

## MACQUARIE ISLAND, ITS CONSERVATION AND MANAGEMENT

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Sub-Antarctic Macquarie Island, 12 785 ha in area, is part of the Australian state of Tasmania. It is managed by the Tasmanian Parks and Wildlife Service, in cooperation with the Australian Department of the Environment and Water Resources, as a World Heritage Area, Nature Reserve, Biosphere Reserve and National Estate property. The reserve encompasses outstanding and unique geological values, exceptional natural beauty, abundant wildlife and internationally significant historic heritage. The island is surrounded by the Macquarie Island Marine Park of 16 200 000 ha. This paper outlines frameworks for the conservation and management of its biota and environment including its unique geology.

**Key Words:** sub-Antarctic, Macquarie Island, conservation, management, World Heritage Area.

### LOCATION AND PHYSICAL CHARACTERISTICS

Macquarie Island is located approximately 1500 km from Hobart at 158°55'E, 54°30'S, roughly halfway between Tasmania and Antarctica (fig. 1). Its nearest neighbours are the New Zealand islands of Auckland and Campbell. The island is nearly 34 km long, up to 5 km wide and has a terrestrial area of 12 785 ha. An undulating plateau of between 150 and 300 m high forms the backbone of the island, whilst Macquarie's highest point, Mt Hamilton, reaches 433 m (Parks and Wildlife Service 2006).

Macquarie Island is located just north of the Antarctic Polar Frontal Zone and has a climate best described as cool, wet and windy, with a mean air temperature of 3.3°C in winter and 7.0°C in summer. The mean annual precipitation of 920 mm is spread over about 312 days and there are on average 268 days of strong winds annually (Parks and Wildlife Service 2006).

Macquarie Island is geologically unique, being the only island composed entirely of oceanic crust, with all rocks having been formed on or beneath the ocean floor. The island is the only exposed section of the Macquarie Ridge, which stretches from around 61°S as far north as New Zealand (Selkirk *et al.* 1990, Parks and Wildlife Service 1999). The seafloor on the eastern side of the island drops steeply to the Macquarie trench at a depth of over 5500 m, whilst the western side slopes somewhat less steeply to a depth of approximately 3500 m (Parks and Wildlife Service 1999).

The island emerged approximately 600 000–700 000 years ago and its numerous raised beach deposits (marking palaeoshorelines) provide graphic evidence of the island's uplift, which has been estimated to be approximately 0.8 mm per year (Adamson *et al.* 1996). The northern part of the island has rock outcrops which illustrate the unique exposure of rocks from the upper mantle (about 6 km below the ocean floor), whereas the southern three-quarters of the island is composed mainly of basalt rocks, such as the extensive pillow lavas which formed on the ocean floor (Parks and Wildlife Service 1999).

### FLORA AND FAUNA

Macquarie Island has no trees or shrubs, but has 47 species of vascular flora, four of which are endemic (including two orchids) (Clements *et al.* 2007). There are generally considered to be five major vegetation formations: tall tussock, short grassland, herbfield, mire and feldmark (Selkirk *et al.* 1990). Only five alien plant species have been recorded in the reserve in recent years (Copson & Whinam 2001).

In common with most other sub-Antarctic islands, Macquarie Island supports a vertebrate fauna of low diversity but high abundance. Amongst the most common species are: Light-mantled Sooty Albatross *Phoebetria palpebrata* (Forster, 1785) (1500 breeding pairs); Southern Elephant Seals *Mirounga leonina* (Linnaeus, 1758) (approximately 80 000); King Penguins *Aptenodytes patagonicus* Miller, 1778 (approximately 170 000 breeding pairs); the endemic Royal Penguin *Eudyptes schlegeli* Finsch, 1876 (approximately 850 000 breeding pairs); and three species of Fur Seal *Arctocephalus* spp. (several hundred) (Scott 1994, Parks and Wildlife Service 2006). The reserve also protects a number of rare or threatened species, including 16 fauna species and one plant species that are listed under the Tasmanian *Threatened Species Protection Act 1995*.

