Agreement on the Conservation of Albatrosses and Petrels

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Biosecurity and Quarantine Guidelines for ACAP Breeding Sites – Background Information

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Background

Invasive alien species pose a significant threat to biodiversity globally (McGeoch *et al.*, 2010, McKinney and Lockwood, 1999), including species listed under the Agreement on the Conservation of Albatrosses and Petrels (ACAP). For centuries, humans have deliberately and unintentionally moved plants, animals and other organisms beyond their natural range. Not all introduced species become established or have an adverse impact in their new locations. Others may be benign initially, but become problematic over time, or due to a change in habitat and/or climatic conditions. Unfortunately, many alien species are invasive, and have and continue to alter the structure and functioning of ecosystems, sometimes leading to local extinctions.

There is compelling evidence, based on global trade and movement patterns, that the threat of invasive alien species to biodiversity is increasing (Hulme, 2009). Although most ACAP breeding sites are relatively isolated, with fewer pathways and entry points for the introduction of alien species than elsewhere in the world, it is clear that even the most remote ACAP breeding sites are not immune to these trends and impacts. For example, at Gough Island in the South Atlantic and Marion Island in the sub-Antarctic, human-mediated introductions of alien species have outweighed natural colonisations by two to three orders of magnitude (Gaston *et al.*, 2003). Even Antarctica is vulnerable to the introduction and impacts of alien species and organisms (Frenot *et al.*, 2005, Hughes and Convey, 2010, Tin *et al.*, 2009, Woods *et al.*, 2009). Moreover, the relatively low species diversity of floras and faunas of the islands on which ACAP species breed make them particularly susceptible to invasion by alien species that are able to fill unoccupied niches, a threat that may increase as climate change proceeds (Bergstrom and Chown, 1999, Chown *et al.*, 1998).

The introduction and establishment of a range of alien species at ACAP breeding sites have been documented by ACAP Parties and the Breeding Sites Working Group (see AC4, Doc 13, Breeding Sites Working Group – Report, ACAP, unpubl. data). It is important to note, however, that current knowledge about the presence and impact of alien species at ACAP breeding sites is by no means complete, especially in relation to plants, invertebrates and microorganisms.

Of the threats to breeding sites assessed by the ACAP Breeding Sites Working Group, those which affected most breeding sites involved invasive alien species. Note that this assessment was made prior to the recent addition of the three North Pacific albatrosses to the list of species covered by the Agreement, but it is not believed that this will greatly affect the results or recommendations. These threats included predation by alien species, especially feral cat *Felis catus* and ship rat *Rattus rattus,* and habitat destruction by alien species (reindeer *Rangifer tarandus*), which affected 26, 16 and 8 breeding sites, respectively (AC4, Doc 13, Breeding Sites Working Group – Report, ACAP, unpubl. data). Other documented threats involving alien species or pathogens include predation by house

mouse *Mus musculus* and Norway rat *Rattus norvegicus*, habitat destruction by European rabbit *Oryctolagus cuniculus*, and moufflon *Ovis ammon* (although Moufflon have since been eradicated from Iles Kerguelen, J. Cooper, pers. comm.), and avian cholera *Pasteurella multocida*. The formal assessment of threats to ACAP breeding sites (and consequently to ACAP species) highlights the impact of introduced mammals, and especially rodents, on island ecosystems. Although the capacity to remove introduced mammals has improved vastly in recent decades, their eradication is still very expensive and difficult to achieve on large islands (Phillips, 2008), so every effort should be made to prevent the introduction and establishment of invasive alien species in the first place. Indeed, preventing the arrival of potentially invasive species is the most effective way to avoid impacts and costs less than managing established invasive species.

ACAP has recognised that invasive alien species pose a serious threat to albatrosses and petrels, and that urgent action is required to manage this threat. Under the ACAP Agreement, Parties are required to take management action to prevent the introduction to habitats, of alien plants, animals and disease-causing organisms that may be detrimental to populations of albatrosses and petrels (Annex 2, Paragraph 1.4.1). Although introduced vertebrates and disease-causing organisms represent the most serious biosecurity threats to albatrosses and petrels presently, the introduction of other taxa may also impact ACAP-listed species. For example, invasive alien plants are known to have a substantial impact on the structure and functioning of terrestrial ecosystems at many ACAP breeding sites (Bergstrom and Chown, 1999, Chown *et al.*, 1998, Frenot *et al.*, 2005, Gaston *et al.*, 2003, Gaucel *et al.*, 2005, Gremmen, 1997, Jones *et al.*, 2003), which in turn may affect the quality and extent of nesting habitat of ACAP species. Moreover, a biosecurity strategy should be comprehensive, aimed at preventing the introduction of all invasive, or potentially invasive, alien species and pathogens.

