

# The eradication of alien mammals from five offshore islands, Mauritius, Indian Ocean

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**Abstract** Following the removal of rabbits from Round Island in 1979 and the publication of a management plan in 1989, the Mauritius Government contracted Wildlife Management International Limited in 1993 to fulfil one of the plan's recommendations to survey the offshore islands of Mauritius and Rodrigues and to prepare an offshore islands management plan. This plan made a number of recommendations and priorities in relation to the removal of alien species. In 1995 work on the priorities began with the removal of Norway rats (*Rattus norvegicus*) and hares (*Lepus nigricollis*) from Gunner's Quoin, ship rats (*R. rattus*) from Gabriel Island and mice (*Mus musculus*) from Ile Cocos and Ile aux Sables. In 1998 cats (*Felis catus*), ship rats and mice were removed from Flat Island and rabbits (*Oryctolagus* sp.), which had been illegally released following the earlier eradications, from Gunner's Quoin. These programmes were hand-laid operations. In all cases the main bait was grain-based pellets containing 0.02gm/kg brodifacoum. The bait was set out on at least half of the maximum grid recommended for the rodent species targeted. The exception was cats, which were trapped in leg-hold traps. Plans are being considered for the re-introduction of reptiles and birds. Some planting of native trees has begun. This paper covers the eradication sector of the management plan.

**Keywords** Ship rat; *Rattus rattus*; Norway rat; *Rattus norvegicus*; mouse, *Mus musculus*; black-naped hare; *Lepus nigricollis*; feral cat; *Felis catus*; brodifacoum.

## INTRODUCTION

The islands of Mauritius have been heavily modified by man and there have been a number of extinctions (Cheke 1987). Conservation work began with efforts to save some highly endangered species, notably the Mauritius kestrel, *Falco punctatus* (Jones *et al.* 1994) and pink pigeon, *Columba mayeri* (Jones and Hartley 1995). It was recognised early that the preservation of what remained of natural habitats was extremely important if the long-term viability of many species was to be assured. This began in two distinct areas, on the offshore islands and in the highlands indigenous forest that still remained. In this paper we consider the first of these habitats – the islands.

Efforts began primarily on Round Island and Ile aux Aigrettes, the first to save the last remnant of the palm savannah of northern lowland Mauritius and the latter, the lowland hardwood forest. Both habitats were in very poor condition.

Round Island was affected by the presence of two browsing species – goats (*Capra hircus*) and rabbits. The goats were removed finally in 1979 by shooting. An unsuccessful rabbit eradication attempt involving shooting was mounted in 1976 (Bullock 1977). The removal of rabbits was delayed for several years due to an organised objection by the Universities Federation for Animal Rights. They pressured the British Government who was to fund the eradication. They objected to the use of the poison strychnine and the funds were withheld.

In 1982 the Jersey Wildlife Preservation Trust raised the possibility of rabbit removal with the New Zealand Wildlife Service. The feasibility study was undertaken in 1984

(Merton 1985) and in 1986 the eradication was carried out (Merton 1987). A management plan for the island was prepared in 1989 (Merton *et al.* 1989). This included a recommendation that the other offshore islands of Mauritius be surveyed with a view to protecting their natural values.

Wildlife Management International Ltd (WMIL) was contracted by the Mauritius Government with funding being

