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Avian Predators and Their Management at Aquaculture Facilities in the Southeastern United States

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Fish-eating birds are a common sight at aquaculture facilities and hatcheries throughout the United States. The broad expanses of open water at fish farms are attractive and important to many species of birds that have lost habitat to development or other land uses. Unfortunately, the fish-eating birds that use these ponds can cause problems for producers. Depredation issues, economic loss, and management methods of bird species are as varied as the species involved and the aquaculture products being farmed. In some cases—as with the production of redfish, hybrid striped bass, shrimp, and shellfish aquaculture—little research has been conducted and much needs to be learned. Bird species that may be an issue for some types of aquaculture production methods and cultured species may not be for others. Individual bird species will also respond differently to management strategies. Aquaculture production practices and fish species produced can also change over time. Therefore, producers must constantly adapt their bird management programs to effectively prevent and reduce damage.

Legal Status

All fish-eating birds are protected by federal law under the Migratory Bird Treaty Act. Some species may have further protections under the U.S. Endangered Species Act or state regulations. For regulations specific to your region, contact experts with the U.S. Fish and Wildlife Service (USFWS), the U.S. Department of Agriculture Wildlife Services (USDA–WS), and your state's natural resource agencies. With the appropriate depredation permits, producers can protect their fish from predation using nonlethal and even lethal methods.

However, depredation permits and orders are issued only under the authority of the USFWS and are species-specific. Depredation permits are farm specific and list the exact species and number of birds of each species that can be taken on each farm. Therefore, farmers must be able to identify the species in question. Farmers can request a technical consultation with experts with the USDA–WS to assist with the USFWS depredation permit process.

This publication includes:

- Descriptions of common avian predators that affect aquaculture in the southeastern United States
- Brief options for managing each predator species
- Summaries of other species that frequent aquaculture facilities but rarely cause serious losses or for which the economic impact has not been established
- A list of related or look-alike species for each species described
- Information on typical management tools, including frightening techniques, other tools and devices, and harassment patrols
- Strategies for integrated bird management

Species Descriptions

Double-crested Cormorants

Of the five species of cormorants in North America, the Double-crested Cormorant (*Nannopterum auritum*; hereafter cormorant) is by far the most numerous and troubling for aquaculture, especially catfish aquaculture.

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Cormorants are large (33 inches long, 5 pounds; 84 cm, 2.27 kg), goose-sized birds with slender, elongated bodies (Fig. 1). Their legs are set far back, which gives them an upright stance. Primarily black, they can have mottled brown or whitish chests and bellies, especially in females or young individuals. During the breeding season (March through June), they may have pronounced, earlike tufts of feathers or crests on the head; these are lost after egg-laying.

Cormorants eat fish primarily but also some invertebrates such as crayfish. A cormorant eats about 1 pound (0.45 kg) of prey per day. Prey is typically 6 inches (15 cm) long or less but can range from 1 inch to over 15 inches (2.5 to 38.1 cm), depending on the prey species. In catfish aquaculture, they typically eat catfish that are 4 to 12 inches (10.2 to 30.5 cm) long.

Cormorants feed by diving and using their webbed feet to swim underwater to catch their prey. They can dive over 66 feet (20 m) and can easily use any area of an aquaculture pond. They feed almost exclusively during the day and rarely if ever scavenge dead fish.

Range and timing: Double-crested Cormorants breed along the coasts of the United States. The interior population, which primarily affects aquaculture, breeds throughout the Great Lakes region, the prairie states, and the Canadian provinces. Breeding colonies are increasingly common in the southeastern states. During winter, migratory cormorants concentrate in the aquaculture-rich areas of Alabama, Arkansas, Louisiana, Mississippi, and Texas. Cormorants breeding from New York to New England primarily winter in the Carolinas, Georgia, and the coastal regions of Florida.

Depredation issues: Double-crested Cormorants can number in the tens of thousands during winter in aquaculture producing areas of the southern United States. In terms of direct predation, they are the most destructive birds to inland aquaculture, especially catfish production. A study estimated that annual losses to overall U.S. catfish production exceed $47 million.

Disease issues: Cormorants can shed viable virulent *Aeromonas hydrophila* (vAh) in their feces for multiple days after consuming infected fish. Aeromonas spp. can cause disease in fish, humans, reptiles, and birds. The extent to which cormorants contribute to the spread of this disease in aquaculture is unknown.

Management options: During winter, cormorants typically forage within about 15 miles (24 km) of their night roosts. They can be managed with a combination of lethal and nonlethal methods on farms and with the dispersal of night roosts near aquaculture facilities by agency staff.

Any lethal management of cormorants requires a depredation permit. Before a permit is issued, it must be demonstrated that nonlethal methods have been or are being used. Producers should contact the USDA Wildlife Services agency in their state before acting. There are many nonlethal options for harassing these birds.

Similar species: Anhinga and Neotropic Cormorant (Fig. 1).

Figure 1. A) Double-crested Cormorant (*Nannopterum auritum*), B) Anhinga (*Anhinga anhinga*), and C) Neotropic Cormorant (*Nannopterum brasilianum*). *Photos: Adobe stock*

Anhinga

Anhingas (*Anhinga anhinga*) are large (34 inches, 86 cm), black diving birds that are shaped like a cormorant (Fig. 1). However, anhingas are smaller and have white to silver feathers on the upper wings and shoulders that give the impression of white patches. The bill is straight (not hooked) and sharply pointed, and the tail is longer than a cormorant's relative to body size.

Anhingas may swim submerged with only their heads and necks protruding above the surface, giving them a snakelike look. They eat whatever fish are available. They feed during the day on all parts of a pond but are likely to be very wary and keep their distance from human activity.

Range and timing: Anhingas occur in eastern Texas and Louisiana and up the Mississippi Valley to Tennessee. They are also found along the lower coastal plain northward to central North Carolina. Anhingas may migrate to Central America and coastal swamps during winter.

Depredation issues: Anhingas are secretive birds that spend most of their time in cypress swamps and slow-moving streams. Their population is very small compared to cormorants and they are not thought to be a significant threat to aquaculture. However, these birds may be a concern at Florida facilities that specialize in tropical aquaculture.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Management options: Nonlethal harassment methods can be used if needed. Because they occur infrequently, lethal methods are likely to be unnecessary.

Neotropic Cormorant

Neotropic Cormorants (*Nannopterum brasilianum*) occur within the wintering range of Double-crested Cormorants and may be seen in aquaculture facilities mainly in the southern United States. Neotropic Cormorants are smaller (24 inches long, 3 pounds; 61 cm, 1.4 kg) than double-crested cormorants, but from a distance or in flight, they can be difficult to tell apart (Fig. 1). Neotropic Cormorants lack crests and have white feathers bordering the mouth below the eye. Some breeding adults may have white plumes on the neck. Their foraging habits are the same as those of Double-crested Cormorants, though they may prefer smaller fish.

