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5

AN EVALUATION OF
MANAGEMENT MEASURES TO CONTROL INVASIVE ORGANISMS
DURING ANNUAL TAKEOVERS AT SUB-ANTARCTIC MARION ISLAND

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Submitted in partial fulfilment of the requirements for the Master of Philosophy
degree in the Department of Environmental and Geographical Science,
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Draft prepared for *Polar Record*

2001

ABSTRACT

Introduced alien organisms are a major threat to the ecological and biotic integrity of sub-Antarctic islands. These oceanic islands represent a unique ecosystem at a global scale. Ecosystem integrity is easily disturbed by invasive alien species but recovers slowly and is difficult to restore. Conservation management at sub-Antarctic islands emphasises precautions against the accidental and deliberate introduction of alien species by human visitors. Management is carried out under national legislation but influenced by instruments of the Antarctic Treaty System (ATS). The sub-Antarctic Prince Edward Islands PEI are managed as a Special Nature Reserve by the South African government. The Prince Edward Island Management Plan (PEIMP) provides a binding framework to manage annual takeovers at Marion Island. The prevention of new introductions of alien species is a primary goal. The PEIMP is assessed in terms of the ATS, national law, SCAR/IUCN recommendations and environmental management best practice. The PEIMP rates well internationally as a conservation plan, but its objectives are significantly compromised non-adherence to environmental planning and management principles. It is recommended that the PEIMP be independently reviewed to bring about a more effective system of environmental management for annual takeovers at Marion Island. Such a revision will bolster South Africa's global status as a leader in sub-Antarctic conservation and science.

ACKNOWLEDGMENTS

The author wishes to acknowledge and thank Ms Susie Brownlie for her supervision, guidance and support in drafting this paper. Thanks are also due to Ms Carol Jacobs of the Directorate: Antarctic and Islands, Department of Environmental Affairs and Tourism, for assisting with information about management aspects of annual takeovers at Marion Island. A final word of thanks goes to Mr John Cooper for his loan of documentation on sub-Antarctic conservation management.

The financial assistance of the National research Foundation (NRF) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are not necessarily to be attributed to the National Research Foundation.

TABLE OF MAJOR HEADINGS

Introduction

The natural environment of the Prince Edward Islands: Intrinsic values and vulnerability

Legal and administrative context

Marion Island: Logistics and annual takeovers

Alien introductions at Marion Island: Significance, history and current threats

Sub-Antarctic island management plans

The Prince Edward Islands Management Plan (PEIMP)

Environmental management during takeovers: The practice

Discussion

Conclusion

INTRODUCTION

Sub-Antarctic islands are located at the northernmost limit of the Southern Ocean (Fig.1).

The Prince Edward Islands (PEI), one of these island groups, are areas of outstanding scientific interest, great natural beauty and high conservation value (Walton, 1986). Their geographic isolation has resulted in relatively simple ecosystems that are closely integrated with the surrounding ocean (Smith, 1987). The islands provide breeding platforms for large populations of seals and seabirds. Many species are endemic (Walton, 1986). The South African government has nominated the PEI for World Heritage Site status (Cooper, 2000).

The potential impacts of alien plants and animals introduced by humans are of paramount concern on these islands. Global warming could aggravate the potential negative impacts. Having evolved in the unique absence of native terrestrial predators and herbivores, sub-Antarctic island ecosystems are poorly buffered against the impacts of introduced alien plants and animals (Holdgate, 1970).

South Africa has sovereignty over the PEI. Management of the PEI is based on domestic practice and legislation, and is not subject to uniform international procedures such as those advocated by the Protocol on Environmental Protection of the Antarctic Treaty. Management is heavily geared towards preventing the introduction of alien species due to human activities (DEAT, 1996).

This paper examines the management of the potentially most significant adverse impact of annual take-overs at Marion Island, namely the introduction of alien plants and animals, in terms of the Prince Edward Islands Management Plan (PEIMP). It provides the biophysical, legal/administrative and institutional contexts of annual take-overs, and an overview of the significance, history and current threats of introduced alien organisms at Marion Island. The PEIMP is evaluated in terms of compliance with relevant international treaties and protocols, national legislation, as well as international and national “best practice” in environmental management.

Finally, the paper make recommendations as to ways in which management at Marion Island could be optimised to meet South African and global obligations as custodians of these unique and significant islands.

THE NATURAL ENVIRONMENT OF THE PEI: INTRINSIC VALUES AND VULNERABILITIES

This section provides background on the environmental processes that relate to oceanic islands in mid- to high southern latitudes, and how these influence the response of island ecosystems to human impacts under conditions of global climate change.

Unique setting of the PEI

Oceanic island environments such as those of the PEI group are very distinctive and markedly different from those of continental areas. As argued by Clark and Dingwall (1985; p 3): “Their isolation means that islands are ideally suited as refugia for threatened plants and animals and as reservoirs for the protection of genetic resources. Islands also offer much scope for the study, understanding and appreciation of intact and holistic natural ecosystems.”

The PEI are located in the southern Indian Ocean at 46°54'S; 37°45'E (Hänel and Chown, 1997), about 2 180 km south-east of Cape Town, South Africa. Remote, wet, windy and cold, Marion (290 km²) is the larger and more southerly of the two islands, which are designated as “sub-Antarctic” by Clark and Dingwall (1985). The PEI group is one of only six sub-Antarctic island groups and as such represents a significant part of a very rare ecosystem on a global scale (Heydenrych and Jackson, 1997). Sub-Antarctic islands share common physical and biotic factors such as their

proximity to the Antarctic Convergence, absence of trees and mean annual temperature ranges of 1°C to 5°C (Clark and Dingwall, 1985).

Besides reflecting the oceanic influence on their climate regime, sub-Antarctic islands such as the PEI group are characterised, amongst others, by limitations of space, a restricted range of habitats, impoverished floras and faunas and a high degrees of endemism due to geographical and ecological isolation (Holdgate, 1970; Clark and Dingwall, 1985; Smith, 1987).

The PEI lie about 200 km north of the circumpolar Antarctic Convergence which exerts an important influence on the ecological functioning of sub-Antarctic islands. The Antarctic Convergence separates the southern, Antarctic, cold water masses from the warmer, sub-Antarctic, water to the north (Lucas, 1996). It is a major oceanographic and biological boundary.

The PEI are of comparatively recent volcanic origin: Marion Island is about 0.5 to 1 million years old. The islands are mountainous with a peat-bog and mire vegetation (Cooper and Condy, 1988). Overall, annual mean surface air temperature on Marion Island increased on an average of 0.025°C per year during the period 1951-1988 (Smith and Steenkamp, 1990).

The PEI: Ecological attributes and uniqueness

The natural environment of Marion Island can be divided into three major habitat types – marine, terrestrial and freshwater – within which a wide range of subsidiary

habitats and animal and plant communities may be recognised (Heymann, et al., 1987). Uniquely, the species-impoverished indigenous fauna of sub-Antarctic islands lacks mammalian herbivores and carnivores that are dominant in continental situations (Holdgate, 1970). Biotic poverty can also be explained in terms of the rigorous climate, past glaciations and relatively recent origin of these islands (Departement of Environmental Affairs and Tourism, 1996; Smith and Steenkamp, 1990). Bergstrom and Chown (1999) distinguish between the older Southern Ocean islands with a continental origin and biota derived from nearby continents, and younger, volcanic islands such as the PEI where the history of the biota remains largely indeterminate.

Trees and shrubs are absent from the tundra-like vegetation of the Prince Edward Islands (Heymann et al., 1987). Of 187 known species of plants, nine (5%) are endemic to the Prince Edward Islands. The most prominent factors affecting the distribution of the 41 plant communities identified on Marion Island are the soil water regime, the influence of salt spray, and trampling and manuring by marine mammals (Smith, 1987).

Owing to their remote oceanic location, the Prince Edward Islands are characterised by very few indigenous terrestrial invertebrates (Hänel and Chown, 1997). Chown *et al.* (1998) listed a total of 37 indigenous insect species for the Prince Edward Islands, excluding Collembola.

The Prince Edward Islands support large breeding populations of native seabird species (Cooper and Condry, 1988) and more than 2 million pairs of birds are believed

to breed at Marion Island (Smith, 1987). In all, 29 species of birds are known to use the islands for breeding and moulting purposes (Hänel and Chown, 1997). Most of these are seabirds, i.e. species that spend much of their time foraging at sea.

Only one other oceanic island group in the Southern Ocean (between latitudes 35°S and 70°S), the Crozets, contains more species of breeding birds than the Prince Edward Islands (Heydenrych and Jackson, 2000). Six bird species that occur at Marion Island are listed in the South African Red Data Book for Birds (Heydenrych and Jackson, 2000).

Marion Island is the second most important breeding locality for King Penguins *Aptenodytes patagonicus* in the world, catering for 30% of the global population (Hänel and Chown, 1997). The population of Macaroni Penguins *Eudyptes chrysolophus* represents 7.5% of the total world population.

Three indigenous seal species breed on Marion Island (Hänel and Chown, 1997). These are the Southern Elephant Seal *Mirounga leonina*; the Antarctic Fur Seal *Arctocephalus gazella*; and the Sub-Antarctic Fur Seal *A. tropicalis*.

Seabirds exert a marked influence on the structure and function of the islands' terrestrial ecosystem by transferring energy and nutrients from the surrounding ocean to the island (Smith, 1987). Soil macro-arthropods are responsible for most of the nutrient release from peat and plant litter (Smith, 1987).

Research opportunities

Sub-Antarctic islands have great scientific importance (Dingwall, 1995) and the PEI are no exception. Information gained from more than 30 years of continuous biological research has resulted in an almost unparalleled understanding of the islands' plants, animals and ecosystems, both in a South African and global context (Hänel and Chown, 1997). Current research efforts concentrate on examining the functional responses of the islands' biota and ecosystems to perturbations caused by invasive alien organisms and a changing climate (Smith, 1991).

Key vulnerabilities

The terrestrial ecosystems of the PEI are tightly integrated with those of the ocean, and are tightly linked internally (Hänel and Chown, 1997). As a result, these islands are susceptible to both internal and external changes such as the impact of invasive terrestrial species or external changes such as global warming (Hänel and Chown, 1997).

The isolation under which these island ecosystems evolved has resulted in a depauperate biota which are highly vulnerable to the introduction of alien plants and animals by humans (Smith, 1987; Clark and Dingwall, 1985). Sub-Antarctic islands ecosystems such as those at the PEI generally lack the niche specialisation of continental situations (Smith, 1987). As a result, most indigenous plant and animal species have a wide ecological amplitude which makes them vulnerable to aggressive alien invaders that have evolved under more competitive conditions (Smith, 1987).

Other than human-introduced biota, terrestrial plant propagules and insects reach southern oceanic islands such as Marion and Prince Edward by means of transport by birds, wind or sea drift (Van Zinderen Bakker, 1971; Greenslade, *et al.*, 1999).

Various authors (e.g. Chown *et al.*, 1998; Bergstrom and Chown, 1999; Kennedy, 1995; Smith and Steenkamp, 1990; Lewis Smith, 1990; Huyser *et al.*, 2000) have pointed to the increased risks of alien introductions and enhanced biological activity on the part of introduced species due to the effects of global atmospheric warming.

The principle processes by means of which island ecosystems and biota are negatively affected by introduced species include the following (Holdgate, 1970; Heymann, *et al.*, 1987):

- Most indigenous species recover extremely slowly following disturbance, whereas some introduced plants and animals spread rapidly and aggressively out-compete the islands' natural fauna and flora;
- Introduced herbivores can dramatically change island vegetation by grazing;
- Introduced predators such as cats or rats can dramatically decrease seabird breeding populations due to predation;
- Disturbance of vegetation by burning, grazing, construction and trampling aids the spread of alien plants; and
- Imported invertebrates often spread readily into niches that have no native occupant, especially in areas where the native vegetation is also disturbed and alien plants are spreading.

