On the verge of extinction: a survey of the mangrove finch *Cactospiza heliobates* and its habitat on the Galápagos Islands

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Abstract The Critically Endangered mangrove finch *Cactospiza* (=*Camarhynchus*) *heliobates* is now confined to Isabela Island in the Galápagos Islands and is exclusively found in mangrove forests. Formerly it occurred also on neighbouring Fernandina Island, but is apparently extinct there. The population size and ecology of the species was relatively unknown until 1994. We conducted surveys, habitat assessments and behavioural observations of the species between 1996 and 2000. Although Isabela Island has approximately 760 ha of mangrove forests, breeding was confirmed at only two sites, comprising 32 ha in total, on the north-western coast. Our estimate of the population in these two areas is 100 individuals. Additionally, 3–5 territories (which probably contained breeding individuals) were discovered on the south-eastern coast. A comparison of habitat parameters showed that tree height and amount of dead wood were significantly higher within than outside territories, and these are therefore likely to be important habitat components for this species. As considerable structural differences were detected between the two sites holding the main populations and all other mangrove stands on Isabela, it seems possible that the latter are sub-optimal habitat. We therefore conclude that one of the reasons for the very limited distribution of the species is habitat degradation caused by hitherto unknown factors.

Keywords *Cactospiza heliobates*, Darwin's finches, Galápagos Islands, mangroves, mangrove finch.

Introduction

The avifauna of almost all oceanic islands and archipelagos of the Pacific Ocean has been drastically altered during the last two millennia by the impact of humans. All but a few very remote islands have lost several species (Steadman, 1995). In this respect the Galápagos Islands, with their still largely intact avifauna, are one of the exceptions, as no species of land bird has become extinct from the archipelago in modern times.

Darwin's finches (subfamily Geospizinae) are the most diverse group of birds on the Galápagos islands, with 14 species (Grant, 1986; Petren *et al*., 2001). The majority of these species are still widespread and common, but the mangrove finch *Cactospiza heliobates* is entirely confined to mangrove forests on the two large western islands, Isabela and Fernandina, although recent evidence suggests that the species is now no longer found on Fernandina (Grant & Grant, 1997). The mangrove finch is categorized as Critically Endangered on the IUCN Red List (BirdLife International, 2000; IUCN, 2003). No comprehensive surveys were made of the species until our first surveys in 1996, and data on the biology of the species were largely absent.

Our work had three main objectives: 1) to survey all mangrove stands on Isabela and Fernandina to locate remaining populations of mangrove finch, 2) to assess the extent and suitability of the available habitat with standardized methods, and 3) to collect data on the biology of the species, especially relating to habitat selection and feeding behaviour.

Methods

A combination of aerial photographs, points located with a Global Positioning System, and vegetation maps (edited by ORSTROM, scale 1:100,000) were used to determine the location and approximate areas of mangrove forests. Surveys were conducted at 22 sites over 54 days during 1996–2000 (Table 1; Fig. 1). The total area of

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Table 1 Surveys for mangrove finches on the islands of Isabela and Fernandina, with site name, area, geographical information, survey dates, total hours of searching and number of individuals detected.

