The Successful Eradication of Black Rats from North Island (Seychelles) in September 2005 and Proposed Strategies to Reduce the Risks of Reinvasions. Réhabilitation des Ecosystèmes…

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PROJET REHABILITATION DES ECOSYSTEMES INSULAIRES

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The eradication of Black rats from North Island (Seychelles) and recommended measures to minimise the risks of reinvasions

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General overview

The negative effects of introduced mammalian pests on societies, economies and eco-systems are well recognised world wide. Introduced rodents and feral cats (*Felis catus*) have long been considered a major conservation problem and the cause of decline or extinction of many species of flora and fauna, particularly on islands.

During the past 3 decades New Zealand, through the NZ Wildlife Service and its successor the Department of Conservation and the Department of Scientific Industrial Research (DSIR) and its successor Landcare Research, has invested heavily in the development of successful techniques to eradicate and/or prevent rodent invasion of islands. Poisons, equipment and methodologies have improved markedly since the early 1960s when the Wildlife Service and a team of volunteers first inadvertently eradicated rats during a rodent control programme on a group of four tiny New Zealand islands. Eradications of rats and/or mice have now been successfully achieved on large islands in temperate or subantartic climate : up to 3,100 ha in area (Langara, Canada) using ground-based, bait station distribution of poison, and over 11,000 using aerial broadcast technologies (Campbell Island, New Zealand sub-Antarctic) (Thomas and Taylor 2002, Towns and Broome 2003). However, in tropical countries, eradication of rats seems to have never been achieved so far on islands larger than 300 hectares. Flat Island in Mauritius (253ha), successfully deratted in 1998 (Bell, 2001) appears to be the largest so far.

Rats introduced from Europe and Asia are widespread in the Seychelles and feral cats occur on at least 19 islands. It is probable that the Black rat *Rattus rattus,* arrived in the Seychelles during the early period of settlement in the 1770s and it now occurs on most islands throughout the archipelago. The Brown rat *R. norvegicus,* could be a more recent arrival. It is present on Mahé and Conception, was found on a few other islands of the St Anne Marine Park (Rocamora & François, 2000), and in the Amirantes on D'Arros (Rocamora & Matyot, 2002). It also had colonised Frégate from where it was successfully eradicated in 2000 (Merton et al. 2002). It may have a wider distribution as more surveys are still required in both inner and outer islands of Seychelles . Although the two species co-exist on the larger islands, the smaller islands where rats occur have usually only one or the other (Hill, 2002; Hill et al., 2003)..

The ubiquitous house mouse, *Mus musculus,* is the only other rodent that has established in the Seychelles Islands and is known to occur on many Islands. As happens elsewhere in the world, introduced pests such as rodents and cats cause a number of problems for both humans and the natural environment in the Seychelles Islands, such as:

- Damage to structures and crops, vectors of pathogens and illness, in particular leptospirosis (Seychelles has one of the highest incidences in the world; Yersin et al., 1998)
- Severe impacts on native flora and fauna, with noticeably fewer endemic birds and seabirds on islands where rats and/or cats occur
- Negative impacts on tourism

In an attempt to rectify these problems, considerable time, effort and money has been expended since 1996 by local island owners, the successive Ministries responsible for Environment, local NGOs (Nature Seychelles & Island Conservation Society), and overseas contractors undertaking cat, rat and mice eradication operations on a total of eight islands in the Seychelles. Despite evidence suggesting success may have been achieved in all cases, in several instances these positive outcomes have been placed in jeopardy by engaging in poor quarantine practice after a campaign has been successfully completed (Table 1 : *Rat and cat eradications*). Rats are still present on many islands in the Seychelles but it is unlikely they can disperse naturally to most islands now cleared of cats and rodents (except Anonyme which is only 0.5km from Mahé but permanently protected by a bait-station grid over the whole island). Movement of people and freight between islands by boat poses the greatest threat of reintroduction of

rodents to islands, but the risks are clearly reduced if the advised abatement protocols (prevention measures) are taken seriously and strictly adhered to, as has been done on D'Arros and Frégate Island. North Island could be the largest non-coralline tropical island in the world from which Black rats will have been eradicated (Rocamora & Climo, 2005).

Seychelles

Seychelles was first discovered by Europeans in 1609 though they appear on Arab charts from the ninth century.The isolated Seychelles archipelago consists of about 115 granite and coralline Islands. The total land area is 455 square kilometres and stretches down the western Indian Ocean between 4 and 8 degrees south and is spread over 1250 kilometres. The Seychelles has two main categories of Islands – the granitic and the coralline. The granitic Islands are all part of the "inner" islands archipelago, whereas the coralline islands form most of the "outer" islands, composed of several groups and archipelagos to the south west of the granitics islands (Amirantes and Alphonse groups, Providence-Farquhar & Aldabra groups). There are about 40 granitic and 75 coralline Islands, and the granitic islands originate from the Gondwanaland shelf..The southern groups are mainly composed of raised coralline atolls that have build up over former volcanic areas. Aldabra is the largest raised atoll in the world.

No indigenous land mammals are present apart from bats, and the endemic species had no defence against alien mammals introduced from the 18th century on (Merton et al., 2001).

Table 1: Rat, mouse and cat eradications in the Seychelles

Island	size	Species	Invasion date	Eradication date	Method	Out-come	Prevention measures
Bird Is.	101	black rat	1960s	1995	ground application	Success	Medium/ good
Fregate Is.	219	brown rat Cats	1995	2000 1980	aerial application Ground base	Success Success	Medium/ good
Curieuse	286	black rat cats	?	2000 2000	aerial application	Reinvaded ? Success	poor
Denis	143	black rat cats	? ?	2000 2000	aerial application	unknown Success	poor/ none
Denis	143	black rat mice	2001	2002	ground application	Success	Poor/ medium
North	201	black rat cats	? ?	2003 2003	aerial application	unknown Success	Poor/ medium
D'Arros	150	brown rat cats mice	? ?	2003 2003 2003	ground application	Success Success Failed	good
Anonyme	10	Black rat	?	2003	Ground application	Success	Medium
North	201	Black rat	?	Sept 2005	Aerial application	***(Success confirmed by Sept. 2006)***	Medium/ good

North Island

North Island (201ha) is the ninth largest of the Seychelles granitic islands, located in the vicinity of Silhouette, the third largest island of the archipelago. The island is 2.2 kilometres long and 1.6 kilometres wide with the highest peak rising to c.180 metres. Unlike many of the other granitic Islands, North Island and Silhouette are formed from syenite, a result of volcanic activity that occurred c. 60million years ago. North Island was the first granitic island to be explored by Europeans in 1609 and was found to be very fertile with a good water supply. Seventeen years after the French settled in Seychelles, the island was already found to be infested by rats (Malavois 1787 in Fauvel, 1909). Its woodland was repeatedly burned down and cleared for agriculture. As a result, coconut trees were extensively planted over most of the island and much of the native vegetation has been replaced by exotic species (Hill, 2002). By the late 1880's it was home to 80 inhabitants who made a living from fishing and market gardening.

North Island is a private tropical sanctuary managed by a company related to Wilderness Safaris, a South African based nature tourist group. A hotel facility completed in 2003 includes 11 guest villas, a restaurant, a spa, a gym, plus a staff village with restaurant, a workshop and a lodge. Since the island has no airstrip or harbour the tourist complex is serviced by boat and barge which are run directly up onto the beach. The island is largely forested with introduced species and a small central plateau area is covered by an old coconut plantation. The company has adopted an ecological restoration policy with the intention of rehabilitating the islands' environment through replanting appropriate native species and translocating several of Seychelles critically endangered species of wildlife. A native plant nursery established in 2000 is already producing tens of thousands of trees for large scale re-planting. Cats were eradicated in 2003 and a rat eradication campaign was conducted in 2003. Appendix 1 provides an aerial picture of North Island with the different roads, tracks and paths existing on the island.

The present 2005 rat eradication on North Island is part of the project 'Rehabilitation of Island Ecosystems' lead by the Island Conservation Society (ICS) and funded by FFEM (*Fonds Français pour l'Environnement Mondial*) and other partners . Its objective is to pursue and enhance the rehabilitation programme on North Island. This includes the eradication of rats as a first priority, the control of alien invasive plants and replanting of native species, and the return of some of Seychelles most critically endangered wildlife. An attempt at eradicating Indian Mynas is also being conducted.

An overview of the 2003 eradication campaign and the rediscovery of black rats on North Island in 2004.

On the 1st March 2004 five rats were seen and killed by members of the gardening team on North Island. The following summarises other potential sightings that lead up to the captures, approximately six months after the aerial eradication was completed. Three potential rat sightings were notified prior to the capture of the five rats on 1st March 2004.

The first reported sighting was made near villa 5 on about the 13th December 2003 by a staff member on night duty. An alleged rat was seen running along the side of a coconut log in the headlights of the buggy the staff member was sitting in at the time. No action was taken for two days, until the contractor returned to the Island on the 15th December and carried out trapping and poisoning. Just three days prior to this sighting two cargo containers with building materials were unloaded from a barge during the hours of darkness. This cargo stayed on the beach until the following day (G. Climo; pers.com). The barge had failed to be fumigated, poisoned or trapped. The landing sight of this barge is approximately 350m away from villa 5. Unfortunately the rodent proof room was not in use.

A second possible sighting of a rat was made on 21st February 2004 near the staff village road and Spa building (now the security office) at 9.45pm. About 10kg of pellet rat bait was spread around the area of

the spa building and construction camp and 5 live traps were set near by in the hopes of catching and confirming that the animal seen was indeed a rat. Two days later on 23rd February 2004, again at 9.50pm at night and close by the second sighting area, a more positive sighting of a rat was made on the road to the new staff houses. Extra pellet rat bait was spread around the area on 24th and 27th February 2004, and a total of 20 live rat traps were set in this area, but nothing was caught over this period.

On the 1st March 2004 a team of gardeners clearing scrub on the plateau area of the island near the old stone house, sighted a rat climbing into a dead Takamaka tree. The tree was pushed over and five rats were caught and killed. The capture site is 150-200 m from the second and third potential sightings and about 300m from the first. Except for coconut palms, some young native plantings and three old huts the flat is clear of significant growth and cover for rats.

Two years later, in March 2005, rats had reached alarming densities on the island. High numbers could be observed all over the plateau and lowland areas by night or even during day time at particular places such as the green waste pile. Despite some trapping being done in the hotel area, rats could not be easily controlled and created considerable damage and nuisance to the resort, representing a health threat to island staff and the clients. In May 2005, a protocol based on intensive rat trapping (instead of poisoning in order to avoid any interference) was defined and an ICS staff (assistant research officer Tony Jupiter) was seconded to North Island for the control of rats around the hotel area and staff village (see in Rocamora & Climo, 2005). The corrected abundance (using formula in Cunningham & Moors, 1996) of rats caught on index traps lines during pre-eradication trapping (175 rats/100 night traps over 4nights) suggests huge densities comprised between 100 and 200 rats/ha. In Mayotte (Comoros archipelago) an islet with an absolute density of 195 rats/ha had a similar corrected abundance index over 4nights of 162 rats/100 night traps (Rocamora & Said, 2005). Although these results are not directly comparable as the trap line on Mayotte had a trap spacing of 15m instead of 25m, it still gives an idea about density levels present in August 2005 on North Island, which probably hosted well over 20.000 rats.

Considerations for pest eradication on North Island

North Island was considered well within the size-range (see above and Table 1) that an eradication campaign against rats would be successfully achieved, especially since mice were not present to complicate the process. Taking into consideration that North Island is moderately large, has a steeper topography than other islands in the Seychelles with a relatively dense vegetation cover in places, and taking account of the relative merits and amounts of time, effort and cost for a repeated effort; an aerial broadcast of toxic bait was thought to be the most appropriate eradication technique to use for a second attempt. Although the advent of global positioning technology and spreader buckets has enabled aerial broadcast of rodenticides to become a routine operation, it still requires an experienced agricultural helicopter operator with a full understanding of the application process to ensure success (Towns and Broome, 2003). Such licensed pilots being not available in Seychelles, the venue of one of them from New Zealand had been provisioned under the project (FFEM, 2004).

Unless an elaborate monitoring programme utilising an appropriate grid coverage of bait stations, traps and detection devices (such as chew sticks) is established, it is only through an absence of rodent sightings or sign over time that aerial operations can be confirmed as successful. A waiting period of two years has been the current accepted standard, but with an intensive trapping programme of several thousand traps-night planned across the island (and a grid system of bait stations covering the entire plateau and lowlands for up to 6 months), it has been suggested to reduce this period to only one year (Rocamora & Climo, 2005). Situated 7km from neighbouring Silhouette Island, it is highly unlikely that rats could ever re-establish on North Island through natural dispersal. However, like all other inhabited islands in the Seychelles, North Island is vulnerable to reintroduction through human activity. Risks can only be minimised through vigilance and by adhering strictly to the code of best practice, as set out below in "Overview of the *Measures to Minimise the Possibility of Reintroduction of Rodents to North Island"*, page 13).

Will this important conservation project have the chance of long-term success? This will mostly depend on the ability of North Island management to maintain strict contingency measures to prevent the accidental reintroduction of rats.

~ The Eradication Campaign ~

Appendix 2 provides a summary of the aerial broadcast application and accepted best practice undertaken during this rat eradication campaign.

Preliminary preparation and organisation

An agreement was reached between North Island and ICS that the proposed eradications on North Island would be by aerial application of toxic pollard pellet bait followed by a period of ground based grid system baiting. Discussions were held in 2004 and the agreement officialised through an MoU in 2005, after the start of the FFEM project.

Operational planning and organisation of equipment and final decisions remained the responsibility of ICS (FFEM project leader and the eradication expert). Purchase of specially formulated coconut lured block bait poison and pellet bait poison, safety equipment, anticoagulant antidote, flagging tape and other field equipment necessary for the operation was made in New Zealand and arrangements made for shipping to the Seychelles.

As a first step, a report presenting the proposed eradication methodology and plan, including a detailed account of all pre and post eradication measures required to minimise the risks of reinvasions was prepared (Rocamora & Climo, 2005). Several visits were conducted by G. Rocamora between March and July 2005 to check on the preparation requirements. A rodent re-invasion prevention plan was formulated from previous plans made in 2003 (Climo 2004) and recommendations made that large-scale rubbish clean up and prevention measures be completed prior to the poisoning campaign. All major dumpsites from hotel construction had been cleaned up satisfactorily during the 2003 campaign and a “preliminary” rubbish disposal system was in use before eradication began (cleanup continued during the eradication period) but many smaller sites including the green waste still needed attention.

Two experienced New Zealand personnel were employed for this eradication. Gideon Climo, ICS eradication consultant expert, arrived in the Seychelles on 26th July 2005 and departed on the 20th November 2005. Helicopter Seychelles, that provided the service of aerial spraying of bait, contracted a skilled agricultural rated Helicopter pilot specialised in aerial broadcast techniques Brendan Wilson, of Otago Helicopters, who arrived in Seychelles on the 25th August and left by the end of September.

