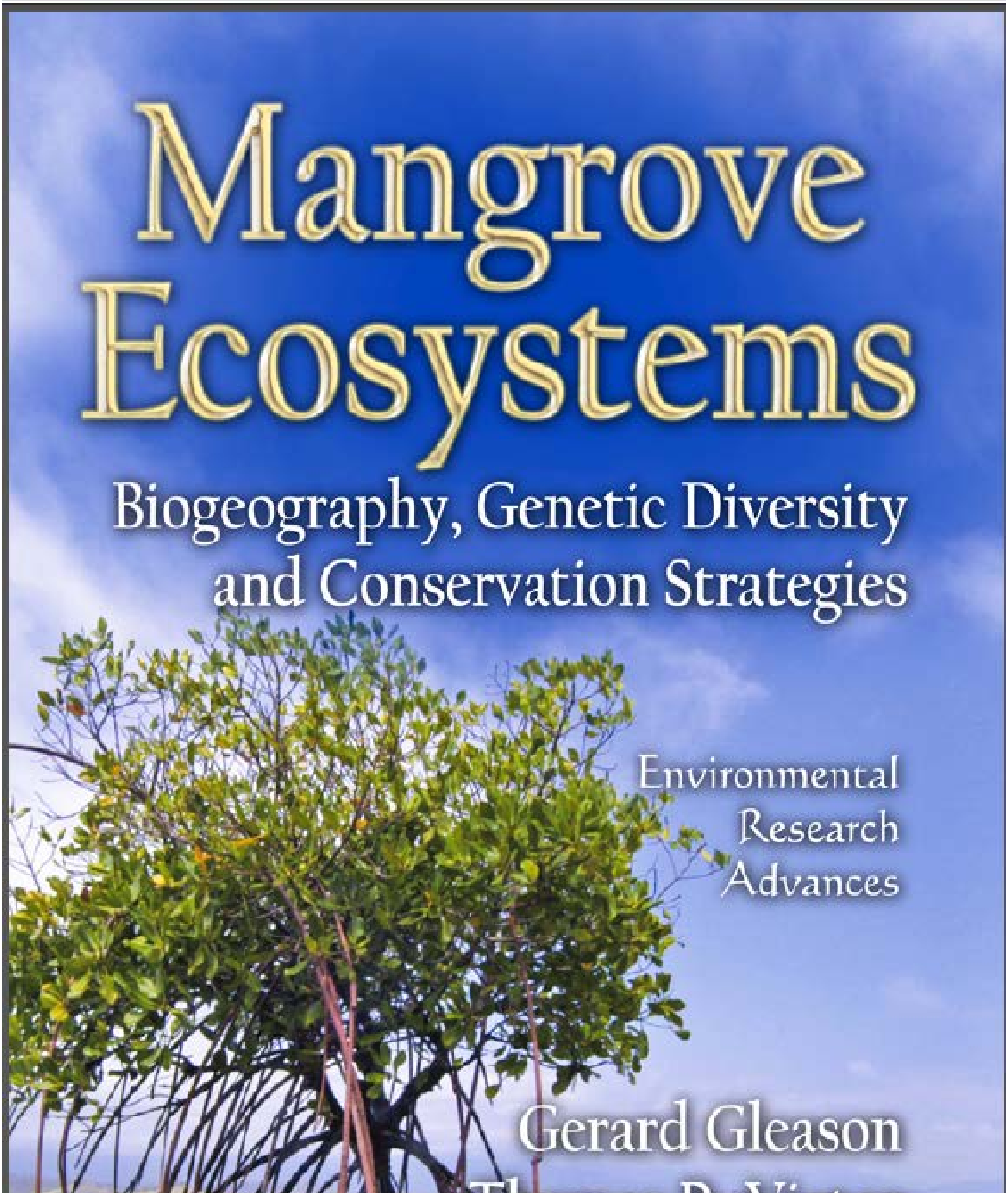

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ENVIRONMENTAL RESEARCH ADVANCES

