<u>The Distribution and Abundance of Myna Birds (*Acridotheres tristis*) and Rimatara Lorikeets (*Vini kuhlii*) on Atiu, Cook Islands.</u>

Photo of Kura taken by McCormack et al, 2006. Other photos taken by R Heptonstall, 2010 on Atiu and Rarotonga, Cook Islands.

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Submitted in accordance with the requirements for the degree of Masters of Science

MSc Biodiversity and Conservation 2010

The University of Leeds
Faculty of Biological Sciences

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Abstract

The Common Myna *Acridotheres tristis* was originally introduced to the island of Atiu, Cook Islands, in 1915 to control the Coconut stick insect *Graeffea crouanii* but it has since become *a* pest itself. The Rimatara lorikeet *Vini Kuhlii* or 'Kura' was reintroduced, after disappearing from the Southern Cook Islands almost 200 years ago, to Atiu on 24th April 2007 from Rimatara, French Polynesia to create a reserve population due to there being only approximately 1000 birds left on Rimatara. Due to observations of mynas reportedly harassing and attacking adult and juvenile Kura at the nest, an eradication programme was introduced by Gerald McCormack, Director of the Cook Island Natural Heritage Trust (CINHT), in May 2009 to reduce the population size of myna birds to give the Kura a couple of peaceful nesting seasons to help establish a stable population on Atiu. A study by J. Mitchell of the University of Leeds in May/June 2009 estimated a starting count of approximately 6000 myna birds prior to the eradication programme. That survey was followed up in May 2010 using two strategies, the transect method and roost counts. Analysis of transect method counts, using the Distance software, estimate there are approximately 3128 mynas on Atiu. Roost counts were at variance with that figure and estimated only 1280 myna birds. The roost counts estimate of 1280 may be the most accurate because all mynas would be in the winter roosts for heat conservation from May to July alleviating the concern that females and young would be nesting away from the roosts during counts, whereas transect counts may involve recounting the same birds numerous times; a problem minimized by repeating transect counts twice daily and using different transects to cover as much of the expected habitat as possible. Only a limited survey of the population of Kura was possible during this visit to Atiu since almost all available time and logistics were focused on myna surveys. An estimate of the Kura population suggests there are approximately 100 birds, which suggests that since the 2007 introduction the Kura population is thriving on Atiu. However, comparisons with the exponential growth rate model of 184 birds suggest this difference could be due to myna bird harassment despite culling. A more comprehensive survey is recommended perhaps using similar strategies to determine whether the myna has any deleterious effect on the Kura. In July 2010 a new myna bounty was introduced and is proving successful as a further 383 myna birds were culled by the end of July. The Atiu Island Council may decide on complete eradication of the myna to give the Kura full advantage of living on Atiu in the absence of the competitive myna bird.

The Distribution and Abundance of Myna Birds and Rimatara Lorikeets on Atiu in the Cook Islands.

1. Introduction

1.1 Invasions and reintroductions on islands

Invasions occur when species are introduced to a non-native area where they rapidly spread and become established following proliferate adaptations to a new environment (Prentis et al, 2008). Invasive alien species are recognized as being a major threat across the globe due to the damages they create both environmentally and economically (Mehta et al, 2007; Holzapfel et al, 2006). The main reasons behind the success of invasive species in a new habitat are due to the lack of natural predators, parasites and pathogens, however, some invasions are unsuccessful due to the species being poorly adapted to the new environment in which it did not evolve (Capizzi et al, 2010; Prentis et al, 2008).

Land-use change and human mobility are the main drivers for species invasions as they provide the pathways for movement and colonization of species into new habitat areas (Holzapfel et al, 2006). These pathways make species invasions possible through increasing trade and transport networks worldwide and can include deliberate and inadvertent introductions, use as medicinal beneficiaries, commodities as food and drink, ornamental and aesthetic products and as biological control agents (Cowie et al, 2003; Rossman, 2001; Mehta, 2007; Mitchell, 2009).

Trade occurring on islands require optimal detection strategies to prevent any unwanted and possibly detrimental species invading, such as the Ship rat (*Rattus rattus*), which can threaten the survival of endemic bird species by predating on eggs and juveniles in the nest (Mitchell, 2009; Hulme, 2009). These strategies include prominent surveillance of all cargo being received as well as the destruction of any accompanying invaders, such as rodents (McCormack, 2008). Another example of a species invasion causing degradation to an island is the Brown tree snake (*Boiga irregularis*), which was accidentally introduced to Guam in 1950 causing multiple species extirpations (Fritts et al, 1998).

In response to alien invasions, several measures can be carried out to prevent further spread in an area, with eradication being the favoured method (Zavaleta et al, 2001).

However, in order to successfully eradicate a species it must first be detected, which requires optimal detection, monitoring and control strategies of the existing invaders to prevent the species becoming established, whilst keeping costs to a minimum in order for eradication to be a feasible option (Mehta et al, 2007). In some instances eradication is ranked as a low option for eliminating invasive species due to certain species being intractable, such as the Brown tree snake (Simberloff, 2001). However, it is being achieved on small islands through the use of simple eradication tools, such as traps and poisons which reduce the number of invaders to a level where eradication can be considered a feasible option, particularly where nesting birds are concerned (Zavaleta et al, 2001).

In order for species to become re-established to their former regions, reintroductions, which are the return of species to their historical ranges, are used whereby wild or captive-bred species are translocated from an already existing area to a new region, which shares similar habitat features to maximize the species chances of survival (Armstrong et al, 2007; Pierre, 1999). Reintroductions can also be implemented to help increase dwindling populations that have been exacerbated by natural disasters such as hurricanes and cyclones or when a species faces immediate, threatening processes (Tweed et al, 2003; Moro, 2003). The benefit of carrying out reintroductions and eradications on islands is due to islands having a small land-mass, which allows for greater control measures for the eradication of invasive species, whilst enabling reintroduced species with a dwindling population size to become re-established through simple eradication techniques in the absence of competition or predation pressures (Zavaleta et al, 2001; Steadman, 2002)

2. The Cook Islands

Figure 1. A section of the world map showing the location and distribution of the Northern and Southern Cook Islands. http://www.worldatlas.com/webimage/countrys/oceania/ck.htm.

The Cook Islands are oceanic islands located in Polynesia in the South Pacific Ocean found almost directly in-between Tahiti and Samoa (Figure 1) (Whistler, 1985; Yonekura et al, 1988). The Cook Islands consist of 15 islands and these are split into the Northern and Southern Group (Dzeroski et al, 2003). Captain James Cook sighted some of these islands in the 1770's during his voyage on the Endeavour (Stamp et al, 1978; Mitchell, 2009). The Northern Cooks consist of Tongareva (Penrhyn), Rakahanga, Pukapuka (Danger Island), Manihiki, Nassau and Palmerston, which are all atolls. The Southern Cooks, which are all 'high islands', include Rarotonga, Aitutaki, Atiu, Mangaia, Miti'aro and Mau'ke (Whistler, 1985). The Southern Cooks is the most populated of the Cook Islands spreading 11.5 km wide and 8 km long, with many shallow lagoon ecosystems (Dzeroski et al, 2003). Rarotonga is the main capital island containing about 9,000 inhabitants, approximately half the total Cook Island population, many of which have migrated across from the outer islands (Whistler, 1985). The islanders call themselves Cook Island 'Maori' and some islands even have their own island language, such as Atiu (Whistler, 1985).

3. Atiu

Atiu is located in the Southern Cook group and is the largest of the 'triangle' islands (2693 ha), which include Miti'aro (2226 ha) and Mau'ke (1842 ha) (Stoddart et al, 1990; Mitchell, 2009). The dimension of Atiu is 6.3 km East-West and 7.25 km North-South and has its own island Takutea, which is a bird sanctuary located 22km off the coast of Atiu (Mitchell, 2009). Atiu is the result of a subconical asymmetric volcano and is surrounded by an elevated limestone makatea which is found towards the centre of the island and ranges anywhere from 6-18m in height in the northwest and eastern parts of the island (Stoddart et al, 1990). The only freshwater lake, Tiriroto, is located in the southwest of the island where the locals swim and fish for freshwater eels (Stoddart et al, 1990). A coral reef surrounds most of the island and is no more than ankle deep and less than 45m wide in some areas, which the locals walk along late at night to catch reef fish (Figure 2) (Stoddart et al, 1990).

Figure 2. Geology of Atiu: Stoddart et al, (1990)

Atiu, like other isolated oceanic islands, has never been connected to any continents, which means the flora and fauna on the island is a result of either long-distance dispersal or species having evolved over time via *in situ* speciation (Chiarucci et al, 2010). Flora on Atiu include the Pacific Banyan (*Ficus proxila*), the highly fragrant Ngaputoru pandanus (*Pandanus arapepe*) and the invasive mile-a-minute weed (*Mikania micrantha*) along with an abundance of fruit trees including Sour sop (*Annona* *muricata*), Passion fruit (*Passiflora edulia*), Java plum (*Syzygium cumini*) and Noni (*Morinda citrifolia*), which has a strong cheese-like smell and is used throughout the Pacific by traditional native healers (Figure 3) (Roberts, 2004; Mitchell, 2009; Cook Island Government, 2002). Atiu also has cows, pigs, dogs and cats, which have been brought onto the island when human settlers arrived and it is understood that pigs outnumber humans 4 to 1 (Stanley, 2009). Atiu is well known for its avifauna with the island also being known as 'Enuamana', translated as 'Island of the Birds' (Mitchell, 2009). Avifauna species include the famous Atiu cave swiftlet or 'Kopeka' (*Aerodramus sawtelli*), which is a unique bird that uses echolocation, like bats, to navigate through the intricate cave systems on the island (Mitchell, 2009; Thomassen et al, 2007), the endangered Rarotongan flycatcher or 'Kakerori' (*Pomarea dimidiata*), which was introduced to Atiu in 2001, Rimatara Lorikeet (*Vini kuhlii*), Mangaia Kingfisher (*Todiramphus ruficollaris*) and the Cook Islands Fruit Dove (*Ptilinopus rarotongensis*) (Stanley, 2009; Mitchell, 2009; BirdLife International, 2010 (A), BirdLife International, 2010 (B), BirdLife International, 2010 (C)).

