Enhancing Farmers' Income through Polyculture of Paddlefish with Catfish in the Southern Region

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Summary

Paddlefish, Polyodon spathula, is an alternative fish species that can be cultured together with channel catfish, Ictalurus punctatus, providing additional income to farmers through diversification. The growth model for this regional project preformed in Alabama, Kentucky and Oklahoma indicated significantly greater weight gains of fish in KY (2.74 kg) and AL (2.52 kg) than fish in OK (2.24 kg). The addition of paddlefish to a catfish pond can increase production up to 300 kg/ha, with input costs of only fingerlings (> 35 cm in total length) and harvest and can contribute to farm income. Market survey identified paddlefish as desirable.

Introduction

As the U.S. aquacultural industry continues to expand, species diversification, modernization of traditional production systems, and the development of innovative production methods must be studied to increase efficient use of water resources and to lower production costs (Harvey, 1991). Traditional aquacultural species in pond culture are expensive because of the high costs for land, pond construction and feed. Polyculture has become a popular method for increasing fish production in inland waters while classical capture fisheries are on the decline (Welcomme, 1992). Conflicting demands for land and water, and the costs for pond construction and feed supplies, will limit the development of intensive aquaculture (Harvey, 1991). Further enhancement of fish production in the world as well as the U. S. will depend on the increased use of polyculture (Bardach, 1972; Huet, 1979; Milstein, 1997). There is also a need for high valued species, especially when there is no substitutive wild catch and a market can be established (Harvey, 1991). Paddlefish, Polyodon spathula, is an alternative fish species that meets these criteria and merits research for our expanding aquacultural industry.

Paddlefish is a filter feeder that relies on zooplankton throughout its life. It is long-lived (> 20 years), and grows rapidly (up to 5 kg/year) reaching sizes up to 90 kg (Mims, 1991). Paddlefish can be captured easily by seining. Paddlefish do not reproduce in static water, but can be propagated artificially (Semmens and Shelton, 1986). These characteristics make paddlefish particularly well suited for polyculture. Production of paddlefish could provide a profitable and sustainable system for meat and potentially for caviar production, and create job opportunities at the same time.

Tremendous numbers of ponds have been constructed and used for catfish production in this country. These ponds are rich in natural foods and nutrients that are promoted by the excess feed and excrement of catfish. Some exotic filter feeder species such as big head carp have been used to increase the yield of fish per acre (Tucker and Robinson, 1990). However, meat from these species is not well accepted by American consumers because it has many small bones and a strong fish taste. However, paddlefish yield a much more valuable meat with mild flavor, firm texture and boneless character (Mims, 1991).

To develop paddlefish culture, it is important to understand at what density to stock paddlefish in catfish ponds to maximize the synergistic interaction between the two species. Kirkendall at el. (1983) observed that 400 kg of paddlefish were produced per hectare of catfish ponds (0.04 ha) with only one stocking density of 900/ha, but this high stocking density resulted in small paddlefish (200 g). Therefore, we used lower stocking densities (75, 125, 175 fish/ha) in this project in order to produce larger paddlefish (>2.5 kg each) that are more suitable for smoked fish products, a value-added product with high monetary value and better consumer appeal. Further, buyer surveys were conducted on paddlefish and their associated value-added products. Based on the results from the surveys, appropriate strategies will be developed to promote paddlefish meat in the markets such as high-end restaurants, gourmet shops and catalogue sale companies.

Objectives/Performance Targets

1. To determine the effects of stocking density on the growth performance of paddlefish in catfish ponds in different areas of the southeast region of the United States and
2. To assess buyers' acceptability of paddlefish meat, willingness to the buy paddlefish products and their relevant demographic information, and to develop appropriate strategies for marketing paddlefish meat.

Materials and Methods

Paddlefish reared at the Kentucky State Aquaculture Research Center were hauled by staff and stocked at three densities (75/ha, 125/ha, and 175/ha) in 0.2ha to 4.8ha commercial channel catfish ponds in Kentucky (KY), Alabama (AL), and Oklahoma (OK). These ponds were in continuous, multi-batch catfish production. Paddlefish fingerlings weighed between 155- 228g and individuals were counted prior to stocking (Spring 2000, 2001).

