus rate per acre was 20,000 fish.

The second phase of this experiment was conducted in four earthen ponds ranging in size from 0.74 to 0.82 acre. Stocking rate was 2,500 channel catfish per acre averaging 8 inches total length. Stocking was done March 3 and the feeding period covered 166 days. A disease outbreak (*Scyphidia*) slowed growth the first 6 weeks of the period and caused unusually heavy mortality which was underestimated when calculating the amount of feed. This resulted in overfeeding and poor "S" conversion. In spite of the low survival and overfeeding, gain per acre per day averaged about 10 pounds and was estimated to be more than 20 pounds for much of the last 30 days of the trial.

Based upon the weight of the fish stocked in phase 2 of this study, initial gain per acre per day with an "S" conversion of 1.3 would be about 5 pounds. Although growth during the first 100 days of the trial was slow because of disease and possibly other factors, more efficient use was made of pond space than would have been the case had the rearing pond been stocked with 2,500 4-inch fingerlings per acre at the start.

Table 2. Results of phase 2 feeding trial comparing two methods of determining amount to feed channel catfish.

	Ponds			
Item	*S-12*	*S-13*	*S-10*	*S-11*
Method	*1*	*1*	*2*	*2*
Wt. fish stocked, lb.	264.0	266.7	284.5	292.4
Wt. fish recovered lb.	1,434.5	1,506.4	1,657.0	1,604.7
Gain, lb.	1,170.5	1,239.7	1,372.5	1,312.2
Amt. feed, lb.	2,031.8	2,204.0	2,498.2	2,536.6
"S" conversion	1.74	1.77	1.82	1.93
Gain/acre day, lb.	9.5	9.3	10.3	9.6
Stocking rate/acre	2,500	2,500	2,500	2,500
Survival per cent	81.8	81.2	87.3	83.7
Pond area acres	0.74	0.80	0.80	0.82

An average static-water rearing pond should be able to maintain a standing crop of 2,000 pounds of channel catfish with suitable conditions for growth. When the weight of fish is at or near this point, space is being used with the highest degree of efficiency. Correspondingly, when the weight of fish is low as is the case at or near stocking, less efficient use is made of the available space. Where the fish present only require 3 pounds of feed per acre per day, 90 percent of the effectiveness of the pond goes unused if 30 pounds per acre per day can safely be fed. Use of small fingerlings for stocking lengthens the period when the pond space is underutilized. Use of larger stockers, up to 10-inch fish or larger, can thus be justified on the basis of more efficient use of rearing pond space.

In the comparison between two methods for determining the amount of feed, periodic seine samples were taken to adjust the feeding rates. The first sample was taken 66 days after stocking the phase 2 ponds. Later sampling was done at approximately 2-week intervals. Results for the four ponds are combined in Table 3 for a generalized picture of the growth in this particular case. Although the rate of growth in this example was affected by the disease problem and resultant mortality, the general pattern is probably

Table 3. Estimated standing crop of catfish per acre at intervals after stocking phase 2 ponds based upon seine samples of the fish population.

Days after stocking	*Av. size in inches, TL*	*No./lb.*	*Wt. of standing crop*[a]	*Gain/ac per day, lb*	*% of growing time used*
0	8.0	7.1	352	—	
66	9.0	5.0	400	0.72[b]	40
91	10.0	3.5	571	6.84	15
111	11.0	2.5	800	11.45	12
129	12.0	2.0	1,000	11.11	11
143	13.0	1.5	1,333	23.78	8
155	14.0	1.2	1,667	27.75	7
166	14.6	1.08	1,851	16.73	7

[a] Weights at stocking and harvest determined by weighing. Intermediate points estimated on basis of average size of fish in seine sample and a survival of 80 percent.
[b] Reflects a mortality of 20 percent applied to the 2,500 fish stocked initially.

typical. Gain per acre per day is low for the first two thirds of the growth period, rising to profitable levels the latter one-third.

