Strategies To Reduce Double-Crested Cormorant Depredation at Aquaculture Facilities in Mississippi

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Abstract: Double-crested cormorant *(Phalacrocorax auritus)* depredation throughout the Southeastern United States has been on the increase over the past 20 years. The increase in depredation coincides with the growth of the aquaculture industry and an expansion of double-crested cormorant wintering populations throughout the Southeast. The U.S. Department of Agriculture–Animal and Plant Health Inspection Service–Wildlife Services plays a major role in reducing double-crested cormorant damage. Nonlethal harassment on farms, dispersal from night roosts, and lethal control have reduced double-crested cormorant depredation at aquaculture farms in Mississippi. However, the efficiency and compatibility of current methods of reducing double-crested cormorant depredation must be improved.

Keywords: aquaculture, catfish, control methods, double-crested cormorant, frightening, *Ictalurus punctatus*, Mississippi, *Phalacrocorax auritus*

The aquaculture industry has grown tremendously in the Southern United States over the last 20 years. Catfish production represents the largest dollar value of the aquacultural industry, accounting for approximately 50 percent of the industry (Mott and Brunson 1997). In Mississippi, channel catfish *(Ictalurus punctatus)* is the primary fish stock raised, but there are a few producers who raise other types of commercial fish. The commercial aquaculture industry in Mississippi has been on a steady increase since the first channel catfish ponds were established there in 1965 (Wellborn 1983). Currently, 360 catfish producers farm 41,312 ha of channel catfish ponds throughout the State (U.S. Department of Agriculture [USDA], National Agricultural Statistics Service [NASS] 1997). The majority of the aquaculture industry (90 percent) lies within the delta region of Mississippi on the western side of the State (Brunson 1991). This region comprises 16,000 km^2 of the Mississippi River alluvial plain, has flat topography, and is commonly known as the Mississippi delta. Catfish ponds are interspersed with cotton, soybean, rice, and corn fields throughout this region.

The typical catfish farm in Mississippi contains a complex of 8-ha ponds encompassing 100 ha of surface water. Ponds range from 1 to 2 m in depth, and catfish densities range from 5,000 to 150,000 fish/ha (Glahn and Stickley 1995). Mississippi is ranked first in the total production of catfish in the United States, and the value of 1996 production exceeded $274 million (USDA, NASS 1997). Two counties in the central delta, Humphreys and Sunflower, produce more catfish than any other single State in the United States (Brunson 1991). In 1994, the production of channel catfish ranked fourth among agricultural commodities in Mississippi (Mississippi Cooperative Extension Service 1995).

Double-Crested Cormorant Population Trends

Historically, double-crested cormorants (DCCO's) have migrated from the Great Lakes and central Canadian regions and wintered along the coastal areas of the Gulf of Mexico, with wintering populations along the lower Mississippi River drainage reported to be very small (Lewis 1929). A small breeding population had been reported in the mid-Southern States until the middle of this century (Jackson and Jackson 1995).

Wintering populations in the lower Mississippi valley have been on an increase since the early 1970's (Alexander 1977–90). These population increases coincide with the expansion of the aquaculture industry. Annual midwinter censuses show that DCCO numbers in the delta have steadily climbed from an average of 30,000 in the winters of 1989–93 (Glahn et al. 1996) to more than 55,000 in the winter of 1996–97 (coauthor Sloan, unpubl. data). Personnel from USDA, Animal and Plant Health Inspection Service's (APHIS) Wildlife Services unit have observed flocks of 25 or more DCCO's arriving in the Mississippi delta in early

September, and appreciable numbers of birds are still present in late April or early May. Localized flocks of fewer than 25 cormorants have been observed throughout the months of June, July, and August. Jackson and Jackson (1995) predicted the DCCO would again become a regular breeding member of the mid-South avifuana and that some concentrations might be expected in the vicinity of aquaculture facilities.

Fish Losses to Double-Crested Cormorants

The DCCO is the primary depredating bird species affecting channel catfish stocks, according to a 1996 survey of catfish producers by USDA's NASS. This survey reported that more than 70 percent of the respondents in Mississippi considered the DCCO as the primary cause of losses to catfish stocks by a wildlife species (Wywialowski 1998). Similarly, a survey of 281 Mississippi catfish farmers in 1988 revealed that 57 percent of delta catfish growers considered cormorants to be a problem at their farms (Stickley and Andrews 1989).

