Assessing effectiveness of reintroduction of the flightless Aldabra rail on Picard Island, Aldabra Atoll, Seychelles

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SUMMARY

The global range of the Aldabra white-throated rail *Dryolimnas cuvieri aldabranus*, the last surviving flightless bird in the Indian Ocean, was restricted to only three islands of Aldabra Atoll in 1998. It was extirpated on the islands of Grand Terre (before the late 1800s) and Picard (soon after 1910), mainly due to the introduction of feral cats by early settlers. In 1999, following the eradication of cats from Picard, 18 Aldabra rails were successfully reintroduced. After the reintroduction, population growth of the Aldabra rail on Picard was predicted to continue to approximately 1,000 pairs by 2010. In this paper, we report on the long-term effectiveness of the reintroduction by updating the Aldabra rail population estimate on Picard 12 years after the translocation and one year after the predicted maximum was expected to be reached. We confirm the predicted carrying capacity on Picard has been reached and probably exceeded; report a reliable survey method for the Aldabra rail, which can be applied to other terrestrial bird species; and recommend subsequent monitoring and conservation management strategies for the Aldabra rail and potentially other species of rail.

BACKGROUND

Reintroductions are an important conservation tool, particularly on islands, to restore populations of native species within their former range. The rail family (Rallidae) is particularly vulnerable to anthropogenic interference and introduced predators and has suffered more extinctions on islands than any other bird family. On the Pacific islands alone, 17 species of island rail have gone extinct since 1600 (Donlan *et al.* 2007). In the Indian Ocean, two *Aphanapteryx* rail species from Mauritius and Rodrigues have become extinct, as well as the Malagasy endemic rail genus *Dryolimnas* that formerly had a representative species on Réunion. The white-throated rail *Dryolimnas cuvieri* is the only surviving representative of this genus, with two subspecies; *D. cuvieri aldabranus* occurring on Aldabra Atoll in the southern Seychelles (Fig. 1), and *D. cuvieri cuvieri* occurring on Madagascar. Other populations of *D. cuvieri* also existed, but have been extirpated from all islands of the Aldabra group with the exception of Aldabra Atoll itself (Rand 1936, Rountree *et al.* 1952, Benson 1967, Cowles 1987, Mourer-Chauviré *et al.* 1999): *D. cuvieri abbotti* became extinct on Assumption by 1937 and *D. cuvieri* ssp. was last recorded on Astove and Cosmoledo in 1908 (Benson 1967, Collar 1993, Skerrett *et al.* 2001). *Dryolimnas cuvieri cuvieri* is able to fly, and as such *D. cuvieri aldabranus* is recognised as the last surviving flightless bird in the Indian Ocean (Penny & Diamond 1971, Skerrett *et al.* 2001). Since there are no Aldabra rails in captivity, the smaller islands of Aldabra now host the only remaining population of *D. cuvieri aldabranus.*

Until 1999, *D. cuvieri aldabranus* survived on only three islands of Aldabra: Malabar, Polymnie and Île aux Cèdres (Fig. 1A). It was extirpated from the islands of Grand Terre (before the late 1800s) and Picard (soon after 1910) due to human interference and the concomitant introduction of feral cats *Felis catus* (still present on Grande Terre; Abbott 1893, Penny & Diamond 1971, Hockey *et al*. 2011). To provide an additional safeguard population, and to boost the total population size, 18 birds (eight males, 10 females) from the Malabar population were translocated and released on the island of Picard in 1999. Rails were kept in large cages close to suitable habitat, fed and monitored until they were acclimatised and released after 6–14 days (Wanless *et al.* 2002). The reintroduction was considered to be successful shortly afterwards (Wanless *et al.* 2002), and population growth modelling indicated that the Picard rail population would reach a carrying capacity of approximately 1,000 breeding pairs within 10 years, thereby increasing the total Aldabra population to 8,000–10,000 breeding pairs (Wanless 2002, Hockey *et al.* 2011).

