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CONSERVING THE CRITICALLY ENDANGERED MANGROVE FINCH: HEAD-STARTING TO INCREASE POPULATION SIZE

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Conserving the critically endangered mangrove finch: Head-starting to increase population size

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The critically endangered mangrove finch (*Camarhynchus heliobates*: BirdLife International, 2013) is one of the most range-restricted birds in the world (Dvorak *et al.*, 2004; Fessl *et al.*, 2010a,b). An estimated 80 individuals (F Cunninghame, pers. obs., 2013) consisting of fewer than 20 breeding pairs are found in 30 ha of mangrove forest at Playa Tortuga Negra (PTN) and Caleta Black (CB) on the northwestern coast of Isabela Island in the Galapagos Archipelago (Fessl *et al.*, 2010a,b). Past research has identified introduced black rats (*Rattus rattus*) and the introduced parasitic fly *Philornis downsi* as the main threats faced by the species (Fessl *et al.*, 2010a,b; Cunninghame *et al.*, 2011; Young *et al.*, 2013). Conservation management has included successful rat control and trial translocation in an attempt to increase the species' range (Fessl *et al.*, 2010a,b; Cunninghame *et al.*, 2011). While these measures produced encouraging results they have not significantly increased the population size or range of the mangrove finch (Young *et al.*, 2013). Parasitism by *P. downsi*, for which no control method yet exists to protect mangrove finches (Causton *et al.*, 2013), coupled with the tendency of translocated birds to return to the source population (Cunninghame *et al.*, 2011), required a more intensive approach to conservation management, using a method called head-starting.

Head-starting to increase population size

Head-starting applies artificial propagation techniques to enhance recruitment of juveniles into a wild population. This strategy has been used to augment populations of critically endangered birds throughout the world (e.g., Cristinacce *et al.*, 2008). The process involves collection of wild eggs or young, followed by artificial incubation and hand-rearing, ending with release of juveniles back into the wild. Certain birds will nest again if a clutch/brood is removed, thereby increasing fecundity, further enhancing ability of conservation programs to maximize juvenile recruitment (Colbourne *et al.*, 2005; Jones & Merton, 2012). To improve survival and establishment chances of reintroduced head-started individuals, the soft-release technique, where supplementary food is provided following their release, has been used internationally in several reintroduction programs of threatened species (Clarke & Schedvin, 1997; Armstrong *et al.*, 2002; Wanless *et al.*, 2002).

Mangrove finch field research has shown that nesting success early in the breeding season is exceptionally low (5% between December to mid-April in 2013) due to egg abandonment and parasitism of nestlings by *P. downsi* resulting in complete brood loss (Fessl *et al.*, 2010b; Cunninghame *et al.*, 2013; Young *et al.*, 2013). Late

nests have higher success as evident in 2013 when 70% of nests fledged chicks from eggs laid after mid-April (F Cunninghame, pers obs). Upon nest failure, mangrove finches readily re-nest; females can lay up to five clutches with an average clutch size of 2.1 (Fessl *et al.*, 2010b).

The availability of eggs from early nests that have little chance of survival to fledging, combined with the likelihood of multiple nesting cycles, made head-starting a promising option as a conservation strategy for the mangrove finch. This would involve the collection of eggs from early clutches leaving wild pairs to rear their own young from later clutches that have higher anticipated levels of survivability. However, the head-starting approach had never been conducted on any bird species within Galapagos; furthermore there have been few attempts to artificially rear any species of Darwin´s finch (Good *et al.*, 2009) and none with the mangrove finch. Consequently, this first attempt was conducted as a trial, collecting from a small number (10) of nests to see whether it presented a viable management technique for increasing the population size.

Mangrove finch head-starting

Project planning, involving Mangrove Finch Project partners Charles Darwin Foundation (CDF), Galapagos National Park Directorate (GNPD), and San Diego Zoo Global (SDZG) as the lead organizations, began in September 2013. The remote location and limited infrastructure in northwestern Isabela meant that artificial incubation and hand-rearing would need to take place in Puerto Ayora, Santa Cruz. An insect-proof rearing room with airlocks and a double-door system was established at the Charles Darwin Research Station (CDRS) to prevent exposure to disease, principally mosquito-vectored avian pox virus that occurs in Puerto Ayora but which is not currently present at PTN. Pre-release aviaries were built and installed in the mangrove forest at PTN in December 2013, following strict quarantine procedures.

