Effects of Roost Shooting on Double-Crested Cormorant Use of Catfish Ponds – Preliminary Results

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Abstract: Double-crested cormorants commonly depredate channel catfish at aquaculture facilities in the southeastern U.S., causing significant economic loss. Prior research has demonstrated regional night-roost harassment (i.e., "major pushes") to be an effective technique to temporarily reduce cormorant use on aquaculture ponds; however, these efforts were extremely labor intensive and changes in impacts were difficult to quantify. We conducted a preliminary study to investigate the efficacy of site-specific, night-roost dispersal ($n = 6$) using lethal control on cormorant abundance by monitoring the number of birds at randomly selected aquaculture facilities for 3 days prior to and following night-roost dispersals. The effect of dispersal varied greatly by study site. At one site, the mean abundance of cormorants on catfish production ponds decreased following dispersal; however, on the other 5 sites the mean abundance of cormorants did not change on catfish production ponds following night-roost dispersal. We recommend further research to evaluate the effectiveness of night-roost dispersal using lethal control. Furthermore, we offer recommendations for the design of future large-scale studies, which include improvements to reduce large variation.

Key Words: aquaculture facilities, bird damage control, catfish ponds, cormorants, dispersal, double-crested cormorant, *Ictalurus punctatus*, Mississippi, *Phalacrocorax auritus*, roosts

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INTRODUCTION

Channel catfish (*Ictalurus punctatus*, hereafter "catfish") production is the largest aquaculture industry in the United States with estimated gross sales of fresh and frozen processed catfish reaching $658 million in 2003 (Engle and Hanson 2004, Hargreaves and Tucker 2004). The fertile Mississippi River Alluvial Valley or Delta region of Mississippi, Arkansas, and Louisiana, and the Blackland Prairies region of east-central Mississippi and west-central Alabama, comprise 95% of the United States' total catfish production (Hargreaves and Tucker 2004). Double-crested cormorants (*Phalacrocorax auritus*, hereafter "cormorants") winter in high densities in the same area, and their use of catfish ponds is well documented (Glahn and Brugger 1995, Glahn and Stickley 1995, Glahn and Dorr 2002, Dorr 2006), with most cormorant foraging days occurring in the winter between January and March (Glahn and Brugger 1995, Dorr 2006). Estimates of economic loss of catfish due to cormorant depredation range from 4-9% of total sales (Glahn and Dorr 2002, Glahn et al. 2002, Dorr 2006) and vary with respect to pond type, stocking density, distance from all-weather roads, and pond size (Dorr 2006). Loss estimates also vary, depending on whether impacts are assessed as a function of loss in biomass at harvest or based on replacement of fingerlings lost (Glahn and Dorr 2002, Glahn et al. 2002, Dorr 2006).

Use of ponds by cormorants is dynamic and likely affected by environmental and anthropogenic events. Prior to the issuance of depredation permits for aquaculture facilities in 1986, catfish farmers were limited to non-lethal tools to disperse cormorants from their ponds (Mott and Boyd 1995, Littauer et al. 1997, Reinhold and Sloan 1999). Exclusion devices (e.g., netting, wiring) were cost prohibitive for large-scale catfish operations due to size and complexity of pond systems and methods of daily operations (Mott and Boyd 1995, Price and Nickum 1995, Littauer et al. 1997). The most common form of harassment on southeastern catfish ponds was harassment patrols (Wywialowski 1999), where farmers and their employees used pyrotechnics and vehicles to actively disperse cormorants from ponds, thereby reducing immediate impacts. With the addition of lethal take as a tool in 1986, shooting cormorants has been used in conjunction with harassment patrols and other non-lethal tools (Mastrangelo et al. 1995). In fact, most damage management on catfish aquaculture facilities now consists of an integrated program combining lethal and non-lethal techniques (Stickley and Andrews 1989, Wywialowski 1999, Barras and Tobin 2003). Localized shooting generally prevents cormorants from landing on a pond and potentially depredating catfish; however, few birds are killed (Hess 1994), with no significant change in population size (Mastrangelo et al. 1995, Belant et al. 2000). Despite the addition of lethal control as a tool to reduce cormorant use on catfish ponds, producers continued to report losses to cormorants in the late 1980s and early 1990s (Glahn and Brugger 1995, Glahn and Stickley 1995, Reinhold and Sloan 1999).

