LESSER NODDY *ANOUS TENUIROSTRIS* MIGRATION FROM A NON-BREEDING AREA IN THE NORTHERN MALDIVES TO A BREEDING SITE IN THE SEYCHELLES

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ABSTRACT

ALI, A.F., PHILLIPS, R.A. & ANDERSON, R.C. 2023. Lesser Noddy *Anous tenuirostris* migration from a non-breeding area in the northern Maldives to a breeding site in the Seychelles. *Marine Ornithology* 51: 181–185.

The Lesser Noddy *Anous tenuirostris* occurs in large numbers in the northern Maldives during the northeast monsoon season (December to April). These birds do not breed in the Maldives, but their breeding site(s) are unknown. We attached GPS Argos satellite transmitters to seven Lesser Noddies roosting on Gallandhoo Island (Haa Alifu Atoll, northern Maldives) on 25 March 2022. Only one transmitter provided data, but it tracked the migration of one Lesser Noddy to the Seychelles, where the bird first roosted on the island of Poivre before moving to the large nesting colony on Cousine. The tracked bird departed the Maldives on 02 April and arrived in the Seychelles on 10 April, covering approximately 2400 km in eight days. Our results highlight the potential benefit of enhanced cooperation and knowledge exchange between the Seychelles and Maldives for improving conservation of Lesser Noddies in the Indian Ocean.

Key words: *Anous tenuirostris*, Lesser Noddy, Maldives, satellite-tracking, Seychelles

INTRODUCTION

The Lesser Noddy *Anous tenuirostris* (Fig. 1) is a tropical tern confined to the Indian Ocean. There are two recognised subspecies: *A. t. tenuirostris* occurs across much of the western Indian Ocean, while *A. t. melanops* occurs in the far eastern Indian Ocean (Gochfeld *et al.* 2020). Within the western Indian Ocean, Lesser Noddies breed in large numbers in the Seychelles and Chagos archipelagos and in smaller numbers elsewhere (Symens 1999, Carr 2011, Skerrett & Disley 2011, Gochfield *et al.* 2020, Carr *et al.* 2021). These birds disperse within the region during non-breeding periods. Although the details of these movements are not known, there are reports of what are presumably non-breeding Lesser Noddies at sea across a wide area, including off Aldabra, Tanzania, Kenya, Somalia, and Oman (Ash & Miskell 1998, Skerrett & Disley 2011, Eriksen & Victor 2013, Gochfield *et al.* 2020).

Fig. 1. Lesser Noddy *Anous tenuirostris*, Haa Alfiu Atoll, Maldives, 14 Feb 2023. Photo credit: Doug Koch

In the Maldives, the Lesser Noddy (local name: kurangi) is one of the most common seabirds (Shafeeg 1993, Ash & Shafeeg 1994, Anderson & Shimal 2020). However, it does not breed in the Maldives in any significant numbers, with just one historical report of breeding from Baa Atoll in the north (Gadow & Gardiner 1903) and, more recently, some unconfirmed reports of relatively few birds breeding in Huvadhoo Atoll in the south (Anderson & Shimal 2020). Nevertheless, non-breeding Lesser Noddies occur in particularly large numbers (many thousands) in the northernmost atoll of the Maldives (Ihavandhoo geographical atoll, which forms part of Haa Alifu administrative atoll) during the northeast monsoon season (December to March/April). Although well-known to local fishermen, this concentration was not reported in published literature until recently (Anderson & Baldock 2001, Anderson 2007). Based on that first report, Haa Alifu Atoll was recognised as an internationally Important Bird Area (IBA, Chan *et al.* 2004). More recently, the uninhabited island of Gallandhoo, which is the Lesser Noddy's main roosting site in Haa Alifu Atoll, has been protected by the Maldivian Ministry of Environment under iulaan (legal directive) 438-ENV/438/2019/150 of 17 June 2019.

