

Operational Plan for the eradication of rodents from South Georgia: Phase 1

South Georgia Heritage Trust

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Related documents

This Operational Plan is part of a suite of documents which describes and specifies most aspects of the South Georgia Habitat Restoration project. The other documents are the Environmental Impact Assessment (SGHT 2010a) and the following Plans: Health and Safety (SGHT 2010b), Biosecurity (SGHT 2010c), Search and Rescue (SGHT 2010d), Crash Recovery (SGHT 2010e), Monitoring (SGHT 2010f) and Oil Spill Response (SGHT 2010g). Together, these documents comprised the basis of the application made to the Government of South Georgia and the South Sandwich Islands for the work to be carried out, and upon which consent was given. Some elements of earlier versions of this OP are now addressed in their separate Plans (e.g. monitoring), and have consequently been removed from this most recent revision of the OP.

Acknowledgments

Many people have assisted in the development of this document through providing information, comments and advice. Particular thanks are due to three people - Derek Brown, Keith Springer and Gordon Liddle. Keith is Manager of the equivalent Macquarie Island project, has been very generous of his time and support, and it is his Operational Plan for Macquarie which provided a template for this document. Derek has been involved in the planning of a rodent eradication campaign on South Georgia for many years, and developed a draft OP for Greene Peninsula in 2008, many ideas of which have been brought across to this document. Gordon Liddle generated much of the early enthusiasm for this project, and coordinated the initial stages of its development. Gordon's knowledge of the island and logistical experience produced an operational framework which assisted later planning.

Other key advisors/contributors include the Island Eradication Advisory Group (Chair: Keith Broome), Bob Brett, Darren Christie, Martin Collins, Andy Cox, Peter Garden, Pete McClelland, Richard McKee, Wiz Pasteur, David Peck, Dion Poncet, Sally Poncet, Les Whittamore and Bill Simmons.

Non-technical summary

Background

South Georgia, a rugged and stunningly beautiful island some 170 km long, lies just south of the Antarctic circumpolar front, some 1750 km east of the southern tip of South America. It is administered as an Overseas Territory of the United Kingdom, has no permanent residents and is visited by thousands of tourists each year.

Despite its remote location in some of the most tempestuous seas on the planet, South Georgia was encountered by accident by several early mariners under sail, but none landed until Captain Cook did so in 1775. Within a decade of Cook's first steps, the island became a magnet for adventurous exploiters of the fabulous densities of wildlife on its beaches and in its nearshore waters. Millions of seals and hundreds of thousands of whales were then killed over the subsequent two centuries - a sequence of over-harvesting that has never been equalled worldwide.

The destruction by whalers and sealers of the populations they harvested has long been recognised, and international regulations subsequently protected the remaining animals, allowing a substantial recovery in most cases. However, little attention has been paid to equally profound damage to other elements of South Georgia's wildlife brought about by those same whalers and sealers. Unknowingly, they allowed stowaway rats to go ashore at many sites, and descendants of those stowaways subsequently spread throughout the vegetated parts of the island. Accomplished predators, the rats consumed the eggs and young of millions of seabirds, to the effect that most species today are greatly reduced in number and completely excluded from areas where rats occur. Another ground nesting bird - the South Georgia pipit - was similarly eradicated from most of the island, and is now confined to the rat-free oases of offshore islands and a narrow strip of inhospitable coastline. It is found nowhere else in the world, and has now lost over 70% of its former habitat to rats.

The spread of rats on South Georgia continues today, their progress only limited by physical barriers - the sea and large areas of permanent ice. With global warming, however, scientists have now shown that glaciers on SG are in rapid retreat, so areas of the island once protected from rats have now been over-run. Even islands currently free of rats are unlikely to retain their status. One such - Saddle Island - has been recently invaded, and others are likely to follow when rats enjoy a ride on a mat of vegetation, or are swept onto a remote shore by the sea.

Introduced alien species are now known to be responsible for a huge loss of biodiversity worldwide, second only to habitat destruction, and the effects are especially profound on islands. Until recently, there was no realistic expectation of being able to control rodent pests on whole islands, let alone remove them entirely. But great strides have been made in the aerial application of toxic bait in the past two decades, and increasingly large islands are now being tackled successfully. An implausible dream only a decade ago, the concept of clearing rats from South Georgia is now feasible. The island is many times larger than the largest yet tackled, and the project would need meticulous planning and field methodology, but it could be done.

After two centuries of human influence, all negative, the wildlife of South Georgia is at a crossroads. Without positive human intervention, one bird species will likely become extinct, and many others will be greatly diminished by being denied the island as a breeding site. But this depressing scenario is not inevitable. While the offshore islands remain rat-free, they act as biological reservoirs from which birds will recolonise the main island if and when it becomes free of rats. If this can be achieved, there is a relatively short window of opportunity to restore South Georgia's ecology and wildlife to the condition in which Cook found it in 1775.

This project

This Operational Plan sets out the planning, organisational, personnel and logistical requirements of a project which aims to clear rodents from Greene and Thatcher Peninsulas, and a headland west of Mercer Bay - three adjacent areas of land on the north coast of South Georgia that surround the only inhabited part of the main island. If time and resources allow, bait will also be spread on Saddle Island, some 83 km to the northwest. The technique used will be the broadcasting of toxic cereal bait (rat poison) in the form of pellets from a spreader underslung from a helicopter. The work is scheduled for mid-Feb until April 2011. This project would bring about spectacular conservation benefits in its own right, adding 50% to the area of prime habitat free of rats, but of greater importance is that this single season of fieldwork would act as a precursor of an island-wide eradication operation. The overall objective is to render South Georgia entirely free of rodents by the year 2015.

In support of the anticipated island-wide operation, the 2011 project will

- test the proposed baiting rates and application method
- ensure the operating systems are satisfactory for the often below-zero temperatures and extreme weather conditions of South Georgia
- test the logistics chain required to support an operation in such a remote environment
- demonstrate the benefits of rat eradication in the most-visited parts of South Georgia
- evaluate the impacts on non-target species

The suite of documents of which this Operational Plan is part (SGHT 2010a-g) describes and explores all aspects of the work and its potential impact on the island, its fauna, residents and visitors. Together these documents deal with the following questions: Why do this work? How will it be accomplished? What are the risks? How will they be managed? What are the consequences?

Eradication methodology & timing

A successful eradication operation on South Georgia must take account of the fact that the island is many times larger than any previously targeted for pest eradication, and that the financial resources potentially available to fund the work are limited because they must be privately raised. The methodology employed should therefore be firmly based on that employed successfully elsewhere, but modified to reflect the unique circumstances of this island and this operation.

The key factor that makes eradication feasible here is that South Georgia's rat population is divided into a number of discrete sub-populations, each separated by geographical barriers such as ice and the sea. The areas of land they occupy can be considered as 'islands' within an island. Crucially, each such sub-population can be eradicated independently of any others, with very little risk of re-invasion. Also important is that rats are at very low densities on most of the terrain of South Georgia to which they have access, and that a high proportion of the distributed bait pellets are expected to be available for rats to consume. Compared to most islands, there are few wild animals likely to remove bait.

The methodology of the project is as follows. Two helicopters will spread toxic cereal-based bait over the entire area, other than that covered by permanent snow and ice, at a rate of 2 kg per ha (0.2t per km²). Some 5-7 days later, the coastal strip as far inland as the limit of the tussac will receive a second bait coverage at an average bait density of 4.5 kg/ha, giving a total of 6.5 kg/ha in all areas of prime rodent habitat. The purpose of the interval between first and second coverage is to increase the probability of removing any mice that may occur in the target area. None are known to exist here, but any that do are likely to be competitively excluded by rats from prime food sources. The interval will allow most or all rats to succumb to the first bait sowing, and any mice to have access to the second drop. The active ingredient in the pellets is Brodifacoum, a second-generation anticoagulant used at 25 ppm. The operation is expected to require some 6 full days of flying for each aircraft, although substantial periods of unflyable weather are expected and allowed for in the schedule. Experience on the nearest equivalent island to South Georgia previously treated (Campbell Island) indicates that a single bait coverage should be adequate to allow every rat access to a lethal dose of the poison - one or two pellets. Some 46 tonnes of bait will be needed if everything goes to plan, but an extra 22% has been ordered to allow for damage, a need to cover more land than expected or to contend with even worse weather than had been anticipated.

To save time during each spreading cycle, the bait bucket will be bulk-loaded with 450kg of bait from a bag underslung from the tines of a telehandler. While the helicopters are away distributing the previous load, four people will refill the bulk bag from 18 paper sacks, each containing 25kg of pellets.

The helicopters will operate from the concrete pad which until recently was covered by the Morrison's accommodation at Grytviken. This is conveniently close to the building that will act as a hangar and over-wintering site for the helicopters - the Engineer's workshop. The helicopters will be equipped with a global positioning (GPS) and tracking system to enable the pilot to maintain flight lines with a high degree of accuracy and achieve the desired bait coverage.

The quality and consistency of bait is critical to an operation like this, and the supplier selected - Bell Laboratories (Wisconsin, USA) - has an excellent and growing reputation for providing bait to successful eradication projects worldwide.

Although a winter campaign is normally preferable for several reasons, the weather on South Georgia at this time of year would very likely prevent a successful operation. Not only would flying be dangerous or impossible most days, but the depth of snow cover could prevent rats from encountering the bait. Consequently, the spreading of bait is planned for late summer

and autumn – from early March until mid-April. This period should see little settling snow, and the breeding seasons of most wildlife will have been completed.

Personnel, equipment and supplies for the project will be shipped to South Georgia from the Falkland Islands. A central storage site will be located to receive material in the weeks and months prior to departure, and port agents have been appointed to manage this element of the project. Movement of most personnel and material to South Georgia will be on M.V. *Pharos*, courtesy of the Government of South Georgia and the South Sandwich Islands (GSGSSI), and on M.V. *Marina Svetaeva* courtesy of One Ocean Expeditions. Other tour ships have offered to transport personnel and smaller items of equipment if timing and circumstances allow.

Project management & staffing

This operation was planned, organised and administered by the equivalent of 1.5 full-time staff in the year to September 2010, when a further dedicated staff member was recruited. The field team will comprise 11 people (for a period of some 8-10 weeks including preparation and wind-up, depending on weather and timing of a suitable return voyage to the Falkland Islands). The Project Director (PD) reports to the South Georgia Heritage Trust (SGHT) via a Steering Committee comprised of four trustees, two representatives of the South Georgia Government and two of the British Antarctic Survey.

The Project Director implements and coordinates all planning and logistical elements of the operation, supported by a Project Administrator and the SGHT CEO in part-time capacities. An Assistant Project Director (APD) will be employed on a part-time basis in the months prior to field operations, and then full-time during fieldwork. The APD is based in New Zealand, centre of expertise in pest eradication on islands.

The PD will coordinate aerial baiting operations on South Georgia, advised by a Decision Support Team comprising the APD, Chief Pilot (CP), Aviation Advisor (AA) and the senior Field Officer. Other external advice will be sought from the Steering Committee and the New Zealand Dept of Conservation's Island Eradication Advisory Group (IEAG) during aerial baiting operations or at any stage of follow-up operations if necessary.

The field team will be accommodated in Larsen House at King Edward Point (KEP), and catered for by an Accommodation Manager. Medical care will primarily be provided by the Project's Paramedic/Doctor, with support from the KEP doctor, who has access to a well-equipped surgery.

Risk management

Long-term loss of availability of a helicopter is the greatest risk to the success of the project, so a number of measures will be taken to manage and reduce this risk. These measures include having two pilots, helicopters with all time-limited parts having plenty of time remaining, a comprehensive stock of spare parts and an experienced engineer to service/repair the machines, protection from weather and animals, and plentiful clean fuel.

Other key risks that will be reduced as far as possible are non-availability of good quality bait in sufficient quantity, loss of key personnel and loss of key equipment other than a helicopter.

Project and Operational Plan development

This Operational Plan will continue to be updated as the Project develops. It will act as a key means of keeping all stakeholders informed and involved. Individually and collectively, members of New Zealand's Island Eradication Advisory Group (IEAG), the acknowledged global experts in this field, have kindly reviewed planning for this Project and provided guidance on many aspects of the work. Their support, and that of others with similar expertise, is welcomed and appreciated. The first formal IEAG review of this OP and the linked EIA was carried out in Auckland in February 2010. The current version of the OP (version 3) has been amended to reflect that IEAG review, comments from GSGSSI personnel, planning developments between 6 December 2009 and 26 November 2010, and results of the visit to Grytviken/KEP in early April 2010 by key personnel representing GSGSSI and the Project. Version 1 was submitted to GSGSSI on 6 December 2009.

Authority from GSGSSI is required to carry out this work, and was granted (subject to conditions now met) in July 2010.

Section 1 - Introduction, rationale, feasibility & objectives

1.1 - Introduction

When Captain Cook took the first human steps on South Georgia in 1775, the island he encountered was a pristine landmass with a wildlife community that had adapted and evolved over at least tens of thousands of years in the absence of any significant predator or land mammal. South Georgia was home to millions of seabirds and seals that used the island as a base from which to exploit some of the richest seas on the planet.

Within a decade of that first footfall, humans began a process of wildlife destruction on and around this remote sub-Antarctic island that lasted two centuries and has not been matched anywhere in the world. First the fur seals were wiped out in their millions, then the great whales feeding offshore in their hundreds of thousands, then elephant seals by the tens of thousands. Meanwhile, unseen and unrecognised, some rodent guests of the sealers and whalers came ashore at several points and began the process of consuming tens of millions of ground-nesting birds and their eggs and chicks.

