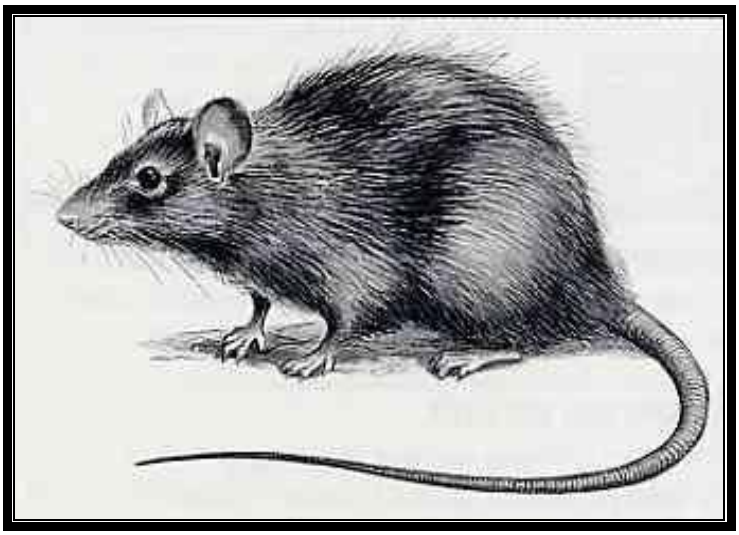
ERADICATION OF BLACK RATS (*RATTUS RATTUS*) FROM SANDY CAY BRITISH VIRGIN ISLANDS

An Invasive Species Control and Monitoring Program of Island Resources Foundation

Implemented on Behalf of the Owner of Sandy Cay



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March 2003

ERADICATION OF BLACK RATS (*Rattus rattus*) from SANDY CAY, BRITISH VIRGIN ISLANDS

Project Summary

Invasive black rats (*Rattus rattus*) were eradicated from Sandy Cay, British Virgin Islands during the 30-day period from November 12 to December 12, 2002. The eradication project was carried out under the auspices of Island Resources Foundation (IRF) on behalf of Sandy Cay's owner.

Sandy Cay (14 acres) is situated approximately 3 miles to the northwest of Tortola and approximately 0.7 miles east of Jost Van Dyke (Figure 1). Although small, it is among the best-studied islands in the area and is the subject of a thorough resource characterisation study (Island Resources Foundation 2001). It is hoped that the island will serve as an example of best practice in the ecological management of small islands in the region and as an accessible natural laboratory for local and regional groups.

The island also provides an excellent opportunity to monitor the recovery of native species following the removal of rats. Rats are highly opportunistic and omnivorous animals, known to exploit a wide range of food sources including many plants and invertebrates as well as lizards, bird eggs and young. Experience on similar islands in the region has shown marked, though largely anecdotal, increases in numbers of nesting seabirds and sometimes in vegetation cover.

A long-term monitoring program for Sandy Cay has been proposed as a cooperative effort between Island Resources Foundation, the H. Lavity Stoutt Community College, and the BVI National Parks Trust. This effort will be designed to closely monitor a range of taxa likely to have been affected by rats, including plants, terrestrial invertebrates and nesting seabirds.