From both a conservation and economic perspective, it is far better to prevent any further accidental or deliberate introductions of alien species than to deal with the consequences thereafter. The most effective way to minimise the risk of introductions is to identify the pathways for invasion and establish a series of barriers across the entire introduction pathway (from source to site), with the aim of preventing the introduction occurring as far back along the introduction pathway as possible (Hulme *et al*., 2008, Reaser *et al*., 2008).

This document is aimed at guiding biosecurity and quarantine work at ACAP breeding sites, and it is primarily designed to be a useful working document for the ACAP community.

Scope and terminology

ACAP breeding sites differ vastly in their geographic, practical, administrative and political contexts, all elements which influence biosecurity planning and implementation. For example, some sites have a resident human population throughout the year, whereas others are visited very rarely. It is important that comprehensive biosecurity strategies and practicable action plans are developed for each of these sites, or groupings of sites, that are appropriate for the scale of the sites and administrative systems in place. The purpose of this document is to summarise guidelines on biosecurity management for breeding sites of ACAP species, and to provide a selected bibliography and list of online resources.

'Biosecurity' refers to the suite of policies and measures that are implemented to prevent the spread of invasive alien species across international and internal borders, including between islands of an archipelago or island group. The terms 'quarantine' and 'biosecurity' are sometimes used interchangeably. In this document, 'biosecurity' is used broadly to encompass quarantine, surveillance and contingency response. 'Quarantine' is used in a narrower sense to refer to the containment of invasive alien species[1], or killing an invasive alien species before it reaches the site. 'Pathways' refer to the geographic routes by which a species moves from one location to another, and 'vectors' are the physical means or agents by which species are transported. In the case of invasive alien species and biosecurity we are dealing with pathways and vectors that are enhanced or created by human activity that move species outside of their natural ranges and give rise to accidental or intentional introductions.

Pathways and vectors for invasive alien species

Preventing the spread of invasive alien species across international boundaries and within countries is best achieved by identifying the pathways and entry points of potential introductions and establishing effective barriers along these pathways to prevent alien organisms from entering and becoming established in new areas. Although the pathways and entry points for ACAP breeding sites are diverse (it is beyond the scope of this paper to list them in detail), they are limited and well defined compared to large landmasses and continental countries. Consequently, designing and implementing an effective biosecurity management system should be less complicated than for many other parts of the world.

There are three broad categories of pathways of introduction:

1. Natural dispersal and colonisation by species, either passively by wind and currents, hitching a ride on or in another animal or raft of vegetation, or actively (in the case of islands, this is normally by flying or swimming),
2. Organisms that are accidentally introduced as a result of human activities that facilitate transport of species to new sites, and
3. Alien species that are deliberately introduced to a new site.

Biosecurity management focuses on the two human-mediated pathways for introduction (i.e. categories 2 and 3). The most challenging of these to manage successfully is the second: the unintentional transfer of species from one area to another. Human visitation of ACAP sites (by aircraft and ship for example) provides a highly effective method by which invasive alien species can be introduced. At many sites, the frequency and volume of human visitation, and of associated supplies and equipment, have been increasing. Given the strong link between the number of human visits, the level of occupancy and the total number of alien species for islands in the Southern Ocean as a whole (Chown *et al.*, 1998), increased visitation to ACAP sites is likely to have led, and will continue to lead, to an increased risk of introducing invasive alien species. Further, climate change may lead to amelioration of local environmental conditions at many ACAP sites, thus making it easier for introduced alien species to become established (Bergstrom and Chown, 1999). Preventing or restricting access to ACAP sites and minimising the volume of imports is an effective way

[1] An alien species whose introduction and/or spread threaten biological diversity. These include plants, animals, microorganisms and their propagules. See www.cbd.int/invasive/terms.shtml

to reduce the risk of human-mediated introductions. Although some sites are managed in this manner, for many others, it is not a practical or realistic option. In these cases it is even more important that a rigorous biosecurity system is in place and implemented by all involved.

