Measurements and movements of Madagascar Teal *Anas bernieri* captured and ringed at Lake Antsamaka in central-western Madagascar

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Abstract

Madagascar Teal *Anas bernieri* were captured at Lake Antsamaka, central-western Madagascar, during the species' annual wing moult to test whether the sexes could be differentiated on morphometrics and report on a little-known species. A total of 345 birds were caught, measured and ringed over a 13 year period (1997–2009), of which 73 were recaptured. Males and females did not differ significantly in body mass; for other body measurements (tarsus, culmen and skull) males were significantly larger. Body mass did not change significantly with wing length for moulting birds re-growing their feathers, implying an adequate food supply to maintain mass during moult at the site. Wing length increased linearly at a rate of 5.72 mm/day in individuals recaptured 1–8 days after first being caught, indicative of feather growth over this period, with growth rates stabilising and diminishing thereafter. One adult female (aged at least 2 years) was caught eight years after first capture, indicating that Madagascar Teal can reach an age of at least 10 years in the wild. Individuals caught and ringed during moult moved up to *c.* 200 km from the ringing site. Declines in numbers moulting at Lake Antsamaka during our study were linked to water depth at the site, which is in turn apparently linked to annual precipitation. Conservation of this species requires protection of the population in several watersheds and at moulting sites where it is very vulnerable to disturbance, capture for food by local people and predation.

Key words: biometrics, longevity, Madagascar Teal, ringing.

The Madagascar Teal *Anas bernieri* is a little-known species of Anatidae, endemic to Madagascar, with a range limited principally to the western coastal wetlands between the Mangoky Delta and Antsiranana and also the extreme northeast of the country (Safford & Hawkins in press). Prior to 1990, it was known to occur only in the

Manambolomaty Delta wetlands of the Antsalova region of Madagascar, where the population was estimated at 100–500 birds in 1993 (Safford 1993). The species was not included in the IUCN red data book before 1986, but was listed as "Vulnerable" from 1986–2000 (Green 1996; Collar & Stuart 1985). Madagascar Teal have been observed only on shallow fresh and brackish water, including marshes, river mouths, small lakes, estuaries and mangroves at around sea level (Morris & Hawkins 1998). It is thought that they may move only a few kilometres between nesting, moulting and dry-season sites (Young 2006). The most recent population estimate is of just 1,500–2,500 birds (Delany & Scott 2006) and the species is now classified as "Endangered" (BirdLife International 2012).

As with all Anatidae species, Madagascar Teal typically regrow flight feathers (especially the primary and secondary wing feathers) after the breeding season, becoming flightless for at least two weeks at this time. In common with close relatives such as the Grey Teal *Anas gracilis*, both members of the pair accompany the brood after hatching (Young *et al.* 1998). Madagascar Teal ducklings fledge in *c.* 45–49 days, and the adults moult following departure of the young (Young 2006). The breeding sites become dry at the start of Madagascar's west coast dry season (April–December), when young teal move to dry season refugia and the adults to safe moult sites such as Lake Antsamaka before also transferring to the refugia (Young 2006). Birds have been captured at one moulting site, Lake Antsamaka in central-western Madagascar, since the late 1990s to improve knowledge on the species' ecology and individual movements. All caught birds are ringed, measured and weighed, with rainfall and lake depth also being recorded. This paper aims to: 1) increase the information available on body measurements for non-captive Madagascar Teal (including feather growth rates), 2) investigate whether the birds' body mass varies with moult stage, 3) describe for the first time the dispersal of individual birds after moulting, and 4) provide preliminary information on the birds' life-span in the wild.