Where these Maldivian birds breed is unknown, although Anderson & Shimal (2020) noted that the Seychelles was a possibility; the bulk of egg-laying on Aride Island (the largest breeding colony in the Seychelles) takes place during late May to late June (Ramos *et al.* 2004) soon after the noddies have left Haa Alifu

Atoll. Another possibility is the Chagos Archipelago, which is closer to Gallandhoo than the Seychelles (*ca*. 1250 km to the northernmost Chagos islands compared with *ca*. 2250 km to the nearest Seychelles islands).

The aims of this study were to use satellite-tracking technology to determine the return migration route and to reveal the breeding site(s) of the Lesser Noddies that spend their non-breeding season in Haa Alifu Atoll. The results are discussed in the context of conservation and management of Lesser Noddies in the Maldives and elsewhere in the Indian Ocean.

METHODS

GPS transmitters (PinPoint Argos 75; Lotek, Wareham, UK) were attached to seven Lesser Noddies caught with long-handled hand nets after dusk on 25 March 2022 while they roosted in *Pisonia grandis* trees on Gallandhoo Island, Haa Alifu Atoll (06°57′N, 072°59′E). This date was shortly before the expected departure of the Lesser Noddies from the Maldives. The devices were programmed to collect a single GPS fix around midday (using a five-minute timing offset for each device) every day for six days to identify foraging areas, along with a single GPS fix around midnight on day seven to identify roosting sites. The cycle would then be repeated. According to the manufacturer, once three GPS fixes are obtained, they will be transmitted using the Argos satellite system. The device has sufficient battery power to make 60 location attempts, although the birds' behaviour and signal interference can prevent GPS communication and Argos data download. Expected battery life with our settings was about two months, and we anticipated that the device would be lost when tail feathers were moulted or the tape attachment deteriorated. All the Lesser Noddies were moulting their tail feathers when captured, and the devices were attached close to the bases (but not covering the preen gland) of two to three of the four innermost tail rectrices using two strips of Tesa® tape and Loctite® Super Glue. Devices were 25 × 14 × 7 mm, and the attachment (including the tape) weighed 4.5 g or a mean 4.3% (range 3.9%–4.5%) of body mass (100–115 g). Birds were held for < 20 minutes to weigh them and deploy the devices, then released. This work was carried out under permit from the Maldivian Environmental Protection Agency (EPA; permit no. EPA/2022/PSR-SB01, issued 15 March 2022).