The nature of human-mediated introduction pathways to ACAP sites varies. Some sites have a permanent human population engaged in trade activities. Others have an ever-changing human population associated with ongoing scientific programmes, with annual or more frequent logistical support. Some sites are visited only very rarely, either because they are remote and inaccessible, or because it is the intention of the relevant authority purposely to restrict access in order to minimise human impacts. Many of the ACAP sites also experience some degree of tourist visitation, through both commercial and private tourism operations. Commercial fishing activities in the waters adjacent to ACAP breeding sites provide another pathway for the potential introduction of invasive alien species. All of these activities provide effective transport mechanisms for the transfer of species and organisms from one area to another. Accidental introductions can take place via the actual transport infrastructure (e.g. aircraft, vehicle, ship/boat), or via contamination of materials, goods and organisms that are being transported. Indeed, all air and marine carriers, vehicles, cargo containers and items transported to ACAP sites have the potential to act as vectors for alien species.

Some items are known to be of higher risk of harbouring pest species, including pathogens. These include, but are not limited to:

- Building materials
- Soils and sand
- Stores
- Packing material, especially paper or cardboard-based materials
- Field gear and outdoor equipment, such as tents, tripods, hiking poles and camera cases
- Clothing (seams, pockets, footwear, socks and Velcro being particularly problematic for the transfer of seeds)
- Wood (especially if untreated)
- Fresh produce (especially large, leafy vegetables)
- Poultry products (most raw poultry products have some degree of contamination with disease-causing organisms and so pose a threat to ACAP species)

In some cases, live plants and animals are deliberately taken to sites as part of horticultural and livestock activities. These imports obviously pose a biosecurity risk that needs to be assessed and managed.

Ships and other vessels have translocated marine species through the release of ballast water and as a result of biofouling of ships' hulls (Lewis et al., 2003, 2005, 2006), Frenot *et al.*, 2005, Lee and Chown, 2007, Hopkins and Forrest, 2008, Wanless *et al.*, 2009). However, the development and implementation of quarantine legislation and protocols to minimise the risk of ship fouling have generally lagged behind the terrestrial aspects of quarantine management.

The objective of a biosecurity and quarantine system is not necessarily to exclude the movement of all goods to a site, although consideration should be given to prohibiting and curtailing high-risk items such as poultry and fresh produce from important and sensitive sites, as has been done at a number of ACAP sites. Rather, the objective is to understand the pathways and vectors for invasive alien species, the risks involved and the management options available. A risk assessment system, in which the probability and consequences of unwanted introductions are formally considered, is an important component of a biosecurity strategy, and should be used to guide and prioritise the development and implementation of practicable biosecurity and quarantine measures targeted at reducing identified risks.

Mitigation of risks

The types of action that can be taken to reduce the risk of invasive alien species entering and becoming established at a site can be divided into three broad categories:

1. Pre-border actions – actions taken outside the site/region, at the source of the pathway, and on the transport mechanism to the site (e.g. ship, aeroplane); require effective quarantine measures and ongoing surveillance and reporting.
2. Border actions – actions taken at site to prevent the arrival of species/pests there; require effective and ongoing surveillance.
3. Emergency response – actions taken to eliminate newly arrived introduced species before they spread far beyond the point of arrival; require ongoing surveillance and resourced and updated contingency plans that can be rapidly implemented.

An effective biosecurity system needs to include all of these elements, but prevention at source is the most critical and cost-effective component, followed by border control actions. Emergency actions, after the arrival of alien species, are the most expensive and there is no guarantee that they will be successful. However, where human visitation and the transport of supplies occur, preventing the introduction of all alien species, including microorganisms, would be very expensive, and almost certainly impossible. Consequently, rigorous surveillance programmes to detect and report alien incursions as soon as they occur and contingency response plans that can be rapidly implemented are essential components of the biosecurity system.