LEGAL AND ADMINISTRATIVE CONTEXT

This section presents an overview of the legal setting – international and South African – within which the Prince Edward Islands (PEI) are managed. The emphasis is on legislation, policies and regulatory measures that apply to conservation and environmental management at these islands.

The sub-Antarctic legal setting

Environmental management in the sub-Antarctic region occurs within the context of two distinct but partly-overlapping administrative jurisdictions, namely the Antarctic Treaty System and the legal systems of sovereign states respectively (Wouters and Hall, 1995). While most islands had some form of conservation status by the early 1990s, not all were subject to legally binding protected area management plans (Dingwall, 1995). Bonner (1984) notes that even though these islands may have some form of conservation legislation, enforcement is difficult in such sparsely-inhabited regions.

The Antarctic Treaty System

South Africa is a founding, non-claimant member of the 1959 Antarctic Treaty. This Treaty has developed into a system of agreements and arrangements that regulate international relations and activities in Antarctica (Viall, 1991). The Treaty applies to the area south of 60° South Latitude. The Protocol on Environmental Protection

establishes a comprehensive international regime for environmental management in the Antarctic.

However, international agreements become effective only when enforced through domestic legislation (Bonner, 1990). The PEI lie north of the Treaty area and are therefore not subject to its provisions (DEAT, 1996). The Antarctic Treaties Act 60 of 1996 incorporates several Antarctic Treaty mechanisms into South African law (Glazewski, 2000). The Act stipulates that if a treaty which refers to Antarctica is also applicable to the Prince Edward Islands, these islands are included in the provisions of the Antarctic Treaties Act (Heydenrych and Jackson, 2000). The PEI are managed as if part of the Antarctic Treaty System (Valentine, pers. comm.). The international Antarctic agreements introduced into South African law are the:

- Antarctic Treaty;
- Protocol on Environmental Protection to the Antarctic Treaty;
- Convention on the Conservation of Antarctic Seals; and
- Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).

The Prince Edward Islands: Legal and conservation status

The Prince Edward Islands Act 43 of 1948 establishes undisputed South African sovereignty over Marion and Prince Edwards islands. The Act applies both the common law and statute law of South Africa to the islands.

The Prince Edward Islands above the low-water mark were proclaimed a Special Nature Reserve in terms of the Environment Conservation Act 73 of 1989 (ECA) on November 3, 1995 (Hänel and Chown, 1997). Classified as a Category 1a (scientific) reserve in terms of the National Register of Protected Areas, the PEI Special Nature Reserve has the strictest conservation status recognised in South African law (Wahl and Naudé, 1996). Management authority is assigned to the Department of Environmental Affairs and Tourism (DEAT) through the Directorate: Antarctica and Islands (DAI) (DEAT,1996).

The declaration of a Special Nature Reserve may not be withdrawn nor its boundaries altered except by parliamentary resolution. The ECA also requires the development of a management plan. The Prince Edward Islands Management Plan (PEIMP) is overseen by the Prince Edward Islands Management Committee (PEIMC) which advises the DEAT on activities at the islands (Hänel and Chown, 1997).

Environmental management: applicable legislation

The PEIMP lists legislation that is deemed applicable to the islands. Statutes introduced since 1996 that are relevant to the management of the PEI are presented in Table 1. The most important statutes from an environmental management perspective are (1) the ECA and the (2) National Environmental Management Act 107 of 1998. Provision relevant to the planning and management of takeover-related activities at Marion Island are presented below.

1. The ECA and environmental impact assessment (EIA) regulations

The ECA applies to the PEI in two important respects: it confirms their high conservation status as a Special Nature Reserve, and provides for mandatory EIAs for scheduled activities that may have a “substantial” detrimental effect on the environment (section 21, ECA). Prescribed procedures for EIAs (e.g. impact scoping, assessment and reporting) have been in force since September 1997. Two EIAs have been carried out at the Prince Edward Islands. The first, which predated the 1997 EIA regulations, assessed and rejected a proposed emergency landing facility at Marion Island (Heymann, *et al.*, 1987). The second assessed the impacts of tourism on Marion Island (Heydenrych and Jackson, 2000).

2. The National Environmental Management Act 107 of 1998 (NEMA)

NEMA largely replaces the ECA but retains its provisions relating to EIAs and protected areas. The prime aim of NEMA is to provide for co-operative environmental governance in terms of Chapter 3 of the Constitution Act 108 of 1996. The aims of the Act are to be achieved by establishing:

- Principles for decision-making on matters affecting the environment; and
- Institutions and procedures promoting co-operative governance and co-ordination of environmental functions.

2.1 National environmental management principles

The foundation stone of NEMA is a set national environmental management principles by which organs of state must assess and motivate their plans and activities

in relation to the environment (Glazewski, 2000). Management interventions at Marion Island are conducted under the aegis of the DEAT and therefore must conform to these principles. NEMA entrenches the precautionary principle in law through the principle that “a risk-averse and cautious approach (must be) applied, which takes into account the limits of current knowledge about the consequences of decisions and actions” (Section 2(4)(a)(vii), NEMA).

The principles also stipulate that the following actions and impacts must be avoided, minimised or remedied:

- Ecosystem disturbance and loss of biological diversity;
- Pollution and degradation of the environment; and
- Negative impacts on the environment and on people's environmental rights.

The Prince Edward Islands would certainly qualify as comprising “sensitive, vulnerable, highly dynamic or stressed ecosystems” that require “specific” attention in management and planning procedures (section 2(4)(r), NEMA).

2.2 Institutions and procedures to promote co-operative governance

Chapter 3 of NEMA establishes mechanisms for co-ordinated implementation of the national environmental management principles by the state:

- Environmental Implementation Plans (EIPs) for national departments scheduled as exercising functions that may affect the environment; and

- Environmental Management Plans (EMPs) for national departments scheduled as exercising functions involving management of the environment.

EIPs focuses on compliance with the national environmental management principles, whilst EMPs focus on environmental norms and standards of departments, intra-governmental co-operation around environmental management, and promotion of integrated environmental management. DEAT is required to prepare both an EIP and EMP, or a consolidated report (Glazewski, 2000).

2.3 Duty of care and remediation of environmental damage

Section 28(1) of NEMA stipulates that every person must take “reasonable measures” to prevent “significant pollution or degradation of the environment”. Where such degradation or pollution is authorised by law, or cannot be reasonably avoided or stopped, it must be minimised and rectified.

2.4 Environmental management co-operation agreements (EMCAs)

Chapter 8 of the NEMA provides that the Minister of Environmental Affairs and Tourism may enter into EMCAs with any person or community for the purpose of promoting compliance with the national environmental management principles. EMCAs can incorporate features such as undertakings by contracted parties to improve on legal standards for environmental protection. They may also provide for measurable targets linked to timeframes, performance audits, independent monitoring and inspections, and penalties for non-compliance.

White Paper on Biodiversity

South Africa ratified the 1992 Convention on Biological Diversity on 2 November 1995 and during 1997 published a comprehensive draft White Paper on the Conservation and Sustainable Use of Biodiversity (the White Paper) (Glazewski, 2000). Policy objectives of the White Paper relevant to takeovers at Marion Island include:

- Identification of important components of biodiversity and threatening processes (1.1);
- Prevention of the introduction of potentially harmful alien species and control and eradication of alien species which threaten ecosystems, habitats or species (1.6);
- Integrating the conservation and sustainable use of biological diversity into all sectoral and cross-sectoral plans, programmes and policies at all levels of government and industry (2.1);
- Avoiding or minimising adverse impacts on biological diversity (2.2); and
- Monitoring to detect and measure changes in biodiversity and evaluate biodiversity conservation programmes (4.2.3).

The Draft White Paper for Sustainable Coastal Development (DEAT, 1999)

Published in March 1999, the Draft White Paper for Sustainable Coastal Development identifies goals and objectives to guide legislative and institutional reform in support of sustainable coastal development (Glazewski, 2000). It recognises that the main

threat to sub-Antarctic islands is the introduction of alien plant and animal species.

Goals relevant to takeovers at Marion Island include:

- Promoting a dedicated, co-operative, co-ordinated and integrated coastal planning and management approach (Goal A3);
- Conducting coastal planning and management activities in a manner that promotes learning through continuous research, monitoring, review and adaptation (Goal A4);
- Maintaining the diversity, health and productivity of coastal processes and ecosystems (Goal D1); and
- Preventing pollution control and waste management measures in order to prevent, minimise and strictly control discharges into coastal ecosystems (Goal E1).

Draft legislation giving effect to the White People is expected to be tabled in Parliament in 2002 (Malan, pers. comm.).

MARION ISLAND: LOGISTICS AND ANNUAL TAKEOVERS

The base station at Marion Island is located at Transvaal Cove (Fig. 2). The base is occupied throughout the year by between 10 and 15 personnel. Over-wintering teams comprise meteorologists from the South African Weather Bureau (SAWB), biological researchers attached to universities and the Department of Environmental Affairs and Tourism (DEAT), and technicians.

Base infrastructure includes a meteorological station, accommodation for 64 people, laboratories, store rooms, two helipads and a hangar for one helicopter, fuel storage facilities and power shacks.

The annual relief or takeover usually takes place over a three-week period in April/May. Stores, fuel, equipment and personnel are transported to Marion Island from Cape Town, South Africa, on the *SA Agulhas*, a resupply and research vessel. The manning and maintenance of the *SA Agulhas* is contracted to a private shipping company which runs the vessel on behalf of DEAT.

Landings on the island are restricted to the takeover period (Heydenrych and Jackson, 2000). Fishing vessels make irregular visits to Marion Island, but only subject to official sanction (Valentine, pers. comm.).

A ship-board Oryx helicopter is used to ferry personnel and supplies to the island during takeovers. The helicopters are crewed by South African Air Force personnel. Waste generated at the base and returning personnel are similarly “back-loaded”

(Valentine, pers. comm.). Researchers may occasionally be flown to Prince Edward Island from the *SA Agulhas*.

The takeover is co-ordinated by the Directorate: Antarctica and Islands (DAI), which appoints an Officer-in-Charge (OIC) for the annual relief. Takeover teams usually involve personnel from the DAI, National Public Works Department (NPWD), SAWB, the leaders of research projects and research assistants. Each component is represented by a group leader. NPWD teams of 8-10 artisans are responsible for routine maintenance and servicing of facilities at Marion Island.

ALIEN INTRODUCTIONS AT MARION ISLAND: SIGNIFICANCE, HISTORY AND CURRENT THREATS

Climate change, human visitation and increased vulnerability to alien introductions

There is an established scientific consensus about the pronounced vulnerability of sub-Antarctic islands to the impacts of introduced alien organisms and the anthropogenic causes, deliberate and accidental, of such introductions (e.g. Holdgate, 1970; Clark and Dingwall, 1985; Watkins and Cooper, 1986; Chown *et al.*, 1998). In general, the factors that have determined contemporary management responses to the problem of introduced alien organisms to sub-Antarctic islands include the understanding that:

- Humankind's greatest threat to the ecosystems of these islands has been to break down the isolation, both localised and global, under which they evolved (Smith, 1987; Kennedy, 1995);
- The broader consequences of human-induced impacts are articulated at the level of ecological systems and processes; (Heymann, *et al.*, 1987) and
- Once established, introduced alien organisms are difficult – if not impossible – to eradicate or manage (Chapuis, *et al.*, 1994; Samways, 2000). The costs involved can be prohibitive: the extermination of feral cats at Marion Island cost the South African government about R 6 million (Heydenrych and Jackson, 2000).

The potential impact of introduced alien organisms was cited as the single most serious threat to the natural environment of Marion Island by two EIAs commissioned by the South African government in 1986 and 1996 respectively.

