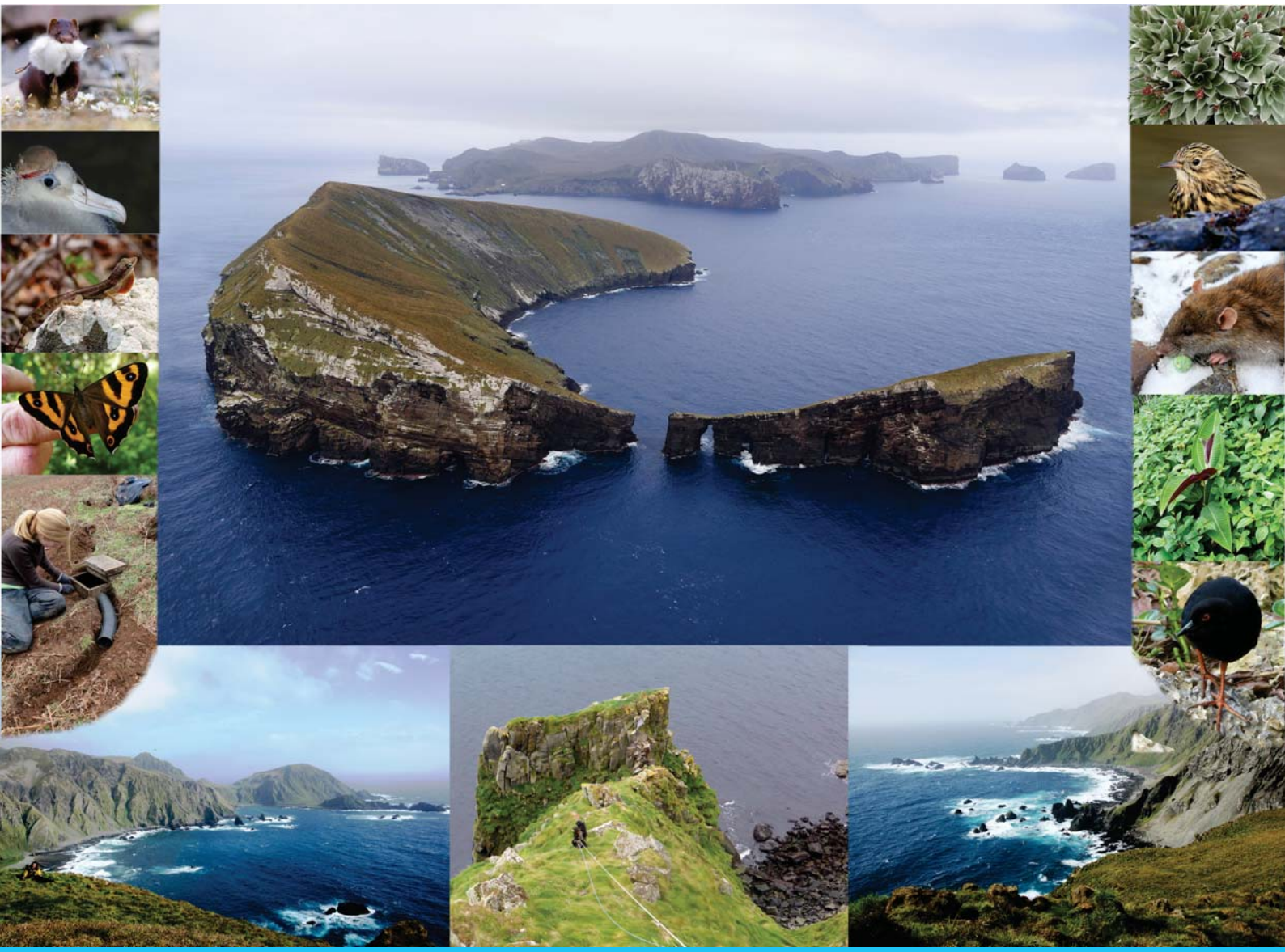
Island invasives: scaling up to meet the challenge

Proceedings of the international conference on island invasives 2017

Edited by C.R. Veitch, M.N. Clout, A.R. Martin, J.C. Russell and C.J. West



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The guidelines for this conference were: "any topic relating to invasive alien species on islands, where the term 'island' is broadly interpreted and (rather ironically from a classical perspective) may include a submarine island – e.g. a coral reef. The invasive species involved may be flora or fauna. Particularly encouraged were papers that relate to the theme of the conference – scaling up to meet the challenge – or to either biosecurity/quarantine or post eradication impacts on native biota."