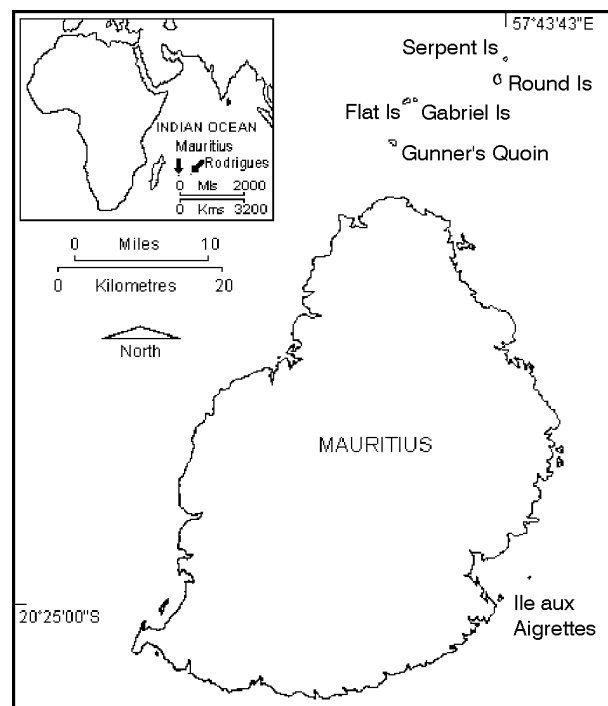
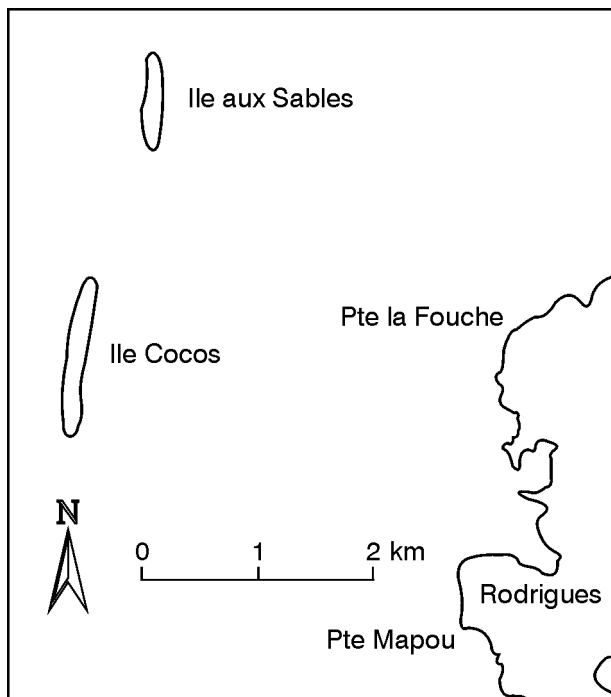


Fig. 1 Location of islands around Mauritius.



**Fig. 2** Location of Ile Cocos and Ile aux Sables adjacent to Rodrigues Island.

provided by Overseas Development Agency, (now Department for International Development) United Kingdom. All of the islands off Mauritius and Rodrigues were visited. In addition to recording the flora and fauna, recommendations were made for both the long and short-term management. Most of the short-term management involved the removal of introduced mammals (Bell *et al.* 1994).

The more valuable islands, both for their biological values and for public use, were given priority. These included Gunner's Quoin, Flat and Gabriel Islands to the north of Mauritius (Fig. 1), Ile aux Aigrettes (Fig. 1), Ile aux Fouquets and Ile de la Passe to the south-east and on Rodrigues, Ile Cocos, Ile aux Sables (Fig. 2) and Crab. Some finance was available to action the recommendations, but this was very limited.

## METHODS

The eradication programmes occurred in 1995 and 1998. Four islands, Gunner's Quoin, Gabriel, Ile Cocos and Ile aux Sables, were treated in 1995 and two islands, Flat and Gunner's Quoin, were involved in 1998. Each is covered separately below. Table 1 lists the islands involved and the details of the eradications.

### 1995 Programme

In 1995 WMIL sent a team to carry out eradications on Gunner's Quoin, Ile Cocos and Ile aux Sables and to trial bait for Indian house shrews (*Suncus murinus*) on Ile aux Aigrettes. These had been selected as the highest priorities during the island survey project.

### Gunner's Quoin

The eradication programme began on Gunner's Quoin (65 ha). Much of the island was covered in low thorn scrub and it was necessary to cut grid lines. This was done on a 25 m grid even though we were removing Norway rat; the usual grid size for eradicating Norway rats is 100 m. The smaller grid enabled the rats to gain access to the bait more quickly and reduced the overall time of the programme. The cutting party consisted of five WMIL staff, two Mauritius Wildlife Foundation (MWF) volunteers and two Government of Mauritius National Parks Conservation Service (NPCS) staff plus a contingent from the Special Mobile Force (Mauritian Army). Bait was laid as the grid lines were cut over a block. The main bait used was Pestoff Rodent Bait 20R (a grain-based pellet made to the Wanganui No. 7 formula containing 0.02g/kg of brodifacoum and dyed green). This was supplemented with Rentokil Rid Rat (a wax block with grain containing 0.05g/kg bromadiolone and dyed green) as a back up. The sowing rate was approximately 15 kg per hectare.