Catfish losses to cormorants have been well documented (Stickley et al. 1992, Glahn et al. 1995, Glahn and Brugger 1995, King et al. 1995). A food-habits study by Glahn et al. (1995) showed that the average size of a catfish consumed by a DCCO is 16 cm, which is also the average size of the catfish fingerling stocked in food fish ponds (Mott and Brunson 1997). Bioenergetics modeling on the impact of DCCO's on the delta catfish industry (Glahn and Brugger 1995) estimated that, in 1989–90 and 1990–91, losses approximated 20 million and 18 million catfish fingerlings (10 to 20 cm), respectively. This is equivalent to approximately 4 percent of the available fingerling class during the November to April study periods. Stickley and Andrews (1989) estimated that cormorants ate $3.3 million of catfish in Mississippi, according to a 1988 survey of Mississippi catfish farmers. These numbers are likely to be higher now because wintering bird numbers surveyed by Wildlife Services during its midwinter surveys have increased by nearly 84 percent since the late 1980's and early 1990's.

Depredation losses vary depending on the location of pond complexes relative to active cormorant night roosting sites. Wildlife Services has identified 65 night roosting sites in the delta, of which usually only a third are active at any one time. Cormorants fly an average of 15.7 km from their night roost to their initial foraging site (King et al. 1995). Telemetry studies (King 1996) have shown that DCCO's fly regularly throughout the delta and to the gulf coast during the midwinter and spring. Thus, cormorant numbers and depredation pressure vary at specific farm complexes throughout the winter months.

Control Methods and Strategies

Many aquaculture producers try to reduce cormorant depredation on their fish stocks. However, attempts to control bird depredation may not be economically justified in all situations. A producer must first determine if birds are causing economic losses (Littauer et al. 1997). If they are, the producer must then determine whether it is economically justified to control these depredating birds. In 1988, catfish farmers in Mississippi reported spending an average of $7,400 per farmer, or a total in excess of $2.1 million, to harass and repel birds from their ponds (Stickley and Andrews 1989).

Several methods are available to alleviate depredation on fish stocks in Mississippi. These can be placed under three basic categories: nonlethal harassment, roost dispersal, and lethal control.

Nonlethal Harassment

Nonlethal harassment devices are widely used and accepted as a control method by many aquaculture producers in Mississippi. These devices move or deter cormorants from a specific area or site (Draulans 1987, Littauer 1990, Booth 1994, Mott and Boyd 1995). Nonlethal harassment devices include (1) human activities and vehicles, such as trucks, all-terrain vehicles, and boats; (2) auditory devices, such as propane exploders and cannons, pyrotechnics (exploding or whistling projectiles or firecrackers), live ammunition, amplified recordings of DCCO distress calls, and electronic noise generators or sirens; and (3) visual repellants such as human effigies (stationary or inflatable), eye-spot balloons, flash tape, or flagging.

Birds often habituate to a device, rendering it ineffective. Using a combination of harassment devices prolongs habituation and provides the greatest amount of protection. Frequent changing and moving devices around pond complexes enhance protection. Stickley et al. (1995) and Stickley and King (1995) used inflatable human effigies to reduce DCCO numbers on catfish ponds. Birds habituated after 7 to 14 days, but the use of additional scaring devices prolonged effectiveness. Littauer et al. (1997) noted that a scaring program must be consistent and aggressive to be successful. Timing is also critical (Mott and Boyd 1995). Harassment must begin as soon as it can be economically justified and continued until all undesirable birds vacate the area.

The expansive size of aquaculture complexes often limits the effectiveness of a harassment program. Simultaneous protection of all ponds can be difficult. Birds may move from pond to pond within the complex during harassment. As a result of this movement, depredation does not decrease on a farm despite harassment.

Roost Dispersal

Double-crested cormorants usually use both day and night roosts. Day roosts usually are near where DCCO's forage and are used to rest during daylight hours. Day roosts are scattered widely throughout the delta and may consist of a single tree, small perching sites (e.g., utility poles, fishing piers), or multiple trees. King et al. (1995) observed that DCCO's traveled an average of 2.6 km from day roosts to foraging sites. Night roosts are used during the night. These roosts differ from day roosts in that they usually consist of a large expanse of trees and can be a considerable distance from an aquaculture facility. King et al. (1995) recorded cormorants flying up to 61.8 km from last foraging site to a night roost. These roosts usually consist of a mixture of bald cypress *(Taxodium distichum)* and water tupelo *(Nyssa aquatica)*.

Harassment of night roosts has proven to be an effective management tool to reduce depredation on fish stocks. Numbers of birds visiting fish ponds can be reduced by 70 percent to 90 percent when birds are dispersed from nearby night roosts (Mott et al. 1992 and 1998). A 1996 survey reported that catfish farmers used roost dispersal more in Mississippi than in any other State as a preventive measure to reduce depredation (Wywialowski 1998). Night roost dispersal may not eliminate the need to harass birds on ponds, but it substantially reduces the amount of harassment needed on farms where birds are causing severe problems (Littauer et al. 1997). A survey of catfish producers in the delta conducted by Mott et al. (1998) reported that farmers implementing a night roost dispersal program spent less money to control cormorants on their farms than did farmers who did not

participate in the dispersal program.