The first, which assessed the impacts of a proposed emergency landing facility on Marion Island, recorded the danger of the introduction of further alien species as an over-riding reason for the investigating Panel's unanimous objection to the project (Heymann *et al.*, 1987). The risk of alien introductions during the construction phase – entailing activities such as transport and disembarkment of materials, and the presence of a 62-strong labour force over an extended period – was construed as potentially the most serious threat (Heymann *et al.*, 1987; p 134).

In the case of the EIA of tourism proposals for Marion Island, the impact of the introduction of alien species on the survival of native organisms was identified as the pre-eminent negative impact that should influence decision-making (Heydenrych and Jackson, 2000; p 77). It was found that even small special interest tours (involving ships carrying 40 to 100 passengers) could result in a permanent and irreversible negative impact on the island were alien species to be introduced. Such introductions would have “devastating effects on the island's vegetation, bird and insect populations” (Heydenrych and Jackson, 2000; p 16). The ship's stay at the island, walking on the island and viewing wildlife were identified as activities that could result in alien introductions. The tourism EIA also noted that notwithstanding existing measures aimed at preventing the accidental introduction of alien organisms – such as irradiation of food, washing of clothes and boots, etc – new species of plants and animals still reached Marion Island regularly with the supply ship.

Of especial concern was the potential introduction of rats to Marion Island which, if it were to happen, would: “(Cause) an impact in excess of that caused by feral cats and would render all previous conservation efforts almost meaningless. Once they have become established, eradication of rats would be almost impossible, or at least exceedingly expensive” (Heydenrych and Jackson, 2000; p 66).

Several authors have also commented on the possible aggravating effects of global atmospheric warming on the changing role of introduced species in ecosystem functioning at sub-Antarctic islands (e.g. Smith and Steenkamp, 1990). Bergstrom and Chown (1999) argue that increases in island temperature and human visitor frequency are likely to result in increasing numbers of successful alien colonisation events.

Lying at the temperate extreme of the sub-Antarctic region, Marion Island is therefore particularly susceptible to alien invasions compared to its colder southern neighbours, especially so if the number of visitors were to increase (Chown *et al.*, 1998; Bergstrom and Chown, 1999).

History and impact of alien introductions

Table 2 presents the chronology, impact, means of introduction and current status of some invasive alien species introduced to Marion Island.

In all, 51 non-marine species that are known or thought to be aliens (18 vascular plant and 33 animal species, including domestic species) have been recorded at the Prince Edward Islands (Watkins and Cooper, 1986; Cooper and Condy, 1988). Only six alien

species (two plants and four invertebrate animals) have been recorded at uninhabited Prince Edward Island. All of these have also been recorded at Marion Island.

Human exploitation and perturbation of the sub-Antarctic environment began with commercial sealing early in the 19th century (Cooper and Headland, 1991; Selkirk *et al.*, 1990). Sealers intermittently occupied the Prince Edward Islands from 1802 to 1931, and there has been an unbroken human presence on Marion Island following the establishment of a meteorological station there with annexation in the summer of 1947-1948. Scientists have visited Marion Island continuously since 1965 (Cooper and Headland, 1991; Watkins and Cooper, 1986).

Other than human-introduced populations of feral cats and mice, Marion Island has also at times supported domestic sheep, dogs, pigs, goats and donkeys (Watkins and Cooper, 1986). The presence of humans has also seen the introduction and, in a number of cases, colonisation of the Prince Edward Islands by alien plants, spiders and insects, fresh water fish and birds (Watkins and Cooper, 1986).

Alien organisms: persistent threats and potential means of introduction

The PEIMP identifies activities that may result in the introduction of alien species to Marion Island during annual takeovers. These activities chiefly relate to the following aspects of takeovers:

- Transport (rodent control measures on the *SA Agulhas* prior to departure for the takeover, and helicopter operations at the island);

- Type and packaging of foodstuffs and equipment; and
- Personal conduct on island (clothing, footwear and behaviour).

Table 3 summarises such activities, aspects that may result in alien introductions and corresponding management measures. Equivalent provisions in the management plans for Heard Island (Australian Antarctic Division, 1995), Macquarie Island (Anon, 1991) and South Georgia (McIntosh and Walton, 2000) are included for comparative purposes.

Introductions of alien species to Marion Island: The management experience

There is an established pattern of anthropogenic vectors which have resulted in the introduction of alien species to Marion Island.

The processes of human-induced introductions are twofold, i.e. accidental (e.g. mice, invertebrates and avian diseases that accompany cargo or supplies) or deliberate (e.g. cats and domestic livestock) (Clark and Dingwall, 1985; Watkins and Cooper, 1986; Heydenrych and Jackson, 2000). Humans can contribute to the spread of introduced organisms on the island by means of physical transfer (e.g. propagules lodged in clothing) or by creating conditions conducive to the spread of invasive plants, e.g. through trampling and disturbance of indigenous vegetation (Heymann *et al.*, 1987). Deliberate introductions of alien organisms to the PEI are prohibited.

However, as alluded by the EIA on tourism (Heydenrych and Jackson, 2000), new alien species reach Marion Island despite current controls. Problems associated with

such introductions and their prevention and eradication in terms of the PEIMP are recorded in the minutes of meetings of the PEIMC between April 1996 and January 2001 (PEIMC, 1996 – 2001).

Three examples presented in Table 4 illustrate problems relating to the practical aspects of implementing management measures to prevent the introduction and distribution of alien organisms at Marion Island.

The risk of alien plants and animals being exchanged reciprocally between Marion and Gough islands by means of shared logistics and infrastructure has been raised in takeover conservation reports relating to both islands. The conservation officer who participated in the Gough Island takeover in 2000 (Gough Island Wildlife Reserve Advisory Committee, 2000) reported observing soil and an alien grass plant presumably from Marion Island (*Poa annua*) embedded in the foot of a PWD ladder last used on Marion Island. Pieces of unidentified grass were found pinched between the ropes of cargo nets presumably last used on Marion Island. On inspection of the *SA Agulhas* moored in Cape Town harbour, it was found that mooring lines had been secured against rats but no measures had been taken to prevent rodents boarding the vessel along the gangplank and attached safety net (Gough Island Wildlife Reserve Advisory Committee, 2000) The conservation officer reported that he had been advised that preventative measures for the gangway would compromise maritime safety regulations (Gough Island Wildlife Reserve Advisory Committee, 2000).

SUB-ANTARCTIC ISLAND MANAGEMENT PLANS

Legal protection and effective implementation of specific management policies and plans are recognised as critical components of protected areas management in the sub-Antarctic. The International Union for Conservation of Nature and Natural Resources (IUCN) and Scientific Committee for Antarctic Research (SCAR) have played an influential role in this regard (e.g. Clark and Dingwall, 1985; Walton, 1986; Dingwall, 1995).

According to IUCN/SCAR workshops in held in Paimpont, France, in 1986 and 1992 (Walton, 1986; Dingwall, 1995), legally-binding protected area management plans for all sub-Antarctic islands should, among others, emphasise and enforce:

- Measures to prevent further or new introductions of alien species;
- Minimisation of logistic impact and local pollution;
- Monitoring to detect environmental changes;
- Active steps to be taken if changes are human-induced; and
- Constant review of management policy and plans.

Besides recommending strict environmental control measures, monitoring and adaptive management, the IUCN/SCAR workshops also advocated an integrated approach to management that incorporated “a full consideration of the control of human impacts on ecosystems” (Walton, 1986; p 3). In addition, the IUCN/SCAR workshops recommended that management would be improved by:

- Appointing independent observers;
- Educating island and ship personnel on conservation objectives; and
- The adoption and implementation of environmental principles by national governments.

These SCAR/IUCN recommendations will henceforth be referred to as the “Paimpont recommendations”.

THE PRINCE EDWARD ISLAND MANAGEMENT PLAN (PEIMP)

Background

The PEI did not have a legal conservation framework prior to publication of a management plan that accompanied their proclamation as a Special Nature Reserve in 1995. Until then, the islands were managed in terms of a voluntary Code of Conduct which stated that activities should be conducted in accordance with the Agreed Measures on the Conservation of Antarctic Fauna and Flora and CCAMLR (Department of Environmental Affairs and Tourism, 1996). The PEIMP therefore provided, for the first time, a legally binding framework for the maintenance and conservation of the PEI protected area and surrounding EEZ (Department of Environmental Affairs and Tourism, 1996).

The PEIMP includes management objectives and policies and guidelines for their implementation. Responsibility for the day-to-day management of the islands is conferred on the Directorate: Antarctica and Islands (DAI) of the DEAT. The PEIMP also provides for the appointment of conservation personnel. The PEI management committee (PEIMC) advises the DEAT on implementation and amendment of the management plan. The DAI reports to the Director-General of Environmental Affairs and Tourism via the PEIMC and the Antarctic Management Committee, an inter-departmental body chaired by Director-General: DEAT that sets policy for the South African National Antarctic Programme.

Management objectives

The management objectives of the PEIMP provide a framework for decision-making to protect the islands' biological diversity and ecological integrity.

The objectives are:

1. To maintain biological diversity, including genetic diversity, species diversity and the diversity of ecological processes;
2. To maintain geological and scenic objects;
3. To minimise interference with natural processes and the destruction of natural features resulting from human interference;
4. To ensure that the obligations to, and provisions of, the Convention on the Conservation of Antarctic Marine Living Resources are met;
5. To protect historic features and objects from human interference;
6. To encourage activities aimed at restoring and rehabilitating damage due to local human activities;
7. To encourage research applicable to objectives (1) through (6) above;
8. To seek co-operation with all parties interested in the conservation of the Southern Ocean and its islands;
9. To create an awareness of the value and fragility of the Islands' ecosystems; and
10. To allow scientific research not in conflict with objectives (1) to (9).

Management policies & guidelines for implementation

The practical aspects of the PEI management plan can be defined in terms of four themes:

1. Access, day-to-day administration and co-operation between supporting agencies;
2. Management zoning;
3. Description and regulation of potentially harmful activities; and
4. Awareness, monitoring and revision of management prescriptions.

1. Access, day-to-administration and co-operation between supporting agencies

Access Marion Island is controlled by entry permits issued by the DEAT in terms of the ECA. Entry will be normally limited to 64 persons. Permits stipulate that the holder must exercise the utmost care to “minimise the disturbance to the habitat (sic) and the environment at all times” (Department of Environmental Affairs, 1996; p 52). Entry permits may be refused or revoked.

The PEIMP provides for three positions to ensure that the management plan is implemented (Fig. 3):

- *A full-time Conservation Officer for the islands* – located in the DAI or the Directorate: Environmental Management, DEAT, this officer is to be the *ex officio* secretary of the PEIMC.

- *Team leader* – the leader of the annual expedition to Marion Island is designated the ultimate enforcement officer on the islands.
- *Officer-in Charge (OIC) of takeovers* – during takeover periods, the responsibilities of the team leader are to be delegated the OIC.

The DAI co-ordinates the planning and provision of all logistics' support for annual takeovers.

Management zoning (Fig. 2)

The PEIMP identifies four zones to which access is limited in accordance with their conservation status. A fifth, the Marine Zone, extends the marine boundary of the Special Nature Reserve to the outer boundary of the PEI EEZ. The zones are:

- **Zone 1 (Service Zone)** – Constitutes the area occupied by the present base on Marion Island. Access is via helicopter or dinghy from the supply ship off-shore. The PEIMC advises the Director-General on the need for EIAs in the Service Zone.
- **Zone 2 (Natural Zone)** – Serves as a buffer zone between the Service Zone and Protected Area Zone. Impacts in Zone 2 are monitored. Limited free walking is permitted. Standard entry permits apply only to Zones 1 and 2.
- **Zone 3 (Wilderness Zone)** – The remainder of the islands is demarcated as Wilderness Zone. Zone 3 is open to approved research, but normally closed to general access by members of the takeover and management teams.

