INSTITUTIONAL CAPACITY BUILDING FOR INVASIVE BIRD MANAGEMENT IN THE PACIFIC

BIODIVERSITY CONSERVATION LESSONS LEARNED TECHNICAL SERIES

20

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Pacific Islands

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The Critical Ecosystem Partnership Fund is a joint initiative of l'Agence Française de Développement, Conservation International, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation.

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CONSERVATION INTERNATIONAL Pacific Islands

CRITICAL ECOSYSTEM PARTNERSHIP FUND

The **Critical Ecosystem Partnership Fund** is a joint initiative of l'Agence Française de Développement, Conservation International, the European Union, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation.

ABOUT THE BIODIVERSITY CONSERVATION LESSONS LEARNED TECHNICAL SERIES

This document is part of a technical report series on conservation projects funded by the Critical Ecosystem Partnership Fund (CEPF) and the Conservation International Pacific Islands Program (CI-Pacific). The main purpose of this series is to disseminate project findings and successes to a broader audience of conservation professionals in the Pacific, along with interested members of the public and students. The reports are being prepared on an ad-hoc basis as projects are completed and written up.

In most cases the reports are composed of two parts, the first part is a detailed technical report on the project which gives details on the methodology used, the results and any recommendations. The second part is a brief project completion report written for the donor and focused on conservation impacts and lessons learned.

The CEPF fund in the Polynesia-Micronesia region was launched in September 2008 and will be active until 2013. It is being managed as a partnership between CI Pacific and CEPF. The purpose of the fund is to engage and build the capacity of non-governmental organizations to achieve terrestrial biodiversity conservation. The total grant envelope is approximately US$6 million, and focuses on three main elements: the prevention, control and eradication of invasive species in key biodiversity areas (KBAs); strengthening the conservation status and management of a prioritized set of 60 KBAs and building the awareness and participation of local leaders and community members in the implementation of threatened species recovery plans.

Since the launch of the fund, a number of calls for proposals have been completed for 14 eligible Pacific Island Countries and Territories (Samoa, Tonga, Kiribati, Fiji, Niue, Cook Islands, Palau, FSM, Marshall Islands, Tokelau Islands, French Polynesia, Wallis and Futuna, Eastern Island, Pitcairn and Tokelau). By late 2012 more than 90 projects in 13 countries and territories were being funded.

The Polynesia-Micronesia Biodiversity Hotspot is one of the most threatened of Earth's 34 biodiversity hotspots, with only 21 percent of the region's original vegetation remaining in pristine condition. The Hotspot faces a large number of severe threats including invasive species, alteration or destruction of native habitat and over exploitation of natural resources. The limited land area exacerbates these threats and to date there have been more recorded bird extinctions in this Hotspot than any other. In the future climate change is likely to become a major threat especially for low lying islands and atolls which could disappear completely.

For more information on the funding criteria and how to apply for a CEPF grant please visit:

- www.cepf.net/where_we_work/regions/asia_pacific/polynesia_micronesia/Pages/default.aspx
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CRITICAL ECOSYSTEM PARTNERSHIP FUND

CONSERVATION INTERNATIONAL Pacific Islands

Location of the project in the Polynesia-Micronesia Biodiversity Hotspot

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Lessons Learned

Running the invasive bird management workshop, Samoa

Below are listed some thoughts on why we believe the workshop was successful and what we recommend doing to make such a workshop more productive in the future.

1. TAILOR WORKSHOP TO LOCATION

To construct a training workshop that is relevant to and resonates with participants, it is important to build content around examples from participants' own experiences. Partnering with a local institution- in our case multiple local institutions- enables workshop designers to draw on case studies and on-going projects that ensured the content touched on subjects and situations that participants could relate to and reflect upon. In Samoa we had the on-going myna control programme to draw on to illustrate different stages within the invasive species management process. This allowed for lively discussion and engaged the audience in what they could see as 'real-life' issues.

A learning point for workshop organisers resulted from the session we ran on leadership. This was considered to be a generic topic that underpinned any successful project, whether it is for invasive bird management or not. We discussed the concept of empowering leadership as a skill that could be learnt and assumed that would be something that would connect with participants. Interestingly in post-workshop feedback some participants felt this concept was not relevant in the Pacific context. The suggestion was that leadership was something that was acquired by being put into such a position by existing political and cultural systems. The implication was that there was not a direct link between learning how to become a leader and actually being put into a leadership position. This does raise a question as to how leadership is 'earned' and, while perhaps culturally acceptable, could well have implications for the success of projects implemented in the region. This is a point which deserves further discussion and unpacking.

2. VALUE LOCAL PARTNERSHIPS

Our partnership with MNRE in Samoa and SPREP ensured that we had critical levels of local support and advice on determining the logistics for the workshop (accommodation, workshop venue etc.) The partnership with MNRE also helped us to gain agreement over the use of local case studies that we could draw upon to illustrate key points.

3. ACCOUNT FOR LOCAL CUSTOM IN WORKSHOP TIMING

We had originally left approximately 30 minutes for the introduction to the workshop and scene-setting. Based on feedback from regional partners it became clear that we would need to carve out more time for formal opening involving multiple local dignitaries. This is important to take into account when considering how to allocate time to different activities.

4. PROVIDE PRE-WORKSHOP MATERIAL

We decided to send all participants an initial review document on invasive bird management globally in order to ensure all were 'up to speed' on what was currently known about the central workshop topic. However, what we failed to do was provide enough time at the start of the workshop to discuss the main learning points from this document, instead assuming all had read it and so were well-versed. This was an error which would be rectified next time.

5. IDENTIFY CORE COMPETENCIES UPFRONT

This workshop was based on achieving particular objectives laid out in the original project proposal. While these objectives we could have strengthened outputs (and outcomes) by identifying specific core competencies, as well as understanding, that we wanted participants to come out with from the workshop. We did spend time developing hands-on skills during the workshop. However, by identifying clearly a set of core abilities we expect participants to come out with and then testing to confirm these abilities had been acquired, we could have added further confidence that the objectives achieved would be long-lasting.

6. SECURE SENIOR COMMITMENT

The workshop was able to generate multiple plans for invasive bird management and feasibility studies. Some are already being developed into actions on the ground. This process could have been strengthened by securing not just the participation of relevant staff on the workshop but also gaining some commitment from their superiors that the skills and understanding gained- and plans drafted- would be given 'space' to be put into practice. While this would prolong the process we should endeavour to secure the commitment of decision-makers before investing in their staff so that an enabling environment is created in which people can put into practice skills and understanding developed.

7. ENCOURAGE SHARING OF PERSONAL EXPERIENCES

A valuable component of the workshop was the talk given by each participant on their experiences of invasive bird management within their own island. This not only surfaced new, unpublished information about bird management but also encouraged participants to discuss their experiences with each other in more informal settings. Next time we would encourage workshop organisers to plan these (short) talks near the start of the workshop providing the maximum time for discussions to ensue between participants.

8. INCLUDE A PUBLIC SHOW OF WORKSHOP OUTPUTS

A useful motivation for participants to have produced a tangible output to the workshop- in this case draft plans for invasive bird management- was a series of talks on the last day for an invited group of local dignitaries. This included the Heads of a number of funding and other conservation organisations. We believe this helped to sharpen participants' resolve to produce something concrete by the end of the workshop.

9. PLAN INFORMAL AS WELL AS FORMAL LEARNING

While significant effort was put into planning the formal, classroom-based component of the workshop, we realise that we did not plan sufficiently the field trip. This was designated to happen on the Saturday in the middle of the course, to help break up to formal learning with something more informal and practical. However, we should have applied the same rigour to the learning outcomes from the field trip as we had done to the formal side. This would have ensured that the time was both productive as well as relaxing. This would have included planning for poor weather conditions, which ultimately reduced the value of the field trip for participants.

10. MULTIPLE PARTICIPANTS; SAME LOCATION

We discussed prior to the workshop the value of spreading our net as wide as possible or focusing on a few key islands to draw participants from. In the end we veered more to the latter. This ensured that we had a critical mass of participants (2–3) from key locations, providing mini-groups that could work on the same plan, relevant to the work back home. While we would have opened the workshop up to more islands if we had selected one from each place, this would have made the production of a provisional feasibility study or management plan for each location difficult to achieve.

11. LONG LEAD-IN TIME FOR WORKSHOP DELIVERY

Given that partners in this project came from the UK, New Zealand and the Pacific we were required to work through Skype in the planning of the workshop. Time zones, work-loads and technical limitations all hampered this dialogue. An alternative idea would have been to organise conference calls using standard phones to ensure reception was sufficient to run the meetings. Whichever method was used in the future, the large distances over which planning may need to take place requires you to begin organising planning meetings long before you would do normally if you could speak together within the same time zone. We recommend that planning for such a workshop begins at least six months prior to its delivery.

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Review of best practice management of common mynas (*Acridotheres tristis*)

with case studies of previous attempts at eradication and control

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1. Introduction

Introduced birds are invasive and/or are pests in many places around the world. The common myna (*Acridotheres tristis*), and in places the jungle myna (*A. fuscus*), have been introduced or have dispersed to many islands in the Pacific and around the world where they may affect biodiversity and agricultural values and are an urban nuisance. This has led many countries to attempt to manage these adverse impacts using eradication or control programmes for the birds – with varying success. Unlike many other pest species, there is no generally accepted 'best practice' to eradicate or control mynas. In 2011, the Durrell Wildlife Conservation Trust (Durrell) was commissioned by Conservation International under the Critical Ecosystem Partnership Fund (CEPF) to review possible best practice methods for planning and delivering pest management. This review would identify what has worked and what has not in international attempts to eradicate or control mynas. The resulting report and its case studies would then form the basis of resource material for a workshop to be held in Samoa in July 2012, again funded by CEPF and facilitated by Durrell. Landcare Research carried out this work for the Durrell Wildlife Conservation Trust in 2012.

2. Objectives

The objectives of this report are to summarise and describe:

- The basic biology of mynas that is relevant to their control as pests
- The general principles of pest management
- The control and monitoring tools available to manage mynas
- Case studies on the successes and failures of past myna control programmes.

The report should be seen as a working document, and may be updated after the workshop and as additional information becomes available.

3. Basic biology of mynas relevant to management

Two species of mynas, the common myna (*Acridotheres tristis*) and the jungle myna (*A. fuscus*) (Figure 1), have adapted to living in urban and suburban areas and exploit the resources provided by humans. However, they are not exclusively commensal, as populations are found on many uninhabited islands (e.g. common mynas on The Three Kings islands off New Zealand (Parkes 2009).

The biological parameters of interest to pest managers include the impacts they have on other species and people, their life cycle (breeding season, communal roosting, and foraging and feeding behaviours), their rate of increase, natural densities, and their general alertness and ability to learn. These are described in several reviews and reports (e.g. Telecky 1989; Tindall 1996; Pierce 2005; Dhami & Nagle 2009) and are merely summarised here.

Figure 1 Common (left) and jungle (right) mynas.

3.1 Impacts on biodiversity

Mynas may affect other species by direct predation or by competition for food or nest sites, often evident in their aggressive behaviour. However, most evidence for these impacts is either anecdotal (mynas are seen eating valued species or molesting nesting birds) or circumstantial (the increase in mynas may have been associated with a decline in native species, or control of mynas resulted in an increase in native birds).

Mynas are known predators of other birds, lizards and invertebrates. For example, mynas destroyed 23% of the eggs and chicks of wedge-tailed shearwater (*Puffinis pacificus cuneatus*) nests on Kauai Island, Hawai'i (Byrd 1979) and they are also known to prey on those of terns (*Sterna* spp.) and noddies (*Anous* spp.) in Fiji (Lever 1987). Feare (1976) noted that mynas took deserted eggs from around sooty tern (*Sterna fuscata*) colonies in the Seychelles but did not note any predation of eggs being incubated.

Mynas harass birds nesting in their territories (Pierce 2005). The aggression at nesting holes may be competition for the site, but mynas appear to harass other birds as a matter of course and not just to displace them from suitable nesting holes. For example, Blanvillain et al. (2003) noted that the fledging rate of the endangered Tahitian flycatcher (*Pomarea nigra*) over the three years 1998 to 2000 was correlated with the extent of encounters and interactions between mynas and flycatchers around the flycatcher nests. Mynas actively interacted twice as much around nests that failed than at nests that succeeded (Blanvillain et al. 2003). Recent unpublished data suggest mynas caused 39% of flycatcher nest failures (once rats had been controlled) but this dropped to 0% once mynas were controlled as well (Ghestemme 2011). Control of mynas on Denis island (see case study 7.2.2) has coincided with an increase in the translocated population of Seychelles paradise flycatcher (*Terspiphone corvina*) (Henriette & Laboudallon 2011).

Mynas were seen harassing the endemic kingfisher (*Todiramphus rufficollaris*) of Mangaia Island which led to consideration of their eradication (Parkes 2006). However, subsequent observations suggested this harassment was not a significant problem for the kingfisher population (G. McCormack, pers. comm.). Furthermore, mynas were no more aggressive, i.e. excluded other species from feeding sites, to other bird species than most other birds in urban areas in Newcastle, Australia (Haythorpe et al. 2012).

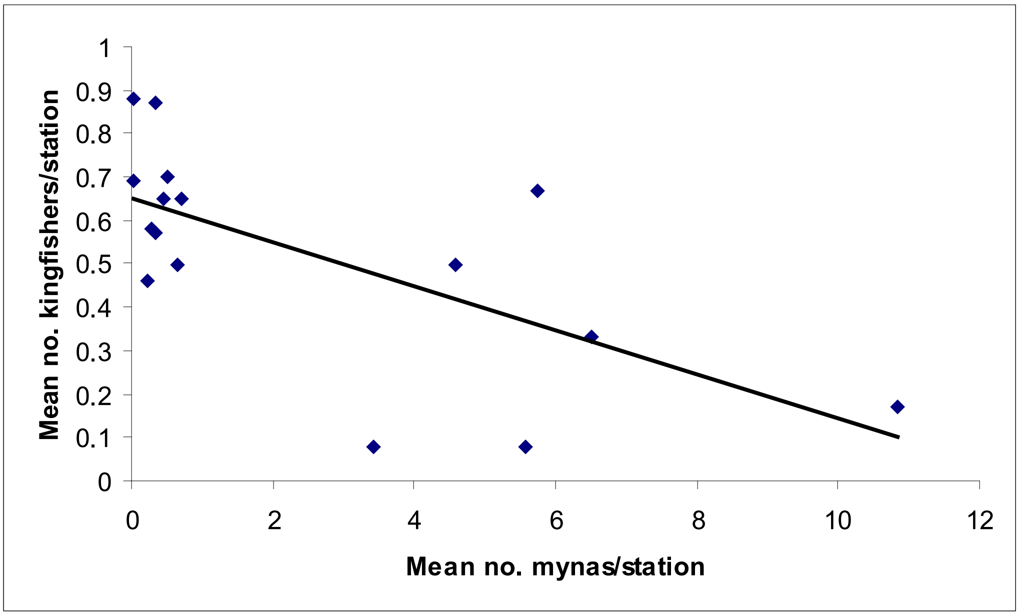
The effect of harassment and competition for holes from mynas on other species is not clear. Predation and aggression must translate into a demographic consequence for the affected species, in order for a claim to be made that mynas have an adverse impact, and this is not so easy to prove.

Pell & Tidemann (1997) showed that mynas dominated native birds at artificial and natural nest sites in a forest reserve near Canberra, but Lowe et al. (2011) and Crisp & Lill (2006) concluded mynas had little impact on native birds in urban Sydney and Melbourne, respectively. A more direct study of bird species interactions in Sydney showed that mynas had no significant influence on the absence of nine native species, although all were negatively correlated with the presence of a native bird, the noisy miner (*Manorina melanocephala*) (Parsons et al. 2006). However, this study also needs to be interpreted with caution because mynas were absent at only 20% of the sites measured (therefore the test has low statistical power) and because the presence of mynas indicated that some native species were more likely to be present, presumably because of shared habitat preferences (Parsons et al. 2006).

Freifeld (1999) counted birds at 57 permanent stations on Tutuila Island (American Samoa) between 1992 and 1996. Common and jungle mynas, which were introduced to the island in the mid-1980s, were counted at 16 of the stations. The collared kingfisher (*Halcyon chloris*) was significantly more abundant at sites with fewest mynas (Figure 2). This is circumstantial evidence of a real impact of mynas, although of course the effect of different habitat preference by the mynas might confound the conclusion – and that could not be tested in this study.

Tindall et al. (2007) removed 457 mynas from the 146-ha Moturoa Island in the Bay of Islands of New Zealand in June 1995 then noted a coincident significant increase in the abundance indices (10-minute bird counts) of tui (*Prosthemadera novaeseelandiae*), grey warbler (*Gerygone igata*) and blackbirds (*Turdus merula*), but not in the kingfisher (*Halcyon sancta vagans*) population. These results were confounded by the eradication of rats and, like those of Freifeld (1999), assume constant detectability across the study periods.

Figure 2 Relationship between myna and kingfisher abundance at bird count sites with mynas on Tutuila Island (data from Freifeld 1999).



A recent study (Grarock et al. 2012) noted the difficulty in ascribing cause and effect relationships between mynas and native bird abundance over short periods of a few years when the effect is not strong. They used long-term bird abundance data gathered in Canberra over 29 years and found there had been a significant negative effect of mynas on seven small bird species, on some but not all hole-nesting species, but no effect on five large species. The impact either reduced bird densities or reduced their pre-myna rates of increase. The authors claim to account for the effects of mynas from those of other factors that might affect urban bird densities. However, Taylor (2012) in an unpublished review in the Canberra Birds Listserver has criticised these conclusions and suggests the model used by Grarock et al. (2912) cannot untangle the multiple potential variables affecting bird numbers in Canberra.

Mynas are known to spread weed seeds, e.g. lantana (Lever 1987). They are also potential vectors of avian malaria in Hawaii (Caughley & Sinclair 1994).

3.2 Impacts on agriculture

Mynas can damage fruit crops (Tracey et al. 2007) and this can be particularly important on tropical islands where fruits are grown at small scales for domestic consumption or for sale in local markets. They also spread pawpaw seeds – sometimes seen as a benefit (C. Feare, pers. comm.).

In Pacific countries where domestic pigs are an important cultural and food item, mynas have learned to gather at places when pigs are being fed and presumably eat a significant proportion of the pigs' food.