Aerial broadcast application

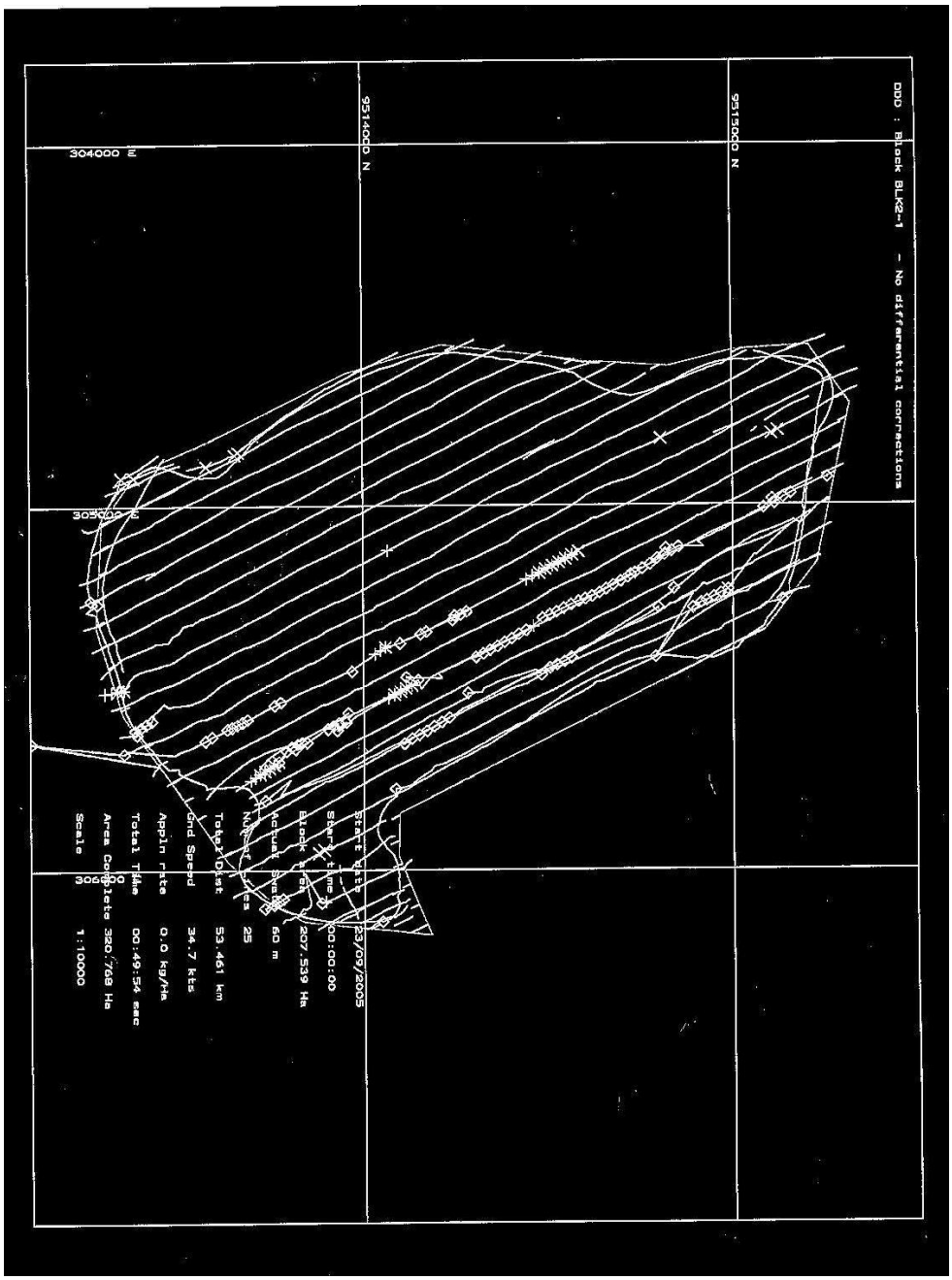
A Bell Jet Ranger helicopter from Helicopter Seychelles Ltd was used for each of the four aerial bait applications. The first three applications were done by New Zealand pilot, the fourth by Rick Dooley of Helicopter Seychelles under special permission from Directorate of Civil Aviation. The special hopper bucket, previously used to spread bait on North Island in 2003 was in need of repair and was set aside as a backup bucket only. A second bucket was brought in from La Reunion,by ICS, hired from the French Austral Antarctic Territories (TAAF). A global positioning system (GPS) used for this type of work was brought from New Zealand but unfortunately had a break down while been fitted to the helicopter and was not in use for the first and second applications.

Even ground-coverage of baits was achieved using a specially constructed motorised spreader bucket suspended below the helicopter, operating under a prearranged pay-load limit of ~ 200 kg (8 bags) per loading or total hook-load of ~ 360kg per bucket sweep.

The GPS was replaced and fitted for the third application only as the unit had to return to New Zealand with the specialized pilot before plans were made for a fourth and finally drop. The shoreline of the island was flown before the third poison drop to log coordinates into the computer for the GPS tracking system. An island area of 201 ha was plotted.

Transect lines running North to South were plotted on an aerial photograph at equal spacings for the pilot to follow for the first, second and fourth applications. These were overflown approximately at a ground speed of about 40-50 knots. Effecting a coverage of 120m swath width (heavier bait would have reached further but at reduced densities) the flight transects were at about 60m apart. This allowed for an overlay of about 50% overlap on each transect, ensuring total coverage over the whole Island (see printout Figure 1 below).

Figure 1. DGPS printout showing bait coverage done during the third drop



A separate coastal flight was done on every application of about 6kg/ha to ensure total overlap with the transect paths at these areas, so bait rate was heavier in the coastal areas. Also on every application

slightly heavier doses were achieved along the “saddle” road from the green waste area to west beech, where the highest densities of rats were recorded. During the third drop, extra transects were done over the northern glacis area also.

A initial six tonnes of rodent pellets containing brodifacoum @ 20ppm (parts per million) in a 10mm diameter cereal based carrier pellet (Pestoff 20r), were imported by ICS for North Island from Animal Control Products, Wanganui, New Zealand. A pulsed regime was planned to involve three separate broadcasts, applied on day 1, day 8 and day 16 , and calibrated to apply pellets at predetermined rates. Planned rates were 15kg/ha for application 1; 7.5 kg/ha for application 2 was and 7.5 kg/ha for application 3 to ensure maximum effectiveness. However the actual rates and pulses differed from that planned (see table 2)., due to circumstances at the time, such as the need to increase the second application rate to 10kg/ha due to heavy rain, and to conduct a fourth application As another eradication in the Seychelles also conducted by ICS was cancelled, the availability of bait was not a limiting factor and an additional 2 tonnes of bait were provided. In total c. 8 tonnes of bait, equivalent to almost 40kg/ha, were used to maximise chances of success for this second eradication campaign. This represents a very high rate compared to previous eradications done in Seychelles and elsewhere in the world. Appendix 3 gives the daily amount of rainfall recorded on North Island and the dates at which the drops were done.

The first three applications were done by specialised helicopter NZ pilot. Local Seychelles pilot Rick Dooley was granted special permission to carry out the fourth (last) application as he had for the third application during the 2003 eradication campaign. During this drop the total amount of bags used was 60 giving a rate of 7.5 kg/ha, but the island was completed using 48 bags and averaged a rate of 6kg/ha. The other 12 bags were distributed over the villa/ front of house area, the “saddle” road from the green waste to west beech, over the glacis area on the northern slope, west beech and the plateau area behind the sunset bar.

The fourth application was carried out due to the capture of an adult male rat four days after the third application and after heavy rain had destroyed a lot of the bait during this time. We will never know whether this was necessary or not, but this was a sensible decision to insure success of the project.

Table 2: Summary of actual bait application rates
(*Based on an island area of 200 ha).

Applications (pulses)	**4**
Pulse intervals (days)	1-2: 8, 2-3: 16 3-4: 19
Application #1 (kg/ha)	14
Application #2 (kg/ha)	10
Application #3 (kg/ha)	8.4
Application #4 (kg/ha)	7.5
No. of bags used Application #1	112
No. of bags used Application #2	81
No. of bags used Application #3	67
No. of bags used Application #4	60
Total bait/ha	**39.9kg**

Ground base application : permanent & grid bait stations

Following each aerial application hand baiting was undertaken throughout the villas, main kitchen area, staff housing and maintenance areas. Block baits were placed in roof cavities and provided for each staff house and pellets hand broadcast throughout the maintenance yards, under staff housing and at rubbish sites. Bait stations were placed at the green waste area near the marsh and at the food burying site on west beech. Buildings and dump sites were checked and re-baited every three days until after the third aerial application, when frequency of checks was reduced to once a week. A total of 31 permanent bait stations placed around habitations, service buildings and beaches (see Appendix 4) were checked twice weekly until all the aerial applications were completed, then were checked at weekly intervals.

It is possible that Black rats may have survived the three aerial applications that were done in August 2003 (Rocamora & Climo, 2005). Although this was never proven and other factors were obvious, fears were raised that the same scenario could repeat in September 2005.

The idea of a ground based baiting system is to prolong access of poison bait to rats after the aerial applications. Such a programme was deployed during the 2002 eradication for black rat from Denis Island, where a total ground base grid system was effective for five months after three hand broadcast applications.

A total island ground-based system on North Island was envisaged but unlikely to be feasible given the hilly and difficult terrain of the island, and the pure fact that an aerial operation had been programmed. However it possible to minimise the risk of having a rat(s) surviving an aerial application by concentrating on the “Hot spot” areas around habitation and waste, plus all lowland areas with a rich vegetation and fruiting trees, and high density of rats where they would be more likely to survive. (Rocamora & Climo, 2005). supported by additional intense survey trapping

A transect grid system (see Appendix 5) was established with the use of a compass and” hip chain” across the eastern and western plateau and lowland areas less than 15-20m high in between. This was completed by the eradication consultant and North Island staff before the first bait application. Spacings between parallel transects was 50m and at each 50m mark along the transect line a station was marked with flagging tape and a bait station set up. The only areas requiring track cutting was the “Saddle” area between the main plateau and west beach and some areas of the northern parts of the main plateau.

The “Dead rat Café “bait stations (ACP-New Zealand) were used at each 50m site and baited weekly with one coconut lured block bait 5 days after the third aerial application. One hundred and sixty two bait stations were enough for the grid system to cover what was considered the most risky areas. Together with the 31 permanent bait stations, this covered about half of the total lowland area under 10m (100ha) initially proposed to be gridded and which would have required four hundred bait stations. This grid baiting system was planned to be continued on weekly basis until the end of December 2005. It was then baited every two weeks for the following three months before it was stopped.

The grid allowed easy access to the areas of highest rat density, and with the use of bait stations, poison was made accessible to rats after the aerial applications for a prolonged period. Effectively, the grid system separates the three main hills.

Trapping

Index trapping

Index trapping for rats was undertaken immediately prior to and up to the second poison application to monitor rat population abundance, to obtain biometric data and to ascertain breeding status and condition. Biometrics (see Appendix 6). were only taken from the first night of index trapping due to the amount of previous records taken by ICS and North Island prior to the eradication project (Rocamora & Climo, 2005). Two index lines using spring cage type traps were baited with fresh coconut and were set at ~25 intervals along an established road (Saddle track) running east-west through a range of habitat types for the full width of the Island (i.e. the same trap line used during the Eradication in 2003). One other was

set up on the high areas of the island (Palosse track). Traps were checked every morning and captures recorded.

The saddle track line run 25 traps from the 26th August to the 15th September and the Palosse line run from the 26th August to the 6th September, giving a total of **174** trap nights for the pre-poisoning period. The trapping session continued from 29th August – 15th September 2005 adding a further **471** trap nights at the time of the first application of poison baits. One hundred and fifty five ship rats were caught during the pre-eradication phase and one hundred and nine more were caught following the first bait application until four consecutive days past without any rats caught. The decrease in rat number after the first drop (Figure 2) was slower than normal, probably due to the high densities found on the island. Five of the 125 females caught during this trapping session were pregnant or showed signs of lactating. The last rats caught during the index trapping session was on the 10th September; although further rats were caught on survey trap lines after index trapping had stopped on the 15th September. Table 3 gives the results of index trap lines (see Appendix 7 for more details).

At 175 rats per 100 trap nights (corrected using formula in Cunningham & Moors, 1996), results for the index trapping session were considerably higher than the 23 rats per 100 trap nights recorded during the first eradication attempt in 2003. This result was probably due in part to the effects of a recolonizing population at its peak, and perhaps partly to the food and shelter provided by the green waste area of which one of the index lines were close to. As a comparison, 68 rats were caught per 100 traps nights during the 2002 eradication of rats from on Denis Island (Climo 2003).

Figure 2: Rats caught on index lines pre and post eradication on North Island, Seychelles 25th August to 14th to September 2005

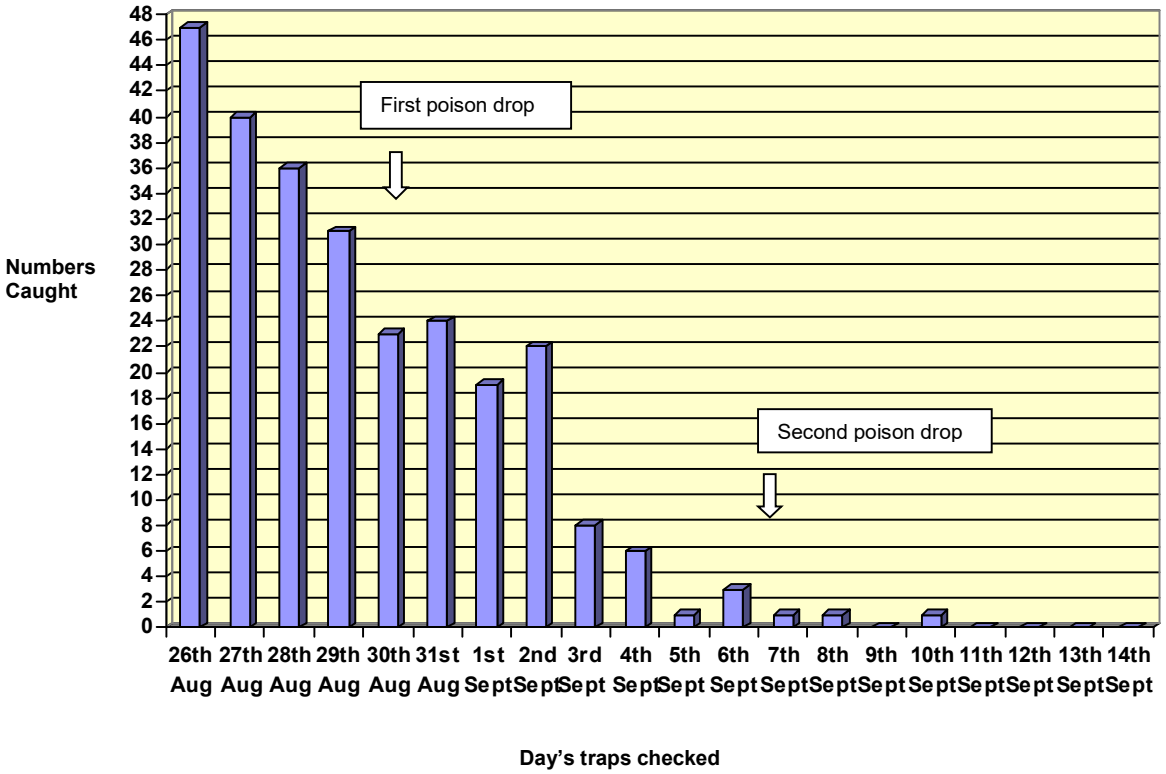


Table 3: Summary of trap nights and rats caught on Index lines:

Male	Trap nights pre-baiting ….. **174** Trap nights post-baiting….. **471**	Rats caught pre-baiting…… **80** Rats caught post-baiting…... **59**
Female	Trap nights pre-baiting ….. **174** Trap nights post-baiting …. **471**	Rats caught pre-baiting …... **75** Rats caught post-baiting….. **50**

Total rats caught per 100 trap nights. …….. **89**
(Un-corrected. Post-baiting nights excluded)

Total rats caught per 100 trap nights. …… **175**
(Corrected (**16** traps sprung etc), Post-baiting nights excluded)

Survey trapping

Monitoring to check for the absence of rats across an island after such an eradication is normally done by periods of random trapping, amongst other methods such as baiting, tracking tunnels and gnaw sticks. To facilitate for any detection of rats and to actively pursue an earlier indicative result to the success of the eradication, an intense survey trapping programme was started nine days after the third aerial application. Traps were positioned mainly along paths and other accesses, and rotated between the different sectors of the island From the existing track net work that was cut during the previous eradication and had to be reopened, additional tracks were cut to provide further access into areas for trapping (see map in Appendix 1). Though some parts are still inaccessible this has significantly increased the survey area in the 3 hilly parts of the Island, Grand Palosse, Bernica and Congoment.

If rats were found in one particular area during the survey trapping additional track networks should be cut immediately in a grid system, much the same way as the plateau areas. Additional “Dead rat café” bait stations would then be placed along this network, along with extra traps until the absence of rats in this area could be ascertained

It will be useful to maintain regularly the tracks so they can be used for future scientific biodiversity monitoring on the island (birds, vegetation, invertebrates, etc.).

One rat was seen in the main kitchen on the 15th September and two rats were caught in traps two days later, one a young male and the other a young female. This occurrence had been experienced on other islands in the Seychelles during rat eradications, which was commonly observed about 14 days after the first drop (Climo pers.com).

Twelve days later, on 27th September, one adult male was trapped on a survey line near the rubbish separation area by the marsh. No visual evidence suggested that the rat had consumed poison (no green dye on droppings and intestines) though this does not always conclude an absolute verdict. As rat densities decline during eradication, any lone rat(s) still to take a lethal dose of poison takes longer to consume it, due to the increased availability of other food through lack of competition (Climo, Merton and Thomas pers.com). Therefore it is not always seen in the stomach as a mass of green bait. Depending on the time of night the rat is caught, it can pass through its stomach contents before being collected after daylight while the rat consumes the bait that has been set in the trap, in this case coconut. The only way to be sure if poison bait is consumed is to take liver sample for brodifacoum analysis. However the rat in this case was not preserved well (we were at that time on another eradication mission on Cosmoledo)

and samples could not be taken. **No rats were ever caught after 27/09/05 during the survey trapping conducted for about a year all around the island.**

Survey trapping was started by the eradication consultant, then performed mostly by North Island Assistant Conservation Officer Unels Bristol, with occasional help from Landscape worker Elliot Ntsele and Conservation Officer Linda Vanherck.