Range and timing: Neotropic Cormorants are found throughout South and Central America and as far north as Southern California to Florida. They are primarily coastal but can commonly be found over a hundred miles inland. They may breed in these regions from February to October. Small numbers may be found farther north in summer. They winter in the southern United States as well. The range of neotropic cormorants has been expanding northward and although still relatively uncommon in most areas of aquaculture production, they are increasing in number.

Depredation issues: Although current population levels are unknown, Neotropic Cormorants are far less abundant and less widely distributed than doublecrested cormorants in the United States. Large local concentrations of Neotropic Cormorants could pose a hazard to individual farms.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Management options: Nonlethal hazing may be used to disperse these birds from farms, but no lethal methods are authorized without a specific depredation permit from the USFWS.

American White Pelican

The American White Pelican (*Pelecanus erythrorhynchos*) is a very large (50 to 65 inches in body length, 12 to 18 pounds; 127 to 152 cm long, 5.4 to 8.1 kg), white bird with black wing tips and a long, yellow or orange bill and throat pouch (Fig. 2). Large flocks of 50 to several hundred birds often loaf on pond levees, in flooded fields, or on sandbars.

Pelicans may fly far in a single day and may not feed near their loafing areas. Pelicans feed day and night and may alter their feeding times to avoid harassment. They feed by scooping fish out of the water as they swim. Because of their foraging strategy of scooping up fish, pelicans can eat relatively small fish if they are abundant as well as quite large fish up to 24 inches (61 cm) or larger, depending on the species. Given this, almost all fish in aquaculture ponds are vulnerable to pelican predation.

Range and timing: American White Pelicans breed extensively in the western United States, the

prairie states, and the western Canadian provinces. Some small breeding colonies are scattered along the Gulf Coast. White pelicans winter primarily along the Gulf Coasts of Mexico, Texas, Louisiana, Mississippi, and Alabama; in inland areas along large rivers, lakes, and reservoirs; and in the aquaculture-producing areas of Alabama, Arkansas, Louisiana, and Mississippi. Some individuals (likely immature birds) do not migrate to their northern breeding grounds.

Depredation issues: American White Pelicans consume about 2.2 pounds (1 kg) of fish per day. Unlike most fish-eating birds, pelicans are large enough to consume most market-sized foodfish in addition to fingerlings. No comprehensive data are available on the economic impacts of pelicans on aquaculture. Preliminary estimates suggest that large flocks of pelicans may cost catfish producers thousands of dollars per day. However, compared to double-crested cormorants, pelicans are much less numerous and less widely distributed during the winter, so the cumulative effect of their foraging is likely much less than that of cormorants on a large scale.

Disease issues: The greatest hazard posed by American White Pelicans may be from their transmission of the *Bolbophorus damnificus* trematode, a parasite that infects channel catfish. Pelicans are the final host for this trematode parasite that kills fingerlings, reduces growth and feed consumption in larger catfish and makes them unsaleable. American White Pelican have been shown to shed vAh in their feces after consuming infected fish.

Management options: Nonlethal hazing may be used to disperse these birds from farms, but no lethal methods are authorized without a specific depredation permit from the USFWS.

Similar species: Brown Pelicans and Wood Storks

Brown Pelican

Brown Pelican (*Pelecanus occidentalis*) typically occupy coastal areas throughout North America, occasionally venturing further inland. The brown pelican is a very large (50 inches, 125 cm) bird with a long, grayish bill and a dark throat pouch (Fig. 2). Its head is white with a yellow tint or plumes. The back of the neck is brown, and the underparts are dark brown or gray. The back has streaks of gray.

Brown Pelicans are found in or near marine environments. They usually feed by diving headfirst from

Figure 2. A) American White Pelican (*Pelecanus erythrorhynchos*), B) Brown Pelican (*Pelecanus occidentalis*), and C) Wood Stork (*Mycteria americana*). *Photos: Adobe stock*

the air into the water at high speed. They also occasionally feed on the surface. In an aquaculture setting, they can consume any size of fish and may use ponds or raceways. Brown Pelicans have been documented as an issue on some coastal aquaculture facilities. They may also be a concern concerning roosting on oyster cages, potentially contributing to *E. coli* in oysters and preventing harvest.

Depredation issues: Brown Pelicans are not often associated with depredation problems. Coastal facilities may be impacted.

Disease issues: Producers of shellfish such as oysters may have issues with brown pelicans defecating on grow-out cages, which can cause problems with high bacterial counts.

Management: Nonlethal hazing may be used to disperse these birds from farms, but no lethal methods are authorized without a specific depredation permit from the USFWS.

Wood Stork

Wood Stork (*Mycteria americana*) are large, white wading birds with black wing tips and tails (Fig. 2). They have naked or nonfeathered heads and long, gray or yellow bills. Wood Storks stand up to 47 inches (120 cm) tall. These birds fly with their necks extended, which distinguishes them from most other wading birds.

Wood Storks feed during the day in shallow water typically less than 18 inches (46 cm) deep in wetlands and along the shorelines of ponds and lakes. They usually wade through the water, sweeping their bills from side to side to catch the fish or other prey they contact. These storks also scavenge, feeding on dead and sick fish that float into shallow water. Although unlikely to be a threat to fish in water deeper than 3 feet, they may forage extensively on fish in ponds that have been drawn down for harvest or where fish are brought to the surface by low oxygen, feeding, or illness.

Range and timing: Wood Storks breed in Florida and may be found in the coastal swamps of Alabama, Georgia, and South Carolina; they are more plentiful in South America. In summer, they may wander as far north as North Carolina and Arkansas. Storks are usually associated with one of two populations that breed in Florida or Central America. Birds from both populations may mix in Louisiana and Mississippi during summer. Storks in Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina are listed as threatened and are protected by the Endangered Species Act. Most Wood Storks migrate south during winter, away from most aquaculture-production areas.

Depredation issues: Large numbers (hundreds to thousands) of Wood Storks can be found on individual farms during summer. Little is known about the effect they have on aquaculture, but they may be attracted to diseased or dying fish that are near the water surface. Storks are attracted to concentrations of fish and may be stimulated to feed by falling water levels, such as drawdowns.

Disease issues: Wood Storks have been shown to shed viable vAh in their feces, for multiple days after consuming infected fish. *Aeromonas* spp. has been shown to cause disease in fish, humans, reptiles, and birds.