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Five eradications, three species, three islands: overview, insights and recommendations from invasive bird eradications in the Seychelles

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Abstract Management and eradication techniques for invasive alien birds remain in their infancy compared to invasive mammal control methods, and there are still relatively few examples of successful avian eradications. Since 2011, five separate eradication programmes for invasive birds have been conducted on three islands by the Seychelles Islands Foundation (SIF). Target species were prioritised according to their threat level to the native biodiversity of the UNESCO World Heritage Sites of the Seychelles, Aldabra Atoll and Vallée de Mai, which SIF is responsible for managing and protecting. Red-whiskered bulbuls (*Pycnonotus jocosus*) and Madagascar fodies (*Foudia madagascariensis*) occurred on Assumption, the closest island to Aldabra, which, at the time, had no known introduced bird species. The growing population of ring-necked parakeets (*Psittacula krameri*) on Mahé posed a threat to endemic Seychelles black parrots (*Coracopsis barklyi*) on Praslin where the Vallée de Mai forms their core breeding habitat. In 2012, red-whiskered bulbuls and Madagascar fodies were detected on Aldabra, so an additional eradication was started. All eradications used a combination of mist-netting and shooting. The intensive part of each eradication lasted three years or less. On Assumption, 5,279 red-whiskered bulbuls and 3,291 Madagascar fodies were culled; on Mahé, 545 parakeets were culled; and on Aldabra 262 Madagascar fodies and one red-whiskered bulbul were culled. Each programme underwent 1–2 years of follow-up monitoring before eradication was confirmed, and four of the five eradications have been successful so far. None of these species had previously been eradicated in large numbers from other islands so the successes substantially advance this field of invasive species management. The challenges and insights of these eradications also provide unique learning opportunities for other invasive avian eradications.

Keywords: Aldabra, Indian Ocean islands, invasive alien bird management and control, mist-netting, parakeets, passerines, shooting

INTRODUCTION

Birds are currently one of the least represented groups of terrestrial vertebrates in the field of invasive alien species research and management, and the development of successful eradication strategies for introduced birds remains in its infancy, especially when compared to well-established invasive mammal control techniques (see: Blackburn, et al., 2009; Feare, 2010; Bauer & Woog, 2011; Strubbe, et al., 2011; Baker, et al., 2014; and Menchetti & Mori, 2014; for potential reasons for the discrepancy). The relatively few examples of successful large-scale avian eradications include rock pigeons (*Columba livia*) from the Galápagos Islands (Brand Phillips, et al., 2012), which at the time was the largest successful eradication of an alien bird from an island system (with 1,477 birds removed), and several eradications of the common myna (*Acridotheres tristis*) (e.g. Saavedra, 2010; Canning, 2011; Feare, et al., 2017). There has, however, been little development of best practices or compilation of lessons learnt so far. Furthermore, we are not aware of any examples of pre-emptive invasive bird eradications from islands to protect native biodiversity on nearby islands.

Since 2011, five separate eradication programmes for invasive alien birds have been conducted on three islands in the Seychelles by the Seychelles Islands Foundation with the aim of protecting endemic biodiversity on Aldabra Atoll and Praslin from the potential impacts of these invasive bird species, should they become established. These eradications targeted: (1) red-whiskered bulbuls (*Pycnonotus jocosus*) on the island of Assumption; (2) Madagascar fodies (*Foudia madagascariensis*) on Assumption; (3) red-whiskered bulbuls on Aldabra; (4) Madagascar fodies on Aldabra; and (5) ring-necked parakeets (*Psittacula krameria*) on the main Seychelles island of Mahé. Red-whiskered bulbuls have a broad introduced range covering 15 countries (Global Invasive Species Database (GISD), 2017), and their impacts on native ecosystems and biodiversity (Clergeau & Mandon-Dalger, 2001; Linnebjerg, et al., 2010; GISD, 2017) have prompted control efforts and even small-scale eradications, but these efforts have not been upscaled in most places. Madagascar fodies are widely introduced across the Western Indian Ocean islands including many of the Seychelles islands, where they threaten native avifauna through hybridisation (Lucking, 1997), and transmission of pathogens (de Sales Lima, et al., 2015). Ring-necked parakeets have been introduced to over 35 countries outside their native range, making them one of the most successful avian invaders in the world, and are known to cause detrimental impacts on native wildlife (Strubbe & Matthysen, 2007; Strubbe & Matthysen, 2009; Strubbe, et al., 2010; GISD, 2017), but have not yet been eradicated or substantially reduced in numbers from any of them.

