Critical problems for bird conservation in the Galápagos Islands

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La avifauna de Galápagos tiene un 50% de endemismo a nivel de especies y subespecies, típico de archipiélagos aislados. Muchas aves de Galápagos están amenazadas de extinción. Aunque varias especies se reconocen como amenazadas por UICN[14], otras no son reconocidas. En Galápagos, la lista de aves amenazadas incluye 16 especies, subespecies y/o poblaciones. Entre ellas, el Pinzón de Manglar *Camarhynchus heliobates* y Cucuve de Floreana *Mimus trifasciatus* tienen poblaciones inferiores a 100 individuos. Los problemas de las especies amenazadas son la pérdida y fragmentación del hábitat, ingreso de especies introducidas que compiten por hábitat o alimento, depredadores o vectores de enfermedades, desastres naturales, pérdida de diversidad genética, actividades humanas como la pesca, agricultura y turismo sin medidas precautelares y el calentamiento global. Estas amenazas afectan a varias especies en forma específica o grupal.

The avifauna of the Galápagos Islands is quite small compared to that of an equal-sized area on the Ecuadorian mainland, with only 88 breeding or regular migrant species. However, a high proportion (c.50%) of these is endemic, either at the species or subspecies level[36]. As is typical of island systems with a restricted land area and high endemism, many of these species are threatened with extinction.

Threats for terrestrial species are often different from those affecting marine species. For terrestrial species, threats often derive from their very limited distributions, simply as a result of the small land area of the islands, only c.45,600 km^2 in aggregate[26]. Most terrestrial species do not even occur across this whole land area, but are restricted to single or a few islands, thereby having very small actual ranges. Marine species often face threats unrelated to range size, but rather to exploitation (at sea) or predation (at nesting sites).

The IUCN Red List[14] includes 13 Galápagos species. The IUCN, however, does not evaluate subspecies or populations, and its taxonomy is not always the most recent. Following the up-to-date taxonomy of the South American Classification Committee of the American Ornithologists' Union[27] and including also Galápagos endemic subspecies results in a list of 16 taxa or populations considered threatened within the Galápagos archipelago, as will be discussed below.

Threats to Galápagos avifauna

Habitat loss. Because 96.7% of the land area of Galápagos is protected by the Galápagos National Park[29], habitat loss is not a significant issue for most lowland terrestrial species. However, much of the non-protected area include the most restricted, vulnerable areas in the humid highlands. These highland habitats have been disproportionately affected by agriculture, including domestic grazing, and introduced pest plants and animals. Plant communities have been severely damaged by introduced feral goats *Capra hircus* and donkeys *Equus asinus*.

Introduced species. Introduced vertebrates are mainly predators that affect bird populations in three ways: killing adult birds (e.g., cats *Felis catus* on many species, or dogs *Canis familiaris* and pigs *Sus scrofa* on flightless or nesting species); destroying nests and young (cats, dogs, black rat *Rattus rattus* and Smooth-billed Ani *Crotophaga ani*); or competing for food (probably rats[19]). On the other hand, introduced plant pests affect Galápagos birds through habitat alteration, including crowding out bird food species or loss of nesting habitat. Introduced invertebrates may affect birds in two ways: competition for food or habitat alteration (for example, the cottony cushion scale *Icerya purchasi*[6]) or as parasites and vectors of diseases. These include current known threats of *Philornis downsi*, a bot-fly parasite affecting nestlings[11,37] and Avipox[30]. Other potential disease threats include West Nile Virus[23], avian influenza, avian malaria and others[15]. These diseases and parasites may kill adults or nestlings outright, make birds more susceptible to predators, or may reduce breeding success.

Natural disasters. Because of small population sizes of many of these threatened groups, natural disasters such as severe El Niño events and large volcanic eruptions may be significant to Galápagos species.

Loss of genetic diversity. Small and/or isolated populations may be threatened by inbreeding and loss of genetic diversity.

Other human activities. Fishing techniques, especially long-lining, are hazardous for many

seabirds which inadvertently get caught on hooks. Human-caused catastrophes such as petroleum spills[25] and other pollution or brush fires may also pose significant threats. In addition, development of land for housing, tourist facilities or agriculture can cause habitat loss. This is especially significant in the highlands of the larger islands, where native habitats are already under pressure from introduced species.

Global climate change. Possibly the most significant threat from global climate change is its potential to affect the frequency and severity of El Niño-Southern Oscillation events. El Niño may severely affect marine species, whereas the cool phase of the oscillation (La Niña events) affects terrestrial species[32,33]. In addition, sea level rise attributable to global warming may damage coastal habitats such as mangroves and lagoons.