Awareness of the biosecurity risks that human visitation poses to ACAP sites has increased markedly in recent years. In recognition of these risks, formal biosecurity and quarantine systems have been developed and are being implemented at a number of sites. There is evidence that where biosecurity and quarantine protocols are effectively implemented, monitored and improved through a process of adaptive management, the frequency of incursions of unwanted pests has been reduced (e.g. Potter, 2007). Despite these successes, there remain many challenges and constraints that need to be tackled to improve biosecurity management. In some cases there is still a lack of awareness and understanding of the impacts of invasive alien species, and the importance of implementing a rigorous biosecurity system. This often means that there is inadequate legislation and protocols, and enforcement of these. The management and implementation of biosecurity systems will often involve many different individuals, departments, agencies, and organisations, even at one site or region – an issue which is particularly challenging in Antarctica, where there is no central body with the capacity to enforce biosecurity protocols and ensure they are being

implemented properly (Hughes and Convey, 2010). Responsibilities and regulations are often unclear or are limited in scope and lack sufficient practical details on the implementation of biosecurity measures (Potter, 2007, Hughes and Convey, 2010).

Legislation, although an important component of biosecurity management, is by itself unlikely to prevent the introduction of all unwanted pests (Potter, 2006). Raising awareness of biosecurity risks amongst all target audiences is essential, as is the need to develop, promote and use additional tools, such as codes of conduct, protocols, guidelines and permit conditions that are targeted at specific audiences (such as field workers, commercial and private tourists, contractors). Achieving such aims will require strong outreach and information programmes to be implemented by the relevant authorities and other stakeholders. Voluntary best practice and compliance is always preferable to relying on legislation alone, particularly where resources for surveillance and enforcement are limited. In reality, the overall success of a biosecurity system will rely in a large part on self-regulation, highlighting the importance of fostering a sense of shared responsibility amongst all those involved in visiting or transporting people and goods to the site in question.

There are a wide range of issues that needs to be considered when developing a biosecurity system, and these issues will vary from site to site. Not only will the biological properties of sites differ, but so will the legal, administrative and political situations, the infrastructure, technical expertise and the general capacity to undertake and oversee biosecurity and quarantine measures. Although there are similarities between ACAP sites and their biosecurity needs, every biosecurity system should be developed specifically for the particular suite of circumstances that prevail within an area or region. In the following section, a summarised list of guidelines that may be of use to the ACAP community in developing and implementing biosecurity and quarantine management systems is provided. It should not be considered a substitute for obtaining appropriate and detailed advice from biosecurity experts.

This Information Paper has also been submitted, in shortened form, as AC5 Doc 19.

Guidelines

General principles

- It is important to build awareness and support amongst the relevant authorities and all those involved in visiting or transporting people and goods to the site in question to demonstrate the serious threat that invasive alien species pose to ACAP sites and species, and indeed more broadly, and the economic and ecological benefits (and necessity) of developing and implementing an effective biosecurity system. The success of such a system depends on changing perceptions, attitudes and behaviour to encourage a sense of shared responsibility.
- Conduct a pathway risk analysis for each site or region to identify and document the pathways and vectors most likely to transfer invasive alien species, the entry points, the range of people and organisations that are involved in these pathways, and the potential consequences of such introductions. This process should be used to prioritise actions and sites. High-risk sites are those locations where there is a higher likelihood of new incursions of invasive alien species occurring. These are generally the points of entry for ships, aircraft and other pathways.