Figure 3. Photo of Noni, *Morinda citrifolia* taken whilst on Birdman George Mateariki's Bird Tour, 2010. Taken by R. Heptonstall

4. Myna Birds

Figure 4. The Common Myna, *Acridotheres tristis*
Taken by R. Heptonstall

The Common Myna or Indian Myna (*Acridotheres tristis*) is a member of the Sturnidae family and its natural range spans from India and Southeast Asia to Central Asia and Afghanistan (Figure 4) (McCormack, 2005; Queensland Government, 2009; Holzapfel et al, 2006). Mynas are social birds that forage in loose flocks of 5-6 birds during the day and gather at communal roosts on an evening, which usually contain 40-80 birds, however some roosts have been known to contain as many as 5000 birds (Queensland Government, 2009). At sunrise when the birds are ready to evacuate the roost they make a lot of noise for approximately 10-15 minutes before the first birds start to leave. This is repeated at sunset as the birds enter the roost in steady flocks before settling down for the night (Mitchell, 2009).

Indian mynas can be identified by distinctive white patches on their wings, which can be clearly seen as the bird is in flight along with a bright yellow bill, legs and feet and a brown glossy plumage (Queensland Government, 2009; Mitchell, 2009). The breeding season occurs 1-3 times a year with an incubation period of approximately two weeks and each brood may contain between 4-6 eggs, which are blue-green in colouration (Queensland Government, 2009; Mitchell, 2009). Favoured nesting sites of mynas include building crevices, woodpecker holes, traffic lights and palm trees with territories ranging from 117m2 to 2ha, which they defend against aggressively (Holzapfel et al, 2006; Queensland Government, 2009). Myna birds are very intelligent and can mimic human speech along with other environmental sounds, especially the Hill Myna

(*Gracula religiosa*), which is a popular cage-bird favoured for its rapid learning ability (Honolulu Zoo, 2008).

Myna birds are omnivorous opportunistic feeders and feed on a wide range of food, such as the ripening fruits of papaya, banana and figs, invertebrates, cereal crops, bird eggs, pet food and small reptiles (Queensland Government, 2009). They prefer tropical and subtropical open habitats and have adapted extremely well to urban environments that have been fragmented by human settlements (Queensland Government, 2009). This high adaptability has enabled myna birds to become globally distributed (except in America and Antarctica), mainly through human introductions, with a global extent estimated at 1,000,000-10,000,000km2 (Queensland Government, 2009; Holzapfel et al, 2006). They have also been nominated as the top 100 “Worlds Worst” invasive species by the IUCN and Invasive Species Specialist Group and are most abundant on islands in the Atlantic, Indian and Pacific Oceans (Holzapfel et al, 2006; Mitchell, 2009; Queensland Government, 2009).

On 22nd June 1906 the Common Myna bird was introduced to Rarotonga, Cook Islands to control a variety of insect pests including the Paper Hornet (*Rango Patia*) and Coconut Stick Insect (*Graeffea crouanii*) (McCormack, 2005). Due to the birds success in attacking certain insect pests on Rarotonga, the Common Myna was introduced from Tahiti to the Outer Island, Atiu, in 1915 as a bio-control agent against the coconut stick insect or “Veve” that had been introduced accidentally by ancient voyaging canoes (McCormack, 2005; McCormack, 2009).

To date, myna birds are heavily disliked in the Cook Islands as they steal food from inside houses, damage ripe fruit and interfere with other nesting birds such as the Mangaia Kingfisher (*Todiramphus ruficollaris*) and Cook Island Fruit Dove (*Ptilinpous rarotongensis*) by harassing both parents and juveniles at the nest (McCormack, 2009; BirdLife International, 2010 (A)).

5. Rimatara Lorikeet

The Rimatara Lorikeet (*Vini Kuhlii*) is in the family Psittacidae and can be identified by its vibrant colouration of a bright red chest, dark green wing plumage, light green tail feathers and dark purple patches on the nape of the neck with orange feet and bill (BirdLife International, 2010 (C)). It is listed as ‘Endangered’ on the IUCN Red List and is protected under several laws including CITES Appendix II, a national legislation on

Rimatara, French Polynesia and by a traditional *tapu* (taboo) on Atiu, Cook Islands following the birds reintroduction to the island in 2007 where it is known as the 'Kura' (McCormack, 2006; McCormack, 2008; BirdLife International, 2010 (C)).

On Rimatara, the lorikeets prefer mixed horticultural woodland habitat and feed on nectar from a range of flowering plants such as Coral trees (*Erythrina indica*), Inga (*Inga ynka*), Banana plants (*Musa cultivars*) and Albezia trees (*Falcataria moluccana*) (McCormack et al, 2010; BirdLife International, 2010 (C)). Little is known about the breeding season of the Rimatara lorikeets; however, behaviour comparisons made with other native birds and lorikeet species suggest the breeding season probably occurs between September and December, with fledging taking place about twelve weeks after the time of egg-laying (BirdLife International, 2010 (D)).

Historical and fossil evidence show the lorikeets range once spanned throughout the Southern Cook Islands, however, until 2007 it was restricted to the island of Rimatara in the Tubuai Islands, French Polynesia (BirdLife International, 2010 (C); McCormack, 2008). It is believed to have become extinct in the Southern Cook Islands in pre-missionary times prior to the 1820's due to the exploitation of its bright red feathers for the adornment of people in elaborate ceremonial head-dresses, god images and in the famous red loincloth ('*ura maro*), particularly on Mau'ke, Aitutaki and Atiu (Figure 5) (McCormack et al, 1996; McCormack, 2006). Within its former natural range, the Rimatara lorikeet lives only on Rimatara (McCormack, 2006).

Figure 5. A picture showing a Rimatara Lorikeet and a traditional head dresses containing the red feathers: (McCormack et al, 2010):http://www.animalpicturesarchive.com/view.php?tid=3&did=26961

Due to its limited distribution and population size, a reintroduction programme was planned to transfer some of the birds from Rimatara to Atiu to establish a reserve population (McCormack, 2007; McCormack, 2008). Atiu was selected due to it having similar vegetation to Rimatara and for being one of only two islands in the Southern Cook Islands, the other being Aitutaki, to have previously supported the Rimatara lorikeet (Figure 7) (McCormack et al, 2010; McCormack et al, 1996). The presence of the introduced Blue Lorikeet (*Vini peruviana*) or 'Nun bird' on Aitutaki made this island unsuitable, as the lorikeets would compete for food and nest sites, making Atiu the only suitable island for translocation (McCormack et al, 2010). It is also the only Southern Cook island to be free from the Ship rat (*Rattus rattus*), which is quoted as being the 'modern destroyer of lorikeets' (McCormack, 2008). The only concern on Atiu is the presence of the Common Myna; however, it was not confirmed to be a serious threat since the Blue lorikeet has flourished on Aitutaki in the presence of myna birds (McCormack, 2008).

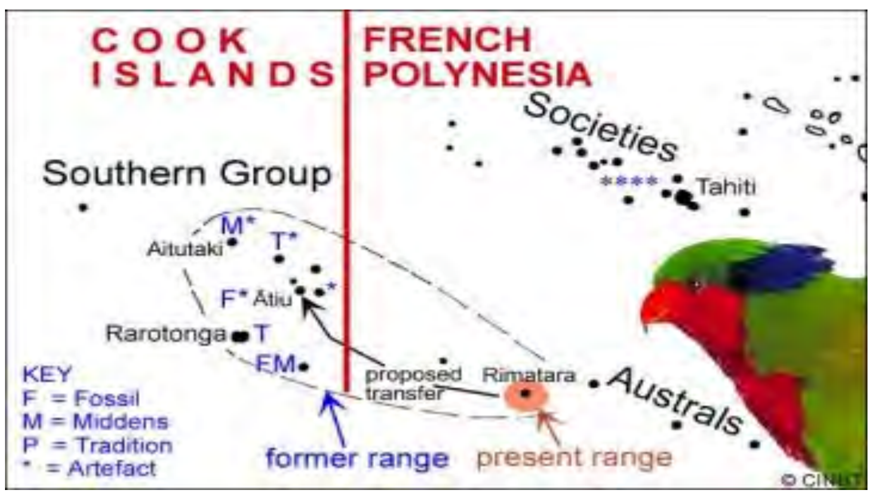


Figure 6. Historical distribution of Rimatara lorikeets (McCormack, 2007): http://www.atiu.info/attractions/birds/lorikeet/

On 24th April 2007, twenty-seven Rimatara lorikeets were reintroduced from Rimatara to Atiu (McCormack et al, 2010). The implementation of this programme was carried out by four organizations: Cook Islands Natural Heritage Trust (CINHT); Te Ipukarea Society (TIS), Zoological Society of San Diego (San Diego Zoo) and the Ornithological Society of Polynesia (MANU) (McCormack, 2006; McCormack, 2008).

Atiu and Rimatara are bound by a Memorandum of Understanding (MOU) that the bird has been given to Atiu as a gift to enhance its survival in the wild whereby the Atiu community is not allowed to sell or give the lorikeets to anyone else under this agreement, which is being upheld by the traditional Queen of Atiu, Rongomatane Ariki (McCormack et al, 2010). Unsuspectingly, two months after the release four Kura left Atiu and flew to the nearby island of Miti'aro 50km away, leaving only 23 birds on Atiu. This lead to concerns over the Kura's survival as Miti'aro is home to an abundance of Ship rat (McCormack, 2008). However, in June 2008 Hannah Wheatley from Leeds University was carrying out a survey on Miti'aro and reported that four Rimatara lorikeets were still present on the island. Despite the concerns, monitoring will be carried out to determine more about the effects of Ship rat on these few lorikeets (McCormack, 2008; BirdLife International, 2010 (D)).