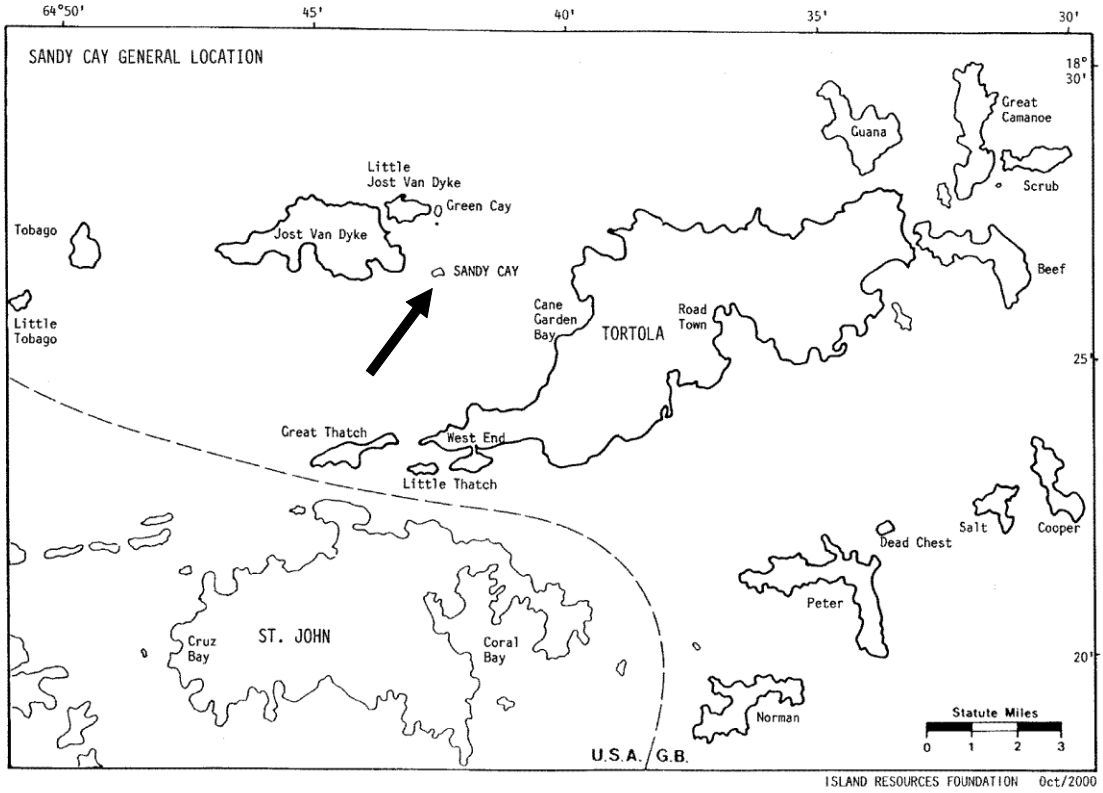


Figure 1. Location of Sandy Cay, British Virgin Islands.

Project Background

In 2002, the Island Resources Foundation initiated a rat eradication and monitoring program for Sandy Cay, a privately owned 14-acre island in the British Virgin Islands (BVI). This effort is a first of its kind in the BVI Territory and will form a part of a new Foundation program initiative on invasive species management.

On behalf of Sandy Cay's owner, Laurance S. Rockefeller, investigators from Island Resources Foundation have been studying Sandy Cay's natural environment and carrying capacity requirements since 2000. A comprehensive environmental profile of the Sandy Cay ecosystem was prepared in March 2001 (*The Sandy Cay Ecosystem: A Resource Characterization*), followed in September by an equally detailed resource management plan for the island (*Sandy Cay, British Virgin Islands: A Management Plan*).

During the course of field research associated with these investigations, Foundation scientists concluded that the island had acquired a significant and growing population of black or tree rats, *Rattus rattus*, and that their presence was undoubtedly having a negative effect on the ecosystem of Sandy Cay.

In the closing months of 2002, Island Resources Foundation assembled a research team for the purpose of undertaking a rat eradication program at Sandy Cay. Funding was provided by the island's owner. An Environmental Impact Assessment for the eradication and follow-up monitoring program was prepared (November 2002), and the project team was convened in Tortola, BVI during the second week of November.

The team was headed by IRF's Jean-Pierre Bacle; the principal scientist was Karen Varnham, a UK ecologist and invasive species specialist who had carried out a similar program in Antigua. Additional participants in the on-site work were: Roy Thomas, Sandy Cay's long-standing horticulturist; Junior Coakley, current caretaker at Sandy Cay; Robert Power of the H. Lavity Stoutt Community College in Tortola; IRF intern Hillary Nobles; and Al Fraser and Piers Helm from Tortola. A total of 16 days (39 person days) were spent on the island from November 12 – December 12, 2002.

THE SANDY CAY RAT ERADICATION PROGRAM

BLACK RATS AS AN INVASIVE SPECIES

Black rats arrived in the Caribbean region from the 15th Century onwards, unwittingly transported from the Old World by European sailing ships and explorers. Having evolved in the tropics of Southeast Asia, the black rat was well suited to its new home and rapidly became established (Atkinson 1985). Ecologically this species is extremely adaptable, able to live in a wide variety of habitats and exploit many different food sources. Many of the small islands to which it was introduced lacked native ground predators, leaving many species extremely vulnerable to rat attack.