Today, under protection from their human predators, the seal populations have recovered and whales are in the process of recovery. But the birds have not been released from their predator, the brown rat, and populations of most species have long since been substantially confined to small rat-free oases on offshore islands and a narrow, inhospitable strip of land on the cold south coast of South Georgia. Furthermore, though less obviously to human eyes, the rats have greatly impacted native insect and vegetation communities. In short, they have changed the entire terrestrial ecology of the island.

The current situation is bad enough, but all indications point to it becoming worse in the short- and medium-term. The only limits to rat population spread are geographical barriers - stretches of sea and permanent ice. But South Georgia's glaciers are in rapid retreat (Cook et al., 2010), and it is now inevitable that they will cease to be effective barriers on a scale of years to decades. In some cases the barrier has failed already (two apparently within the last two years). Furthermore, although the chances of rats reaching a currently rat-free offshore island are extremely small in any year, the probability is cumulative. Sooner or later a rare colonisation event will occur, such as a vegetation mat being washed ashore with rats aboard, or a pregnant rat being transported by an abnormally strong current.

Proof of this became apparent very recently when Saddle Island, which had remained free of rats for two centuries and hosted dense populations of burrowing petrels, was found to have been invaded (Sally Poncet, in litt. July 2008). And a rat was found ashore, though fortunately dead, on Bird Island in 2006. With time, it is all but inevitable that the remaining rat-free islands will succumb to invasion. Consequently, without human intervention to eradicate rats from South Georgia it is also inevitable that the endemic pipit will become extinct and many seabirds will be driven away from the island entirely. At least 13 species are known to be vulnerable to rat predation on South Georgia, and a further seven may be affected.

After two centuries of human influence, all negative, the terrestrial wildlife of South Georgia is at a crossroads. Without positive human intervention, one bird species will almost certainly become extinct, and many others will be greatly diminished by being denied the island as a

breeding site. But the positive news is that this depressing scenario is not inevitable. While the offshore islands remain rat-free, they act as biological reservoirs from which birds will recolonise the main island should it become free of rats. If this can be achieved, there is a relatively short window of opportunity to restore South Georgia to the condition in which Cook found it in 1775.

1.2 - Rationale

There are no cost-effective ways of *controlling* rodent populations on South Georgia in a way that would benefit native wildlife over a meaningful period of time. Until recently, there was also no realistic prospect of removing rats from South Georgia, or indeed from the many other sub-Antarctic islands whose wildlife was similarly suffering from rodent predators. However, in the 1980s and 1990s, government agencies and conservation groups in New Zealand were gaining an impressive reputation for clearing introduced pests from increasingly large islands in their archipelago (e.g. Cromarty et al., 2002). In 2001 the NZ Department of Conservation took on what still remains the largest island successfully tackled to date – sub-Antarctic Campbell Island (McClelland 2001). Spreading toxic bait from helicopters, the entire island was cleared of rats in a few weeks. Less than a decade later the island is already fast regaining the wildlife it had lost over nearly two centuries (e.g. Miskelly and Fraser, 2006; Thompson et al., 2005). Rodents have now been eradicated from approximately 300 islands since the 1970s, mainly around New Zealand but increasingly elsewhere (Broome et al. 2005; Broome 2009; Howald et al. 2007; Saunders and Brown 2001; Towns & Broome, 2003).

Success at Campbell acted as the catalyst for a larger and complex, multi-species operation on Macquarie island (Copson 2004; Springer 2008), a project that has been many years in the planning and is due to recommence in April 2011 after a false start caused by shipping delays and exceptionally poor weather in 2010. Simultaneously, people concerned at the continuing damage to wildlife and ecology on South Georgia began to seriously contemplate the feasibility of a helicopter-based campaign bringing much-needed relief from rats, either in some relatively small areas, or audaciously on the whole of the main island (e.g. Poncet 2000; Christie & Brown 2007).

Further analysis showed that South Georgia, although many times the size of Macquarie or Campbell islands, offered the unique advantage of having its rat population divided into many discrete subpopulations, each separated from all others by extensive stretches of sea or by permanent ice barriers such as glaciers. This held the hope that the island could be tackled over several years, with no risk of cleared areas being recolonised from other areas. Consequently, and in close consultation with the Government of South Georgia and the South Sandwich Islands (GSGSSI), the South Georgia Heritage Trust (SGHT) took the decision in principle to clear SG of rats using aerial baiting, as on Campbell. Expert guidance from New Zealand indicated that clearance of the whole island was feasible, even with a baiting density lower than the industry standard elsewhere, because rat density was apparently low on SG. A multi-year project would allow techniques to be evaluated and, if necessary, improved in subsequent years.

The present document relates only to Phase 1 of the proposed SG Habitat Restoration project – the clearance of two substantial baiting zones around and near the GSGSSI/ British

Antarctic Survey (BAS) base of KEP, one smaller adjacent one, and Saddle Island. It is, in principle, a single-species eradication operation because the only pest species known to occur in these areas is the brown rat (*Rattus norvegicus*), although it is possible (albeit unlikely) that one or more undetected populations of mice exist here. Although Phase 1 is planned and expected to precede three further years of fieldwork to clear the remainder of SG (Phase 2), it does not depend on a second Phase. The conservation value of clearing rats from the Greene, Thatcher and Mercer zones (in total 15,200 ha or 152 km²) are substantial in their own right, and the size of the glaciers on either side of these areas should ensure that rats do not reinvade the cleared areas for many years. An Operational Plan for Phase 2 of the SG eradication programme will be developed and submitted for IEAG review by Sept 2011.

The objective of this document is to provide a description of, and rationale for, the logistical and operational planning on which the project will be based. These plans are substantially based on preparations for the Campbell and Macquarie Island operations and, where possible, follow recommendations made by the Island Eradication Advisory Group (IEAG) in regard to these and other eradication campaigns (DOC 2005, 2009). As mentioned above, this version of the O.P. also incorporates amendments arising from the IEAG review of version 1 in February 2010.

1.3 - Risk of re-invasion

Rightly, a standard test of whether an eradication operation should be attempted anywhere, for any organism, relates to the risk of the species returning once the work has been carried out. South Georgia has a long and unenviable record of sequential introductions of alien species by its human residents, so the question is especially relevant here.

The GSGSSI is responsible for managing this risk, and some years ago appointed a full-time employee to work on the issue. The focus of the government's subsequent efforts has been to minimise the risk of invasive alien species (IAS) being brought ashore by visiting ships and yachts. Administrative procedures on biosecurity now regulate all such visits, and a heightened general awareness should aid its effectiveness. A new quarantine building at KEP, site of the only vessel dock on South Georgia, is now used for unpacking supplies and equipment that could possibly harbour rodents, and permanent bait stations are in use to help reduce the probability of any newly-arriving rodents spreading beyond the base.

Outwith KEP/Grytviken, the risk of rodents going ashore from anchored vessels is very small, and again greater awareness of the damage caused by invasive species should help reduce the risk further.

Should re-invasion occur, geographical spread of the population is likely to be limited, at least in the short-term, especially because it is most likely to occur where people live and where rat sign may be noticed. Awareness of the situation, and rapid response, should allow a reasonably high probability of eradicating the invader before it becomes established. In the worst case scenario, a similar project to that addressed in this Operational Plan may be required.

In summary, the risk of subsequent invasion of South Georgia by rodents is small, though certainly not negligible. Recent improvements in biosecurity procedures, vigilance,

infrastructure and awareness should reduce it further. Short of prohibiting all ship visits and all human landings, the risk is about as low as could reasonably be expected.

This being the case, an eradication operation is considered appropriate and justifiable by GSGSSI, SGHT (sponsors of the project) and most visitors to South Georgia. The very existence of the eradication operation will inevitably raise awareness of the dangers of invasive species in years to come, and consequently in itself help to keep the island free of rodents into the foreseeable future.

Should rats be found at KEP/Grytviken subsequent to an eradication operation, it will be very important to determine whether they are newly arrived or derived from survivors of the baiting attempt. This is best decided by genetics, and consequently reference samples of the extant population should be securely archived in anticipation of this eventuality. The Project Director has arranged for samples from c20 rats to be taken and stored frozen or in Dimethyl sulphoxide (DMSO) before the field operation begins.

1.4 - Feasibility

No project of this size and complexity, being carried out on an island unlike any other previously treated, has a guaranteed result. However, the probability of success can be greatly enhanced by managing and minimising known risks, and by leaning heavily on the experience and expertise of people and agencies who have succeeded elsewhere in circumstances as close as possible to those pertaining on South Georgia. This is the approach that has been adopted in the development of plans for the current project.

Most of the factors influencing the success of the operation are controllable to varying degrees, but the weather encountered during the operation is clearly not one of these. South Georgia's weather is notoriously changeable and often unflyable for consecutive days. To minimise the risk of weather causing overall failure, a generous margin has been allowed. A maximum of six full days of flying should be sufficient to carry out the work, and 30 days have nominally been allocated, although arrangements will be made to extend this time if necessary.

The recognised world leaders in this field, the IEAG, use five principles to assess the feasibility of an eradication operation, and these principles are as appropriate to this project as any other. They are listed below, with a brief explanation of why the sponsors believe that it passes these five tests.

1. Can all individuals be put at risk by the eradication technique?
2. Can they be killed at a rate exceeding their rate of increase?

Experience on Campbell Island, the nearest in size and climate to the area being targeted on South Georgia, demonstrated that a single aerial treatment with Brodifacoum bait met these two conditions. The techniques proposed for Phase 1 of the South Georgia rodent eradication project are very similar in all but seasonality and bait sowing density. For reasons discussed below (sections 9.7 & 9.4) these modifications reflect differences in climate and scale between the two islands, and should maximise the probability of success with the resources available.

3. Is the probability of pest re-establishment manageable to near zero?

See section 1.3 above. Recent attention to the risk of new introductions of IAS to South Georgia by GSGSSI, including strict administrative procedures, infrastructure and public awareness has brought about improvements which now satisfy this test.

4. Is the project socially acceptable to the community involved?

There are no permanent residents on South Georgia. The GSGSSI endorses an eradication operation, as do most or all of its current seasonal residents (who have been kept up to date with plans by way of discussions with, and lectures by, team members). A consultation exercise by GSGSSI in 2010 generated supportive responses from important stakeholders such as the South Georgia Association and the International Association of Antarctica Tour Operators (IAATO). It is highly probable that subsequent visitors will be in favour of eradicating rodent pests if such action benefits native wildlife.

5. Do the benefits of the project outweigh the costs?

This is the most difficult question to answer, because it implies putting a subjective financial value on wildlife. It also involves value judgements concerning, for example, the cruelty of poisoning an unknown number of rats compared to the cruelty those rats and their progeny would cause to the unknown number of bird chicks that they would otherwise consume in decades to come. Perhaps the most appropriate answer is that the financial cost of the project has already been contributed from many donors of different nationalities who, by definition, believe that the benefits outweigh the costs.

1.5 - Objectives of this document

This Operational Plan has been written to provide details of the logistical, technical and operational elements of a plan to eradicate brown rats (*Rattus norvegicus*) from three adjacent areas of South Georgia (Greene Peninsula, Thatcher Peninsula and the land west of Mercer Bay) and Saddle Island. It should be read in conjunction with the partner Environmental Impact Assessment (EIA) and site-specific Initial Environmental Evaluations (IEEs), which cover all environmental and ethical issues, alternative methodology considered, previous eradication work on South Georgia, legislation and international agreements, non-target poisoning issues and risks to human health (SGHT 2009b).

Although the EIA is valid for an all-island eradication campaign, this Operational Plan is deliberately restricted to a one-season project covering a small proportion of the island (Phase 1 of an anticipated all-island eradication programme). Lessons learned from Phase 1 will be used to inform and improve an O.P. for Phase 2 - the eradication of rodents from the remainder of South Georgia.

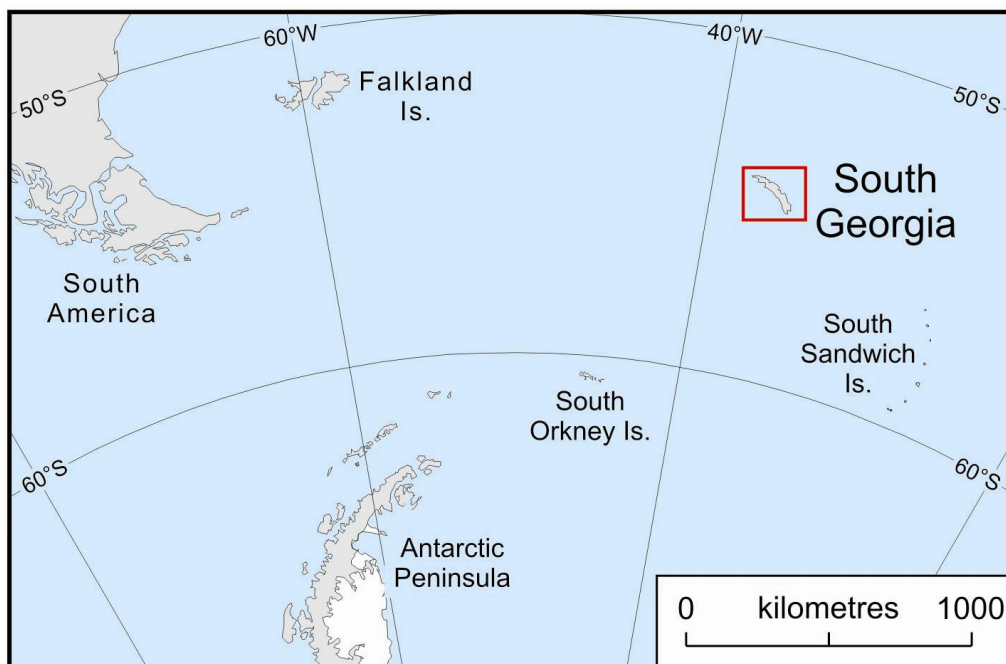
Section 2 - Operational Area

2.1 – South Georgia

South Georgia is located in the sub-Antarctic region of the Southern Ocean. It is centred at approximately 54°20'S, 36°47'W, and lies approximately 1350 km east south-east of the

Falkland Islands and 1750 km east of the tip of South America (see Map 1). South Georgia and its offshore islands comprise some 3,750 square km. Most of the main island is covered in permanent snow and ice, and uninhabitable by mammals. Similarly, most of the satellite islands are free of mammals. Some 800 square km, or 20% of the area of South Georgia, is occupied by rats.