In this paper, we present a general overview of each eradication including: (i) the main methods applied in each phase; (ii) the relative success and numbers of birds culled with each method; and (iii) the difficulties encountered. Finally, we suggest 10 key insights and recommendations that can be applied to further eradication attempts and adopted for best practice, and offer a positive outlook for the future of introduced bird management.

METHODS

Location and background of project

The Seychelles archipelago consists of 115 islands across the Western Indian Ocean region (Fig. 1). The country has two UNESCO World Heritage sites; Aldabra Atoll, which was inscribed on the World Heritage list in 1982, and the Vallee de Mai, inscribed in 1983. Aldabra (15,250 ha; 9°24' S, 46°20' E; Fig. 1), one of the largest raised coral atolls in the world, is famous for its remarkable

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biodiversity, including the largest giant tortoise population in the world, huge seabird colonies, pristine marine ecology and its relative lack of ecological disturbance. The Vallée de Mai (4°19′ S 55°44′ E), a 20 ha site on the island of Praslin (Fig. 1), is a mature palm forest dominated by the endangered endemic giant palm, the coco de mer (*Lodoicea maldivica*). A public trust, the Seychelles Islands Foundation (SIF), is responsible for managing and protecting both sites. The sites form crucial strongholds for many endemic and/or endangered species, and both sites host endemic bird species that face increasing threats from the invasive birds present on nearby islands. This context prompted SIF to consider and initiate pre-emptive management action of the introduced species in 2010, to ensure protection of the endemic species.

In the case of Aldabra, Assumption Island (1,171 ha, 9°44' S, 46°30' E; Fig. 1), only 27 km away, had populations of red-whiskered bulbuls and Madagascar fodies which were introduced in the 1970s. Aldabra's native avifauna, including the endemic Aldabra fody (*Foudia aldabrana*) and a native sub-species of Madagascar bulbul (*Hypsipetes madagascariensis rostratus*), had long been considered threatened by the proximity (*sensu* propagule pressure, Simberloff, 2009) of these introduced birds on Assumption (Roberts, 1988). The main threats posed by the potential spread of these introduced species to Aldabra were considered to be competition, hybridisation and transmission of novel pathogens. When the Assumption eradication of red-whiskered bulbuls and Madagascar fodies was being planned in 2010/2011, Aldabra was not known to have any introduced bird species and may have been the largest tropical island to be free of invasive birds. Unfortunately however, both of the introduced species from Assumption were identified on Aldabra in early 2012, soon after the start of the Assumption eradications. This was thought to be due to the increasing populations of both species on Assumption, so an additional eradication operation for these new populations on Aldabra was quickly planned.