### HISTORY

Macquarie Island was discovered by sealing parties in 1810 and the island's abundant fur seals, elephant seals, (and later) penguins, were subsequently all heavily exploited. Scientific expeditions followed, most notably Sir Douglas Mawson's Australasian Antarctic Expedition which operated a scientific station on the island between 1911 and 1914. Commercial exploitation of the island's wildlife ceased in 1919 (Cumpston 1968).

The Australian Antarctic Division (AAD) has operated a scientific station at the Isthmus since 1948, and approximately 14–25 people are based on the island each year. The station supports research in space and atmospheric physics, meteorology, human biology and medicine, biology, and geosciences.

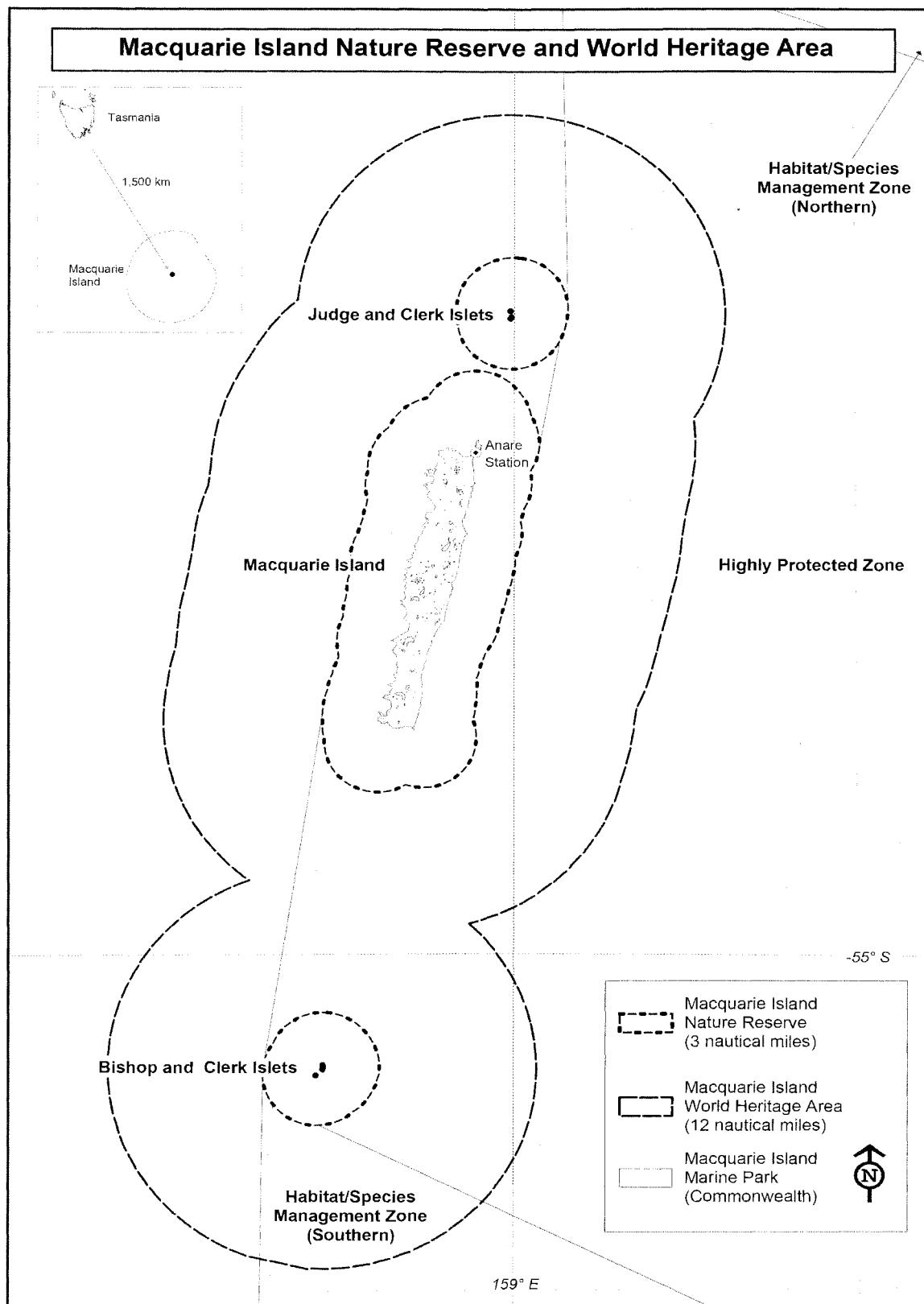


FIG. 1 — Macquarie Island Nature Reserve and World Heritage Area. Reproduced with permission from the Tasmanian PWS.