Map 1 - Location of South Georgia



2.2 - Ownership and status

South Georgia is an Overseas Territory of the United Kingdom. It is managed and regulated by its own Government, headed by a Commissioner and based in the Falkland Islands. All lands are Crown Land.

2.3 - Occupation, management and visitation

Humans are resident on South Georgia at only two sites – King Edward Point (KEP)/Grytviken on the central north coast, and Bird Island off the western end of the mainland. Bird Island is rat free, and will not be affected by this operation at any time.

The settlement at KEP/Grytviken lies in a sheltered cove within Cumberland East Bay. It hosts the administration of the island, a scientific base operated by BAS and a museum run by the SGHT. It is situated on the Thatcher Peninsula, and consequently is within the area to be covered during this project. Some 22 people are normally resident in summer, and 13 in winter.

Cumberland Bay receives many ship calls year-round - principally fishing boats in winter and tourist vessels in summer. Some 7,800 tourists go ashore at a number of designated sites per annum, and almost all of them visit the museum in the Manager's Villa at Grytviken whaling station. Most of the ships anchor in King Edward Cove, but some, especially those

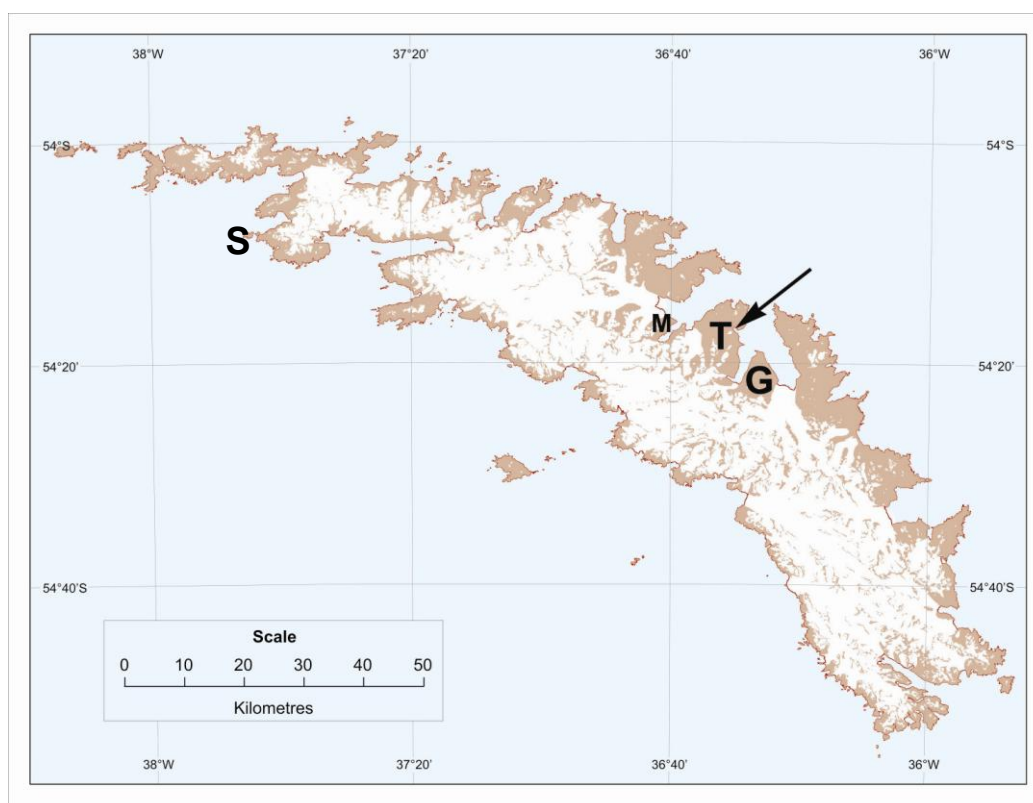
on Government, BAS or Royal Navy business, occupy the single jetty at KEP. The island also receives some tens of private yacht visits per year.

2.4 - Area of operation

This plan covers the operation required to eradicate rats from three adjacent areas of land on the central north coast of South Georgia, (Greene Peninsula, Thatcher Peninsula and an unnamed headland immediately west of Mercer Bay - collectively referred to as the Core Area), together with Saddle Island. Each will be referred to as a 'baiting zone'. The Core area is situated in Cumberland Bay. It surrounds the administrative and scientific base at KEP and the whaling station at Grytviken, site of the first permanent human habitation on the island.

Map 2 - Locations of the 2011 field operation

Arrow points to KEP/Grytviken. T = Thatcher Peninsula, G = Greene Peninsula, M = Mercer zone, S = Saddle Island.

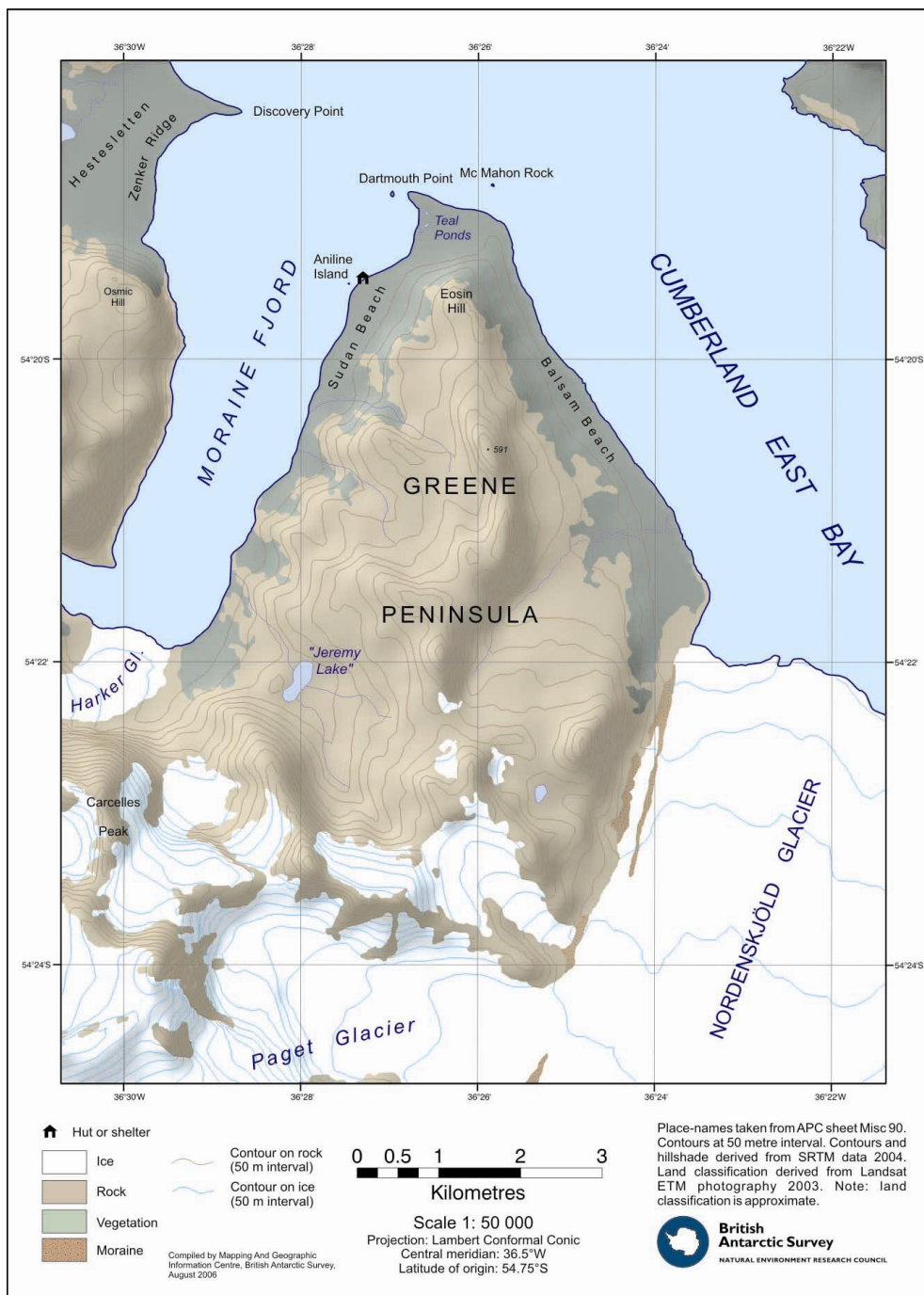


2.4.1 Greene Peninsula

Greene Peninsula occupies 4107 ha of ice-free terrain between the Nordenskjold Glacier and Cumberland East Bay to the east, Moraine Fjord and the Harker and Hamberg Glaciers to the west, with the central Allardyce Range creating a high, permanently iced barrier to the south. Within the proposed treatment area, the terrain reaches a height of 591m above sea level, but the mountains rise sharply inland, to 1000m-plus, and eventually to South Georgia's tallest mountain, Mt Paget at 2933m.

It is assumed that the glaciers to both sides are effective barriers to rat travel. This is demonstrated by the thin sliver of land between the Harker and Hamberg glaciers being the only rat-free area on the entire north-eastern coastline of South Georgia. DNA tests indicate that rats within the Greene Peninsula area are distinct from those in adjacent areas, suggesting the physical barriers have prevented intermingling of populations. Most other glaciers on South Georgia will permit rat movement to areas on either side of them because their termini do not reach the sea or have navigable areas of moraine or intertidal shoreline. It is on this basis that Greene Peninsula has been chosen as the most obvious first area for testing eradication methods on South Georgia.

Map 3 – Topography, Greene Peninsula



Greene Peninsula has low bird biodiversity with only 6-10 breeding species recorded (McIntosh & Walton 2000). The IUCN-classified 'Vulnerable' white-chinned petrel is present in a few small breeding colonies. McIntosh & Walton (2000) also record breeding southern giant petrel and snow petrel, and also the presence of gentoo penguin and northern giant petrel. The South Georgia pintail is recorded in low numbers, and Greene may be a key location for the sparse South Georgian population of speckled teal, though relatively few have been observed in recent years.

With rat eradication, the potential for recovery by smaller seabird species, such as prions, South Georgian and common diving petrels and possibly blue petrels is high (Poncet 2000). Antarctic prions are known to occur in the tiny section of land immediately to the west of Greene Peninsula, between the Harker and Hamberg Glaciers.

Greene Peninsula has comparatively diverse higher native plant assemblages, with 24 species (of the 25 taxa recorded on SG) being recorded in the area. This is significantly more than found on Bird Is, Cooper Is or other important ecological areas (McIntosh & Walton 2000). It also has significant diversity of cryptogrammic (lower) plant species, with 146 species of mosses, liverworts and lichens, amongst the highest diversity recorded for discrete areas, and comparable with Bird Island.

2.4.2 Thatcher Peninsula

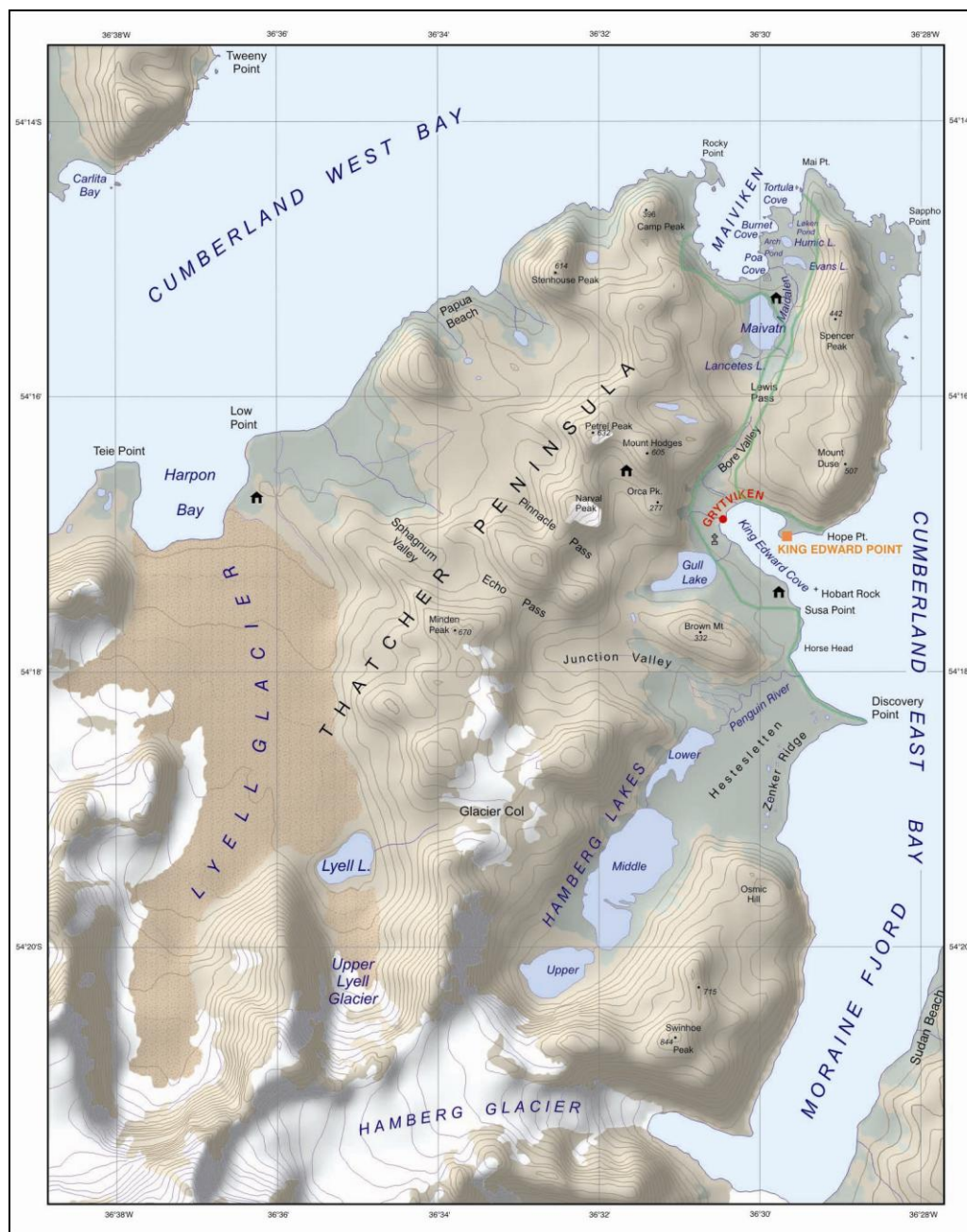
At 9510 ha, Thatcher peninsula is the largest of the three baiting zones to be covered during this operation. Only some 1620 ha is vegetated, however, and rat density is likely to be very low in the remainder. The highest point is the 844m Swinhoe Peak, but substantial areas of rock and scree lie at 300m or above.