Hypothetical application of the concept

A system of management designed to make better use of the rearing pond space throughout the feeding period appears to be a worthwhile goal. In the above-described example, use of a two-phase stocking scheme gave an average yield per acre per day of 25 pounds for phase 1 and 10 pounds for phase 2. A more efficient system might employ 4 to 6 phases. Table 4 illustrates a hypothetical case where 5-inch fish are started and divided through 4 phases. Using this design, phase 1 would be stocked with 667 pounds of 5-inch fingerlings to be divided when a size of 7 inches is reached. At that time a standing crop of 2,000 pounds per acre would be present. Gain per acre per day the first 2 weeks after stocking should be 15.4 pounds $\left(\frac{3\% \text{ of } 667}{1.3\ (\text{S value})}\right)$. For the final 2 weeks it should be about 23 pounds per acre per day (30 lb. feed; 1.3 "S" value). Later phases are programmed for comparable rates of gain.

Operation of a hypothetical 15-pond unit with all ponds the same size is illustrated in Figure 1. The time period covers 365 days from October 15 of one year through October 14 of the next. Included are 3 warm-season growing periods of 51 days each and 1 cool-season period of 212 days. Division of the stock could be effected by draining the ponds or by use of traps and seining. Research by Greenland and Gill (1974) suggests that application of these techniques can remove a significant percentage of the catfish from a suitably constructed pond. If draining is done, a water reuse system might be desirable in many locations. Although the time schedule outlined appears somewhat arbitrary, in practice,

Table 4. Hypothetical situation for manipulating catfish stock to obtain sustained high gain per acre per day from the rearing pond[a].

Stocking phase	*Size to stock*	*Size to divide*	*No. per acre for 2,000 lb.*	*No. per acre for 3,000 lb.*
1	5-inch 30.0/lb.	7-inch 10/lb.	20,000	30,000
2	7-inch 10.0/lb.	9-inch 5/lb.	10,000	15,000
3	9-inch 5.0/lb.	11-inch 2.5/lb.	5,000	7,500
4	11-inch 2.5/lb.	15-inch 1.0/lb.	2,000	3,000

[a] For a 1 year period divided into phases 1-4 as follows: 51 days May 16-July 5; 51 days July 6-August 25; 51 days August 26-Oct. 15; 212 days Oct 16-May 15.

Stocking Phase[a]	POND	Size-in.	Number per acre	POND	Size-in.	Number per acre	POND	Size-in.	Number per acre
1	1	5	20,000	6	9	5,000	11	11	2,000
2		7	10,000		11	2,000		9	5,000
3		9	5,000		11	2,000		11	2,000
4		11	2,000		9	5,000		11	2,000
1	2	7	10,000	7	9	5,000	12	11	2,000
2		9	5,000		11	2,000		11	2,000
3		11	2,000		7	10,000		11	2,000
4		11	2,		9	5,000		7	10,000
1	3	7	10,000	8	11	2,000	13	11	2,000
2		9	5,000		5	20,000		11	2,000
3		11	2,000		7	10,000		11	2,000
4		5	20,000		9	5,000		11	2,000
1	4	9	5,000	9	11	2,000	14	11	2,000
2		11	2,000		7	10,000		11	2,000
3		5	20,000		9	5,000		9	5,000
4		7	10,000		11	2,000		11	2,000
1	5	9	5,000	10	11	2,000	15	11	2,000
2		11	2,000		9	5,000		11	2,000
3		11	2,000		11	2,000		9	5,000
4		9	5,000		11	2,000		11	2,000

Figure 1. Multiple cropping system for 15 equal size pond units for growing one pound size channel catfish.

[a]Phase 1, Oct. 16-May 15, 212 days; phase 2, May 16-July 5, 51 days; phase 3, July 6-Aug. 25, 51 days; phase 4, Aug. 26-Oct. 15, 51 days.

the rotation would by necessity be implemented over a period of time so that available labor, equipment, markets, fingerlings for restocking and weather conditions could be taken into account.

Some ideas regarding ways of dividing the fish stock to maintain optimum density for high gain per acre per day are as follows:

1. Drain one pond—divide crop for restocking into two new ponds.
2. Trap or seine 1/2 of fish from one pond and move to another pond of equal size.
3. Build 4 ponds in single series one below another, doubling the size of each successive unit. Move fish downhill by gravity, recirculating water to upper level by pumping.
4. Build ponds side by side at about same level with gates. Open gates to divide the stock.
5. Include smaller pond inside large pond. Break levee or raise water level to permit fish population to expand.
6. Build smaller ponds on small side valleys and larger ones on main stream. Drain combinations of smaller area into large finishing ponds recirculating water to partly refill uppermost ponds.
7. Develop a system of moving fish between adjacent ponds through irrigation pipe utilizing a fish pump. Work in conjunction with a trapping basin in the rearing pond being harvested.