## CONSERVATION AND MANAGEMENT

### Reserve status and tenure

Macquarie Island enjoys the very highest levels of national and international protection. It was declared a Wildlife Sanctuary in 1933 and given its current status as a Nature Reserve in 1978. Macquarie Island Nature Reserve covers the island, outlying islets (Judge and Clerk islets and Bishop and Clerk islets), and surrounding state waters out to three nautical miles (nm), resulting in a total area of 87 500 ha.

The island, islets and surrounding waters out to 12 nm were inscribed as a World Heritage Area in 1997, largely based on their outstanding geoheritage and natural beauty values (Parks and Wildlife Service 2006). In addition, Macquarie Island is a Biosphere Reserve; a National Estate property; and has Critical Habitat values under the *Environment Protection & Biodiversity Conservation Act 1999*. Most of the ocean on the eastern side of the island out to 200 nm is encompassed by the Macquarie Island Marine Park, the second largest Marine Protected Area in the world with an area of approximately 16 200 000 ha. The Marine Park supports a highly protected zone and two habitat species management zones (Department of the Environment and Water Resources 2007).

### Management framework

Macquarie Island Nature Reserve is part of the Australian state of Tasmania and is managed by the Tasmanian Parks and Wildlife Service (PWS). The PWS and the Australian Department of the Environment and Water Resources have cooperative management arrangements for the World Heritage Area and the Macquarie Island Marine Park. The AAD has generously supported PWS management of the reserve over many years and all PWS staff on the island go there as part of the Australian Antarctic Program.

A new management plan was proclaimed in 2006 and will provide management direction for the reserve for at least the next seven years. The plan has established three management zones in order to regulate infrastructure levels and manage the impacts of human activities in the reserve. Zone A (Services Zone) covers the area around the Australian Antarctic Division scientific station, Zone B (Limited Access Zone) covers the remainder of the island, and Zone C (State Marine Waters) encompasses the marine area (fig. 2).

All scientific programs on Macquarie Island require a permit, and as the reserve has been declared a restricted area under the *National Parks and Reserved Land Regulations 1999*, all visitors must have an access authority to enter. Special Management Areas (fig. 3) have also been established around the coastline to regulate access by Australian Antarctic Program expeditioners to sensitive parts of the reserve during the breeding seasons of vulnerable wildlife species such as seals, albatross and penguins.

### Introduced vertebrate pests

In common with most sub-Antarctic islands, Macquarie has had a number of accidentally or deliberately introduced vertebrate pest species which have adversely affected reserve values (De Villiers *et al.* 2006). These include: Weka *Gallirallus*

*australis scotti* (Ogilvie-Grant, 1905) (eradicated in 1989); Feral Cats *Felis catus* Linnaeus, 1758 (eradicated in 2000); European Rabbits *Oryctolagus cuniculus* (Linnaeus, 1758); House Mice *Mus musculus* Linnaeus, 1758; and Ship Rats *Rattus rattus* Linnaeus, 1758.

Rabbits and rodents are currently significantly impacting on the island's native flora and fauna. Some of the species (together with their designation under either Australian or Tasmanian threatened species legislation) most threatened by this impact are: Grey Petrels *Procellaria cinerea* Gmelin, 1789 (Endangered); Black-browed Albatross *Diomedea melanophris* Temminck, 1828 (Endangered); Blue Petrels *Halobaena caerulea* (Gmelin, 1789) (Vulnerable); and White-headed Petrels *Pterodroma lessonii* (Garnot, 1826) (Vulnerable).