Since the Kura's reintroduction to Atiu the birds have been breeding successfully however, eyewitness reports have been made of mynas seriously harassing parents and juveniles at the only two nests on the Island, which included a youngster being knocked to the ground and continuously attacked as it emerged from the nest (McCormack et al, 2010; McCormack, 2009). As a result of this it was agreed that a reduction in the number of myna birds was required and in May 2009 a myna bird eradication programme was implemented on Atiu by the CINHT, in order to give the Rimatara lorikeets a couple of peaceful nesting seasons to be able to establish and increase their population size on the island (McCormack, 2009).

In June 2010, a group of 8 students and 4 adults from Rimatara came to Atiu to see how well the Kura was doing since its introduction. This was a week full of celebrations, activities and feeds produced by each of the 5 villages on Atiu: Mapumai, Teenui, Ngatiarua, Tengatangi and Areora, to honor the arrival of their guests. The students were all under the age of 11 and enjoyed the islands welcome immensely. This visit was important to re-enforce the memorandum that Atiu and Rimatara have for the Kura and the presence of the younger students will help to carry on this mutual understanding for future generations to come (Figure 8).

Figure 7. Relative sizes of Atiu and Rimatara: http://www.atiu.info/attractions/birds/lorikeet/

Figure 8. A Rimatara student dressed as the Rimatara lorikeet
Taken by R. Heptonstall

6. <u>The Eradication Programme</u>

Due to growing concerns over crop damage and the detrimental effects caused to the Kura, an eradication programme was implemented on Atiu to reduce the number of myna birds on the island. The programme is being lead by Gerald McCormack, Director of the Cook Island Natural Heritage Trust (CINHT) with a dedicated SWAT team including 'Birdman' George Mateariki and his loyal assistant Andrew (Maara) Akava. The programme is funded by the Critical Ecosystem Partnership Fund (CEPF) through the Te Ipukarea Society (TIS) and also includes local funding from Atiu Villas and Air Rarotonga (McCormack, 2009). Birdman George is well known and respected on Atiu for his wealth of knowledge of the islands flora and fauna. He was also involved in the Kakerori recovery programme as well as being a member of the reintroduction team that caught and translocated the 27 Kura from Rimatara to Atiu (Mitchell, 2009).

The eradication programme commenced in May 2009 with Birdman George and Maara finding all the myna roosts on Atiu with the help of teacher Bazza Ross and students from Enuamanu School. This involved walking around the island in the few hours before sunset to detect the roosts by listening for the loud squawking noises made by the mynas inside the roost before they settled down for the night. This method resulted in a total of 38 roosts being found over a two-week 'hunting' period (McCormack, 2009; Mitchell, 2009). Once the roosts had been found, the SWAT team baited areas surrounding the roosts using trays of rice mixed with several drops of the poison DRC1339, also known as Starlicide (Mitchell, 2009; McCormack, 2009). Starlicide was selected as it highly effective in killing myna birds in a humane manner by gradually making them unconscious and without signs of stress. The poison is also biodegradable in the environment where it is broken down by soil microbes and sunlight. Chickens are susceptible to the poison, however, they need much larger doses to be affected and to date there have been no sightings of dead chickens on the island (McCormack, 2009). A bounty was also created in 2009 to encourage the locals to help trap and kill myna birds using traditional chicken traps; each person received $1NZ for every myna bird or right foot collected and $2NZ per nest, awarded by the CINHT (Mitchell, 2009).

At the beginning of July 2010, poisoning was stopped and a new bounty was introduced by the CINHT to increase the efforts of myna bird eradication on the island following an overall successful year of the programme. This bounty has been set up for a two month period for July and August 2010, where the locals will now earn $4NZ for every myna bird or right foot and $400NZ at the end of each month for the person or team who kills the most mynas and gives them to Birdman George to be recorded. This bounty is in position to get more of the local community involved to help reduce the number of myna birds on Atiu as they have apparently increased in number since

January 2010 following an abundant fruiting season. If this new bounty is successful in trapping a large number of the remaining mynas by the end of August, the programme will continue for an extra month. If the number of mynas is reduced further by the end of September, the Atiu Island Council may have the opportunity to decide to go for complete eradication of mynas on the island, whereby Gerald McCormack will provide 1000 rounds of ammunition for shooters to go around and kill the remaining myna birds. If this occurs, the Island Council may also have the opportunity to reintroduce myna birds to Atiu in a few years if there is an apparent increase in palm tree damage since the removal of one invasive species can lead to increased numbers of another invasive species, such as the coconut stick insect (Zavaleta et al, 2001; McCormack, 2009). The latest report on the new myna bounty competition states 383 birds were culled by the end of July 2010, with Andrew (Maara) Akava trapping the most birds with 158 legs and claiming the first of two $400NZ prizes (email from Malcolm, 5 August 2010).

7. Aim

The aim of this project is to determine the distribution and abundance of the Common Myna bird. The myna bird eradication programme began in May 2009 and this project will assess the current population of myna birds to see how successful the eradication programme has been over the past year. This is the first real assessment of the myna bird population on Atiu since poisoning began.

In addition, due to the potential deleterious effects on the proliferation of the Kura by the Myna bird, a limited survey is to be carried out to assess the current population of the Kura to estimate whether the population is thriving in the presence of the Myna since the introduction of 23 birds to Atiu in April 2007.

8. Method

Myna Bird

Two methods were carried out to determine the population size of the myna birds on Atiu since the start of the poisoning programme in May 2009.

8.1 Roost Counts

The roosts that were studied in this project were the same roosts that were used in last year's study by Mitchell, 2009 that assessed the distribution and abundance of myna birds prior to the commencement of the eradication programme (Figure 9). The same method was followed for this year's project; however, these results will show whether the myna bird population has changed after a full year of the eradication programme.

Last year, students from Enuamanu school went out at night over a two week period to locate as many roost sites as possible and from this information, 10 roosts were chosen at random and used in last years study of the myna birds. The same 10 roosts were studied again in this project to determine whether the population of myna birds had changed and so that an exact comparison could be made between the total population of myna birds, their distribution and their abundance from 2009-2010. Each of the 10 roosts were observed twice a day at sunrise (from 6.30am) as the myna birds left their roosts and again at sunset (from 5.30pm) as the birds came back to roost in the evening. The roosts were repeatedly observed and the highest count was used to get a more precise estimate of the maximum number of myna birds at each roost site.

In contrast with the 2009 study, roost counts were carried out by at least two people surveying opposite sides of the roosts to increase probable detection rates, and the number of birds that left or entered the roosts were recorded. The numbers of birds observed were counted using a hand-held clicker counter and counts were recorded after 5-minute intervals so that the area could be watched closely for as long as possible until no more birds were observed. By having at least two people surveying the roosts from either side, it gives a greater chance of counting all the birds in the roosts to give a 100% detection rate at roost sites.

8.2 Transects

In the 2009 study 12 transects were chosen which followed roads and forest paths along different areas and vegetation types around the island. Transects 3 and 8a were removed from the 2010 project due to time limitations to allow for Kura observations and transects 11 and 12 were removed due to no myna birds being seen there in 2009 and 2010, possibly due to the areas (Makatea) being too dense therefore unsuitable for mynas.

Each transect was walked at a reasonable pace in the morning from 7.30am straight after roost counts and again in the late afternoon from 3.00pm prior to evening roost counts. This is due to myna bird activity being at its height around these times as they hunt for food after leaving the roost and prior to going back to roosts for the night. Myna birds were counted and tabulated using the distances at which they were seen or heard from the road using a range finder. The distances ranged from 0-100 metres away. If a bird was heard but not seen it was a count of one as there was definitely one bird in the area, unless other birds could be heard in different directions away from the road, then the estimated number of birds that could be heard were recorded.

Transects were categorized into four different vegetation areas following a study by Simonette and Franklin in 1989 and these areas include the Makatea (560ha), Village (37ha), Horticultural Inland (512ha) and Coastal Road (80ha) (Mitchell, 2009).

Data collected from this transect method will be input to the Distance software to determine the number of myna birds per hectare on the island. The total number of myna birds from each of the four different vegetation areas will provide the estimated total population of myna birds on Atiu.

9. Rimatara Lorikeet or 'Kura'.

Four methods were used to assess the distribution of the Rimatara Lorikeet on Atiu: - Transects, Point Distance Counts, Instantaneous Counts and a Group Observation Count.

9.1 Transects

The transect method that was used for the Kura is the same method that was carried out for the Myna birds. The same transects were used as they covered a wide range of different vegetation types and sections across the island, which gave a good mixture of habitats to survey. Each transect was walked at a reasonable pace from 7.30am in the morning and then repeated in the late afternoon from 3.00pm. These times are when the birds are most active. The number of birds that were seen were recorded and usually seen during flight as they vocalize loudly, which makes it easier to spot them in the air.

9.2 Point Distance

Initially, a point distance method was carried out using 8-minute intervals where the maximum number of birds seen in that 8-minute period was recorded as the maximum number of birds present in the area at that instance. This method was repeated three times after each successive 8-minute interval and a new count was started for each period; however there was confusion as to whether the birds were being repeatedly counted as most Kura were spotted as they flew overhead. They were also seen circling banana plantations so it was possible that the birds were being recounted in the same 8-minute periods. Due to this confusion the point-distance method was rejected and an instantaneous count method was done.

9.3 Instantaneous Count

The local people on Atiu provided six sites where Kura have regularly been spotted feeding at banana plantations. The instantaneous count method is a basic count of the number of birds found in these areas at any one time. The maximum number of birds that are seen at any one time is recorded and this is the precise minimum number of birds in the area at this instance. If a greater number of birds are seen all together after the previous count has been recorded, and the count is higher, then this count is the new maximum (true minimum) number of Kura in the area.

This method had no time limits and was carried out simply by watching the specified site and counting the maximum number of birds seen there without repeats, or until it was too confusing to know how many more birds there may be after a lengthy time period. The highest number of birds recorded during the entire time period was the maximum number of birds seen together at that time.

The results of this method could also be used to determine whether Kura have preferential feeding areas. If the same number of birds were counted in that area following repeats on different days, it would suggest that these birds have a preferential feeding area, however this was not the case. This method was eventually rejected, as it did not give a reliable count of the number of Kura across the island, hence a group observation count was carried out for greater accuracy.

