A HISTORICAL PERSPECTIVE OF CATFISH PRODUCTION IN THE SOUTHEAST IN RELATION TO AVIAN PREDATION

DONALD F. MOTT, U.S. Department of Agriculture, Animal and Plant HealthInspection Service, Animal Damage Control, Denver Wildlife Research Center, P.O. Drawer 6099, Mississippi State, MS 39762

MARTIN W. BRUNSON, Department of Wildlife and Fisheries, Mississippi State University, Box 9690, Mississippi State, MS 39762

ABSTRACT: Production of aquaculture species, especially catfish (Ictalurus punctatus) in the Mississippi Delta, is a relatively new and expanding industry. Catfish production represents the largest dollar value of the aquaculture industry, accounting for approximately 50% of the entire industry. Mississippi is responsible for 82% of the total U.S. catfish production. Fish-eating bird populations have capitalized on this new food source. Double-crested cormorants (Phalacrocorax auritus), great blue herons (Ardea herodias), and great egrets (Casmerodius albus) are the primary predators on catfish. Cormorant caused losses in excess of $2 million per year have been reported in Mississippi. U.S. Department of Agriculture research and operational assistance programs have been established in the southeast to determine the economic impact that birds have on the aquaculture industry, and to develop and implement technology that can be used in integrated strategies to solve bird depredation problems.

Proc. East. Wildl. Damage Mgmt. Conf. 7:23-30. 1997.

Aquaculture, the culture of aquatic plants and animals, has been around for over 3,000 years but is a relatively new industry in the United States. In the U.S., the aquaculture success story has been the cultivation of channel catfish. Catfish production accounted for about half of the value of all aquaculture products harvested in this country during 1990 (Price and Nickum 1993). Catfish cultivation occurs principally in the southeastern states of Alabama, Arkansas, Louisiana, and Mississippi. As production of catfish in the southeast increased so did predation by fish-eating birds.

This paper examines the phenomenal growth of the catfish industry in the southeast and explores the role that fish-eating birds and the U.S. Department of Agriculture (USDA) Animal Damage Control (ADC) program play in the production of this aquacultural crop.

We thank F. L. Boyd, T. W. Booth, M. D. Hoy, D. LeBlanc, and P. Mastrangelo for providing information about ADC program activities in their respective states. J. Glahn, T. King, G. Larson, and G. M. Linz kindly reviewed drafts of this paper.

CATFISH PRODUCTION IN THE SOUTHEAST

Growth of the catfish industry in the southeast and particularly in Mississippi has been amazing. The first commercial catfish pond in Mississippi was constructed in 1965 (Welborn 1983), but the most rapid growth occurred during the 1980's when the industry more than doubled in size. There are now 37,450 ha of water in production within the state (USDA 1994). Mississippi, together with Arkansas (8,300 ha), Alabama (7,000 ha), and Louisiana (4,200 ha) account for 92% of all U.S. catfish acreage. Slightly over 60% of all U.S. catfish acreage is located in Mississippi (USDA 1994) but 82% of the 200 million kg (440 million pounds) of catfish processed in the U.S. last year (USDA 1995) were processed in that state.

Per capita consumption of catfish in the U.S. has increased from 0.25 pound to 0.95 pound since 1987, thanks to an aggressive marketing campaign funded by a voluntary assessment paid by producers and feed manufacturers. The Catfish Institute is a Mississippi-based non-profit promotion and marketing entity dedicated solely to the promotion of catfish and the catfish industry. Although imports of catfish have, in recent years, exceeded exports, the Catfish Institute is working hard to develop European and other markets for U.S. catfish to complement the already strong U.S. sales.

THE MISSISSIPPI DELTA

Most catfish production in Mississippi occurs in the northwest part of the state in a 16,000 km^2 alluvial plain of the Mississippi River, commonly referred to as the Mississippi Delta. Catfish production is interspersed with cotton and soybean acreage throughout this intensively farmed region.

Catfish cultivation in the Delta is characterized by large, intensive pond systems. The average Delta catfish farm comprises 175 water ha, with an average pond size of 5-6 ha. The combination of size, scope, and intensity of management on Delta catfish farms makes this industry unique in U.S. aquaculture. Approximately 50 fish and shellfish species are cultured nationwide, but catfish represents the largest dollar value. Pond culture of catfish in the Delta is perhaps the most visually striking and impressive of all systems currently in use.