Three survey trap lines of about 25 traps each were kept active and checked daily for periods of 10 days, followed by 4 days when traps were sprung and "rested", while lines were moved to a new locality then opened for another period of 10 days. Under this programme seventy five days were trapped by the end of December 2005, giving a total trap night of 4875 nights. Although it was originally planned to reduce thereafter to periods of one week every month until May 2006 (Rocamora & Climo, 2005), it was decided to carry on reduced but still intensive trapping for two more months. Until 15th January, trapping continued with 60 traps checked daily, then once every two days till end of February. Since March, the same protocol has been reduced to 50 traps x 2 nights every two weeks and has continued until July, then done one last time during the last two weeks of September 2006. This represents in total **more than 8500 night x traps** (uncorrected) performed, probably **the most intensive post eradication rat trapping protocol ever performed for any island in the world.**

Ground-truth bait density checks

Five 10m by 10m (100m2) quadrats were established on North Island to measure bait densities and rate of bait consumption after each aerial application of poison pellets. The corners of each quadrat were delineated by fluorescent tape, and then further subdivided into quarters to make counting easier and more accurate. The quadrats were placed in widely separated localities to sample environmental effects in a range of vegetation types, elevations, aspects and exposure to the elements. Quadrat **'One'** was established on the plateau in open managed grassland with a sparse growth of tall coconut. Quadrat **'Two'** was on the north edge of the plateau under the canopy of Badamier and mango forest growing on damp marshy soils with no ground cover apart from dense leaf cover on forest floor. Quadrat **'Three'** was set up exposed to full sunlight some 95m above sea level on gradual sloping granite outcrops with no vegetation but a few patches of grasses. Quadrat **'Four'** was exposed to full sunlight in open, semi-cleared grassland with few coconut palms on the coastal flat about 10m from the bank at the southern end of West Beach. Quadrat **'Five'** was placed about 80m above sea level under canopy of palm, Takamaka and Bilimbi in thick ground fern (semi-cleared from quadrat).

Plots were checked immediately after each aerial bait application. Baits in each grid were counted, collected and left in the centre of each grid and checked and counted daily thereafter, until bait take had ceased or baits had broken down to an extent that they were no longer recognisable. Conditions of baits were also recorded and a scale of decomposition was given. Coastal areas received higher application rates on the all four drops because a percentage loss of baits to crabs was anticipated. . Table 4 gives the results of the density checks after each application and details on daily counts are given on Appendix 8.

Two days after the first drop significant amounts of bait were lost to land-crabs on the coastal quadrat (4) and snails on the forest plateau quadrat (2). But no significant loss was detected from ants or birds.

In reality, it is difficult to determine bait take by rodents with any accuracy, but over the 8 day period between the first and second drop **49%** of bait disappeared predominately from crabs and snails. Between the second and third drop, a period of 16 days, **54%** of bait disappeared again mostly from crabs and snails. However due to heavy rain two days after the third drop **97%** of bait disappeared during the 19 days between the third and fourth applications.

Rats captured on the index line started to show signs of bait intake (green colour of droppings and intestines) 2-3 days after the first drop. After 4-5 days, some captured rats showed clear signs of internal bleeding. Dead rats were found on the 5th September, 7 days after the first application, and the last rat was caught on the 27th September 2005.

Unfortunately rainfall was experienced after all bait applications, the heaviest being after the first and third applications (see Appendix 3). All previous eradication campaigns in Seychelles have usually been done

during the months of July and August, for being in average the driest months of the year. It was not possible to do it earlier in 2005 due to the late start of the project (early May) and the importance of the tasks to be undertaken to prepare the island for the eradication.

Bait remained in good condition on most parts of the island for the first three days after the first application. Many pellets from the first application still appeared to be available to rats in viable condition 5 nights after the drop, though bait had became sodden on the third day from heavy rain but dried and stayed mostly in a doughy form until the second drop. Baits under cover in shady situations still looked firm, although beginning to show early signs of disintegration, mainly because of snails and ant activity.

Because rains had somewhat affected the bait during the 2nd and 3rd day after the first drop (total 46mm); we decided to conduct the second drop after 8 days, earlier to what was planned. Bait from the 3rd drop was significantly affected after more than 110mm of rains during the 4th and 5th days after the drop. There were no significant problems with rain after the second and fourth drops.

After 5 days of sun exposure, baits in open areas were pale and bleached by the sun, but had not become hard and unpalatable. At 7-14 days after application bait quality usually had noticeably declined. However, many pellets from the fourth application still appeared to be viable and available to rodents 12 days later, when the quadrats were removed.

Table 4: Showing bait density (numbers of pellets) from each 10m by 10m quadrat following each application.

Application	Quadrat One	Quadrat Two	Quadrat Three	Quadrat Four	Quadrat Five	AV rate kg/ha
One 29th August	50	22	16	82	95	**13.2**
Two 6th September	17	68	32	69	51	**11.8**
Three 23rd September	36	29	22	115	6	**10.4**
Four 12th October	25	45	20	48	21	**7.9**

Risks of brodifacoum baits to non-target species

It is accepted that aerial broadcast of toxins poses a threat to some non-target species of fauna, and this is unavoidable. However, these relatively minor losses are fully mitigated against when consideration is given to the overall benefits to native flora and fauna through removing introduced rodents from island ecosystems.

Brodifacoum is progressively lower in toxicity from mammals to birds to reptiles (i.e. approximately 10x the amount of poison for a bird and 100x that for a reptile per kg than for a mammal) and studies from New Zealand indicate no impact to insect and other invertebrate populations (crabs, snails) (Both et al., 2001; Booth et al., 2003), although the question of toxicity to snails has been raised by Gerlach (in litt.) but remains uncertain. Non-target animals were inevitably killed during our operation and measures were taken to ensure that species of conservation concern were not put at risk. Pelleted and block baits were dyed green or blue in order to minimise their attractiveness to non-target bird species.

Fortunately, there were very few animals that required management during the eradication.

As a precaution, most of the Aldabran giant tortoises present on the island were put into captivity before the operation began, even though they are at low risk to brodifacoum poisoning. Twelve tortoises were captured at first, mostly from the plateau area, but at least six remained allusive in the higher areas of the Island. Two of these were captured later (after the eradication had started) and all fourteen were released on the 25th October, after about two months in captivity. The tortoises that remained in the hills during the eradication were not closely monitored. These (4) tortoises have been repeatedly observed during the 3 months following the eradication (2 on Bernica, 2-3 on Palosse). Interestingly, a very old squeletton carcase overgrown by fern roots corresponding to a tortoise that died before the eradication was also found by January 2006.

Conversely, there was some concern for the welfare of the two Seychelles kestrel that remained on the island. Being a native bird of prey, these were also at risk from secondary poisoning although its diet is mainly composed of reptiles and it was thought that one bird had survived in the wild on North Island during the 2003 eradication. Attempts were made to capture the two birds on North Island prior to the 2005 eradication, but were done without success. However both individuals apparently survived the eradication as they were observed at repeated occasions in October, November & December by staff from both North Island (Greg Wepener, Unels Bristol) and ICS (Gérard Rocamora; André Labiche), and later throughout 2006 until September.

Observed mortality

Table 5 below shows the number of dead birds or reptiles found per species between the start of the eradication (29/08/05) and the 24/10/05.

Most non-target mortality occurred with introduced birds. The Indian Myna were killed in high numbers (see below). Smaller numbers of dead bodies were found amongst other ground feeding birds known to be vulnerable to *brodifacoum* poisoning: the introduced Madagascar fody, the Malagasy turtle dove (hybridised with endemic reddish-head subspecies *rostrata*), the introduced Ground Dove and the native Moorhen. All these birds must have been poisoned through direct ingestion of bait. Despite the initial size of the cylinder cereal bait pellets (1mmx30mm), their breaking up during the drops and further decomposition makes them also potentially dangerous for small ground feeding passerines.

Barn owls were decimated and probably eradicated from secondary poisoning during the eradication in 2003 after feeding on dead or dying rats. However, few birds were known to be on the island and may again have been eradicated. Two dead Barn Owls bodies were collected during the eradication period, (one on 8/09 and one on 24/10) with no records of this species until September 2006 when one bird nearly dead plus another dead body were found. This suggests that some may have survived the eradication, or more likely that some recolonisation may have occurred from Silhouette due to the total

absence of sightings for about a year. Being an introduced predator, that should be controlled or eradicated under the FFEM project, this was of no conservation concern.

Among the reptiles, only a few endemic Seychelles skinks were found dead during the eradication period but it is unclear whether this has any link at all with the eradication. Although skinks are not very susceptible to brodifacoum poisoning, they can be affected by secondary poisoning by eating invertebrates having eaten the poison (Eason & Spurr, 1995). In another rat eradication conducted in 2005 in Mayotte (Comoros archipelago), some limited mortality of skinks has been recorded (Rocamora & Said, 2005). The hypothesis that Brodifacoum could affect their ability to thermo regulate by controlling their sun exposure has been raised.

Table 5: Measures of protection and non-target mortality from first drop to 24/10/05

Non-target species	Status	Distribution	Measures taken for protection	Numbers collected
Barn Owl *Tyto alba*	introduced pest	most granitic Islands	None	**3**
Indian mynah *Acridotheres tristis*	introduced pest species	all Islands	None	**50**
Madagascar turtle dove *Streptopelia picturata*	hybrid introduced/native stock	all Islands	green dye in pellets and low Brodifacoum loading. (20ppm)	**6**
Barred ground dove *Geopelia striata*	introduced	all Islands	green dye in pellets and low Brodifacoum loading. (20ppm)	**2**
Madagascar fody *Foudia madagacariensis*	introduced	all Islands	None	**7**
Common Moorhen *Gallinula chloropus*	Native	most granitic Islands	None	**3**
Skink, gecko and Invertebrate spp.	endemic	all Islands	None	**2-3**
Aldabran giant tortoise *Geochelone gigantea*	introduced from Aldabra	most Islands	all known animals captured and enclosed.	**0**

The first dead birds were recorded on the 6th , 8 days after the first drop (also the day of the second drop) which is a normal time compared to what has been observed during previous eradications in Seychelles (G. Climo, pers.com.). This delay is probably due to the time it takes for the pellets to break up and become more easily edible by birds, and also for Brodifacoum to accumulate in the birds's body until a lethal dosis is reached.

Last dead birds were found on 24th October, although these were old carcases that had obviously died more than a week ago. During previous rat eradication in Seychelles, where a maximum of 3 drops were applied, bird mortality was recorded up to 1-3 weeks after the last drop (G.Climo, pers. com). The first graph below shows clearly that the bird mortality occurred for its majority between the second and third drop (45 birds), then decreased between the third and fourth drop (21 birds). Few birds apparently died after the fourth drop.

The next graph, where dead birds have been grouped by 8 days periods (and the old carcases found on 24/10 referred to the previous period), illustrates the very regular decrease of the amount of dead birds. The reason behind this interesting regular pattern deserves further investigation. It looks like if only a determined fraction of the bird population is at risk from poisoning by Brodifacoum pellets (for example those coming to feed on the plateau and other areas where pellets are easily available). If all birds present on the island were equally likely to be poisoned, bird mortality would be expected to continue well beyond the fourth drop. Instead, mortality appears to reach a maximum even though many more individuals from the species concerned (mynas, fodies, turtle doves) are still present on the island. The gradual decrease of the numbers found dead could reflect the progressive acquisition of the lethal dosis by birds with different feeding habits, the ones coming to feed more occasionally on the plateau taking more time to dye.

Figure 3: Bird mortality recorded during the 2005 rat eradication on North Island

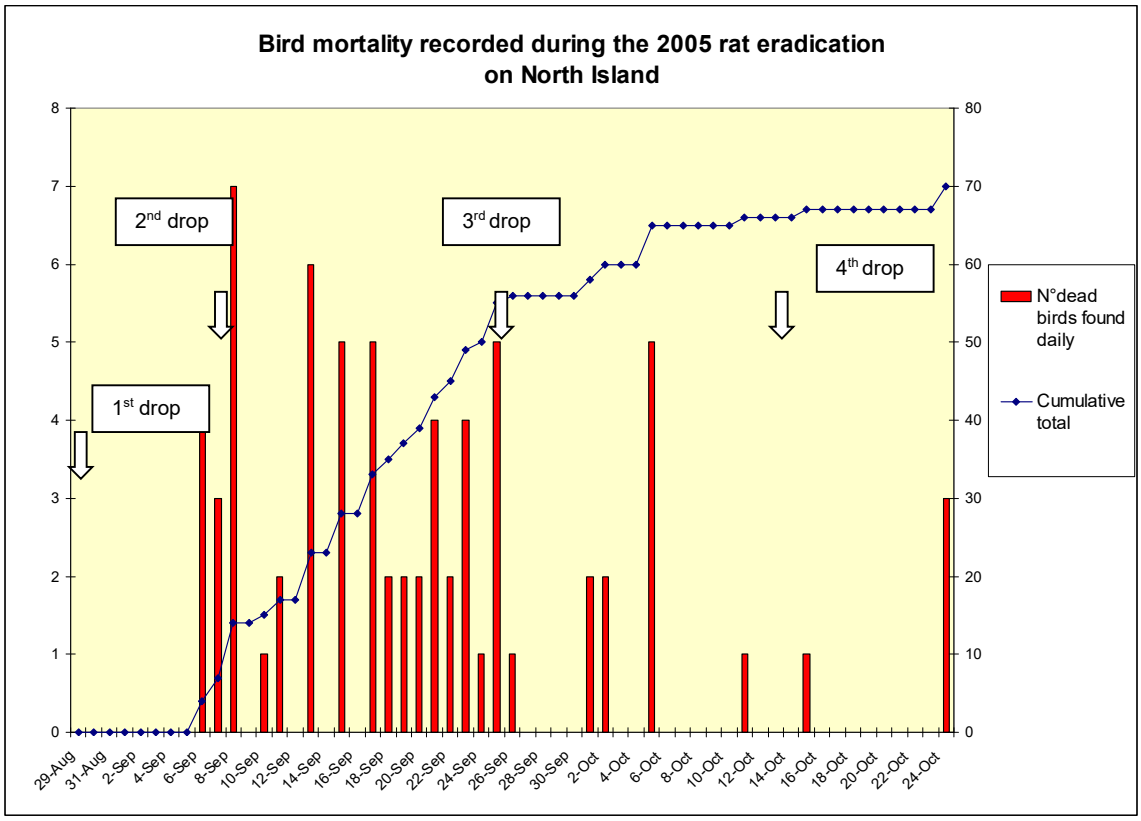
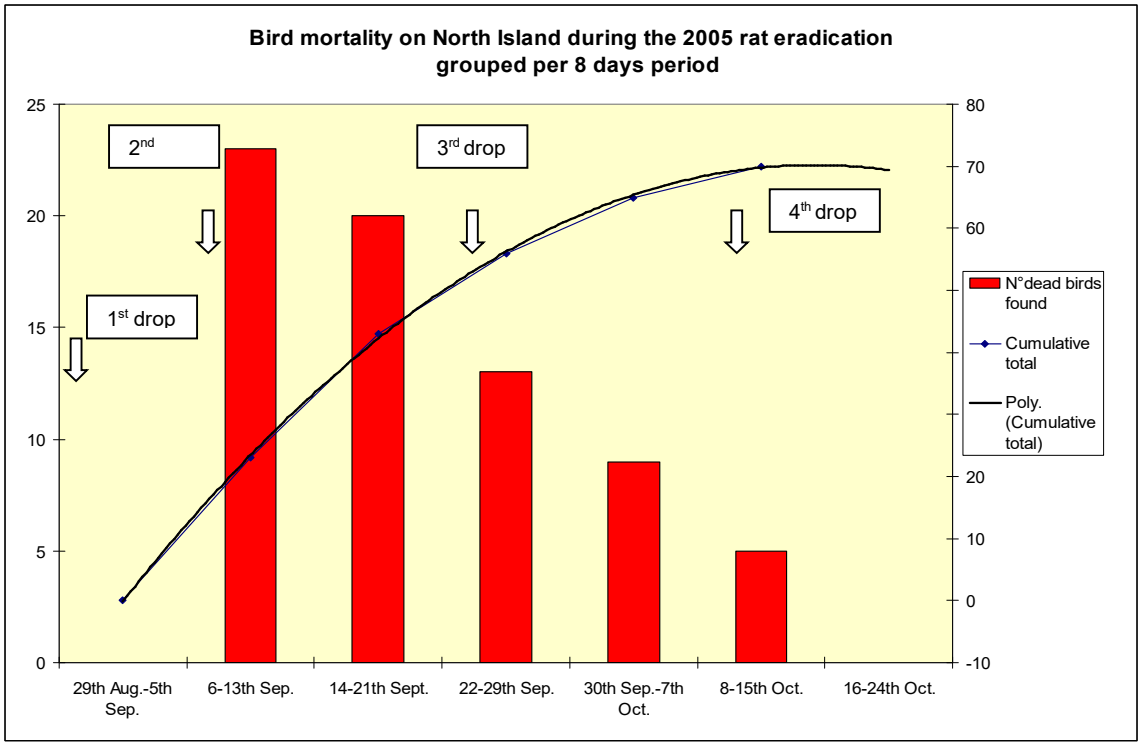