Island/Site	Area (ha)	Coordinates	Date(s)	Hours searching	Number of mangrove finches
Fernandina					
Punta Espinosa	?	00°16′ S 91°27′ W	21+22/8/1997	10	none
Mangle Gavilanes	?	00°21′ S 91°23′ W	27/5/1996	6	none
Punta Mangle	?	00°27′ S 91°23′ W	18–20/8/1997	12	none
Isabela					
Caleta Black	11	00°12′ S 91°23′ W	9–18/5/1997, 1–31/1/1999	>50	21 pairs in 1997, 16 pairs in 1999
Playa Tortuga Negra	22	00°14′ S 91°23′ W	13+14/1, 5–17/2/1997, 14–16/5/1997, 1–31/1/1999	>50	37 pairs in 1997, 36 pairs in 1999
Tagus Cove	?	00°15′ S 91°22′ W	12/2+22/3/1998, 10/2/1999	5+2+2	3–4 individuals in 1998
Bahía Urvina	140	00°22′ S 91°16′ W	26+27/1/1998	8+17	none
Bahía Elisabeth	16	00°35′ S 91°05′ W	28+29/5/1996, 28/1/1998	4+18	none
West of Bahía Elisabeth I	25	00°40′ S 91°12′ W	26/5/1996, 28/1/1998	4+6	none
West of Bahía Elisabeth II	?	00°40′ S 91°14′ W	28/1/1998	no landing possible	not surveyed
Puerto Fregata	?	00°41′ S 91°16′ W	13/7/2000	3	none
Punta Moreno	70	00°42′ S 91°20′ W	29/1/1998, 20/12/1998, 13+14/7/2000	19+5+6+5	none
Cabo Rosa	5	01°02′ S 90°10′ W	30/1/1998	4	none
West of Villamil	20–40 ?	00°57′ S 91°00′ W	1/3/1997, 25+30/1/1998, 21/12/1998	16	none
SE coast, sub-area 1	25	00°34′ S 90°59′ W	25/2/1997	18	none
SE coast, sub-area 2	50	00°37′ S 90°56′ W	26/2/1997	17	none
SE coast, sub-area 3	65	00°37′ S 90°54′ W	26/2/1997	4	none
SE coast, sub-area 4	90	00°38′ S 90°51′ W	27/2, 3/3/1997, 24/1/1998, 20/3/2000	16+3+10	one singing male 1997
SE coast, sub-area 5	28	00°43′ S 90°50′ W	28/2/1997	13	none
SE coast, sub-area 6	6	00°41′ S 90°50′ W	2+3/2/1997, 24/1/1998, 22+23/12/1998, 22/3/2000	13+5+10+24	2–3 territories
SE coast, sub-area 7	50	00°44′ S 90°49′ W	2/3/1997	13	none
SE coast, sub-area 8	8	00°50′ S 90°50′ W	1/3/1997, 24/1/1998	10+3	one singing male 1997

mangroves on Fernandina was not accurately mapped but is probably <50 ha. Isabela has the most extensive mangrove forests of the Galápagos Islands, totalling *c.* 750 ha. The largest mangrove stand, with an estimated total area of 320 ha, is on the south-east coast.

Standardized point counts were conducted at each site surveyed. Depending on habitat structure, counts lasting 5–8 minutes were made at points at least 100 m apart. During this time all land birds seen or heard were recorded. A playback tape of mangrove finch song from Playa Tortuga Negra on the north-west coast of Isabela was used in February 1997 to increase the likelihood of detecting birds. Following the discovery of a different song type on the south-eastern coast in 1997 (see results), tapes of both song types were used in January 1998 and March 2000. Most surveys were conducted in January, February

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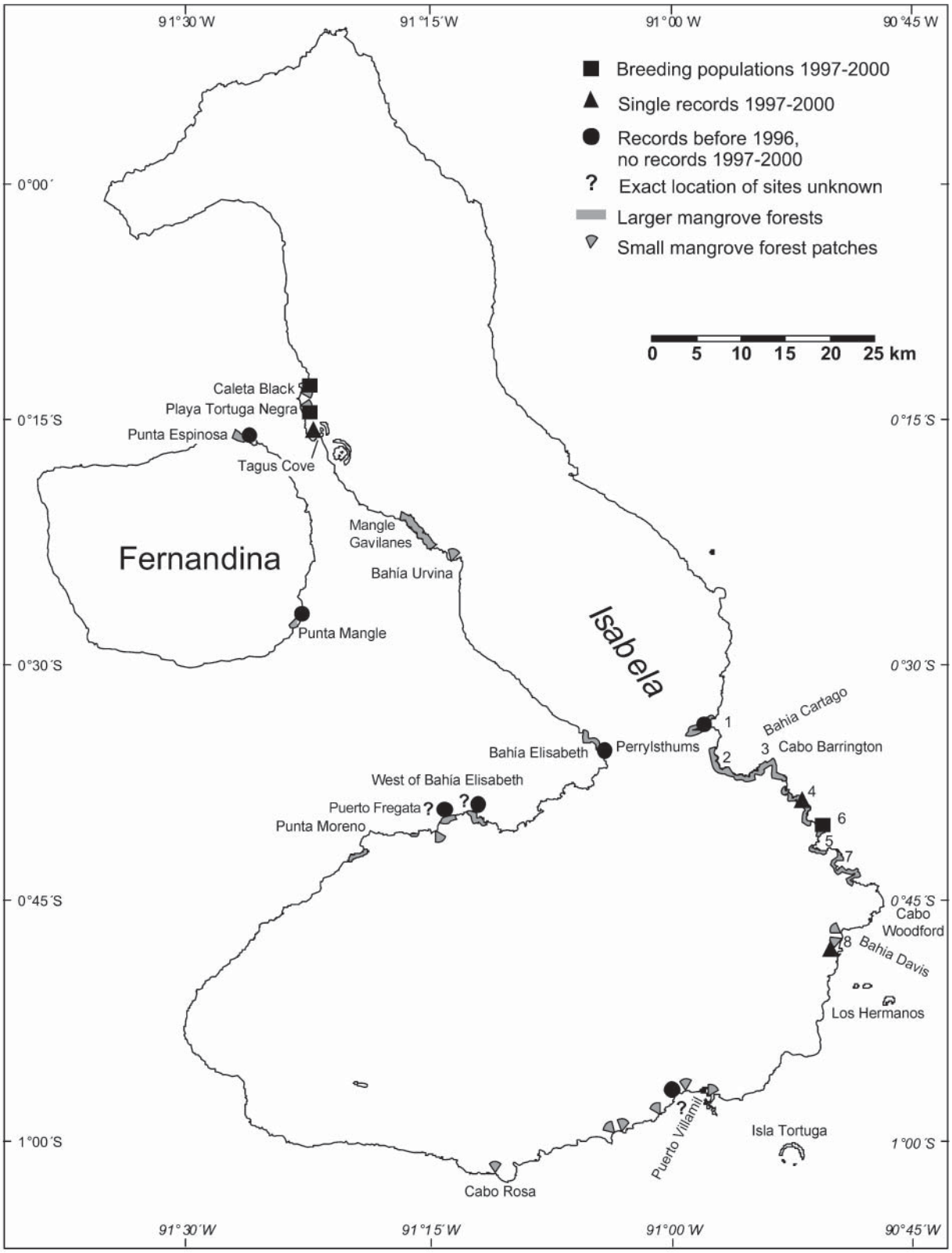