Management options: Because they are listed as threatened in Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina, management options are limited in those regions. In fact, other fish-eating birds, including cormorants, cannot be hazed or shot while storks are present. Therefore, any damage at aquaculture facilities should be reported immediately to the nearest USFWS and USDA Wildlife Services offices. These birds should not be harassed or killed without special approvals.

Similar species: White Ibis (See "Ibis" on page 8).

Great Blue Heron

Great Blue Heron (*Ardea herodius*) are tall (51 inches, 130 cm), bluish-gray wading birds with white heads, black plumes, and pointed yellow bills (Fig. 3). These birds have long necks and legs and fly with their necks pulled back under their heads and legs extended.

They typically wade or wait along wetland or pond margins and strike their prey. Great Blue Herons primarily eat fish but will consume almost anything within reach, including crustaceans, frogs, insects, snakes, small mammals, and even other birds. They will also scavenge fresh dead prey. Great Blue Herons will perch on raceways, tanks, ponds, and seine socks to catch fish that are confined and easy to access. On catfish ponds, they feed on fish near the surface of the water, especially weak or sickened fish, and will also consume healthy fish that rise to feed or because of low oxygen levels. They feed primarily during the day but may also feed at night, especially in areas where

they are harassed. Because of their large size and erect profiles, herons and egrets are obvious and easy to see.

Range and timing: Great Blue Herons are common throughout the United States, breeding northward into Nova Scotia to British Columbia and coastal Alaska. Most migrate south in winter, with some going as far as northern South America. Great Blue Herons are found on aquaculture facilities in the southeastern United States year-round, although numbers tend to be higher in spring and fall because of migration.

Depredation issues: Great Blue Herons eat about 1 pound (0.45 kg) of fish per day. Because they most often eat dead or weakened fish, they do not appear to have an economically significant effect on catfish aquaculture. However, they can consume healthy catfish when the fish are near the surface, such as during fish feeding. Great Blue Herons probably do more damage to trout baitfish production, and economic projections indicate that losses in trout and baitfish production can be significant. The minnows consumed are market sized, so herons are consuming finished product. Also, baitfish ponds are shallow, and the fish are more accessible. Great Blue Herons can eat relatively large and valuable trout for foodfish and stocking, and research has shown that they can cause considerable depredation and economic loss to trout aquaculture. The larger fish, including broodfish of many species, may also be damaged from spearing by great blue herons in raceways or other systems, though the economic impact of these injuries is unknown. Great Blue Herons also impact inland shrimp aquaculture and may contribute problems with bacterial transmission on marine oyster farms.

Disease issues: Great Blue Herons showed infection with the nematode Eustrongylides ignotus, a parasitic disease in freshwater fish as well as *Clinostomum* more commonly referred to as "yellow grubs". The extent of transmission in aquaculture by birds for the above diseases is unknown.

Management options: Great blue herons should be excluded from raceways and other small production systems. Harassment, reinforced with lethal control, should be practiced in baitfish systems. Depredation permits are required for the use of lethal methods.

In catfish production systems, great blue herons should be hazed when the fish are being fed floating feeds or when the fish are concentrated in a sock or other confinement. If ponds are drawn down for seining to depths of 2 feet or less, all wading birds should be hazed from these areas until water levels are returned to normal. At other times, the dispersal of these birds may not be justified economically.

Similar species: Great Egret, Little Blue Heron, Sandhill Crane (no aquaculture depredation issues noted for Sandhill Cranes)

Great Egret

The Great Egret (*Ardea alba*) is a large (41 inches, 104 cm), white heron with a yellow bill and black legs and feet (Fig. 3). These wading birds feed in shallow water on fish, amphibians, crustaceans, and other small vertebrates. They may feed alone or in large groups in areas of abundant prey, such as ponds with diseased fish. They feed mainly by stalking and wading along pond edges.

Range and timing: Great Egrets are distributed in tropical and temperate regions worldwide. In North America, they breed in the southeastern United States but also as far north as the upper Midwest, and up the eastern coast to Massachusetts. Great Egrets winter well into South America but are found year-round throughout the aquaculture production areas of the U.S. Southeast. Their abundance in the Southeast is typically greatest during the spring and fall migrations.

Depredation issues: Great Egrets consume about 0.66 pounds (300 g) of fish daily. In catfish aquaculture, they eat mostly dead or diseased fish. They forage primarily at pond edges and the water's surface and typically do not cause significant economic damage. Exceptions may be during fish feeding and when other factors, such as low oxygen, bring fish to the surface or pond edge.

However, Great Egrets can cause significant damage to baitfish, inland shrimp, and ornamental fish aquaculture. They may pose a hazard to cultured fish in easily accessed raceways or shallow ponds or during drawdowns or harvest.

Disease issues: Great Egrets showed infection with the nematode *Eustrongylides ignotus*, a parasitic disease in freshwater fish. Great egrets have been shown to shed viable vAh in their feces, for multiple days after consuming infected catfish. Commercial catfish infected with vAh experience ulcers, tissue hemorrhages, and death. Species of the genus *Clinostomum* which are common parasites of fish, amphibians, and birds, primarily egrets and herons.

Depredation issues: Great Egrets can cause substantial losses to baitfish production, ornamental fish production, and inland shrimp aquaculture. They should be hazed using nonlethal methods from areas where such damage could occur. They can be excluded from raceways or small ponds with netting or perimeter fencing. Federal and state depredation permits are required for any lethal control to supplement nonlethal methods.

Management options: In most cases, foraging by Great Egrets does not pose an economic threat to catfish production. Healthy catfish are available to these birds only when the fish are at the water surface, as when they rise to feed or frequent the shallow zones of hillside ponds. Concentrations of great egrets should be followed up by pond inspections by producers, as they may identify ponds with other issues such as disease or low oxygen.

Similar species: Snowy Egret, Little Blue Heron (immatures are mostly white)

Little Blue Heron

Little Blue Herons (*Egretta caerulea*) are of medium size (24 inches, 60 cm) and are blue-gray with dark legs and brownish necks and heads as adults (Fig. 3). The immatures are white with bluish bills and greenish legs; they resemble snowy egrets. Little Blue Herons prey on small fish, crustaceans, small amphibians, and insects. They forage by stalking in shallow water along pond edges.

Range and timing: These herons are found throughout the southern U.S. states, down to Central America, South America, and the Caribbean. They can be found year-round in the U.S. southern coastal regions but migrate northward, breeding as far north as the central plains states and the Atlantic coast to New Jersey.

Disease issues: Little Blue Herons may carry parasites of the genus *Clinostomum*, commonly termed "yellow grubs".

Depredation issues: Little Blue Herons may consume up to 0.2 pounds of food per day. They are of little concern to catfish producers but do depredate baitfish, tropical fish, and inland shrimp aquaculture.