Figure 4. Bird mortality on North Island during the 2005 rat eradication grouped per 8 days periods

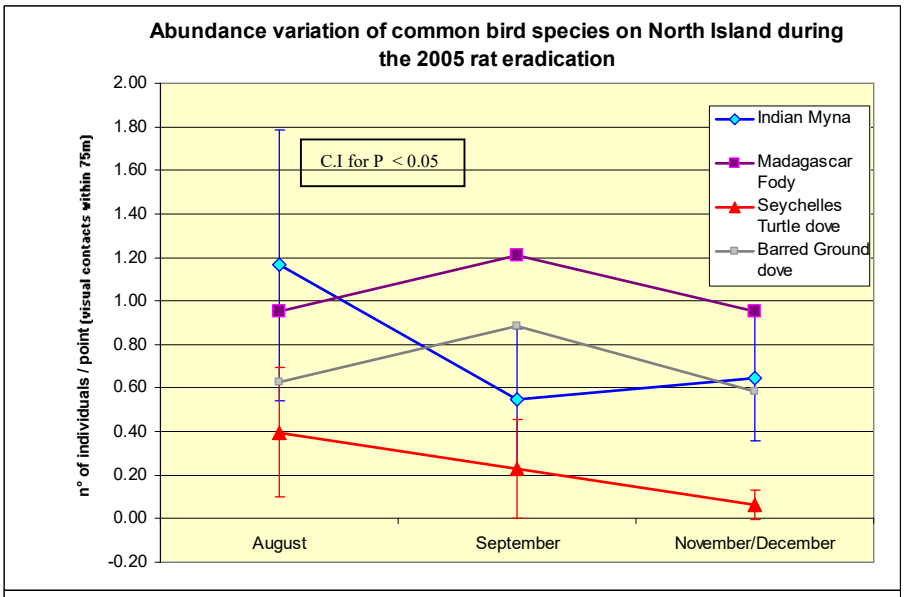


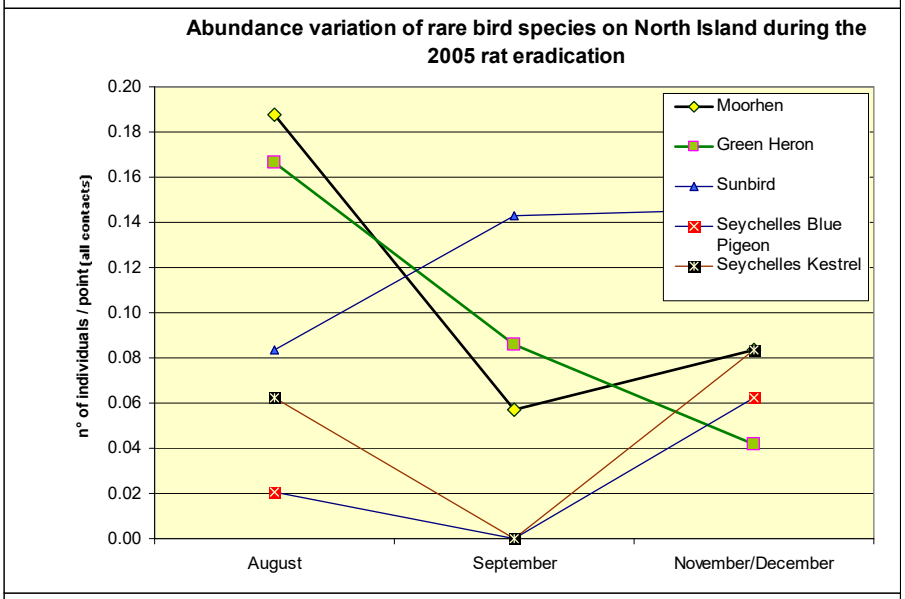
Estimated mortality

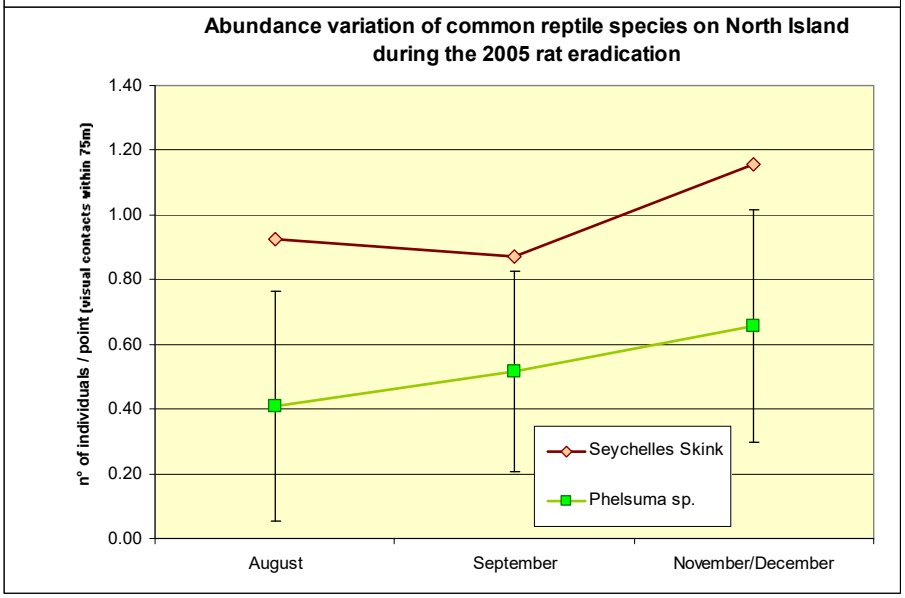
In view of investigating the possible effects of the aerial spread of Brodifacoum baits, point counts of 10 minutes were conducted randomly along paths and the plateau/lowland areas, to monitor the abundance of birds and reptiles before (48 points late August 2006), during (35 points mid-September 2006) and after (48 points late November/early December 2006) the eradication. During the point counts, all perched birds, skinks or geckos observed were recorded together with the horizontal distance to the center of the point. The counts were divided in 3 periods (2, 5 &10mn). Indices of abundance were calculated for each species in terms of average number of individuals per point (within 75m for common bird species; and within 15m for the skinks and geckos). Birds only heard or flying above were also recorded but not taken into account to calculate indices of abundance, except for species rare on the island where all contacts were considered. Appendix 9 shows the variations recorded, which were tested statistically.

Among the common bird species, only the Myna and the Madagascar Turtle Dove showed a clear decline in numbers. Despite a drop of 53% in Myna numbers between August and September, followed by a slight increase until the end of November, none of the differences were statistically significant (Man-Whitney Test two-tailed P value = 0.1456 for August-September & 0.6517 for August-November). This is probably due to an insufficient number of points conducted in September (35) and to the clustered distribution of Mynas on the plateau that increase the standard deviations and confidence intervals. The slight increase observed between September and November, although not significant, may correspond to some breeding having already taken place since the end of the eradication. This may have compensated the mortality that occurred after the 3rd and 4th poison drop, which happened on the 12th October.

The Turtle Dove's decline was dramatic (- 84%) and statistically very significant (Wilconxon test P=0.0068). The two other common species, the Madagascar Fody and Barred ground dove showed a stable/fluctuating pattern.


Abundance variation of common bird species on North Island during the 2005 rat eradication
n° of individuals / point (visual contacts within 75m)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
C.I for P < 0.05
Indian Myna
Madagascar Fody
Seychelles Turtle dove
Barred Ground dove
August
September
November/December


Abundance variation of rare bird species on North Island during the 2005 rat eradication
n° of individuals / point (all contacts)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Moorhen
Green Heron
Sunbird
Seychelles Blue Pigeon
Seychelles Kestrel
August
September
November/December


Abundance variation of common reptile species on North Island during the 2005 rat eradication
n° of individuals / point (visual contacts within 75m)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Seychelles Skink
Phelsuma sp.
August
September
November/December

Among the rare bird species, Moorhen and the Green-backed heron seem to have been also affected. Although differences could not be tested statistically because of too small sample sizes, there was a clear general impression that encounters with both species were becoming less frequent, particularly with the Moorhen for which several individuals were found dead. Since both of these species feed on a large variety of items on the ground, it is not surprising that there were affected by the poison drop. There was an equivalent number of contacts for the endemic Seychelles Kestrel, as the only pair present on the island survived the eradication in the wild. The two other endemic species, the Seychelles Sunbird and the Seychelles Blue Pigeon were observed more often after the eradication. Although all these species occur in relatively small number on the island, they are common elsewhere in Seychelles and, with the exception of the Kestrel, they are not of conservation concern.

An apparent increase in abundance was recorded for the Seychelles skink (+25%) and for the Phelsuma gecko (+60%), but none was found statistically significant (Mann-Whitney two-tailed P value of 0.2918 and 0.3379).

It was not possible to interpret differences between (and within) plateau and hill as the number of points in each habitat type taken separately is too limited.

The exact number of dead birds for each of the species cannot be determined precisely. However we can estimate roughly that several tens of Madagascar Fodies, as well as several tens of Madagascar Turtle doves may have died during the eradication. It is likely that the number of Moorhens that died is also 3 to 5 times higher than what was observed, i.e. probably 10-15 birds. Very few Ground doves appear to have died, probably less than 10. Most of the Barn Owls present on the island (probably 5-10) appear to have died during the eradication. It is difficult to appreciate the level of mortality suffered by skinks and geckos.

In the case of the Mynas, 56 pre-eradication point counts (of 2mn) were analysed using *Distance Sampling* and gave a population estimate of **850 birds** (430-1697; $P < 0.05$; see Appendix 10). The recorded variations of abundance, which show a **53% decrease** followed by a slight (non significant) increase, provide a population estimate of 400 mynas (202-798, $P<0.05$) by mid September 2006, and c.470 (237- 933; $<P<0.05$) remaining on the island by early December 2006.Hence, the total number of Mynas that died during the eradication can be estimated at about **400 birds** (between 230 and 900 taking into account the confidence intervals). This represents c. 8 times the number of birds that were found dead.

Dead birds were mostly found on plateau and lowland areas, none along the path on the hills.
This may be due to a conjunction of factors:

- the total area prospected in the lowland plateau areas is much higher in proportion compared to the narrow paths on the hill's. However, no dead birds have been found in the large extention of Glacis.
- plateau areas were also far more intensively used by island staff that were instructed to report or bring back any dead birds found.
- compared to the hill, which forest are covered by a dense fern undergrowth, there is on the lowlands much more open areas where birds can and congregate and come to the ground to feed on the bait

-

Human risks

The risks of brodifacoum to humans are minimal (see “Information on brodifacoum” below p31). A large quantity of bait (several kilogrammes) is required to have toxic effect on people. However all measures was taken to ensure health risks were minimal.

Any risk to human health was managed by ensuring:

1. All residents on the island were briefed about the use of the brodifacoum and the danger of interfering with it. No small children were present on the island over this period.
2. No drinking water storage and /or collection were in danger and no areas required screening to prevent contamination. Brodifacoum does not enter aquifers and contaminate water.
3. All guests were aware of the operation.
4. The eradication consultant brought a supply of the brodifacoum antidote (vitamin K1) in case of accidental poisoning.

~ Recommended Measures to Minimise the Risk of Reintroduction of Rodents to North Island ~

There are many examples of successful rodent eradications being achieved within the Seychelles and overseas (see above). All recognised standards of best practice were followed during the current campaign and all evidence suggests success in preventing recolonisation, as one year has passed without sightings or sign being found. Eradication of rats from North Island was only the first phase of an ongoing programme and, with regular visitations by boats and service barges; vigilance is required to ensure that rodents are not reintroduced by human activity.

Rodents are one of the worlds' most successful colonisers. Islands like Curieuse and Denis in 2000, or North Island in 2003, received large volumes of boat traffic and cargo and neither had correctly implemented the **reintroduction prevention strategies** or **rodent abatement protocols** that had been advocated to protect them. Conversely, islands that did implemented significant standards of prevention measures, such as Frégate, Bird, Denis (Second campaign 2002), D'Arros, Anonyme (and many other islands in New Zealand and other parts of the world) have remained free of rats and mice since the eradication took place. **The risk of reintroduction is real** and there is a high level of commitment by management and staff on North Island, but if we are to avoid reinvasion happening, standards for implementing rat contingency protocols must be kept high in the long term;

Most of the measures summarized below were key requirements given by ICS during the pre-eradication phase that were appended to the ICS/NI MoU. These are now in place and have become a permanent infrastructure in the management of North Island. It is essential however that all the requirements for the ongoing protection of North Island included in the 2005 proposal document (Rocamora & Climo, 2005), and the following protocols discussed at length and agreed during the course of this eradication campaign, are fully implemented if the risk of accidental reintroduction of rodents to North Island is to be minimised.

Rat abatement measures

The implementation of rodent abatement measures is of upmost importance, all the evidence gathered to date indicates that eradication procedures are effective if done to a high standard. However without the implementation of these abatement measures the risk of re-invasion on North Island in the future is likely.
An example of how these measures can be effective was reflected during the eradication attempt of 2003 with a noticeable population decrease in rat numbers. This was in part due to the considerable reduction in rubbish and foods available for rodents following a massive clean up after hotel construction was complete. Also, during the current eradication, rat numbers trapped around the green waste area were dramatically reduced after the final cleanup.

The objective of abatement is to reduce the probability of introducing rats over a number of steps until the probability of re-invasion is minimal.

This process normally takes three steps;

1. **prevent introduction:** bait stores, fumigate bulk cargo, bait on boats, stores in sealed bins, control unauthorised landings
2. **containment on the island:** cargo taken to rodent proof store for unpacking, rat fence on a harbour etc
3. **eliminate invaders quickly:** limit food and shelter by good garbage disposal and maintain permanent poison stations/traps at hot spots

The implementation of these basic procedures, tailored to North Island will at each step progressively reduce the chance of rodents becoming established.

It is strongly recommended, therefore, that the following measures, guidelines and rodent abatement protocols are undertaken and strictly adhered to:

Transportation of people, stores and cargo

The first and best line of defence is to stop rodents from getting aboard transport and supply vessels. While it is recognised that clean-ship requirements and rodent prevention practice cannot always be controlled by the North Island management team, implementation of best rodent-prevention procedures can be influenced through the development of a positive, public relations strategy. There is an urgent need to inform and **educate local business communities servicing North Island** about why radical changes in policy and practice are necessary with regards to transportation and landing of clients, luggage, stores and general cargo and what is now required to protect islands with rodent-free status in the Seychelles.

The installation of permanent poison and/or rodent trapping stations in appropriate sites on the wharves and shore facilities used by regular supply vessels could be encouraged to reduce the opportunity of rats finding their way onto these ships. Permanent toxic bait and trap stations to both monitor for and/or deal with rodents that might have slipped aboard, should similarly be placed on every vessel that travels to the island. Reliable personnel such as the storeman on Mahé, the environmental officer and security officer on North Island should be given specific delegated responsibility to ensure these stations are regularly checked and maintained in good order. Store packers and ships crews should be made aware of the importance of recording and reporting any sightings or incidence of rodent sign found at their onshore facility or aboard their vessel so extra precautionary measures can be taken to deal to the problem.

Items such as crates of drink, gas bottles, sealed containers of chemicals etc that have not been opened and repacked in the Seychelles provide few secure hiding places for rodents and therefore pose less of a quarantine risk – these may not need to go into rodent-proof enclosure for inspection during the transportation process. Supplies and cargo posing the greatest risk of harbouring rodents include **foods, cardboard boxes, fibrous bales, bagged products such as grains and rice and building materials.**

All stores likely to harbour rodents and loosely bought items must be sealed in tough rodent-proof containers before being shipped to North Island, including items regularly transported across on the *Buttcat*. **Stores must remain sealed until opened for inspection in the rodent-proof room on the island.** Because they damage easily and increase risk, cardboard boxes do not make good packing containers. Contents of any boxes or containers damaged prior to (or during) transit, should be repacked or sealed in rodent–proof containers before being transferred to the island. Colour coded containers could be used to identify types of stores or materials they contain or areas intended for distribution on the Island, making it easier for management to keep track of in-coming goods. Containerised bulk-cargo must be fumigated before dispatch. Any boats moored close to the island overnight can pose **a huge risk of rodents swimming ashore**, so all boat operators must be made aware of North Island's commitment to re-invasion issues. Delegated authority should be given to the environmental officer to put systems in place that will ensure the protocols have been followed *before* a boat beaches on North Island (e.g. a tick signed-off questionnaire).

The objective of the rodent abatement process is to reduce the risks of re-introduction of rats over a number of steps, until the probability has been minimised as much as possible. It is simple logic that if goods are checked, rodent-free and sealed before the boat leaves Mahé, then all the other steps that follow, including the use of the rodent-proof room, will be simple, efficient and cost-effective. The high risk factor should not be left until goods reach the rodent-proof room. By that time the chance of reinfesting the Island should be at its' very lowest, a mere final but necessary precautionary insurance.