This zone has 46.3 km of shoreline, much of it with a vegetated belt. This includes Maiviken, which has a substantial colony of gentoo penguins. The peninsula has a number of lakes and tarns, including Gull Lake, which provides the water for the hydro-electric scheme now powering KEP and Grytviken. Drinking and other domestic water for the buildings is drawn from the Bore Valley stream, which drains from the north.

The Thatcher baiting zone includes Teie Point, comprising about 150 ha of flat land and good tussac. Poncet (2000) reported 100-200 pairs of white-chinned petrel, 12 pairs of southern giant petrel, and a 'few' SG pintail here. Moulting king penguins were seen but there were no breeding colonies. Freed of rat predation, tussac-living birds such as burrowing petrels and pipits should recolonise this area.

King Edward Cove is a sheltered anchorage on the eastern side of Thatcher Peninsula, and along its shores are the only permanently occupied buildings on the South Georgia mainland. King Edward Point is the main base, and around the bay lies Grytviken, with a museum and church. Cruise ships often anchor in the bay. The baiting work will not pose significant dangers to visitors (standard operating procedures will ensure that helicopters do not overfly ships or tourists), and ship visits will continue during the operation. This will necessitate formal briefings for all ships' crew and passengers from the onset of flying operations throughout the period that bait pellets remain on the ground (probably the remainder of the visitor season).

Map 4 – Topography, Thatcher Peninsula



2.4.3 Mercer baiting zone

This headland comprises 1601 Ha, including rock-covered moraine, of which only 91 Ha is vegetated. It has a coastline of some 10.3 km. The glacier which separates it from land to the north, the Neumayer, is large and presumed to be impenetrable to rats. To the south, only the narrow Geikie Glacier separates the Mercer zone from Thatcher Peninsula, which is why these two areas of land must be cleared of rats at the same time. The straight-line distance from the Mercer zone to Grytviken, the operational base, is between 11 and 16 km. The shortest practicable flying route is over a 300m pass, and some 3km longer.

Much of the peninsula is of steep terrain, with scree and bare rock. It is likely that rat density is very low here.

Map 5 – Core Area baiting zones

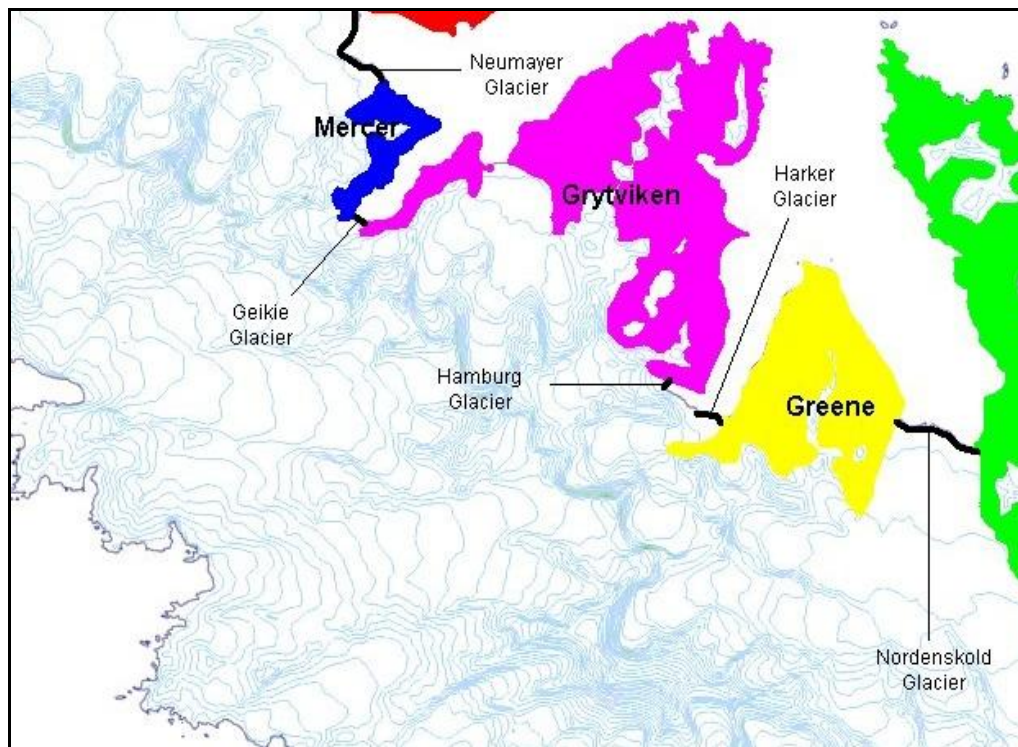


Table 1. Characteristics of the three baiting zones of the Core Area to be treated in Phase 1.

	Mercer	Thatcher	Greene
Glacier boundaries	Neumayer, Geikie	Geikie, Hamburg	Harker, Nordenskjold
Flight distance from KEP	14 km / 19 km	0 km / 15 km	5 km / 16 km
Available to rats	1601 ha	9510 ha	4107 ha
Area of vegetation	91 ha	1618 ha	852 ha
Unvegetated ice-free ground	1510 ha	7892 ha	3255 ha
Coastline length	10.3 km	46.3 km	14.2 km

2.4.4 Saddle Island

Some 2 km long and 106 ha in surface area, Saddle Island is situated 280 m off Wilson Harbour (Map 2), near the Northwest end of South Georgia. It is heavily vegetated, with steep sides. The straightline distance from Grytviken is 83 km, but avoidance of the highest parts of the Allardyce Range could demand a flight path of some 90-100 km.

Section 3 - Operational summary

Tables 2 - 5 show the key elements of this operation in all its phases (Planning, Preparation, Baiting & Post-baiting) and indicate essential project milestones to achieve the eradication of rodents from the Greene, Thatcher, Mercer and Saddle baiting zones.

Table 2 - Operational Summary – planning phase

Timing	Requirement	Responsible
completed	Establishment of a Steering Committee. The Steering Committee may be modified as required.	SGHT
completed	Recruitment of PD	SGHT, SC
completed	Conduct bait palatability trials on SG pintails to determine their likely vulnerability to significant levels of mortality due to consuming bait.	PD
completed	Specify & place contract for a report on the characteristics of all baiting zones on SG. Receive and review report to inform OP.	PD
completed	Develop a draft OP for the eradication of rats on Greene and Thatcher Peninsulas	PD
completed	Develop a draft Environmental Impact Assessment (EIA) for the eradication operation, and Initial Environmental Evaluations (IEE) for each baiting zone.	LP, PD
completed	Submit EIA and OP to GSGSSI for review by agreed date. ---KEY MILESTONE---	PD
completed	Source sufficient guaranteed funding and resources to complete Phase 1 of the SGHR project. ---KEY MILESTONE---	SGHT
completed	Identify & request in-kind support from GSGSSI for the sharing of resources, use of infrastructure, advice, personnel assistance in Stanley and on SG.	PD, SC, SGHT

Table 3 - Operational Summary – preparation phase

Timing	Requirement	Responsible
continuous	Update Operational Plan.	PD, IEAG, SC
completed	Select and appoint an Assistant Project Director (APD)	PD, SC
completed	Select and appoint a Chief Pilot and an Aviation Advisor	PD, SC
completed	Review all helicopter requirements for operation, including consumables & safety gear. Place orders for consumables. Purchase and ship safety gear.	PD, AA, CP, AO
completed	Assess and specify building work required to provide a hangar at Grytviken and move helicopters to and from it.	CP, PD, GSGSSI SC rep
completed	Select remaining field team	PD (CP/AA)
completed	Investigate insurance requirements, seek quotes and purchase	CEO, PD
By end Nov 2010	Send out contracts to field team	CEO, PD, AO
completed	Solicit tenders for bait; select bait supplier.	PD
completed	Decide on Jet A1 fuel contractor for operation. Place order.	PD
completed	Complete and submit to GSGSSI the Project's Plans for Health and Safety, SAR, Oil Spill Response, Crash Recovery, Monitoring and Biosecurity	PD, Contractor (Wiz Pasteur)
completed	First Readiness Check. Decide on whether to proceed with field ops in 2011 or delay by a year. ---KEY MILESTONE---	SGHT, SC, IEAG, PD, CEO
completed	Identify final bait requirement and place order. ---KEY MILESTONE---	PD
completed	Develop and sign a formal MOU between SGHT & GSGSSI covering issues such as provision of support for the project, cost & payment for services rendered etc	SGHT, GSGSSI, PD,
Completed	Select and purchase helicopters	PD, CEO, CP, AA, SGHT

By end Dec 2010	Investigate requirements for helo maintenance, seek bids, place contracts.	PD, CEO, AO, CP
Completed	Investigate CAA permitting requirements. Develop & submit appropriate documentation (including detailed helo operational Manual) to support application for Aerial Work certificate.	AA, PD, CP, AO
By end Jan 2011	Receive all necessary CAA permits/licences	PD, AA, AO
By 10 Jan 2011	Load helicopters onto MOD ship at Marchwood for passage to East Cove, FI.	PD, CP, HE, AO
By Nov 2010	Purchase and ship field operational equipment.	PD, AO, CEO
Jan 2011	Arrange for daily provision of weather forecasts	PD
Completed	Test designs for pintail VHF transmitters on captive birds; order transmitters and receiving equipment.	PD
By Jan 2011	Arrange for tissue samples from at least 20 rats to be collected and stored for archiving	PD/GSGSSI
15 Dec 2010	Second readiness check ---KEY MILESTONE---	PD, APD, CP, AA, Stanley rep
10 days before sailing	Third readiness check ---KEY MILESTONE---	PD, APD, CP, AA, Stanley rep
8 Feb 2011	Fly helicopters onto <i>Marina Svetaeva</i> in Stanley Harbour. Embark CP, PD, HE, Accommodation Manager, SFO. Depart for SG.	PD, CP, HE
16-18 Feb 2011	Load M.V. <i>Pharos</i> with personnel, equipment and supplies at FIPASS, Stanley. Depart for SG.	PD, APD, CP, AA, FO, VM
24-28 Feb 2011	Undertake procedures to secure human water supply	PD, BAS, DP

Table 4 - Operational Summary – baiting phase

Timing	Requirement	Responsible
Mid-late Feb 2011	Unload helicopters, fuel, bait and all other operational materials at KEP. ---KEY MILESTONE---	PD, APD, AA, FOs, CP, HE
Mid-late Feb 2011	Deploy VHF transmitters on 15 SG pintails	PD, FO
24-28 Feb 2011	Preparation for aerial operations. Set up VHF repeater station.	PD, APD, CP, AA, FOs
Mid-late Feb 2011	Prepare and test helicopters for flying ops.	CP, AA, HE
Mid-late Feb 2011	Testing of helicopter equipment. Calibrate bait bucket distribution.	PD, APD, CP, HE
March/April 2011	Aerial baiting operation in Greene, Thatcher, Mercer and Saddle zones.	Field team
March 2011	Hand-bait man-made structures at KEP and Grytviken. Hand-bait field huts.	PD, FOs

Table 5 - Operational Summary – post-baiting phase

Timing	Requirement	Responsible
March/April 2011	Release statement to media on completion of operation	SGHT, GSGSSI, PD
2-4 weeks after baiting	Locate duck transmitters to determine fate of birds post bait-spreading.	PD
By 2 weeks after baiting	Secure remaining fuel for use in following season	APD
End March/ early Apr 2011	At conclusion of field operations pack equipment (incl helicopters) and left-over consumables either for storage at Grytviken or transport to Stanley	PD, APD, CP, HE
April 2011	Transport personnel and equipment/supplies to Stanley	PD, APD, CP

By 1 st <i>Pharos</i> visit after baiting	Load unused bait onto <i>Pharos</i> for transportation to the Falkland Islands for use by Falklands Conservation or SG Surveys	APD/VM
By 1 st <i>Pharos</i> visit after baiting	Either secure helicopters for overwinter storage in hangar or load for transportation to FI, as necessary	HE, CP, AA
By end May 2011	Post Operational debrief of project & brief initial report.	PD, SC, SGHT
By end Sept 2011	Completion of full post-operational report & recommendations for Phase 2. ---KEY MILESTONE---	PD
End Oct 2011	Brief IEAG on Phase 1 operation & results	PD

