COMPARISON OF TWO STOCKING DENSITIES FOR CHANNEL CATFISH PRODUCTION IN EARTHEN PONDS

by

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ABSTRACT

Texas Parks and Wildlife Department rears Imperial strain channel catfish to 225 mm total length for stocking into community fishing lakes, state parks lakes, and other highly utilized water bodies. The stocking densities of these fish for production ponds at the Jasper State Fish Hatchery have traditionally been 50,000-60,000 fish/ha. At these densities, production has been hampered by poor water quality, especially low dissolved oxygen levels, and slow growth. We compared two stocking densities (60,000 fish/ha vs. 30,000 fish/ha) for differences in production and water quality variables to determine if a low stocking density can improve fish production and water quality. Fish were reared for 22 weeks in earthen ponds (0.28-0.36 ha) and fed commercial feed to satiation twice daily. Water quality did not statistically differ between treatments. Similarly, most of the production variables examined (survival, growth rate, weight harvested, number of fish harvested, and feed conversion ratio) did not significantly differ between treatments. The low-density treatment produced significantly bigger fish, in terms of total length or number of fish/kg, than the high-density treatment and allowed production of 225-mm fish in one growing season.

INTRODUCTION

The Jasper State Fish Hatchery (JSFH) rears 225-mm Imperial strain channel catfish fingerlings for stocking into community fishing lakes, state parks lakes, and other highly utilized water bodies in Texas. Earthen ponds are utilized at the JSFH for rearing channel catfish to the requested size. These ponds are supplied with water by gravity flow through a 53.3-cm (21-in) outside diameter supply line. The gravity flow system can provide the hatchery with several hundred gallons of water per minute, but the actual quantity of water reaching the hatchery is highly variable due to water level fluctuations at the source. The result is that some hatchery ponds may be without water supply while other ponds may experience reduced water flows during production cycles with high water demand. The production cycle for 225-mm catfish extends from early July to November and usually includes periods of insufficient water flows. This lack of adequate water flow eliminates the strategy of flushing ponds with fresh water to improve water quality. This situation makes managing ponds for desirable water quality conditions for advanced catfish production challenging.

The catfish culture protocol used by the JSFH calls for receiving 50-mm catfish from the A. E. Wood Fish Hatchery (AEW) in San Marcos, Texas. Normally, these fish are received in early July. Prior to arrival, production ponds are prepared by filling them with water that is filtered through 500-μm saran socks. Because water pressure is highly variable, pond filling begins 2-4 weeks prior to the anticipated stocking date. Hatchery personnel travel to the AEW and transport the fingerlings in a 2,380-L hauling box that is attached to a gooseneck trailer back to the JSFH. Upon arrival at the hatchery, the fish are tempered with pond water for up to an hour to minimize the effects of water quality differences on the fish. The fish are then enumerated by dip-netting and weighing a sample of 50 fish. This process is performed ten times to obtain a mean number of fish per kilogram. If the fish had not been measured at AEW, then the fish in a sample of 30 fish are individually measured to obtain the average length in millimeters. Once the number of fish per kilogram has been established, the kilograms of fish needed to obtain the desired stocking rate is weighed and stocked into the production ponds. Feed is offered to the fish the next day. Normally, fish are fed a floating pellet appropriate for their body length. The amount of feed fed has traditionally been based upon an established percentage of the fish biomass in the pond and fed in two rations daily. For this study however, fish were fed to satiation twice daily. Studies have indicated that optimal growth and efficiency in feed conversion are achieved when fish are fed to satiation two times per day (Andrews and Page 1975). Water quality is checked every morning and evening for dissolved oxygen, temperature, and pH using a Yellow Springs Instruments model 610 multi-parameter probe which is attached to an YSI 600XL data logger. If morning dissolved oxygen levels in ponds are below 4 mg/L, feeding is suspended in those ponds for that day. If ponds continue to have dissolved oxygen levels below 4 mg/L for two consecutive mornings, then the ponds are lowered during the day and refilled overnight with fresh water. Feeding of fish resumes when morning dissolved oxygen levels are above 4 mg/L. If dissolved oxygen (DO) levels drop below a critical level (DO = 2.5mg/L), a tractor-driven aerator is utilized to provide emergency aeration. Remedial action is taken to correct low DO in production ponds because catfish reduce feed intake under conditions of oxygen stress (Tucker et al 1979) or reduce feed consumption when DO levels fall below 2.0 mg/L (Hargreaves and Steeby 2000).

The production requests for 225-mm channel catfish from the JSFH have varied widely; however, these requests have not exceeded output from the available pond space and will not exceed output from these ponds if stocking rates are reduced from the 60,000 fish/ha typically used at the JSFH. This stocking rate was established based upon an expected survival of 50%, however percent return of advanced catfish in the JSFH ponds has been consistently improving with improved culture practices, whereas the target size of 225 mm is rarely attained during the production cycle. Tucker and Boyd (1978) suggested that 2,500-3,000 kg/ha of catfish can be produced in un-aerated ponds without serious risk of oxygen depletion. Using a standard length-weight table (Piper 1970), 30,000 fingerlings averaging 225 mm should have a harvest weight of approximately 2,800 kg. Therefore, the objective of this study was to determine if low stocking rates of 30,000-35,000 fish/ha can improve 225-mm catfish production and water quality compared to the current rate of 60,000 fish/ha.