Large catfish ponds are not drained for harvest, but rather a "continuous cropping" technique is employed. The typical harvest/restock scenario involves seining with a mesh size that will capture harvestable size (0.5 kg) fish while allowing smaller fish to pass through. Those fish that are removed are replaced immediately with fingerlings (10-18 cm). Consequently, most ponds contain mixed-size populations that are selectively harvested 3-6 times annually. This "topping" system has stabilized both flow of fish to processors and cash-flow to producers, but has created widely dispersed numbers of small fish that are vulnerable to predation by birds.

Although much of the Delta has been drained for farmland, more than 10% of the original wetland remains. These areas, consisting of cypress swamps and bayous, provide breeding and roosting habitat for fish-eating birds that are involved in conflicts with the aquaculture industry in the Delta.

ANIMAL DAMAGE CONTROL INVOLVEMENT

Catfish producers in the Delta and elsewhere in the southeast did not experience avian depredation conflicts until the early 1980's. As catfish acreage and bird populations increased so did producer anguish over fish-eating birds on their ponds.

As bird problems grew, the ADC operational programs in Alabama, Arkansas, Louisiana, and Mississippi responded by assisting producers in developing and implementing damage management plans, providing training in the use of abatement techniques, and loaning equipment. ADC personnel also began recommending the issuance of U. S. Fish and Wildlife Service depredation permits to producers. These permits allow the removal of a limited number of depredating birds. Incorporated into integrated damage management plans, this strategy involves the removal of birds in order to supplement and reinforce nonlethal control methods. In 1988, the ADC program established a research station at Mississippi State University, Starkville, MS to study the impact that birds have on the aquaculture industry in the southeast and to develop and improve technology to reduce these conflicts. The same year, ADC operations established a district office in the Mississippi Delta at Stoneville, MS to provide additional assistance to the catfish producers in Mississippi and to assist ADC research efforts.

In 1994, the escalating bird problems in aquaculture resulted in increased funding to augment control efforts and support research programs. This allowed ADC to increase its presence and effort in the catfish producing states in the southeast. In Alabama, ADC operations hired a full-time biologist who was located in the center of the main catfish production area of the state. An aquaculture coordinator was also added to the staff at the Stoneville district office. This biologist coordinates all operational activities within the catfish production areas of Mississippi. In

Louisiana, the ADC program expanded their efforts to deal with emerging problems with American white pelicans (Pelecanus erythrorhynchos) on catfish ponds. Research on pelican behavior and population status was also initiated. In Arkansas, active bird scaring programs were expanded to catfish producing areas experiencing bird problems.

Much of the following information results from the combined efforts of the research and operational components of the ADC program.

AVIAN PROBLEMS AT CATFISH FARMS

Bird Species Involved

The expanding U.S. aquaculture industry has experienced increasing bird depredations. Fish-eating birds cause a significant amount of distress at most fish production facilities, including catfish farms, in the southeastern states (Scanlon et al. 1978, Mott 1978, Stickley and Andrews 1989). Although many birds are known to prey on fish, in the major catfish producing states concern has been directed mostly at double-crested cormorants and wading birds, especially the great blue heron and great egret. Most recently, American white pelicans are becoming more numerous at aquaculture facilities in Arkansas, Louisiana, and Mississippi. Pelican foraging behavior, higher food requirements, and their nightime foraging habits make these birds potentially troublesome to fish producers.

Coincidental with the growth of the catfish industry in Mississippi, double-crested cormorant numbers have shown a dramatic growth in the past 20 years, apparently related to decreased pesticide contamination and increased legal protection afforded this species (Ludwig 1984, Vermeer and Rankin 1984). Dolbeer (1990) estimated an annual rate of growth of 18% during the 1970's and early 1980's for the inland populations of cormorants. The National Audubon Society (1970-87) has chronicled this buildup in wintering cormorants in Mississippi. Dolbeer (1991) analyzed band recovery records to determine the migration patterns and origins of cormorants involved in catfish predation problems. He found that from 38 to 70% of the birds from Saskatchewan through the Great Lakes area were recovered in the lower Mississippi Valley. A peak number of about 30,000 cormorants now winters in the Mississippi Delta (Aderman and Hill 1995, Glahn and Stickley 1995).