9.4 **Group Observation Count**

The observation method was used to achieve an overall count of Kura on the island using a large team of people to count as many birds as possible across the island. It was centered mainly in the North of the island due to there being a larger number of banana plantations spread about here, along with four areas being observed in the south of the island as they are known feeding areas for Kura (Figure 11). This method was carried out across the island at roughly the same time to make sure that the number of birds that were recorded at each location at that time were definitely different birds. This also reduced the possibility of any double counting of birds as these locations were spread far enough apart to prevent this. Two counts were carried out over two days:

1. The first count began at 4.30pm. Twelve students from Enuamanu School and four adults were present. A total of eight banana plantations were observed and two people were dropped at each of the chosen locations. Before the survey commenced, all observers were instructed to not count birds that had flown overhead then recently flown back over in the opposite direction, as this could be a re-count. If they saw birds fly overhead in one direction then more birds flew across in the same direction, then that could be added to the previous count as it likely to be a new bird and not a double count.
2. The second count began at 3.00pm. Sixteen students and four adults were present this time and two more locations were added near to two of the original locations to incorporate the extra four students. The same method was carried out and the maximum number of birds seen was recorded as the highest count at each location. After 90 minutes, counting stopped and the total number of Kura that had been counted at each location was recorded along with the locations, which are highlighted on the map of the island (Figure 11).

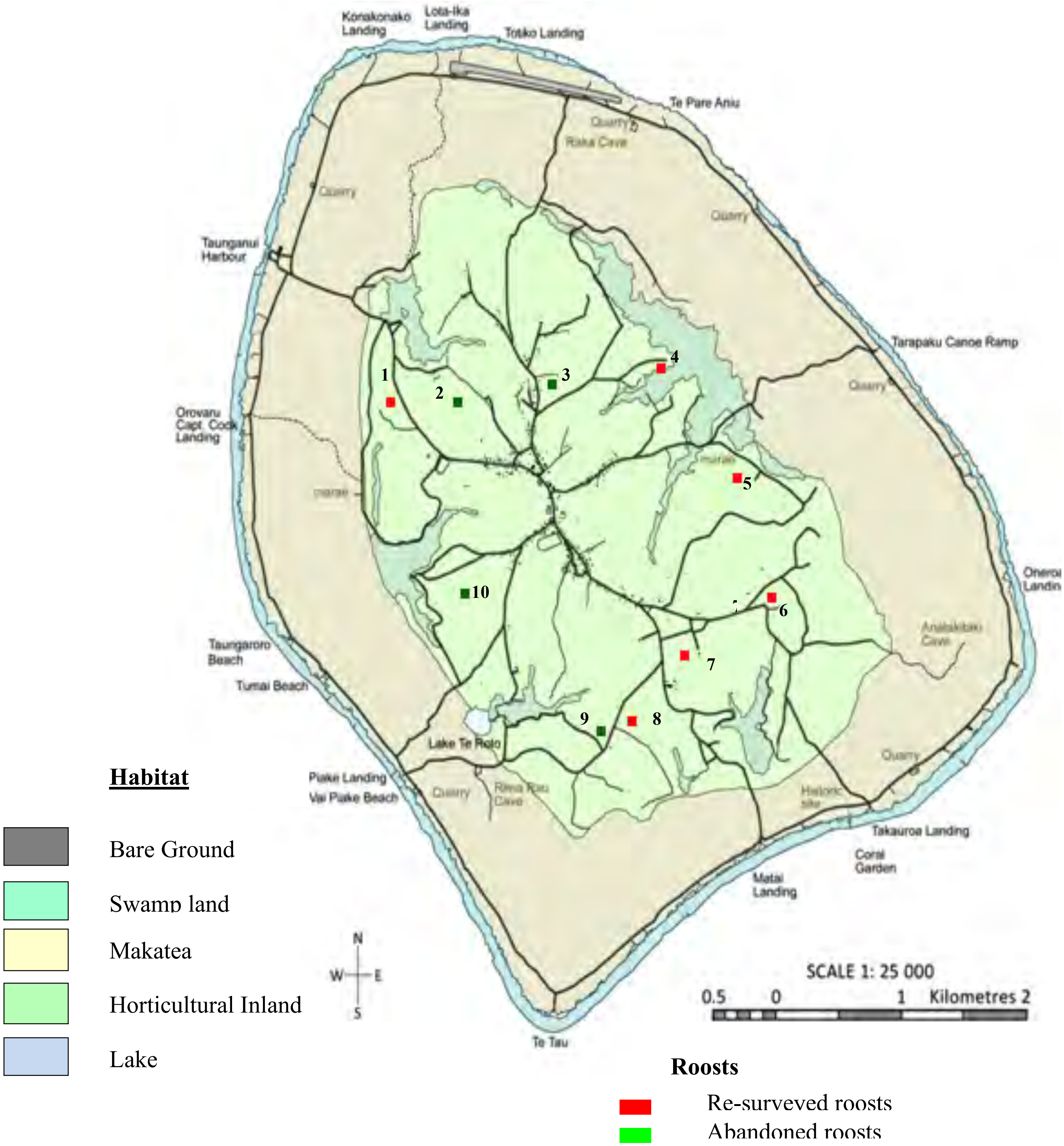


Figure 9. An aerial view of Atiu showing the roosts that were re-surveyed for morning and evening roost counts. These are the same roosts that were originally surveyed in 2009.

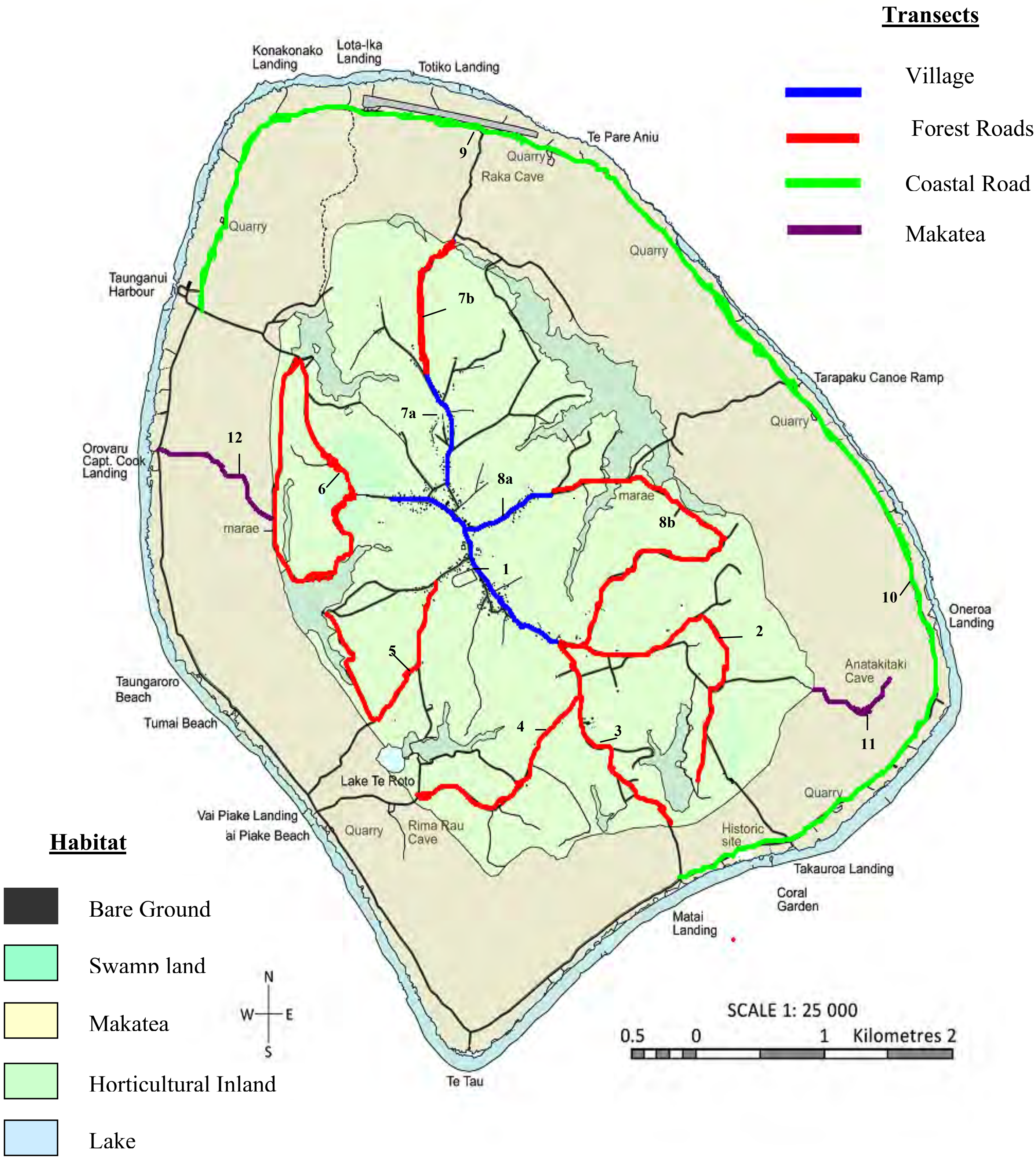


Figure 10. An aerial view of Atiu to show the transects that were surveyed during the transect method. Each transect is colour-coded according to the habitat type or vegetation area that they covered.