There were no formal bait stations as such, the bait was just laid on the ground and the position marked with a numbered plastic tag. Laying directly on the ground is practical if the weather and soil are dry enough so that the bait maintains its shape and attractiveness. It is also only practical when there are no important non-target species.

The black-naped hare (*Lepus nigricollis*) was not originally targeted, as we did not expect them to take the bait. Once it became obvious that hares were taking the bait, this was laid wherever we found hare sign.

### Ile Cocos and Ile aux Sables

Cocos and Sables Islands are two small coral sand islets (15 and 8 ha respectively), which were infested with mice. The vegetation was primarily grassland (*Stenotaphrum dimidiatum*) with patches of *Pisonia grandis* and *Casuarina equisetifolia* trees. Ile Cocos is a tourist destination and has high numbers of breeding noddies, *Anous stolidus* and *A. tenuirostris*. There is a warden station on Ile Cocos.

Here we used a 10 m grid and 25 mm plastic tubes as bait stations where land crabs were dense. The same bait as on Gunner's Quoin was used.

### Ile aux Aigrettes

To determine whether it was possible to eradicate Indian house shrew from Ile aux Aigrettes some trials were undertaken using newly-developed bait. A fish meal and vegetable oil paste with 0.05 mg brodifacoum per kg were laid at 14 sites around the island. The bait stations were laid in the late afternoon and left overnight. The stations were observed during the evening and any shrew activity was noted. The stations were removed the following morning and checked for shrew sign.

**Table 1 Eradication timing, method, target species and island involved during the eradication programmes in Mauritius.**

ISLAND	SIZE (ha)	TARGET SPECIES	METHOD	TIMING
Gunner's Quoin	65	Norway rat <i>Rattus norvegicus</i>	Hand-laid 25 m grid Pestoff 20R & Rid Rat. 15 kg/ha	26/9 - 26/10/95
Gunner's Quoin	65	Black-naped hare <i>Lepus nigricollis</i>	Hand-laid. Isolated bait stations (areas of hare activity) Pestoff 20R. 15 kg/ha	26/9 - 26/10/95
Gunner's Quoin	65	Domestic rabbit <i>Oryctolagus</i> sp.	Hand-laid. Isolated bait stations (areas of rabbit activity) Pestoff 20R. 10 kg/ha	Undertaken by NPCS in late 1998
Ile Cocos	15	Mouse <i>Mus musculus</i>	Hand-laid 10 m grid Pestoff 20R. 10 kg/ha	1/11 - 21/11/95
Ile aux Sables	8	Mouse <i>Mus musculus</i>	Hand-laid 10 m grid Pestoff 20R. 10 kg/ha	1/11 - 21/11/95
Gabriel Island	42	Ship rat <i>Rattus rattus</i>	Hand-broadcast Pestoff 20R & Rid Rat. 20 kg/ha	27/11 - 29/11/95
Flat Island	253	Ship rat <i>Rattus rattus</i>	Hand-laid 25 m grid Pestoff 20R 15 kg/ha	1/9 - 28/10/98
Flat Island	253	Mouse <i>Mus musculus</i>	Hand-laid 25 m grid Pestoff 20R 15 kg/ha	1/9 - 28/10/98
Flat Island	253	Feral cat <i>Felis catus</i>	Leg-hold traps Secondary poisoning	1/9 - 28/10/98

## Gabriel Island

Before departing from Mauritius we decided to lay left over bait on Gabriel Island (42 ha) in an effort to remove the very high incidence of ship rat. Gabriel Island is covered mainly with a low endemic shrub (*Psiadia arguta*) with some *Lantana camara*. About 50% of the island was grassland. The bait was laid in a day using a team of 12 persons spread out in a line broadcasting the bait as they went. Both Pestoff Rodent Bait 20R and Rentokil Rid Rat were used. The sowing rate was approximately 20 kg per hectare.

As the island is very close to Flat Island it was recommended that eradication be carried out there within 12 to 18 months to prevent re-colonisation of Gabriel Island.