Fig. 1 Locations of mangrove forests and distribution of the mangrove finch on the islands of Isabela and Fernandina. Sub-areas on the south-eastern coast are indicated with numbers 1–8.

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and March, the presumed main breeding season of mangrove finches and of all other Darwin's finches. Counts were made in the mornings between 07.00 and 12.00 and in the afternoon between 15.00 and 17.30. The latitude and longitude of every census point was determined with a Global Positioning System. The interior of almost all forests was inaccessible without cutting a path, and bird counts were therefore made only from the landward and seaward margins of the mangroves. During February 1997 and March 1998 two people covered the inland margin and a third went along the shore with a dinghy. As most forests were only narrow stretches of 20–50 m along the coast, the majority were covered in this manner. At Playa Tortuga Negra and Caleta Black mangrove finches were counted using the same methods, but point counts were made along forest transects as well as at the margins.

Habitat parameters (vegetation composition as percentages of different tree species, percentage canopy cover, vegetation height, and percentage leaf litter cover) were recorded by visual estimation within a radius of 15 m of every census point. The amount of dead wood >10 cm in diameter (both standing and lying) was counted, i.e. how many dead branches or trunks were visible from the census point. Additionally, we recorded whether the census point was directly connected to the open sea or separated from the sea by a beach. The latter areas were only inundated during high tides. In Playa Tortuga Negra and Caleta Black the same methods for sampling vegetation structure were used, with the exception that the proportions of tree species were recorded in four categories: 0 = not present, 1 = present, but $<10\%$, 2 = 10–50%, 3 = $>50\%$. Data on vegetation structure were not collected for sites on Fernandina.

Data on feeding behaviour were collected at Playa Tortuga Negra over 9–11 March 2000, during 06.00–12.30 and 16.00–18.00, with a total observation time of 40 hours. Continuous observations were conducted with binoculars or the naked eye until the focal bird was lost from sight. We recorded the type of the first foraging technique and feeding substrate used after each change of substrate or tree. Individuals were not ringed and we therefore could not identify individuals. From their spatial distribution and differences in plumage, however, we estimated that we collected data from at least 18 individuals. The mean number of observations per individual was 5.3, range 2–10. We recorded all prey items obtained during observations. As a result of the birds' tameness, most observations were made from <10 m, and therefore identification of prey was often possible to the level of Order. Six different foraging techniques were distinguished: peck = forceful and quick vertical downward movement of head and beak onto bark of dead wood, remove = removal of bark of dead wood by inserting either both or only the lower mandible sideways under the bark and levering it forcefully, bite = bite into petioles of leaves or the base of curled leaves, probe = quick insertion of the beak into curled leaves, collect = collecting fruit and seed from the ground and nectar from flowers, and glean = take prey from the surface of the substrate.