Summary Abbreviations

AA -	Aviation Advisor
AO -	Administration Officer
APD -	Assistant Project Director
BAS -	British Antarctic Survey
BC -	Base Commander (KEP)
CEO -	SGHT Chief Executive Officer
CP -	Chief Pilot
DGPS -	Differential Global Positioning System
FO -	Field Officer
FI -	Falkland Islands
GSGSSI -	Government of South Georgia & the South Sandwich Islands
HE -	Helicopter engineer
IEAG -	Island Eradication Advisory Group (NZ Dept of Conservation)
PD -	Project Director
SC -	Project Steering Committee
SFO -	Senior Field Officer
SG -	South Georgia
SGHT -	South Georgia Heritage Trust
VM -	Vessel Master

Section 4 - Project management and staffing requirements

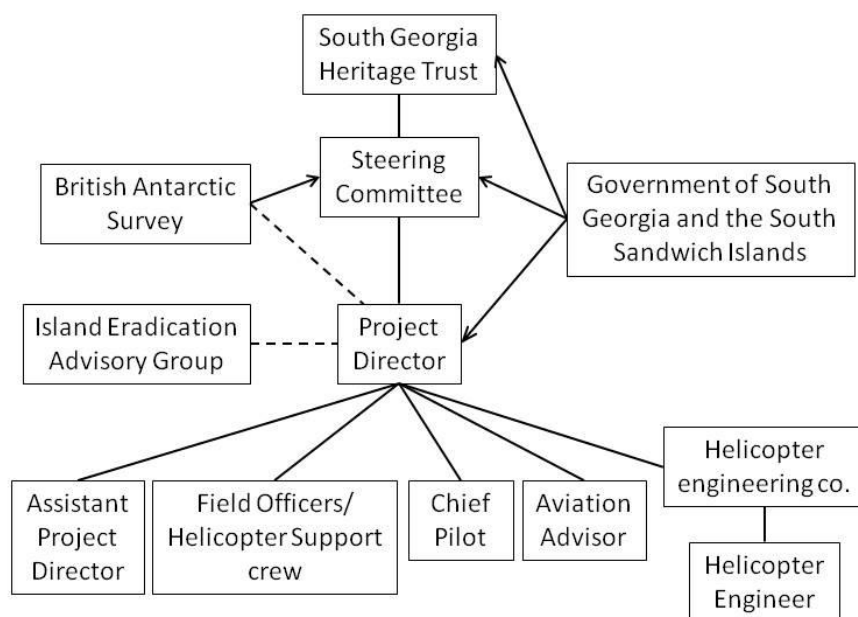
4.1 - Introduction

Figure 1 outlines the project management structure. By the standards of some other island eradication projects, this is a relatively simple matrix with few layers between the top of the tree and the bottom. This mostly reflects the fact that the South Georgia project is being administered by a non-governmental organisation (a UK registered charity), whereas those for Campbell and Macquarie Islands, for example, have been administered and funded by one or more publicly-accountable governmental agencies.

That said, those responsible for leading, organising and administering the South Georgia project are aware that standards to be set and met must at least equal those observed elsewhere. The current chair of the SGHT, the chair of the Steering Committee and the PD have all spent most of their careers in government service, and will use their accumulated experience to ensure that the SG project benefits from the best elements of government administration, while being freed of the less effective elements.

The project must also meet the requirements of, and will be influenced by, the GSGSSI. The objective is for this work to be carried out as a partnership between SGHT and GSGSSI. Excellent lines of communication, and a clear understanding of respective responsibilities and contributions, will be crucial to the successful completion of this project. To that end a formal Memorandum of Understanding has been signed between the Trust and GSGSSI.

Figure 1 - Organisational structure for this project. Dashed lines represent advisory links. Lines with arrows represent legislative, advisory and decision-making links.



4.2 - Project Staff

Suitably experienced and qualified staff are critical to the success of this operation. The following criteria must be met when recruiting staff.

- Highly skilled helicopter pilots with previous experience in eradication operations.
- Highly motivated and responsible staff with appropriate skills and experience and a commitment to the task they are undertaking.
- Staff responsive to living and working harmoniously in a small community for extended periods in remote areas.

4.2.1 - Project Director (PD)

A Project Director will be required throughout all stages of the project. The post has been full-time from January 1st 2010, i.e. 13 months before the project team is expected to arrive on South Georgia. The PD has overall responsibility for all planning, operational, logistical and budgetary matters relating to the project. The PD reports to the Steering Committee, comprising representatives of the SGHT, GSGSSI and BAS.

Managerial and operational requirements of the PD include:

- Promoting a culture of excellence, efficiency and delivery within the project team
- Keeping all stakeholders informed and involved
- Keeping the Operational Plan continuously updated
- Keeping the Environmental Impact Assessment updated
- Submitting the OP, EIA and other Plans to GSGSSI for approval
- Purchasing the helicopters and arranging for their transportation to South Georgia
- Coordination of all materials and equipment purchased for the operation and ensuring their secure storage until required for transportation to South Georgia

On South Georgia the PD will have responsibility for decision making for all aspects of the operation through consultation with a Decision Support Team comprising the APD, CP, AA and Senior Field Officer. External advice may also be sought from the Steering Committee and IEAG as required. During aerial baiting operations the PD will coordinate daily planning based on close scrutiny of daily flight line data and the weather forecast.

On return to the UK, the PD will write a comprehensive report on the operation, both to close this project and to prepare for Phase 2 of the SG rodent eradication programme which is expected to commence in Feb 2013.

4.2.2 - Assistant Project Director (APD)

The APD will have taken part in similar aerial bait-spreading operations elsewhere. With the Aviation Advisor (who will be similarly experienced), the APD will assist the PD in ensuring

that the South Georgia project is carried out as effectively and efficiently as possible, benefitting from lessons learned in other eradication campaigns.

The APD will advise the PD on a part-time basis in the year prior to the fieldwork, and will be employed full time during the fieldwork. The APD will supervise and participate in operations at the bait loading site and consider methods to improve field operational techniques. The APD will analyse daily flight line data and advise the PD on issues arising.

In the six months prior to fieldwork, the APD will be kept fully informed of key developments, and will be fully involved in decision-making, with the objective that he could assume the PD role in the event that the PD is indisposed prior to, or during, fieldwork.

4.2.3 - Aviation Advisor (AA)

The AA will be employed on a consultancy basis, as required, prior to the onset of field operations, then full-time (as pilot) until the conclusion of the project wrap-up. The AA will have responsibility for selecting and managing the Chief Pilot for this operation. The AA will advise the PD and SGHT on all aspects of helicopter operation and maintenance.

4.2.4 - Administration Officer (AO)

The Administration Officer provides administrative support and capability, assisting in equipment sourcing, invoice processing, field team coordination, shipping arrangements and stakeholder communications. The AO is nominally employed on a part-time basis, but works full-time during particularly busy periods.

4.3 - Field staff

The following personnel will undertake and assist in the fieldwork components of the operation.

4.3.1 - Chief Pilot

A highly skilled helicopter pilot will be required for the field ops period and periodically in the months prior to this. This pilot will be selected by the AA and PD in consultation.

4.3.2 - Helicopter engineer

An engineer with experience of the type of helicopter used in this operation will be employed by the maintenance company. When not occupied on priority duties, this person will help with refuelling and refilling the bait bucket.

4.3.3 - GPS/mapping specialist

This person will be familiar with the GPS system in use, and will coordinate the collection, storage and analysis of flightline data on a daily basis. He will advise the PD and CP of gaps in bait coverage so that they can be quickly filled. This team member will also be responsible for gathering weather forecast data at dawn each day, and for providing the PD and CP with a synopsis upon which a decision can be made for operations that day.

4.3.4 - Field Officers

Two staff will carry out a diverse range of field tasking, including servicing the helicopters in terms of filling the bait spreader and refuelling. They will coordinate the hand-baiting of the KEP/Grytviken buildings, and one will be trained in the setting up of the GPS unit and collecting and analysing daily GPS data from the helicopters, with a view to leading this work in the latter part of Phase 1 and all of Phase 2. The Field Officers will help carry out the monitoring of (a) bait distribution and density, and (b) impacts on non-target wildlife. They will report to the PD.

4.3.5 - Accommodation Manager

This person will have responsibility for all domestic services, including cooking, laundry, cleaning Larsen House and domestic waste disposal. If circumstances allow, this person will sometimes assist with bait-loading.

4.3.6 - Paramedic/doctor

The team will be under the care of a physician with exceptional fieldwork experience. This person will help coordinate the medical evacuation of any personnel injured in the field.

4.3.7 - Telehandler driver/boatman

Experienced in the handling of plant and boats at KEP, this person will be the primary bait loader when the helicopters return with an empty bucket. The post-holder may also be required to take charge of any boat-based S&R operation, and be on standby for boatwork as necessary.

Section 5 - Field Operational Preparations

5.1 - Coordination of equipment and materials in Stanley

As the jump-off point for South Georgia, Stanley is the location to which all equipment and materials will be sent at the outset. Here, our port agents (Sullivan Shipping) will receive the goods and store them securely in readiness for loading onto a ship at FIPASS. FIPASS is not rat-free, and consequently great care must be taken to ensure that rats have no possible access inside the containers to be shipped and that non-containerised goods are thoroughly inspected for possible rat ingress before loading onto a ship destined for South Georgia.

The vast bulk of goods to be shipped will be containerised and/or held in sealed drums (helicopter fuel).

At appropriate intervals, an audit/inspection of the stored goods will be carried out to ensure that everything expected to be in the Falklands has indeed arrived, and that everything is in good condition. Two Readiness Checks (see section 5.2 below) will be part of this process. The senior Field Officer acts as Stanley Representative to handle all matters there on behalf of the PD, and will be assisted by another Stanley resident who has particular responsibility for checking incoming equipment and biosecurity measures.

5.2 - Readiness Checks

The IEAG recommends the carrying out of a sequence of formal checks in the weeks and months prior to an operation commencing. By the standards of most eradication operations of its size, this project has been planned and assembled by a very small organisational team, so it will be particularly important to check that preparations are progressing satisfactorily, and to identify anything that has been overlooked or is running behind schedule. The first Readiness Check took place in September 2010 - some five months before the field team is due to embark from Stanley en route to South Georgia. It encompassed all elements of the Project, and was carried out by the PD and AA.

It is unlikely that all physical assets will be gathered in one place other than at KEP/Grytviken just before field operations begin, by which time it will be too late for most potential omissions or errors to be rectified. Readiness checks must therefore of necessity cover multiple locations. The second Check will occur 6 weeks before field operations are due to commence. Overall responsibility will reside with the PD, who will delegate (in writing to avoid misunderstandings) as appropriate to the APD, the AA and CP (for helicopter operational matters) and to an independent assessor in Stanley for equipment and supplies already in the FI. The latter could appropriately be a GSGSSI representative on the SC.

The third and final Check will occur 10 days before departure of the MV *Pharos* from Stanley to KEP with the bulk of personnel and supplies aboard. This will allow time for last-minute deliveries by air. This check will be made by the PD, APD, possibly a member of the IEAG and one other (again possibly a GSGSSI rep on the SC).

Section 6 – Transportation

All materials, equipment and personnel for the SGHR project will be shipped to South Georgia from Stanley in the Falkland Islands, some 3-4 days sailing time to the west. There are no facilities for aerial resupply at South Georgia, although in emergency the Royal Air Force has previously been persuaded to make a drop of equipment parts into Cumberland Bay, for collection by boat. That facility may be available to the project *in extremis*, but must not be expected nor planned for.

6.1 - Gathering material and equipment in the Falkland Islands.

The fastest and/or most economical route and method will be used to ship goods to the Falklands. Air freight is delivered once per week via Chile, and can be flown on the RAF airbridge from the UK at least weekly by prior arrangement. Sea routes are available via Marchwood, UK and Rio Grande do Sul (Brazil). The greatest bulk is represented by the bait, the helicopters and the helicopter fuel. The bait has a limited shelf life, so manufacture, land transportation and shipping will be coordinated to minimise the length of time between manufacture and sowing.

On arrival in the Falklands, all goods will be securely stored until being needed for loading *en route* to SG. Facilities for this are available at FIPASS, but other locations may prove better and/or cheaper and will be investigated in good time before operations commence. Most material will remain as originally packed, but the helicopters will have their rotor blades

refitted and be flight-tested before being flown onto a ship (Marina Svetaeva) for onward passage to SG.

The bait will arrive in the Falkland Islands packed in seven 20-foot shipping containers. The bait itself will be sealed to prevent ingress of moisture and insects, but the containers will not be sealed. If possible, the containers should be stored somewhere clear of earwigs - possibly on FIPASS - and stacked to provide the smallest possible contact with the ground. Prior to loading onto the *Pharos*, the containers will be fumigated against insects.

6.2 - Transportation between FI and SG.

Ships of GSGSSI and BAS routinely travel on this route and can be used to transport material and personnel. In addition, many tourist vessels make the same journey, and may be available to ferry personnel and small items of freight by prior arrangement.

The primary means of transporting bulky material to KEP will be the GSGSSI's M.V. *Pharos*. This ship makes the trip monthly, and can handle palletised goods as well as up to six 20' shipping containers. The BAS ships RRS *Shackleton* and RRS *James Clark Ross* (JCR) are also available to transport palletised and containerised goods to KEP, though their movements are less frequent and irregular. All three ships routinely berth at the dock at KEP in a very sheltered bay, and offload freight using their own heavy-lift cranes. Consequently it can be assumed that freight consigned to these vessels will be delivered to KEP in less than a week unless a very rare event such as engine or crane failure occurs.