Aldabra (9°24′ S, 46°20′ E) in the Seychelles archipelago, is a large (34 × 14.5 km) raised coralline atoll consisting of a rim of four main islands (Picard, Polymnie, Malabar and Grande Terre; Fig. 1) with a total land area of approximately 152.5 km^2 (Seychelles Islands Foundation, Unpubl. data). Aldabra has been strictly protected since 1976, was inscribed on the UNESCO World Heritage list in 1982 and has been managed entirely for research and conservation since 1979 by the Seychelles Islands Foundation.

ACTION

To assess the long-term effectiveness of the reintroduction and verify this prediction, we surveyed Picard's rails 12 years after the translocation. Our aims were to determine the rail population size on Picard; confirm whether the predicted carrying capacity has been reached or exceeded; and develop a survey method that can be repeated for the Aldabra rail and potentially other territorial ground-nesting birds in dense vegetation.

The rail survey was carried out on the island of Picard (approximately 9.4 km^2) at the beginning of the breeding season, between 31 October and 28 November 2011. Five straight-line transects of 650–1,000 m in length (covering

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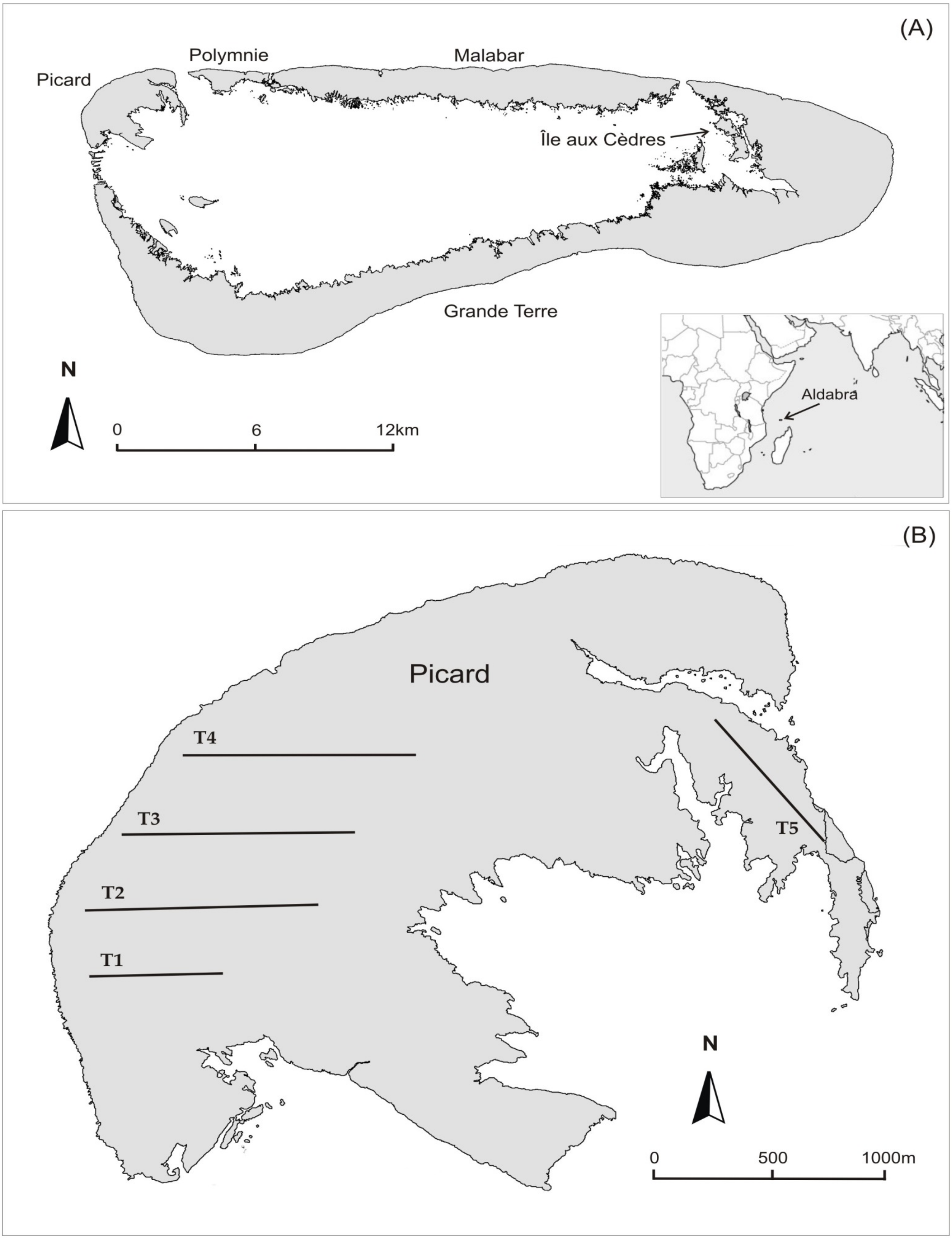

