

Habitat Change and its Effects on Puerto Rican Raptors

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Forest habitat is disappearing from the tropics at an alarming rate. The composition, diversity and numbers of birds have shifted with the change in habitats. Many species have become extinct or locally extirpated, whereas others tenuously survive only as small remnant populations about to disappear with further habitat destruction, hunting pressure, or from lack of numbers.

Habitat loss has been responsible for the majority of bird population declines in the West Indies (64%; n = 39 species for which reason for decline is known). The West Indian island of Puerto Rico is an extreme example of the effects of habitat destruction on island ecosystems in the past 500 years. Raffaele (1983) considered habitat destruction and disturbance as the cause of population declines in 49 of the 51 endangered bird species in Puerto Rico.

In this paper I describe the changes in forest habitat that have occurred in Puerto Rico and the associated changes in the raptor fauna.

Environmental change is a normal dynamic process in the West Indies. In contrast to the warm and moist climate of the region today, dry cool climates prevailed 15,000-20,000 years BP (Before Present), and savannahs and other vegetation types adapted to this climate probably dominated (Pregill 1981, Olson and Hilgartner 1982). Some former resident birds, such as the Burrowing Owl (Athene cunicularia), were typical of a xeric, savannah-like habitat. About 13,000 years ago the climate shifted to the current, more mesic condition and the avifauna shifted toward its present composition. Two other raptor species have recently disappeared from Puerto Rico, probably in response to climate-related shifts in habitat: the Crested Caracara (Polyborus [Latebrosus] plancus) disappeared before Columbus' arrival (Olson 1976), but the Cave [Puerto Rican Barn] Owl (Tyto cavatica) may have persisted into the colonial period (Wetmore 1927).

More recently, the natural ecosystems on Puerto Rico have been drastically altered by human activities. The Taino Indians, with their limited and ephemeral agricultural practices, had only minor influence on the various wet and dry forests that once covered the island. But when Europeans began to colonize it in the 17th century, the landscape quickly changed as forests were cleared for agriculture. As early as 1750, a third of the natural vegetation on Puerto Rico had been cleared. Between 1800 and 1850, the island's human population tripled, then doubled again in the next 50 years, so that by 1900 there were about 1 million human residents (114 people/sq.km). During this period the land used for agriculture doubled and about three-quarters of the island had been converted to crop- and pasture-lands.

Essentially the entire island had been cut-over by 1912, when less than one percent of the virgin forest remained (Murphy 1916, Wadsworth 1949). Fortunately for several native forest bird species, 2,270 ha of virgin or partially degraded Pre-Columbian forest had been preserved in the Sierra de Luquillo. With its rugged topography and rainfall of up to 500cm per year, even the lower elevations of this inhospitable area were not settled until 1820 to 1890. Most of the forest has been under continuous protection, first under Crown dominion and as a forest reserve during the Spanish possession of Puerto Rico, and later as a United States National Forest.

Even though Puerto Rico's human population continues to grow at a rapid rate, during the past 30 years wildlife habitat has been improving over much of the island. "Operation Bootstrap" (locally "Fomento"), a programme started in the late 1940s to improve Puerto Rico's economic status, changed an agrarian-based society to one primarily founded on light industry and business. With this economic shift, agricultural land use declined dramatically. The recent (since about 1960) decline of the sugar cane industry has benefited savannah-dwelling birds (e.g. Puerto Rican Short-eared Owl *Asio flammeus portoricensis*). Half of Puerto Rico's 890,340 ha are abandoned agriculture or grazing lands and 40% (323,760 ha) of the island now has regenerated to natural secondary forests (Schmidt 1982). This has improved habitat conditions for several bird species that use seral growth forests.

Of possible future importance to Puerto Rico's avian diversity are the proposed monocultures of pines and other plantation species (Schmidt 1982). In other regions where native forests have been replaced with exotic plantations, substantial changes have occurred in the native avifauna (Bell 1979, Clout 1980, Lamothe 1980, Friend 1982).

