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Growth, Weight, and Survival of Paddlefish, *Polyodon spathula*, Stocked at Two Densities in Channel Catfish, *Ictalurus punctatus*, Ponds

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ABSTRACT

Paddlefish, *Polyodon spathula,* are new to aquaculture in Kentucky. Since paddlefish feed on zooplantkon, it is possible to culture them in ponds used for catfish aquaculture with little additional feed and aeration costs. Here we examined the growth, weight and survival in paddlefish cultured at two stocking densities (125/ha and 175/ha). There were two replicates per stocking density. The paddlefish were sampled several times during the growth period and all surviving fish were harvested after one year. Results of this study indicate that paddlefish at the lower stocking density (125/ha) are heavier than paddlefish cultured at the higher stocking density (175/ha). Mean growth rate and survival rate did not differ significantly between the two stocking densities. Preliminary economic analysis suggests that paddlefish contribute to catfish farm income by $220/ha and $151/ha, for 125/ha and 175/ha stocking density, respectively.

INTRODUCTION

Paddlefish, *Polyodon spathula,* is a filter feeding zooplanktivore, which has demonstrated a strong consumer acceptance in recent taste tests (Meyer pers. comm. 2001). Past research has clearly shown the aquaculture potential of paddlefish in ponds (Semmens and Shelton 1986; Tidwell et al. 1991). Current research at Kentucky State University is focused on polyculture of paddlefish with channel catfish, *Ictalurus punctatus,* in commercial ponds (Mims 2001). The term "polyculture" refers to the culture of multiple species in the same pond. Catfish ponds are usually eutrophic from the decomposition of excess feed and fish excrement. Such ponds support sufficient zooplankton to maintain paddlefish culture. Successful polyculture of paddlefish and catfish could increase profit margins for catfish producers.

Paddlefish research has been part of the mainstream aquaculture research in Kentucky for the last 15 years. Production research has shown that paddlefish have a faster growth rate (6–10 lbs/year) in relatively cool Kentucky waters than in the Mississippi Delta area (Schardein et al. 2001). Pond culture of paddlefish is permitted in Kentucky; however, some states consider paddlefish to be a sport species and restrict its aquaculture. Consequently, Kentucky might have a competitive advantage in paddlefish aquaculture over major southern aquaculture states.

Here, we report field-trial results from one year of paddlefish polyculture in four commercial channel catfish ponds in Kentucky. Specifically, we sought to test for differences in weight gain and survival at harvest of paddlefish stocked at two densities in catfish ponds and to evaluate the farm-level economic impact of paddlefish aquaculture in Kentucky.

MATERIALS AND METHODS

Paddlefish fingerlings (mean weight 122.9 g; mean total length 37.4 cm) were stocked into

Table 1. Physicochemical characteristics of ponds containing paddlefish.

Parameter	Stocking density (per ha)		Sample size	*P*-value
	125 Fish	175 Fish		
Temperature (°C)	17.5 (± 8.7)*	17.6 (± 8.3)	16	0.92
Dissolved oxygen (mg/L)	7.8 (± 3.6)	8.0 (± 4.1)	16	0.96
pH	6.4 (± 0.4)	6.9 (± 0.5)	16	0.15
Nitrite (mg/L)	0.17 (± 0.04)	0.40 (± 0.05)	16	0.42
Non-ionized ammonia (mg/L)	0.02 (± 0.02)	0.02 (± 0.03)	16	0.92
Alkalinity (mg/L)	68.8 (± 25)	39.1 (± 25.8)	16	0.05

* Values are means ± 1 standard deviation.

2.0-ha commercial grow-out catfish ponds in western Kentucky (Graves County) on 14 March 2000. Four ponds, previously stocked with channel catfish fingerlings at 24,700/ha, were stocked with either 125 paddlefish fingerlings/ha or 175 paddlefish fingerlings/ha, with two replications per treatment. Catfish were fed once daily to satiation with a commercial catfish diet containing 32% crude protein. Individual weights and lengths of catfish were unattainable due to a multi-year, multi-batch production regime, which made tracking of survival rates and biomass from each catfish stocking prohibitively difficult.

Paddlefish were sampled in July and October 2000 and February 2001, for the first year using a 91.5-m seine (15.24-cm bar mesh). Weights and lengths were recorded for all sampled paddlefish. Ponds were harvested in March 2001 and paddlefish were counted, weighed, and measured. Dissolved oxygen and temperature were monitored daily using a YSI oxygen meter (YSI, Yellow Springs, Ohio). Emergency aeration was provided when dissolved oxygen fell to 3.0 mg/L, using a PTO-powered aerator. Total ammonia nitrogen (TAN), nitrite, pH, and alkalinity were recorded biweekly using a Hach Model FF-1A Field Kit (Hach, Loveland, Colorado). Non-ionized ammonia was calculated and recorded, based on Boyd (1990).

Average growth and survival parameters of paddlefish from the two stocking regimes were compared using standard *t*-tests. Any differences in water quality parameters were also investigated using the same methodology. A brief economic analysis was conducted to investigate the revenue contribution of paddlefish ($/ha), net of stocking and labor expenses associated with paddlefish culture. Prices of paddlefish fingerlings and foodsize paddlefish were derived from interviews with paddlefish producers, fingerling suppliers, and industry experts. We estimated a break-even cost of $1.70/ paddlefish fingerling using Kentucky State University hatchery data derived by one of us (S. Dasgupta). We assumed market price paddlefish fingerlings to be $2/head. Foodsize paddlefish price was kept at $2.20/kg (live-weight). Wage rate for hired labor was kept fixed at the $5.25/hr (minimum wage rate).

RESULTS AND DISCUSSION

There were no differences in mean temperatures, pH, dissolved oxygen, nitrites, and non-ionized ammonia in ponds between the 125 fish/ha and 175 fish/ha stocking densities (Table 1). There was a significant difference ($P = 0.05$) in average pond alkalinity between the two stocking densities. This indicates a difference in the buffering capacity of the ponds; however, the differences in alkalinity are unlikely to affect growth and mortality in paddlefish, particularly when the average pH levels do not differ significantly at the two stocking densities (Boyd 1990).

Growth rate (mean ± standard deviation) ranged from 8.27 ± 0.99 g/day in low-density ponds to 6.34 ± 0.58 g/day in high-density ponds (Table 2). Clearly, growth rate seemed higher with low-density stocking; however, small sample sizes precluded statistical analysis. There were significant differences between stocking densities in the mean harvest weight of the paddlefish. Fish weights(mean ± standard deviation) at harvest were 3.23 kg ± 0.56 kg and 2.52 kg ± 0.45 kg for sampled fish at 125 fish/ha and 175 fish/ha, respectively (Table 2). The survival rates were 53.6 % ± 13.58 % and 52.2 % ± 4.03 %, for the low-density and high-density ponds, respectively;

Table 2. Weights, harvest densities, survival and growth rates for paddlefish cocultured in channel catfish ponds.

	Stocking density (per ha)		Sample size	*P*-value
	125 Fish	175 Fish		
Average stocking wt. (kg)	0.120 ± 0.038*	0.126 ± 0.033	60	0.28
Average harvest wt. (kg)	3.23 ± 0.56	2.52 ± 0.45	59	0.00
Harvest density (head/ha)	67 ± 17	92 ± 7	2	—
Survival (%)	53.6 ± 13.6	52.2 ± 4.0	2	—
Growth rate (g/day)	8.27 ± 0.99	6.34 ± 0.58	2	—

* Values are means ± 1 standard deviation.

small sample sizes precluded statistical analysis.

Figure 1 shows changes in weight of paddlefish at different times of the growth cycle for the two stocking densities. Mean weight gain was similar at the two stocking densities from March 2000 to February 2001. Clearly, variability (the standard deviation) in weight was consistently higher at the lower stocking density.

Figure 1 shows a rapid weight gain in paddlefish stocked at 125 fish/ha, between February and March 2001. Mims and Clark (1991) discovered a sudden increase in average weight of paddlefish, overwintered in polyculture ponds. They reported that weight gain in paddlefish, stocked in ponds with catfish, averaged 71% over spring months. Zooplankton have been found to be abundant during spring months. Onders et al. (2001) reported large numbers of zooplankton in late winter and early spring in Kentucky's reservoirs. Ivleva (1969) explained that spring and fall blooms of zooplankton are associated with a dying biomass of phytoplankton. This suggests that paddlefish have ample food supply in late winter/early spring months, which contributes to the sudden growth spurt.

Our study did not provide any information on potential effects of paddlefish on growth and survival of catfish in the polyculture ponds. Hence, we can only show the additional income that paddlefish might contribute to a commercial catfish farm.