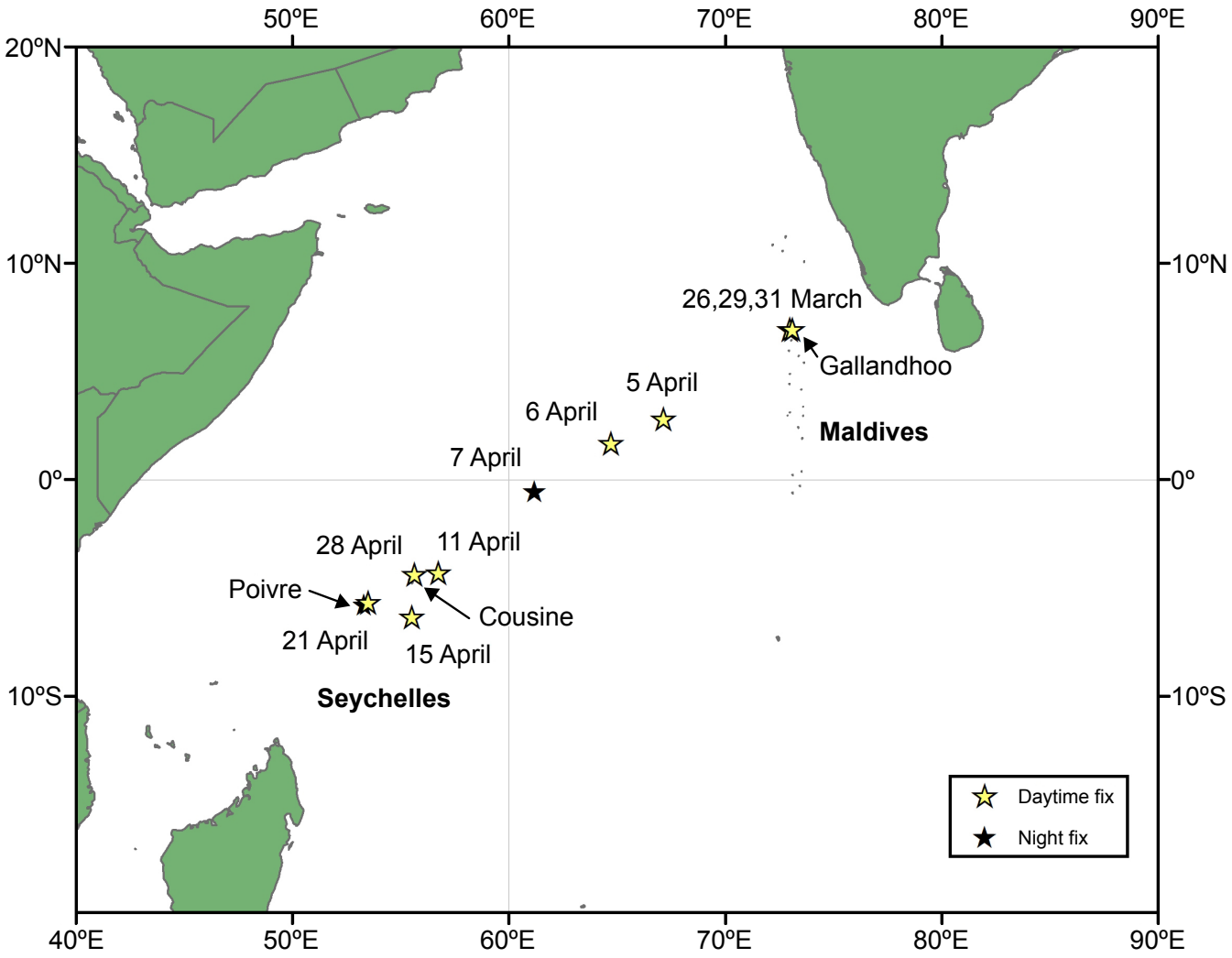

Fig. 2. Migration route of a non-breeding Lesser Noddy *Anous tenuirostris* tracked from the Maldives to roosting and breeding sites in the Seychelles in March–April 2022.

RESULTS

Valid fixes were obtained post-deployment from only one of the seven Lesser Noddies fitted with a device. Nine daytime and two night-time GPS locations, at intervals of 2–7 days and 2 weeks, respectively, were obtained from this bird between 26 March and 28 April 2022 (Fig. 2). There were three fixes at sea near Gallandhoo on 26–31 March before the bird left the Maldives on a southwest bearing. Travel speeds between daylight fixes on 05 April and 06 April (1 day), and between the daytime fix on 06 April and the night-time fix on 07 April (1.5 days) were consistent at *ca*. 300 km/d (*ca*. 12.5 km/h). Assuming direct flight at a constant speed on a constant bearing, the tracked bird would have departed the Maldives on 02 April and arrived in the Seychelles on 10 April, covering *ca*. 2400 km in 8 days. After arrival in the Seychelles, the bird roosted for at least one night on Poivre Island (21 April). Following that, there was a daytime fix a week later, on Cousine Island (28 April), with no fixes obtained in the intervening period.

DISCUSSION

Ours is the first tracking study of any seabird from the Maldives. As far as we are aware, there are only three published tracking studies of noddies elsewhere, though there are five species in the genus, all with wide breeding distributions (Maxwell *et al.* 2016, Surman *et al.* 2017, Surman *et al.* 2018). Data that we obtained, though sparse, demonstrated for the first time that at least a proportion of the non-breeding Lesser Noddies in the northern Maldives breed in the Seychelles. It is, of course, also possible that some Lesser Noddies from the northern Maldives breed elsewhere, potentially in the Chagos Archipelago. Lesser Noddies also occur seasonally in Huvadhoo Atoll in the south of Maldives in some numbers; their breeding colonies are also unknown.

