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## Effects of Fires on Foraging and Breeding Wading Birds in the Everglades

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**ABSTRACT.**—Nests, eggs, and chicks of nesting wading birds were unharmed by two fires in the Everglades. However, at least 50 adult White Ibises (*Eudocimus albus*) foraging away from the breeding colonies were killed during one fire. These results are counter-intuitive given that well-flighted adult birds seem more capable of escaping a fire than immobile nests or eggs. Nests probably were unharmed because of their location in wet willow (*Salix carolina*) and buttonbush (*Cephalanthus occidentalis*) islands. The adult birds foraging in a small cattail (*Typha angustifolia*) stand may have been trapped by flames in surrounding tall sawgrass (*Cladium jamaicense*) or debilitated by smoke inhalation. These observations provide insight into the direct effects of fire on wading bird

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Many studies have documented relationships among habitat, fire, and avian abundance (Howard et al. 1959, Vogl 1973, VantHul et al. 1997, Reynolds and Krausman 1998). However, the direct effects of fire on bird survival are rarely reported (Bigham et al. 1964, William and Stasiak 1979). Birds directly affected by fire usually are ground nesters whose eggs or chicks are vulnerable to ground fires (William and Stasiak 1979) or waterfowl that are flightless during wing molt (Hohman et al. 1992). Flighted, adult birds seem well equipped to escape fire and smoke. Here we report on the effects of fires on large breeding colonies of wading birds in the Ev-

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everglades and on the fire-related death of approximately 50 adult White Ibises (*Eudocimus albus*) found away from colonies.

We studied wading birds in northern Water Conservation Area 3A (WCA 3A) of the central Everglades ecosystem from January 1994 to July 1999. This area is a seasonally inundated grassland dominated by extensive stands of sawgrass (*Cladium jamaicense*) and cattail (*Typha angustifolia*). The flat, open landscape is occasionally broken by cypress heads and tree islands. Lower elevation islands are vegetated with willow (*Salix caroliniana*) and buttonbush (*Cephalanthus occidentalis*), cypress (*Taxodium* spp.), or introduced melaleuca trees (*Melaleuca quinquinerva*). A mix of tropical hardwoods is found on islands of higher elevation (Craighead 1971, Gunderson 1994).

*Effects of fire on wading bird breeding colonies.*—On 2 May 1994, we saw lightning start a ground fire north of Alligator Alley (Interstate Highway 75) and immediately west of Florida St. Rt. 27 in northeastern WCA 3A. This fire burned more than 2,833 ha during one week. The burned area consisted of contiguous stands of sawgrass and cattail, with widely dispersed tree islands. The study island is large (about 2 km greatest dimension), dominated by willow and buttonbush, and embedded in a matrix of cattail and sawgrass. This tree island (“Alley North”) is the site of one of the largest wading bird colonies in the Water Conservation Areas (26° 11' N; 80° 31' W). At the time of the 1994 fire, the colony contained approximately 2,100 nests of wading birds (including White Ibises, Glossy Ibises (*Plegadis falcinellus*), Black-crowned Night Herons (*Nycticorax nycticorax*), Great Egrets (*Ardea alba*), Great Blue Herons (*A. herodias*), Roseate Spoonbills (*Ajaia ajaja*), Anhingas (*Anhinga anhinga*), Snowy Egrets (*Egretta thula*), Tri-colored Herons (*E. tricolor*), and Little Blue Herons (*E. caerulea*). On 8 May, we found that most of the grassy vegetation surrounding the colony was burned, although the lower stems and roots of grasses had been protected by shallow (about 2–10 cm) surface water. The shrubby vegetation within the colony showed no evidence of fire, even though the grassland vegetation on the immediate borders obviously had burned. Walking through the colony, we found no evidence of nest abandonment or of dead or

moribund chicks of any species, despite the thick smoke that drifted into the colony during the fire.

On 16 April 1999, a larger fire, apparently of anthropogenic origin, began in the same area. The fire burned 70,010 ha north of Alligator Alley before ending on 30 April. During 1999, the Alley North colony contained approximately 8,000 nests of the same species that used the colony during 1994. As in 1994, the sawgrass and cattail surrounding the Alley North colony was burned to the ground, but the roots were protected by 2–5 cm of water or saturated soil. The vegetation within the colony did not burn. The 1999 fires also burned around the Mud Canal colony (26° 00' N, 80° 32' W) south of Alligator Alley, but the colony vegetation and nesting birds similarly were unaffected.

We conclude from these examples that under moderately wet conditions (i.e., soil still moist or covered by some surface water) the vegetation in willow and buttonbush colonies is unlikely to burn, and that fire poses little risk under these conditions to wading bird nests in the Everglades. Unlike tree islands dominated by tropical hardwoods, the substrate of willow tree islands is either lower than or at the same level as the surrounding marsh. Therefore, the willow and buttonbush colonies are likely to be as wet or in some cases in deeper water than surrounding areas. Further, willow and buttonbush do not tend to accumulate dead, above-ground biomass and create a moist, poorly flammable humus (Craighead 1971). Willow and buttonbush, therefore, provide relatively little fuel to initiate or sustain fires, especially when water is at or close to the soil surface. Large wading bird colonies are located almost exclusively in willow and buttonbush tree islands in the central Everglades (90% of colonies in 1994; Frederick 1995). Although this preference for nesting in wet or deep water areas may arise primarily because of the nesting birds' need for a water barrier beneath or surrounding the colonies for protection from mammalian predators (Rodgers 1987, Frederick and Collopy 1989), we suggest that nesting in willow colonies also provides a degree of protection from fires in wetland environments.

*Fire-related mortality away from colonies.*—As part of a study of White Ibis repro-

ductive physiology, on 1 April 1999 we trapped and radio tagged a female White Ibis near the Alley North colony in northern WCA 3A. Subsequently, this bird was identified through her activities as a breeder in the colony. On 21 April, this bird's transmitter gave a mortality signal, located approximately 7.6 km northeast of the colony. Upon reaching the site on 24 April, we found the carcass of the marked bird as well as approximately 50 other dead adult White Ibises. We found the birds within a  $15 \times 15$  m space in the northwest corner of a stand of dense cattail ( $75 \times 50$  m), with a few dead birds scattered up to 150 m from this concentration. The cattail was desiccated and brown, but not burned to the same extent as the surrounding sawgrass. All birds were found ventral side down. The carcasses were badly decomposed and the feathers were charred and blackened. We concluded from the vegetation and the condition of the birds that the fire had passed across the cattail area relatively quickly.

Direct effects of the fire seem to be a plausible explanation for the death of the birds. The birds may have been debilitated by smoke inhalation or trapped at the cattail island with dense, low smoke overhead from the burning surroundings. The birds may have gone to the cattail stand to take refuge from the fire. The ibises also may have been purposely foraging close to the fire line, in response to insects or other prey being driven by the smoke and flame (Smallwood et al. 1982). The birds may have been unable to fly because of low, thick smoke, which could happen with a rapid wind shift. Indeed, the concentration of birds in this relatively unburned area suggests strongly that they were seeking refuge from fire and smoke.

Previous work has shown that nests and eggs on the ground are most susceptible to fire (William and Stasiak 1979), with an assumption that flighted birds could easily escape fire. Our report suggests important exceptions to these general rules. First, we found apparent selection of the least flammable vegetation by nesting ciconiiform birds, as well as little damage to nests during a fire, even to those of ground-nesting species. Second, we found a group of dead adult birds whose death was most likely caused by fire, suggesting that even flighted adult birds may not always escape the effects of fire.

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