Weight and length data were collected and recorded at stocking and every 3 months until harvest from all locations. Samples were obtained by partial seining with a four hundred –foot seine. Final data were collected at harvest. Water quality parameters (total ammonia nitrogen, nitrite, pH, and alkalinity were recorded biweekly using a Hach Model FF-1A Field Kit (Hach, Loveland, Colorado). Un-ionized ammonia (NH3) data were calculated and recorded, based on a conversion

table by Boyd (1990). Dissolved oxygen and temperature were monitored daily using an YSI oxygen meter and a (YSI, Yellow Springs, Ohio). Farmers practiced standard pond management procedures (emergency aeration and chemical treatments) common to traditional catfish production.

Average growth and total survival of paddlefish from all stocking densities and locations were compared using a standard t-test. In addition, differences in water quality parameters between stocking densities and locations were also tested using a standard t-test. To determine effects among survival, weight gain, harvest weight and stocking densities, data were analyzed using multi-regression procedures. A complete economic analysis of the revenue contribution of paddlefish ($/ha), and input cost (seed stock, labor), were conducted.

A workshop for the Purchase Area Aquaculture Cooperative (PACC) plant in Kentucky was conducted to educate employees on paddlefish processing. Further, marketing was also conducted after the paddlefish were processed to produce a complete summary of the total production cycle. Chefs of eighteen upscale restaurants were surveyed to assess paddlefish, their willingness to buy and other categorical information on their business.

Results and Discussion/Milestones

Fish Production

In the first year, only Kentucky catfish ponds gave suitable results and statistical analyses for paddlefish survival, growth and yield. High mortality of paddlefish (including catfish) stocked in some of the ponds in OK and AL occurred from anoxia conditions during the 12-month production cycle. In Kentucky, results indicated that paddlefish at lower stocking density (125/ha) are heavier (3.23ƒp0.56 kg) than paddlefish (2.52ƒp0.45 kg) cultured at higher stocking density (175/ha). Mean growth rate and survival rate did not differ significantly between the two stocking densities. Water quality was not significantly different between the two stocking densities except for alkalinity, which unlikely affected growth and survival of the paddlefish (see attached publication Schardein et al. 2002 for more details).

Since paddlefish are filter-feeders, it was expected that density-dependent growth would be higher for a lower densities, as there would be less natural food at higher densities. Our results are consistent with the hypothesis that stocking at 125/ha yielded significantly heavier foodfish than the average harvest weight of fish stocked at 175/ha. These results represented the first field trial for introducing paddlefish into commercial channel catfish ponds and show positive results of producing small quantities of paddlefish. Preliminary economic analysis suggested that paddlefish contribute to catfish farm income by $220/ha and $151/ha, for 125/ha and 175/ha stocking density, respectively.

In the second year, the mean weights of paddlefish in KY, AL and OK were 2.74, 2.52 and 2.24 kg, respectively after one year of growth. Production yields were up to 300 kg/ha.

The following growth model was developed:

Weight = EXP[4.616+1.011*time+0.008*stock density-0.102(Lnstock density*time) +0.129(KY)*0.220(AL)].

In all densities, growth was curvilinear (no plateaus in growth were reached) that indicated further growth could have occurred or higher stocking densities could be feasible. In all locations, paddlefish were subjected to above seasonal temperatures and low water levels (little or no water replacement due to drought conditions). Survival was significantly higher the second year 73% (AL), 65% (KY) and 54% (OK). Improvements in hauling paddlefish fingerlings and pond management are credited for the higher survival. Catfish farmers in this study felt that the paddlefish were beneficial in maintaining good water quality, though a comparison on water quality from pond water having only catfish was not part of this study.

Market Survey

Paddlefish fillets were taken to chefs at 24 upscale restaurants in Kentucky. Eighteen restaurant chefs agreed to sample and respond to our survey. Less than half of the chefs have had experience with preparing paddlefish. On a scale of 1 to 6 (1: extremely undesirable, 6:extremely desirable) the 18 chefs rated the paddlefish the following: flavor 3.76, texture 3.02, moistness 4.00, appearance 4.35 and cooking ease 4.29. The chefs were asked, “how paddlefish compared with their gold standard seafood products such as sea bass, halibut and Dover sole)?