3.3 Impacts on people

People perceive mynas as pests. They are listed among the top 100 invasive species in the Invasive Species Specialist Group (ISSG)'s list of problem vertebrates, and have been 'voted' as Australia's most significant pest in a poll conducted in 2004 (see Lowe et al. 2011). This is clearly an exaggeration of their true pestiness relative to other invasive animals, but does reflect the fact that they are one of the most common invasive species interacting with people.

They are an urban nuisance. They nest in houses, foul water tanks, form noisy aggregations, and are seen being aggressive to the native birds that people often like to see in their gardens.

Mynas may also carry parasitic mites which can be transmitted to other birds and cause dermatitis in humans (Saavedra 2010).

3.4 Mynas as assets

One reason people introduced mynas to islands was as a biocontrol of invertebrate pests such as coconut stick insects, paper hornets and cattle ticks (McCormack 2005; Parkes 2006). The coconut stick insect (*Graeffea crouanii*) was a major defoliator of coconuts and still causes damage in 'sporadic outbreaks' in the Pacific (e.g. Paine 1968). It is likely that mynas do mitigate this problem, although outbreaks continue to occur on islands with mynas (Parkes 2006), so the birds are not the whole solution to the problem.

Current damage to coconuts on Atiu Island has been coincident with (and probably caused by) the removal of most mynas (see case study 7.2.3). One condition set by the Atiuans was that if damage to coconuts became too severe or long-lasting mynas could be reintroduced to their island (G. McCormack, pers. comm.).

3.5 Annual life cycle

Mynas may form long-lasting pairs that defend territories of up to about 2 ha around their nests during the breeding season (Pell & Tidemann 1997). They are also highly social birds and, outside the breeding season, often form feeding flocks. Mynas (other than nesting females) often form large night-time roosts of several hundred or even thousands of birds.

In New Zealand and Australia, mynas lay eggs from August (or a little later in New Zealand) through to early March, with most between November and January. The clutch size is generally 3 or 4 eggs. The chicks are fledged about 3 to 4 weeks after hatching, and are dependent on their parents for another 3 weeks. Two broods are usual but they can produce three (Heather & Robertson 2005; Markula et al. 2009).

However, whether these generalities apply to all island populations or to populations under active control is unknown. Any differences may have implications for control programmes.

3.6 Population dynamics

Densities of established populations of mynas have been estimated in several places. In the case studies reported here, they ranged from around 1/ha in parts of Canberra, to 2.4 /ha on Denis and Atiu islands, to 4.7/ha on Fregate Island – the latter being accurate as the birds were counted as they were trapped to extinction. Densities in Pretoria (South Africa) ranged from 0.6/ha in semi-natural areas, to 2.4/ha in urban areas, and up to 3.3/ha in suburban areas (van Rensburg et al. 2008).

Estimates of the finite rate of increase of about 1.5 (exponential rate = 0.4) have been recorded for two tropical populations on Fregate and Ascension islands (see the case studies in this review). These are likely to be near the intrinsic rates of increase, as the start density for the Fregate Island population was low and the time period over which the changes were measured was short. Thus despite a fecundity rate of up to eight offspring per pair, most (seven out of the eight) eggs and/or chicks are not recruited into the population.

This rate of increase essentially means that around half of the population (once a control has reduced a population) would have to be removed each year merely to stop it increasing.

3.7 Behaviour

Mynas are clever birds that are pre-disposed to adapting their behaviours to avoid dangers posed when living amidst people (Griffin 2008).

Mynas form large roosting flocks throughout the year in some places, although it is not clear if this is universal as breeding birds may or may not join roosts (Telecky 1989). They prefer to roost in dense canopy trees (Yap et al. 2002). They form smaller foraging parties, and are most vigilant when only single or pairs of birds are present, although forming groups had no effect on the foraging rate or food intake. They are more vigilant in the afternoon than in the morning (Newey 2007).

King (2010) has suggested that myna feeding groups consist of a few leaders and many followers. This supposed hierarchy has not been confirmed in detail for mynas but has been confirmed for other group-feeding birds such as pigeon (Nagy et al. 2010). In relation to trapping mynas, King (2010) suggests that if a high ranking leader first solves the problem of entering a trap, it will soon be followed by many followers. Conversely, if a follower is the first to enter the trap then fewer birds will follow it. This may have implications for the best decoy birds to use as call birds, and explains the observation from Denis Island (see Feare 2010a).

Mynas avoid places where they hear distress calls or observe other mynas being molested by humans (e.g. when disposing of trapped birds) (Griffen & Boyce 2009).

Common myna (*Acridotheres tristis*). © Chrharshaw. Source: Wikimedia Commons.

4. Managing pest animals: planning, delivering and monitoring a project

There are whole books written on how to plan and manage pests[1] and weeds (e.g. Braysher (1993), Hone (1994), and Clout & Williams (2009) have many relevant examples), and these are subsets of the more general study of wildlife ecology and 'harvesting' theory, e.g. Caughley (1977), Sinclair et al. (2006). It is not the intention to cover all this material here. This review, and upcoming workshop, focus on the process to plan and deliver a pest control project – in this case on pest birds such as the myna – but they are underpinned by the theory and practice of pest and wildlife management.

4.1 Project cycle

The Pacific Invasive Initiative (PII) has developed a project cycle to describe the phases of a typical invasive species management planning and delivery process (Figure 3) in which part of the information set out in each phase cascades to the next phases of the cycle. In some planning systems the whole cycle is encapsulated in a single document. For example, if the people with the problem own the island, get all the benefits of the proposed action and have the funds to do it, then they are the only stakeholder that can say start or stop and can proceed as they like. However they still might think about the options to start, how to do it, who should do it, etc. using the project cycle outlined here.

This is sensible as decisions to proceed with the project (or to stop and reconsider) have to be made at several different places in the cycle. Spending time and money on, for example, details of operational planning would be redundant if the feasibility phase led to a 'stop' decision. Planning documents that group all these stages together can also result in non-productive arguments between stakeholders with no expertise or stake at that level of the cycle.

Often, however, the proponents and beneficiaries have to seek outside funding or capacity to achieve their goals. Outside funders usually want to see that their money is going to be efficiently spent and achieve the goals and benefits claimed. In this case, addressing the particular interests of the funding stakeholders becomes critical.

Basically the phases of the PII project cycle address five main questions, each aimed at a different audience and with overlapping sets of wider stakeholders (Table 1). It can help to produce the planning steps (a to d) as discrete documents in language and content specific to the target

1 In the Pacific, "pests" usually refer to species that are a nuisance to people or affect agriculture or other production values, while "invasive species" refer to those affecting biodiversity. Mynas are both pests and invasive species so the terminology can be confusing. More generally, "pest" implies a species that adversely affects some asset valued by people, and so a pest can be both an introduced invasive species or a native species and affect both production values and biodiversity values. Generally, people think of invasive species as pests, but not all invasive species are seen as pests – they may introduced and common but have no effect on people or the things they value.

stakeholder audience. Of course the details within each phase of a project are usually very specific to the target species and that project. However, the PII has developed a set of guidelines (for eradication of rodents and feral cats) that attempt to generalise best practice options so managers can select the best approach for their particular project. What follows in this review sets out some of these generalisations most relevant for the eradication or sustained control of mynas that might act as background for the production of an invasive bird guideline in the PII format.

Figure 3 Phases of the Pacific Invasives Initiative project cycle.

Table 1 Key questions across the phases of an invasive species management project: who asks them, who answers, who is the decision-making audience, and which wider stakeholders are most interested. The PII also has an earlier phase of prioritisation and project selection, but here it is assumed that a bird pest project has already been identified as a priority for more detailed consideration and potential.

PII project phase	Key questions	Who should ask?	Who should answer?	Decision audience	Wider stakeholders
Project selection Project justification	Is it a priority project? Is there a problem worth fixing?	Beneficiaries	Proponents, advocates	Beneficiaries, proponents and funders	Anyone affected by the pest
Feasibility	What are the strategic, tactical and logistical options to fix it?	Proponents and potential funders	Independent analysts	Funders	Potential project governance team; wider community in their role as potential constraints
Project design	How is the project to be governed, designed and managed?	Governance team	Project team	Funders and proponents	Potential operational team
Operational plan	How will the project be delivered?	Project team	Operational manager	Governance team via the project manager	Wider community that is affected by planned work
Implementation					
Assessment	Was the problem fixed? What ongoing work needs to be done?	Beneficiaries, governance team	Depends on complexity of the questions – operational manager or researchers	Beneficiaries, funders	All internal stakeholders, external stakeholders

4.1.1 Project selection and justification

Selecting one project from a list of possible projects is not simple when financial resources prevent doing every one. Additionally, the scale over which any ranking of projects is done (local, national, regional) is also set by how the funding is to be allocated, and whether the ranking is for pests of biodiversity and/or pests of economic values. Input costs for pest control can usually be estimated in dollars, but unless the benefits of action can also be expressed in dollars a cost/benefit comparison between competing project proposals is not possible – or is at least contentious. Even when the benefits have some monetary value, prioritisation is often confounded by collateral non-monetary outcomes, such as the social and cultural sustainability of affected communities (e.g. McGregor & Bishop 2011).

Choquenot & Parkes (2000) recommended using cost-minimisation or benefit-maximisation approaches to allocating limited budgets to pest control to protect biodiversity values. Cost-minimisation sets the desired outcomes of pest control and attempts to achieve them most efficiently – thus with a limited budget a manager might attempt more projects in a prioritised list. Benefit-maximisation identifies the strategy that gives the best outcome for a fixed budget – thus with a limited budget a manager might make sure of success in the highest priority projects. This prioritisation process is worthy of a workshop on its own, and is addressed no further here.

Once a project has been nominated for further development, those championing it need to expand on the values or assets at risk from the putative pest that were noted (usually in brief) in the prioritisation system. This is usually done by those who benefit directly from the project (particularly when the pest is affecting an economic asset) or by proponents representing the wider beneficiaries (particularly when the asset is a community-owned one such as biodiversity).

4.1.2 Assess the management options in a feasibility study

This phase aims to convince those who have to approve and/or fund the project not only that it is worth doing (repeating the justification details above) but that the various ways of doing it have been considered. The 'ways of doing it' need to consider which strategies are appropriate or possible (eradication, sustained control, or do nothing), what tactics are available and best suited to each strategy, what set of options are likely to be supported by key stakeholders, and give a first estimate of the costs for each option. Feasibility studies are aimed primarily at the decision-making stakeholders but also set the scene for the next phases of the project. Feasibility studies need to be convincing, critical and unbiased, and so are best done by someone other than the proponents or those with a stake in delivering the project, at least for complex or risky projects.

One key decision all pest project managers have to make is whether to attempt eradication, plan for sustained control, or to do nothing because the problem is intractable with current resources and capacities. The rationale behind such a decision is most appropriately argued in a feasibility study.

Feasibility studies identify the constraints and uncertainties inherent in the various options to manage the problem so the risks are transparent to decision-makers. Depending on the nature of these risks, their options are then to stop the project, delay the project and resolve some of the uncertainties, or proceed despite the uncertainties but try and resolve them (by adaptive management) as the project proceeds.

The basic biology of many common invasive species is often well understood, but for mynas this is still a work in progress. Managers always face an issue about whether to start managing in the absence of perfect knowledge about the problem or to invest in research to improve knowledge before management begins (e.g. Feare 2010b). There can be no hard and fast rule to help with this choice, but one way forward is to use the management itself as a way to improve knowledge about the problem (e.g. Parkes et al. 2006).

Eradication

Eradication is the permanent removal of the whole population of pests. Once achieved it stops any further damage that the pest was causing and may allow natural recovery or active restoration of past damage. However, to achieve eradication some conditions[2] should be met (Parkes & Panetta 2009):

- The average annual long-term rate of removal in source populations must be greater than the annual intrinsic rate of increase. This rule covers the older 'all at risk and rates of removal' criteria (Parkes 1990), and is applicable to situations where we have source-sink populations or where Allee effects[3] have been argued to negate the 'all at risk' condition (Liebhold & Bascompte 2003). It also implies the funds are available to achieve the rule.
- There is no immigration of individuals that can breed. Logically this can never be quite met as the pest arrived once and could do so again. Therefore, on-going border management and surveillance is needed with the location of the effort along the risk chain (from source populations, on vectors such as ships, to the site being protected). This is based on assessment of the risks and likelihood of reinvasion and the costs of remedying any breach.
- There must be no net adverse effects. Eradication may not be desirable if the adverse effects on non-target species of the control methods available are predicted to be unacceptable and unresolvable, or if the consequences of removal of the pest outweigh the benefits (Courchamp et al. 2003).

Clearly, one has to have the tools to kill or remove the animals and a strategy to apply them to ensure all the above 'start rules' are met, and all the constraints on their application (stakeholder support, legal sanctions, environmental and non-target issues, funding, etc.) need to be overcome or managed. If the rules cannot be met and/or any constraints not overcome, then eradication is not possible, and setting it as a goal can distract from the planning required for optimal sustained control.

Eradication strategies fall into two categories. Some achieve their goal with a single event that, if done well, may kill 100% of the target population, e.g. the eradication of rodents using aerial baiting. Others achieve their goal by applying a sequence of events that successively reduce the target population to zero. Eradication of established populations of mynas (and most birds) are of this type. These control events may be simply repeated application of one technique but usually are a mix or sequence of different control techniques. These two types of eradication have quite distinct management consequences.

For the first type, managers get one chance at success. In these cases, meticulous planning, over-engineering, fail-safe and back-up systems are the rule because everything must go right on the day (or few days) of the operations (Cromarty et al. 2002). The rule is 'do not start unless it is all in place'. However, generally such methods (e.g. aerial baiting for insular rodents) provide no information on the success or failure from the operation itself and, because the cost or ability to detect and locate survivors (so any can be killed cheaply) is often more than the cost to repeat the whole operation, adherence to the start rules is the key to success.

For the second type of eradication, the sequence of control events themselves can provide managers with on-going information on the location and changes in numbers of survivors, such

2 Several sets of obligate and desirable rules and conditions have been proposed, but the most recent by Hone et al. (unpublished) were summarised by Parkes & Panetta 2009).

3 Allee effects are factors that put low density populations at risk of natural extinction.

as GPS locations of traps or animals shot, trap-catch rates or kill-rates. This allows managers to be flexible and adaptive as the project proceeds, so having everything just right on day one is not as critical. However, for these projects it is the 'stop rules' that are difficult: how do you know that no animals are left when no more are seen or killed; and so when should you stop, demobilise and declare success? In this type of project it helps to think about managing it in phases:

Initial knockdown

Good maps showing where the pests are and are not (a delimitation survey) are an important input for planning an eradication operation. If the population is not present over the whole area, a general rule is to deal with outlying sub-populations first; at least if these are capable of sustaining themselves without input from the core populations. This 'rule' has evolved from weed management where outliers are likely to be self-sustaining. It is less rigid for animals where outlying groups may not be viable sub-populations and in fact rely on dispersal from the core population – in which case the core is the key target.

A second rule of thumb for this initial phase is to first use control methods that do not teach survivors to be wary. It is often a mistake to deploy all the control tools in the toolbox at once from the start. Sub-optimal control tools may kill a few animals but may also interfere with the effectiveness of the optimal methods.

The third rule of thumb is to attempt to do this initial phase as quickly as possible to avoid a drawn out process; if the initial phase is spread across many years, the animals can replace a large part of their losses in every breeding season.

Therefore, some thought about the best sequence of control tools is required when several methods are available.

Mop-up of survivors

Most eradication attempts of this type reach the stage when only a small proportion of the original population is left. This often consists of old, wary individuals that have survived all thrown at them in phase 1, and/or are animals living in places where any control is difficult, e.g. the topography makes access hard, or the presence of people or livestock restricts the use of some control tools. Clearly good feasibility and plans should predict how these survivors will be located and killed, and good operational plans should not leave such contingencies to chance.

Validating success

Eventually a stage is reached when no more animals are found or killed and it might be that the eradication has succeeded. However it is difficult to determine whether this is indeed true so the project can stop and success be declared (see section 6.2).

Sustained control

Sustained control is a much more complicated strategy than eradication (Choquenot & Parkes 2001). By definition it is a form of harvesting, as the pest population has to be reduced (in size and/or distribution) to a level such that their effect on the asset to be protected is absent or mitigated, and then they must be culled periodically to ensure that this state is maintained.

Therefore, a key decision that must be made either before a project starts or, (more usually) by starting a project and finding out as it proceeds, is *how few pests is few enough?* This requires some knowledge about the relationship between pest density and the density or condition of the biodiversity or other assets being affected. It is this relationship and the biology of the pest (its population stability, rates of increase, etc.) that ideally determine the frequency and/or intensity of control. Some managers prefer or need to set this target density at zero and then manage any immigrants. Sometimes the asset being affected is so vulnerable that a zero pest target is required, at least until the asset has recovered and is less vulnerable. However, when some higher pest density is sufficient to allow the asset to recover, setting target pest densities much lower than required is costly and so has opportunity costs. The increased costs come either because the cost per unit removal of pests increases exponentially as pest density declines (for control methods that accrue as a cost/pest removed), or the maintenance control has to be applied more frequently.

Do nothing

If eradication is not possible and if the capacity to reduce the density or distribution of the target pest cannot be achieved (usually because no effective control tool or ability to deliver it is available) or if the on-going commitment to fund sustained control is absent, then managers should do nothing. Of course if the problem is critical, the solution is to invest in research to develop a tool (if that was the issue) or lobby for commitment from funders.

4.1.3 Project design

Once funding is approved in principle and one of the options has been selected from the feasibility study, someone has to deliver the work on the ground. The first step is to form a suitable team to design the higher levels of project management. Such tasks include re-defining the recommended option on strategy and tactics from the feasibility study, appointing project and financial governors, setting timelines and milestones, appointing staff, planning to manage risks, and planning monitoring.

4.1.4 Operational planning

Generally the project design team will appoint an operational manager whose task is to write a detailed plan on what is to be done, decide who is going to do it and manage staff, volunteers, and contractors as appropriate. An operational plan includes the actual control work, but also needs to include who does what with respect to monitoring and biosecurity. Often the operational manager will need to bring in outside advisors on technical aspects of these planning items. An operational plan might be very specific for some types of project (e.g. eradication by aerial baiting of rats where everything has to go right on the day), but might be more flexible for other types of project (e.g. eradication by successive culls, events where new information comes from the project monitoring, and for all sustained control projects). Training the people doing the work may take place in this phase or may be done in the implementation phase, depending on the particular type of project.

4.1.5 Implementation

Do the control and monitor outcomes.