- Develop, promote and adopt an effective policy and legal framework and practical protocols for biosecurity and quarantine management for each site or region. It is important that legislation and protocols are tailored for the sites in question (giving due consideration to the administrative, political, geographical and practical circumstances), and respond to the priorities identified in the risk assessment process. Protocols and legislation needs to be clearly defined and should include sufficient information on exactly how the measures are to be put into practice. Ensure full participation by all stakeholders in the development and implementation of legislation and protocols, and that mechanisms are established to maximise compliance with and enforcement of these protocols.
- Sufficient resources and capacity/expertise should be allocated to implementing the biosecurity management system, and this should be done in a prioritised manner (i.e. responding to the priority needs identified in the risk assessment). Roles and responsibilities for biosecurity management need to be clearly defined and properly coordinated.
- It is important to consider the appropriate scale at which biosecurity measures should be applied. For example, management plans developed for Antarctic Specially Protected Areas (ASPAs) apply only to that specific area, rather than to the broader region of which the site forms part (Hughes and Convey, 2010). Biosecurity measures implemented in a specific ASPA will clearly not be effective (and will indeed be undermined) if the same or stronger measures are not applied in adjacent areas.
- For Southern Ocean islands, the number of introduced species is strongly related to the number of occupants and visitors to a site (Chown *et al.*, 1998), a relationship which is likely to be true for all ACAP sites. Therefore restricting human access and the volume of imports to sites will reduce the risk of introducing invasive alien species.
- Close human contact with wildlife is thought to contribute towards the introduction and spread of diseases, and so should be prohibited, or at least regulated through a permit system (Potter, 2006).
- Strict and comprehensive biosecurity and quarantine measures are required to restrict introduction pathways and prevent the spread and establishment of invasive alien species. Actions need to be taken along the entire introduction pathway, aiming to prevent and restrict the introduction as far back along that pathway as possible. Actions can be categorised into three broad categories: 1) pre-border control to prevent invasive alien species infesting materials and infrastructure destined for the site, 2) at border control to monitor for and detect any invasive alien species that may have arrived at the site and take the necessary actions to ensure that they do not enter the site, and 3) emergency response systems to respond rapidly to newly arrived introduced species before they become established.

Pre-border control at source points

- Consider prohibiting imports of high-risk vectors of invasive alien species and pathogens, or at least treating items to reduce the risk of contamination. Soils, river sand, fresh fruit and vegetables, for example, are known to be key vectors for alien species and pathogens, and their import is prohibited at some ACAP sites. Where banning the import of all fruit and vegetables is not a practical option, thorough

screening and careful packing of these items is important (as is the strict management of supply, packing and storage facilities – see below). Maintain strict standards by for example using reputable suppliers with Integrated Pest Management accreditation, and making import permits conditional on proof of compliance at the point of export. The use of hydroponic operations to supply or supplement fresh produce has also been used at a number of sites to minimise the risk of introducing invasive alien species; however, pest infestations from these facilities have been detected (Potter, 2006).

- Poultry products are known to harbour pathogens which can infect ACAP species. Indeed avian cholera (caused by *Pasteurella multocida*), which is known to be widespread in poultry, is probably the major cause of the decline in the Indian yellow-nosed albatross *Thalassarche carteri* population at Amsterdam Island, and may also be threatening the Amsterdam albatross *Diomedea amsterdamensis* and the sooty albatross *Phoebetria fusca*. Many research stations in the Antarctic and sub-Antarctic have now curtailed the import of poultry products, or require that they be treated - eggs irradiated and poultry deboned - before being transported to the site (e.g. Cooper *et al.*, 2003, Potter, 2007). Similarly, due to a concern about the potential for pathogens to infect wood, the use of wooden components in cargo containers is avoided at some sites, using plastic and other recyclable, synthetic packaging instead. At other sites, wood packaging is only is only allowed to be offloaded if it is new and complies with minimum certified standards, such as the ISPM 15 Wood Treatment Standard (Hughes and Christie, 2008).
- Simple and pragmatic measures relating to the type of cargo and packaging materials used, and the location of the storage and packing facilities can lead to a marked reduction in the contamination of cargo and supplies (Whinam *et al.*, 2005, Lee and Chown, 2009). Minimising the quantity of cargo and equipment transported to and offloaded at ACAP sites can also reduce the risk of transferring invasive alien species.
- Ensure that effective quarantine management is carried out at all source points, and especially at high priority source points. Storage and packing facilities used for cargo and supplies destined for ACAP sites should be regularly inspected, especially in the period leading up to departure for the site, and thoroughly cleaned (preferably fumigated) at least once per year, and in response to any incursions or contaminated material. Adequate rodent and pest control measures must be implemented throughout the year, through the ongoing deployment and inspection of rodent bait stations and both flying and crawling invertebrate traps. These measures should also be extended to adjacent wharf areas. Ensuring that the cargo arrives at the storage and packing facilities a few days before the date of departure will allow thorough screening, inspection and cleaning/fumigation if required.
- Packing of foodstuffs and other items should be done in a manner which minimises the risk of transferring pests. As far as is practicable, items should be packed into firmly sealed and pest proof containers. If boxes or cartons are used, they should also be sealed. Proper rodent proofing requires all holes >5 mm to be securely sealed. Packing should take place in a secure (pest-free) environment and preferably during daylight hours when pests are generally less active. Half-packed containers should be kept closed when not packing. Containers should be packed above the floor and with building windows closed or fitted with screens.