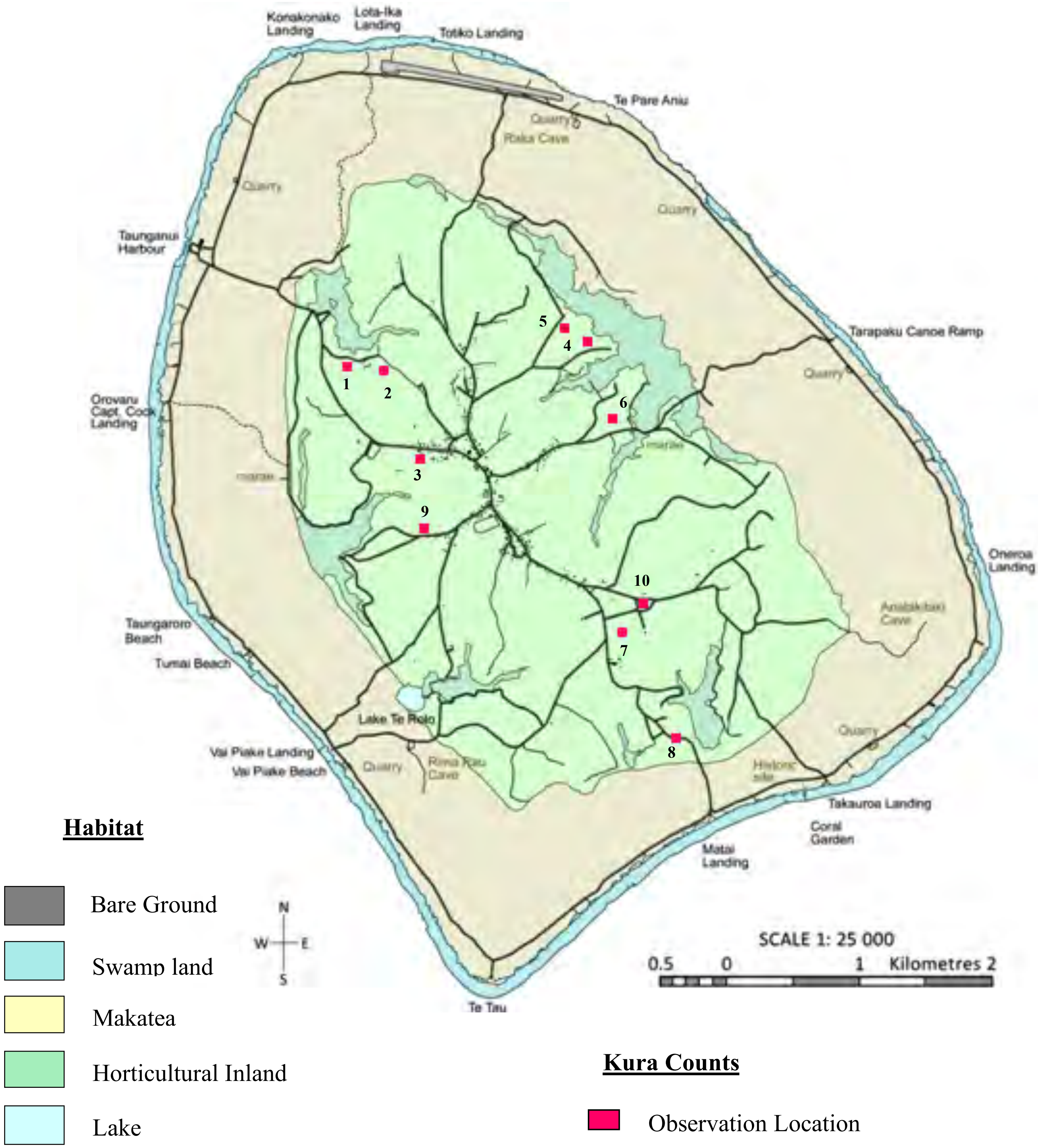


Figure 11. An aerial map of Atiu showing the locations of banana plantations surveyed during two Kura observation counts. Locations 9 and 10 were additional areas surveyed on day two due to having four extra volunteers.

10. Results: Myna Birds

10.1 Roost Counts

All the roosts that were surveyed in 2009 were re-surveyed again this year to produce direct comparisons between the number of myna birds present between 2009 and 2010 in order to determine the success of the eradication programme. This year's results assume a 100% detection rate following at least two people observing both sides of all the roosts (Table 1). The red roost numbers show the numbers that the roosts were labeled in 2009.

Roosts	Highest Count for 2009	Highest Count for 2010
1 (8)	73	19
2 (10)	74	Roost found abandoned
3 (1)	53	Roost found abandoned
4 (9)	218	138
5 (7)	162	122
6 (6)	81	27
7 (4)	85	64
8 (3)	39	110
9 (2)	Outlier in 2009 study	Roost found abandoned
10 (5)	36	Roost found abandoned
Total	821	480
Average No. of birds per Roost (Total/No.of roosts)	91.22	80

Standard Deviation	60.303	50.62
Standard Error	20.101	20.66
Number of Roosts on Atiu	38	16
Total (Average x No. of roosts)	3466.44 (assuming 50% detection)	1280 (assuming 100% detection)
Total (x 50%)	6932.89	N/A
Total +/-	1527.67	849.92
Upper 95% Confidence Interval	8460.56	2129.92
Lower 95% Confidence Interval	5405.21	430.08

Table 1.Results from the roost count data to show direct comparisons between the highest roost counts surveyed in the roost count method in 2009 and 2010. Figures in red are taken from Mitchell, 2009.

10.2 Transects

The results from the Distance software show the population of myna birds per hectare across the island. This has been calculated by multiplying Density against the area (Ha) for each different habitat area (Table 2).

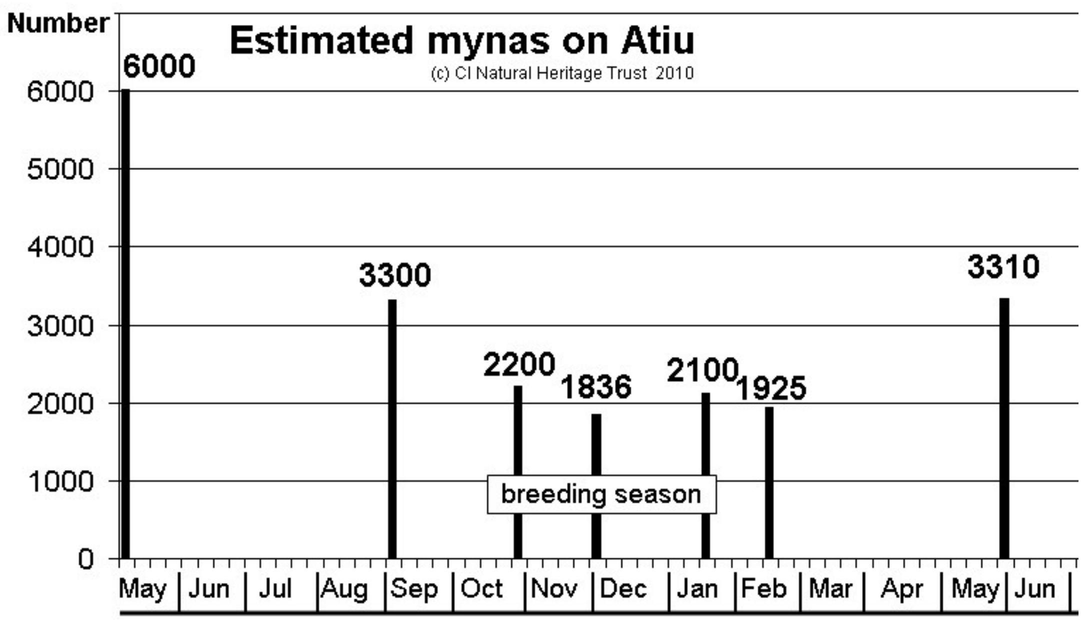
Habitat Type	Area (Ha	Density (Ha^{-1})	Population Size	Range 95% Certainty (80%)
Village	37	12.94 26.6	479 984	302 - 760 655 - 1476
Coastal Road	80	0.55 2.3	44 184	25 - 78 40 - 784
Horticultural Inland	512	5.09 6.5	2605 3328	1820 - 3729 2560 - 4352
Makatea	560	0 0	0 0	0 0
Total			3128 4496	

Table 2. The estimated population size of myna birds on Atiu for May/June 2010. All figures in red are taken from the survey of 2009 carried out by Jessica Mitchell, MSc, University of Leeds.

After running all the Distance models using observations as 'clusters of objects' for each of the three habitat areas, the best fit for the 'Village' area was the 'Negative Exponential/Cosine' model (minimum AIC=541.98). The model with the best fit for both the 'Horticultural Inland' and 'Coastal Road' was the 'Uniform/Cosine' model (min AIC=43.329 and AIC=531.264, respectively). The average cluster size E(s) for the Village was 11 birds, the Horticultural Inland was 8 birds and the Coastal Road was 4 birds.

10.3 Myna Bird population estimate

Graph 1 shows the estimated number of myna birds on Atiu based on last year's data from Mitchell, 2009. There were approximately 6000 birds estimated to be on Atiu at the start of the eradication programme in May 2009. In May 2010 there were estimated to be approximately 3310 myna birds on Atiu.



Graph 1. A graph to show the breeding season (October-February) and the estimated number of mynas on Atiu based on data from Mitchell, 2009. (McCormack, 2010. Email to R. Heptonstall).

10.4 Results: Rimatara Lorikeet

Group Count Observations

Location Number	Observation Day 1	Observation Day 2
1	26	16
2	7	8
3	9	3
4	24	39
5	13	10
6	5	3
7	16	12
8	4	6
9	N/A	7
10	N/A	7
Total	104	111

Table 3. Observation counts of the Kura on Atiu, 2010. *Locations 9 and 10 were included on day two due to an extra four voluntary students joining the count.

Table 3 shows the number of Kura seen at each location during the observation period.