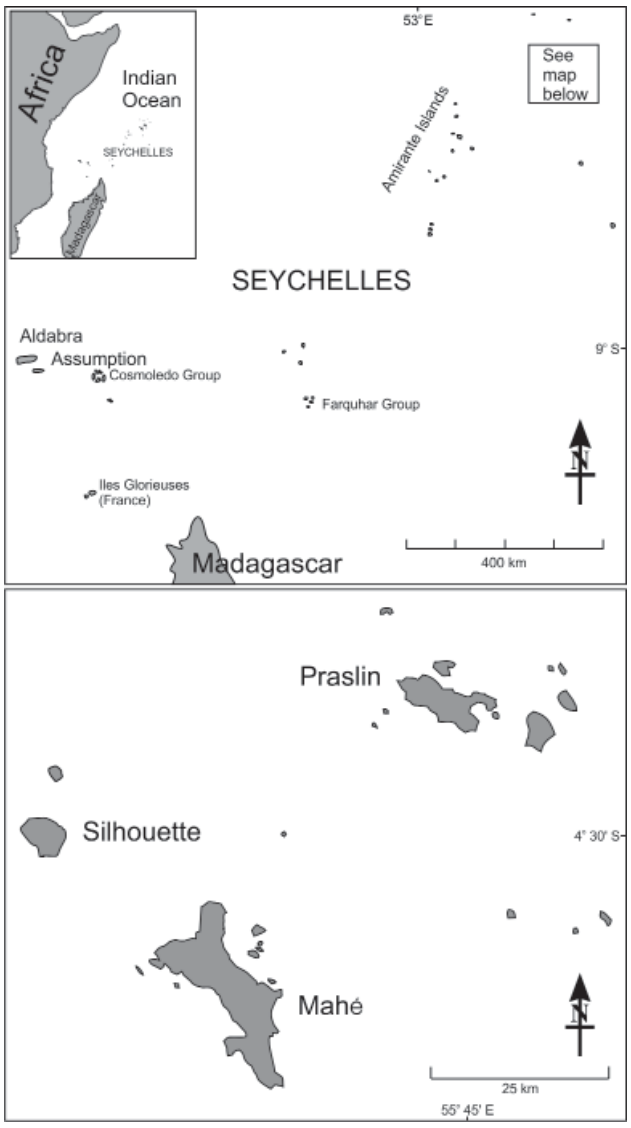

Fig. 1 Location of the Seychelles archipelago in the Indian Ocean (top, inset), the main islands and island groups of the Seychelles, including Aldabra and Assumption (top), and the inner Seychelles islands (bottom), showing Mahé, Silhouette and Praslin.

In the case of the Vallée de Mai, the mature coco de mer palm forest at this site forms the main breeding area for the Seychelles black parrot (*Coracopsis barklyi*), which is endemic to the island of Praslin and a flagship species for this island. The main Seychelles island of Mahé (Fig. 1), ca. 37 km away from Praslin, had a rapidly growing population of introduced ring-necked parakeets since the 1990s. The increasing probability of their establishment on Praslin, was accompanied by threats to the black parrot through competition and pathogen transmission. The presence of the parakeets on Mahé was thus considered the most pressing threat to these endemic parrots, which number only 520–900 birds on one island in the wild (Reuleaux, et al., 2013). In addition, long-term conservation plans for the black parrot include possible translocations of the species to other islands (Rocamora & Laboudallon, 2009) and such interventions could not be considered while ring-necked parakeets remained on Mahé.

Eradication time-frames and methods

All of the eradications were initiated in 2011/2012 and started with a 2–6 month initial phase, which included surveys to estimate the population size and distribution of the introduced bird populations, and trials to identify the most effective eradication methods.

Population estimates were carried out by island-wide distance sampling for Madagascar fodies and red-whiskered bulbuls on Assumption, grid-based surveys on Aldabra, and standardised roost counts for ring-necked parakeets on Mahé.

The choice of eradication methods trialled in the first phase of each project (see Table 1) was based on literature research, staff experience with the species, advice from experts, and experimentation. The trialled methods included trapping (using a number of types of trap, bait, trapping locations, decoys and playback), ground mist-netting, shooting and poisoning, as well as manual methods such as location and hand-capture of birds at nests and roosts. For the ring-necked parakeets, high-level (canopy) mist-netting was also trialled, which involved mist-nets set up in the canopy at 8–15 m from the ground using either bamboo poles or tree branches. The outcomes of these initial trials in terms of capture rates, efficiency, cost and labour intensiveness were then assessed and informed the choice of focal method(s) for the main phase of each eradication (Table 1). Thereby, the methods used for each eradication varied by island, species and phase of the project. Nevertheless, amendments needed to be made throughout the main eradication phase as the situation changed, so flexibility and adaptability in approach was essential.

The initial phase was followed by a second phase of intensive eradication efforts which lasted about three years for all of the eradications. During this phase the focus was on reducing the target bird population numbers to zero

Table 1 Trialled methods in phase 1 and focal methods in phase 2 for each of the eradications.