In 1993, U.S. Department of Agriculture's Wildlife Services (WS) and Mississippi catfish farmers initiated a regional cormorant roost dispersal program, whereby multiple night-roosts were simultaneously harassed with non-lethal pyrotechnic (i.e., noise making) devices (Mott et al. 1998). These events were commonly referred to as "major pushes". While the roost dispersal program achieved the immediate desired effect of shifting cormorants away from high concentrations of catfish farms, the results were temporary (Glahn et al. 2000, Tobin et al. 2002). Producers outside the roost dispersal area also spent more money on cormorant management, as producers within the dispersal zone spent less (Mott et al. 1998), suggesting that impacts may have been redistributed rather than eliminated.

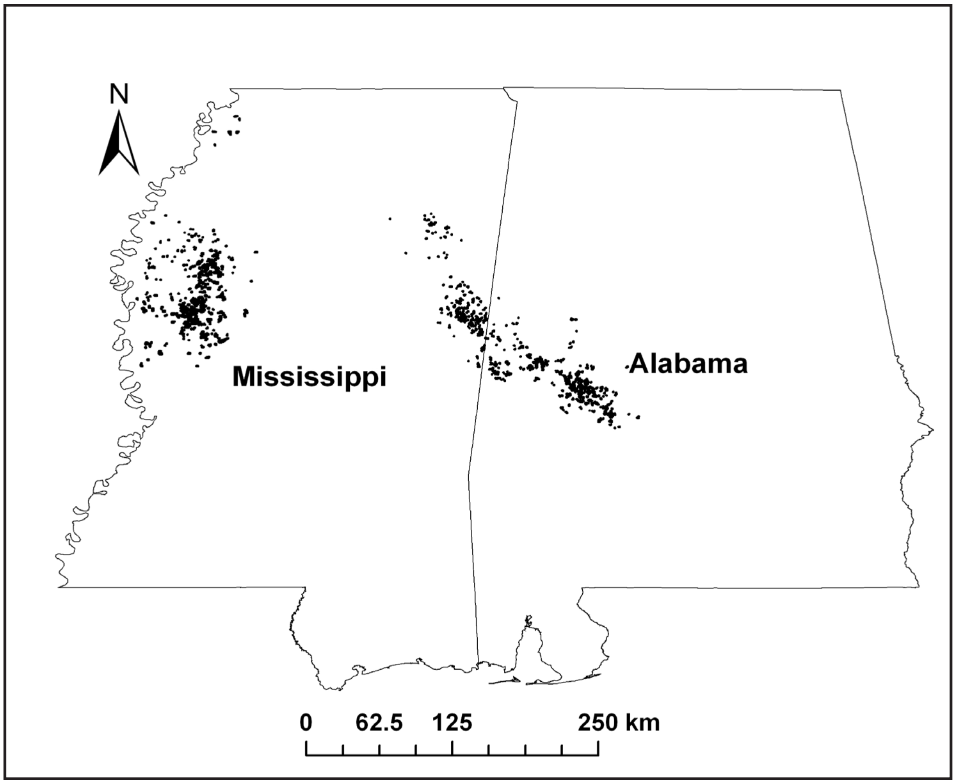

Figure 1. Six cormorant night-roost dispersals were conducted in catfish production areas of Mississippi and Alabama during the winters of 2004 and 2005. Polygons represent catfish production ponds.

In 1998, United States Fish and Wildlife Service (USFWS) issued a standing depredation order (USFWS 1998; 50 CFR 21.47) in 13 states (12 southern states and Minnesota), thereby allowing aquaculturalists to take cormorants without a permit when found committing or about to commit depredation to aquaculture stock. Shooting cormorants on the roost was not allowed under the order, despite strong support from most aquaculturalists and WS (Glahn et al. 2000). Glahn et al. (2000) found that producers took more cormorants under the depredation order than with individual permitting; however, there still was no apparent impact on the cormorant population. Glahn (2000) further compared the effects of lethal and non-lethal roost harassment and found no difference in the time required to disperse roosts or the duration of effectiveness. As with previous studies involving lethal control of wintering cormorants (Hess 1994, Mastrangelo et al. 1995, Belant et al. 2000), few cormorants were taken using this technique (Glahn 2000). Discussion over the need to use lethal control on cormorant roosts continued from 1999-2003 during the development of an Environmental Impact Statement (EIS) by USFWS (Hanisch and Schmidt 2006). With publication of the final rule and Record of Decision in October 2003, the standing aquaculture depredation order was amended and WS was given authority to take cormorants at winter roosts. Barras and Tobin (2003) recommended that research efforts continue to evaluate the effects of lethal control on local and regional cormorant populations and include the potential added benefits of lethal reinforcement on hazing. The objective of this preliminary study was to examine the effects of roost shooting on cormorant use of adjacent catfish ponds.