Bait must be kept isolated from fuel to prevent any risk of contamination. The bait will be kept in steel shipping containers until reaching Grytviken. Fuel will be transported in drums to KEP, although there may be a necessity to palletise them in Stanley for loading on the *Pharos*.

6.3 - Biosecurity: minimising the risk of transporting alien organisms

A separate Biosecurity Plan has been completed (SGHT 2010c). Standard GSGSSI biosecurity procedures will be followed to prevent people, goods or equipment importing organisms to South Georgia. Additional measures will be required for non-standard circumstances, such as the importation of a helicopter. The measures will include:

- briefing all personnel on the dangers of accidental biological importations and what actions they must take to avoid this
- baiting of boxes, containers and any other receptacle to which rodents could gain access, prior to leaving the Falklands
- Fumigation of all shipping containers transported to KEP against insects.
- rigorous inspection and cleaning of clothes, footwear, daypacks and other personal gear
- use of quarantine building at KEP for unpacking of supplies and equipment where possible

- bleaching and cleaning of helicopter skids prior to arrival at KEP
- vacuum cleaning of helicopter cabin, including seats

6.4 - Removing material at the conclusion of the 2011 operation

Any material or equipment to be removed from SG at the end of the season will be consigned to the *Pharos* for transportation to Stanley. This may include unused bait and the helicopters, which may subsequently be used in the Falklands. If the helicopters are needed there for bait-spreading operations it is likely that the bait buckets will also be transported at the same time.

Section 7 - Team living arrangements and medical care

7.1 Feeding and Accommodation

Larsen House, within the base at KEP, will be the main accommodation unit for the project. It can house eight people in twin-bedded rooms, and has a kitchen and dining area. Three further bed spaces will be found in the main BAS base, museum buildings or elsewhere by arrangement with GSGSSI, the BAS Base Commander or museum staff.

Food was ordered through the BAS base well in advance of the season commencing, and has been delivered to KEP. The Accommodation Manager will cater for the project team in Larsen house. This person will also be responsible for maintaining the cleanliness of Larsen House and ensuring that base procedures are followed in the disposal of the domestic waste.

7.2 Medical care

By arrangement with BAS and the BAS Medical Unit (BASMU), the Project Paramedic will be supported by the KEP base doctor and have access to the well-appointed surgery at KEP. All consumables will be either brought in when Project staff arrive, or replaced quickly at the conclusion of the fieldwork.

Section 8 - Brodifacoum Bait

8.1 - Source of bait & quantity required

A key factor in the success of this project will be the use of toxic bait that is effective, of high quality and of predictable physical characteristics for spreading. Variations in pellet density or size, or the density of brodifacoum between batches, could cause the project to fail. Bait for Phase 1 of the Project will be supplied by Bell Laboratories (Wisconsin, USA) - a company with a growing reputation for providing bait for successful pest eradication operations worldwide.

Some 44 tonnes of brodifacoum bait are estimated to be required to undertake this eradication operation, including 0.6 t for bucket calibration. A further 22% of this figure (taking the total to 56 tonnes, or 7 shipping containers) will be ordered to allow for contingencies such as bait damage or deterioration, substantial bad weather requiring more

bait re-sowing than expected, or a greater area to be covered due to glacier retreat since the most recent mapping.

8.2 - Bait specifications

Specifications of the bait required include detailed documentation of

- Bait formulation including size, weight, toxic loading, Bitrex exclusion, moisture content, colour, hardness and the maximum permitted fragmentation.
- Packaging and delivery standards.
- Supply date.
- Bait packed on new, clean and certified kiln-dried pallets.
- Secure storage of consignment throughout production.

8.3 - Mould Issues

Mould on bait could, in extreme circumstances, compromise the success of the operation. The following considerations will be implemented to minimise mould issues:

- Weatherproofing and condensation protection of the bait through all transportation phases.
- Security of the bait during transportation to South Georgia by placing the bait bags, on pallets, in shipping containers.
- Provision of dessicant bags within each pallet-load.

Monitoring for mould growth on the inside of containers and on bait bags will be undertaken whenever practical, and in dry conditions.

The bait has been ordered and manufactured. At the time of writing (mid-November 2010) it is en route to the Falklands by ship. The bait is in paper sacks stored on pallets and sealed against moisture ingress. The containers in which it is stored were steam-cleaned before packing.

8.4 - Bait storage on South Georgia

On arrival at KEP, the bait will be transported to Grytviken on pallets, where it will be put into containers and stored until required. The bait will not be moved unnecessarily, to minimise the risk of damage.

Section 9 - Bait broadcasting operations

9.1 - Overview

The helicopters will conduct aerial baiting guided by a Geographical Positioning System (GPS) to ensure accuracy of coverage. The helicopters will sow the bait using an underslung broadcasting bucket fitted with a mechanised spinner which throws the 12.5mm 3g brodifacoum baits out to an effective swathe width of approx 80 metres (40 m either side of helicopter flight path). Normal operational height during sowing is 150 - 500 feet above ground level, but this can be varied according to the prevailing wind speed and direction, ground topography and proximity of sensitive wildlife concentrations.

To minimise the risk of errors, the baiting strategy will be kept as simple as possible. Sowing runs will normally be parallel straight lines, beginning and ending at the coast. When large lakes are encountered, their margins will be treated in the same way as the marine coast. Spreading will commence and stop as the aircraft crosses the coastline. To ensure complete coverage, every coastline (marine and freshwater) will have an extra dedicated run along its margin, designed such that the outermost edge of the sown strip is just in the water. There is no measurable environmental risk in this (DOC 2009), and such a run will mitigate the considerable risk of leaving bait gaps in favoured rodent habitat. A deflector will be fitted for these runs, providing a sharp 'edge' to the pellet distribution pattern and consequently ensuring that minimal bait enters the water and is wasted. The deflector halves the swathe width, and doubles baiting density. There is often a steep incline near the coastline, and coastal areas are favoured by rats, so the double-density treatment here will be greatly beneficial.

The aim will be to maintain a single rolling front (bait sown systematically to avoid target species entering previously treated areas), which normally moves daily. A strategy will be in place to deal with circumstances in which weather or other operational circumstances prevents the front moving almost continuously.

9.2 - Island field operations prior to baiting work

These include:

- Setting up and testing the VHF repeater
- Operational staff briefing updates and field training.
- Disconnection of any field hut guttering used for drinking water.
- Carrying out a SAR exercise.

9.3 - Daily operational decision making

Decisions on aerial operations will be made between the pilots and PD or delegate at first light each day. Given the limited hours of light and the need to use all available windows of opportunity, all staff will be prepared daily for aerial operations on short notice, i.e., as soon as possible after flying operations have been confirmed. The entire team will remain on stand-by (within station limits) until otherwise informed by the PD or delegate.

The following actions will be undertaken daily for the duration of aerial broadcasting operations:

- Receive latest weather reports.
- On-site weather assessment with pilots as soon as possible after daylight.
- Liaise with Government Officer and KEP Base Commander regarding proposed operations and potential conflicts with other activities in the operational area (evening prior).
- Notification to field operational team of plan for the day.
- Assess action and logistic requirements for next day (evening prior).
- Assign team members to tasks for next day (evening prior).

9.4 - Prescription rates

Given the sheer scale of the proposed island-wide operation (for which Phase 1 will be used as a trial), rat eradication on South Georgia needs to be practically feasible and financially efficient without significantly compromising the prospects of success.

For the following reasons, bait densities normally used on more temperate islands are likely to be a substantial overkill for South Georgia:

- Rats on South Georgia are strongly allied to the coast and tussac, although rat sign is also found inland
- Home ranges are very large, with diameters of over 400m apparently common
- Rat densities away from favoured (coast and tussac) habitats are very low, and home ranges are expected to be even larger than in prime habitats
- There are very few non-target species (and individuals of these species) that will consume significant bait quantities. Reindeer are an obvious exception elsewhere on South Georgia, but do not occur in the areas to be covered by the current operation.

The proposed baiting application for this project is substantially based on the successful Campbell Island operation, which offers the nearest equivalent to South Georgia in terms of islands previously treated. We will sow bait at densities close to those used on Campbell Island in areas of dense vegetation favoured by rodents, and apply a reduced rate in non- or sparsely-vegetated areas where rodent density is known to be very low. Bait densities used on Campbell Island and elsewhere take account of the effect of slope. The bait will be sown in two passes. The first pass will cover all rat-accessible terrain at a standard density of 2 kg/ha (except for a narrow coastal strip of 4 kg/ha due to the deflector - see 9.1 above). The second pass will cover only those areas of dense vegetation, at an average of 4.5 kg/ha, and will occur some 5-7 days after the first pass. The purpose of the interval between passes is to allow most or all rats to be killed by Pass 1, and consequently allow any mice or subordinate rats in the area to have uninhibited access to bait sown in Pass 2.

Pass 1 will comprise:

- A single application of 2 kg/ha for all land not covered in permanent ice, with no overlap between adjacent runs.
- One narrow (40m) 'headland' run of 4 kg/ha along every coastline (marine and freshwater), with the outer margin of the swath just entering the water. This is designed to fill any gaps inadvertently left by the spinner being switched off at the end of a swath, and to concentrate bait in the often rising ground near sea level that is favoured by rats.

Pass 2 will comprise:

- Parallel runs of 4kg/ha, with 10m overlap (giving an average of 4.5 kg/ha overall), over all areas of dense vegetation.

This will ensure that key rodent habitat (i.e. shoreline and tussock) receives bait at or above the density that brought success on Campbell Island, and that no rodent should be more than a few metres from a bait pellet.

The weight of bait distributed is likely to be more than the total biomass of rodents in the treatment area. When it normally takes only 1-2% of bodyweight in bait to kill a rat, current knowledge of rat ecology on South Georgia indicates that the proposed sowing rates should be more than sufficient to ensure eradication of the target species.

An earlier proposal for a lower baiting rate of 1.3 kg/ha in non-vegetated areas and runs centred 180m apart to minimise cost (SGHT 2009a) was attractive, but eventually rejected in favour of the above strategy. The proposed gap of 100m between baited strips may well be too large to provide a high probability of eradicating house mice (*Mus musculus*), a species which may occur undetected at low densities in areas with rats and could increase in number if they survived and the rats were removed. Nonetheless, in extremis (such as long periods of non-flyable weather risking completion of a baiting zone) eradication of rats should still be very highly probable if 40m gaps between swaths were left in areas with no vegetation, i.e. average bait density was reduced to 1.3 kg/ha. In such circumstances, no rodent would be more than 20m from plentiful bait pellets, a distance well within a rat's home range and plausibly within that of any mice living in such impoverished habitat.

Table 6. Summary of bait quantity and flying time required to carry out the eradication of rodents from Greene, Thatcher and Mercer and Saddle baiting zones, with no contingency for damage or exceptionally poor weather.

	Area (ha)	Bait quantity (t)	Flying time (hrs)
All ice-free land within the baiting zones at 2 kg/ha, including an additional 'headland' run along the margin of every coastline (marine and freshwater) to cover any gaps where spinner is turned on and off. The latter involves a deflector to 'bounce' half of the	15,300	31.8	47

swathe back to the opposite side and thereby double the 'on ground' bait density to 4 kg/ha.			
All areas of vegetation covered at 4kg/ha with an additional 10m overlap between swaths (giving 4.5 kg/ha overall)	2667	11.9	14
Contingency for repeats (6 occasions x 3 runs of 4km)	576	1.7	4
Bait bucket calibrations		0.6	1
TOTAL		46.0	66

9.5 - bait buckets

Some 150 litres of 4-stroke petrol for spreader buckets will be required, based on a usage rate of approximately 2 litres for each hour of operation. This quantity (with a 30% contingency) will be sourced in Stanley. To avoid the risk of losing the entire quantity through damage to one container, the petrol will be stored in 10 x 20-litre approved containers.

9.6 - Boundary definition

Although recent maps of both baiting zones are available, inter-annual changes in the perimeter of glaciers and other permanent ice will necessitate visual inspection and GPS tracking of the interface between areas potentially occupied by rats at the time of bait-spreading and those not occupied. Furthermore, the limits of dense tussac must be defined using the same technique in order to determine which areas should be sown at the higher bait density. Consequently, the PD, APD and both pilots will fly all boundaries prior to bait-sowing in each zone. The PD and Decision Support Team will then agree baiting boundaries to be loaded into a digital map of each zone, and these will be used to generate flightlines for bait-spreading.

9.7 - Timing of baiting operations

A winter campaign is normally preferable for several reasons, but the weather on South Georgia at this time of year would very likely prevent a successful operation. Not only would flying be dangerous or impossible on many days, but the depth of snow cover could prevent rats from encountering the bait. Consequently, fieldwork is planned for late summer and autumn – from mid-February until the end of March (and extendable until late April if necessary). This period should see little settling snow, and the breeding seasons of most wildlife will have been completed. The few data on seasonality of rat reproduction on South Georgia (Pye and Bonner, 1980) indicate that litters are produced mostly or entirely in summer (Dec-Feb), consistent with the subsequent onset of near-freezing temperatures and a diminishing food supply. In other regions with considerable seasonal variation in food supply and temperature, the reproductive rate of brown rats is greatly diminished (Calhoun, 1963).

The successful clearance of rats from Grass Island in summer (November 2000) provides a local demonstration of ability to eradicate rats at other than 'optimal' times of year (Poncet 2001).

9.8 - Bait loading operations

Bait loading will be via a bulk bag carried by the telehandler. The telehandler driver and two further personnel will receive the empty bucket and release the bait into it from the bulk bag via a drawstring. In the event of mechanical failure of the telehandler, a second machine will be available and kept on standby.

Prior to the arrival of the aircraft, these three people and one other will have opened 18 x 25kg paper bait bags and deposited their contents into the bulk bag, giving a total of 450kg. The empty paper bags will be collected and secured for later disposal before the helicopter arrives for reloading.