Thirteen percent said that paddlefish was “about equal” to their gold standard, 68% said that paddlefish was “slightly inferior” to their gold standard, and 19% said that paddlefish was”much inferior” to their gold standard. When asked, “how much their restaurant would pay for paddlefish with respect to their gold standard seafood products?”, 6% of the chefs said they would pay equal to the gold standard prices (range $12 to 14/lb), 31% said they would pay at 75% of their gold standard and 63% of the chefs would pay 50% of their gold standard. This would indicate a willingness to pay about $6 to 7/lb for paddlefish. Most of the chefs found that the paddlefish meat was versatile and could be prepared in many ways (eight (8) different responses on preparation). All but one chef indicated that they could use paddlefish on their menu. On the average chefs indicated that they could use about 14 pounds per week over about 25 weeks per year. In these 18 restaurants alone, about 5,000 pounds of paddlefish fillets/year could be purchased which represents a production of about 20,000 pounds of live-weight fish/year. This would represent about $0.80 to $1.00/ lb liveweight to the farmers.

Impact of Results/Outcomes

To date, this project has made catfish farmers aware of the potential of polyculture of paddlefish and catfish for positive net returns. In Kentucky, a tobacco settlement grant ($411,000) through the Office of the Governor Ag. Policy (OGAP) was awarded to Aquaculture of Kentucky, Inc. to build a paddlefish hatchery and to provide fingerlings to over 60 catfish farmers in the PAAC. Also, Shuckman’s Fish Company and Smokery (www.kysmokedfish.com) received a $300,000 grant from (OGAP) to upgrade plant including state-of the art smokehouse and cryovac packer for smoked paddlefish and other fish products.

In the future, farmers could provide a regular supply of paddlefish meat to markets that were identified from this project and further expand into other markets. In combination with all-female paddlefish technology developed at Kentucky State University Aquaculture Research Center and farmers, all-female paddlefish could be available for stocking reservoirs and producing mature fish for caviar production.

Economic Analysis

Preliminary economic analysis is provided in the attached power point presentation as presented at the World Aquaculture Society Conference in Louisville, KY Feb. 20, 2003 at a special session on “Paddlefish in Aquaculture: Perspectives and Directions.”

Publications/Outreach

Publications:

Schardein, M.J. 2003. Polyculture of paddlefish with catfish in the southern region of the United States. Master of Science thesis, Kentucky State University, Frankfort, KY (in review).

Schardein, M.J., S. Dasgupta, and S.D. Mims. 2002. Growth, weight, and survival of paddlefish, Polyodon spathula, stocked at two densities in channel catfish, Ictalurus punctatus, ponds. Journal of the Kentucky Academy of Science 63(2):93-96.

Schardein, M.J., S. Dasgupta and S.D. Mims. 2003. Second year data on paddlefish, Polyodon spathula, stocked at three densities in commercial channel catfish, Ictalurus punctatus, ponds. Published Abstract, Special session Paddlefish in Aquaculture: Perspectives and Directions, Aquaculture America 2003, Louisville, KY, Feb. 18-21.

Schardein, M.J. and S.D. Mims. 2003. Feasibility of polyculturing paddlefish in commercial channel catfish ponds in the southern region. Journal of World Aquaculture Society (in preparation).

Burdine, K.H., A.L. Meyer and S.D. Mims. 2003. Market potential of farm-raised paddlefish.
Aquaculture (in preparation).
Pamphlet:Mims, S.D., 2002. Reservoir ranching of paddlefish in Kentucky: A state survey.

Farmer Adoption

Catfish farmers in Kentucky and Illinois have expressed their interest to continue to grow paddlefish in polyculture with catfish once fingerlings are commercially available.
This production method could also provide the large stocker fish that would be needed for reservoir ranching and caviar production. Currently a pilot project using public reservoirs is being considered. This pilot project would require about 10,000 paddlefish stockers that would be purchased through the PAAC, a fish farmer cooperative in KY.

Over 80 fish farmers have been reached by this project. It is recommended that farmers interested in polyculturing paddlefish with catfish would stock at least a 12-14-inch (total length) fish, in the fall or spring (cool months, below 70ƒ²C). Fish should be hauled in water with 0.5% salinity (NaCL) at temperatures below 70ƒ²C using compressed or liquid oxygen. Oxygen levels in catfish ponds should be maintained above 3 ppm. Paddlefish are easy to sort and should be sorted from the catfish first to prevent injury. Paddlefish can be hauled to processing plant on ice similar to hybrid striped bass.

Areas Needing Additional Study

Further marketing channels need to be studied on various fillet sizes in order to determine production of fish size and hence density. Once market channels with greatest potential have been identified, appropriate promotional strategies should be developed. Paddlefish should also be tested in polyculture with other fish species and crustaceans (freshwater shrimp).

Participants: