Aldabra Atoll Biosecurity Plan v2.1

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1.0	Grant Harper	31 Jul 2014	1st version
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2.1	Veronique Banane & Christina Quanz	30 May 2021	2nd revision

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Cover photo: Supply boat 'Little Boy' at Aldabra Atoll, October 2018 (SIF)

INTRODUCTION

This biosecurity plan has been drafted for the Seychelles Islands Foundation to guide the establishment of biosecurity protocols and infrastructure as part of the management of Aldabra Atoll. This plan provides a background to the current situation on Aldabra with regard to Invasive Alien Species (IAS) and suggests practical and sustainable tasks required to initiate biosecurity and should be implemented as soon as possible. Note that this document deals with terrestrial IAS only. Marine IAS are beyond the scope of this plan but need consideration and a plan drafted to deal with these threats.

The first Aldabra Biosecurity Plan was written in 2014 as part of the European Union (EU) funded Invasive Alien Species project ('*Mainstreaming the management of invasive alien species to preserve the ecological integrity and enhance the resilience of Seychelles World Heritage Sites'*, DCI-ENV/2010/220-252) but not fully implemented due to lack of resources and infrastructure. The plan was reviewed under new funding from the Indian Ocean Commission (COI) and EU for the project '*Institutionalisation and implementation of biosecurity measures to ensure sustainable conservation management of biodiversity on Aldabra Atoll'* (EDF/2016/358-516 GRT/CN 291). The project is nested under the wider project *'Coastal, Marine and Island Specific Biodiversity Management in ESA-IO Coastal States'* as an external section of the EU.

As the plan is a dynamic document it will require further updates and review if new IAS are found either on Aldabra Atoll, on any of the granitic and outer islands of the Seychelles, and at the port or airport on Mahé. New techniques and/or revised approaches to IAS quarantine or detection should also be incorporated as updated information becomes available.

This plan is arranged so that some sections can be standalone documents. These can be printed off and referred to when Biosecurity Officers are carrying out biosecurity procedures, as prompts, or for reference on the wall of a biosecurity room for example.

Since the first Biosecurity Plan (2014), there have been eradications of sisal (*Agave sisalana*) on Aldabra, along with Madagascar fodies (*Foudia madagascariensis*) and red-whiskered bulbuls (*Pycnonotus jocosus*) from both Aldabra and neighbouring Assumption Island (Bunbury, et al 2019). These achievements are further steps in restoring the ecosystem of an oceanic UNESCO world heritage site and highlight the need to have much improved biosecurity to intercept any incursions by non-native species. Alongside the recent invasive species eradications there has been considerable progress in the establishment of a biosecurity culture within SIF, along with the development of procedures and infrastructure since 2014. Construction of a biosecurity building on Aldabra is nearing completion at the time of writing and a biosecurity room has been established at SIF Head Office on Mahé. There are now Biosecurity Officers at both Aldabra and Head Office, and staff carry out biosecurity checks for all persons (including staff and visitors) and supplies travelling to Aldabra and arriving at Aldabra.

This document provides information to:

1. Explain what biosecurity is and why it is needed
2. Identify key biosecurity threats to Aldabra
3. Establish and run a biosecurity system for the management of Aldabra Atoll
4. Maintain surveillance for IAS that may circumvent the biosecurity system
5. Initiate emergency procedures for an IAS incursion on Aldabra (Appendices 3-5)

This document should be referred to while planning and carrying out all biosecurity work.

CONTENTS

1. WHAT IS BIOSECURITY?

Island biosecurity is the management of pathways used to transport people and supplies to islands in order to prevent transferring plant or animal species to a new place where they may establish a breeding population and become invasive, i.e. an invasive alien species ('IAS'; Figure 1). Each and every transport event brings with it the risk of an inadvertent introduction of a known or potential pest species such as a rodent, invertebrate, weed, fungus or disease.

Island biosecurity comprises three main aspects:

1. *quarantine* (to prevent the movement of any species in the first instance),
2. *surveillance* (to detect any incursion as soon as possible after it occurs) and
3. *incursion response* (to prevent irreversible establishment of an alien species once it has arrived).

1.1 WHY PREVENT THE MOVEMENT OF PESTS?

- In virtually all cases it is substantially more cost-, resource- and time-efficient to prevent pests from reaching islands than to attempt a response to a pest incursion or, in the worst-case scenario, to eradicate an established pest population (Rout et al. 2011).
- Any interception of potential IAS negates the need to respond to an incursion. Incursion responses are the last resort and, in many cases, will not detect the IAS as it can be like looking for a needle in a haystack.
- For example, research shows that a single rat arriving on even a small island is extremely difficult to trap or kill and can elude capture for many weeks (Russell et al. 2005); this scenario has occurred on Frégate Island in the Seychelles (Thorsen et al. 2000). A pregnant female rat could conceivably have time to produce offspring during the period of an incursion response.
- Similarly, the establishment of highly invasive and destructive invertebrates such as yellow crazy ants could occur relatively easily on Aldabra without significant investment in, and very careful adherence to, the biosecurity protocols laid out in this plan. Yellow crazy ants caused an 'ecological meltdown' on Christmas Island and are known to impact a variety of species and ecosystems. Once species such as these are present, they are very difficult and expensive to remove.

Figure 1. IAS species can wreak havoc on entire ecosystems: Black rat predating a bird (left) and yellow crazy ants attacking a hermit crab (right)

1.2 IAS PATHWAYS TO ALDABRA

Pathways that can enable IAS to reach Aldabra are created with the transportation of people, gear and supplies. The main pathways are supply boats, Assomption Island transfers and tourist visits (Figure 2). IAS can also be transported around the atoll by boat and with people going on camp.

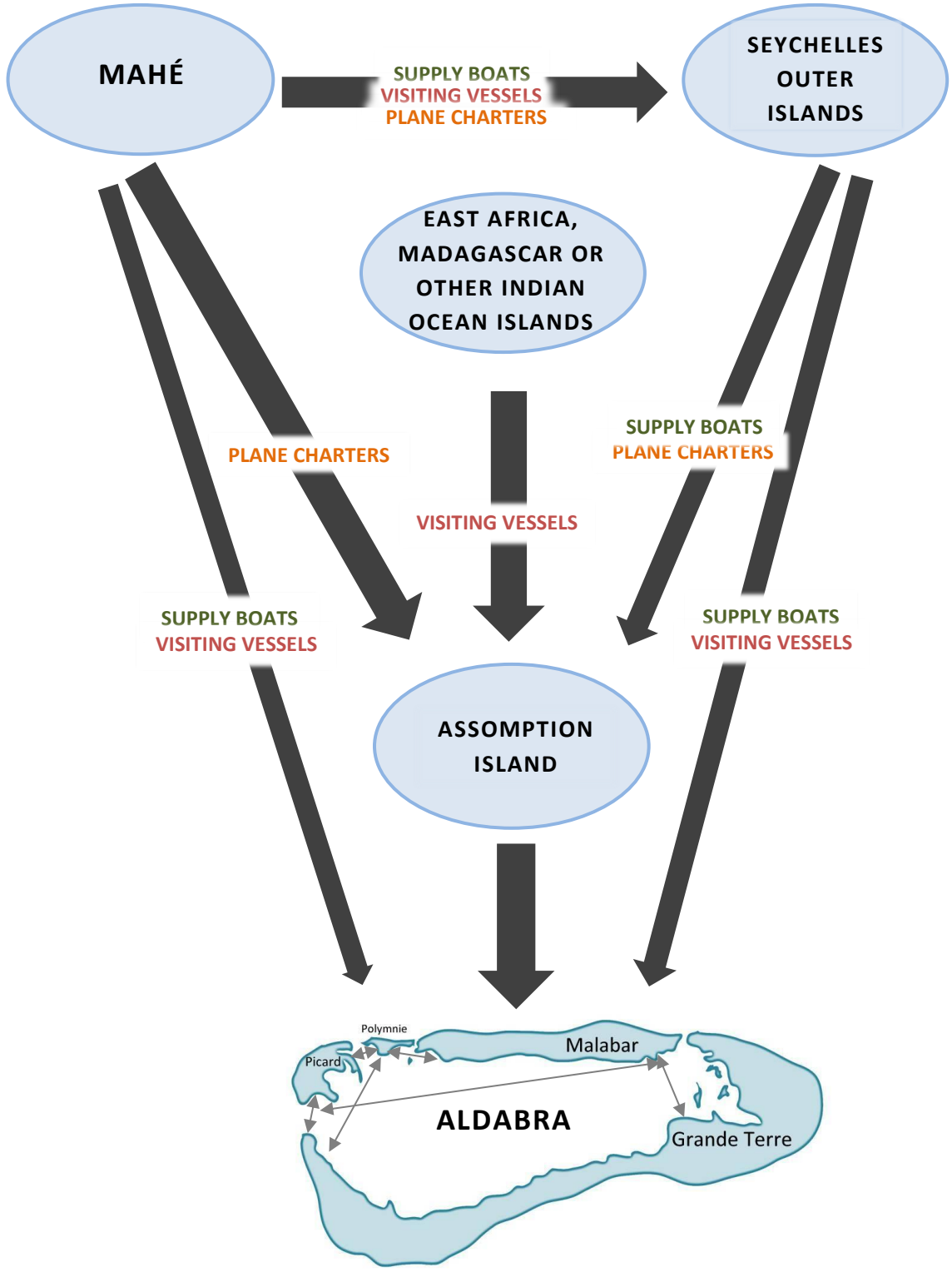


Figure 2. Invasive alien species pathways to Aldabra and within the atoll. Note: 'Visiting vessels' can be cruise ships, small tourist boats or research vessels.

There are some risks which are the same for each pathway, but some are unique to a certain pathway. Some pathways carry more risk than others due to

a) the nature of the cargo, for example a boat can carry large machinery and construction materials which can easily conceal IAS,
b) the travel route, for example, cruise ships usually stop at other islands prior to reaching Aldabra, or
c) frequency, for example, flights to Assomption Island occur frequently over the northwest season.

An assessment of the likelihood and risk associated with the main pathways indicates that a beaching supply boat is the highest risk pathway for IAS to reach Aldabra, followed by a non-beaching supply boat, passenger transfer via Assomption and finally cruise ships and small visiting boats (Table 1).

Biosecurity procedures for the management each of the IAS pathways are provided in following sections 3: Managing Biosecurity on Mahé and 4: Managing Biosecurity on Aldabra.

Table 1. Pathways and likelihood of IAS incursions to and within Aldabra

Pathway	Likelihood of IAS presence	Risk of invasion by IAS	Sources of IAS
Supply boat: beaching boat	Extremely likely	Extremely high risk	On boat itself or on machinery/tyres, in soil/gravel, in construction supplies, in food supplies, in personal parcels and on boat crew
Supply boat: non-beaching	Very likely	High risk	In food supplies, in general supplies or in personal parcels
Passenger transfer via Assomption	Very likely	High risk	In food supplies, in general supplies, in or on personal gear (e.g. shoes, luggage)
Cruise ships/ small visitor boats/vessels	Likely	High risk	In personal gear (e.g. daypacks, shoes, pockets). Fresh food brought from elsewhere
Camp trips around atoll	Likely	Medium risk	In camp supplies, construction or personal gear
Natural dispersal	Likely	Medium risk	Invasive species can colonise new places via their own means, e.g. cats could swim to other islands from Grande Terre. The invasion of Aldabra by the Madagascar fody and red-whiskered bulbul from their introduced range on Assomption Island is also an example of this pathway.

1.3 PREVENTING IAS REACHING ALDABRA

The chances of successfully intercepting any potentially IAS are significantly higher ***before*** they arrive on Aldabra (Figure 3). To have the greatest chance of interception, six important principles of island biosecurity can be followed to guide actions:

1. The highest priority is having a *quarantine facility and secure quarantine practices* in place.
2. The next highest priority is ensuring *secure, pest free transport* for people and supplies.
3. *Surveillance equipment* such as traps are important but of lower priority.
4. Following biosecurity procedures correctly every time is vital.
5. Quarantine facilities and equipment should be well-maintained and in good condition at all times, otherwise there is no point having them.
6. Biosecurity management should follow the most suitable current best practice which meets at least the minimum standards.

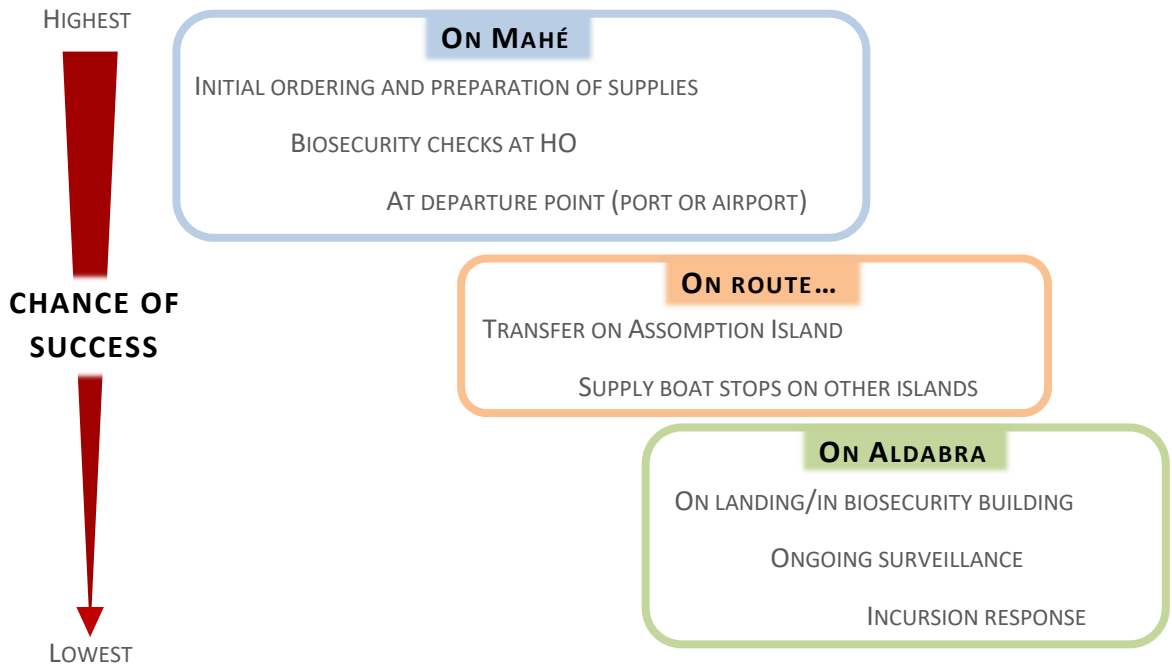


Figure 3. Opportunities for stopping IAS reaching Aldabra via the transport of people and supplies are greatest when biosecurity procedures are implemented early in the process (after Broome 2007).

2. WHAT ARE THE KEY BIOSECURITY THREATS TO ALDABRA ATOLL?

Aldabra Atoll is managed by the Seychelles Islands Foundation (SIF) for the Government of the Republic of Seychelles. It has outstanding natural features and because of this has been a UNESCO World Heritage Site since 1982. Aldabra Atoll has had low levels of human impact, but has a small number of IAS, some of which SIF is controlling and some of which have been eradicated. Of these IAS, the black rat (*Rattus rattus*) and feral cat (*Felis catus*) are having the greatest impacts on Aldabra's biodiversity and ecosystem functioning and it is proposed that these two species will be eradicated in the future. As part of the management of IAS on Aldabra, this biosecurity plan will help prevent any further incursions of IAS or re-invasion by rats or cats once they are eradicated.

2.1 SITE DESCRIPTION

Aldabra Atoll is situated in the southwest Indian Ocean, 420 km northwest of Madagascar, 640 km from the East African mainland and 1100km southwest of the inner Seychelles (Figure 4). At 15,500 ha, Aldabra is one of the largest elevated coral atolls in the world. It is *c*. 18 m above mean sea level at its highest point, although the greater part of the land lies only *c.* 5 m above mean sea level. The atoll consists of four main islands that are separated by tidal channels, the widest being 300 m across (Figure 5). The atoll was first settled in the late 19th century and since then has mostly had a permanent human presence, engaged in logging (mangrove), fishing and harvesting the green turtle population up until the 1970s (Stoddard 1971).

The current Research Station on the southern tip of Picard Island (930 ha) was established in 1971. It comprises a group of buildings including a laboratory, offices, accommodation and a library. The mean rainfall for Aldabra is approximately 966 mm unevenly distributed through the year, with most rain falling during a wet season from January to April and the remainder of the year being dry or very dry (Walsh 1984).

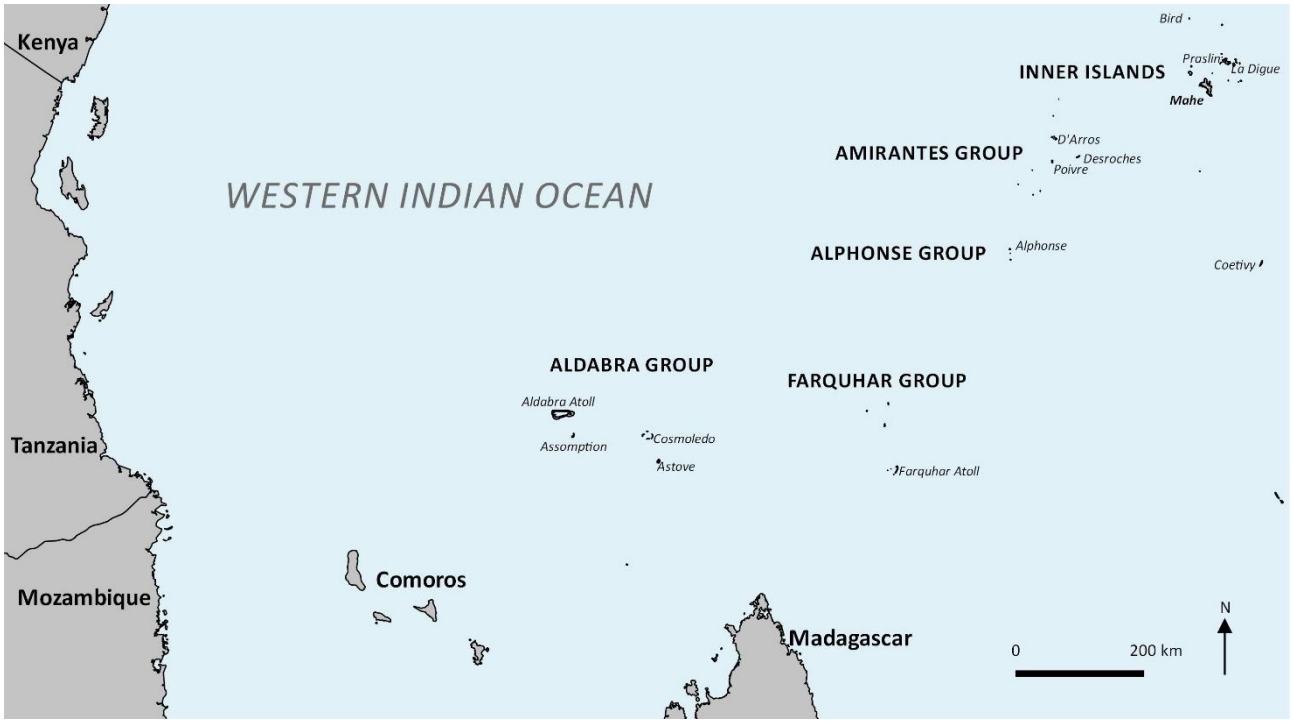


Figure 4. The islands and archipelagos of the Republic of Seychelles.