Seven foraging substrates were recognized: bark = bark of dead trunks, branches and twigs, dead wood = trunks of dead wood without bark, leaf = green leaves attached to branches, dead leaf = dead leaves attached to branches, leaf litter = dead leaves on the ground and embryos of mangroves, ground = ground without leaf litter, and flower = flowers from which mangrove finches collected nectar. Food types were recorded as caterpillars, larvae = larvae of beetles and hymenoptera, insects = other insects, spiders, seeds, fruits and nectar.

Results

Finch distribution and density

Mangrove forests of a significant size occur at only three sites on Fernandina (Table 1). Surveys of these areas in 1996 and 1997 totalling 28 hours failed to locate any mangrove finches. Breeding populations were found at three sites on Isabela: Playa Tortuga Negra and Caleta Black in the north-west and sub-area 6 in the south-east (Fig. 1). At Playa Tortuga Negra mangrove finches were recorded at 35 of 59 census points in February 1997. Population size was estimated to be 37 pairs with a density of 1.7 pairs per ha. A count in the same area in 1999 resulted in an estimate of 36 pairs, suggesting that this population was relatively stable. At Caleta Black in May 1997 finches were seen at 19 of 45 census points; population size was estimated at 21 pairs, with a density of 1.9 pairs per ha. In 1999 the same area was visited for one day and the population was estimated at 16 pairs. At sub-area 6 on the south-eastern coast three birds (a presumed pair and another singing male) were observed in March 1997, three singing males in January 1998, one pair in December 1998 and one pair (male singing and presumed female collecting nesting material) and two other singing males in March 2000. The songs of the males were different from those of birds from Playa Tortuga Negra. Most song bouts consisted of three syllables and were transcribed phonetically as a slow tschrrm-tschrrm-tschrrm (Fig. 2).

Taking into account the variation in population estimates in 1997–2000 and assuming that every male had a mate, the combined population estimate for the three known locations is 55–63 pairs or 110–126 adult individuals. Additionally, at a site near Tagus Cove *c.* 600 m south of Playa Tortuga Negra two males and two presumed

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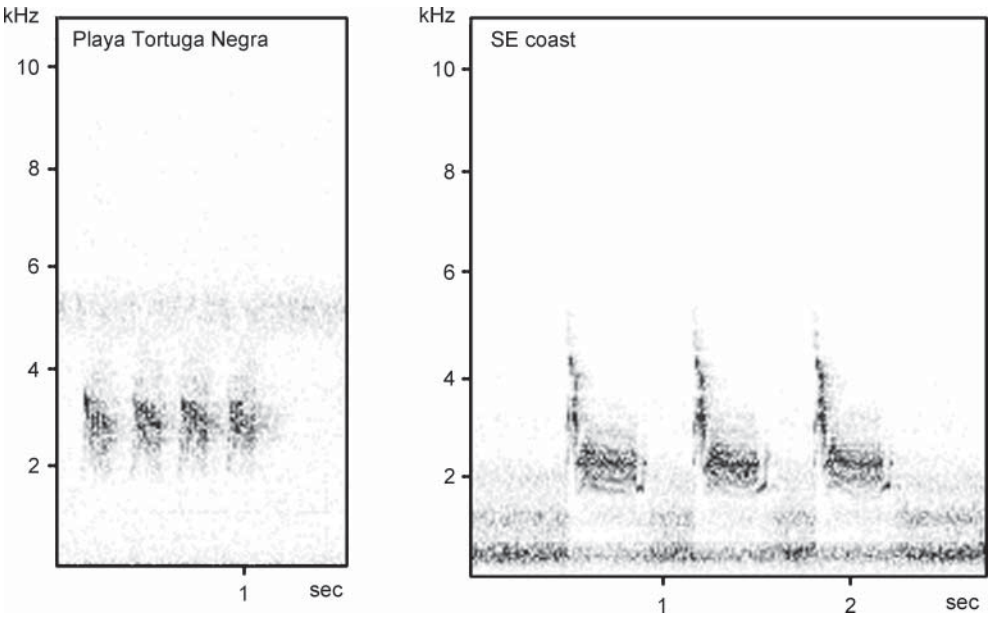

Fig. 2 Sonograms of mangrove finch songs from the south-eastern coast and Playa Tortuga Negra on the west coast. Most song bouts from the south-eastern coast consisted of three syllables, some of two or only one syllable. In contrast song bouts from the west coast always consisted of four syllables which were sung with higher speed.

females (not singing) were observed in February 1998 and two adult males and a juvenile in March 1998. Although males were actively singing and apparently defending territories, no nests were found. This site has no mangroves and the dominant tree is *Bursera graveolens*. Since we did not detect finches in a follow-up visit in February 1999, it is possible that birds from Playa Tortuga Negra disperse to this marginal habitat during wet years (as in 1998), when food is more abundant. On the south-eastern coast in February and March 1997 singing males were recorded at two other sites (sub-areas 4 and 8) close to sub-area 6. However, during repeat visits in January 1998 and March 2000 we could not confirm the presence of mangrove finches at these sites.