In addition, our data reveal the general migration direction (southwest) and travel speed (*ca*. 300 km/d). The estimated date of return of the tracked bird (10 April) and its presence on the breeding island of Cousine on 28 April both correspond well with field observations that a few Lesser Noddies arrive on Cousine as early as the first week of April, with the majority arriving from mid- to late-April, and the first eggs are laid during the first week of June (Cousine Island conservation manager Melissa Schulze pers. comm.). Our study also indicates that Lesser Noddies in the Seychelles move between different islands for roosting. More generally, these results emphasise the advantages of enhanced cooperation and knowledge exchange between the Seychelles and Maldives for improving conservation of Lesser Noddies in the Indian Ocean.

Why the devices fitted to the other birds failed to provide data is unclear. Even for the Lesser Noddy that we tracked successfully, only 11 GPS fixes were obtained over a 34-day period. This amounts to just a third of location attempts and suggests problems with antenna orientation relative to the satellites, with GPS signal interference, or with Argos data download. The noddies were all moulting their tail rectrices when captured, and it is possible that the feathers to which the device was attached were shock-moulted, pulled out, or broken, leading to device loss in the period before the first GPS fixes would have been transmitted via the Argos system (i.e., 6 days for the bird that was tracked successfully). Transmissions were unlikely to be received from devices lost at sea, as they would likely sink, or those that drop into dense vegetation or below tree cover on land. Tail feather loss or breakage accounted for high loss rates of archival GPS devices deployed on Sooty Terns *Onychoprion fuscatus* in two previous studies (Soanes *et al.* 2015, Neumann *et al.* 2018). Finally, because the noddies are so aerial, they may have been unable to sustain the increased flight costs associated with the additional load of the device, particularly if the birds were underweight; this study was conducted during a La Niña year (see below). In contrast, data were obtained in a previous study from all 17 Lesser Noddies fitted with smaller (2 g) archival GPS devices for a few days during the breeding season, attached as in our study with tape to two central tail rectrices (Surman *et al.* 2017). We would therefore discourage researchers from deploying larger devices on back or tail feathers on similarly sized noddies or terns. Deployment using harnesses may be even more problematic than using tape, given evidence that it caused high mortality rates in several previous studies of pelagic seabirds (Phillips *et al.* 2003, Thaxter *et al.* 2016). Geolocators (Global Location Sensors) deployed at breeding colonies may be an alternative for tracking migration of small (100–120 g) noddies and terns, although device retrieval rates varied considerably across studies (Egevang *et al.* 2010, Fijn *et al.* 2013, Surman *et al.* 2018).

Our study showed that at least some of the Lesser Noddies from the Seychelles spend their non-breeding season in the Maldives. At both the Seychelles and Reunion Island, Lesser Noddies are abundant over shelf waters year-round and, until our study, there was no clear evidence that they dispersed further from their colonies in the non-breeding period (Catry *et al.* 2009). Lesser Noddies tracked with geolocators at the Houtman Abrolhos islands off western Australia were also largely resident, remaining in the general vicinity or slightly to the south of the colony in their non-breeding season (February–September, Surman *et al.* 2018).

Seabirds are of particular importance to Maldivian fishermen, many of whom practice traditional pole-and-line tuna fishing. The presence of seabirds, feeding over tuna schools, helps fishermen to locate the tunas (Shafeeg 1993, Anderson 1996, Jauharee & Adam 2012, Miller *et al.* 2016). It is in large part because of this interaction that seabirds are protected in the Maldives. In the past, Maldivian seabirds, including Lesser Noddies, were harvested by local fishermen for food and to keep as pets. Despite their current protection, they are still subject to a small amount of hunting. More seriously, seabird roosting and nesting sites are frequently disturbed by human visitors and, in many cases, they are threatened or destroyed by human development. This includes recent proposals to develop Haa Alifu Atoll as an international transhipment port or regional bunkering centre.