Study site

Lake Antsamaka, in the Antsalova district of central-western Madagascar (19°02'S, 44°22'E; Fig. 1) is part of the larger Manambolomaty Ramsar site. It is shallow and saline, *c.* 7m above sea level, with an area of *c.* 174 ha in the wet season. The lake is ephemeral, typically without standing water from October–December inclusive, but may become dry much earlier (from July), depending on the amount of rainfall in the area and also on the extent of flooding from River Manambolomaty. Lake vegetation is dominated by water lilies *Nymphea stellata*, *N. lotus* and *Logorosipho madaggascariensis*, with patches of Purple Nutsedge *Cyperus rotundus* and rushes *Juncus* sp. The lake is an important habitat for waterbirds in central-western Madagascar, and two endangered duck species – the Madagascar Teal and the White-backed Duck *Thalassornis leuconotus insularis* – occur at the site (Woolaver & Nichols 2006).

Methods

Since 1997, regular attempts have been made to catch Madagascar Teal at Lake

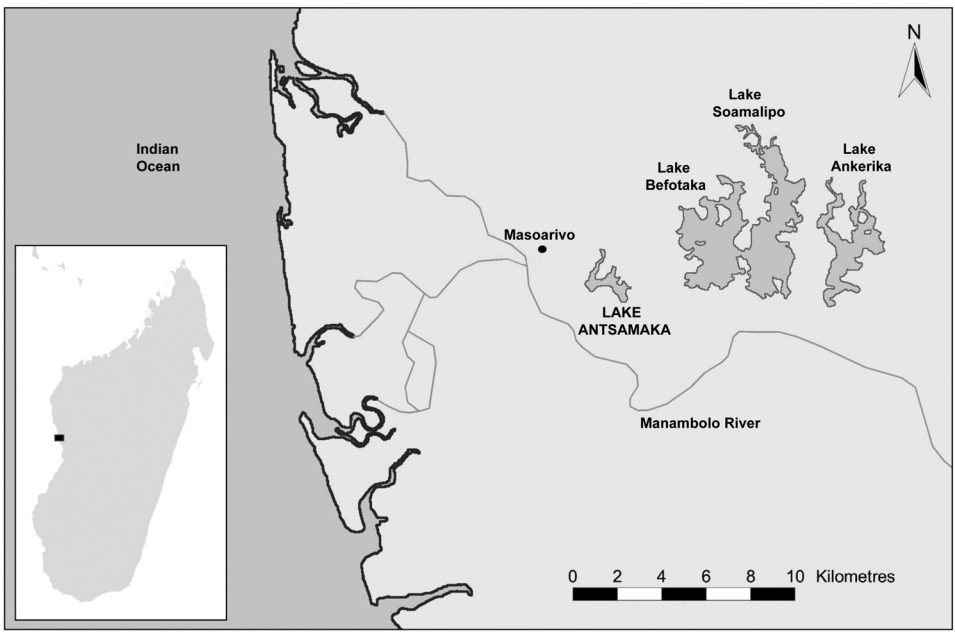

Figure 1. Location of the Madagascar Teal ringing site, Lake Antsamaka, in Madagascar.

Antsamaka during the moulting period (mid-April to mid-June), although in some years the lake dried early and the birds departed. In the first two years, the birds were caught using nets 6 m long and 2 m wide, placed in the lake with a support at each end and with the bottom 50 cm of the net submerged. Moulting ducks were pushed slowly toward the net and corralled. In subsequent years the catching technique was changed and ducks were pushed toward the vegetated edge of the lake. Once out of the water the ducks hid under the vegetation where they remained motionless and were easily caught by hand. For each bird captured a variety of measurements were taken including skull length (mm; from top of the head to tip of the bill); culmen (mm; from the un-feathered base of the bill to its tip), tarso-metatarsus (mm; from the tarsal joint to the base of foot) and body mass (to the nearest 1.0 g). Wing length (to the nearest mm; from carpal joint to the end of longest primary feather) was also recorded to determine the stage of the moult. Finally, birds were ringed with coloured plastic rings fitted to one leg and a numbered metal ring fitted to the other leg. The metal rings were all provided by The Société Jersiaise in Jersey through the Durrell Wildlife Conservation Trust. It is not possible to sex Madagascar Teal by external characters and, as field workers were not trained in cloacal sexing, this was not undertaken to avoid undue stress to the birds. The sexes differ in their calls,

however, with males having multi-syllabic whistles and females a harsh, croaking quack (Young 2005; Safford & Hawkins in press) and this was noted for each bird on release after ringing. Sex was not assigned for those birds that did not call on release. The birds were all adults and considered to be at least 2 years old because wing moult does not occur until at least one year old (*i.e.* after the first breeding attempt) and Madagascar Teal do not breed at the Lake Antsamaka moulting site.