Island	Species	Methods trialled in phase 1	Phase 2 focal method(s)
Assumption	Red-whiskered bulbul	Trapping, shooting, poisoning, hand-capture at nests/roosts	Mist-netting, then shooting
Assumption	Madagascar fody	Trapping, shooting, poisoning, hand-capture at nests/roosts	Mist-netting, then shooting
Aldabra	Red-whiskered bulbul	Mist-netting, shooting	Mist-netting
Aldabra	Madagascar fody	Mist-netting, shooting, hand capture	Mist-netting, supplemented by shooting with air rifle & hand capture of fledglings
Mahé	Ring-necked parakeet	Trapping, canopy mist-netting, ground mist-netting, nest cavity targeting, shooting along flight lines and feeding areas	Shooting along flight lines and feeding areas with shotgun

as quickly and efficiently as possible using the methods identified in the trial phase. The second phase started in 2012 for Madagascar fodies and red-whiskered bulbuls on both islands, and in 2013 for the ring-necked parakeets after approval to use firearms was granted. It ended when no more birds could be detected.

Outreach was an important part of the ring-necked parakeet eradication in particular and efforts were made at the start of the intensive phase of this project to reach as many people as possible to encourage them to call the team with any information on sightings. We initially used all means available (including radio, TV, talks and presentations, newspaper and magazine articles, social media posts, website, newsletters, posters, stickers) to spread the message, and fine-tuned this according to responses over time.

The third and final phase consisted of monitoring (direct observations at all sites, island-wide point counts on Assumption; grid-based surveys in and surrounding the invaded area of Aldabra; roost and feeding tree checks at all known sites on Mahé) to confirm that no individuals of the target species remained. The monitoring was implemented in four 2–3 week periods with a team of 2–4 local scientific staff who had experience in one or more bird eradications, every 3–6 months.

RESULTS

Bird removal

Table 2 summarises pre-eradication population estimates and the total number of birds culled in each eradication, with estimates of the size of the introduced bird populations ranging from two to 4,300.

To date, four of the five eradications have been successful, with only the ring-necked parakeet eradication still in the monitoring phase. On Assumption and Aldabra, there were no sightings of either introduced bird species in two years of monitoring so both islands are again considered free of invasive birds.

Efficiency of control methods

The proportion of birds culled using different methods varied in each eradication (Fig. 2) and only a summary is provided here. The predominant and most effective methods for all campaigns were shooting and mist-netting (Table 1; Fig. 2).

For the ring-necked parakeets on Mahé, mist-netting caught 25 birds in the trials and first two months of the intensive phase of the campaign, but quickly became unfeasible as the birds learnt to avoid the nets even when set up in different places. Trapping caught no birds. The

Table 2 Summary of the pre-eradication population estimate and the number of birds culled for each of the target populations.

Island	Species	Pre-eradication population estimate	Number of birds culled	Population estimation method and reference
Assumption	Red-whiskered bulbul	4,300	5,279	Distance sampling; Feare & Fries-Linnebjerg, 2012
Assumption	Madagascar fody	1,600	3,291	Distance sampling; Feare & Fries-Linnebjerg, 2012
Aldabra	Red-whiskered bulbul	2–3	1	Direct observations; van de Crommenacker, 2012
Aldabra	Madagascar fody	150–200	262 (incl. hybrids)	Point counts; van de Crommenacker, 2012
Mahé	Ring-necked parakeet	288	545*	Roost counts; Birch, et al., 2012

* The 545 ring-necked parakeets included 543 from Mahé, one bird from Silhouette and one bird from Praslin. The single ring-necked parakeets culled on Praslin and Silhouette were assumed to have flown there from the Mahé population as there were no records of captive birds on either island.

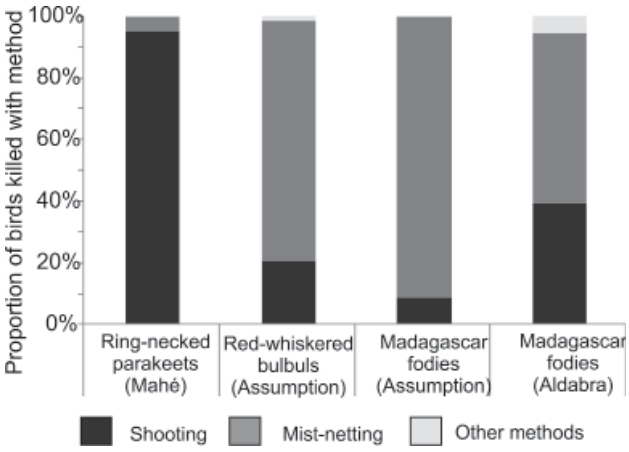

Fig. 2 The proportion (%) of birds culled on each introduced bird eradication (ring-necked parakeets [*Psittacula krameri*] from Mahé, red-whiskered bulbuls [*Pycnonotus jocosus*] and Madagascar fodies [*Foudia madagascariensis*] from Assumption; and Madagascar fodies from Aldabra) using the main eradication methods of shooting and mist-netting. 'Other methods' include trapping and manual capture. The red-whiskered bulbul eradication on Aldabra is not included in this figure because there was only one bird (mist-netted).

parakeet on Silhouette was culled by a member of the public using a catapult – a method not trialled on Mahé. The bird on Praslin was hand-caught.