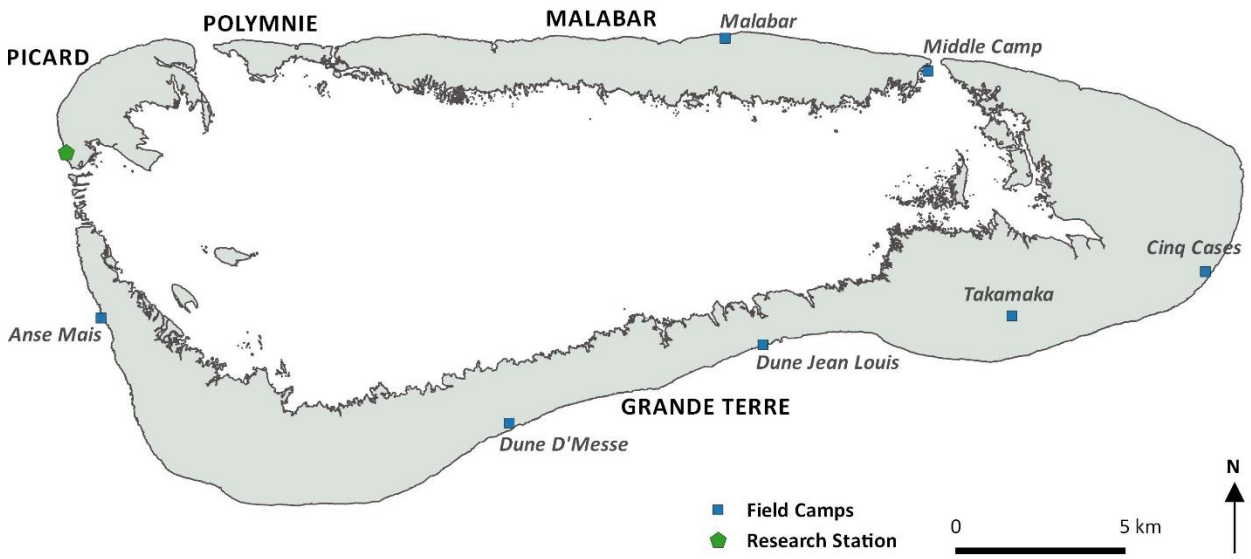


Figure 5. The islands and field camps of Aldabra Atoll.

2.2 NATIVE FLORA AND FAUNA

The principal vegetation types on Aldabra are; (A) mixed scrub, which is a very variable community of shrubs about 3-5 m tall and may have a very open or closed canopy; (B) *Pemphis* scrub, dominated by *Pemphis acidula*, which can form dense pure stands up to 6 m tall and is found on rough dissected limestone, with little soil and where the water table is saline; (C) mangrove forest, up to 10 m tall, which comprises eight species on most of the lagoon coast, and (D) extensive open shrub land of *Lumnitzera* and *Thespesia* at the eastern end of the atoll (Stoddard & Fosberg 1984). On Ile Picard, the first three vegetation types predominate with *Pemphis* covering the largest area, and mangrove forest about 150ha.

Of the terrestrial fauna, the most obvious is the Aldabra giant tortoise *Aldabrachelys gigantea*, which is found on all main islands except Polymnie, with a population that exceeds 100,000 individuals. In addition, there are several species of geckos and skinks, and large populations of green turtles *Chelonia mydas* and hawksbill turtles *Eretmochelys imbricata*. Twelve extant species of endemic landbird species or subspecies, largely derived from Madagascar, breed on the atoll. Several species of seabird breed on the island, including boobies, frigatebirds, tropicbirds, several tern species, and a race of tropical shearwater, *Puffinus lherminieri colstoni*, apparently confined to Aldabra. Four species of bats are present. Endemic insects form some 23% of the estimated more than 1000 species (Cogan et al. 1971).

2.3 ALIEN (INTRODUCED) SPECIES ON ALDABRA

Invasive alien species are one of the biggest threats to Aldabra. Since humans first began visiting the atoll, they have introduced plant and animal species from elsewhere in the world, either accidentally or intentionally for food, shelter or trade. The following sections list all introduced plant, vertebrate and invertebrate species recorded as present on Aldabra and their current status. This section covers not only *invasive* alien species (i.e. those that are spreading and known to be causing detrimental impacts to Aldabra's native biodiversity) but alien (introduced) species which may or may not currently be invasive but have the potential to become invasive.

2.3.1 Plants

About 70 plant species are known to have been introduced, intentionally or accidentally, to Aldabra (Fosberg & Renvoize 1980, Robertson 1989, Friedmann 2011), most of which were apparently located around the settlement on Picard Island (Table 2). At least 12 species appear to be no longer present. Some species may have disappeared as a result of eradication programmes but there is virtually no information available on which species were targeted and when. Other introduced plant species appeared to have died out naturally. For many recorded species, it is not known whether they are still present because there have not been any recent surveys for introduced plants. Due to the lack of information or recent surveys on the status of introduced plants on Aldabra, it is recommended that the presence and distribution status of all recorded species be formally checked and updated in the table below in the near future.

The status of a number of plant species listed below is complicated due to uncertainty over whether the species is native or introduced. For example, *Casuarina equisetifolia* is well adapted to the changeable conditions of small islands and is widespread across Pacific and Indian Ocean islands, its seeds being easily dispersed by sea. It is not inconceivable that it could naturally reach Aldabra. However, the oldest trees are found at coastal sites used frequently by early visitors to the island while from these places, the populations have spread around the coastline with the smallest trees found on the peripheries indicating an introduction either by Arab traders centuries ago or early settlers in the 19th century. Few other plants are able to survive under its shade so its spread is some cause for some concern.

In general terms, introduced plants can have devastating impacts on entire ecosystems. They can outcompete native vegetation and change the structure of plant communities, ultimately impacting native fauna. On Aldabra, most of the recorded introduced plant species have not spread widely from settlement sites and/or have not become invasive. A few did begin to spread however, such as sisal (*Agave sisalana*), which was cultivated by early settlers at several sites around the atoll for its fibres. Trials were conducted in 2013 to assess control methods and it was successfully eradicated from Aldabra in 2018. The introduced herb, *Stachytarpheta jamaicensis* (rat's tail/zepi ble), originally occurred only around settlements but now invades coastal grassland, champignon and inland tortoise turf and its seeds are locally dispersed by tortoises. It is periodically controlled around the research station to reduce its impacts and restrict its spread although the effectiveness of the control is not known.

Further information on some of the introduced plants listed below can be found in the supporting document *Aldabra Atoll: A guide to potentially invasive alien plants* (Harper & SIF 2018), or the books '*Invasive Alien Species in Seychelles: Why and how to eliminate them? Identification and management of priority species*' by Rocamora and Henriette (2015), and in '*Flora of the Seychelles: A field guide to selected plants*' by Hansen and Laboudallon (2013).

Table 2. Introduced and potentially introduced plant species recorded on Aldabra Atoll (Fosberg & Renvoize 1980, Robertson 1989, Friedmann 2011) and, if known, their present status and range.

Plant species	English name	Creole name	Present status and range
Dicotyledons			
Abutilon angulatum		Mauve batard	Unknown. May be native
Abutilon pannosum		Mauve batard	Unknown. May be native
Acalypha indica		Herbe chatte	Occasional around Settlement and Old Settlement
Alternanthera pungens		Brede emballage	Unknown
Amaranthus dubius	Amaranth	Bred, payater	Unknown
Amaranthus viridis	Amaranth	Brede malabar	Present in small patches around Old Settlement
Annona squamosa	Sugar apple		Known only from one location on Back Path. Unknown if still present
Asystasia gangetica	Chinese violet	Lerb manztou	Unknown
Boerhavia coccinea		Patate cauvin	Unknown. May be native
Brassica nigra	Black mustard		Unknown
Capsicum annuum	Capsicum	Piment	Restricted to enclosed garden
Capsicum frutescens	Capsicum	Piment	Restricted to enclosed garden
Carica papaya	Papaya	Papay	Not now present
Casuarina equisetifolia	Casuarina	Sed, filao	Widespread around atoll. May be native or introduced. Claimed to be spreading but not substantiated.
Catharanthus roseus	Madagascar periwinkle	Roz anmer	Widespread but abundant only around Settlement where it is periodically controlled
Clitoria ternatea	Blue pea	Liane madame	Unknown
Cleome gynandra	African cabbage	Brede caya	Unknown
Cleome strigosa		Brede caya	Common on beach crests on Picard, sparse elsewhere. Possibly native
Corchorus aestuans			Unknown
Curcubita moshata	Crookneck pumpkin	Zironmon	Restricted to enclosed garden
Cyanthillium cinereum	Purple fleabane	Herbe de flaque	Unknown
Datura metel	Devil's trumpet	Fleur poison	Unknown (may no longer be present)
Delonix regia	Flame tree	Flambwayan	No longer present (only one tree existed by the chapel but it has since died)
Euphorbia hirta	Jean Robert		Common in disturbed areas around the atoll
Euphorbia prostrata	Prostrate splurge	Traînasse	Common around Settlement and huts but not invasive
Euphorbia tithymaloides	Devil's backbone	Bois mal gaz	Unknown
Gossypium hirsutum	Cotton	Koton	Eradicated by Royal Society
Ipomoea batatas	Sweet potato	Batate	Previously cultivated. No longer present
Ipomoea obscura	Obscure morning glory	Liane maron	Unknown

Plant species	English name	Creole name	Present status and range
Lagenaria siceraria	Bottle gourd		Previously cultivated. No longer present
Lantana camara	Lantana	Vyey fiy	Eradicated by Royal Society
Launaea intybacea	Bitter lettuce	Lasteron	Unknown
Leonotis nepetifolia		Dacca, monte au ciel	Unknown
Manihot esculenta	Cassava	Manioc, cassava	Previously cultivated. No longer present
Mirabilis jalapa	4 O'Clock flower	Belle du nuit	Unknown
Momordica charantia	Bitter melon		Previously cultivated, not now present
Moringa oleifera		Brede morongue	About ten trees, present around Settlement/Old Settlement
Nicotiana tabacum	Tobacco	Tobac	Unknown
Ocimum basilicum	Sweet basil	Basilic de france	Restricted to enclosed garden
Ocimum gratissimum	African basil	Basilic grande feuille	Restricted to enclosed garden
Ocimum tenuiflorum	Sacred basil	Basilic petite feuille	Restricted to enclosed garden
Passiflora suberosa	Wild passionfruit		Small numbers of plants around Settlement, Back Path and Ile Esprit
Phyllanthus amarus	Gale of the wind	Curanellia	Unknown
Ricinus communis	Castor oil plant	Tantan	Eradicated by Royal Society
Senna occidentalis	Stinking weed	Kaspyant	Unknown
Sida acuta		La bolze	Found around Settlement
Sida rhombifolia		Herb dur	Formerly found sparsely around Settlement but may not be present now
Solanum lycopersicum	Tomato	Tomate	Restricted to enclosed garden
Solanum melongena	Eggplant	Aubergine	Restricted to enclosed garden
Solanum nigrum	Black nightshade	Bréde martin	Unknown
Stachytarpheta jamaicensis	Rat's tail	Zepi ble	Present on south Grande Terre on the Dune d'Messe transect. Common around Settlement, Old Settlement and Back Path but controlled periodically
Striga asiatica	Asiatic witchweed	Lerb diri	Very common in Old Settlement. May or may not be native
Synedrella nodiflora	Nodeweed		Present in small, localised patches around Old Settlement
Tamarindus indicus	Tamarind	Tamare	A few trees around Settlement (~5)
Teramnus labialis subsp. arabicus			Unknown
Tribulus cistoides		Pagode, fagot	May be no longer present; may have been native
Trichosanthes cucumerina		patole, snake gourd	Formerly cultivated, not now present
Tridax procumbens	Tridax daisy	Herbe caille	Common in Old Settlement

Plant species	English name	Creole name	Present status and range
Turnea ulmiflora	Holy rose/yellow alder	Koket	**Now only present on Back Path, Picard, where it is invading open champignon. Control required**
Vigna unguiculata	Black-eyed pea/cow pea		Cultivated in the past, not known if still present
Monocotyledons			
Agave sisalana	Sisal	Sisal	Recently eradicated by SIF
Bambusa vulgaris	Bamboo	Bambou	Not now present
Cymbopogon citratus	Lemon grass	Citronelle	Not now present
Digitaria horizontalis	Jamaican crabgrass		Present around Settlement
Digitaria setigera	East Indian crabgrass		Unknown
Eleusine indica	Indian goosegrass		Present around Settlement
Ischaemum rugosum	Saramolla grass	Herbe pette de poule	Unknown (previously only recorded at Takamaka)
Megathyrsus maximus	Guinea grass	Fatak	Not now present
Phoenix dactylifera	Date palm		A few isolated stands exist in Takamaka area; not invasive
Zea mays	Maize		Formerly cultivated, not now present

2.3.2 Invertebrates

In terms of invasive invertebrates, Aldabra appears to have fewer than many other islands. A scale insect species (*Icerya seychellarum*) was introduced in the late 1960s and reached very high numbers within 10 years (Roberts 1989). At high levels of infestation scale insects can reduce plant growth and may lead to plant death. Biological control of the scale insects was undertaken using a natural predator sourced from Mahé, the cocconellid ladybird *Rodolia chermesina*. It was first released at Cinq Cases in 1989 (Gery & Dubois 1990). After monitoring, it was reported that infestation levels of the scale insect had decreased significantly, likely as a result of the ladybird (Johnson and Threadgold 1999). The scale insect is still present so Aldabra staff are advised to remain vigilant for any signs of an increase in occurrence.

Other insects thought to have become established in the past 100 years are the potter wasp *Eumenes maxilllosa*, a stored products beetle *Oryzaephillus surinamensis*, and a stick-tight flea *Echidnophaga gallinacea* (Cogan 1984).

2.3.3 Vertebrates

Of the vertebrate species listed below, only three – the black rat, the feral cat and the four-clawed gecko – are currently present on Aldabra, the remaining species having been eradicated or dying out naturally. A summary of the current status and impacts of each species are given below.

- **Black (or ship) rats** (*Rattus rattus*)

Black rats are known to have been present on Aldabra for at least 130 years but have been shown genetically to have been introduced about the same time Arab traders established bases in the Comores and Madagascar in the 9th century (Harper & Bunbury 2015, Cheke 2010, Tollenaere et al. 2010); recent genetic studies support this conclusion (GH & SIF, unpubl. data). Rats are implicated in the decline of several bird species on Aldabra, including the extinction of the Aldabran brush warbler *Nesillas aldabranus* (Roberts 1987), and are known nest predators of Aldabra fodies *Foudia aldabrana* (Frith 1976).

- **Feral cats** (*Felis catus*)

Cats have been present since at least the late 19th century and are now found only on Grande Terre. Cats consume turtle hatchlings and invertebrates and are implicated in the decline of several bird species on Aldabra (Seabrook 1990, Wanless et al. 2002).

- **Dogs** (*Canis domesticus*)

Dogs were recorded in small numbers on Grande Terre in the 1960s but later died out (Stoddard 1971).

- **Goats** (*Capra hircus*)

Goats were introduced about 1890 and were found on all the main islands at one stage (Stoddart 1971). A long-term eradication programme removed the last goat from Aldabra, on Grande Terre, in 2012 (Bunbury et al. 2013; Bunbury et al. 2018). Goat browsing severely damaged the vegetation which directly impacted tortoises through competing with them for food and through the destruction of the tortoises' shade trees.

- **Red-whiskered bulbul** (*Pycnonotus jocosus*)

A single male red-whiskered bulbul was located in the Takamaka region of Grande Terre in 2012, and was probably self-introduced from Assomption Island, some 30km away. It was caught in a mist-net and culled on Aldabra in July 2013 (Bunbury *et al.* 2013) and the species was confirmed eradicated from Assomption in 2017 (Bunbury et al. 2019). This species could have competed with the native Aldabra bulbul *Hypsipetes madagascariensis rostratus* and spread novel pathogens.

- **Madagascar fody** (*Foudia madagascariensis*)

A population of Madagascar fodies was discovered in 2012 in the Takamaka region of Grande Terre, and were later shown genetically to be self-introduced from an introduced population on nearby Assomption Island, some 30km away (van de Crommenacker et al. 2015). An eradication programme was initiated at Takamaka in 2012, as well as on Assomption and the species was confirmed to be eradicated from both Aldabra and Assomption in 2017 (Bunbury et al. 2019). This species was shown to hybridise and compete with the Aldabra fody (*Foudia aldabrana*) (van de Crommenacker et al. 2015) and could have potentially spread novel pathogens to Aldabra's avifauna.

- **Four-clawed/Pacific house gecko** (*Gehyra mutilata*)

Present on Picard since at least 2008 and only recorded there. Considering its highly cryptic nature it is possible it has spread to other islands of the atoll with field gear. Adapts well to a range of conditions, preys on invertebrates and smaller lizards and competes with native geckos for resources.

2.4 KEY RISK SPECIES FOR ALDABRA

- Plant and animal species that are not present on Aldabra but have the potential to be introduced and have impacts on native species pose a risk to the ecological integrity of Aldabra. Likewise, invasive species present on Aldabra that are currently restricted in range but have the potential to spread to other places on the atoll also pose a serious risk. It is for these reasons that having robust biosecurity procedures in place on Mahé and Aldabra are of utmost importance.
- **Vertebrates:** While those not already present on Aldabra are less likely to be accidently introduced than invertebrates, small animals like mice or rats can easily stow themselves away in small spaces. Introduced vertebrate species are known to have severe impacts in some environments so many of these are a serious risk for Aldabra.
- **Invertebrates:** Several particularly invasive invertebrates present in the Seychelles have so far not invaded or established on Aldabra. These species pose a particularly high risk to Aldabra due to their known heavy impacts on native flora and fauna, their abundance on other Seychelles islands and the ease by which they could be unwittingly transported via people and supplies.
- **Plants:** Assessing the risk factors for plants is difficult because of the extremely high number of introduced plants present on Mahé and other Seychelles islands, and a lack of knowledge on their potential impacts. Nevertheless, there are several plant species that are known to be widespread and invasive on many Seychelles islands, and tolerant of a range of conditions, so are high risk for Aldabra.
- A **risk assessment** (Table 3) was used to identify the species that pose the highest risk. The *Risk Factor* results from a combination of two criteria:
- *Likelihood of Invasion*, i.e. how likely it is that the species will arrive on Aldabra on a scale of very high to low (see Table 4 for explanation of the categories), and
- *Impact Severity*, i.e. if species invades, how severely it will impact Aldabra on a scale of critical to low (see Table 5 for an explanation of the categories).
- By combining these factors, it is possible to determine the Risk Factor (very high to low). This was done by assigning numbers to categories in each of the criteria. These were then added together to give a final score which corresponded to a level of risk.
- The **key risk species** for Aldabra are listed in Table 6 in order of their risk factor.

Table 3. Risk Assessment: species are given scores based on their likelihood of invasion and impact severity; the combined scores correspond to a level of risk.

Likelihood of Invasion	*Impact Severity*	**Risk Score**
4 - Very High	4 - Critical	**7 or 8 = Very high**
3 - High	3 - High	**5 or 6 = High**
2 - Medium	2 - Medium	**4 = Medium**
1 - Low	1 - Low	**2 or 3 = Low**

Table 4. Factors considered in Table 2: Key Risk Species for Aldabra for assessing the likelihood of a species incursion (GH, pers. ref.).