MANGROVE ECOSYSTEMS

BIOGEOGRAPHY, GENETIC DIVERSITY AND CONSERVATION STRATEGIES

GERARD GLEASON
AND
THOMAS R. VICTOR
EDITORS

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New York

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CONTENTS

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Chapter 5

MANGROVE FINCH *CAMARHYNCHUS HELIOBATES*: AN OBLIGATE MANGROVE SPECIALIST FROM THE GALÁPAGOS ISLANDS

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ABSTRACT

Mangrove Finch *Camarhynchus heliobates* is endemic to the Galápagos Islands, Ecuador and today found only in north-west Isabela. The finch, one of the iconic Darwin's finches (Geospizinae), has specialised to live in mangrove forest, a very rare habitat in the typically arid, volcanic, islands, and further specialised to live in mangrove separated from the sea but still inundated on high tides. The separation from the sea allows leaf-litter to build up on the forest floor in mangroves with no crab species. Presumably naturally rare with such a restricted choice of habitat, Mangrove Finch is threated by a range of natural events and invasive animals especially Black Rat *Rattus rattus* and the parasitic fly *Philornis downsi*. Future conservation proposals are outlined.

INTRODUCTION

Mangrove Finch is considered to be the rarest of the Darwin's Finches (Grant & Grant 1997; Dvorak et al. 2004). A programme of intense study was initiated in 2006 to fully establish the species' ecology and to causes of rarity, determine current threats and propose and trial conservation measures. The UK's Darwin Initiative funded projects (Conservation of the Mangrove Finch (*Cactospiza heliobates*) project number 15-005 (2006-2009; Darwin Initiative 2013a) and Restoration of the Mangrove Finch in Isabela, Galápagos project

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number EIDPO031 (2009-2011; Darwin Initiative 2013b)) by a partnership of Durrell Wildlife Conservation Trust (Jersey, Channel Islands), Charles Darwin Foundation (Puerto Ayora, Santa Cruz, Galápagos, Ecuador) and Galápagos National Park Service (Puerto Ayora, Santa Cruz, Galápagos, Ecuador).

Figure 1. Mangrove Finch *Camarhynchus heliobates*. May 2012. Photo by Francesca Cunninghame

TAXONOMY

The Mangrove Finch *Camarhynchus heliobates* is a member of the Darwin's finches (subfamily Geospizinae), the most diverse group of endemic birds in Galápagos with 13 (BirdLife International 2013) or 14 (Neotropical Birds Online 2011) species living in this island group and one species, *Pinaroloxias inornata*, found only on Cocos Island about 600km to the north (Grant 1999). Mangrove Finch, not seen by Darwin himself during his brief visit in 1835 (Darwin 1845), was the last species of Darwin's Finch named, and, collected by the Stanford University Expedition in 1898/99, was described in 1901 (Snodgrass & Heller 1901).

Descended from a common ancestor (Sato et al. 2001), the Darwin's Finches in Galápagos are separated into five genera and, found in a wide variety of habitats, exhibit a high degree of variability, notably in bill size and structure (Herrel et al. 2010). The five species of *Camarhynchus* are the tree-finches and while three, Small Tree-finch *Camarhynchus parvulus*, Large Tree-finch *C. psittacula* and Woodpecker Finch *C. pallidus* are widely distributed throughout the islands, two, Medium Tree-finch *C. pauper* and Mangrove Finch, have extremely limited distributions.

Mangrove Finch and its sister species Woodpecker Finch are extremely similar in appearance and there is no single diagnostic plumage character that separates the two (see Fessl et al. 2011 for identification of Mangrove and Woodpecker Finches). Males and females of both species cannot be separated with confidence except for some older male Mangrove Finches that have acquired black feathers on the head. While, typically much plainer than Mangrove Finch with a warmer and paler brownish coloration, Woodpecker Finch only very

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rarely develops a dark head. Mangrove Finches also show a broad whitish or (rarely) creamy supercilium broadest above the eye and widening in front of it, in some birds forming a paler area between the bill base and the irides whereas Woodpecker Finches tend to have plainer faces with no marked supercilium.