All cargo and stores arriving on North Island must in every instance, first be cleared through the rodent proof room. Strict adherence to this basic quarantine measure is essential if zero tolerance of reintroduction of rodents to North Island is to become an operational reality.

Progress and compliance

- During the campaign rodent re-introduction prevention policies were being followed to a reasonable high standard from North Island perspective but more needs to be done from the Mahé side on the service vessels and handling of stores. Subsequently, a store where quarantine and controlled packing for boats can be done routinely has been acquired on Mahé. This room should be rodent proof and bait stations placed in the vicinity. **This is of paramount importance to the success of this campaign and keeping the island rat-free**.

- No boats bringing food goods to the island were packed or fumigated correctly after the final application of bait. The situation has improved to an extent in 2006 and fumigation was applied at some point to transport thatched roof and other high risk materials, however more needs to be done. Plastic tubs were supposed to be ordered and used to pack and transport checked goods, but this did not materialise (September 2006). Procedures for fumigating containerised cargo on Mahé and transferring the container directly to North island with customs officers is been investigated.

- Measures to reduce risk of rodent reintroductions by adopting a "clean ship" policy was fully discussed, understood and agreed with both Island Management and staff. Michellin has bait stations and two live traps on board that must be checked before every departure from Mahé. A plastic sign much the same as a "non smoking" sign could be placed inside the cabin of the boat as a remainder for these procedures eg "Have you checked bait stations ?", and a form ticked and signed off . Protocols for loading and unloading of boats have been finalised and agreed (see Appendix 11 & 12).

- Investigation is been made into the use of a mooring for the Michellin, where it will not have to be tied to a pier. This will reduce the risk of rodent coming about during the night.

Rodent-proof room

The rodent-proof enclosure is an important part in the final quarantine procedures. Because alternative beaches are used depending on seasons and sea condition, it was agreed that a single rodent-proof room would be kept on the island, but goods would be brought from either beaches with a rodent-proof trailer that was ordered and put into service before the start of the eradication campaign. A smaller trailer to take all luggage and small parcels from staff was also put into service. The rat proof room built in 2003 was repaired before the eradication campaign began and was used and remained in a satisfactory manner during most of the eradication project. Procedures for the use of the rodent proof room have been circulated by North Island environmental department and have become an intricate part of management. However some parts of these procedures discussed in detail during the campaign need to be adopted with more vigilance and are identified as follows:

All newly landed stores and bulk cargo is to be transferred immediately from the beach to the rodent-proof enclosure with the rat-proof trailers. No breakout of containers or packaging is to be undertaken for redistribution to other Island facilities directly from the beach or anywhere else outside the enclosure. The unpacking of all supplies must be undertaken within the properly closed and secure environment of the rodent-proof enclosure. Any rodents that may be contained within the stores/cargo will then be confined, caught and destroyed. Some key considerations are as follows;

1. Each trailer load must be off loaded into the inclosure and doors remained closed while other loads are been transported.

2. No stores should be removed from the inclosure until ***all*** items are in the room and have been checked. Personal staff belongings can be checked all at once and bags removed, so staff are not" in and out" regularly while procedures are taking place. Doors are to remain closed ***at all times*** during inspections.

3. Items put into the inclosure for inspection should not be stacked up high as this will provide a good “ladder” for the rodent to escape.

4. The inclosure should not be used as a store and should remain empty for the use of quarantine of stores.

5. Make regular inspections of the inclosure for damage or any maintenance needed. ***If your finger can fit under or in any gap a rodent can escape from the enclosure.***

Progress and compliance

- A rodent-proof room has been built and was in use before the eradication campaign. Strict procedures have been written up for the use of the room and distributed among staff and has been adopted satisfactory. However these procedures need to be reinforced and stores need to be removed as soon as possible after the inspection. “Person” traffic should also not occur in and out of the inclosure during the inspection process.

- **New metal sheeting lining the enclosure is urgently needed**. Many of the sheets are rusty and provide purchase for rodents. This was supposed to be ordered and work should commence ASAP. Care must bee take when overlapping sheets not to have the sheets “Bulge” and where this may occur, will need to be riveted flat. If left unrectified it will provide good climbing purchase and an escape route for a rodents

- The enclosure was damaged during an unloading procedure which split the door framing causing the doors to drop on there hinges which restricted there closure. This was first provisionally repaired, until a more permanent fixture and strengthen was done in 2006.. A more substantial framing to hold the large doors and larger hinges are needed. This could be done when the sheeting is replaced. The doors themselves should be extended to do away with the plywood “Add ons” where the sheet metal can continue to the top of the door frame.

- A **new rodent-proof room**, safer and easier to maintain should be built from blocks and concrete as a best long term solution.

Food waste and refuse disposal procedures

It is essential that at no time are food or food scraps to be accessible to rodents**,** Any food made available to a rodents essentially reduces the chances of a colonising rat or mouse taking poison bait or entering a trap. Ideally, food scraps and garden refuse could be used to make compost for the gardens or revegetation areas and use one of any number of appropriate closed systems. An excellent example is a unit catering for disposal of refuse for a population of about three hundred people on Lord Howe Island, off the eastern coast of Australia. At present food waste is buried at a single designated site and covered daily while further investigations are made into other systems.

Improvement of food waste management and disposal was a key ICS requirement prior to the start of the eradication. During the eradication programme rubbish bins were collected and contents disposed of daily. The current disposal of domestic refuse used throughout the staff village and hotel encourages primary separation into categories such as glass, tins etc. The initial sorting system seems to be working well and should continue, but set procedures need to be enforced.

Progress and compliance

- Small bins have been provided to each staff house to enable easy primary separation of waste at its source. ***Some*** foods were still being placed in these bins after the eradication, so this problem will need to be to be addressed and regularly monitored.

- Five rubbish collection bays are provided in the staff housing area and within reach to all staff. This seems to be working extremely well. Ideally all such areas should be provided with a smooth concrete base with a low nib wall or lip to aid cleaning and reduce smell. A rotation system is in place and bins are been emptied daily, washed and aired before use. This needs to be kept up to high standards. The job by collection staff is to leave a clean area behind them, not just to empty bins.

- A separate concrete pad with sloping floor and drainage has been constructed near the maintenance area where refuse is now separated into bulk bags for removal from the Island. Soapy water is used for the cleaning but a sieve trap incorporated into the drain to catch food scraps would be ideal – this would be checked and cleaned on a regular basis. Such a system would aid hygiene and reduce smells that attract rodents and flies.

- Though left over food was disposed of in a satisfactory manner during the eradication by daily burying in deep holes, a more long term disposal system is needed. North Island had proposed to purchase a macerator to process food waste. This was agreed in its MoU with ICS and still needs to be done or replaced by an equivalent improved system (e.g. incinerator).

Disposal of green waste and large discarded items

Rodents do not survive well without cover and none more so than that provided by accumulations of human refuse. North Island staff had carried out huge efforts before the eradication campaign began completing the clean up of accumulated construction materials and green waste.

Recommendations were made before the eradication to remove the huge accumulation of green waste, notably the separation of coconuts from this pile for removal from the Island (Rocamora & Climo, 2005). Similar recommendation was done by Ministry of Health officials for a general clean up of the island (Mrs Rose, pers. com.). Further agreement was made to accelerate this timely and costly process by discontinuing the separation of coconuts and flattening the green waste pile, then covering and compacting the result with soil (Climo pers.com). Some less composed waste was buried and capped with 1-2m of soil. A team of 8 people was hired for 10 days to achieve this cleanup. However a large pile of hard coconuts remained in the green waste area during the eradication and was hand baited regularly during the campaign as well as placing traps and bait stations around the perimeter. This pile was carefully moved after the second drop to confirm if rats were present in the pile, which proved absent.

Materials such as wood, concrete, household items, old engines etc were removed and taken off the island prior to the eradication. High priority must be given to disposing of all accumulated piles of rubbish that can provide prime habitat for rodents.

The large areas of timber behind the villa area and in the main dump site which requires sorting and stacking of reusable material and all discards burnt or removed as soon as possible. It is also important that smaller rubbish sites in forested areas be dealt with, where septic tank units and toilets and other discarded materials have been dumped. It would be a prudent to identify a single designated area where larger unwanted items can be stacked in a more controlled, tidy fashion until removal from the Island can be arranged.

Future vegetation cuttings need to be mulched using a shredder and used around gardens or spread thinly through the forest. This includes coconuts that are regularly collected from the hotel or plateau area and should not be any more piled up in a same area as it used to be the case in the past. North Island used to be a large coconut plantation and despite the vegetation rehabilitation programme in place which plans to progressively coconut trees, they will still remain a dominant species for a number of years.

Progress and compliance

- A commendable cleanup of maintenance storage areas, green waste, and the island in general was completed before the eradication campaign. Systems in place to deal with waste management issues appear to be working well. A mulcher was purchased and is being used to

dispose green waste on a regular basis. However some other areas need investigation and attention, such as the disposal of the large amounts of coconuts collected daily

Permanent bait stations

A monitoring system of 37 stations containing block baits has been established in areas considered to have the greatest chance of detecting rodent incursions (Appendix 1 lists the position of all sites). Baits and traps will need to be checked regularly for sign of rodents and baits will need to be replaced every two weeks to remain effective - or sooner if bait shows any sign of deterioration. The four larger stations on the coast previously contained kill traps and could continue to have so once good lasting traps are sourced and if these stations can be installed in a way to minimise access to crabs and skinks. If so, these would need to be checked and serviced at least three times a week. Bait needs to be kept in good condition and available in stations at *all times* - they should be replaced at first sign of deterioration.

It is essential that entrance holes of stations be kept clear of objects and weedy growth and broken or lost stations replaced immediately. All bait and trap stations will need to be cleaned periodically.

As access to the front of house can sometimes be difficult for staff not associated with the villas, the checking of bait stations in the villa kitchenettes will be done by house keeping. It is planned to be done during gas bottle inspections every 2 weeks.

With fortnight checks planned from 2006 onwards, a minimum of 5-7 tubs of waxed block bait will be needed to last a year. A minimum of one month should be allowed for any orders to be delivery by plane, and three months by ship. ICS office will help with sorting the necessary authorisations from Ministry of Health / Pesticide board.

Progress and compliance

- Regular checks and servicing of all permanent bait and trap stations were carried out regularly by North Island staff with due diligence. A full time staff member experienced in eradication campaigns was employed in October and its time mostly dedicated to the ongoing maintenance post-eradication tasks.

- Extreme vigilance is required during the first few months. Detection of rats in very low densities can be difficult and signs could be missed.. However if rats already occur in good numbers then it would be expected that rodent monitoring would detect signs at the stations or at the traps.

Promoting awareness

It is important that management and staff are made aware of the unique status of North Island and fully informed of what is required to keep it rodent-free. They should be made to feel proud of what has been achieved and be encouraged to follow the protocols to the letter in support of the vision for a better island. New employees should be personally informed of the situation and procedures to be followed when they go through their induction on arrival at the Island.

Poster displays about the eradication campaign could be prepared and used for public education both in the North Island facilities and elsewhere in the Seychelles. Pamphlets containing similar information could be produced for inclusion with promotional handouts to clients and visitors prior coming to the island. This will give people forewarning of quarantine procedures and why they are in place and considerably reduce the possibility of “unwelcome” surprises when they arrive at the Island. A leaflet presenting the activities conducted under the FFEM project and highlighting the importance of abatement measures to keep the island rat-free will be available for guests and visitors by the end of 2006.

Staff and guests travelling to North Island from other Islands where rats and mice are present need to be aware that they too could harbour rodents in their belongings, especially if they are bringing foods and

boxes to the Island. We know of cases where this has happened in the Seychelles and it must be avoided at all costs on North Island. The process of keeping everybody informed and aware will need to be ongoing.

Progress and compliance

- Since the start of the rat eradication process in May 2005, all new staff coming to work on the island have all been briefed individually on the necessary precautions to be taken to keep the island rat free. Regular staff meetings have also been undertaken

Responsibility for rodent prevention/detection and management

The overall task of rodent prevention has been given to the Island Environmental officer who shall oversee other department's compliance. Procedures based on the measures above have been internally produced, from the packing and loading of stores in Mahé to the safe unloading in the North Island rodent proof room (see Appendix 1).

Clearly, the risks of reintroduction are great and there can be no half measures taken if continued rodent-free status for this island is to be achieved. The position requires the following ongoing *permanent rodent abatement measures:*

1. Implement, maintain (and improve where possible) the food waste disposal procedures.

2. Maintain quarantine procedures: ascertain that all stores on arrival were correctly packed ***or*** fumigated before shipping and ensure that all bulk packages are transferred to the security of the rodent-proof room prior to opening and sorting for local redistribution on North Island.

3. Maintain the system of permanent bait stations at rodent hot spots on a weekly basis until the end of 2005. For long term management after 1st January 2006 stations can be checked every 2 weeks, sooner if bait appear to be deteriorating faster than anticipated - however bait should remain in the stations at all times.

4. Ordering new supplies of waxed block bait when needed for permanent bait stations (see Appendix 13). A combined order may be negotiated with ICS or other rat free islands)

5. Follow up of any reports of rodents on both North Island and the boats that service it and implement contingency plan accordingly to the Pest response plan (see Appendix 14).

6. Actively promote awareness of the potential rodent risks within staff and management of North Island and promote the need for ongoing quarantine protocols with visitors, service personnel and boat operators.

7. Implement and maintain reporting procedures on a regular basis.

8. Plan overlap of information between new recruited environmental management and other staff.

Progress and compliance

- At the end of the eradication, a full time staff with previous experience of rat eradication (Unels Bristol) was employed to assist the Conservation Officer (Linda Vanherk) in dealing with the various rodent abatement measures. All the tasks were undertaken by both officers with a high level of dedication and efficiency. Monthly reports were produced between November 2005 and September 2006 and circulated to ICS.

- The overall commitment and compliance with these measures on North Island during the post-eradication period can be considered satisfactory although some improvements (mentioned in previous sections) are still required.

- On a few occasions, alleged 'rat' sightings or 'possible rat' sightings were reported and investigated using the pest response plan recommended protocol (p.39). However none were confirmed and no rats have been recorded on the island since the last that was trapped on 26th September 2005.

- A total of more than **8500 night-traps** were conducted during the post-eradication rat monitoring period, between October 2005 and September 2006, making it probably the island with the most intensive post eradication rat trapping scheme ever conducted. This has allowed to ascertain the rat-free status of the island less than a year after the eradication.

- Rat trapping, checking the permanent bait stations and the grid bait stations was started by the rat eradication consultant and meticulously continued throughout the next 11months mainly by Assistant Conservation Officer Unels Bristol.

Post eradication maintenance calendar

A calendar was prepared to organise the three different post-eradication activities:

- 1) intensive rat trapping.

- 2) bait replacement and check of permanent bait stations,

- 3) bait replacement and check of the 50m grid system of bait stations that need to be conducted.

The calendar below gives an example for the month of November 2005, and these activities were continued unchanged until the end of the year.

In January and February 2006, the intensity of survey trapping was reduced by checking traps (c.75 originally, then down to c.60) once every two days instead of every day. In March, traps were only used two nights every two weeks, and from April to July, traps were only used two nights per month. By the end of September 2006, the last 60 traps were used for two nights.

Bait stations of the 50m grid system were continued to be checked (and bait replaced) until the end of March, then left in place until end of September 2006 when the grid was taken out.

Checking and bait replacement on Permanent bait stations has been continued and will remain unchanged

Figure 5: Maintenance guide for month of November 2005

Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Rat trapping

Permanent Bait stations replacement/check

Bait stations Grid system replacement/check

Trapping: to continue throughout month for periods of 10 days with 4 days where traps are rested. Between 6th - 9th and 20th – 23rd November move traps to new sites.

Permanent bait stations: To be check every Monday. Villa staff to check villas (One in kitchenette, one under villa) and Environment staff to check others (See list).

Grid system bait stations: To be checked every Wednesday.

Picture 1: Rubbish waste sorting area on North Island, Seychelles

~ Ascertaining success ~

The campaign has progressed well and there was no reason to believe that success would not be assured. Two years of "*doing nothing, wait and see"* (for aerial broadcast) or monitoring with loaded bait stations and/or traps (ground-based programmes) without sign of rats, is the standard period of waiting before declaring positive success. In temperate or subantarctic climates, two years is enough for rats that may have survived the operation to build up significant numbers and be trapped.

In this campaign, however, the intention from the outset has been to actively pursue an earlier indicative result of only one year, which reflects better the all year round favourable conditions for rodents in the tropical climate of Seychelles, the size of the island and how the abatement measures are being implemented. This will allow earlier reintroductions of endemic species, though transfers to the island should not be hurried.

With this in mind a intense trapping survey was started shortly after index trapping was completed (see survey trapping). It was repeated throughout the first 3 months post-eradication, then progressively reduced in intensity (see details in previous sections). Should any rats have survived on the island, we are confident that the intensive trapping system in place during this past year (totalling 8500 night-traps) would have allowed to detect the presence of a growing rat population. In 2004, rats were detected only c. 5 months after the previous eradication campaign despite a much less intensive trapping survey, which gives an idea about the capacity for rats to build up rapidly their numbers on North Island.