Ring-necked parakeet eradication outreach

Television adverts were found to have prompted ca. 70% of all callers with information on sightings of the parakeets, with less than 10% of responders prompted by newspaper and magazine articles and the remainder from presentations, social media and having seen the posters.

DISCUSSION

Difficulties encountered

For each island and species, there was a particular set of challenges to overcome. On Aldabra, Madagascar fodies very closely resembled the endemic Aldabra fodies. This caused problems with capture of non-target species, and identification of introduced vs endemic species at a distance. The two species also quickly hybridised (van de Crommenacker, et al., 2015), making the eradication decisions more complex. Most birds targeted therefore needed to be identified at very close range to ensure that no Aldabra fodies were culled. Aldabra's physical challenges also included impenetrable vegetation, treacherous terrain and extremely demanding logistics. The invaded area was in the most remote part of Aldabra, initially had no field station, freshwater or facilities, and is only accessible via boat on a high tide, followed by a one-hour hike. Establishing basic infrastructure was therefore an essential pre-requisite for this eradication to proceed.

On Assumption the main challenges were higher than estimated population sizes of both target species, and the fact that neither species behaved as predicted from previous observations elsewhere. For example, trapping was initially anticipated to be an important and relatively simple capture method throughout the eradication, but this method appeared almost completely ineffective in extensive trials of the first phase. The failure of birds to accept bait (without traps) or to enter traps, combined with the high densities of both species, meant that mist-netting was by far the most effective capture method in the early part of the intensive eradication phase. This was labour-intensive and most successful when targeted at flight lines to and from nocturnal communal roosts. The propensity for communal roosting varied seasonally and the location of flight lines required constant monitoring to maximise mist-net captures. As numbers of target birds fell and mist-netting became less effective, shooting became the dominant method in the last year of the eradication. Both bird species on Assumption also appeared to be extremely wary of humans, even before the start of the project, and this became more marked as the eradication progressed. The originally planned methods therefore had to be re-assessed early in the project and underwent continual assessment as the eradication progressed.

On Mahé, mist-netting and trapping of ring-necked parakeets proved ineffective or inefficient – the birds were found to fly and roost usually too high for mist-netting, and several specialised trap designs (including the use of decoys) were unsuccessful. Poisoning could not be considered on Mahé because of possible effects on humans and non-target species. This left shooting as the only viable alternative, which was a politically and socially difficult method to adopt. Mahé is an inhabited island, with a population of ca. 80,000 people, and eradication activities had to occur in inhabited areas as the birds were predominantly observed in agricultural and cultivated areas with crops and fruit trees. The Seychelles is, for historical and security reasons, highly sensitive about the use of firearms and this resulted in a delay of two years before firearms were approved for use on the project. Shooting was then permitted to external hunters, provided they were accompanied by a military escort at all times and used only shot-gun and air rifle. Ring-necked parakeets are also highly intelligent birds and became 'educated' and wary very quickly. For example, we think they learnt to recognise and avoid the project car and staff uniforms. Shooting therefore had to be done with extreme caution (e.g. from cryptic locations, wearing camouflage gear, only shooting at groups of one or two birds, and shooting only when the hunter was very confident of a strike). A final critical issue with working on an inhabited island was public perceptions concerning the project, especially with such a charismatic target species and because the success of any eradication partly depends on public support and contribution (Mack, et al., 2000). SIF tackled this potential problem from the outset by conducting intensive outreach campaigns to try to ensure that as many people on Mahé as possible were aware of the eradication and the reasons for it. Lack of support did cause occasional problems with access to private land and misinformation. Fortunately, the parakeets were a known pest and commonly viewed as a threat to farming and endemic wildlife, so the majority of people encountered were in favour of the project and very supportive.

