Journal of the Arkansas Academy of Science

Volume 35 Article 28

1981

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RATION/DENSITY COMPARISONS WITH CAGED CHANNEL CATFISH*

Caged fish culture as a production method for rearing catfish and trout was first started in the United States in the late 1960's and has now become more practical than ever for certain situations (Newton, 1980). This is especially true for the utilization of farm ponds which are suitable for cages because the fish cannot be easily harvested otherwise. Since 1967, university and governmental researchers have studied and developed caged catfish culture for the fish farming industry (Lewis, 1969; Schmittou, 1969; Collins, 1971). They first dealt with culture techniques involving potentials and adaptations of the method. They used numerous types of cages and gradually refined studies to include nutritional trials, stocking sizes and rates, genetics, and fish health (Collins, 1978).

Research conducted during the 1970's, primarily in Arkansas and Oklahoma, has further refined cage culture methodology and application potentials (Collins, 1971; Collins, 1978; Newton, 1980; Kilambi et al., 1977). These studies are valuable because they demonstrate the variety of situations for using cage culture, the improved feed quality for confined fish culture, and the resource potential for both home and commercial ventures.

Cages are ideal for evaluating rations for fish diets (Newton and Dean, 1978; Newton et al., 1980). The need continues for testing available rations for efficient and economical fish production. This study compares two rations of similar protein levels, 33% and 36%, but quite different in cost with three stocking densities of channel catfish.

A total of 18 cages were stocked with catfish fingerlings during May 1980. The cages (0.9 m^3) were arranged in units of three across the south end of a 1.6 ha farm pond on the University of Arkansas at Pine Bluff Agricultural Research Station as described previously by Newton and Merkowsky (1976). Six cages were each stocked with 200, 350, and 500 fingerlings (average wt. 28 g), respectively, in a randomized pattern. Experimental conditions were triplicated simultaneously for ration and density evaluations. Three cages of each fish density were fed either a 36% protein trout ration or a 33% protein catfish ration formulated as floating pellets. All fish were fed five days per week at the rate of 4% of their estimated body weight, regardless of density or ration combinations.

The study period began 14 May and ended on 30 August due to an oxygen depletion which killed fish in approximately two-thirds of the cages. Nevertheless, all data were collected from each cage similar to usual harvest operations in previous studies (Newton et al., 1980). Statistical comparisons revealed no significant differences between data collected from dead or live fish. Therefore, the relative validity of the assumptions and determinations reported herein are believed to be accurate for practical comparisons among density and ration combinations.

Evaluations of the rations and stocking densities were based upon weight gain, food conversion efficiency (FCE), survival, and production costs per kilogram of catfish produced. Comparisons between rations revealed no significant differences among net production, FCE, and survival. Due to the difference in feed costs (the 33% protein ration was $16/45.5 kg, while the 36% protein ration was $25/45.5 kg) the 33% protein ration was the most cost efficient at all stocking densities (Table 1). With either ration, the cost per kilogram of fish produced was less at the higher stocking densities (350 and 500 fish); however, production costs were still lower for all densities with the 33% protein catfish ration. The greatest net profit per cage was obtained with the highest fish density for both rations.

There were significant differences in net production among each stocking density, although survival and FCE were similar (Table 2). Fish stocked at 350 per cage had higher average individual gains than fish stocked at 200 or 500 per cage, which had similar average gains. Both FCE and survival were consistently within normal ranges necessary for successful caged catfish production. Survival was unusually high, until the occurrence of the oxygen depletion. One of the disadvantages of cage culture is that caged fish are more susceptible to oxygen problems than fish in an open pond.

Since the fish stocked at 350 per cage had higher individual gains with both rations, it appears that this stocking density was optimum for producing larger size fish. Fish density considerations have been studied for some time (Schmittou, 1969; Konikoff and Lewis, 1974), and it has been determined that generally a minimum number of 5-6 fish per 30 cm^3 is required to avoid behavioral problems. We have used 7-8 fish in most of our studies; however, the maximum or optimum number to stock deserves further attention. A high quality, less expensive catfish ration outperformed a more expensive trout ration on the basis of fish production, economy, and availability.

This study was supported with funds provided by USDA, SEA/CR under PL 95-113.

Table 1. Economics of raising channel catfish in cages with either a 33% ration or a 36% protein ration.

Ration	Stocking density	Gross sales	Total expenses	Net profit per cage	Production cost/kg of fish
33% protein catfish ration	200	$ 69.98	$ 49.08	$ 20.90	53c
	350	$142.00	$ 78.16	$ 63.84	41c
	500	$162.43	$ 90.32	$ 71.94	42c
36% protein trout ration	200	$ 65.90	$ 57.44	$ 8.43	65c
	350	$140.03	$ 98.02	$ 42.01	52c
	500	$166.24	$112.37	$ 53.87	51c

33% protein ration 35¢/kg
36% protein ration 55¢/kg
Fixed expenses:
Cage cost and depreciation (5 yrs)

Channel catfish live weight selling price $1.65/kg
Variable expenses:
Fingerlings, feed, and labor

Table 2. Production of channel catfish reared in cages at three stocking densities and fed 33% and 36% protein rations.