Nest collection

Mangrove finch nest collection at PTN occurred over four weeks beginning in late January 2014. Nesting behavior of wild pairs was monitored to identify when nests were suitable for collection. Tree climbers collected nests by hand, placed them in padded bags, and then lowered them by rope to team members on the ground. To avoid embryo damage or death due to cooling, the eggs were immediately placed into cotton wool cups inside a warm thermos. Two people relayed the thermos out of the forest to the camp where the eggs were transferred to a portable incubator (Figure 1). Some nests also contained chicks, which were transported in an open thermos and once in the portable incubator were fed with abdomen contents of moths every 60 minutes. Nest harvests took place on three separate occasions. Eggs and chicks were transported inside portable incubators by helicopter or onboard the GNPD's boat, the Guadalupe River, with the transfer to CDRS taking 8-16 hours. In total 10 nests from eight wild pairs were collected, including 21 eggs and three recently hatched chicks, and taken to the captive rearing facility.

Figure 1. Mangrove finch eggs in cotton wool in nest cups inside portable incubator at Playa Tortuga Negra ready for transfer to CDRS. Photo: © Beate Wedelin

Artificial incubation and hand-rearing

Upon arrival, eggs were installed in cradle incubators (Brinsea Octagon) at 37.8°C, with automated turning mechanisms with additional 180° hand-turns three times per day. Eggs were weighed daily and humidity altered accordingly to control appropriate water-loss from each egg over the incubation period. The eggs were candled daily to evaluate fertility and embryonic development. Of the 21 eggs collected, 19 were viable for incubation (90.5% viability). Seventeen of the eggs were fertile (89.5% fertility) and 15 hatched (88.2% hatchability), representing eight wild pairs (Figure 2).

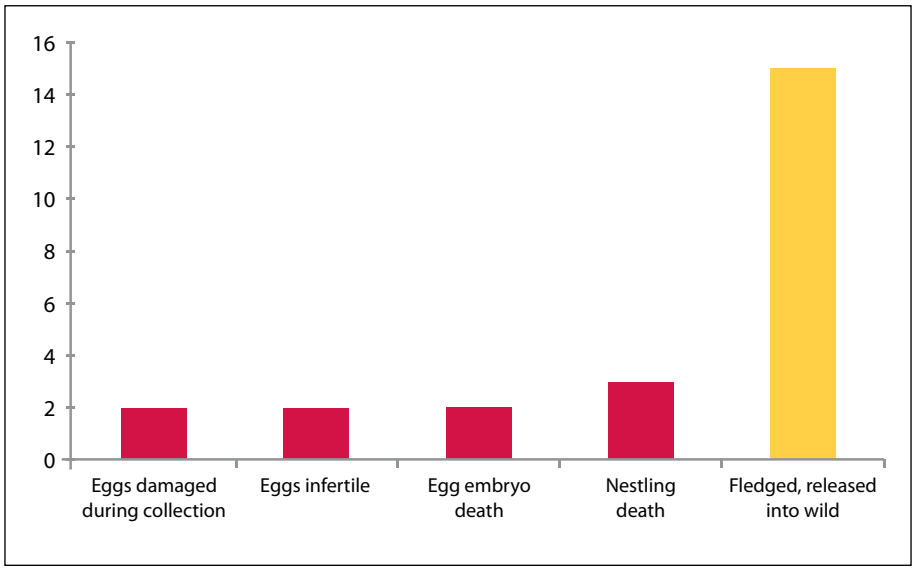

Figure 2. Outcome of 24 mangrove finches collected as eggs (21) or nestlings (3) for head-starting, 2 February – 6 May 2014.

The three wild-hatched chicks were all infested with *P. downsi* larvae in nasal and/or ear cavities. These were removed with a layer of Vaseline preventing larvae from breathing. One of these chicks arrived severely dehydrated and anemic due to parasites and died a few hours later. Two other chicks, which hatched from artificially-incubated eggs, died at six days old with symptoms suggesting omphallitis (yolk sack infections) (Figure 2).

Newly hatched chicks were kept in individual nest cups in brooders (initially modified Brinsea Octagons, then Lyon Animal Intensive Care Units). Prior to fledging, chicks were kept in communal nest cups to facilitate the development of correct species identity. Upon fledging (at 14-18 days), birds were transferred to wire cages, still inside the hand-rearing room under quarantine conditions (Figures 3a-3c).

Figure 3a. Mangrove finch nestlings inside Brinsea Octagon Incubator modified as a brooder (Photo: © Juan C Ávila). **3b.** Mangrove finch nestling in individual nest cup (Photo: © Juan C Ávila). **3c.** Mangrove finch fledglings inside holding cage inside quarantine captive rearing room prior to transfer to Playa Tortuga Negra (Photo: © Francesca Cunninghame).

Chicks were fed on a captive diet, appropriate for insectivorous passerines, according to protocols established by SDZG. For the first 14 days, chicks were fed hourly 15 times a day from 06h00 until 20h00. After 15 days, feeding was reduced to every two hours and after 19-20 days to every three hours. To encourage the fledglings to feed for themselves, dishes of prepared food were put in their cages once they reached 18-28 days old. A total of 15 chicks were successfully raised to independence (83.3% chick survivability) (Figure 2).