10.5 Exponential Growth Rate Model

An exponential growth rate model was produced to show the predicted population size of Kura on Atiu between 2007-2010 (Table 4). The growth rate model has been calculated based on each breeding pair producing two young (a 100% growth rate) using the following equation:

$$y = a\,(1+r)^x$$
$$y = 23\,(1+1.00)^x$$
$$y = 23\,(2)^x$$

a = initial population at the start

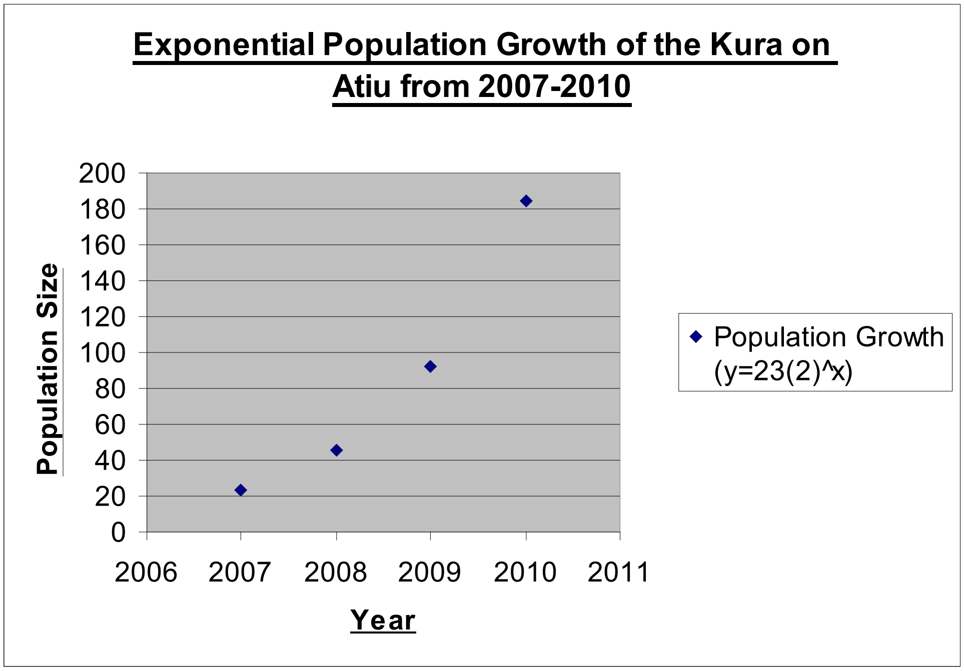
r = growth (as a percentage)

x = Number of time intervals

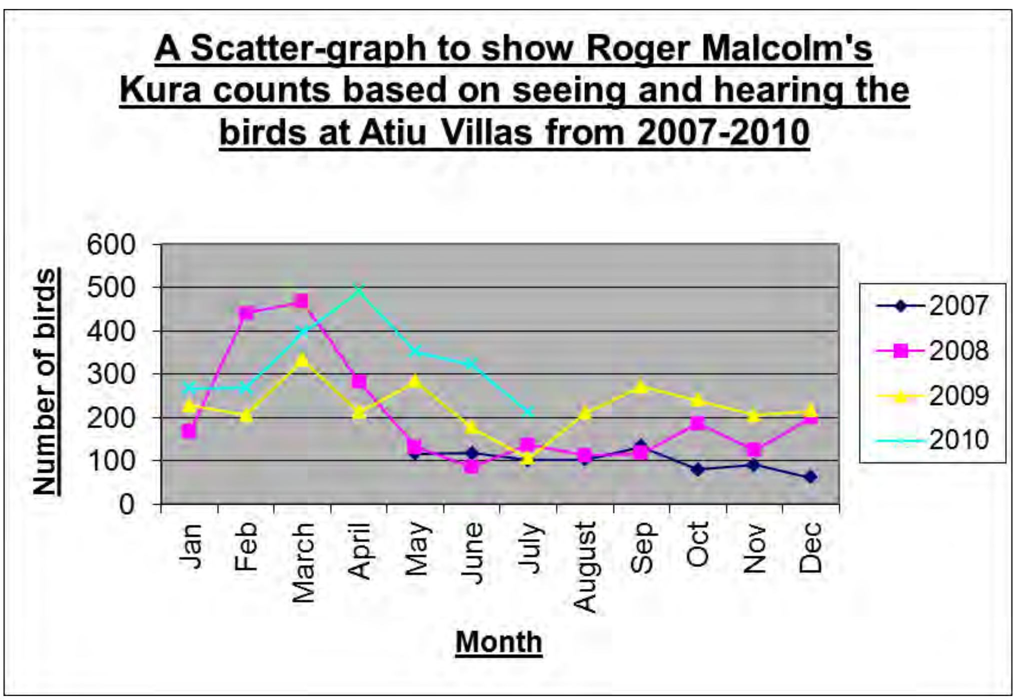
Year	2007 Start	2008 Time Interval 1 Y=23(2)^1	2009 Time Interval 2 Y= 23(2)^2	2010 Time Interval 3 Y= 23(2)^3
Total Kura on Atiu	23	46	92	184

Table 4. This table is based on 23 Kura having one brood each with two young per year.

*Exponential Growth and Decay equation: Roberts, D. (1998): http://www.eoearth.org/article/Exponential_growth



Graph 2. A scatter graph to show the predicted population growth of Kura on Atiu between 2007-2010.



Graph 3. A Scatter-graph to show the variations in Kura counts every month between 2007-2010 based on the number of birds seen and heard at Atiu Villas by Roger Malcolm, Atiu Villas (Malcolm, 2010).

11. Discussion

11.1 Myna Birds

The results from the Distance software show an overall reduction in the number of myna birds on Atiu from 4496 in 2009 to 3128 in 2010 (Mitchell, 2009). The results of the myna bird population size in each of the three habitat areas show a smaller population size this year compared to the pre-poisoning population size in 2009, with the Village containing 479 birds (984 in 2009), the Coastal Road containing 44 birds (184 in 2009) and the Horticultural Inland containing 2605 birds (3328 in 2009). The overall trend in bird density in each habitat correlates well with last year's results as the Village still contains the highest density of myna birds and the Coastal road contains the lowest density, reflecting myna birds preference for urban areas (Table 2) (Holzapfel et al, 2006).

Surveys of the Makatea last year showed an absence of myna birds in this habitat area, which was highlighted again in this year's survey, therefore the only two Makatea transects, 11 and 12, were removed from the project (Mitchell, 2009). Myna birds are well known for living commensally with humans and will avoid dense forested areas, which probably explains the absence of myna birds here again this year (Pell et al, 1996; Mitchell, 2009). Comparisons of the total number of roosts between 2009 and 2010 show nearly a 60% reduction from 38 roosts to 16, highlighting the success of the poisoning programme.

Direct comparisons of the roosts surveyed in the roost count method in 2009 and 2010 clearly show four out of ten roosts are now dormant, which is due to the reduced population size of mynas (Table 1). However, one of the remaining six roosts actually showed an increase in the number of myna birds present (Table 1). Myna birds are highly intelligent with reports stating they are quick to recognize threats, therefore, the remaining birds from freshly poisoned roosts may have abandoned them and moved away to join another roost in order to avoid the threat of being poisoned (McCormack, 2009).

From comparing this years transect and roost count data, the transect results show a higher population estimate of myna birds on Atiu (3128 birds) compared to the roost count results (1280 birds). According to Mitchell, 2009, it is difficult to determine which method is the most accurate as they are both based on estimates. Transect data from

2009 was provided by Gerald McCormack (Graph 1) and the two results appear to correlate fairly well, however, this data is based on a 50% detection rate taken from Mitchell, 2009. Mitchell 2009 states, “a 50% detection rate is a major source of uncertainty”, after having performed roost counts on her own. Roost counts carried out for this project were all performed with at least two observers per roost and in some cases as many as four observers, to substantially reduce the detection error. This suggests that the roost count estimate of 1280 birds is the most accurate population size estimate of myna birds on Atiu, compared with the transect results. The highest roost count from each roost was used in order to ensure the maximum population size was estimated.

Further discussion with Gerald McCormack concluded that the transect estimates may be higher than normal due to this method being slow to reflect the actual reduction of birds following poisoning. It is proposed that birds from the horticultural inland are drawn into the village area to feed, keeping the number of mynas in the village transects higher than they actually are. Also, as the population decreases in the horticultural inland, there may be more space available for these birds to congregate along roadsides, keeping forest counts higher than expected during transect walks (email from McCormack, 16 August 10). This could explain the larger population size estimate for the transect method than is actually the case, proving that the roost count method is the most accurate. The fact that this survey was carried out in winter (May-June) outside of the birds breeding season can also support this assumption. During the myna breeding season (October-February) females incubate their eggs overnight, causing the majority of the birds in summer roosts to be largely made up of males (Queensland Government, 2009). However, in winter females and their young would join the roosts as they depend on heat conservation to keep warm and stay alive during the cold nights, which would alleviate concerns over the possibility of any missed birds during roost observations, making roost counts the most accurate method for estimating the total number of myna birds on Atiu (email from McCormack, 16 August 10).

Observations of myna bird behavior reportedly changed during poisoning with more mynas appearing to congregate in much larger flocks than usual as they moved between areas for feeding and socializing than had previously been observed in 2009 when the population size was stable (email from McCormack, 16 August 2010). This larger flock size could be explained due to the reduction in the number of roosts causing the remaining birds to group together in larger flocks, which may have some relationship with roost sharing and could also explain the reason for the higher roost count observed in the remaining roosts this year. The average cluster sizes of birds in the village, horticultural inland and coastal areas show clusters of 11, 8 and 4 birds, respectively. Unfortunately Mitchell, 2009 did not state any cluster sizes in her report as these results could have been compared with last year's data to determine whether cluster size increased and whether this was in relation to the observed increases in flock sizes in the village.

11.2 Rimatara Lorikeets

The results from the individual Kura counts show quite a bit of difference between the two observations; however, there is very little difference in the total number of birds observed overall in the same areas over the two day survey period suggesting there are at least 100 Rimatara lorikeets on Atiu. Using these observation counts and comparing them with the 23 birds that were originally introduced to Atiu from Rimatara in 2007, it is clear that the population size of Rimatara lorikeets has increased successfully. Juvenile lorikeets have also been reported on the island with the first sighting being reported on 21st February 2008 by George Mateariki and Roger Malcolm, showing the lorikeets are breeding successfully on Atiu (McCormack, 2008).

The different methods that were carried out were done due to the transect method failing to detect many lorikeets at all (only 10 observation records for Kura compared with 145 myna bird observation records). The point-distance method became confusing due to not knowing whether birds had been recounted, as they were observed arriving, leaving and circling the observation areas. To overcome this, an instantaneous count was introduced; however, even though this method gave fairly good records of the number of Kura in specific areas, it did not provide an accurate count of the number of Kura on the island so it was rejected in favour of a more specific group observation count. The group observation counts were carried out over two days (the third day was called off due to torrential rain). The results obtained on day one and two were 104 and 111 (Table 3), respectively, which are fairly close and suggests there are at least 100 Kura on Atiu.