Likelihood of invasion	**Very high**	**High**	**Medium**	**Low**
Ability to colonise	Strong ability to colonise	Moderate ability to colonise	Some ability to colonise	Poor coloniser
Incursion pathways to site	Many	Several	A few	Few, if any
History of invasions elsewhere	Many recorded invasions worldwide	Several recorded invasions worldwide	Some recorded invasions worldwide	Few, if any
Cryptic (individuals, seeds or plant parts)	Excellent ability to hide, often very small	Can remain hidden if poor biosecurity in place	Generally obvious during even cursory inspection	Large, unable to hide under any circumstances
Degree of commensalism	Strongly associated with human activity	Moderately commensal	Slightly commensal	Not associated with human activity

Table 5. Factors considered in Table 2: Key Risk Species for Aldabra for assessing the impacts of IAS (from www.pacificinvasivesinitiative.org).

Impact category	**Explanation of severity of impact**		
	Biodiversity	*Economic*	*Cultural*
Critical	Loss of a threatened species from the island	Inability to re-grow crops, no income from tourism, and/ or high costs in management.	Extinction or permanent destruction of cultural value.
High	Loss of at least one native species from island.	Loss of major crops, income from tourists, or high control costs.	Major degradation of cultural significance.
Medium	Decline in populations of many native species.	Decrease in food and income from crops, and/ or tourism.	Degradation in an area or decline in species of significance.
Low	Decline in population of at least one non-endemic species	Small decrease in crop yields	Small changes in abundance of culturally significant native species or quality of an area on the island.

*Table 6. The **key risk species identified for Aldabra**, including the likelihood of invasion (see Table 4), impact severity (see Table 5), overall **Risk Factor** (resulting from the **Likelihood of the IAS arriving on Aldabra** and the **Impact Severity** if it became established) and description of potential impacts. For more details refer to the Aldabra Atoll Potential Invasive Species Guides for animals and plants.*

Note: This list is not comprehensive but includes IAS that are known risks elsewhere and considered to be highest risk for Aldabra. When new IAS or threats from current IAS are identified they should be added to this table. In any case, any unusual animal or plant should be treated as an IAS until proved otherwise.

Invasive species	Known range	Likelihood of invasion	Impact severity	Risk	Impact description and notes
Yellow crazy ant *Anoplolepis gracilipes*	Mahé and most other inner islands	Very high	Critical	Very high	Likely impacts on virtually all terrestrial animal species on Aldabra. Known to be highly invasive and damaging to entire tropical ecosystems and are extremely difficult to eradicate.
Mouse *Mus musculus*	On Assomption, Mahé, inner and outer islands	Very high	High	Very high	Likely impacts on native insects and vegetation through seed predation. Possible impacts on seabirds and land birds.
Norway (or brown) rat *Rattus norvegicus*	Mahé and nearby inner islands	High	Critical	Very high	Probable impacts include loss of seabirds, the tropical shearwater in particular, the Aldabra rail and nightjar; potential declines in reptiles, including tortoises and turtles, insects and molluscs including marine species; effects on vegetation through seed predation. Eradicated from Frégate, D'Arros and Conception islands.
Cat *Felis catus*	Aldabra (Grande Terre), also Assomption, Cosmoledo, Mahé	High	Critical	Very high	If cats spread to other islands of Aldabra from Grande Terre the probable impacts would be loss of seabirds and land birds, the white-throated rail in particular, as well as declines in sea turtles, skinks and geckos.
White-footed house ant *Technomyrmex albipes*	Mahé and most other inner islands	Very high	Medium	High	Likely to become a household pest and form associations with other plant pests like scale insects and aphids. *T. albipes* was found in supply materials in 2014 and controlled.
Puncture vine *Tribulus cistoides*	On Assomption	Very High	Medium	High	Forms low sprawling mats that can shade out low-growing plants and seedlings. Spiky seeds are an annoyance to people.
Pacific house gecko *Gehyra mutilata*	Aldabra (Picard), all inner islands, Denis, Coëtivy and Farquhar	Very high	Medium	High	Likely impacts include predation on moths, beetles and smaller geckos, and also competition with native reptiles.
Asian house gecko *Hemidactylus frenata*	Mahé and some outer islands (Bird and the Amirantes)	High	Medium	High	Likely impacts on native insects through predation as well as competition with existing reptile species (particularly the native Aldabra *Hemidactylus*).

Invasive species	Known range	Likelihood of invasion	Impact severity	Risk	Impact description and notes
African land snails *Achatina immaculate* and *Lissachatina fulica,* **Rosy wolf snail** *Euglandia rosea*	Mahé and inner islands	High	Medium	High	Probable impacts on reptile, insect and mollusc populations. Small African land snail caught in Aldabra supplies in 2014.
Spiralling white fly *Aleurodicus dispersus*	Mahé and inner islands	High	Medium	High	Impacts on many plant species are likely.
Argentine ant *Linepithema humile*	Not in Seychelles but is elsewhere in Indian Ocean (S. Africa and Australia)	High	Critical	High	Probable impacts on a range of native wildlife and likely disruptions to ecosystem function. Known to disrupt pollination and seed dispersal of native plants and displace native insects.
Red imported fire ant *Solenopsis invicta,* **Little fire ant** *Wasmannia auropunctata*	Not present in Seychelles or elsewhere in Indian Ocean	Medium	Critical	High	Multiple, serious impacts – social, ecological and agricultural – documented in Pacific Ocean countries and elsewhere. Elicit painful bites and stings.
Hairy caterpillar *Euproctis species*	On Mahé and inner islands	Medium	High	High	Can quickly reach plague proportions. Causes defoliation of a wide range of host plants at high numbers.
Indian myna *Acridotheres tristis*	Most inner islands	Medium	High	High	Preys on native birds, eggs, nestlings, reptiles, and large invertebrates. Competes with cavity nesters such as kestrels. Eradicated from Denis, Frégate, Aride, Cousin and Cousine.
Brown tree snake *Boiga irregularis*	West Pacific Ocean: Guam, Indonesia, Australia, Solomons	Low	Critical	High	Potentially catastrophic impacts on birds, bats and lizards. Readily transported around Indian Ocean on large ships and planes.
White cedar *Tabebuia pallida*	On Assumption, Mahé and inner islands	High	Low	Medium	Competition with native tree species through shading, formation of dense thickets and supressing germination. *Tabebuia* seedlings found in construction materials in 2014
Wild tamarind *Leucaena leucocephala*	On Assumption and most other Seychelles islands	High	Low	Medium	Forms dense stands or thickets and displaces native plants. Seeds dispersed by rats and birds. Will coppice when cut back. Is considered one of the 100 worst invasive species by the Invasive Species Specialist Group.
Wild passionfruit *Passiflora suberosa*	On Aldabra, Assumption and many inner and outer islands	High	Low	Medium	Smothers native plants.

Invasive species	Known range	Likelihood of invasion	Impact severity	Risk	Impact description and notes
Castor oil plant *Ricinus communis*	On Assumption and many other Seychelles islands	High	Low	Medium	Competes with native pioneer plants on forest edges and open areas.
Madagascar periwinkle *Catharanthus roseus*	Aldabra, Assomption and almost all other Seychelles islands	High	Low	Medium	Forms thick ground cover and crowds out low-growing native plants.
Rat's tail *Stachytarpheta jamaicensis*	Aldabra, Assomption and almost all other Seychelles islands	High	Low	Medium	Invasive species that can form thickets, crowding out native plants.
Cotton *Gossypium hirsutum*	Assomption and many other islands	High	Low	Medium	Crowds out low-growing native plants.
Yellow alder *Turnera ulmifolia*	Aldabra (Picard, Malabar and Grande Terre) and most of the Seychelles	High	Low	Medium	Forms low thick groundcover that can shade out low-growing native plants and seedlings.
Devil's horsewhip *Achyranthes aspera var. aspera*	Many inner and outer islands	Medium	Medium	Medium	Can overtop low growing native vegetation. On Aldabra it could compete with the native variety, *Achyranthes aspera* var*. fruticosa*.
Lantana *Lantana camara*	On Assomption, Mahé and several other inner islands	Medium	Medium	Medium	Out competes native shrubs by forming dense stands and is readily dispersed by birds, often over large distances and between islands.
Madagascar fody *Foudia madagascariensis*	Most inner islands, as well as Amirantes and Farquhar	Low	High	Medium	Impacts on native birds, especially Aldabra fody, through competition or hybridisation. Recently eradicated from Assumption and Aldabra.
Indian musk shrew *Suncus murinus*	Mauritius, Maldives and other Indian Ocean islands	Low	High	Medium	Likely high impacts on native reptiles, insects and molluscs if established on Aldabra. Not currently in Seychelles but if reaches Mahé would be a potential risk.
Sisal *Agave sisalana*	On Assumption and most other Seychelles islands	Medium	Low	Medium	Invades quickly and out-competes native plants.
Stinking passion flower *Passiflora foetida*	Assomption and the largest inner islands	Medium	Low	Low	Prevents or delays native plant regeneration. Will invade disturbed or open sites.

Invasive species	Known range	Likelihood of invasion	Impact severity	Risk	Impact description and notes
Devil tree *Alstonia macrophylla*	Mahe and most other inner islands	Medium	Low	Low	Reproduces very rapidly due to massive seed production. Invades sites and dominates forests.
Amaranth *Amaranthus dubius*	Aldabra (maybe gone), Assomption and many other islands	Medium	Low	Low	Forms thick covering, crowding out low-growing native plants.
Khaki weed *Alternanthera pungens*	Assomption	Medium	Low	Low	Forms dense mats that smother native seedlings.
Crested tree lizard *Calotes versicolor*	Mahé and inner islands	Low	Medium	Low	Likely impacts on reptile, insect and mollusc populations.
Tenrec *Tenrec ecaudatus*	Mahé	Low	Medium	Low	Probable impacts on reptile, insect and mollusc populations.
Snakes: Wolf snake *Lycognathophis seychellensis*, **Seychelles house snake** *Lamprophis geometricus*	Mahé and inner Islands	Low	Low	Low	Probable impacts on reptile and insect populations if managed to establish. Both species are endemic to Mahé but not Aldabra.
Feral rabbit *Oryctologus cuniculus*	Ile aux Récifs, Chauve-Souris, Cosmoledo, Descoueufs, Marie-Louise.	Low	Low	Low	Highly destructive of low growing vegetation. Can reach very high population densities.
Chicken *Gallus gallus domesticus*	Most inner and outer islands	Low	Low	Low	Impacts on native plants, ground-feeding birds such as rails and doves, native lizards and invertebrates.
Tiger mosquito *Stegomyia albopicta*	Most inner islands but absent from most outer islands including Aldabra	Low	Low	Low	This mosquito can be a carrier for several diseases, including chikungunya, yellow fever, encephalitis and dengue fever. It is most likely to be transmitted in larval form in standing water.
Red sandalwood/coral wood *Adenanthera pavonina*	On Assumption and most other Seychelles islands	Low	Low	Low	Rapidly invades undisturbed native forest and forms open thickets. Overtops adjacent trees.
Coco plum *Chrysobalanus icaco*	Mahé and other inner islands	Low	Low	Low	Forms thickets that prevent the growth of native plants and suppresses regeneration.

Invasive species	Known range	Likelihood of invasion	Impact severity	Risk	Impact description and notes
Papaya/pawpaw *Carica papaya*	Most islands of the Seychelles	Low	Low	Low	Can quickly form dense stands, crowding and shading native trees.
Obscure morning glory *Ipomoea obscura*	Aldabra (but may be gone now) and most other Seychelles islands	Low	Low	Low	A long-lived perennial climber and will smother native forest with 15m high vines.
Cathedral bells *Kalanchoe pinnata*	Most inner islands, Alphonse, Coëtivy, D'Arros, Desroches, Farquhar	Low	Low	Low	Forms dense stands that crowd out native vegetation. Salt and drought tolerant so establish easily.
Creeping beggarweed *Desmodium incanum*	Mahé and most other inner islands.	Low	Low	Low	Its dispersal is mediated by sticky seeds, which can adhere to people, animals and machinery. Its spreading low stature habit helps it to both dominate other low vegetation and persist within it.
Koster's curse *Clidemia hirta*	Mahé, Silhouette and North islands	Low	Low	Low	Sticky fruits stick easily to shoes and clothes. Dominates clearings and smothers other plants.

3. MANAGING BIOSECURITY ON MAHÉ

The management of biosecurity on Mahé concerns, above all, the prevention of IAS reaching Aldabra from Mahé via the movement of people and supplies to the atoll. This requires following specific biosecurity procedures for IAS pathways to Aldabra such as supply boats, planes to Assomption Island and tourist vessels (see section 1.2 IAS pathways to Aldabra). The biosecurity procedures carried out on Mahé form the first step in a 'biosecurity chain' between Mahé and Aldabra and will be complemented by biosecurity procedures carried out by Aldabra staff on Aldabra, Assomption and on board visiting vessels.

Biosecurity on Mahé also involves liaison with the transport companies used by SIF, tourist vessels and other organisations concerned with biosecurity in Seychelles.

As no pest-proof rooms or buildings currently exist for the specific purpose of biosecurity, the development or sourcing of such facilities should be a very high priority for SIF.

The following parts in this section outline the roles and responsibilities for personnel conducting biosecurity on Mahé, provide requirements for a biosecurity-specific facility and, finally, set out biosecurity procedures for sending people and supplies to Aldabra by supply boat or plane.

3.1 BIOSECURITY STRUCTURE AND ROLES ON MAHÉ

- A designated *Mahé Biosecurity Officer* has been established; the role is integrated into the staff contract and salary covered by SIF, such that it is not dependent on external funding.
- Biosecurity duties and obligations will eventually be included in all contracts for research and logistics staff members.
- The Mahé Biosecurity Officer, and all staff members involved in biosecurity should be given regular and adequate training to carry out their duties. This should include participation in any local biosecurity or invasive species workshops or IAS conferences, discussing biosecurity regularly in staff meetings and learning about biosecurity practices in other Seychelles organisations. The Biosecurity Officer should also attend any plant or insect identification workshops that become available.
- The Mahé Biosecurity Officer is primarily responsible for ensuring that correct biosecurity procedures are followed for each transport of supplies and people to Aldabra. Other duties include maintaining the Mahé biosecurity facilities, biosecurity reporting (see Appendix 5: Mahé biosecurity report template) and the appointment of additional Biosecurity Officers when these are required. The Biosecurity Officer is also responsible for liaising with other organisations and agencies about biosecurity in the Seychelles. The Biosecurity Officer works closely with the Operations Officer to ensure all supplies have biosecurity checks before loading on the supply vessel or plane.
- Additional temporary Biosecurity Officers should be assigned by the Mahé Biosecurity Officer to assist with biosecurity procedures when necessary (such as when extra support is required for supply boat events). They should be given adequate training to carry out their duties and to take a lead role when required. Biosecurity duties should be prioritised over other work duties when biosecurity measures are required.
- Only the Mahé Biosecurity Officer and Operations Officer should have access to the biosecurity facilities. Additional key holders should be kept to an absolute minimum.

3.2 MAHÉ BIOSECURITY FACILITY

SIF urgently needs to find a place to carry out biosecurity checks and packing for Aldabra in an environment tightly controlled for the exclusion of animal or plant pests. The ideal situation would be to have a dedicated biosecurity facility either attached to or near SIF Head Office.

A good biosecurity facility would have adequate space for checking all supplies and personal luggage being sent to Aldabra, with an adjacent secure store for holding supplies until they are moved to the port or airport (Figure 6). Having the biosecurity facility located in the same building as Head Office would allow staff ready access and an ability to make the facility pest free. The following sections describe the specifications and maintenance requirements for such a facility but apply as much as is possible to any interim biosecurity areas.

3.2.1 Biosecurity facility: Requirements

1. The facility should be divided in two, so unchecked goods arriving from suppliers, and luggage, can be separated from checked goods, in a pest-proof store room ready to be sent to Aldabra. There should be only one entry and no external exit from the biosecurity room and one exit only from the biosecurity store (Figure 6).
2. The building must be well lit with no dark corners. Any doors, windows or holes for wiring must be tightly fitting and have a metal lip to prevent rodents gnawing through.
3. There should be no gaps greater than 5 mm around the walls and doors. For invertebrate proofing all gaps must be sealed, however if this is not possible then invertebrate detection and control methods will be required. Any windows, vents, fly-screen mesh or doors must shut securely.
4. The floor should be sealed and painted to enable easier cleaning and detection of small invertebrates.
5. The biosecurity facility must be kept free of rodents, invertebrates, seeds and micro-organisms. This can be enabled through a regular surveillance programme of cleaning, trapping, baiting, spraying and fumigation. Sticky pads/traps should be used in the store at all times.
6. The building should be air-conditioned to allow personnel to work in comfort while checking stores and equipment. The air-conditioning is only required to operate while people are inside the store.
7. Instructive signs should be placed around the building which detail operational requirements (e.g. keep doors shut at all times).
8. All doors and windows in the biosecurity building should remain securely closed/locked whenever it is not in use to stop organisms becoming established inside the building.
9. A large freezer or, better still, freezer room could be included as part of the biosecurity room. This would be for freezing high risk dry goods or equipment (likely to hold invertebrate eggs/larvae or seeds) for 48 hours before being sent to the island.

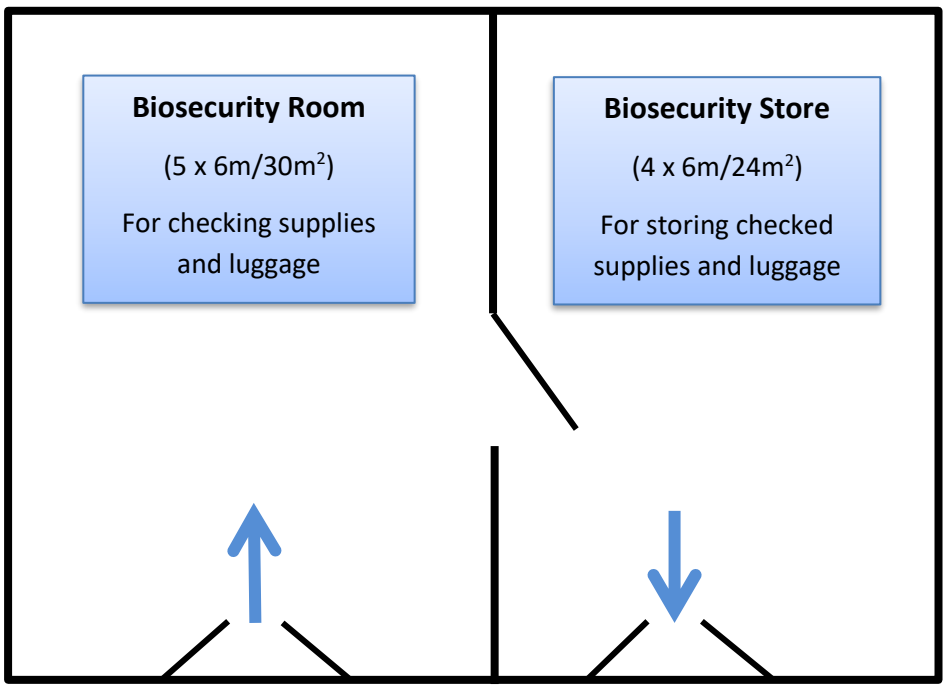


Figure 6. Suggested layout of SIF biosecurity facility on Mahé

3.2.2 Biosecurity facility: Maintenance

Once built, the Mahé biosecurity facility will need to be maintained to a very high standard as it is the first line of defence against IAS reaching Aldabra. The following maintenance and surveillance guidelines should be applied (and also to temporary biosecurity stores as much as is practical):

- The biosecurity room is not a store room and should be kept clear at all times, except during a biosecurity check. Rubbish and packaging must be removed from the building after each biosecurity check.
- If any perishable food is stored in the building before being moved to the wharf or hangar, it must be packed in pest-proof containers. Non-perishable foods do not need to be stored in pest-proof containers but must be checked carefully before re-packing or moving out.
- A spring-clean must occur at least twice annually where floors are thoroughly cleaned (with bleach or strong disinfectant).
- When not in use, which may be for many weeks or months, the facility should remain completely free of any contamination by plants and animals. As such, surveillance and control devices (such as in Figure 6) should be placed in the rooms and checked regularly to confirm there are no incursions during intervening periods.
- The entire facility should be fumigated four times a year or have automatic insecticide aerosol dispensers set up inside.
- Surveillance and control methods include: sticky traps or residual insect spray for insect surveillance, automatic insecticide aerosols for insect control, ant poison dispensers, and rodent bait stations and traps for rat and mouse control (Figure 7).