Rainfall and lake depth were recorded at Lake Antsamaka from 2000–2009 inclusive. A rain gauge, installed and placed 1 m above the ground, was read at 07:00 h each day throughout the year. Lake depth was monitored by weekly readings of water levels on a wooden post (marked at 1 cm intervals) installed in the lake. An annual count of teal was conducted each July across all areas of open water in the study area: three main lakes and 3–6 small ponds among the mangroves, depending on drought. The counts were coordinated (made near-simultaneously) at all sites by field workers using binoculars and spotting scopes. Differences between males and females for each of the body size measures (body mass, tarsus, culmen and skull length) were analysed using Mann-Whitney U tests. Spearman's rank correlations assessed whether there was a trend in the numbers of birds: 1) counted, and 2) captured over time, and also tested for an association between the depth of the lake and the number of birds counted and caught. Linear regression analysis was used to determine changes in wing length (indicative of feather growth) between initial capture and recapture.

Results

A total of 345 individuals was caught between 1997 and 2009, of which 73 were recaptured in subsequent years (Table 1). The number of birds caught was very low during the first year because the capture session was too late in the season compared to the moulting period. Numbers caught were higher in years 2, 3 and 4 but decreased and fluctuated thereafter; no individuals were caught in 2006, 2008 and 2009 (Table 1). There was no correlation between number of individuals captured and number of individuals counted (r_S = 0.46, n = 13, P = 0.15, n.s.), but there was a significant decline over time both in the number of individuals caught (r_S = –0.66, n = 13, P = 0.01) and in the numbers counted each year (r_S = –0.64, n = 13, P = 0.04; Fig. 2). The sex ratio of captured birds which vocalised on release was 1.8 males to each female (n = 210); 135 (39%) of the 345 birds caught did not call. The maximum interval between capture and recapture was eight years, for a teal originally ringed as an adult (*i.e.* at least 2 years old) in 1999 and recaptured in 2007.

Biometrics data recorded for 119 male and 64 female Madagascar Teal during the moulting period are presented in Table 2. Although males were marginally heavier than females, sex differences in body mass were not statistically significant (U = 3205.5, P = 0.07, n.s.). Other measurements did differ significantly, with males having longer tarsus (U = 2270, P < 0.001), culmen (U = 1780, P < 0.001) and skull lengths (U = 1223, P < 0.001) than females, albeit that there was substantial overlap in the

Table 1: Number of individual Madagascar Teal caught, ringed and recaptured from 1997–2009.

Year first ringed	No. ringed	No. recaptured in each year											
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1997	15	3	13	–	–	–	–	–	–	–	–	–	–
1998	89	–	19	4	–	–	–	–	–	–	–	–	–
1999	66	–	–	20	–	–	5	3	–	–	1	–	–
2000	94	–	–	–	–	–	3	2	–	–	–	–	–
2001	7	–	–	–	–	1	–	–	–	–	–	–	–
2002	3	–	–	–	–	–	–	–	–	–	–	–	–
2003	26	–	–	–	–	–	–	3	1	–	3	–	–
2004	27	–	–	–	–	–	–	–	–	–	2	–	–
2005	6	–	–	–	–	–	–	–	–	–	1	–	–
2006	0	–	–	–	–	–	–	–	–	–	–	–	–
2007	12	–	–	–	–	–	–	–	–	–	–	–	–
2008	0	–	–	–	–	–	–	–	–	–	–	–	–
2009	0	–	–	–	–	–	–	–	–	–	–	–	–
TOTAL	345	3	21	24	0	1	8	8	1	0	7	0	0