Songs of the two species are more readily distinguishable (Fessl et al. 2011a). Vocal activity is greatest during the breeding season, e.g. with the onset of heavy rains, normally from December to mid April. Mangrove Finches typically sing 3-4 syllables: *tscha- tscha-tscha-tscha … tscha-tscha-tscha-tscha* whereas the Woodpecker Finch's song sounds more metallic and melodious (*tschue-tschue-tschue-tschue*) and its frequency is slightly higher. Some birds in north-west Isabela add a soft whistle at the end of their song, which is never heard in Mangrove Finches. Interestingly, Mangrove Finches in the south-east of Isabela had songs very different from those in the north-west, the song being slower, *tschrrm-tschrrm-tschrrm*, with each syllable repeated 2-3 times (Brumm et al. 2010). Song is culturally transmitted in Darwin's finches, and Mangrove Finches singing like Woodpecker Finches have been recorded.

DISTRIBUTION

Mangrove Finch is restricted to dense stands of mangrove forest in Galápagos (Grant & Grant 1997; Dvorak et al. 2004). Mangrove is itself very scarce in the highly arid islands and accounts for possibly as little as 5% of the islands vegetation cover. The forests are often isolated in extensive areas of inhospitable volcanic lava with dispersing birds having to cover over several kilometres of un-vegetated ground and land birds are accordingly not very diverse in most mangroves. Mangrove Finch is known historically from at least five different localities on Isabela and two on Fernandina but is currently only known to occur in two small mangrove forests on the north-west coast of Isabela, at Playa Tortuga Negra (PTN; 18ha) and Caleta Black (CB; 10ha) (Dvorak et al. 2004; Cunninghame et al. 2013). These two sites, separated by 4km of barren lava with three smaller mangrove stands (the selvitas; less than 4ha) between the two sites are usually considered as one overall site globally. A second population persisted until recently (last recorded in 2009 despite searches in 2011 and 2012) on the south-east coast of Isabela around Bahía Cartago (*c*.300ha ;) *c*.70 km from the main population in the north-west.

Historically, Mangrove Finch had a wider distribution with records from five different locations on Isabela and one on Fernandina (Dvorak et al. 2004). Some areas formerly occupied by Mangrove Finch may have changed considerably (e.g. Bahía Urbina on Isabela Island and Punta Espinosa on Fernandina Island have been uplifted by volcanic activity) or could have always been a sink population (e.g. Fernandina), but hardly any historical information is available on abundance or habitat characteristics. Most knowledge about this finch's former distribution comes from scientific expeditions and the main collection sites were north-western Isabela and eastern Fernandina. For example, the Hopkins-Stanford Expedition in 1899 took 26 birds from PTN and 12 birds from Fernandina (Snodgrass & Heller 1904) and the expedition of the California Academy of Science in 1905/06 another 25 birds from north-western Isabela with no records for Fernandina despite several visits (Gifford 1919).

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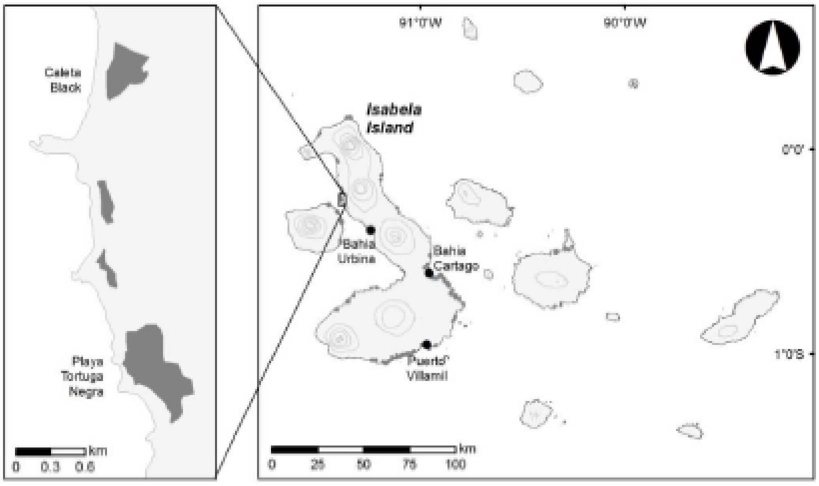

Figure 2. Current (Playa Tortuga Negra, Caleta Black) and recent (Bahía Cartago) Mangrove Finch *Camarhynchus heliobates* distribution, Isabela Island, Galápagos, Ecuador. The trial translocation site (Bahía Urbina) is also shown. Mangrove habitat is marked in dark grey. This map is courtesy of Mandy Trueman.