4.1.6 On-going requirements

Some projects may have stop rules defining the point at which eradication was achieved (see section 6.2). However, even these projects need some on-going biosecurity process to match the expected risk of re-invasion. All sustained control projects are by their nature on-going so the results of monitoring need to feed back to the first five stages of the cycle to see if the goals were realistic, the methods feasible, and the project design and operation working effectively and efficiently – otherwise the funds or commitment to maintain the project will stop!

All pest projects require some level of ongoing surveillance and reaction to immigration. The pest reached the island or place at least once in the past, so logically it could do so again. The chances of this happening can be very low, e.g. only if people deliberately reintroduce the species, or they can be high, e.g. there are source populations and vectors such as ships or source populations within flying or swimming distance for the pest. The consequences of re-invasion might be trivial and simple to manage, e.g. a new pet animal discovered might be removed or sterilised, or they may be disastrous and hard to manage other than by repeating the original eradication.

Given that money to manage these risks is always limiting (or nearly always, see Jarrad et al. 2011) the question is where along the risk chain (from source population, on likely vectors, to on-island surveillance and reaction) can a manager reduce the greatest amount of risk for a given investment? The answer is not clear, and certainly not the same for all pest species.

5. Methods to manage mynas

There are many ways mynas can be killed or removed, and each have potential advantages and disadvantages (Table 2).

Table 2 Summary of advantages and disadvantages of control methods for mynas

Method	Main advantages	Main disadvantages	Best to use in phase
Traps	Few non-target risks	Teaches birds to avoid traps – quickly if used inappropriately	Initial knockdown
Nets	Few non-target risks	Limited success	Mop-up
Nest snares	Labour intensive but can catch wary adults	Limited scope for large-scale control	Mop-up
Shooting	Can target wary birds	Limited in some urban areas	Mop-up
Poisons	Can eliminate many birds; low chance of creating wary survivors	Non-target risks	Initial knockdown

5.1 Traps

Many types of traps have been used to catch and remove mynas. All traps need to be baited with food, but decoy traps, i.e. those with call birds held in a cage adjacent to or within the trap, appear to be better than traps baited/lured only with food (see Table 3).

Traps are best set in open spaces, presumably because mynas are less wary when they are away from habitats that might harbour predators, and in places without human disturbance. These conditions take advantage of mynas' favoured feeding strategies and social behaviour. Plentiful, attractive food as a lure and socially active decoy birds are essential for best effect (e.g. King 2010).

Call or decoy birds increased trap success by an order of magnitude over simple traps (Table 3). The experiment (King 2010) set a MynaMagnet trap with no decoy birds between June 2006 and December 2007, and then with a decoy bird from April 2008 to January 2010. One cannot rule out a year effect, but the order of magnitude difference in success rates strongly implies that decoy birds are essential for optimal success. Interestingly, work done on Denis Island (see case study 7.2.2) suggests that some mynas make better call birds than others to lure mynas into a trap (Feare 2010a), a suggestion that requires further experimental work to clarify and determine whether such birds can be identified a priori and so used to improve trap success. Some practitioners (Elder undated) suggest that mynas caught outside the target population make the best call birds.

Table 3 Trap success rates with and without decoy mynas in a MynaMagnet trap set in suburban Canberra (after King 2010)

	Trapping effort (trap-days)	Mynas caught	Starlings caught
No decoy birds	131	8	395
With decoy birds	276	205	112

5.1.1 The MynaMagnet trap (www.mynamagnet.com.au)

The Myna Magnet trap (Figure 4) uses food to lure birds into one cage (the left hand cage in the left configuration or the lower cage in the right hand configuration). The other cage holds a call bird which attracts mynas to the area and also lures them into the holding cage. Birds are initially allowed to escape from the holding cage but eventually the holding cage is orientated and fuzzle/funnel valves fitted so that the birds are trapped. The trapped birds act as additional call birds to lure more mynas to the trap. Water, food and shelter from the sun and rain are also provided in the holding cage.

One trapping group in New South Wales (Elder, undated) recommends baiting around a trap for days or even weeks until the birds are used to the trap. Then remove all bait from around the trap and offer baits in the trap. They also recommend using small baits that the birds eat on the spot, rather than large baits which mynas often fly away with. Birds caught should not be removed or killed (if possible) while free mynas can observe their fate. Removal at night is best.

The traps come in two sizes (the MynaMagnet and MiniMyna), and cost about USD$400 and US$200, respectively. They come with a large plastic cover to enclose the holding cage so birds can be killed with carbon monoxide from a car exhaust or compressed CO_2 (Tidemann & King 2009). Other humane methods to kill birds include crushing the neck just behind the skull with round-nosed pliers.

Figure 4 Myna Magnet trap.

Smaller decoy traps with a central cage for the call bird and several small catching compartments around it have been used, e.g. on Tenerife Island. These usully catch one bird per compartment.

5.1.2 Australian Crow (MAC) trap

Figure 5 Large 'crow trap' used to trap starlings in Western Australia.

This large trap (Figure 5) has been used successfully to trap starlings in Western Australia (Parkes 2008). It has a long one-way entry system along the groove on the top and a small cage for holding a call bird. The author is not aware of it having been used for mynas but it may be useful at sites where large numbers of mynas congregate – providing suitable call-birds and/or attractive baits.

Campbell et al. (2012) showed that the MynaMagnet trap caught about 1.5 times more starlings than the crow trap.

5.1.3 Funnel and other traps

There is a large variety of box and funnel traps that have been used to trap mynas. Generally they are not successful although the last mynas on Fregate Island were caught in such a trap. These traps rely on bait to attract the mynas and appear to catch more young birds than traps using decoy birds (Feare & Saavedra Cruz 2009).

5.2 Nets

Standard bird mist nets have been used to catch mynas although Tindall (1996) found them ineffective in his study on Moturoa Island in New Zealand. Tidemann (2010) experimented with large nets to enclose whole roost sites, but without much success.

Gun (cannon or rocket) nets are sometimes used to net large flocks of birds but to the author's knowledge have not been used to net mynas.

5.3 Nest snares

Snares set in nest holes or artificial nest boxes (Figure 6) have been used to catch breeding adults. (Millett et al. 2005).

Figure 6 Nylon fishing lines set as snares in a nest box.

5.4 Shooting

Shooting, where appropriate, can remove a large number of mynas. The best firearm might depend on the phase of any project, with silenced airguns or rifles being used when birds are naïve or to shoot breeding birds at their nest sites especially when young are present and the adults are committed to return to feed them, while shotguns might be better once birds are wary. On Atiu Island single shooters have removed large numbers of birds but it is thought a team approach may be required, i.e. where birds that escape on shooter cab be waylaid by a second shooter positioned at an appropriate escape route

5.5 Poisoning

Poisons are a vital tool for pest management but need to be used with care. Registered toxins should be used according to the instructions on the manufacturer's label as this is generally a condition for their legal use in most countries, and is usually underpinned by best practice and research. However, most countries do not list mynas on the labels of registered toxins so the use of, for example, Starlicide® to target munas is an off-label use and required some special approval such as experimental use permits.

All vertebrate toxins have some potential adverse affects – they may kill non-target animals, and some are persistent in the food chain or environment even when they do not kill the animals. Most vertebrate toxins kill a range of animal species, although each toxin affects different classes of vertebrates in different ways, e.g. the anticoagulants used to target rats can have a range of toxicities for birds from quite toxic (brodifacoum) to not very toxic (diphacinone). Anticoagulants are not very toxic at all to most reptiles (e.g. Fisher et al. 2012). Anticoagulants also have an advantage (as a control tool) in that animals that eat them do not show symptoms for some time and so do not learn to associate feeling sick with eating baits. Some toxins can be metabolised to non-toxic chemicals quite quickly in animals that eat them or can be quickly degraded by bacteria and fungi in the environment, especially if they are water soluble. Others are not quickly metabolised in animals that eat them and so the animal itself (alive or dead) can present a secondary risk to predators or scavengers. Other toxins can bind to soil particles and persist in the environment. The symptoms caused by different toxins in different species also range from quite mild to quite severe and thus not humane.

The ideal toxin is one that is lethal to the target species and less so to non-target species (targetting can involve making the bait preferred or available to targets but not non-targets); has delayed symptoms so animals do not learn to avoid baits if they eat sub-lethal doses; does not persist in the bodies of animals that eat baits or in the environment; and is humane. Most managers have to trade off these ideals for target efficacy to some extent, e.g. the persistence of some very good rodenticide anticoagulants (such as brodifacoum) mean they should not be used repeatedly or continuously to control rodents. Using them once to eradicate rats is effective and limits the accumulation problem, but continuous use as a sustained control tool will cause potential problems – accumulation in the food chain or an increase in genetic resistence in the target species.

Fisher et al. (2012) have reviewed many avicides that might be usable in eradication projects, in their case of sparrows and feral pigeons on the Juan Fernadez islands of Chile. More general reviews of avicides have been done by Spurr & Eason (1999), and by Tracy et al. (2007). As with other vertebrate toxins there are a range of chemicals that have been used, and fortunately two toxins most commonly used have many of the desirable characteristics noted above.

These two toxins are alpha-chlorolose and Starlicide®. Alpha-chlorolose is a narcotic and an acute toxin. At low doses in birds it leads to mild convulsions before somnolance and eventual recovery. At higher doses the somnolance leads to death. When the climate is colder fewer birds recover from the somnolance. It is not persistent in animals that eat it, with most excreted within 24 hours. Birds are more susceptible to alpha-chlorolose than mammals, with LD_{50s} ranging from 32 to 178 mg/kg for birds and 100 to 1000 mg/kg for mammals (Spurr & Eason 1999). The LD_{50} for mynas is likely to be about 75 mg/kg – that of starlings – which would mean half the mynas (weighing 125 g) would die from a dose of 9.3 mg of the toxin. Dogs and cats have been reported as non-target victims of alpha-chlorolose (Fairweather et al. 2008).

The advantages of alpha-chlorolose is that some non-target victims can be rescued and resuscitated, especially in warm climates. The main disadvantage is that although birds do not give distress calls when poisoned they do act oddly with erratic flight, and wing and tail convulsions. Mynas that have not eaten baits are frightened away and also associate the fright with the bait and avoid it in the future.

Tindall (1996) used alpha-chlorolose (1% by weight on 1 cm^3 pieces of white bread) in places that had been pre-fed with non-toxic baits for 3 or 4 days, and in places with no pre-feed but with a call bird. He observed 32 mynas feeding and recovered 13. The rest flew off but were assumed to have died. While this trial showed alpha-chlorolose could kill mynas it was insufficient to show whether it could control populations. A few months later Tindall (1996) trapped 425 mynas on the island.

Starlicide® (or DRC 1339) is a more useful toxin for mynas than alpha-chlorolose. It has a very low LD_{50} for mynas of 1.19 mg/kg (Avery et al. 2011). The LD_{50} for starlings is around 4 mg/kg and for Norway rats is 1500 mg/kg, so mynas are very susceptible to the toxin. Providing the correct doses are used, it has delayed symptoms so that mynas that eat baits show no symptoms at the feeding site and so do not deter other birds from feeding. It is important not to put too much toxin in the baits to ensure these symptoms are delayed and the birds do not associate baits with symptoms.

The recommended way to use Starlicide® is to pre-feed for many days until all local mynas are used to the bait, then mix a 2.5 g sachet of the toxin with 1 kg of bait and mix that with about 10 times the weight of non-toxic bait (B. Simmons, pers. comm.) The toxin can be surface coated on to bait and it helps to add a little icing sugar to the mix to mask any taste – the toxin is bitter to mammals but birds are not supposed to be able to taste it. An alternative method is to use 130 ml of a 7.5% solution on 1 kg of bait (New Zealand Food Safety Authority 2002). The toxin is absorbed through the bird's gut into the blood and is metabolised in its liver within 3 to 24 hours (Ramey et al. 1994) and the metabolites are excreted so the toxin and its products do not accumulate in the birds. This means little toxin remains in the bird and so reduced non-target risks to animals that may eat dead or dying mynas. For example, only 10% of DRC 1339 remained after 30 minutes in starlings dosed with very large amounts of the toxin (Cunningham et al. 1981). Symptoms include listlessness, inactivity and increased breathlessness. Death is non-violent and without spasms, which is important if birds learn to avoid baits by watching others that appear ill (DeCino et al. 1996).

Oral toxicity to humans is probably low, but as little is known about its other effects on the skin or when inhaled people should wear gloves and face masks when preparing the baits.

Baiting near roost sites and at favoured feeding sites (rubbish dumps, pig sties) have been tried. It may be best to provide the toxic bait in the late afternoon so that birds do not generally display symptoms until they are roosting at night. This should minimise any potential for learning in other mynas.

5.6 Nest destruction

When nests can be located it is possible to disrupt the breeding of birds by simply destroying the nests, or removing the eggs and chicks. The extent to which this assists in controlling the population depends on the proportion of nests destroyed and the capacity of the breeding birds to find alternative safe nesting sites.

On tropical islands mynas appear to have long breeding seasons and so may rear replacement clutches if the first nest is destroyed. This will limit the effectiveness of nest/egg destruction as a control tool unless all clutches are destroyed.

6. Monitoring methods for mynas

6.1 Estimating changes in myna numbers

Several studies have 'estimated' the abundance of mynas or the trend in numbers after control, as discussed in the following sections.

6.1.1 Counts in roosts

On Atiu Island, Mitchell (2009) and Heptonstall (2010) counted birds leaving a randomly selected subset of roosts at dawn and returning at sunset over repeated days. They used the highest count as the estimate of birds in each roost. They estimated the number of roosts on Atiu and by extrapolating the number of mynas in the population, i.e. a census. Mitchell (2009) did this before the birds were controlled and Heptonstall (2010) a year later after large numbers had been removed (see case study 7.2.3). Mitchell (2009) reported that the islanders had found 38 roosts on Atiu Island and, from her surveys of nine roosts, recorded highest counts averaging 91 ± 20 (SE) birds per roost with a range of between 36 and 218 birds. Heptonstall (2010) found 3 of the 9 roosts had been abandoned after the myna control but that the numbers of birds in the remaing roosts had not declined significantly (mean = 80 ± 21 (SE) with a range of 27 to 138 birds per roost).

This method obviously assumes that maximum counts detect all birds in each roost, and that there is not some between-day effect if birds use more than one roost. Tidemann (2010) suggested mynas have low roost fidelity.

6.1.2 Transect counts

Several studies have counted birds (generally in the morning after roosting birds have dispersed) along standard routes (Mitchell 2009; Heptonstall 2010; King 2010). These indices (mynas/km) can be used to estimate trends (King 2010); with some major assumptions about constant detection probabilities which are unlikely to be met if the population is under some sort of control. Alternatively, Program Distance has been used to estimate myna density if the distances the birds are detected from the transect are recorded (e.g. Heptonstall 2010).

6.2 Validating eradication

If you search and find no mynas, what is the probability that no mynas are present, i.e. that eradication has been achieved or that no birds have colonised the area?

This is a major issue which occurs at the end of all eradication projects and in biosecurity surveillance. In the past it has been answered by a combination of arbitrary repeat searches with no sign of survivors, or by a wait-and-see approach to allow any survivors (and their offspring) to become visible by weight of numbers.

However, there are now objective methods to measure this probability (e.g. Ramsey et al. 2009, 2011), and they could be applied to myna eradication projects. The information needed is (a) the detection probability of the search system or device – note that control methods such as traps or shooting are also detection devices, and (b) where the search/detection system is deployed – if you do not look in certain places you can say nothing about presence or absence of the birds in those places. It is obviously important to measure the detection characteristics of the system while there are still birds to detect, rather than try and do this at the end of the eradication when little or no information can be obtained.

Detection probabilities are the probability that, given at least one animal is present, the device will detect an animal. A device might be a specialist surveillance tool such as a camera trap, it may be the control device such as a trap, or it might be a person searching. All might be deployed as some array to cover all or part of the area where an animal may be present.

The analytical methods to determine the probability of eradication (or the extra surveillance to increase this probability to a level at which the risk of false declaration of success is acceptable to managers) are complex (e.g. see Ramsey et al. 2009, 2011 for examples for feral pig and feral cat eradications, or Anderson & Samaniego-Herrera (2011) for rat eradication). Generally, statistical advice should be sought both during phase 1 and 2 above (when the necessary data need to be collected) and to analyse the results.

6.3 Measuring the benefits of myna control

The impacts of mynas on other birds are subtle, so measuring any benefit from myna control is not simple. The author is not aware of any methods used to date that are not potentially confounded by other management or by the lack of formal experimental controls (see section 3.1 and the case studies in section 7).

Measuring the benefit of control of nuisance mynas in urban areas is essentially a social issue. Perhaps the simplest way would be to count the number of complaints from the public before and after the mynas were controlled.

7. Case studies

With the previous sections as background we can now look at projects that have attempted to control or eradicate mynas and see whether they conformed to best practice and whether they succeeded or failed.

The case studies have been divided into attempts to eradicate small and incipient populations, attempts to eradicate large established populations, and sustained control programmes for large populations. Clearly, the boundaries between these classes of projects can be blurred, as unrealistic goals are set or as sustained control projects mutate into eradication ones or vice versa.

7.1 Attempts to eradicate small populations

Small populations can be recent arrivals living in small parts of large islands, or small populations (both recent or long-established) on small islands.

7.1.1 Tenerife Island

Tenerife Island (203 438 ha) in the Canary Islands of Spain is a volcanic island with a population of nearly 1 million people. Mynas escaped from the pet trade and were first seen in the wild in 1994. Twelve birds were estimated to be present in 1999 (Saavedra 2010).

Over five months in 1999/2000, a small decoy trap with a call bird but no bait caught nine birds in 60 trapping days. Another one was shot with an air pistol. Although two birds were thought to remain, none have been confirmed since the project ended (Saavedra 2010).

7.1.2 Gran Canaria Island

Gran Canaria Island (156 000 ha) in the Canary Islands of Spain is also a volcanic island with a human population of nearly 1 million people. Mynas escaped from the pet trade and were first seen in the wild in 2006. Three birds were trapped in 2006 in 9 trap-days of effort using a decoy trap with call bird and with food as lures (Saavedra 2010). No new birds have been reported.

7.1.3 Mallorca Island

Mallorca Island (208 000 ha) in the Spanish Balearic group in the Mediterranean Sea is a continental island with a human population of nearly 1 million. Mynas were first seen in 1998 when birds escaped the pet trade (Saavedra 2010). In 2006, small decoy traps were set for 27 trapping-days effort and removed 13 birds over 30 days. One further bird was shot. It was estimated that seven mynas survived this operation. It is claimed none were present in late 2009 but it was not reported how these residual birds were removed (Saavedra 2010).