Mangrove finch habitat on Isabela

At Playa Tortuga Negra the forest is composed of white *Laguncularia racemosa*, red *Rhizophora mangle* and black mangroves *Avicennia germinans*. White mangroves were recorded at 59 (100%), red mangroves at 47 (80%) and black mangroves at 25 (42%) of the census points. At Caleta Black both red and white mangroves were equally common and widespread (present at 37 and 38 of 47 census points) but black mangroves were absent. Both forests had a relatively open canopy, leaf litter covered much of the surface and dead wood was abundant (Table 2). Median height of the forest in both Caleta Black and Playa Tortuga Negra was 12 m, with the highest stands reaching 25–29 and 25 m respectively.

All mangrove forests on the southern coast were small, with only one (Cabo Rosa) exceeding *c*. 4 ha. We only recorded habitat data from this one larger area. There are five mangrove stands of a significant size on the western coast, the largest being at Bahía Urvina and Punta Moreno. All forests are composed exclusively of white and red mangroves. The forest at Punta Moreno is an almost pure stand of white mangroves. Canopy cover is high in all areas and leaf litter was absent at most census points or present only at the forest margins. The majority of census points had at least small amounts of dead wood. Median tree height differs only slightly between the areas but maximum tree height varies widely: at Bahía Urvina some small stands reach heights of 18–20 m, but in Bahía Elisabeth and Punta Moreno the tallest trees are no more than 10–13 m. Most mangrove forests on the south-eastern coast were more or less narrow strips (20–200 m) along the coastline and only sub-areas 3 and 4 have larger areas of forest. White mangroves dominated, with a median proportion of 60%, compared to 40% for red mangroves. Black mangrove and button mangrove *Conocarpus erecta* were only found at a few census points. Median tree height was 5–8 m in most areas and only two census points had trees taller than 15 m. Canopy cover was 100% almost everywhere and leaf litter was absent at most census points, with the exception of the forest margins. Dead wood was scarce except in sub-area 8, which had substantial amounts at almost every census point.

The vegetation structure of Playa Tortuga Negra and Caleta Black differ from all other areas (Table 2): trees are

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Table 2 Habitat characteristics of the mangrove forests on Isabela. Medians, with quartiles, for percentage canopy cover and leaf litter cover, number of lying and standing pieces of dead wood, and tree height, within a 15 m radius of the census points. +, mangrove finches present in more than one year; (+), in only one year; −, absent (see Table 1).

Area	Mangrove finches	Canopy cover (%, with quartiles)	Leaf litter cover (%, with quartiles)	Pieces of lying dead wood (quartiles)	Pieces of standing dead wood (quartiles)	Tree height (m, with quartiles)	No. of census points
Caleta Black	+	60 (50/80)	30 (0/80)	5.5 (3/7)	?	12 (9.5/17)	25
Playa Tortuga	+	60 (50/80)	50 (10/80)	6 (5/12)	?	12 (10/15.5)	45
Bahía Urvina	−	100 (90/100)	0 (0/10)	4 (1/10)	0 (0/2)	7 (5/9)	58
Bahía Elisabeth	−	100 (80/100)	0 (0/0)	2 (0/6)	1 (0/3)	5 (4.25/6.25)	31
W of Bahía Elisabeth	−	95 (80/100)	0 0/0)	2 (0/8)	1 (0/2)	6 (6/7)	25
Punta Moreno	−	95 (80/100)	5 (0/28)	2 (0/6)	2 (0/6.8)	6.25 (5/8)	34
Cabo Rosa	−	95 (8/100)	10 (0/30)	0 (0/4)	0 (0/1)	5.5 (4.25/8.25)	10
SE coast, sub-area 1	−	100 (100/100)	0 (0/10)	0.5 (0/2.8)	0 (0/1)	6 (4.25/6.25)	56
SE coast, sub-area 2	−	100 (100/100)	0 (0/10)	3 (1/4.3)	5 (2.8/9)	7 (5/8)	59
SE coast, sub-area 3	−	100 (100/100)	0 (0/15)	0 (0/0)	2 (1/3,5)	5 (4.25/6)	48
SE coast, sub-area 4	−	100 (100/100)	0 (0/0)	0 (0/0)	3 (0.3/5)	6 (5/8)	73
SE coast, sub-area 5	(+)	100 (100/100)	0 0/10)	0 (0/15)	1 (0/2)	8 (6/15)	60
SE coast, sub-area 6	+	100 (100/100)	5 (0/12.5)	0.5 (0/15)	1 (0/5)	5 (5/8)	18
SE coast, sub-area 7	−	100 (100/100)	0 (0/5)	15 (0/15)	1 (1/2)	5 (5/6)	39
SE coast, sub-area 8	(+)	100 (100/100)	10 (0/50)	15 (15/15)	4 (3/7)	7 (6/8)	14