Most recent population estimates number *c*.100 individuals at all sites combined, making Mangrove Finch the rarest of the Darwin's finches and possibly the bird species most at risk of extinction in Galápagos (Fessl et al. 2010b).

Figure 3. Mangrove Finch *Camarhynchus heliobates* site NW Isabela (Playa Tortuga Negra in foreground). Photo by Francesca Cunninghame.

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Ecology

Feeding and Diet

Data from study at PTN and CB 2007-2008 (Fessl et al. 2010a; Fessl et al. 2011b). Mangrove Finches are restricted to mangrove stands of at least 1ha in area containing three mangrove species Red *Rhizophora mangle*, White *Laguncularia racemosa* and Black *Avicennia germinans*. The finches seem to prefer mangroves that are separated from the sea by banks of sand which prevent organic material being washed away, therefore allowing leaf litter and dead wood to accumulate. There are no fish or crab species within the mangrove forest at PTN and CB. Hermit crabs can be found on the mangrove edge but are absent from the interior. The finches employ a variety of feeding techniques changing for the humid (reproductive period) and the dry season. Insect larvae and spiders are the most important food sources observed. They search for most of their prey with extractive foraging techniques (probing into branches and twigs, levering bark, pecking, biting or perforating leaves and stems) during the wet and dry seasons, and surface glean occasionally during the dry season. The finches may feed on fruit during the wet season when fruits of the Palo Santo tree *Bursera graveolens* and the shrubs *Scutia pauciflora, Tournefortia psilostachya* and *Vallesia glabra* are available. These plants are only found at the periphery of the mangroves.

Figure 4. Dune separating mangrove from sea at Playa Tortuga Negra. High tide. Photo by H G Young.

Birds use the few available feeding substrates differently between seasons. Specific parts of Red Mangrove are the second most used substrate during the dry season and used seven times more often compared to the humid season. In both seasons, dead wood was the substrate predominantly used, with dead White Mangrove and dead Red Mangrove being

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equally searched. Black Mangrove (at PTN) is also used. During the wet season, dead trunks, bark, branches and twigs are equally visited but during the dry season the smaller structures (branches, twigs) are searched proportionally more often.

Beside fruit, only five different prey types have been observed, although twelve different invertebrate orders were encountered in three investigated substrates. Birds took significantly different prey in each season with spiders and Lepidoptera larvae the most important group in the wet season, while Lepidoptera larvae and small Coleoptera and its larvae were the main prey types in the dry season.

Interactions between feeding techniques, substrates and prey types have been observed. Some feeding techniques are restricted to certain substrates and/or seasons and are associated with specific prey types. Two foraging techniques, *perforation* and *opening of stems and leaves,* have been observed on specific parts of Red Mangrove and almost exclusively during the dry season. *Perforation* is used on aerial roots and hanging fruits of Red Mangrove where the prey was exclusively a small Coleoptera (*Coccotrypes rhyzophorae*) and its larvae (approximately 5mm in length, most often in groups of ten), a known parasite of mangrove tree species of unknown status in Galápagos. *Opening* is used to access specific Lepidoptera larvae (*Characoma nilotica*) that feed and hide in buds of Red Mangrove. Caterpillars and pupae of the same genus are predominately found in the litter during the wet season and birds search for them with the *lever* technique. Birds feed by gleaning the surface on dead wood or in the litter during the wet season mainly, taking spiders (*Olios galapaogensis* and its brood sacs, 65%) and crickets (*Neseocia cookconii*, Tettigonidae, Orthoptera, 30%)

Dead wood (standing and lying) and leaf litter are the preferred feeding habitat throughout the year. Different parts of Red Mangrove are especially important in the dry season when the finches feed on Lepidoptera larvae developing in the buds and on the larvae of a small beetle (*Coccotrypes myzophorae*) that parasitizes fruits and aerial roots.