While such a system may seem involved and difficult to establish, it is typical of the requirements for intensive management of a sizable public fish hatchery. It should present no major problems for a skilled pond manager with a production unit designed to accommodate the system. The returns for the added effort are attractive. Based upon a frost-free growing season of 240 days, production per acre from a 15-pond unit of equal size ponds should be 4,267 pounds without exceeding a feeding rate of 30 pounds of feed per acre per day. This is 123 percent more production than would be expected from single phase stocking over the 240 day growth period. Use of ponds of unequal size but proportionate to the expected growth rate during four phases might result in a system such as is diagrammed in Figure 2. Such an arrangement might be developed using available sites in a small watershed moving the fish downstream for efficient water use and minimum handling of the fish stock.

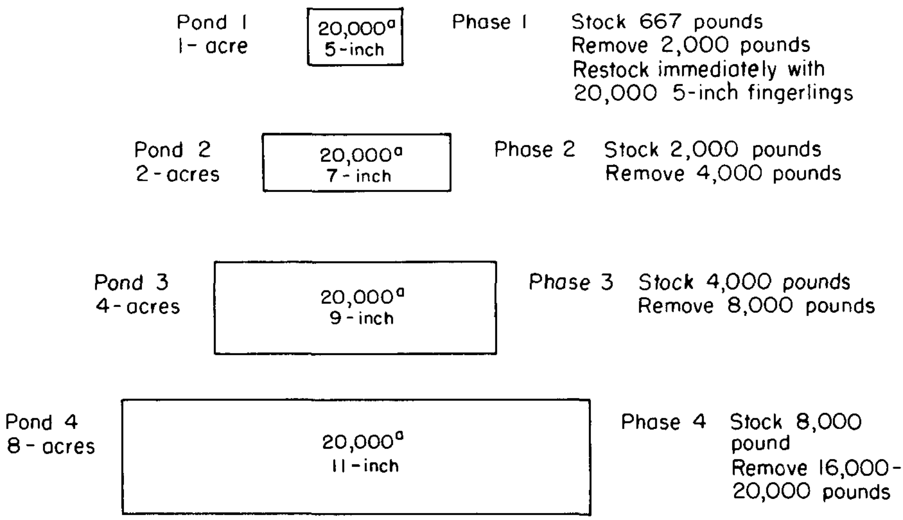

Figure 2. Multiple cropping system for unequal size pond units proportioned for 4 growth phases.

[a]Less mortality, a total of 10-20 percent estimated for 4 phases.

[b]Phase 1 212 days, Oct. 16-May 15; Phase 2 51 days, May 16-July 5; Phase 3 51 days, July 6-Aug. 25; Phase 4 51 days, Aug. 26-Oct. 15.

The practicality of the above concept in a given situation will be dependent upon several factors. Facilities designed to permit dividing the stock will be necessary. Labor and equipment for capturing and transferring the stockers without undue stress must be available. More attention to oxygen levels will be needed since a higher feeding rate will be used over an extended period. For existing production operations where the above requirements cannot be met, dividing the stock periodically will not have a profitable application. Under such conditions however, it may be profitable to buy 10-11 inch stockers or add additional pond space of a suitable design to make phase stocking feasible. Another application of this concept is periodic cropping by seining to remove harvestable sizes, and restocking with smaller fish to replace the number removed. This technique is already being practiced with favorable results where growing ponds are seinable (Lovell, et al., in press).

If commercial fish production is to be in a competitive position with other forms of animal husbandry, it undoubtedly will require production facilities specifically designed and constructed to make the most effective use of the inputs required. This could necessitate renovation of ponds presently in use, or construction of pond systems specifically designed for catfish culture. At a time when high feed and other production costs have greatly reduced profit margins, critical examination of all aspects of the process of growing catfish commercially should be emphasized. More efficient use of available pond space through periodic division of the stock appears worthy of special attention.

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