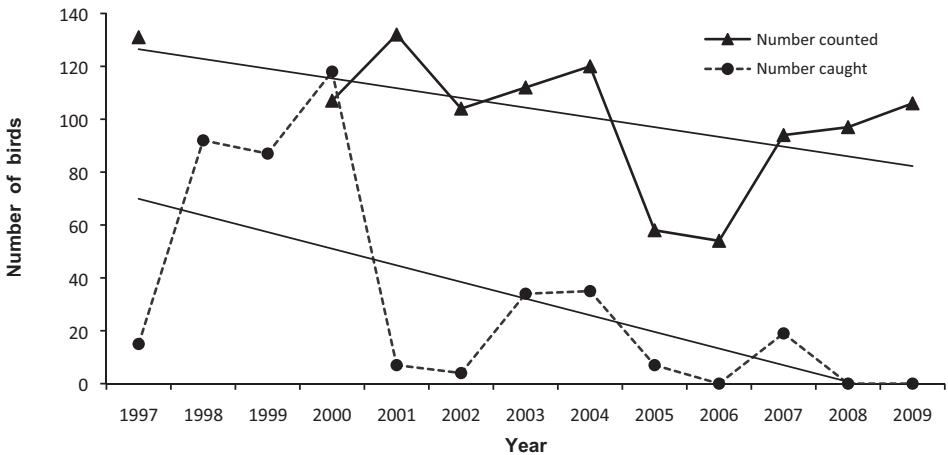

Figure 2. The number of individual Madagascar Teal caught each year at Lake Antsamaka, and the maximum annual count at the site.

ranges recorded for each sex (Table 2). For 27 birds caught twice which were re-growing their feathers, wing length (including primary length) correlated significantly with the duration between catches ($r_s = 0.428$, $n = 27$, $P = 0.006$). Wing length increased linearly at a rate of 5.72 mm/day in individuals recaptured 1–8 days after first being caught (linear regression: $R^2 = 0.75$, $t_{1,20} = 8.33$, $P < 0.01$), indicative of feather growth over this period, with growth rates stabilising and diminishing thereafter (Fig. 3). Body mass recorded for birds caught for the first time in a season (*i.e.* omitting birds that might have lost mass because of capture a few days earlier) appeared to be higher towards the end of the moult (indicated by longer wing lengths, for birds known from subsequent capture to be re-growing their feathers) but

Table 2. Measurements and weight of Madagascar Teal during moult.

	Male	**Female**
	$n = 119$	$n = 64$
Body mass (g)	378 ± 36 (290–490)	368 ± 34 (300–450)
Wing (mm)	129 ± 25 (80–210)	117 ± 28 (82–205)
Tarsus (mm)	46 ± 2 (41–50)	45 ± 2 (41–95)
Culmen (mm)	38 ± 3 (34–49)	36 ± 2 (32–48)
Skull (mm)	82 ± 2 (77–90)	79 ± 3 (75–90)

the correlation between mass and wing length did not prove statistically significant ($R^2 = 0.29$, $t_{1,25} = 1.86$, $P = 0.08$, n.s.; Fig. 4).

Annual rainfall ranged from 44 cm (in 2005) to 329 cm (in 2004), with mean of 109 cm over the years 2000–2009. The lake depth varied between 240 cm in 2004, corresponding with the period of highest rainfall, and 50 cm (in 2006 and 2009). Lake depth was positively correlated with the number of teal captured across years ($r_S = 0.77$, $n = 10$, $P = 0.009$).

Four individuals ringed during the study were re-sighted and two recovered elsewhere in Madagascar. All observations were at coastal locations (Fig. 5). Two birds were caught in fishing nets at Bemia Lake (30 km from the study area) and two were seen at Lake Bedo during a waterbird survey in the Menabe central coastal wetlands, about 100 km south of the ringing site. One bird was killed by hunters at Lake Bedo and a second by local people at Behoria, 200 km north of Lake Antsamaka.