- The potential of large cargo items to be vectors is related to the proximity of the cargo to source material, the nature of the surface area of the cargo (some surfaces provide better habitats for alien species and their propagules) and the cleaning regime (Whinam *et al.*, 2005). Thorough inspection and cleaning of all cargo items is required to ensure they are free of biological material.
- Expedition field equipment (such as bags, tents, tripods and hiking poles) and clothing (especially footwear, hiking socks, pockets, seams and Velcro closures of outer clothing) are highly effective vectors, especially for seeds and other plant propagules (Whinam et al., 2005, Lee and Chown, 2009). These should be thoroughly cleaned and inspected before packing. Some research and support programmes at ACAP sites have banned or are phasing out the use of Velcro to reduce the risk of transporting alien propagules.
- Biosecurity management at source points, and indeed along the entire introduction pathway, will be greatly improved if dedicated and sufficiently experienced biosecurity/quarantine officers are tasked to oversee the quarantine-related measures.

Pre-border control during transportation

- As with the storage and packing facilities, it is crucial that effective quarantine measures are strictly implemented on all vessels, aircraft and vehicles that visit ACAP sites, as well as at the storage sites for these (e.g. hangars). Require that all supply vessels visiting the site maintain rat free certification and other pest control certificates.
- Rodent bait stations and flying and crawling insect traps should be deployed, constantly monitored and regularly serviced. Methods to prevent rodents embarking onto vessels and disembarking from vessels and aircraft are well established and should be reasonably easy to implement. See for example the World Health Organisation technical advice for inspecting and issuing ship sanitation certificates (World Health Organisation, 2007).
- Attending formal education and information sessions on biosecurity and quarantine measures should be made compulsory for all crew and passengers, in which the importance of biosecurity is explained, and the required inspection and cleaning techniques for personal effects is described. Pamphlets, posters and other educational material should also be made readily available.
- Inspection and cleaning of all high risk clothing and other personal effects known to transport pests (see above) should be made an obligatory pre-disembarkation requirement, including boot-washing with a biocide, such as Virkon or domestic bleach (sodium hypochlorite). See for example the simple and practical guidelines for decontaminating boots and clothing developed and implemented by the International Association of Antarctica Tour Operators (IAATO) (IAATO, 2010).
- To minimise the risk of introducing marine invasive alien species, the hulls of vessels visiting the site should be regularly cleaned of biofouling (preferably between each voyage) and regularly inspected. Policies on ballast water exchange should be developed and implemented to restrict this introduction pathway for marine invasive alien species. See the International Maritime Organisation (IMO) ballast water exchange guidelines (http://www.imo.org/Conventions/Mainframe.asp?topic_id=867) for further information.

- The appointment of a dedicated biosecurity officer to oversee quarantine-related tasks on regular supply voyages to ACAP sites is a cost effective action with potentially high benefits (Whinam *et al.*, 2005).

At border or entry control

- All vessels should use serviceable rat guards on all mooring lines at all times. The number of mooring lines should be minimised, and crossed mooring lines should be avoided. As a precaution, rodent bait stations should be deployed on the vessel and in the landing area to minimise the risk of introducing rodents to the site. It is also important that rodents are prevented from moving from infested sites onto vessels that may then be moving to other sites that are free of rodents.
- Doors, hatches and gangways should be closed/raised when not in use, especially at and after dusk.
- Keeping docks and wharves immediately adjacent to ships well lit at night helps deter rodents.
- Dock-side waste storage containers should be properly serviced and have tight-fitting lids kept closed when not actually in use.
- Implement thorough inspection procedures for cargo and other items prior to offloading to check that the goods meet the conditions of entry. Ideally, purpose built quarantine facilities should be established at the key landing areas to allow further examination and storage of goods in a secure area, from which pests cannot escape. The quarantine facilities serve as a final barrier to prevent the introduction of alien species, and should be able to cope with the highest risk organism likely to be handled by the facility.