RAPTORS AND HABITAT CHANGES IN PUERTO RICO

Because of their dependence on old-age forest, populations of several raptor species declined proportionately to the amount of forest destruction. Forest raptors endured in several patches of forest in the rugged mountain and coastal limestone karst regions. But these degraded pockets of habitat were too small or too disturbed to provide adequate refuge and certain raptor species disappeared from one area after another.

The endemic Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*) probably once inhabited forested areas throughout the island. Now the total estimated population of 230-250 birds (Cruz and Delannoy 1983) is limited to the relict original forests (e.g. Sierra de Luquillo, forest remnants in the Sierra de Cayey and Cordillera Central) and some regeneration forests and plantations (e.g. Maricao). Populations of this hawk may be increasing with the regeneration of second growth forest in abandoned agriculture lands.

The endemic Puerto Rican Broad-winged Hawk (*Buteo platypterus brunnescens*) was common in the 19th century (Gundlach 1878), but was rare by 1911 (Wetmore 1927). It is apparently dependent on large tracts of old-age forest and its decline was directly related to the near-complete destruction of virgin forests in Puerto Rico. Breeding populations are now known only from the remnant virgin forest of the Sierra de Luquillo (estimated 40-50 birds) in eastern Puerto Rico, and from the regenerated forests of the wet limestone karst region around Rio Abajo Commonwealth

Forest (about 40-60 birds) in the north-west (American Ornithologists' Union 1976; Wiley and Snyder, unpubl. data). The Broad-winged Hawk is common in the West Indies only where the Red-tailed Hawk (Buteo jamaicensis) is absent, which suggests that competition may be an important factor in broadwing distribution.

In contrast to the Sharp-shinned and Broad-winged Hawks, the Red-tailed Hawk probably benefited by the cutting of the original forests. It is abundant in dense virgin forests as well as open woodlands and forest edges, but nesting success and productivity is greater in the more open habitats (Wiley and Snyder, unpubl. data).

Cavity nesters are particularly vulnerable to the destruction of forest habitat. Of 39 bird species King (1978, 1979) listed as declining in the Caribbean, 16 (41%) are cavity dwellers. The Puerto Rican Screech-Owl (Otus nudipes) undoubtedly suffered population declines from the loss of nesting habitat (cavities) as the island's forests were eliminated. However, the species is now common throughout much of Puerto Rico where there are native and exotic trees of suitable size for cavity formation.

Newton's [Virgin Island] Screech-Owl (Otus nudipes newtoni), a race of the Puerto Rican Screech-Owl, has been confirmed only from Vieques Island in Puerto Rican territory and three Virgin Islands (Bond 1956). However, it has not been reported from Vieques Island in recent years (Sorrie 1975, pers. comm.), and may now be extinct there. Like the Puerto Rican Screech-Owl, Newton's Screech-Owl is a secondary cavity nester, and thereby needs sizeable trees with cavities for nesting. The decline of this owl probably resulted from the near-complete forest destruction throughout its range (Sorrie 1975, Kepler and Kepler 1978). However, unlike the Puerto Rican race, Newton's Screech-Owl has not recovered despite the limited habitat regeneration within its range. Perhaps numbers reached such a low level that it could not recover despite habitat improvements.

The endemic Puerto Rican Short-eared Owl probably expanded its range in Puerto Rico with the clearing of forests. However, it was earlier reported as scarce (Bond 1956, Ziswiler 1967), perhaps because of the extensive conversion of these open areas to crops, and predation by introduced rats (Rattus rattus and R. norvegicus) and the small Indian mongoose (Herpestes auro-punctatus). The Short-eared Owl is now widespread in the lower montane pasturelands. The fallow grasslands left in abandoned agricultural lands have provided additional nesting and hunting habitats for this owl.

Similarly, the American Kestrel (Falco sparverius) has probably benefited from the cutting of forests and, more recently, the reversion of abandoned croplands to savannahs and mixed woodlands.