The poison bait stations also act as monitoring devices and baits are usually counted and checked for rat-chew marks when they are replaced. Though baits are been looked at during replacement, detecting signs of rat-chew mark is not easy as snails are consuming much of the bait, therefore making it difficult to trace any sign. Fresh rat droppings in the bait stations or inside buildings would also give early warning of problems. A permanent baiting system in rodent "hot spots" has been put in place to be checked on regular basis .In addition, a temporary baiting grid system was set up across much of the lowland areas and maintained active during 6 months after the eradication (see details on permanent bait stations and grid system in previous sections).

Because of North Island management's commitment and ICS surveillance and support, one year should also be a sufficient amount of time to judge on the routine application of the abatement measures for the island to be keep free in the long term.

More than a year after the last rat was trapped on North Island (27.09.06), no rats have been recorded during the intensive rat trapping survey (more than 8500 night x traps) that has been conducted since September 2005 (Unels Bristol, Gideon Climo, Elliot Ntsele & Linda Vanherck, monthly reports & pers. comm.). Strict protocols and abatement measures (rat proof room, loading & unloading procedures, permanent bait stations, etc.) have been put into force on a permanent basis to prevent reinvasion.

By the end of September 2006, **we consider that North island can be safely considered rat free and able to remain so as long as the required abatement measures and improvements detailed in this report and previous documents are implemented.**

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- The statistical tests regarding the differences of abundance of birds & reptiles before & after the eradication were done by Dylan Evans.

~ Photographs ~

Up left:
North Island (201ha)

***Left* : *Helicopter Seychelles* spreading cereal bait with Brodifacoum**

***Below*: Filling up the spreader-bucket**

***Left* : checking the spreader-bucket**

***Below*: preparations & discussions with the pilot.**

Left **: New type of rat trap being tried before the eradication**

Above**: Bait station Dead Rat Caffé with Brodifacoum cereal blocks (temporary 50m grid)**

Left **: traps from line traps before the start of the eradication**

Below**: Indian Mynas (invasive alien species) poisoned after the drops of Brodifacoum bait**

Left **: rat-proof trailer for the transport of goods from the landing beaches to the rat proof room**

Left **: the rat proof room**

Left **: trailer, goods to be checked, and visitors coming to collect their checked luggage in the rat proof room**

~ Appendices ~

Appendix 1

Map of North Island showing access tracks used for eradication and locations of bait quadrats

Rat trapping index line

Existing road system

Track system cut during 2003

Track system cut during 2005

Bait Quadrats

Appendix 2:

Aerial broadcast application Summary and accepted best practice

- A differential global positioning system (DGPS) along with a special hopper bucket was used for the application of the bait to insure proper coverage over the whole Island.

- Eight tonnes of rodent pellets containing brodifacoum @ 20ppm (parts per million) in a 10mm diameter cereal based carrier pellet (Pestoff 20r), was used for the eradication. Four applications were broadcast over a period of 43 days.

- A total area of 201 hectares was plotted by the GPS.

- The pay-load limit arranged by Helicopter Seychelles was ~ 200 kg (8 bags) for each load and as the bucket was about 160kg this made the total hook-load ~ 360kg.

- Baits were evenly spread from the motorized hopper bucket suspended from underneath the helicopter using an effective coverage of 120m swath width. Heavier bait would have reached further but at lower rates. This acted as overlays of about 50% on the next transect line to as insurance for a total coverage of the whole island.

- The planned rate used for the first application was 15kg/ha due to the much higher densities of rats recorded. The second application was done at 10kg/ha and the third at 8kg/ha. A fourth application was decided after a male rat was caught after the third application and heavy rain had increased the breakdown on the bait, and this was done at 7.5kg/ha. Rat index trapping was carried out on North Island during and after the first and second bait application.

- The North Island aerial operation applied rodenticide at a density of one bait between 1.3 m and 1.9m over the entire Island; a figure confirmed by the helicopter GPS printout on the third drop.

- Five 10m by 10m (100m2) quadrats were established on North Island to measure bait densities, rate of bait consumption and decomposition after each aerial application. During the North Island eradication campaign, baits were available to rats for up to 53 days (up till 22nd October) so far in all parts of the Island, though for a period of about one week baits were very in low densities due to heavy rain.

- It is an understood that the home range of a territorial animal equates to the area that the individual can defend i.e. outside pressure from competing neighbours generally determines the size of a territory or animals living space (although with social species territories can overlap).

- Ground-based eradication techniques applying rodenticides in protective stations have been successful against *Rattus rattus* setting transects and stations at predetermined intervals of 25, 50 and 100 m apart, i.e. dispensing poison at distances of up to 100 x 100 m between baits. On North Island, an additional 50mx50m grid of 162 bait stations was set up in lowland 'hotspots' and areas of higher densities of rats and kept operating for 6 months, in order to extend the duration of bait availability and minimise risks of rats surviving in these areas. This added to the 31 permanent bait stations set to minimise risks of reinvasion.

- Aerial broadcast of rodenticide is a proven technique successfully employed in many countries around the world. Eradications of rats have been achieved after only one or two (the current accepted standard) applications. Though this is different for tropical areas, as insurance, three

applications were programmed though four had to be carried out on North Island to minimize possible risk of failure.

- The possibility had been suggested that rats in tropical situations were living an arboreal existence in the crowns of coconut palms, never descending to the ground. A study designed to test this was undertaken on Denis Island in 2002 when 8 rats were live-trapped in the crowns of coconut palms, fitted with radio transmitters and tracked for forty-one days. Only a proportion of the study animals regularly climbed the trees, and all of those descended to the ground during the day or for a period at least during the night. That any rat would stay in the crown of a coconut palm for 6 weeks without returning to the ground is highly unlikely. Such research is long overdue and other more involved studies on the arboreal behaviours and re-colonization of black rat are currently underway, on some islands in New Zealand (Climo and Thomas pers.com 2005).

- Using radio telemetry, it was shown on Ulva Island (NZ) that when rat populations decreased as the eradication progressed, individuals were moving greater distances to gain access to bait (Thomas and Taylor 2002).

Appendix 3:

North Island rainfall during the 2005 rat eradication

Date	JUL 05	AUG 05	SEP 05	OCT 02	NOV 02	DEC 02	JAN 03
1	Nil	Nil	26.0mm		Nil		
2	Nil	Nil	2.0mm	2.0mm	Nil		
3	Nil	Nil	Nil	Nil			
4	Nil	Nil	Nil	Nil			
5	Nil	Nil	0.5mm	Nil			
6	1.0mm	Nil	Nil	Nil			
7	2.5mm	Nil	Trace	Nil			
8	Nil	3.0mm	Nil	Nil			
9	Nil	Nil	Nil	Nil			
10	Nil	Nil	Nil	Nil			
11	3.5mm	Nil	Nil	Nil			
12	1.5mm	Nil	Nil	Nil			
13	Nil	6.5mm	2.3mm	Nil			
14	Nil	1.5mm	Nil	15.0mm			
15	Nil	Nil	Nil	Nil			
16	Nil	4.0mm	2.1mm	0.3mm			
17	Nil	Nil	Nil	Nil			
18	Nil	Nil	Nil	Nil			
19	Nil	Nil	5.5mm	Nil			
20	1.0m	Nil	Nil	Nil			
21	36.0mm	Nil	Nil	Nil			
22	1.5mm	Nil	0.5mm	Nil			
23	Nil	Nil	Nil	Nil			
24	5.0mm	Nil	Nil	Nil			
25	1.0mm	Nil	0.5mm	8.2mm			
26	Nil	Nil	16.0mm	Nil			
27	Nil	4.0mm	24.0mm	85.0mm			
28	0.5mm	14.0mm	85.0mm	60.1mm			
29	Nil	Nil	Nil	Nil			
30	Nil	Nil	Nil	Nil			
31	Nil	20.0mm	-	Nil			
Totals For Month	**63.6**	**53.0**	**164**	**170**			
No. Of days	10	7	12	6			

Days on which bait was dropped

Appendix 4:

Location of Permanent Rodent Bait Stations

Bait station	Location
	Guest Villas
#1	Villa one in kitchenette on floor behind rubbish bin.
#2	Villa two in kitchenette on floor behind rubbish bin.
#3	Villa three in kitchenette on floor behind rubbish bin.
#4	Villa four in kitchenette on floor behind rubbish bin.
#5	Villa five in kitchenette on floor behind rubbish bin.
#6	Villa six in kitchenette on floor behind rubbish bin.
#7	Villa seven in kitchenette on floor behind rubbish bin.
#8	Villa eight in kitchenette on floor behind rubbish bin.
#9	Villa nine in kitchenette on floor behind rubbish bin.
#10	Villa ten in kitchenette on floor behind rubbish bin.
#11	Villa eleven in kitchenette on floor behind rubbish bin.
	Hotel grounds
#12	Coastal side of track heading to main pool.
#13	Under dive centre deck facing beach
	Hotel kitchen
#14	In cool store under shelf
#15	Kitchen Waiters corner under cupboards.
	Helicopter pad
#16	East end of beach behind shelter
#17	West end of beach under casurina tree
	Staff houses and Service buildings
#17	Store/shop building
#18	Store/shop building
#19	East end of village under house #B12, near vegetable garden.
#20	Staff Kitchen on floor under pasta shelf
#21	Staff diner on floor in dish wash area near bins.
#22	South end of village under Environment staff house #A4.
#23	North end of the village under house # B25.
#24	West end of village under house block # near laundry.
#25	In Laundry on floor near soap dispensers
#26	Maintenance area on outside deck.
#27	Maintenance area under building.
#28	Behind waste sorting shed.
#29	House keeping hub in store room.
#30	House keeping room in tea room.
#31	Sunset bar under the bench with sink.

Boats

#32	Cabin of “Buttcat”
#33	Cabin of “Michellin”

Mahe

#34	In the North Island Mahe office on the floor in main room.
#35	In the Mahe staff house.
#36	In the Mahe staff house.
#37	Helicopter Seychelles main building, Mahe

Appendix 5.

Temporary bait station grid in plateau / lowland hotspots

Appendix 6

Additionnal *Rattus rattus* biometric measurements

North Island: 26/08 – 9/09 2005 (see also Rat eradication Plan, Rocamora & Climo, 2005)

Sex	Age	Weight (grams)	Head & Body length (mm)	Right ear length (mm)	Right hind foot length (mm)	Tail length (mm)	Pregnant	Lactating-Comments
Female	J	96	140	-	39	Broken	-	-
	A	214	193	-	37	260	No	?
	A	265	189		36	270	Yes	4 Dev Emb
	J	160	182		35	250	No	
	A	215	173		36	248	No	Skin scabs
	A	290	171		37	230	No	
	A	195	163		36	230	Yes	3 Dev Emb
	A	235	185		38	252	Yes	4 Dev Emb
	A	255	191		37	260	Yes	3 large Em
	A	225	182		35	175	No	
	A	215	176		36	256	No	
	A	265	198		38	60	No	Lactating
	A						No	
	A						No	
	A						No	
	A						No	
	A						No	
	A						No	
	J						No	
	J						No	
	J						No	
	A						No	
	A						No	
	A						No	
	A						No	
	A						No	
	A						No	
	A						NO	
	J						No	
	J						No	
	A						Yes	4 large Em
	J						No	
Av. (adult)								
Range (adult)								

Sex	Age	Weight (grams)	Head & Body length (mm)	Right ear length (mm)	Right hind foot length (mm)	Tail length (mm)	Pregnant	Lactating-Comments
Female	A A A A A A A A A A A A A A A A A A A J J J						Yes	3 Dev Emb
Av. (adult) Range (adult)								

Sex	Age	Weight (grams)	Head & Body length (mm)	Right ear length (mm)	Right hind foot length (mm)	Tail length (mm)	Comments
Male	A	270	193	-	39	244	
	A	365	196	-	41	270	
	A	195	181		37	237	Skin scabs
	J	165	260		37	186	
	J	135	150		36	245	
	J	115	155		35	225	
	A	215	184		35	260	
	A	250	190		38	258	
	A	255	190		38	266	
	A	245	190		37	260	Skin scabs
	J	65	125		32	175	
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	J						
	J						
	J						
	A						
	A						
	A						
	A						
	A						
	J						
Av. (adult)							
Range (adult)							

Sex	Age	Weight (grams)	Head & Body length (mm)	Right ear length (mm)	Right hind foot length (mm)	Tail length (mm)	Comments
Male	J J J A A A A A A A A A A A A A A A J J						
Av. (adult) Range (adult)							

Appendix 7:

Number of rats caught daily on two trapping index lines pre and post eradication

1. Trap-Catch record sheet for Palloss track (data: G. Climo / ICS)

Trap Night 1: 26th August 2005 Pre-control

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-
Set bait ok																									-
Spr/ bait ok																		*							-
Set bait gone																									-
Spr/bait gone																									-
Skink/Snail																									-

Trap Night 2: 27th August 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat	*	*	*		*	*	*	*	*	*	*	*	*	*	*	-	-		-	-	-	-	-	-	-
Set bait ok																-	-	*	-	-	-	-	-	-	-
Spr/bait ok				*												-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 3: 28th August 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat	*		*	*	*		*	*	*	*	*	*	*		*	-	-	*	-	-	-	-	-	-	-
Set bait ok																			-	-	-	-	-	-	-
Spr/bait ok		*												*					-	-	-	-	-	-	-
Set bait gone																			-	-	-	-	-	-	-
Spr/bait gone						*													-	-	-	-	-	-	-
Skink/snail																			-	-	-	-	-	-	-

Trap Night 4: 29th August 2005 First bait drop

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat	*	*		*		*	*	*	*				*		*	-	-	*	-	-	-	-	-	-	-
Set bait ok			*		*					*	*	*		*		-	-		-	-	-	-	-	-	-
Spr/bait ok																-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 5: 30th August 2005 Post control

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat	*		*	*			*	*	*							-	-	*	-	-	-	-	-	-	-
Set bait ok					*					*	*	*	*	*	*	-	-		-	-	-	-	-	-	-
Spr/bait ok		*				*										-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 6: 31st August 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat	*					*										-	-	*	-	-	-	-	-	-	-
Set bait ok		*	*	*	*		*		*	*	*	*	*	*	*	-	-		-	-	-	-	-	-	-
Spr/bait ok								*								-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 7: 1st September 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat																									
Set bait ok																									
Spr/bait ok																									
Set bait gone																									
Spr/bait gone																									
Skink/snail																									

Trap Night 8: 2nd September 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat							*		*				*			-	-		-	-	-	-	-	-	-
Set bait ok	*	*	*	*	*	*		*		*	*	*		*	*	-	-	*	-	-	-	-	-	-	-
Spr/bait ok																-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 9: 3rd September 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat																-	-		-	-	-	-	-	-	-
Set bait ok	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	*	-	-	-	-	-	-	-
Spr/bait ok																-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 10: 4th September 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat																-	-		-		-	-	-	-	-
Set bait ok	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	*	-	-	-	-	-	-	-
Spr/bait ok																-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-								

Trap Night 11: 5th September 2005

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat																-	-		-	-	-	-	-	-	-
Set bait ok	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	*	-	-	-	-	-	-	-
Spr/bait ok																-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Trap Night 12: 6th September 2005 **Second drop** **Traps Closed**

Trap No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rat																-	-		-	-	-	-	-	-	-
Set bait ok	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	*	-	-	-	-	-	-	-
Spr/bait ok																-	-		-	-	-	-	-	-	-
Set bait gone																-	-		-	-	-	-	-	-	-
Spr/bait gone																-	-		-	-	-	-	-	-	-
Skink/Snail																-	-		-	-	-	-	-	-	-

Appendix 8:

Daily counts of number of baits on density quadrats

(data: G. Climo / ICS)