Because the finch prefers to forage in leaf litter and dead wood lying on the ground, mangroves that are separated from the sea (e.g. by a beach as PTN and CB) are more suitable than lagoon systems (as in Fernandina) from which dead wood and litter is washed into the sea or decomposes in lagoons. This difference might explain the much lower density of mangrove finches in the east coast of Isabela (most mangrove stands are not separated from the sea) and the disappearance of Mangrove Finch populations in Fernandina. In the Galápagos, only four mangrove species occur: Red, White, Black and Button Mangrove *Conocarpus erectus*. In PTN, the first three species are prevalent (36%, 56% and 6.6% of trees respectively), whereas in CB there are only White and Red Mangroves, in equal amounts. The sites in Cartago formerly with Mangrove Finches consist mainly of Red and White with very few Black Mangrove trees. Button Mangroves could represent potentially suitable Mangrove Finch habitat, as these trees produce a lot of litter as well as dead wood and have branching that would make good nesting substrate for finches to build their nests. This tree species is widespread in southern Isabela where the finch probably once lived (Dvorak et al. 2004), including at the Ramsar site in and close to the town of Puerto Villamil.

Darwin's finches are behaviourally flexible and have developed a whole range of new or unusual foraging techniques to access certain food types, including the use of twigs or cactus spines to extract arthropods out of tree holes by the Woodpecker Finch (Eibl-Eibesfeldt 1961). Curio and Kramer (1964) observed one out of six Mangrove Finches several times using a tool to access arthropods; however, although Mangrove Finch foraging behaviour has been studied intensively during both seasons, no bird has since been observed using a tool.

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This behaviour observed by Curio and Kramer could either be an innovation by a single individual or more likely an incorrect species identification.

Nesting

Data from PTN and CB (see Fessl et al. 2010a; Fessl et al. 2011b) Like all Darwin's finches, Mangrove Finch breeds during the rainy season (late December to April) and breeding may be continuous until the rain stops. Although 1-2 clutches may be laid per breeding season, up to four clutches can be laid during strong *El Niño* events when conditions are good (HV, pers. comm.). Infrequently, some pairs may breed during the dry season (May to mid-December) but production is poor or absent during the dry conditions of *La Niña* events.

Figure 5. Mangrove at Playa Tortuga Negra. Photo by H G Young.

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Although Red Mangrove is a preferred feeding substrate for Mangrove Finches they do not use this tree species for nesting as the branching is too open. Thus, pure Red Mangrove stands are not suitable for Mangrove Finches.

Mangrove Finches build dome-shaped nests in trees at 4-30m height (average: 13m); preferring the outermost branches of Black and White Mangroves. The choice of trees for nesting' however, does not appear to be random. At CB, there are no Black Mangroves and finches nest exclusively in White Mangroves while at PTN, where three mangrove species are present, nearly half the nests recorded have been on Black and half on White Mangroves although Black Mangroves represent only 10% of the 276 trees counted at study plots. Nests were built in areas with more Black Mangroves, in higher trees and at sites with higher flooding frequency during high tide.

Males build display nests and females finish the chosen nest (inner layer); only the female incubates eggs (usually for around 14 days) and the male feeds her occasionally. In the first days after hatching, the female sits on the chicks and the male feeds chicks and, sporadically, the female. Later, both parents feed the chicks which are ready to fledge at 12-14 days old. The chicks stay with their parents for 2-4 weeks before becoming independent but it seems that some, if not all, young birds stay in their parents' territory until the next breeding season after which they are probably chased away and must attempt to establish their own territory.

THREATS

Now confined to two small mangroves on the north-west coast of Isabela, the exact causes of the decline in Mangrove Finch numbers are unknown (Fessl et al. 2010b). Being restricted to such a rare forest type and having further specialised habitat requirements suggest that at no time has this species been anything other than rare. However, it has undoubtedly declined since its description and been extirpated from several former sites including, very recently, the Island's south-east coast. Habitat loss through collection of firewood and felling of larger trees may have been a problem particularly near Isabela's only human habitation at Puerto Villamil and stochastic events such as volcanic eruption or seismic uplifts of land are always a threat in much of Galápagos. Predation by invasive animals such Black Rats *Rattus rattus*, feral cats *Felis catus*, Smooth-billed Ani *Crotophaga ani*, and insects such as the parasitic fly *Philornis downsi*, the fire ant *Solenopsis germinate* and paper wasp *Polistes versicolor* may be more significant.