33% protein ration				
Stocking density	Percent survival	Net production (kilograms)	Food conversion efficiency	Average fish gain (grams)
200	94	37	1.14	196
350	99	77	1.29	221
500	95	85	1.27	181

36% protein ration				
Stocking density	Percent survival	Net production (kilograms)	Food conversion efficiency	Average fish gain (grams)
200	90	34	1.22	193
350	97	75	1.33	235
500	99	87	1.25	176

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**Published with the approval of the Director of the Arkansas Agriculture Experiment Station.*

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ECONOMICS OF RAINBOW TROUT PRODUCTION IN ARKANSAS*

The major area of rainbow trout *(Salmo gairdneri)* production in Arkansas is the northwest section of the state. This region is noted for its karst topography with associated underground rivers and springs having ideal water supplies and temperatures for trout production. With increased trout usage for both recreational purposes and personal consumption, northwest Arkansas trout producers presently cannot meet demands. By contrast, the delta areas of Arkansas have copious amounts of shallow, easily obtainable water and readily available production sites that are being used seasonally for producing farm raised channel catfish *(Ictalurus punctatus)*. Collins (1972) and Newton et al. (1977) reported that trout may be reared in cages and ponds in southern Arkansas when water temperatures remain below 21° C. This condition occurs seasonally, usually November through April.

The objectives of this study were to further refine pond production methods and to consider the economic potentials of winter trout rearing in the southern portion of the state.

Fish averaging 119 g each were obtained from a northwest Arkansas commercial producer in November, 1979. Fish were conditioned from raceways to ponds and cages for three weeks before commencing the study. One portion of the experiment consisted of stocking 150 trout in each of three 0.9 cubic meter cages anchored in a 1.6 ha stock pond. The second part consisted of stocking two 0.1 ha ponds each with 500 fish. Both trials were conducted simultaneously at the University of Arkansas at Pine Bluff Research Station from 18 November 1979 through 1 April 1980.

All fish were fed a 36% protein commercial floating trout ration. Caged fish were fed five days a week, while pond fish were fed every day. The caged fish were fed on fewer days than the pond fish because they were set up on a different feeding schedule from the pond fish. Feeding rates were adjusted according to water temperature (Klontz, 1978) and were calculated as a percentage of body weight which was estimated bimonthly (based on an assumed growth rate of 1.7:1 feed conversion efficiency (FCE) or 3.74 kg of food fed for 1 kg of fish produced).

The average total weight harvested per cage was 29.05 kg, a total net gain of 10.64 kg over average initial stocking weight (Table 1). Survival averaged 89% for the caged trout. Fish increased from an average individual size of 122 g to 216 g each during the period, for a 79% average gain. This was similar to growth rates obtained in previous studies in Arkansas (Collins, 1972; Newton et al., 1977). Food conversion efficiency was 1.75:1, higher than that of the previous studies.

The harvest weight of pond-reared trout was 121.36 kg (1213.6 kg/ha), a net gain of 53.8 kg over initial stocking weight (Table 2). Trout survival in ponds averaged 99.5%, which was also similar to that reported earlier by Newton et al. (1977) but higher than survival reported by Kilambi et al. (1977) and Collins (1972). Individual trout increased from 136 g to an average of 245 g in the ponds. The FCE of trout produced in ponds was 1.65:1. There was a noted difference among fish from the two ponds in both total net production and FCE. These differences may be partially explained by variation in water quality between ponds. During the entire period, fish were observed actively feeding in one pond, while only sporadically in the other pond.

Water temperature during the study period averaged 10° C and ranged from 3.8 C - 15.4 C (Fig. 1). Klontz (1978) noted that food conversion efficiency and activity of trout were favorable until water temperature dropped below 10° C. He reported an optimum temperature level of 14.4° C for trout feed consumption. Growth of trout slowed below 8° C and ceased below 5.6° C. During our study, conditions for growth were favorable 75% of the study period and were best for trout production 40% of the time. November, December, March, and April were the best months for trout production.

Winter culture of trout appears quite economically promising. Cages stocked with 150 fish yielded a net profit of $17.10 per cage. Profit would be slightly lower if labor costs were subtracted. Expenses per cage for the growing season were: feed $10.20 ($0.55/kg) and $49.50 for fingerlings ($0.33 ea). Live weight wholesale price was $2.64 per kg. If trout were marketed on a retail market as opposed to wholesale ($4.07/kg), a net profit of $56.70 per cage would be reasonable. Kilambi et al. (1977) found that a stocking rate of 300 fish per cubic meter did not significantly limit growth of caged trout.

Pond-reared trout, at a stocking rate of 5000 per hectare and a harvest weight of 1169 kg, would net $433.96 per hectare based upon a live-weight selling price of $2.64 a kilogram. Expenses (per hectare) were: feed cost $1061.61 ($0.55/kg), and fingerling cost of $1590.60 ($0.33 ea). Profit margins may be increased by higher stocking rates. Jenson (1979) found that a stocking density of 8650 fish per hectare was not limiting to growth of trout in Alabama ponds.

Trout reared along with catfish in ponds during winter, as reported by Reagan and Robinette (1975) and Newton et al. (1977), had a net return on a per hectare per year basis which was higher because the two fish crops could be harvested yearly. Polyculture of trout and catfish also is feasible because nearly 90% of the trout can be captured with only one seine haul without harvesting the catfish. This combination reduces the