Rabbits change vegetation communities through grazing, whilst rodents can prey upon the eggs and chicks of small seabirds as well as affect invertebrate communities and impact on the recruitment of plants (Copson 1986, Shaw *et al.* 2005). The dominant coastal vegetation type on Macquarie is tall tussock *Poa foliosa* (Hook f.) Hook. f. Once tussock has been lost to rabbit grazing, landslips start to occur and species unpalatable to rabbits (such as mosses) dominate the slope. Tussock loss has adverse micro-climatic effects on seabird burrows (less dark, colder, drier and less wind protection) and also reduces protection from native predators such as skuas *Catharacta lönbergi* (Mathews, 1912) (Threatened Species Unit 2004). Rabbits also indirectly impact upon burrow-nesting seabirds by allowing an inflated skua population to exist, thereby increasing skua predation pressure (Jones & Skira 1977, Skira 1984). The island skua population is currently at the highest level recorded.

Rabbit numbers have increased significantly recently as a result of resistance to myxoma virus, removal of cats as a predator and possible island warming. In response to such rabbit and rodent impacts, a combined Rabbit and Rodent Eradication Plan for the island was developed in consultation with international experts (Parks & Wildlife Service 2007). The eradication plan proposes using helicopters to conduct an intensive aerial baiting program over the whole island. The plan envisages that all rats and mice should be killed by the bait drops, but that some rabbits are likely to survive. Consequently a multi-year on-ground phase using hunting teams and dogs is also planned in order to mop up any surviving rabbits.

Surveys undertaken by PWS in 2005, 2006 and 2007 have revealed that most of the island's coastal slopes have now suffered over 50% rabbit grazing damage. In recognition of the severity of the feral animal problem on Macquarie, the Australian and Tasmanian governments agreed in mid-2007 to jointly fund the eradication plan. A lengthy preparation period for the eradication program has now commenced, during which all of the necessary environmental and safety approvals, in addition to the major logistical groundwork required will be undertaken. The Macquarie Island Rabbit and Rodent Eradication Plan will be the largest and most ambitious sub-Antarctic island eradication ever undertaken.

### Tourism

Although a Nature Reserve, educational tourism is allowed under the management plan. This has been limited to