Management options: Management is like that for other wading birds, with hazing methods as a primary nonlethal means. Barriers and netting are effective on smaller raceways and ponds. Any supplemental lethal control requires a depredation permit.

Green Heron

The Green Heron (*Butorides virescens*) is a small (22 inches), dark heron with a bluish-green back, a brown neck with white flecks, yellow to orange legs, and a black crown (Fig. 4). They feed on small fish, crustaceans, and insects, and usually hunt by waiting along the shorelines of ponds.

Range and timing: Green Herons are found throughout the United States (except the interior mountain west), north to southern Canada, and southward to South America.

Depredation issues: Green Herons may eat up to 0.15 pounds (68 g) of prey per day and, like little blue herons, are a threat to baitfish, tropical fish, and inland shrimp aquaculture. Although common, they are typically not as abundant in aquaculture as other species such as great egrets. Their small populations, combined with their small size, limit depredation losses.

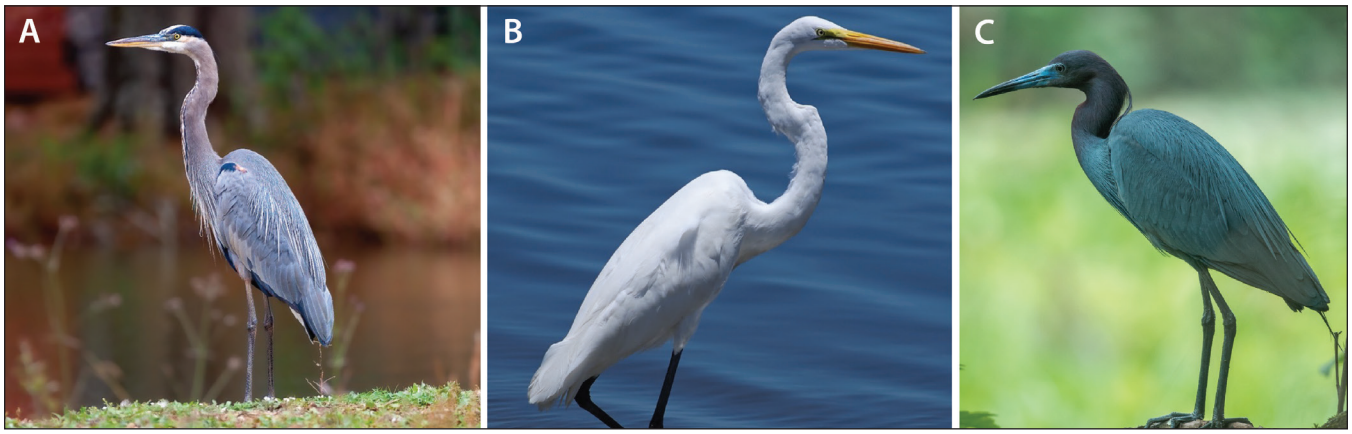

Figure 3. A) Great Blue Heron (*Ardea herodius*), B) Great Egret (*Ardea alba*), and C) Little Blue Heron (*Egretta caerulea*). *Photos: Adobe stock*

Disease issues: Green Heron is a definitive host for the gill trematode, Centrocestus formosanus, which causes damage to fish gills. Green Herons may also be infected by parasite species of the genus *Clinostomum*.

Management options: Management is like that for other wading birds, with hazing methods as a primary nonlethal means. Barriers and netting are effective on smaller raceways and ponds. Any supplemental lethal control requires a depredation permit.

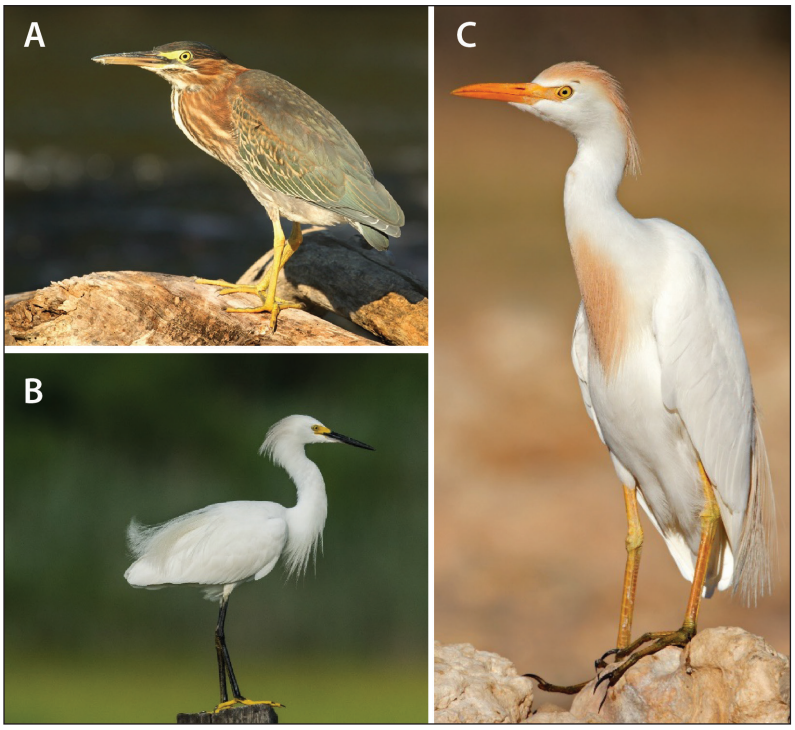

Figure 4. A) Green heron (*Butorides virescens*), B) Snowy egret (*Egretta thula*), and C) Cattle egret (*Bubulcus ibis*). *Photos: Adobe stock*

Snowy Egret

Snowy Egrets (*Egretta thula*) are medium-sized (27 inches, 69 cm) white herons with dark legs and yellow feet (Fig. 4). They feed by stalking and waiting along pond banks.

Range and timing: These birds are found throughout the aquaculture production areas of the southeastern United States and along the Atlantic Coast to Maine. They breed as far north as the Great Plains of the United States and range into southern South America.

Depredation issues: Snowy Egrets eat up to 0.2 pounds (91 g) of fish and crustaceans per day. These birds may pose a threat to baitfish, tropical fish, and inland shrimp aquaculture. They typically are not as common in aquaculture as are some other wading birds but may be locally abundant in some areas, such as Florida and Louisiana.

Disease issues: Snowy Egrets showed infection with the nematode *Eustrongylides ignotus*, that can a parasitic disease in freshwater fish. They may also be infected by the parasite species of the genus *Clinostomum*.

Management options: Management is like that for other wading birds, with hazing methods as a primary nonlethal means. Barriers and netting are effective on smaller raceways and ponds. Any supplemental lethal control requires a depredation permit.