In the Mississippi Delta, great blue herons are found year around, whereas great egrets traditionally winter further south in Mexico, Central and South America with some wintering along the Gulf coast (Palmer 1962). Stickley et al. (1995a) suggested that about 7,000 great blue herons were supported by the catfish industry in the Mississippi Delta. Similar information on the population of great egrets is lacking.

The status of white pelicans in the Mississippi Delta is less understood. King (unpubl. data) counted peak wintering populations of about 3,300 pelicans in late March 1995 along the Mississippi River. Band recoveries of pelicans trapped in southern Louisiana and the Mississippi Delta were exclusively from a breeding colony in southwestern Minnesota (D. T. King, U.S. Dept. Ag., Starkville, M.S., pers. commun.)

Extent of Losses

Because cultivation of catfish in the U.S. is relatively new, little documented evidence on the extent of bird caused losses existed when problems became more noticeable. One of the first projects of the ADC research station at Starkville, MS was to conduct a survey of Mississippi catfish farmers regarding their perception of the bird problem. Of the 281 farmers questioned during 1988, 87% (244) felt they had a bird problem and out of necessity had to take some action to attempt to reduce losses (Stickley and Andrews 1989). Despite producer expenditures of $2.1 million to combat bird predation, Stickley and Andrews (1989) estimated that cormorants in Mississippi still consumed up to $3.3 million worth of catfish. Stickley et al. (1992) found that cormorants could have a devastating impact on catfish populations if allowed to feed unmolested. They determined that an average of 30 cormorants feeding for an hour at the average feeding rate of 5 catfish per cormorant-hour would cost $13.45, whereas the cost would be $75.64 at the highest foraging rate (28 catfish per cormorant-hour). They calculated that an average of 30 cormorants feeding at the highest foraging rate could remove half the fingerlings in a 8 ha pond in 30 days. Glahn et al. (1995) examined cormorants collected at catfish ponds and found that catfish composed 64% of their stomach contents. Catfish and gizzard shad (Dorosoma cepedianum) accounted for over 90% of their diet. In a further analysis of losses, Glahn and Brugger (1995) used a bioenergetics modelling approach to estimate the impact of wintering cormorants on the Mississippi Delta catfish industry. This was accomplished using recent literature sources and specific data on wintering cormorant populations, their food habits, daily activity, and digestion efficiencies. They estimated that in the Mississippi Delta cormorants may have eaten up to 20 million catfish per winter in 1989-90 and 1990-91. This represents approximately 4% of the estimated standing crop at a replacement cost of $2 million annually.

Less information is known about wading bird predation on catfish. Stickley et al. (1995a) conducted censuses and observations of great blue herons on catfish farms in one Mississippi Delta county and analyzed the stomach contents of 124 great blue herons taken under depredation permits in scattered locations throughout the Delta. Biomass in stomachs from herons collected at catfish farms averaged 41% catfish and 38% sunfish (Lepomis spp.). Observational data indicated that individual herons take an average of 12 10-cm catfish fingerlings daily. Based on an average population of 22 herons, the average catfish farm could be losing $3,800 per year to herons.

In Alabama, Ross (1994) studied great blue herons and great egrets on commercial catfish facilities to gather data on their diet composition and foraging behavior. Through observations, he calculated that the great blue heron diet was composed of 60% catfish with sunfish and various minnows (including Gambusia spp.) accounting for most of the other prey species. Great egrets consumed more sunfish (38%) than catfish (34%) and minnows made up 16% of their diet. Using these data and foraging observations reported by Ross (1994), great blue herons were estimated to each consume about 900 g of catfish per day, whereas, a great egret ate just under 450 g of catfish per day.