- Zone 4 (Protected Zone: Special Entry Area) – All areas or sites potentially sensitive to human interference are to be demarcated for special protection. The entire Prince Edward Island is demarcated as Zone 4. All entry is prohibited subject to a Special Permit.

Description and regulation of potentially harmful activities

The PEI management plan defines some 14 clusters of activities, applicable policies and practical measures that must be followed to manage the islands and potential human-related impacts (Table 5) Management measures that deal with the prevention and control of alien organisms are marked with an asterisk:

- Infrastructure (construction and maintenance) and camping *
- Waste and sewage disposal *
- Fuel supply and storage
- Vehicle, boat and aircraft use *
- Visits to Prince Edward Island *
- Import of plant and other material *
- Research
- Historical conservation
- Protection and management of fauna & flora *
- Control of introduced plants and animals *
- Prevention of introduction of new alien species *
- Release of rehabilitated indigenous species
- Controlled removal of endangered species

- Protection and management of the Marine Zone.

4. Awareness, monitoring and revision of management prescriptions

The management plan includes an education policy aimed at ensuring that all visitors to the PEI are aware of their natural and historical values, as well as their ecological significance. The staff of the DAI and the expedition team leader must ensure that all visitors take the same precautions, especially with regard to the introduction of rodents, other animals and plants. A Code of Conduct is to be supplied to visitors. The PEI management plan is to be monitored and periodically revised in order to ensure its relevance. A comprehensive review of the plan must be undertaken at five-yearly intervals.

ENVIRONMENTAL MANAGEMENT DURING ANNUAL TAKEOVERS: THE PRACTICE

The PEIMP provides for three officially-designated positions to oversee implementation of management measures, i.e. a full-time departmental Conservation Officer, the over-wintering expedition's Team Leader, and an Officer-in-Charge of takeovers at Marion Island. In practice, a somewhat different dispensation has developed.

Background

The DAI has been unable to appoint a full-time conservation officer for the PEI as stipulated by the PEIMP due to budgetary constraints and personnel restructuring in the DEAT (Valentine, pers. comm.; PEIMC, 1996 – 2001). A report submitted to the PEIMC by a senior participant in the 1998 relief voyage raised two concerns in this regard (PEIMP, 1998b):

- Environmental issues on Marion Island were being confused with scientific activity; for the second time in two years a research assistant had been appointed as takeover environmental officer; and
- An independent, qualified environmental officer should be appointed to take care of environmental issues.

The PEIMP also noted that the takeover OIC should not double up as the environmental officer (PEIMP, 1998b). As a result, it was resolved to rotate takeover

environmental officers through the members of the PEIMC (1998b). This arrangement came into effect in 1999 when a senior member of the PEIMC accompanied the relief voyage as conservation officer for the first time. The roles of relief and expedition conservation officers have subsequently been defined in separate duty statements (Skinner, pers. comm.). Conservation officers are expected to have either knowledge and experience of the PEI, or to have a conservation background (Skinner, pers. comm.).

The respective duties of the Relief Conservation Officer (RCO) and Team (over-wintering) Conservation Officer TCO are outlined below:

Relief conservation officer (RCO)

- Appointed by the PEIMC (through the Director-General of DEAT) for the duration of annual takeovers (about 30 days). The appointment is made a month or two in advance of the relief voyage. Usually a member of the PEIMC.
- Must liaise closely with the incoming and outgoing TCOs. These three conservation personnel are responsible for conservation issues during the takeover. Decisions about conservation issues must be made in conjunction with the OIC and both expedition team leaders.
- Can delegate authority to OIC or either of the over-wintering TCOs.
- Must submit a report to the PEIMC within 30 days of the return of the relief vessel to South Africa. The report is tabled at a six-monthly meeting of the PEIMC. Its recommendations are considered for implementation. A report is forwarded to the Director-General: DEAT (Skinner, pers. comm.).

- The RCO's brief covers (a) the period preceding the voyage to Marion Island and arrival there, and (b) the relief and its conclusion.

Team conservation officer (TCO)

- Appointed by the PEIMC for the duration of the over-wintering expedition (about 14 months).
- Appointed during team training, about six weeks prior to departure for Marion Island. Either a biologist or field assistant.
- Conservation duties are additional to other commitments.
- Incoming, over-wintering TCO is instructed to liaise closely with the outgoing TCO and the RCO.
- During the takeover, the TCO shares identical responsibilities with the RCO regarding the control of introduced organisms and awareness training.
- Must submit monthly reports to DEAT on monitoring, conservation and any PEIMC recommendation (e.g. monitoring of alien species and receiving of packages from fishing vessels). These reports are forwarded to the PEIMC (Skinner, pers. comm.).

Co-management before and during annual takeovers

Scientific, logistic and maintenance activities at the Prince Edward Islands entail varying degrees of collaboration between a variety of agencies and institutions co-ordinated by the DAI. In terms of the PEIMP management plan, the DAI is responsible for co-ordinating a series of planning meetings to ensure that all essential

tasks are co-ordinated and that visits to the islands are effective. The PEIMC is given an opportunity to comment on final arrangements for annual takeovers and ensure that proposed activities are consistent with the management objectives for the PEI (DEAT, 1996). As a member of the PEIMC, the RCO is usually involved in pre-takeover meetings of the committee, as well as during logistic planning session of the DAI (Skinner, pers. comm.). The DPW, SAWB and SAAF are also represented at the DAI's pre-takeover planning meetings

Environmental awareness during takeovers

There is no formal contract or written undertaking that commits participants in takeovers to compliance with the PEIMP (Skinner, pers. comm.). However, adherence to these provisions is emphasised in a number of ways (Skinner, pers. comm.):

- During team training;
- In Sailing Instructions;
- In the permits issued;
- During lectures *en route* and at Marion Island; and
- By means of documentation, such as copies of the PEIMP to all group leaders and overwintering team members and a guide (Hänel and Chown, 1997) to the PEI Special Nature Reserve.

Visitors to Marion Island are also issued with a two-age flyer that details practical environmental precautions to be taken by all participants in the takeover prior to boarding the *SA Agulhas* in Cape Town.

Enforcement of the PEIMP

The provisions of the PEIMP are enforced through education, monitoring and reporting (Skinner, pers. comm.). All issues arising from conservation reports by the RCO and TCO are either forwarded to the PEIMC for consideration or tabled at the six-monthly PEIMC meetings for recommendation to the Director-General: DEAT. New conservation measures are implemented through the Sailing Instructions, correspondence to the Team Leader/TCO, and tasking of the OIC/RCO. All changes to the management regime will be incorporated in the five-yearly revision of the PEIMP (Skinner, pers. comm.).

The DAI is considering implementing a system whereby participants in takeovers must give written confirmation of their awareness of, and adherence to, the provisions of the PEIMP (Skinner, pers. comm.). All group leaders will be expected to sign a conservation certificate, thereby accepting responsibility for their group. Overwintering team members will be expected to do likewise. A draft conservation certificate is to be tabled at the next PEIMC meeting on 27 September 2001 for consideration and any amendments before it is forwarded to the Director-General: DEAT for approval (Skinner, pers. comm.).

There is no formal legal system in place to deal with incidents of non-compliance with the PEIMP (Skinner, pers. comm.). However, expedition bonuses can be withheld if participants do not meet their commitments or wilfully do not adhere to the PEIMP. Participants can also be prohibited from participating in future voyages. During takeovers, breaches of a "minor" nature are dealt with by the OIC, in conjunction with the RCO. Matters of a more serious nature can be recorded in the

various takeover reports after the return of the ship. During the relief voyage, group leaders are expected to ensure that their respective groups adhere to the PEIMP's provisions.

There are no rewards in place as all participants in takeovers are expected to comply with the PEIMP. The current management dispensation at Marion Island does not include a system of independent environmental audits, although DEAT can request such an audit at any time (Skinner, pers. comm.).

DISCUSSION

Overall, South Africa's management of the Prince Edward Islands has enjoyed a good reputation, including the years preceding the adoption of the current management plan (e.g. Holdgate, 1970; Clark and Dingwall, 1985). However, commentators persistently pointed to the need to give the PEI appropriate legal conservation status enforced by an effective management plan in line with the broader conservation requirements of sub-Antarctic islands (e.g. Walton, 1986; Cooper and Condy, 1988). Special Nature Reserve status for the PEI, enforced through the PEIMP, offers sound administrative evidence of South Africa's commitment to the preservation and management of these islands as globally valued elements of the national conservation estate. It remains to be established, however, how the provisions of the PEIMP translate into practice – and particularly in relation to the principle threat to the ecological integrity and conservation value of the PEI, namely invasive exotic organisms.

In order to establish the effectiveness of the PEIMP as a decision framework and management instrument during annual takeovers, the management plan will be assessed in terms of:

- Compliance with the Antarctic Treaty System, South African legislation and the principles of integrated environmental management (IEM);
- The adequacy of published measures to prevent the introduction of alien organisms to Marion Island;
- The adequacy of the definition and allocation of management responsibilities; and

- The adequacy of practical measures to prevent the accidental introduction of alien organisms to Marion Island.

Compliance: Antarctic Treaty System, South African legislation and IEM

The PEIMP is introduced by a section detailing its legal status and applicable legislation, followed by a brief treatment of the Antarctic Treaty and CCAMLR. There is no reference to the Consultative National Environmental Policy Process which was initiated in May 1995, and ultimately led up to NEMA, or international conventions such as the 1992 Convention on Biodiversity that may apply to the management of the PEI .

Antarctic Treaty System

There appears to be considerable ambiguity as to the application of the Antarctic Treaties Act and Antarctic Treaty instruments to the management of the PEI.

The PEIMP states that it will follow:

- The General Rules of Conduct for the Preservation and Conservation of Living Resources in Antarctica;
- The Articles of the Agreed Measures for the Conservation of Antarctica Fauna and Flora of the Antarctic Treaty (Appendix V);
- Measures related to the Agreed Measures; and

- Relevant Conservation Measures promulgated under the Convention on the Conservation of Antarctic Marine Living Resources (Appendix VI).

It is not apparent how inclusion of these Antarctic Treaty measures improves on the existing provisions and procedures of the PEIMP. If they are integrated within the general framework of the management plan, compliance with Antarctic Treaty mechanisms should be stated from the outset as a management objective of the PEIMP.

It is also not clear how these measures would be enforced. South Africa has undisputed sovereignty over the islands and their 200 nautical mile EEZ. In addition, the PEIMP states that the PEI lie outside the Antarctic Treaty area and are therefore are not subject to its provisions (DEAT, 1996; p 10). Yet under the section titled “Legal protection”, the then-Draft Antarctica Treaties Bill, 1996 is deemed applicable to the islands (DEAT, 1996; p 33). If the Antarctic Treaties Act 60 of 1996 were indeed to apply to the PEI, this would mean that the PEIMP would be legally bound to give effect to the Antarctic Treaty and subordinate instruments such as the Protocol on Environmental Protection (the Madrid Protocol).

South Africa ratified the Madrid Protocol in August 1995 (Glazewski, 2000) and it entered force in January 1998. Besides its provisions on interim and comprehensive environmental evaluations, the Madrid Protocol requires Contracting Parties to report annually on the steps they have taken to implement the protocol. Reports must, among others, be submitted to the Committee on Environmental Protection and be made publicly available. The Madrid Protocol also provides for inspections by observers to

ensure compliance with the Protocol (Article 14). Such observers would have complete freedom of access at any time to all areas of Antarctica (understood to include the PEI under the Antarctic Treaties Act) in terms of Article VII of the Antarctic Treaty. The PEIMP makes no reference to the Madrid Protocol or its environmental assessment and reporting requirements. Neither does it explicitly provide for independent environmental inspections as contemplated by the Madrid Protocol and Antarctic Treaty.