taller, the canopy is relatively open, and leaf litter and dead wood are abundant. Sub-area 6 on the south-eastern coast is similar in vegetation structure to the surrounding areas that do not have mangrove finches.

Separation from the sea appears to be an important indirect factor for the habitat of mangrove finches. This is the only habitat parameter that differs significantly between mangrove forests with (all three separated from the sea) and without (three out of 12 separated from the sea) records of mangrove finches in a univariate comparison (Fisher Exact test, $P = 0.024$). Mangrove forests inland are separated from the sea either by a sandy beach (as with Playa Tortuga Negra and Caleta Black) or a lava flow (as with sub-area 6) and receive water only during high tide, from groundwater.

At Playa Tortuga Negra census points with mangrove finches had significantly more black mangrove, taller trees, a greater canopy cover and more dead wood (Table 3). At Caleta Black, census points with mangrove finches had significantly taller trees and there was a tendency for canopy cover to be greater. In a second analysis both areas were combined in a logistic regression, with the significant variables of the previous analysis used as independent variables and the presence of mangrove finches as the dependent variable. Black mangroves were excluded as a variable because they do not occur in Caleta Black. Tree height and dead wood were significantly correlated (Spearman-rank correlation, $R = 0.291$, $P = 0.008$) and were therefore combined into one variable with a principal component analysis. The logistic regression revealed that the combined variable tree height/dead wood significantly predicts the presence of mangrove finches (dead wood/tree height: Wald coefficient = 6.725, df = 1, $R = 0.205$, $P = 0.010$;

Table 3 Comparison of habitat structure, with Mann-Whitney U-tests, for census points at which mangrove finches were present or absent (with number of points in parentheses) at Playa Tortuga Negra and Caleta Black (see Tables 1 and 2). Significant differences are in bold.

	Playa Tortuga Negra				Caleta Black			
	Mangrove finch				Mangrove finch			
	Present (n = 35)	Absent (n = 24)	*z*	P	Present (n = 19)	Absent (n = 26)	*z*	P
Red mangrove	2	2	−0.837	< 0.402	2	2	−0.465	< 0.641
White mangrove	3	3	1.026	< 0.308	3	3	0.211	< 0.833
Black mangrove	1	0	−3.294	< **0.001**				
Tree height (m)	14	10	−2.464	< **0.013**	15	12	−1.972	< **0.048**
Canopy cover (%)	75	60	−3.124	< **0.002**	70	60	−1.761	< 0.075
Leaf litter (%)	35	50	1.242	< 0.214	5	40	1.03	< 0.303
Dead wood (number)	11	6	−2.091	< **0.032**	6	5	< 0.448	< 0.876

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canopy cover: Wald coefficient = 0.382, df = 1, $R = 0.000$, P = 0.537).

Feeding behaviour

Mangrove finches are mainly insectivorous and use a wide range of feeding techniques on different substrates. Their strong bill enables them to remove bark from dead wood, sometimes pecking into the wood directly. They searched fresh and dead leaves as well as leaf litter for prey and, less frequently, they collected fruits, nectar and seeds from the ground (Figs. 3a & b). The profitability of the different feeding substrates deviated slightly from the observed use (Fig. 3c). Mangrove finches found 40% of their food on green and dead leaves, 30% in dead wood (bark and wood combined) and 24% on the ground, predominantly in leaf litter and embryos of mangroves. More than 90% of the food consists of arthropods, mostly insect larvae and occasionally other insects (mostly butterflies and beetles) and spiders (Fig. 3c). Although white mangroves are more abundant at Playa Tortuga Negra, mangrove finches spent more time searching the leaves of red mangroves (29.7 vs 65.6% of all observations).