AVIAN CONTROL METHODS AT CATFISH FARMS

Frightening Strategies

Attempts to control avian predation at catfish farms most often include the use of bird frightening devices. Littauer (1990a) described a number of auditory devices that have been used successfully to chase birds off aquaculture facilities. These include pyrotechnics fired from hand held pistols or shotguns; live ammunition (primarily .22 caliber cartridges that are lower in cost than pyrotechnics); propane gas exploders that emit loud explosions at controllable intervals; and recorded distress calls of the primary depredating species. Visual frightening devices are used that include human-shaped effigies or scarecrows, reflective mylar ribbon (flash tape), helium balloons, and beach balls with eye spots. Littauer (1990a) also recommended parking vehicles on pond levees as an effective means of scaring birds. This technique seems to work especially well when birds are being harassed from a vehicle as part of an overall scaring program.

Although frightening devices are used most frequently in the southeastern states to control bird damage, little factual data on their effectiveness exists. Stickley et al. (1995b) evaluated an electronically-controlled, effigy type frightening device during the winter months in Mississippi. During its frightening routine, the blaze-orange effigy inflates to its full height of 1.7 m, bobs up and down, and emits a high-pitched wail before collapsing. Replicated testing of this device at catfish farms showed dramatic reductions in cormorant numbers. Some cormorants, usually only single birds or small groups, appeared to habituate to the device over time. Overall, this device, used in conjunction with harassment patrols, was judged superior to the use of other frightening methods such as propane exploders or harassment patrols alone.

An effective frightening program on catfish farms with large ponds and high bird pressure can require continuous harassment by one or more employees driving pond levees. Littauer (1990b) described such a strategy that involved driving the levees while employing a variety of frightening devices including pyrotechnics, live ammunition, distress calls, and electronically generated noises. Integrated and aggressive approaches are the key words in this tactic. Frightening programs should be initiated early in the damage season before the birds establish a feeding pattern; efforts should begin early in the day; a variety of devices should be used; and the location of devices (i.e., scarecrows and exploders) should be changed frequently.

Despite determined efforts to frighten birds off catfish ponds, individuals or small groups may habituate to the frightening program. To minimize habituation, Slater (1980) suggested, among other things, that occasional reinforcement with shooting should be incorporated. Littauer (1990b) also implied that the limited killing of birds would reinforce a frightening program.

Dispersing cormorants from nightime roost sites is an alternative way to reduce their predation at catfish ponds. In Mississippi, Mott et al. (1992) demonstrated that roosting cormorants can be easily relocated by use of pyrotechnic devices and as a result the number of cormorants foraging near the roost were substantially reduced. Results of a recently completed 2-year evaluation of this technique in the Mississippi Delta further illustrate its utility in reducing cormorant predation (Mott unpubl. data). In this study, catfish farmers were responsible for dispersing cormorants from up to 40 different winter roost sites each year. Because of the success of dispersal and observed benefits by catfish farmers, Delta-wide roost dispersal will continue under the guidance of the Mississippi ADC operations program.

Exclusion Techniques

The surest means of preventing catfish losses to birds is to mechanically exclude them from access to the fish. A variety of nets, wires, ropes, strings, and nylon lines strung at differing heights and configurations have been used to prevent birds from foraging at aquaculture facilities (McAtee and Piper 1937, Lagler 1939, Naggiar 1974, Barlow and Bock 1984, Moerbeek et al. 1987, Davis 1990, May and Bodenchuk 1992, Mott and Flynt 1995, Mott et al. 1995). Although exclusion devices were judged useful under some circumstances (usually on small ponds) the logistics of constructing these systems on the larger catfish ponds (6-10 ha) in the southeastern states have not been devised (Littauer 1990b, Davis 1990). Levees on many farms are not wide enough to accommodate poles and other supporting structures needed to span long distances. Likewise, many catfish farmers find barrier systems impractical due to their interference with harvesting and other cultural practices. Estimates of $2,500 per ha to enclose a pond may also make such systems prohibitively expensive (Littauer 1990b).

Electric fencing systems may hold promise for economically excluding wading birds from catfish ponds. Mott and Flynt (1995) evaluated a two-strand electric fence barrier to exclude great blue herons and great egrets from catfish ponds. Fencing 5 ponds resulted in >90% reduction in pond use by these birds.