MATERIALS AND METHODS

Eight earthen ponds (0.28-0.36 ha) were selected for this study. Filling of ponds with water began approximately one month prior to the anticipated stocking date. The water was filtered through 500-μm saran socks to prevent the introduction of wild fish into the rearing ponds. The ponds were randomly chosen to be either a high-density or a low-density treatment. Target study stocking rates were 35,000 fish/ha and 68,000 fish/ha for the low-density and high-density treatments, respectively.

On June 26, 2001, fish for the study were received from the AEW by ground transportation. Upon arrival, fish were tempered for water quality and stocked into ponds at 53,062-68,201 fish/ha for the high-density treatment and 34,682-35,263 fish/ha for the low-density treatment. Ponds were monitored twice daily for temperature, pH, and dissolved oxygen levels. In addition, ammonia levels were taken in ponds once a week. If morning dissolved oxygen levels were below 4 mg/L or un-ionized ammonia nitrogen levels exceeded 0.1 mg/L (Warren 2001), feeding of fish was suspended. To improve water quality in these situations, the affected pond was partially drained during the day and refilled with fresh water at night. This activity was repeated until water quality conditions improved (i.e., DO ≥6 mg/L). If morning dissolved oxygen levels fell below 2.5 mg/L, emergency aeration was provided using a tractor-driven aerator.

Fish were offered a floating 1/16” pelleted, 32% protein commercial feed beginning the day after stocking. Feed size was increased to 1/8” and 3/16” floating feed when fish samples indicated an average length of 150 and 175 mm total length, respectively. Fish in all ponds were fed to satiation twice a day unless water quality (DO or un-ionized ammonia levels) prohibited feeding.

Fish were sampled once a week to determine average length and body condition. Initially, fish were sampled by taking a grab sample with a dip net near the pond drain box. As the fish grew larger and were able to avoid capture by dip netting, the sampling method was switched to hook and line. Sampling involved measuring 30 fish individually to get an average length for the pond and weighing each fish to determine body condition. When samples indicated that the fish had reached the 225-mm target size, ponds were drained to harvest the fish. Available man power and equipment for stocking fish into designated water bodies limited the number of ponds that could be harvested in a week. Because of this restriction, when samples indicated that the average fish length in a low-density pond had reached 225 mm, the pond was scheduled for harvest along with a high-density pond with the largest average fish size. This technique was used to equalize the production days for the treatments.

At harvest, each pond was drained to about 1/3 its full volume and the fish removed by running a wire-mesh seine through the pond. Fish were placed in tarred bucket and weighed before being placed into a hauling unit consisting of three 757-L tanks filled with water. When the majority of the fish had been harvested, 10 samples of 50 fish each were taken from the hauling unit and weighed. This information was used to calculate the number of fish/kg. This number was multiplied by the total weight of fish harvested to obtain the number of fish harvested. In addition, 30 fish were measured for total length to obtain an average harvest length for each pond. After all ponds had been harvested, the data were compiled and analyzed using the Means and *t*-test procedures of the Statistical Analysis System (SAS Institute 2002). Statistical significance was set at $P \leq 0.05$.

RESULTS AND DISCUSSION

The culture period lasted an average of 132 production days for the high-density treatment and 131 production days for the low-density treatment. Overall, decreasing the stocking density appeared to have had a positive effect by enabling the JSFH to obtain the 225-mm target length within one production cycle. Fish size, in terms of mean total length and mean number of fish/kg, significantly differed between treatments (Table 1), whereas mean values of growth rate, survival, weight harvested, number harvested, feed conversion ratio (FCR), or water quality parameters (DO, temperature, and pH) did not significantly differ between treatments (Tables 1 and 2). Mean total length was significantly greater ($P < 0.05$) for the low-density treatment than for the high-density treatment; however, mean growth rate (mm/day) was not significantly different between treatments. The high-density ponds had a mean daily growth of 1.12 mm/day and the low-density ponds had a mean daily growth of 1.35 mm/day. The increased growth rate of 0.33 mm/day promoted by the low-density treatment, while not statistically significant, resulted in meeting the 225-mm target size within the study period. The number of fish/kg harvested was also significantly greater for the low-density treatment. The low-density treatment ponds had a mean size of 11.22 fish/kg compared to the 17.19 fish/kg for the high-density treatment. It is important to note that the standard deviation suggested that the fish from the low-density treatment ponds were more uniform in weight compared to fish from the high-density treatment ponds. Fish from the low-density treatment ponds had a standard deviation of 0.59 fish/kg compared to a standard deviation of 2.90 fish/kg for fish from the high-density treatment ponds. In terms of total weight harvested, there was no significant difference between treatments. The high-density treatment ponds had a mean harvest weight of 720.42 kg and the low-density treatment ponds had a mean harvest weight of 711.93 kg. This observation is important, especially when the number of fish harvested was significantly different between treatments. The high-density treatment ponds had a mean of 12,373 fish harvested and the low-density treatment ponds had a mean of only 7,990 fish harvested. The difference in survival between treatments, while not statistically different, was significant from a production standpoint. The high-density treatment ponds had a mean survival of approximately 66% (range = 53.88-75.65%) and a standard deviation of 9.15 whereas the low-density treatment ponds had a mean survival of 76.34% (range = 74.14-81.52%) and a standard deviation of only 3.47%. These results indicate that the low-density treatment ponds produced an average of approximately 10% more of the stocked fish with little size variation among them compared to the high-density treatment ponds. The high-density treatment had a mean FCR of 1.32 compared to 1.29 for the low-density treatment. There was no significant difference in FCR between the two treatments.

This study was implemented because the JSFH was unable to attain the 225-mm target size for catfish before low water temperatures slowed their growth in late fall. Several studies have indicated that stocking rate influences fish production. In one study, conducted over a three-year period on a commercial facility, researchers found that net production, in terms of weight, increased with an increase in stocking density, but the mean weight of the fish, in terms of kg/fish, decreased as stocking density increased (Tucker et al 1993). The present study showed that there was no significant difference in weight harvested between the two treatments but there was a significant difference in terms of mean weight of the fish. The low-density ponds yielded a mean weight of 711.93 kg and the high-density ponds yielded a mean weight of 720.42 kg; yet in terms of mean fish weight, a significant difference was realized. Fish from the low-density ponds had a mean of 11.22 fish/kg while fish from the high-density ponds had a mean of 17.19 fish/kg. This research revealed that while a commercial producer could expect a greater yield, in terms of weight harvested, the fish would be of a smaller size than the fish would have been if stocked at a lower density. In another study dealing with the effect of stocking density on production characteristics and costs, researchers found that the cost per fish produced was reduced significantly as stocking density increased but fish length at harvest was greater as stocking density decreased (Engle 2001). While high stocking densities may be more cost effective for commercial producers as suggested by Engle (2001), the present study results indicated that catfish production goals for the JSFH might be better served by reducing stocking densities in order to increase the length of fish at harvest. The present study results concur with earlier findings that stocking density has significant effect on fish harvest length and that the JSFH can produce 225-mm catfish from 50-mm fingerlings in approximately 130 production days with stocking rates of 34,000 -35,000 fish/ha.

Another area of concern was water quality and the limited ability to improve water quality by adding fresh water to ponds. In a study by Cole and Boyd (1986), channel catfish ponds were stocked at different densities and fed 3% of the body weight. They found that little supplemental aeration was needed at a feeding rate of 56 kg/ha/day; however, as feed consumption increased, water quality decreased and more aeration was required. Thus, I expected the high-density ponds to experience water quality problems compared to the low-density ponds. However, there was no significant difference in water quality between the treatments. This may, in part, be attributed to the fact that the fish were fed to satiation twice daily instead of by percent body weight. Apparently, feed waste, if any, was minimal with the satiation feeding strategy. The low-density treatment fish were fed 64 kg of feed less than the amount fed to the high-density treatment fish and yet there was no significant difference in the weight harvested between the treatments.

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Table 1.–Mean ± SD total length, fish/kg harvested, growth rate, survival, weight harvested, fish harvested and food conversion ratio for channel catfish ponds stocked at two different densities. Values along a row bearing the same letter are not significantly different (*P > 0.05*).

Variable	High-density treatment	Low-density treatment
Total length (mm)	205.78 ± 6.20x	233.53 ± 7.78y
Fish/Kg	17.19 ± 2.9x	11.22 ± 0.59y
Growth rate (mm/day)	1.12 ± 0.07z	1.35 ± 0.19z
Survival (%)	66.06 ± 9.15z	76.34 ± 3.47z
Weight harvested (kg)	720.42 ± 41.79z	711.93 ± 60.32z
Fish harvested	12,373.25 ± 2,133z	7,990.25 ± 898.61z
Food conversion ratio	1.32 ± 0.07z	1.29 ± 0.029z

Table 2.–Means ± SD of water quality variables in channel catfish ponds stocked at two different densities. Values along a row bearing the same letter are not significantly different (*P > 0.05*).

Variable	High-density treatment	Low-density treatment
Morning Temperature (°C)	25.72 ± 4.67z	25.75 ± 4.67z
Afternoon Temperature (°C)	27.92 ± 5.74z	28.07 ± 5.59z
Morning Dissolved Oxygen (mg/l)	5.23 ± 1.55z	5.30 ± 1.48z
Afternoon Dissolved Oxygen (mg/l)	9.47 ± 2.00z	9.58 ± 2.35z
Morning pH	6.66 ± 0.34z	6.64 ± 0.28z
Afternoon pH	8.05 ± 0.87z	8.09 ± 0.93z

PWD RP T3200-1560 (4/10)