All personnel will pay particular attention to ensure that no materials are drawn into the aircraft rotors or air-intakes, and that the bulk bag is controlled when empty and affected by helicopter downwash.

Two bait-loading teams of four people each will alternate duties in order to provide continuous cover during meal breaks and allow rest periods without costing any operational down-time.

9.9 - Public safety and health

The EIA for this Project (SGHT 2010a) and the Health and Safety Plan (SGHT 2010b) cover Health and Safety issues relating to the spreading of toxic bait. They should be read in conjunction with this document.

All personnel living at KEP/Grytviken will be fully briefed about the operation, its purpose, logistical elements and dangers. They will be informed about the bait and the steps taken to ensure no risk to their health. Notification regarding brodifacoum anticoagulant use will be placed in conspicuous places around the KEP station and Grytviken museum prior to baiting operations.

Actions will be implemented to safeguard the integrity of drinking water supplies (Section 9.12.1) and the wellbeing of all personnel on the island throughout the operation. These actions are outlined further in the EIA.

Prior to helicopter operations, the Chief Pilot and PD will brief the loading teams on safety and familiarity of the aircraft and associated equipment. Safety equipment and clothing will be provided and worn by all members of the bait loading teams. A first aid kit will be available nearby, but anything other than the most minor injuries will be referred to the team doctor.

Cruise ships will deliver tourists to KEP/Grytviken throughout the project duration. Ship operators will be informed of the project before the season begins. All tourists will receive printed information about the Project in their GSGSSI 'welcome' packs and will be briefed on the purpose and practicalities of the work before they step ashore. These briefings will include a short Powerpoint presentation (developed by the PD) given by ship staff, the

Government Officer, or a member of the project team. The briefing will include a description of the bait pellets and their toxicity, and a request not to touch any pellets encountered. No bait spreading will occur in proximity to tour ship visitors ashore. A suite of Standard Operating Procedures will include the prohibition of helicopters overflying exclusion zones around tour ships and their passengers ashore.

9.10 - Weather forecasting

Accurate weather forecasting is essential to identify all potential windows of reasonable weather opportunity and thus maximise operational efficiency. Inclement weather conditions are likely to be the limiting factor in terms of the speed of coverage, and could ultimately cause the project to fail.

The following resources are available on the BAS intranet, which is accessible at KEP:

1. Meteogram 5-day projections, updated twice a day.
2. Surface pressure and wind charts; 12, 36 and 72 hour forecasts. Updated every 12 hours.
3. Ozone charts.
4. Grib files.
5. Satellite photos, updated several times a day.

In addition, actual weather is shown and recorded on equipment at the KEP Base.

If required, one of the weather forecasting team at the BAS base at Rothera may be tasked to provide a daily synopsis for South Georgia. Whether or not this service is required will be resolved between the AA, CP and PD.

Wind, rainfall and visibility are all crucial elements in dictating whether the helicopters can fly, and whether bait should be dropped. Area forecasts will be useful in predicting both, but the topography of South Georgia often produces very different weather in locations separated by short distances. The project team will consequently need to be alert to unexpectedly good, or unexpectedly bad, weather occurring at almost any time, and to have in place protocols to react appropriately to both. These will best be decided on location and developed in light of experience.

9.11 - Priority of zones

Greene Peninsula will be treated first to ensure that at least one substantial and ecologically important zone is completed no matter how bad the weather. Subsequent priorities will also be largely determined by weather. Mercer zone is small enough to be baited in a single day, and might be available even when progress cannot be made on Thatcher Peninsula. Saddle Island is of lower priority, and will only be treated if time and other resources allow, and if treatment of the Core Area is not compromised.

9.12 - Hand baiting

Advice from the IEAG is that hand-baiting is a less dependable means of eradicating rodents than aerial broadcasting. Consequently, hand-baiting will only be employed in areas

inaccessible to helicopter drops. On Greene and Thatcher Peninsulas this applies only to made-made structures at Grytviken and KEP, and to a small number of field huts.

A checklist of all such structures will be compiled and used to ensure that every structure is treated. All spaces will receive bait, including those under buildings, under floors, in walls, ducts and attics. Special care will be taken to adequately bait the remaining old buildings at Grytviken, including the church and museum, because they may well have awkward and unknown spaces in which rats have been living for many decades. This will be a painstaking and time-consuming task, and adequate time must be allocated to it. Hand-baiting will occur within 48 hrs of aerial baiting in the same vicinity. Plentiful quantities of bait will be deposited to avoid the need to routinely replenish bait stations. A check will be made of each such station some 7 days after their establishment.

Special measures will be taken to ensure that food stores are secure against rodent ingress, and that no food is accessible in rubbish bins etc.

The buildings at KEP have only very short lengths of guttering to protect people passing through external doorways, and none is used for drinking water catchment. Tasked personnel will remove any bait pellets remaining in the guttering some 7 days after sowing.

9.12.1 - Station water supply

Immediately following the aerial bait drop, staff will follow the main water systems feeding the dam and remove any bait within two metres of these waterways. A week and two weeks following the bait application a search will be made for animal carcasses within 20m of the water supply, and these will be removed. Following the bait application, the dam will be flushed as part of its annual maintenance program, the pipe inlet filter will be cleaned, and then it will be allowed to refill. Cotton filters in each of the buildings will be replaced at weekly intervals for a month after baiting. Brodifacoum is insoluble in water (see EIA), and the amount of sediment from bait pellets entering the KEP/Grytviken water supply should be many orders of magnitude lower than that necessary to cause illness, even if no filters were fitted. The measures described above are consequently related to the *perception* of risk, rather than to the risk itself, and are based on the approach to be followed by the Australian Antarctic Division during the bait-spreading operation on Macquarie Island in 2010 (Springer, 2008).

9.12.2 - Field Huts

To minimise food availability to rodents, all food and all rubbish in and around field huts will be removed or thoroughly secured against rodent ingress prior to baiting.

Any field hut downpipes feeding rainwater tanks will be disconnected and their inlets covered prior to aerial baiting operations commencing. Following the aerial bait drop, all baits will be cleared from guttering. Water tank inlet pipes will be reconnected after at least 25mm of rain has washed clean the hut roofs.

9.12.3 - Vegetated islets within lakes and tarns

Any such areas will be specifically targeted for rodents in case they are either large enough to support an ongoing rodent population or are accessed by rodents when connected by ice

bridges when lakes freeze. To be certain that small islets have received bait, it may be necessary to deliver some by hand from a helicopter.

All possible efforts will be made to minimise the amount of bait entering lakes or tarns, though not at the risk of failing to bait some areas of land.

9.12.4 - Offshore rock stacks/skerries

All vegetated rock stacks and skerries will be treated, if necessary by delivering bait by hand from a helicopter. A checklist of all such sites will be compiled before the operation, against which treatment will be checked.

9.12.5 - Caves

Any caves large enough and potentially with adequate food resources to allow rodents to remain within them should be identified and hand-baited. Some caves are known to occur in the Phase 1 area of operations, and will be investigated with a view to treating them separately

9.12.6 - Wrecks and hulks

All whaling vessels at Grytviken will be hand-baited, and wrecks will be investigated to establish whether they could hold living rats. If so, bait will be dropped on them by hand from a hovering helicopter.

9.13 - Other operational issues

9.13.1 - Cliffs and slopes >50°

Aerial baiting operations on cliffs and slopes >50° present a particular challenge on South Georgia because of the unpredictable and often severe wind conditions. These areas will therefore be flown as a priority in relatively calm and clear conditions, consistent with maintaining a manageable rolling front between baited and unbaited areas. Where steep slopes are low and near the coast, they are normally vegetated with tussac and are favoured rodent habitat. They would consequently receive relatively high bait density (see section 9.4). If they are high, they will likely be unvegetated, have very low densities of rodents and will receive bait at the density of 2 kg/ha (section 9.4).

Very steep slopes (>70°), especially those involving cliffs rising directly from the sea, demand special treatment. These will be tackled using a deflector on the bucket, and with the pilot ensuring by eye that pellets land and remain on all vegetated ledges.

9.13.2 - Lakes

A number of substantial bodies of fresh water occur in the three baiting zones. In most circumstances the most effective way of dealing with them, yet avoiding gaps in bait coverage, will be to continue the flight line without deviation, but to shut off the bait flow at the near margin and start it again at the far margin. This should occur even if only part of the swath would otherwise enter the water. Subsequently, the helicopter will make a separate

and continuous baiting run around the edge of the lake, with the edge of the swath just entering the water (see section 9.4).

9.13.3 - Snow

If snowfall occurs immediately after aerial broadcasting operations and covers the bait, the initial response will be to observe the amount of time the bait is covered and check bait quality on the ground after the snow has melted. In the case of bait sown onto an existing ground cover of snow, the response will depend upon how long the snow has been present, over what area, and the bait's condition (sign of bait decay). If snow is present for >1 week, it is likely the area will require re-sowing. Decisions relating to these scenarios will be assessed by the PD in consultation with the Decision Support Team.

9.13.4 - Sensitive wildlife sites

A successful baiting operation depends on sufficient bait being distributed to be accessible to every rat. The use of helicopters to broadcast bait is recognised as the best method to achieve this. It is acknowledged that helicopter noise during spreading operations has the potential to disturb wildlife colonies. The issues of disturbance need to be weighed against the ecological benefits of succeeding in this, as in every eradication operation.

Trials on South Georgia, Macquarie Island and elsewhere have demonstrated that the type of flying required by aerial bait-spreading operations should not cause damaging disturbance to wildlife if some simple rules are observed (SGHT 2009b). The only potential for causing the deaths of significant numbers of birds is when operations are close to breeding colonies, especially those of king penguins. To mitigate disturbance issues, pilots will be briefed each day by the PD or APD on all areas where aerial operations may cause disturbance to native species. There is one, very small, king penguin breeding colony within the operational area of this Project (at Penguin River near Grytviken). Helicopter flight lines will avoid this colony, and bait will be spread over it at an altitude of 500 feet, with an observer on the ground noting the reaction of the penguins.

9.14 - Baiting strategies following a break in operations

On resumption of baiting operations following interruptions due to climatic or other operational impediments, the following strategies (adapted from the Campbell Island Eradication Plan 2001) will normally be implemented:

- Flying continues the following day – no buffer area required.
- No flying for 1-3 days since last application – Two swathes with no overlap (total of 160m) will be flown immediately behind the front.

No flying for 4+ days. Three swathes with no overlap (total of 240m) will be flown immediately behind the front.

Potential bait reapplication circumstances will be assessed on a case-by-case basis by the PD in consultation with the Decision Support Team on the island.

9.15 - Post daily aerial operations

At the close of each day's operations, the following actions will be undertaken:

- Tally of the number of bait bags used.
- Downloading of GPS data and production of flight line maps.
- Disposal of all rubbish generated from daily operations, e.g. bait bags.
- Storage of empty fuel drums.
- Daily review and debrief of operations with all team members, including reporting and discussing accidents or near misses.
- Options and priorities listed for next available flying period.

An analysis of the accuracy of each bait application will be monitored at the close of daily aircraft operations. The PD, APD and pilots will analyse flight line imaging, made available by downloading GPS data from the aircraft. Any obvious gaps or doubts in the quality of sowing operations will require a follow up application of that particular area at the next available opportunity. Pilots can return to any operational area with extreme accuracy using the GPS system.

Analysis of flight lines should be achievable on a computer screen but, if hard copies are required, the facility to print them should be available on the KEP base. The PD will need to clarify the availability of this equipment to the project team as part of the tripartite discussions with BAS and GSGSSI.

Section 10 – Helicopters & helicopter operations

10.1 - Introduction

South Georgia represents one of the most extreme environments in which helicopters can be flown. Plans and operations must consequently take full account of the remoteness of the island, its harsh and fickle weather, mountainous terrain, paucity of human habitation, lack of existing hangar facilities and abundance of wildlife areas sensitive to disturbance.

Most of these concerns have been addressed by limiting the first phase of the SGHR project to areas adjacent to the only site of permanent human habitation on the main island, where the weather is generally less hostile than in most other parts of SG. The vast majority of the terrain to be covered by aerial bait-spreading is within 10km of the operational base at Grytviken, and no areas are more than 16km distant. This is important for communications and safety during this first year of operations.

The second element of risk reduction involves the choice of aircraft type. The requirement is for a rugged, reliable helicopter which handles well in strong winds and preferably has two engines. These requirements are met by the Bolkow 105, a 4-bladed German-built light helicopter which has a proven track record with emergency services and the offshore oil industry, is twin-engined and has a rigid rotor head, allowing shut-down in wind speeds

higher than those tolerated by most other models. This operation will be flown with two such aircraft.

The remoteness of South Georgia prevents replacement of an operational helicopter within an adequate timeframe. Consequently it is imperative that all possible steps are taken to minimise the risk of a major mechanical breakdown or accident leading to a permanent grounding during the operation. To this end, the risk of mechanical failure has been minimised by selecting an aircraft type of proven reliability and, further, by ensuring that no time-limited parts are near the end of their operational life. The risk of accident due to pilot error will be minimised by employing pilots with a wealth of relevant experience.

Helicopter operations during this Project will be flown subject to strict Standard Operating Procedures which will be designed to minimise risk to crew, KEP residents and visitors. These will include, for example, prohibition of overflying cruise ships.

10.2 - Operational considerations

In order to maintain a safe and efficient helicopter operation, the following requirements must be observed:

- Prevention of fatigue and operational down time in good weather by not over-working the two pilots.
- Protection of the helicopters from the effects of salt, sand blasting, storms and wildlife damage.
- Provision of adequate fuel to complete the full operation safely.
- Availability of skilled and responsible support personnel for refuelling & maintenance.
- Availability of comprehensive list of spare parts for maintenance and repair.
- Availability of aircraft wash-down facilities to reduce the build up of salt.
- Familiarity of all personnel with the aircraft and all operational safe working practices.
- Security of all rubbish and materials by operational personnel working around the aircraft during aerial baiting operations.