Discussion

The number of individuals captured fluctuated among years during our study, but declined overall. This decrease may be partly but not totally related to a decline in the overall number of Madagascar Teal at the site, as there was no significant correlation between the number of individuals captured and the number of individuals counted. Fewer birds were caught in years when the lake was shallower, which suggests that

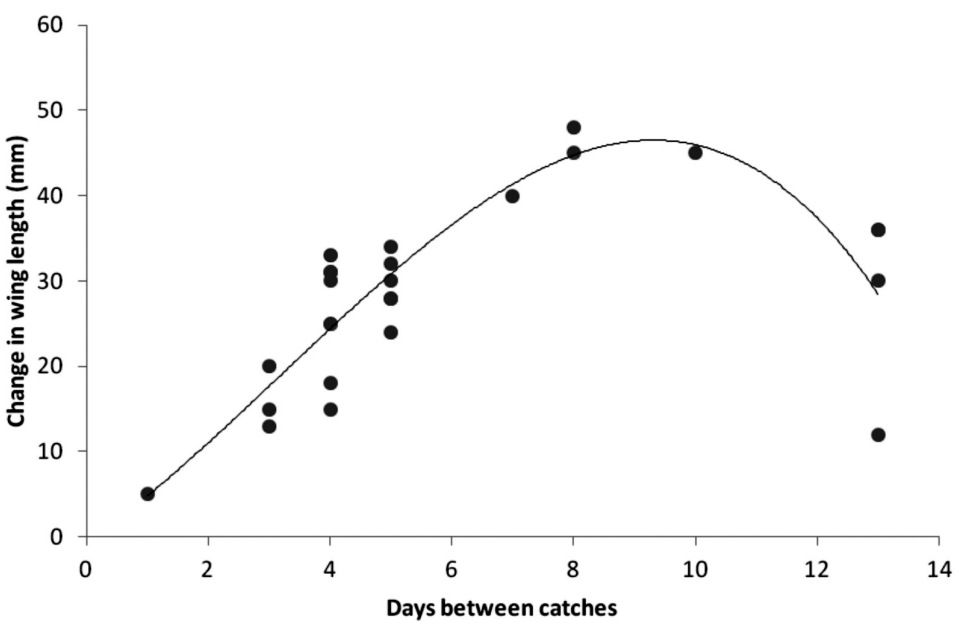

Figure 3. Increase in wing length (reflecting increase in feather length) recorded for individual Madagascar Teal captured and recaptured within a moulting season.

