

Colonial Waterbirds and North American Aquaculture

Scott J. Werner¹, D. Tommy King¹, James F. Glahn¹, and Jay V. Huner²

¹U.S. Department of Agriculture, National Wildlife Research Center,
Mississippi Field Station, P.O. Drawer 6099,
Mississippi State University, MS 39762-6099, USA
E-mail: Scott J Werner@USDA.gov

²University of Louisiana- Lafayette, College of Applied Life Science,
Crawfish Research Center, P.O. Box 44650
Lafayette, LA 70504-4650, USA
E-mail: jhuner@louisiana.edu

The term aquaculture in North America typically refers to freshwater culture of various finfish and crustacean species. The primary North American aquaculture species are baitfish, catfish, crayfish, hybrid striped bass, mollusks, salmon, tilapia, trout, and ornamental fishes. Aquaculture in the United States presently involves over 4,000 individual farms, and total sales exceed \$975 million per year (USDA 2000). According to this 1998 census, the five states with greatest aquaculture sales are Mississippi (\$290 million of catfish), Arkansas (\$84 million of catfish and baitfish), Florida (\$77 million of ornamentals, mollusks, etc.), Maine (\$76 million of Atlantic salmon), and Alabama (\$59 million of catfish). Because states associated with aquaculture comprise a portion of the distributional range of several waterbird species, and because aquacultural facilities can provide aquatic habitat for these birds, several waterbird species occupy North American aquaculture facilities. Although these habitat relations are important ecologically, several fish-eating waterbirds can impact aquacultural production.

This overview summarizes the predominant waterbirds observed near aquaculture facilities, and methods used to minimize fish-eating bird impacts to aquacultural production. Several reviews have been previously prepared regarding waterbirds associated with North American aquaculture and the techniques used to minimize fish-eating bird impacts (see Selected References). The avian species discussed herein are protected by federal regulations in Canada, Mexico, and the United States.

Waterbirds Associated with Aquaculture Facilities

Several waterbirds have been observed to spend at least part of their year near predominant aquaculture industries in North America (Table 1). Although published research has documented negative impacts associated with relatively few waterbirds (American white pelicans, black-crowned night herons, double-crested cormorants, great blue herons, great egrets, green herons, little blue herons, *Plegadis* spp. ibis, snowy egrets, tri-colored herons, white ibis, yellow-crowned night herons), several other waterbird species have been observed to consume fish at aquaculture facilities in North America.

The presence of waterbirds at aquaculture facilities is often seasonal, though behavioral changes (i.e., early or late migrations) and increased annual occupancy have been observed concomitant with the growth of some industries. Double-crested cormorants and American white pelicans typically occupy southern states (associated with aquaculture) from October through April, though nesting cormorants have been recently observed in Mississippi (Reinhold et al. 1998) and American white pelicans have recently been observed at Mississippi catfish farms in July.

Methods Used to Minimize Waterbird Depredation

Complete enclosure is presently effective for reducing fish-eating bird impacts at some trout and ornamental aquaculture facilities in North America. The effective, non-lethal techniques available to temporarily deter fish-eating birds from aquaculture facilities include overhead wires, monofilament, and poly-filament; perimeter fencing (including electric); auditory stimuli (propane cannons, pyrotechnics, distress calls); visual stimuli (lights, lasers, balloons, streamers); and habitat modifications. Depredation

permits have also been issued by regulatory agencies to supplement the effectiveness of these non-lethal management techniques.

The effectiveness of exclusion techniques to reduce waterbird depredation at aquaculture facilities has been reviewed by several authors (see Selected References). Exclusion techniques can temporarily deter fish-eating birds from individual aquaculture facilities. Overhead wires and monofilament, floating ropes, and inflatable effigies have been used to exclude fish-eating birds from specific fish ponds. Floating ropes have also been used to deter cormorants from landing on catfish production ponds. Although floating ropes can be effective in reducing the abundance of waterbirds, fish-eating birds have been observed to adapt to the ropes after a few weeks.

Though habitat modifications (e.g., altered hydrology, vegetation management) can reduce waterbird abundance, the surface water associated with aquaculture facilities is necessary for fish production. Given the gregarious nature of some waterbirds, and the availability of roosting and foraging habitats adjacent to aquaculture facilities, dispersal of night roosts is presently the most effective, non-lethal technique to temporarily deter some waterbirds from aquaculture facilities (e.g., double-crested cormorants).

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TABLE 1	bait fish	fingerling catfish	foodfish catfish	brood catfish	crawfish	ornamentals	salmonid	tilapia
American White Pelican	P	D	D	D	D	OT	D	P
Anhinga	----	OT	P	P	OT	OT	----	
Black-crowned Night-Heron	P	OT	P	P	OT	OT	D	P
Bonaparte's Gull	OT	OT	P	P	OT	OT	OT	P
Brown Pelican	----	OT	P	P	----	P	----	OT
Caspian Tern	----	----	----	----	P	P	P	P
Cattle Egret	P	P	P	P	OT	P	P	P
Common Tern	P	----	----	----	P	----	----	----
Double-crested Cormorant	OT	D	D	P	D	OT	D	P
Forster's Tern	OT	OT	P	P	D	OT	P	P
Great Blue Heron	D	D	P	P	D	D	D	OT
Great Cormorant	----	----	----	----	----	P	P	----
Great Egret	D	D	P	P	D	D	OT	P
Green Heron	OT	P	P	P	OT	D	D	P
Herring Gull	OT	OT	P	P	D	OT	OT	P
Little Blue Heron	D	P	P	P	D	D	D	P
Loon spp.	----	----	----	----	----	----	----	----
Neotropic Cormorant	----	OT	P	P	D	OT	----	P
Plegadis spp. ibis	P	P	P	P	D	P	----	P
Ring-billed Gull	OT	OT	P	P	D	OT	OT	P
Roseate Spoonbill	----	----	----	----	D	P	----	P
Snowy Egret	OT	OT	P	P	D	D	P	P
Tricolored Heron	----	OT	P	P	OT	D	----	P
White Ibis	P	P	P	P	D	P	----	P
Wood Stork	P	P	P	P	D	P	----	P
Yellow-crowned Night-Heron	OT	OT	P	P	D	P	P	P

P=PRESENT, these are bird species that (1) have not been observed to eat fish at freshwater aquaculture facilities;

(2) spend part of their year near predominant aquaculture industries; AND

(3) have not been documented to "take" these fish in the literature. (e.g., Great cormorants and Florida aquaculture).

OT=OCCASIONAL TAKE, these are bird species that (1) have been observed to eat fish at freshwater aquacult. facil., though impact res. is needed;

(2) spend part of their year near predominant aquaculture industries; AND

(3) have not been documented to "take" these fish in the literature. (e.g., American white pelican and Florida aquaculture).

D=DOCUMENTED, these are bird species that (1) have been observed to eat fish at freshwater aquaculture facilities;
(2) spend part of their year near predominant aquaculture industries; AND
(3) have been documented to "take" these fish in the literature. (e.g., Great blue herons and Florida aquaculture).