Figure 7. Left: glue (sticky) trap for insects, small lizards and mice; right: rodent bait stations

- A programme of checks (Table 6) will ensure no rodents, reptiles or invertebrates become established in the biosecurity facility when not in use.
- All bait stations, rodent traps and sticky traps need to be individually numbered so they are ticked off as they are checked and/or replaced.
- Bait stations, rodent traps and sticky traps can all be purchased at pest control suppliers (for example www.pestcontroldirect.co.uk).

Table 6. Biosecurity surveillance schedule for the Mahé biosecurity facility.

Surveillance method	Number and placement	Frequency
Automatic insecticide dispenser	One inside each room (two total)	Always present *Alternative*: use fumigation bomb four times a year
Sticky traps/glue boards	One inside each room at possible access points (two total)	Check and change monthly but check daily for a week leading up to the departure of a boat or plane
Residual insecticide spray	Inside each room at possible access points (two active)	Apply once a month around access points (stays active for 30 days)
Non-selective ant bait	One inside each room (two total)	Set up one week prior to the departure of a supply boat or plane. Poison can be liquid, granular or gel
Rodent bait stations	One inside each room (two total)	Check and change monthly but check daily for a week leading up to the departure of a boat or plane
Rodent traps	One mouse trap and one rat trap in each room (two of each in total)	Set for 2-3 nights per month

3.3 BIOSECURITY PROCEDURES ON MAHÉ

This section sets out the biosecurity procedures that should be followed on Mahé prior to the transport of any supplies (e.g. food, equipment, personal luggage) or people (e.g. SIF staff, researchers, visitors) via supply boat or plane to Aldabra or Assomption. It also covers the transit period between Mahé and Assomption or Aldabra. Biosecurity procedures that are required upon arrival of people and supplies to Assomption or Aldabra are described in the following section (4. Managing biosecurity on Aldabra).

3.3.1 Supply boats

- **To function most effectively, SIF's biosecurity procedures should be synchronised with any biosecurity practices and procedures carried out by IDC, UCPS and other transport management companies contracted for supply vessels to Aldabra.** Transport companies should be encouraged to engage and participate in good biosecurity practices under Part 7 of the Animal and Plant Biosecurity Act 2014.
- **Beaching supply boats** should be carefully planned so that they will not need to beach overnight. They should go straight to Aldabra and not stop at any other island. Any stop elsewhere en route creates another potential IAS pathway; full effort must be directed towards identifying any potential sources of IAS on board or in the supplies before the boat leaves Mahé, again when it leaves other outer islands and again when it arrives at Aldabra.
- **Prior to transport:** The transport operator and boat captain should be briefed prior to departure and made aware of the risks of IAS (preferably well ahead of time). The captain should be asked whether there are any pets (e.g. birds, cats) on board and whether any rodents, ants or other IAS have recently been observed. Visual checks of supply boats should be made to check for the presence of potential pests before departure.
- **Biosecurity officer:** An SIF biosecurity officer would, ideally, be on the boat for the duration of the voyage to check and clean any additional equipment or stores picked up en route, and to check and maintain IAS detection devices for the entire journey.
- **IAS detection:** Detection devices should be established on board the vessel when it arrives at port to detect the presence of possible IAS before loading of supplies.

  Note: detection devices would ideally be present on board a week before departure to intercept any IAS that may be present and prove the boat is rodent free before any supplies are loaded. However, this is not practical because boats are usually not in port more than a day or two before departure. In such cases, detection devices should be set up as soon as possible after the boat arrives in port.
- All boats should have rodent snap-traps, poison bait stations, insect sticky traps, automatic aerosol insecticides and residual insecticide set out and operating within SIF's allocated storage area and at other locations around the boat before and during travel to Aldabra (depending on which methods are most appropriate, see Table 7). These should stay in place for the entire journey.
- **Packing:** Supplies should be packed into as much as possible into **pest-proof containers** (see 3.3.2 Packing requirements). There are specific requirements for foodstuffs, large or bulky items, personnel and luggage, and anything that may carry a risk of disease or foreign microorganisms. See following sections for instructions.
- Once packed appropriately, supplies can be transported ahead of departure to a clean area at the port (e.g. in UCPS shed at Zone 21) or into a shipping container that is already on board.

- **After departure:** Supplies should remain in sealed containers at all times while in transit. If anything is required to be opened in transit it must be fully repacked and re-sealed in a rodent-secure area.
- Once the boat has departed, a biosecurity report should be compiled (see template in Appendix 6) and submitted to relevant Aldabra and HO staff prior to the arrival of goods on the atoll.

Table 7. Biosecurity surveillance schedule for supply boats

Surveillance method	Where	When
1. Cleaning of shipping containers	Inside and outside of containers thoroughly cleaned to remove any pests	Prior to packing
2. Automatic insecticide residual insect spray	Spray residual insecticide around access points of containers and storage areas	Prior to packing and again prior to departure
3. Sticky traps/glue boards	One inside each container/storage room	Set when boat arrives and check on the day of departure
4. Ant bait station	One inside each container/storage room, on main deck and inside cabin area	Set when boat arrives and check on the day of departure
5. Rodent bait stations	One inside container and up to 7 more (depending on size of boat) at other points around boat, including the kitchen	Set when boat arrives is moved onto boat and check on the day of departure
6. Rodent snap traps (only if SIF staff can check them daily)	One mouse and one rat trap in container and up to 3 more of each at other places on boat (depending on size)	Set when boat arrives and check on the day of departure
7. Fumigation (or fumigation bomb)	Inside shipping container and any allocated storage room	Day of departure
8. Professional insecticide treatment of boat	All boat surfaces sprayed with non-target (general) insecticide	Day of departure

3.3.2 Packing requirements

- **All supplies for Aldabra must be inspected, packed and stored in the Mahé biosecurity facility before loading on the boat or plane**, with the minimum delay at the wharf/airport. Until the new facility is constructed, other rooms may be used if suitably prepared, i.e. cleaned and made secure from rodents and insects as much as possible (see previous section 3.2.2 Biosecurity facility: Maintenance).
- **Rodent and invertebrate proof containers must be used to transport all supplies, equipment and luggage (as practicable).** Supplies contained within sealed containers have a much reduced risk of picking up potential IAS en route between Mahé and Aldabra.
- **Suitable container types:**
  - aluminium/metal containers (Figure 9)
  - plastic drums/barrels with screw-on lids (Figure 9)
  - large, sturdy plastic crates ('fish bins') with tops firmly zip-tied and/or taped down (Figure 9)
  - securely sealed ice/cooler boxes for carrying perishable foods
  - sealable drybags for supplies sent by plane
  - containers should be sturdy enough to allow stacking

Figure 9. Examples of containers for transporting supplies and luggage

The following container types are *not suitable* and must not be used:

- *Styrofoam/poly boxes,* as rodents can easily gnaw holes in them (Figure 10)
- *Corflute*, as the internal baffles can easily conceal insects or their eggs (Figure 10)
- *Cardboard/carton boxes***,** as they are easily damaged, difficult to clean and inspect for insects or seeds, and are not completely sealable. If used they should be placed inside sealable containers
- *Plastic bags,* including gunny bags, as they cannot be sealed properly
- Any containers with ill-fitting lids, cracks or holes of any size should not be used

- Containers should be kept as clean as possible.
- Items being packed should be visually inspected for dirt, insects and seeds either before and/or as they are placed into containers.
- Containers must be immediately sealed once packed with lids securely fastened. If re-opened, this should be done in a pest-proof room.
- Packing of containers should facilitate easy lifting and carrying wherever possible so should not be made too heavy (e.g. pack light items with heavy items to balance out the weight). It is advised that the weight of white drums should not exceed 20kg and the weight of aluminium boxes should not exceed 25kg. However, flexibility and discretion when packing is allowed as the weight of some items can exceed 25kg.

Figure 10. Left: Personal food parcel sent to Aldabra in 2013 with rat gnawing evident on styrofoam packaging; Right: corflute showing internal baffles that could conceal insects.

3.3.1 Foodstuffs

Natural (unprocessed) food items, such as fruits, vegetables and eggs, pose one of the highest risks to Aldabra through their high potential to harbour disease, bacteria, viruses, fungi and invertebrates. They are also likely to attract rodents if not packaged securely. The following guidelines should be followed:

- **Purchasing of fruit and vegetables must take place two days prior** departure to allow sufficient time for cleaning and drying.
- **Prioritise sourcing of fruit and vegetables from Seychelles Trading Company (STC)** wherever possible as their imported produce has been treated and checked by customs and is usually cleaner and free of disease and insects. If certain fruits and vegetables are not available at STC they may be sourced from the local market but it should be noted they may pose a higher level of risk than imported and treated crops and require additional cleaning, especially root vegetables.
- **All fruit and vegetables must be thoroughly inspected** for soil, disease and insects before sending to Aldabra and washed if necessary. Vegetables and fruit sent in staff parcels must be inspected carefully.
- **Root vegetables (e.g. potato, sweet potato or carrots) must be clean and completely free of soil**, especially if they were grown locally (Figure 8). Pre-washed produce is preferred but if not available then efforts should be made to find the cleanest source, or allocate sufficient time to cleaning and scrubbing.
- **Fruit and vegetables which have potential hiding places for invertebrates** (e.g. cabbage, bananas and all leafy green vegetables) *must be carefully inspected and excess leaves removed*. The most commonly sighted insects are ants, tiny flies and caterpillars.
- **If pineapples are sent** it should be ensured that the top (leafy) part, once removed, is disposed of in an incinerator, to avoid any risk that it grows into a plant when discarded on Aldabra.
- **Eggs should be inspected and any dirt wiped off** as it could harbour diseases that affect birds or people.
- **Fresh foods should be packed in rodent and invertebrate proof containers,** ice boxes or chillers once checked and cleaned.
- **Parcels from home for Aldabra staff which contain fresh food** must also be thoroughly inspected and packed in pest-proof containers prior to transport (See Appendix 8: Staff Parcel Memo).

Figure 8. Left: dirty damaged potatoes should not be sent to Aldabra. Right: well-scrubbed sweet potato

3.3.6 Large items

- **Large or bulky items that cannot be packed in sealed containers (e.g. Figure 11) pose a high biosecurity risk because they can conceal IAS in many places which are not easily checked and are exposed to IAS while in storage and transit.** Examples of such items include fuel drums, timber, gravel, machinery, bags of cement or crusher dust, pipes, LPG bottles, furniture and electrical equipment.
- If possible, large items should be broken down to fit inside sealed containers or a shipping container.
- If not sealed, large items must be visually inspected carefully and thoroughly for dirt, seeds, insects and insect eggs, invertebrate silk (may hold insect/spider eggs) and animal holes prior to transit and again on arrival at Aldabra before unloading.
- Large items that are difficult to inspect thoroughly should be placed inside a container or biosecurity room that is being fumigated if possible, or alternatively they should be sprayed with insecticide around any crevices or holes and then wrapped in heavy duty plastic wrap/pallet wrap to prevent access by invertebrates or picking up dirt/soil in transit (e.g. Figure 11).
- Secure storage of large items and construction materials prior to departure to Aldabra is an important part of biosecurity procedures to ensure seeds and invertebrates do not become part of the cargo.

Figure 11. Examples of large and bulky items (left) and plastic wrapping of PVC pipes (right)

3.3.3 Disease risk

- **The risk of introducing a new, potentially harmful plant or animal disease to Aldabra requires special consideration.** Such diseases are not visible but can be carried in soil, plant material, equipment used with animals or with people who have potentially been in contact with disease.
- Disease risk can be significantly reduced through thorough cleaning and treatment with a biocide such as Jeyes™, Trigene™ or Virkon™ for any items that could potentially carry disease.
- No soil or dead plant material other than detailed under 3.3.1 and newly treated timber should be taken to Aldabra.
- Any equipment used for work with animals (e.g. mist-nets or bird bags) should be brand new if possible, or if not, should be washed thoroughly before transport in biocide. If not able to be cleaned easily, items should be frozen inside a deep freeze for 48 hours. This applies to SIF equipment as well as that brought by external researchers.

- Any equipment used for marine work (e.g. nets), if not new, must be free from plant fragments or any other aquatic organisms. Items should be washed thoroughly in biocide. If not able to be cleaned easily, items should be frozen inside a deep freeze for 48 hours. This applies to SIF equipment as well as that brought by external researchers.
- Some wildlife diseases can be transmitted via humans. Therefore, it is important to find out if any person travelling to Aldabra has had recent contact with any aviculture facility, domestic animals or poultry and/or diseased wildlife.
- If recent contact with such facilities or wildlife is known, it must be ensured that no clothing, footwear or equipment used at such sites is taken to Aldabra without thorough cleaning (i.e. washing and treatment with biocide). It is strongly recommended that separate equipment and clothing is used where possible.
- On no occasion should anyone coming from a known disease outbreak area travel to Aldabra without first seeking advice from a recognised expert or veterinarian.

3.3.4 Personnel and luggage

- **All personnel travelling to Aldabra must watch the staff biosecurity video and, if they are staff, read the biosecurity section of the staff induction leaflet at least a week prior to departure**. These resources provide information on why and how biosecurity should be carried out at home when packing to travel to Aldabra. The video demonstrates the level of cleanliness required for luggage and what to expect when bringing luggage to Head Office prior to departure.
- **All personnel travelling to Aldabra must bring in their luggage for biosecurity checks at least 48hrs before departure**. Personal luggage and gear must be clean and free of soil, seeds and invertebrates. All clothing should be washed immediately prior to packing to remove any soil or seeds. Items needed for the last night on Mahé and the journey (contained in one small bag) do not need to be brought in but should be checked at the airport or office on the day of departure.
- Checks of personal gear prior to departure to Aldabra should be carried out inside the biosecurity room by the person who owns the gear. This should be done under supervision of the Mahé Biosecurity Officer, simply to see that it is done and in case any IAS need to be dealt with. Sufficient time needs to be set aside to carry out this important task to a high standard.
- Biosecurity checks should involve unpacking, checking and re-packing of all bags and equipment. The search should concentrate on places that are most likely to conceal seeds, insects and mice such as shoes, socks, jackets, pockets, Velcro fastenings, bags and sleeping bags.
- Bags must have all openings securely fastened and, ideally, not have any holes. Once checked, bags and other gear must be packed in sealable containers and stored in the biosecurity facility until transported to the plane or boat.
- Staff parcels are particularly likely routes for IAS to get to Aldabra as they often contain locally grown fruit and vegetables and are packed in unsealed boxes. Staff should be given the staff parcel memo (Appendix 8) which lists acceptable and unacceptable food items and provides packing guidelines for family members. All staff parcels should be checked before departure.

3.3.7 Plane to Assomption

To function most effectively, SIF's biosecurity procedures should be synchronised with any biosecurity practices and procedures carried out by IDC in regards to flights to Assomption. IDC should be encouraged to engage and participate in good biosecurity practices under Part 7 of the Animal and Plant Biosecurity Act 2014.

IDC staff should be made aware of the risks of IAS. Visual checks of the aircraft should ideally be made to check for the presence of potential pests before departure.

1. **Biosecurity officer:** For planes to Assomption, a biosecurity officer should be assigned for the flight (i.e. one of the existing passengers). This person should be responsible for ensuring supplies and luggage remain secure and unopened until passengers are met by the Aldabra Biosecurity Officer when they reach Assomption. This includes ensuring passengers do not inadvertently pick up any potential IAS such as seeds or ants while transiting through Assomption (or other stopover islands such as Alphonse). Upon completion of check-in, the biosecurity officer is to brief all passengers that he/she is to be contacted in the event that they observe anything of biosecurity concern or if anything is unclear.

2. **Passengers:** The biosecurity officer or other head office staff should ensure that passengers embarking for Aldabra have watched the SIF biosecurity video and been made aware of SIF's biosecurity requirements at least a week prior to the plane departure. Follow the instructions given in previous sections for managing personnel and disease risk, if applicable. For large groups of people, it may be necessary to start biosecurity checks of their luggage several days before the plane departure. Checked luggage should immediately be transferred to pest-proof containers.

3. **Packing:** As for supply boats, all food, supplies and personal luggage should be thoroughly inspected for IAS and packed well into pest-proof containers prior to transport. The airport, the plane itself and Assomption Island (and Alphonse) are all breaks in the biosecurity chain between Mahé and Aldabra where IAS could be present. Unlike on a supply boat, it is not possible to have rodent and insect traps around the supplies at all times. Therefore, it is very important to ensure IAS cannot access supplies or luggage throughout the journey. Follow the instructions given in the previous sections for packing requirements, food and luggage.

4. **At the hangar:** Once appropriately packed, supplies and luggage should be taken to the IDC hangar ahead of departure, *ideally one day prior,* to assist IDC with their flight planning. When supplies arrive at the hangar, IDC staff carry out safety checks and weigh each container or piece of luggage. An SIF biosecurity officer should be present for this procedure to ensure that containers are not accessed by potential IAS and are resealed properly.

5. **Departure day:** On the day of departure, passengers should arrive at the IDC hangar at least two hours early for final biosecurity checks. An SIF biosecurity officer should be present to carry out these checks. Hand luggage, fresh food, and shoes of passengers should be inspected for IAS and pockets emptied. Dirty items that cannot be cleaned sufficiently should be refused for transport.

   If possible, the biosecurity officer should also check the containers coming out of the IDC storage rooms for loading on the place to ensure they still appear properly sealed.

6. **After departure:** A biosecurity report should be compiled (see template in Appendix 6) and submitted to relevant Aldabra and HO staff as soon as possible. Aldabra staff should be notified immediately of any risks associated with the cargo or journey.

4. MANAGING BIOSECURITY ON ALDABRA

The management of biosecurity on Aldabra involves first and foremost the 'at the border' prevention of IAS arriving on Aldabra via the movement of people and supplies to the atoll. This requires maintaining specific biosecurity procedures for possible IAS pathways such as visits from supply boats, tourist vessels and the transfer of people to and from Assomption Island (see section 1.2 IAS pathways to Aldabra). The purpose of these biosecurity procedures is to maintain a tight 'biosecurity chain' between Mahé and Aldabra (in the case of SIF supply boats and planes) and provide a barrier to IAS arriving from any other visiting vessel (such as cruise ships or research boats).

In addition to external IAS pathways, biosecurity on Aldabra also encompasses the management of IAS pathways within the atoll (to prevent the spread of IAS present on some islands but not others), ongoing surveillance monitoring for IAS, the maintenance of a purpose-built biosecurity building and last but not least, the response to any IAS incursion.