Discussion

On Fernandina the first and apparently only record of large numbers of mangrove finches is from 1899, when 14 specimens were collected on the east coast (Snodgrass & Heller, 1904). Excepting records of one bird in 1971 (Harris, 1973) and three birds in 1974 (Grant & Grant, 1997) there are no other published records of the species from this island. Since intensive surveys in March 1994 and January 1995 (Grant & Grant, 1997) and our own searches failed to locate the species we conclude, in agreement with Grant & Grant (1997), that the mangrove finch no longer breeds on Fernandina.

Earlier surveys on Isabela (Curio & Kramer, 1964; Grant & Grant, 1997) recorded mangrove finches only from Playa Tortuga Negra and Caleta Black on the north-western coast. We found substantial breeding populations only in these two areas, with a combined population estimate for the two sites of *c*. 100 individuals. On the south-eastern coast of Isabela we found only 3–5 territories, despite our hope that a substantial breeding population may exist in these mangrove forests, which are the most extensive on the Galápagos Islands. Nonetheless, the discovery of a new site for the species is important and, in addition, these finches have a distinct song type. Song is known to be culturally transmitted in other species of Darwin's finches (Gibbs, 1990), and it is thus unlikely that the birds are vagrant individuals from the north-western coast. Other species of Darwin's

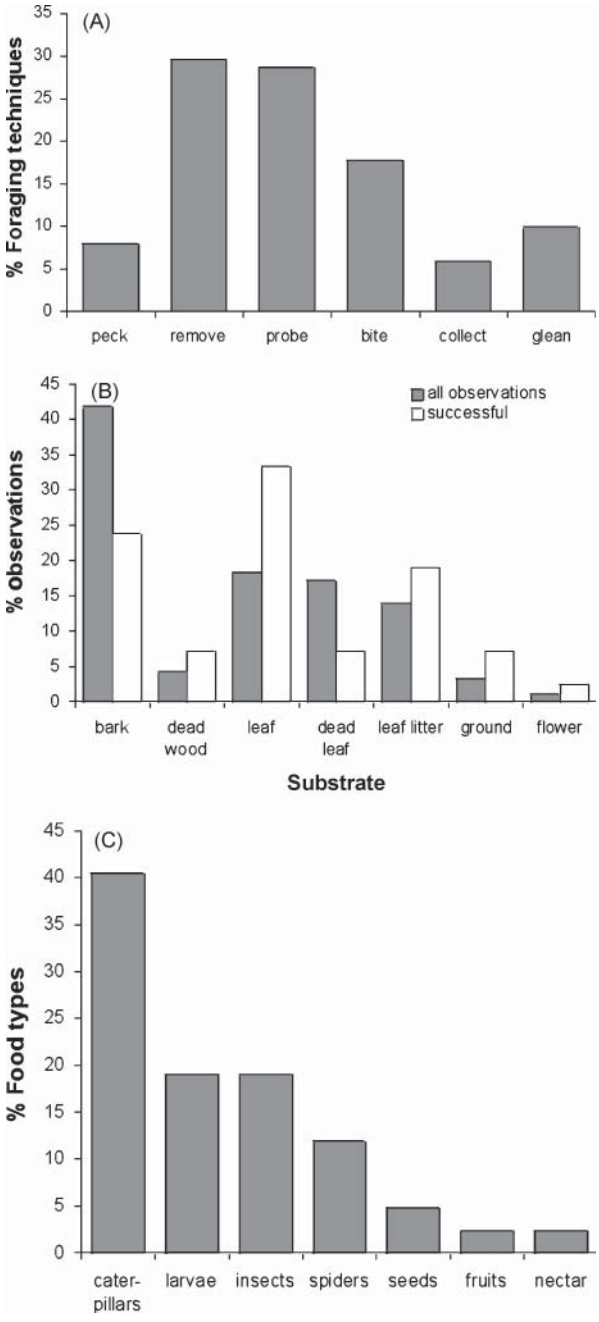

Fig. 3 The feeding behaviour of mangrove finches at Playa Tortuga Negra: (A) foraging techniques ($n = 101$), (B) substrates used ($n = 93$ for all observations and $n = 42$ for successful foraging), and (C) food types obtained ($n = 42$).

finches also responded to playback of songs, but as the deviating mangrove finch song did not resemble that of any other species it is unlikely that it resulted from misimprinting of the song of another species. These mangrove finches are most likely a remnant of a once larger breeding population. We were neither able to confirm the presence of the species in two other formerly occupied sites in western Isabela (last recorded in 1899; Snodgrass

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& Heller, 1904) nor at any of the other remaining mangrove stands surveyed.