Black Rats have been seen to significantly reduce the breeding success of Mangrove Finches, largely by predating eggs (Fessl et al. 2010a). Trials with artificial eggs and nests have shown the willingness of rats to visit finch nests and a systematic programme of rat control at PTN and CB has reduced rat numbers to almost nil at times of the year. Mangrove Finch nesting success has improved accordingly since rat control was instigated suggesting that if rats alone were the main problem the recovery of the finch might be relatively straight forward.

Feral cats are common at the breeding sites and are potential predators of inexperienced juveniles as well as of adults, as Mangrove Finches spend much feeding time on the ground. This is a potential problem especially in the adjacent small mangrove patches, as birds are

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more often seen at the edges. Cats are now controlled at the sites through bi-annual programmes and, although difficult to arrange, these reduce the threats from this predator. A further invasive species, the Smooth-billed Ani is now widespread over the archipelago. They are known to be predators of invertebrates and small vertebrates (Rosenberg et al. 1990) and are very territorial birds (Quinn & Startek-foote 2000) which may disturb Mangrove Finch breeding activity and thus represent an extra possible threat. They have been encountered in PTN and CB in small groups of 3-8 individuals and have been controlled in the past.

A significant threat stems from nestling mortality following parasitism by larvae of the fly *Philornis downsi*: a fly first recorded in the islands in the 1960s and most likely introduced by humans (Causton et al. 2006). Parasitism by *P. downsi*, an obligate bird parasite (the adult fly is non-parasitic), was first identified in the Galápagos in 1997 (Fessl et al. 2001) and at the Mangrove Finch sites on Isabela in 2000 (HV, pers. records). A mortality rate of 16-95 % due to parasitism has been recorded in other Darwin's finches (Dudaniec et al. 2006; Fessl et al. 2006; Huber 2008). Mortality is negatively correlated with brood size (Fessl & Tebbich 2002, Dudaniec et al. 2006). The Mangrove Finch with a mean clutch size of only 2.1 (Fessl et al. 2010b) is, therefore, particularly vulnerable. Complete brood loss due to *Philornis* parasitism for the Mangrove Finch was between 10 and 15%, information on partial brood loss is incomplete (Fessl et al. 2010b) and may have been as high as 37% in 2013. It is possible that the full extent of the problems for the finches caused by *Philornis* was formerly masked by predation of the finches' eggs by rats. With the successful control of rats at the sites and increases in the finches' hatching success the full threat from the parasite is becoming obvious.

Current Conservation Management

Introduced Rat Control

In 2007, through nest monitoring and artificial nest experiments the negative effects of rat predation on fledging success was made apparent (Fessl et al. 2010b). Mangrove Finch breeding success showed an increase in fledging success after rat control was initiated (Fessl et al. 2010b).

Since November 2007, permanent bait stations have been positioned every 50m in and surrounding the periphery of Mangrove Finch breeding habitat. During the breeding season (Nov – May) all bait stations are checked monthly and Klerat (0.05g brodifacoum per kilo) is placed into each bait station. Bait consumption by non target invertebrates and hermit crabs mean that the minimum amount of bait is administered each time to ensure that bait is available for rat uptake over three nights (c. 60g of bait per station). Between June and October bait stations are checked and refilled twice. Rat monitoring (live-trapping) during the rat control programme showed a reduced number of rats following the deployment of bait, and in relation to an experimental control site where no poison was deployed. Rat monitoring continues to be conducted twice yearly during November and March, at the end of the dry and end of the wet season. This monitoring shows that rats are regularly present in low numbers from continual reinvasion and that bait application is sufficient to control these numbers (Cunninghame et al. 2013). Current plans to replace poison stations with multiple-kill traps

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(Good Nature New Zealand) are underway and funding is being sought to reduce having to continually administer a cumulative toxin into the environment.