Annex 1 to the Madrid Protocol (Environmental Impact Evaluations) provides that the preliminary stage of environmental impact evaluation of proposed activities shall be considered in accordance with appropriate national procedures. In South Africa, such procedures are legislated through the ECA and NEMA. Ensminger *et al.* (1999) have shown that the quality and rigour of national environmental assessment procedures may actually exceed the standards and thresholds set by the Madrid Protocol.

The inclusion of Antarctic Treaty System instruments in the PEIMP should be reconsidered unless it can be shown by comparative analysis that this will result in an improved quality of environmental management at the PEI.

Environment Conservation Act

The ECA was the most important national legislation applying to the PEI at the time of adoption of the PEIMP in 1995. In conferring Special Nature Reserve Status on the PEI, sections 18(6) and (7) of the ECA imposed strict limits on access to Marion Island. These provisions are still in force and effectively underpin the management

regime at the islands by controlling the number and type of visits to Marion Island, as well as restricting movement and activities through zoning. Entry permits do not, however, explicitly alert visitors to mandatory measures that must be taken to prevent the introduction of alien organisms to the island in terms of the PEIMP.

Section 29(2)(b) of the ECA provides for a maximum fine of R8000 and/or imprisonment of up to five years for persons who contravene the conditions of access permits to Marion Island. This is not made explicit in the PEIMP.

The ECA does not define “management plan”. Neither does it stipulate the objectives or content of such a plan. The Act also does not provide for the appointment of a management committee, which is a discretionary function ascribed to the Director-General: DEAT in terms of the PEIMP (DEAT, 1996; p 34).

Integrated Environmental Management

The PEIMP precedes the promulgation of national EIA regulations in 1997. However, the Department of Environment Affairs in 1992 published a series of six documents outlining the IEM procedure and giving broad guidelines for key stages in the procedure (Department of Environment Affairs, 1992). The PEIMP does not refer to the IEM procedure or the endorsement thereof by the then-Department of Environment Affairs.

IEM is defined as a procedure “designed to ensure that the environmental consequences of development proposals are understood and adequately considered in

the planning process" (Department of Environment Affairs, 1992). The basic principles of IEM are (Preston *et al.*, 1996):

- A broad understanding of the term "environment";
- Informed decision-making;
- Accountability for decisions and for the information on which they are based;
- An open, participatory approach in the planning of proposals; and
- Pro-active and positive planning.

The PEIMP is mute on the question of how EIAs are to be conducted, other than that the PEIMC will advise the Director-General: DEAT on the necessity for EIAs, compile the brief and review the results of the assessment.

National Environmental Management Act

NEMA was promulgated three years after the proclamation of the PEI Nature Reserve. The Act has fundamental ramifications for the PEIMP and its provisions for managing takeover-related activities at Marion Island.

Under NEMA, DEAT must, among others, describe to the national Committee for Environmental Co-ordination (CEC) by means of separate or combined environmental implementation and management plans:

- Policies, plans and programmes that may significantly affect the environment;

- The manner in which it will ensure that its policies, plans and programmes will comply with the national environmental management principles set out in Chapter 2 of the Act, as well as any national norms and standards as envisaged under section 146(2)(b)(i) of the Constitution;
- Recommendations for the promotion of IEM as referred to in Chapter 5 of the Act; and
- Arrangements for co-operation with other national departments with a bearing on environmental management.

The annual takeover at Marion Island is a DEAT programme that holds a significant risk of adverse environmental impacts if effective precautions are not taken to prevent the introduction of alien species to the island. DEAT would have to demonstrate how the PEIMP and its objectives comply with the national environmental management principles. Similarly, DEAT would have to indicate how it promotes the objectives of IEM with respect to takeover-related activities. Furthermore, arrangements for co-operation around environmental management with the NPWD, South African National Defence Force and other national departments involved in takeover activities will have to be described.

The NPWD is not listed among the national departments required to submit an EIP or EMP in terms of Schedules 1 and 2 of the Act. This is an unfortunate omission. In effect, it means that DEAT is theoretically expected to take sole responsibility for environmental accountability for takeover-related activities. NPWD personnel, their equipment and activities represent a substantial opportunity for the introduction of exotic species to Marion Island. As such, the NPDW should also be obliged to give

formal account of its compliance with the national environmental management principles and promotion of the objectives of IEM in the execution of its duties during takeovers to Marion Island.

Adequacy of published measures

Paimpont recommendations

The PEIMP describes a range of practical measures that must be implemented to prevent the introduction of alien organisms to Marion Island, during both the pre-voyage and island phases of takeovers. This is consistent with the recommendations of the respective Paimpont workshops which stress that island management plans should emphasise measures to prevent further or new introductions of alien species (Walton, 1986; Dingwall, 1995).

Heard Island, Macquarie Island and South Georgia management plans

There is also a close correspondence between the PEIMP and the management plans for Heard Island, Macquarie Island and South Georgia with regard to precautionary measures aimed at preventing the introduction of alien organisms during visits to the respective islands.

The PEIMP does not, however, categorically state that the prevention of the introduction of alien organisms to the PEI is a management objective. This objective

is only inferred, whereas the management plans for Heard Island, Macquarie Island and South Georgia state it explicitly.

Adequacy of the definition and allocation of management responsibilities

Management responsibilities for the PEI are defined in terms of two inter-acting components:

- DEAT's administrative hierarchy which leads from the Director-General: DEAT via the DAI to the Officer-in-Charge (OIC) of takeover logistics and activities at Marion Island; and
- The PEIMC and a full-time departmental conservation officer (CO).

The official departmental line function is clearly spelled out: ultimate authority for enforcement of the PEIMP during takeovers is vested with the OIC. What is less clear, however, is the role and authority of the CO.

The PEIMP states that a departmental CO shall be appointed to ensure that the management plan is implemented. The PEIMP does not, however, define the authority of the CO in relation to the OIC. Neither does the PEIMP circumscribe the professional abilities and duties of the OC other than that he (sic) must be familiar with the conservation needs of the PEI and serve as secretary to the PEIMC.

At most, the CO's influence on takeover-related activities appears to be limited to an advisory, not executive, capacity in that the PEIMC of which he (sic) is a member

advises (author's emphasis) the Director-General: DEAT on management matters (DEAT, 1996). In effect, COs as contemplated by the PEIMP have significantly fewer powers compared to honorary provincial nature conservation officers in South Africa (e.g. sections 21 and 22 of the Western Cape Nature Conservation Laws Amendment Act 3 of 2000).

Environmental considerations and takeover planning

The PEIMP provides for two mechanisms that potentially introduce environmental considerations into the pre-takeover planning phase: co-ordinating meetings and an opportunity for the PEIMC to ensure that activities are consistent with the objectives of the PEIMP.

The PEIMP does not, however, stipulate formal procedures or guidelines by which the environmental consequences of takeover-related activities are to be understood and adequately considered during the pre-voyage planning process. Neither does it assign responsibilities nor accountability mechanisms to ensure that the management prescriptions of the PEIMP or any other environmental considerations are identified and effectively integrated with planning decisions (Brown and Hill, 1995).

The role of the PEIMC as overseer of the PEIMP is not defined, other than it will ensure in the course of its annual meeting that "activities are consistent with the management objectives" of the PEIMP (DEAT, 1996; p 37). It is not clear if the ambit of "activities" includes pre-departure logistic matters such as the storage, cleaning and packing of containers prior to being loaded on to the *SA Agulhas*.

Distribution of responsibilities

Responsibility for the implementation of pre-voyage management precautions regarding alien organisms is distributed between DEAT, the CO, the Master of the ship, and the OIC. In terms of the PEIMP, the CO is only responsible for ensuring that measures relating to the import of poultry produce and sterilisation of construction material are enforced. DEAT, in turn, is generally responsible for ensuring compliance with measures to prevent the introduction of new alien species. The Chief Directorate of Sea Fisheries (i.e. Marine and Coastal Management) is responsible for the fitting and certification of rat guards on vessels likely to visit the PEI. No official or entity is charged with responsibility for enforcing, or accepting accountability, for measures prohibiting the import of plant material or fresh vegetables of the Brassicaceae family to Marion Island.

The PEIMP does not explain how these respective responsibilities are to be coordinated or monitored, or to whom designated officials or entities are accountable.

The PEIMP's assignment of conservation-related duties and responsibilities pertaining to takeovers is fragmented, uncoordinated and vague. There is no formal, integrated mechanism by which to monitor and enforce compliance with the management measures pertaining to the prevention of the introduction of alien organism to Marion Island during annual takeovers. It is not clear how accountability is to be established or monitored. There is also no provision for independent auditing of the effectiveness of the PEIMP.

Adequacy of practical measures

Recurring problems: infrastructure and operations

Problems relating to the implementation of PEIMP measures to prevent the introduction of alien organisms to Marion and Prince Edward islands have arisen at several of the PEIMC's 11 meetings since April 1996 (PEIMC minutes, 17 April 1996-20 February 2001).

Incidents of non-compliance with the PEIMP with regard to the storage and cleaning of containers and equipment, rat guards on the *SA Agulhas*, and cleaning of clothing and footwear are summarised in Table 4. The incidents reveal both infrastructural and operational problems relating to management interventions.

Infrastructural issues include having separate sets of containers for Marion Island, Gough Island, the SANAE IV Antarctic base respectively, and the design of rat guards. Operational issues relate to the manner and condition in which containers are stored, the installation of rat guards on mooring lines, and departmental and individual responsibility for ensuring that clothing and footwear are free of organisms alien to the PEI.

Operational solutions

In most instances, the PEIMC recommended operational solutions to the respective problems. It is apparent, though, that the recommendations of the PEIMC were not necessarily carried out effectively. The dilatory installation of rat guards, notwithstanding the potentially irreversible ecological impact of rodent introductions to Marion Island, has remained a persistent source of concern to the PEIMC and respective conservation officers and OICs since September 1996. The exposure of containers to weeds and their propagules has, likewise, not been adequately addressed by the NPWD despite having been raised with the PEIMC at least three times over a four-year period. The presence of soil and exotic seeds on some clothing and boots issued by the DEAT stores to takeover personnel and expeditioners has also been brought to the attention of the PEIMC more than once.

Non-implementation

The proceedings of the PEIMC suggests that critical elements of the management regime relating to the prevention of the introduction of alien species to Marion Island during annual takeovers are not being applied consistently. The failure to ensure effective and consistent implementation of basic but essential precautionary measures compromises the prime aim of the PEIMP, i.e. the conservation and sustained preservation of a unique ecosystem. The erratic or non-implementation of PEIMC recommendations also raises questions about the organisational ability of the DAI, NPWD and private operators of the *SA Agulhas* to give practical effect to their

respective obligations under the PEIMP. The challenge is to establish why this is so, and to develop sustainable and effective remedies.

Shortcomings

Valentine (pers comm.) has pointed to two notable shortcomings in the current approach to managing the environmental aspects of takeovers at Marion Island:

- There is no continuity of environmental management in relation to takeovers; and
- Reports by RCOs are not always followed up.

The question of continuity returns to that of the inability of the DAI, due to reasons reputedly beyond its control, to appoint a full-time CO as provided for by the PEIMP. The PEIMC has instead established the current system whereby RCOs are appointed from its ranks for takeovers at Marion Island on a year-by-year basis. The RCO functions in terms of detailed duty statement, which represents a significant advance upon the PEIMP's silence on the duties and powers of the CO. Several issues, however, must be considered in relation to the role and powers of the RCO during takeovers:

- Annual appointment of an RCO reinforces the general fragmentation of environmental functions and powers that characterise annual takeovers at Marion Island;
- It is not clear whether the RCO's role is advisory to the OIC, or whether he/she has powers under the ECA to enforce the provisions of the PEIMP;

- The RCO duty statement does not stipulate that the RCO must attend pre-takeover planning meetings; this is only presumed;
- As a member of the PEIMC, which is a statutory body accountable to the Director-General: DEAT, the RCO does not meet the requirement of independence of observers as recommended by the IUCN/SCAR (Walton, 1986;) and Cooper and Condy (1988); and
- The RCO is not required to be proficient in the methods and procedures of IEM (particularly with respect to an open, integrated and participatory approach to planning, and familiarity with NEMA and the national environmental management principles); prior experience of the PEI or a conservation background are the sole requirements for the post.