Other Control Methodology

Other methods of damage prevention include considerations given to the initial design of the fish-raising facility and management of the fishery stock. Salmon and Conte (1981) recommended constructing ponds in a rectangular rather than square shape, since there is more shoreline in a rectangle from which to harass birds. Overhead wire or netting systems can be more easily established on rectangular ponds, which have shorter distances to span.

Recommendations have also been made to stock more vulnerable fish (such as fingerlings) near the center of human activity and near buildings (Salmon and Conte 1981, Glahn et al. 1995). In Mississippi, Glahn et al. (1995) reported the highest consumption of catfish fingerlings occurs during late winter and early spring just before most cormorants migrate out of the area. This foraging coincides with intensive stocking of ponds with fingerlings to replace harvested adult fish. In this situation, delaying stocking catfish until after cormorants migrate would reduce this predation.

Future Outlook for Control of Bird Problems

The goal of reducing bird predation at catfish farms is not based on the development of a single method as a panacea for all damage problems, since none are likely to be cost-effective in all situations. Instead, the continuing emphasis is on developing a number of alternative solutions that can be integrated into a comprehensive management plan for cost-effectively reducing fish-eating bird damage.

LITERATURE CITED

Aderman, A. A. and E. P. Hill. 1995. Locations and numbers of double-crested cormorants using winter roosts in the Delta region of Mississippi. Pages 143-151 in D. N. Nettleship and D. C. Duffy, eds. The double-crested cormorant: biology, conservation, and management. Colonial Waterbirds 18 (Special Publication 1). In Press.

Barlow, C. G. and K. Bock. 1984. Predation of fish in farm dams by cormorants, Phalacrocorax spp. Austr. Wildl. Res. 11:559-566.

Davis, J. T. 1990. Field trials of string and streamer controls on bird depredation at aquaculture ponds. Unpublished Report. Texas A&M Cooperative Extension Service, College Station, Texas. 5pp.

Dolbeer, R. A. 1990. Double-crested cormorant population status in North America, 1970-1989. Unpublished Report. Denver Wildlife Research Center, Bird Section Research Report. No. 451. 11pp.

____. 1991. Migration patterns of double-crested cormorants east of the Rocky Mountains. J. Field Ornithol. 62:83-93.

Glahn, J. F. and K. E. Brugger. 1995. The impact of double-crested cormorants on the Mississippi Delta catfish industry: A bioenergetics model. Pages 168-175 in D.N. Nettleship and D.C. Duffy, eds. The double-crested cormorant: biology, conservation, and management. Colonial Waterbirds 18 (Special Publication 1). In Press.

______. and A. R. Stickley, Jr. 1995. Wintering double-crested cormorants in the Delta region of Mississippi: Population levels and their impact on the catfish industry. Pages 137-142 in D.N. Nettleship and D.C. Duffy, eds. The double-crested cormorant: biology, conservation, and management. Colonial Waterbirds 18 (Special Publication 1). In Press.

___, P. J. Dixon, G. A. Littauer, and R. B. McCoy. 1995. Food habits of double-crested cormorants wintering in the Mississippi Delta. Pages 158-167 in D.N. Nettleship and D.C. Duffy, eds. The double-crested cormorant: biology, conservation, and management. Colonial Waterbirds 18 (Special Publication 1). In Press.

Lagler, K. F. 1939. The control of fish predators at hatcheries and rearing stations. J. Wildl. Manage. 3:169-179.

Littauer, G. A. 1990a. Avian predators: frightening techniques for reducing bird damage at aquaculture facilities. Southern Reg. Aquaculture Publ. 401. Miss. Coop. Extension Serv., Mississippi State, Miss. 4pp.

__. 1990b. Control of bird predation at aquaculture facilities: strategies and cost estimates. Southern Reg. Aquaculture Publ. 402. Miss. Coop. Extension Serv., Mississippi State, Miss. 4pp.

Ludwig, J. P. 1984. Decline, resurgence and population dynamics of Michigan and Great Lakes double-crested cormorants. Jack-Pine Warbler 62(4): 91-102.

May, A. J. and M. J. Bodenchuk. 1992. "Wire" grid excludes cormorants from commercial catfish ponds. The Probe 125:4.