In addition to the problems caused by the rats themselves, their arrival was also the reason for the introduction of cats and mongoose. Brought into the region to control rats, these two species then went on to cause massive ecological problems in their own right. Black rats are implicated in the decline of many native species, and are arguably the most damaging of the commensal species of *Rattus*: they are the only one to be included in the IUCN's list of 100 of the world's worst invasive species (IUCN 2001). For example, following the removal of rats from 10 ha Great Bird Island, Antigua in 1995, in addition to other ecological benefits, the number of critically endangered Antiguan racer snakes (*Alsophis antiguae*) doubled within 18 months (Daltry *et al*. 2001, Varnham *et al.* 1998).

The importance of small islands in the region, and indeed the world, is not to be underestimated. With huge pressure for development throughout the Caribbean region, undeveloped islands are increasing in both scarcity and importance. These islands are often the last remaining refuges for some of the region's native wildlife, and are also extremely important as breeding sites for many species of seabird. They also provide safe havens for establishing new populations of species that are threatened on larger, more heavily built up islands. Finally, these small islands often have fewer introduced species, and their ecological restoration is therefore easier and cheaper than that of the main islands, and also more likely to be successful over the long term.

METHODS

The Baiting Grid

Rats were eradicated using a grid of bait points covering the entire surface of the island. A 30 x 30m grid was used in this instance, with 2 blocks of Weatherblok™ bait (manufactured by Syngenta Agrochemicals) containing 0.005% brodifacoum placed at each grid point. A further line of bait points was placed at intervals of approximately 20m around the perimeter of the

island, as rats on small islands spend a lot of time foraging around the strand line (pers. obs.).

Baiting Protocol

The bait points were checked daily for the first nine days of the project, and then four more times over the course of a further 15 days from the first baiting. The amount of bait remaining at each point was recorded, along with any identifiable animal signs. Hermit crabs (*Coenobita* sp.) were abundant across the island and active at the majority of sites. Rat activity was defined as the presence of fresh rat droppings. Any droppings found were cleared away from the site so that new droppings were known to have appeared since the last check. While not every rat feeding at a bait point is guaranteed to leave droppings, they can serve as a useful index of rat activity. Sometimes it is possible to check the wax bait for signs of rat teethmarks, but due to the high level of crab activity on Sandy Cay these marks were unlikely to have remained visible for long enough to be useful.

Usually the bait points were checked in the mornings and then rebaited in the afternoons; this was done to ensure that the bait would not all be eaten by crabs during the day before the rats became active at dusk. Two blocks of bait (40g total) were placed at each point on the first day, and extra blocks added as necessary to ensure that there were always at least 2 blocks at a point—approx. 3.36 kg of bait for total coverage (40g of bait x 84 bait points).

Risks to Non-target Species

Brodifacoum is a powerful biocide known to affect birds and, to a lesser extent, lizards, as well as mammals. However, risks to non-target species in this instance were judged to be very low. Rats were the only terrestrial mammals resident on the island. The formulation of the bait in a wax block made it inaccessible to the bird species observed on the island. Likewise, the lizard species present (*Anolis* spp. and *Ameiva* sp.) also lacked the ability and inclination to take the relatively large (40 x 40 x 10mm) blocks of bait. The only non-target species believed to be at any risk was the laughing gull (*Larus atricilla*) which may have been at risk of secondary poisoning by scavenging carcasses of rats that had died in the open. Rats killed by anticoagulant poisoning tend to die in their nests or burrows and are seldom found on the surface.

On Sandy Cay, as well as in previous projects on Antiguan islands, no dead or poisoned non-target species were found despite careful searches. Due to the low risk to non-target species, bait stations were not considered necessary to contain the bait.

Hermit Crabs

Hermit crabs consumed large quantities of the bait, especially at the start of the project. They are very agile and easily able to reach baits nailed to trees

(Figure 2a). For the first few days the priority was to ensure the ready availability of bait to rats, so baits were placed where they were accessible to both rats and crabs (Figure 2b).