Cattle Egret

Cattle Egrets (*Bubulcus ibis*) are small, white egrets with yellow plumes. They are often seen feeding in large groups on pond banks and in pastures (Fig. 4).

Depredation issues: Cattle Egrets eat mainly insects and pose little if any threat to aquaculture.

Management options: They may be dispersed with nonlethal techniques if their presence seems to attract other, more hazardous fish-eating birds.

Glossy Ibis and White Ibis

Ibises are medium-sized (25 inches, 63 cm) wading birds found in rice fields, crawfish ponds, and other shallow-water habitats in southern Louisiana, Texas, and Florida. The Glossy Ibis (*Plegadis falcinellus*) is an iridescent brown with a dark bill and legs (Fig. 5). The White Ibis (*Eudocimus albus*) is white with a curved red bill, red face, and black wing tips (Fig. 5). Ibises feed by wading through shallow water.

Depredation issues: These birds may consume up to 0.3 pounds (136 g) of crawfish or shrimp per day, though the economic impact they have on these cultured species is unknown.

Disease issues: We found no information that indicates that these ibises are a vector of disease for commercial aquaculture species.

Figure 5. Top: Glossy Ibis (*Plegadis falcinellus*). Bottom: White Ibis (*Eudocimus albus*). *Photos: Adobe stock*

Lesser Scaup and Greater Scaup

Lesser Scaup (*Aythya affinis*) and Greater Scaup (*Aythya marila*) are large diving ducks (18 to 20 inches, 45 to 50 cm) with iridescent greenish or purple heads, black breasts, gray backs, black rumps, and blue bills (Fig. 6). Females are dull brown with white feathers at the base of the bill. These ducks usually feed by diving underwater and sifting through sediments or catching prey near the pond bottom.

Range and timing: These ducks winter throughout the southeastern United States, with the greater scaup frequenting more coastal or marine environments.

Depredation issues: Scaup may be seen in very large rafts (more than 1,000 birds) on aquaculture facilities. Scaup feed mainly on invertebrates at the bottom of fishponds, but damage to baitfish is well documented. Scaup may also consume shrimp, crawfish, and fish food, though the economic impact of this behavior is unknown. They are unlikely to impact catfish aquaculture.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Management options: Hazing methods are a primary nonlethal means of management. Barriers and netting are effective on smaller raceways and ponds. Any supplemental lethal control requires a depredation permit. Baitfish farmers often allow hunting on their ponds during the waterfowl season as a means of deterrence.

Mallard

Mallards (*Anas platyrhynchos*) are large (28 inches, 70 cm) ducks familiar for their green heads. They have white neck rings, olive-colored bills, brown breasts, silver-gray vermiculated (bearing wavy, wormlike lines) backs and flanks, dark rumps, and white tail feathers. The female is mottled brown, and its orange bill has a black patch (Fig. 6).

To meet their daily needs, mallards use many types of habitats within a wetland complex, including aquaculture ponds. They are dabbling ducks and usually feed on the water's surface or by tipping up with their heads underwater.

Range and timing: Mallards breed throughout the northern United States and Canada and winter throughout the southeastern United States.

Depredation issues: These ducks eat many types of animal and plant foods, including small fish or fish feeds when they are available and easy to access. Some producers have reported that these birds sometimes eat large amounts of baitfish.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Management options: Hazing methods are a primary nonlethal means of management. Barriers and netting are effective on smaller raceways and ponds. Any supplemental lethal control requires a depredation permit. Although mallards are not as common as scaup, baitfish farmers may gain some benefit from hunting on their ponds during the waterfowl season as a means of deterrence.

Gulls

Several species of gulls are found on aquaculture facilities in the southeastern United States, including Herring Gulls (*Larus argentatus*), Ring-billed Gulls

(*Larus delawarensis*), Laughing Gulls (*Leucophaeus atricilla*), and Bonaparte's Gull (*Chroicocephalus philadelphia*).

Herring Gulls are the largest of these species (26 inches, 65 cm). They are white with gray wings, black wing tips, pink legs, and a large, yellow bill with a red spot on the lower mandible (Fig. 7). Adult Ring-billed Gulls are about 19 inches (48 cm) and white with gray wings and black wing tips. They have yellow legs and a yellow bill with a black ring just below the tip of the bill (Fig. 7).

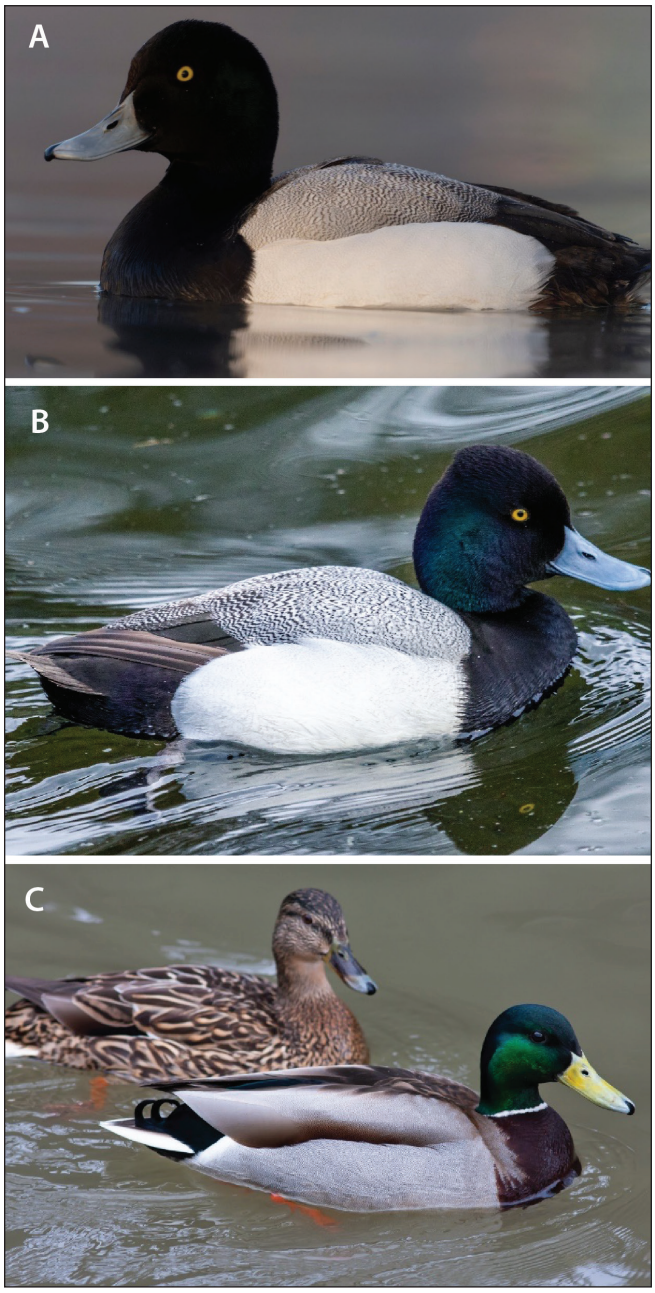

Figure 6. A) Greater Scaup (*Aythya marila*), B) Lesser Scaup (*Aythya affinis*), and C) Mallard (*Anas platyrhynchos*). *Photos: Adobe stock*

Bonaparte's Gulls are small (13 inches, 33 cm). Their heads are black during the summer and white with a black spot during the winter. They have white bodies, gray wings with white wing tips, and black on the trailing edges of the wings (Fig. 7).