Surveillance and reporting

- It is important that effective surveillance systems are in place at the points of entry, and indeed along the entire introduction pathway, that enable rapid detection of alien species.
- Rapid and reliable identification of pests or contaminants is crucial to inform the appropriate response. In some situations the evidence will be obvious, such as the presence of soil or progagules on cargo, and can be easily dealt with. However, in many cases, the evidence will not be as easy to interpret and respond to. An effective surveillance system needs to cater for all of these eventualities.
- It is important to note that the probability of detecting introduced species is a function of their abundance. Consequently, introduced species are often hard to detect until they have begun to spread, at which point eradication is much more difficult and expensive. Consequently, effective surveillance systems require experienced and adequately resourced personnel with knowledge of: baseline levels of invasive alien species at the site in question, what to look out for and where to focus observations and how to respond to alien species or contaminants that are detected. A high general awareness of biosecurity issues amongst the broad range of people that visit or are resident at the particular site not only helps prevent introductions in the first place, but also ensures greater vigilance that may help detect unwanted pests before it is too late to contain them.
- Formal and standardised reporting of possible incursions and introductions is an important component of the surveillance system. Data should be collected for any

biosecurity breach (and sent to an identified individual with overall responsibility for the system), including; when/where found, what the pest was (with a sample preserved if possible for identification), what it was found on (i.e. the possible source with tracking details, such as consignment number) and what the response was. Repeat offenders or weaknesses can then be identified and resolved, or protocols strengthened.

Emergency response

- No biosecurity system is able totally to prevent the introduction of alien species. As long as humans are visiting and transporting goods to ACAP sites, there is a risk of introducing unwanted alien species. The aim of emergency response is to eliminate newly arrived species before they spread beyond the point of entry.
- Contingency plans for managing different kinds of newly arrived species (as well as for the management of avian disease outbreaks – see Friend and Franson (1999) for useful guidelines on the subject) should be in place and constantly tested, even if only by simulation exercises. In these plans, lead and support roles need to be defined and allocated. Equipment and supplies necessary to deal with incursions should be defined in the plans. A ready supply of the necessary equipment and supplies should be maintained at the site, and regularly checked and serviced.
- Shipwrecks and both *force de majeure* and illegal landings may be pathways for the incursion of pests, especially rodents, and should be responded to rapidly so that any incursions can be detected and contained before they move beyond the landing site.
- For a detailed review of issues to consider when preparing and implementing a contingency response to rodent invasions, see Russell *et al.* (2008).

Compliance, enforcement and review

- It is easier to enforce quarantine and biosecurity measures for programmes and activities which are under direct control of the authorities for the site in question (e.g. national scientific and support programmes), than for more dispersed activities, such as tourism. For pathways that are less directly controlled by the relevant authorities, there are other mechanisms which can be used to facilitate implementation of quarantine and biosecurity measures, such as detailed and practicable codes of conduct, permit conditions and effective awareness programmes. In many cases it will be possible to engage with a large number of people through member organisations, such as IAATO.
- The use of a self-audit system (combined with spot checks) in which all visitors to a site sign a declaration stating they have read, understood and will comply with the biosecurity code of conduct and prescriptions before being allowed to disembark is a useful mechanism to encourage compliance. For this to be effective, though, it requires clear and detailed information explaining the risks associated with alien species, the pathways involved, as well as exactly how to inspect and decontaminate items which may be potential vectors. Another benefit of an effective awareness programme is that there is a heightened vigilance for alien species, both on the vessel and also at the site.
- It is important to note that the development and implementation of an effective biosecurity system are ongoing processes. Each new incident highlights shortcomings of the system that need to be remedied. Ongoing improvements in the

design of packaging materials and general biosecurity practices should also be integrated into updated plans as part of an adaptive approach to the management of biosecurity at ACAP sites.