## 1998 Programme

The Outer Islets Advisory Committee recognised that the recently cleared Gabriel Island was at risk from re-infestation as long as rats were still present on neighbouring Flat Island. A lagoon separates the islands by some 500 m but at low water the distance is minimal because of the exposed reef. WMIL was contracted by the Government of Mauritius to eradicate all alien mammals on Flat Island – ship rat, mouse and feral cat.

## Flat Island

About half of Flat Island (253 ha) is covered with trees and scrub. This meant that establishing a grid required lines to be cut before bait was laid.

The grid was set at 25 m because of the presence of mice. The grid took four weeks to establish and there were 3500 bait stations. The party consisted of six WMIL, two NPCS and two MWF staff. The bait was laid directly on the ground despite the high level of crabs (*Coenobita* sp. and *Cardisoma* sp.), apart from nine stations where bait was placed in round tubes raised off the ground.

The only bait used was Pestoff Rodent Bait 20R. This was laid in five pulses, with a break of two to three days between each lay.

Cats were only targeted toward the end of the programme as we expected a number to succumb to secondary poisoning. Leg-hold traps were used and were placed where a cat had been sighted or fresh cat sign was present.

## Gunner's Quoin

Before we left New Zealand for the Flat Island project we were advised that although earlier reports had indicated hares had been removed from Gunner's Quoin, this now appeared to be an error as heavy browsing and sign had been seen on one of the monitoring trips. Extra bait was

taken so that another attempt to remove the hares could be made. An inspection prior to starting Flat Island revealed that the culprits were not hares but rabbits which must have been released subsequent to the removal of hares. Some of the hunting fraternity was suspected as they used to visit the island to shoot hares. WMIL did not have time after completion of Flat Island to lay the bait but advised NPCS who undertook to spread the bait.

### Problems

The work was without any serious problems. The only complication was the high numbers of crabs. On parts of Ile Cocos and Ile aux Sables high concentrations of large land crabs occurred where there were low-lying embayments, which flood in extreme high tides. In such sites we set out bait in plastic tubes as described earlier. This did not deter the crabs, which took both the bait station, complete with bait, down into their holes. After two days the empty bait station would be pushed out of the burrow. In addition to using bait stations, some bait was broadcast in these areas to ensure there was some bait still available to mice if they were present.

Crabs (both land and hermit) were also present in large numbers on Gabriel Island. It was thought these might cause a possible failure of the eradication. To overcome this we laid a heavier than usual amounts of bait (20 kg/ha).

On Flat Island both crabs were present in a section of the island but it was found necessary to raise only nine bait stations about 15 cm above the ground to exclude them. However earlier experience showed that the best way to overcome crabs (at least where there are no non-target species at risk) was to increase the amount of bait applied.

### RESULTS

Post eradication monitoring has been carried out mainly by NPCS. They have regularly reported on the success of the eradications and are discussing options for the future use of the islands, many of which had been suggested in the report on the Survey and Management Plan for the Outer Islands (Bell *et al.* 1994). Some recovery of the vegetation had been noted even before we left the islands.

### Gunner's Quoin

During the eradication, rats began to die within two days and bait take had ceased within a week, apart from areas where hares were taking bait. A few dead hares were found but at least one hare was still alive when we left the island. Bait was still available to any survivors. A check before we departed from Mauritius showed no evidence of any hares present. This was confirmed later during visits by NPCS.

The return visit and bait lay for rabbits in 1998 resulted in their removal. It appeared that these animals were the

domestic strain as most were coloured either black, black and white or fawn. It is a good example of the need to ensure that no immigration, either accidental or deliberate, occurs after eradication.

The first changes were noted before the eradication team left the island. The vegetation was responding to the lack of browsing but the most interesting observation was the increased visibility of the skinks (*Scelotes bojerii* and *Cryptoblepharus boutonii*). These lizards seemed to have responded to the removal of their main predator, the rat, and spent more time in the open rather than in rock crevices.

The NPCS monitoring trips recorded a strong seedling growth of *Dracaena concinna*, *Latania loddigesii* and *Pandanus vandermeerschii*. Previously rats destroyed most, if not all, the seeds. The other major find was the rediscovery of the night gecko (*Nactus coindemirensis*) which was only known from two previous specimens. It is now regularly seen.