The lack of a co-ordinated, explicit and accountable system of environmental management for annual takeovers to Marion Island would appear to account for the reason why RCO reports are not followed up.

Environmental management systems (EMS): aspiring for best practice

The purpose of an EMS is to identify aspects of an organisation's activities that have the potential to impact on the environment. Policies and objectives must be formulated to ensure that activities are effectively managed and follow a cycle of continuous improvement (Antarctica New Zealand, 2001). The International Organization for Standardization (ISO) Standard 14001 specifies the basic requirements for an organisational EMS (South African Bureau of Standards, 1996).

The key requirements of an EMS are (Hill and Bowen,1996):

- Determining an environmental policy to judge all activities which are to be managed by setting the desired level of environmental performance;
- Providing an organisational structure and determining the responsibilities, authority, lines of communication and the resources needed to implement the EMS;
- Developing an environmental management programme (EMP) that stipulates environmental objectives and targets to be met, and work instructions and controls to be applied in order to achieve compliance with the organisation's environmental policy; and
- Undertaking periodic audits of environmental performance and the effectiveness of the EMS.

ISO 14001-style EMSs have not escaped criticism, though. The standard does not establish absolute requirements for environmental performance beyond a policy commitment to compliance with applicable legislation and regulations, and to continual improvement (EEB/BEC, 1996). Nothing stops an organisation, however, from committing itself to higher standards of environmental performance or compliance than prescribed by law.

An EMS for the PEI has been in the pipeline since at least 1996, when it was minuted as a formal agenda item at the first meeting of the PEIMC (PEIMC, 1996 – 2001).

The matter was again raised in 1997 (PEIMC, 1996 – 2001), but not dealt with

conclusively. The South African National Antarctic Programme developed and implemented an Environmental, Health and Safety Management System (EHSM) for the construction and operational phases of the SANAE IV base (Skinner, pers. comm.). The SANAE IV EHSM is audited annually during the summer takeover. The EMS of the New Zealand Antarctic Institute has been operational since October 1999 (Antarctica New Zealand, 2000). Specific action plans and procedures have been developed in accordance with legislation and other Antarctic agreements (Antarctica New Zealand, 2000).

EMS: The Antarctic New Zealand experience

The Antarctica New Zealand EMS was developed with the assistance of an environmental consultancy with expertise in such systems (Antarctic New Zealand, 2000). As a first step, an environmental policy was finalised and made available to all staff and the public. An independent audit of New Zealand's Antarctic activities in 1994 identified and assessed the organisation's activities to identify aspects that impact on the environment. Priorities for management of these activities were also determined.

The next step entailed developing an action plan to address each of these aspects. The action plan includes environmental objectives such as compliance with applicable legislation and industry best practice. It also sets targets to commission compliance and implement industry best practice procedures by a set date. Environmental performance indicators serve as measurable criteria to assess compliance with best practical standards and procedures.

Internal audits are conducted on a 12-monthly basis by the Antarctic New Zealand Environment and Policy Officer. External audits are done by the Environmental Assessment and Review Panel, an advisory group to the New Zealand Ministry of Foreign Affairs and Trade which administers the New Zealand Antarctica (Environmental Protection) Act (Waterhouse, pers. comm).

An EMS manual has been distributed to key personnel and various staff are responsible for overseeing and implementing different components of the system. EMS training was included in pre-season training for personnel participating in the 1999/2000 summer expedition to Antarctica. A key theme of the EMS approach is that of individual and organisational commitment to improved standards of environmental performance, coupled with accountability.

Consideration should be given to an EMS for the PEI, drawing on the experiences of Antarctica New Zealand and SANAE IV. The potential advantages of an EMS would include:

- Commitment of all participants in takeovers to a continual cycle of improvement as defined by policy and legislation (e.g. the PEIMP and NEMA);
- Setting targets and deadlines for all aspects of activities that may have adverse environmental impacts (e.g. installation of rat guards, storage of containers and the condition of DEAT-issue clothing);

- Assigning responsibility for the achievement of targets and implementation of activity-specific action plans (both within DEAT as well as for the OIC, RCO, group leaders and individual participants);
- Introducing internal and external accountability by means of management reviews and external auditing;
- Ensuring consistent, monitored implementation of management measures and procedures; and
- Addressing the lack of continuity by setting in place a management system that is explicit in its objectives and the methods means by which they are to be achieved and by whom.

Environmental Management Cooperation Agreements (EMCAs)

NEMA's provision for EMCAs gives statutory effect to negotiated agreements that bind co-signatories into contracts that contain many of the features of the EMS approach, e.g. measurable targets for improving environmental performance, independent monitoring and performance audits. EMCAs go one step further than EMSs, however, by stipulating that contracting parties must undertake to improve on legal standards of environmental protection. In an environment as vulnerable and unique as the PEI, such an approach would almost certainly imply ready and regular application of the "risk adverse" precautionary principle contained in Chapter 1 of NEMA.

The DEAT and the DAI would gain the following advantages by entering separate EMCAs with bodies such as the NPWD and the company in charge of the SA

Agulhas:

- Participants in takeover logistics and related activities would be left with no doubt as to their legal obligations in terms of compliance with the Prince Edward Islands Management Plan and the precautionary standards set by the national environmental management principles;
- The chain of command between the DEAT, as the responsible lead and co-ordinating agency for takeovers, would be given contractual effect and remove any ambiguity in this regard;
- An EMCA between the DEAT and its various supporting agencies would provide for clear and systematic adherence to an environmental management system that is underpinned by measurable, mutually agreed targets, monitoring and independent auditing of compliance and standards of improvement; and
- It would result in an appropriate and explicit distribution of environmental responsibility in support of the objectives of the Prince Edward Island Management Plan.

CONCLUSIONS

The PEI, situated in the sub-Antarctic, are a significant part of a very rare and vulnerable ecosystem on a global scale. The Prince Edward Islands Special Nature Reserve and its management plan represent a significant positive step towards legally binding protection of the globally important conservation and scientific values of the PEI.

The objectives of the PEIMP are fundamentally sound and its measures to prevent the introduction of alien organisms to Marion Island during annual takeovers are of a high international standard. It would appear, however, that the PEIMP is not functioning optimally as an effective and responsive framework for integrated environmental decision-making and that its management prescriptions are not being consistently applied or evaluated.

The most critical shortcomings of the PEIMP and its attendant management framework appear to be:

- Ineffectual integration of environmental oversight in the pre-voyage planning phase and during the operational phase of takeovers at Marion Island;
- Vague definition of responsibilities and authority in relation to conservation obligations throughout the takeover cycle;
- A lack of formal accountability for compliance with mandatory conservation measures and conservation-related recommendations of the PEIMC;

- An absence of overall professional responsibility for environmental co-ordination and communication; and
- No provision for regular independent audits to monitor compliance with the procedures and prescriptions of the PEIMP.

Non-compliance with the PEIMP, and especially the provisions to prevent alien species from being introduced to Marion Island, represents a major threat to the ecological integrity and scientific value of the PEI. If the values of the PEI continue to be compromised by ineffectual management, there is a potential risk that South Africa's international standing as a leader in sub-Antarctic conservation and research may well be called into question.

South African legislation and the IEM procedure, as well as international standards for environmental management, present various options for developing a more systematic and effective management system for annual takeovers at Marion Island. These range from self-regulatory mechanisms such as environmental management systems (EMSs) to statutory contracts and environmental reporting requirements in the form of EMCAs or EIPs and EMPs under NEMA.

A more formal, statutory approach would be to consider negotiating EMCAs between DEAT and other logistics' roleplayers in annual takeovers.

In the interim, however, it would seem appropriate that DEAT appoints an environmental control officer (ECO) to take charge of environmental co-ordination

preceding and during takeovers to Marion Island. The ECO would preferably be independent of the PEIMC and directly accountable to the Director: DAI.

The ECO would preferably be a professional environmental manager with extensive experience of EMSs, environmental management programmes and conflict management. The ECO would have guaranteed and structured access to the outgoing TCO to ensure that the biophysical and ecological impacts of takeover-related activities are properly recorded and dealt with.

However, since this paper only looked at one aspect of management, namely the potential introduction of alien species during annual takeovers, it is not appropriate to prescribe specific, long-term management remedies. It is therefore felt that management of the PEI should be evaluated holistically. The most appropriate tools to address deficiencies in the system, taking into account opportunities and constraints of operating in a sub-Antarctic setting, should be applied.

A first step could entail commissioning an expert independent audit of the full spectrum of takeover-related activities, procedures and responsibilities.

Ends

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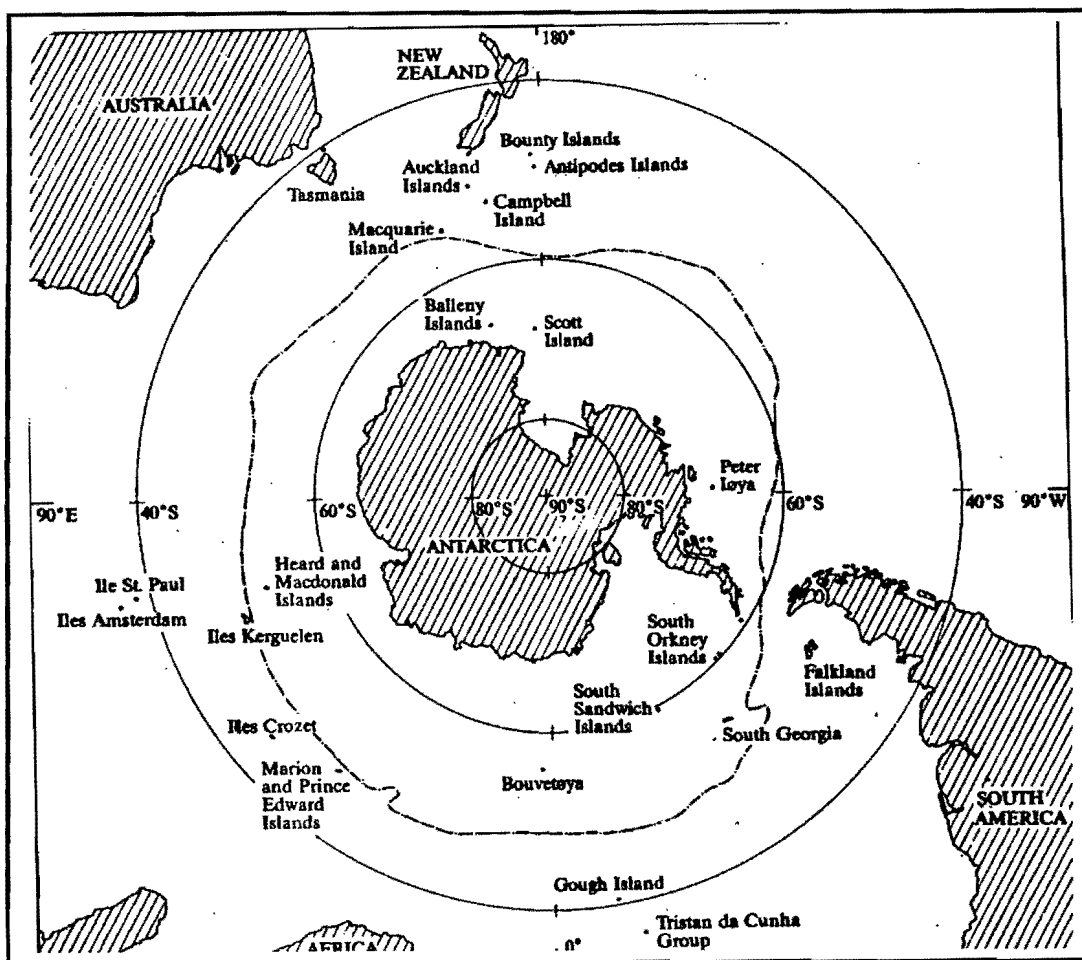
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Fig. 1: Location of sub-Antarctic Islands