Species accounts

Criteria for including species, subspecies or populations in the following accounts are: 1) fewer than 1,500 individuals in the population; 2) breeding population restricted to a single island; or 3) small but unknown population and probably declining. There are 16 species, subspecies or Galápagos populations meeting at least one of these criteria. These species and the threats they face are discussed below. A summary of the threats is presented in Table 1.

Galápagos Penguin *Spheniscus mendiculus* and **Flightless Cormorant** *Phalacrocorax harrisi*

Because of their small population sizes, these two species (Fig. 1 for Flightless Cormorant) are threatened by natural disasters, especially El Niño events[33], loss of genetic diversity and human activity (fishing). Introduced predators, especially cats, dogs and rats may be a threat, especially to nesting penguins[32].

Waved Albatross *Phoebastria irrorata*

Almost the entire population breeds on a single island, Española (Fig. 2)[3]. The principal threat, however, is mortality due to long-line fishing and directed fishing off the Peruvian coast[20]. Some long-lining is permitted in the Galápagos Marine Reserve[22]. The species is also affected by introduced mosquitoes during the breeding season[2].

Galápagos Petrel *Pterodroma phaeopygia*

Threats exist both on land and at sea, where they also face long-lining as the primary threat. On land, habitat alteration by introduced plants (blackberry *Rubus* spp. and quinine trees *Cinchona pubescens*), habitat loss to development, predators, and construction of towers and powerlines threaten nesting petrels[7,8,31].

Greater Flamingo *Phoenicopterus ruber*

Although not globally threatened[14], it is considered as threatened in Ecuador[13,21]. The Galápagos population is quite small, between 320 and 550 individuals[17]. Threats include predation by pigs and other introduced species.

Galápagos Hawk *Buteo galapagoensis*

In recent years Galápagos Hawk[4] has benefited from an increased food supply (carrion) resulting from goat eradication efforts[5]. However, it faces continued persecution by humans on inhabited islands, especially in the agricultural zones.

Galápagos Rail *Laterallus spilonotus*

The main threat to this marginally flightless species[24] is probably habitat loss through conversion by the introduced plants *Cinchona pubescens* (Santa Cruz) and *Rubus niveus*, but may include loss of habitat to agriculture activity as well[12], and threats from introduced predators, especially cats.

American Oystercatcher *Haematopus palliatus galapagensis*

This endemic subspecies—therefore not evaluated by IUCN[14]—has a very small population, probably fewer than 500 individuals, which almost certainly has never been much larger. Introduced predators may affect this ground-nesting species.

Lava Gull *Leucophaeus fuliginosus*

The current population of Lava Gull (Fig. 3) is probably smaller than the 800 individuals estimated by Snow & Snow[28] in the late 1960s. An estimate for southern Santa Cruz Island[1], where one of the larger populations exists, resulted in 81 individuals. The IUCN[14] lists the species as Vulnerable, which probably understates the seriousness of its status.

Vermilion Flycatcher *Pyrocephalus rubinus nanus* and *P. r. dubius*

Populations of the two Galápagos subspecies, *P. r. nanus* and *P. r. dubius*, are quite small and apparently declining; the species is already extinct on San Cristóbal[36]. However, the reasons for the decline are unclear.

Galápagos Martin *Progne modesta*

This is possibly the least-known species in Galápagos. Its population is very small, probably much fewer than 500 individuals and the species can only be found consistently at a few sites[36]. It is listed by the IUCN[14] as Vulnerable, but the species' scarcity and probable decline might warrant Endangered status. Threats may include introduced diseases or parasites, and possibly introduced predators such as rats.

Table 1. List of threats. Known threats are indicated by a •; those threats not well known but suspected are marked '?'.Threat category from IUCN[14] CR (Critically Endangered), EN (Endangered), VU (Vulnerable), LC (Least Concern).