This section outlines the roles and responsibilities required for conducting biosecurity on Aldabra, provides requirements for the biosecurity building and, finally, sets out biosecurity procedures for managing the main IAS pathways to and around Aldabra: *(1) supply boats, (2) transfer via Assomption, (3) cruise ships/visitor boats* and *(4) camp trips around the atoll.* For each of these pathways, the associated risks, mitigation measures for reducing risks and biosecurity procedures are described.

IAS surveillance and incursion response procedures are dealt with in subsequent sections (5. IAS Surveillance at Aldabra and 6. Incursion Response).

4.1 BIOSECURITY STRUCTURE AND ROLES ON ALDABRA

- The overarching responsibility for biosecurity on Aldabra lies with the Aldabra Science Coordinator (ASC) but may be delegated to the Assistant Aldabra Science Coordinator (AASC). Responsibilities include regular (throughout the year) maintaining biosecurity surveillance and the biosecurity building all the time?, managing IAS pathways from outside and within Aldabra, biosecurity reporting (see Appendix 6: Aldabra biosecurity reporting template), staff training and the appointment of Biosecurity Officers when these are required.
- **Aldabra Biosecurity Officer/s:** One or two designated officers should be assigned by the ASC to assist with the ongoing maintenance of biosecurity on Aldabra (such as surveillance, the biosecurity building and camp biosecurity) and when extra support is required for supply boat visits, trips to Assomption and tourist visits. They should be given adequate training to carry out their duties and to take the lead in biosecurity when required. This should include participation, if possible (or online), in biosecurity or invasive species workshops and any plant or insect identification workshops that become available in Seychelles. Duties should also include discussing biosecurity regularly in staff meetings, being familiar with this biosecurity plan and associated documents, and briefing other Aldabra staff before supply boat visits.
- The designated Biosecurity Officer/s should be assisted by other Aldabra staff to encourage all staff to be aware of, involved in and engaged in biosecurity duties. This helps to prevent the loss of biosecurity knowledge over time with staff changes and to ensure the success of biosecurity procedures. The cooperation of all Aldabra staff and visitors to the atoll is paramount to the success of biosecurity.

4.2 ALDABRA BIOSECURITY BUILDING

A disused diesel tank bunded site at Aldabra has been retrofitted as a biosecurity building and was first commissioned for use in March 2020. The site has the advantage of being near the usual landing beach and close to the shop. It is of sufficient size to enable the quarantine of all food, luggage and supplies arriving at the Research Station in a usual supply or passenger transfer trip.

The biosecurity building should be used for:

a) checking all supplies brought onto Aldabra,
b) checking all personal luggage of staff and researchers on arrival to Aldabra, and
c) checking and packing supplies for field camps.

Only the ASC and IM should have access to the biosecurity building. Additional key holders should be kept to an absolute minimum.

4.2.1 Biosecurity building: Requirements

1. The biosecurity building must be kept free of rodents, invertebrates, seeds and micro-organisms. This can be enabled through a regular surveillance programme of cleaning, trapping, baiting, spraying and fumigation. Sticky pads and traps should be used in the store at all times.
2. The building must be well lit with no dark corners or areas.
3. Any doors, windows or holes for drainpipes or wiring must be tightly fitting and have a metal lip to prevent rodents gnawing through.
4. There should be no gaps greater than 5 mm around the walls and doors. For invertebrate proofing all gaps must be sealed, however if this is not possible then invertebrate detection and control methods will be required. Any windows, vents, fly-screen mesh or doors must shut securely.
5. The floor should be sealed and painted to enable easier cleaning and detection of small invertebrates
6. The building should be air-conditioned to allow personnel to work in comfort while checking stores and equipment. The air-conditioning is only required to operate while people are inside the store.
7. Instructive signs should be placed around the building which detail operational requirements (e.g. keep doors shut at all times).
8. All doors and windows in the biosecurity building should remain securely closed/locked whenever it is not in use to stop organisms becoming established inside the building.

4.2.2 Biosecurity building: Maintenance

- The Aldabra biosecurity building needs to be maintained to a high standard. It is, in general, not a store room and should always be kept clear, except during a biosecurity check.
- Food and gear can be temporarily stored in the building overnight, for instance the night before departing for camp, or if supply boat biosecurity checks were not finished during the day. Any perishable food must be stored in pest-proof containers. Other foods do not need to be in pest-proof containers but must be checked carefully before packing or moving.
- When not in use, the building needs to remain completely free of any contamination by plants and animals. As such, pest control and surveillance devices should be deployed regularly to confirm there are no incursions (see schedule Table 8).

- Surveillance and control methods should consist of sticky traps for insect surveillance, fumigation or automatic insecticide dispensers for insect control, and bait stations and traps for rat and mouse control. The maintenance schedule should be included in the research and/or logistics work plan.
- A spring-clean must occur at least twice annually where floors are thoroughly cleaned with bleach or strong disinfectant.
- Rodent 'bolt-holes' should be placed into a corner of each room (Figure 12). These are a simple solid box with a rat trap and bait inside. Rodents will run along the edge of the wall and into a 'bolt-hole', inside which are multiple ways they can be killed.

Figure 12. Example of a rodent 'bolt-hole'

- A Victor™ mouse snap trap should also be placed in each of the rooms. Each trap should be housed inside a small box/cover that precludes rats (with an entry hole of ~15mm diameter). This is because rats are neophobic (dislike of unfamiliar things) so if a rat trips a mouse trap, it will become wary and less likely to enter the bolt-hole.
- If any invasive species or potentially invasive species are detected in the biosecurity building, photographs should be sent to HO for initial identification immediately. Identification information will guide the timing and intensity of any incursion response.
- Physical samples of the possible IAS should also be kept for positive identification and DNA sampling and sent to Mahé as soon as possible. A report should be written on the detection and response. Remaining individuals should be destroyed.

Table 8. Maintenance schedule for Aldabra biosecurity building

Surveillance method	Placement	Frequency
Automatic insecticide dispenser OR fumigation bombs	One inside biosecurity room	Always present OR use fumigation bomb four times a year
Insect sticky traps OR residual insecticide spray	A trap inside each room or residual insecticide around all entry points	Check sticky traps twice a year and immediately before a supply boat OR apply insecticide twice a year and immediately before a supply boat.
Non-selective ant bait	Place inside each room	Immediately prior to the arrival of a supply boat or plane. Poison can be liquid, granular or gel form.
Rodent bolt hole	One in each room	Check bait and set trap for one night every 6 months and immediately before a supply boat or plane
Mouse traps	One in each room	Set immediately before a supply boat or plane

4.3 SUPPLY BOAT BIOSECURITY PROCEDURES FOR ALDABRA

Supply boats can anchor offshore at Aldabra and offload supplies onto smaller boats for transfer to land, or can be large barges which are capable of landing on shore when the tides are high enough. Beaching allows large or difficult loads to be moved, usually using a digger or earthmover. Supply boats usually stop at other islands en route to Aldabra. For example, for the solar system construction, a large amount of concrete was required from Mahé and a front-end loader was brought down on a boat that beached so that the loader could be driven directly onto land. The boat first landed at Desroches Island to collect the loader and then made another stop at Assomption to collect the operator.

Supply boats, especially those that beach, provide the greatest number of opportunities for IAS to reach Aldabra and are therefore the highest risk of the possible IAS pathways that exist for Aldabra. There have been several instances of IAS (snail, insects, seeds) being intercepted during boat landings on Aldabra, highlighting the *extremely high risk* this pathway poses.

Risks:

! **A supply boat that beaches is like a 'bridge' between Mahé and Aldabra.** The IAS do not have to cross any water barrier to arrive on Aldabra, so any IAS at Port Victoria could conceivably arrive at Aldabra within 4-5 days of departure, if there were no biosecurity checkpoints en route.

! **Any overnight stay of a beached boat increases the risk immensely as any small mammal/reptiles/invertebrates hiding on board or in stores can come ashore undetected in the dark**.

! Significant risks are added if the boat lands at any other islands en route to Aldabra, as many outer islands have IAS also.

! Soil, which can contain tiny seeds, soil organisms and insect eggs, can be transferred directly to Aldabra from the boat surface or from machinery on/in tyres, wheel bays, engine bay or operators' platform.

! Boat crew that directly access Aldabra without any checks for possible IAS on clothing or shoes.

! Boat crew sometimes keep potential IAS on board as pets (e.g. cats, Indian mynas, crows or bulbuls) which could easily come ashore while the boat is landed. Rodents, cats, bats, flying insects and pet birds can even reach Aldabra from offshore.

! On any type of supply boat, IAS can get access to boxes of supplies either on Mahé or in transit if the boat has IAS like rodents or ants on board.

Mitigation actions:

- Given the high biosecurity risk associated particularly with supply boat beaching events, the best way to reduce much of this risk would be to have no beachings at all on Aldabra. However, this is not practical due, at times, to the need for large quantities of supplies or bulky items to be delivered or large amounts of waste need to be removed from the island. Supply boat beaching events therefore require extra careful management and special attention.
- In the event of a supply boat beaching, the boat should only beach during daylight. **Overnight beaching substantially increases the risk of an IAS incursion and should be prohibited.**
- Careful planning to schedule the boat arrival on an early morning high tide and departure on the evening high tide would reduce the chance that the boat will need to remain beached overnight. If an overnight beaching is absolutely unavoidable, effort must be made to prevent IAS escaping during the night (see procedures below).
- For boat landings, full effort should be directed towards identifying any potential sources of IAS on board and in the supplies to be brought ashore when it arrives at Aldabra, specifically on any machinery that will be brought on land.
- On beaching and non-beaching supply boats, construction materials, fuel drums and all other supplies should be thoroughly inspected by Biosecurity Officers before any offloading begins (Figure 10).
- If possible, have an SIF staff member on board the supply boat for the duration of the journey. Frequent biosecurity inspections by a staff member during the voyage are a good way for detecting IAS en route. Supply boat crew are not to be relied on to carry out biosecurity checks at any time.

Biosecurity procedures:

1. **Prior to arrival of the supply boat**: Clean and prepare the biosecurity building.
2. **Ant control:** Fill 20 ant bait stations with a liquid or gel bait and set at 5m spacing around the beaching site or unloading site (for non-beaching boats).
3. **Rodent control:** Until rats are eradicated from Aldabra, only mouse prevention should be attempted. Bait 20 mouse traps (with a peanut butter and oats mixture) and set around the beaching or unloading site (in places likely to attract mice like under bushes or in and under houses). Traps should be Victor™ mouse snap traps housed in small, wooden or corflute boxes that preclude rats (see previous section 4.2.2 Biosecurity building: Maintenance for further details).
4. **On arrival of the supply boat**: IM and Aldabra Biosecurity Officer approach and board the boat. Inform the captain that biosecurity checks must be carried out before offloading (and beaching) can happen.
5. **Take**: A *biosecurity kit* containing a camera, sample bags/containers, insecticide, biocide, a bucket and cleaning equipment (such as scrubbing brushes, cloths, tweezers, a broom).
6. **Conduct biosecurity checks**: First, check the boat for any signs that IAS could be on board such as rodent droppings, chew marks, spider webs, lizard eggs or dead insects (Figure 14). Check the kitchen as well as the state of any bait stations or sticky traps set up by SIF staff on Mahé prior to the boat departing. Document any signs of IAS with a camera.
7. Next, check the supplies and anything else that will be brought ashore such as machinery, looking for signs or presence of IAS. Pay particular attention to the *tyres of machinery* which could have seeds stuck in or on them, and to any *unsealed/unwrapped items* such as wood and other construction materials

which may have places for insects to hide. Crevices and holes which are impossible to see into but in which insects may be hiding should be sprayed with insecticide.

8. **Photograph and collect**: Any seeds or plant material found should be moved away or collected to avoid them being transported ashore. Any insects, mice or reptiles encountered should be collected into sample bags or containers and photographed in case identification is required.

9. **Clean:** For beaching events, as much as possible, remove dirt from the floor of the boat and tyres of machinery to avoid dirt from Mahé or other islands being transferred onto Aldabra. Spray tyres and the soles of boat crew's shoes with biocide to prevent foreign viruses, microorganisms or pathogens being transferred between islands.

10. **Attach rat guards:** to all mooring ropes of beaching boats. It is especially important that rat guards are in place during the early morning and evening, when rodents are more likely to be active.

11. **Unloading:** Once the Biosecurity Officer has sufficiently checked the boat and has no concerns, supplies may be unloaded from the boat:

- *Unsealed items* need to be moved immediately inside the biosecurity building.
- *Sealed containers* can be left outside the biosecurity building until there is space for checking them.
- *Frozen goods* can be taken directly to the shop.
- *Large, bulky items* do not need to go through the biosecurity building, such as fuel drums, cement, aggregate, large pieces of timber, long metal/PVC pipes and water tanks. These kinds of items should have been checked on the boat but should also be checked as they are offloaded.

12. **Inside the biosecurity building:** All containers should be carefully and fully unpacked inside the Biosecurity Room by the Biosecurity Officer/s, with the door and any other opening remaining firmly shut until all items are checked. Completely unpack and check each container before opening the next. At completion of the biosecurity check the goods can be transferred to the Biosecurity Store and moved out of the building from there.

13. **If overnight beaching is unavoidable:** To prevent the escape during the night of any IAS that have remained unnoticed, the back of the boat should be drawn up off the ground if possible. Extra mouse traps and ant poison should be placed on board the boat and around the beaching site.

14. The Biosecurity Officer should submit a short report to HO summarising how procedures were followed, risks were managed and whether any further risks were identified (see report template Appendix 7).

Figure 14. Biosecurity checks on a supply boat

4.4 ASSOMPTION ISLAND BIOSECURITY PROCEDURES

Most SIF staff and visitors to Aldabra (and sometimes tourists) transit through Assomption Island on their way to and from the atoll. Travel to Assomption is via the IDC plane, which lands at a maintained airstrip there. Passengers coming from Mahé are met at Assomption by Aldabra staff for transfer to the atoll by boat. When not filled with people, the plane also usually carries fresh food and other small supplies for Aldabra.

Assomption Island is a break in the biosecurity 'chain' from Mahé to Aldabra. This pathway is considered a *high biosecurity risk* because of (1) the many opportunities for IAS to hitch a ride to Assomption from Mahé on people or supplies, (2) the many IAS present on Assomption that are not present on Aldabra, and (3) the frequency of transfers between Aldabra and Assomption over the course of a year (between 6 and 10).

Risks:

- ! IAS such as seeds, soil and small rodents/reptiles/insects can be accidently transported from Mahé to Assomption and then to Aldabra on the clothes, shoes and luggage of passengers.
- ! Supplies for Aldabra from Mahé can also harbour IAS if not properly checked before departure from Mahé (or well-cleaned in the case of fresh vegetables and fruit).
- ! The risk of transporting IAS increases if an overnight stay is required due to the presence of the many introduced species on Assomption that don't occur on Aldabra such as mice (see list Table 9). The longer people going to Aldabra must stay on Assomption, the greater the opportunities for IAS to access personal gear, luggage or supplies, which are often attractive items to IAS like fresh food.
- ! Many invasive plants are present on Assomption but not Aldabra (Table 9), some of which have seeds that are easily spread, such as the spiky seeds like puncture vine/fagot (*Tribulus cistoides*) or light, wind dispersed seeds like kasi (*Leucaena leucocephala*).
- ! The ability for people to reach Aldabra within hours of leaving Mahé means that seeds of potentially invasive plants (e.g. passionfruit) can arrive within the gut of any staff, researchers or visitors coming from via the plane to Assomption.
- ! These risks are all increased with increased frequency of flights each year.

Table 9. Invasive alien species present on Assomption but not on Aldabra

Species	English name	Kreol name	Notes
Mus musculus	Mouse	Souri	Never recorded on Aldabra
Alternanthera pungens	Khaki weed	Brede emballage	Recorded once on Aldabra but may no longer be present
Amaranthus dubius	Amaranth	Bred payater	May no longer be present on Aldabra
Agave sisalana	Sisal		Very common on Assomption; recently eradicated from Aldabra
Carica papaya	Pawpaw/papaya	Papay	No longer present on Aldabra
Gossypium hirsutum	Cotton	Koton	No longer present on Aldabra
Lantana camara	Lantana	Vyey fiy	No longer present on Aldabra
Leucaena leucocephala	Wild tamarind	Kasi	Never recorded on Aldabra
Passiflora foetida	Wild passionfruit	Bonbon plim	May no longer be present on Aldabra
Ricinis communis	Castor oil plant		No longer present on Aldabra
Tribulus cistoides	Puncture vine	Fagot	May no longer present on Aldabra. Not known whether invasive.

Mitigation actions:

- Install a raised platform (~1m above ground) on Assomption at the end of the tractor track at next to the beach, on which to put luggage and supplies on before transfer to the Aldabra boat. In the interim, if supplies are laid on the ground they should be put on a tarpaulin to reduce the risk of insects or seeds adhering to luggage or supplies.
- Biosecurity checks should be carried out on people and supplies by any biosecurity staff present, prior to loading the Aldabra boat. The shoes of all passengers should be cleaned, checked for seeds and sprayed with biocide before getting on the Aldabra boat (Figure 15).
- People must avoid opening any sealed containers or bags aside from their day pack on Assomption to reduce the chance of IAS accessing luggage or supplies.

Biosecurity procedures:

1. **On arrival of the plane at Assomption:** The person on the plane from Mahé, who is the designated Biosecurity Officer, is responsible for maintaining biosecurity standards until handing over to the Aldabra Biosecurity Officer.
2. Transfer all containers and bags to the beach without opening them and place on a tarpaulin to await loading onto the Aldabra boat.
3. **Conduct biosecurity checks:** Shortly before loading the Aldabra boat, check whether sealed containers or bags are intact. If there is any sign of entry by an IAS, the container or bag should be opened, checked thoroughly and resealed before loading onto the Aldabra boat.
4. Check the day packs/bags and shoes of passengers transiting to Aldabra (Figure 15). Remove all seeds and dirt. Ask people to check their pockets for seeds. Soles of shoes should be treated with biocide.

5. **If a longer stay is needed:** If a stay of several hours or days is required on Assomption, it may be necessary to transfer frozen goods to a freezer, move supplies inside and access personal luggage. In this scenario, the Biosecurity Officer needs to be present and supervise re-packing to ensure no IAS gain entry to pest-proof containers.
6. **On arrival at Aldabra:** Transfer all containers/bags/supplies from the boat into the Biosecurity Room and placed inside as soon as space is available. Any *sealed* containers can be left outside until there is space for checking them. Frozen goods can be taken directly to the shop.
7. All containers should be carefully and fully unpacked inside the Biosecurity Room by the Biosecurity Officer and a designated assistant, with the door and any other opening remaining firmly shut until all items are checked.
8. Completely unpack and carefully check each container before opening the next one.
9. At completion of the biosecurity check the goods can be transferred to the biosecurity building and moved out of the building from there.
10. The Biosecurity Officer should submit a short report to HO summarising how procedures were followed, risks were managed and whether any further risks were identified (see report template Appendix 7).

Figure 15. Biosecurity checks on Assomption

4.5 VISITING VESSEL BIOSECURITY PROCEDURES FOR ALDABRA

The majority of tourists come to Aldabra on board large cruise ships but some tourists, and occasionally visiting researchers, arrive on smaller live-aboard boats or yachts. Tourists who visit Aldabra can do several activities such as land tours, snorkelling, diving and lagoon tours, all of which are strictly based around Picard.