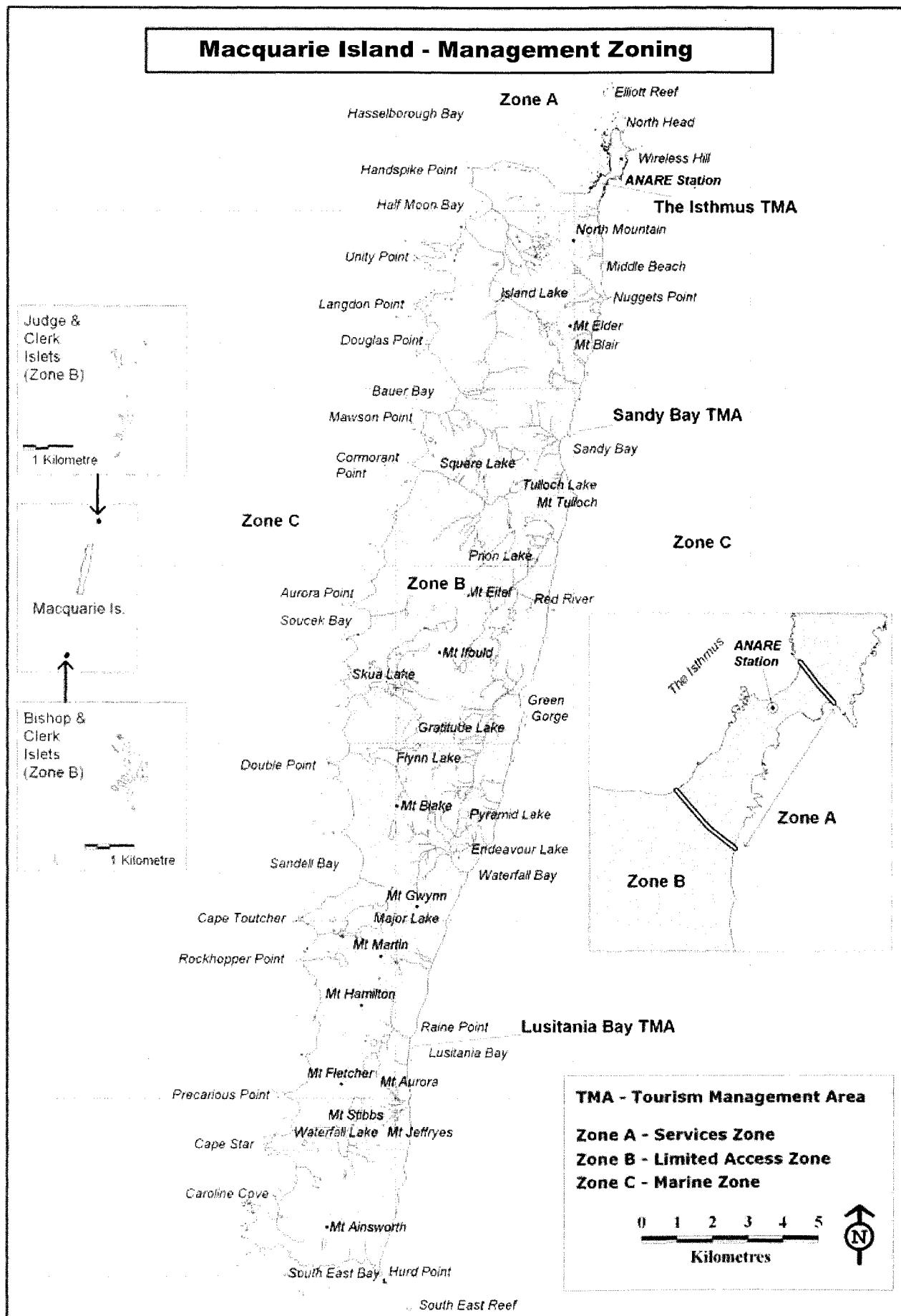


FIG. 2 — Macquarie Island Management Zoning. Reproduced with permission from the Tasmanian PWS.