The ever-increasing numbers of newly established night roosts can be a limiting factor in maintaining a successful dispersal program. In 1993, when DCCO night roost dispersal began, a total of 48 known night roosting sites existed in the delta (Mott et al. 1998), but by 1997 this number had increased to 65 (coauthor Sloan, unpubl. data). Locating the roost, acquiring permission to access the site, and physically entering and dispersing the roost can be extremely difficult and labor intensive. The nonlethal strategies used may also limit the effectiveness of roost dispersal due to the ability of the birds to habituate to the devices.

The night roost dispersal program in Mississippi is a joint cooperative effort among Wildlife Services, fish farmers, private hunting organizations, State agencies, and other Federal agencies. Currently, Wildlife Services coordinates the program, but the bulk of the actual dispersal is conducted by farmers and concerned individuals.

Throughout the delta, 65 night roosting sites are monitored and dispersed. Roosts are monitored several times weekly by individuals on the ground and also weekly or once every 2 weeks with aerial surveys conducted by Wildlife Services. Dispersal begins as soon as a significant number of DCCO's begin to occupy a roost site, thus preventing birds from habituating to any particular roosting site. Several individuals in trucks, boats, or all-terrain vehicles disperse birds by firing pyrotechnics as birds attempt to enter the roost. Dispersal efforts begin about 2 hours before sunset and continue until a half hour after sunset. Cormorants are usually dispersed after 3 consecutive evenings of harassment.

Simultaneous dispersal of all night roosts has the greatest impact on reducing bird numbers at aquaculture facilities. Currently, Wildlife Services organizes a simultaneous dispersal effort once each month from November to March over the entire delta. During other times, participants are encouraged to disperse roosts within their specific areas. The key to success of the night-roost dispersal program is coordination among all parties involved.

Lethal Control

The primary function of lethal control is to reinforce and enhance nonlethal control methods. The effectiveness of nonlethal control methods may be increased by shooting select target animals (Rodgers 1988, Hess 1994, Mastrangelo et al. 1997, Littauer et al. 1997). DCCO's are protected under the Migratory Bird Treaty Act, and until recently fish producers had to obtain a depredation permit from the U.S. Department of the Interior's U.S. Fish and Wildlife Service (FWS) before they could legally implement lethal controls. However, in 1998, Federal regulations were amended to allow the take of DCCO's in 13 (mostly Southeastern) States without a Federal permit (63 Federal Register 10550). In these States, cormorants may be taken at freshwater commercial aquaculture facilities or State-operated hatcheries, but only in conjunction with an established nonlethal harassment program that has been certified by USDA Wildlife Services. In some States (excluding Mississippi) a State depredation permit is still required before lethal controls are implemented.

For the years 1993 and 1994, approximately 8,200 DCCO's were taken nationwide under FWS depredation permits, and 68 percent of these were taken in the Southeastern States of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee (Trapp 1997). Belant et al. (in press) reported that 847 permits were issued from 1987 through 1995 authorizing the take of 54,912 DCCO's in the Southeastern United States. Only 64 percent (35,332) of the birds authorized were actually taken. Mississippi, Alabama, Arkansas, and Louisiana accounted for more than 90 percent of the permits issued (780) and DCCO's taken (33,883). In 1997, Mississippi had 125 aquaculture producers with more than 28,350 ha of water operating under federally issued DCCO depredation permits.

Belant et al. (in press) compared the number of DCCO's taken in each of nine Southeastern States between 1987 and 1995 with the mean number of DCCO's observed annually during Christmas Bird Counts in each State. No negative association was found, which suggests that the number of cormorants taken annually in each State under depredation permits had no detectable effect on subsequent wintering populations. Belant's team further concluded that the number of cormorants taken did not adversely affect the continental breeding populations.

Hess (1994) looked at unlimited take of cormorants at two catfish facilities in the Delta. More than 3,000 person-hours were spent attempting to shoot birds, but only 290 birds were taken. Hess attributed the low kill rate to be a learned behavior by birds to avoid being shot. However, he also reported that fewer DCCO's attempted to enter the treatment areas, indicating that lethal control methods reduced fish losses.

This information and an increase in Wildlife Services' midwinter DCCO census estimates over the past 4 years indicate that lethal control of cormorants under the current depredation permit system does not have a significant negative impact on wintering populations of DCCO's in Mississippi. Because lethal control reinforces nonlethal methods, it is a biologically sound strategy for reducing DCCO depredations on fish stocks in Mississippi.

Conclusions

Depredation on fish stocks by DCCO's is of great concern to the aquaculture industry. With the expansion of the industry and an increase in cormorant wintering populations, the effectiveness and compatibility of current methods of reducing depredation on fish stocks must improve. Management implications should focus on the long-term goal of managing DCCO populations. Wildlife Services is currently developing the framework for a cooperative effort between the FWS and State wildlife and fisheries agencies to develop a comprehensive, national DCCO management plan.

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