As the project progressed a variety of methods were used to reduce the amount of bait lost to crabs. These methods included hanging the bait from overhanging vegetation on fishing line or thin wire (Figure 2c). Small aluminium foil dishes (c. 15cm diameter) were used at some points, to try and keep crabs from the bait (Figure 2d). The crabs themselves are not susceptible to the poison, but animals eating them may be at risk of secondary poisoning. The hermit crabs have no known terrestrial predators on Sandy Cay with the possible exception of rats. This relationship was exploited by killing small numbers of crabs that were known to have been eating the bait, typically 1 to 4 per bait point. This was intended firstly to reduce bait loss to crabs and secondly to possibly poison rats feeding on the bodies of the crabs.

Figure 2. Techniques to prevent hermit crabs eating the bait.

a. Hermit crab eating bait

b. Usual method of presenting bait

c. Bait suspended from fishing line

d. Bait protected by aluminium dish

Rat Activity

Figure 3 shows the distribution of bait points on the island, 84 in total. During the course of the eradication programme 28 of these bait points showed signs of rat activity, defined by the presence of fresh rat droppings. The daily pattern of rat activity for the first six days of the project is shown in Figure 4. No further signs of rat activity were seen following day 6. Table 1 summarises the number of active rat sites and the consumption of bait for the first six days of the project. Most of the active sites were located at the edges of the island, in accordance with findings from other small islands of this kind.

A total of 17.52kg of bait were used in the duration of the project. Five rat carcasses were found, and the smell of decomposing rats was detected in at least four other sites. All carcasses were collected and incinerated to prevent their being eaten by non-target species. Most of the dead rats were found by first observing patches of unusually high hermit crab activity. The crabs very quickly congregated around dead rats and, if left undisturbed, reduced to them to skeletons in a matter of hours.

Figure 3. Grid map of Sandy Cay showing position of bait points.

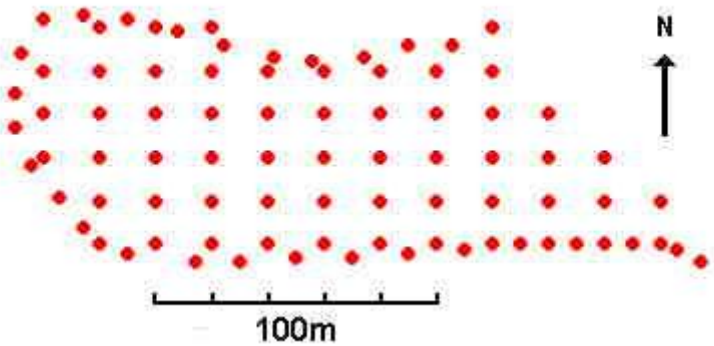
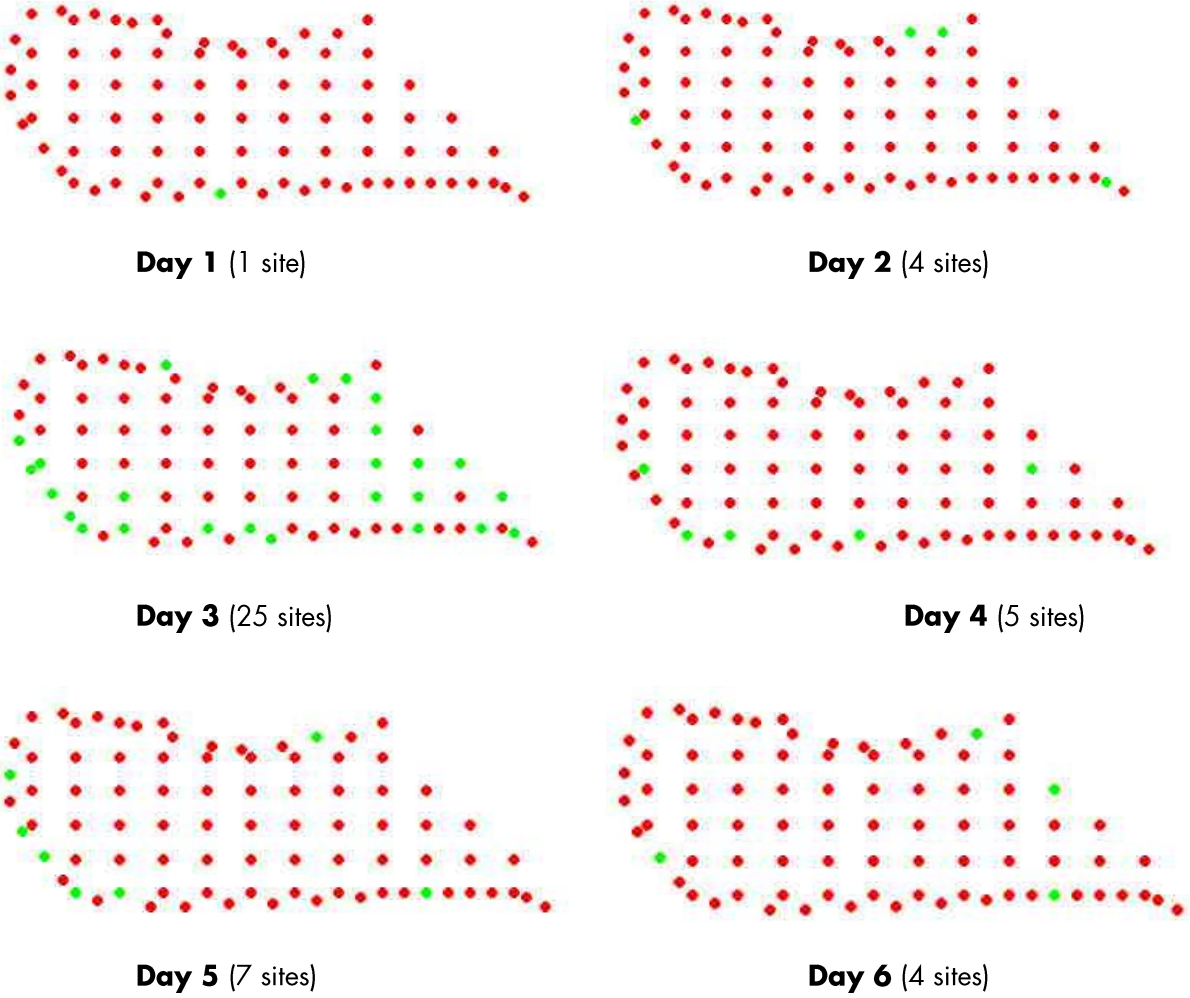