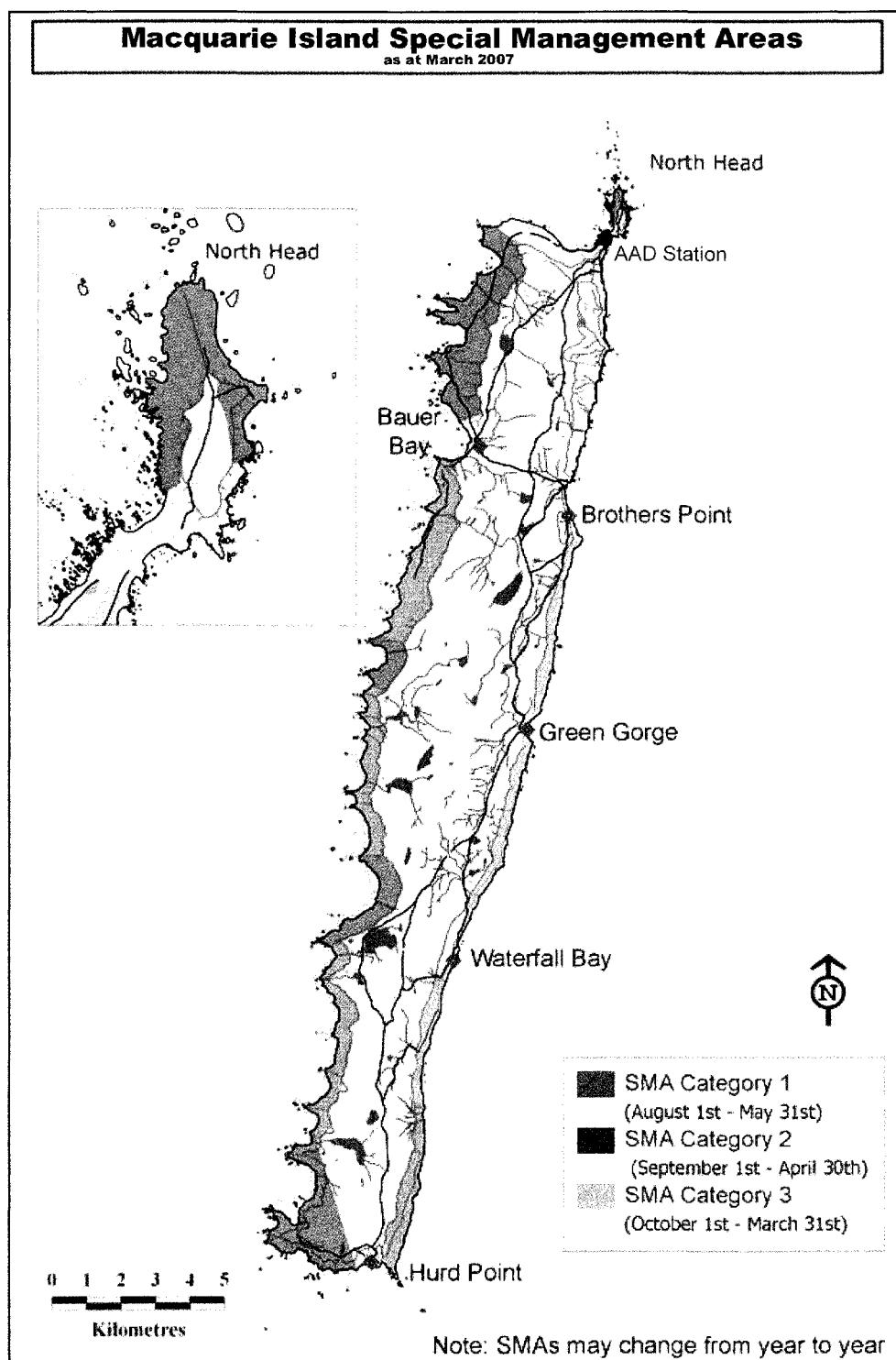


FIG. 3 — Macquarie Island Special Management Areas. Reproduced with permission from the Tasmanian PWS.

around six to eight tourist ships visiting the island each summer, which have been landing between 300 and 500 passengers since regular commercial visits began in 1990. Visit applications are assessed against a range of environmental, safety and economic criteria. A large increase in visitation was experienced over the 2005–2006 season, however, and interest in visits to the island appears to be increasing. All tourist visits are ship-based (for a maximum of two days each) and closely supervised by PWS and AAD staff. Three Tourism Management Areas have been designated in order to regulate access, with tourists generally being restricted to the beaches and specially constructed boardwalks at the Isthmus and Sandy Bay in addition to being allowed to Zodiac cruise off Lusitania Bay.

### Quarantine

Quarantine is likely to remain the most important long-term management issue for the island. In recognition of this, the AAD and PWS have developed a comprehensive quarantine management program for the island under which pre-departure and on-arrival measures are strictly enforced, and all introductions are logged and investigated (Whinam *et al.* 2005). Enforcing an ongoing rigorous quarantine regime for Macquarie will be even more important once rabbits and rodents have been eradicated. In addition, managing the increasing levels of visitation to the island (such as educational tourism), will probably require more proactive measures (such as addressing the threat of introduced marine pests) and greater resources in order to maintain an acceptable level of risk over the long-term (Lewis *et al.* 2006). The increased levels of communication and cooperation in the field of sub-Antarctic island management in recent years is a very welcome development which should yield benefits for tourism and quarantine management.

### Historic heritage

Macquarie Island has internationally significant historic heritage with outstanding examples of early steam digester technology at several sites, such as Hurd Point and the Nuggets (Nash 2003). Many of these down-island sites, however, are degrading rapidly due to weathering, storms and wildlife disturbance. A large collection of movable historic artefacts located at the scientific station also needs ongoing conservation management (Clark 2003). The rapid rate of change at many sites provides only a limited window of opportunity for active management to be successful. Considerable resources will be required to properly address the long-term management of historic heritage sites and artefacts on the island.

### SUMMARY OF MANAGEMENT ISSUES

The most important and pressing management issue is that of vertebrate pest control and eradication. The island is currently experiencing unprecedented levels of rabbit grazing damage, resulting in severe impacts on reserve values and threatened seabird species. An ambitious rabbit and rodent eradication plan has been developed and has recently been funded. The continued degradation of Macquarie Island's internationally significant historic heritage sites is also an issue that needs to be addressed in the very near future, before too much more of

the resource is lost. Finally, the increased interest in educational tourism may also result in increased environmental risk, particularly from a quarantine perspective.

### ACKNOWLEDGEMENTS

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### REFERENCES

**Adamson, D.A., Selkirk, P.M., Price, D.M., Ward, N. & Selkirk, J.M.** 1996: Pleistocene uplift and palaeoenvironments of Macquarie Island: evidence from palaeobeaches and sedimentary deposits. *Papers and Proceedings of the Royal Society of Tasmania* **130**(2): 25–32.