Ten key insights and recommendations

Here is a list of 10 key insights from these eradications, which can serve as a basis for recommendations for practitioners who are considering invasive alien bird eradications. The eradications presented here cover islands from both ends of the ecological disturbance spectrum, from the most ecologically depauperate (Assumption), to the least disturbed and most biodiversity-rich (Aldabra) making the lessons relevant to a broad suite of islands.

1. Large-scale invasive bird eradications are feasible

Red-whiskered bulbuls in the Seychelles occurred only on Assumption, plus the single bird on Aldabra, so the outcome of these eradications has been national

elimination of the species. With the parakeet's range on the Seychelles encompassing only Mahé, if this eradication is successful, it will mark a second national eradication of an invasive bird species of high concern. Madagascar fodies remain established in high numbers on many islands of the Seychelles, but their eradication from two very different islands confirms the feasibility of this approach, should there be a need to consider their eradication elsewhere. Therefore, our first key message is that eradications of invasive alien birds from islands are feasible, even if the population of the target species exceeds 5,000 birds.

2. Pre-emptive action should be considered as a means to remove perceived threats

The three initial eradications of red-whiskered bulbuls and Madagascar fodies on Assumption, and ring-necked parakeets on Mahé, were based on the precautionary principle, i.e. the aim was to protect threatened endemic biodiversity pre-emptively based on perceived threats. This was justified in the case of the red-whiskered bulbul and the ring-necked parakeet, which have known detrimental impacts in their introduced ranges. However, even in the case of the Madagascar fody, the impacts of which on endemic birds have been questioned (Garrett, et al., 2007), the perceived threats were verified during the course of the eradications: (i) all three target species reached the islands of concern and at least one of these species established a breeding population (Madagascar fodies on Aldabra); (ii) hybridisation was confirmed to occur between introduced and endemic fodies on Aldabra (van de Crommenacker, et al., 2015); and (iii) several potentially novel pathogens were identified in the invasive species (SIF, unpubl. data).

3. Don't assume what you know of a species from other locations will apply in a new area – plan to conduct initial trials

Based on experience of the same species elsewhere, we expected a main method for catching Madagascar fodies and red-whiskered bulbuls to be trapping, and planned accordingly with respect to equipment and logistics. Trapping can be an effective capture method elsewhere for these species (N.B. & P.H., pers. obs.; C.G. Jones, pers. comm., all in Mauritius), but was found to be almost completely ineffective on Assumption for reasons that are unclear, and the birds never became accustomed to baited areas. This was despite several members of staff working on the project who had extensive experience successfully trapping these species in other locations. This caused delays at the beginning of the eradication while methods were re-assessed and other equipment sourced. A similar problem was encountered with the ring-necked parakeets, which have been successfully trapped in other countries (e.g. Bashir, 1979; Hussain, et al., 1992), but could not be trapped using the same or similar trap designs on Mahé, although these problems were less significant, as trapping parakeets had not been assumed as a main method of capture. It is important to note that we are not ruling out any particular method for targeting these species elsewhere. Trapping may still be a highly effective capture technique in other places for these species, so our advice here is simply that initial small-scale trials should be conducted to determine the feasibility of several different methods and save time and funding.

4. One size doesn't fit all birds

Shooting was by far the most effective method for ring-necked parakeets in the Seychelles, while mist-netting proved to be generally more effective for passerines (although this depended on the phase of the eradication). However, a flexible approach and willingness to modify the strategy was critical for the success of these eradications. Even within the same species and island, our techniques needed to be assessed and 'tweaked' frequently (and often substantially) to maintain efficient capture rates. For example, on Assumption, there was a switch in the final year of the intensive phase of the eradication, from using mist-nets as the main method of capture to firearms (this switch also applies to mynas; Feare, et al., 2017). This was decided when catch rates in mist-nets (i.e. the density of target population) had dropped too low for continued progress with the eradication (i.e. population recruitment rates were thought likely to be equal to or higher than capture rates).

5. Don't count your eggs before they hatch

For all three species, there were more birds present than had been estimated by survey methods. This was the case regardless of which estimation method was used. The higher numbers are likely to have been primarily due to recruitment of young birds into the populations since distance sampling is based on classical closed population sampling (Cassey & McArdle, 1999) but the survey methods (roost counts, distance sampling) could also have produced underestimates. The higher figures had implications for the planning and especially the costs of completing the eradications.