7.1.4 Fuerteventura Island

Fuerteventura Island (166 000 ha) in the Canary Islands of Spain is also a populated (nearly 1 million people) volcanic island. Mynas were first seen in the wild in 2006 as escapees from a zoo (Saavedra 2010). Twenty birds were trapped in a small decoy trap in 10 days in 2008, leaving a small number of survivors. Mynas were present in late 2009 (Saavedra 2010).

7.1.5 Fakaofo Atoll

Fakaofo Atoll in the Tokelau Islands (400 ha of land) is a coral atoll with a small human population. *Rattus exulans* is present. Twelve common mynas were reported as having arrived as stowaways on a ship from Samoa in 2004 and by early 2006 it was estimated that 40 birds were present (Nagle 2006).

The effect on local biodiversity from these mynas was not known but the islanders wanted to be precautionary and eliminate any potential threat and avoid the known nuisance the birds might cause. The island council provided a bounty of NZ$200 which resulted in only one bird being killed.

A feasibility study conducted in 2006 searched four of the Fakaofo motu suspected of having mynas and found three jungle mynas on Fale Motu but no common mynas. After discussion with Environment & Quarantine staff it was decided that the small population could potentially be eradicated and an operational plan was developed. A decoy trap and nest-box traps were constructed and staff were trained in their use.

The decoy trap was set on top of a pig pen that the mynas visited and the nest-box trap set up near known roosting and nesting sites.

The decoy bird was caught using alpha-chlorolose on bread and butter bait. No birds were trapped and the decoy bird eventually escaped. In 2009, the pig pens adjacent to Fale Motu were moved to Fenua Fala Motu, about 3.5 km along the atoll (S. Pelasio, pers.comm.) and it seems the birds followed. The cage trap and nest traps were not redeployed but local staff continued to destroy nests and eggs found. Two birds were photographed on Fakaofo in 2010, but none were apparently present in early 2012. It is possible that the nest destruction had stopped recruitment and the original mynas had died, but in early 2012, mynas were seen on Nukunonu Atoll some 64 km to the northwest (R. Pierce, pers. comm.).

7.1.6 Cousin Island

Mynas were introduced to the Seychelles from Mauritius in the late 18th century and are (or have been) present on most of the larger granitic islands and some of the coral cays in the country. The birds have been managed on five of these islands but source populations remain on the larger islands so even where the resident birds have been removed, reinvasion remains likely and so surveillance and prompt reaction to this likelihood is required.

Cousin Island (27 ha) is a granitic island lying 2.4 km from Praslin Island in the Seychelles. It is now largely forested and has research station and is visited by tourists but has no resident inhabitants. Five of the endemic Seychelles bird species are present and potentially threatened by mynas.

Mynas were apparently only temporary visitors until the late 1990s when 20–30 birds were present (Murray 1998) but had declined to a population of 6–10 birds in 2000 (Millett et al. 2005). Four birds were shot and one trapped at a nest between 2000 and 2002 and this apparently has removed the resident population (Millett et al. 2005).

The absence of suitable habitat (non-forested areas) suggests this island may not sustain populations of mynas.

7.1.7 Cousine Island

Cousine Island (27 ha) is a granitic island 2 km from Cousin Island and about 5 km to Praslin Island. It is managed as a private conservation and ecotourism venture involving a major restoration programme to manage weeds, replant native vegetation and reintroduce native vertebrates (Samways et al. 2010). Barn owls (*Tyto alba*) are also controlled but the island never had introduced rodents (Samways et al. 2010).

As with Cousin Island the island does not support a permanent population of mynas. Six birds were killed in 1992 and eight in 1994, but 4 pairs were estimated as being present in 1996. Currently no birds are on the island, but it is thought birds fly over from Praslin Island so ongoing surveillance and control is required.

7.1.8 Lessons from small eradication case studies

- Trapping alone, or trapping with some shooting appears to have been successful in most cases.
- Claims of eradication success are often uncertain. Birds were thought to have survived the control in some cases but their fate was unknown.
- Short intensive control campaigns (9 to 150 days duration) have apparently succeeded (on the Spanish islands).
- Ongoing control over many years (2–7 years duration) has removed mynas from some of the Seychelles islands, but restoration of indigenous vegetation on these islands may have reduced their attractiveness to mayns. Despite this, recolonisation is an issue for these islands.
- There is a suggestion that atolls may not be suitable habitat for mynas. Even on those inhabited by people (e.g. the Tokelau islands, and Tarawa) invasions of mynas have failed to establish and indeed may die out.
- While a short intensive eradication might be delivered by outside contractors, cases where recolonisation is likely are better managed by ensuring local capacity is in situ and ready to react promptly to a new population.

7.2 Attempts to eradicate large populations

7.2.1 Fregate Island

Fregate Island (219 ha) is a high (125 m asl) granitic island in the Seychelles lying about 23 km from la Digue Island and 45 km west of Mahe Island. It has a permanent human population associated with a tourist hotel. Fregate Island was the last refuge of the endangered Seychelles magpie robin (*Copsychus sechellarum*) and the endangered Seychelles white eye (*Zosterops modestus*) has ben introduced. Introduced cats were eradicated in the 1980s (Watson et al. 1992) and Norway rats and mice in 2000 (Merton et al. 2002). The evidence for mynas being a critical pest for Fregate Island's native species is (as elsewhere) weak, being based on observations of interference with incubating magpie robins and evidence of chick and egg predation on other smaller passerines in the Seychelles (Henriette Payet 2007; Feare 2010a). Justification for their eradication was therefore largely precautionary rather than based on hard evidence of a demographic impact on any of the native species.

It is not recorded when mynas arrived on Fregate but it was estimated there were 400–600 birds present in the early 1990s (Millett et al. 2005). An attempt at control was begun in 1992 by providing the local policeman with a firearm and later (in 2001) by nest trapping resulting in over 1000 birds being dispatched (Millett et al. 2005) (Figure 7). Nest trapping accounted for only about 12 pairs of birds in the first campaign, but as these were gun-shy birds within magpie robin territories it was suggested to be of value (Millett et al. 2005). Shooting ceased in 2002 before eradication was achieved – it was estimated (method not stated) that eight mynas were present in late 2002 (Millett et al. 2005).

The second campaign in 2010 had the advantage of experience from the first and from other attempts against mynas on other islands in the Seychelles. Up to 15 cage traps deployed at five sites were used. The traps used decoy or call birds and were baited with papaya. These were the main tactic deployed and accounted for 92% of the birds (Canning 2011) (Figure 8). One person (G. Canning) assisted by other staff from the island's tourist facility conducted the eradication. No estimate of the trapping effort (e.g. trap-nights) was given.

The last few birds, always of particular interest when eradication is the aim, were not caught in the cage traps but were finally caught in larger walk-in traps in 2011 (Canning 2011).

Four species of non-target birds were trapped (n = 111) with 12 mortalities. Hermit crabs were also trapped and released.

Figure 7 Annual number of mynas killed on Fregate Island, 1992–2002 campaign and 2010–2011 campaign (blue bars). The estimated maximum numbers of survivors (Feare et al. 1992, Millet et al. 2005) are shown in the brown bars.

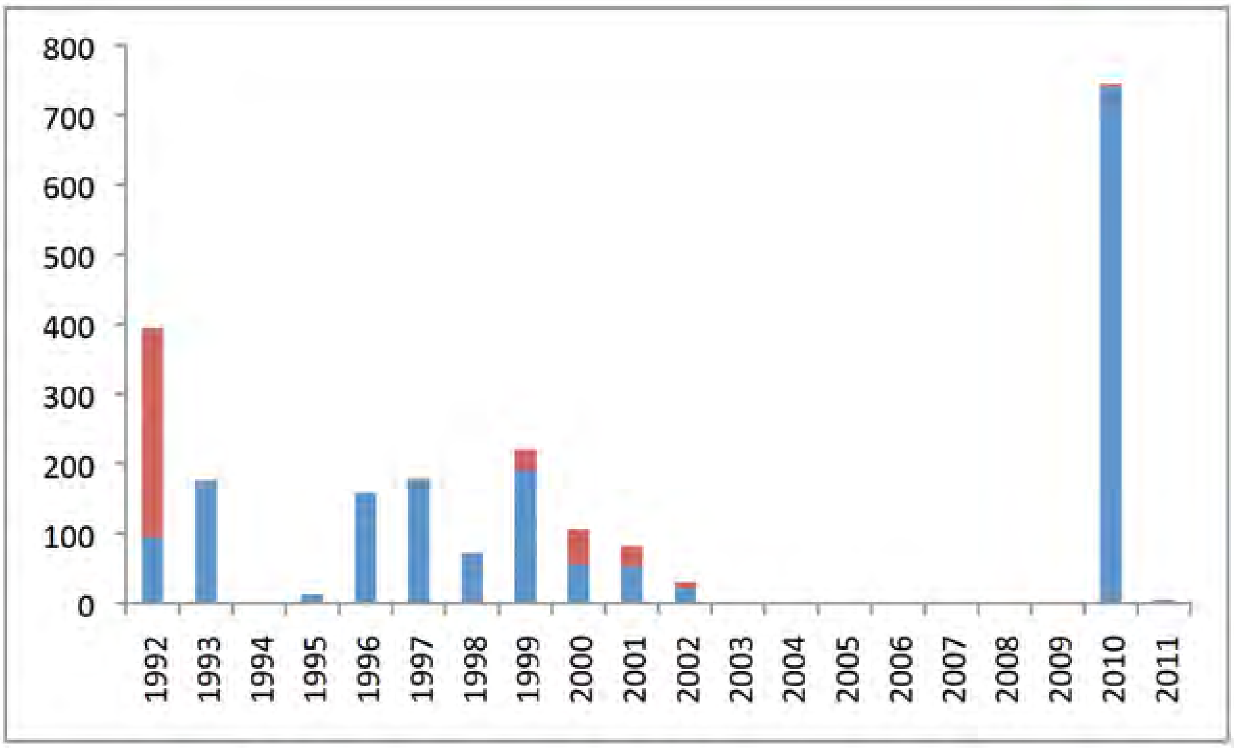
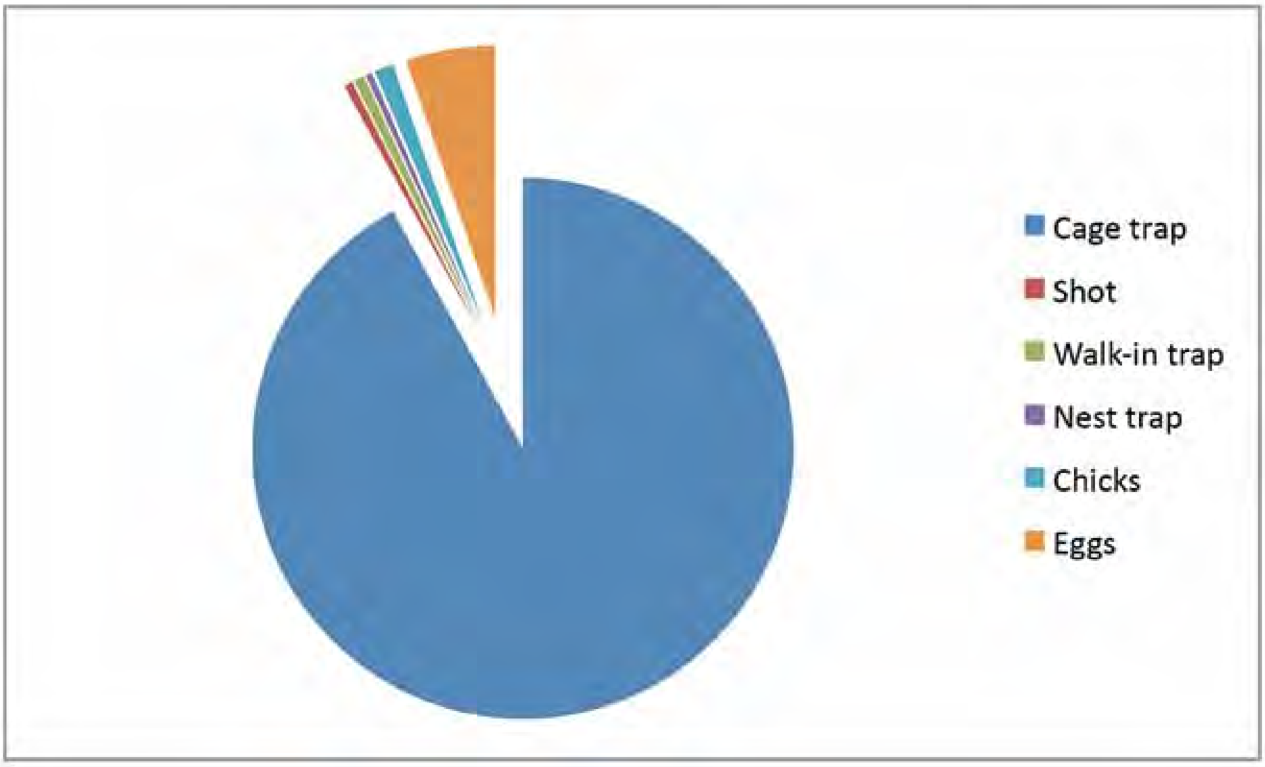


Figure 8 Proportion of mynas killed by four different control techniques and number of chicks and eggs destroyed in nests, Fregate Island 2010–2011 (after Canning 2010).



Points to note:

- The first attempt at eradication, largely using shooting, killed a lot of birds but the technique would have rapidly taught survivors to be very wary. The only secondary control tool used was applied in the territories of magpie robins (i.e. largely as part of research on this species) and not as part of a widespread 'mop-up' phase.
- Only eight birds were estimated to be present after this early campaign. However these are enough to grow over the following 8 years to account for the 1036 mynas dispatched in 2010/11:

  $\log_e N_t = \log_e N_0 + rt$

  $\log_e 1036 = \log_e 8 + rt$

  where r is the annual exponential rate of increase

  $r = 0.397$ or a finite rate λ of 1.487

  and N is the population size in year zero (N_0) and after time t (N_t).

  This estimate seems realistic from in situ breeding alone, i.e. without any immigration, and is the same as the rate calculated ($\lambda = 1.47$) for Ascension Island mynas (Hughes et al. 2008, unpubl. data quoted in Saavedra 2009).
- The density of mynas was 4.73/ha.
- The last five birds could not apparently be trapped in the cage traps but required an alternative method (a walk-in trap).

7.2.2 Denis Island

Denis Island (143 ha) is a coral island (4 m asl) in the Seychelles, lying about 50 km from Praslin Island. The island has been much modified by past human activities but is now a privately owned farm and luxury tourist resort whose owners are attempting to restore the island's biodiversity by reintroducing native biota (Shah 2001). Mynas are known or suspected to adversely affect the species being introduced (e.g. Komdeur 1996). Cats and ship rats (*Rattus rattus*) were removed in 2000 (Merton et al. 2002). Rats either reinvaded or the eradication failed and were finally eradicated in 2002 (Climo 2003).

Mynas were common in 2001 with a population guessed to be 300–350 (Hill 2002). The first control campaign began in August 2001 using toxic baiting with Starlicide® (DRC1339) followed by shooting, the latter accounting for 26 birds over 12 days. Millett et al. (2005) estimated between 40 and 60 birds remained when the project was terminated in October 2001– when the attempt to eradicate ship rats failed.

The campaign against mynas was restarted in May 2010 following the reintroduction of four species of endemic birds and the subsequent discovery of head injuries on three species which was attributed to mynas (J. van der Woude, pers. comm. To C. Feare) The current presence of introduced populations of native birds meant the use of toxins was constrained so this campaign now relies on trapping by short-term volunteers (Feare 2010a). Distance sampling on transects was used to estimate a population of 1000 mynas in May 2010, and by August over 500 birds had been removed with decoy traps (Feare 2010a). A total of 950 birds had been removed by April 2011 (C. Feare, pers. comm.). A second distance sampling survey in April 2012 estimated 78 mynas were left (J. van der Woude, unpubl. data). Between April 2011 and November 2012, 22 mynas were caught and although numbers alive remain low, this effort was insufficient to progress towards eradication (C. Feare, pers. comm.). Nevertheless, it appears the productivity of the Seychelles magpie robin and flycatchers has improved.

Points to note:

- It appears the nature of the decoy bird itself determines trap success rate. Traps set in groups have high between-trap variability, suggesting the call bird itself is somehow important, or that subtle differences in trap construction or site variations may play a role.
- Lack of staff continuity is a major problem, especially when eradication is the aim. Most trapping on Denis Island is conducted by short-term contracted volunteers working on a variety of projects. Interruptions in effort occur when the volunteers prioritised other tasks or became ill.
- The release of Seychelles robins and fodies before the attempt to eradicate mynas has restricted the control options, as poisoning would have been risky to the native birds.
- In this case, the trapping project suffers from trap-competition from Madagascar turtle doves (*Streptopelia picturata*) and moorhens (*Gallinula chloropus*) which exclude mynas and damage traps.

7.2.3 Atiu Island

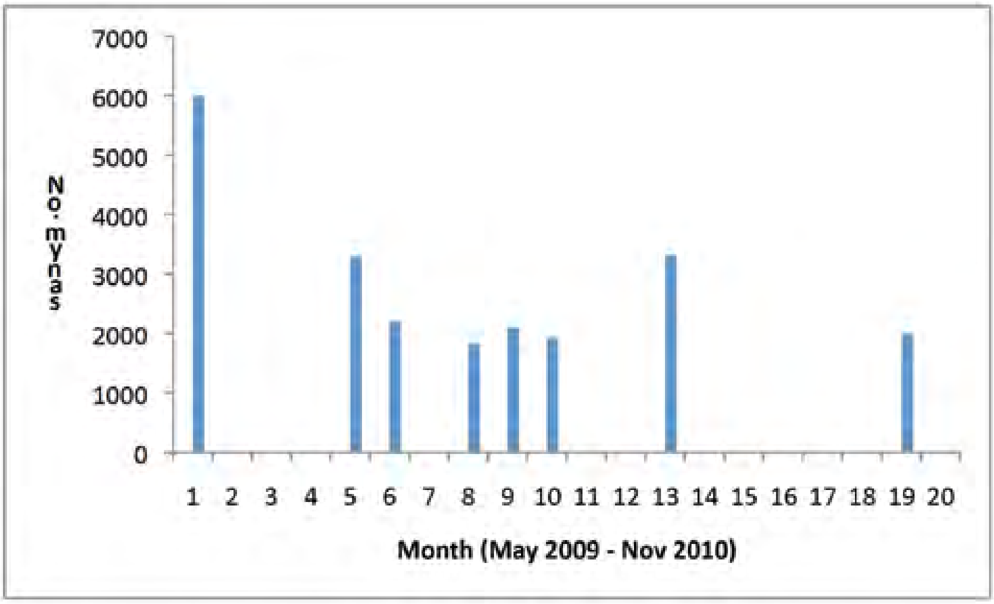
Atiu Island (2600 ha) at 19° 59'S and 158° 07'W is a low volcanic island with a surrounding makatea lying about 75 km from Mauke Island and 187 km from Rarotonga. The latter two are potential source populations of mynas. It has a human population of over 500. Atiu is also known as Enuamanu (bird island); species include the reintroduced Rimatara lorikeet (*Vini kuhlii*). Mynas are known to harass the lorikeets (McCormack 2011) but, in retrospect, do not appear to have compromised the establishment of them – given many mynas were removed during the control project (G. McCormack, pers. comm.).