The revegetation was heavily browsed as a result of the introduction of rabbits but is now improving again. Along with the indigenous plants, the weed species were also flourishing and some, such as a creeper (*Cissus* sp.), may become a problem. A systematic control programme may be necessary.

### Cocos and Sables Islands

The only area where mice were noticeable was at the warden station. These soon disappeared as the eradication programme continued. To date there have been no spectacular changes on Cocos and Sables Islands.

### Gabriel Island

The WMIL team had departed Mauritius before this eradication could be confirmed. Later checks by NPCS proved the eradication had been successful. The most noticeable change on Gabriel Island has been the regeneration of *Pandanus* and *Latania*, which had not occurred for many years. There also appears to have been an increase in wedge-tailed shearwaters (*Puffinus pacificus*) and red-tailed tropicbird (*Phaethon rubricauda*) but there has been no formal assessment.

### Flat Island

During the eradication bait take was heavy after the first baiting (80-90%). On the second and third pulses, only about 10% of stations had been visited and after the fourth, bait was taken only from less than 10 stations. The final baiting was untouched apart from that taken by insects, crabs and lizards. One cat was seen and this animal was successfully trapped the same night, using a leg hold trap and was destroyed. Only one other cat was found, dead, and this had almost certainly been a victim of secondary poisoning. It is probable that the cat population was very

small although sign showed they were roaming the whole island. They most likely originated from animals left behind either deliberately, to keep rats down around camps (camp areas used by day trippers) or accidentally, when pets were brought on to the island and they could not be found before leaving.

## Ile aux Aigrettes

The trial baiting for shrews on Ile aux Aigrettes was not successful. It was thought that they could detect the 'bitrex' – an additive used in some brodifacoum-based poisons and this put them off taking the bait. Brodifacoum had been proved a suitable poison for shrews (Morris and Morris 1991). However bait trials they carried out showed that there had to be a very high consumption of bait if the shrews were to ingest a fatal dose at 50 ppm. This may mean that to be effective in the field, higher concentrations are needed and chemical companies have expressed reluctance to supply these doses.

More trials to find attractive bait should be undertaken before any further attempt is made to poison the shrews.

## CONCLUSIONS

The removal of rats and subsequent improvement in the vegetation on Gunner's Quoin opens the opportunity to re-establish or translocate some threatened species. Because of the limited range of trees and shrubs, it is likely that some of the restricted lizards (e.g. Guenther's gecko (*Phelsuma guentheri*) and Telfair's skink (*Leiolopisma telfairii*)) could be the first choice. Later when the vegetation has recovered further (after 10yrs?) some of the threatened smaller insectivorous passerines could be introduced (e.g. Mauritius fody (*Foudia rubra*) and Paradise flycatcher (*Tersiphone bourbonensis desolata*)).

Unfortunately there have been no spectacular changes on Ile Cocos and Ile aux Sables. These islands are too small to provide habitat for some of the Rodrigues threatened species. A larger island, such as Crab, would need to be restored if new habitat was to be provided for the local endemic warbler (*Acrocephalus rodericanus*) and fody (*Foudia flavicans*). At 15 ha Ile Cocos may be a suitable site for the re-introduction of these birds as they can exist at very high densities if food supply is adequate. Intensive planting of native plants would have to occur before this can happen to ensure food availability.

As the largest offshore island, Flat Island has the greatest potential for use in threatened species management. The island's vegetation is primarily introduced trees and shrubs but some planting of native species has begun. Even without further planting the island could be used at present for some of the threatened species, such as Mauritius fody, flycatcher and perhaps olive white-eye (*Zosterops chloronthos*). The introduction of the Mauritius cuckoo

shrike (*Coracina typica*) and bulbul (*Hypsipetes olivaceus*) could follow later as the forest cover improves and is made more diverse.

Flat Island is a popular tourist and picnic site. This aspect has to be taken into account when planning the continuous rodent-free state of the island and future translocations and monitoring. The development of a management plan for this island and Gunner's Quoin will address these aspects. This is scheduled for the near future.

The Mauritius Government and its NGO collaborator, MWF, are to be commended for their far-sighted vision to not only remove alien mammals from their important islands, but also for establishing formal management plans and following these through with active management.

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