METHODS

This study was conducted during the winters of 2004 and 2005 in high density catfish aquaculture areas of the Delta region of Mississippi and the Blackland Prairie region of east-central Mississippi and west-central Alabama (Figure 1). We determined when cormorant night-roosts were dispersed, based on damage reports from catfish producers and from routine surveillance of commonly used night-roosts. Once a particular night-roost was identified for dispersal, we developed a sampling route to monitor the response of cormorants on surrounding catfish production ponds.

We used a geographic information system of catfish ponds and cormorant night-roost sites to randomly select sampling points adjacent to catfish production ponds within a 20-km radius of the chosen cormorant night-roost. In some cases, we selected sample points outside the 20-km radius when adequate numbers of ponds were not available near the roost. The number of sample points depended upon availability of personnel to conduct sampling and the proximity of ponds to the roost. Prior to data collection, we verified that ponds were actively managed for fish production at each sample point. Observers returned to sample points each day and recorded the number of cormorants observed on surrounding fish ponds for 2 minutes and then traveled to the next sample point. Cormorants flying over or between sample points were not included in this study. At sunrise, observers counted the number of cormorants using the night-roost and waited for the cormorants to leave the roost and begin foraging before counting cormorant abundance at fish ponds. We sampled fish ponds and roost sites for 3 days prior to and

Table 1. Counts of cormorants at night-roosts 3 days before and after roost dispersal during winters of 2004 and 2005 in Mississippi and Alabama, USA.

Site	Date	Treat -ment	Cormorant Count
Port of Columbus	02/18/2004	Pre	1,966
	02/19/2004	Pre	2,545
	02/20/2004	Pre	1,933
	02/21/2004	Post	450
	02/22/2004	Post	958
	02/23/2004	Post	1,459
Demopolis	03/16/2004	Pre	580
	03/17/2004	Pre	769
	03/18/2004	Pre	630
	03/19/2004	Post	131
	03/20/2004	Post	110
	03/21/2004	Post	8
Pickensville-Lubbub [a]	12/05/2004	Pre	1,869
	12/06/2004	Pre	3,110
	12/07/2004	Pre	3,470
	12/10/2004	Post	1,032
	12/11/2004	Post	120 [b]
	12/12/2004	Post	235 [b]
Little Mossy Lake	02/07/2005	Pre	No count
	02/08/2005	Pre	3,370
	02/09/2005	Pre	3,800
	02/10/2005	Post	43
	02/11/2005	Post	965
	02/12/2005	Post	1
Ellison Brake-Mossy Lake [c]	02/27/2005	Pre	3,000
	02/28/2005	Pre	2,000
	03/01/2005	Pre	2,500
	03/02/2005	Post	0
	03/03/2005	Post	350
	03/04/2004	Post	0
Wolf Broad	03/05/2005	Pre	300
	03/06/2005	Pre	360
	03/07/2005	Pre	300
	03/08/2005	Post	0
	03/09/2005	Post	350
	03/10/2005	Post	0

[a] Pickensville and Lubbub night-roosts were dispersed simultaneously.
[b] Represents the Pickensville night-roost count only.
[c] Ellison Brake and Mossy Lake night-roosts were dispersed simultaneously.

3 days following each night-roost dispersal.

Roosts were dispersed by WS employees and their designated agents, as specified in the final rule and Record of Decision in October 2003. Employees and their designated agents entered roost sites by boat approximately 1-2 hours before sunset and shot birds entering the roost until sunset. Number of boats used was determined by WS employees, based on size and shape of roosts. Number of shooters per boat ranged from 2-3. Shooting continued until 30 minutes after sunset, if enough illumination allowed for safe shooting and recovery of downed cormorants. Cormorants were shot with shotguns only, using approved non-toxic shotshells in 12 gauge or 10 gauge. All downed cormorants were recovered immediately on site and were disposed of by in-ground burial off site. All information from banded birds collected was sent to the USFWS Migratory Bird Banding Laboratory for data entry and analysis.

We calculated the mean number of cormorants observed at sample points for the 3 days pre-dispersal and the 3 days post-dispersal, to estimate cormorant usage of ponds at each sample point. For each dispersal event, we compared the treatment effect (night-roost dispersal) using a paired *t*-test (or nonparametric analogue), where pairs consisted of the mean number of cormorants at each sample point pre- and post-dispersal. We hypothesized the mean abundance of cormorants on catfish production ponds would decrease following the night-roost dispersals and used $\alpha = 0.05$ to assess statistical differences.