Mynas were first introduced to Atiu Island in 1916 as a biocontrol for coconut stick insects. The island has *Rattus exulans* but not ship rats. Feral cats, chickens, and pigs are present as well as domestic goats and cattle.

The reintroduction of the lorikeet motivated an attempt to control mynas in May 2009. The Cook Islands Natural Heritage Trust, which designed and leads the lorikeet reintroduction project, obtained support from the Atiu Island Council to implement a myna reduction programme using Starlicide. Sustained control was the initial strategy chosen largely because eradication was thought to be too expensive and have no certainty of success.

Two island residents began the experimental poisoning with Starlicide in May 2009. The rest of the community was encouraged to contribute by trapping and shooting for a $1 bounty. In five months it was estimated that over 3000 mynas were poisoned and 640 trapped or shot by the community, reducing the population by about 50% by the end of the year (Figure 9). Estimates of the numbers of mynas present have been made by extrapolation from counts along transects through the villages and transects through the forest, pig sty and taro gardens. The poisoning was not as effective in winter 2010 and the 2009/10 breeding season resulted in an estimated increase of about 1000 birds. Current estimates put the population at about 2000 (from the village transects) or 1000 (from the forest/garden transects) (Figure 9).

Figure 9 Number of mynas estimated to be present on Atiu Island during the poisoning and bounty control campaign, 2009/10 (after McCormack 2011).



Boiled rice was used as the bait for the Starlicide as it was not attractive to native birds, and free-ranging chickens could be excluded using netting. Sugar was added after November 2010. Areas near roosts were pre-fed for 'a couple of days' before the toxic bait was laid. However, this was apparently only effective for one day as no birds approached the baits thereafter. Poisoning was then moved from near roosts to grassy feeding areas and road sides, and in trays placed in buildings and pig sties. Many dead birds were found but of course the effectiveness of poisoning is difficult to estimate, especially given the concurrent trapping and shooting by the islanders.

The bounty of NZ$1 was paid for each right foot of a myna in 2009, increasing to NZ$2, then finally NZ$4 in 2010. It is not clear whether these birds included birds found dead from poisoning or just the trapped birds. NZ$10 was also paid for each myna nest presented. As of early 2012 about 2000 bounties had been paid. The birds were shot and trapped under this bounty scheme. No decoy or call birds were used in the traps.

In July/August 2010 the Natural Heritage Trust organised a community trapping contest with the $4 bounty and a $400 monthly bonus for the winning team, resulting in 514 mynas being killed. At this time the Trust and the Island Council decided to attempt to eradicate the mynas, and it was agreed that experienced shooters (using shotguns) would be used one week every month. The shooters operated in areas that were publically notified so local people were not too inconvenienced. In late 2010, the best shooter was killing about 85 mynas per day but in March 2012 he was shooting about 40 birds per day. To March 2012, about 4500 mynas had been shot.

Current estimates of the numbers of mynas left range between 1000 and 2000. The aim is to shoot, trap and poison enough of these surviving birds before September 2012 (the start of the new breeding season), and then to focus on nest destruction (and perhaps shooting the adults at the nests) to try and achieve eradication.

The project is implemented by the Cook Islands Natural Heritage Trust with funding and support from CEPF, the Ipukarea Society (an environmental NGO in the Cook Islands), Air Rorotonga, and two local businesses on Atiu Island (Atiu Villas and Snowbird Laundry). A local person (George Matearīki) leads the field work, and a Rarotongan (Jason Turara) leads the shooting team.

The lorikeet population has increased from the 23 birds reintroduced in 2007 to about 120 in mid-2010, suggesting some benefit from the myna control (McCormack 2011).

The project also benefited from more formal attempts to monitor the numbers of mynas before and during the control (see section 6.3).

Points to note:

- The density of mynas before any control was about 2.3/ha
- Trapping was not sustained as the mynas became trap-shy after a few months.
- Baiting near roosts appeared to be effective for only a short time presumably because the myans had developed an aversion to the treated baits.
- The initial bounty system paid NZ$1 per myna (the right foot as the token) but this was increased to NZ$4 per token after November 2010 with a monthly prize of NZ$400 drawn. Increasing the value of bounties is good practice but needs to increase exponentially to provide a rational economic incentive as pest density approaches zero (or the survivors become ultra-wary).
- Surviving birds are wary and often first detected only by a quiet warning call without being sighted (J. Parkes pers. obs.). This may explain the difference in population estimates from the village transects where birds are more visible in the more open habitat of the village compared with the forest counts where detection relies more on hearing mynas and so may be biased low.
- This project relies on local capacity with support from local and outside sponsors. Local capacity and local funding is a strength if the eradication turns out to take a long time or reverts to a

sustained control project. However, as the surviving mynas become more wary and cryptic it may be that additional skills will have to be deployed if deadlines to achieve eradication are short, and thus outside capacity and funding may become necessary.

- The mix of local capacity with control delivered by residents and outside expertise with the specialist contracted shooters is interesting. As the survivors become harder to kill it is likely that the outside contractors (and perhaps other methods) will become critical if eradication is to be achieved. The targetted use of decoy traps and shooting of adults at nests might be considered.

7.2.4 Lessons from large eradication case studies

- Deadlines to achieve eradication are important in cases when the target species has a high rate of increase and success is achieved by a series of control events (c.f. one-off eradication such as aerial baiting of rodents).
- Deadlines imply funding commitment and the capacity to operate in all phases (initial knock-down, mop-up and validation) of an eradication.
- The Seychelles case studies, although eventually successful, show that the planning did not initially set these deadlines or funding and capacity commitments. This is a consequence of the 'emergency response' nature of these projects that developed only after native birds were reintroduced and observed to be affected by the mynas.
- The Atiu Island case study is interesting because they have achieved phase 1(initial knock-down), are part way through phase 2 (mop-up), but will need to consider whether current tactics alone will achieve eradication and how long this will take given their current funding profile, or whether supplementary control methods will have to be deployed.
- Unlike many other invasive species eradication projects where managers have many successful precedents to follow (and unsuccessful ones to avoid mistakes), there are too few myna eradication precedents to guide predictions of timeframes. This uncertainty has obvious planning and budgetary consequences.

7.3 Attempts at sustained control

The first three case studies in this section had some initial intention to eradicate the mynas but the projects to date have not realistically made the attempt.

7.3.1 Ascension Island

Ascension Island (8800 ha) is a high volcanic island (850 m asl at its highest point) at 07° 57'S, 14° 24'W with the nearest land (with mynas) being St Helena Island some 1300 km to the south. Much of the island is bare lava and scoria and it is inhabited by people servicing a military and civilian communications base and military airfield. Feral cats were eradicated between 2002 and 2006 (Ratcliffe et al. 2009) and feral goats in 1944 (Ashmole & Ashmole 2000). Rabbits, donkeys, sheep, ship rats and mice are still present. Introduced birds include sparrows (*Passer domesticus*) and canaries (*Serinus flaventris*) (Ashmole & Ashmole 2000).

Mynas were introduced to Ascension from Mauritius in 1879 (Ashmole & Ashmole 2000). They are most common around human habitation and the local rubbish dump.

An options paper was produced in 2009 (Allan 2009). Mynas on Ascension Island eat sooty tern eggs, but because Feare (1976) suggested these were largely deserted eggs around the colony edge it is unclear whether this has any critical impact. They are a nuisance around the urban areas and may harbour diseases such as Salmonella. The options paper thought it was 'probably possible' to eradicate the mynas but suggested 'selective removal' of nuisance birds might be a better option at least in the short term. Allan (2009) thought there was a need to better assess the impacts of mynas on Ascension island and if a need was clear (and the local people wished to act) then a pilot project to determine best control methods should be conducted and costed so that the feasibility of eradication could be determined.

Action was instituted in 2009 with two projects conducted between late September and December. The first project used traps to control mynas at several sites (rubbish tips, water tanks and a sooty tern colony) (Saavedra 2009). In this study, three trap designs were used: MynaMagnet decoy traps, locally built decoy trap, and a small trap used without a call bird but usually baited with white bread.

A total of 623 mynas were trapped and euthanased. The locally-built decoy trap appeared to perform best (5.29 mynas caught per day set) with the two MynaMagnet traps catching 3.15 and 3.36 mynas per day set and the un-decoyed trap only 1.96 birds/day set. However, comparisons are probably not valid because their deployment across the sites and over time was not balanced, because the second project removed a large number of birds by poisoning (see below), and of course different call birds were used in the traps (see the conclusions implied by Feare (2010a) and King (2010)).

The second project aimed to train local islanders in the use of Starlicide®. The trial used sweetened boiled rice baits over three days around the island rubbish tip (Feare 2010b). All bait was taken on the first day, 80% on the second and 50% on the third. The estimated population at risk before the poisoning was 360 birds and after the poisoning it was estimated 109 birds remained. One hundred and fourteen dead birds were found mostly in roosts and at a freshwater source (C. Feare, pers. comm.).

Point to note:

- This was essentially a trial of the methods to build local capacity to continue the control. Any sustained control (or eradication) depended on the island residents continuing the program of control. There was no evidence of this when I was on the island in 2010.

7.3.2 Saint Helena Island

Saint Helena Island (12200 ha) is a high volcanic island (798 m asl at its highest point) at 15°58'S, 05°43W with the nearest land being Ascension island. The island is inhabited with about 5000 people living in three main towns (Ashmole & Ashmole 2000). There are eight other species of introduced birds present on the island: chukar partridge (*Alectoris chukor*), ring-neck pheasants (*Phasianus colchicus*), pigeons (*Columba livia*), peaceful doves (*Geopelia striata*), Madagascar fody (*Foudia madagascarensis*), Java sparrow (*Padda oryzivora*), waxbills (*Estrilda astrilda*) and canaries (*Serinus flavaventris*). Norway and ship rats, mice, feral cats, and rabbits are also present (Ashmole & Ashmole 2000).

Mynas were introduced first in 1815 to control cattle ticks and again in 1885 (Rowlands et al. 1998). There is some evidence that mynas predate the eggs and chicks of the endemic threatened wirebird (*Charadrius sanctaehelenae*) and they may also compete for food with this species (McCulloch 1991; Feare & Saavedra Cruz 2009).

Feare & Saavedra Cruz (2009) compared trapping success rates of six traps and showed that decoy traps (i.e. with call birds) generally caught more mynas than various funnel traps (Table 4). These results need to be tempered with caution as it was not clear that all types were deployed at each site and sites had different myna densities.

Table 4 Trap success rates of six traps used in urban areas of Saint Helena Island, July 2009 (after Feare & Saavedra Cruz 2009)

Trap type	No. mynas caught	Hours set	Mynas caught/h
Large decoy	47	61	0.77
Small decoy	62	112	0.55
Funnel	42	137	0.31
Square decoy	29	136	0.21
Funnel/decoy	4	66	0.06
Bob wires	2	47	0.04

Of the birds caught in decoy traps 28.3% were immature, while 45.3% of those in funnel traps were immature.

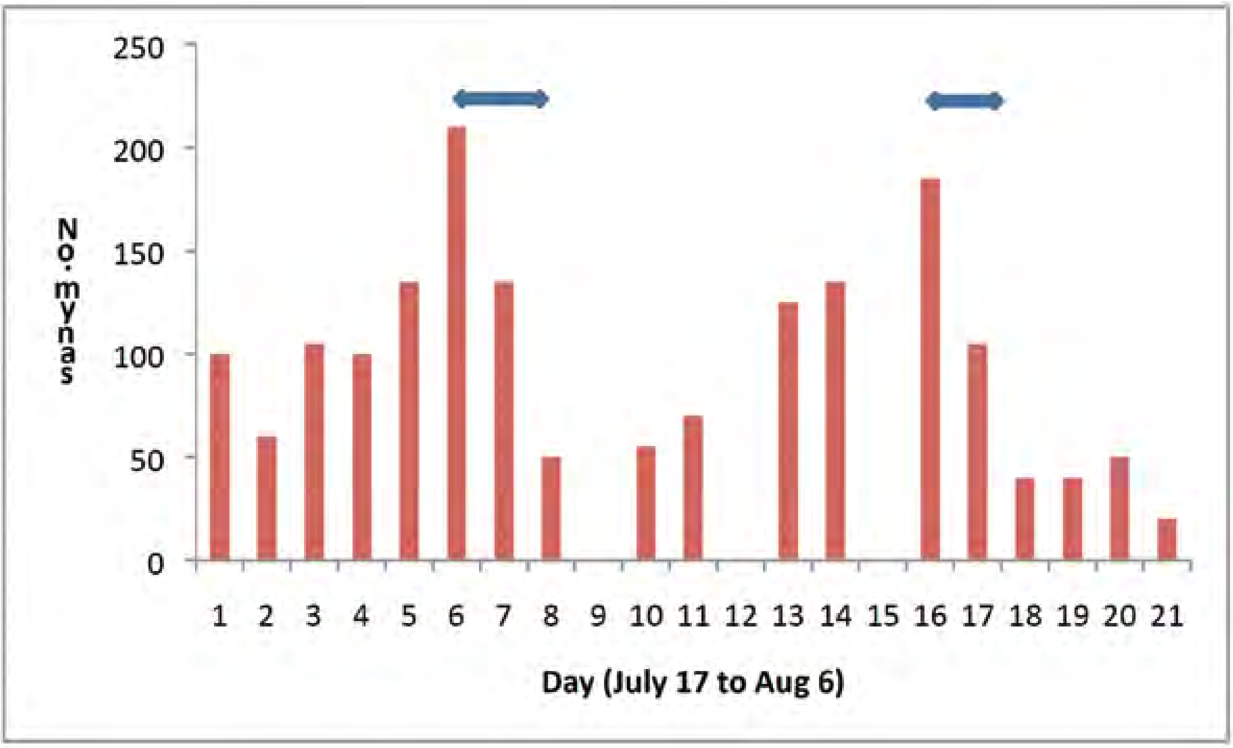
This project also trialled Starlicide® in long-grained rice boiled in sugar water and with turmeric added to mask any taste of the toxin. Non-toxic bait was fed for three days before each toxic trial, and the toxic bait deployed twice (2224 July and 13 August) at the municipal refuse site. All non-toxic bait was eaten within 2 hours of its deployment in both trials. In the toxic baiting, all bait was eaten within an hour on days 1 and 2, but only ground-broadcast baits were eaten on day 3 for the first trial, while in the second trial some bait remained uneaten on day 2 and 30% uneaten on day 3.

Dead mynas were found at roosts and around the refuse tip but the reduction in birds using the tip after each baiting was modest, and recovery (at least after the July baiting) was rapid (Figure 10).

Point to note:

- As with Ascension Island, this project aimed to build capacity among local people to continue the control. It is not reported that this has happened.

Figure 10 Number of mynas estimated in early morning counts at a refuse tip on St Helena Island 17 July to 6 August before and after two poison trials using Starlicide baits (each over 3 days – the blue arrows) with 3 days pre-baiting before each (after Feare 2010c).



7.3.3 Canberra

Canberra, the capital city of Australia, has a population of over 400 000 people and covers about 81 000 ha of urban and suburban habitats surrounded by pastoral farmland and native eucalypt and exotic pine forests.

A mechanism for the potential effect of mynas on the native birds of Canberra has been suggested by Pell & Tidemann (1997) who showed that mynas dominated native birds at artificial and natural nest sites in a forest reserve. However, despite the proof of impact being weak, Canberrans dislike mynas and, like other Australians, give mynas the 'worst pest' status in Australia in some surveys. Clearly this is more a reflection of urban citizens' dislike of the birds than of any real impact – at least compared with the catastrophic pests present in rural Australia (e.g. rabbits, foxes, cane toads). The main reasons people gave for their dislike of mynas were the noise from communal roosts, fouling of premises, and general nuisance (Tidemann undated).

Mynas were largely absent from Canberra until the late 1960s when birds from Sydney were deliberately released (Gregory-Smith 1985). They had spread across most suburbs by the 1990s with densities of over 100/km^2 reported in some areas (Tidemann & Pell 1996). By 2000, mynas were the most common exotic bird recorded in surveys (Tidemann undated).

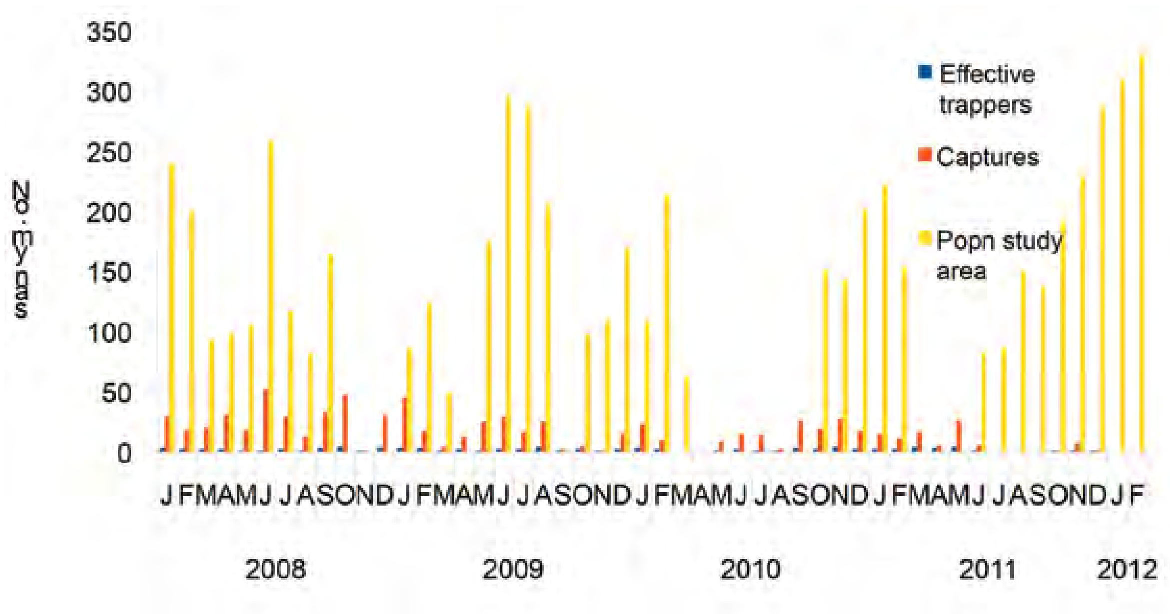
A community action group of 1280 members runs 960 traps. Since 2006, at least 28 800 mynas have been caught and killed (King 2010).