**Clark, L.** 2003: *Macquarie Island – A Conservation Assessment*, Report for Australian Antarctic Division, Kingston: 173 pp.

**Clements, M.A., Mackenzie, A.M., Copson, G.R., Molloy, B.P., Carmichael, N., Skotnicki, M.L. & Selkirk, P.M.** 2007: Biology and molecular phylogenetics of *Nematoceras sulcatum*, a second endemic orchid species from subantarctic Macquarie Island. *Polar Biology* **30**: 859–869.

**Copson, G.** 1986: The diet of the introduced rodents *Mus musculus* L. and *Rattus rattus* L. on subantarctic Macquarie Island. *Australian Wildlife Research* **13**: 441–445.

**Copson, G. & Whinam, J.** 2001: Review of ecological restoration program at subantarctic Macquarie Island: Pest Management progress and future directions', *Ecological Management and Restoration* **2** (2): 129–138.

**Cumpston, J.S.** 1968: *Macquarie Island*, Australian Antarctic Division, Department of External Affairs, Canberra: 380 pp.

**Department of the Environment and Water Resources** (accessed 20 March 2007). Macquarie Island Marine Park. <http://www.environment.gov.au/coasts/mpa/macquarie/index.html>

**De Villiers, M.S., Cooper, J., Carmichael, N., Glass, J.P., Liddle, G.M., McIvor, E., Micol, Th. & Roberts, A.** 2006: Conservation management at Southern Ocean islands: towards the development of best-practice guidelines. *Polarforschung* **75**: 113–131.

**Jones, E. and Skira, I.J.** 1977: Breeding distribution of the Great Skua at Macquarie Island in relation to numbers of rabbits. *Emu* **79**: 19–23.

**Lewis, P.N., Bergstrom, D.M. & Whinam, J.** 2006: Barging in: a temperate marine community travels to the subantarctic. *Biological Invasions* **(2006)**: 1–9.

**Nash, M.** 2003: *Conserving Macquarie Island's Historic Heritage: Conservation Planning Guidance*. Tasmanian Heritage Office, Department of Tourism, Parks, Heritage and the Arts, Hobart: 61 pp.

**Parks and Wildlife Service** 1999: *Macquarie Island – A New Arrival. The Geological Development of a Young Island*. Department of Primary Industries, Water and Environment, Hobart: 17 pp.

**Parks and Wildlife Service** 2006: *Macquarie Island Nature Reserve and World Heritage Area Management Plan*. Parks and

Wildlife Service, Department of Tourism, Arts and the Environment, Hobart: 177 pp.

**Parks & Wildlife Service** 2007: *Plan for the Eradication of Rabbits and Rodents on Subantarctic Macquarie Island*. Parks and Wildlife Service, Department of Tourism, Arts and the Environment, Hobart: 30 pp.

**Scott, J.J.** 1994: *Marine Conservation at Macquarie Island*, Parks and Wildlife Service and Department of Environment, Sport and Territories, Hobart: 141 pp.

**Selkirk, P.M., Seppelt, R.D. & Selkirk, D.R.** 1990: *Subantarctic Macquarie Island: Environment and Biology*. Cambridge University Press, Cambridge: 285 pp.

**Shaw, J.D., Hovendon, M.J. & Bergstrom, D.M.** 2005: The impact of introduced ship rats (*Rattus rattus*) on seedling recruitment and distribution of a subantarctic megaherb (*Pleurophyllum hookeri*). *Austral Ecology* (2005) **30**: 118–125.

**Skira, I.J.** 1984: Breeding Distribution of the Brown Skua on Macquarie Island. *Emu* **84**: 248–249.

**Threatened Species Unit** 2004: *Draft Fauna Recovery Plan: Threatened Macquarie Island Burrowing Petrels 2004–2008*. Unpublished Report. Department of Primary Industries, Water and Environment, Hobart: 55 pp.

**Whinam, J., Chilcott, N. & Bergstrom, D.M.** 2005: Subantarctic hitchhikers: expeditioners as vectors for the introduction of alien organisms. *Biological Conservation* **121** (2005): 207–219.

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