Unfortunately, results obtained from this project on the Rimatara lorikeets were difficult to collect and cannot be analysed statistically as they are based on simple observation counts. However, due to the complications experienced during the lorikeet survey and through only having simple counts from the group observation method, an exponential growth model was produced to predict the population growth of lorikeets on Atiu, along with a comparison of these figures with group observation counts and observation counts carried out and recorded by Roger Malcolm of Atiu Villas since 2007 (Graph 3). The exponential growth model was used as it is a useful method for predicting population growth of a species following its introduction to a new environment in the absence of other competitors or predators, although it is not expected to be indefinite and is being used purely to show the early stages of the population growth (McGinley et al, 2008).

Results from the exponential growth table predict there are 184 lorikeets on Atiu in 2010 (Graph 2, Table 4) following each breeding pair having one brood containing two young per year, with 100% survival (email from McCormack, 4 August 2010).

Comparing the exponential growth counts with the group observation counts (Table 3, Table 4), there is an approximate difference of 77 birds (taking the average of the two observation count totals to give 107 birds), which could possibly be due to birds being at different locations to the ones surveyed during the group observation counts and thus not being counted (Table 2). However, the fact that the exponential growth rate predicts 184 birds compared to the group observation count of 107 birds cannot be excluded and could be an indication that the Kura are not thriving as well as expected as predicted by the exponential growth rate. This could be due to myna harassment despite the culling or it could be due to the fact there were significantly more male than female Kura in the original 23. It is doubtful that the myna is depleting food resources of the Kura as personal observations suggest there is an abundance of food for Kura to eat. This survey could be improved next time by having a larger observation team and more observation areas across the island. Using Roger Malcolm's observation counts between June-August his July 2010 count states there are 83 +/- 14 Kura on Atiu (email from Malcolm, 5 August 2010). His figure is lower than the group observation counts, however these counts are based on birds seen or heard in the areas surrounding Atiu Villas at the southern end of the island, and therefore any birds in the north of the island may not have been counted as it is unclear whether all Kura's inevitably fly near Atiu Villas every day to be able to be counted. Nevertheless, Roger's counts show an increase in the number of Kura seen and heard between 2007-2010, supporting the fact that the Kura is breeding successfully on Atiu.

12. Recommendations

Future projects could include (a) a comprehensive study directed at obtaining an accurate assessment of the Kura population and related trends on Atiu in the presence or absence of the myna bird (b) a repeat study directed at obtaining an accurate assessment of the myna bird and related trends (c) a repeat study of the Coconut stick insect to assess whether the myna cull has, in any way, affected the proliferation of the stick insect and (d) a more comprehensive appraisal of the specific habitats on Atiu, such as an update on the work of Simonette and Franklin 1989 (Mitchell, 2009).

13. Acknowledgements

I would like to thank: Gerald McCormack for his invaluable supervision and assistance throughout this project. Dr Steve Compton, my tutor at Leeds University for his supervision and Jessica Mitchell, 2009, for her advice and for having undertaken the project on which I was able to build my project this year. The University of Leeds for funding, direction and opportunity to carry out this project. The World Parrot Trust for their generous funding towards costs. Queen Rongomatane Ariki and the Atiu Island Council for their generous hospitality and kindness throughout my stay on Atiu. Birdman George Mateariki, Atiu ornithologist extraordinaire, for his superior knowledge of the flora and fauna of Atiu and his generous hospitality and patience along with his able assistant Andrew (Maara) Akava. Bazza Ross, English Teacher at Enuamanu School for taking me under his wing, his enduring support, generosity and guidance in every aspect of my Atiu endeavor. Enuamanu school students who, under Bazza and George's supervision and guidance, scoured the island day and night for signs of roost activity for me. Roger Malcolm for his Kura count data and Marshall Humphrey's for his hospitality. My dear friend Amy McCulla, BSc (Hons) Zoology Aberdeen, for her assistance and company during early morning and evening roost counts and transect walks, who diverted from her New Zealand visit to accompany us for three weeks. Hannah Stephenson, BSc (Hons) Environmental Science, my colleague from the University of Leeds who, whilst studying the Coconut Stick Insect, found time also to assist and accompany me during roost and transect walks to ensure a high detection rate. Mama and Papa Porio for exceptional generosity, warmth of spirit, and continual care that kept us safe and comfortable throughout our stay. Ina Mokoroa, Atiu Island

Secretary, and his wife Terangi for their generous hospitality and support both on Atiu and Rarotonga and to all the Atiu community who were so welcoming, kind and resourceful on our behalf.

I would wholeheartedly recommend any MSc student or researcher to undertake a project in the Cook Islands, and particularly on Atiu. Meitaki Ranuinui!

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15. Appendices

Myna Bird Raw Data

	Y = Yes (Surveyed)	No. of Observations			
Roost	**AM**	**PM**	**AM**	**PM**	
1	Y, Y	Y,	15, 14	19,	
2	Abandoned	Abandoned			
3	Abandoned	Abandoned			
4	Y, Y	Y	132, 138	70, 51	
5	Y, Y	Y,	112, 122	105,	
6	Y, Y	Y,	21, 24	27,	
7	Y		44, 51	42, 64	
8	Y		92, 67	110, 69	
9	Abandoned	Abandoned	82, 87	104, 1`08	
10	Abandoned	Abandoned			

Transect: 1					
Habitat Type: Village					
Length: 1.7km					
	7.50am, 30/05	7.30am, 31/05	7.45am, 1/06	4.45pm, 24/06	3.20pm, 28/06
	AM			**PM**	
Distance	with gerald	with gerald	from gerald		
from transect	1	2	3	1	2
line (m)	Mynas(M)	M	M		
0-5.	6, 2	15, 10	11, 18	4, 11	9, 3
5-10.	4, 12	28, 18	8, 3	11, 10	22, 15
10-20.	20, 18	5, 7	14, 19	10, 14	8, 6
20-30.	24, 9	6, -	10, 6	3, 6	7, 45
30-40.	11, 1	19, 4	4, 5	0, 20	7, 0
40-50.	39, 27	3, 11	13, 5	1, 0	
50-75	7, 1	2, -	9, 1		
75-100	0, 0	0, 0	0, 6		
Total	111, 70	0, 0	79, 63	29, 61	53, 69
Finish Time	8.40am, 9.25am	8.17am, 9.10am	8.25am, 9am	5.10pm, 5.35pm	3.43pm, 4.05pm

Transect: 2					
Habitat Type: Horticultural Land					
Length: 2.3km					
	WC still, clear	Overcast, windy			
	AM		**PM**		
Distance	7.45am, 11/06	7.50am, 21/06	16.05pm, 30/05	16.15pm, 11/06	
from transect	1	2	1	2	
line (m)					
0-5.	16, 8	8, 2	19, 1	16, 22	
5-10.	13, 19	19, 14	14, 1	14, 20	
10-20.	15, 10	24, 20	31, -	16, 14	
20-30.	5, 10	6, 0	6, 2	11, 1	
30-40.	3, 2		42, -		
40-50.			3, -	8, 0	
50-75			2, -		
75-100					
Total	52, 49	57, 36	117, 4	65, 67	
Finish time	8.15am, 8.40am	8.20am, 8.45am	17.10pm	5.45pm, 6.10pm	

Transect: 4				
Habitat Type: Horticultural Inland				
Length: 1.6km				
	02-Jun			
Time and Date	7.25am	8.45am, 11/06	4.40pm, 17/06	4.10pm, 21/06
	AM		**PM**	
Distance				
from transect	1	2	1	2
line (m)				
0-5.	11, 15	6, 3	10, 4	
5-10.	6, 3	6, 13	22, 6	2,
10-20.	6, 5	4, 9	5, 1	18, 4
20-30.	1, 1	4, 3	0, 3	3, 3
30-40.	3, 0	3, 0		
40-50.	0, 0			
50-75	0, 0			
75-100	0, 0			
Total	27, 24	23, 28	37, 13	23, 7
Finish Time	7.50am, 8.20am	9.05am, 9.30am	5pm, 5.20pm	4.30pm, 4.55pm

Transect: 5			
Habitat Type: Horticultural Inland			
Length: 2.0km			
Time and Date	22/06, 8.20am	4.20pm, 12/06	4.15pm, 26/06
	AM	**PM**	
Distance			
from transect	1	1	2
line (m)			
0-5.	1, 6	13, -	1, 7
5-10.	11, 3	21, -	15, 7
10-20.	1, 3	7, -	1, 7
20-30.	2, 4		5, 4
30-40.			2, 0
40-50.			
50-75			
75-100			
Total	15, 16	41, -	24, 25
Finish Time	8.45am, 9.15am	5.30pm	4.40pm, 5.10pm

Transect: 6				
Habitat Type: Horticultural Inland				
Length: 2.8km				
Time/Date	10am, 12/06	8am, 21/06	22/06, 4.15pm	15.05pm, 1/06
	AM		**PM**	
Distance	WC:	WC:	WC:	WC:
from transect	1	2	1	2
line (m)				
0-5.	1, -	1,	3, 0	5, -
5-10.	2, -	2,	12,0	7, -
10-20.	7, -	1,	6, 0	7, -
20-30.	7, -	2,	2, 0	4, -
30-40.	1, -			11, -
40-50.				
50-75				
75-100				
Total	18, -	6,	23, 0	25, -
Finish Time	11am, -	8.45am	5.15pm	16, 05pm