Online resources

Australia 2004. Australia's Antarctic quarantine practices. In: Antarctic Treaty Consultative Meeting XXVVII, Committee for Environmental Protection VII. Information Paper 31, Cape Town, South Africa, 24 May to 5 June. Can be downloaded from http://www.ats.aq/devAS/ats_meetings_documents.aspx?lang=e

New Zealand 2007. Non-native species: pathways and vectors between New Zealand and Scott Base, Antarctica. In: Antarctic Treaty Consultative Meeting XXX. Committee for Environmental Protection X. Information Paper 36, New Dehli, 30 April to 11 May. Can be downloaded from http://www.ats.aq/devAS/ats_meetings_documents.aspx?lang=e

New Zealand 2009. A framework for analysing and managing non-native species risks in Antarctica. In: Antarctic Treaty Consultative Meeting XXXII. Committee for Environmental Protection XII. Information Paper 36, Baltimore, USA, 6-17 April. Can be downloaded from http://www.ats.aq/devAS/ats_meetings_documents.aspx?lang=e

United Kingdom 2009. Procedures for vehicle cleaning to prevent transfer of non-native species into and around Antarctica. In: Antarctic Treaty Consultative Meeting XXXII. Committee for Environmental Protection XII. Working Paper 32, Baltimore, USA, 6-17 April. Can be downloaded from http://www.ats.aq/devAS/ats_meetings_documents.aspx?lang=e

http://www.ats.aq/documents/cep/Register_Updated_2009_e.pdf - provides a register of Antarctic Specially Protected Area (ASPA) Management Plans, and links to the PDF versions of the plans. Detailed biosecurity measures are described in ASPAs 118, 130 and 170 (Hughes and Convey 2010), which can all be downloaded from the register.

http://www.cbd.int/invasive/ - Invasive section of the Convention on Biological Diversity website. It is a useful source of information and materials on the subject of invasive alien species management, including biosecurity and quarantine management.

http://www.imo.org/Conventions/Mainframe.asp?topic_id=867 - International Maritime Organisation (IMO) ballast water exchange guidelines.

http://www.cbb.org.nz – Website for the Centre for Biodiversity and Biosecurity, which brings together experts in biosecurity, conservation biology and biodiversity research from Landcare Research and the University of Auckland. The website includes links to a number of useful databases on invasive alien species.

http://www.anstaskforce.gov/Documents/Pathways_Training_and_Implementation_Guide_Jan_2007.pdf - US Department of Agriculture National Invasive Species Taskforce and Aquatic Nuisance Species Task Force Training and Implementation Guide for Pathway Definition, Risk Analysis and Risk Prioritization

http://www.sgisland.gs/index.php/%28g%29south_georgia_biosecurity?useskin=gov – biosecurity measures and self-audit checklist required for all vessels landing passengers crew, expedition staff or stores on South Georgia.

http://www.iaato.org/docs/Boot_Washing07.pdf - boot, clothing and equipment decontamination guidelines for members of IAATO (International Association of Antarctica Tour Operators)

http://www.doc.govt.nz/publications/conservation/threats-and-impacts/biosecurity/ - New Zealand Department of Conservation site with publications and information on biosecurity

http://www.cic.govt.nz/pdfs/chatham-islands-biosecurity-draft.pdf - A biosecurity strategy to help prevent the entry and establishment of pests onto the Chatham islands (Environment Canterbury).

www.managementofbiologicalinvasions.net – a new open access peer-reviewed online journal focusing on the management of biological invasions, including technical and scientific works, as well as descriptive management works.

http://www.gbrmpa.gov.au/__data/assets/pdf_file/0019/4465/seabirds1.pdf - Guidelines for managing visitation to seabird breeding islands (WMB Oceanics Australia).

http://www.invasivespecies.gov/ - US Department of Agriculture National Invasive Species Information Centre.

http://www.gisp.org/ - Website of the Global Invasive Species Programme; a useful source of toolkits, training and awareness materials, and publications.

http://www.gisp.org/publications/toolkit/Toolkiteng.pdf - Wittenburg R. and Cock MJW, (eds) 2001. Invasive alien species: a toolkit of best prevention and management practices. CAB International, Wallingford, Oxon, UK.

http://www.sprep.org/att/publication/000699_RISSFinalLR.pdf - Guidelines for invasive species management in the Pacific, including biosecurity and quarantine measures.

http://www.biosecurity.govt.nz/biosec/sys/strategy/biostrategy - *Tiakina Aotearoa* – The Biosecurity Strategy for New Zealand; a link to the strategy and accompanying documents.

http://www.who.int/ihr/travel/TechnAdvSSC.pdf - World Health Organisation. 2007. Interim technical advice for inspection and issuance of ship sanitation certificates.

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