McAtee, W. L. and S. E. Piper. 1937. Excluding birds from reservoirs and fishponds. U.S. Dep. Agric., Leafl. 120. 6pp.

Moerbeek, D. J., W. H. Van Dobben, E. R. Osieck, G. C. Boere, and C. M.Bungenberg De Jong. 1987. Cormorant damage prevention at a fish farm in the Netherlands. Biolog. Conserv. 39:23-38.

Mott, D. F. 1978. Control of wading bird predation at fish-rearing facilities. Pages 131-132 in A. Sprunt, J. Ogden, and S. Winckler, eds. Wading Birds, Res Rep. #7. National Audubon Soc., New York. N.Y.

__ and R. D. Flynt. 1995. Evaluation of an electric fence system for excluding wading birds at catfish ponds. Prog. Fish Cult. 57:88-90.

___, K. J. Andrews, and G. A. Littauer. 1992. An evaluation of roost dispersal for reducing cormorant activity on catfish ponds. Proc. East. Wildl. Damage Control Conf. 5:205-211.

_____, R. D. Flynt, and J. O. King. 1995. An evaluation of floating ropes for reducing cormorant damage at catfish ponds. Proc. East. Wildl. Damage Control Conf. 6:93-97.

Naggiar, M. 1974. Man vs. birds. Florida Wildl. 27:2-5.

National Audubon Society. 1970-1987. American Birds, Central Southern Region, 25:754; 26:615; 28:649; 31:339; 32:362; 33:228; 35:307; 36:302; 37:309; 38:212, 325; 40:290; 41:291, 445.

Palmer, R. S. 1962. Handbook of North American birds. Volume 1, loons through flamingos. Yale University Press, New Haven, 567pp.

Price, I. M. and J. G. Nickum. 1993. Aquaculture and birds: the context for controversy. Pages 6-18 in J. V. Huner, ed. Management of fish eating birds on fish farms: A symposium. National Aquaculture Association/National Audubon Society. 51pp.

Ross, P. G. 1994. Foraging ecology of wading birds at commercial aquaculture facilities in Alabama. M.S. Thesis, Auburn Univ., Auburn. 65pp.

Salmon, T. P. and F. S. Conte. 1981. Control of bird damage at agriculture facilities. U.S. Fish and Wildl. Serv. Wildl. Manage. Leafl. 475, 11pp.

Scanlon, P. F., L. A. Helfrich, and R. E. Stultz. 1978. Extent and severity of avian predation at federal fish hatcheries in the United States. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies. 32:470-473.

Slater, P. J. B. 1980. Bird behaviour and scaring by sounds. Pages 105-114 in E. N. Wright, I. R. Inglis, and C. J. Feare, eds. Bird problems in agriculture. British Crop Protection Council. Croydon, U.K. 210pp.

Stickley, A. R., Jr., and K. J. Andrews. 1989. Survey of Mississippi catfish farmers on means, effort, and costs to repel fish-eating birds from ponds. Proc. East. Wildl. Damage Control Conf. 4:105-108.

__, G. L. Warrick, and J. F. Glahn. 1992. Impact of double-crested cormorant depredations on channel catfish farms. J. World Aquaculture Soc. 23:192-198.

___, J. F. Glahn, J. O. King, and D. T. King. 1995a. Impact of great blue herons on channel catfish farms. J. World Aquaculture Soc. 26:194-199.

___, D. F. Mott, and J. O. King. 1995b. Short-term effects of an inflatableeffigy on cormorants at catfish farms. Wildl. Soc. Bull. 23:73-77.

U.S. Department of Agriculture (USDA). 1994. Aquaculture Situation and Outlook. Commodity Economics Division, Economic Research Service, AQS-13, Washington, D.C. 48pp.

___. 1995. Catfish Processing. National Agric. Stats. Service. AQ-1, Washington, D.C. 6pp.

Vermeer, K. and L. Rankin. 1984. Population trends in nesting double-crested and pelagic cormorants in Canada. The Murrelet 65:1-9.

Wellborn, T.L., Jr. 1983. The catfish story: farmers, state services create new industry. 1983 Yearbook of Agriculture, U.S. Dep. of Agric., pp 298-305.