As most counts were made from the margins of the forest the interior of large stands was not covered, and we could therefore have missed some mangrove finches. In 1997 spontaneous song activity of the birds discovered on the south-eastern coast was low compared to mangrove finches in both Playa Tortuga Negra and Caleta Black but they were nevertheless responsive to playback. All areas on Isabela, except one, were surveyed at least once during the breeding season (one area west of Bahía Elisabeth, which was not accessible in January 1998, still needs to be visited). Even if most birds in a denser population were vocally inactive, we would probably have detected some birds using song playback. It is therefore unlikely that any large breeding population escaped our attention. However, we cannot exclude the possibility that other small groups of birds, such as that in sub-area 6 on the south-eastern coast, still exist.

Our results indicate which habitat parameters may be relevant for mangrove finches, but cannot completely explain their presence or absence in certain areas, or why they have disappeared from sites where they occurred in the past. Caleta Black and Playa Tortuga Negra have a markedly different vegetation structure compared to all other mangrove forests on Isabela. Tree height and cover of leaf litter were higher, and canopy cover lower (Table 2). Sub-area 6 in the south-east does not, however, differ markedly in vegetation structure from the surrounding areas where mangrove finches do not occur, and separation from the sea is the only parameter that is significantly different between sites with and without observations of mangrove finches in this area. Mangrove stands separated from the sea accumulate more leaf litter on the forest floor and have significantly more dead wood. Our data show that in Playa Tortuga Negra dead wood and leaf litter were two of the most important feeding substrates, where the birds obtained 30% (dead wood) and 19% (leaf litter) of their food.

At Playa Tortuga Negra and Caleta Black a comparison between census points with and without records of mangrove finches showed a significant relationship between the presence of birds and a combined tree height/dead wood parameter. Mangrove finches seem to prefer high trees for nesting (H. Vargas, pers. obs.) and dead wood is an important source of insects.

Our data, from comparison within mangrove finch areas and between areas with and without mangrove finches, indicate that tall stands of forest separated from the sea, with abundant dead wood and leaf litter, seem to be the preferred habitat for the species. Snodgrass & Heller (1904), the first people to see the species, recognized that breeding sites of mangrove finches had no visible connection to the ocean and fill up with water only during high tide. Most mangrove forests on the south-eastern, southern and western coast of Isabela are directly connected to the open sea and do not offer this type of habitat, and the evidence suggests that these forests are sub-optimal habitat for mangrove finches.

The Galápagos Islands are an active area geologically and uplift of whole sections of the coastline occurs. Such events can cause the destruction of stands of mangrove forests or at least alter their structure, and this must have an impact on mangrove finches living there. For example, Plate 24 in Grant (1986) shows several larger stands of mangrove forest in the south of Cerro Ballena on the south-eastern coast of Isabela Island. This picture was probably taken in 1974 or 1975, when these sites were surveyed (Grant & Grant, 1997). Twenty years later, the area (sub-area 8 in Fig. 1) is considerably smaller than shown on the Plate. It is likely that the amount and quality of habitat suitable for mangrove finches changes frequently over the centuries. Even if other low-density populations are discovered in future surveys, the mangrove finch currently has one of the smallest breeding areas of any species of bird. Any negative impact on the currently occupied habitat, either from natural causes such as uplift or from human impact, could lead to the extinction of the species.

Although both Playa Tortuga Negra and Caleta Black are protected by the Galápagos National Park, there is a need to implement stricter conservation measures such as the investigation and control of introduced pest species that could have an impact on the mangrove finches (black rat *Rattus rattus*, smooth-billed ani *Crotophaga ani*, fire ants *Wasmannia auropunctata*, and parasitic flies *Philornis downsi*) and regular patrols of the area to prevent illegal camps of sea cucumber fishers. Our future research will concentrate in these two areas and will examine the causes of population fluctuations and declines in this species. The introduced black rat *Rattus rattus* is abundant in sites currently occupied by the mangrove finch and in other areas, and is a possible cause of the decline of the species. During periods of drought mangrove finches may be particularly vulnerable to the detrimental effects of rats or to other factors such as hybridization, inbreeding or disease. Over the next 3 years we will conduct field experiments to determine the impact of black rats, taking into account the effects of droughts.

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