Laughing Gulls are small (17 inches, 43 cm) and have white bodies and dark grayish-black wings with black wing tips. Their heads are black during the summer and white in the winter (Fig. 7). Laughing gulls occur mainly along the coast and are seen only rarely at inland aquaculture facilities.

Most immature gulls have brownish or faded plumage until their third or fourth year and may be difficult to distinguish without a detailed guide. Gulls can feed while swimming or by diving and skimming prey while in flight.

Disease issues: Various gull species have been shown to carry the *Aparavirus*, which is the causative agent for Taura syndrome (TS) in shrimp. It is unknown to what extent they may transmit TS among farms. Producers of shellfish such as oysters may have issues with gulls defecating on grow-out cages, causing problems with high bacterial counts.

Depredation issues: Gulls may scavenge on dead or sick fish at aquaculture facilities and feed on small fish such as baitfish and tropical fish near the surface. Little is known about their potential depredation impacts on aquaculture.

Terns

Common Terns (*Sterna hirundo*) and Forster's Terns (*Sterna forsteri*) are small (16 inches, 15 inches; 40 cm, 38 cm, respectively), gull-like birds. Adult terns have forked tails, white necks and underparts, gray wings and backs, and black crowns.

Common Terns have darker wings and black wing tips (Fig. 8). The immature common tern has a black patch on the back of the head and neck instead of a fully black crown. The immature Forster's Tern has black, tear-shaped patches on the sides of the head, trailing rearward from the eye.

Depredation issues: Terns are graceful fliers that may hover and dive to feed on aquatic prey at the water's surface. They occasionally feed at aquaculture facilities, especially during spring and fall migration. They will eat small numbers of fish at the surface but

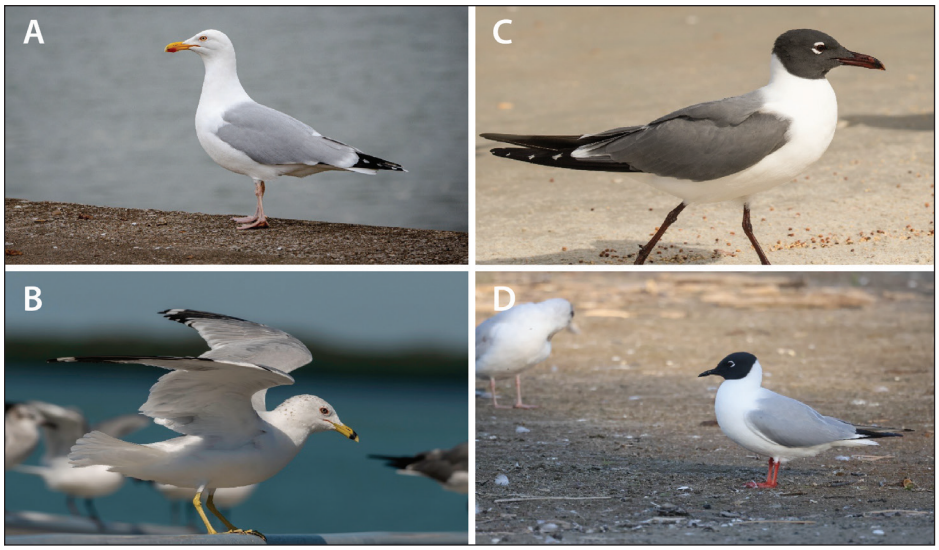

Figure 7. A) Herring Gull (*Larus argentatus*), B) Ring-billed Gull (*Larus delawarensis*), C) Laughing Gull (*Larus atricilla*), and D) Bonaparte's Gull (*Larus Philadelphia*). *Photos: Adobe stock*

are not usually an economic threat unless they concentrate in large numbers.

Disease issues: We found no information that indicates that these bird species are vectors of disease for commercial aquaculture species.

Management options: Many species of terns are protected by state and federal law. Producers should determine the status of these birds in their areas before attempting to manage them.

Figure 8. Top: Common Tern (*Sterna hirundo*). Bottom: Forster's Tern (*Sterna forsteri*). *Photos: Adobe stock*

Raptors

Raptors of interest to aquaculture facilities include ospreys, great horned owls, and bald eagles.

Ospreys (*Pandion haliaetus*) are large (24 inches, 61 cm), hawklike birds that prey almost exclusively on fish. These birds have brown backs and wings and white necks, heads, and underparts. The osprey's brown eye stripe makes it easy to recognize (Fig. 9).

Range and timing: Ospreys breed along the Atlantic and Gulf Coasts, into the interior of the northern United States and Canada. They spend winters in the southern United States, along the Atlantic and Gulf Coasts, and into southern Louisiana and Texas.

Depredation issues: Although they were once rare, osprey populations are increasing throughout their range. Ospreys hover and dive feet-first into the water to capture large, market-sized fish. They have been reported to damage primarily trout and sportfish at hatcheries for sportfish stocking purposes.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Management options: Ospreys are considered a species of special concern in many states, and no action should be taken to manage them on aquaculture facilities without first consulting local wildlife authorities and the USFWS.

Great Horned Owls (*Bubo virginianus*) are large (25 inches, 65 cm), mostly brown birds, with large yellow eyes and hornlike ear tufts (Fig. 9).

Range: These owls are widely distributed throughout the eastern United States.

Depredation issues: They occasionally take large, market-sized, or broodfish that are near the surface, especially trout. However, they are not considered an economic threat to aquaculture in general.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Bald Eagles (*Haliaeetus leucocephalus*), familiar as our national symbol, are very large (31 inches, 78 cm) birds of prey that eat mostly fish and carrion. The adult is brown with a white head and tail, a large, yellow bill, and yellow legs (Fig. 9). Immature birds are mostly brown and lack the white head and tail.