Date	Quadrat One				Quadrat Two				Quadrat Three				Quadrat Four				Quadrat Five			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
29th August	8	12	7	5	4	3	2	3	5	4	4	3	22	17	19	24	34	13	34	14
30th August	12	17	14	7	2	8	1	11	6	4	7	5	22	21	6	12	37	22	42	16
31st August	13	18	15	7	0	3	0	0	-	-	-	-	1	0	0	0	35	22	46	15
1st September	13	18	13	8	0	0	0	0	7	2	2	2	0	0	0	0	36	22	47	14
2nd September	10	14	11	8	0	0	0	0	-	-	-	-	0	0	0	0	-	-	-	-
3rd September	11	13	11	8	0	0	0	0	7	0	1	0	0	0	0	0	31	22	33	4
4th September	11	14	13	5	0	0	0	0	-	-	-	-	0	0	0	0	-	-	-	-
5th September	10	15	13	6	0	0	0	0	0	0	0	0	0	0	0	0	32	22	32	3
6th September	3	4	5	5	19	15	18	16	10	8	7	7	17	21	17	14	22	18	6	5
7th September	5	4	5	7					12	8	8	7					24	16	6	5
8th September	5	4	5	7	19	15	17	17	11	8	9	7	17	24	18	17				
9th September	5	4	5	7					-	-	-	-								
10th September	5	4	5	7	19	15	17	17	-	-	-	-								
11th September									-	-	-	-	19	25	18	17				
12th September					19	15	17	17	11	0	0	7	19	25	19	17				
13th September	5	4	4	7	16	15	14	17	8	0	0	6	17	17	19	17	25	17	6	5
14th September									-	-	-	-								
15th September									-	-	-	-	13	14	17	17				
16th September	5	4	4	7	12	14	14	16	2	0	0	0								
17th September	5	4	4	7					-	-	-	-								
18th September	5	4	4	7	6	12	13	15	-	-	-	-	6	0	14	17				
19th September	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20th September	5	4	4	6	0	4	12	10	0	0	0	0	0	0	12	14	24	17	6	5
21st September	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22nd September	4	4	4	4	0	0	11	3	0	0	0	0	0	0	11	13	24	17	5	5
23rd September	4	5	14	13																
24th September					6	8	6	9					22	24	33	36	1	2	0	3
25th September																				
26th September									5	9	3	5								
1st October	3	0	10	12	0	0	0	0	0	9	2	0	0	0	0	0	0	2	0	3
11th October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3
12th October	2	2	2	1	15	16	8	6	4	8	3	5	8	9	17	14	9	5	3	4
19th October	2	2	2	1	14	15	6	3	-	-	-	-	6	2	17	14	9	5	0	4
22nd October	2	2	1	1																
25th October	2	2	0	1	13	15	6	3	4	7	0	0	6	0	14	18	9	5	0	2

Appendix 9:

Abundance variation of non target bird & reptile species during the 2005 rat eradication on North Island

(data : G. Rocamora / ICS)

	Myna			Fody			Turtle dove			Ground dove		
Dates	28/08	30/11	18/09	28/08	30/11	18/09	28/08	30/11	18/09	28/08	30/11	18/09
Hill												
N° points	27	27	16	27	27	16	27	27	16	27	27	16
N° visual contacts (within 75m)	19	8	4	19	11	8	3	0	5	5	2	5
Plateau												
N° points	21	21	19	21	21	19	21	21	19	21	21	19
N° visual contacts (within 75m)	50	24	14	22	29	32	16	3	3	25	26	26
Whole island												
N°points	48	48	35	48	48	35	48	48	35	48	48	35
N° visual contacts (within 75m)	69	31	18	41	40	40	19	3	8	30	28	31
average abundance per point (n°ind./pt)	**1.17**	0.65	0.55	**0.95**	0.95	1.21	**0.40**	0.06	0.23	**0.63**	0.58	0.89
Stdev	2.20	1.02	0.98	1.61	0.98	1.08	1.05	0.24	0.69	1.50	1.41	1.75
C.I. P<0.05	0.62	0.29	0.33	0.46	0.28	0.36	0.30	0.07	0.23	0.42	0.40	0.58
trends	strong decrease			stable/fluctuating			strong decrease			stable/fluctuating		

	Sunbird			Blue Pigeon			Kestrel			Moorhen			Green Heron			Whimbrel		
dates	28/08	30/11	18/09	28/08	30/11	18/09	28/08	30/11	18/09	28/08	30/11	18/09	28/08	30/11	18/09	28/08	30/11	18/09
Hill																		
N° points	27	27	16	27	27	16	27	27	16	27	27	16	27	27	16	27	27	16
N° visual contacts (within 75m)	0	0	0	1	0	0	2	2	0	0	0	0	0	0	1	0	0	0
All contacts	0	1	0	1	0	0	2	4	0	0	0	0	4	0	2	0	0	0
Plateau																		
N° points	21	21	19	21	21	19	21	21	19	21	21	19	21	21	19	21	21	19
N° visual contacts (within 75m)	3	3	4	0	1	0	0	0	0	5	2	1	3	1	0	2	1	0
All contacts	4	6	5	0	3	0	1	0	0	9	4	2	4	2	1	2	1	0
Whole island																		
N°points	48	48	35	48	48	35	48	48	35	48	48	35	48	48	35	48	48	35
N° visual contacts (within 75m)	3	3	4	1	1	0	2	2	0	5	2	1	3	1	1	2	1	0
Total number of contacts	4	7	5	1	3	0	3	4	0	9	4	2	8	2	3	2	1	0
average abundance per point (n°ind./pt)	**0.08**	**0.15**	**0.14**	**0.02**	**0.06**	**0.00**	**0.06**	**0.08**	**0.00**	**0.19**	**0.08**	**0.06**	**0.17**	**0.04**	**0.09**	**0.04**	**0.02**	**0.00**

	Skink			Phelsuma		
dates	28/08	30/11	18/09	28/08	30/11	18/09
Hill						
N° points	19	24	16	19	24	16
N° visual contacts (within 15m)	21	32	15	8	15	9
Plateau						
N° points	20	14	15	20	14	15
N° visual contacts (within 15m)	15	12	12	8	9	7
Whole island						
N°points	39	38	31	39	38	31
N° visual contacts (within 15m)	36	44	27	16	24	16
average abundance per point (n°ind./pt)	**0.92**	1.16	0.87	**0.41**	0.66	0.52
Stdev	1.13	1.13	0.88	0.55	0.81	0.81
C.I. P<0.05	0.36	0.36	0.31	0.17	0.26	0.29
trends	stable/fluctuating			stable/increase		

Appendix 10:

Distance sampling results for the population size estimate of Mynas on North Island in August 2005

(from 56 point counts of 2 minutes; data: G. Rocamora / ICS)

Model selected = Half normal with simple polynomial adjuntments, with no truncations nor constraints. Myna distribution considered clustered in this analysis. Other analysis were performed with models providing other adjustments, truncations or constraints, with or without a clustered distribution. The selected model, despite not having the lowest AIC nor the highest X^2 value (normally indicating best model fitting the data, although see Buckland et al., 1993; p.342) had acceptable values for both parameters. Compared to other models, it had the overall best set of parameters, providing the best Estimated Detection Radius (best shouldered model) and Density Coefficient of Variation (best precision), and the most conservative and realistic population estimate.

```
Estimation Options Listing
 Parameter Estimation Specification
 ----------------------------------
 Encounter rate for all data combined
 Detection probability for all data combined
 Expected cluster size for all data combined
 Density for all data combined

 Distances:
 ----------
 Analysis based on exact distances
 Width: use largest measurement/last interval endpoint

 Clusters:
 ---------
 Analysis based on exact sizes
 Expected value of cluster size computed by: regression of log(s(i)) on g(x(i))

 Estimators:
 -----------
 Estimator  1
 Key: Half-normal
 Adjustments - Function              : Simple polynomials
             - Term selection mode   : Sequential
             - Term selection criterion : Akaike Information Criterion (AIC)
             - Distances scaled by   : W (right truncation distance)

 Estimator selection: Choose estimator with minimum  AIC
 Estimation functions: constrained to be nearly monotone non-increasing

 Variances:
 ----------
 Variance of n: Empirical estimate from sample
 Variance of f(0): MLE estimate

 Goodness of fit:
 ----------------
 Cut points chosen by program
```

Glossary of terms

Data items:
n - number of observed objects (single or clusters of animals)
L - total length of transect line(s)
k - number of samples
K - point transect effort, typically K=k
T - length of time searched in cue counting
ER - encounter rate (n/L or n/K or n/T)
W - width of line transect or radius of point transect
x(i) - distance to i-th observation
s(i) - cluster size of i-th observation
r-p - probability for regression test
chi-p- probability for chi-square goodness-of-fit test
Parameters or functions of parameters:
m - number of parameters in the model
A(I) - i-th parameter in the estimated probability density function(pdf)
f(0) - 1/u = value of pdf at zero for line transects
u - W*p = ESW, effective detection area for line transects
h(0) - 2*PI/v
v - PI*W*W*p, is the effective detection area for point transects
p - probability of observing an object in defined area
ESW - for line transects, effective strip width = W*p
EDR - for point transects, effective detection radius = W*sqrt(p)
rho - for cue counts, the cue rate
DS - estimate of density of clusters
E(S) - estimate of expected value of cluster size
D - estimate of density of animals
N - estimate of number of animals in specified area

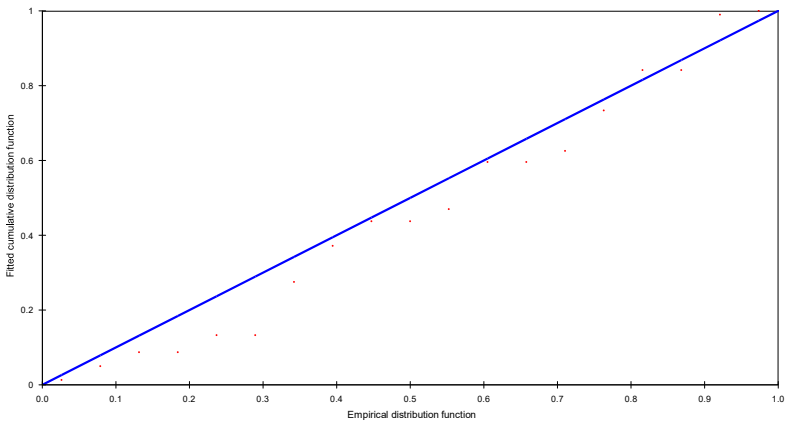
```
            Detection Fct/Global/Model Fitting

Effort       :    56.00000
# samples     :    56
Width        :    50.00000
# observations:    19


Model  1
  Half-normal key, k(y) = Exp(-y**2/(2*A(1)**2))
    Results:
    Convergence was achieved with   11 function evaluations.
    Final Ln(likelihood) value =  -73.961140
    Akaike information criterion =   149.92229
    Bayesian information criterion =   150.86671
    AICc =   150.15758
    Final parameter values:   19.072350

Model  2
  Half-normal key, k(y) = Exp(-y**2/(2*A(1)**2))
  Simple polynomial adjustments of order(s) :  4
    Results:
    Convergence was achieved with   13 function evaluations.
    Final Ln(likelihood) value =  -73.661192
    Akaike information criterion =   151.32239
    Bayesian information criterion =   153.21126
    AICc =   152.07239
    Final parameter values:   16.708026      2.0157982

  Likelihood ratio test between models  1 and  2
    Likelihood ratio test value    =     0.5999
    Probability of a greater value =   0.438617
*** Model  1 selected over model  2 based on minimum AIC
            Detection Fct/Global/Parameter Estimates
```

Effort : 56.00000
samples : 56
Width : 50.00000
observations: 19

Model
Half-normal key, k(y) = Exp(-y**2/(2*A(1)**2))

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95 Percent Confidence Interval	
A(1)	19.07	2.261			
h(0)	0.28404E-02	0.59638E-03	21.00	0.18360E-02	0.43943E-02
p	0.28165	0.59136E-01	21.00	0.18205	0.43573
EDR	26.535	2.7857	10.50	21.296	33.063

Detection Fct/Global/Plot: Qq-plot
Detection Fct/Global/K-S GOF Test



Kolmogorov-Smirnov test

D_n = 0.1831 p = 0.5473

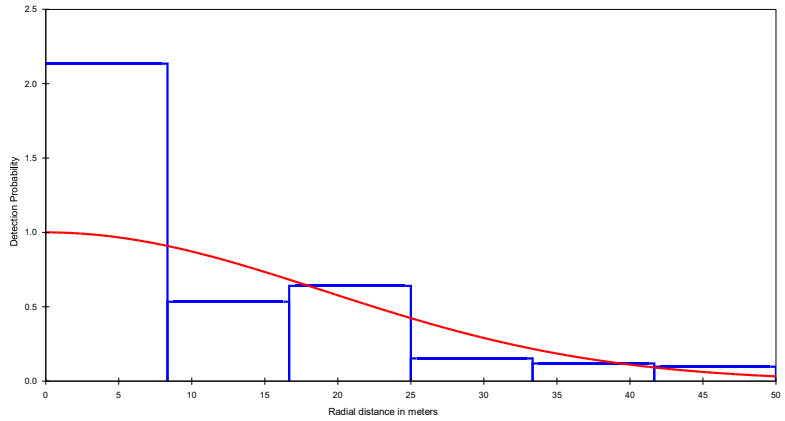
Cramer-von Mises family tests

W-sq (uniform weighting) = 0.0872 0.600 < p <= 0.700
Relevant critical values:
W-sq crit(alpha=0.700) = 0.0796
W-sq crit(alpha=0.600) = 0.0979

C-sq (cosine weighting) = 0.0684 0.500 < p <= 0.600
Relevant critical values:
C-sq crit(alpha=0.600) = 0.0629

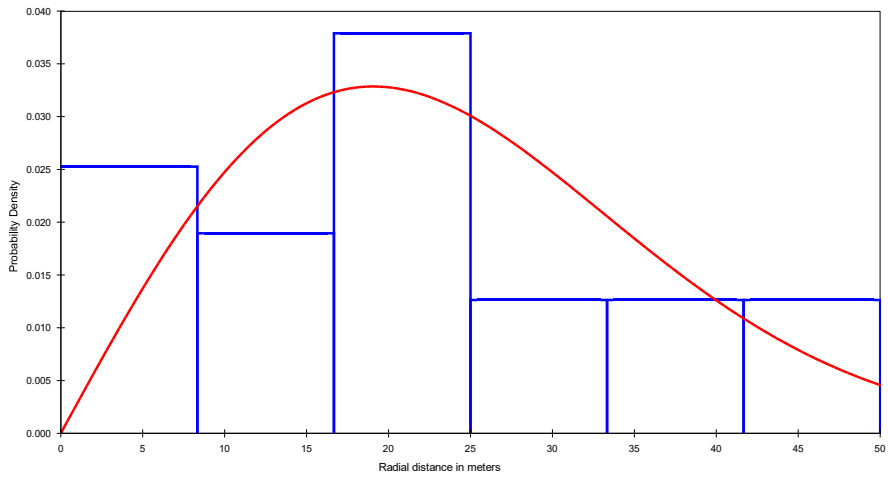
The program has limited capability for pooling. The user should judge the necessity for pooling and if necessary, do pooling by hand.

Detection Fct/Global/Plot: Detection Probability 3



Radial distance in meters

Detection Fct/Global/Plot: Pdf 3



Cell i	Cut Points		Observed Values	Expected Values	Chi-square Values
1	0.000	8.33	4	1.79	2.739
2	8.33	16.7	3	4.44	0.469
3	16.7	25.0	6	5.09	0.164
4	25.0	33.3	2	4.05	1.039
5	33.3	41.7	2	2.46	0.085
6	41.7	50.0	2	1.17	0.582

Total Chi-square value = 5.0788 Degrees of Freedom = 4.00

Probability of a greater chi-square value, P = 0.27930

```
The program has limited capability for pooling.  The user should
judge the necessity for pooling and if necessary, do pooling by hand.

Goodness of Fit Testing with some Pooling

 Cell        Cut        Observed    Expected   Chi-square
  i        Points       Values      Values      Values
-------------------------------------------------------------
  2    0.000      16.7        7       6.23       0.095
  3    16.7       25.0        6       5.09       0.164
  4    25.0       33.3        2       4.05       1.039
  5    33.3       50.0        4       3.63       0.038
-------------------------------------------------------------
Total Chi-square value =     1.3361  Degrees of Freedom =  2.00

Probability of a greater chi-square value, P = 0.51270
            Cluster size/Global/Estimates

Effort       :    56.00000
# samples    :    56
Width        :    50.00000
# observations:    19

Expected cluster size estimated based on regression of: log(s(i)) on g(x(i))

Regression Estimates
--------------------
Slope     =    0.721721      Std error   =    0.432718
Intercept =    0.102590      Std error   =    0.274775
Correlation=   0.3750        Students-t  =    1.66788
Df        =    17           Pr(T < t)   =    0.943173

Expected cluster size =   2.7696     Standard error    =  0.43297

Mean cluster size     =   2.0000     Standard error    =  0.31530
** Warning: Size bias adjustment has increased expected cluster size. **

            Density Estimates/Global

Effort       :    56.00000
# samples    :    56
Width        :    50.00000
# observations:    19

Model  1
  Half-normal key, k(y) = Exp(-y**2/(2*A(1)**2))

          Point       Standard    Percent Coef.       95% Percent
 Parameter  Estimate      Error      of Variation     Confidence Interval
 ---------  -----------  -----------  --------------  ----------------------
  h(0)    0.28404E-02  0.59638E-03      21.00      0.18360E-02  0.43943E-02
  p       0.28165      0.59136E-01      21.00      0.18205      0.43573
  EDR       26.535       2.7857         10.50      21.296       33.063
  n/K     0.33929      0.81690E-01      24.08      0.21084      0.54598
  DS       1.5338      0.48999          31.95      0.82244      2.8604
  E(S)     2.7696      0.43297          15.63      1.9954       3.8441
  D        4.2480      1.5108           35.57      2.1370       8.4442
  N        854.00      303.73           35.57      430.00       1697.0
 ---------  -----------  -----------  --------------  ----------------------
```

```
Measurement Units
---------------------------------
Density: Numbers/hectares
   EDR: meters

Component Percentages of Var(D)
-------------------------------
Detection probability   :  34.9
Encounter rate          :  45.8
Cluster size            :  19.3
          Estimation Summary - Encounter rates

                Estimate     %CV     df    95% Confidence Interval
               -------------------------------------------------------
          n       19.000
          k       56.000
          K       56.000
          n/K    0.33929      24.08    55.00 0.21084      0.54598
          Left    0.0000
          Width   50.000
          Estimation Summary - Detection probability

                Estimate     %CV     df    95% Confidence Interval
               -------------------------------------------------------
Half-normal/Polynomial
          m       1.0000
          LnL    -73.961
          AIC     149.92
          AICc    150.16
          BIC     150.87
          Chi-p  0.51270
          h(0)   0.28404E-02   21.00    18.00 0.18360E-02  0.43943E-02
          p      0.28165      21.00    18.00 0.18205      0.43573
          EDR     26.535      10.50    18.00  21.296      33.063
          Estimation Summary - Expected cluster size

                Estimate     %CV     df    95% Confidence Interval
               -------------------------------------------------------
Average cluster size
                2.0000      15.77    18.00  1.4390      2.7797
Half-normal/Polynomial
          r      0.37500
          r-p    0.94317
          E(S)    2.7696      15.63    17.00  1.9954      3.8441
          Estimation Summary - Density&Abundance

                Estimate     %CV     df    95% Confidence Interval
               -------------------------------------------------------
Half-normal/Polynomial
          DS      1.5338      31.95    61.60 0.82244      2.8604
          D       4.2480      35.57    78.36  2.1370      8.4442
          N      854.00      35.57    78.36  430.00      1697.0
```

Appendix 11:

Mahé Boat Loading Procedures

The long term eradication of rats on North Island requires two things; the successful eradication of existing rats and the prevention of rats reinvading the island. If rats have a chance to reinvade they will. One of the biggest risks to North Island is rat reinfestation through transport to the island of goods and materials. A quarantine procedure for goods coming to the island is essential to prevent rodents arriving accidentally with transported goods.