On the positive side, mynas have declined in bird surveys from being the third most common bird in Canberra to the 14th most common (Handke 2011). However, this evidence of relative decline may be due to an increase in abundance of other species, or to an increase in the cryptic behaviours of persecuted mynas, and may have simply exacerbated a natural decline (K. Grarock, unpubl. data) commonly seen as invasive species pass through an irruption following establishment and then a collapse as they overexploit their resources (Caughley 1977). Trapping success rates have also declined in areas with intensive trapping but again it is unclear whether this represents a real reduction in numbers or an increase in trap avoidance behaviour as birds learn about the dangers of traps (Handke 2007 in King 2010). King's (2010) evidence suggests that adult mynas continued to forage at the site traps were set, but did so more warily and cryptically. They associated danger with entering the trap, rather than with the mere presence of the trap, as they continued to forage on the trap without entering it – clever birds!

Experiments with traps left open but otherwise the same (with bait and call birds) showed mynas were the last species to become accustomed to entering them and the first to cease doing so when something was changed in the layout of the system. Even minor changes would cause accustomed mynas to stop entering the traps for about 12 weeks, during which time they observed the fate of other species (starlings and native birds) before resuming entry (D. King, pers. comm.) – and see the behaviour of common mynas at traps in Apia when jungle mynas and bulbuls were entering the traps in the Samoan case study.

Despite this large overall cull of mynas, the current control effort does not appear to have much effect on myna numbers in six contiguous suburbs with an area of 1500 ha. Here the monthly cull of less than 50 (mostly naïve) birds appears to have had little effect on the number of mynas counted in a standard transect since 2008 (Figure 11). The stability of this population appears to be due to occupation by experienced mynas of a few secure, reliable nest sites throughout the year (D. King, pers. comm.).

Figure 11 Number of mynas trapped (red bars), number of effective trappers (blue bars) and number of mynas remaining in six suburbs, Canberra (after D. King, pers. comm.).



Points to note:

- It is not the number trapped that counts in sustained pest control operations but the number remaining – and thus their impacts.

- Effective control may require putting the birds that hold territories at risk. Juveniles may be easier than these adult birds to trap or control but many juveniles may not survive and few will breed if resources such as nest sites are limiting.
- Reliance on one control method in sustained control projects may be unwise as birds learn to avoid that method, and pass that learned behaviour on to new members of their foraging group.
- The impressive number of citizens of Canberra involved reinforces the sustainability of this programme. However, the very number also means changing strategies and tactics (if and when required) is difficult.

7.3.4 Upolu Island (Samoa)

Upolu is the main populated island of Samoa at 112 500 ha with a population of 134 000 people.

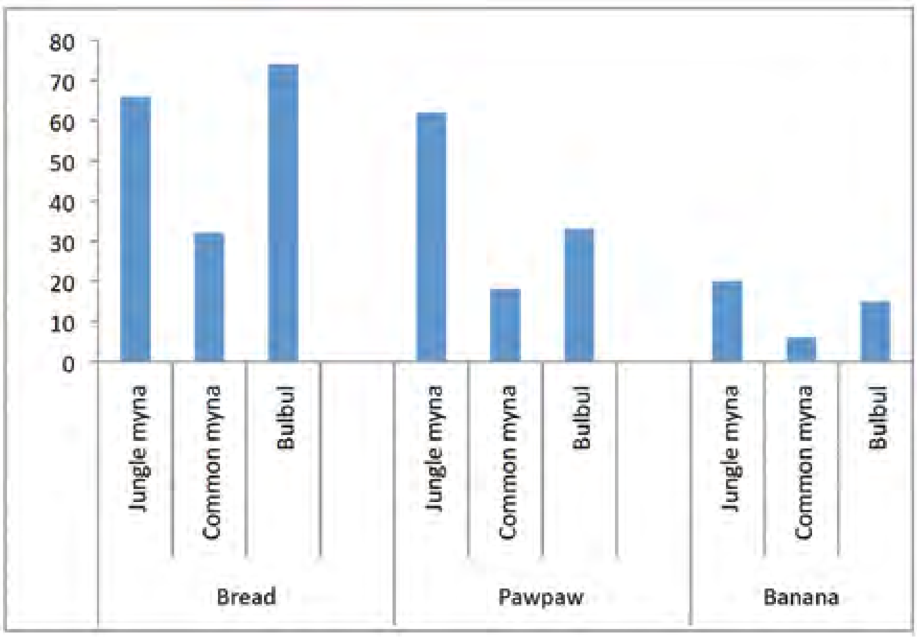
Common and jungle mynas, red-vented bulbuls, red jungle fowl, and rock doves are present, along with rodents, feral cats, feral and stray dogs, and feral pigs. Jungle mynas were first seen in 1965 and common mynas in 1988 (Watling 2001). One (Gill 1999) or both species are now also on Savai'i.

The main motivation for the current control on mynas has been to reduce their nuisance around urban areas and to limit damage to some fruit crops (Doherty 2006).

Trapping using one trap of the MynaMagnet design began in 2004 but was unsuccessful, with only a few mynas being caught. No pre-feeding was done and the trap was moved about. A trapping attempt in 2006 (at dusk and dawn at the same site with no pre-feeding) caught only jungle mynas and bulbuls, while common mynas observed from a distance. This attempt was disrupted by dogs attempting to reach the buttered bread bait (B. Nagle, pers. comm.), and so perhaps was curtailed too early (see the behaviour of mynas at Canberra traps).

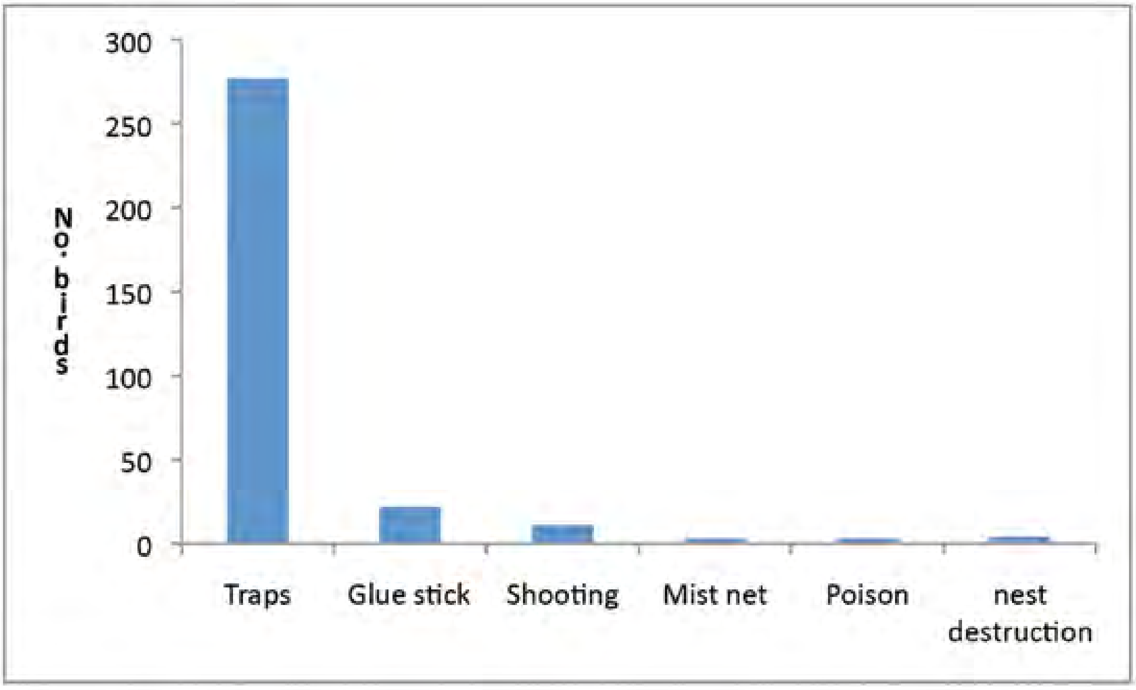
A trial using Starlicide was conducted at a rubbish depot and in the centre of Apia. Bread was better bait than pawpaw or banana in non-toxic trials (Figure 12).

Figure 12 Number of mynas and bulbuls feeding on three non-toxic baits at the Tafaigata rubbish depot, Apia (after Anon 2009).



When toxic bread was used, the three introduced species (jungle and common mynas and bulbuls) were the most common birds seen feeding at the baits (Figure 13). Native species (banded rail and the Polynesian starling) were not commonly seen feeding on the baits (Figure 13).

Figure 13 Numbers of six species of birds seen feeding on toxic baits, Apia.



Because of the delay between ingestion and death when Starlicide is used, dead animals are not easily found. In this trial across three sites, the species found dead were 113 mynas (species not noted), 3 bulbuls (*Pycnonotus cafer*), 6 banded rails (*Gallirallus philippensis goodsoni*) and 1 Polynesian starling (*Aplonis tabuensis*).

Since the poisoning campaign was expanded in 2009 nearly 6000 dead mynas have been collected in sites around Apia.

A severe cyclone that hit Apia in December 2012 destroyed many myna roosting sites and appears to have reduced or dispersed the population (M. Bonin, pers. comm.).

Point to note:

- The benefits of removing 6000 mynas might in this case be measured in a reduction in myna use of areas where they annoy people. This might be seen in fewer birds or (as on Atiu Island) by the abandonment of some roosts.

7.3.5 Lessons from sustained control case studies

- A risk in all attempts to sustain control of a pest is that funding or capacity to continue with the program ceases, the pest population recovers, and the impacts return. Whether this then results in further action depends on the motivation of people to start again, but the start-stop-start process acheives temporary benefits and is inefficient.
- One issue all sustained control projects face is how often and how intensively to apply the control. Options range from continuous control to once every year or even longer, depending on the target density for the pest and its rate of recovery.

7.4 Eradication of other pest birds

Many pest birds are controlled around the world (e.g. Woolnough et al. 2008). Our case studies below focus on a few that have successfully eradicated populations. There are some very large ongoing attempts to eradicate pest birds, including an attempt to eradicate starlings (*Sturnus vulgaris*) from Western Australia (Parkes 2008) and ruddy ducks (*Oxyura jamaicensis*) from Great Britain (Henderson 2010).

7.4.1 Pigeons in the Galapagos

Feral pigeons (*Columba livia*) were present on three islands in the Galapagos (Isabela, San Cristobal and Santa Cruz), both in urban and agricultural areas. Impacts of pigeons on biodiversity and human health in the Galapagos Islands were not known but the government of Ecuador takes a precautionary approach to all exotic species in the Galapagos and attempts to eradicate them.

A campaign to eradicate the pigeons began in 2000 and had succeeded on all three islands by 2005/06 with confirmation being made in 2007 (Phillips et al. 2012). The process followed was to conduct a delimitation survey and census of the birds, activate a public awareness campaign, and then remove the pigeons.

Three methods were trialled (shooting, trapping, and poisoning with alpha-chlorolose). Shooting with a high-powered .25 air rifle was tested and proved best, removing 87% of the 1477 birds killed. Some birds (12%) were captured in lofts or cages by hand, i.e. they were to some extent people's domestic animals, while the rest were poisoned in a trial on Santa Cruz Island that was halted because of non-target risks (Phillips et al. 2012).

The estimated population on each island before the control began and subsequent number killed shows the difficulty in accurate census estimates (Table 5).

Table 5 Estimated and revealed population sizes of feral pigeons on three islands in the Galapagos and time to achieve the eradications on each island (after Phillips et al. 2012)

Island	Estimated population size	Number of birds killed	Months to achieve eradication
Santa Cruz	200	256	11
San Cristobal	220	803	15
Isabela	130150	418	37
Total	Up to 570	1477	

7.4.2 House crows on Socotra Island

The Yemeni island of Socotra (350 000 ha) at the mouth of the Gulf of Aden is a biodiversity hotspot (as a relict of Gondwanaland now between Africa and Arabia) with, for example, 37% of its 825 species of higher plants being endemic (Cheung & DeVantier 2006). The island is populated by about 43 000 people. Ship rats, mice, feral cats, the lesser Indian civet cat (*Viverricula indica*), and domestic goats, cattle, sheep, camels and donkeys are present.

Indian house crows (*Corvus splendens*) are a major avian pest that is spreading around the Arabian Peninsula, up and down the east coast of Africa as far south as Durban and north to the Gulf of Aqaba. They are eventually likely to reach the Mediterranean coast via Egypt or Israel and Gaza. Starlicide is often used to control house crows in mainland Yemen (Jennings 1992) while trapping is common in the large east African cities they inhabit, and shooting is reported to be conducted at Eilat in the Gulf of Aqaba (Woolnough et al. 2008).

House crows arrived on Socotra Island in 1995 or 1996 as one pair hitching on a ship, presumably from Aden where they are common and cause many problems (Suliman et al. 2011). A bounty system was introduced on Socotra in 1998 and, in a period of 10 years, over 550 chicks and eggs were removed from a peak population estimated as 23 breeding birds. The bounty ceased in 2008. The campaign to eradicate the crows on Socotra was restricted to a two-week period in April 2009. Shooting was the only method applied and was conducted by outsiders (accompanied by a Yemeni official and interpreter) with silenced .22, and .17 rifles and a shotgun. Six birds were shot with the .22 rifle on the first day, and three on the second day with the .17 rifle (which allowed shooting at a longer range), after which three birds left the urban area. On the fourth day the shotgun was used and three birds were killed. No further crows were detected in 500 hours of searching, but seven days later a single bird was reported, the team redeployed and after four days of pursuit it was shot with the shotgun.

7.4.3 Sparrows on Round Island

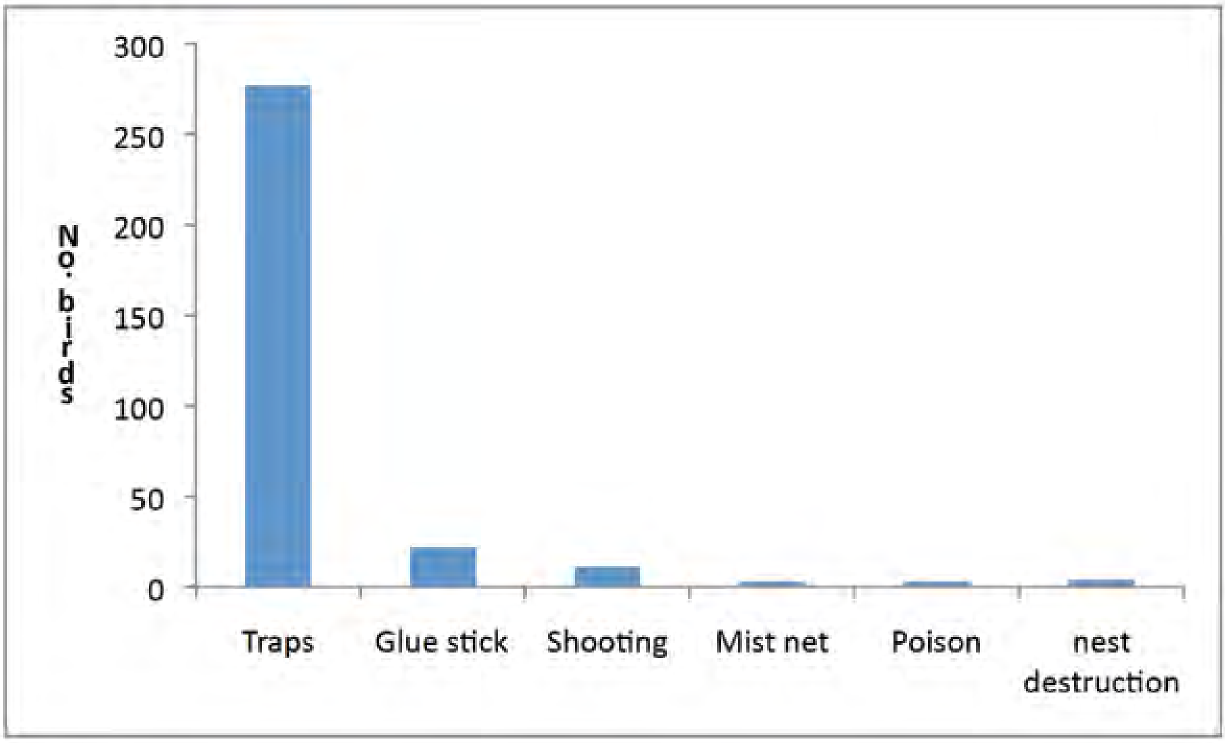
House sparrows (*Passer domesticus*) established on Round Island (219 ha) in Mauritius in 1982, having blown in during a cyclone presumably from Mauritius or one of the islands between (Bednarczuk et al. 2010). Round Island is uninhabited and with the removal of feral goats and rabbits in the 1980s is an important refuge for Mauritian island biodiversity (Bullock et al. 2002).

Eradication was attempted between October 2008 and February 2009 when 320 birds were killed using a variety of techniques (Figure 14). Trapping was most successful but evidence suggested that the birds rapidly became trap-shy with capture rates declining from about 5.5 birds/day on day 1 of trapping to about 0.5 birds/day on day 3 of trapping (Bednarczuk et al. 2010).

Surveys over accessible parts of the island before the control detected about 100 sparrows, but this was clearly an underestimate of the population size.

The eradication failed. Bednarczuk et al. (2010) noted the problem was partly due to the artificial deadline set for funding the contractor rather than an open-ended deadline set by the last sparrow. The assumption that immigration is zero may also not be true (C. Feare, pers. comm.).