Source: Selkirk *et al.* (1990)

Table 1: Prince Edward Islands: Summary of applicable legislation & implications for environmental management during annual takeovers

Environment Conservation Act 73 of 1989 –“Legal and Administrative Context”
National Environmental Management Act 107 of 1998 – “Legal and Administrative Context”
Marine Living Resources Act 15 of 1994 (Repeals and replaces Sea Fisheries Act 15 of 1994)
<ul style="list-style-type: none"> • Provides for conservation of marine ecosystem
National Heritage Resources Act 25 of 1999 (Repeals and replaces National Monuments Act 46 of 1973)
<ul style="list-style-type: none"> • Declares culturally significant & specially valued heritages as part of national estate • Establishes SA Heritage Resources Agency • Provides for impact assessment reports & heritage conservation management plans
Prince Edward Islands Act 43 of 1948 – “Legal and Administrative Context”
South African Citizenship Act 44 of 1949
Seabirds and Seals Protection Act 46 of 1973
<ul style="list-style-type: none"> • Protects seabirds and seals, including species that occur at Prince Edward Islands
Dumping at Sea Control Act 73 of 1980
<ul style="list-style-type: none"> • Imposes criminal sanctions for dumping scheduled substances into sea without permission • Modelled on Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972
Maritime Zones Act 15 of 1994
<ul style="list-style-type: none"> • Defines internal waters, territorial waters (12 nautical miles from baselines), a contiguous zone (24 nautical miles), a maritime cultural zone (24 nautical miles), the exclusive economic zone (200 nautical miles) nautical & the continental shelf
<ul style="list-style-type: none"> • Antarctic Treaties Act 60 of 1996 – “Legal and Administrative Context”

Table 2: Chronology, impact, means of introduction and current status of some invasive alien species introduced to Marion Island*

Year of introduction	Organism	Impact	Means of introduction	Current status
Pre-1818	House mouse <i>Mus musculus</i>	Potential major impact on ecosystem function due to predation on decomposer soil invertebrates. Possibly responsible for extinction of a flightless moth <i>Pringleophaga kerguelensis</i>	Believed to have been accidentally introduced with sealers' supplies	Naturalised & widespread
19 th century	<i>Poa annua</i> (grass)	Colonises areas manured by penguins & seals	Presumably with sealers' supplies	Naturalised & widespread
1949	Domestic cat <i>Felis catus</i>	Predation caused local extinction of Common Diving Petrel <i>Pelacanooides urinatrix</i> & virtual extinction of three other species of burrowing petrel	Introduced to control mice at weather station	Feral cat population exterminated by 1991 after 14-year control programme
1950s, early 1960s	<i>Agrostis stolonifera</i> (grass)	Aggressive invader of drainage lines	Probably introduced with soil or livestock fodder.	Naturalised & widespread
1950, early 1960s	<i>Sagina apetala</i> (low-growing, spreading herb)	Prone to spreading in trampled areas such as building sites	Possibly with fodder for introduced sheep. Rapid spread may be assisted by movement of researchers etc around island from base station.	Naturalised & widespread
1960s	<i>Deroceras caruanae</i> (slug)	Limited impact on vegetation of drainage line complexes, but may increase if global warming persists	Possibly with provisions for base station. Believed to have been transported to field huts on helicopter-borne packing crates.	Locally naturalised
1983	Thistle <i>Sonchus</i> sp.	Potentially invasive	Probably introduced with building sand	All plants destroyed
1986	Diamond-back moth <i>Plutella xylostella</i>	Feeds on Kerguelen cabbage <i>Pringlea ascorbutica</i> , causing extensive damage, stunted growth	Possibly with fresh cabbage supplies or natural migration	Naturalised

*Sources: Watkins & Cooper, 1986; Huntley, 1971; Smith, 1987; Heymann *et al.*, 1987; Hänel & Chown, Department of Environmental Affairs & Tourism, 1996; 1997; Bergstrom & Chown, 1999.

Table 3: Activities that may result in alien introductions to Marion, Heard & Macquarie islands & South Georgia: management measures

POTENTIAL IMPACT	MARION ISLAND	HEARD ISLAND	MACQUARIE ISLAND	SOUTH GEORGIA
<p>SHIP'S STAY AT ISLAND</p> <ul style="list-style-type: none"> Introduction of rodents 	<ul style="list-style-type: none"> All visitors and scientists must take same precautions with regard to introduction of rodents, other animals and plants All vessels visiting islands must be certified free of rodents No wharves or mooring facilities will be constructed on the islands Any mooring directly on to land prohibited Vessels must be anchored at least 200m from the islands, except when pumping fuel ashore or subject to written permission to anchor closer for scientific and management purposes When moored at any harbour, vessels likely to visit the islands shall be fitted with rat guards on all mooring lines 	<ul style="list-style-type: none"> Educate all visitors to Territory to avoid practices which might lead to introduction of non-indigenous species Deratting certificate from Australian Quarantine Inspection Service or equivalent from country last visited 	<ul style="list-style-type: none"> Any vessel visiting reserve must be certified free of rodents No wharves or mooring facilities will be constructed in reserve Direct mooring to the land will be prohibited Vessels must be anchored at least 200m from reserve except where written permission given to anchor closer for scientific or management purposes 	<ul style="list-style-type: none"> All vessels visiting South Georgia, whether tied up at jetties or anchored in bays, must adhere to good practice de-ratting protocols Secure, robust containers to be used for all equipment, foodstuffs to be put ashore to prevent entry by biota – particularly rodents, invertebrates Care should be taken when packing equipment, food before arrival at S Georgia to avoid transporting alien biota to island Immediately before loading, unloading, all cargo to be re-inspected for signs of rodent activity Care to be taken by visitors, expeditions when packing, re-packing and using equipment, clothing, footwear and foodstuffs to avoid transporting alien biota on to island and between different sites on island When moored at a jetty, foodstuffs should not be left on deck and hatches should be secured, particularly at night

POTENTIAL IMPACT	MARION ISLAND	HEARD ISLAND	MACQUARIE ISLAND	SOUTH GEORGIA
<p data-bbox="144 274 467 355">TYPE, PACKAGING OF SUPPLIES AND PERSONAL CONDUCT ON ISLAND</p> <ul data-bbox="144 412 493 466" style="list-style-type: none"> • Disease, non-rodent alien transfers 	<ul data-bbox="530 274 897 1252" style="list-style-type: none"> ▪ DEAT may require that any packing and materials, equipment, vehicles, vessels/ helicopters and foodstuffs – whether for scientific or personal use – be suitably cleaned, fumigated and/or irradiated and inspected before arriving on islands ▪ All poultry produce, including eggs, taken to island shall be irradiated ▪ No poultry produce which has been taken to island shall be fed to local avifauna; all waste material must be properly incinerated ▪ No poultry produce, including eggs, from the supply vessel may be deposited in the Marine Zone ▪ All waste poultry produce, including eggshells, will be returned to SA for disposal ▪ No domestic pets, organic material and ornamental plants allowed on island ▪ Fresh vegetables of Brassicaceae family (eg, cabbages, cauliflowers, broccoli and Brussels sprouts) not permitted on island 	<ul data-bbox="908 274 1275 1252" style="list-style-type: none"> ▪ Educate all visitors to Territory to avoid practices which might lead to introduction of non-indigenous species ▪ Clean footwear, clothing and equipment prior to landing ▪ Fumigation or inspection of all cargo to be taken ashore ▪ Prohibition on discharge of ballast water in territorial seas ▪ Prohibition of landing of any plants of the Brassica family ▪ Prohibition of landing of any fresh (unwashed, unpreserved, non-irradiated or non-fumigated) fruit or vegetables ▪ Prohibition of landing of all poultry products – other than egg powder and products that may contain egg powder (provided that such products are kept securely sealed in container in enclosed shelter and only opened, used in an enclosed shelter) ▪ Report to Australian Antarctic Division any sighting of alien species ▪ Where appropriate or possible remove or destroy any human-introduced non-indigenous species 	<ul data-bbox="1286 274 1653 1252" style="list-style-type: none"> ▪ No poultry produce from ships or boats may be deposited in Tasmanian territorial waters around reserve ▪ Managing authority may require any materials, equipment, transport (vehicles, vessels, helicopters) and foodstuffs – whether for scientific or tourist or personal use – to be suitably cleaned and/or fumigated before entering reserve ▪ Procedures agreed to between managing authority and Antarctic Division will be implemented by latter to prevent/control establishment of any exotic species imported into reserve due to expedition activities ▪ No poultry produce taken into reserve may be fed to local avifauna ▪ All waste material must be properly incinerated ▪ No poultry produce may be taken on field trips or to field huts 	<ul data-bbox="1664 274 2039 1252" style="list-style-type: none"> ▪ See Introduction of rodents ▪ Ballast pumping should take place before entering Maritime Zone (intention to enforce as condition of fishing licences, other entry permits) ▪ All vessels required to retain poultry wastes, dispose at appropriate facilities outside SGSSI Maritime Zone ▪ If vessel unable to comply with this requirement, then should not consume poultry while inside South Georgia Site of Scientific Interest Maritime Zone

Table 4: Some recurring problems relating to management precautions preceding and during annual takeovers, Marion Island*

MANAGEMENT ASPECT	PROBLEM & YEAR/S RAISED WITH PEIMC	PEIMC RECOMMENDATIONS/MANAGEMENT RESPONSE
Storage & cleaning of containers & equipment to prevent introduction of alien organisms	<ul style="list-style-type: none"> • Potential cross-contamination of Marion & Gough islands by using same containers for both islands (1997, 1999, 2000) • Containers stored outside on concrete slabs infested with or exposed to weeds (Cape Town, PWD stores) (1997, 1999, 2000) • Containers containing remnants of plant material (Cape Town, DEAT stores) (1998) • Bird droppings on plastic wrapping of mattress loaded into open container destined for Marion Island (Cape Town, DEAT stores) (2000) • Open packets of food lying around in DEAT store may encouraged rodents (2000) 	<ul style="list-style-type: none"> • Containers for Marion & Gough islands must be washed & stored separately (July 2000) (complete sets for each destination too expensive) • Spot checks of storage areas by COs (October 1999) • Storage areas must be treated with herbicide (July 2000) • All containers to be sealed and certified when washed and returned (October 1998)
Rat guards on SA Agulhas moorings before takeover voyage to prevent introduction of rodents	<ul style="list-style-type: none"> • Protocol on rodents not being adhered to (unspecified) (1996,1997) • Design of rat guards not effective (1998) • Rat guards not placed on all mooring lines (1998, 1999) 	<ul style="list-style-type: none"> • New rat guards secured with bolts used prior to Gough Island takeover (October 1998) • Unspecified problems with Portnet to be taken up with Minister of Environmental Affairs and Tourism (October 1999) • New, unspecified, design for rat guards manufactured and implemented (October 1999)
Cleaning of clothing & footwear (of propagules, soil, etc) to prevent introduction of alien organisms	<ul style="list-style-type: none"> • Exchange of DEAT-issued clothing between Gough and Marion islands holds risk of inter-island propagule transfer (1999) • DEAT-issued boots contained mud and seed, presumably from Gough Island (1999, 2000) • Seeds in velcro jacket and trouser fastenings (2000) 	<ul style="list-style-type: none"> • Signed declaration from all participants regarding precautions taken with clothing and footwear to be in place for 2000 Marion relief voyage (October 1999) • Boots must be properly cleaned at DEAT stores (July 2000) • Poster advising that dirty boots to be returned to storeman • "Boot-washing ceremony" to be held <i>en route</i> to islands • Cleaning of boots must be included as provision in clothing list signed by participants

*Sources: Minutes of PEIMC meetings, April 1996 – July 2000.