Table 1. Summary of rat activity and bait take.

Day	No. of active rat sites	Estimated amount of bait left (kg) (remainder of 3.36kg)	Estimated amount of bait taken (kg)
1	1	0.54	2.82
2	4	0.62	2.74
3	25	0.72	2.64
4	5	0.90	2.46
5	7	1.62	1.74
6	4	2.06	1.30
7	0	2.46	0.90
8	0	2.08	1.28
9	0	1.72	1.64
		Total bait used	**17.52**

Figure 4. Sites of rat activity (stations of activity circled) on Sandy Cay during the first six days of the project.



PREVENTING REINVASION

Towards the end of the project 18 permanent bait stations were set around the edge of the island, each containing a reservoir of 120 g of bait. These stations, made of heavy-duty plastic, were fixed on top of one-gallon paint cans to prevent access to hermit crabs (Figure 5). The bottom of the cans is cemented into the ground for stability and the stations can only be opened using a specially designed key. The stations were positioned away from the trails wherever possible to prevent interference from visitors and each station has a sign attached to the lid, explaining the purpose of the station, warning of the nature of the contents and asking people to call Island Resources Foundation if further information is needed.

The stations will be checked every month to six weeks and bait replaced as necessary. Staff checking the stations have been trained to recognize and distinguish signs of crab and rat activity. A realistic protocol describing what to do in the event of rats being rediscovered on the island has been

appropriately distributed. The first few checks will be particularly important as crabs may work out how to get in to the stations. In these cases, overhanging vegetation may need to be removed, and if the problem persists the station may have to be moved altogether.

The bait stations have a dual role—to warn if rats have returned to the island and also to poison new arrivals. On an island as small as Sandy Cay, 18 well-stocked and properly maintained bait stations should be enough to prevent rats from re-establishing. If they do return, rats are likely to do so singly and infrequently. As long as they encounter a bait station before they encounter a rat of the opposite sex, they will not re-establish on the island.

The results from the Sandy Cay rat eradication showed that almost all rat activity was concentrated around the edges of the island. Therefore there is a good chance that rats arriving on the island will concentrate their efforts to find food here, increasing their chances of encountering a station.