Figure 1. (A) Location of Aldabra Atoll in the Indian Ocean (inset) with the locations of Picard Island and the three islands where the Aldabra rail occurred before the reintroduction (i.e. Malabar, Polymnie and Île aux Cèdres), and (B) the locations of the five transects cut for the survey on Picard.

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4,450 m in total) were cut through the dense vegetation a few days before the start of the survey. Four transects (W–E direction) approximately 400 m apart were located in the west of Picard and one (SE–NW direction) was located in the north-east (Fig. 1B).

Aldabra rails form monogamous pairs that aggressively defend their territory year-round and vocalise with a typical duet that intensifies as the breeding season approaches (Huxley & Wilkinson 1977, Wanless & Hockey 2008). The survey technique was modified from previous studies on Aldabra rails (Hambler *et al.* 1993, Huxley 1982, Wanless 2002) and Henderson rails (Jones *et al.* 1995), and was based on the fact that territorial pairs will reveal themselves by immediately responding to playback call and investigating the 'intruder' (Wanless 2002). The survey was timed immediately before the start of egg-laying, at the peak of rail vocalisations (Wanless 2008).

In the morning (06:00–09:00 h) a playback call of a territorial pair duet was played for 5 min at points 50 m apart along the five transects. Playback volume was set to the call volume of a rail pair and fixed for the duration of the survey. The playback usually attracted a rail pair less than 2 min after starting. No individual marking was done during the survey so, to avoid double counting, detailed notes on behaviour were taken at each playback point to determine the extent of the territories (direction and estimated distance of calling pairs from playback points, direction of territorial pair arrival and departure, behaviour, other pairs in the vicinity, etc.). Multiple visits to mangrove areas, using playback, confirmed that there are no nesting/breeding rails in these areas; hence mangrove habitat was excluded from the survey.

To obtain the number of territories/ha we used a formula previously applied by Jones *et al.* (1995) for the flightless Henderson Island rail. We confirmed that the territory conditions of Aldabra rails matched those of the Henderson's rails (i.e. very dense scrub, saturated population) and therefore applied the same assumptions. The formula assumes that the territories intersected by a random straight-line transect are tightly packed, contiguous, do not overlap and are roughly hexagonal in shape:

$d = 8265.335 / L2$ where d is territories/ha and L is mean territory diameter (m).

To calculate the total number of rails on Picard, the extent of suitable habitat (excluding mangroves and pools) was calculated from a comprehensive vegetation map (Gibson & Phillipson 1983) using ImageJ Software (National Institutes of Health, Bethesda, Maryland). There is 700 ha of suitable habitat on Picard, of which approximately 140 ha is classed as 'mixed scrub' and 560 ha as 'Pemphis' (i.e. *Pemphis acidula,* a shrub covering large parts of Aldabra forming a dense vegetation structure; Gibson & Phillipson 1983). These two vegetation types were pooled, and the transects were positioned in such a way that they crossed the gradient of these two vegetation types, starting approximately 200 m from the coast going towards the lagoon in a straight line.

The rail population includes non-breeding adults without territories ('floaters'). Due to their high mobility our survey method is not suitable for estimating the number of floaters. Furthermore, without long-term observations or individual marking they are difficult to identify. Therefore we calculated their numbers using an estimate by Wanless (2002) which assumes one floater per two territories if the population on Picard is saturated.