OTHER CAUSES OF FOREST RAPTOR DECLINES

Loss of habitat has undoubtedly been the major cause of forest raptor declines in range and numbers, but other factors have also been critical. Many of the recent problems (e.g. warble fly [Philornis pici, P. obscura] parasitism) could probably have been absorbed by the larger populations in earlier times, but these sources of loss can severely affect declining populations that consist of few individuals.

Warble fly parasitism of chicks has been the most important cause of Sharp-shinned Hawk nest failure in the Maricao Forest population (Cruz and Delannoy 1982, 1983; Delannoy 1982). Seventy percent of nests with chicks ($n = 24$) contained parasitized young and overall nest success was 30% (12 of 40 nests successful between 1979 and 1983). Warble fly parasitism in the Luquillo Forest occurs at a lower, yet substantial, level (Wiley and Snyder, unpubl. data; Wiley 1985).

Another factor that may have figured prominently in forest raptor declines is the spread of the Pearly-eyed Thrasher (Margarops fuscatus) into Puerto Rican forests where 30 years ago the species was absent or rare (Snyder and Taapken 1978, Wiley 1980). Whether the thrasher's recent range expansion is the result of a natural ecological release or a response to environmental changes related to man's activities is not known. The thrasher is an important predator of Sharp-shinned Hawk eggs and chicks. Nest success in the Luquillo Forest in recent years (1973-1984) has averaged 39% ($n = 39$ nests; Wiley and Snyder, unpubl. data). There was good circumstantial evidence that failure at 7 nests (29%) was the result of thrasher predation. Sharp-shinned Hawks may be naive and have no behavioural defenses to protect their eggs and young chicks from predation by the recently-established thrasher. Certainly, contents of nests left unattended while female hawks fly to males during food exchanges are vulnerable to thrashers.

Hurricanes have always been an important factor in the ecology of tropical islands. When Puerto Rican raptor populations were widespread and composed of large numbers of birds, hurricanes were much less of a threat. However, once they had shrunk to low numbers and were restricted to much-reduced ranges, hurricanes posed a serious threat to survival on the island. If a severe hurricane were to pass directly over one of these pockets, it could cause the loss of the population, particularly in combination with the other known adverse factors.

Man has also had long-lasting effects on the forest raptor populations in several indirect ways. Rats were unintentionally introduced to the island by Europeans early in the colonial period. Rats eat hawk eggs and chicks, and compete with cavity nesting raptors for breeding sites (Wiley and Snyder, unpubl. data).

The colonists also introduced another serious competitor of cavity nesting species - the honeybee (Apis mellifera). Honeybees prefer cavities similar in volume to those used by the Puerto Rican Screech-Owl and American Kestrel. They have taken over kestrel and owl nests after the breeding season, thereby excluding the former residents from breeding at those sites in the future. Another consequence of honeybee introduction has been the destruction of nesting cavities by man while harvesting honey.

Recently, many exotic bird species have become established in Puerto Rico as a result of accidental and intentional introductions by man. Several of these, such as parrots and European Starlings (Sturnus vulgaris), are cavity nesters and may become serious competitors with the kestrel and screech-owl.

CONCLUSIONS

Even with reforestation and habitat protection, recovery of raptor populations is not guaranteed. Bird populations on islands, with their

limited areas and habitat diversity, are very susceptible to change, be it through cutting, or by disturbance from introduced competitors and predators. Often, as with some Puerto Rican raptors, many of these factors act simultaneously to depress a species. Populations do not always recover, even though certain environmental conditions are improved, because other detrimental factors subsequently become more important. As an example, the Puerto Rican Broad-winged Hawk has shown little population increase although forest habitat has expanded on the island. Other factors, perhaps restriction to old-age forests or competition with the Red-tailed Hawk, may be currently limiting its expansion. Other species, such as the kestrel and Short-eared Owl (and, with the recent regeneration of forests, the Sharp-shinned Hawk), have probably increased in numbers and range with the changes in habitat.

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