Figure 5. One of the permanent bait stations left on Sandy Cay.

The stations are mounted on top of one-gallon paint cans in order to prevent bait theft by hermit crabs. The crabs are unable to climb the sheer walls of the paint can, while rats can jump easily onto the platform provided by attaching the paint can lid to the side of the station. The stations are carefully situated to ensure that crabs cannot climb onto the platform from nearby vegetation or rocks, but that the station remains accessible to rats.

In any case the chances of rats returning to the island appear slim, despite the number of visitors to the island. Most visiting boats are charter vessels, and they appear to be clean and well maintained. Also these boats moor offshore and visitors reach the island in small dinghies that are extremely unlikely to contain rats. The greatest risk of reinvasion is in the transport of bulky cargoes such as building supplies, something unlikely to happen on Sandy Cay in the near future. If large amounts of material are to be transported to the island for any reason then simple bio-security measures, such as not leaving packed materials overnight in places likely to be frequented by rats, can be used to reduce risks of reinvasion.

PROJECT OUTCOMES

- **Immediate benefits to biodiversity**

  A wide range of taxa on Sandy Cay can be expected to benefit from rat eradication. Plants may benefit through reduced seed predation and increased seedling survivorship. Terrestrial invertebrates, especially flightless ones, will benefit from the absence of rat predation. Reptiles and birds will benefit directly through reduced predation, and indirectly through reduced competition for food. Significant improvements in bird and possibly turtle breeding success should be evident. The ecological consequences are likely to be widespread and, in some cases, unpredictable.

- **Immediate benefits to human health**

  Human visitors to the island will also benefit, as the risk of rat-borne pathogens such as leptospirosis and salmonella are removed.

- **Local capacity building**

  The project has served to raise local awareness of the problems caused by invasive species, and has further demonstrated the effectiveness of a control, management, and monitoring program that addresses such problems. The project has raised particular interest within the BVI National Parks Trust and may serve as a catalyst for other invasive species control programs at sites administered by the Trust.

  A well-written article in the *BVI Standpoint*, a local newspaper, provided a clear and understandable account of the Sandy Cay project and invasive species control in general. There is local interest in establishing a monitoring program on Sandy Cay, quantifying the ecological changes following the removal of rats, and perhaps utilizing students at the H. Lavity Stoutt Community College (HLSCC) to assist with monitoring tasks. The long-term bird records maintained by Roy Thomas and more recently by Island Resources Foundation will be valuable in any such monitoring program. Rob Power of HLSCC has been asked by Island Resources Foundation to assume responsibility for checking and maintaining the permanent bait stations.

  Finally, based on the success of the Sandy Cay project, Island Resources Foundation is currently seeking funding to produce a rat eradication manual, designed in particular for small "offshore" islands in the region.

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APPENDIX 1

INSTRUCTIONS FOR CHECKING AND MAINTAINING PERMANENT BAIT STATIONS

SANDY CAY RAT ERADICATION PROJECT
NOTES FOR BAIT STATION CHECKS

The bait stations should be checked every six weeks or so, or as often as funding permits. The person(s) checking the stations should take the following material on each trip:

- Machete, secateurs for trimming vegetation
- Data sheets
- Sample tubes for suspect droppings
- Bait (about half a bucket)
- A few spare nuts and bolts
- Keys for stations (at least 2)
- Marker pens
- Spare warning signs for lids
- Glue to attach warning signs

Check for damage to the bait, refill if necessary, trim vegetation or move station if necessary

Every three or four months the bait should be entirely replaced with new bait. The stations can each hold around 6 blocks, so it will take 108 blocks to refill all 18 stations. Each 5kg bucket of weatherblok contains 250 blocks, so about half a bucket will be needed to rebait all stations.

When baiting a station, thread six blocks of bait onto the metal skewer provided. This can then be pushed into position in the bait chamber (the rounded end of the metal loop on the end of the skewer should be positioned in the center of the station, pointing downwards). The plastic tray should be left underneath the bait kebab; it is very useful for catching droppings and can easily be removed for inspection of droppings and for emptying bait crumbs. If some of the blocks are half eaten, it is acceptable to leave them in place until the next time all the blocks are replaced. But remove any crumbs and droppings so you can tell whether there is fresh damage next time. Put them into a plastic bag and take them off the island with you. Ideally, they should be incinerated or disposed of in the same way as old bait, as described

in the paragraph below. If any blocks are found to be wet or mouldy, they should be replaced immediately.