All birds were ringed with unique color combinations to enable identification, and blood samples were taken for sexing and genetic analysis.

Recordings of wild mangrove finch calls were played daily in the hand-rearing room to encourage the development of appropriate vocalizations. Quarantine regulations meant it was not possible to use natural substrates to encourage foraging, so cardboard tubes and shredded newspaper were offered. Once the fledglings had been

feeding independently for at least seven days, they were transported back to PTN overnight in mosquito-proof boxes onboard the GNPD boat, the Guadalupe River, in two groups, seven on 13 March and eight on 28 March.

Pre-release aviary care at Playa Tortuga Negra

Soft-release principles were used. Fledglings were housed for four to six weeks in specially made aviaries (7.2 x 3.6 x 2.4 m) situated in a clearing within the mangrove forest at PTN (Figure 4). These aviaries enabled fledglings to adapt to their natural habitat before release to the wild. Natural foraging material (Fessl *et al.*, 2011) was placed throughout the aviaries. While prepared food dishes were provided twice daily, emphasis was placed on encouraging the birds to forage. Lepidopteran larvae found in fallen black mangrove (*Avicennia germinans*) seeds on the forest floor are an important food source at certain times of year for wild mangrove finches. These were collected along with adult moths and fed to the captive birds daily. Behavioral observations showed that individuals spent an average of 45% of their time foraging on natural substrates (P Medranda & A Carrión, pers. obs.). Wild mangrove finches approaching the aviaries interacted non-aggressively with captive fledglings; captive fledglings displayed interest only in mangrove finches.

Figure 4. Mangrove finch fledglings on a natural black mangrove perch inside the pre-release aviaries within the mangrove forest at Playa Tortuga Negra. Photo: © Paul Medranda

Post-release monitoring

The release of the15 fledglings was conducted to coincide with the end of the breeding season of wild mangrove finches to reduce intra-specific territorial aggression. Releases took place on 20 and 25 April and 6 May. The aviaries were left open, and food and water provided twice daily inside the aviaries until 10 May. Four days prior to closing the aviaries, fresh food was replenished just once a day. The aviaries were closed on the evening of 14 May, two days before the field team left the site.

Birds were fitted with 0.35-g radio transmitters (Holohil, Canada) two days prior to release (Figure 5). Upon opening, aviaries were observed daily from 06h00 until 18h00 to monitor supplementary feeding visits of each bird. All but two birds returned regularly to feed.

Figure 5a. VHF transmitter (0.35 g) mounted on the underside of the tail on a head-started mangrove finch fledgling prior to release. Photo: © Paul Medranda. **5b.** Released head-started mangrove finch with VHF transmitter antennae showing. Photo: © Francesca Cunninghame

Additional survival and dispersal results were gathered through telemetry monitoring. Birds were radio-tracked for a maximum of 19 days following release, as determined by transmitter battery life. However, 11 transmitters stopped functioning prematurely due to becoming unattached or technical problems. While released fledglings were found predominantly within mangroves at PTN, five were also located outside of the forest, up to 3 km away. The monitored birds were observed foraging for invertebrates on six tree and shrub species, and feeding on the fruits of *Bursera graveolens* and *Castela galapageia*. Two individuals regularly spent the early morning feeding on *B. graveolens* fruits in the arid zone, alone or with wild birds. This is the first record of mangrove finches in arid zone vegetation. Captive-reared fledglings were seen following unrelated wild adult males with fledglings, a behavior that has been observed with wild fledglings.

Two individuals never returned for supplementary feeding. One was found in a small patch of mangrove forest 1 km to the north of PTN where it was observed foraging each day. The other was not located and its transmitter was found 14 days later, 2 km south in arid zone vegetation. On 15 May, the last day the field-team conducted monitoring, the whereabouts of only eight fledglings were known suggesting that seven were no longer in the vicinity of PTN, or their transmitters had ceased working. No mortalities were confirmed.

Fledging success in the wild population

From 18 nests not collected for head-starting that were monitored at PTN (16) and CB (2), 27.7% were successful, with only five pairs of wild mangrove finches rearing a total of six fledglings (Table 1, Figure 6). Nests failed due

Table 1. Comparative number of nestlings fledged and nesting success of head-started and wild mangrove finch nests during the 2014 breeding season (25 January – 6 May 2014). Total is number of confirmed eggs or nestlings found in early stage of development. Wild total is lower than actual due to failed nests with unknown contents not being included. Consequently, actual fledging success and nesting success for wild nests is almost certainly lower than indicated.