6. Identify the weak points of your target species

Each target species was found to have at least one trait or habit which either increased their vulnerability at certain times or to certain methods, or could be used to improve eradication effectiveness. The communal roosting sites of ring-necked parakeets enabled regular standardised counts to be conducted, which initially provided a valuable way to monitor the population numbers, flight lines and the impacts of the eradication efforts and later formed an essential location for targeting the remaining birds. These sites proved so useful that parakeets were not targeted at roosts until close to the end of the project to ensure that the roost sites were not disturbed or compromised. Red-whiskered bulbuls also roosted communally in the early stages of the project and could be targeted with mist-nets along their flight lines towards roosts, which maximised the mist-net catch. Later in the eradication, their habit of vocalising from prominent perches meant that they could be reliably located from several hundred metres away, which greatly helped in the search for and targeting of the last few birds. Madagascar fodies were found to have a tendency to form large foraging groups, especially in the non-breeding season, which, when spotted, provided key areas for mist-netting.

7. Use research to aid management decisions on the ground

A scientific and research-based approach was an important aspect of the eradications and greatly facilitated management decisions on the ground. This included collecting comprehensive data and samples from all birds caught, regularly analysing the effectiveness of methods and approaches, and setting up external research partnerships for analysis which could not be done on site. The strongest example of this was the case of the Madagascar fody introduction to Aldabra, for which SIF was able to quickly establish a collaboration with university researchers, ensuring that the samples and data collected could be rapidly and effectively analysed. The resulting research outputs included analysis of origin (Assumption) and timing (recent, but probably pre-dating the start of the eradication) of the invasion, as well as confirmation of hybridisation between the endemic and

introduced species and more insights into this process (van de Crommenacker, et al., 2015). A collaboration was also established for disease-screening of ring-necked parakeet and black parrot blood samples to provide information on the pathogen status of each species.

8. Training of local staff is essential for project success

Few people with the necessary technical skills needed for the eradications existed in the Seychelles when the project started, so more than 30 local staff were intensively trained on the job throughout the eradications. Five of these staff members subsequently led parts of the eradications and were crucial to their success. Several of the staff members have subsequently been recruited in other invasive species management positions within SIF and elsewhere, so the eradications have increased in-country capacity in this field. Indeed, local staff training is seen as one of the biggest achievements of the eradications and has had the additional benefit of providing a strong sense of national ownership to the eradications.

9. Assess effectiveness of publicity and focus on the most appropriate means

Outreach activities are important in any eradication but in some, they are an essential means of achieving success. For the ring-necked parakeet eradication, on assessing where callers had heard about the project we found that the vast majority were prompted by the TV advert so we were able to focus on this for the rest of the project, which reduced costs and time without compromising the information received. In addition to public outreach, we found it was essential to liaise with other stakeholders in the environmental sector about the importance of the eradications. We noticed that the eradications tended to bring out strong feelings either for or against the project, and most people appreciated an opportunity to ask questions and understand the reasons for it. Our impression was that the outreach and education carried out for these projects went a long way to increase public support although we have no way of quantifying this

10. The early bird catches the worm

In the case of these eradications, we are certain that pre-emptive action has been a more effective and cost-efficient strategy to protect endemic species than would have been the case had we waited for the introduced species to spread to Aldabra and the Vallée de Mai (or other islands in the Seychelles) and establish populations. Indeed, this had already started to happen with all three species and, had we waited much longer, eradication may have proved an impossible task. Finally, at least one and potentially two of these invasive bird species are now nationally eradicated from the Seychelles and there is minimal risk of them being reintroduced to the sites in the future. We therefore consider the biodiversity and ecological integrity of the Seychelles World Heritage sites to have been safeguarded from these particular threats by these eradications.

CONCLUSION

Although all three species targeted here are known invasive species, and control efforts have been made or are underway in several places, there were no previous records of them being removed in such large numbers, or their complete eradication from any other islands or countries. The challenges and successes of these eradications provide a unique learning opportunity and offer a positive outlook for the future of introduced bird eradications. The fact that these eradication successes (or near successes) in the Seychelles are the first of their kind suggests that a change in approach and mindset to invasive bird eradications is timely. We believe that insights gained from these programmes can be used as a basis to significantly advance the field of invasive bird management and to initiate the development of best practices for eradication attempts.

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