Control of Feral Cats

Feral cats are potential predators of Mangrove Finches especially as the birds spend a significant time feeding on the ground; however, their effect on the species is unknown (Fessl et al. 2010b). Introduced cats are present around all areas of Mangrove Finch habitat and the Galápagos National Park conduct biannual cat control in the area.

Control of Philornis downsi

At present there is no effective control or management against the parasitic fly to protect Mangrove Finch nestlings (Causton et al. 2013). In 2012, CDF and GNP held an international workshop to develop an action plan for managing *Philornis downsi* (Causton et al. 2013). Local and international research is underway focussing on different aspects of the action plan; experimental trapping for adult flies has been initiated at PTN since early 2012 and developments are underway for testing nest specific control methods for the 2013-14 breeding season. However, due to the inaccessibility of Mangrove Finch nests individual treatment of nests has until now not been possible.

Methods for permanently suppressing fly populations such as biological control, Sterile Insect Technique and mating disruption are also being investigated (Causton et al. 2013).

Methods to Increase Range and Population Size

Translocation

Due to the exceptionally restricted range of the Mangrove Finch and limited natural dispersal, one of the most beneficial actions for its conservation would be direct re-establishment of populations within its historic range (Fessl et al. 2010a; Fessl et al. 2010b). Limitations seen in captive-breeding trials using related Woodpecker Finch, resulted in the proposed direct translocation of wild-caught Mangrove Finches (Fessl et al. 2010a). Although studied for several years, Mangrove Finches had never been held in captivity, birds having only been handled in the field for ringing, measuring and blood-sampling. Therefore, development of techniques for holding after capture and transportation and an understanding of how finches adapt to new sites was essential and a first phase, trial, translocation was proposed.

Mangrove Finch habitat at PTN and CB is unique in the Galápagos (Dvorak et al. 2004; Fessl et al. 2010a) and former finch sites at Bahía Cartago and Bahía Urbina were considered suitable for translocation based on current knowledge (Dvorak et al. 2004) and, following visits in early 2010, 10ha of established mangrove forest at Bahía Urbina was selected as the

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preferred site through its suitability for rat control and its proximity to the source population for the first ever transport of the species (Cunninghame et al. 2011).

Rat control is essential for the protection of breeding Mangrove Finches (Fessl et al. 2010b) and a rat control was established with twice yearly monitoring to ensure its effectiveness. Rat numbers at the release site have been reduced following the implementation of baiting in late May 2010.

Capture of birds for translocation took place in late May 2010 once all nesting in the 2009/2010 breeding season was finished (Cunninghame et al. 2011). The agreed number of birds for transfer was 10 individuals although composition of this group would need to be determined by ease of capture. Preference was placed on transferring juveniles; however, in order to make up a suitable number of birds for release, adults were included. All birds were transferred on the same day as their capture.

Birds were captured using mist-nets and ten Mangrove Finches were caught, five adults and five juveniles from the 2009/2010 breeding season, however, only nine of these were chosen for transfer to avoid removing more than two adult males from the source population.

All birds were healthy and fit for transfer. Transmitters with external aerials (Holohil Systems Ltd., Ontario, Canada) weighing 0.41g were fitted to the inter-scapular region of all individuals transferred. The finches were placed in specially built transport boxes and provided with locally caught invertebrates as food. A speed boat transported the birds. This was the first time Mangrove Finches had been held captive and the duration held between capture and release varied from 2-7 hours. Birds reacted very well during their time in confinement and all arrived at the release-site in excellent health.

Post-Release Monitoring

1. Telemetry

Telemetry monitoring was carried out following release, the battery life of the transmitters determining a maximum monitoring period of 22 days (Cunninghame et al. 2011). Birds were radio-tracked daily on foot and by kayak using a R1000 receiver (Communications Specialists Inc, Orange, California) and a 3-element yagi aerial (Sirtrack Electronics, Havelock North, New Zealand) to attain a minimum of one fix per bird/per day.