CONSEQUENCES

The length (diameter) of rail territories recorded along individual transects was 67–83 m (average across all transects: 72 m) with average territory area 0.63 ha (or 1.6 territories/ha). From this, the total number of territories on Picard accounting for suitable habitat was estimated to be 1,106 territories (range: 840–1,288) plus 553 floaters (range: 420–644), resulting in a total of approximately 2,765 adults (range: 2,100–3,220). Average territory diameter on Picard in the present study (72 m) is comparable to previous studies on Malabar and Polymnie using similar methods (70–87 m: Huxley 1982; 70 m: Hambler 1993; 67–72 m: Wanless 2002). Considering that habitat on Picard and Malabar is similar (Gibson & Phillipson 1983), the Picard rail population appears to be saturated as predicted by Wanless (2002) and probably exceeds the predicted estimate.

DISCUSSION

Twelve years after the translocation of 18 birds from Malabar, the Aldabra rail population on Picard has substantially increased to almost 3,000 individuals, which is well above the predicted carrying capacity and demonstrates the effectiveness of reintroduction for this species. The number of territorial pairs on Picard is approximately 10% higher than predicted (Wanless 2002). Furthermore, our estimate is based on a conservative floater ratio of one per two territories (Wanless *et al.* 2002), while Hockey *et al.* (2011) based their population model on one floater per one territory, which, if applied to our results, would further increase the estimate.

In estimating the size of the saturated population on Picard, Wanless (2002) extrapolated the vegetation classification and rail densities on Malabar and Polymnie applied by Huxley in 1982. On Malabar, Huxley (1982) recorded the Aldabra rail density to be twice as high in Pemphis than in dense mixed scrub. During our survey on Picard it also appeared that rail density was higher in areas where Pemphis was dominant (>50% coverage). However, we chose not to present these two vegetation types separately since they are not always clearly distinct and transition between them is gradual and complex (Gibson & Phillipson 1983; pers. obs.).

Assuming that previous estimates for Malabar and Polymnie still stand, we estimate that the present Aldabra rail population consists of approximately 10,000 breeding pairs on the whole atoll. While Aldabra's status as a World Heritage site secures its immediate protection, the Aldabra rail remains confined to only four islands, with a total suitable habitat area of 30–35 km^2 and could be seriously threatened by the accidental introduction of a non-native predator or novel pathogen. For example, an accidental introduction of cats to Malabar, which currently holds the largest Aldabra rail population, would potentially cause rail extinction on this island within 20 years (Hockey *et al.* 2011).

Protection alone does not prevent potential threats from e.g. accidental introductions of alien species, novel pathogen transmission or the effects of sea level rise, which are predicted to be severe for islands (Wetzel *et al.* 2013). We therefore recommend the following three conservation measures for the

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Aldabra rail: (1) the total population should be regularly monitored at 5 year intervals, using the methodology described here. More frequent monitoring should be unnecessary unless there is a suspected population decline, in which case the survey should be done immediately; (2) eradication of cats from Grand Terre and other suitable islands in the rail's former range should be investigated and, if feasible, implemented. The presence of cats is the main barrier against reintroducing rails to Grand Terre, which would free up an additional area of 112 km^2; and (3) reintroductions (using soft-release techniques) of Aldabra rails to other islands in the Aldabra group (Assumption, Astove and Cosmoledo) should be considered following introduced predator eradications. In parallel with these conservation measures, genetic research should be used to confirm the taxonomic status of the Aldabra rail. Priority should be given to such research to both improve knowledge of the population's origins and potentially provide it with the conservation leverage it may require in the future.

Rails are particularly vulnerable to anthropogenic influences (Donlan *et al.* 2007, Johnson & Stattersfield 1990) and currently, about three-quarters of all surviving flightless rail species (15 of 20 extant flightless rail species) are globally threatened (Taylor & van Perlo 1998). Flightless island rails are particularly vulnerable due to their insular evolution in the absence of humans and predators (Steadman 1995, Taylor & van Perlo 1998). The Aldabra rail was also nearly lost, disappearing from most of its former range due to human activities; the sub-species has been temporarily safe-guarded by its reintroduction to Picard and subsequent population increase, combined with strict protection of Aldabra. No post-reintroduction management interventions, such as supplementary feeding or reproductive manipulation, were applied to enhance population growth, indicating that the Aldabra rail is capable of colonising and adapting well to new areas, providing the habitat is similar and predators are absent. This is an important and encouraging outcome, both for future translocations of Aldabra rails to different islands within the region to re-establish their former range, and for other island species of rail to areas where they have become locally extinct.

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