Figure 14 Success (number of birds) of six control methods used on Round Island (after Bednarczuk et al. 2010).



Lessons from case studies on other birds

- Outside contractors (with a local guide) were successful on Socotra Island, while local residents were employed as full-time staff in the Galapagos. Both these cases were on islands with large permanent populations of people so ongoing liaison and compliance was important. In contrast the use of volunteers and temporary staff on Round Island failed to achieve success in this uninhabited and remote island. Clearly best practice will depend on the circumstance but such considerations have to be made during the feasibility and project planning phases of the projects.
- Open-ended deadlines (as on Round Island) are generally not a good idea for eradication attempts as the intensity and commitment of the operation can drift towards a sustained control strategy. Uncertain end-points for myna eradication will be inevitable but indicate the need to set partial milestones (e.g. some rules or points in the process to move between phases) or review timetables. If there are to be set deadlines for success, it behoves funders to resource the operation so they can be achieved – given the inevitable uncertainties a priori. Note that performance-based or fixed-price contracts are one way to impose efficiency on contracted eradications, providing a fair way can be developed to judge the success milestones (e.g. see the eradication program for feral pigs on Santa Cruz Island; Parkes et al. 2010).
- Bounty systems can reduce pest populations in the initial knock-down phases (if the motivation is sufficient) but do not appear to be capable of contributing to the mop-up phases of a project. This not just a matter of increasing the rewards as densities decline, but of the need to change tactics and increase the expertise of the operators.

7.5 General conclusions from case studies

Trapping alone has succeeded in eradicating mynas from small colonising populations and from one larger established population on a smaller island, Fregate Island. Large numbers of birds can be trapped from extensive urban populations (e.g. Canberra) but not if trapping practice is not optimal (e.g. Upolu). However, it is also clear that trapping becomes less effective over time in some places (though not yet apparently on Denis Island).

Poisoning with Starlicide has also killed large numbers of birds in some cases (e.g. Atiu, Ascension and St Helena islands) but the attempts appeared to have declining efficacy and were not sustained to see if an end point (relict number of mynas or minimal effectiveness) was reached.

Shooting rapidly teaches survivors to be wary but may be useful to kill the last (or first) birds in a population if used skilfully. A large number of mynas are currently being shot on Atiu Island using skilled specialist hunters, and it will be interesting to see how low this population can be driven before alternative methods are required to find and kill the last birds.

In general it is worth considering afresh how a series of control tools might be deployed. A general rule is to use the method first (i.e. in the initial knockdown phase) that teaches survivors least, removes whole groups of animals in social species, and (less importantly) kills most. Then deploy methods that do not have these ideal characteristics. For mynas the control might be ordered as poisoning (if appropriate), trapping and shooting – with specialist techniques such as nest snares kept to the very last if nesting adults can be located.

However, the case studies do not provide a rigorous test of this order of attack, so the question is open for resolution by practice.

The planning process used in each case study has not been compared with the ideal planning process introduced in this review. Sometimes the information was not available. However, the workshop can explore whether the case studies that failed (to date) might have suceeded if they had been better planned.

8. Acknowledgements

I thank first the people responsible for the projects used as case studies. The way their reports and papers have been set out in this review are mine but I have tried to ensure authors and project leaders have had a chance to comment on my interpretation of their work.

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Invasive Bird Management Workshop

EXECUTIVE SUMMARY

An Invasive Bird Management workshop was held in Apia, Samoa between 9 and 18 July 2012 as a key component of a longer-term project to build capacity within the region for invasive bird eradication or control, with a particular focus on the common or Indian myna *Acridotheres tristis*. The workshop was funded by Critical Ecosystems Partnership Fund (CEPF), facilitated by the Durrell Wildlife Conservation Trust (Durrell) with technical support from the Pacific Invasives Initiative (PII) and Landcare Research - Manaaki Whenua (LCR) of New Zealand. Logistical support was provided by the Secretariat of the Pacific Regional Environment Programme (SPREP) and the Pacific Invasives Initiative (PILN). The workshop was run in collaboration with the Ministry of Natural Resources and Environment (MNRE) of the Government of Samoa. Twenty participants from eight Pacific Island Countries and Territories (PICTs) attended the workshop (Appendix1).

There were three primary objectives for the workshop:

1. To train a minimum of 15 invasive species managers from countries within CEPF focal island states in the planning, implementation and evaluation of invasive bird management programmes
2. To initiate new myna eradication/control programmes within CEPF focal island states to minimise the spread of the species across the region (minimum of three draft plans developed)
3. To support the development of Samoa's existing myna management programme as a contribution towards the Government's National Invasive Species Action Plan 2008 – 2011

The workshop was designed to provide both opportunities to learn new skills and develop understanding and create space for the development of draft project plans of relevance to each participant in their home state. Workshop topics built on the existing invasive species project management process developed by PII, modified to take into account the focus on invasive birds. Participants were taken through the project process from project selection to conducting feasibility studies, developing project and operational plans and finally to implementing and sustaining the project. Throughout emphasis was placed on the need to identify and engage primary stakeholders and to adopt best practice principles with regards to the deployment of management techniques. Lectures, small group problem-solving activities and plenaries were interspersed with practical skills development tasks including the production of different live trap types and post-mortem studies to collect data on target species reproductive status and demography.

Participant feedback on the workshop was complimentary, 70% of respondents identifying that the workshop was Very Valuable (the remaining 30% rated it as Valuable). Sixty-five percent of respondents considered it to be Very Relevant to their professional development, with a further 30% stating it was Relevant. All would recommend the workshop to their colleagues.

1. The PII Project Process and review of mynas

The project funded LCR to produce a background review[1] of mynas and their management that followed the project development process developed by the PII. The PII Project Process has been developed as a step-wise approach to assist proponents, funding agencies, and project teams involved with invasive species management. The process has six stages (Figure 1) that projects ideally follow to ensure they do not fail, at least because of factors managers and decision-makers can influence during the life-cycle of a project.

1.1 Selecting projects

Most countries and agencies have more invasive species problems to solve than money and other resources to solve them with. Selecting which problems to address was discussed as a preliminary issue in the workshop. In particular it is not always clear whether mynas are of sufficient concern to biodiversity, agriculture or peoples' wellbeing to justify action (see the American Samoa case below). However, even in the absence of proof, a precautionary approach is often best to stop mynas spreading between islands (see the Fiji case below), or to deal with small populations of recent origin (see the Tarawa case below). The workshop noted newspaper reports[2] of economic loss of FJD14.6million in 2008 to airlines in Fiji's national airline resulting from bird-strike, which included myna birds as a problem species.

Evidence of direct myna bird attacks on native (and threatened) species was also reported by participants, including an observed attack on a fledgling Endangered Rimatara Lorikeet (Vini kuhlii) in the Cook Islands; the Endangered Ma'o ma'o (*Gymnomyza samoensis*) in Samoa[3]; and the likely attack of the Critically Endangered Seychelles Paradise Flycatcher (*Terpsiphone* corvine), Seychelles Warbler (*Acrocephalus sechellensis*) and Seychelles Fody (*Foudia sechellarum*). This adds to the growing body of evidence presented in peer-reviewed papers[4] identifying the myna as a threat to other native or endemic bird life.

1.2 Feasibility studies

Feasibility studies are an essential part of good planning. They aim to show funders and decision-makers that the project's proposers have thought through their problem and have clear goals, a clear analysis of whether eradication is possible or whether control must be sustained, and that all the constraints and problems (e.g., social issues with stakeholders, legal permits, and non-target issues)

1 Parkes, J. (2012) Review of best practice management of common mynas (*Acridotheres tristis*) with case studies of previous attempts at eradication and control: a working document. Landcare Research Unpublished Report

2 http://www.fijitimes.com/story.aspx?id=89651

3 http://www.samoanbirds.com/

4 Blanvillain *et. al.* 2003 Biological Conservation 109; Tindall *et al.* 2007 *Pacific Conservation Biology* 13

have been considered. Initial estimates of costs for the treatment options are provided. Funders and decision-makers can then invest with more confidence in the recommended or selected option when they can see the risks of failure have been minimized. The majority of participants on the current workshop were able to acknowledge that their projects sat at this stage. It was recognized by participants that several of their invasive bird projects had begun without a feasibility study being conducted first, leading to some uncertainty over what would be possible and what it would take to achieve pre-determined goals. As a consequence a significant amount of time was devoted during the workshop to writing draft feasibility plans for the invasive bird projects being developed or revised.

1.3 Project design

Once approval to proceed has been gained, a project governance and management system needs to be developed. It helps to know who is responsible for overseeing the project at policy levels (governance) and who is responsible for the day-to-day management decisions and staff/contractor management (a project manager). During the workshop consideration was given to different decision-making models in place on the different islands and how they could be modified to enhance efficiency and effectiveness.

1.4 Operational planning

The implementation of a project requires the project manager to have a detailed plan to organize and deliver the day-to-day activities. Staff and the governance group can use the operational plan as a template to check how the project is proceeding and whether or not changes need to be made.

1.5 Implementation

If all the above is done well, the people doing the work can be trusted to get on and do the job with appropriate guidance when required (see the sustaining the project phase). During the workshop, opportunities were created for participants to share their skills in the building and testing of different myna bird trap designs. We also discussed best practice in the deployment of toxins and the need to have clear protocols in place to help staff on the ground to follow this best practice.

1.6 Sustaining the project

All good projects monitor (a) how their project management itself is performing (usually via reports to the governance group from the project or operational manager), (b) the immediate operational results of effort and effects on the target invasive species, and (c) on whether this results in benefits to the assets being protected. The aim of these assessments is to sustain the project as it proceeds and to adapt the management as the results and benefits become clear. During the workshop a range of monitoring techniques and approaches to both track project function and to evaluate impacts on biodiversity and socio-economic goals were considered.

2. Managing mynas – where are Pacific countries up to?

Projects that propose to (or are) managing mynas in the Pacific are at various stages of development. They range from initial justification required to do anything; to intentions to act but as yet action is at the exploratory phase; to projects that have begun but might proceed in several directions; to projects that are nearing their end point when difficult decisions have to be addressed to ensure eradication is indeed achieved.

The workshop also considered myna eradication and control and eradication projects elsewhere in the world. What is clear is that as in the Pacific the precedents for success are few and the uncertainties around the best way forward are many, compared for example with management of many mammalian invasive species.

This uncertainty on the best practice for mynas was clear from the review and was reinforced by the workshop participants. However, a positive outcome of the workshop was that we can see a way to address both the 'process' issues and the technical constraints faced by managers of invasive bird management projects.

2.1 Just beginning but need justification – the American Samoa experience

The participants from American Samoa represented biodiversity agencies and as such would need to justify any myna management based on the impacts of mynas on native species. Myna impacts on biodiversity may be subtle but the workshop itself resulted in new knowledge in this area from other places around the world that will help decisions on the priority of myna management. By the end of the workshop the participants from American Samoa had decided to develop a study design to gain a more robust understanding of myna birds on the native wildlife of the Samoan archipelago.

2.2 Decided to act but deciding what is feasible – the Tarawa experience

A few mynas exist on Tarawa but seem to be absent from the other islands of Kiribati. It is planned to take a precautionary approach and eradicate the Tarawa population as a potential source for birds hitching rides on ships to other islands. During the workshop participants from Kiribati developed their thinking around the steps they need to take to achieve this goal.

2.3 Deciding to act but focusing on stopping spread – the Fiji experience

Mynas are common on the main Fijian islands but are absent from most others. It is not clear how best to stop the spread. Mynas have flown at least 60 km between islands in New Zealand, but are also thought to hitch rides on ships to more distant islands. Should Fiji develop surveillance and incursion response plans for ships' captains to deal with any mynas seen on board, or should people on myna-free islands be trained in surveillance and incursion response to spot and kill any immigrants? These are questions that are addressed in typical feasibility studies – thinking of ways to solve them is the point in the process where Fiji agencies are now.

2.4 Action well underway, but where to now – the Samoa experience

Mynas are of sufficient nuisance in Apia to attract the attention of the Prime Minister, as well as being likely problems to native birds, invertebrates and lizards and to villagers and their crops. The MNRE has been attempting to reduce myna densities since 2005 and, with Government funding has removed many thousands of birds. However, many more thousands are left and the problem roosts in Apia town remain. So, MNRE is at a phase when it is thinking about whether a change in strategy (perhaps an initial focus on the problem roosts) and tactics (possible new methods to remove whole roosts) is required to at least resolve the nuisance part of the myna problem. They are also considering how to develop more robust monitoring tools to evaluate the consequences of myna control on their population size and impacts.

2.5 Action (eradication) now towards the end, but how to get the last birds – the Atiu experience

Managers of an attempt to re-establish Rimatara lorikeets on Atiu Island in the Cook Islands began to control mynas to improve the chance of survival and breeding of the lorikeets, which are now established. However, the Atiu people themselves decided to turn this control project into an attempt at eradication. The project has removed a high proportion of the mynas by trapping, shooting and poisoning but is approaching the difficult end stage when surviving birds are much more difficult to remove. They now need to consider how to change their tactics to get these last wary birds and then to know when they have succeeded and can stop. At the workshop a focus was placed on developing new trapping techniques to support ongoing efforts to remove birds through shooting and the use of toxins.

3. Some process issues and how to resolve them

3.1 Use of toxins

The World Bank has recently produced some guidelines to ensure projects funded under their auspices use toxins appropriately. The workshop noted the need to ensure users of toxins are appropriately trained. It also noted that it is essential to deploy only toxins (and the methods to use them against nominated species) that are registered for use in each country. Registration for legal use is underpinned by research on that toxin, and use conditions are specified on the label when the product is purchased.

The various options to use toxins (or other management tools) need to be discussed in a feasibility study. If a registered and legal toxin is selected as the best tool then most of the World Bank guidelines can be addressed by using it according to the label or by reference to the underpinning research. In certain circumstances further analysis around the choice of management method may be required. If no product is registered for use managers can either invest in research to have the toxin/product tested leading to an experimental permit to use or to full registration – depending on jurisdiction- or consider alternatives to the use of toxins.

4. Some technical issues and how to resolve them

The workshop identified several areas where there is no certainty about what is best practice and we present these here in summary with some suggestions for the way forward to resolve the uncertainties. More formal experimental designs are being developed to answer these technical issues and some workshop participants will actively seek ways to conduct the research.

4.1 What traps are best for what purpose?

A simple experiment to compare the efficacy of two main trap designs – the method of entry – will be trialed. The idea is to keep all other factors (trap size, baiting methods, decoy birds, sites, etc. constant and to see if the way birds enter multiple catch traps affects the number of birds caught. This pair-wise approach will then allow the best design to be compared with any new design of trap entry systems, or as other trap characteristics are compared.

4.2 Some issues with current treatments

Workshop participants tabled preliminary data on the LD50 of Starlicide® for common mynas from USDA. It appears common mynas are more susceptible to the toxin than starlings. Thus lower doses of the toxin than those recommended on the current labels may be appropriate. No information was available on the LD50 of Starlicide® for jungle mynas which are about 75% of the size of common mynas and lower rates still may be effective.

4.3 A novel method – removing whole roosts of mynas

It was proposed by MNRE staff that nuisance roosts might be dispersed or the birds killed by applying a repellent (simple water) or a toxin sprayed within the roost. It is proposed to test the feasibility of applying a toxin to all birds in a roost such that they will die after preening themselves.

We would need to test the dose rates and method of application in cage trials and then (if that worked) engineer a spray system that could be deployed within the roosts to target all birds. This could be done under experimental permits in New Zealand and if it worked countries might seek formal registration.

4.4 Are mynas effective biocontrol agents for cattle ticks and coconut stick insects?

Some State agricultural agencies have suggested mynas may control cattle ticks. The workshop suggested research would be required to see whether (a) cattle in areas with mynas have ticks, (b) whether mynas actually eat ticks, and (c) whether this saves farmers money spent on chemical treatments for ticks.

The Atiu Island eradication of mynas provides a partial natural experiment on the efficacy of mynas as a biocontrol for coconut stick insects. The workshop noted that stick insects are problems in some countries with abundant mynas so the birds are not an effective biocontrol in those places.

5. Conclusions

5.1 A decision to act

The workshop clearly motivated countries with invasive bird problems to take further action to manage those problems. Proposed actions ranged from developing research projects to dispel 'received wisdoms' concerning myna birds through, inter-island biosecurity planning to prevent further spread and complete eradication in a couple of circumstances.

5.2 Development of new skills

The exchange of experience in and ideas for using different management techniques allowed people to consider changing their current techniques and improve efficacy, e.g. use of decoy birds to trap wary mynas on Atiu.

5.3 Filling information gaps

Several information gaps and technical constraints were identified and suggestions made on how to resolve them. The workshop resolved that there were important areas of research (e.g. into testing trap efficacy) that could best be addressed through working collaboratively across island states.

5.4 A need for ongoing dialogue and information exchange

The need for open discussion and sharing of information to help build the knowledge base in the Pacific was recognized and it was resolved that existing pathways and networks should be used to achieve this goal.

6. Outputs of the workshop

As stated as objectives in the original CEPF proposal, the workshop generated several significant outputs to further invasive bird management projects within the region.

6.1 Global review of myna bird management programmes

6.1.1 This review-enriched with new information that surfaced at the workshop- collates, we believe for the first time, what is known about attempts to control or eradicate or control myna birds from islands. Lessons learnt from other invasive bird projects are also included to provide valuable indicators of how to improve on current management success rates.

6.2 Invasive Bird Management workshop resource pack

6.2.1 This electronic pack of information (compiled on DVD) combines all lecture material with support notes and published and unpublished reports, providing an invaluable resource pack for invasive species managers within the Pacific.

6.3 Four draft Feasibility Studies for the management of invasive birds on Pacific Islands

6.3.1 Eradication of myna birds on Tarawa island, Kiribati

6.3.2 Eradication of the common myna on Atiu, Cook Islands

6.3.3 Preventing range expansion of the red-vented bulbul, New Caledonia

6.3.4 Control of common and jungle mynas in Samoa

6.4 Two draft research project proposals to inform the management of myna birds on Pacific islands

6.4.1 Determining negative impacts of the common myna on biodiversity in American Samoa

6.4.2 Establishing experimental protocols for evaluating efficacy of different trapping techniques.

Team from Kiribati discuss development of feasibility study for myna eradication.

George presents his draft plan for eradication of myna on Atiu, Cook Islands.

Dissecting myna birds to look at impacts of toxins currently in use in Samoa.

Use of decoy traps to lure in multiple birds.