10.3 - Helicopter Storage

10.3.1 - Day to Day

A secure tie-down facility will be installed at the location where the helicopters routinely land to be refuelled. This will be on the concrete base near the hangar. This facility can be used to secure the aircraft quickly, or in normal circumstances when flying operations are to continue same day. Overnight, for servicing, or when severe weather is predicted, the helicopters will be manoeuvred into the hangar using purpose-made travelling wheels (with pneumatic tyres) attached to the skids and a towing trolley.

10.3.2 - Hangar

No purpose made hangar facility exists on South Georgia, but the Engineer's Workshop at Grytviken whaling station is large enough to offer secure storage and protection for two helicopters, and would provide a dry space in which the engineer can undertake maintenance work. Recent refurbishment of this building by GSGSSI has made it watertight. Lighting and heating will be provided via an existing diesel-powered generator and a space-heater. The workshop has a doorway inadequately large to receive a 4-bladed aircraft, so the blades will be folded before the aircraft are hangared. This process requires two people and ten minutes per helicopter.

During an inspection in April 2010 by the AA, PD and GSGSSI Clerk of Works, the only work identified as needed before helicopter operations could proceed was a horizontal pad immediately outside the doorway. This was established under GSGSSI supervision in December 2010.

In the event that facilities in the Engineer's Workshop are inadequately warm, wind-proof or clean for a particularly delicate repair job on a helicopter, the boatshed at KEP may be made available for a limited time, by prior arrangement with GSGSSI and BAS. It is large enough to accommodate a helicopter.

10.3.3 – Helicopter protection outside the hangar

The only sites at which the helicopters will land or be moved to are not occupied by seals. Fencing will route tourists around the helicopter working area.

10.4 - Fuel supply

A maximum of 107 drums (210 litres) of Jet A1 will be sufficient to undertake the bucket calibration and aerial baiting operation with no re-sowing (calculated at 200 ha/hr). A further five hours of flying (six drums) may be needed for boundary flying, reconnaissance and in support of monitoring work. To ensure a generous allowance for contingencies such as the need to re-bait areas after long periods of down-time, 150 drums of helicopter fuel will be purchased and sent to the island for this operation.

The supply of Jet A1 fuel will be undertaken by Stanley Services, using drums kindly supplied by BAS. The full drums will be delivered to FIPASS by a given date. Upon arrival at KEP, they will be unloaded and transported around the bay to Grytviken for storage outdoors.

Any fuel remaining at the end of the project can either be retained for future flying on the island or returned to Stanley for resale.

10.5 – Maintenance

Maintenance will be carried out in conformity with UK CAA regulations. Professional helicopter operating companies will provide the requisite oversight, and the engineer will be certified and supported in accordance with Part 145 requirements. Adequate spare parts and other consumables to keep the helicopters in effective operation will be available on site. The helicopter engineer will oversee or conduct any necessary repairs or maintenance, assisted

as necessary by the pilots (who themselves will be experienced in helicopter engineering procedures).

Facilities to perform maintenance and repair of the helicopters will be provided in the hangar. An ability to remove the rotor assembly, engine or transmission unit will be offered through the availability of the telehandler.

Spare parts for repairs to the broadcasting buckets will be purchased with the buckets, and a reserve bucket will be taken to the island as a contingency for irreparable damage.

The helicopters will be serviced as close as possible to the start of baiting operations. The baiting programme will be completed before another major service is required (within 100 flying hours).

10.6 - Refuelling

All equipment necessary for refuelling the helicopters has been sourced in New Zealand and will be sent to SG on the Marina Svetaeva. Refuelling will be undertaken from fuel drums by the duty pilot with the assistance of the loading team. Approximately 227 litres of fuel will be required per hour of flying. Appropriate fuel spill contingency equipment will be stored at the refuelling site.

10.7 - Safety

A Health and Safety Plan for the operation, anticipating worst case scenarios and emergency contingencies has been prepared (SGHT 2010b).

All safety regulations specified in legislation and Standard Operating Procedures will be followed. All staff will be briefed by the AA and CP on arrival at South Georgia regarding:

- Safety features of those aircraft being used.
- Operational procedures for hitching and unhitching loads.
- Communicating with pilots.
- Bait loading procedures.
- Refuelling procedures.
- Appropriate protective clothing.

KEP is equipped with a surgery, and two doctors will be on hand to provide medical support. In the case of a life-threatening emergency, personnel will be moved to Stanley hospital by ship (for onward air travel if necessary), and insurance has been obtained for this eventuality.

10.8 – Search and Rescue (SAR)

A SAR Plan has been developed (SGHT 2010d) and sets out the detail of this aspect of the operation. The intention is that the Project team will be adequately prepared such that it is not dependent on BAS or GSGSSI personnel for SAR support unless previously agreed.

The primary SAR resource will be the helicopter(s), though other means of transport will be used in the event that neither is flyable for any reason. Access to most areas overflown by the helicopters is achievable on foot from KEP/Grytviken. A fast harbour launch and trained crew at KEP will be held at readiness should it be needed to transport SAR teams by sea to any part of the operating area, and a second launch will normally also be available as backup. The vast bulk of the target areas are within 2km of the coast, and no areas are further than 6km. The greatest distance that might have to be travelled by sea is 20km. Weather conditions adequate for flying should also be adequate for operation of the harbour launches.

Both helicopters will carry flight-following transmitters which send their location at regular intervals (usually every 1 or 2 minutes) during flight. The tracks are available to anyone with internet access and the appropriate code. In the event of a helicopter being late in returning to base, and no radio contact made, the last known position of the aircraft can quickly be established and SAR efforts focussed on that location.

10.9 – Radio communications

For operational and safety reasons, good radio communications between the helicopters and ground crew are crucial. A marine-band VHF repeater will be installed at a suitable location high on Thatcher Peninsula, and this should give almost uninterrupted coverage of the entire area of flying operations. In addition, the helicopters will be equipped with an HF radio transceiver and a satellite phone. The PD will have a VHF radio at hand whenever a helicopter is airborne, as will a member of the bucket-refilling team. VHF communications are also available in the KEP Base Commander's office and on the harbour launches.

10.10 - Broadcasting buckets

Three broadcasting buckets are required for the aerial sowing of brodifacoum baits in this operation. One of these is a contingency for irreparable damage. After delivery to KEP, the buckets will be transported to Grytviken and stored in the hangar building until required.

The buckets will have mechanical spinners attached to enable the dispersal of baits to a swath width of approximately 80 metres (40m each side of bucket). Swath width will be measured during bucket calibration, which will be conducted at Grytviken with toxic bait prior to full bait-spreading operations. The football pitch area behind the station is flat, with relatively short grass, providing suitable terrain for bait distribution to be monitored. All three buckets will be calibrated with the appropriate apertures to 2 kg/ha and 4 kg/ha - the two application rates required for this operation.

At the close of baiting operations both broadcasting buckets and other associated helicopter equipment and materials will accompany the helicopter, either to storage overwinter at Grytviken or back to Stanley for use in the FI.

10.11 - Helicopter preparations prior to eradication operations

- Flying and defining the operational boundaries of the three baiting zones to produce maps. These flights will be used also for pilot familiarisation and be undertaken in the presence of the PD and APD.

- Logging the three operational zone boundary maps into helicopter GPS systems.
- Briefing of pilots on sensitive areas by PD.
- Briefing of all operational personnel on Operational Procedures by PD and CP.
- Safety briefing of all operational personnel by CP and PD.

Section 11 - Risk management

The success of an operation of this size and complexity, carried out at the end of a long supply chain and in challenging climatic and geographical conditions, is dependent on literally hundreds of functioning components. In the event of failure, the vast majority of these can be replaced, repaired or circumvented with alternative solutions. But there are some which are critical, and could potentially cause the entire operation to fail. It is important to identify these critical elements at an early juncture and do all possible to minimise the risk that they represent. The following is a list of those elements, with a summary of the steps that will be taken to reduce risk:

- Helicopters in working order. This is probably the single greatest risk. Every effort must be made to avoid either machine becoming unserviceable. Reduce risk by (a) having an experienced mechanic/engineer on site to service and repair the aircraft, (b) having a comprehensive spares kit on site to deal with all but the most major mechanical failure, (c) set up a process to have other spares sent to SG as rapidly as possible, (d) avoid pilot fatigue (e) having adequate protection against damage caused by weather or animals, (f) servicing the helicopters as soon as possible before deployment, (g) taking great care to adequately protect the helicopters en route between Stanley and KEP.
- Pilot available to fly the helicopters. Reduce risk by avoiding pilot fatigue.
- Adequate flying weather to complete the project. Reduce risks by (a) allowing a generous amount of down-time in calculations of project duration, (b) arranging the provision of best available weather forecasts, (c) as far as possible ensuring that other factors do not inhibit flying in good weather.
- Adequate bait, in good condition, to carry out the eradication. Reduce risks by (a) triple-checking quantity ordered, (b) allowing a generous margin for error and bait wastage, (c) ensuring the bait is packed in containers that minimise risk of deterioration, (d) checking bait condition frequently, (e) investigating alternatives for transport to Stanley, (f) ensuring bait is isolated from fuel to prevent contamination.
- Adequate helicopter fuel, in good condition, to carry out the eradication. Reduce risks by (a) triple-checking quantity required, (b) allowing a generous margin for error and wastage, (c) obtaining fuel from a reputable source, (d) if possible, shipping fuel to SG well in advance of fieldwork.
- Availability of personnel, equipment and supplies at SG when required. Reduce risk by (a) shipping equipment and supplies as early as possible, (b) being aware of

alternative possible shipping arrangements, (c) discussing possibility of altering sailing date of MV *Pharos* with GSGSSI in the event that other circumstances render this a possible way of avoiding operational delay.

- Availability of team leader in the field. Reduce risk by ensuring that APD is adequately informed to be able to substitute for PD.
- Availability of telehandler for multiple important tasks at KEP/Grytviken. Reduce risks by (a) arranging for a second machine to be available and on standby (b) having spares and a mechanic available for repair in the event of damage or breakdown (c) having at least two qualified drivers available.
- Availability of functioning bucket for bait spreading. Reduce risks by (a) having spares available in the event of damage or breakdown, (b) having spare bucket available.

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Appendix 1. Civil Aviation Authority regulations

All flying in the UK Overseas Territories is regulated by Air Safety Support International Ltd (ASSI), a wholly owned subsidiary of the UK Civil Aviation Authority. ASSI ensures implementation of the Air Navigation (Overseas Territories) Order 2007. Standards to be met by civil aviation in the OTs are specified in Overseas Territories Aviation Requirements (OTARs) published by ASSI. The PD, in consultation with the CP and AA, will assume responsibility for ensuring that the helicopters and both pilots used in this operation meet the pertinent regulations and have all necessary certificates.

The helicopters will be UK registered, and consequently will be flown under UK CAA regulations. An aerial work certificate from the CAA will be required to carry out the bait-spreading work, and this has been applied for.

Appendix 2. Contract(s) for helicopter maintenance

A costing exercise demonstrated that purchase and resale of helicopters would be far cheaper than leasing them every year for several years. Consequently, the aircraft to be used in this project will be owned by the SGHT, although the specialist task of maintaining them will be contracted out. In Phase 1 of the Project it is likely that two companies will together provide the necessary services in conformity with UK CAA regulations - those of Part M (oversight and prediction of maintenance scheduling) and Part 145 (engineer and spares).

Appendix 3. Entry Permits for South Georgia

All personnel travelling to South Georgia must have an entry permit issued by the Government. The AO will be responsible for ensuring that all necessary paperwork is sent to the Government in good time, and that permits have been issued before personnel leave their place of residence en route to SG.

Appendix 4. Assistance from KEP base

KEP/Grytviken is a small community of people with limited resources, where everyone has a task to perform. Although there will inevitably be interest in the work of this project and willingness to help among station personnel, it is essential that the influx of 11 new people with different priorities does not negatively impact the functioning of the base or the quality of life of the BAS/GSGSSI personnel there.

A Memorandum of Understanding between the parties (BAS/GSGSSI/SGHT) will be required to clearly set out the nature and extent of expected services, co-operations and links.

These are expected to include:

- Set up of telephone and email accounts for project personnel, and subsequent use of terminals and satellite telephone.
- Occasional use of station machinery including the JCB telehandler for unloading project equipment and supplies from ships.
- Supply of food and supplies to Larsen House
- Use of station recreational and office-support facilities.

Appendix 5. Acronyms used in the text

AIS -	Alien Invasive Species
APD -	Assistant Project Director
ASSI -	Air Safety Support International Ltd
AO -	Administration Officer
BAS -	British Antarctic Survey
BASMU -	BAS Medical Unit
CP -	Chief Pilot
DGPS -	Differential Global Positioning System
DMSO -	Dimethyl Sulphoxide
EIA -	Environmental Impact Assessment
FO -	Field Officer
FI -	Falkland Islands
FIPASS -	Falkland Interim Port And Storage System
GSGSSI -	Government of South Georgia and the South Sandwich Islands
IEAG -	Island Eradication Advisory Group (NZ Dept of Conservation)
KEP -	King Edward Point (GSGSSI/BAS administrative base)
NZ -	New Zealand
OP -	Operational Plan
OTARS -	Overseas Territories Aviation Requirements
PD -	Project Director
RAF -	Royal Air Force
SAR -	Search and Rescue
SC -	Steering Committee (SGHT)
SG -	South Georgia
SGHR -	South Georgia Habitat Restoration
SGHT -	South Georgia Heritage Trust
UK -	United Kingdom