When it is time to replace all the blocks, empty them into a strong plastic bag and take them off the island. They may still contain significant amounts of the active ingredient, and care needs to be exercised. Do not leave them anywhere they could be found by children or by domestic or wild animals. If the discarded bait is to be used for other purposes, make certain that potential users have a copy of the manufacturer's instructions and will use the bait responsibly. In particular make sure all users are aware of the risks of secondary poisoning to animals such as domestic cats and wild raptors from eating poisoned rats. If nobody wants the leftover bait, it should be placed in one of the original containers (the white buckets with the sealable lids). The bucket should then be punctured with a few small holes and disposed of on a registered landfill site. This is the recommendation of the scientist at Syngeta who supplies bait to the Antigua project.

If any stations or paint cans are damaged, they can be brought in for repair and replaced during the next check. It will not be significant if one or two stations are off the island for a short time, but make sure they are replaced properly during the next visit. There are two spare stations and six spare paint cans at the IRF office in Road Town.

Signs on Lids

These should be laminated to protect from the weather. Suggested text:

> *Invasive rats have been eradicated from this island to help native wildlife. This station contains toxic bait designed to prevent rats from returning to the island. If left alone, the stations are no danger to humans or other animals, but the bait inside should not be handled by unqualified staff. Please do not touch the stations and if you require more information call xxxxx. Thank you.*

Identifying Droppings

Personnel checking the stations should be able to identify rat, crab and cockroach droppings. Big cockroach droppings can look like mouse or young rat droppings, but are relatively shorter and squatter and have ridges down the sides. Rat droppings are about 1cm / 0.5" long and are usually cigar shaped, with rounded, tapering ends. Sometimes one of the ends is pointed. They are made up of lots of little bits of stuff, such as vegetation fragments and small shiny pieces of insect exoskeleton. If they have been eating the bait, the droppings have a more uniform consistency, and are blue and waxy. But if you break one open you can clearly see that it is made up of a mosaic of little bits.

Crab droppings are the most likely thing to be confused with rat droppings, as those of large crabs can be similar in size (though most are much smaller).

The key differences are that crab droppings are cylindrical, rather than tapered, and have flat ends. Also, if you break them open, you will see that they have a very fine texture, as they grind their food up into very tiny particles. If in doubt, collect a sample of droppings into a rigid container (to avoid them being squashed) and take them back to Tortola. If possible, email a digital photo of the droppings to Karen Varnham, or, failing that, send via regular post as soon as possible.

What to do if crabs get in once

Some stations will be found empty except for crab droppings. When this happens, look around to see how they might be getting in. The most likely route is by climbing up overhanging vegetation and dropping onto the roof of the station. Once inside they tend to stay there until all the bait is gone. Past experience on other islands suggests that once one crab has secured entry, others tend to follow, and often the only solution is to drastically cut back surrounding vegetation or to move the station altogether.

What to do if crabs/ ants/ roaches keep getting in

Relocate stations. This will need cement, trowel, and possibly a hammer to break the old cement off the bottom of the can (if there's too much). Find another suitable site, somewhere that cannot easily be seen from the trail. Ideally, it should be screened by vegetation and out of direct sunlight (they can get pretty hot inside and the bait can melt), but without too much overhanging vegetation. Often sites will have to be made more suitable via a bit of pruning.

How to assemble stations

You will need:

1. a bait station, plus key to open it
2. paint can, plus lid
3. 2 nuts and bolts
4. wrench
5. screwdriver.

First, bolt the paint can lid to the station, using the hole near the entrance of the station. Have the head of the bolt in the station, with the rest of it sticking out through the bottom — you do not want anything to get in the way of rats coming in. Then bolt the station onto the top of the paint can, using the hole in the center of the station. Again, have the bolt pointing down into the paint can to avoid obstacles for rats inside the station. It is usually more convenient to assemble the stations in the field, at the site you are going to set them — they are even more awkward to carry around once assembled.