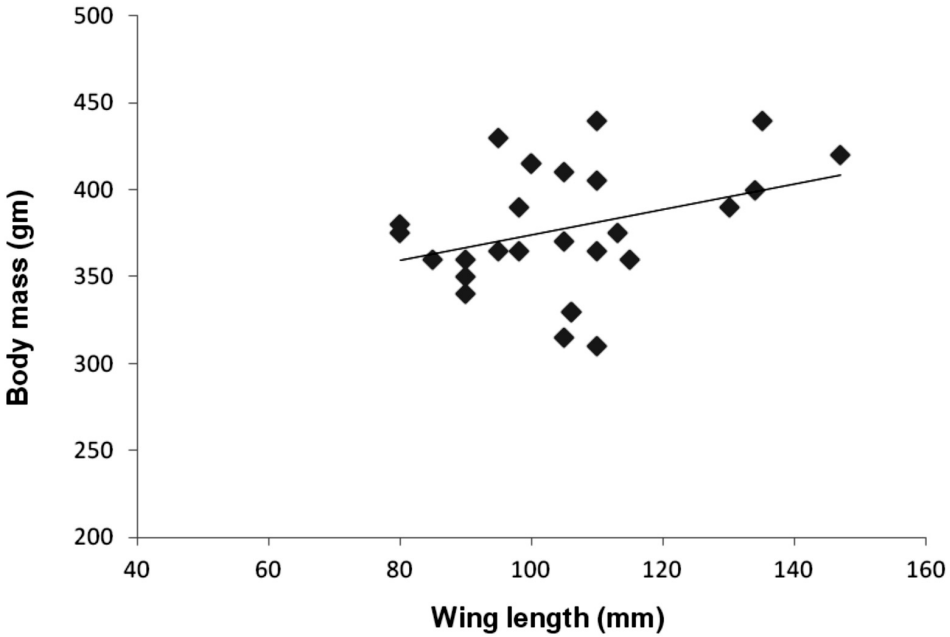

Figure 4. Madagascar Teal body mass in relation to moult stage, indicated by wing length. Measurements are for first capture dates, for birds re-growing their feathers.

variation in lake depth may influence ability to catch teal moulting at Lake Antsamaka. It is also possible, however, that the decline in numbers counted and caught over time is due to birds using other sites to moult, due to human disturbance at the lake. The reduced catching success therefore may be due to a combination of several factors including the lake depth, vegetation cover which serves to ensure flightless ducks' safety (the extent of vegetation was not specifically recorded at site, but was consistent with lake depth in that emergent vegetation suitable for cover disappears as the lake dries) and human disturbance including capture effects. As of 2010, we have stopped the catching and ringing programme for five years while continuing to monitor the number of moulting birds at Lake Antsamaka. This will help to clarify the reason for the decline in the number of teal moulting in the site.

Like their close relative the Grey Teal (Marchant & Higgins 1990), male and female Madagascar Teal are similar in body mass; males are larger on average, but there is substantial overlap in the range of measures recorded (Safford & Hawkins in press). For the other body size measures considered here, males were significantly larger than females, but again there was substantial overlap in the ranges. Madagascar Teal therefore does not seem to show a large degree of sexual dimorphism, and consequently it seems that body size cannot be used to identify males and females reliably in the field.