Species	IUCN Status	Introduced vertebrates	Introduced plants	Introduced invertebrates	Diseases or parasites	Habitat loss	Natural disasters	Global climate change	Loss of genetic diversity	Other human activity
Spheniscus mendiculus	EN	Cats, dogs, rats on nesting birds[33]			?	Volcanic eruptions, especially on Fernandina	Especially El Niño events[33]	•	•	Fishing, through tangling in nets[34], and competition
Phoebastria irrorata	CR				•		•	•		Long-line and directed fishing[20]
Pterodroma phaeopygia	CR	Cats, pigs, and rats on eggs and nestlings	*Cinchona pubescens* and *Rubus* spp. over-grow colonies[31]			•				Collisions with towers and powerlines[7,8], potential wind power development on Santa Cruz
Phalacrocorax harrisi	EN	Predators on nests and nestlings[32]				Volcanic eruptions on Fernandina	Especially El Niño events[32]	•	•	Fishing, through tangling in nets, and competition
Phoenicopterus ruber	LC	Predators on nests, especially pigs			Die-offs possibly caused by avian cholera	•	•	Lagoons may be threatened by sea level rise		•
Buteo galapagoensis	VU					•			Small populations on some islands[4]	Persecution on inhabited islands in agricultural zones
Laterallus spilonotus	VU	Especially cats[24], but also rats	*Cinchona pubescens* on Santa Cruz; *Rubus niveus*			Continuing conversion of highland habitat to agriculture[12]			?	
Haematopus palliatus galapagensis	none	Predators on nests							?	
Leucophaeus fuliginosus	VU	Predators on nests, especially cats and dogs				?			?	Fishing activities, hooks and nets. Feed on refuse in town.
Pyrocephalus rubinus nanus and *P. r. dubius*	none	?		?	Possibly avian pox or *Philornis downsi*[37]	?			?	
Progne modesta	VU	Rats?			Avian pox or *Philornis downsi*?	?		?	?	
Mimus trifasciatus	EN	Predators, chiefly rats, but not yet present on islets where the species occurs; *Crotophaga ani*[35]		?	*Philornis downsi*[37], pox[9]	?	Prolonged drought from La Niña events	•	Divided into two very small populations on separate islets	
Mimus melanotis	EN	Probably cats and rats	?	?	*Philornis downsi*[37] and avian pox	?	•	?		?
Mimus macdonaldi	VU			?	?		Prolonged drought from La Niña events			•
Camarhynchus pauper	VU	Predators such as cats and rats	?	?	*Philornis downsi*[37]	?			?	
Camarhynchus heliobates	CR	Predators such as cats, rats, *Crotophaga ani*		Fire ants kill nestlings	*Philornis downsi* and avian pox	•	Prolonged drought from La Niña events	Sea level rise threatens mangroves	Very small, isolated populations	•

Figure 1. Flightless Cormorant *Phalacrocorax harrisi* on nest, Cape Douglas, Fernandina Island, Galápagos, 8 September 2002 (David A. Wiedenfeld)

Figure 2. Waved Albatross *Phoebastria irrorata*, Cevallos Point, Española Island, Galápagos, 1 June 2003 (David A. Wiedenfeld)

Figure 3. Lava Gull *Leucophaeus fuliginosus* on nest, west of Puerto Ayora, Santa Cruz Island, Galápagos, 6 May 2005 (David A. Wiedenfeld)

Figure 4. Floreana Mockingbird *Mimus trifasciatus*, Champion Island, Galápagos, 21 May 2004 (David A. Wiedenfeld)

Floreana Mockingbird *Mimus trifasciatus*
The Floreana Mockingbird (Fig. 4) probably numbers no more than 150 individuals, and the most recent surveys revealed a sharp decline in 2006[16] followed by a partial recovery in 2007[18]. It is now confined to two small islets. The accidental introduction of predators must be avoided as they could deplete its small population rapidly. The introduced fly parasite *Philornis downsi* is known from both islets[37], whilst avian pox has also been recorded[9]. Other potential threats include introduced Smooth-billed Ani *Crotophaga ani*, prolonged droughts and inbreeding as there is apparently no gene flow between the two islets.

San Cristóbal Mockingbird *Mimus melanotis*
The population of the San Cristóbal Mockingbird is unknown, but is at most only a few thousand birds, all restricted to one island.

Española Mockingbird *Mimus macdonaldi*
The species is restricted to a single island, but one with no introduced mammalian predators[19], and *Philornis downsi* has apparently not yet reached the island[37]. Because Española has no consistent fresh water, prolonged drought can cause significant mortality.

Medium Tree-Finch *Camarhynchus pauper*
The population size of the Medium Tree-Finch is unknown but probably very small, as the species is restricted to Floreana Island. IUCN lists the species as Vulnerable, but its small population size and significant threats suggest upgrading it to Endangered.

Mangrove Finch *Camarhynchus heliobates*
The Mangrove Finch is one of the most endangered species in the world. Its population is fewer than 100 individuals, possibly as few as 50, restricted to only two sites with a total of c.12 ha on Isabela Island[10]. With a population size so small, the

Mangrove Finch faces threats from nearly everything; avian diseases and introduced predators have been reported, whilst catastrophic events may prove disastrous.

Discussion

Although the Galápagos Islands have to date lost no bird species to extinction[38], a significant percentage of the Galápagos avifauna is threatened[21]. The main threats are introduced mammalian predators, parasites, diseases and invasive plants. The combination of very small populations of many Galápagos species (several probably never occurred in very large numbers) combined with their oceanic-island naiveté[38] means Galápagos birds often have a perilous population status. Even though the Galápagos National Park Service and Charles Darwin Foundation have made strong conservation efforts in the Galápagos, problems remain and in many cases the threats have grown[12]. Species with such restricted ranges and small populations can never be assumed to be beyond threat. Conservationists must continue their efforts to solve the difficult and thorny problems to protect such unique species as those found in the Galápagos Islands.

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