Range and timing: Bald Eagles are increasing throughout their range and may be seen throughout the aquaculture production areas of the Southeast, especially during winter.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Depredation issues: These birds swoop over the surface of the water and grab large fish with their talons. They are not known to cause economic damage to aquaculture.

Figure 9. A) Osprey (*Pandion haliaetus*), B) Great Horned Owl (*Bubo virginianus*), and C) Bald Eagle (*Haliaeetus leucocephalus*). *Photos: Adobe stock*

Management options: Management is not recommended and may not be legal. Bald Eagles have been removed from the federal list of endangered species but are protected by state law in many states. The Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act protect them nationwide. They may not be harassed without a permit.

Other Species

Other species of note are belted kingfishers and common grackles.

Belted Kingfishers (*Ceryle alcyon*) are small (13 inches, 33 cm) fish predators that have a large, crested head; white throat and belly; blue-gray back, head, and tail; and a sharp, black beak. Females have a reddish-brown band across the breast, whereas males have a blue-gray band (Fig. 10).

Range: Belted Kingfishers occur throughout the southeastern United States.

Depredation issues: These birds hunt from perches or hover and dive on fish or crawfish at the surface of the water. However, they usually forage singly or in pairs, so they likely have little economic impact.

Disease issues: Belted Kingfishers are the primary host for the trematode parasite Uvulifer ambloplitis, which causes black spot disease in freshwater fish. The extent to which kingfishers vector this disease in aquaculture is unknown.

Common Grackles (*Quiscalus quiscula*) are large (13 inches, 34 cm) blackbirds that have long tails and yellow eyes. The plumage in males is iridescent purple, green, or bronze, depending on light conditions (Fig. 10). The female has a shorter tail and relatively dull plumage with less iridescence.

Range: Although the numbers of grackles have declined in recent years, they are still abundant in the eastern United States, numbering in the millions.

Grackles are also expanding their range west of the Rocky Mountains.

Depredation issues: Grackles eat baitfish or parts of baitfish, especially minnows. Even though individual birds may catch relatively few fish at the water's surface, wintering and migrating flocks of grackles can easily number in the thousands.

Disease issues: We found no information that indicates that this bird species is a vector of disease for commercial aquaculture species.

Management options: If large numbers of grackles gather at baitfish facilities, they should be dispersed. Producers should learn about local regulations before using lethal methods.

Figure 10. Top: Belted Kingfisher (*Ceryle alcyon*). Bottom: Common Grackle (*Quiscalus quiscula*). *Photos: Adobe stock*

Methods for Controlling Bird Predation at Aquaculture Facilities

The fish-eating birds described above forage at aquaculture facilities throughout the United States, and each species causes a different type and level of damage and may be an issue for some types of aquaculture but not others. Birds may eat only diseased or weakened fish, or they may forage heavily on healthy fish. Birds can spread disease pathogens and parasites. All these factors dictate the level of potential impacts and therefore the management intensity needed to mitigate those impacts.

As discussed above, all fish-eating birds are protected by the Migratory Bird Treaty Act. These birds may not be killed in the United States without a depredation permit. Currently, there are no depredation orders for any of the species listed above except Common Grackles, which are covered under the 21.150 Depredation order. Please consult the USFWS Migratory Bird Office for your region before controlling these birds, as regulations can change.

The regulatory authority for managing migratory birds rests with the USFWS. If fish-eating birds are damaging an aquaculture facility, the USFWS may issue a depredation permit that allows the producer to kill a limited number of most species to reinforce the effects of nonlethal techniques.

Some fish-eating birds are also protected by the Endangered Species Act. Wood Storks in certain states and locations receive this protection. No lethal or nonlethal control activities can be used to control any bird species using aquaculture facilities in this region if Wood Storks are nearby. The Bald and Golden Eagle Protection Act further protects eagles and prohibits all hazing activities near Bald and Golden Eagles (*Aquila chrysaetos*), except with special permission from the USFWS.

On-farm management

Producers are best able to manage bird damage because they know their farms intimately and can continuously watch the patterns of bird use throughout the year. Because different bird species pose different hazards, dispersal activities should be tailored to the birds using the farm.

American White Pelicans: Because of the amount of fish that they can consume and the number of trematodes and bacteria they can spread to ponds, American white pelicans can have a disastrous effect on catfish production. Producers should try to keep all pelicans off their farms.

Cormorants: Although cormorants eat about half as much as pelicans, they are much more plentiful and sometimes visit ponds in large flocks, causing extensive damage. Cormorants move often among ponds and farms and feed by diving, so they can use an entire pond. They respond only to persistent management with lethal and nonlethal techniques.

Herons and egrets: Herons and egrets feed primarily by wading around pond banks and in shallow water. The greatest threat they pose to catfish aquaculture is when the fish are feeding and are near the water's surface and within reach of these wading birds. Dispersal techniques should be used while the fish remain at the surface of the water.

Conversely, herons and egrets can cause considerable damage to baitfish and inland shrimp aquaculture and should be dispersed whenever present.

Frightening Techniques

Propane Exploders

Propane exploders are noisemakers that use a mechanical igniter to burn propane gas and cause an explosion that sounds like a firearm. One exploder should be used for every 3 to 5 acres (1.2 to 2.0 ha). These noisemakers should be aimed at the area to be protected, such as a pond or roost. Designs include

rotating cannons that fire in different directions, timers that vary the frequency of explosions, and remote-controlled systems that allow one operator to detonate several cannons.

Propane exploders are most effective when the location, timing, and pattern of bursts are varied daily. Birds adapt easily, and using this device in a way that causes it to be predictable will reduce its effectiveness. When available, limited supplemental lethal control likely increases the propane exploders' effectiveness.

Pyrotechnics

The three types of pyrotechnics are used most to disperse birds: screamers, bangers, and cracker shells.

Screamers and bangers are 0.6 inch (15 mm) pyrotechnics fired from specially designed .22 caliber pyrotechnic launchers. The pyrotechnics are ignited by a .22 caliber blank, and launchers are available for single and multi-shot use. Screamers emit a shrill, screaming sound to frighten birds. Bangers explode with the force of a strong firecracker.

Shell crackers are pyrotechnics housed within a shotgun cartridge. They are usually fired from an inexpensive, single-shot shotgun. Shell crackers are best fired from an open-cylinder shotgun, but the cartridges often foul the barrel, which must be cleaned often to extend the life of the shotgun. The effect of shell crackers is like that of bangers.

Pyrotechnics should be aimed in the vicinity of the birds being dispersed. The types of pyrotechnics used should be alternated, and firing should continue until the birds are dispersed. All pyrotechnics can cause fires if not used carefully. Some states and localities may have special regulations for their transport, use, and storage.