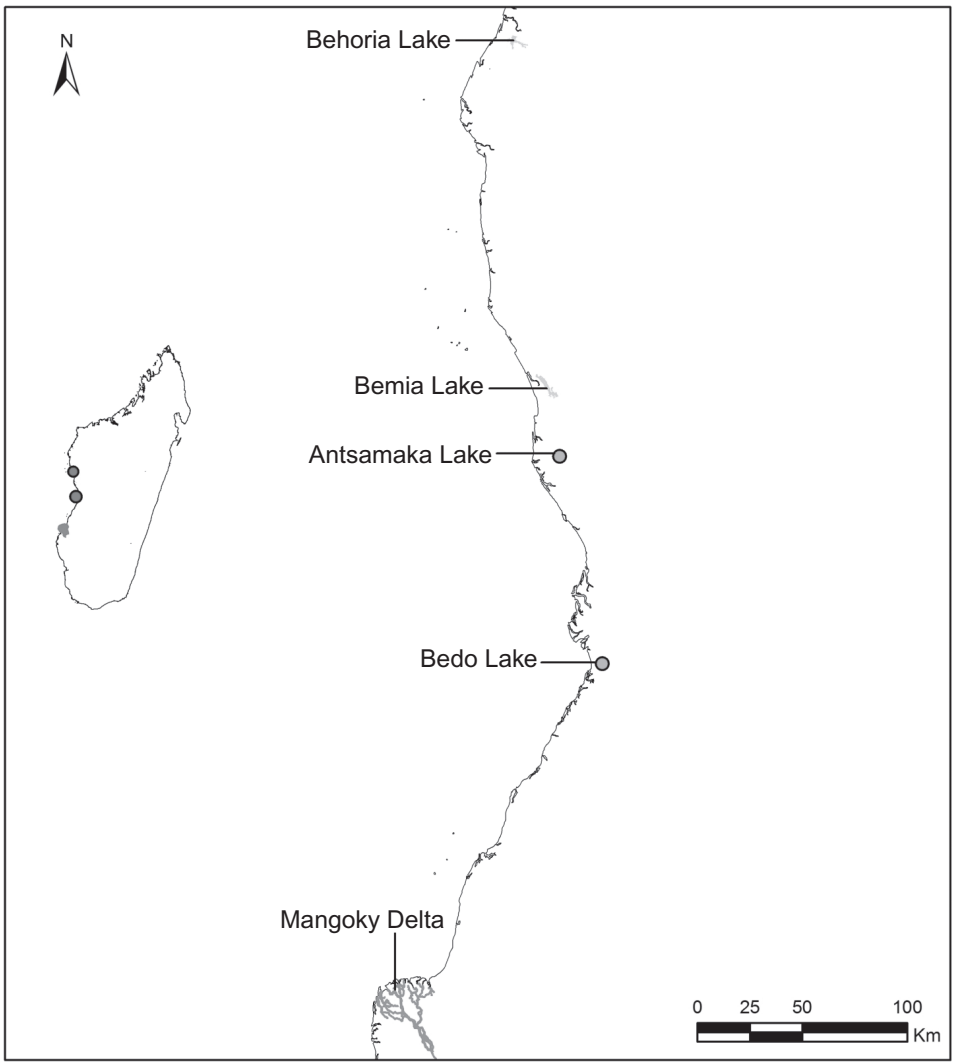

Figure 5. Sites where ringed Madagascar Teal were re-sighted, along the coast of western Madagascar.

An individual female was recaptured in 2007, eight years after first being caught. As birds of ≤ 1 year are thought not to occur at Lake Antsamaka, and captured birds therefore were at least two years old on ringing, it seems that Madagascar Teal can reach at least 10 years of age in the wild. Additionally, one male caught in the wild in 1993 lived until 2004 (aged 13 years) in captivity (Young *in litt.*), indicating that both wild and captive Madagascar Teal can have long life-spans. The sex ratio recorded for Madagascar Teal

moulting at Lake Antsamaka (that called during handling and could be sexed) was 1.8 : 1, with males being nearly twice as numerous as females. Sex ratios may vary within a species' range; for instance, if males compete with females for food resources in the non-breeding season or smaller-bodied females require a more temperate climate (Owen & Dix 1986; Carbone & Owen 1995). Given that sex was determined by the birds' calls, however, and that 135 (39%) of the 345 birds caught did not call, cloacal sexing should be undertaken for Madagascar Teal at Lake Antsamaka to determine whether the apparent preponderance of males is attributable to males being more likely than females to vocalise on release.

Primary feather growth rates of 5.8 mm/day are similar to those of Mallard (5.5–6.7 mm/day; Panek & Majewski 1990) and the similarly sized Teal *Anas crecca* (4.8 mm/day; Sjöberg 1988) in Europe. However, unlike many dabbling duck species in Europe (*e.g.* King & Fox 2012) and in Africa (*e.g.* Ndlovu *et al.* 2011), Madagascar Teal did not lose mass during wing moult, suggesting that Lake Antasmaka not only provides a safe refuge from potential predators during the flightless period, but that it also supplies sufficient sources of exogenous energy to meet the energy demands of individuals throughout the moult.

Sightings of ringed individuals indicate that Madagascar Teal can move at least 220 km from their moult site; the furthest distance between re-sighted birds was > 400 km within *c.* 1,500 km of Madagascar coastline with wetlands potentially suitable for the birds. These sightings suggest that the teal disperse between different breeding areas and that individuals may travel over large annual ranges. Lake Antsamaka is an important moulting site for Madagascar Teal, but after the moult some birds move to other areas. These results indicate that long-distance movements occur, possibly due to the birds taking advantage of differing conditions between watersheds. The fluctuation in numbers recorded moulting at Lake Antsamaka also suggests that Madagascar Teal use of a site is not stable; for instance, teal may be forced to move to other sites when Lake Antsamaka is too dry. Ensuring the future survival of the endangered Madagascar Teal therefore requires conservation of wetlands across several watersheds, including the shallow, well-vegetated inland wetlands used during the moult.

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