MNRE staff consider how to develop existing myna control plan, Samoa.

Practice setting up myna magnet traps.

CEPF Large Grant Final Project Completion Report

Institutional Capacity Building for Invasive Bird Management in the Pacific

Organization Legal Name

Durrell Wildlife Conservation Trust

Project Title

Institutional Capacity Building for Invasive Bird Management in the Pacific

Date of Report

28 February 2013

Report Author and Contact Information

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CEPF Region

Polynesia-Micronesia Hotspot

Strategic Direction

Strategic Direction 1. Invasive species prevention

Grant Amount

$74,873

Project Dates

1 December 2011 – 31 December 2012

durrell

Conservation Impacts

Please explain/describe how your project has contributed to the implementation of the CEPF ecosystem profile

The aim of this project was to support the CEPF Strategic Direction 1: Prevent, control, and eradicate invasive species in key biodiversity areas. 1.3 Perform research, provide training in management techniques, and develop rapid response capacity against particularly serious invasive species.

The project has contributed to the implementation of this strategic direction by developing the capacity within government and non-government organisations within CEPF focal countries (and beyond) for the planning and delivery of invasive bird management projects. The project had a specific focus on the management options for introduced myna birds, a species of significant concern within the region.

Please summarize the overall results/impact of your project against the expected results detailed in the approved proposal

The immediate aims of the project were to:

1) A minimum of 15 invasive species managers from countries within CEPF focal island states trained in the planning, implementation and evaluation of invasive bird management programmes

2) The initiation of new myna control/eradication programmes within CEPF focal island states to minimise the spread of the species across the region

3) The improved efficacy of Samoa's existing myna management programme as a contribution towards the Government's National Invasive Species Action Plan 2008–2011

In reality the project achieved the following:

1) Twenty participants from eight island states attended the training workshop delivered in July 2012

2) Five draft feasibility/control/eradication plans were developed during the workshop designed to contribute to the control of invasive birds across the region

3) One of these five plans included recommendations for revisions to the existing myna management programme on-going in Samoa

The development and dissemination of the 'Best Practice' guidelines for invasive bird management through regional networks (e.g. PILN) should ensure that lessons learned from this project can be applied to the wider region.

PROJECT APPROACH

The Pacific Invasives Initiatives (PII) experience in informing myna management projects in the region has highlighted the impacts of a failure to set clear management goals and uncertainty in how to deploy known techniques to achieve them. Management goals need to be determined consensually and there must be strong leadership and long-term commitment if they are to be realised.

The current project consisted of three stages:

1) Review of existing myna control techniques employed internationally, their efficacy and applicability to Pacific island circumstances. This stage occurred prior to arrival in Samoa

2) Training in the development of feasibility and operational plans for myna bird removal/eradication. A key component of these plans was the application of monitoring (and adaptive management) to optimize operational outcomes and to allow lessons to be learnt. This took place over a two week training workshop in Samoa (July 2012)

3) Support in developing management plans for mynas on other Pacific islands. Although planning began during the workshop, it continued afterwards as participants developed their plans back home. The training workshop brought together invasive bird managers from CEPF qualifying countries. Training was based around a tailored version of PII's Resource Kit for invasive species management. The kit leads project managers through: Project Selection, Feasibility Study, Project Design, Operational Planning, Implementation and Sustaining (e.g. stakeholder engagement, Monitoring and Evaluation). As these control measures may involve the use of recognised pesticides training included conducting environmental impact assessments and mitigating the adverse impacts of pesticide use on non-target species and human lives and livelihoods. Training considered the guidelines as laid out in World Bank Procedure BP 4.01- Annex C. To help in this delivery World Bank Biodiversity Specialist, Dr. Valerie Hickey was consulted in the development of the workshop and reviewer of workshop content.

A seminar was held on the final day of the workshop, where Heads and senior officials from government and regional non-government organisations based in Samoa were invited to hear the results of participants' deliberations and draft plans for invasive bird management in their respective countries.

A technical report summarizing case studies and lessons learnt in invasive bird management globally was produced and disseminated region-wide through the PILN network, providing a resource for invasive bird management projects region-wide. Both the training workshop and the technical report emphasized the need for feasibility studies to be conducted prior to embarking on full control or eradication programmes.

Link to CEPF Investment Strategy

The specific strategic direction addressed was Strategic Direction 1. Prevent, control, and eradicate invasive species in key biodiversity areas.

Planned Long-term Impacts - 3+ years (as stated in the approved proposal):

The long-term goal of the project is to build capacity within the Pacific (and specifically within CEPF focal island states) for the successful management of invasive bird species, with a particular focus on mynas. In achieving this goal this project will have the following long-term impacts:

1) Capacity established within the region for the successful management of mynas in key biodiversity areas

2) Quick-response protocols in place to prevent the establishment of populations in newly invaded areas/islands, thereby controlling the spread of the species through the region

3) Enhanced strategic planning and fund-raising capabilities for the implementation of invasive bird management programmes across the region

4) The establishment of quick-response teams within the region, trained in the process of invasive bird control/eradication, able to respond quickly and effectively to new invasive species threats as they arise

Actual Progress Towards Long-term Impacts at Completion:

The project was able to train more than the target number of conservation professionals from across the region, injecting new skills and understanding into their respective organisations. The current project focused on developing the skills and understanding required to prevent further spread and control or eradicate existing populations where possible. By highlighting the potential impacts of invasive birds on island ecosystems in the Pacific we hope to have raised awareness of the importance of responding to new arrivals as and when they occur.

All participants have access to the procedures and protocols involved in conducting feasibility studies to determine in a timely manner the options available to island authorities for the management of new arrivals. All participants have been connected to an invasive bird management expert network (extending beyond the region) which they can draw on as and when required to meet their needs.

The training workshop provided skills and understanding in strategic planning and fund-raising to support the implementation of invasive bird management programmes within the region. Finally, the project developed institutional and individual linkages across the region able to provide peer support in invasive bird management when required. These linkages will be supported longer term through the PILN network.

Planned Short-term Impacts – 1 to 3 years (as stated in the approved proposal):

On completion of the project we will have had the following short-term impacts:

1) A minimum of 15 invasive species managers from countries within CEPF focal island states trained in the planning, implementation and evaluation of invasive bird management programmes;

2) The initiation of new myna control/eradication programmes within CEPF focal island states to minimise the spread of the species across the region;

3) The improved efficacy of Samoa's existing myna management programme as a contribution towards the Government's National Invasive Species Action Plan 2008 – 2011.

Actual Progress Toward Short-term Impacts at Completion:

1) Twenty invasive species managers from across the region were trained in the planning, implementation and evaluation of invasive bird management programmes

2) Five draft management/feasibility plans were developed during the workshop providing the raw material for new projects to be developed and existing ones to be refined

3) One of these five plans- produced by MNRE staff- considered recommendations for improvements to the existing myna management programme, on-going in Samoa

Please provide the following information where relevant

- *Hectares Protected*: N/A
- *Species Conserved*: N/A
- *Corridors Created*: N/A

Describe the success or challenges of the project toward achieving its short-term and long-term impact objectives

The primary challenge to realizing change on the ground within the region, with regards to invasive bird management, is the ability of participants on the workshop to apply what they have learnt back in the workplace. This will in part depend on the institutional support that exists to make invasive bird management a priority.

Were there any unexpected impacts (positive or negative)?

While the focus (and financial resource) was directed to CEPF focal countries, participants from New Caledonia, American Samoa and New Zealand invested in attending the workshop in July. This broadened the network of peers that CEPF country participants could draw upon and brought additional skills into the workshop. As a consequence of the workshop, a plan is currently being developed to control the spread of the red-vented bulbul in New Caledonia and in New Zealand experiments have begun to test the efficacy of trapping techniques for myna birds.

Project Components

Please report on results by project component. Reporting should reference specific products/ deliverables from the approved project design and other relevant information.

Component 1 Planned:

Developed "best practice" protocols for the management of myna populations on islands.

Component 1 Actual at Completion:

'Best practice' guidelines produced. The guidelines have been developed further- along with lessons learned from the workshop- to produce a CEPF technical series report (number 20) which will be distributed region-wide.

Component 2 Planned:

Designed and delivered a training workshop to build capacity, in particular within CEPF target island states, for the strategic planning and implementation of control/eradication programmes for mynas.

Component 2 Actual at Completion:

An eight-day workshop was delivered in Apia, Samoa in July 2012. Topics covered included strategic planning and the implementations of control/eradication programmes for mynas.

Component 3 Planned:

Enabled participants to produce draft management plans or review existing ones for the control/ eradication of mynas within their island state.

Component 3 Actual at Completion:

Five draft management/ feasibility plans (in the form of power point presentations) were developed for further discussion within participants' own organisations and island states.

Component 4 Planned:

Established a network of invasive species managers able to draw on expertise from within and beyond the region to help plan future control/eradication programmes for new invasive bird species problems as they arise.

Component 4 Actual at Completion:

The twenty participants on the workshop have access to each other through the PILN network, including access to the invasive bird management experts within and beyond the region. They are also connected through the Durrell Conservation Learning Network which provides them with access to approximately 1000 peers globally.

Were any components unrealized? If so, how has this affected the overall impact of the project?

While the five draft management/ feasibility plans were produced we would have ideally liked all participants to develop them further on return to their organisations. This is an on-going process and we are currently following up with participants to track project development and to provide support where necessary.

Please describe and submit (electronically if possible) any tools, products, or methodologies that resulted from this project or contributed to the results.

The main products from this workshop are contained within the CEPF Technical Series Report (number 20) on Lessons Learnt in Invasive Bird Management.

Lessons Learned

Describe any lessons learned during the design and implementation of the project, as well as any related to organizational development and capacity building. Consider lessons that would inform projects designed or implemented by your organization or others, as well as lessons that might be considered by the global conservation community.

Below are listed some thoughts on why we believe the workshop was successful and what we recommend doing to make such a workshop more productive in the future.

1. TAILOR WORKSHOP TO LOCATION

To construct a training workshop that is relevant to and resonates with participants, it is important to build content around examples from participants' own experiences. Partnering with a local institution- in our case multiple local institutions- enables workshop designers to draw on case studies and on-going projects that ensured the content touched on subjects and situations that participants could relate to and reflect upon. In Samoa we had the on-going myna control programme to draw on to illustrate different stages within the invasive species management process. This allowed for lively discussion and engaged the audience in what they could see as 'real-life' issues.

A learning point for workshop organisers resulted from the session we ran on leadership. This was considered to be a generic topic that underpinned any successful project, whether it is for invasive bird management or not. We discussed the concept of empowering leadership as a skill that could be learnt and assumed that would be something that would connect with participants. Interestingly in post-workshop feedback some participants felt this concept was not relevant in the Pacific context. The suggestion was that leadership was something that was acquired by being put into such a position by existing political and cultural systems. The implication was that there was not a direct link between learning how to become a leader and actually being put into a leadership position. This does raise a question as to how leadership is 'earned' and, while perhaps culturally acceptable, could well have implications for the success of projects implemented in the region. This is a point which deserves further discussion and unpacking.

2. VALUE LOCAL PARTNERSHIPS

Our partnership with MNRE in Samoa and SPREP ensured that we had critical levels of local support and advice on determining the logistics for the workshop (accommodation, workshop venue etc.) The partnership with MNRE also helped us to gain agreement over the use of local case studies that we could draw upon to illustrate key points.

3. ACCOUNT FOR LOCAL CUSTOM IN WORKSHOP TIMING

We had originally left approximately 30 minutes for the introduction to the workshop and scene-setting. Based on feedback from regional partners it became clear that we would need to carve out more time for formal opening involving multiple local dignitaries. This is important to take into account when considering how to allocate time to different activities.

4. PROVIDE PRE-WORKSHOP MATERIAL

We decided to send all participants an initial review document on invasive bird management globally in order to ensure all were 'up to speed' on what was currently known about the central workshop topic. However, what we failed to do was provide enough time at the start of the workshop to discuss the main learning points from this document, instead assuming all had read it and so were well-versed. This was an error which would be rectified next time.

5. IDENTIFY CORE COMPETENCIES UPFRONT

This workshop was based on achieving particular objectives laid out in the original project proposal. While these objectives we could have strengthened outputs (and outcomes) by identifying specific core competencies, as well as understanding, that we wanted participants to come out with from the workshop. We did spend time developing hands-on skills during the workshop. However, by identifying clearly a set of core abilities we expect participants to come out with and then testing to confirm these abilities had been acquired, we could have added further confidence that the objectives achieved would be long-lasting.

6. SECURE SENIOR COMMITMENT

The workshop was able to generate multiple plans for invasive bird management and feasibility studies. Some are already being developed into actions on the ground. This process could have been strengthened by securing not just the participation of relevant staff on the workshop but also gaining some commitment from their superiors that the skills and understanding gained- and plans drafted- would be given 'space' to be put into practice. While this would prolong the process we should endeavour to secure the commitment of decision-makers before investing in their staff so that an enabling environment is created in which people can put into practice skills and understanding developed.

7. ENCOURAGE SHARING OF PERSONAL EXPERIENCES

A valuable component of the workshop was the talk given by each participant on their experiences of invasive bird management within their own island. This not only surfaced new, unpublished information about bird management but also encouraged participants to discuss their experiences with each other in more informal settings. Next time we would encourage workshop organisers to plan these (short) talks near the start of the workshop providing the maximum time for discussions to ensue between participants.

8. INCLUDE A PUBLIC SHOW OF WORKSHOP OUTPUTS

A useful motivation for participants to have produced a tangible output to the workshop- in this case draft plans for invasive bird management- was a series of talks on the last day for an invited group of local dignitaries. This included the Heads of a number of funding and other conservation organisations. We believe this helped to sharpen participants' resolve to produce something concrete by the end of the workshop.

9. PLAN INFORMAL AS WELL AS FORMAL LEARNING

While significant effort was put into planning the formal, classroom-based component of the workshop, we realise that we did not plan sufficiently the field trip. This was designated to happen on the Saturday in the middle of the course, to help break up to formal learning with something more informal and practical. However, we should have applied the same rigour to the learning outcomes from the field trip as we had done to the formal side. This would have ensured that the time was both productive as well as relaxing. This would have included planning for poor weather conditions, which ultimately reduced the value of the field trip for participants.

10. MULTIPLE PARTICIPANTS; SAME LOCATION

We discussed prior to the workshop the value of spreading our net as wide as possible or focusing on a few key islands to draw participants from. In the end we veered more to the latter. This ensured that we had a critical mass of participants (2-3) from key locations, providing mini-groups that could work on the same plan, relevant to the work back home. While we would have opened the workshop up to more islands if we had selected one from each place, this would have made the production of a provisional feasibility study or management plan for each location difficult to achieve.

11. LONG LEAD-IN TIME FOR WORKSHOP DELIVERY

Given that partners in this project came from the UK, New Zealand and the Pacific we were required to work through Skype in the planning of the workshop. Time zones, work-loads and technical limitations all hampered this dialogue. An alternative idea would have been to organise conference calls using standard phones to ensure reception was sufficient to run the meetings. Whichever method was used in the future, the large distances over which planning may need to take place requires you to begin organising planning meetings long before you would do normally if you could speak together within the same time zone. We recommend that planning for such a workshop begins at least six months prior to its delivery.

Sustainability/Replicability

Summarize the success or challenge in achieving planned sustainability or replicability of project components or results.

The main concern, as discussed previously, is in ensuring that an enabling environment is created for participants once they complete training. Implementation of the skills and understanding gained from the capacity-building initiative will depend largely on willingness of decision-makers to enable their staff to put the new skills and understanding into practice. I believe this is an important area of focus for any future funding rounds. While we endeavored to consult with and involve decision-makers from participants' own organisations, we will need to track them to determine if they are encouraged to apply the new skills and develop the plans or recommendations emanating from the workshop.

Safeguard Policy Assessment

Provide a summary of the implementation of any required action toward the environmental and social safeguard policies within the project.

While the project itself did not have adverse impacts on the environment we had a responsibility to ensure those trained were aware of how to mitigate potential impacts on the environment of pesticide use. Consequently, we built into the project training in mitigating impacts on non-target species and human livelihoods. This training is in line with the recommendations laid out by the

World Bank in documents including Bank Procedure 4.01- Annex C. Note World Bank biodiversity specialist Dr Valerie Hickey was invited to the workshop and played an important role in developing workshop content.

Additional Funding

Provide details of any additional donors who supported this project and any funding secured for the project as a result of the CEPF grant or success of the project.

Donor	Type of funding*	Amount	Notes
Durrell Wildlife Conservation Trust	A	6000	50% staff time (1 month in total)
Landcare Research	A	10,000	50% staff time (1 month in total)
Pacific Invasives Initiative	A	16,800	100% staff time (3 weeks in total)
Ministry of Natural Resources and Environment (Samoa), Government of Samoa	A	8,250	Staff time for support in the planning and delivery of the workshop
MNRE, Samoa	A	1,000	Contribution to venue hire for the workshop

**Additional funding should be reported using the following categories:*

A Project co-financing (Other donors contribute to the direct costs of this CEPF project)

B Grantee and Partner leveraging (Other donors contribute to your organization or a partner organization as a direct result of successes with this CEPF project.)

C Regional/Portfolio leveraging (Other donors make large investments in a region because of CEPF investment or successes related to this project.)

Performance Tracking Report Addendum

CEPF GLOBAL TARGETS

Provide a numerical amount and brief description of the results achieved by your grant. Please respond to only those questions that are relevant to your project.

PROJECT RESULTS	If relevant, provide your numerical response for results achieved during the annual period.	Provide your numerical response for project from inception of CEPF support to date.	Describe the principal results achieved during the project.
1. *Did your project strengthen management of a protected area guided by a sustainable management plan? Please indicate number of hectares improved.*			
2. *How many hectares of new and/or expanded protected areas did your project help establish through a legal declaration or community agreement?*			
3. *Did your project strengthen biodiversity conservation and/or natural resources management inside a key biodiversity area identified in the CEPF ecosystem profile? If so, please indicate how many hectares.*	20 invasive species management practitioners trained	15 practitioners trained	
4. *Did your project effectively introduce or strengthen biodiversity conservation in management practices outside protected areas? If so, please indicate how many hectares.*	As above.		
5. *If your project promotes the sustainable use of natural resources, how many local communities accrued tangible socioeconomic benefits?*			

Information Sharing and CEPF Policy

CEPF is committed to transparent operations and to helping civil society groups share experiences, lessons learned, and results. Final project completion reports are made available on our website, www.cepf.net, and publicized in our newsletter and other communications.

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