Measures to stop reinvasion on the island itself is a final precaution. Most of the actual responsibility to ensure that a rat doesn't stow away on route to North Island will fall on the Mahe Office.

The following procedure details the boat loading process for shopping, staff luggage and containerized goods and aims to make the risk of rat reintroduction from these sources non-existent.

Boat Loading Procedure Shopping and Staff:

- All island shopping, staff shopping and staff baggage must be packed into the plastic boxes provided before transfer to the boat. Until this system is in place, all independent salesmen and key Mahe personel must adhere to the following when transporting goods to the cay and subsequent loading:
    - Do not at any time leave boxes standing unattended on jetty during loading;
    - Pipes to be checked for rodents (flow water inside for those that cannot be checked by view) and ends subsequently closed off before putting them on the boat:
    - Extra care should be taken with cartons and bags: these should be carefully checked for chew marks and droppings, and subsequently for hidden invader animals.
    - After checking, cardboard boxes and bags should be immediately properly taped close.
    - Do not load unauthorized plants or animals.
    - Planks to be treated before loading.

- If possible, boats not to stay moored at the jetty overnight. Any loaded boats left in Mahe overnight must have baited bait stations aboard. Cones/bottles to be attached on the mooring ropes. Baiting stations to be set up around the moored boat, on the jetty. Bait stations and block bait will be given to the Mahe office for this purpose. Bait blocks must be replaced weekly (barges) or 2-weekly (boats)
- All containers must be fumigated prior to transport to the island.
- Island Contractors must be informed of the importance to inspect their gear for seeds, rodents or insects before transport to the Island.

Mahe storage of goods:

- Angel Fish complex care taker to place and subsequently monitor and re-bait bait stations around the complex.

Responsibilities:

- **Ensuring shopping is packed in plastic boxes – Gerard Servina.**
- **Ensuring all boats leaving from Mahe have bait stations aboard and bait blocks are regularly changed (use of log book)– Gerard/Paul.**
- **Ensuring contractors are informed of the need to inspect goods for seeds, rodents and insects before transport – GM.**
- **Supervision of the placing of baiting stations, and their subsequent rebaiting – Environment Assistant & Mahe Staff. Angel Fish complex to be involved.**
- **Ensuring Mahe office and boats/barges have a sufficient supply of bait and bait stations – Environment Officer.**
- **Process running smoothly and alteration of procedure if necessary – Environment Officer.**

Appendix 12:

Boat (shopping & staff luggage) & Barge (cargo) Unloading Procedures

The long term eradication of rats on North Island requires two things; the successful eradication of existing rats and the prevention of rats reinvading the island. If rats have a chance to reinvade they will. One of the biggest risks to North Island is rat re-infestation or other rodent invasion through transport to the island of goods and materials. A proper unloading procedure is essential for the safe unpacking and checking of goods for any rodents that may accidentally come in with transported goods.

The following procedures detail the process for unloading barges (containing cargo) and boats (containing shopping & staff luggage) and aim to make the risk of rat reintroduction or alien invader animals' invasion from these sources non-existent.

Barge/ Boat unloading procedure:

- All boats/ barges coming to North Island must have permanent bait stations aboard. Any loaded boats/ barges overnighting in Mahe prior to travel to NI must have bait stations placed on board, and poison blocks are to be replaced regularly in boats, and weekly or more often if required in barges (wet blocks to be replaced). Small boats need one bait station, larger boats need 2 – 3 bait stations.
- Unbaited Elliott traps in wooden boxes (imitations of sheltered places to attract escaping rodents on exposed beaches during offloading) to be set up on the beach during offloading of barges containing food items, cardboard boxes and building material with cavities.
- The only cargo items exempted (as per agreement of the General Manager and Environmental Officer), are listed below (*). All other goods, including staff shopping and baggage, must go to the rodent proof room ("rat room").
- The rodent proof trailer must be used to transport goods (cargo, shopping and staff luggage) to the rodent proof room. For smaller loads, a gator with rodent proof canopy can be used instead.
- Goods should be packed in rodent proof sealed containers in Mahe before loading where possible.

- Future cargo should be transported as whole containers rather than being destuffed in Mahe – this will enable fumigation to be undertaken prior to offloading on North Island.

(*) Exemptions of cargo items that do not need to go to the rodent proof room:

The list of exemptions given below are due to the negligible risk of harboring rodents or the difficulty of transporting items to the rodent proof room. Items that are not taken to the rat room have to be checked on the beach. This is the responsibility of the Maintenance Manager and Security Officer.

- Drums containing petrol, oil, chlorine and hazardous chemicals (if not packed in cardboard boxes)
- Large containers of cleaning chemicals (if not packed in cardboard boxes)
- Crates of drinks
- Cling wrapped packets of water
- Cement
- Aggregate
- Timber planks
- Diesel
- Gas cylinders
- Large unpacked machinery (motor compartments need to be checked on the beach for mice and poison blocks put inside at Mahe prior to transport)
- Cling wrapped tins of chemical product (eg paint)
- Tyres
- Copper

- Metal and PVC piping – large rolls of piping needs to be checked on Mahe and the ends plugged immediately after inspection. These can be checked using compressed air.
- Rolls of building plastic
- Shade cloth

Responsibilities:

- Ensuring that bait stations are placed on incoming boats/ barges and re-baited timely (weekly for barges) – Skipper and Gerard (Mahe Office). Incoming boats' baiting to be verified by the Dive Center Manager (for shopping boats and charter boats), Security Officer and Environment Department's staff.
- Offloaded goods not to be placed on the beach but directly loaded into rat proof trailer and transported to rodent proof room where goods and staff bags are inspected behind closed door – Maintenance Manager, Security Officer and Central Store Manager.
- Process running smoothly and alteration of procedure if necessary – Environmental Officer.

Further rodent proof room procedures:

- Permanent bait stations must be kept in the rodent proof room at all times and rebaited when necessary (every 2-4 weeks).
- Elliott traps (no bait) to be kept in the rodent proof room at all times, checked every 2 weeks and set up again if accidentally closed.
- All goods transported in rodent proof trailer must be inspected by the Security Officer with the rodent proof room door closed throughout the inspection.
- No goods are to be stacked against the walls of the rodent proof room as to allow rodents access to the ceiling.
- No nails, string or posters are to be put on the walls.
- All goods must be checked by the Manager of the Central Store and the Security Officer with the exception of maintenance goods which can be checked in the rodent proof room by the Manager of the maintenance store.
- All goods that are checked may be removed from the room but must be removed before the next trailer load enters the room.
- No person should enter the rodent proof room without the consent of the Central Stores manager
- No goods are to be removed without the permission of the Central Stores Manager.
- Staff baggage is to be checked by the Security Manager and not removed before given clearance.

Responsibilities:

- Ensuring bait stations in rodent proof room are in place and re-baited –Assistant Environment Officer & Manager of Central Stores.
- Ensuring goods are not checked until rodent proof room is closed, and rodent proof room is not opened until inspection is finalized – Central Store Manager and Security Officer.
- Ensuring that goods are stacked in an appropriate manner – Manager Central Stores.
- Checking goods before release – Manager Central Stores.
- Checking staff baggage before release – Security Manager.
- Process running smoothly and alteration of procedure if necessary – Environmental Officer.

NO DEVIATION FROM THIS PROCEDURE WITHOUT THE APPROVAL OF THE GENERAL MANAGER AND THE ENVIRONMENTAL OFFICER.

Appendix 13:

Product list and ordering details

Both the Larger **Protecta rat bait station** on the off loading beach/ Petite Anse and the smaller **Protecta rat bait station LP** with locks can be purchased through gideonclimo@hotmail.com or Fax (0064) 03 5424162.

The **Waxed Pestoff Rodent blocks** 10kg bucket 0.02g/kg (4cm by 2.5cm) for use in bait stations can be ordered from Animal Control Products, Private bag 3018, Wanganui, New Zealand.
Phone (0064) 06 3442260 Email: pestoff@clear.net.nz . You will have to specify for the block to be coconut lured which is the best to use in this case. It is estimated that if blocks in all stations are replaced every 2 weeks that one 10kg bucket of block bait will last about 3 months. Permit will apply in the import of this product.

Some form of live capture trap similar to the **Elliott** should remain as stock on the Island and these can also be purchased through gideonclimo@hotmail.com. The “cage” type trap available in the Seychelles are fine but do not last long and are not good mouse traps.

Appendix 14:

PEST RESPONSE PLAN

Have you seen or found sign of a Rat or Mouse?

What to do in the event of a rodent incursion or detection during maintenance

Any sighting that could be attributed to rodents must be reported, no matter how likely or remote the possibility that it will be confirmed (Unless considered malicious). The following steps must be taken should such an event occur:

1. **Assess the situation:**
   The person who has seen or detected any sign of rodents, or is merely suspicious of their find, ***must*** report it to the Environmental officer without delay. All cases must be taken seriously and fully investigated.

As for any sighting that could be attributed to rodents the same importance should be placed for any sign found such as foot prints on beaches or in soft soil, droppings and gnawing on foods, wood, soap etc.
Any sign must be reported no matter how likely or remote the possibility is that it will be confirmed. The following steps must be taken should such an event occur:

The officer who received notice must elicit as much information as possible from the person who sighted or has found sign of rodents before they leave the park. Information of interest would be;

- What was observed or what type of sign has been found.
- When was the observation made?
- Exact locality rodent or sign was found.
- Distance from observer when seen.
- Were any photos taken by the observer?

Any information collected should be recorded on the standard response form and reported to management. Contact North Island manager if further help is required. Consider getting in experienced trappers if the situation requires this sort of response.
Decisions will need to be made on how long to continue any response and what to do if the matter can not be salvaged.

> If the situation poses any risk to native fauna, especially threatened bird species MERN?? should be contacted and/or local organisations such as ICS and Nature Seychelles. Some threatened species may also need to be relocated or put into captivity.

1a. Is it rodent sign that has been found? – Droppings, footprints:
The following steps must be taken before continuing with the action below:

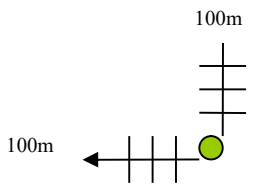
1. First the person heading the investigation must visit the site/s.
2. Record any information not already given.
3. Take photos of prints and sample of scats would be very important.
4. Measurements between footprints and the stride should also be taken from any suspicious prints. **Try not to disturb the site to much.**

Judgement must be made of the possible age of droppings or prints, which species is involved and what action is to taken. If these judgements cannot be made samples of scats and/or photos and relevant information must be sent to a rodent expert for immediate analysis.

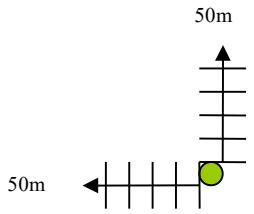
If it the nature of the sign can be confirmed by the Environmental officer that the sign is not from a pest or has reason to believe the sign is old and therefore not a risk to the park, then action may not be required.

2. **Take Action**. **Establish search area**:
Action should be taken as soon as possible and preferably before dark or first thing the next morning to confirm if rodents are present and if rat of mouse are involved. Even if there are traps/poison stations in use as part of control lines extra rodent traps and poison should be set in appropriate protective stations in the vicinity of the rodent sighting or sign as soon as possible.
However if there is any uncertainty or samples have been sent away for analysis then the follow action should take place as a precaution:

RATS: If rats have been sighted establish **~25** trap sets / bait stations in a grid like system in the affected area no more than 25 m apart over an area of about 200 m around the point of sighting. A tracking tunnel at each trap site would also be needed.



MICE: If mice have been sighted establish about **~50** trap sets / bait stations in a grid like system in the affected area no more than 15 m apart over an area of about 100m from the point of sighting. A tracking tunnel at every second station would also be needed.



Where at all possible within the search area place traps in areas most likely to attract or harbour rodents, such as near water, buildings and bush margins. The use of any live traps would be beneficial as well in the search area. The date, number of traps set and locations must be meticulously recorded in the diary from the response kit including production of a map detailing their relative positions.

Traps should be baited with fresh peanut butter and rolled oats or almonds, and block bait or pellets (Pest off) used in all poison bait stations. Use different baits and lures on the same search area and if hand broadcasting is considered an appropriate option under the circumstances then pellets should be used. Bait stations in the affected area must be replenished as often as needed to keep the baits as fresh and attractive to rodents as possible.

Set traps finely and stake down firmly. Spend the time to make good quality sets. **Do not disturb the search area to much** and check for rodent sign while doing the trap lines. Make sure **all** traps sets used are working well and exclude any that are not. (See best practice manual for setting of rodent

traps and sign). The use of different types of traps and covers is also beneficial such as live traps, wire covers, wooden covers. You may even be able to utilise natural materials on site like rocks.

Care must be taken to exclude native fauna from accessing poison or kill traps and extra protection to keep them out of the stations (without compromising rodent catch) may need to be considered.

Permanent stations. Once this initial response has been dealt with all permanent stations in the hotspot areas (Traps or Poison) should be checked and replenished with fresh bait regardless of when the last routine maintenance check was done.

3. **Advance search Area:**
   Should any rodent have been caught in the search a wider area will need to be established to confirm if rodents exist over a wider area of the Island or just in a localised area. Take a look at past records and summarize the rodent hotspots and target these areas. Set up several grids / lines around hotspot areas 25 metres apart. Use about **25** traps / tracking tunnels in each area with fresh baits checked every two days.

   If disturbance by people can be eliminated, the establishment of some tracking sand pits in key areas of the Island would also be useful as some rodents shy off using stations.

4. **Maintain Action**
   All stations (traps and poison) within the "search area" **must be checked daily without fail** during the intense investigation period and detailed notes recording results and observations from these actions must be taken and filed in a central repository.
   Trapping and poisoning should continue at this level for a least <u>two weeks</u> after all bait take or sign of rodents has ceased and normal regular maintenance procedures should then resume. If fresh rodent sign is detected at any stage after this then a return to the daily checking regime should kick-in again.

Further assistance or advice could be sought if the situation poses a risk to native fauna, especially threatened bird species. MERN or local organisations such as ICS and Nature Seychelles should be contacted immediately.

5. **Response debrief:**
   The person undertaking the response action should keep the Environmental officer and North Island Manager informed of progress. It is on the basis of his/her reporting that further implementation or alternative action will be taken to eradicate the new wave of colonising pests or measures to safeguard threatened species on the Island. It will require dedication and cooperation from many people and input from a range of specialist experts to properly retrieve the situation should a new rodent incursion ever occur.
   All rodents caught or found should be kept for autopsy and identification by freezing or placing in ethanol - they can provide crucial data (breeding status, age class, condition etc) required to make strategic decisions to resolve the problem.