Cruise ship/tourist visits pose a *high biosecurity risk* as large numbers of people can come ashore who have come from a variety of places before reaching Aldabra. The risk is somewhat ameliorated by the short periods in the daytime they spend ashore with little more than day packs and the clothes they have on.

Risks:

! Tourists, researchers and boat crew can accidently transport seeds, insects, mice or small reptiles in their personal belongings onto Aldabra from places they, or their boat, have visited prior, such as Mahé, Assomption, other Seychelles islands, Madagascar, West Indian Ocean islands or East Africa.

! Cruise ship groups sometimes come ashore with fresh food, containers and umbrellas for serving guests on the beach, providing several places for IAS to be inadvertently carried on to land.

! Tourist vessels occasionally bring supplies for Aldabra or donate fresh food surplus to requirements as a gesture of goodwill; these things, particularly fresh food, may harbour insects or other IAS.

! Boats could potentially have IAS on board, such as pet birds or cats, which may be able to access Aldabra. Previously, species from Madagascar have been found on cruise ships/yachts in the Seychelles (lemurs and bats) or Aldabra (a bat).

Mitigation actions:

➢ Make all visiting yachts/ships aware of the need for biosecurity, what the risks are and what visitors can expect on arrival. All passengers and crew members coming onshore must watch the SIF biosecurity video for visitors. Biosecurity checks should come as no surprise when they arrive. This also sends a strong message that SIF is serious about biosecurity for a World Heritage Site in its care.

➢ Prior to arrival, boats should check their vessel for any insects or animals on board and report them to the Aldabra staff on arrival. Biosecurity checks of guests and crew should be carried out on board the tourist boat or cruise ship prior to anyone coming ashore on Aldabra.

➢ All supplies, donated food, fresh food and picnic gear should also be checked on board or processed through the biosecurity building as per the usual procedures for supply boats.

➢ Ideally the Aldabra Biosecurity Officer/s should clear the tourist vessel at Assomption and/or carry out biosecurity checks on the boat prior to its arrival at Aldabra.

Biosecurity procedures:

1. **Before the boat arrives:** The Expedition Leader or key contact for the visiting vessel should already have been briefed about the rules and regulations for visiting Aldabra, including biosecurity requirements, by SIF Head Office staff and the ASC/Tourism Coordinator. They will have received a copy of the Aldabra biosecurity video which they are required to show all guests prior to them arriving at Aldabra and a copy of the Aldabra Tourism Package documents for tour operators and guests, both of which contain the biosecurity requirements for tourist and research boats visiting Aldabra.

2. **When the boat arrives:** Check that the key contact person understands the biosecurity requirements for Aldabra, that guests have seen the biosecurity video and/or been briefed on biosecurity (such as in a presentation given by an Aldabra staff member or the Expedition/Trip Leader). Determine the potential IAS risks for the boat (based on where the boat has come from, who is on board and what, if any, IAS detection devices are on board).

3. **When tourists/visitors come on land:** All visitors and boat crew (including zodiac drivers) must undergo biosecurity checks by SIF staff before setting foot on Aldabra. These are best done on the main vessel before people disembark, ideally as they are preparing to board their small transfer boat/zodiac.

4. **Take:** A biosecurity cleaning kit containing plastic basins/buckets, hard scrubbing brushes, tweezers, teaspoons, table knives, small containers for specimens, and biocide if none on board the visiting vessel.

5. **Biosecurity checks:** SIF staff must physically inspect the shoes and bags of anyone coming ashore (Figure 16). Footwear should have all soil and seeds removed and the soles treated with biocide (spray onto soles or dip into a shallow tray containing biocide). Note that biocide cannot penetrate through soil clumps hence the importance of removing dirt before treatment. Check bags for seeds and fresh food. Check that people have emptied any pockets on their clothing.

   Other items being brought ashore, such as food, umbrellas, ice boxes or other containers must also be checked on board the boat, especially if it will be brought ashore at La Gigi. Alternatively, checking could be done in the biosecurity building if landing is in front of the station.

6. **Unannounced vessels:** If a vessel arrives unannounced, the Aldabra Biosecurity Officer should visit the vessel before any crew or passengers disembark onto the island. Discuss the itinerary of the boat prior to reaching Aldabra to understand the possible risks and IAS that may be on board. Passengers should be given a biosecurity briefing and/or be shown the Aldabra Biosecurity Video. Undertake biosecurity checks of the vessel and passengers as per the procedures for other visitors.

Figure 16. Biosecurity checks by Aldabra staff on visiting vessels

4.6 ALDABRA CAMP BIOSECURITY PROCEDURES

Trips to field camps occur at least once a month on Aldabra, often more frequently, for staff to carry out monitoring, for hut and trail maintenance or for visiting researchers to do fieldwork. Camp trips usually involve staying at one of the seven field huts around the atoll but sometimes require camping away from established hut sites.

Camp trips pose a *medium risk* to Aldabra. Many species are currently restricted to Picard or even just to the Settlement area so there is potential for these species to be further dispersed to other parts of the atoll through camp activities, including day trips. Some invasive plants have already been dispersed around the atoll in this way such as zepi ble/rat's tail (*Stachytarpheta jamaicaensis*) and roz anmer/Madagascar periwinkle (*Catharanthus roseus*). The scale insect (*Icerya seychellarum*) may also have been dispersed around the atoll as a result of people movement.

If a highly invasive species, such as an introduced ant only present on Picard, was accidently introduced to the large island of Grande Terre as a result of a camp trip, it could require a huge amount of time, effort and cost to remove (or may be impossible). However, as camp trips usually involve small numbers of people and gear, it is easily possible to ensure bags and field supplies are always free from seeds, dirt and insects.

Risks:

- ! Many introduced plant species, the Pacific house gecko and possibly some insects are currently restricted to Picard (or even Settlement), and cats are restricted to Grande Terre. While it is highly unlikely that a cat could be inadvertently transported between islands by boat, seeds and invertebrates from Picard could easily get stuck on, or be concealed in shoes, bags, gear or construction materials (or in people's guts in the case of seeds!) and be transported around the atoll with people.
- ! Camp trips that involve multiple huts as well as day trips to camps further facilitate the accidental spread of IAS between islands.
- ! Camping away from established hut sites could lead to the accidental transfer of an introduced species to a part of the atoll that may never be visited again, thus any resulting infestation would go unnoticed.
- ! Likely invasive species, such as ants, may be accidently introduced to the Settlement area, for example via a supply boat or cruise ship visit, but not immediately detected. The movement of people, supplies or gear from Picard to other atoll locations risks dispersing the IAS further, potentially worsening an already bad situation.

Mitigation actions:

- It is essential to consider biosecurity practices when going on field camps within Aldabra. All footwear, clothing, food, tents, monitoring equipment, construction material and any other gear should be clean and free from dirt, seeds, plant material, invertebrates, reptiles and rodents.
- Biosecurity checks should be carried out on everything being taken to camp prior to departing from Picard. Biosecurity checks should also be carried out on camp before moving from one hut/camp site to another.
- Schedule sufficient time to carry out biosecurity checks. This should be done in the biosecurity room.
- No plants or animals should be knowingly transferred between islands on Aldabra.
- Fresh products containing viable seeds should only be consumed at the station on Picard due to potential weed risks.
- People coming from Mahé should not undertake any field trips within 48hrs of arriving at Aldabra. If they must leave station, they should defecate only in the designated camp toilets (such as at Cinq Cases, Takamaka or Middle Camp) or into a hole at a beach below the mean high tide mark where seawater will kill the seeds (at camps without toilets).
- Periodic ant surveillance monitoring should be conducted at certain camps to facilitate early detection of invasive ant species that may have been transported from Picard to other islands.

Biosecurity procedures:

1. **Before departure:** pack any bags and containers in a clean environment. Shake out bags and containers before beginning to pack things into them. Remove any dirt, seeds and insects from personal gear, paying special attention to sleeping bags, clothes, socks, shoes and Velcro fastenings. Inside the biosecurity room, personal gear unpacked, rechecked and packed again. It should then remain secure inside the biosecurity room until departure.
2. Food items should be visually inspected for signs of insect damage and then packed inside the shop directly into pest-proof containers. Food should be stored inside the biosecurity building until departure (with perishable items inside pest-proof containers). Perishable food must only be packed into backpacks immediately before departure and this should be done in the biosecurity building.
3. Tents are high risk due to the number of places where IAS can be concealed. Tents should be opened out and thoroughly checked before being stored in the biosecurity building until departure. Tents, including pegs and poles should be clean and free from dirt. All other gear, including construction materials should also be checked, inside the biosecurity building if possible.
4. Check if ant surveillance monitoring is required on the camp trip and prepare materials as required.
5. **During camp:** as much as possible, keep hut/camp site clean and rubbish contained. If any insects or seeds are found in personal gear or other supplies once arrived at camp they should be destroyed/contained. Conduct ant surveillance if required.
6. **When leaving camp (to go to another camp or back to station):** shake out bags and inspect clothes and gear as it is being packed to ensure everything is free of dirt, seeds, plant material, lizards and insects.
7. **On arrival back to station:** clean containers, tents and any other work gear before storing.

5. IAS SURVEILLANCE ON ALDABRA

Surveillance is a systematic programme of inspections and surveys to determine the presence of a risk organism. Surveillance monitoring significantly increases the chance of detecting an incursion early on.

- ***Passive surveillance*** (i.e. informal observations) for IAS already occurs as part of the *Aldabra Opportunistic Sightings* monitoring programme. Through this programme, Aldabra staff are made aware of some of the key risk species to look out for and are encouraged to report sightings. In particular, all sightings or evidence of cats are recorded in the Opportunistic Sightings database. While this should continue, **any reports of IAS (other than of cats on Grande Terre) should first be directed to the Aldabra Biosecurity Officer and ASC.**
- Staff and visitors to Aldabra should be encouraged to immediately report any unusual sightings, such as of all mammals, any different birds, colourful or unusual reptiles or strange invertebrates. Observers should collect as much information as possible for identification, ideally with photos and a specimen (see next section – Incursion Response).
- Passive surveillance is most effective when everyone is aware of the key IAS (and potential IAS) to look out for. Staff should use the *Aldabra Atoll Guide to Potentially Invasive Alien Species* for plants and animals (Harper & Cook 2019a, 2019b) to become familiar with the species considered a risk to Aldabra.
- ***Active surveillance*** on Aldabra should focus on groups of particular concern such as ants, invasive plants, scale insects and rodents (once black rats have been eradicated from the atoll). For example, active surveillance of plant disease and plant-damaging invertebrates already occurs as part of the regular phenology monitoring on Picard.
- Guidelines for active surveillance of plants, ants and rodents are provided below. Active surveillance for ants (ants being of particularly high concern) should be established as soon as possible on Picard (as the most likely place that invasive ants could become established).
- The most likely site for invasive species to become established on Aldabra is at the research station on Picard so there should be a heightened awareness of possible IAS in that area. SIF staff should be aware of likely pathways for invasive species to arrive at Aldabra (see 1.2 IAS pathways to Aldabra) so that they recognise situations where there is potential for IAS to move around.

5.1 PLANT SURVEILLANCE

There are many more invasive plants than native plant species in the granitic Seychelles islands. This means that there are a very high number of plant species that could potentially be transported to Aldabra as seeds or small fragments. Although Aldabra currently hosts relatively few introduced plants, several invasive plants have already established on the atoll.

Surveillance for potentially invasive plants as well as plant disease and plant-damaging invertebrates should consist of the following:

- It is not possible for staff to be aware of all potential plant species that could be introduced to Aldabra but they should at least become familiar with *Aldabra Atoll: A Guide to Potentially Invasive Plant Species* (Harper & Cook 2019) which contains descriptions of the most likely, and worst, plants that could invade.
- Staff and visitors should be encouraged to report any unusual plant, even if it turns out to be native.
- Introduced plants are most likely to establish first in disturbed areas such as construction zones, tracks and around houses/huts so staff should be encouraged to keep an eye out for any unusual plants growing in these areas in particular.
- Staff should also report infestations of invasive (or introduced) plant species that are already present on Aldabra but may have spread to a new area, increased in abundance or are found in a previously unreported location. This should be reported by the ASC in monthly or quarterly reports.
- Staff carrying out phenology monitoring on Picard must record and report any evidence or presence of spiralling whitefly, scale insects or any unusual plant damage (e.g. Figure 17).
- Consideration should be given to establishing phenology monitoring on other islands (e.g. Grande Terre) so that there is more potential for new plant-damaging invertebrates or disease to be detected on the atoll or the spread of existing IAS (e.g. scale insects) to be noticed.

Figure 17. Examples of evidence of plant-damaging invertebrates that should be noted during phenology monitoring or through general observations. From left: spiralling whitefly (not present on Aldabra); coccids (scale insects) on Aldabra; and insect damage to leaves of endemic Aldabra plant, Acalypha claoxyloides (note: this particular type of damage to A. claoxyloides is not unusual).

5.2 ANT SURVEILLANCE

Ants are very difficult to control unless detected at an early stage, hence the need for intensive biosecurity measures on Mahé and surveillance on Aldabra. Even if an invasive ant population is still small and localised when detected, an eradication attempt can be initiated but would require a long-term commitment and significant resources.

5.2.1 Attractive lure monitoring

Attractive lure monitoring should be used as a regular surveillance method for ants. This is a useful method for detecting ants at low abundance because the lures, or baits, draw in ants that would likely go unnoticed in a visual survey. It can also be used for delimiting an infestation (to determine the extent of an incursion).

Target species

There are five ant species considered a very high or high risk for Aldabra (see Table 6 in Section 2.4: Key risk species), but to carry out active surveillance for all five would be time consuming (requiring the use of multiple lures) and would require Aldabra staff to be confident they could distinguish the five target species from other ants that may be attracted to the lures. Ant identification, especially of small species, is very difficult for non-experts and Aldabra experiences a naturally high staff turnover rate so it is unrealistic to expect rangers to quickly become familiar with a large number of ant species. Therefore, for simplicity and effectiveness, it is recommended that ant surveillance focus on the species that currently poses the highest risk and is the most likely to arrive – the yellow crazy ant (*Anoplolepis gracilipes*). This species is also large (for an ant), conspicuous when present and common on Mahé so it is likely staff could correctly identify it during surveillance (Figure 18).

It may also be possible to include the white-footed house ant (*Technomyrmex albipes)*, as a target species as it is common on Mahé as a household pest so would likely be known by Aldabra staff. However, it is not easily distinguishable from the already present *T. difficilis* so may not be suitable for this surveillance method.

Figure 18. From left: yellow crazy ant (*Anoplolepis gracilipes*); white-footed house ant (*Technomyrmex albipes*); difficult white-footed ant (*T. difficilis*)

Lures

Yellow crazy ants (as well as white-footed house ants) respond very well to sugar lures. Any sugar-based lure can be used such as jam, honey or cotton wool/toilet paper soaked in a 20% sugar syrup. Lures can be placed on pieces of paper, white laminated cards, in shallow sided container lids or similar. These are placed out in the areas around possible IAS entry points and, after a short time, inspected for the presence of the target species.

Note: different lures (either protein-based or sugar-based) attract different species of ant, so if a different species was being targeted, a different lure may be more effective (e.g. little fire ants love peanut butter). For general surveillance, multiple types of lures (based on advice given by an invasive ant expert) are used to attract all species of ant.

Location

To facilitate early detection of ant incursions, surveillance on Aldabra should be undertaken at the research station on Picard since this is the most likely area where invasive ants will arrive and establish. To cover the likely entry points for an IAS (e.g. supply boat beaching zones and any unloading zone) as well as areas where invasive ants are most likely to establish (such as around the kitchen, shop and houses), the surveillance area should stretch from House #6 at the northern end of the research station to the ASC house (Figure 19), roughly between the high tide line and the line of dense pemphis scrub.

Surveillance should also be carried out periodically around the huts at field camps on Malabar and Grande Terre.

Figure 19. The extent of the research station and settlement area on Ile Picard (encompassed by the black outline). The biosecurity building is marked by a red diamond.

Frequency and timing

At the research station, surveillance should be carried out four times a year. It should occur roughly every three months on Picard or twice during the northwest and twice in the southeast, for example, in November and February, May and August. The May and August surveillance events should, if possible, take place immediately or soon after the supply boat visit.

Additionally, each field camp should each be surveyed twice a year: once during the southeast and once in the northwest.

Personnel

Ant surveillance should be the responsibility of the Aldabra Biosecurity Officer but other staff members should know how to conduct the monitoring so that it can be carried out when the Biosecurity Officer is not present on a field camp or at the research station. Furthermore, the more staff members are involved in active surveillance and are familiar with the target species, the more likely it is that an incursion will be noticed early, through either formal or informal observations.

1. **Lure preparation:**

- Either get some honey or light-coloured jam or make up a 20% sugar solution (20g white sugar and 80ml water) and find some cotton wool or toilet paper to soak in it.

2. **Lure placement:**

- Place cards or lids out throughout the surveillance zone on Picard (or at field camps, around the hut) at 10m spacings (or roughly one card within each $10m^2$).
- For optimal placement, look for 'micro-sites' of favoured ant habitat within the area (which is basically everywhere except sand and bare ground). Also place in the shade where possible, to avoid desiccation of the lure.
- If using sugar syrup, place a small plug of cotton wool (approx. one third of cotton ball) or similar sized wad of toilet paper into the sugar solution then remove excess liquid and transfer it to the card or lid. Alternatively, place a small amount of jam or honey on the card or lid (about the size of a pea, Figure 20).

Figure 20. Sugar based lures, from left: cotton wool soaked in sugar syrup in a jar lid; pea-sized drop of apricot jam on a 10x10cm card; small smear of honey

3. **Conditions required:**

- Surveillance should not occur during or after rain while the ground surface is still wet. Also, no rain should occur between placement of bait traps and their retrieval.
- Lures should be placed between 7 and 10am, when ants are likely to be more active (i.e. before it gets too hot).

4. **Collecting the lures:**

- Lures should stay out for one hour or until the lure is starting to dry out (which may be less than an hour). Observe ant recruitment to the lure. If large numbers of ants quickly consume the lure, consider doubling the quantity.
- After about an hour (or less), collect up the cards or lids. As each card is reached it should be checked for the presence of the target species. Be aware of species that could be confused with the target species.
- If any target species or other suspicious ants are found, collect some specimens in a pot and mark the site immediately with flagging tape and a GPS so that it can be found again. Place the specimens in the freezer for several hours to kill the ants then put into 95% ethanol for preservation of genetic material.
- Follow the incursion response general actions (Section 6.1) and the Ant Incursion Protocol (Appendix 4).

5.3 RODENT SURVEILLANCE

This section only applies once black rats have been eradicated from Aldabra (unless rat presence needs to be confirmed in parts of the atoll) and is intended to give an idea of what surveillance will be required post-eradication.

Once eradication is confirmed, active rodent surveillance should consist of a permanent network of traps and bait stations on set up around the research station on Picard and at field huts. Passive surveillance should also be encouraged and staff should be aware of the signs to look for that may indicate rat presence.

5.3.1 Permanent trap and bait station networks

- A network of rodent traps and bait stations should be permanently set out around the Research Station on Picard (40 of each) and at all field huts (10 of each).
- **Rat traps:** The recommended rat trap is a DOC200, a metal spring trap which is typically housed inside a sturdy wooden tunnel-type box (Figure 21, http://www.predatortraps.com/). This trap design is used extensively for rat control throughout New Zealand. The metal trap itself is very powerful and will almost never fail to hold a brown or black rat (as opposed to Victor rat snap traps, which are less strong and may occasionally allow large rats to escape). Traps can be purchased from CMI Springs in New Zealand (http://www.cmisprings.com/predatortraps.html).