Fig. 2: Marion Island and management zones (DEAT, 1996)

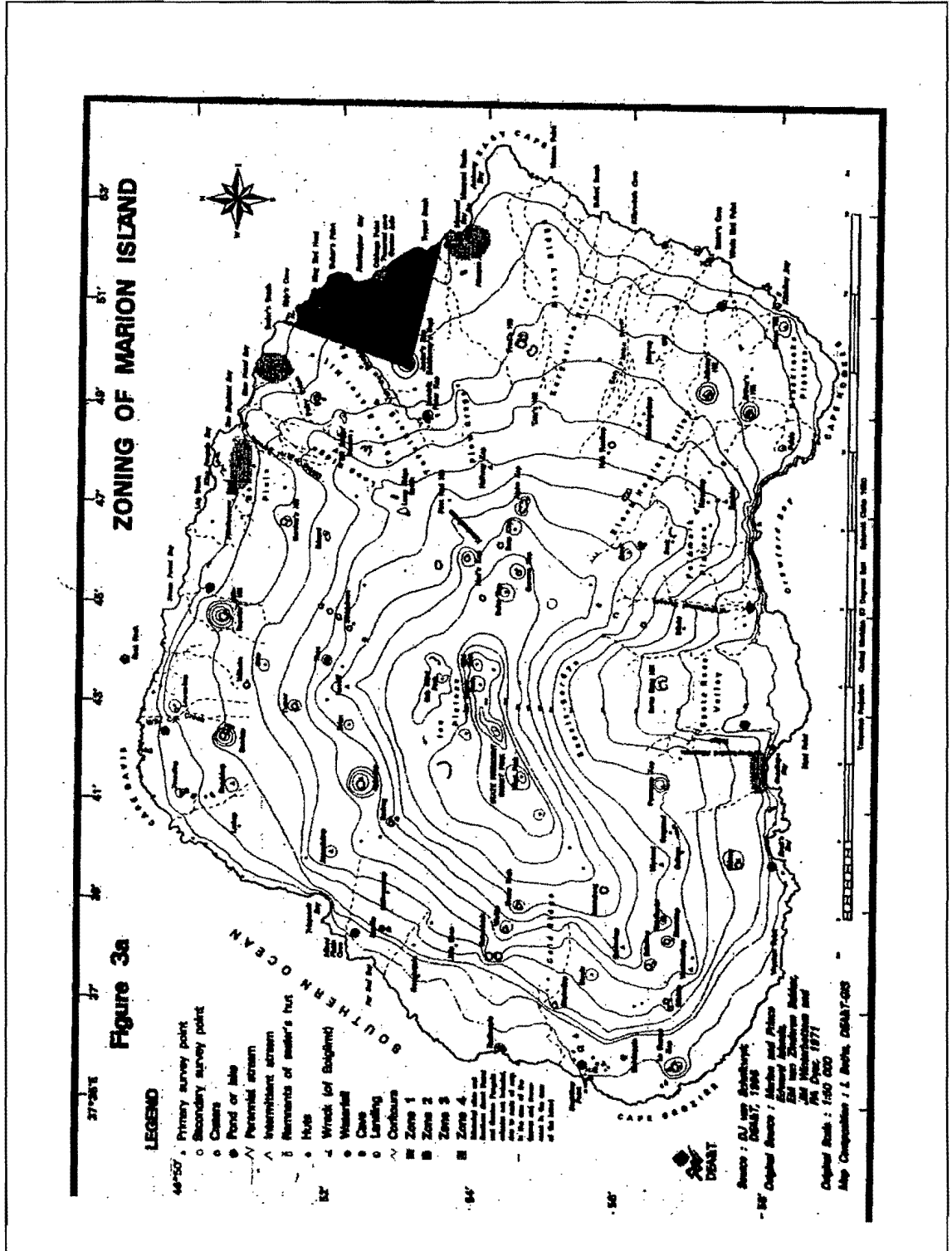


Fig. 3: Implementation of PEIMP during annual takeovers: Management hierarchy

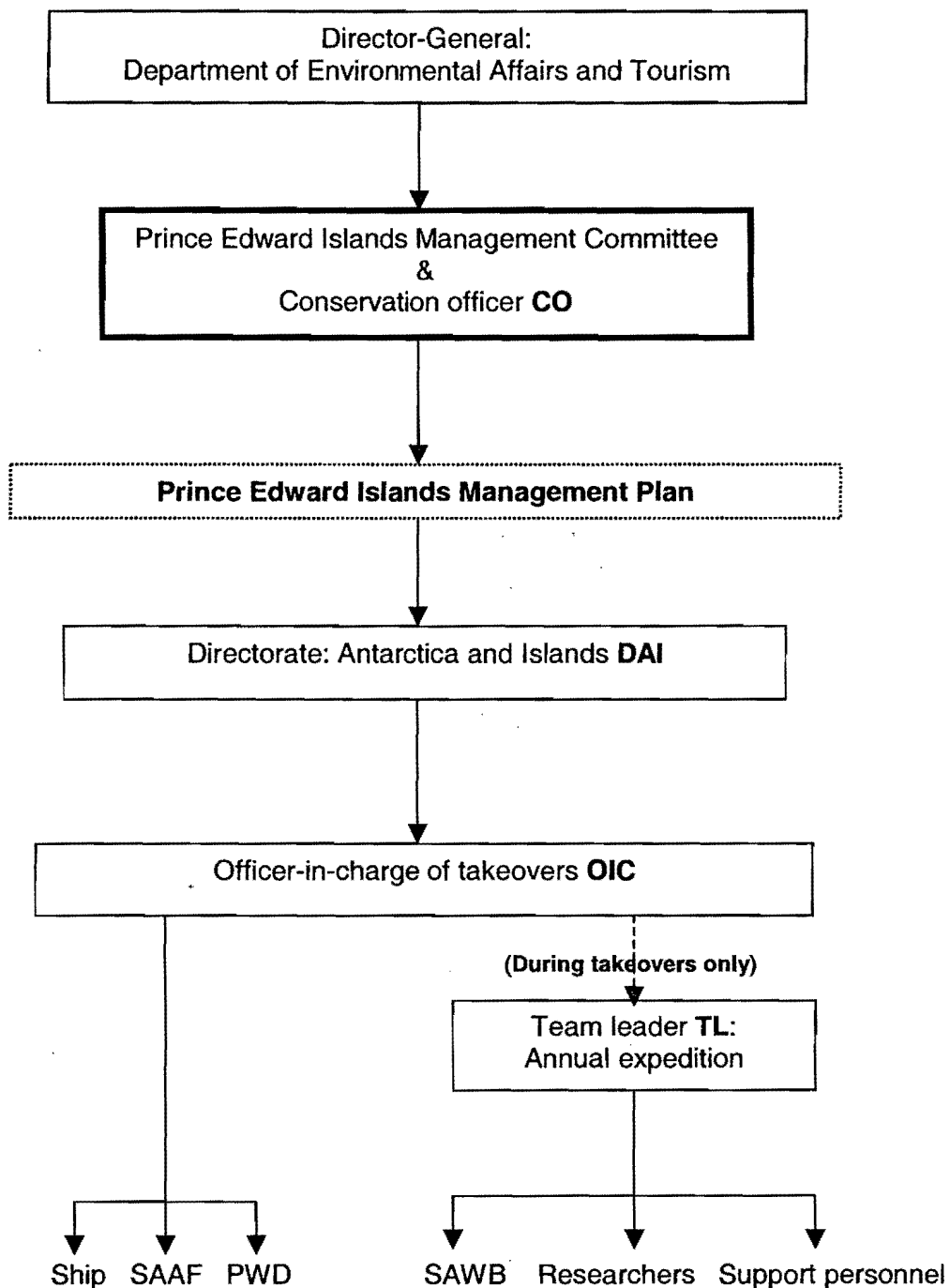


Table 5: PEI Management Plan: Provisions & responsibilities relating to introduction & control of alien biota during routine takeovers

ACTIVITY or ISSUE	RESPONSIBILITY
INFRASTRUCTURE Camping (5.1)	
All equipment to be kept clear of alien organisms & camping equipment to be fumigated prior to landing.	DAI CO or OIC
WASTE & SEWAGE DISPOSAL Poultry produce (6.7)	
Radiation of all poultry produce. Incineration of all poultry waste. No poultry to be taken to Prince Edward Island. No poultry produce to be deposited in 200 nautical mile Marine Zone. All shipboard waste poultry produce to be returned to South Africa.	DEAT CO Master of vessel OIC TL
Kitchen waste (6.8)	
All food waste to be separated & incinerated.	
VEHICLE, BOAT & AIRCRAFT USE Airdrops (8.4)	
Contents of airdrop packages must be adequately sterilised.	CO/delegate
VISITS TO PRINCE EDWARD ISLAND (9.2)	
Supplies & equipment No live alien fauna or flora (except vegetables for human consumption) or their propagules shall be introduced on to Marion or Prince Edward islands. All supplies & equipment to be packed in environment maintained free of fauna (e.g. rats) & flora or their propagules (e.g. seed). All containers to be suitably sealed to prevent ingress of alien fauna & flora or their propagules & thereby transported to/between Marion and Prince Edward islands. All necessary precautions to be taken to prevent transfer of fauna & flora or propagules from Marion to Prince Edward island or <i>vice versa</i> . Helicopter operations & expedition personnel All footwear, protective clothing, equipment, cargo cabins & spaces, wheels & other undercarriage structures to be inspected to ensure freedom of alien plants or animals & their propagules before any landing on Prince Edward Island.	OIC/delegate
IMPORT OF PLANT & OTHER MATERIAL (10)	
No domestic pets allowed on islands. No organic material & ornamental plants permitted on islands. All fresh vegetables of Brassicaceae family prohibited (e.g. cabbages, cauliflowers, broccoli, Brussels sprouts). Fumigation (methyl bromide), hosing down, scrubbing of vehicle/helicopter tyres & field equipment. All construction material (e.g. soil, stone, cement) to be sealed & sterilised.	CO OIC

Abbreviations:

CO	Conservation Officer
DAI	Directorate: Antarctica and Islands
DEAT	Department of Environmental Affairs and Tourism
MCM	Marine and Coastal Management
OIC	Officer-in-Charge
PEIMC	Prince Edward Islands Management Committee
TL	Team leader

ACTIVITY or ISSUE	RESPONSE
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PROTECTION & MANAGEMENT OF FLORA & FAUNA (13)	
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Where research indicates, & the DEAT considers it necessary, management

programmes will be developed & implemented to ensure the

indigenous species and/or control/eradication of

Every effort will be made to prevent further

1996; p 47).

General Rules of

Resource

CAPTIONS

- Fig. 1: Location of Sub-Antarctic islands
- Fig. 2: Marion Island & management zones
- Fig. 3: Implementation of PEIMP during annual takeovers: Management hierarchy
- Table 1: Prince Edward Islands: Summary of applicable legislation & implications for environmental management during takeovers
- Table 2: Chronology, impact, means of introduction and current status of some invasive alien species introduced to Marion Island
- Table 3: Activities that may result in alien introductions at Marion, Heard & Macquarie islands & South Georgia: management measures
- Table 4: Some recurring problems relating to management precautions preceding and during annual takeovers, Marion Island
- Table 5: PEI Management Plan: Provisions & responsibilities relating to introduction & control of alien biota during routine takeovers