Some advantages of paddlefish polyculture with channel catfish include: 1) paddlefish do

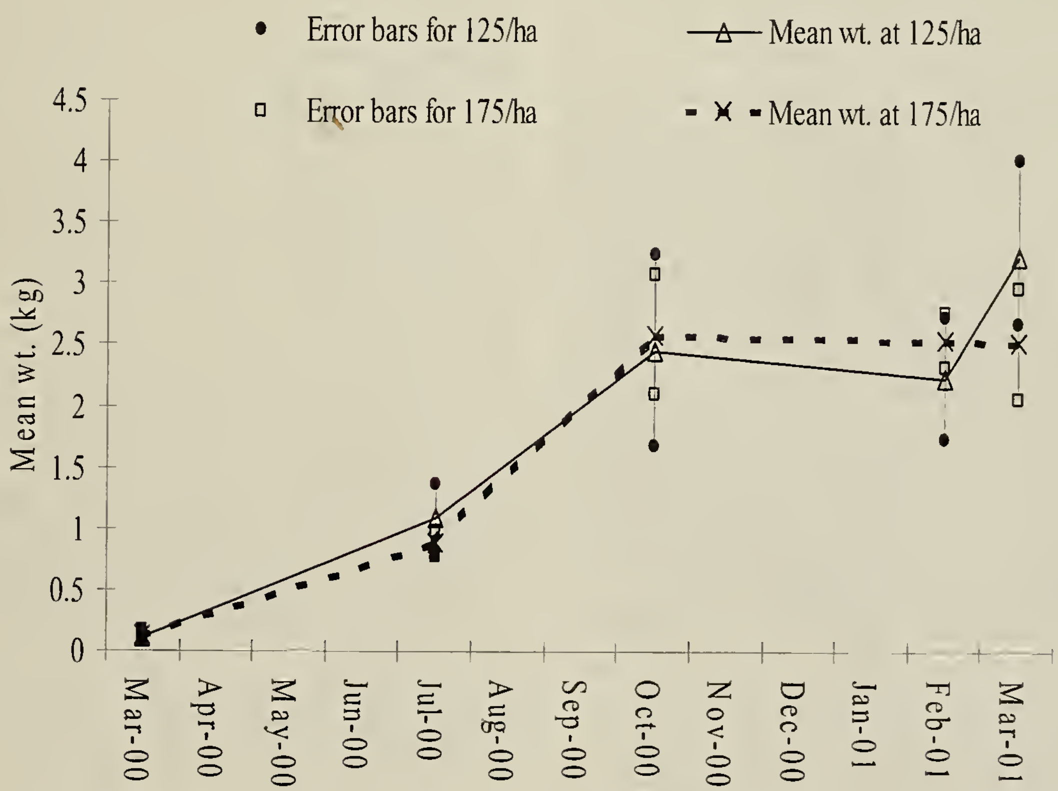

Figure 1. Seasonal mean weights of paddlefish stocked at two densities (125/ha and 175/ha) in catfish ponds between March 2000 and March 2001. Data are presented as mean ± standard deviation of weight at each observation.

not require additional prepared feed and additional aeration, management or labor during the growing season and 2) paddlefish do not require additional capital investments. The only costs associated with paddlefish are the cost of fingerlings for stocking and the additional labor cost at harvest in order to sort paddlefish from channel catfish. Paddlefish are relatively docile and most are easily captured in one seine-haul through a catfish pond. Field trials from commercial 2-ha ponds have demonstrated that it took two individuals no longer than 30 minutes to remove paddlefish from catfish after a seine haul. We estimated a maximum of one hour of labor sorting paddlefish from catfish after harvesting a 2-ha pond.

The average stocking and labor costs of paddlefish are 125/ha × \$2.00/head + 1 hr × \$5.25/hr (or \$255.25/ha) and 175/ha × \$2.00/head + 1 hr × \$5.25/hr (or \$355.25/ha), for the 125/ha and 175/ha stocking densities, respectively. Using mean harvest weight and survival rate for the two stocking densities (Table 2), the expected revenues from paddlefish (\$/ha) were computed to be \$476.10/ha and \$506.44/ha, for the 125/ha and 175/ha stocking densities, respectively. Hence, the expected net returns for paddlefish were evaluated to be \$220.85/ha and \$151.19/ha, for the 125/ha and 175/ha stocking densities, respectively.

CONCLUSIONS

Since paddlefish are filter-feeders, it is expected that density-dependent growth would be higher at lower densities, as there would be less natural food at higher densities. Our results are consistent with the hypothesis that stocking at 125/ha yield significantly heavier foodfish than the average harvest weight of fish stocked at 175/ha. Survival rates for both stocking densities, on average, were equivalent. Although more paddlefish were harvested from ponds stocked at 175/ha, the higher operating costs at 175/ha made the lower stocking density more profitable.

This study represents the first field trial introducing paddlefish into commercial channel catfish ponds. While the results show the feasibility of producing small quantities of paddlefish, further research is needed to evaluate the impact of pond management on growth and survival rates of catfish and to identify optimal paddlefish biomass capacity in channel catfish ponds.

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