How to set stations

Dig a hole, mix cement (1 part cement: 2 parts sand?). It works satisfactorily if mixed with seawater. Mix to the consistency of thick lumpy porridge. Position the paint tin in hole, making sure the entrance platform (paint tin lid) is accessible to rats — about 6″ of ground, or c. 6-8″ from a nearby branch or rock that the rat could jump onto the platform from. Avoid overhanging vegetation that could be used by hermit crabs to drop onto the station.

Responding to suspected signs of rats

1. Refill affected stations with fresh bait as soon as possible and collect any droppings or remains of bait blocks that may be left. Compare these with the reference collection to see if rats are the likely cause. Send digital pictures of suspicious droppings or other signs to Karen Varnham if a second opinion is needed (or the actual articles if time permits).

2. Scatter bait around the affected stations (1-2 kg or 50-100 blocks per station). Set emergency bait stations in the immediate area.

3. Revisit all the stations on the island within one week to see if any more damage has occurred. Scatter more bait around the affected stations. If possible, make several smaller distributions of bait over several days rather than one big one, as most of the bait is likely to be eaten by hermit crabs within 24 hours. Use the spare bait stations in the IRF Road Town office if necessary.

4. If there is a suspicion that rats are the likely cause, it would be useful to have someone camp on the island for a few days. This would allow for longer searches, night walks in affected areas (where accessible) to listen for rats and use of traps (a small number of Sherman live capture rat traps and snap traps are held in the IRF office). If no one is able to camp, the island should be revisited at least at weekly intervals for the next 2-3 weeks, repeating steps 1-3.

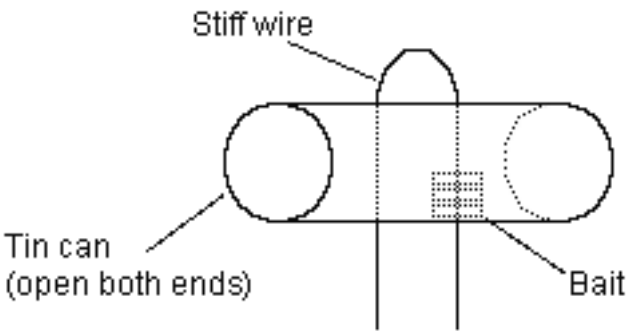
5. If rats are confirmed to be present in a restricted area, continue distributing bait as frequently as possible for 2-3 weeks. If at all possible, one or more individuals should camp on the island for as much of this time possible. It may be helpful to have a marked series of bait points (like those used in the usual rat eradication campaigns), consisting of a few blocks of bait every 10-20m for at least 100m around the affected station. In some cases, it may be possible to use the original grid tracks. Pay particular attention to nearby permanent bait stations in case they start showing signs of rats and extend the area of poisoning as necessary.

6. If rats have become widespread, it may not be possible to get rid of them without a full-scale repeat eradication. In this case there is little point in continuing to monitor the stations while this is being planned, particularly

on smaller islands which can be cleared again relatively cheaply and quickly.

Emergency bait stations

This simple bait station is made out of a tin can with two holes in either side, with a loop of strong wire pushed through these holes. Bait blocks can be secured inside the can by pushing the wire through their central holes. The station is supported by pushing the wire securely into the ground. The wire should be long enough so that the can is held at least 10cm above ground level to discourage hermit crabs getting in. Alternatively, the station could be made more stable by passing the support wires through a second tin can, perpendicular to the first, dented at the top so that the upper can sits snugly on it.



This method has two advantages over simply scattering the bait on the ground. Firstly, it allows the bait to be checked for signs of rat activity, which is impossible if it is just scattered around. This means there is a greater chance of finding definite signs of rats, such as teeth marks and droppings, and also may give a clearer idea of where they are concentrated. Secondly, it should prevent, or at least slow down the loss of bait to hermit crabs. It would be sensible to take 10-20 of these stations and a good supply of bait along on all routine checks of the bait stations so that immediate action can be taken if rats are suspected to be present. A combination of both methods, bait stations and scattering of bait, is likely to be the most effective.

Alternatively, bait can be placed on nails and hammered into the bases of trees (about 6" off the ground), or suspended from overhanging vegetation by thin wire or fishing line. In this case it should be about 4" off the ground. The trick is to make the bait easy for rats to eat, but difficult for hermit crabs. It can take quite a bit of trial and error to find this balance. If you suspect rats are back on the island though, it's better to lose bait to crabs than to have it inaccessible to rats.