Transect: 7a+7b				
Habitat Type: Village/Horticultural Inland				
Length: 2km				
Time/Date	7.50am, 1/06	23/06, 8.15am	4.05pm, 16/06	10/06, 3.20pm
	AM		**PM**	
Distance	WC:	WC:	WC:cloudy, wind	WC:clear, sunny
from transect	1	2	1	2
line (m)				
0-5.	4, 8	11, 1	7, 4	7,7
5-10.	17, 5	7, 3	9, 12	10, 47
10-20.	9, 12	4, 14	11, 21	49, 0
20-30.	4, 15	3, 6	5, 1	4, 7
30-40.	4, 9	8, 7		1, 2
40-50.	1, 2			3, 19
50-75				
75-100				
Total	39, 51	33, 31	32, 38	74, 82
Finish Time	8.35am, 9.10am	8.45am, 9.15am	4.32pm, 4.55pm	4.10pm, 4.40pm

Transect: 8a			
Habitat Type: Village			
Length: 0.6km			
Time/Date	9/06, 8.20am	8/06, 7.15am	4pm, 2/06
	AM		**PM**
Distance	WC:	WC:	WC:
from transect	1	2	1
line (m)			
0-5.	25,	20, 37	3,6
5-10.	31,	15, 33	2,5
10-20.	10,	9, 7	19,7
20-30.	3,	6, 0	9,3
30-40.		0, 1	2,0
40-50.		0, 0	0,1
50-75		1, 1	0,0
75-100		0, 0	0,0
Total	69,	51, 79	35,22
Finish Time	8.40am	7.45am, 8.15am	4.30pm, 4.50pm

Transect: 9		
Habitat Type: Coastal Road		
Length: 6.1km		
Time and Date	10am, 15/06	23/06/10, 3.20pm
	AM	**PM**
Distance	WC:	WC:
from transect	1	1
line (m)		
0-5.		1,
5-10.	8, -	2,
10-20.	5, -	3,
20-30.		
30-40.		
40-50.		
50-75		
75-100		
Total	13	6,
Finish Time	11.30am	4.10pm

Transect: 10		
Habitat Type: Coastal Road		
Length: 4.9km		
Time/Date	11.30am, 15/06	23/06, 4.10pm
	AM	**PM**
Distance	WC:hot, clear	WC:
from transect	1	1
line (m)		
0-5.	6, -	
5-10.	4, -	5,
10-20.		
20-30.		
30-40.		
40-50.		
50-75		
75-100		
Total	10, -	5,
Finish Time	2.05pm	4.40pm

Kura Raw Data: carried out at the same time as the Myna transect counts (above).

Weather conditions: Overcast, Still						
Transect:1						
Habitat Type: Village						
Length: 1.7km						
Time/Date	Srt 7.50am, 30/05	7.30am, 31/05		4.45pm, 24/06	3.20pm, 28/06	
	AM			**PM**		
Distance	WC:	WC:	WC:	WC:	WC:	WC:
from transect	1	2	3	1	2	6
line (m)	Kura	0, 0	0, 0			
0-5.	0, 0	0, 0	0, 0			
5-10.	0, 0	0, 0	0, 0	0, 1		
10-20.	0, 0	0, 0	0, 0		0, 2	
20-30.	2, 0	0, 0	0, 0			
30-40.	0, 0	0, 0	0, 0			
40-50.	0, 0	0, 0	0, 0	2, 0		
50-75	0, 0	0, 0	0, 0			
75-100	0, 0	0, 0	0, 0			
Total	2, 0	0, 0	0, 0	2, 1	0, 2	
Finish Time	8.40am	8.17am	8.25am, 9am	5.10pm, 5.35pm	3.43pm, 4.05pm	

Transect: 2					
Habitat Type: Horticultural Land					
Length: 2.3km					
Weather Conditions: Still, Sunny					
Time/Date	21/06, 7.50am	7.45am, 11/06	4.15pm, 11/06	16.10pm, 30/05	
		AM	**PM**		
Distance	WC:	WC:clear, still	WC:	WC:	WC:
from transect	1	2	1	2	5
line (m)					
0-5.					
5-10.					
10-20.					
20-30.			2, 0	1,0	
30-40.		2, -			
40-50.				3,0	
50-75		0, 1			
75-100					
Total	0, 0	2, 1	2, 0	4,0	
Finish Time	8.20am, 8.45am	8.15am, 8.40am	5.45pm, 6.10pm	17.10pm	

Transcect: 4				
Habitat Type: Horticultural Inland				
Length: 1.6km				
Time/Date	7.25am, 2/06	8.45am, 11/06	4.40pm, 17/06	21/06, 4.10pm
	AM		**PM**	
Distance	WC:	WC:clear, still	WC:	WC:
from transect	1	2	1	2
line (m)				
0-5.	0, 0	0, 0	0,	
5-10.	0, 0	0, 0	0,	
10-20.	0, 0	0, 0	0,	
20-30.	0, 0		0,	0, 1
30-40.	0, 0		0,	
40-50.	0, 0		0,	
50-75	0, 0		0,	
75-100	0, 0		0,	
Total	0, 0	0, 0	0,	0,1
Finish Time	7.50am, 8.20am	9.05am, 9.30am	5pm, -	4.30pm, 4.55pm

Transect: 5					
Habitat Type: Horticultural Inland					
Length: 2.0km					
Time/Date	22/06, 8.20am	8.20am, 24/06	16.20pm, 12/06	16.15pm, 26/06	
	AM		**PM**		
Distance	WC:	WC:	WC:	WC:	WC:
from transect	1	2	1	2	5
line (m)					
0-5.			0		
5-10.			0		
10-20.			0		
20-30.			0		
30-40.			0		
40-50.			0		
50-75			0		
75-100			0		
Total	0, 0	0,0	0	0, 0	
Finish Time	8.45am, 9.10am	8.45am, 9.15am	5.30pm, -	4.40pm, 5.10pm	

Transect: 6					
Habitat Type: Horticultural Inland					
Length: 2.8km					
Time/Date	10am, 12/06	21/06, 8am	22/06, 4.15pm	15.05pm, 1/06	
	AM		PM		
	WC:	WC:	WC:	WC:	WC:
Distance					
from transect	1	2	1	2	5
line (m)					
0-5.				0, 0	
5-10.				0, 0	
10-20.			1, 0	0, 0	
20-30.				0, 0	
30-40.				0, 0	
40-50.				0, 0	
50-75				0, 0	
75-100				0, 0	
Total	0, 0	0, 0	1, 0	0, 0	
Finish Time	11am,	8.45am,	5.15pm	16.45pm	

Transect: 7a+7b					
Habitat Type: Village/Horticultural Inland					
Length: 2km					
Time/Date	7.50am, 1/06	23/06, 8.15am	4.05pm, 16/06	10/06, 3.20pm	
	AM		PM		
Distance	WC:	WC:	WC:cloudy, windy	WC:	WC:
from transect	1	2	1	2	5
line (m)					
0-5.	0, 0		0,	0, 1	
5-10.	0, 0		0,		
10-20.	0, 0		0,		
20-30.	0, 0		0,		
30-40.	0, 0		0,		
40-50.	0, 0		0,		
50-75	0, 0		0,		
75-100	0, 0		0,		
Total	0, 0	0, 0	0,	0, 1	
Finish Time	8.35am, 9.10am	8.45am, 9.15am	4.32pm, 4.55pm	4.10pm, 4.40pm	

Transect: 8a				
Habitat Type: Village				
Length: 0.6km				
Time/ Date	3/06, 7.15am	9.06,8.20am	4pm, 2/06	
	AM		**PM**	
Distance	Weather:	Weather:	Weather:	Weather:
from transect	1	2	1	4
line (m)				
0-5.			0, 0	
5-10.			0, 0	
10-20.			0, 0	
20-30.		1, 0	0, 0	
30-40.			0, 0	
40-50.			0, 0	
50-75			0, 0	
75-100			0, 0	
Total	0,0	1, 0	0, 0	
Finish Time	7.45am, 8.15am	8.20am, 8.40am	4.30pm, 4.50pm	

Transect: 9		
Habitat Type: Coastal Road		
Length: 6.1km		
Time/Date	10am, 15/06	23/06, 3/20pm
	AM	**PM**
Distance	Weather:	Weather:
from transect	1	1
line (m)		
0-5.	0,	
5-10.	0,	
10-20.	0,	
20-30.	0,	
30-40.	0,	
40-50.	0,	
50-75	0,	
75-100	0,	
Total	0,	0, 0
Finish Time	11.30am, -	4.10pm,

Transect: 10		

Habitat Type: Coastal Road		
Length: 4.9km		
Time/Date	11.30am, 15/06	23/06, 4.10pm
	AM	**PM**
Distance	Weather:	Weather:
from transect	1	1
line (m)		
0-5.	0,	
5-10.	0,	
10-20.	0,	
20-30.	0,	
30-40.	0,	
40-50.	0,	
50-75	0,	
75-100	0,	
Total	0,	0, 0
Finish Time	2.05pm	4.40pm

Kura Group Observation Counts

Kura locations and times that each pair of volunteers were dropped at each location.

Day 1

Day 1, 12 students and 4 adults
1.. NW-4.30pm, (x2) Area before roost area 2- Teenui
2. NW-4.30pm, (x2) roost 2 area- Teenui
3. NW- 4.35pm, (x2) Teenui Village area behind houses (Hannah/June)
4. NE- 4.40pm (x2) Roost 4 area (Bazza) Mapumai
5. NE- 4.45pm (x2) Mattas coffee plantation- Mapuumai
6. E- 4.50pm (x2) Down hill past queen Ada's house -Mapumai
7. S- 5pm, (x2) Down opposite road to Marshall's-Areora
8. S- 5.10pm, (x1) Koes plantation

Day 2. Locations 9 and 10 added on day 2 due to having extra volunteers.

Day 2, 18 students and 4 adults
1. 3.30pm
2. 3.30pm
3. 3.40pm
4. 3.45pm
5. 3.50pm
6. 4pm
9 New Area B-4.05pm (2 students)
10 New Area C below Marshall's (x1)- 4.15pm (1 student)
7 4.16pm
8- 4.30pm-5.15pm then headed back to pick everyone up in order of last drop offs.

Kura Observation Counts

Location Number	Observation Day 1	Observation Day 2
1	26	16
2	7	8
3	9	3
4	24	39
5	13	10
6	5	3
7	16	12
8	4	6
9	N/A	7
10	N/A	7
Total	104	111