	Total eggs or nestlings	Total chicks fledged	% Fledging success*	Total nests	Nests fledged^	% Nesting success
Head-started	24	15	62.5	10	9	90
Wild	28	6	21.4	18	5	27.8

* Incorporates assessments of fertility, hatchability, and chick survivability, since this data is not available for the wild nests.
^ Nests that fledged at least one young.

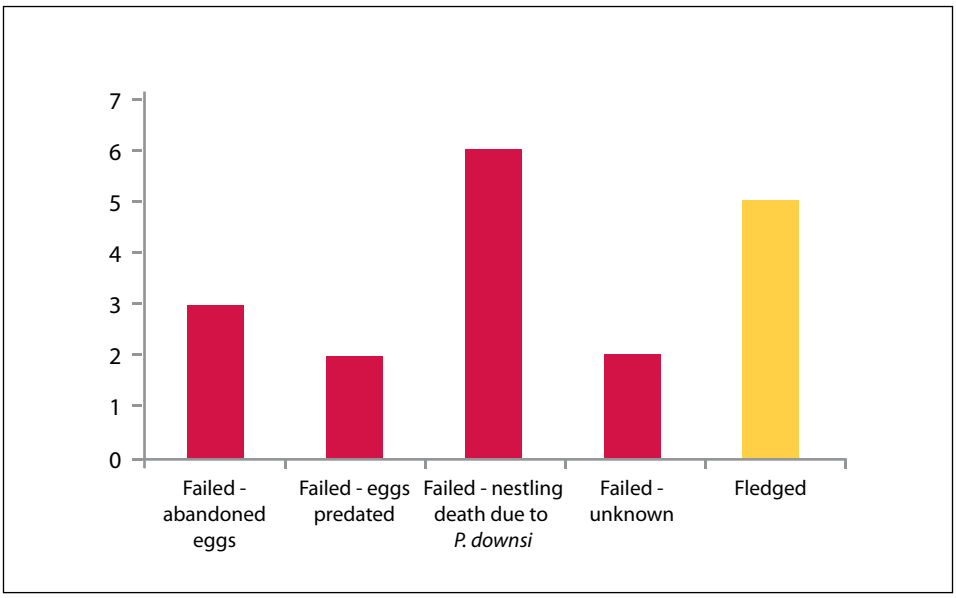

Figure 6. Outcome of 18 wild mangrove finch nests at Playa Tortuga Negra and Caleta Black 25 January – 03 April 2014. Nests with at least one chick fledged are represented as fledged; only those nests where the entire brood was lost to *P. downsi* parasitism are represented in the "Failed – nestling death due to *P. downsi*" column.

Figure 7. Released head-started mangrove fledgling foraging in mangrove forest at Playa Tortuga Negra. Photo: © Francesca Cunninghame

to: death of nestlings from *P. downsi* parasitism (33.3%), egg abandonment (16.7%), egg predation (11.1%), and undetermined causes (11.1%) (Figure 6).

Conclusion and recommendations

The collection, artificial incubation, hand-rearing, and release of 15 fledgling mangrove finches back into their native habitat represent an important step for the conservation of this Critically Endangered species (Figure 7).

At least one fledgling was successfully reared from nine of the 10 nests collected (35.7% total season's nests). Based on the assumption that nests collected for head-starting were destined to fail, head-starting increased both nesting success and the number of chicks fledged by over 200% in one season. Given that this first year was a trial, the number of head-started fledglings produced was low. However, there is potential to further increase fledgling productivity through the collection of more nests. Project planning is underway to determine the best use of head-starting in conjunction with continued management to control threats in the wild and to meet the long-term goals of mangrove finch conservation to increase population size and range of the species.

Continual conservation management is needed for several years to improve the status of the mangrove finch due to its extremely small population size and restricted range. Head-starting, with complementary wild population management, will be needed and the following recommendations should be considered.

- Evaluate this year´s progress in consultation with stakeholders to improve efficiencies and develop a plan for intensive species management over the next five years.
- Use head-starting for a minimum of three to four years to increase population size.
- Use genetic data and studbook-keeping when harvesting eggs to ensure maintenance of genetic variation in the population.
- Use captive-reared fledglings to repopulate other mangrove forests within historic range of the species.
- Continue introduced rat control and increase cat control in all areas inhabited by mangrove finches.
- Carry out trial of rat-specific, multi-kill canister traps (GoodNature NZ) at PTN with the goal of replacing bait stations (and brodifacoum) with non-toxic control.
- Trial methods of *P. downsi* control in wild nests in collaboration with the *Philornis* Project (CDF).
- Continue to build capacity within local institutions and in the local community through training GNPD personnel, local and mainland Ecuadorian staff, students, and volunteers in captive rearing and field techniques (tree climbing, bird monitoring, and telemetry).
- Continue with activities that raise awareness of the mangrove finch within the local community at Puerto Villamil on Isabela.

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