Figure 21. DOC 200 rat trap

- **Trap boxes:** The trap boxes (Figure 22) will have to be constructed on Mahé or on Aldabra. Traps should be made using treated, solid wood of 25mm thickness, but not plywood or MDF (medium-density fibreboard/chipboard). Galvanised steel mesh should be used at each end to provide air flow through the trap, helping to avoid dampness and bad odour. Building instructions are provided online. To discourage crabs or rails stealing bait from bait stations, the entrance holes in the mesh should be made only just large enough for rats to access (30mm diameter).

Figure 22. DOC 200 trap box

- **Mouse traps:** Along with the DOC200 rat trap and bait, trap boxes should also contain a Victor™ mouse snap trap (Figure 23) in the gap between the rat bait and the back of the trap box (http://www.victorpest.com). Mice can travel over the rat trap plate without setting it off (the plate is usually set at about 80g, while an adult mouse does not weigh more than 30g) to reach the mouse trap.

Figure 23. Victor mouse trap

- **Trap box set up:** Trap boxes should be elevated above the ground (c. 30mm) to discourage hermit crabs from entering but it may need some trial and error to determine the best distance off the ground. Traps could be set on two small 30mm planks or blocks which are not as wide as the box so that the box edges overhang, making climbing into the box difficult for crabs.
- **Bait:** Traps should be baited with a well-mixed combination of rolled oats and peanut butter or Nutella™ (these are known and successful lures on tropical islands but other types or brands may work). During the dry season, traps could be baited with salted fish as it will be less palatable to insects and therefore likely to last longer than the peanut butter mixture.
- **Trap placement:** Trap boxes should be placed approximately 50m apart throughout the research station, including La Gigi, and at field camps, to maximise potential coverage. The location of all traps and bait stations should be recorded on a GPS, be clearly marked with flagging tape and bright coloured plastic markers, and should be in relatively easy places to check regularly.
- **Bait stations:** Rodent bait stations containing toxic rodent poison (Figure 24) should be placed out on the same permanent network as the trap boxes on Picard and at field camps. Like trap boxes, they should also be set 30mm off the ground to preclude hermit crabs. Entrance holes will have to be modified so that they are no more than 30mm in diameter. This could be done by creating 30mm holes in pieces of thick plastic which are then screwed and/or glued on to the existing entrance holes.

Figure 24. Rodent bait station

- **Frequency:** On Picard, traps should be set, and bait stations baited with poison bait, for *one night a month*, in addition to being set *during, and immediately after, a supply boat*. Traps should only be baited and set between the evening and the early morning to avoid trapping birds. Bait stations should not permanently contain poison bait to avoid invertebrate damage and to reduce the possibility of neophobia in rodents (dislike/avoidance of anything new or unfamiliar).

- On camps, traps should be set, and bait stations should be baited, for one night on each overnight visit. Traps and bait stations should be set early the following morning.
- In addition to this permanent network, other non-permanent detection devices could be considered for use during supply boat visits and on overnight camps such as Victor™ snap traps set in trees.

5.3.2 General observations

- When visiting tropicbird islets, abandoned or failed eggs should be inspected for evidence of rat predation. Typically, eggs eaten by rats have many jagged edges (Figure 19) and teeth marks can often be identified on the edges. When rats are not present, failed or abandoned eggs are generally intact or broken open without characteristic rat-gnawed edges.
- Also search for rat droppings under any cover and for chew marks on vegetation, especially fruit, seeds and growth tips. Such checks should be part of any routine monitoring at seabird habitats once rats are eradicated from Aldabra.
- Rodents can be quite active in the evening while it is still light (although at high densities will be seen at all times of the day, especially around food sources like seabird colonies or coconut groves and fruiting trees). Searching at night using a strong headlamp or spotlight can detect rats foraging in trees or on the ground. At the high-tide mark, rodent gnawing could be evident on bones of dead seabirds and fish (Figure 25).

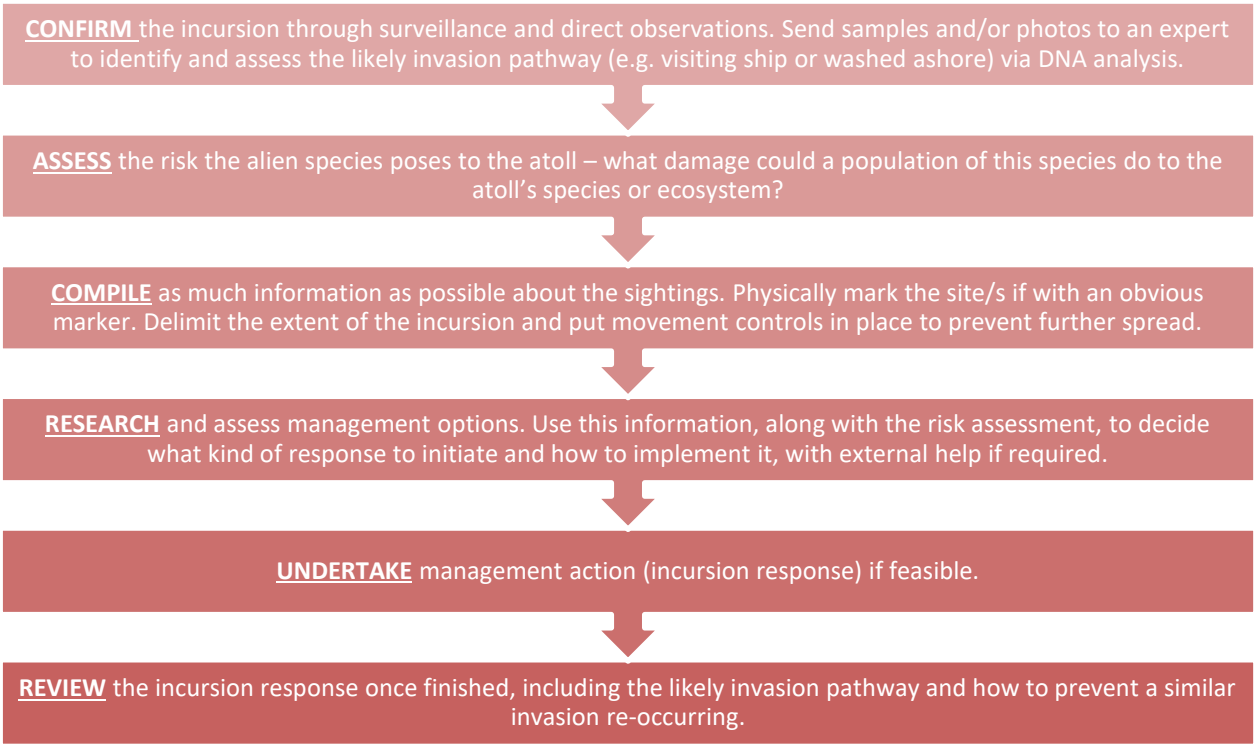
Figure 25. Left: egg eaten by rat. Note jagged edges. Right: rat chew marks on soap. Note sets of double grooves created by paired rat teeth. Crab chews are much less even, do not show teeth grooves and are messier.

6. INCURSION RESPONSE

All possible or suspected incursions on Aldabra should be reported immediately to the Aldabra Biosecurity Officer. SIF Head Office should then be informed as soon as possible and provide advice as required.

- Time is of the essence in responding to animal incursions. The response should be immediate, before the species can breed and establish a population, and it should be given very high priority since the impacts and costs can escalate quickly and irreversibly.
- Responses to pest plant incursions are of less urgency but nevertheless pest plants should be dealt with as soon as they are identified in order to prevent their further spread via plant fragments or seeds. In order to act fast against a potential pest plant, identification should not take longer than 24 hours.
- Any invasive species incursion response on Aldabra should be led by the Aldabra Science Coordinator and/or the Biosecurity Officer. All staff are expected to step in and help if needed.
- The type of response required is impossible to predict for each possible incursion scenario as it will depend on the type of incursion such as the species, location and timing. Suggested incursion protocols are provided for rodents (Appendix 2), ants (Appendix 3) and pest plants (Appendix 4), however a specific and detailed operational plan should be prepared when an incursion is reported.
- SIF Head Office should contact a local or international expert, preferably one who is familiar with Aldabra, as soon as possible to provide advice on the type and size of response necessary (list provided in Appendix 1). SIF has substantial expertise in eradicating birds so previous eradication reports, protocols and staff should be consulted for methodology and information.
- Rodent, bird and ant incursion response kits should be compiled and stored on Aldabra (list provided in Appendix 2). The equipment should be kept separate from other research gear and not used until an incursion response is necessary.

6.1 INCURSION RESPONSE: GENERAL ACTIONS



7. RECOMMENDATIONS

Since the first biosecurity plan (v1.0, Harper 2014), many steps have been taken by SIF to decrease the biosecurity risks associated with the movement of people and supplies to Aldabra. Despite these positive changes, some high risk potential sources for IAS remain that cannot easily be eliminated, for example:

- Although strict biosecurity procedures are now followed, supply boats that beach on Aldabra remain the highest risk to biosecurity due to an inability to ensure they are completely pest-free, especially if first visiting other islands. Beaching supply boats are often necessary, however, when large quantities of supplies or construction materials need to be sent to Aldabra, or rubbish transferred from Aldabra to Mahé. It is also not usually financially viable for SIF to sole-charter a large supply boat that can travel directly to Aldabra.
- Despite routine biosecurity checks now in place on Mahé, there is still a chance that IAS could reach Aldabra via people and supplies which have first landed on other islands that have IAS (e.g. Assomption or Madagascar).
- Yellow crazy ant abundance has increased anecdotally on Mahé and Praslin, and empirically in the Vallée de Mai (Moumou *et al.* 2018). This means that extra vigilance is required for biosecurity checking on Mahé and Aldabra (which may require additional staff members and time).

The following actions would reduce these risks, further strengthen the 'biosecurity chain' and put SIF in a better position to plan a rat and cat eradication on Aldabra:

1. Supply boats should travel directly from Mahé to Aldabra without stopping at other islands on the way.
2. Supply boats should be sole chartered by SIF, under a contractual agreement, as often as possible so that there is greater control over the route to Aldabra.

3. Overnight beaching substantially increases the risk of an IAS incursion and is strongly discouraged. Supply boat beachings, in general, should ideally be avoided to avoid a high risk situation for IAS. If necessary, however, beachings must be carefully planned with regard to tides so the boat arrives on a high tide in the morning and either leaves or is anchored offshore on the evening high tide.
4. Thorough pest control targeting rodents and invertebrates should be carried out on all supply boats prior to departure for Aldabra. This should include professional fumigation of shipping containers and insecticide spraying of the boat area.
5. An SIF staff member should be present on supply boats bound for Aldabra to carry out IAS surveillance and control en route.
6. A raised platform (~1m above ground) should be constructed at the landing beach at Assomption to keep luggage and supplies off the ground.
7. Trial, then establish, surveillance monitoring for ants on Aldabra at the Station and at field huts. This includes designing appropriate recording forms and data storage.
8. Build up adequate supplies on Aldabra for ant and pest plant incursion responses (see Appendix 2).
9. Determine which introduced and native invertebrate species, particularly ants, are currently present on Aldabra. An initial survey should focus on Picard as this is where the introduced species are most likely to be present.
10. Contact various experts on Mahé, or elsewhere in an Indian Ocean nation, to ascertain their willingness to help with identification of IAS and provide advice on incursion response if required.
11. Phenology monitoring should be extended to Grande Terre to increase the surveillance opportunities for plant-damaging insects or diseases. It should be ensured that the type of plant damage is recorded if known (e.g. fungal, rat, caterpillar, scale insect).
12. Any supply boat service providers should be encouraged to improve their biosecurity standards such as by providing a clean environment on board and at loading sites, and being aware of the high risk invasive species to watch out for en route to Aldabra.
13. There should be regular discussion with IDC staff and management so that they understand why SIF is establishing biosecurity procedures and how they will be carried out.
14. Maintain the current level of biosecurity reporting and awareness for supply boats and planes. This is an excellent way of monitoring how biosecurity is being carried out, provides valuable documentation of any problems, and also acts as a tool for the continued improvement of biosecurity practices.
15. Conduct an annual review of boat and plane re-supply reports to review the biosecurity procedures and how they can be adjusted to fit with changes in staff, transport or programme priorities.
16. Include SIF biosecurity practices in all staff contracts and induction. Keep biosecurity information and protocols for staff up to date.
17. Include biosecurity as a discussion point at staff meetings on Mahé and Aldabra. This will help make biosecurity become part of the workplace culture and provide opportunities for staff to suggest ways to improve the system.
18. The invasive plant and animal identification guides should be updated every 2-3 years by the Biosecurity Officer and/or suitable experts to add new species if necessary and to help staff identify new vs. existing species, e.g. for ants.

FUTURE CONSIDERATIONS

- **Biosecurity culture**

Having high-quality biosecurity procedures in place is becoming standard practice internationally for islands with Aldabra's status (and for many that are of less importance for biodiversity). Therefore SIF should continue to show that it takes biosecurity seriously and make this known to all SIF staff, transport companies and cruise ships. This might encourage other organisations and companies involved with islands to improve their own biosecurity practices.

- **Rats**

Currently, there is little point setting up rodent surveillance on Aldabra or preparing for an incursion response with the abundance of black rats already present on Aldabra. While suggested procedures for rodent surveillance and incursion response are included in this plan, they will need modification and updating once rats are eradicated to account for developments and advances in control techniques. By the time the proposed rat and cat eradication goes ahead on Aldabra it is essential that the biosecurity plan is fully operational and running well to ensure the smooth introduction of rodent surveillance procedures and to sustain the outcome of the eradication by preventing new rat incursions.

Once rats are eradicated from Aldabra, the presence of rats and mice on Assomption and other Seychelles islands will pose a much greater risk to Aldabra. Liaison with IDC management about biosecurity and the possibilities for rat (and cat) eradications on Assomption should be pursued at a high management level.

- **Marine**

Marine IAS are beyond the scope of this plan but need consideration and, eventually, a plan drafted to deal with these threats.

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APPENDIX 1. WHERE TO GET HELP

- For help with (and confirmation of) identification of any suspicious plant or animal, SIF Head Office should be contacted in the first instance and knowledgeable staff within the organisation consulted.
- Following is a list of experts who could be consulted for further help with identification or management, but initially, correspondence should be directed to the appropriate expert by Head Office staff.

Plants

Katy Beaver
Plant Conservation Action group, Seychelles
kbeaver@seychelles.net

Bruno Senterre
Seychelles National Herbarium
bsenterre@gmail.com

Invertebrates

Pat Matyot (Seychelles ants and other insects)
Seychelles Broadcasting Corporation
Pat.Matyot@sbc.sc

Monica Gruber (invasive ant management)
Pacific Biosecurity, Victoria University of Wellington
monica.gruber@vuw.ac.nz

Lori Lach (ant management and eradications)
James Cook University
lori.lach@jcu.edu.au

Ben Hoffman (ant management and eradications)
CSIRO Australia
ben.hoffman@csiro.au

Vincent Florens (snails)
University of Mauritius
vin.florens@uom.ac.mu

Owen Griffiths (snails)
Bioculture Ltd, Mauritius
owen@bioculturegroup.com

Birds

Adrian Skerrett
Mahé Shipping Ltd
askerrett@hotmail.com

Gerard Rocamora
Island Biodiversity & Conservation Centre
sounds@seychelles.net

Reptiles

Sacha Rocha
University of Vigo, Spain
sprocha@gmail.com

Nik Cole
Durrell Institute of Conservation and Ecology
nikccole@hotmail.com

Rodents

Grant Harper
Biodiversity Restoration Specialists, New Zealand
biodivrestoration@gmail.com

APPENDIX 2. SURVEILLANCE AND INCURSION RESPONSE GEAR LIST

Pest plants

The following items should be stored on Aldabra in case an invasive plant incursion is discovered; these would be sufficient to control a small infestation. The tools required should be reviewed if a large infestation is found.

- 1L broad spectrum herbicide concentrate, e.g. Glyphosate. Check expiry date or replace every 4-5 years.
- A selection of hand tools, e.g. secateurs, hand saws, loppers, machetes
- Handheld sprayer (5L capacity)

Ants

The following items should be kept on Aldabra so that a small incursion response can be implemented quickly if needed. For a large incursion response, the specific type and amount of ant poison required will need to be determined and sourced from abroad.

- General long-lasting (residual) insect spray (concentrate powder or liquid)
- Manual spreaders for poison (5)
- Ant poison (1kg of gel bait such as Vanquish Pro, 1L of liquid insecticide such as Attrathor). Check expiry date and replace once expired.

Rodents (post-eradication)

Once rats and cats have been eradicated from Aldabra, the following items will be required on Aldabra for rodent surveillance monitoring with some extra kept in storage so that a small-scale incursion response could be implemented if necessary. Numbers suggested here are approximate; exact numbers should be determined when eradication is complete.

	Surveillance	**Incursion Response**
- Zip-lock bags - packets of 50 (for transporting rodent bait)	5+	20+
- Rolls of flagging tape (for marking trap locations)	3	10
- Permanent plastic markers (for marking trap locations)	20+	100+
- Lacing wire - 0.3mm (for tying snap traps to trees)	1 roll	3 rolls
- Cable ties - bag of 30+ (for tying snap traps to trees)	4	10
- Specimen containers (for collecting samples of IAS)	10	20+
- 70% ethanol (for storing samples of IAS)	1L	2L
- Disposable gloves (for handling bait or taking samples)	5 pairs	10+ pairs
- 10L/20L plastic pails with lids (for storing/transporting bait)	2	10+
- Personal protective equipment (for handling poison)	1 set	2 sets
- DOC200 rat traps	100	100
- Rat snap traps	100	200+
- Mouse snap traps	100	200+
- Rodent bait stations	100	200+
- Smooth peanut butter (1kg)	1	5
- Rolled oats (1kg)	1	5
- Toxic rat baits	to be determined	to be determined

APPENDIX 3. RODENT INCURSION PROTOCOL

This brief protocol only applies once black rats have been eradicated from Aldabra and is intended to give an idea of what sort of response will be required in the event of a rodent incursion. It should be revised and elaborated on once eradication has been completed.

Note: For rodent incursions, a certified *rodent detection dog* is generally the most effective tool to use because a well-trained dog can quickly and accurately indicate the location of the rodent. However, as no rodent dogs are present in the Seychelles and due to the remoteness of Aldabra, it is unlikely that a dog would be able to be sourced quickly in the event of a rodent incursion (although they can be sourced from overseas). Therefore, the following techniques would be used instead (although it would be useful if canine detection capabilities were developed in the Seychelles with local NGOs and government organisations for the future benefit of rodent-free islands).