Reductions in seabird numbers may also have a knock-on effect for coral reef health and resilience in the face of climate change. Seabirds bring large quantities of nutrients onto their roosting islands, which enhance productivity of both the island flora and the adjacent waters (McCauley *et al.* 2012, Graham *et al.* 2018). The waters around Haa Alifu Atoll appear to be particularly productive during the northeast monsoon season. Not only are Lesser Noddies more abundant there in the northeast monsoon than in the southwest monsoon, but so too are several other marine predators, including large-sized tunas (both Skipjack *Katsuwonus pelamis* and Yellowfin *Thunnus albacares*), as well as Manta Rays *Mobula alfredi*, and Pantropical Spotted Dolphins *Stenella attenuata* (Rochepeau & Hafiz 1990, Anderson *et al.* 1998, Anderson 2005, Anderson *et al.* 2011).

From studies during the breeding season elsewhere, Lesser Noddies appear to have relatively short foraging ranges and a limited ability to switch prey compared to other tropical seabirds (Catry *et al.* 2009). Nevertheless, Lesser Noddies breeding on the Houtman Abrolhos islands regularly foraged in deep water, beyond the edge of the continental shelf (Surman *et al.* 2017). In the Maldives, too, Lesser Noddies mostly forage in deep oceanic water outside the atolls (Shafeeg 1993, Anderson 2007, Anderson & Shimal 2020). To better understand the feeding ecology of Lesser Noddies in Maldivian waters, further research could combine tracking (perhaps using smaller GPS loggers) with monitoring of their diet. The latter might be carried out by non-invasive DNA analyses of guano collected on Gallandhoo, a technique that has been used in other seabird research to determine prey diversity as well as spatial and temporal overlap with local fisheries (McInnes *et al.* 2017).

Productivity and abundance of marine predators in Maldivian waters are affected by changes in oceanographic conditions, with El Niño Southern Oscillation and Indian Ocean Dipole (IOD) events having particularly profound impacts (Anderson *et al.* 1998, Thushara & Vinayachandran 2020). Early 2022 was marked by a negative IOD/La Niña event (Bureau of Meteorology 2022), which appears to have reduced seasonal productivity around Haa Alifu Atoll, at least towards the end of the northeast monsoon season. In April 2022, the oceanic waters around the atoll appeared extremely clear (i.e., lacking in phytoplankton) and the number of Lesser Noddies at sea was much smaller than seen in April 1998 and April 2013 (RCA pers. obs.). It is possible that lack of food led many to depart early, and this may also have reduced the weight and condition of the birds.

During the northeast monsoon season, several thousand Lesser Noddies roost on Gallandhoo Island overnight, arriving after dusk and leaving before dawn. Although recognised as an IBA and protected under a legal directive of the Maldivian Ministry of Environment, which does not permit boat landings except under permit, there was clear evidence during the fieldwork for this project of visits to poach turtle eggs. In addition, on Gallandhoo, there were large numbers of Brown Rats *Rattus norvegicus*, which were active in daylight and in darkness. Given the importance of Gallandhoo, not just for Lesser Noddies but for the richness of both its vegetation and the adjacent reef, there is a strong case for eradication of the rats.

Extensive effort and resources have been invested in eradication of invasive species, including rats, in the Seychelles (Russell *et al.* 2016). Around 50 000 pairs of Lesser Noddies breed on Cousine Island, with some evidence of a slow decline (Hart *et al.* 2022). Given that our results show migratory connectivity, there is the potential for international cooperation to improve conservation management of Lesser Noddies across the region. There is a long history both of rodent eradication in the Seychelles and of seabird nesting habitat protection and restoration on Cousine Island since the 1990s (Hart *et al.* 2022). It would be unfortunate for the conservation gains in the Seychelles to be negated by lack of action in what appears to be an important non-breeding region. Indeed, there is potential for knowledge exchange that might lead to eradications of invasive rats and to other restoration efforts on islands in the Maldives; there is clear evidence from numerous other island groups in the western Indian Ocean of the conservation benefits for diverse species, including noddies, terns, and other seabirds (Russell *et al.* 2016).

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