Effigies

An effigy is a model of a person, object, or animal that may frighten birds. Types of human effigies used near aquaculture ponds include scarecrows, mannequins, plywood silhouettes, and inflatable effigies such as the scary-man device. These models have varying degrees of effectiveness.

The scary-man device was evaluated extensively in Mississippi, where it dramatically reduced the number of cormorants at catfish facilities when used with harassment patrols. These devices were temporarily effective when placed along pond banks, one per 34 acres (13.8 ha) of surface water, and set to inflate once every 5 to 12 minutes. Each display lasts 15 to 30 seconds.

Because birds can become accustomed to effigies, they are most effective when moved at least every 3 days and used with other techniques, especially lethal control.

There are also effigies of predators, such as plastic alligator heads and raptor silhouettes. The effectiveness of these tools has not been formally evaluated and there is little information about their effect on bird depredation.

Effigies of dead or injured birds scare birds in other situations, but it is not known whether they will repel fish-eating birds from aquaculture ponds.

Other Tools and Devices

Effectiveness varies or is unknown for mechanisms such as sonic devices, lights, lasers, and dogs.

Sonic devices such as sirens, high-intensity sound devices, recorded distress or alarm calls, and electronic guards designed for livestock protection may be effective but have not been scientifically studied as tools for preventing loss due to fish-eating birds. They have shown some effectiveness with gregarious flocking birds such as blackbirds and starlings.

Spotlights, strobe lights, and lasers can be used to locate and disperse birds, working best in low-light conditions or at night. Some success has been shown in using handheld lasers to disperse night herons, night-feeding pelicans, and cormorants in roosts. Effectiveness varies by situation and bird species.

A laser should be aimed directly at the birds and moved from side to side. To disperse a roost, the beam should be moved from one side of the roost to the other and aimed at individual birds if possible. Lasers come in primarily red and green. There is some evidence that some birds respond differently to these colors. Handheld lasers are available from vendors that sell other bird dispersal devices. Although automated systems are also available, cost can be an issue.

Dogs may be used to scare birds and other wildlife at small facilities or near populated areas where other techniques cannot be used, but their effectiveness is unknown.

Harassment Patrols

During harassment patrols, bird chasers drive along pond levees using a route that enables them to observe the open-water areas of the facility. Harass-

ment patrols should be conducted continuously in areas with many birds and their frequency varied according to the number of birds present.

Some bird chasers use live ammunition along with pyrotechnics and other devices because small-caliber ammunition and shotgun shells may be less expensive than pyrotechnics. If birds will be shot, the producer must have a current USFWS depredation permit. All birds killed must be documented and reported to the USFWS. Bird chasers must be able to identify depredating species on the permit and take only those birds. The use of live ammunition is dangerous, and chasers must follow all appropriate firearms safety precautions. Only steel shot or other nontoxic shot should be used in shotguns.

On catfish aquaculture, supplemental lethal control combined with nonlethal methods has been shown to reduce bird use of aquaculture over nonlethal methods alone.

Near-Farm Management

Most fish-eating birds center their daily activities on an important site such as a night roost, a daytime roost, or a loafing area, and they can damage aquaculture facilities within easy flight distance. Double-crested Cormorants usually feed within about 15 miles of the roost they used the previous night. Therefore, dispersing their roosts in lakes or wetlands near aquaculture facilities may be extremely effective at reducing the number of cormorants using the farms. Pelicans also may forage near their daytime loafing areas, but their daily migration distances are much greater than those of cormorants.

Dispersing fish-eating birds from roosting and loafing areas may require teams of several people using nonlethal tools, such as pyrotechnic screamers and bangers, along with lasers after dark. Using a combination of tools works best. The teams should enter the roost area at least 2 hours before sunset and fire pyrotechnics at the cormorants as they enter the roost to prevent them from settling. Dispersal teams may also try dispersing the birds after they have settled in the roost, but ambient light and weather conditions can affect how readily the cormorants will leave the roost.

Roosts should be dispersed on at least 2 and sometimes 3 successive nights. If several roosts are near a farm where damage is occurring, all the roosts should be dispersed simultaneously to ensure that the cormorants are moved from the area. Cormorant roost dispersal is effective at reducing depredation at the farm and even regional levels when coordinated efforts are made.

When they aren't foraging, American white pelicans use levees and shallow-water areas such as rice fields, waterfowl impoundments, flooded fields, and abandoned catfish ponds as resting or loafing areas. To make such areas less attractive, managers should remove standing water if possible.

Wetlands, however, are essential habitats for many other species of wildlife and are protected by many state and federal laws. The management of wetland habitats should not be attempted without the appropriate regulatory approvals. Areas near aquaculture facilities that serve as pelican loafing sites should be patrolled several times daily and the birds repeatedly hazed to ensure that they are dispersed.

Integrated Bird Management

The most effective approach to managing bird predation in aquaculture is to integrate all applicable tools and techniques into a comprehensive program. Both hazing and lethal techniques may be needed. Lethal control should be used to reinforce nonlethal methods and to remove or retrain birds that have lost their fear of the bird management program.

Each day, employees responsible for harassment patrols should help move and alter the pattern of devices such as propane exploders and effigies. Farm managers should work with wildlife damage management biologists to keep birds from feeding or resting on the farm. Farm managers should also work with wildlife biologists to identify off-site loafing or roosting areas of cormorants and pelicans. Together, biologists and producers should devise a plan for dispersing fish-eating birds from these locations during the periods of greatest risk. In the southeastern United States, populations of fish-eating birds are largest in winter. However, nonbreeding pelicans and southern breeding populations of cormorants and wading birds may be a year-round threat for some producers.

Technical Assistance

For assistance with managing fish-eating birds in your state, contact USDA Wildlife Services by calling toll-free 866-487-3297. You can also contact your state's extension service.

Summary

While bird management programs can be very cost-effective, the damage that occurs on aquaculture is as varied as the bird species present, the aquaculture products farmed, and the production practices used. Methods that work well on, for example, trout aquaculture may not work on catfish aquaculture. The primary species that cause damage on trout aquaculture will not be the same as those for catfish aquaculture. In addition, farms in some locations may not have significant depredation issues, whereas other farms are hit hard. Lastly, very little has been published on avian depredation issues with redfish, hybrid striped bass, shellfish, and shrimp aquaculture. Much work needs to be done to address these aquaculture sectors.

Because of these issues, it is extremely important that you consult with your state USDA Wildlife Services programs and request a site visit to evaluate your farm and recommend best management practices. University extension programs can also be an excellent source of information. Finally, always consult the USFWS and your state agencies before implementing a dispersal program, particularly if it involves lethal control, to avoid potentially costly violations.

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