1. **Permanent network:** An existing rodent trap and bait station network in and around the research station should have already been established for surveillance (see 5.3.1 Permanent trap and bait station networks). This network should be baited immediately once a suspected incursion has taken place. For a mouse incursion, extra mouse traps should be set inside buildings.
2. **Additional network:** Another network of snap traps (mouse or rat depending on which species is being targeted) should be set out around the incursion area. Network size Victor™ professional mouse snap traps should be used for mice incursions as the required 'set-off' weight is a lot less than for rat traps. Victor™ professional rat snap traps can be used for all rat species but may fail to hold a large Norway rat. Additional bait stations should also be deployed.
3. Map, clearly mark (with plastic coloured markers or flagging tape on a nearby trees and buildings) and number all traps and bait stations so that they can be easily relocated without requiring searching time.
4. Traps should be baited with a well-mixed combination of rolled oats and peanut butter or Nutella™.Traps should be checked in the morning and un-set, then re-set and re-baited each evening to avoid trapping birds. Bait stations should be checked each morning, or every second day if staffing is limited.
5. Set traps where there is plenty of cover and likely food sources such as the food shop, kitchens, coconut groves, compost bins, rubbish bins, dead animals or the high tide line. Victor rat traps need to be set at least 1m up in trees with cable-ties through holes drilled in the base plate to avoid interference by coconut crabs. Victor mouse traps should be set a little way off the ground to preclude most hermit crabs, but not up in trees, as mice are less likely to climb.
6. Keep accurate records of all checks, including any bait take and interference. Keep any fur, body parts, and eaten bait for later confirmation of the species using DNA analysis.
7. Trapping should be continued for two weeks after the last rodent was trapped. Bait stations can be re-stocked with more resilient bait (e.g. wax poison blocks). On-going checks for rodent gnawing should continue for two months at the cessation of the trapping response. Standard surveillance can be re-instated at this time.

APPENDIX 4. ANT INCURSION PROTOCOL

The following information should be used to guide an emergency control response to an invasive ant incursion but should not replace the need to seek expert advice. Specific instruction from suitable experts is required:

a) **for control and management information specific to the species that is being targeted,**
b) **for help to assess the feasibility of control, and**
c) **for information regarding the safe use of pesticides and their application methods.**

PLAN OF ACTION

For any response to an ant incursion there are several steps which should be followed, some of which may be done simultaneously:

1. **Obtain samples** for positive identification and for assessment of likely invasion pathway (e.g. from Seychelles, visiting ship or washed ashore) via DNA analysis. Send high resolution photos immediately to an expert via SIF HO (see list of experts in Appendix 1). Send whole specimens as soon as possible (store them ≥75% ethanol). The *Aldabra Guide to Potentially Invasive Animals* can be consulted to help with identification.

   Correct identification of ants to species level is important, as foraging behaviour and food preferences can vary greatly between species. These factors affect how the ants will respond to baiting and poisons.

2. **Assess the risk** the ant species poses to the atoll once it has been positively identified – what damage could a population of this species do to the atoll's species or ecosystem? Research successful management of the ant in environments similar to Aldabra and seek advice from suitable experts in ant eradication.

3. **Collect** the following information:

- number of sightings
- exact location of sightings (with GPS coordinates)
- habitat types of sighting locations
- time of day of sightings
- life stages seen (e.g. workers, queen, nest, larvae)
- any observations of foraging (record food items)

4. **Research** the target species biology, rate of spread and whether there are insects, such as scale insects, that can worsen or facilitate its invasion. Ants' food preferences vary during their breeding cycle. For example, the presence of larvae often increases worker ants demand for protein that otherwise mostly forage for sweet things.

   This information helps to choose a bait that will be attractive to the ant species and in choosing the best time to put the bait out. Also, if the ants are known to form associations with other insects, treating both the ant and the associated insect may increase the chances of management success.

5. **Delimit** the extent of the incursion using attractive lure monitoring. For determining the extent of the infestation, start by defining a circular search area with the detection site at the centre and with a 150m radius (Figure A). This area should then be divided into 15x15m grid squares (using GIS). Place a lure in each grid square containing suitable ant habitat (basically anything other than sand or bare ground).

If the ant species has a known or observed preference for a particular lure type (e.g. yellow crazy ants are often prefer sugar over protein while African big-headed ants usually prefer protein and little fire ants love peanut butter) then only the preferred lure should be used. If the target IAS is detected within 50m of the search area boundary, expand the area by 50m and continue with lure monitoring. Continue this way until no invasive ants have been detected for 50m.

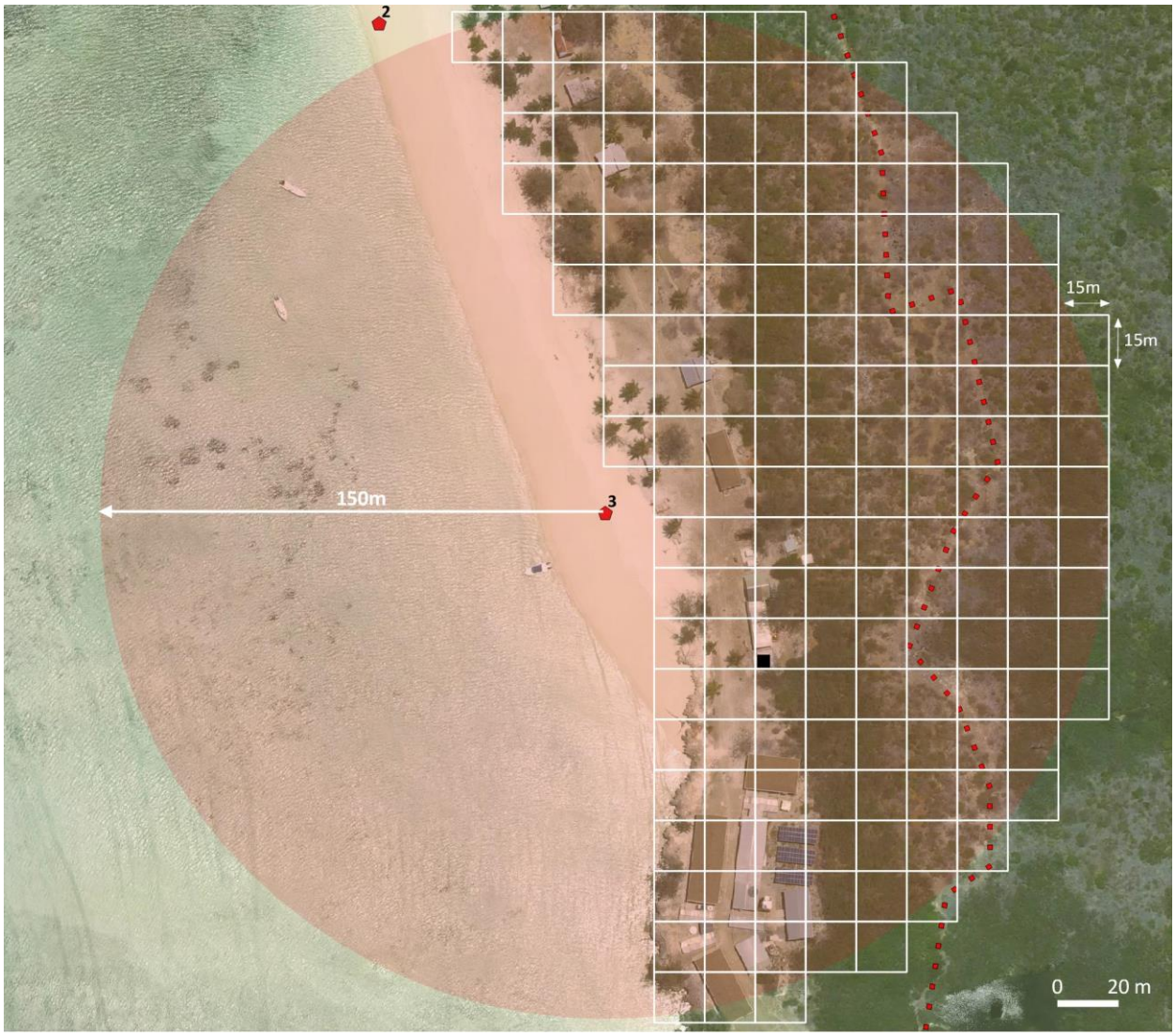

Figure A. Example of a delimitation search area around detection site 3 with a 150m radius (red circle) and a 15x15m grid square placed wherever there is suitable ant habitat.

6. **Contain** the infestation to prevent further spread. Create a pesticide barrier just inside and around the boundaries of the infestation, remove/dismantle potential nest sites, and tightly control the movement of people and objects in and out of the infested area.
7. **Undertake control** if deemed feasible and worthwhile. **Note:** Large infestations are unlikely to be manageable immediately with the resources available on Aldabra. In such situations, large amounts of pesticides and other resources will need to be delivered from Mahé.
8. **Review** the incursion response once finished, including the likely invasion pathway and how to prevent a similar invasion re-occurring. Continue to conduct surveillance monitoring to determine success.

SMALL SCALE ANT CONTROL

If the incursion is thought to consist of a small number of ants, or one or two nests, an immediate attempt should be made to eradicate the individuals with suitable ant poisons placed around the detection site and/or the nest. Any use of pesticides to control ants should be done only under the guidance of HO and an invasive ant expert.

If the infestation is thought to be larger than this, with many ants observed over a large area or multiple nests, no control attempt should be made until the delimitation surveys have determined the extent of the population and a suitable expert has been consulted.

Poisons/pesticides for ant control

- Ant infestations are typically controlled with pesticides (poisons). There are several types of pesticide (such as neurotoxins, stomach poisons and insect growth regulators) that work to kill ants in different ways. Pesticides consist of the active ingredient (for example, fipronil, pyriproxyfen or hydramethylnon) mixed together with a bait to attract the target ant, in the form of either solid granules, powder, gel/paste or liquid.
- The type of bait used is often dependent on the food preferences or foraging ecology of the target ant species. Therefore, different ant species can require different pesticides (or multiple products used together). Pesticides and control methods that have been successful in one environment type can have no effect in another.
- Most large-scale ant control is done with granular baits, as these can be spread over an area more easily and consistently than gel, powder or liquid baits, or can easily be contained in bait stations. Granular bait can be distributed over open areas by hand, in bait stations, or with hand-held bait spreaders (Figure B) or mechanical mist-blowers.

Figure B. Hand-held bait spreader

- Gel baits can be used to reach elevated areas and stick to foliage or tree trunks. Powder, liquid and spray poisons can be used in areas where it is not appropriate to broadcast granular or gel baits, such as around houses or buildings.
- As a general rule, bait should not be applied during rainy weather (or when rain is likely within the following 6 hours). Bait should be applied when ants are most actively foraging – typically during the cooler parts of the day, 6:00-10:00 am and 3:00-6:00 pm.

Safety with poisons

Pesticides should always be used with extreme care, especially on Aldabra, where medical help is not easily accessible and there are high natural values to be protected. Many ant pesticides are toxic to animals other than just ants, and all are toxic to people. Before using pesticides, read the product safety information for the product and follow the safety instructions on the label. Wear gloves when handling pesticides and always wash hands with soap and water before eating, drinking or smoking after handling pesticides.

Recommended products

Some, or both, of the following pesticide products could be stored on Aldabra to enable a response to an ant incursion if it is detected early:

1. **Vanquish Pro** is a gel bait containing a low concentration of fipronil. Low dose fipronil is toxic to many ant species and can be easily ingested by ants of all sizes. The formulation of Vanquish Pro makes it attractive to ants whether they are foraging for carbohydrates/sugars or protein food sources. Being a gel, it should last longer than granules, which may break down in the heat of Aldabra.

2. **Attrathor** is a concentrated form of liquid fipronil and attractant which is diluted in water and used as a spray in areas where other bait types are not appropriate, or as a barrier to prevent ant movement. Once applied to a surface, the water rapidly evaporates leaving an invisible residue. The attractant in the residues draws the ants to the area, where they become covered in the poison and then carry it back to their nest.

APPENDIX 5. PLANT INCURSION PROTOCOL

Use this protocol for any suspected arrival of an alien plant on Aldabra Atoll.

1. Take high resolution photographs of suspected alien plant including its general habit, leaves, any seedlings, flowers or fruit and the infestation site (Figure A). Use photos to help confirm identification of the plant species using the *Aldabra Guide to Potentially Invasive Plants*; if not in the guide, seek advice from relevant plant experts (see list in the guide). Any identification made on Aldabra should also be confirmed by an expert.

Figure A. For accurate identification, plant photos should show the vegetative features of the plant, and flowers or fruit, and the habitat in which it is growing

2. Record the following information:

- date plant was discovered and name of observer
- type of plant (e.g. grass, herb, woody shrub, tree)
- plant size
- number of plants
- whether any are flowering or fruiting
- whether seedlings are present
- location and GPS coordinates
- description of surrounding habitat

3. Establish the extent of the invasion. Good mapping is essential for effective control of invasive plants so that repeat visits can be made to eradicate seedlings/propagules that may remain after the parent plant(s) is removed. Permanently mark all locations of located plants in order to find the site again.

4. With the above information and a confirmed identification, assess the risk the alien species poses to the atoll – what damage could a population of this species do to the atoll's species or ecosystem? Based on the risk assessment, design an incursion response plan, with external advice if required.

5. If deemed to pose a risk to Aldabra if it became established, remove the plant/s as per the designed incursion response plan (e.g. by hand or treated with herbicide). If plants are to be dug out, remove all the roots from the ground and contain all material securely in a plastic bag. Dispose in an incinerator. If herbicide treatment is required, appropriate health and safety procedures should be followed.

6. Take care there are no seeds or root fragments left at site and carry out repeat visits to confirm eradication. Remove any seedlings during later visits and if any doubt over seedling identity, pull it out.

APPENDIX 6. MAHÉ BIOSECURITY REPORT TEMPLATE

This template should be used by the Mahé Biosecurity Officer/s to guide biosecurity reporting. Reports should be produced for each supply boat event and plane to Assomption. Reports should contain the following information as minimum but can include other relevant information.

Report title (e.g. Mahé Biosecurity Report – Supply boat 'Little Boy')

Biosecurity officer(s)

Report date

1. Transport details:

- Transport type (e.g. supply boat or plane, owned and/or chartered by xxx company)
- Dates of transport departure from Mahé and planned arrival on Aldabra/Assomption
- Islands visited on route
- Summary of SIF cargo on board
- Note any other information regarding the transport that is relevant to biosecurity.

2. Pre-departure:

a. *Preparation:* Describe what actions were taken to ensure biosecurity rooms and storage areas were clean and free of pests prior to packing and checking procedures (e.g. fumigation).

b. *Surveillance*: List the number and type of pest control devices (e.g. sticky traps, rodent bait stations) deployed leading up to the transport departure and describe anything found (e.g. type of insects caught or evidence of rodent presence).

c. *Biosecurity checks:* Describe any checks carried out (e.g. for fresh goods, general supplies or personal luggage). Provide details (and photos if possible) for anything that was found (e.g. insects, seeds etc).

d. *Packing:* Describe what steps were taken to ensure supplies are rodent and insect proof (e.g. secure containers used for all food, wood wrapped in plastic, water tank entrances sealed etc.).

e. *Briefings:* what kind of biosecurity information/briefing was given and to whom (e.g. boat captain).

f. *Pest control en route:* For supply boats, describe what steps were taken to ensure the supplies remain secure from IAS until arrival at Aldabra. Provide the number, type and location of detection devices deployed.

3. Risk Issues

- List any risks associated with the transport or supplies for the benefit of the Aldabra team (e.g. unsealed goods, unsecured storage facilities on supply boat, machinery etc).

4. Comments

- Points for discussion about biosecurity procedures, e.g. difficulties, highlights

5. Recommendations

- Recommended actions for the Aldabra team on arrival of the boat/plane
- Recommendations for HO in regards to general biosecurity procedures, e.g. improvements or requirements

APPENDIX 7. ALDABRA BIOSECURITY REPORT TEMPLATE

This template should be used by the Aldabra Biosecurity Officer or ASC to guide biosecurity reporting for supply boats and planes.

Report title (e.g. Aldabra Biosecurity Report – Supply boat 'Little Boy')

Biosecurity officer(s)

Report date

1. **Transport details:**

- Transport type (e.g. supply boat beaching or anchored offshore, owned/chartered by xxx company)
- Dates of transport departure from Mahé and actual arrival on Aldabra/Assomption
- Islands visited on route (as this may have changed from the original plan)
- Transit time on Assomption, if applicable
- Summary of cargo

2. **Unloading procedures:**

a. *Surveillance*: List the number and type of pest control devices (e.g. rodent bait stations or insect control) found on board, if applicable, and describe the state of the devices upon arrival at Aldabra

b. *Biosecurity checks:* Describe what kind of checks were carried out (e.g. fresh food, machinery, boat crew) and where (e.g. on board boat, on shore and/or in biosecurity building)

c. *Potential IAS intercepted (if applicable):* Include description, location, photos and actions taken

d. *Boat personnel:* Record any information provided by the captain or crew regarding biosecurity or IAS

3. **Comments**

- Points for discussion regarding the transport specifically or about general biosecurity procedures, e.g. issues, difficulties or highlights

4. **Recommendations**

- Recommended actions for Aldabra and HO for the next transport
- Recommendations for HO in regards to general biosecurity procedures, e.g. improvements or requirements

APPENDIX 8. STAFF PARCEL MEMO

MEMO

From: SIF Head Office

Thru': CEO

To: All Aldabra Staff

Date: 25 September 2018

Subject: Sending personal parcels to Aldabra

Aldabra as protected site with UNESCO World Heritage status is known as one of the most undisturbed ecosystems in the world. It is therefore important that Aldabra is protected from introduced pests and diseases. It is the responsibility of all staff members to ensure that all biosecurity measures are adhered to in order to prevent introduction of pests on Aldabra.

For this reason all home-care parcels for Aldabra are searched and cleaned thoroughly by designated biosecurity officers. Your parcel will be checked for the presence of rodents, seeds, insects, soil, and debris. Please note that any item that is deemed a biosecurity risk will not be permitted on Aldabra.

List of things to check and clean before bringing your parcel to head office:

Fruits and vegetables from home gardens

- Check for defects caused by insects/ fungus. Fruits with insect scars are not to be taken to Aldabra.
- All soil to be removed and washed completely on root crops e.g. potatoes/cassava.
- Check for trapped insects in hidden places e.g. in banana bunch.
- Remove of all excess leafy material e.g. on pineapples, corn, strawberries etc.
- Papaya, Passion fruit and lemongrass are not allowed to be send to Aldabra
- No seeds are allowed to be send to Aldabra

Containers & packing material

- Containers or bags containing the parcels should be thoroughly cleaned
- If possible place your fruits in a sealed container/Tupperware

The transportation of staff parcels to Aldabra can take between 1-14 days depending on the type of transport and itinerary. Even on a plane there is always a risk of delay with cargo and often items get stuck on Assomption due to rough seas. Only unripe fruits that do not perish quickly are allowed. Refrain from sending fruits and other goods that perish quickly.

Advise your families to not bring the parcel much earlier than the announced deadline to minimize the time at head office waiting for transportation, and avoid the spoiling of fresh goods.

Do not expect your parcel to be chilled prior or during the transport.

Please be aware that transportation of any cargo to Aldabra is always risky. Losses and damages due to delays beyond SIF's control do unfortunately happen. **Please advise your family members to leave their contact details at the office** so that they can be contacted in the event of a delay to return the fruits and goods before they are spoiled.

SIF allowed and prohibited foods (kindly note Island Development Company might apply different rules):

Strictly prohibited	**Allowed (if checked and authorized by biosecurity)**
Passion fruit	Oranges
Papaya/pawpaw	Apples
Lemongrass	Pears
	Green Bananas
	Green Mangos
	Pineapple
	Lemons
	Starfruits
	Golden Apple
	Guavas
	Pumpkins
	Sweet Potato
	Cassava
	Only for air cargo:
	Grapes
	Strawberries with no leaves
	Chillies
	Avocadoes

Thank you for your understanding and cooperation.

Your SIF biosecurity team