Telemetry monitoring was cut short by the premature detachment of at least three of the transmitters resulting in individuals being monitored for 2-16 days. The range of the transmitters, 200-300m within the forest, was good enough to confirm the presence or absence of a bird from within any patch of mangroves. All birds were found to be alive and close to the reintroduction site 48 hours after release. One juvenile returned to PTN within the first week following release, the remaining eight birds stayed in the general area around the release site until signals were lost, transmitters fell off or batteries ran out. One juvenile was found dead in the arid zone vegetation 500m from the release site.

2. Observational monitoring

Once the transmitters stopped functioning, monitoring was continued through direct observation and listening. Playback was used to illicit response from any Mangrove Finch in the search area consisting of mangrove forest at the release site extending up the coast to PTN

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in case any birds had returned. Searches were conducted monthly following the end of telemetry monitoring for between 4-17 days until May 2011. Observations of ringed birds have continued through the 2011/12 and 2012/13 breeding seasons to May 2013.

For four months following termination of telemetry monitoring no Mangrove Finches were located at Urbina (Cunninghame et al. 2011). In November 2010, however, an adult male responded to playback and a month later, in December, this bird, along with another adult male, was observed singing back at PTN. These individuals were observed throughout the breeding season of 2010/11, 2011/12 and 2012/13 and successful breeding was confirmed for one individual in 2012 and 2013. Since early 2011 the juvenile that returned to PTN soon after translocation was observed and has been regularly seen through to April 2013. During May 2011 one of the adult females was found at PTN. All sightings of known transferred individuals were confirmed by reading their colour-rings in the field.

Radio-tracking of Mangrove Finches following their translocation was successful providing the devices remain attached. Monitoring of Mangrove Finches by observation and listening surveys was challenging and it took several months following the end of radio-tracking before any birds were re sighted. No calls were heard until the onset of the breeding season four months later and it is possible that birds were present but not detected. No Mangrove Finch has been detected at the release site since November 2010.

Only one juvenile bird was confirmed returning to the source population immediately following release. The presence of three further adult birds at PTN detected from December 2010 shows that Mangrove Finches exhibit strong site fidelity and are capable of making relatively long-distance flights over expanses of exposed lava fields.

If treated as a trial in terms of developing translocation techniques for conservation of Mangrove Finch then this exercise has been successful. Knowing that at least four of the birds removed from the source population are now again part of that population is encouraging and having determined the fate of over 50% of translocated birds highlights the ability of dedicated field teams to manage this species. However, in terms of increasing the range of the species and establishing the founders of a geographically distinct population we have not been successful. Further re-introductions are needed to re-establish Mangrove Finch across its historic range and using information from this first translocation, methods can be modified and improved to increase chances of permanent establishment of new populations it is preferable to conduct future reintroductions without having to remove birds from the source population

Head-Starting

In order to increase the population size of the Mangrove Finch funding (Save Our Species 2013) has been secured to conduct an *in situ* trial to see whether this methodology can be used to produce more chicks each breeding season. Nesting success of Mangrove Finches during the months of the breeding season is exceptionally low (95% failure in 2012-13) with 71% of the fledgling success occurring in the last four weeks of the season. Consequently collection of early laid clutches and hand rearing of chicks hatched presents an opportunity to produce multiple chicks per pair, coupled with the fact that upon nest failure mangrove finches re nest immediately providing the climate conditions are adequate. Collecting eggs prior to hatching is essential to avoid nestlings being already parasitised by *P. downsi*. The

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prevalence of avian pox virus around all inhabited areas on the Galápagos (Parker *et. al.* 2011; Deem et al. 2012) and its apparent absence in the isolated Mangrove Finch habitat mean that any artificial rearing needs to be done *in situ* to prevent the introduction of novel pathogens to the population. If methods for head-starting Mangrove Finches can be successfully developed young birds produced could be used for future re-introductions, therefore increasing the range of the Mangrove Finch without removing established birds from their already restricted and low population.

Although the Mangrove Finch remains very rare, clear long-term strategies to support its continued survival are in place. Predator control and monitoring of finches and their predators will, however, need to be continued for the foreseeable future. With the expected future development of control measures for *Philornis downsi* this fly too will need to be eradicated from the proximity of nesting finches and monitored closely. We are indebted to the Galápagos National Park Service for their support throughout this project and their dedication to saving the Mangrove Finch.

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