RESULTS

We recorded cormorant abundance before and after 6 night-roost dispersals (1 at each of 6 sites) from February 2004 to March 2005. Night-roost dispersals appeared to be effective, as counts of cormorants at roosts typically decreased following dispersal (Table 1).

A mean of 23 points were sampled at catfish production ponds associated with each roost dispersal event (min = 8, max = 37), and the mean distance of sample points from the night-roost was 13.2 km (min = 1.2, max = 32.7). Mean counts of cormorant abundance at catfish production ponds pre- and post-dispersal were not distributed normally. Thus, we elected to use the nonparametric signed rank test, with no assumption of normality (SAS Institute Inc. 2004). The night-dispersal effect was not consistent among the 6 study sites. At one study site, there was a significant decrease in the ranks of mean cormorant abundance, but on the remaining sites there was no difference in the signed ranks for mean cormorant abundance pre- versus post-dispersal (Table 2).

DISCUSSION

Killing cormorants on catfish ponds to reduce local or regional populations has not been a management goal nor has it been investigated with scientific rigor. Rather, lethal control has been used as a tool to reinforce hazing

Table 2. Differences in mean counts of cormorants observed on catfish production ponds before and after cormorant night-roost dispersals near catfish production facilities during winters of 2004 and 2005 in Mississippi and Alabama, USA. Pre- and post-treatment effects were compared with the nonparametric signed rank test.

Night roost	*n* [a]	Pre-Dispersal	(SE)	Post-Dispersal	(SE)	Difference	S	*P*
Port of Columbus	8	2.5	(1.0)	4.5	(1.9)	-2.0	-3.0	0.500
Demopolis	16	16.4	(9.5)	4.0	(2.4)	12.4	30.0	0.015
Pickensville - Lubbub	28	5.1	(3.1)	3.0	(1.5)	2.1	15.0	0.420
Little Mossy	24	4.8	(1.5)	2.9	(1.1)	1.9	34.0	0.247
Ellison Brake - Mossy Lake	37	11.7	(4.8)	42.6	(34.2)	-30.9	-96.5	0.057
Wolf Broad	23	12.6	(5.4)	9.5	(4.1)	3.1	18.0	0.545

[a] Number of points sampled within fixed radius surrounding night roosts

of cormorants on catfish ponds, in order to reduce their occupancy time on ponds and depredation of catfish (Hess 1994, Mastrangelo et al. 1995, Glahn et al. 2000). Tobin et al. (2002) found that cormorants harassed on roosts changed night-roosts more frequently than cormorants not harassed. Furthermore, 81% of cormorants returned to un-harassed night-roosts, whereas only 11% of harassed cormorants returned to the same roost (Tobin et al. 2002). Keller et al. (1998) used lethal control in Bavaria, Germany to reduce local populations of great cormorants (*Phalacrocorax carbo*), and thereby reduce local fish depredation. However, they found that despite killing the equivalent of 50-100% of the mean cormorant population in Bavaria, cormorants killed on Bavarian lakes were quickly replaced by migrating cormorants. Thus, they concluded that shooting was an inappropriate management tool for reducing impacts on fish during cormorant migration (Keller et al. 1998).

We could not separate the effect of lethal control versus non-lethal harassment in this study, but we suspect using lethal control for dispersal had nominal influence. During dispersals, very few birds (<5%) were killed before the cormorants abandoned the roost; thus, using pyrotechnics may have dispersed the birds just as effectively.

The abundance of cormorant roosts now commonly found throughout the study areas may have reduced the effectiveness of dispersals in this study. Cormorants may have simply moved to an adjacent roost and remained within proximity of the catfish production ponds we sampled, rather than dispersing from the study areas. The efficacy of roost harassments and dispersal may be limited with the number of roosting sites currently available. In future studies, the proximity of other roosts should be accounted for in the statistical analysis.

Due to the variability in the response of cormorant abundance at catfish production ponds during this study, we recommend increasing the number of study sites in future studies addressing the effect of night-roost dispersals. The gregarious behavior of these birds makes counts of abundance problematic, which may only be addressed with large sample sizes. For example, in this study we observed >1,000 birds at a number of sample points for only one day during the study. This extent of variability makes statistical comparisons difficult, without large samples to increase precision of count estimates.

Another improvement to study design would be inclusion of a control in addition to the pre-dispersal counts on fish production ponds. At one study area, we observed an increase in cormorant abundance at sample points following roost dispersal, and we believe the spatial distribution of cormorants was influenced by unmeasured events such as changes in weather or cormorant harassment by catfish producers. Cormorant abundance should be monitored at a control area beyond the influence of the targeted roost, so that potential confounding effects may be identified and accounted for in statistical analyses.

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